Chapter 7
User Interface and Decision Visualization Applications

- **Key to successful use of MSS is the *user interface***
- **The simpler the better**
- **Many MSS applications have *hard to use* user interfaces**

7.1 Opening Vignette: Geographic Information System at the Dallas Area Rapid Transit (DART)

- Buses
- Vans
- Light Rail System

By the Mid-1980s Could Not

- Respond to customer requests
- Make changes rapidly
- Plan properly
- Manage security

- **DART had**
  - 5,000 daily customer inquiries
  - Over 200 bus routes
  - Over 13,500 bus stops

Geographic Information System (GIS) Solution

- View and analyze data on digitized maps
- Now, DART Employees can
  - Rapidly respond to customer inquiries (response time cut by 1/3)
  - Provide more accurate information
  - Plan services
  - Perform environmental impact studies
  - Cut bus schedule production costs
  - Track bus locations via GPS
  - Improve bus security
  - Monitor subcontractors
  - Analyze productivity and utilization

- **Analysis time cut from days to less than an hour**
- **Preparation of special maps: time cut from up to a week to five minutes (cost cut from $15,000 to pennies)**

7.2 User Interfaces: An Overview

- Most computer users have limited computer experience
- Inexperienced users do not want to learn the computer-oriented details
- Most systems were developed for experienced users
- Need better user interfaces

- The design of an appropriate MSS user interface could be the most important determinant of success of the MSS implementation

To many users, the user interface is the

User Interface Design is Influenced by User Characteristics

- MSS execution time
- Learning time of the MSS
- Ease of recall
- System's versatility
- Errors made by end users
- Quality of help
- Adaptability to changes in the users' computer competency
- Concentration level required by end users
- Fatigue from using the system
- Command uniformity
- Fun the user derives

User Interface

- Human-computer interaction
- Surface
- Physical aspects (see Figure 7.1)
  - Input Devices
  - Display (Output) Devices

The Cyclical Process (Figure 7.1)

1. Knowledge
2. Dialog
3. Action Language
4. Computer
5. Presentation Language
6. User's Reaction

Important Issues in Building a User Interface

- Choice of input and output devices
- Screen design
- Human-machine interaction sequence
- Use of colors and shading
- Information density
- Use of icons and symbols (especially for object-oriented)
- Information display format

The User Interface Management System (UIMS)

- Accommodates the various information representations
- Accommodates the action languages
- Provides an interface between the system user and the rest of the system

7.3 Interface Modes (Styles)

- **Interface (or interactive) Mode: the combination of presentation and action languages**
- **Determines how information is entered and displayed**
- **Determines the ease and simplicity of learning and using the system**
  - **Menu interaction**
  - **Command language**
  - **Questions and answers**
  - **Form interaction**
  - **Natural language processing**
  - **Graphical user interface (object manipulation)**

Menu Interaction

- Includes Pull-down Menus (in GUI)
- Command Language
- Questions and Answers
- Computer asks, user answers
- Form Interaction

Natural Language

- Mainly with keyboard
- Some with voice input and output
- Major limitation
- Inability of the computer to understand natural language
- AI advances are improving it

Graphical User Interface (GUI)

- Icons (or symbols) are directly manipulated by the user
- Most common PC GUI OS: Windows 95
- Usability of four styles along four dimensions (Table 7.1)
- Hybrid Modes
  - NLP + Hypermedia
  - Command + Menu
  - GUI + Menu

TABLE 7.1 Comparison of Interface Modes.

Dimensions	Menu Interaction	Fill in the Blanks (Forms)	Command Languages	GUI	Questions and Answers
Speed	Slow at times	Moderate	Fast	Could be slow	Slow at times
Accuracy	Error free	Moderate	Many errors	Error free	Moderate
Training time	Short	Moderate	Long	Short	Short
Users' preference	Very high	Low	Prefer, if trained (only)	High	High
Power	Low	Low	Very high	Moderate-high	Moderate
Flexibility	Limited	Very limited	Very high	Moderate-high	High (if open ended)
Control	The system	The system	The user	The system and the user	The system

Source: Based on Majchrzak et al. [1987].

User Interface Importance

- Interface cost can be 60 to 70 % of the total DSS cost
- Ideally, interface adaptable to different users' needs and communicate consistent commands internally

7.4 Graphics

- **Graphics Software**
- **Purpose: to present visual images of information**
- **Integrated software packages: create graphic output directly from databases or spreadsheets**
  - **Stand-alone graphics packages**
  - **Integrated packages - often include**
  - **3-D graphic presentations and virtual reality**

The Role of Computer Graphics

- Help managers "visualize" data, relationships, and summaries (Figure 7.2)
- Graphics forms (Table 7.2)

TABLE 7.2 Types of Computer Graphics

- ***Text*** **plays a critical role in graphics--listing points that the speaker is discussing, showing subject titles, identifying components and values of a chart, and so on.**
- ***Time-series charts*** **show the value of one or more variables over time.**
- ***Bar and pie charts*** **can be used to show total values (by the size of the bar or pie), as well as component values, such as breakdowns of, say, "source of money received."**
- ***Scatter diagrams*** **show the relationship between two variables, such as the number of air travelers who fly on Mondays, Tuesdays, and so on.**
- ***Maps*** **can be two- or three-dimensional. Two-dimensional maps are useful for showing spatial relationships, for example, the locations of customers and the locations of a company's customer service facilities. Three-dimensional maps show surface contours with a three-dimensional effect (see the GIS in the opening vignette).**
- ***Layouts*** **of rooms, buildings, or shopping centers convey much information in relatively simple diagrams.**
- ***Hierarchy charts*****, such as organizational charts, are widely used.**
- ***Sequence charts*****, such as flowcharts, show the necessary sequence of events, and which activities can be done in parallel.**
- ***Motion graphics*****, such as motion pictures and television, clearly will continue to perform vital functions.**
- ***Desktop publishing*** **systems that have extensive graphic capabilities (e.g., transferring a picture into the computer, laying it in a desirable position, and then printing it) are gaining in popularity.**

Source: Based on R. H. Sprague, Jr. and B. McNurlin, *Information Systems Management in Practice*, 1st ed., 3rd ed. Englewood Cliffs, NJ: Prentice-Hall.

7.5 Multimedia and Hypermedia

- **Multimedia**
- **Pool of human-machine communication media (Table 7.4)**
  - **Sound**
  - **Text**
  - **Graphics**
  - **Animation**
  - **Video**
  - **Voice**

TABLE 7.4 Human-Machine Communication Media

Computer	**Projected still visuals**
CRT and terminals	**Slide**
CD-ROM	**Overhead**
Computer interactive videodisk	**Graphic materials**
Digital video interactive	**Pictures**
Compact disc interactive	**Printed job aids**
Computer simulation	**Visual display**
Teletext/videotext	
Intelligent tutoring system	**Audio**
Hypertext	**Tape/cassette/record**
Image digitizing	**Teleconference/ audioconference**
Scanners	**Sound digitizing**
Screen projection	**Microphone**
Object-oriented programming	**Compact disc**
	Music
Motion image	**Text**
Video disc (cassette)	
Motion pictures	
Broadcast television	
Teleconference/ videoconference	
Animation	
Virtual reality	

Source: P. Chao et al., "Using Expert Systems Approaches to Solve Media Selection Problem: Matrix Format," *Proceedings of the Association of Computer Interface Systems*, Los Alamitos, CA: IEEE Computer Society Press, November 1990. © IEEE.

Hypermedia

- **Virtual reality via Virtual Reality Modeling Language (VRML) for Web delivery**
- **Hypermedia: multimedia documents linked by association**

Multiple Layers of Information

- Menu-based natural language interface
- Object-oriented database
- A relational query interface
- A hypermedia abstract machine
- Media editors
- Change management virtual memory

- Especially effective in searching

Hypermedia Characterizations

- Explicitly linked different information structures
- Multimedia
- Linking information by association

Classes of Hypermedia

- Presentation for knowledge and data navigation (Figure 7.3)
- Active participation in research to help record, organize, and integrate information and processes (Figure 7.4)
- Hypertext
  - Nonlinear information access
  - Follow a thread (drill)
  - Internet browsing

Multimedia, Hypermedia, the Internet/Web and the Object-oriented Approach

- GUI Icons
- Visual Programming
- Web Hooks

- Electronic Document Management (EDM)
  - Problems with paper documents
  - EDM systems
  - Multimedia and Web access

7.6 Virtual Reality

- 3-D Presentations
- 3-D user interfaces
  - Manufacturing
  - Marketing
- Virtual reality (VR)
  - Decision making
  - Advertising
  - Data visualization
  - Visual, spatial, and aural immersion
- VRML: Virtual Reality Markup Language for the Web

TABLE 7.5 Examples of Virtual Reality Applications.

Industry	Application
Automotive/Heavy Equipment/Military	• **Design testing** • **Virtual prototyping** • **Engineering analysis** • **Ergonomic analysis** • **Virtual simulation of assembly, production, and maintenance** • **Training**
Medicine	• **Training surgeons (with simulator)** • **Surgery** • **Physical therapy**
Research/Education	• **Virtual physics lab** • **Hurricane studies** • **Galaxy configurations** • **Representation of complex mathematics** • **Virtual Museums**
Amusement	• **3-D Race car games (on PC)** • **Air combat simulation (on PC)** • **Virtual Reality arcades** • **Virtual Reality parks**

***Source*: Compiled from J. Adam, "Virtual Reality is Real," *IEEE Spectrum*, VR Special Report 1993.**

7.7 Geographic Information Systems (GIS)

- Computer-based system for capturing, storing, checking, integrating, manipulating, and displaying data using digitized maps
- GIS Software
- GIS Data In-house or purchased
- GIS and Decision Making

GIS Applications

- Political campaign support
- Consumer marketing and sales support
- Sales and territory analysis
- Site selection
- Fleet management
- Route planning
- Disaster planning
- Regulatory compliance

- GIS and the Internet/Intranet
- GIS Servers
- Client GIS data
- Emerging GIS Applications
- With GPS
- Intelligent GIS
- Virtual reality
- More Web hooks

DSS In Focus 7.6: How Companies are Using GIS

- **Super Valu, the country's No. 1 supermarket wholesaler, uses a GIS to help locate stores. GIS frees up analysts from mundane manual mapping tasks to actually analyze the problem at hand.**

- **Western Auto, a Sears Roebuck subsidiary, integrates company data with GIS to create a detailed demographic profile of a store's neighborhood so it can set up the right product mix for its customer base. This establishes customer loyalty more quickly. The result is that on average, a store breaks even on its operating expenses in six months instead of previous to the GIS, when it took an average of 18 months.**

- **Travelers Insurance uses a desktop GIS to perform statistical analysis for site-planning, demographics of populations served, database visualization for employers and sales support.**

- **Sears, Roebuck & Co. has deployed a GIS to replace a computerized, route-planning system that required truck dispatchers at each distribution center to have extensive knowledge of roads and traffic in their regions.**

- **Health maintenance organizations and medical clinics using mapping to determine optimum clinic locations.**

- **Several healthcare providers are using GIS to better understand the market they serve. Two such ways are to chart regional anomalies in their service area, such as higher than normal cancer rates, and to analyze potential partnerships with other providers to expand the service area of the healthcare system, as well as assess the need and potential market for expensive capital investments, such as magnetic resonance imaging scanners.**

- **Wood Personnel Services Inc., a Nashville-based employment agency, boosted placements by 25 percent in one year by mapping neighborhoods where temporary workers lived, then locating marketing and recruiting sites there.**

- **Wilkening & Co., a Park Ridge, IL, Consulting firm, uses Wessex's First St. GIS to design optimized sales territories and routes for clients, slashing their travel costs by an average of 15 percent.**

- **CellularONE, a San Francisco cellular network provider, uses MapInfo from MapInfo Corp. to map its entire cellular network, helping it to identify clusters of call disconnects and dispatch field-service technicians for troubleshooting.**

- **Acordia Senior Benefits, a subsidiary of Acordia Inc., uses Infomark from Equifax Marketing Decision Systems Inc. and ArcView from Environmental Systems Research Institute Inc. to map out locations for new insurance products and to decide when not to get into an area.**

- **NESA, a Danish utility, has implemented a comprehensive information management system based on ESRI's Arc/Info GIS system, to encourage and enhance data accessibility. GIS provided a greater potential for improving the daily routine and for creating possibilities for new applications, versus CAD or standard database software.**

- **In northern California, Pacific Bell is using GIS to help plot a broadband network of fiber-optic cable.**

(*Source:* Condensed from Bidgoli [1995], Borch [1996], Hamilton [1996], Swenson [1996a], Westmose [1996], and public domain documents.)

7.8 Natural Language Processing (NLP)

- Applied artificial intelligence technology
- Communicating with a computer in English (or other human) language

- Advantages:
- Disadvantages:

- Natural language understanding
- Natural language generation
- Versus speech recognition

7.9 Natural Language Processing: Methods

- **Natural language into the computer**
  - **Example: English into Netscape Navigator Commands**
- **Natural language into another natural language - English to French**

Major NLP Techniques

- Key word search (pattern matching)
- Language processing (syntactic and semantic analysis)
- Neural computing (relatively new)

Key Word Analysis (Pattern Matching)

- **Pattern matching process:**
  - **Search for selected key words or phrases**
- **Provide canned response**
- **Flow diagram (Figure 7.5)**

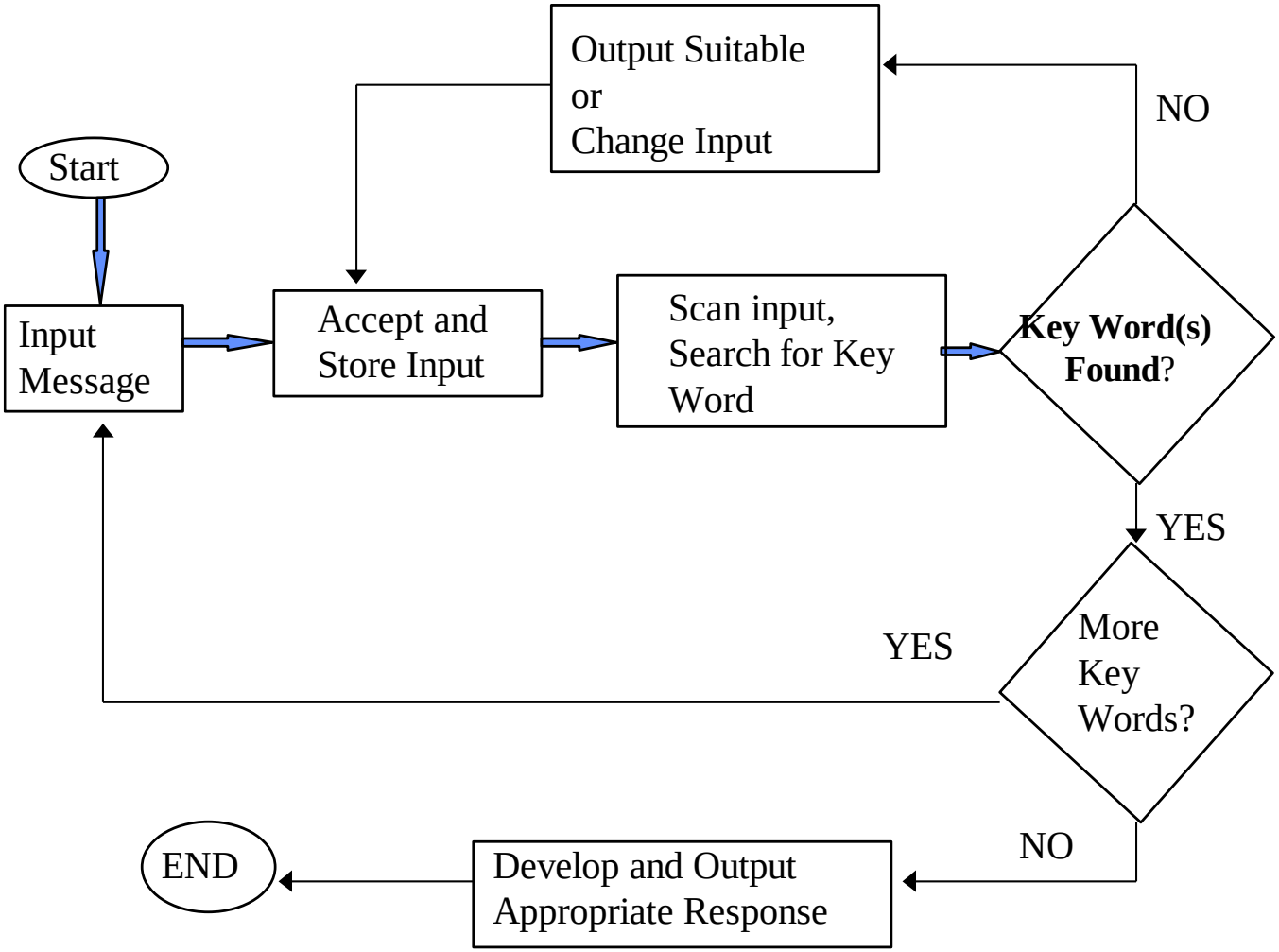

FIGURE 7.5 The Process of Key Word Analysis.

Key Activities

- Parsing to determine word boundaries
- Pattern matching to compare to prestored words and phrases

- OK for few key words

Language Processing (Syntactic, Semantic, and Pragmatic Analysis)

- **Problems**
  - **Many words with multiple meanings**
  - **Many structures including those words in sentences**

Definitions

- Syntax analysis looks at the way a sentence is constructed; the arrangement of its components and their relationships
- Syntactic processes analyze and designate sentences to clarify the grammatical relationships between words in sentences
- Semantics assigns meaning to the syntactic constituents
- Pragmatic analysis relates individual sentences to each another and to the surrounding context

The Procedures

- How Language Processing Works
- Simplified block diagram (Figure 7.6)
  - Parser
    Lexicon
  - Understander
  - Knowledge base
  - Generator

Parser Syntactically Analyzes the Input Sentence

- Each word is identified and its part of speech clarified
- The Parser maps the words into a structure called a parse tree
- The Parse tree shows the meanings of all of the words and how they are assembled
- The Lexicon is a dictionary
- The Parser is a pattern matcher and builds the parse tree
- The Understander works with the knowledge base to determine sentence meaning
- The Knowledge base is a repository of knowledge

- **The understander uses the parse tree to reference the knowledge base**
- **The understander can draw inferences from the input statement**
- **The generator can initiate additional action**

7.10 Applications of Natural Language Processing and Software

- Database interfaces
- Abstracting and summarizing text
- Grammar analysis
- Natural language translation
- Computer language to computer language translation
- Letter composition
- Speech understanding

7.11 Speech (Voice) Recognition and Understanding

- The computer recognizes the normal human voice
- Advantages of Speech Recognition
  - Ease of Access
  - Speed
  - Manual Freedom
  - Remote Access
  - Accuracy
- Good Morning Dave (2001)

Classifying Speech Recognizers

- Word Recognizers
- Continuous Speech Recognizers
- Speaker Dependent
- Speaker Independent

- Voice Synthesis
- Computers speak

TABLE 7.6 Voice Technology Applications Sampler

Company	Applications
Scandinavian Airlines, other airlines	Answering inquiries about reservations, schedules, lost baggage, etc.
Citibank, many other banks	Informing credit card holders about balances and credits, providing bank account balances and other information to customers
Delta Dental Plan (CA)	Verifying coverage information
Federal Express	Requesting pickups
Illinois Bell, other telephone companies	Giving information about services, receiving orders
Domino's Pizza	Enabling stores to order supplies, providing price information
General Electric, Rockwell International, Austin Rover, Westpoint Pepperell, Kodak	Allowing inspectors to report results of quality assurance tests
Cara Donna Provisions	Allowing receivers of shipments to report weights and inventory levels of various meats and cheeses
Weidner Insurance, AT&T	Conducting market research and telemarketing
U.S. Department of Energy, Idaho National Engineering Laboratory, Honeywell	Notifying people of emergencies detected by sensors
New Jersey Department of Education	Notifying parents when students are absent and about cancellation of classes
Kaiser-Permanente Health Foundation (HMO)	Calling patients to remind them of appointments, summarizing and reporting results
Auto manufacturers	Activating radios, heaters, and so on, by voice
Texoma Medical Center	Logging in and out by voice to payroll department
St. Elizabeth's Hospital	Prompting doctors in the emergency room to conduct all necessary tests, reporting of results by doctors
Hospital Corporation of America	Sending and receiving patient data by voice, searching for doctors, preparing schedules and medical records
Robbins Lumber	Enter data on arriving logs

7.12 Research on User Interfaces in MSS

- **4 Independent Variables**
  - **1. Human user**
    - **Demographics (age, education, experience)**
    - **Psychological (cognitive style, intelligence, risk attitude).**
  - **2. Decision environment**
    - **Decision structure**
    - **Organizational level**
    - **Others (stability, time pressure, uncertainty).**

3. Task

- Decision support (e.g., complexity level)
- Inquiry/information retrieval
- Data entry
- Word processing
- Computer-aided instruction.

4. Interface characteristics

- Input/output media
- Dialogue type
- Presentation format (tabular, graphical, colors, animation)
- Language characteristics (help facility, default options, other options).

Dependent Variable: Human/Computer Effectiveness

- Usefulness
- Perceived ease of use
- Performance (time, errors, profit)
- User attributes (satisfaction, confidence)
- Use of system option (high, low).

– Hwang and Wu [1990]

Results of Some Experiments

1. Colors improve performance
2. Graphic versus tabular: inconclusive

- Research on Graphics and Modeling
- Metagraphs to represent system structure graphically for analysis

- New Interfaces
  - Fish-eye View for GUI - Xerox Parc Research Center

TABLE 7.3 Comparison Between the Current User Interface Generation of Command-based Interfaces and the Potential Next Generation of Interfaces Across 12 Dimensions.

	Current Interface Generation	Next-Generation Interfaces
User focus	Controlling computer	Controlling task domain
Computer's role	Obeying orders literally	Interpreting user actions and doing what it deems appropriate
Interface control	By user (i.e., interface is not explicitly made visible)	By computer (since user does worry about the interface as such)
Syntax	Object-Action composites	None (no composites since single user constitutes an interaction unit)
Object visibility	Essential for the use of direct manipulation	Some objects may be implicit and hidden
Interaction stream	Single device at a time	Parallel streams from multiple devices
Bandwidth	Low (keyboard) to fairly low (mouse)	High to very high (virtual realities)
Tracking feedback	Possible on lexical level	Needs deep knowledge of object semantics
Turn-taking	Yes; user and computer wait for each other	No; user and computer both keep going

Interface locus	Workstation screen, mouse, and keyboard	Embedded in user's environment, including entire room and building
User programming	Imperative and poorly structured macro languages	Programming-by-demonstration and nonimperative, graphical languages
Software packaging	Monolithic applications	Plug-and-play modules

Source: J. Nielson, "Noncommand User Interfaces, *Communications of the ACM*, April 1993, p. 86.

Summary

- Users want computer systems that are easy to use
- The user interface represents the system to most users
- The user interface must be relatively friendly
- Graphics are crucial
- GIS
- Virtual reality
- Natural language processing and speech recognition
- Research on user interfaces continues

Internet Exercise

10. Contact IBM (http://www.ibm.com) to find information about their Voice Type Dictation, Merlin and other voice technology products.

Group Exercise

Each group member will interview five computer users at school, work or home. For each user, identify the three interface modes preferred by the user, ranked in descending order. Also, the interviewer should discern the reasons why people prefer a particular interface mode. Then, the group will consolidate their findings and prepare a report to guide a novice computer user to the interface(s) with which he should become familiar.

Questions for the Opening Vignette

1. Why is a GIS considered a graphical user interface?
2. What are the advantages of GIS from a user interface point of view?
3. Which of the capabilities listed in the vignette support actual decision making?

Exercises

1. What is a natural language? Name two. What distinguishes a natural language from a computer language? Is Esperanto a natural language? Why or why not?
2. Obtain an NLP/DBMS software (e.g., Q&A). Try to use it on the database of Chapter 4, Exercise 5. Compare the use of a regular DBMS to the one supported by NLP.
3. Explain why icons in the Windows environment might be easier to use than typed commands. Demonstrate the two to verify your opinion.

4. **Why is it “easier” for a natural language to be translated into another by a human versus by a computer?**
5. **In the early days of language translation, the expression “The spirit is willing, but the flesh is weak” was translated to Russian and then back to English. The new English rendering was “The vodka is good, but the meat is rotten.” What happened? Why?**

Questions for Case Application 7.1

1. Identify the voice recognition and voice synthesis portions of the system.
2. Identify all the tasks, which do not involve voice, carried out by a computer.
3. What paperwork can be eliminated by such a system?
4. What are the benefits to Nabisco?
5. What are the benefits to the employees?
6. What alternative communication technologies described in this chapter can be used instead of the system described here? Would you recommend any of these; why or why not?
7. Are there any disadvantages to the use of the technology? Explain.