CHAPTER 3

Enabling Technologies for Modern Manufacturing Environments

REVIEW QUESTIONS:

3.1 An entity relationship diagram (ERD) is a modeling tool used to create an enterprisewide model of an organization. Enterprisewide models show all major entities of a company and the relationships between these entities. An entity in an ERD is a person, place, object, event, activity, process, or concept about which data are recorded. The purpose of an ERD is to show which entities interact with each other. In other words, an ERD shows how entities fit together to form the enterprise. It is a road map of the information flows.

ERDs are used by management accountants and systems consultants working for the "Big Six" accounting firms. Six major organizational entities were illustrated within the text:

- Financial accounting
- Management accounting
- Master scheduling
- Material requirements planning
- Capacity planning requirements
- Bill of materials

To develop an enterprisewide model and ERD, management accountants must work together with the other organizational members involved in these entities. Once the information system team completes the ERD, it becomes a "blueprint" guiding ICBIS design.

3.2

• *Cost accounting entity*	Provides costs of manufactured products for cost management and the financial accounting entity.
• *Inventory entity*	Maintains beginning and ending financial and nonfinancial data about RMI, WIP, and FGI.
• *Plant and equipment entity*	Provides a record of available production resources, and provides depreciation data for product costing.
• *Performance measurement entity*	Contains performance evaluation measures used to assess the functional entities involved in cost management.
• *Analysis and reporting entity*	Provides reports to managers for their use in planning, operational control, and special decisions.

3.3 A listing of all the subassemblies, parts, and raw materials that are needed to manufacture a product.

3.4

• *Processors*	The mainframe, minicomputers, and microcomputers.
• *Peripherals*	Video disks, magnetic disks, touch screens, mice, graphical user interfaces, and hand-held wands.

3.5
- *Financial accounting LAN* — Enables financial accounting personnel to perform financial accounting tasks. This LAN is connected to the financial accounting database for uploading and downloading data under strict input, processing, output, and database controls.
- *Management accounting LAN* — Performs cost accounting, raw materials, work-in-process, and finished goods inventory costing and control. It provides plant and equipment control, and depreciation accounting. This LAN also outputs performance measurement reports and other analyses and reports for cost management, planning, and decision making.
- *Engineering LAN* — Performs many of the manufacturing functions such as master scheduling, material requirements planning, capacity requirements planning, and the bill of materials.
- *Factory Floor LAN* — Controls manufacturing operations and collects manufacturing data with bar code scanners.

Why LANs are interconnected:
These four LANs must be interconnected through an ICBIS so that data can be shared between them. Each LAN collects, processes, stores, and reports information needed by organizational members within the other LANs. For example:
- The *financial accounting LAN* contains data on inventory, fixed assets, and sales orders needed by the factory floor LAN.
- The *management accounting LAN* shares information on depreciation, inventory, and fixed assets with the financial accounting LAN. It also interacts with the engineering LAN to obtain bill of materials and MRP II information for cost management reporting. The factory floor LAN provides the management accounting LAN with data on manufacturing operations, such as usage of direct materials and direct labor.
- The *engineering LAN* depends on both the management accounting LAN and the factory floor LAN to transmit data needed by it.
- The *factory floor LAN* transmits data to both the management accounting LAN and the engineering LAN.

3.6
- Hand-held light wands
- Stationary fixed-beam scanners
- Stationary moving-beam scanners
- Hand-held lasers
- Imaging array readers

3.7 Bar coding effectively eliminates the need for source documents. Bar-coded labels are directly imprinted on, or physically attached to, direct materials, WIP components, and finished goods. When these labels are scanned by a reading device, the underlying data are immediately transmitted to the computer. The data are processed to meet the needs of various entities throughout the ICBIS.

If a fully integrated bar code network is in place, accounting reports, that once lagged production by days and weeks, are generated in a matter of minutes. This real time feedback allows management to monitor and control critical areas, identify problems and inefficiencies, and take corrective action before big problems occur.

In highly automated factories, robots can electronically scan bar-coded components on a moving conveyor line. These robots are then instructed by the computer to complete an assembly or perform a certain process.

Bar code scanning can also facilitate direct labor operational control through providing instructions to workers, signalling the start and completion of specific labor operations, tracking direct labor usage, and indicating when problems are occurring to the visual factory control center.

3.8 MRP is a materials scheduling program geared toward maintaining adequate inventory levels, and having items available at the time they are needed for production. MRP can be a stand-alone program or a module within an MRP II program.

MRP II expands MRP into a broader approach for planning and scheduling all the resources of the enterprise, including engineering, finance, manufacturing, logistics, and marketing. Its major purpose is integration of these functional areas.

An MRP II system can involve only the core modules listed in Problem 3.9 or it can be expanded to include all the modules shown in Exhibit 3-5. MRP II systems can be custom tailored to fit the needs of each enterprise.

3.9

Let's Talk

Students have produced ***two answers*** to this question:

First, only the core modules have been listed. Their reasoning is that the other modules shown in Exhibit 3-5 exist in different entities and LANs. These are accessed as needed through an ICBIS.

Second, all the modules in Exhibit 3-5 have been listed.

You can integrate these answers by suggesting that they represent the ends of a of range of MRP II modules available. MRP II modules are used to achieve the goals of system integration and enterprisewide modeling. An enterprise may just purchase a core package of modules (answer 1) to integrate within its already existing ICBIS. Another company may purchase all the modules available (answer 2) in creating a new ICBIS. The number of modules needed depends on the particular needs of the firm.

Exhibit 3-5 is included in the acetates package available from West Publishing.

Illustrating with example software packages:
You may wish to obtain sales brochures to pass around class.

Micro-MAX MRP™ illustrates the separate modules that can be purchased to fit the needs of the particular firm. It contains 13 different modules. Interestingly, it is a microcomputer program.

MAPICS™ is a fully integrated mainframe program to illustrate the other extreme.

(Micro-MAX MRP is a trademark of Micro-MRP, Inc., Foster City, California. MAPICS is a trademark of MAPICS, Inc., Atlanta, Georgia.)

Let's Talk

An interesting sidelight:

MRP II systems are now being applied to service industries. In these applications, the bill of materials is replaced with a "bill of skills" needed. These can take the form of specific organizational roles, skills, or people!

Answer 1:
The core modules of MRP II include:
- Order entry
- Master Schedule
- Bill of materials
- Material requirements planning
- Capacity requirements planning

Answer 2:
MRP II can include all of the following modules:
- Electronic data interchange (EDI) with customers
- Order entry
- Accounts receivable
- Master Schedule
- Bill of materials
- Product costing
- Material requirements planning
- Inventory control
- Capacity requirements planning
- Shop floor control
- Routings and work centers
- Purchasing and accounts payable
- EDI with vendors

3.10 Problems solved by MRP II:

- *Material shortages* — Using EDI and MRP, vendors can be more effectively and efficiently scheduled.
- *Poor quality* — MRP II can provide information for rating vendors, such as a quality performance rating and vendor performance inquiry displays (Exhibit 3-6).
- *Poor customer service* — Using EDI, customers can place orders and receive delivery time online and in real time. MRP II can provide sales personnel with information such as ATP quantities.
- *Poor productivity* — EDI with both customers and vendors can reduce many manual order processing costs (see also Problems 3.14 and 3.21). MRP II and bar code scanning can reduce many manual processing costs associated with tracking production.

3.11 *Define EDI:*

Electronic data interchange is a computer-to-computer communications network that enables a number of business transactions, such as ordering, shipping, billing, and payments, to be conducted between companies electronically.

Forming a metacorporation with EDI:

A metacorporation (hypercorporation or virtual company) is a network of business enterprises composed of a manufacturing (or merchandising or service) firm, its vendors, customers, banks, and carriers, that are integrated via telecommunication and computer technologies to carry on business electronically in a synchronized, cooperative fashion.

EDI permits different companies to communicate with one another online and in real time with little human intervention. Companies can buy, sell, deliver, charge, and pay without preparing various documents and mailing them. In this way, trading partners can be linked together to form a metacorporation.

3.12 The entities comprising an EDI system are:

- The clearinghouse
- Carriers
- Vendors
- The buying and selling company
- Customers

3.13 Major EDI transactions include:

- Sales price information from vendor to customer.
- Request for price quotes from customer to vendor.
- Quotation from vendor to customer.
- Purchase order from customer to vendor.
- Purchase order acknowledgement from vendor to customer.
- Shipping notice from vendor to customer
- Invoice from vendor to customer.
- Remittance advice (payment) from customer to vendor.

3.14 The benefits of EDI consist of:

- Reduction in paperwork and chance of human errors in preparing it.
- Cost savings from:
  - Reduction in paper forms, mailing them, and filing them (storage).
  - Labor savings associated with preparing, processing, and storing paper forms.
  - Labor savings from verification process and error corrections.
  - Reduction in some bank charges.
- Better integration between vendors, the company, and its customers.
- Improved inventory control through synchronized production scheduling and materials ordering.
- EDI automation also reduces product lead time.

CHAPTER-SPECIFIC PROBLEMS:

3.15 An ERD for the customer ordering process:

Let's Talk

Students will create different solutions to this problem.

You may wish to "comfort" those students who are upset because their solutions do not match this one. Different systems designers no doubt will design different systems for the same application.

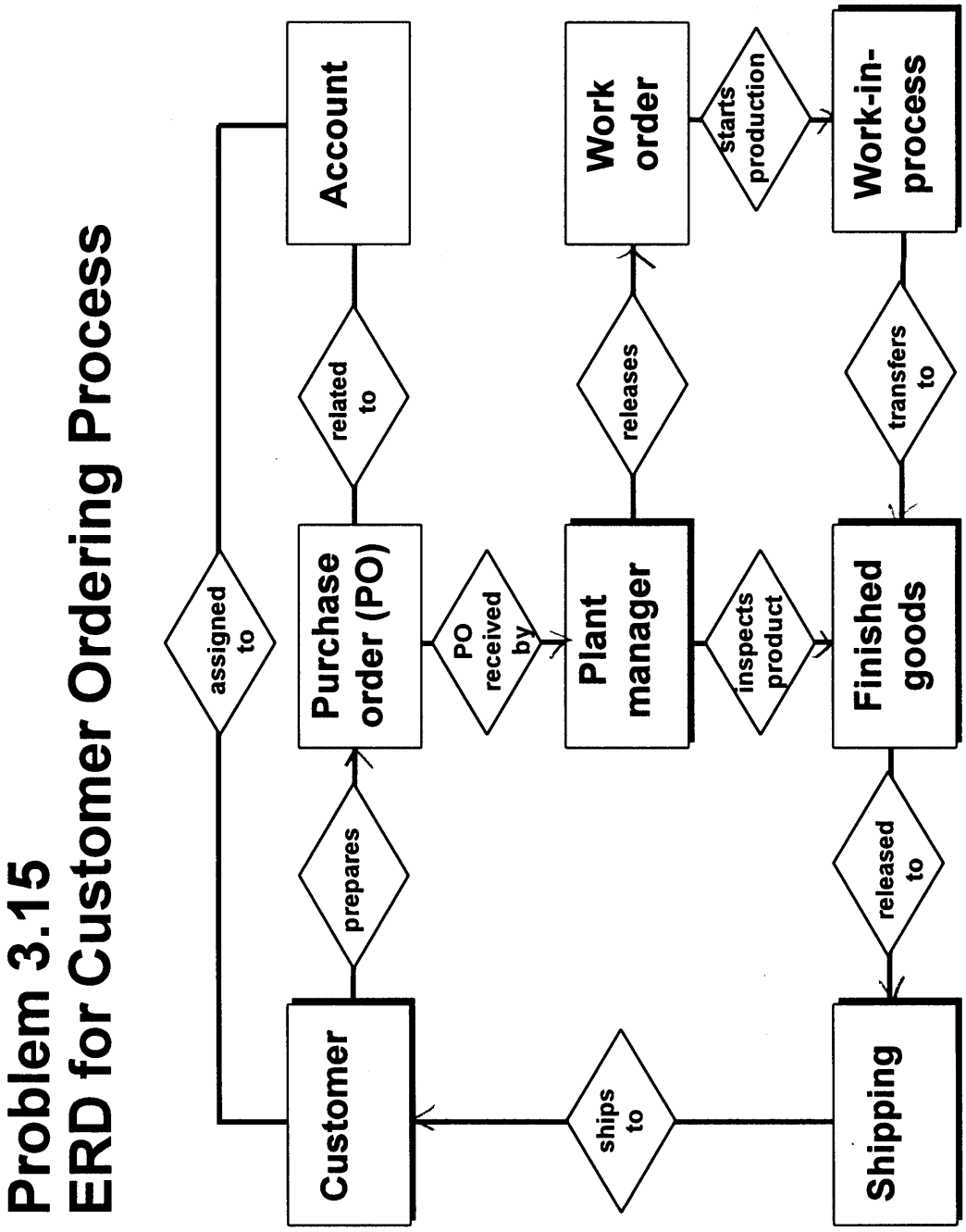
Different solutions are not necessarily right or wrong. The real point of this problem is to allow students the chance to think about and model the relationships between entities. A little practice with ERDs is beneficial for student understanding, topical closure, and long-term retention.

Students may also be comforted to learn that a large number of computer-aided software engineering (CASE) packages are available to prepare ERDs, as well as other modeling tools, electronically. Examples of CASE packages are:

- Andersen Consulting's *Foundation* suite of CASE tools
- Ernst & Young's *Navigator Systems*
- Price Waterhouse's *Arrae*

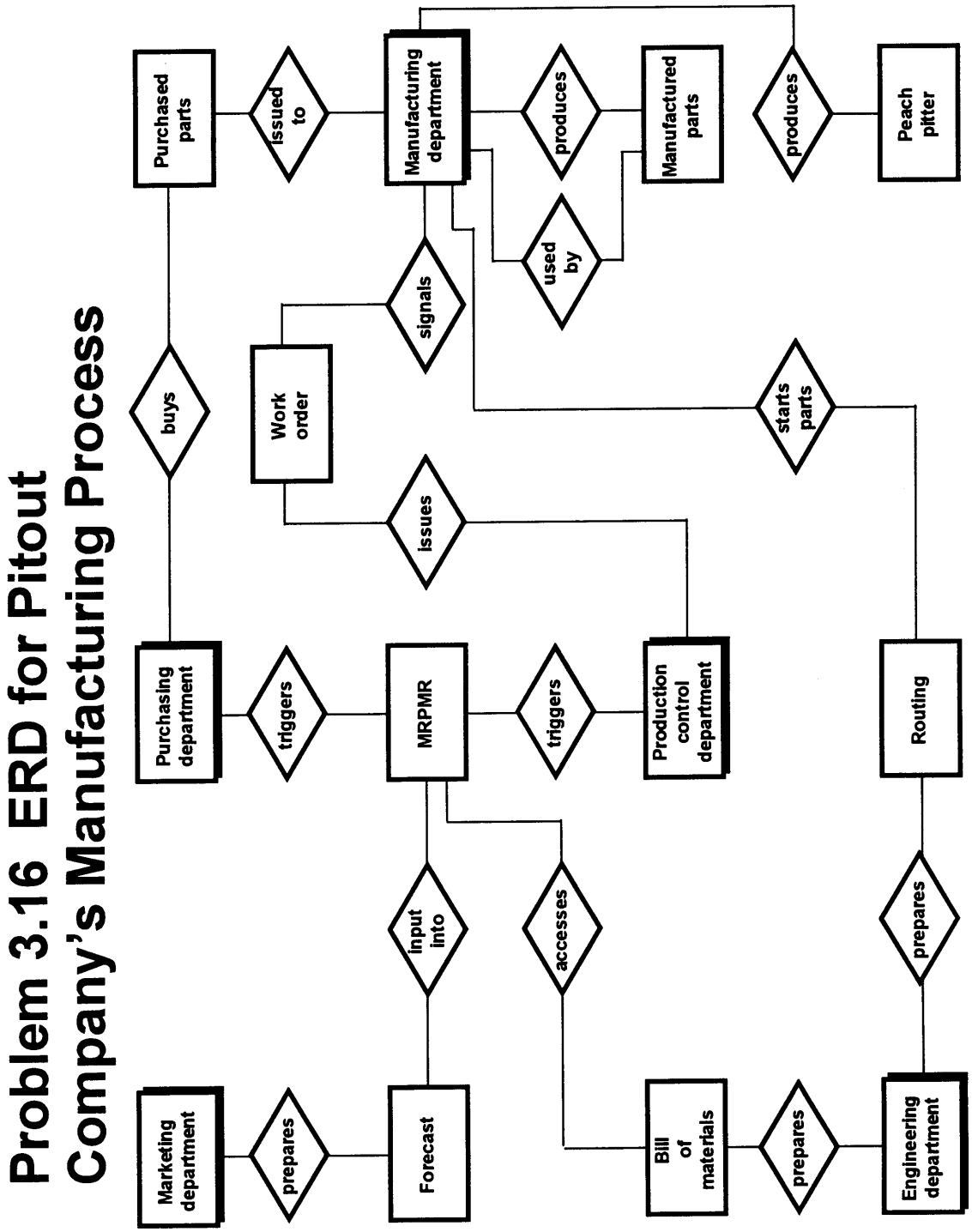
If the acetate transparency for this problem is too hard for students to read, you may wish to copy it and hand it out to them in class. You can then use the transparency and students can refer to their handouts.

3.15 An ERD for the customer ordering process:



See "Let's Talk" box at the beginning of Problem 3.15.

3.16 An ERD for Pitout Company's manufacturing process:



3.17

$$\text{Quality performance rating} = \frac{\text{Number of parts passing inspection}}{\text{Number of parts inspected}}$$

$$= \frac{11{,}400 \text{ parts}}{12{,}000 \text{ parts}}$$

$$= 0.95$$

$$= \underline{\underline{95\%}}$$

3.18

$$\text{Quality performance rating} = \frac{\text{Number of parts passing inspection}}{\text{Number of parts inspected}}$$

	Current Year	19X5	19X4
Parts passing inspection	900	1,128	1,056
Parts inspected	1,000	1,200	1,100
Quality performance rating	90%	94%	96%
Number of parts received (= inspected - rejected)	900	1,128	1,056

$$\text{Percent <over> or under standard} = \frac{\text{Dollars at standard - Dollars purchased}}{\text{Dollars at standard}}$$

	<$10,000> / $50,000	<$10,800> / $60,000	<$10,340> / $55,000
	<20%>	<18%>	<18.8%>

Is vendor performance improving?

Three measures are available within this problem:

- Quality performance rating: Decreasing trend for the last 3 years.
- Number of late shipments: Increasing trend for the last 3 years.
- Purchasing price variance: Decreased from first to second year, but then increased from second to third year. Third year is greater than first year.

Based on these 3 trends, vendor performance is decreasing.

Actions to take:

- Quality must be increased. A positive method is to offer an incentive for maintaining a minimum quality performance rating. For example, a 98% rating can be set, with a bonus structure for surpassing it. Additionally, a long-term contract can be guaranteed as long as the minimum rating is maintained. A negative method involves charging penalties for falling below the minimum rating.
- The same type of positive or negative incentive can be created for on-time delivery based on a minimum allowable number (an ideal minimum is zero!).
- The long-term contract can eliminate the purchasing price variance.

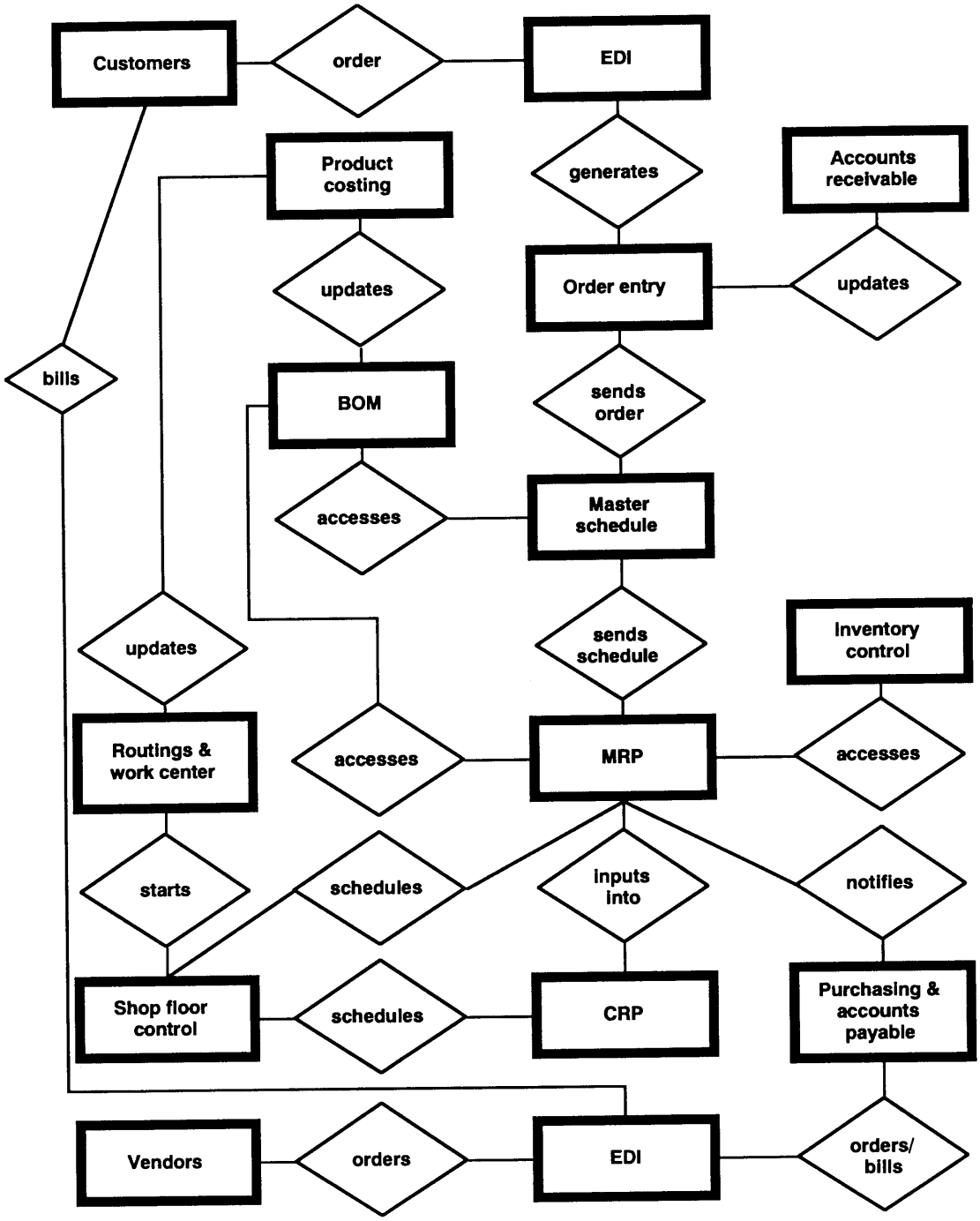
3.19 The available-to-promise (ATP) quantity is calculated by the following formula:

ATP = (On-hand balance + Master schedule) - Booked orders

= (40 + 100) - 20

= 120 10" valves

3.20 See "Let's Talk" box at the beginning of Problem 3.15.
ERD for MRP II system:



3.21 *Manual entry costs per day:*

- Filling in forms:
  2,000 forms x 100 characters per form
  x 2 seconds per character x $0.005 per second $2,000

- Keying costs:
  840,000 characters x 0.5 seconds per character x $0.003 per second 1,260
Total daily manual entry costs $3,260

Error correction costs per day:
- Errors:
  2,000 forms x 100 characters per form x 10% error rate 20,000

- Error corrections:
  20,000 errors x 5 minutes per error
  x ($0.008 per second x 60 seconds per minute) $48,000

- Rekeying costs:
  20,000 errors x 0.5 seconds per error x $0.003 per second 30
Total daily error correction costs $48,030

Total daily manual data entry and error correction costs **$51,290**

Annual cost savings from bar code scanning:
- Manual data entry costs:
  $51,290 per day x 300 days $15,387,000.00

- Bar code scanning costs:
  1,040,000 characters per day x 0.002 seconds per character
  x $0.0002 per second x 300 days per year <124.80>
Total annual cost savings from bar code scanning **$15,386,875.20**

Annual cost of errors:
$48,030 per day x 300 days per year $14,409,000

See "Let's Talk" box on the next page.

Let's Talk

The problem does not provide the direct technology costs associated with the bar code scanning equipment. These costs include:

- Depreciation of the capitalized equipment cost.
- Costs of repairs and maintenance.
- Costs of taxes and insurance on the equipment.
- Cost of electricity to run the equipment.

Using bar code scanning equipment will increase profits as long as these costs are less than the annual operating costs savings of $15,386,875.20 shown in the solution.

You may also wish to ask students if there are any other costs that should be included in the analysis. Some we have thought of include:

- Costs of terminating or retraining the current data entry personnel.
- Costs of training shop floor workers to use the bar code scanning equipment.
- Differential costs associated with computer processing for manually prepared forms versus bar code scanning.
- Other costs of collecting and delivering data to the people preparing and inputting the forms.

THINK-TANK PROBLEMS:

3.22
- Mainframe
- Minicomputer
- Graphical user interface
- Mouse
- Hand-held wands and lasers
- Optical disk
- Magnetic disk

3.23

Let's Talk

As is true for ERDs, students will create many different technology platforms. We try to keep two ideas in mind when presenting this material:

First, Chapters 2 and 3 only provide a cursory coverage of these complex topics. Therefore, we employ the KISS principle ("Keep it simple, stupid!").

Second, solutions are not right or wrong. The important point is that students think about and attempt to simply model the process. Did they include all the entities within their ERDs? Did they include all the computer processors and peripherals within their technology platforms?

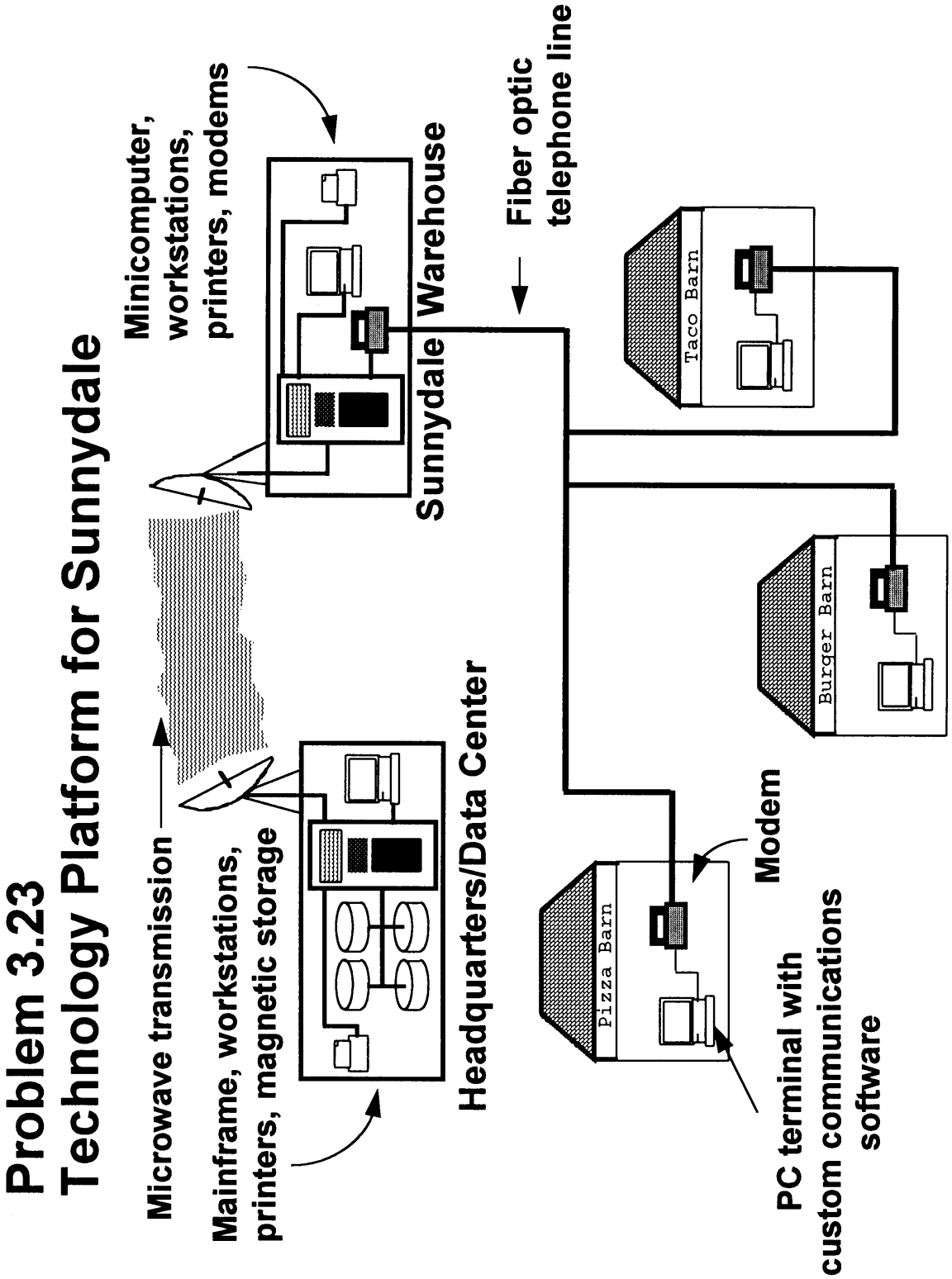
Let's Talk

If you believe computer skills are important, these problems present a unique opportunity to encourage and excite your students. Graphics are fun for those students who like to be creative. Some will use graphics programs to prepare their answers. If one of their solutions is well done, you may wish to prepare an acetate of it and use it in class. Not only will this make the student (or students if you use more than one) feel good, it may encourage others to explore "the wonderful world of microcomputing."

Additionally, some students believe CIS and MIS courses are not related to accounting courses. Too often we hear complaints such as, "This is supposed to be an accounting course, not a CIS course." These types of complaints are usually associated with spreadsheet programs. Because the rest of the text incorporates spreadsheet programs, you may find an advantage to linking computer usage (the modern management accountant's communication medium) to the tasks we perform. Graphics are an unobtrusive way to do this.

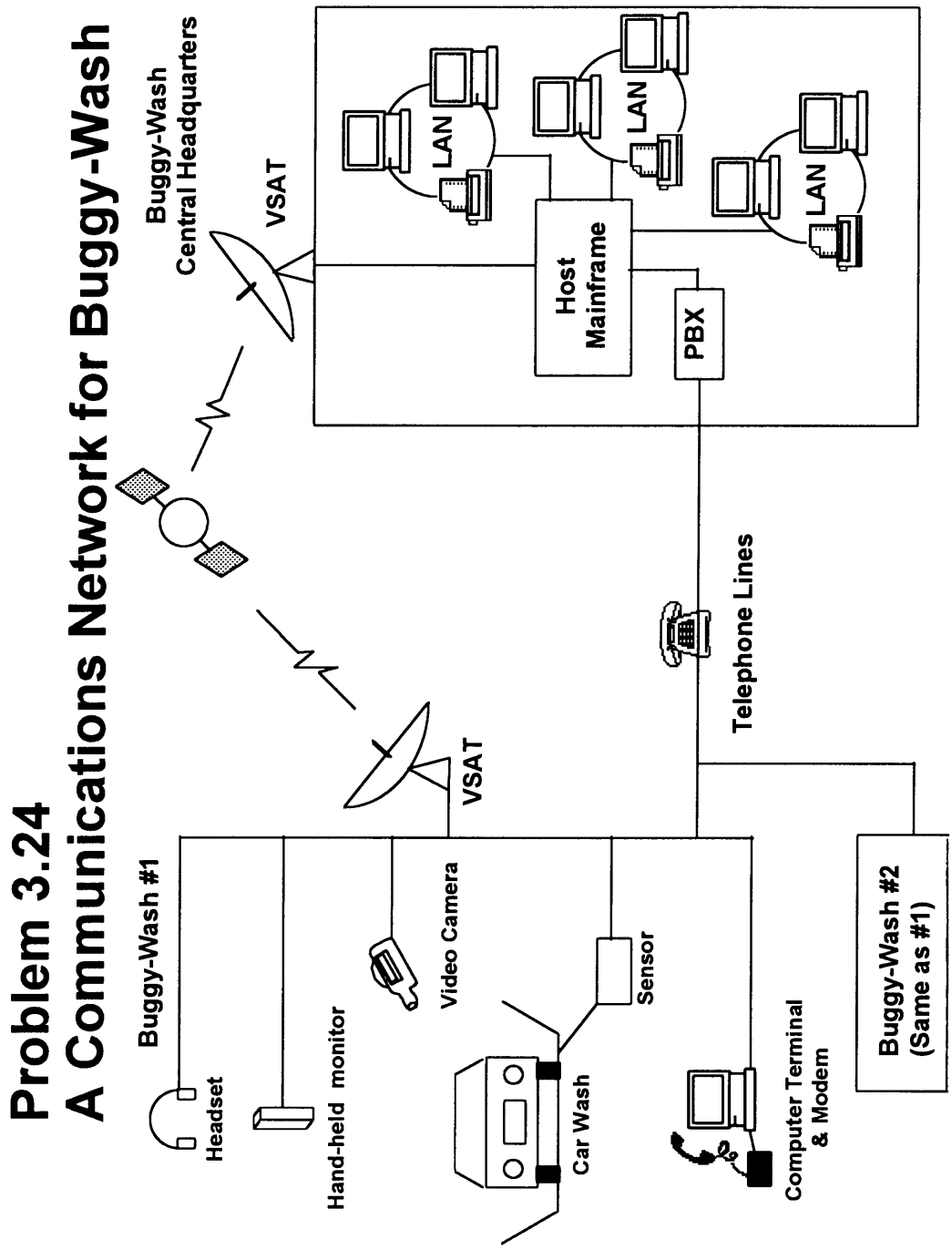
You may also want to associate graphics to spreadsheet programs by referring back to Chapter 1. Radar charts and spreadsheet graphics are illustrated in Exhibits 1-1, 1-4, 1-5, 1-9, and 1-10. Students may start to develop an appreciation for the power (and fun) of spreadsheets, as well as the need for spreadsheets in producing high quality management accounting information.

3.23 A technology platform for Sunnydale:



See "Let's Talk" boxes at the beginning of Problem 3.23.

3.24 A communications network for Buggy-Wash:



3.25 a. Competitiveness:

- Competitiveness requires flexibility. Flexibility requires quick response time. Quick response time requires communication across functional boundaries.
- The highly structured organization limits communication to rigid and formal one-to-one channels up and down the hierarchy. Thus, the highly structured organization limits customer and vendor access to it.
- The flexible organization allows many-to-many communications improving responsiveness to external stakeholders. It eliminates the barriers to efficient and effective communication.

b. Team concept:

- A flexible organization eliminates barriers between functional areas. Therefore, communication, coordination, information sharing, and group problem solving are promoted through reduced layers of management.
- Rather than promoting teams, the structured organization requires one-to-one communication up and down strict lines of the management hierarchy. Organizational members become fixated on their own jobs and not concerned with the needs of others within the enterprise. This is a problem resulting from the task fractionalization principle of scientific management.
- In flexible organizations, anyone can communicate with anyone else. Both between organizational members, and with vendors and customers, this "freedom to communicate" helps to build the feeling of team membership.
- The team concept requires top management commitment. The flexible organization opens the lines of communication with top management. Managers move about the enterprise and interact directly with suppliers and customers. Thus, workers and external stakeholders can experience this commitment firsthand.

c. EDI, groupware, and enterprisewide models are tools used in flexible organization design.

- EDI:
  EDI promotes quicker and more direct communication between external stakeholders and the appropriate people in the firm. It allows information sharing for speedier response times leading to better customer service. Thus, quicker solutions to customers' problems should result.

- Groupware:
  Groupware applications support the team concept that is essential for flexible organizations. These applications include:
  - Electronic calendars
  - Videoconferencing and screen sharing
  - Electronic bulletin boards and FAXs
  - Electronic and voice mail
  - Online, integrated databases

- Enterprisewide modeling:
  The enterprisewide model shows the relationships between organizational entities. This allows everyone to "see the big picture." Most importantly, the open lines of communication in flexible organizations require that people know who to contact. The enterprisewide model provides this information.

d. An ICBIS supports the flexible organization through its reliance on EDI, groupware, and enterprisewide modeling (see answer c above). It also supports the following organizational processes:

- Communication:
  Without an ICBIS linking LANs, WANs, and external stakeholders via EDI, internal and external communication channels become very restrictive, inefficient, and ineffective.

- Decision making:
  The integration and consolidation of previously separate decision systems enhances decision-making effectiveness and efficiency.

- Authority and control:
  The ICBIS supports increased centralization of control. This provides more consistency in control decisions. At the same time, the authority to make decisions is given to those closest to the problem. An ICBIS provides access to the information needed for effective and efficient decision making.

- Job content:
  An ICBIS helps overcome the following problems witnessed in highly structured organizations:
  - A tendency to routinize and narrow job content.
  - A decline in organizational communication as people tend to become concerned only with their tasks.
  - A decline in problem solving skills in the people who have first contact with external stakeholders.

e. • Interoperability:
  Interoperable computer system designs distribute information system services to all users throughout the enterprise in an optimal sharing and cooperative manner. This allows the right information to be at the right location at the right time, promoting the flexible organization.

- Cooperative and enterprisewide processing:
  This is the opposite of fragmented and departmentalized information. Cooperative and enterprisewide processing facilitates the abilities of all stakeholders to access and share needed information.

- Client/server:
  This concept allows users to access the ICBIS at any location, supporting information sharing and group problem solving.

- End-user computing:
  Users develop applications in their LANs. With access to centralized enterprisewide data, localized decision making is facilitated. Quick response time and flexibility are consequently supported.

- Downsizing:
  Downsizing is the process of designing a technology platform that is smaller and less expensive than traditional mainframe-based systems. Applications are offloaded to minicomputers, microcomputers, and LANs. This increases the availability of specific applications where they are needed. By downsizing, access time to the mainframe is also improved, further increasing quick response times.

> ***Let's Talk***
>
> If you wish to research these terms and ideas further, see John G. Burch, *Systems Analysis, Design, and Implementation* referenced in footnote 3 of the chapter.

f. MRP II supports both organizational designs. Whether strict functional boundaries or no boundaries exist, MRP II coordinates and integrates production-related activities.

g. - Productivity:
    - Effectiveness: Through ready access to information where it is needed and group problem solving, better decisions should result.
    - Efficiency: By reducing organizational barriers, communication and coordination are improved resulting in quicker decisions, decreased response times, and reduced lead times.

  - Quality:
    Flexible organizations empower more employees (as well as vendors) with the responsibility for quality output. Consequently, a greater motivation exists throughout the enterprise to provide high quality products and services.

- Product development cycles:
  Flexible organizations improve the ability of customers to access who they need. This decreases lead time. Customer ideas can be implemented quicker as these ideas are exchanged and discussed without the need to go through layers of hierarchical communication channels and different departments one at a time.

> ***Let's Talk***
>
> Students may be more willing to participate in this discussion if you ask them how many times they have been frustrated as they have been transferred from one person to another when trying to get a problem solved.

- Customer service:

> ***Let's Talk***
>
> One of our MBA students, Cui Qing Chen, provided the following illustration in answer to this question:
>
> I remember playing a game called "telephone" when I was younger. One person whispers a phrase to the next person, who then whispers it to the next person, and so on, until the last person recites the phrase aloud. Invariably, the final phrase bears little resemblance to the original phrase. This demonstrates what can happen to the simplest messages.
>
> If front line employees have to convey everything they are learning about customer needs upward through a maze of managerial levels, while problem solvers have to convey what they are learning about new technologies and solutions through different departments and layers of management, it is very unlikely that many customer needs will be understood, much less satisfied!

Flexible organizations minimize the potential for these types of situations. Vendors and customers can access the people needed. Lateral communications between organization members facilitate better customer service and quicker response.

With structured organizations, properly trained front-line people may get the customer to the right person efficiently. Flexible organizations, though, allow the customer to access the right person directly. This may increase the customer's **perception** of high quality service.

- Management effectiveness:
  Flexible organizations force managers out of their offices. Through interactions with employees, vendors, and customers, managers should gain a greater sense of what is going on and the needs of these stakeholders.

3.26 a. Reasons for morning meetings:

- Test employee knowledge, interest in the company's operations, and motivation to be part of a team.
- Promote participation and foster open communications so that employees feel that they are involved in the entire company's operations (not just in their own jobs).

Let's Talk

The problem states that the morning meeting is a quiz. Later in the problem, though, Eaton's commitment to *kaizen* is illustrated. Combining these two points, the meetings may be more than only to quiz employees.

From the *kaizen* illustration, Eaton's management recognizes that the person doing a job knows more about it than anyone else. We suspect each person is given the chance to update the team on vital information within his or her area. If so, both employees and managers gain a better understanding of the company's overall financial condition, as well as its specific operational problems.

According to Tom Peters (in *Thriving on Chaos: Handbook for a Management Revolution*), people are the key to continuous improvement. Knowledge is power and information provides knowledge. People with the proper information will assume responsibility. When employees understand the "big picture" and where they can specifically contribute to improving it, the chances for success increase.

Thus, the commitment to *kaizen* suggests that the quizzes also may serve as a springboard into discussions of operational problem areas and suggestions for improvement.

b. Rewarding suggestions for improvement gives the workers a sense of recognition and accomplishment, as well as pride among their peers and management. This should encourage them to continue to share their knowledge and creatively devise further improvements. It can also promote a sense of ownership in Eaton.

c. • ICBIS:
An ICBIS improves information flows to all organizational members. The morning meetings demonstrate how Eaton's management promotes information sharing and use. Therefore, an ICBIS can be an integral part of their team building and participative management philosophies.

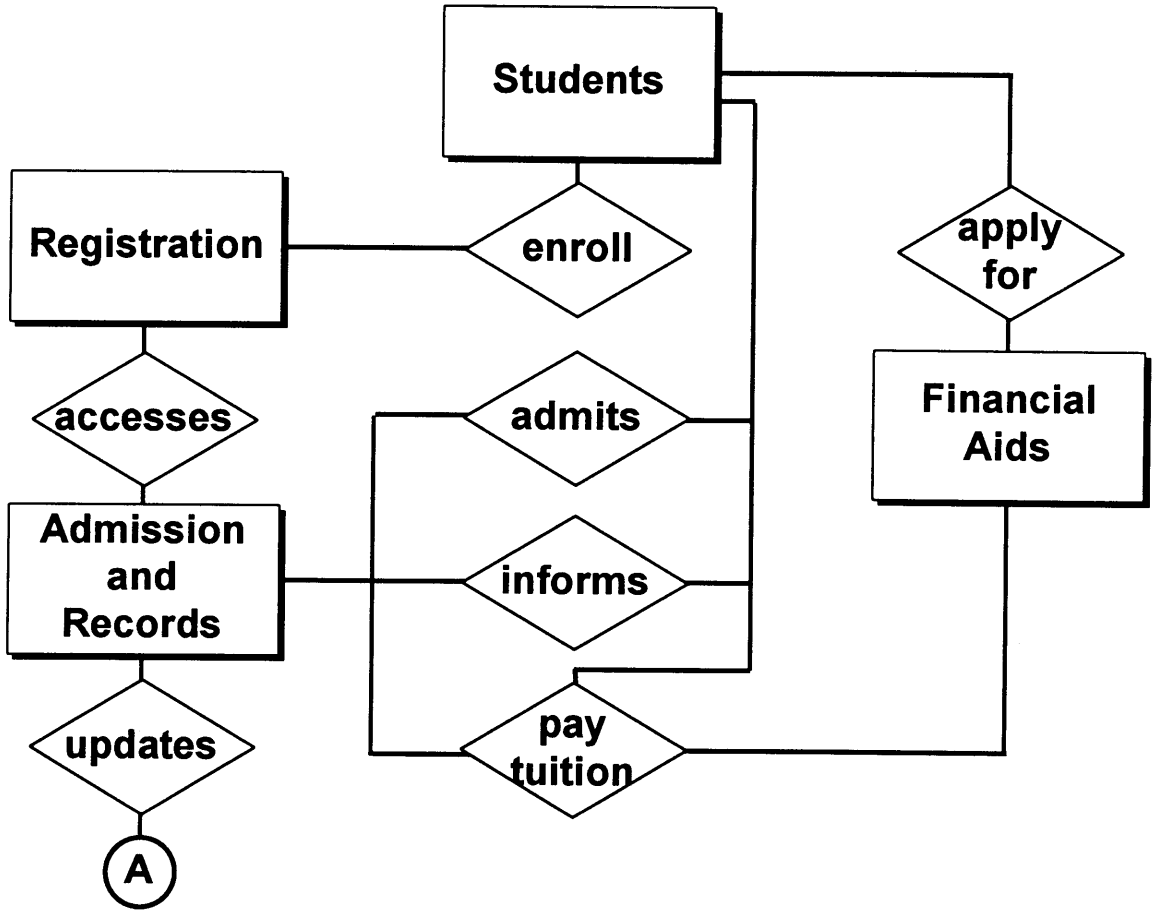
• Visual factory:
While ICBIS information can be used in the morning meetings, a visual factory can be used during daily operations to accomplish information sharing, team building, and group problem solving. The use of an ICBIS can help employees recognize the importance of using visual factory information in operational control. In combination, an ICBIS and visual factory strengthen Eaton's management style.

d. Eaton demonstrates many characteristics of a flexible organization:
- The morning meetings highlight information sharing across functional areas and hierarchical layers.
- Employee suggestions for improvements show how information flows are not restricted to top-down rigid channels of communication.
- The suggestions also demonstrate how employees are empowered to be creative and improve operations.
- Team problem solving is seen in the new machines and the "Scrap Attack."
- The statement about workers operating in teams and (more or less) acting as their own bosses supports the breaking down of functional barriers.

e. • Eaton's turnaround is in part due to its flexible organizational structure, evidenced by its participative management style, encouragement and reward of worker suggestions for improvements, information sharing, and team problem solving.
- Eaton's success is also due to its commitment to *kaizen* and TQM. *Kaizen* is continuous improvement through small, incremental changes. This process begins with identifying large problems and then asking "why" five times in succession. The result is a number of smaller problems, each more easily addressed by the workers. Thus, everyone in the organization is involved in creating suggestions for improvement.
- The workers recognize that if Eaton does not remain competitive and profitable, they will not have jobs very long. Through the use of morning meetings, rewards for improvements, and team problem solving, Eaton's management shows the workers that increased profits is not the goal, though. The workers' real goal is a high quality product. High quality results from improved information, new technology, and better methods (such as preheating dies). High quality, in turn, leads to increased profits and long-run survival.

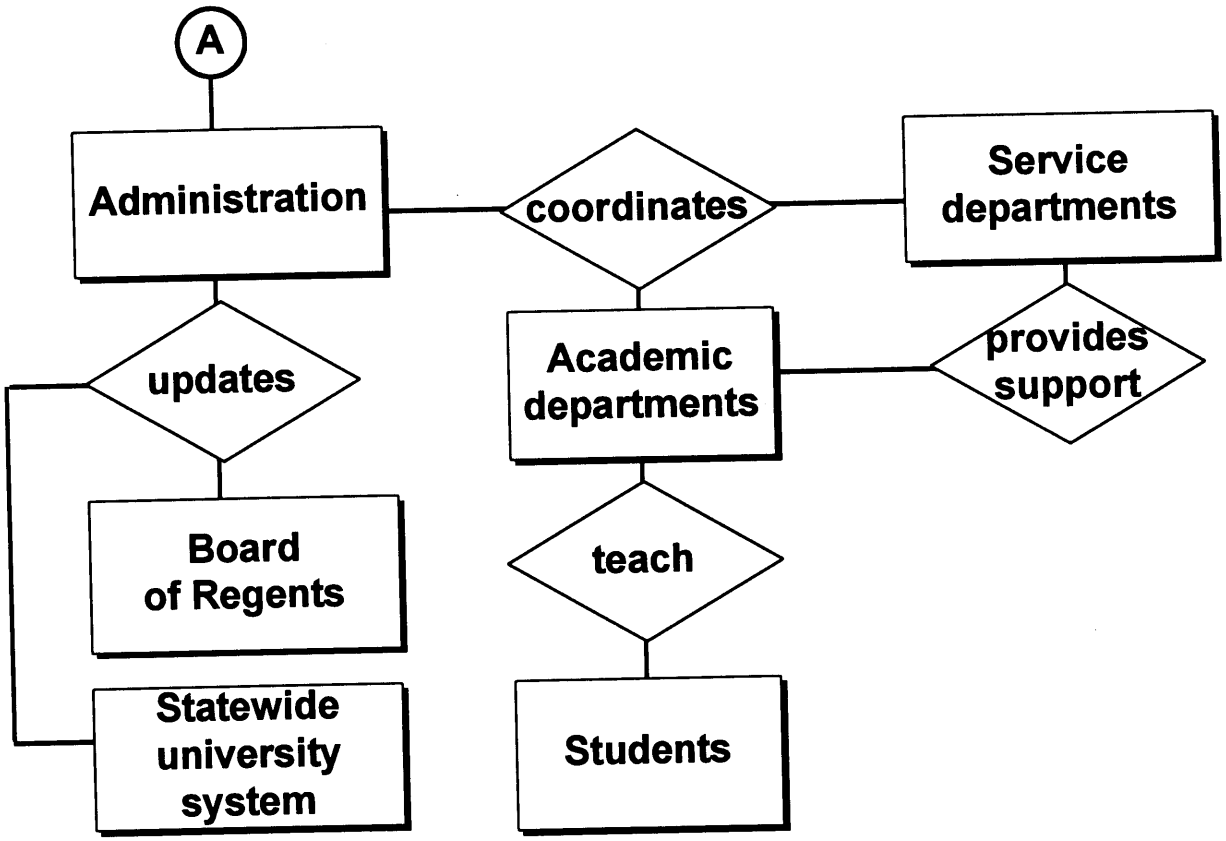
3.27 See the "Let's Talk" boxes at the beginning of Problems 3.15 and 3.23.
ERD for State University (page 1 of 2):

Problem 3.27
ERD for State University



ERD for State University (page 2 of 2):

Problem 3.27
ERD for State University (part 2)



Technology platform for State University: