Learning Objectives

• To describe enterprise systems.
• To describe enterprise resources planning systems.
• To explain the organization value chain.
• To describe the relationship of the organization value chain and an enterprise system.
• To illustrate the value of systems integration.
• To show how an enterprise system provides support for an organization’s processes.
• To summarize the major modules contained in an enterprise resource planning system.
• To describe how an enterprise system supports major business event processes.
• To enumerate the pros and cons of implementing enterprise systems.

Enterprise Systems

At the time that Nestlé SA, the Switzerland-based consumer goods company, embarked on a worldwide implementation of SAP’s R/3 enterprise resource planning (ERP) software, they had 200 operating companies in 80 countries. Nestlé USA, the $8.1 billion U.S. subsidiary, had nine autonomous divisions that did not have common processes, systems, or organization structures. They even had 29 different names for the ingredient vanilla, and were paying 29 different prices for that vanilla, from the same vendor! Each division and factory was allowed to name, and develop specifications for, vanilla and all of their other raw material purchases.

One of the purposes for the worldwide SAP implementation was to standardize processes and systems across the organization. The fact that Nestlé USA had 9 different general ledgers and 28 points of customer entry gives one some idea of the problems they faced. To achieve common practices, divisional functions, such as manufacturing, purchasing, marketing, sales, and accounting, Nestlé would need to give up their old approaches to doing business.

The Nestlé SAP project was not without its problems. The project team learned, for example, that this was not a software project nor was it an IT project. Because this project changed the way people worked, it required that the team focus their attention on change management. As a result the project took several years longer and cost millions of dollars more than had been planned.1 Personnel resisted the changes in business practices that were taking place. For example, as a result of employees’ unwillingness to adapt to new supply chain tools, turnover of personnel who forecasted demand for Nestlé products reached 77 percent.

In the end Nestlé implemented six SAP modules—purchasing, financials, sales and distribution, accounts payable, accounts receivable, and advanced planning and optimization (APO)—as well as parts of Manugistics’ supply chain module.2 Business practices were standardized across divisions and operating companies. For example, the purchasing group for confections used the same best practices as the purchasing group for beverages. We’ll have one vanilla, thank you! Also, as a result of using one common database, discount terms offered by the salesperson were honored by

1 The project was started in 1997 and restarted in 2000 with the signing of a $280 million contract with SAP. The last rollout of the SAP system took place in 2003.
2 Manugistics (http://www.manugistics.com) is a software vendor providing software to implement an organization’s supply chain. Supply chain, APO, and the other software modules are described later in the text.
accounts receivable. Previously, with separate databases, communicating these terms proved difficult.

As of May 2002 the SAP project had saved Nestlé USA $325 million, the majority of savings arising from improved demand forecasting. In the past, the salesforce, demand planners, and factories all had separate databases. With the new business processes and ERP system, forecasts are more accurate resulting in reduced inventory and costs to re-distribute inventory that had resulted from too much product being sent to one place and not enough to another.3

**SYNOPSIS**

Nestlé SA undertook their SAP project to take advantage of the benefits, including the competitive advantage, that can accrue for organizations that integrate business processes and implement ERP systems. But, as Nestlé learned, significant costs and business disruptions may be endured before the benefits are realized. To function effectively in any modern organization, you will need to understand the benefits and costs of organization-wide integration of information systems and the ERP software used in the integration process.

In this chapter we describe these systems and the functionality they provide. We broadly introduce the business processes that ERP systems support. What you learn here, while it is important in its own right, will provide important background for your study in later chapters of the text.

**INTRODUCTION**

We place the enterprise systems icon here to indicate that this entire chapter is entirely about enterprise systems. The other two icons, controls and e-Business, will be placed at appropriate places throughout the remainder of the chapter.

As defined in the Preface and Chapter 1, enterprise systems (also known as enterprise-wide information systems and enterprise information systems) integrate the business process functionality and information from all of an organization’s functional areas, such as marketing and sales, cash receipts, purchasing, cash disbursements, human resources, production and logistics, and business reporting (including financial reporting). They make possible the coordinated operation of these functions and provide a central information resource for the organization. For example, the enterprise system might facilitate the purchase of some office equipment by:

- Providing an electronic order form (a purchase requisition).
- Applying business rules to ensure that complete information and proper approvals have been obtained. For instance, the system might need to connect to accounting processes and data to determine that the purchase is within the requester’s budget.
- Routing the order to appropriate authorities for specific approvals. The system may need to connect to human resource processes and data to determine appropriate approvers.
- Sending the order to a buyer in purchasing for preparation of a purchase order to be sent to a vendor. The system may assist the buyer with selection of an appropriate vendor.
- Being connected to the enterprise systems of business partners, such as the vendor that will sell us the office equipment.
- Completing the business process by making data available for ongoing management and analysis of the purchase and subsequent related events. For example, data would be available for (1) receiving the equipment and enabling routing of it to the purchasing party, (2) projecting funding requirements to pay for purchases, (3) analyzing the vendor’s performance (e.g., timeliness, quality, and price), and (4) comparing the purchasing party’s budget and actual expenditures.

Notice that there are several points during this purchase process where controls might be implemented by the enterprise system. For example, by ensuring that proper approvals are obtained and that the purchase is within the purchaser’s budget, the enterprise system reduces the risk that unauthorized purchases will be made.

Organizations install enterprise systems to differentiate themselves from their competitors. For example, with an enterprise system an organization should be able to conduct business in a timelier and less costly manner and provide services to its customers that would otherwise not be possible. Also, as previously noted, the enterprise system collects data about each business event, as well as data about an organization’s business
partners and other aspects of the business, such as inventory, manufacturing, and human resources. This data contains nuggets of gold that management can mine and use to monitor the organization’s operations, improve performance, and create additional business opportunities. We’ll discuss more about the advantages, and disadvantages, of enterprise systems as our discussion continues.

**Enterprise Resource Planning (ERP) Systems**

Enterprise resource planning (ERP) systems are software packages that can be used for the core systems necessary to support enterprise systems. Think of the relationship between enterprise systems and ERP this way: an organization’s enterprise system might comprise customer relationship management software from one vendor, warehouse and shipping software that was developed internally by the company’s information systems function, and an ERP system from a second vendor. Any combinations like this are possible.

The point is that a company might adopt all modules offered by an ERP system vendor. In that particular case the ERP system and the ES are, for all practical matters, one in the same. For example, the Walt Disney Corporation is engaged in a four-year, £240 million project to implement SAP worldwide to replace ERP systems from multiple vendors.\(^4\) Or, the ERP system might be one of many software solutions that comprise the enterprise system. It might be helpful for you to think about ES as the general phenomenon and ERP systems as a specific instance of the phenomenon. A number of ERP systems are commercially available. The dominant player is SAP whose R/3 product commands the largest percentage of the Fortune 500 market. Table 2.1 lists some of the other ERP vendors, their market share, and number and type of customers.

ERP products are designed to offer integration of virtually all of an organization’s major business functions. Figure 2.1 (page 44) depicts this integration in the SAP R/3 system. The large diamond in the center depicts the core of the R/3 system, including the centralized database. The smaller boxes surrounding the center represent the basic SAP R/3 modules that an organization might adopt. The empty boxes represent third-party add-on modules that could be implemented to extend the R/3 system’s functionality.

The third-party modules in Figure 2.1 complement an ERP system such as R/3 to provide the full range of functionality required for support of an enterprise system. Some of these modules, such as Web interfaces for customers and business partners, may be required to engage in e-Business. The most common add-on modules include:

- **Customer relationship management (CRM) software**, such as that from Seibel Systems, Inc., builds and maintains an organization’s customer-related data. This data is collected from multiple customer interactions, such as Web, call centers, field sales, and service calls. The data is aggregated, managed, and coordinated across the entire organization to support identification, acquisition, and retention of customers and to maximize the benefits of those relationships. You have experienced the functionality of a CRM system if you have set up an account with Amazon.com or other Web vendors. These vendors keep track of such things as your name, address, and purchases. In this way they can personalize your shopping experience and increase their business by making the experience pleasant and more efficient for you and by offering to sell you products that are consistent with your buying habits.

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Customer self-service (CSS) software, often an extension of CRM software, allows an organization’s customers to complete an inquiry or perform a task (including sales) without the aid of an organization’s employees. These integrate with ERP systems to allow customers to check the status of their orders, review inventory availability, and even check production plans. Again, you have experienced such software when making purchases on the Internet.

Sales force automation (SFA) software is another extension of CRM software that automates sales tasks such as order processing and tracking.

Supply chain management (SCM) software, such as that from Manugistics, Inc. and i2 Technologies, Inc., helps plan and execute the steps in an organization’s supply chain including demand planning; acquiring inventory; and manufacturing, distributing, and selling the product. You may recall that Nestlé implemented Manugistics supply chain software.

Product lifecycle management (PLM) software manages product data during a product’s life, beginning with the design of the product, continuing through
manufacture, and culminating in the disposal of the product at the end of its life. PLM software integrates data across many units of an organization, such as engineering, logistics, and marketing, and data from partner organizations, such as vendors, contract manufacturers, and distributors. PLM software is offered by vendors of engineering software, ERP vendors, and specialized providers such as Arena Solutions and Agile Software.

- Other third-party modules extract data from ERP systems and from legacy systems that may still exist within an organization (or subsidiary of the organization). For instance, Hyperion Software focuses on financial and accounting applications, but is very effective at executing consolidations of financial information for multinationals.
SAP R/3 and other similar products reflect large, monolithic ERP systems made up of a number of modules that can be selected for implementation. Third-party add-ons selected by the organization must be connected (or “bolted on”) to the ERP system through an interfacing facility provided by the ERP vendor or a third party. Technology Summary 2.1 describes enterprise application integration (EAI), an approach to connecting together multiple pieces of an enterprise system. Technology Application 2.1 describes a few EAI examples. Notice that EAI is also an approach to connecting the enterprise systems of different organizations, such as would be needed for B2B integrations.

Technology Summary 2.2 describes an alternative approach that very well could be adopted in the near future whereby an organization may select software modules from a variety of vendors. Rather than being connected together, the modules would communicate and coordinate activities through middleware. Web services, another method used for systems integration is described in Chapter 10.

Originally, the implementation of ERP systems was targeted to large multinational manufacturers such as General Motors, Goodyear, and General Mills. Such early adopters made sense, as companies like these would be expected to see the greatest benefits from ERP systems: that is, large multilocation and multidivision companies often present the greatest challenges to managers who want to coordinate worldwide activities and mine data from corporate databases to improve overall organizational decision making. Plus, ERP systems arose from early manufacturing requirement planning (MRP) applications, which were specifically designed for manufacturing companies; hence, it is no surprise that the early adopters were in the business of making products.

ERP systems have seen many improvements over time. Most ERP system vendors now offer solutions for a wide variety of industries, such as retail, banking, financial,
entertainment, construction, and so on. ERP systems allow companies to standardize systems across multiple locations and multiple divisions in order to link business processes and data in a consistent fashion and provide organization-wide data accessibility. This is what we saw with the Disney example cited previously. Another reason that Disney was able to implement one ERP package worldwide is the ability of a single package to provide the needed capacity—to scale sufficiently—for the scope of Disney’s operations.6

Not only were early adopters primarily involved with manufacturing, but they were also very large enterprises, primarily because implementation costs were so enormous that smaller companies simply could not withstand the economic burden. These systems typically took a year or more to implement at a cost of up to hundreds of millions of dollars, necessitating a similarly significant return in benefits. As advances in the technology underlying these systems have evolved, small- and medium-sized enterprises (SMEs) have driven the new implementation base. You can see in Table 2.1 (page 43) that there are some major players in the market for ERP systems for SMEs. For instance, Microsoft’s acquisition of Great Plains in 2001 and Navision in 2002 would be one indicator of the importance of this market segment.

**Enterprise Systems Value Chain**

To examine the role that enterprise systems play in the success of an organization, we might look at the activities performed by the organization as a **value chain**, a chain of activities performed by the organization to transform inputs into outputs valued by the customer. An organization creates a competitive advantage by creating more value for

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6 Simons, “Disney Keeps Global SAP Roll-out on Track.”
Event-driven architecture (EDA) is an approach to designing and building enterprise systems in which business events† trigger messages to be sent by middleware between independent software modules that are completely unaware of each other. This differs from the traditional, internally driven, enterprise architectures. Event-driven processes operate in the following manner.

1. Each business event is handled individually as it appears, rather than waiting for a batch of events to accumulate. Business events are then processed in a timely manner.
2. The business unit that experiences a business event “pushes” the event to the recipient rather than waiting for the recipient to request, or “pull,” the event to them. Recipients learn immediately about relevant business events.
3. Business events are pushed immediately and simultaneously to all interested parties. For example, when a vendor sends a notice that a shipment will be delayed, interested parties such as purchasing, receiving, manufacturing, sales, and the customer would be notified.
4. The meaning and attributes of each business event is documented, as a process is developed, and is shared across multiple processes within the system.
5. Event notifications are managed in a systematic way to ensure that event data is sent to the correct recipient at the right time and that there is appropriate follow-up.

These technical-level design aspects of an EDA generate two business-level opportunities that enable the enterprise to operate in real-time and to choose the best available modules for the enterprise system, the so-called “best of breed” approach to software selection. A “real-time enterprise” driven by an EDA experiences reduced delays and business processing overhead resulting in more responsive and flexible business units. For example, senders and receivers can operate asynchronously and the sender is not tied up waiting for the receiver to respond or to process the event. And, not being restricted to software modules provided by the ERP vendor, or those that can be connected to existing ERP and legacy systems, the organization can put together an enterprise system that is more closely tailored to the needs of each business unit and business process. These modules need not know about the existence or location of any other modules. When a business event occurs, they send an event notification to the middleware (also known as a “publish” or “send”) and the middleware notifies those modules that have asked to receive this type of event (also known as “subscribe”).

† A business event is a meaningful change in the state of the enterprise such as creating a new employee record, submitting a purchase order to a vendor, receiving a payment from a customer, picking goods from the warehouse and delivering to the shipping department, and revaluing inventory.


and by responsiveness to customer requirements for such features as product design and customization, and quality of service during and after the completion of a sale.

You may be familiar with Dell, Inc. (http://www.dell.com), the online seller of computers, printers, software, and related goods and services. The company has a reputation as an extremely efficient manufacturer and distributor. Indeed, Dell’s value chain is one of the best in the world. It takes raw materials, manufactures computers and other products, and delivers them to customers in a timely manner at an attractive price. The keys to Dell’s success are its business processes (Dell holds 550 patents for them) and the application of IT to drive those processes and to integrate its suppliers, customers, manufacturing, shipping, and after-sales support (i.e., the value chain). In this section we describe some ways that enterprise systems play a key role in creating the value customers seek.

Figure 2.2 depicts a generic organization value chain and value system. The activities in the value chain, the value activities, may be divided into two categories, primary and support activities. The primary activities are depicted in the figure and are those directly involved in marketing, selling, producing, and delivering the good or service to the customer, and include functions such as moving raw materials into and around the organization, producing and delivering goods to the customer, and performing services such as installation and after-sales support. The secondary activities are those that provide the supporting infrastructure to enable the primary activities and include functions such as procurement, information technology (IT), human resources and accounting. Note that we depict the value chain as overlaying the functional activities of an organization. To efficiently and effectively serve the customer, the value chain must traverse these traditionally independent activities, often referred to as “silos,” and join these activities together into an end-to-end business process (often called cross-functional integration).

IT has been able to assist in creating additional value by reducing the cost or improving quality in the performance of these activities. For example, IT has been successfully applied to optimize the cost and quality of raw materials by providing information to help select the right material at the right cost from the right vendor. Also, IT has been applied to the production scheduling process to balance the cost and timeliness of manufacturing. Notice that in both of these examples, IT assisted in creating value by lowering costs and differentiating the product. In the first case quality differentiates the product in that we obtain the materials that allow us to manufacture a product that is consistent with our quality objectives. In the second case the timelines of availability of the product was the differentiating factor.

In these two examples, IT assisted in value creation within individual activities. However, value activities are interdependent and need to be closely coordinated to be most effective in creating value for the customer. As described in the next section, enterprise systems are required to provide the necessary interactivity (and interbusiness process) communication and coordination. For example, to really optimize value to the customer (e.g., Dell), the activities related to marketing the product, receiving the customer order, scheduling the order into production, delivering and installing the product, and providing after-sales support, must all be coordinated to ensure the delivery of the product at the cost, and with the quality, the customer expects.

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8 Ibid.
9 The term *silo* is used to refer to organization functions—such as product development, marketing, and manufacturing—that stand alone, disconnected, and often unaware of activities taking place in the other functions.
Figure 2.2 Value Chain and Value System

a. Organization’s value chain

Primary activities

Move raw materials

Produce and deliver

Market and sell

Install and service

Secondary activities

Marketing and sales

Production

Logistics

Human resources

Information technology

Accounting

b. Organization’s value system

Supplier value chains

Organization value chains

Buyer value chains
Finally, an organization’s value chain is but one component in a value system that extends back (upstream) to the organization’s suppliers—each with their own value chain and value system—and forward (downstream) to the customers—each with their own value chain and value system. Value optimization in the value system requires interorganizational information sharing and coordination in the supply chain, a subject discussed in Chapter 10.

**The Value of Systems Integration**

As previously discussed, one of the values provided by an enterprise system is the coordination of value activities in the value chain. The system performs this coordination by sharing data across business processes. In this section we describe what life would be like without integrated systems and then how enterprise systems solve some of those problems. Figure 2.3 depicts the processing of a customer order in the Customer Service Department at Sudbury, Inc., a hypothetical company that manufactures and sells electronic subassemblies. As you can see in the figure, Sally the Sudbury customer sales representative (CSR) needs to have access to information from a variety of sources in order to tell customers when and if they can expect to receive their order and how much that order will cost.

**The Problem**

Imagine first, that Sudbury’s information processes are completely disaggregated and follow along as we describe the problems that it would cause for Sally. First (see flow 1), Sally needs to know if this is an existing customer in good standing (i.e., that they have good credit). Let’s assume that Sally can key in the customer’s name and obtain this data.

Second (see flow 2), Sally needs to be able to tell the customer when he would receive the item. This date, known as “available to promise” or ATP, may be a function of several elements of data:

- If the item is on the shelf in one of Sudbury’s warehouses, and is not committed to another customer, the item would be available after it has been picked from the shelf, packed for shipment, and delivered to the customer. With no automated link to current inventory data, Sally would need to examine computer printouts of inventory balances or call the warehouses to ask someone to look on the shelf.

- If the item is not on the shelf (see flow 3), the item would be available when released from manufacturing, unless that quantity has been committed to another customer. Sally could review production schedules to determine when the item would be available and would add to that the time normally required to pick, pack, and ship the item to this customer. This would not, however, tell her if the item had already been allocated to another customer.

- In the event that the item must be scheduled for manufacturing, Sally would need to know when it could be scheduled, and how long the manufacturing process would take. This would depend on the availability of the production line and personnel, as well as the required raw materials (see flow 4). This latter piece of information may require contacting the vendors that supply these materials to determine when they can promise delivery (see flow 5). This is the ATP from Sudbury’s vendors.
Let’s assume that Sally has determined when the item will be available to ship to the customer. What price will be charged to this customer for this order? This price may be found on a static price list that Sally keeps near the phone. However, prices may be dynamically determined by the marketing department (see flow 6), and this determination may be based on customer status, market conditions, quantity being purchased, and current manufacturing costs. This implies multiple flows into the marketing process not depicted in Figure 2.3.

Once pricing has been determined, Sally needs to know if the amount of the order falls within this customer’s credit limit. Now, we assume that Sally has obtained the credit limit from the customer data that she has (flow 1), But, let’s assume that the amount of money that the customer already owes Sudbury must be considered (see flow 7). Without direct access to the open accounts receivable data, Sally will need to call accounting to approve this order.

Finally, let’s assume that it is Sudbury policy not to turn down an order for insufficient credit without first checking with the credit department (see flow 8). Without an integrated system, this would require that Sally call the credit department.

Do you think that Sally wants to keep the customer on the phone throughout this process? Not likely. Would you consider this to be good customer service? We hope not. What does Sudbury need to do?
The Solution

The solution, as we are sure you have surmised, is to integrate the disaggregated processes of Figure 2.3 (page 51) into an enterprise system. Look again at Figure 2.3 and let’s see how the process would change if the pieces of the customer service process were integrated.

• As before, input of the customer name or number would give Sally access to the customer data (flow 1).

• Upon entering the number of the requested item, the enterprise system would establish the ATP date by determining if the item is available in any of Sudbury’s worldwide warehouses (flow 2), or is scheduled to be manufactured (flow 3), and if scheduled for manufacture, when it would be available (flows 4 and 5).

• Once the source of the item is known, the system will automatically determine the price (flow 6) and the customer’s credit worthiness (flows 7 and 8).

So, Sally does not need to keep the customer on the phone forever! With an integrated system, all of the previous steps would be determined in a matter of seconds. Should the item not be available in a time consistent with the customer’s request, the system can provide data with which management can make decisions to allocate available items from other customers; plan increased production; streamline warehouse and factory logistics to reduce manufacturing, picking, packing, and shipping time; and other such decisions. This process, called “capable to promise (CTP),” and ATP will be discussed further in Chapter 12.

ENTERPRISE SYSTEMS SUPPORT
FOR ORGANIZATIONAL PROCESSES

An information system supports the functioning of an organization in several ways. First, it facilitates the functioning of the organization’s operations as business events occur by, for example, providing data as required to complete the event, applying business rules to ensure that the event is handled properly, and communicating the need for action to business units. Second, the information system retains records about business events that have occurred. Third, the information system stores data that is useful for decision making. In the sections that follow we describe how the information system provides this support and how that support is more robust when an enterprise system provides the support. First, however, we provide an overview of the capturing of data during the execution of business processes.

Capturing Data During Business Processes

The data captured as business processes unfold should be sufficient for someone who was not a party to the business event to reconstruct every aspect of what happened—whether he or she is in accounting, marketing, human resources, financial management, manufacturing, or any other part of the organization. Typically, this mandates that data be collected and stored related to the four Ws:

• The who relates to all individuals and/or organizations that are involved in the event (sometimes called agents to the event).

• The what relates to all resources that are exchanged as a result of the event.
• The *where* relates to the locations in which (1) the event takes place, (2) exchanged resources reside before and after the event, and (3) the agents are during the event.

• The *when* relates to the time periods involved in completion of the event—including future exchanges of resources (e.g., payment of cash for an account receivable) arising from the event.

Once the details of the four Ws (i.e., the event data) are collected and recorded, the data can be aggregated and summarized in any manner that a given user chooses. Aggregations and summarizations are temporary and for the user’s application only, but the event data remain available to other users in their original form. For routine applications such as the generation of accounting reports, programmed procedures can be developed to generate such reports automatically.

**Enterprise Systems Facilitate Functioning of the Organization’s Business**

In Chapter 1 we introduced you to two types of data, master data (entity-type data) and business event data (event-type data). Normally, a business event processing system operates with one or more data tables (often called “files”). Some of these tables are used to obtain reference information, such as the warehouse location of an item of merchandise. Other tables are used to organize and store the data that are being collected, such as sales order or inventory data. We hope that the hierarchy of data pictured in the table on the right side of Figure 2.4 is familiar to you from your computer programming or management information systems courses. Let’s quickly review. A character is a basic unit of data such as a letter, number, or special character. A field (a single cell in a table) is a collection of related characters that comprise an attribute, such as a customer number.

**Figure 2.4 Data Maintenance: Create Customer Record**

<table>
<thead>
<tr>
<th>Credit Department</th>
<th>Information system (or enterprise system)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Records</strong></td>
<td><strong>Characters</strong></td>
</tr>
<tr>
<td><strong>Fields</strong></td>
<td>Customer number</td>
</tr>
<tr>
<td>TA349846</td>
<td>Acme, Inc.</td>
</tr>
</tbody>
</table>

Customer table (partial)
number or a customer name. A record (a row in a table) is a collection of related data fields (attributes) pertaining to a particular entity (person, place, or thing, such as a customer record) or event (sale, hiring of a new employee, and so on). A table (or file) is a collection of related records (sometimes called entity/event instances), such as a customer table or a sales order table.

Figure 2.4 depicts a typical data maintenance activity for a single table—the addition of a new customer record to the customer table—and provides us with an example of how an information system can facilitate the functioning of the organization’s business processes. For example, the name and the address fields will be used to address monthly invoices. Figure 2.5 depicts how the existence of the customer record—including the credit limit—provides the basic authorization required to enter the customer’s order. Without the customer record, the computer would reject the customer order in Figure 2.5. Thus, it is important to separate authorizations for data maintenance activities from authorizations for business event processing activities. This separation between, for example, the Credit Department in Figure 2.4 and the Sales Department in Figure 2.5, provides an important control, segregation of duties, a topic explored in greater detail in Chapters 8 and 9.

**Figure 2.5 Business Event Data Processing: Enter Customer Order**

Figure 2.5 depicts a typical business event processing activity—entering a customer’s order. Let’s examine a series of events that might take place during the course of capturing a customer’s order and delivering the goods to the customer. First, as noted previously the customer table provides the credit and other customer data required to authorize the order. Next, data regarding the quantity and selling price of the inventory is obtained from the inventory table. Finally, an order to pick, pack, and ship the ordered
goods (including the inventory location obtained from the inventory table) would be sent to the warehouse.10

In enterprise systems there should be only one version of each of the tables depicted in Figure 2.5 and that central database would be used by all functions in the organization, such as marketing, accounting, and logistics. For example, there will be only one record for each customer and one credit limit, worldwide. All of the inventory data worldwide would be available (often called “visible”) during the processing of customer orders. The centralization of the data permits an organization to have accurate and reliable data and to operate their business processes in a consistent manner throughout the organization.

In addition, the communication across functions is enhanced in enterprise systems. For example, in Figure 2.5 we see that data related to the inventory is readily available during entry of the customer order. And, we see that a request for shipment is sent directly to the warehouse. (We don’t see any document here because the transmission to the warehouse is electronic.) Finally, although not shown in the diagram, the purchasing function could be informed immediately that merchandise has been sold and may need to be replenished. Thus, the enterprise system with a centralized database and communication among the organization business functions provides a higher level of support for the functioning of the business than would be possible by less-integrated approaches to the information system.

**Enterprise Systems Record That Business Events Have Occurred**

As the business event progresses, the information system must capture the multifaceted data to track the progression of the process. To capture the sales event, we need to record data related to the customer and the salesperson (the who), the goods ordered (the what), the delivery location (the where), and the date of sale and promised delivery (the when). This information would then be linked with information already stored that relates to, for example, the supplier of goods that were not available. Based on the combined information, a purchase order might be sent to the supplier. For the purchase order we record the supplier (the who), the goods (the what), the location to which the goods will be delivered (the where), and the delivery date from the supplier to our company (the when) and link the purchase order to the order from our customer.

All of the data in our example that is required for the sales, billing, purchasing, and general ledger functions are all captured and available in a typical information system. But with an enterprise system the data is linked together. Thus, if the delivery date is changed by the supplier, the salesperson has immediate access to the change and can notify the customer. To accomplish this, the salesperson pulls together the necessary data by utilizing links between the changed order information, the sales order, and the customer, and narrows the search to only the sales that he or she is handling. Very quickly, the salesperson has the information needed to notify the customer of any delay in shipment.

Notice how this discussion relates to the event-driven architecture in Technology Summary 2.2 (page 47) If there was an event-driven architecture, the notice from the

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10 Notice the direction of the flows into and out of the tables. We obtain data from the customer and inventory tables and send data to the sales order (i.e., a new sales order record) and inventory (i.e., a changed quantity on hand) tables.
supplier about a changed delivery date would cause the “pushing” of notices to the salesperson, the customer, and other interested parties.

**Enterprise Systems Store Data for Decision Making**

Figure 2.6 depicts a manager using the data collected and stored by the organization’s information system. We show only those data tables that we had in Figure 2.5. Hundreds, indeed thousands, of tables of data are available in a typical information system.

**Figure 2.6 Using Stored Data for Decision Making**

Some simple examples follow of how our manager might use the data to make decisions. A warehouse manager might look at sales orders that have not yet been shipped to follow-up and find out why. An inventory manager might look at the inventory data to follow-up on those items with low balances on hand.

With an enterprise system, potential queries can be complex and yield results that are more significant. For example, a marketing manager might want to have a list of those customers who have not made a purchase in a month. To obtain this information, the manager would need to combine the customer and sales tables. Or, the credit manager might want to compare customer credit limits, sales, billing data, and payment data to determine if credit limits need to be adjusted for customers with high sales or late payments. Finally, a logistics manager might want to examine the time of the day that orders are received and delays in shipping those orders to determine if staffing in the warehouse needs to be scheduled at different times. All of these queries assume that data can be shared across multiple functional areas, a common situation with enterprise systems.
CHAPTER 2  Enterprise Systems

MAJOR ERP MODULES

To give you an appreciation for the typical, core modules in an ERP system we will de-
scribe here five modules in the SAP R/3 system: (1) sales and distribution, (2) materi-
als management, (3) financial accounting, (4) controlling and profitability analysis, and
(5) human resources. These modules are included in Figure 2.1 on page 44. Most ERP
systems have similar modules with comparable functionality.

Sales and Distribution

The Sales and Distribution Module (SD) of the SAP R/3 system contains the functions
related to the sale of goods to customers and includes recording a customer order, ship-
ing goods to the customers, and billing the customer. There are connections to the
Materials Management module to check the availability of inventory and to record the
issue of the goods, to the Financial Accounting module to post the sale, and to the Con-
trolling module for profitability analysis related to the sale. The three major steps in the
SD process (order entry, shipment, and billing) are briefly outlined here.

The SD order entry process might start with receiving and recording an inquiry from
a customer and preparing and recording a sales quotation. Should the customer choose
to place an order, the process continues with the receipt and entry of a customer order.
Upon entering the order, the R/3 system would check the customer’s credit, determine
availability of the goods ordered, and record the order (now called a sales order). If this
is a new customer, the customer data would be added to the database using a data main-
tenance activity similar to that in Figure 2.4 (page 53).

The SD shipment process includes scheduling the shipment, picking the goods from
the shelf, packing the goods for shipment, and recording the shipment. Organizations
often choose to record each of these steps as they occur to keep a complete record of
the sale as it progresses. Once the post shipment event has been entered, the inventory
quantity-on-hand is reduced and the sale is scheduled for billing.

The SD billing process creates invoices for all shipments that are ready to be billed.
The billing process may be automatically triggered by each shipment or may be executed
periodically by an action taken by a billing clerk. In this latter case, multiple shipments
to a customer might be consolidated and placed on a single invoice.

Materials Management

The Materials Management (MM) module of the SAP R/3 system contains the func-
tions related to the acquisition of goods from vendors and management of the goods
while they are in stock. The module includes preparing and recording a purchase order,
receiving the goods from the vendor, and recording the vendor’s invoice. The MM
module interacts with the SD module during the processing of customer orders, with
the Financial Accounting module to post the receipt of the goods and the vendor in-
voice, and with the Controlling module for analysis of the costs associated with the pur-
chases. The three major steps in the MM process (creating a purchase order, receiving
the goods, and recording the vendor invoice) are briefly outlined here.

The MM purchase order process might start with the preparation of a purchase req-
qustion by a person or function within the organization and sending a request for quo-
tation (RFQ) to one or more vendors. Once responses to the RFQ have been processed
and a vendor selected, the purchase process continues with the creation and recording
of a purchase order and communication of that purchase order to the vendor. Should this be a new vendor, the vendor data would be added to the database using a data maintenance activity similar to that in Figure 2.4 (page 53).

The MM goods receipt process includes comparing the received and ordered quantities, recording the receipt, and increasing the quantity-on-hand. When the vendor invoice is received and entered, the R/3 system performs a three-way match between the purchase order, the receipt, and the invoice. If these agree, the invoice is recorded.

**Financial Accounting**

The Financial Accounting (FI) module plays a central role in the SAP R/3 system. Business events from other modules, such as SD and MM, are incorporated by the FI module into the general ledger accounts and included in the external account statements, the balance sheet, profit and loss statement, and statement of cash flows. The FI module also includes accounts receivable and accounts payable functions to record and manage that data directly and to complete events begun in the SD and MM modules. Some specific examples follow.

After a customer is billed in the SD module, the accounts receivable portion of the FI module manages that receivable until paid (e.g., aging of open receivable, dunning for late payments) and records the customer payment. Also, in the absence of the SD module and for special circumstances, such as one-time sales of non-merchandise items, invoices may be directly entered in the FI module.

Once a vendor invoice has been entered in the MM module, the accounts payable portion of the FI module schedules the invoice for payment and executes that payment at the appropriate time.

**Controlling and Profitability Analysis**

The Controlling (CO) module of SAP R/3, often called Controlling and Profitability Analysis (CO/PA), handles internal accounting, including cost center accounting, profitability analysis for sales, activity-based accounting, and budgeting. For example, the CO module can produce internal profit and loss statements for portions of an organization’s business.

**Human Resources**

The Human Resources (HR) module of SAP R/3 includes functions related to the recruitment, management, and administration of personnel, payroll processing, and personnel training and travel. For example, when a new employee is hired, it is from within the HR module that the human resources department would add the personnel data to the database using a data maintenance activity similar to that in Figure 2.4 (page 53). The HR module is also used to maintain data related to benefits, training, and work shifts. Finally, the payroll function facilitates the processing of payroll for countries throughout the world and to prepare payroll reports in accordance with the jurisdictions of those countries.

**Enterprise Systems Support for Major Business Event Processes**

Most organizations group their major business events into two processes, the order-to-cash process and the purchase-to-pay process. For ease of presentation, this text divides
these further into processes comprised of a few closely related events. For example, we describe the process employed to enter a customer’s order and to ship the goods to the customer as the order entry/sales process, while the management of the accounts receivable and the billing of the customers are included in the accounts receivable/billing/cash receipts process. In the sections that follow, we describe the two major processes, order-to-cash and purchase-to-pay, describe how an enterprise system supports those business processes, and map those processes into the chapters where they are covered in this text. Our discussion is limited to the purchase of goods, not services, and to goods acquired for resale, not goods acquired as raw material inputs to a manufacturing process.

**Order-to-Cash**

Figure 2.7 (page 60) depicts the order-to-cash process, which includes the events surrounding the sale of goods to a customer, the recognition of the revenue, and the collection of the customer payment. The order-to-cash process comprises all activities in the order entry/sales process (Chapter 10), the billing/accounts receivable/cash receipts process (Chapter 11), and the applicable parts of the general ledger process (Chapter 16). Follow along with us as we describe the numbered steps in Figure 2.7 and how an enterprise system supports the business activities in those steps. The order-to-cash process includes:

- **Step 1**, pre-sales activities, includes responding to customer inquiries and requests for quotes (RFQs). Organizations may choose to collect and retain a rich assortment of customer-related data about prospective and active customers. This data is recorded in an ERP system and can be analyzed to determine what goods are being requested by customers and the RFQs that do, and do not, result in customer orders. Some organizations purchase separate CRM packages to supplement the customer-related features in standard ERP systems.

- **Step 2**, sales order processing, includes capturing and recording customer orders. At this point in the process an enterprise system would link together customer, inventory, purchasing, and vendor data to determine if the customer is in good standing and likely to pay the bill (i.e., using customer credit and inventory pricing data) and where and when inventory will be available to send to the customer (i.e., using worldwide inventory quantity-on-hand, on-order, and vendor data). At the conclusion of step 2 the enterprise system sends a picking request to the appropriate warehouse. If goods are not available within the organization, a purchase order would be sent to a vendor.

- **Step 3**, pick and pack, includes picking the goods from the shelf in the warehouse and packing the goods for shipment. Each of these events may be recorded in the enterprise system to maintain a record of the progress and to retain control over the location of the goods.

- **Step 4**, shipping, include transferring the goods to the organization’s transportation function, or to a third-party carrier, for shipment to the customer. The enterprise system would choose the appropriate routing and carrier, record the reduction in the inventory quantity-on-hand, calculate and record the cost of goods sold and inventory reduction in the general ledger, and record data to be used in the billing process. Some enterprise systems are configured to immediately trigger the billing process when a shipment takes place.

- **Step 5**, billing, includes preparing the customer invoice and recording sales and accounts receivable data in the general ledger. The enterprise system links together
sales, customer, and inventory data to ensure that the invoice contains correct quantities, prices, terms, addresses, etc. It is at this point that the enterprise system can be used to analyze sales profitability by comparing product costs to selling price.

- Step 6, payment, includes capturing and recording cash receipts and updating cash and accounts receivable amounts in the general ledger. Data in the enterprise system will be used to manage customer credit and invest available cash.

Figure 2.8 depicts the SD menu from the R/3 system and points to the SD options described previously. Figure 2.9 shows the audit trail that the R/3 system retains to document the completion of the steps in the sales process.

**Purchase-to-Pay**

Figure 2.10 (page 62) depicts the purchase-to-pay process, which includes the events surrounding the purchase of goods from a vendor, the recognition of the cost of those goods, and the payment to the vendor. The purchase-to-pay process comprises all of the activities in the purchasing process (Chapter 12), the accounts payable/cash disbursements process (Chapter 13), and the applicable parts of the general ledger process.
**Figure 2.8** SD Menu Options in the R/3 System

Source: Reprinted with permission from SAP.

**Figure 2.9** SD Audit Trail for Completion of Steps in the R/3 Sales Process

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Follow along with us as we describe the numbered steps in Figure 2.10 and how an enterprise system supports the business activities in those steps. The purchase-to-pay process includes:

- **Step 1**, requirements determination, includes preparing a purchase requisition to request the purchase of goods from a vendor. An enterprise system may automatically generate the purchase requisition on the basis of data such as quantity-on-hand, quantity-on-order, and expected demand. Ad-hoc requests may be entered by authorized individuals within the organization. An enterprise system will review purchase requests to determine that they are authorized and within budget.

- **Step 2**, purchase order processing, includes preparing and recording purchase orders. An enterprise system assists the buyer in identifying sources of supply for the requested item, preparing RFQs to be sent to vendors, analyzing vendor quotations, and selecting vendors by comparing vendor prices, terms, and past performance (e.g., timely, accurate deliveries).

- **Step 3**, goods receipt, includes comparing the on-order quantity and the quantity received, increasing the quantity-on-hand, creating a record of the receipt, and recording the cost of inventory in the general ledger. If the two-way match fails, the enterprise system notifies the proper personnel to ensure timely reconciliation.
The enterprise system also ensures timely availability of the goods by routing them to the function that requested them or directing that they be placed on the shelf in the warehouse and made available for immediate sale. Finally, the enterprise system records data related to the vendor’s performance (e.g., delivery accuracy and timeliness) to be used in future purchase decisions.

- **Step 4**, invoice verification, includes receiving vendor invoices; three-way matching of the purchase order, receipt, and vendor invoice; and recording accounts payable in the general ledger. An enterprise system links this data together to make the three-way match possible and provides the interface to the general ledger. If the three-way match fails, the enterprise system notifies the proper personnel to ensure timely reconciliation of differences.

- **Step 5**, payment processing, includes preparing and recording cash disbursements and updating cash and accounts payable amounts in the general ledger. An enterprise system facilitates this process by using vendor and accounts payable data to schedule payments in accordance with vendor terms and to receive discounts, as appropriate.

Figure 2.11 depicts the MM menu from the R/3 system and points to the options described previously. Figure 2.12 (page 64) shows the audit trail that the R/3 system retains to document the completion of the steps in the purchase process.

### Figure 2.11 MM Menu Options in the SAP R/3 System

<table>
<thead>
<tr>
<th>SAP standard menu</th>
<th></th>
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<tbody>
<tr>
<td>Office</td>
<td></td>
</tr>
<tr>
<td>Logistics</td>
<td></td>
</tr>
<tr>
<td>Materials Management</td>
<td></td>
</tr>
<tr>
<td>Purchasing</td>
<td></td>
</tr>
<tr>
<td>Purchase Order</td>
<td></td>
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<tr>
<td>Purchase Requisition</td>
<td></td>
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<tr>
<td>Outline Agreement</td>
<td></td>
</tr>
<tr>
<td>RFQ/Quotation</td>
<td></td>
</tr>
<tr>
<td>Master Data</td>
<td></td>
</tr>
<tr>
<td>Environment</td>
<td></td>
</tr>
<tr>
<td>Inventory Management</td>
<td></td>
</tr>
<tr>
<td>Goods Movement</td>
<td></td>
</tr>
<tr>
<td>Goods Receipt</td>
<td></td>
</tr>
<tr>
<td>Goods Issue</td>
<td></td>
</tr>
<tr>
<td>Transfer Posting</td>
<td></td>
</tr>
<tr>
<td>Subsequent Adjustment</td>
<td></td>
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<tr>
<td>Material Document</td>
<td></td>
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<tr>
<td>Reservation</td>
<td></td>
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<tr>
<td>Periodic Processing</td>
<td></td>
</tr>
<tr>
<td>Environment</td>
<td></td>
</tr>
<tr>
<td>Invoice Verification</td>
<td></td>
</tr>
</tbody>
</table>

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SUMMARY

In Chapter 1 we introduced the qualities of information (see Exhibit 1.2 on page 24 and Figure 1.7 on page 25) that should be the goals of any information system. Enterprise systems achieve these goals in the following manner:

- Enterprise systems can collect a wide variety of data about business events and make that data available for use by all of an organization’s personnel. The data should help all users (i.e., relevance, understandability) make decisions (i.e., decision usefulness), and analyze past events to make predictions about future events (i.e., predictive/feedback value).

- An enterprise system’s central database retains one version of data elements, uses that data to verify the accuracy of new data elements entered into the database, and applies business rules to permit only authorized changes to the database. Combined, these improve the reliability, validity, and accuracy of the database.

- Organization-wide enforcement of data standards and business rules means that business events will be handled consistently across the organization, that all relevant data will be collected (i.e., completeness) and that the collected data will be verifiable and neutral.

- The integrated nature of the enterprise system makes all data available in a timely manner.

- Shared services for efficiency and consistency. For example, an organization can ship products to customers from multiple shipping points while billing their customers from one central location.

The following table summarizes some of the advantages and disadvantages of enterprise systems for an organization. Notice that some of the advantages and disadvantages relate to the ERP systems that are used to support the core systems of the enterprise system.

Figure 2.12 Audit Trail for Completion of Steps in the R/3 Purchase Process

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Pros/Benefits and Cons/Disadvantages of Enterprise Systems

Pros Of Enterprise Systems
- Single database
- Integrated system (e.g., visibility to do ATP)
- Process orientation (vs. function)
- Standardization of business processes and data, easier to understand across the organization
- Faster business processes (e.g., customer fulfillment, product development)
- Timely information
- Better financial management (partly due to integration)
- One face to the customer
- Reduced inventory
- Improved cash management
- Productivity improvements, reduced personnel
- Full and accurate financial disclosures
- Improved budgeting, forecasting, and decision support
- Seamless integration and accessibility of information across the organization
- Catalyst for reengineering old, inefficient business processes

Pros Of ERP Packages
- One package across many functions (if one ERP)
- “Best practices”
- Modular structure (buy what you need)
- No development needed
- Configurable
- Reduced errors (i.e., business rules, enter data once)

Cons Of Enterprise Systems
- Centralized control vs. decentralized empowerment
- Inability to support traditional business processes that may be best practices for that organization
- Loss of flexibility in rapidly adapting to desired new business processes in the post-implementation period
- Increased complexity of maintaining security, control and access permissions for specific information embedded in central database
- The rigidity of “standardization” can impede creative thinking related to ongoing business process improvements

Cons Of ERP Packages
- Complex and inflexible
- Implementation horror stories
- Best practices are shared by all who buy
- Difficult to configure
- Long implementation
- Best of breed might be better (than single ERP package)
- Can’t meet all needs (i.e., developed for many user types)

REVIEW QUESTIONS

RQ 2-1 Describe the key features of an enterprise system.
RQ 2-2 Describe the key features of an enterprise resource planning (ERP) system.
RQ 2-3 What is a value chain?
RQ 2-4 What is the relationship of the organizational value chain and an enterprise system?
RQ 2-5 Describe the problems caused by lack of information systems integration.
RQ 2-6 Describe the four ways that an enterprise system supports the functioning of an organization’s processes.
**RQ 2-7** Explain why it is important to capture the who, what, where, and when in describing business events.

**RQ 2-8** Describe four modules of the SAP R/3 system.

**RQ 2-9** Describe the 6 steps in the order-to-cash process.

**RQ 2-10** How does an enterprise system support the order-to-cash process?

**RQ 2-11** Describe the 6 steps in the order-to-cash process.

**RQ 2-12** How does an enterprise system support the purchase-to-pay process?

**RQ 2-13** List the advantages and disadvantages of an enterprise system.

**DISCUSSION QUESTIONS**

**DQ 2-1** Once the core of an ERP system has been implemented, any of the modules may then be implemented separately. What is the implication of being able to implement an ERP system on a piece-by-piece basis?

**DQ 2-2** Dover Company is considering taking customers' orders on their Web site.
   a. What information would Dover collect from the customer during this process?
   b. What information would need to come from Dover’s system to complete the order?
   c. How would an enterprise system facilitate this exchange of information?

**DQ 2-3** Discuss the pros and cons of consolidation of the ERP software industry.

**DQ 2-4** Refer to Figure 2.5 (page 54) and identify the key business event data (who, what, where, and when) you would want to capture.

**DQ 2-5** Describe how an enterprise system can assist an organization in optimizing its value system.

**DQ 2-6** Consider a business process that you have experienced at work, as a customer, or as a student. Examples might include any process in a work setting such as payroll and purchasing, or any process with which you have interacted, such as ordering from a Web site, obtaining a loan, eating at a restaurant, or registering for classes at your college or university. Describe the degree to which the steps in the process are integrated. What is/was the impact of that integration on you and on the organization?

**DQ 2-7** Describe a situation in which information would be shared between two of the “silos” in Figure 2.2 (page 49). What data would be shared? Why would the data be shared? *(Hint: You might refer to Figures 2.3, 2.7, or 2.10.)*

**DQ 2-8** Why might a firm decide to implement only certain modules in an enterprise resource planning system rather than a complete implementation?

**PROBLEMS**

**P 2-1** Conduct research on successful and unsuccessful ERP implementations. What seem to be the key elements of a successful implementation? What seem to be the key elements of an unsuccessful implementation? What conclusions can be reached?
CHAPTER 2  Enterprise Systems

P 2-2 Conduct research on an ERP package other than SAP and compare the modules that it has to those described within this chapter for the SAP R/3 system.

P 2-3 Conduct research on an ERP package, such as Great Plains or Navision, intended for small- to medium-sized (SME) organizations. Compare that package for available modules, functionality, etc. to the SAP R/3 system.

P 2-4 Choose a Web site with which you are familiar, such as Dell, Amazon, etc. Illustrate the order-to-cash process, from the customer’s perspective, illustrated by that site.

P 2-5 Conduct research on the Web sites of either CIO Magazine or CFO Magazine for stories about ERP implementation successes and failures. Using specific examples, describe the reasons for the successes and failures.

KEY TERMS

enterprise systems  customer self-service (CSS) software  enterprise application integration (EAI)
enterprise-wide information systems sales force automation (SFA) software event-driven architecture (EDA)
enterprise information systems supply chain management (SCM) software business event
enterprise resource planning (ERP) systems product lifecycle management (PLM) software value chain
customer relationship management (CRM) software order-to-cash process purchase-to-pay process