

Chapter 13

Building Information Systems

LEARNING OBJECTIVES

After reading this chapter, you will be able to answer the following questions:

1. How does building new systems produce organizational change?
2. What are the core activities in the systems development process?
3. What are the principal methodologies for modeling and designing systems?
4. What are the alternative methods for building information systems?
5. What are new approaches for system building in the digital firm era?

Interactive Sessions:

Can Business Process Management Make a Difference?

Zimbra Zooms Ahead with OneView

CHAPTER OUTLINE

13.1 SYSTEMS AS PLANNED ORGANIZATIONAL CHANGE
Systems Development and Organizational Change
Business Process Redesign

13.2 OVERVIEW OF SYSTEMS DEVELOPMENT
Systems Analysis
Systems Design
Completing the Systems Development Process
Modeling and Designing Systems: Structured and Object-Oriented Methodologies

13.3 ALTERNATIVE SYSTEMS-BUILDING APPROACHES
Traditional Systems Life Cycle
Prototyping
End-User Development
Application Software Packages and Outsourcing

13.4 APPLICATION DEVELOPMENT FOR THE DIGITAL FIRM
Rapid Application Development (RAD)
Component-Based Development and Web Services

13.5 HANDS-ON MIS PROJECTS
Management Decision Problems
Improving Decision Making: Using Database Software to Design a Customer System for Auto Sales
Achieving Operational Excellence: Redesigning Business Processes for Web Procurement

LEARNING TRACK MODULES

- Unified Modeling Language (UML)
- A Primer on Business Process Design and Documentation
- A Primer on Business Process Management

CIMB GROUP REDESIGNS ITS ACCOUNT OPENING PROCESS

CIMB Group, headquartered in Kuala Lumpur, is Malaysia's second largest financial services provider and the third largest company on the Malaysian stock exchange. It offers a full range of financial products and services, including consumer banking, corporate and investment banking, insurance, and asset management, and its retail banking network of over 1,100 branches is the largest in Southeast Asia.

What's wrong with this? Not much, except management wants to do even better. The company launched a five-year information technology transformation initiative in January 2008 to align its information technology investments more closely with its resources. It used the ARIS business process management (BPM) tool from IDS Scheer to identify 25 different areas for improving technology, people, and processes. The ARIS software helped identify gaps and inefficiencies in existing processes.

The process of opening an account at a retail branch was singled out as needing improvement. Improving this process was given high priority because it provided customers with their first impression of CIMB Group's service and customer experience.

The old account-opening process was cumbersome and time-consuming, requiring filling out four separate data entry screens for customer information, account details, name and address details, and details concerning the automated teller machine (ATM) card. New technology created opportunities for a short-cut. Malaysia has a compulsory identity card for its citizens and permanent residents known as the Government Multipurpose Card, or MyKad. It is the world's first smart identity card, incorporating a microchip with identification data (such as name, address, gender, and religion) and capabilities for user authentication, government services, electronic payments, education, loyalty programs, mobile applications, and other conveniences.

CIMB Group's systems-building team modified the front end of the customer account system to reduce the number of data entry screens and to accept customer data obtained from scanning a MyKad card. By automatically extracting most of the identification data required to open an account from a MyKad card, CIMB only needs to use a single data entry screen to set up a new account. CIMB Group was thus able to streamline the account-opening process, reducing the time required to open a bank account by 56 percent. The experience became more personal and engaging for both the bank officer and the customer. Productivity has increased, lowering CIMB Group's cost by 8 to 9 percent annually.

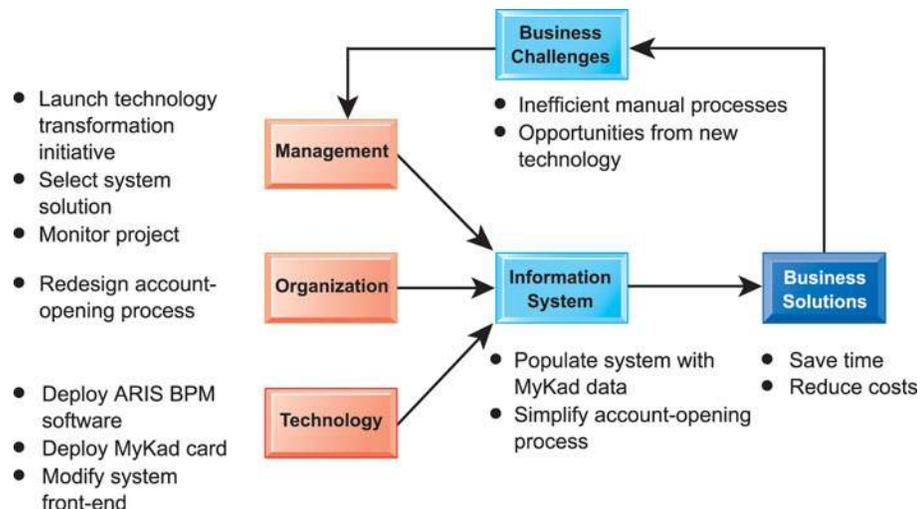
Sources: Avanti Kumar, "Reaching for the Skies," MIS Asia, April 16, 2010; www.ids-scheer.com, accessed October 5, 2010; and www.cimb.com, accessed October 5, 2010.



The experience of CIMB Group illustrates some of the steps required to design and build new information systems. Building the new system entailed analyzing the organization's problems with existing information systems, assessing people's information requirements, selecting appropriate technology, and redesigning business processes and jobs. Management had to monitor the system-building effort and evaluate its benefits and costs. The new information system represented a process of planned organizational change.

The chapter-opening diagram calls attention to important points raised by this case and this chapter. CIMB Group's process for setting up a new account was excessively manual and inefficient, dragging down business operations and raising costs. It also detracted from the brand image the company wanted to project as a company with high-quality customer service. Management had an opportunity to use information technology and the information stored in MyKad smart cards to streamline and redesign this process.

CIMB's system-building team evaluated alternative system solutions. It selected a solution that replaces the process of entering customer and account data manually into a series of four data entry screens with one that obtains most of the same data by swiping a MyKad smart card. This solution did not replace CIMB's existing banking system entirely, but enhanced it with a more efficient and streamlined user interface. These enhancements improved business operations by reducing the amount of time to open a new account with CIMB Group and making the customer experience more pleasant.



13.1 SYSTEMS AS PLANNED ORGANIZATIONAL CHANGE

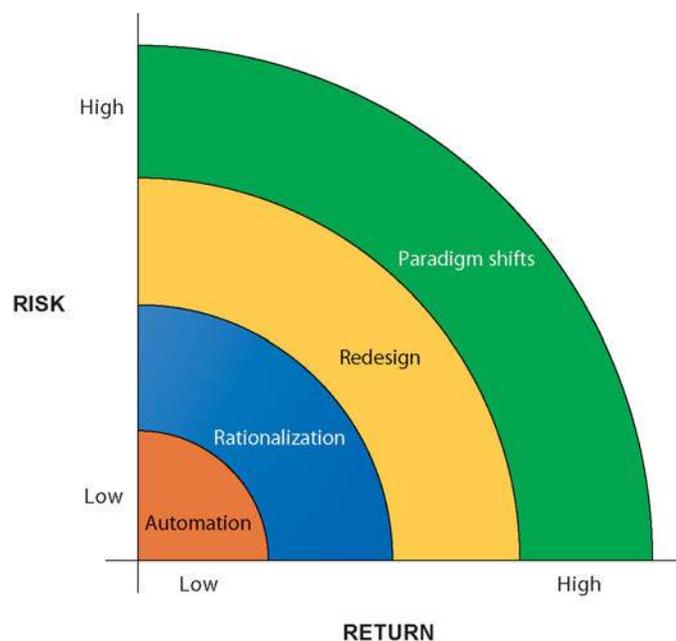
Building a new information system is one kind of planned organizational change. The introduction of a new information system involves much more than new hardware and software. It also includes changes in jobs, skills, management, and organization. When we design a new information system, we are redesigning the organization. System builders must understand how a system will affect specific business processes and the organization as a whole.

SYSTEMS DEVELOPMENT AND ORGANIZATIONAL CHANGE

Information technology can promote various degrees of organizational change, ranging from incremental to far-reaching. Figure 13-1 shows four kinds of structural organizational change that are enabled by information technology: (1) automation, (2) rationalization, (3) business process redesign, and (4) paradigm shifts. Each carries different risks and rewards.

The most common form of IT-enabled organizational change is **automation**. The first applications of information technology involved assisting employees with performing their tasks more efficiently and effectively. Calculating paychecks and payroll registers, giving bank tellers instant access to customer deposit records, and developing a nationwide reservation network for airline ticket agents are all examples of early automation.

FIGURE 13-1 ORGANIZATIONAL CHANGE CARRIES RISKS AND REWARDS



The most common forms of organizational change are automation and rationalization. These relatively slow-moving and slow-changing strategies present modest returns but little risk. Faster and more comprehensive change—such as redesign and paradigm shifts—carries high rewards but offers substantial chances of failure.

A deeper form of organizational change—one that follows quickly from early automation—is **rationalization of procedures**. Automation frequently reveals new bottlenecks in production and makes the existing arrangement of procedures and structures painfully cumbersome. Rationalization of procedures is the streamlining of standard operating procedures. For example, CIMB Bank's system for handling retail banking accounts is effective not only because it uses computer technology but also because the company simplified the business process for opening a customer account. CIMB streamlined its workflow to take advantage of the system's new user interface and software for importing personal data from MyKad.

Rationalization of procedures is often found in programs for making a series of continuous quality improvements in products, services, and operations, such as total quality management (TQM) and six sigma. **Total quality management (TQM)** makes achieving quality an end in itself and the responsibility of all people and functions within an organization. TQM derives from concepts developed by American quality experts such as W. Edwards Deming and Joseph Juran, but it was popularized by the Japanese. **Six sigma** is a specific measure of quality, representing 3.4 defects per million opportunities. Most companies cannot achieve this level of quality, but use six sigma as a goal for driving ongoing quality improvement programs.

A more powerful type of organizational change is **business process redesign**, in which business processes are analyzed, simplified, and redesigned. Business process redesign reorganizes workflows, combining steps to cut waste and eliminate repetitive, paper-intensive tasks. (Sometimes the new design eliminates jobs as well.) It is much more ambitious than rationalization of procedures, requiring a new vision of how the process is to be organized.

A widely cited example of business process redesign is Ford Motor Company's invoiceless processing, which reduced headcount in Ford's North American Accounts Payable organization of 500 people by 75 percent. Accounts payable clerks used to spend most of their time resolving discrepancies between purchase orders, receiving documents, and invoices. Ford redesigned its accounts payable process so that the purchasing department enters a purchase order into an online database that can be checked by the receiving department when the ordered items arrive. If the received goods match the purchase order, the system automatically generates a check for accounts payable to send to the vendor. There is no need for vendors to send invoices.

Rationalizing procedures and redesigning business processes are limited to specific parts of a business. New information systems can ultimately affect the design of the entire organization by transforming how the organization carries out its business or even the nature of the business. For instance, the long-haul trucking and transportation firm Schneider National used new information systems to change its business model. Schneider created a new business managing logistics for other companies. This more radical form of business change is called a **paradigm shift**. A paradigm shift involves rethinking the nature of the business and the nature of the organization.

Paradigm shifts and reengineering often fail because extensive organizational change is so difficult to orchestrate (see Chapter 14). Why, then, do so many corporations contemplate such radical change? Because the rewards are equally high (see Figure 13-1). In many instances, firms seeking paradigm shifts and pursuing reengineering strategies achieve stunning, order-of-magnitude increases in their returns on investment (or productivity). Some of these success stories, and some failure stories, are included throughout this book.

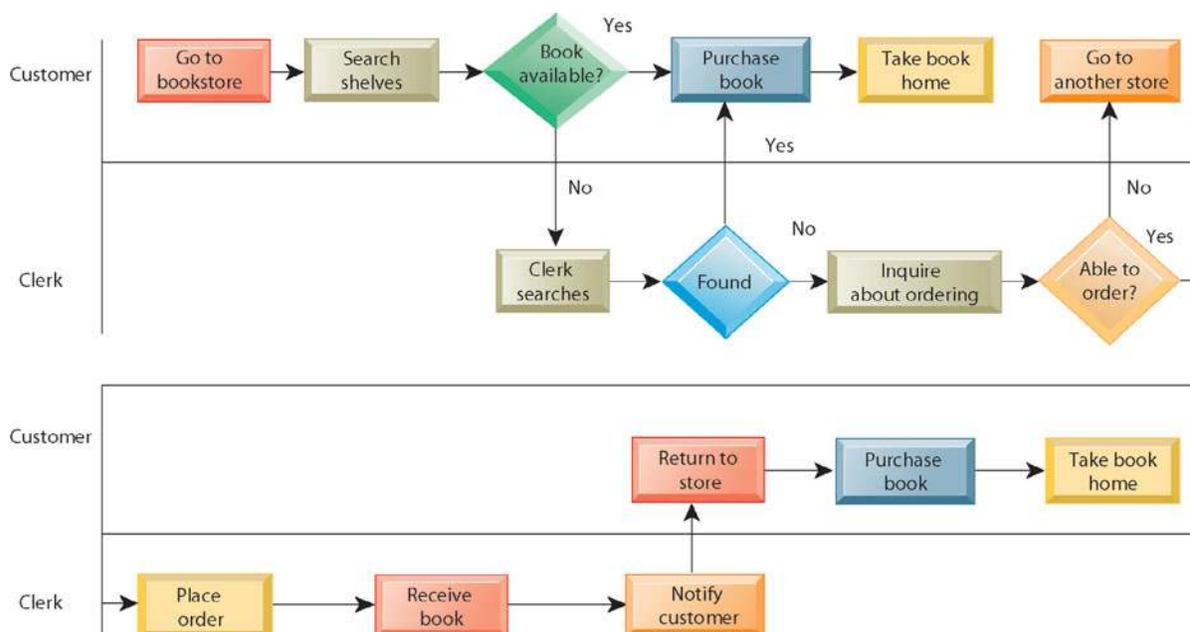
BUSINESS PROCESS REDESIGN

Like CIMB Group, described in the chapter-opening case, many businesses today are trying to use information technology to improve their business processes. Some of these systems entail incremental process change, but others require more far-reaching redesign of business processes. To deal with these changes, organizations are turning to business process management. **Business process management** provides a variety of tools and methodologies to analyze existing processes, design new processes, and optimize those processes. BPM is never concluded because process improvement requires continual change. Companies practicing business process management go through the following steps:

- 1. Identify processes for change:** One of the most important strategic decisions that a firm can make is not deciding how to use computers to improve business processes, but understanding what business processes need improvement. When systems are used to strengthen the wrong business model or business processes, the business can become more efficient at doing what it should not do. As a result, the firm becomes vulnerable to competitors who may have discovered the right business model. Considerable time and cost may also be spent improving business processes that have little impact on overall firm performance and revenue. Managers need to determine what business processes are the most important and how improving these processes will help business performance.
- 2. Analyze existing processes:** Existing business processes should be modeled and documented, noting inputs, outputs, resources, and the sequence of activities. The process design team identifies redundant steps, paper-intensive tasks, bottlenecks, and other inefficiencies.

Figure 13-2 illustrates the “as-is” process for purchasing a book from a physical bookstore. Consider what happens when a customer visits a physical book-

FIGURE 13-2 AS-IS BUSINESS PROCESS FOR PURCHASING A BOOK FROM A PHYSICAL BOOKSTORE



Purchasing a book from a physical bookstore requires many steps to be performed by both the seller and the customer.

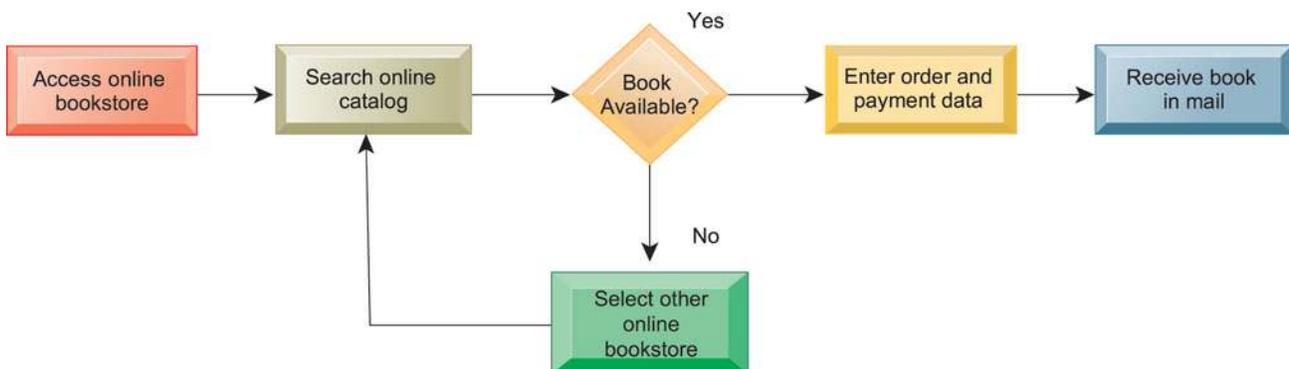
store and searches its shelves for a book. If he or she finds the book, that person takes it to the checkout counter and pays for it via credit card, cash, or check. If the customer is unable to locate the book, he or she must ask a bookstore clerk to search the shelves or check the bookstore's inventory records to see if it is in stock. If the clerk finds the book, the customer purchases it and leaves. If the book is not available locally, the clerk inquires about ordering it for the customer, from the bookstore's warehouse or from the book's distributor or publisher. Once the ordered book arrives at the bookstore, a bookstore employee telephones the customer with this information. The customer would have to go to the bookstore again to pick up the book and pay for it. If the bookstore is unable to order the book for the customer, the customer would have to try another bookstore. You can see that this process has many steps and might require the customer to make multiple trips to the bookstore.

3. Design the new process: Once the existing process is mapped and measured in terms of time and cost, the process design team will try to improve the process by designing a new one. A new streamlined "to-be" process will be documented and modeled for comparison with the old process.

Figure 13-3 illustrates how the book-purchasing process can be redesigned by taking advantage of the Internet. The customer accesses an online bookstore over the Internet from his or her computer. He or she searches the bookstore's online catalog for the book he or she wants. If the book is available, the customer orders the book online, supplying credit card and shipping address information, and the book is delivered to the customer's home. If the online bookstore does not carry the book, the customer selects another online bookstore and searches for the book again. This process has far fewer steps than that for purchasing the book in a physical bookstore, requires much less effort on the part of the customer, and requires less sales staff for customer service. The new process is therefore much more efficient and time-saving.

The new process design needs to be justified by showing how much it reduces time and cost or enhances customer service and value. Management first measures the time and cost of the existing process as a baseline. In our example, the time required for purchasing a book from a physical bookstore might range from 15 minutes (if the customer immediately finds what he or she wants) to 30 minutes if the book is in stock but has to be located by sales staff.

FIGURE 13-3 REDESIGNED PROCESS FOR PURCHASING A BOOK ONLINE



Using Internet technology makes it possible to redesign the process for purchasing a book so that it requires fewer steps and consumes fewer resources.

If the book has to be ordered from another source, the process might take one or two weeks and another trip to the bookstore for the customer. If the customer lives far away from the bookstore, the time to travel to the bookstore would have to be factored in. The bookstore will have to pay the costs for maintaining a physical store and keeping the book in stock, for sales staff on site, and for shipment costs if the book has to be obtained from another location.

The new process for purchasing a book online might only take several minutes, although the customer might have to wait several days or a week to receive the book in the mail and will have to pay a shipping charge. But the customer saves time and money by not having to travel to the bookstore or make additional visits to pick up the book. Booksellers' costs are lower because they do not have to pay for a physical store location or for local inventory.

4. Implement the new process: Once the new process has been thoroughly modeled and analyzed, it must be translated into a new set of procedures and work rules. New information systems or enhancements to existing systems may have to be implemented to support the redesigned process. The new process and supporting systems are rolled out into the business organization. As the business starts using this process, problems are uncovered and addressed. Employees working with the process may recommend improvements.

5. Continuous measurement: Once a process has been implemented and optimized, it needs to be continually measured. Why? Processes may deteriorate over time as employees fall back on old methods, or they may lose their effectiveness if the business experiences other changes.

Although many business process improvements are incremental and ongoing, there are occasions when more radical change must take place. Our example of a physical bookstore redesigning the book-purchasing process so that it can be carried out online is an example of this type of radical, far-reaching change. When properly implemented, business process redesign produces dramatic gains in productivity and efficiency, and may even change the way the business is run. In some instances, it drives a “paradigm shift” that transforms the nature of the business itself.

This actually happened in book retailing when Amazon challenged traditional physical bookstores with its online retail model. By radically rethinking the way a book can be purchased and sold, Amazon and other online bookstores have achieved remarkable efficiencies, cost reductions, and a whole new way of doing business.

BPM poses challenges. Executives report that the largest single barrier to successful business process change is organizational culture. Employees do not like unfamiliar routines and often try to resist change. This is especially true of projects where organizational changes are very ambitious and far-reaching. Managing change is neither simple nor intuitive, and companies committed to extensive process improvement need a good change management strategy (see Chapter 14).

Tools for Business Process Management

Over 100 software firms provide tools for various aspects of BPM, including IBM, Oracle, and TIBCO. These tools help businesses identify and document processes requiring improvement, create models of improved processes, capture and enforce business rules for performing processes, and integrate existing systems to support new or redesigned processes. BPM software tools also provide analytics for verifying that process performance has been

improved and for measuring the impact of process changes on key business performance indicators.

Some BPM tools document and monitor business processes to help firms identify inefficiencies, using software to connect with each of the systems a company uses for a particular process to identify trouble spots. Canadian mutual fund company AIC used Sajus BPM monitoring software to check inconsistencies in its process for updating accounts after each client transaction. Sajus specializes in “goal-based” process management, which focuses on finding the causes of organizational problems through process monitoring before applying tools to address those problems.

Another category of tools automate some parts of a business process and enforce business rules so that employees perform that process more consistently and efficiently.

For example, American National Insurance Company (ANCO), which offers life insurance, medical insurance, property casualty insurance, and investment services, used Pegasystems BPM workflow software to streamline customer service processes across four business groups. The software built rules to guide customer service representatives through a single view of a customer’s information that was maintained in multiple systems. By eliminating the need to juggle multiple applications simultaneously to handle customer and agent requests, the improved process increased customer service representative workload capacity by 192 percent.

A third category of tools helps businesses integrate their existing systems to support process improvements. They automatically manage processes across the business, extract data from various sources and databases, and generate transactions in multiple related systems. For example, the Star Alliance of 15 airlines, including United and Lufthansa, used BPM to create common processes shared by all of its members by integrating their existing systems. One project created a new service for frequent fliers on member airlines by consolidating 90 separate business processes across nine airlines and 27 legacy systems. The BPM software documented how each airline processed frequent flier information to help airline managers model a new business process that showed how to share data among the various systems.

The Interactive Session on Organizations describes how several companies used similar tools for their business process management programs. As you read this case, think about the kinds of changes the companies using these BPM tools were able to make in the way they ran their businesses.

13.2 OVERVIEW OF SYSTEMS DEVELOPMENT

New information systems are an outgrowth of a process of organizational problem solving. A new information system is built as a solution to some type of problem or set of problems the organization perceives it is facing. The problem may be one in which managers and employees realize that the organization is not performing as well as expected, or that the organization should take advantage of new opportunities to perform more successfully.

The activities that go into producing an information system solution to an organizational problem or opportunity are called **systems development**. Systems development is a structured kind of problem solved with distinct activities. These activities consist of systems analysis, systems design, programming, testing, conversion, and production and maintenance.

INTERACTIVE SESSION: ORGANIZATIONS

CAN BUSINESS PROCESS MANAGEMENT MAKE A DIFFERENCE?

If you're a large successful company, business process management might be just what you're looking for. AmerisourceBergen and Diebold Inc. are two examples. AmerisourceBergen is one of the world's largest pharmaceutical services companies and a member of the Fortune 25, with \$70 billion in revenue in 2009. It provides drug distribution and related services designed to reduce costs and improve patient outcomes, servicing both pharmaceutical manufacturers and healthcare providers.

Because it is so large, AmerisourceBergen has numerous and complicated relationships with manufacturers, pharmacies, and hospitals. Frequently changing business conditions cause contract prices to fluctuate. When they do, both the distributor and manufacturer need to analyze these changes and make sure they comply with their business rules and federal regulations. Managing these contract and pricing details associated with each of these relationships had been very time-consuming and paper-intensive, relying heavily on e-mail, telephone, fax, and postal mail. Many of these processes were redundant.

AmerisourceBergen's management believed the company had many old and inefficient business processes. After an extensive BPM vendor analysis, the company selected Metastorm BPM software. Metastorm BPM provides a complete set of tools for analyzing, managing, and redesigning business processes. Business professionals, managers, and information systems specialists are able to create rich graphical models of business processes as well as new user interfaces and business rules. Metastorm has an engine for deploying redesigned processes along with capabilities for integrating the processes it manages with external systems.

For its first BPM project, AmerisourceBergen decided to automate and implement an online collaborative contract and chargeback process, which is responsible for a \$10 billion annual cash flow. This process drives the establishment of pricing and terms with each of the company's manufacturers and also controls compliance with pricing terms and the payment of rebates from the manufacturer if the company is forced to sell at a lower price to compete. Any disputes or inaccurate pricing data create costly delays in obtaining the refunds the company is owed.

Metastorm BPM makes it possible for all contract changes to be recorded into the system and validated against internal business rules, and also enables AmerisourceBergen to link with its trading partners for collaborative BPM. All contract information is housed in a single repository, making it much easier to investigate chargebacks and communicate contract and pricing information with trading partners and among internal departments.

The BPM project was successful and resulted in lower headcount, fewer disputes, more accurate pricing information, and a high return on investment. This early success encouraged the company to expand BPM to other areas of the business and use it to support a broader business transformation program. AmerisourceBergen used Metastorm BPM to create six new specialized processes for managing and automating high-volume, highly specialized supplier credits which interface with its SAP enterprise system.

To meet federal and industry-specific regulations, AmerisourceBergen must carefully track and match all direct, indirect, and third-party credits with the appropriate product inflows and outflows. The company used Metastorm BPM to create specialized processes that interface with SAP, including the ability to receive, track, reconcile, and expedite all credit variances, such as discrepancies in invoices and purchase orders. After the SAP system identifies the variances, it passes credits to Metastorm BPM for exception handling, resolution, and reconciliation with master credit data. Reconciled credits are then returned to the SAP system. More than 1.2 million credit/debit adjustment documents and paper-based credits are seamlessly passed between Metastorm and SAP this way.

To date, AmerisourceBergen has automated nearly 300 processes, benefiting from more efficient and accurate record tracking, faster turnaround times, greater management into key performance indicators, and an online audit trail of all activities. AmerisourceBergen's BPM projects had such positive outcomes that the company won a Global Excellence in BPM and Workflow award in 2009.

Diebold, Inc. is another recent convert to business process management. Diebold is a global leader in integrated self-service delivery and security systems

and services, with 17,000 associates across 90 countries. The company makes, installs, and services ATMs, vaults, currency-processing systems, and other security equipment used in financial, retail, and government markets. Diebold hoped to use business process management to understand and improve its order fulfillment process. The company selected Progress Savvion's BusinessManager BPM solution for this task.

BusinessManager provides a platform for defining an organization's business processes and deploying those processes as Web-accessible applications. The platform gives managers real-time visibility to monitor, analyze, control, and improve the execution of those processes and can integrate these processes with existing operational systems. BusinessManager receives and organizes data from multiple sources to provide a more complete view of the Diebold order process. Diebold managers are able to track orders in

real time at any step in the process and also predict future performance based on past data. Since the tool enables managers to learn how long each step of the process usually takes, they can forecast where orders ought to be and compare that with where the system says the orders actually are. BusinessManager can detect whether production of an item is complete and where specific items are located.

Pleased with these capabilities, Diebold immediately used BusinessManager for other processes, such as issue resolution. The system aggregates input from various sources, such as workers in the field and in factories. Diebold is now able to quickly identify issues raised by employees and customers and determine how long it takes to resolve them.

Sources: Judith Lamont, "BPM, Enterprisewide and Beyond," *KMWorld*, February 1, 2010; "Customer Success Story: AmerisourceBergen," www.metastorm.com, accessed November 4, 2010; and www.progress.com, accessed November 4, 2010.

CASE STUDY QUESTIONS

1. Why are large companies such as AmerisourceBergen and Diebold good candidates for business process management?
2. What were the business benefits for each company from redesigning and managing their business processes?
3. How did BPM change the way these companies ran their businesses?
4. What might be some of the problems with extending BPM software across a large number of business processes?
5. What companies stand to gain the most by implementing BPM?

MIS IN ACTION

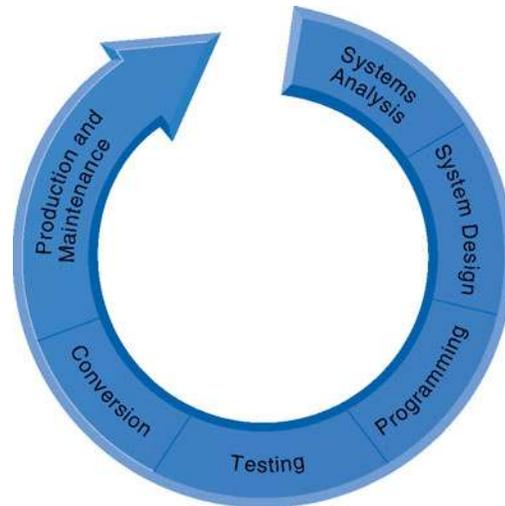
Search online for "BPM software provider" or "enterprise-wide BPM" and visit the Web site of a major BPM vendor not mentioned in this case. Then answer the following questions:

1. What types of companies have benefited from this software?
2. What are some of the important functionalities of the BPM products offered?
3. Would this company have been a better fit than Savvion or Metastorm for Diebold or AmerisourceBergen, respectively? Why or why not?

Figure 13-4 illustrates the systems development process. The systems development activities depicted usually take place in sequential order. But some of the activities may need to be repeated or some may take place simultaneously, depending on the approach to system building that is being employed (see Section 13.4).

SYSTEMS ANALYSIS

Systems analysis is the analysis of a problem that a firm tries to solve with an information system. It consists of defining the problem, identifying its causes,

FIGURE 13-4 THE SYSTEMS DEVELOPMENT PROCESS

Building a system can be broken down into six core activities.

specifying the solution, and identifying the information requirements that must be met by a system solution.

The systems analyst creates a road map of the existing organization and systems, identifying the primary owners and users of data along with existing hardware and software. The systems analyst then details the problems of existing systems. By examining documents, work papers, and procedures; observing system operations; and interviewing key users of the systems, the analyst can identify the problem areas and objectives a solution would achieve. Often the solution requires building a new information system or improving an existing one.

The systems analysis also includes a **feasibility study** to determine whether that solution is feasible, or achievable, from a financial, technical, and organizational standpoint. The feasibility study determines whether the proposed system is expected to be a good investment, whether the technology needed for the system is available and can be handled by the firm's information systems specialists, and whether the organization can handle the changes introduced by the system.

Normally, the systems analysis process identifies several alternative solutions that the organization can pursue and assess the feasibility of each. A written systems proposal report describes the costs and benefits, and the advantages and disadvantages, of each alternative. It is up to management to determine which mix of costs, benefits, technical features, and organizational impacts represents the most desirable alternative.

Establishing Information Requirements

Perhaps the most challenging task of the systems analyst is to define the specific information requirements that must be met by the chosen system solution. At the most basic level, the **information requirements** of a new system involve identifying who needs what information, where, when, and how. Requirements analysis carefully defines the objectives of the new or modified system and develops a detailed description of the functions that the new system must perform. Faulty requirements analysis is a leading cause of systems failure and high systems development costs (see Chapter 14). A system

designed around the wrong set of requirements will either have to be discarded because of poor performance or will need to undergo major modifications. Section 13.3 describes alternative approaches to eliciting requirements that help minimize this problem.

Some problems do not require an information system solution but instead need an adjustment in management, additional training, or refinement of existing organizational procedures. If the problem is information related, systems analysis still may be required to diagnose the problem and arrive at the proper solution.

SYSTEMS DESIGN

Systems analysis describes what a system should do to meet information requirements, and **systems design** shows how the system will fulfill this objective. The design of an information system is the overall plan or model for that system. Like the blueprint of a building or house, it consists of all the specifications that give the system its form and structure.

The systems designer details the system specifications that will deliver the functions identified during systems analysis. These specifications should address all of the managerial, organizational, and technological components of the system solution. Table 13-1 lists the types of specifications that would be produced during systems design.

Like houses or buildings, information systems may have many possible designs. Each design represents a unique blend of all technical and organizational components. What makes one design superior to others is the ease and efficiency with which it fulfills user requirements within a specific set of technical, organizational, financial, and time constraints.

TABLE 13-1 DESIGN SPECIFICATIONS

OUTPUT

Medium
Content
Timing

INPUT

Origins
Flow
Data entry

USER INTERFACE

Simplicity
Efficiency
Logic
Feedback
Errors

DATABASE DESIGN

Logical data model
Volume and speed requirements
File organization and design
Record specifications

PROCESSING

Computations
Program modules
Required reports
Timing of outputs

MANUAL PROCEDURES

What activities
Who performs them
When
How
Where

CONTROLS

Input controls (characters, limit, reasonableness)
Processing controls (consistency, record counts)
Output controls (totals, samples of output)
Procedural controls (passwords, special forms)

SECURITY

Access controls
Catastrophe plans
Audit trails

DOCUMENTATION

Operations documentation
Systems documentation
User documentation

CONVERSION

Transfer files
Initiate new procedures
Select testing method
Cut over to new system

TRAINING

Select training techniques
Develop training modules
Identify training facilities

ORGANIZATIONAL CHANGES

Task redesign
Job design
Process design
Organization structure design
Reporting relationships

The Role of End Users

User information requirements drive the entire system-building effort. Users must have sufficient control over the design process to ensure that the system reflects their business priorities and information needs, not the biases of the technical staff. Working on design increases users' understanding and acceptance of the system. As we describe in Chapter 14, insufficient user involvement in the design effort is a major cause of system failure. However, some systems require more user participation in design than others, and Section 13.3 shows how alternative systems development methods address the user participation issue.

COMPLETING THE SYSTEMS DEVELOPMENT PROCESS

The remaining steps in the systems development process translate the solution specifications established during systems analysis and design into a fully operational information system. These concluding steps consist of programming, testing, conversion, production, and maintenance.

Programming

During the **programming** stage, system specifications that were prepared during the design stage are translated into software program code. Today, many organizations no longer do their own programming for new systems. Instead, they purchase the software that meets the requirements for a new system from external sources such as software packages from a commercial software vendor, software services from an application service provider, or outsourcing firms that develop custom application software for their clients (see Section 13.3).

Testing

Exhaustive and thorough **testing** must be conducted to ascertain whether the system produces the right results. Testing answers the question, "Will the system produce the desired results under known conditions?" As Chapter 5 noted, some companies are starting to use cloud computing services for this work.

The amount of time needed to answer this question has been traditionally underrated in systems project planning (see Chapter 14). Testing is time-consuming: Test data must be carefully prepared, results reviewed, and corrections made in the system. In some instances, parts of the system may have to be redesigned. The risks resulting from glossing over this step are enormous.

Testing an information system can be broken down into three types of activities: unit testing, system testing, and acceptance testing. **Unit testing**, or program testing, consists of testing each program separately in the system. It is widely believed that the purpose of such testing is to guarantee that programs are error-free, but this goal is realistically impossible. Testing should be viewed instead as a means of locating errors in programs, focusing on finding all the ways to make a program fail. Once they are pinpointed, problems can be corrected.

System testing tests the functioning of the information system as a whole. It tries to determine whether discrete modules will function together as planned and whether discrepancies exist between the way the system actually works and the way it was conceived. Among the areas examined are performance time, capacity for file storage and handling peak loads, recovery and restart capabilities, and manual procedures.

Acceptance testing provides the final certification that the system is ready to be used in a production setting. Systems tests are evaluated by users and

reviewed by management. When all parties are satisfied that the new system meets their standards, the system is formally accepted for installation.

The systems development team works with users to devise a systematic test plan. The **test plan** includes all of the preparations for the series of tests we have just described.

Figure 13-5 shows an example of a test plan. The general condition being tested is a record change. The documentation consists of a series of test plan screens maintained on a database (perhaps a PC database) that is ideally suited to this kind of application.

Conversion is the process of changing from the old system to the new system. Four main conversion strategies can be employed: the parallel strategy, the direct cutover strategy, the pilot study strategy, and the phased approach strategy.

In a **parallel strategy**, both the old system and its potential replacement are run together for a time until everyone is assured that the new one functions correctly. This is the safest conversion approach because, in the event of errors or processing disruptions, the old system can still be used as a backup. However, this approach is very expensive, and additional staff or resources may be required to run the extra system.

The **direct cutover strategy** replaces the old system entirely with the new system on an appointed day. It is a very risky approach that can potentially be more costly than running two systems in parallel if serious problems with the new system are found. There is no other system to fall back on. Dislocations, disruptions, and the cost of corrections may be enormous.

The **pilot study strategy** introduces the new system to only a limited area of the organization, such as a single department or operating unit. When this pilot version is complete and working smoothly, it is installed throughout the rest of the organization, either simultaneously or in stages.

The **phased approach strategy** introduces the new system in stages, either by functions or by organizational units. If, for example, the system is

FIGURE 13-5 A SAMPLE TEST PLAN TO TEST A RECORD CHANGE

Procedure		Address and Maintenance "Record Change Series"		Test Series 2		
Prepared By:		Date:		Version:		
Test Ref.	Condition Tested	Special Requirements	Expected Results	Output On	Next Screen	
2.0	Change records					
2.1	Change existing record	Key field	Not allowed			
2.2	Change nonexistent record	Other fields	"Invalid key" message			
2.3	Change deleted record	Deleted record must be available	"Deleted" message			
2.4	Make second record	Change 2.1 above	OK if valid	Transaction file	V45	
2.5	Insert record		OK if valid	Transaction file	V45	
2.6	Abort during change	Abort 2.5	No change	Transaction file	V45	

When developing a test plan, it is imperative to include the various conditions to be tested, the requirements for each condition tested, and the expected results. Test plans require input from both end users and information systems specialists.

introduced by function, a new payroll system might begin with hourly workers who are paid weekly, followed six months later by adding salaried employees (who are paid monthly) to the system. If the system is introduced by organizational unit, corporate headquarters might be converted first, followed by outlying operating units four months later.

Moving from an old system to a new one requires that end users be trained to use the new system. Detailed **documentation** showing how the system works from both a technical and end-user standpoint is finalized during conversion time for use in training and everyday operations. Lack of proper training and documentation contributes to system failure, so this portion of the systems development process is very important.

Production and Maintenance

After the new system is installed and conversion is complete, the system is said to be in **production**. During this stage, the system will be reviewed by both users and technical specialists to determine how well it has met its original objectives and to decide whether any revisions or modifications are in order. In some instances, a formal **postimplementation audit** document is prepared. After the system has been fine-tuned, it must be maintained while it is in production to correct errors, meet requirements, or improve processing efficiency. Changes in hardware, software, documentation, or procedures to a production system to correct errors, meet new requirements, or improve processing efficiency are termed **maintenance**.

Approximately 20 percent of the time devoted to maintenance is used for debugging or correcting emergency production problems. Another 20 percent is concerned with changes in data, files, reports, hardware, or system software. But 60 percent of all maintenance work consists of making user enhancements, improving documentation, and recoding system components for greater processing efficiency. The amount of work in the third category of maintenance problems could be reduced significantly through better systems analysis and design practices. Table 13-2 summarizes the systems development activities.

TABLE 13-2 SYSTEMS DEVELOPMENT

CORE ACTIVITY	DESCRIPTION
Systems analysis	Identify problem(s) Specify solutions Establish information requirements
Systems design	Create design specifications
Programming	Translate design specifications into program code
Testing	Perform unit testing Perform systems testing Perform testing
Conversion	Plan conversion Prepare documentation Train users and technical staff
Production and maintenance	Operate the system Evaluate the system Modify the system

MODELING AND DESIGNING SYSTEMS: STRUCTURED AND OBJECT-ORIENTED METHODOLOGIES

There are alternative methodologies for modeling and designing systems. Structured methodologies and object-oriented development are the most prominent.

Structured Methodologies

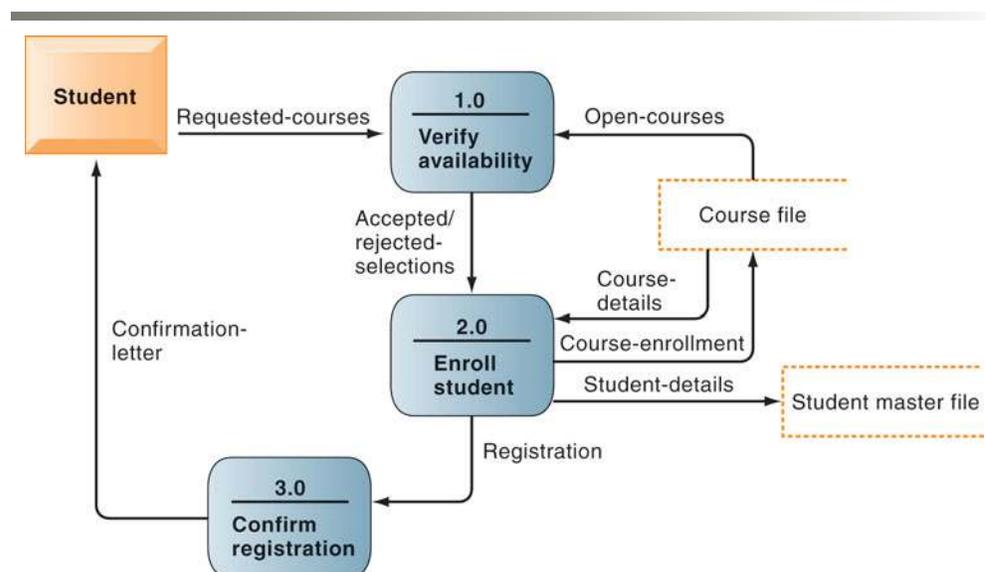
Structured methodologies have been used to document, analyze, and design information systems since the 1970s. **Structured** refers to the fact that the techniques are step by step, with each step building on the previous one. Structured methodologies are top-down, progressing from the highest, most abstract level to the lowest level of detail—from the general to the specific.

Structured development methods are process-oriented, focusing primarily on modeling the processes, or actions that capture, store, manipulate, and distribute data as the data flow through a system. These methods separate data from processes. A separate programming procedure must be written every time someone wants to take an action on a particular piece of data. The procedures act on data that the program passes to them.

The primary tool for representing a system's component processes and the flow of data between them is the **data flow diagram (DFD)**. The data flow diagram offers a logical graphic model of information flow, partitioning a system into modules that show manageable levels of detail. It rigorously specifies the processes or transformations that occur within each module and the interfaces that exist between them.

Figure 13-6 shows a simple data flow diagram for a mail-in university course registration system. The rounded boxes represent processes, which portray the

FIGURE 13-6 DATA FLOW DIAGRAM FOR MAIL-IN UNIVERSITY REGISTRATION SYSTEM



The system has three processes: Verify availability (1.0), Enroll student (2.0), and Confirm registration (3.0). The name and content of each of the data flows appear adjacent to each arrow. There is one external entity in this system: the student. There are two data stores: the student master file and the course file.

transformation of data. The square box represents an external entity, which is an originator or receiver of information located outside the boundaries of the system being modeled. The open rectangles represent data stores, which are either manual or automated inventories of data. The arrows represent data flows, which show the movement between processes, external entities, and data stores. They contain packets of data with the name or content of each data flow listed beside the arrow.

This data flow diagram shows that students submit registration forms with their name, identification number, and the numbers of the courses they wish to take. In process 1.0, the system verifies that each course selected is still open by referencing the university's course file. The file distinguishes courses that are open from those that have been canceled or filled. Process 1.0 then determines which of the student's selections can be accepted or rejected. Process 2.0 enrolls the student in the courses for which he or she has been accepted. It updates the university's course file with the student's name and identification number and recalculates the class size. If maximum enrollment has been reached, the course number is flagged as closed. Process 2.0 also updates the university's student master file with information about new students or changes in address. Process 3.0 then sends each student applicant a confirmation-of-registration letter listing the courses for which he or she is registered and noting the course selections that could not be fulfilled.

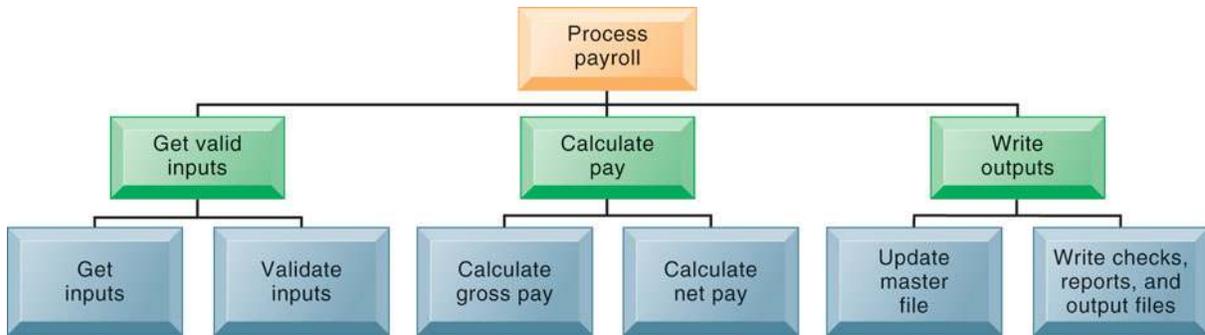
The diagrams can be used to depict higher-level processes as well as lower-level details. Through leveled data flow diagrams, a complex process can be broken down into successive levels of detail. An entire system can be divided into subsystems with a high-level data flow diagram. Each subsystem, in turn, can be divided into additional subsystems with second-level data flow diagrams, and the lower-level subsystems can be broken down again until the lowest level of detail has been reached.

Another tool for structured analysis is a data dictionary, which contains information about individual pieces of data and data groupings within a system (see Chapter 6). The data dictionary defines the contents of data flows and data stores so that systems builders understand exactly what pieces of data they contain. **Process specifications** describe the transformation occurring within the lowest level of the data flow diagrams. They express the logic for each process.

In structured methodology, software design is modeled using hierarchical structure charts. The **structure chart** is a top-down chart, showing each level of design, its relationship to other levels, and its place in the overall design structure. The design first considers the main function of a program or system, then breaks this function into subfunctions, and decomposes each subfunction until the lowest level of detail has been reached. Figure 13-7 shows a high-level structure chart for a payroll system. If a design has too many levels to fit onto one structure chart, it can be broken down further on more detailed structure charts. A structure chart may document one program, one system (a set of programs), or part of one program.

Object-Oriented Development

Structured methods are useful for modeling processes, but do not handle the modeling of data well. They also treat data and processes as logically separate entities, whereas in the real world such separation seems unnatural. Different modeling conventions are used for analysis (the data flow diagram) and for design (the structure chart).

FIGURE 13-7 HIGH-LEVEL STRUCTURE CHART FOR A PAYROLL SYSTEM

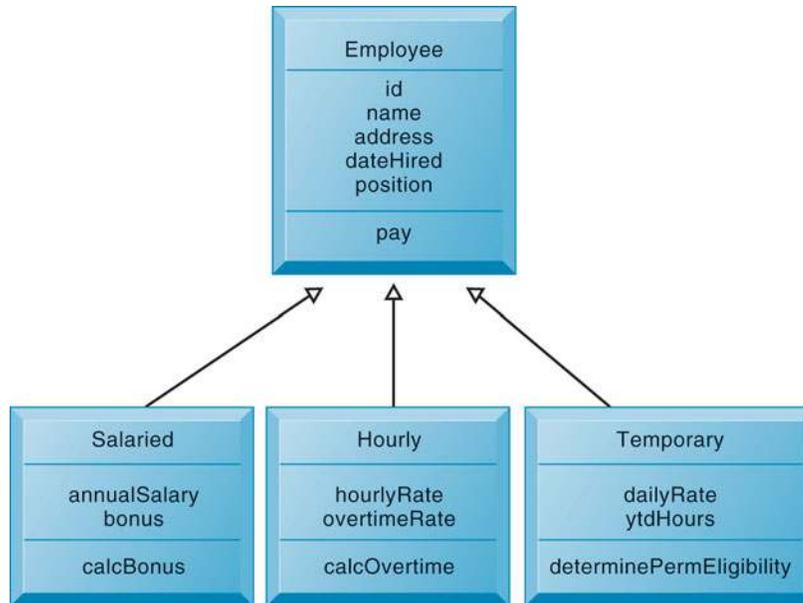
This structure chart shows the highest or most abstract level of design for a payroll system, providing an overview of the entire system.

Object-oriented development addresses these issues. Object-oriented development uses the **object** as the basic unit of systems analysis and design. An object combines data and the specific processes that operate on those data. Data encapsulated in an object can be accessed and modified only by the operations, or methods, associated with that object. Instead of passing data to procedures, programs send a message for an object to perform an operation that is already embedded in it. The system is modeled as a collection of objects and the relationships among them. Because processing logic resides within objects rather than in separate software programs, objects must collaborate with each other to make the system work.

Object-oriented modeling is based on the concepts of *class* and *inheritance*. Objects belonging to a certain class, or general categories of similar objects, have the features of that class. Classes of objects in turn can inherit all the structure and behaviors of a more general class and then add variables and behaviors unique to each object. New classes of objects are created by choosing an existing class and specifying how the new class differs from the existing class, instead of starting from scratch each time.

We can see how class and inheritance work in Figure 13-8, which illustrates the relationships among classes concerning employees and how they are paid. Employee is the common ancestor, or superclass, for the other three classes. Salaried, Hourly, and Temporary are subclasses of Employee. The class name is in the top compartment, the attributes for each class are in the middle portion of each box, and the list of operations is in the bottom portion of each box. The features that are shared by all employees (id, name, address, date hired, position, and pay) are stored in the Employee superclass, whereas each subclass stores features that are specific to that particular type of employee. Specific to hourly employees, for example, are their hourly rates and overtime rates. A solid line from the subclass to the superclass is a generalization path showing that the subclasses Salaried, Hourly, and Temporary have common features that can be generalized into the superclass Employee.

Object-oriented development is more iterative and incremental than traditional structured development. During analysis, systems builders document the functional requirements of the system, specifying its most important properties and what the proposed system must do. Interactions between the system and its users are analyzed to identify objects, which include both data and processes. The object-oriented design phase describes how the objects will

FIGURE 13-8 CLASS AND INHERITANCE

This figure illustrates how classes inherit the common features of their superclass.

behave and how they will interact with one other. Similar objects are grouped together to form a class, and classes are grouped into hierarchies in which a subclass inherits the attributes and methods from its superclass.

The information system is implemented by translating the design into program code, reusing classes that are already available in a library of reusable software objects and adding new ones created during the object-oriented design phase. Implementation may also involve the creation of an object-oriented database. The resulting system must be thoroughly tested and evaluated.

Because objects are reusable, object-oriented development could potentially reduce the time and cost of writing software because organizations can reuse software objects that have already been created as building blocks for other applications. New systems can be created by using some existing objects, changing others, and adding a few new objects. Object-oriented frameworks have been developed to provide reusable, semicomplete applications that the organization can further customize into finished applications.

Computer-Aided Software Engineering

Computer-aided software engineering (CASE)—sometimes called *computer-aided systems engineering*—provides software tools to automate the methodologies we have just described to reduce the amount of repetitive work the developer needs to do. CASE tools also facilitate the creation of clear documentation and the coordination of team development efforts. Team members can share their work easily by accessing each other's files to review or modify what has been done. Modest productivity benefits can also be achieved if the tools are used properly.

CASE tools provide automated graphics facilities for producing charts and diagrams, screen and report generators, data dictionaries, extensive reporting facilities, analysis and checking tools, code generators, and documentation generators. In general, CASE tools try to increase productivity and quality by :

- Enforcing a standard development methodology and design discipline
- Improving communication between users and technical specialists
- Organizing and correlating design components and providing rapid access to them using a design repository
- Automating tedious and error-prone portions of analysis and design
- Automating code generation and testing and control rollout

CASE tools contain features for validating design diagrams and specifications. CASE tools thus support iterative design by automating revisions and changes and providing prototyping facilities. A CASE information repository stores all the information defined by the analysts during the project. The repository includes data flow diagrams, structure charts, entity-relationship diagrams, data definitions, process specifications, screen and report formats, notes and comments, and test results.

To be used effectively, CASE tools require organizational discipline. Every member of a development project must adhere to a common set of naming conventions and standards as well as to a development methodology. The best CASE tools enforce common methods and standards, which may discourage their use in situations where organizational discipline is lacking.

13.3 ALTERNATIVE SYSTEMS-BUILDING APPROACHES

Systems differ in terms of their size and technological complexity and in terms of the organizational problems they are meant to solve. A number of systems-building approaches have been developed to deal with these differences. This section describes these alternative methods: the traditional systems life cycle, prototyping, application software packages, end-user development, and outsourcing.

TRADITIONAL SYSTEMS LIFE CYCLE

The **systems life cycle** is the oldest method for building information systems. The life cycle methodology is a phased approach to building a system, dividing systems development into formal stages. Systems development specialists have different opinions on how to partition the systems-building stages, but they roughly correspond to the stages of systems development that we have just described.

The systems life cycle methodology maintains a very formal division of labor between end users and information systems specialists. Technical specialists, such as system analysts and programmers, are responsible for much of the systems analysis, design, and implementation work; end users are limited to providing information requirements and reviewing the technical staff's work. The life cycle also emphasizes formal specifications and paperwork, so many documents are generated during the course of a systems project.

The systems life cycle is still used for building large complex systems that require a rigorous and formal requirements analysis, predefined specifications, and tight controls over the system-building process. However, the systems life cycle approach can be costly, time-consuming, and inflexible. Although systems builders can go back and forth among stages in the life cycle, the systems life cycle is predominantly a “waterfall” approach

in which tasks in one stage are completed before work for the next stage begins. Activities can be repeated, but volumes of new documents must be generated and steps retraced if requirements and specifications need to be revised. This encourages freezing of specifications relatively early in the development process. The life cycle approach is also not suitable for many small desktop systems, which tend to be less structured and more individualized.

PROTOTYPING

Prototyping consists of building an experimental system rapidly and inexpensively for end users to evaluate. By interacting with the prototype, users can get a better idea of their information requirements. The prototype endorsed by the users can be used as a template to create the final system.

The **prototype** is a working version of an information system or part of the system, but it is meant to be only a preliminary model. Once operational, the prototype will be further refined until it conforms precisely to users' requirements. Once the design has been finalized, the prototype can be converted to a polished production system.

The process of building a preliminary design, trying it out, refining it, and trying again has been called an **iterative** process of systems development because the steps required to build a system can be repeated over and over again. Prototyping is more explicitly iterative than the conventional life cycle, and it actively promotes system design changes. It has been said that prototyping replaces unplanned rework with planned iteration, with each version more accurately reflecting users' requirements.

Steps in Prototyping

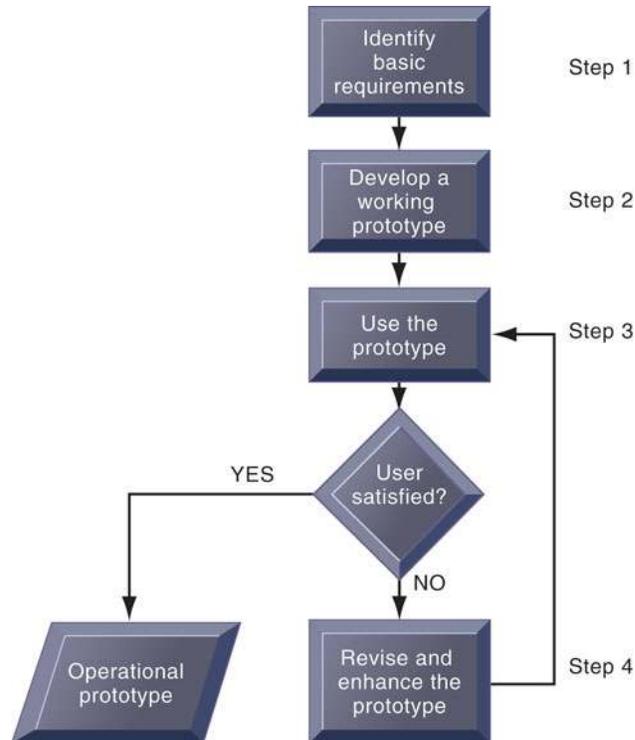
Figure 13-9 shows a four-step model of the prototyping process, which consists of the following:

- Step 1: Identify the user's basic requirements.* The system designer (usually an information systems specialist) works with the user only long enough to capture the user's basic information needs.
- Step 2: Develop an initial prototype.* The system designer creates a working prototype quickly, using tools for rapidly generating software.
- Step 3: Use the prototype.* The user is encouraged to work with the system to determine how well the prototype meets his or her needs and to make suggestions for improving the prototype.
- Step 4: Revise and enhance the prototype.* The system builder notes all changes the user requests and refines the prototype accordingly. After the prototype has been revised, the cycle returns to Step 3. Steps 3 and 4 are repeated until the user is satisfied.

When no more iterations are required, the approved prototype then becomes an operational prototype that furnishes the final specifications for the application. Sometimes the prototype is adopted as the production version of the system.

Advantages and Disadvantages of Prototyping

Prototyping is most useful when there is some uncertainty about requirements or design solutions and often used for designing an information system's **end-user interface** (the part of the system with which end users interact, such as online display and data entry screens, reports, or Web pages). Because prototyping encourages intense end-user involvement throughout the systems

FIGURE 13-9 THE PROTOTYPING PROCESS

The process of developing a prototype can be broken down into four steps. Because a prototype can be developed quickly and inexpensively, systems builders can go through several iterations, repeating steps 3 and 4, to refine and enhance the prototype before arriving at the final operational one.

development life cycle, it is more likely to produce systems that fulfill user requirements.

However, rapid prototyping can gloss over essential steps in systems development. If the completed prototype works reasonably well, management may not see the need for reprogramming, redesign, or full documentation and testing to build a polished production system. Some of these hastily constructed systems may not easily accommodate large quantities of data or a large number of users in a production environment.

END-USER DEVELOPMENT

Some types of information systems can be developed by end users with little or no formal assistance from technical specialists. This phenomenon is called **end-user development**. A series of software tools categorized as fourth-generation languages makes this possible. **Fourth-generation languages** are software tools that enable end users to create reports or develop software applications with minimal or no technical assistance. Some of these fourth-generation tools also enhance professional programmers' productivity.

Fourth-generation languages tend to be nonprocedural, or less procedural, than conventional programming languages. Procedural languages require specification of the sequence of steps, or procedures, that tell the computer what to do and how to do it. Nonprocedural languages need only specify what has to be accomplished rather than provide details about how to carry out the task.

Table 13-3 shows that there are seven categories of fourth-generation languages: PC software tools, query languages, report generators, graphics languages, application generators, application software packages, and very high-level programming languages. The table shows the tools ordered in terms of ease of use by nonprogramming end users. End users are most likely to work with PC software tools and query languages. **Query languages** are software tools that provide immediate online answers to requests for information that are not predefined, such as “Who are the highest-performing sales representatives?” Query languages are often tied to data management software and to database management systems (see Chapter 6).

On the whole, end-user-developed systems can be completed more rapidly than those developed through the conventional systems life cycle. Allowing users to specify their own business needs improves requirements gathering and often leads to a higher level of user involvement and satisfaction with the system. However, fourth-generation tools still cannot replace conventional tools for some business applications because they cannot easily handle the processing of large numbers of transactions or applications with extensive procedural logic and updating requirements.

TABLE 13-3 CATEGORIES OF FOURTH-GENERATION LANGUAGES

FOURTH-GENERATION TOOL	DESCRIPTION	EXAMPLE	
PC software tools	General-purpose application software packages for PCs.	WordPerfect Microsoft Access	<p style="text-align: center;">Oriented toward end users</p> 
Query language	Languages for retrieving data stored in databases or files. Capable of supporting requests for information that are not predefined.	SQL	
Report generator	Extract data from files or databases to create customized reports in a wide range of formats not routinely produced by an information system. Generally provide more control over the way data are formatted, organized, and displayed than query languages.	Crystal Reports	
Graphics language	Retrieve data from files or databases and display them in graphic format. Some graphics software can perform arithmetic or logical operations on data as well.	SAS/GRAPH Systat	
Application generator	Contain preprogrammed modules that can generate entire applications, including Web sites, greatly speeding development. A user can specify what needs to be done, and the application generator will create the appropriate program code for input, validation, update, processing, and reporting.	WebFOCUS QuickBase	
Application software package	Software programs sold or leased by commercial vendors that eliminate the need for custom-written, in-house software.	Oracle PeopleSoft HCM mySAP ERP	
Very high-level programming language	Generate program code with fewer instructions than conventional languages, such as COBOL or FORTRAN. Designed primarily as productivity tools for professional programmers.	APL Nomad2	

End-user computing also poses organizational risks because it occurs outside of traditional mechanisms for information systems management and control. When systems are created rapidly, without a formal development methodology, testing and documentation may be inadequate. Control over data can be lost in systems outside the traditional information systems department. To help organizations maximize the benefits of end-user applications development, management should control the development of end-user applications by requiring cost justification of end-user information system projects and by establishing hardware, software, and quality standards for user-developed applications.

APPLICATION SOFTWARE PACKAGES AND OUTSOURCING

Chapter 5 points out that much of today's software is not developed in-house but is purchased from external sources. Firms can rent the software from a software service provider, they can purchase a software package from a commercial vendor, or they can have a custom application developed by an outside outsourcing firm.

Application Software Packages

During the past several decades, many systems have been built on an application software package foundation. Many applications are common to all business organizations—for example, payroll, accounts receivable, general ledger, or inventory control. For such universal functions with standard processes that do not change a great deal over time, a generalized system will fulfill the requirements of many organizations.

If a software package can fulfill most of an organization's requirements, the company does not have to write its own software. The company can save time and money by using the prewritten, predesigned, pretested software programs from the package. Package vendors supply much of the ongoing maintenance and support for the system, including enhancements to keep the system in line with ongoing technical and business developments.

If an organization has unique requirements that the package does not address, many packages include capabilities for customization. **Customization** features allow a software package to be modified to meet an organization's unique requirements without destroying the integrity of the packaged software. If a great deal of customization is required, additional programming and customization work may become so expensive and time-consuming that they negate many of the advantages of software packages.

When a system is developed using an application software package, systems analysis will include a package evaluation effort. The most important evaluation criteria are the functions provided by the package, flexibility, user friendliness, hardware and software resources, database requirements, installation and maintenance efforts, documentation, vendor quality, and cost. The package evaluation process often is based on a **Request for Proposal (RFP)**, which is a detailed list of questions submitted to packaged-software vendors.

When a software package is selected, the organization no longer has total control over the system design process. Instead of tailoring the system design specifications directly to user requirements, the design effort will consist of trying to mold user requirements to conform to the features of the package. If the organization's requirements conflict with the way the package works and the

package cannot be customized, the organization will have to adapt to the package and change its procedures.

The Interactive Session on Technology describes the experience of Zimbra, a software company that selected a software package solution for its new marketing automation system. As you read this case, be aware of the management, technology, and organization issues that had to be addressed when the company selected a new software package solution.

Outsourcing

If a firm does not want to use its internal resources to build or operate information systems, it can outsource the work to an external organization that specializes in providing these services. Cloud computing and SaaS providers, which we described in Chapter 5, are one form of outsourcing. Subscribing companies would use the software and computer hardware provided by the service as the technical platform for their systems. In another form of outsourcing, a company could hire an external vendor to design and create the software for its system, but that company would operate the system on its own computers. The outsourcing vendor might be domestic or in another country.

Domestic outsourcing is driven primarily by the fact that outsourcing firms possess skills, resources, and assets that their clients do not have. Installing a new supply chain management system in a very large company might require hiring an additional 30 to 50 people with specific expertise in supply chain management software, licensed from a vendor. Rather than hire permanent new employees, most of whom would need extensive training in the software package, and then release them after the new system is built, it makes more sense, and is often less expensive, to outsource this work for a 12-month period.

In the case of **offshore outsourcing**, the decision tends to be much more cost-driven. A skilled programmer in India or Russia earns about USD \$9,000 per year, compared to \$65,000 per year for a comparable programmer in the United States. The Internet and low-cost communications technology have drastically reduced the expense and difficulty of coordinating the work of global teams in faraway locations. In addition to cost savings, many offshore outsourcing firms offer world-class technology assets and skills. Wage inflation outside the United States has recently eroded some of these advantages, and some jobs have moved back to the United States.

Nevertheless, there is a very strong chance that at some point in your career, you'll be working with offshore outsourcers or global teams. Your firm is most likely to benefit from outsourcing if it takes the time to evaluate all the risks and to make sure outsourcing is appropriate for its particular needs. Any company that outsources its applications must thoroughly understand the project, including its requirements, method of implementation, anticipated benefits, cost components, and metrics for measuring performance.

Many firms underestimate costs for identifying and evaluating vendors of information technology services, for transitioning to a new vendor, for improving internal software development methods to match those of outsourcing vendors, and for monitoring vendors to make sure they are fulfilling their contractual obligations. Companies will need to allocate resources for documenting requirements, sending out RFPs, travel expenses, negotiating contracts, and project management. Experts claim it takes from three months to a full year to fully transfer work to an offshore partner and make sure the vendor thoroughly understands your business.

INTERACTIVE SESSION: TECHNOLOGY

ZIMBRA ZOOMS AHEAD WITH ONEVIEW

Zimbra is a software company whose flagship product is its Zimbra Collaboration Suite (ZCS), an open source messaging and communications software package, that relies heavily on Ajax to provide a variety of business functions. Purchased by Yahoo in 2007, the company now has accumulated 50 million paid mailboxes. In addition to e-mail, ZCS combines contact lists, a shared calendar, instant messaging, hosted documents, search, and VoIP into one package, and can be used from any mobile Web browser.

As an open source software company, Zimbra uses viral marketing models, word-of-mouth marketing, and open standards to grow its business. Customers are as free to criticize Zimbra and ZCS as they are to praise the company and its flagship offering. For the most part, this strategy has proven very successful for the company thus far.

Zimbra makes sales via its Web site and offers both free and commercial versions. Zimbra's business model hinges on driving large numbers of visitors to its Web site, allowing them to try the most basic version of the software for free, and then persuading them to purchase one of its more full-featured commercial versions. Zimbra has over 200,000 visitors to its Web site each week.

Zimbra's sales process begins when one of these 200,000 weekly visitors downloads a 60-day trial version. Salespeople try to identify which people using the trial version are most likely to upgrade to one of its commercial versions and then contact them via e-mail and telephone to try to close the sale. To make this work, Zimbra's sales team needs to be able to weed out the interested buyers from its huge volume of Web visitors. As Greg Armanini, Zimbra's director of marketing, pointed out, the sales team will be overwhelmed with a large number of unqualified leads unless sales and marketing automation tools are able to focus sales reps only on the leads that will generate revenue.

Zimbra uses its Web site to track visitor activity and tie it to sales lead information in its Salesforce.com customer relationship management (CRM) system. Identifying sales prospects that visit the Web site regularly and alerting sales reps when those prospects are visiting the site helps the sales team select which prospects to contact by telephone and when to call them.

Zimbra initially used marketing automation software from Eloqua, which had a large number of features but was too complicated for both marketing and sales staff to use. For example, the Eloqua system required salespeople to code conditional logic for any data field containing data they wanted to collect. Though doable, this task was a poor use of Zimbra's sales staff time. Eloqua only worked with the Microsoft Internet Explorer Web browser, while two-thirds of Zimbra's sales department used Mozilla Firefox. And Eloqua was expensive. Zimbra could only afford its entry-level package, which provided access to only five salespeople and one marketing person.

Zimbra did not need many of Eloqua's features, but it did need a more streamlined solution that focused on the core areas of its marketing strategy: lead generation, e-mail marketing, and Web analytics. The new marketing automation system had to be easy to install and maintain. Many available options required several well-trained administrators, and Zimbra could not afford to allocate even one employee for this purpose.

After examining several software products, Zimbra choose OneView, an on-demand marketing automation solution from LoopFuse, a Georgia-based software company that specializes in sales and marketing automation. OneView was more highly targeted than the Eloqua software. Not only that, but much of OneView consists of automated processes that allowed Zimbra to quickly implement the solution and to maintain it without dedicating someone to the task full-time. The core functions of OneView include Web site visitor tracking, automated marketing program communication, customer activity alerts, and CRM integration.

Zimbra was also pleased with LoopFuse's convenient pricing options, including its "unlimited seating" and "pay-per-use" options, which allowed Zimbra to pay for only the services it needed for as many users as it required. Because of these options, Zimbra was able to deploy LoopFuse across almost its entire 30-person sales force.

Other benefits of OneView include easy integration with Salesforce.com, Zimbra's preferred CRM solution, simplified reporting processes, and the ability to manage a larger number of leads thanks to having more salespeople and time to devote to

demand generation. OneView works with multiple Web browsers, including Firefox. The old solution offered so many ways to handle and organize data that generating data reports could take a long time. With OneView's simplified reporting processes, the sales staff can generate reports in a fraction of the time.

Has OneView improved Zimbra's bottom line? OneView reduced the amount of time Zimbra spent

using and maintaining its marketing system by 50 percent. Zimbra reports that since changing vendors, it has witnessed a jump in its close rate on qualified sales leads from 10 to 15 percent, a huge increase. The answer appears to be a resounding "yes."

Sources: Jessica Tsai, "Less is More," *Customer Relationship Management*, August 2009, www.destinationCRM.com; and "LoopFuse OneView helps Zimbra Raise Sales and Marketing Efficiency by 50 Percent," www.loopfuse.com, May 2009.

CASE STUDY QUESTIONS

1. Describe the steps in Zimbra's sales process. How well did its old marketing automation system support that process? What problems did it create? What was the business impact of these problems?
2. List and describe Zimbra's requirements for a new marketing software package. If you were preparing the RFP for Zimbra's new system, what questions would you ask?
3. How did the new marketing system change the way Zimbra ran its business? How successful was it?

MIS IN ACTION

Visit the LoopFuse Web site and then answer the following questions:

1. List and describe each of the major features of LoopFuse OneView.
2. Select two of these features and describe how they would help Zimbra's sales team.

Outsourcing offshore incurs additional costs for coping with cultural differences that drain productivity and dealing with human resources issues, such as terminating or relocating domestic employees. All of these hidden costs undercut some of the anticipated benefits from outsourcing. Firms should be especially cautious when using an outsourcer to develop or to operate applications that give it some type of competitive advantage.

Figure 13-10 shows best- and worst-case scenarios for the total cost of an offshore outsourcing project. It shows how much hidden costs affect the total project cost. The best case reflects the lowest estimates for additional costs, and the worst case reflects the highest estimates for these costs. As you can see, hidden costs increase the total cost of an offshore outsourcing project by an extra 15 to 57 percent. Even with these extra costs, many firms will benefit from offshore outsourcing if they manage the work well. Under the worst-case scenario, a firm would still save about 15 percent.

13.4 APPLICATION DEVELOPMENT FOR THE DIGITAL FIRM

In the digital firm environment, organizations need to be able to add, change, and retire their technology capabilities very rapidly to respond to new opportu-

FIGURE 13-10 TOTAL COST OF OFFSHORE OUTSOURCING

TOTAL COST OF OFFSHORE OUTSOURCING				
Cost of outsourcing contract		\$10,000,000		
Hidden Costs	Best Case	Additional Cost (\$)	Worst Case	Additional Cost (\$)
1. Vendor selection	0%	20,000	2%	200,000
2. Transition costs	2%	200,000	3%	300,000
3. Layoffs & retention	3%	300,000	5%	500,000
4. Lost productivity/cultural issues	3%	300,000	27%	2,700,000
5. Improving development processes	1%	100,000	10%	1,000,000
6. Managing the contract	6%	600,000	10%	1,000,000
Total additional costs		1,520,000		5,700,000
	Outstanding Contract (\$)	Additional Cost (\$)	Total Cost (\$)	Additional Cost
Total cost of outsourcing (TCO) best case	10,000,000	1,520,000	11,520,000	15.2%
Total cost of outsourcing (TCO) worst case	10,000,000	5,700,000	15,700,000	57.0%

If a firm spends \$10 million on offshore outsourcing contracts, that company will actually spend 15.2 percent in extra costs even under the best-case scenario. In the worst-case scenario, where there is a dramatic drop in productivity along with exceptionally high transition and layoff costs, a firm can expect to pay up to 57 percent in extra costs on top of the \$10 million outlay for an offshore contract.

nities. Companies are starting to use shorter, more informal development processes that provide fast solutions. In addition to using software packages and external service providers, businesses are relying more heavily on fast-cycle techniques such as rapid application development, joint application design, agile development, and reusable standardized software components that can be assembled into a complete set of services for e-commerce and e-business.

RAPID APPLICATION DEVELOPMENT (RAD)

Object-oriented software tools, reusable software, prototyping, and fourth-generation language tools are helping systems builders create working systems much more rapidly than they could using traditional systems-building methods and software tools. The term **rapid application development (RAD)** is used to describe this process of creating workable systems in a very short period of time. RAD can include the use of visual programming and other tools for building graphical user interfaces, iterative prototyping of key system elements, the automation of program code generation, and close teamwork among end users and information systems specialists. Simple systems often can be assembled from prebuilt components. The process does not have to be sequential, and key parts of development can occur simultaneously.

Sometimes a technique called **joint application design (JAD)** is used to accelerate the generation of information requirements and to develop the initial systems design. JAD brings end users and information systems specialists together in an interactive session to discuss the system's design. Properly prepared and facilitated, JAD sessions can significantly speed up the design phase and involve users at an intense level.

Agile development focuses on rapid delivery of working software by breaking a large project into a series of small subprojects that are completed in short periods of time using iteration and continuous feedback. Each

mini-project is worked on by a team as if it were a complete project, including planning, requirements analysis, design, coding, testing, and documentation. Improvement or addition of new functionality takes place within the next iteration as developers clarify requirements. This helps to minimize the overall risk, and allows the project to adapt to changes more quickly. Agile methods emphasize face-to-face communication over written documents, encouraging people to collaborate and make decisions quickly and effectively.

COMPONENT-BASED DEVELOPMENT AND WEB SERVICES

We have already described some of the benefits of object-oriented development for building systems that can respond to rapidly changing business environments, including Web applications. To further expedite software creation, groups of objects have been assembled to provide software components for common functions such as a graphical user interface or online ordering capability that can be combined to create large-scale business applications. This approach to software development is called **component-based development**, and it enables a system to be built by assembling and integrating existing software components. Increasingly, these software components are coming from cloud services. Businesses are using component-based development to create their e-commerce applications by combining commercially available components for shopping carts, user authentication, search engines, and catalogs with pieces of software for their own unique business requirements.

Web Services and Service-Oriented Computing

Chapter 5 introduced *Web services* as loosely coupled, reusable software components delivered using Extensible Markup Language (XML) and other open protocols and standards that enable one application to communicate with another with no custom programming required to share data and services. In addition to supporting internal and external integration of systems, Web services can be used as tools for building new information system applications or enhancing existing systems. Because these software services use a universal set of standards, they promise to be less expensive and less difficult to weave together than proprietary components.

Web services can perform certain functions on their own, and they can also engage other Web services to complete more complex transactions, such as checking credit, procurement, or ordering products. By creating software components that can communicate and share data regardless of the operating system, programming language, or client device, Web services can provide significant cost savings in systems building while opening up new opportunities for collaboration with other companies.

13.5 HANDS-ON MIS PROJECTS

The projects in this section give you hands-on experience analyzing business process problems, designing and building a customer system for auto sales, and redesigning business processes for a company that wants to purchase goods over the Web.

Management Decision Problems

1. A customer purchasing a Sears Roebuck appliance, such as a washing machine, can also purchase a three-year service contract for an additional fee. The contract provides free repair service and parts for the specified appliance using an authorized Sears service provider. When a person with a Sears service contract needs an appliance repaired, such as a washing machine, he or she calls the Sears Repairs & Parts department to schedule an appointment. The department makes the appointment and gives the caller the date and approximate time of the appointment. The repair technician arrives during the designated time frame and diagnoses the problem. If the problem is caused by a faulty part, the technician either replaces the part if he is carrying the part with him or orders the replacement part from Sears. If the part is not in stock at Sears, Sears orders the part and gives the customer an approximate time when the part will arrive. The part is shipped directly to the customer. After the part has arrived, the customer must call Sears to schedule a second appointment for a repair technician to replace the ordered part. This process is very lengthy.

It may take two weeks for the first repair visit to occur, another two weeks to receive the ordered part, and another week for the second repair visit to occur in which the ordered part is installed.

- Diagram the existing process.
 - What is the impact of the existing process on Sears' operational efficiency and customer relationships?
 - What changes could be made to make this process more efficient? How could information systems support these changes? Diagram the new improved process.
2. Management at your agricultural chemicals corporation has been dissatisfied with production planning. Production plans are created using best guesses of demand for each product, which are based on how much of each product has been ordered in the past. If a customer places an unexpected order or requests a change to an existing order after it has been placed, there is no way to adjust production plans. The company may have to tell customers it can't fill their orders, or it may run up extra costs maintaining additional inventory to prevent stock-outs.

At the end of each month, orders are totaled and manually keyed into the company's production planning system. Data from the past month's production and inventory systems are manually entered into the firm's order management system. Analysts from the sales department and from the production department analyze the data from their respective systems to determine what the sales targets and production targets should be for the next month. These estimates are usually different. The analysts then get together at a high-level planning meeting to revise the production and sales targets to take into account senior management's goals for market share, revenues, and profits. The outcome of the meeting is a finalized production master schedule.

The entire production planning process takes 17 business days to complete. Nine of these days are required to enter and validate the data. The remaining

days are spent developing and reconciling the production and sales targets and finalizing the production master schedule.

- Draw a diagram of the existing production planning process.
- Analyze the problems this process creates for the company.
- How could an enterprise system solve these problems? In what ways could it lower costs? Diagram what the production planning process might look like if the company implemented enterprise software.

Improving Decision Making: Using Database Software to Design a Customer System for Auto Sales

Software skills: Database design, querying, reporting, and forms

Business skills: Sales lead and customer analysis

This project requires you to perform a systems analysis and then design a system solution using database software.

Ace Auto Dealers specializes in selling new vehicles from Subaru. The company advertises in local newspapers and is also listed as an authorized dealer on the Subaru Web site and other major auto-buyer Web sites. The company benefits from a good local word-of-mouth reputation and name recognition and is a leading source of information for Subaru vehicles in the Portland, Oregon, area.

When a prospective customer enters the showroom, he or she is greeted by an Ace sales representative. The sales representative manually fills out a form with information such as the prospective customer's name, address, telephone number, date of visit, and make and model of the vehicle in which the customer is interested. The representative also asks where the prospect heard about Ace—whether it was from a newspaper ad, the Web, or word of mouth—and this information is noted on the form also. If the customer decides to purchase an auto, the dealer fills out a bill of sale form.

Ace does not believe it has enough information about its customers. It cannot easily determine which prospects have made auto purchases, nor can it identify which customer touch points have produced the greatest number of sales leads or actual sales so it can focus advertising and marketing more on the channels that generate the most revenue. Are purchasers discovering Ace from newspaper ads, from word of mouth, or from the Web?

Prepare a systems analysis report detailing Ace's problem and a system solution that can be implemented using PC database management software. The company has a PC with Internet access and the full suite of Microsoft Office desktop productivity tools. Then use database software to develop a simple system solution. Your systems analysis report should include the following:

- Description of the problem and its organizational and business impact
- Proposed solution, solution objectives, and solution feasibility
- Costs and benefits of the solution you have selected
- Information requirements to be addressed by the solution
- Management, organization, and technology issues to be addressed by the solution, including changes in business processes

On the basis of the requirements you have identified, design the database and populate it with at least 10 records per table. Consider whether you can use or modify Ace's existing customer database in your design. You can find this

database on the myMISlab. Print out the database design. Then use the system you have created to generate queries and reports that would be most useful to management. Create several prototype data input forms for the system and review them with your instructor. Then revise the prototypes.

Achieving Operational Excellence: Redesigning Business Processes for Web Procurement

Software skills: Web browser software

Business skills: Procurement

This project requires you to rethink how a business should be redesigned when it moves to the Web.

You are in charge of purchasing for your firm and would like to use the Grainger (www.grainger.com) B2B e-commerce site for this purpose. Find out how to place an order for painting supplies by exploring the Catalog, Order Form, and Repair Parts Order capabilities of this site. Do not register at the site. Describe all the steps your firm would need to take to use this system to place orders online for 30 gallons of paint thinner. Include a diagram of what you think your firm's business process for purchasing should be and the pieces of information required by this process.

In a traditional purchase process, whoever is responsible for making the purchase fills out a requisition form and submits it for approval based on the company's business rules. When the requisition is approved, a purchase order with a unique purchase order identification number is sent to the supplier. The purchaser might want to browse supplier catalogs to compare prices and features before placing the order. The purchaser might also want to determine whether the items to be purchased are available. If the purchasing firm were an approved customer, that company would be granted credit to make the purchase and would be billed for the total cost of the items purchased and shipped after the order was shipped. Alternatively, the purchasing company might have to pay for the order in advance or pay for the order using a credit card. Multiple payment options might be possible. How might this process have to change to make purchases electronically from the Grainger site?

LEARNING TRACK MODULES

The following Learning Tracks provide content relevant to topics covered in this chapter:

1. Unified Modeling Language (UML)
2. A Primer on Business Process Design and Documentation
3. A Primer on Business Process Management

Review Summary

1. *How does building new systems produce organizational change?*

Building a new information system is a form of planned organizational change. Four kinds of technology-enabled change are (a) automation, (b) rationalization of procedures, (c) business process redesign, and (d) paradigm shift, with far-reaching changes carrying the greatest risks and rewards. Many organizations are using business process management to redesign work flows and business processes in the hope of achieving dramatic productivity breakthroughs. Business process management is also useful for promoting, total quality management (TQM), six sigma, and other initiatives for incremental process improvement.

2. *What are the core activities in the systems development process?*

The core activities in systems development are systems analysis, systems design, programming, testing, conversion, production, and maintenance. Systems analysis is the study and analysis of problems of existing systems and the identification of requirements for their solutions. Systems design provides the specifications for an information system solution, showing how its technical and organizational components fit together.

3. *What are the principal methodologies for modeling and designing systems?*

The two principal methodologies for modeling and designing information systems are structured methodologies and object-oriented development. Structured methodologies focus on modeling processes and data separately. The data flow diagram is the principal tool for structured analysis, and the structure chart is the principal tool for representing structured software design. Object-oriented development models a system as a collection of objects that combine processes and data. Object-oriented modeling is based on the concepts of class and inheritance.

4. *What are the alternative methods for building information systems?*

The oldest method for building systems is the systems life cycle, which requires that information systems be developed in formal stages. The stages must proceed sequentially and have defined outputs; each requires formal approval before the next stage can commence. The systems life cycle is useful for large projects that need formal specifications and tight management control over each stage of systems building, but it is very rigid and costly.

Prototyping consists of building an experimental system rapidly and inexpensively for end users to interact with and evaluate. Prototyping encourages end-user involvement in systems development and iteration of design until specifications are captured accurately. The rapid creation of prototypes can result in systems that have not been completely tested or documented or that are technically inadequate for a production environment.

Using a software package reduces the amount of design, programming, testing, installation, and maintenance work required to build a system. Application software packages are helpful if a firm does not have the internal information systems staff or financial resources to custom develop a system. To meet an organization's unique requirements, packages may require extensive modifications that can substantially raise development costs.

End-user development is the development of information systems by end users, either alone or with minimal assistance from information systems specialists. End-user-developed systems can be created rapidly and informally using fourth-generation software tools. However, end-user development may

create information systems that do not necessarily meet quality assurance standards and that are not easily controlled by traditional means.

Outsourcing consists of using an external vendor to build (or operate) a firm's information systems instead of the organization's internal information systems staff. Outsourcing can save application development costs or enable firms to develop applications without an internal information systems staff. However, firms risk losing control over their information systems and becoming too dependent on external vendors. Outsourcing also entails "hidden" costs, especially when the work is sent offshore.

5. *What are new approaches for system building in the digital firm era?*

Companies are turning to rapid application design, joint application design (JAD), agile development, and reusable software components to accelerate the systems development process. Rapid application development (RAD) uses object-oriented software, visual programming, prototyping, and fourth-generation tools for very rapid creation of systems. Agile development breaks a large project into a series of small subprojects that are completed in short periods of time using iteration and continuous feedback. Component-based development expedites application development by grouping objects into suites of software components that can be combined to create large-scale business applications. Web services provide a common set of standards that enable organizations to link their systems regardless of their technology platform through standard plug- and-play architecture

Key Terms

Acceptance testing, 499

Agile development, 514

Automation, 489

Business process management, 491

Business process redesign, 490

Component-based development, 515

Computer-aided software engineering (CASE), 505

Conversion, 500

Customization, 510

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Review Questions

1. How does building new systems produce organizational change?

- Describe each of the four kinds of organizational change that can be promoted with information technology.

- Define business process management and describe the steps required to carry it out.
- Explain how information systems support process changes that promote quality in an organization.

2. What are the core activities in the systems development process?
 - Distinguish between systems analysis and systems design. Describe the activities for each.
 - Define information requirements and explain why they are difficult to determine correctly.
 - Explain why the testing stage of systems development is so important. Name and describe the three stages of testing for an information system.
 - Describe the role of programming, conversion, production, and maintenance in systems development.
3. What are the principal methodologies for modeling and designing systems?
 - Compare object-oriented and traditional structured approaches for modeling and designing systems.
4. What are the alternative methods for building information systems?
 - Define the traditional systems life cycle. Describe each of its steps and its advantages and disadvantages for systems building.
- Define information system prototyping. Describe its benefits and limitations. List and describe the steps in the prototyping process.
- Define an application software package. Explain the advantages and disadvantages of developing information systems based on software packages.
- Define end-user development and describe its advantages and disadvantages. Name some policies and procedures for managing end-user development.
- Describe the advantages and disadvantages of using outsourcing for building information systems.
5. What are new approaches for system building in the digital firm era?
 - Define rapid application development (RAD) and agile development and explain how they can speed up system-building.
 - Explain how component-based development and Web services help firms build and enhance their information systems.

Discussion Questions

1. Why is selecting a systems development approach an important business decision? Who should participate in the selection process?
2. Some have said that the best way to reduce systems development costs is to use application software packages or fourth-generation tools. Do you agree? Why or why not?
3. Why is it so important to understand how a business process works when trying to develop a new information system?

Video Cases

Video Cases and Instructional Videos illustrating some of the concepts in this chapter are available. Contact your instructor to access these videos.

Collaboration and Teamwork: Preparing Web Site Design Specifications

With three or four of your classmates, select a system described in this text that uses the Web. Review the Web site for the system you select. Use what you have learned from the Web site and the description in this book to prepare a report describing some of the design specifications for the system you select.

If possible, use Google Sites to post links to Web pages, team communication announcements, and work assignments; to brainstorm; and to work collaboratively on project documents. Try to use Google Docs to develop a presentation of your findings for the class.

Are Electronic Medical Records a Cure for Health Care?

CASE STUDY

Creating more efficient health care systems in the United States has been a pressing medical, social, and political issue for decades. Despite the fact that 15 percent of Americans are uninsured and another 20 percent on top of that are underinsured, or unable to pay for necessary health care, the U.S. spends more money per person on health care than any other country in the world. In 2009, the United States spent \$2.5 trillion on health care, which was 17.6 percent of its gross domestic product (GDP). Approximately 12 percent of that figure was spent on administrative costs, most of which involve the upkeep of medical records.

The astronomical health care spending figures in the United States are inflated by inefficiency, errors, and fraud. The good news is that information technology may present an opportunity for health care providers to save money and provide better care. Health care providers have begun to create electronic medical record (EMR) systems at the urging of the government in an effort to eliminate much of the inefficiency inherent in paper-based record-keeping. Many insurance companies are also lending their support to the development of EMR systems.

An electronic medical record system contains all of a person's vital medical data, including personal information, a full medical history, test results, diagnoses, treatments, prescription medications, and the effect of those treatments. A physician would be able to immediately and directly access needed information from the EMR without having to pore through paper files. If the record holder went to the hospital, the records and results of any tests performed at that point would be immediately available online.

Many experts believe that electronic records will reduce medical errors and improve care, create less paperwork, and provide quicker service, all of which will lead to dramatic savings in the future: an estimated \$77.8 billion per year. The government's short-term goal is for all health care providers in the United States to have functional EMR systems in place that meet a set of basic functional criteria by the year 2015. Its long-term goal is to have a fully functional nationwide electronic medical recordkeeping network.

Evidence of EMR systems in use today suggests that these benefits are possible for doctors and hospitals, but the challenges of setting up individual systems, let alone a nationwide system, are daunting. Even with stimulus money, many smaller practices are finding it difficult to afford the costs and time commitment for upgrading their recordkeeping systems. In 2010, 80 percent of physicians and 90 percent of hospitals in the United States are still using paper medical records.

It's also unclear whether the systems being developed and implemented in 2010 will be compatible with one another in 2015 and beyond, jeopardizing the goal of a national system where all health care providers can share information. And there are many other smaller obstacles that health care providers, health IT developers, and insurance companies need to overcome for electronic health records to catch on nationally, including patients' privacy concerns, data quality issues, and resistance from health care workers.

The government plans to pay out the stimulus money provided by the American Recovery and Reinvestment Act to health care providers in two ways. First, \$2 billion will be provided up front to hospitals and physicians to help set up electronic records. Another \$17 billion will also be available as a reward for providers that successfully implement electronic records by 2015. The stimulus specifies that to qualify for these rewards, providers must demonstrate "meaningful use" of electronic health record systems. The bill defines this as the successful implementation of certified e-record products, the ability to write at least 40 percent of their total prescriptions electronically, and the ability to exchange and report data to government health agencies. Individual practices can receive up to \$64,000 for successful implementations, and hospitals can make as much as \$11.5 million.

But in addition to the reward of stimulus money, the government will also assess penalties on practices that fail to comply with the new electronic recordkeeping standards. Providers that cannot meet the standards by 2015 will have their Medicare and Medicaid reimbursements reduced by 1 percent per year until 2018, with further, more stringent penalties coming beyond that time if a sufficiently

low number of providers are using electronic health records.

Electronic medical recordkeeping systems typically cost around \$30,000 to \$50,000 per doctor. While the stimulus money should eventually be enough to cover that cost, only a small amount of it is available up front. For many providers, especially medical practices with fewer than four doctors and hospitals with fewer than 50 beds, this creates a significant problem. The expenditure of overhauling recordkeeping systems represents a significant increase in the short-term budgets and workloads of smaller health care providers. Smaller providers are also less likely to have started digitizing their records compared to their larger counterparts.

Many smaller practices and hospitals have balked at the transition to EMR systems for these reasons, but the evidence of these systems in action suggests that the move may be well worth the effort. The most prominent example of electronic medical records in use today is the Veterans Affairs (VA) system of doctors and hospitals. The VA system switched to digital records years ago, and far exceeds the private sector and Medicare in quality of preventive services and chronic care. The 1,400 VA facilities use VistA, record-sharing software developed by the government that allows doctors and nurses to share patient histories. A typical VistA record lists a patient's health problems, weight and blood pressure since beginning treatment at the VA, images of the patient's X-rays, lab results, and other test results, lists of medications, and reminders about upcoming appointments.

But VistA is more than a database; it also has many features that improve quality of care. For example, nurses scan tags for patients and medications to ensure that the correct dosages of medicines are going to the correct patients. This feature reduces medication errors, which is one of the most common and costly types of medical errors, and speeds up treatment as well. The system also generates automatic warnings based on specified criteria. It can notify providers if a patient's blood pressure goes over a certain level or if a patient is overdue for a regularly scheduled procedure like a flu shot or a cancer screening. Devices that measure patients' vital signs can automatically transmit their results into the VistA system, which automatically updates doctors at the first sign of trouble.

The results suggest that electronic records offer significant advantages to hospitals and patients alike. The 40,000 patients in the VA's in-home monitoring program reduced their hospital admissions by 25

percent and the length of their hospital stays by 20 percent. More patients receive necessary periodic treatments under VistA (from 27 percent to 83 percent for flu vaccines and from 34 percent to 84 percent for colon cancer screenings).

Patients also report that the process of being treated at the VA is effortless compared to paper-based providers. That's because instant processing of claims and payments are among the benefits of EMR systems. Insurance companies traditionally pay claims about two weeks after receiving them, despite quickly processing them soon after they are received. Additionally, today's paper-based health care providers must assign the appropriate diagnostic codes and procedure codes to claims. Because there are thousands of these codes, the process is even slower, and most providers employ someone solely to perform this task. Electronic systems hold the promise of immediate processing, or real-time claims adjudication, just like when you pay using a credit card—claim data would be sent immediately, and diagnostic and procedure code information are automatically entered.

VistA is far from the only option for doctors and hospitals starting the process of updating their records. Many health IT companies are eagerly awaiting the coming spike in demand for their EMR products and have developed a variety of different health record structures. Humana, Aetna, and other health insurance companies are helping to defray the cost of setting up EMR systems for some doctors and hospitals. Humana has teamed up with health IT company Athenahealth to subsidize EMR systems for approximately 100 primary care practices within Humana's network. Humana pays most of the bill and offers further rewards to practices that meet governmental performance standards. Aetna and IBM, on the other hand, have launched a cloud-based system that pools patient records and is licensed to doctors both inside and outside of Aetna.

There are two problems with the plethora of options available to health care providers. First, there are likely to be many issues with the sharing of medical data between different systems. While the majority of EMR systems are likely to satisfy the specified criteria of reporting data electronically to governmental agencies, they may not be able to report the same data to one another, a key requirement for a nation-wide system. Many fledgling systems are designed using VistA as a guide, but many are not. Even if medical data are easily shared, it's another problem altogether for doctors to actually locate the information they need quickly and easily.

Many EMR systems have no capacity to drill down for more specific data, forcing doctors to wade through large repositories of information to find the one piece of data they need. EMR vendors are developing search engine technology intended for use in medical records. Only after EMR systems become more widespread will the extent of the problems with data sharing and accessibility become clearer.

The second problem is that there is a potential conflict of interest for the insurance companies involved in the creation of health record systems. Insurers are often accused of seeking ways to avoid providing care for sick people. While most insurers are adamant that only doctors and patients will be able to access data in these systems, many prospective patients are skeptical. In 2009, a poll conducted for National Public Radio found that 59 percent of respondents said they doubted the confidentiality of online medical records; even if the systems are secure, the perception of poor privacy

could affect the success of the system and quality of care provided. One in eight Americans have skipped doctor visits or regular tests, asked a doctor to change a test result, or paid privately for a test, motivated mostly by privacy concerns. A poorly designed EMR network would amplify these concerns.

Sources: Katherine Gammon, "Connecting Electronic Medical Records," *Technology Review*, August 9, 2010; Avery Johnson, "Doctors Get Dose of Technology From Insurers," *The Wall Street Journal*, August 8, 2010; David Talbot, "The Doctor Will Record Your Data Now," *Technology Review*, July 23, 2010; Tony Fisher and Joyce Norris-Montanari, "The Current State of Data in Health Care," *Information-Management.com*, June 15, 2010; Laura Landro, "Breaking Down the Barriers," *The Wall Street Journal*, April 13, 2010; Jacob Goldstein, "Can Technology Cure Health Care?," *The Wall Street Journal*, April 13, 2010; Deborah C. Peel, "Your Medical Records Aren't Secure," *The Wall Street Journal*, March 23, 2010; Jane E. Brody, "Medical Paper Trail Takes Electronic Turn," *The New York Times*, February 23, 2010; and Laura Landro, "An Affordable Fix for Modernizing Medical Records," *The Wall Street Journal*, April 30, 2009.

CASE STUDY QUESTIONS

1. What management, organization, and technology factors are responsible for the difficulties in building electronic medical record systems? Explain your answer.
2. What stages of system building will be the most difficult when creating electronic medical record systems? Explain your answer.
3. What is the business and social impact of not digitizing medical records (to individual physicians, hospitals, insurers, patients)?
4. What are the business and social benefits of digitizing medical recordkeeping?
5. Name two important information requirements for physicians, two for patients, and two for hospitals that should be addressed by electronic medical records systems.
6. Diagram the "as-is" and "to-be" processes for prescribing a medication for a patient before and after an EMR system is implemented.

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