



Pearson New International Edition

Information Systems Management

McNurlin Sprague Bui
Eighth Edition

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PEARSON

Pearson Education Limited

Edinburgh Gate

Harlow

Essex CM20 2JE

England and Associated Companies throughout the world

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PEARSON

ISBN 10: 1-292-02354-6

ISBN 13: 978-1-292-02354-0

British Library Cataloguing-in-Publication Data

A catalogue record for this book is available from the British Library

Printed in the United States of America

Table of Contents

1. Information Systems Management in the Global Economy Barbara C. McNurlin/Ralph H. Sprague, Jr./Tng Bui	1
2. Strategic Uses of Information Technology Barbara C. McNurlin/Ralph H. Sprague, Jr./Tng Bui	42
3. Strategic Information Systems Planning Barbara C. McNurlin/Ralph H. Sprague, Jr./Tng Bui	77
4. Designing Corporate IT Architecture Barbara C. McNurlin/Ralph H. Sprague, Jr./Tng Bui	115
5. Managing Telecommunications Barbara C. McNurlin/Ralph H. Sprague, Jr./Tng Bui	156
6. Managing Corporate Information Resources Barbara C. McNurlin/Ralph H. Sprague, Jr./Tng Bui	193
7. Managing Partnership-Based IT Operations Barbara C. McNurlin/Ralph H. Sprague, Jr./Tng Bui	231
8. Technologies for Developing Effective Systems Barbara C. McNurlin/Ralph H. Sprague, Jr./Tng Bui	264
9. Management Issues in System Development Barbara C. McNurlin/Ralph H. Sprague, Jr./Tng Bui	298
10. Managing Information Security Barbara C. McNurlin/Ralph H. Sprague, Jr./Tng Bui	340
11. Supporting Information-Centric Decision Making Barbara C. McNurlin/Ralph H. Sprague, Jr./Tng Bui	365
12. Supporting IT-Enabled Collaboration Barbara C. McNurlin/Ralph H. Sprague, Jr./Tng Bui	405
13. Supporting Knowledge Work Barbara C. McNurlin/Ralph H. Sprague, Jr./Tng Bui	443

Glossary

Barbara C. McNurlin/Ralph H. Sprague, Jr./Tng Bui

479

Index

495

INFORMATION SYSTEMS MANAGEMENT IN THE GLOBAL ECONOMY

INTRODUCTION
THEMES
MANAGEMENT OF IS
A LITTLE HISTORY
THE ORGANIZATIONAL ENVIRONMENT
<i>The External Business Environment</i>
<i>The Internal Organizational Environment</i>
<i>Business Strategies in the New Work Environment</i>
THE TECHNOLOGY ENVIRONMENT
<i>Hardware Trends</i>
<i>Software Trends</i>
<i>Data Trends</i>
<i>Communications Trends</i>
THE MISSION OF IS ORGANIZATIONS
A SIMPLE MODEL
A BETTER MODEL
<i>The Technologies</i>
<i>The Users</i>
<i>System Development and Delivery</i>
<i>IS Management</i>
ORGANIZATION OF THIS BOOK
<i>Case Example: MeadWestvaco Corporation</i>
QUESTIONS AND EXERCISES
REFERENCES

INTRODUCTION

Information technology (IT)—computers and telecommunications—continues to have the revolutionary, restructuring impact that has been expected and touted for years. The rapid advances in the speed and capacity of computing devices, coupled with the pervasive growth of the Internet, digital storage, wireless and portable devices, and multimedia content, are constantly changing the way we live and work.

Although IT affects nearly all aspects of human endeavor, we emphasize its use in managing and operating organizations, including business enterprises, public institutions, and social and charitable communities. Anytime people work together to jointly pursue objectives, IT is changing the way they work.

Managing and operating IT for these purposes has been a field of practice for some 50 years. First known as business data processing and later as management information systems (MIS), the field is now called information technology (IT). In this text, we distinguish between IT (the technology) and the organization that manages the technology, which we call the IS (information systems) organization. IS combines the technologies, people, data, and business processes for fostering the use of IT to improve organizational performance.

THEMES

Due to the growth and pervasiveness of IT, organizations are operating in a different environment from that of just a few years ago. The nature of this environment is explored in several themes in this edition of the book. The following three themes are woven through the text:

- **Globalization.** You may have heard this common wisdom. The world seems to be getting smaller or flatter. Events in a faraway land can impact others in another part of the globe. As a result, a major theme in today's world is globalization, whereby companies seek to offer or procure their goods and services around the world. However, the worldwide expansion of brands and the emergence of global institutions continue to encounter major protests from groups, and even nations, that want to maintain their local identity. Companies feel this backlash in their use of IT: locales and regions want systems that suit their culture, preferences, or lifestyles. In addition, they want jobs to stay put, and not move to a far-off country. In response, IS executives are seeking to achieve a balance between implementing a single, enterprisewide IT infrastructure and tailoring systems to fit local needs—and locating work where it is most cost effective.
- **E-enablement.** Doing business electronically has been fundamental since the 1950s, but now the Internet has transformed the way people conduct business. The before-Internet economy is evolving into an electronic economy where clicks and bricks exist side by side. The 2001 dot-com crash might have seemed a hiccup in the increasing use of the Internet for business and commerce. However, it has not deterred companies from e-enabling their businesses, that is, integrating the Internet into how they work. In fact, the term “e-business” has the broad connotation of doing business electronically. E-business has much to do with building e-enabled relationships with consumers and other enterprises,

not just executing transactions electronically. E-commerce, on the other hand, is being used in the more limited sense of buying and selling electronically, as in handling commerce transactions.

The vision is ubiquitous connectivity among everyone on earth, with the ability to communicate electronically, transfer multimedia files, and access information—anywhere and anytime—from around the world at the touch of a button on a wireless device.

- ***Business Intelligence Through Knowledge Sharing and Knowledge Management.*** The third major theme is how to deal with all the world's knowledge. One aspect of this is the transfer of knowledge between people (sharing), because the most important asset in enterprises is the people and the knowledge they possess. The other aspect is the transfer of knowledge from people's heads into lasting things, such as processes, products, best practices, databases, directories, software, and such. People walk out the door each night (or leave the company); these other artifacts do not, but they do grow stale and outdated. This second area is called knowledge management. Both aspects have to do with managing people and the knowledge they possess. IT can be used for both.

Later in this chapter, we discuss two kinds of knowledge work: procedure based and goal based. Emphasis on knowledge work is shifting from the former to the latter. At the same time, a major shift is taking place from information access to content management, which includes searching, filtering, synthesizing, assimilating, and sharing knowledge resources. The importance of content management is reinforced by the fact that intellectual assets are considered by many to be the only source of sustainable competitive advantage for organizations. The ultimate goal is to devise an IT-enabled environment to promote creativity that would benefit all participating communities of practices.

MANAGEMENT OF IS

Although IT is used in space exploration, national defense, medicine, entertainment, and many other aspects of human activity, the majority of information technologies are used to manage organizations.

The process of managing IT in organizations is becoming increasingly complex as it becomes more important. To illustrate why, here are just three major trends that impact IT management:

- Governance of IT—that is, deciding who makes which IT decisions—is shifting from being handled exclusively by IS executives to being a collaborative effort between IS business and their constituencies.
- The role of IS is shifting focus from application delivery to system integration and infrastructure development.
- The constant struggle between outsourcing and insourcing is becoming a way of life for many IS organizations, to the extent that a major responsibility of IS is developing and managing relationships with external service providers (ESPs).

In a historical perspective, it is interesting to note that the use of computers has been elevated to a new level every decade. As illustrated in Figure 1, the first use of

Information Systems Management in the Global Economy

TIME FRAME	COMPUTER USE TRENDS	EMERGING APPLICATIONS	SOME LEADING VENDORS
1950s	Calculator	Bookkeeping	Texas Instruments
1960s	Computer	Accounting, Payroll	IBM, Honeywell, CDC, Univac, Burrough, GE
1970s	Management Information Systems	Financial Applications, Inventory Management, Production, etc.	Digital, IBM, Unisys
1980s	Decision Support and Applied Artificial Intelligence	Portfolio Management, Project Management, Executive Information Systems	IBM, Lotus, Apple, Sun Micro Systems, Oracle, Microsoft
1990s	Communicator	Office Automation, E-mail, Instant Messaging, File Transfer	IBM, MCI, AT&T, AOL, Netscape
2000s	Partnership Promoter/Social Enabler	E-commerce, Supply Chain-Management, Social Networking, Mobile Computing	IBM, Oracle, SAP, Microsoft

FIGURE 1 Evolution of Business Computing

computer chips was the calculator, primarily for the many bookkeeping activities of business in the 1950s. Texas Instruments invented the first electronic handheld calculator and has since significantly contributed to the use of mathematical modeling in business. About a decade later, IBM offered to the world its first generation of business computers with sufficient processing power to run data-intensive business applications. Managers in the 1960s saw the introduction of computer applications for accounting and payroll. During this era, most IT activities emerged from the bookkeeping and accounting departments.

The next decade saw the development of mainframes, and many organizations create the department of Management Information Systems (MIS) or IS Department to keep these systems running. IBM consolidated its leadership position in the computer industry. However, it saw the birth of two potential competitors, SAP and Oracle, all inspired by IBM work. Oracle improved the relational database concept initially developed by IBM to launch the first commercial SQL (Structured Query Language) relational database management system. Oracle has become a major provider of computer-based business solutions. SAP, founded by five former IBM employees, focused on real-time, collaborative, inter-enterprise business solutions. Thus, the 1970s marked the debut of the most successful business software ever—Database Management Systems (DBMS). MIS applications have allowed managers to increase the efficiency of their daily operations.

The 1980s marked a new era for the computer. While scientists were busy fine-tuning computer networks, IBM released the first PC that ran on a 4.77-Mhz Intel 8088 processor with MS-DOS written by Microsoft in 1981. A quarter of a century later, it is estimated the world had produced more than one billion personal computers. The phenomenal adoption of the personal computer has facilitated the deployment of a new generation of business software, known as Decision Support Systems and Applied Artificial Intelligence. Computers are not only used for data processing of daily business operations (such as

payroll and accounting). They are embedded with decision algorithms that help managers make decisions ranging from cash-flow management to inventory decisions.

Thanks to the rapid growth of the Internet, the 1990s saw an exponential use of computers for office automation and networking. As “the communicator,” computers allow users to do e-mails, transfer files, and use instant messaging. A research estimated that in 2003, 65–72 percent of world’s computing power was dedicated to supporting human needs for communications. In addition to e-mail, Microsoft’s Word, PowerPoint, and Excel software have become the industry standards for sharing information. Later in the decade, the World Wide Web allowed billions of pages to be made available on the Internet.

The Internet economy has come of age in the 2000s, thanks to a number of significant developments in e-business software, and open source software such as Linux, Enterprise Resource Planning, and supply-chain management software. The first years of the 2000s can be characterized by the widespread adoption of computer networks as a means to promote business partnerships and implement strategic alliances and global cooperation.

As we prepare to move onto the 2010s, the Internet has firmly changed the social fabric. It is a platform where people do business, find entertainment, and enhance social life.

This brief historical review reminds us of the growing importance of IT. The purpose of this text is to describe how IT is being managed today in leading-edge enterprises. Thus, this text is appropriate for anyone who is using IT to improve organizational performance—IS executives, technical managers, top executives, business unit executives, line managers, and employees at all levels of an organization.

This chapter briefly reviews the recent history of IT and its management in organizations. Then it identifies a number of organizational and technical trends that are affecting IT management. Finally, it presents a framework for thinking about how IT is used and managed in organizations.

A LITTLE HISTORY

Most people are surprised to learn that the United States passed from the industrial era to the information era in 1957. In that year, the number of U.S. employees whose jobs were primarily to handle information (information workers) surpassed the number of industrial workers.

In the late 1950s and early 1960s, though, information technology to support information work hardly existed. Only the telephone was widespread, and did not reach every desk. Computers were just beginning to be used in data-processing applications, replacing electric accounting machines. Even where computers were in use, their impact was modest.

Most other information work in general offices was done without much support from technology. Xerographic office copiers were introduced in 1959. Electric typewriters were commonplace, but the first word processor would not arrive until 1964. Facsimile machines were used only in specialized applications and would not be in general office use until the 1970s. However, the future of technology support for information workers was extremely bright. Many of the foundations of IT had been invented, and costs were starting their steady long-term fall.

Information Systems Management in the Global Economy

Another milestone was reached in about 1980, when the number of U.S. information workers surpassed the number of U.S. workers in all other sectors combined. In other words, information workers exceeded 50 percent of the U.S. workforce. However, the technology to support these information workers remained slow, expensive, and segmented into special-purpose categories.

IT was initially used to perform manual information work more quickly and more efficiently. Then it was used to manage work better. Now we are well into the third stage of technology assimilation, in which IT makes pervasive changes in the structure and the operation of work, business practices, organizations, industries, and the global economy.

Today, the information and communications technologies (ICT) sectors continue to grow strongly, with significant and rapid growth in developing nations. As the ICT global market is constantly exploring new technologies (such as mobile computing), emerging Asian and eastern European countries are rapidly becoming both leading producers and adopters of disruptive technologies. According to a study by OECD (“Information Technology Outlook 2006 Highlights,” 2006, Geneva, OECD), the ICT section is expected to grow at 6 percent in 2006 and the market is accelerating its global restructuring of ICT production and services.

In its 2007 IT salary and skills survey, Global Knowledge reported that salaries are rising again, and the increase is proportional to the level of education and training of IT workers.

The next two sections explore the changes in the work environment and the technical environment.

THE ORGANIZATIONAL ENVIRONMENT

How IT is used depends on the environment surrounding the organization that uses it. This environment includes economic conditions, characteristics of principal resources (especially labor), management philosophies, societal mores, and other factors. This environment changes constantly. Simultaneously, technological advances affect the way IT is used. An ongoing debate centers around whether technology drives change in organizations or merely supports it. This “chicken or egg” debate is giving way to the realization that IT and its use and management co-evolve, each influencing the other.

This section explores two aspects of the organizational environment: the external forces that are causing executives to reexamine how their firms compete, and the internal structural forces that affect how organizations operate or are managed. It then considers how these environmental trends have led to a new set of goals for the new work environment.

The External Business Environment

Today, the turbulent business world includes shorter and shorter product cycles, a U.S. telecommunications industry in constant turmoil, investor doubts about corporate truthfulness, computer security, and terrorism. For better or worse, IT contributes to this turbulence because it allows information to move faster, increasing the pace at which individuals and organizations can respond to events. One result is higher peaks and lower valleys, caused by an IT-charged herd instinct. The following are the main changes taking place in our global marketplace.

The Internet Economy

The *new* economy has been much publicized by the outgrowth of business-to-consumer (B2C) retailing and selling over the World Wide Web (Web). The pioneer of the Web-only business model was Amazon.com, with its ability to use the Internet to sell and ship books to consumers at substantially lower costs. However, the overwhelming bulk of e-business belongs to business-to-business (B2B), with buyers and sellers using Internet exchanges (or e-marketplaces) to find and consummate business deals. eBay is the most well-known exchange, but there are other industry-specific exchanges, such as business procurement along the value-chain network. The main point is that today's economy is encompassing both old and new ways of operating, and IT is a major underpinning of the way these two worlds interface with each other.

Global Marketplace

The entire world has become a conglomeration of electronic marketplaces. To succeed, large companies believe they need to be global, meaning huge and everywhere. Merger mania is occurring across industries as companies aim for this goal. Mergers even cross national boundaries. It is not unusual for a British food company to own U.S., French, and other food and beverage companies; for a Swiss pharmaceutical company to buy out its American and Japanese counterparts; or for a Chinese computer manufacturer to buy a laptop division of a major American IT company. "Think globally, act locally" has become a popular adage among multinational corporations.

In addition, the Internet enables companies to work globally—with three main operating arenas, Asia/Pacific, the Americas, Europe and the Middle East and Africa (EMEA)—and work around the clock by passing work from one region to the next, following the sun.

The global marketplace has become a two-way street. Firmly entrenched companies find unexpected competitors from halfway around the world bidding on work via the Internet. Parts and subassemblies are being manufactured in many countries to cut overall labor costs and then shipped to other countries for final assembly.

The Internet also allows small firms to have a global reach. Norwegians can order extra-hot chili sauce from Texas. Europeans can order books over the Internet from U.S. companies before those books become available in their own country's bookstores, at a more advantageous currency exchange rate. And so on. The business environment is now global, but local tastes still matter. As noted earlier, local backlashes against globalization are a factor that global enterprises need to include in their planning.

Micro-markets

The Internet has created new markets for new kinds of goods and services: digital micro-products. Digital micro-products—such as Apple's 99-cent I-tunes songs, Amazon.com's 49-cent short books, Disney's \$4.99 short videos, or freeware—are products in digital forms that can be delivered anywhere, at any time, at a low or zero acquisition cost and no delivery costs. These products illustrate two emerging trends that have been identified in electronic commerce as micro-commoditization and micro-consumption, which are expected to significantly impact the market for digital goods. Unlike other products, digital micro-products often have a selling price that is very low, fixed, and identical for all products. With these product characteristics, the impact of price on sales (quantity) is trivial and thus mitigated and channeled into

quality perception, so price is no longer the primary demand factor. Alternatively, quality signal is likely to become a key demand factor.

Business Ecosystems

A new term is creeping into the business lexicon: ecosystem. An ecosystem is a web of self-sustaining relationships surrounding one or a few companies. For example, Microsoft and Intel are the center of the Wintel ecosystem that has dominated the PC world. And, the new generation of Intel-based Apple's iMac computers is expected to consolidate this ecosystem, further enabling participating members to move toward shared visions, securing their investment strategies through strategic partnership. Yet, although they dominate the PC ecosystem, they are far less dominant in other ecosystems, such as the Internet ecosystem and the wireless communications ecosystem. The point about ecosystems is that they appear to follow biological rules rather than industrial-age, machine-like rules. They require flexibility because relationships change more frequently; they are more organic. Relationships and co-evolution require a different corporate mind-set from the command-and-control mind-set of the past.

Decapitalization

Tangible items, such as capital, equipment, and buildings, were the tenets of power in the industrial age. Today, intangible items, such as ideas, intellectual capital, and knowledge, have become the scarce, desirable items. Many argue that the business world is moving from tangible to intangible; it is decapitalizing. In many situations, knowledge is more important than capital. For this reason, managing talent has become as important as managing finances. Without talent, ideas dwindle, the new-product pipeline shrivels up, and the company becomes less competitive.

Faster Business Cycles

The tempo of business has accelerated appreciably; companies do not have as much time to develop new products or services and move them into the marketplace. Once on the market, their useful lives tend to be shorter as well, so speed has become of the essence. Efforts to accelerate time to market or to reduce cycle time often depend on innovative uses of IT to transform creative ideas into profitable products.

Instant Gratification

The Internet is about instant gratification. One of the successes of YouTube is due to the use of the Flash technology that allows instant viewing of video clips without the need to download large video files. The need of instant coffee, lottery tickets with instant-win notification, and instant pain relievers is extended to the need for instant access to digital products and services. Google builds one of its successes on the ability of its search engines to instantly deliver relevant information to its surfers, and its new Web-based uploader that allows users to share their break-up stories. The desire to satisfy society's demand for instant gratification could, however, lead to quality problems as products are hastily brought to the markets.

Accountability and Transparency

The rise and fall of dot-coms probably should have been expected; some of their business plans truly could not make money. However, the ensuing debacle in the overbuilt telecommunications industry and the corporate financial shenanigans in several indus-

tries around the world have shaken investor confidence and led to calls for greater transparency of corporate operations and greater accountability of corporate officers. These events have increased the pressure for corporate ethics, and the expensive-to-comply-with Sarbanes-Oxley Act in the United States was passed in 2002 to reinforce investment confidence and protect investors by improving the accuracy and reliability of corporate disclosure. IT will surely play a role in implementing the ensuing regulations and fostering transparency. Discussions of IT ethics might also increase.

Rising Societal Risks of IT

In spite of the unequivocal benefits that IT has brought to the world, it has also negatively affected millions of people—through network shutdowns, computer viruses, identity thefts, e-mail scams, movement of white-collar jobs to lower-cost countries, and such—which has led to increasing calls for government regulation and for vendors and corporations to take action. This edition includes more discussion of the societal risks that accompany the benefits of IT.

Now, more than in the past, CIOs need to address the dark side of IT, which includes protecting the privacy of individuals whose information they store and securing their networks, databases, and computers from cybercrime, computer viruses, and such. They also need to consider the societal effects of outsourcing, and ease, as much as possible, the human misery that comes from employees losing their jobs or having to oversee work performed in distant places.

The Internal Organizational Environment

The work environment is also changing, and the art of managing people is undergoing significant shifts. These changes are profound enough to change organizational structures. Frances Cairncross,¹ management editor at the *Economist*, writes in her book, *The Company of the Future*, that the relationship between IT and enterprise structure is growing more widespread and deeper. She believes that the company of the future will look much like the Japanese keiretsu (the associations of independent and interdependent businesses working in concert). Here are some of the changes we see affecting how people work and how organizations operate. Some support Cairncross's belief.

From Supply-Push to Demand-Pull

In the industrial age, companies did their best to figure out what customers wanted. Firms were organized to build a supply of products or services and then “push” them out to end customers on store shelves, in catalogs, and such. The Internet, which allows much closer and one-to-one contact between customer and seller, is moving the business model to demand-pull. In this model, companies offer customers the components of a service or product, and the customers create their own personalized versions, creating the demand that pulls the specific product or service they want through the supply chain, or rather, the demand chain.

To move to this consumer-pull mass customization business model, companies need to essentially reverse their business processes to be customer driven. In fact, this model can lead to suppliers and customers co-creating or negotiating products and services. For example, book buyers who put their critiques of books through online reviews and useful votes on Amazon.com's Web site are, in a sense, co-creating part of Amazon's service to other book buyers.

Here's another bookseller example. Borders is the second-largest book retailer in the United States. Its president has decided to replace the industry's supply-push approach with a new demand-pull approach. Traditionally, and still today, booksellers push those books that publishers pay them to promote in their bookstore windows, on near-the-door tables, and in other high-traffic areas.

Borders' president thinks these short-term incentives might actually hurt overall sales in categories, so he is shifting Borders to "category management," which means publishers will help co-manage 250 book categories, reports Trachtenberg.² In return for being part of the decision-making process by recommending titles to Borders, the publishers will help pay for the market research Borders will do to find out what book buyers want. For instance, Borders wants to find out which books are bought on impulse, which ones sell better when the cover is showing, which types should be grouped together, where sections should be located, and even how to price books.

Borders' competitors are watching this demand-pull experiment with great interest. Some doubt that it will work, reports Trachtenberg, arguing that selling books is not like selling screwdrivers or prescription drugs. One thing Borders has already learned through its market research, though, is that one-fourth of its cookbooks are bought as gifts.

"Customer-centricity" is another term for this trend. It means replacing product-centric thinking with customer-centric thinking. The result: Organizational structures shift from product groups to customer groups. One way to view this shift is to see it as turning traditional thinking inside-out. When companies focus on products, they are thinking inside-out. When they think about customers and customer groups, they think outside-in.

Although you might think this shift means keeping customers happy, it can actually have the opposite effect for some customers. When companies create customer clusters using data-warehousing and data-mining techniques, they find out which clusters are profitable and which are not. They may then institute policies that cater to the profitable customers and charge or let go the unprofitable ones.

Self-Service

Bank automated teller machines (ATMs) were an early and successful example of customer self-service. The 1990s saw an increase in systems that let consumers access corporate computer systems to purchase products, inquire about the state of an order, and, in general, do business with the firm online on their own. FedEx was one of the first companies to leverage the Web by allowing customers to directly access its package-tracking system via its homepage. Today, companies that ship products via FedEx have links to the same homepage, providing that service to their customers. When customers serve themselves, employees can concentrate on services that customers cannot help themselves and other kinds of work. More importantly, self-service has shown to be an effective means for customer empowerment, extending the value from the business to the customer.

Real-Time Working

The genesis of the notion of real-time enterprise, we believe, was the military, whose personnel fly planes and drive tanks using instrument panels. These panels show the pilots and soldiers the surrounding terrain as it exists at the moment, so that they can

Information Systems Management in the Global Economy

respond to changes and threats in real time. The term has been adopted in business and means operating a business in as close to real time as possible, using computer systems to indicate the state of the “business terrain” as it exists at the moment.

For example, members of a sales team about to talk to a potential global customer can have up-to-the-minute information about that customer—late-breaking news about the company, recent management changes, latest orders to the company (if any), sales tips from other employees—all gathered for them from many sources.

Other examples of real-time working are knowing inventories as of right now (not one week or one month ago), knowing cash on hand right now (not at the end of last month), and being able to reach someone when you need them, perhaps via instant messaging. With accurate, up-to-date information on company operations, customer orders, inventory stocks, and on-demand access to others, people have better information to make decisions. Thus, businesses are making a major push to have real-time information in hand and real-time access to people, which are not easy feats, especially for enterprises with global operations.

Real-time working is more than just providing instant up-to-date information. According to (Gartner), a respected research firm in I.T. and Business, it is a quest for strategic gain. Firms will have to implement new collaborative business rules and roles before event-driven actions. IT can help implement real-time working with computer-based content management and Internet portals.

Team-Based Working

The trend is toward people working together on projects. Rather than depending on chains of command and the authority of the boss, many organizations emphasize teams to accomplish major tasks and projects. Peter Drucker’s classic article in the *Harvard Business Review*³ uses the analogy of a symphony, where each member of the team has a unique contribution to make to the overall result. Task-oriented teams form and work together long enough to accomplish the task, then disband. This project-based working, where people sometimes work simultaneously on several projects with different teams across different organizations, is generating major interest in the information systems called “groupware.” Groupware provides IT support for meetings, collaborative work, and communications among far-flung team members. Cairncross¹ believes the increased ability to collaborate in new ways using IT is one of the forces driving the changes in organizational structures, and that enterprises that use the technology to work in new collaborative ways will be the winners.

Anytime, Anyplace Information Work

Information workers are increasingly mobile, so computers and networks are needed not just for accessing information, but also for communicating with others. One of the hallmarks of IT today is that the communication capabilities of computers are seen as more important than their computing capabilities. Communication technology has developed to the point where information work can be done anywhere with a laptop computer, cell phone, or PDA. Electronic mail, voice mail, and instant messaging (IM) cross time zones to allow work to be conducted anytime, anywhere. People sporadically work from home, rather than commute every day, and they work in their preferred geographical location, even if it is remote from the main office. The advances in wireless technology enable people to work in an airport, at a customer site, while walking, and so on.

Outsourcing and Strategic Alliances

To become more competitive, organizations are examining which work they should perform internally and which they should give to others. Outsourcing, having a third party perform information work for you, may be a simple contract for services or a long-term strategic alliance. Between these two extremes are a variety of relationships that are redefining the way organizations work together. The thinking is: We should focus on what we do best and outsource the other functions to people who specialize in them, to make us more world-class in all our functions. The result is becoming known as the extended enterprise. IT is providing the information and communication means to manage complex sets of workflows.

Demise of Hierarchy

In the traditional hierarchy, people performing the same type of work are grouped together and overseen by a supervisor. The supervisor allocates the work, handles problems, enforces discipline, issues rewards, provides training, and so on. Management principles such as division of labor and chain of command define this traditional work environment.

This structure is no longer best in many instances. Self-managed groups, whether working on an assembly line or in an insurance company, provide much of their own management. In these quality circles, they have lower absenteeism, yield higher productivity, produce higher-quality work, and are more motivated than workers in traditional settings.

A major reason for the demise of hierarchy is that the more turbulent business environment—represented by the changes just noted—challenges the premises of a hierarchical structure because it cannot cope with rapid change. Hierarchies require a vertical chain of command, where lines of responsibility do not cross and approval to proceed on major initiatives is granted from above. This communication up and down the chain of command can take too much time in today's environment. IT enables team-based organizational structures by facilitating rapid and far-flung communication.

Business Strategies in the New Work Environment

Thomas Friedman's bestseller, *The World Is Flat*, is another forceful essay on unfolding the new structure of the global economy. As a result of these changes in the internal and external organizational environment, enterprises around the world are redefining their work environment—a tumultuous proposition, at best—without any true guidance. We see the following overarching goals for thriving in the new work environment:

- Leverage knowledge globally
- Organize for complexity
- Work electronically
- Handle continuous and discontinuous change

Leverage Knowledge Globally

Knowledge is now being called intellectual capital to signify its importance. This is not the knowledge in an expert system or a Lotus Notes database, but rather the knowledge in people's heads. Knowledge that people know but cannot really explain to others is called tacit knowledge, as opposed to explicit, explainable knowledge. Companies that

are able to leverage tacit knowledge globally will be successful—provided, of course, its use is directed by a sound strategy.

Brook Manville and Nathaniel Foote of McKinsey & Company⁴ point out that knowledge-based strategies begin with strategy, not knowledge. Intellectual capital is meaningless unless companies have the corporate fundamentals in place, such as knowing what kind of value they want to provide and to whom.

They also point out that executing a knowledge-based strategy is not about managing knowledge but about nurturing people who have the knowledge, tapping into the knowledge that is locked in their experience. Although companies have numerous systems in place to share explicit knowledge, the key to unlocking tacit knowledge is a work environment in which people want to share. A manufacturer that tried to foster greater knowledge transfer while downsizing discovered that the combination was impossible. Why would employees share what they know when the bosses were looking for ways to consolidate expertise?

The means to tap tacit knowledge is to foster sharing and to support the sharing with technology. E-mail and groupware can provide the interconnection, but the driving force is the culture. When people want to share, they form worknets—informal groups whose collective knowledge is used to accomplish a specific task. The sharing and leveraging of knowledge happens through organizational “pull”—people needing help from others to solve a problem—rather than organizational “push,” which overloads people with information. Therefore, leveraging knowledge is all about raising the aspirations of each individual, say Manville and Foote.

Organize for Complexity

A second overarching goal of companies, whether they recognize it or not, is to be able to handle complexity. Why? One reason is that the world has become so interconnected that simple solutions no longer solve a problem. Another reason is that issues are systemic. Corporate decisions can have an environmental impact, a human resources impact, an economic impact, and even an ethical impact. Furthermore, capturing market share often-times requires allying with others who have complementary expertise. Alliances increase complexity; so does specialization. Have you bought shampoo, crackers, or tires lately? These used to be fairly straightforward decisions. Today, the choices are so numerous that consumers can spend an inordinate amount of time making a selection. To thrive in such an age, companies need to be organized to be able to handle complexity.

Work Electronically

Just as the marketplace is moving to the marketspace, the workplace is moving to the workspace. Taking advantage of the Internet, and networks in general, is a third major goal of enterprises these days. But just as the move from horse and buggy to train to automobile to jet plane was not simply a change in speed, but a change in kind, so, too, is the move to working in a space rather than a place a change in kind. It requires different organizing principles, management tenets, compensation schemes, organizational structures, and such. It also changes how organizations interact with others, such as their customers.

George Gilder,⁵ columnist and author, noted that business eras are defined by the plummeting price of the key factor of production. During the industrial era, this key factor was horsepower, as defined in kilowatt hours. It dropped from many dollars to

7.5 cents. For the past 40 years, the driving force of economic growth has been transistors, translated into millions of instructions per second (MIPS) and bits of semiconductor memory. The latter has fallen 68 percent a year, from \$7 per bit to a millionth of a cent. Likewise, the cost of storage has become almost trivial, less than 50 cents per gigabyte.

MIPS and bits have been used to compensate for the limited availability of bandwidth. The microchip moved power within companies, allowing people to vastly increase their ability to master bodies of specialized learning. Microchips both flattened corporations and launched new corporations. Bandwidth, on the other hand, moves power all the way to consumers. That is the big revolution of the Internet, Gilder contends, and the reason behind the move to relationship marketing with consumers.

The use of bandwidth is becoming more available as the economy changes. For example, TV is based on a top-down hierarchical model with a few broadcast stations (transmitters) and millions of passive broadcast receivers (televisions). The result is “lowest-common-denominator” entertainment from Hollywood. The Internet, on the other hand, is a “first-choice” culture, much like a bookstore. You walk in and get your first-choice book. First-choice culture is vastly different from lowest-common-denominator culture. As the Internet spreads, the culture will move from what we have in common to one in which our aspirations, hobbies, and interests are manifested.

Handle Continuous and Discontinuous Change

Finally, to remain competitive, companies will need to innovate continually—something most have generally not been organized to do. Continual innovation, however, does not mean continuously steady innovation. Innovation occurs in fits and starts. Change takes two forms: continuous change (the kind espoused by total quality management techniques) or discontinuous change (the kind espoused by reengineering). When a product or process is just fine, but needs some tuning, continuous change improves its efficiency. However, when it is not fine, discontinuous change is needed to move to an entirely new way of working. The two often form a cycle. Companies need to be able to handle both for their products and processes.

These four major goals underlie the new work environment. This organizational environment sets the backdrop for exploring the emerging technology environment.

THE TECHNOLOGY ENVIRONMENT

The technology environment enables advances in organizational performance. The two have a symbiotic relationship; IT and organizational improvements co-evolve. IT evolution can be described using the four traditional areas of hardware, software, data, and communication.

Hardware Trends

In the 1950s and 1960s, the main hardware concerns of data-processing managers were machine efficiency and tracking new technological developments. Batch processing was predominant; online systems emerged later. At that time, hardware was centralized, often in large, showcase data centers behind glass walls.

Information Systems Management in the Global Economy

In the mid-1970s, processing power began to move out of the central site, but only at the insistence of users who bought their own departmental minicomputers and word processors. In the 1980s, mainly due to the advent of personal computers (PCs), this trend accelerated far beyond the expectations of most people, especially IS managers. In the 1990s, the IT world was focused on networks, ranging from local area networks (LAN) to high-speed wide-area networks to support client-server computing. In this underlying structure, a client machine on the desktop, a laptop, or a handheld provides the user interface, and a server on the network holds the data and applications. This same client-server model is used for interacting with the Web.

The major development in hardware toward mobile and handheld devices is led by two factions: telecommunications companies (and the cell phone manufacturers that serve them) and handheld computer manufacturers, such as Palm and Microsoft. Functionality is expanding with devices handling both voice and data. Use of wireless hardware has become the norm for the anytime-anyplace workforce.

These hardware trends are further distributing processing beyond organizational boundaries to suppliers and customers. The result is the movement of enterprise-wide hardware and processing power out of the control—although perhaps still under the guidance—of the IS organization. Many futurists predict that hardware will evolve from the desktop to embedded devices. These are self-contained special-purpose applications with a dedicated computer installed in the devices, such as Personal Digital Assistants (PDAs) and handheld computers.

Software Trends

The dominant issue in software and programming in the 1960s was how to improve the productivity of in-house programmers—those who created mainly transaction-processing systems. Occasionally, IS management discussed using outside services, such as time-sharing services, application packages, and contract programming from independent software houses. The software industry was still underdeveloped, though, so application development remained the purview of IS managers.

Later, programming issues centered first around modular and structured programming techniques. Then the topic expanded to life cycle development methodologies and software engineering, with the goals of introducing more rigorous project management techniques and getting users more involved in early stages of development. Eventually, prototyping (quick development of a mock-up) became popular.

Then two other software trends appeared. One, purchased software, became a viable alternative to in-house development for many traditional, well-defined systems. Two, IS managers began to pay attention to applications other than transaction processing. Software to support decision support systems (DSS), report generation, and database inquiry shifted some programming from professional programmers to end users.

During the 1990s, the push for open systems was driven primarily by software purchasers who were tired of being locked in to proprietary software (or hardware). The open systems movement continues to demand that different products work together, that is, interoperate. Vendors initially accommodated this demand with hardware and software black boxes that performed the necessary interface conversions, but the cost of this approach is lower efficiency.

Another major trend in the 1990s was toward Enterprise Resource Planning (ERP) systems, which tightly integrate various functions of an enterprise so that management

can see cross-enterprise financial figures and order and manufacturing volumes. Some firms implemented ERP to replace legacy systems that were not Y2K compliant (i.e., the systems would think that an “02” would mean 1902 rather than 2002). Implementing ERP involves integrating components, which is called systems integration, rather than application development. Implementation has been expensive and troublesome, especially for companies wanting to modify the ERP software to fit their unique processes. However, for many large corporations, their ERP system has become their foundation information system, in essence, defining their IT architecture.

Like hardware, software is becoming more network-centric. Rather than replacing legacy systems, many companies are adding Web front ends to broaden access to the systems to employees, customers, and suppliers. Companies are establishing corporate portals where employees log into their company intranet to use software housed at that site. This approach moves the software from being decentralized (on PCs) to being centralized (on a server somewhere).

Another change in software is the move to Web Services. Web Services are packages of code that each perform a specific function and have a URL (Uniform Resource Locator; an address on the Internet) so that they can be located via the Internet to fulfill a request. For example, if you have accessed FedEx’s Web site to track a package, you have used a Web Service. MacAfee’s virus protection also is delivered to PCs using a Web Services approach. The software industry is morphing into a Web Services industry.

The significance of Web Services is that it moves software and programming to being truly network-centric. As SUN Microsystems claimed more than a decade ago, the network becomes the heart of the system, linking all Web Services. Packages of code can be concatenated to produce highly tailored and quickly changed processes. In the past, once software was programmed to handle a process in a specific way, it essentially cast that process in electronic concrete because the process could not change until the software was modified. The tenet of Web Services is that a process is defined at the time it is executed, because each Web Service decides at that time which of its many options to use to answer the current request. The world of Web Services entails its own jargon, standards, and products. Importantly, it builds on the past—functions in legacy systems can be packaged to become Web Services. The last two years have witnessed the widespread adoption of service-oriented architecture (SOA). Service orientation refers to an architecture that uses loosely coupled applications or services to support the requirements of business processes.

As discussed in the hardware trends, embedded applications will eventually become a major task for software developers. With an estimation of more than 10 to 15 billion connected devices in the next few years—from PDAs to mobile phones—networking and security remain key priorities.

Another emerging trend is the increasing recognition that Web-based interface alone is not sufficient. With the proliferation of ubiquitous computing, Web-based interfaces should be supplemented with complementary “anywhere accessible” applications that require a new type of interface rich in interactivity and intuitiveness.

Data Trends

The evolution of the third core information technology area—data—has been particularly interesting. At first, discussions centered around file management and techniques for organizing files to serve individual applications. Then generalized file management

Information Systems Management in the Global Economy

systems emerged for managing corporate data files. This more generalized approach led to the concept of corporate databases to serve several applications, followed a few years later by the concept of establishing a data administration function to manage these databases.

As discussed earlier, in the 1970s, the interest in data turned to technical solutions for managing data—database management systems (DBMS). As work progressed, it became evident that a key element of these products was their data dictionary. Dictionaries now store far more than data definitions; they store information about relationships between systems, sources and uses of data, time cycle requirements, and so on.

For the first 20 years of information processing, discussions about data concerned techniques to manage data in a centralized environment. It was not until the advent of fourth-generation languages and PCs that interest in letting employees directly access corporate data began. Then users demanded it. If data across systems are defined the same way, they can be more easily exchanged.

In addition to distributing data, the major trend in the early 1990s was expanding the focus from data resources to information resources, both internal and external to the firm. Data management organizes internal facts into data record format. Information management, on the other hand, focuses on concepts (such as ideas found in documents, especially digital documents such as Web pages) from both internal and external sources. Thus, information resources encompass digitized media, including voice, video, graphics, animation, and photographs.

Managing this expanded array of information resources requires new technologies. Data warehousing has arisen to store huge amounts of historical data from such systems as retailers' point-of-sale systems. Data mining uses advanced statistical techniques to explore data warehouses to look for previously unknown relationships in the data, such as which clusters of customers are most profitable. Similarly, massive amounts of document-based information are organized into document repositories and analyzed with document mining techniques. In addition, as noted earlier, businesses now emphasize intellectual capital management. Some believe knowledge can reside in machines; others believe it only resides in people's heads. Either way, knowledge management is of major importance in the new economy because intangibles hold competitive value.

The Web has, of course, broadened the term "data" to mean "content," which encompasses text, graphics, animation, maps, photos, film clips, and such. Initially, Web content was managed by the content creators, such as marketing departments. However, with the huge proliferation of sites, enterprises realized they needed to rein in all the exuberance in order to standardize formats, promote their brands in a common manner, establish refresh cycles for their content, and create approval and archival processes. Content management has become very important, and as one manager observed, it is a lot like running a newspaper.

Three major data issues now facing CIOs are security (protecting data from those who should not see it) and privacy (safeguarding the personal data of employees and customers). Furthermore, regulations (such as the 2002 Sarbanes-Oxley Act in the United States) now require company officers to verify their financial data. Because the processes that handle financial data are undoubtedly automated, CIOs need to document and ensure the accuracy of these processes. Thus, numerous aspects of data

safeguarding have become important. In the coming years, content management solutions, thanks to the ease in which they can manage unstructured data, will likely constitute a software foundation for other applications to build, retrieve, and store data.

Communications Trends

The final core information technology is telecommunications and technology convergence. This area has experienced enormous change and has now taken center stage. Early use of data communications dealt with online and time-sharing systems. Then interest in both public and private (intracompany) data networks blossomed.

Telecommunications opened up new uses of information systems, and thus it became an integral component of IS management. Communications-based information systems were used to link organizations with their suppliers and customers. In the early 1980s, a groundswell of interest surrounded interorganizational systems, because some provided strategic advantage. Also during the 1980s, the use of local area networks (LANs) to interconnect PCs began. PCs started out as stand-alone devices, but that only took advantage of their computing capabilities. It soon became clear that they had communication capabilities as well, so companies jammed even more wires in their wiring ducts to connect desktops to each other and then to the corporate data center.

Until the Internet appeared, enterprises leased lines from telecommunications carriers to create wide area networks (WANs) that linked their offices and factories. The only publicly available telecommunication system was the voice telephone system. Transmitting data from PCs in small offices that did not have leased lines generally entailed using a modem to dial up a computer at another site.

The Internet changed all that. Internet Service Providers (ISPs) appeared seemingly overnight to provide PC users with a local number for dialing into the Internet to search the Web, converse in a chat room, play text-based games, send e-mail, and transfer files. The Internet provided for data the equivalent of the worldwide voice network. Today, the Internet's protocol has become the worldwide standard for LANs and WANs. In fact, it will soon be the standard for voice as well.

Perhaps the most exciting developments in telecommunications technology is wireless—wireless long distance, wireless local loops (the last-mile connection of a home or office), wireless LANs (increasingly handled by Wi-Fi technology), and even wireless personal area networks (PANs). Wireless does not just enable mobility; it changes why people communicate, how they live, and how they work. It is a paradigm shift, and we are in the early days of wireless. VoIP (Voice over Internet Protocol) has become popular in many organizations or countries, with greater penetration in developing countries such as China and India. Many industry analysts predict that by 2009, over 70 percent of worldwide voice connection will be wireless.

While the Internet continues to be the key networking technology, alternate technologies such as peer-to-peer technology, Bluetooth, or wireless mesh network, make it possible to deploy communications or collaborative applications without the reliance on Internet servers. Examples include local messaging systems, or RFID-based inventory management.

A number of unresolved issues remain salient. Reliability and security of networks, development and migration to new communications standards, and uneven access to networks (digital divide) are among a few but critical issues that management needs to strategize.

THE MISSION OF IS ORGANIZATIONS

With the organizational and IT environments as backdrops, we now turn to the mission of the IS organization. In the early days, transaction processing systems (TPS) acted as “paperwork factories” to pay employees, bill customers, ship products, and so on. During that era, the performance of the IS organization was defined by efficiency (or productivity) measures such as the percentage of uptime for the computer, throughput (number of transactions processed per day), and the number of lines of program code written per week.

Later, during the MIS era, the focus of IS departments shifted to producing reports for “management by exception” or summary reports for all levels of management. This era gave us the classic IS objective to “get the right information to the right person at the right time.” In this era, IS was judged on effectiveness measures (in addition to the efficiency measures of the previous era).

For today’s environment, the mission of IS organizations has broadened to the following:

To improve the performance and innovativeness of people in organizations through the use of IT.

The objective is improvement of the enterprise, not IS; so, ideally, IS performance is based on business outcomes and business results. IT is but one contributor to improving enterprise performance and competitiveness. This text focuses on the resources used by IS organizations.

A SIMPLE MODEL

We propose a simple model to describe the IS function in organizations. Figure 2 represents the process of applying IT to accomplish useful work. On the left is the technology, and on the right are the users who put it to work. The arrow represents the process of translating users’ needs into systems that fill that need. In the early days of IT, this translation was performed almost entirely by systems analysts.

Figure 3 is a simple representation of what has happened over the past 50 years. Technology has become increasingly complex and powerful; uses have become increasingly sophisticated. Information systems are now viewed as system products and users

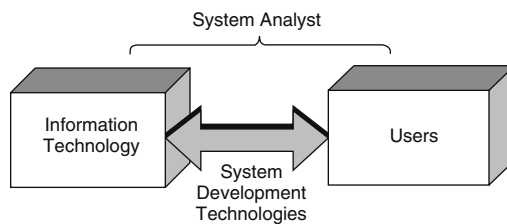


FIGURE 2 A Simple Model of Technology Use

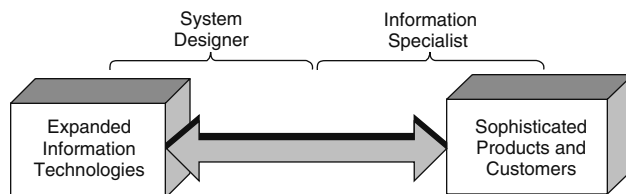


FIGURE 3 Systems Professionals Bridging the Technology Gap

Information Systems Management in the Global Economy

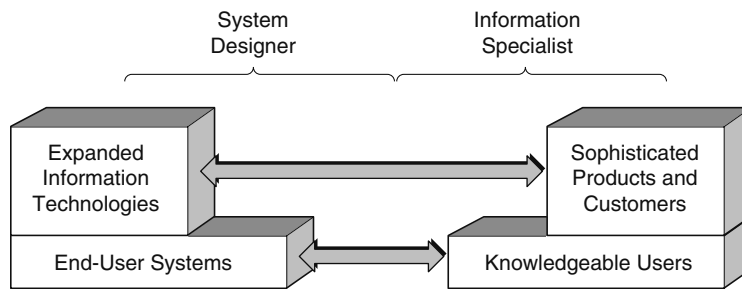


FIGURE 4 Users Bridging the Technology Gap

have become customers. The increased distance between the two boxes represents the increasingly complex process of specifying, developing, and delivering these system products. It is no longer feasible for one system analyst to understand the fine points of all the technologies needed in an application as well as the nuances of the application. More specialization is required of systems professionals to bridge this wider gap.

Systems professionals are not the only ones who can help bridge this gap between the technology and its users. Technology has become sophisticated enough to be used by many employees and consumers. At the same time, they are becoming increasingly computer literate; many employees even develop their own applications; hence, the notion of end-user computing. Figure 4 depicts this trend. Today, some of the technology is truly user-friendly, and some applications, such as Web page development, database mining, and spreadsheet manipulation, are handled by non-IT staff. Transaction systems, however, are still developed and maintained by professional developers, either inside or outside the firm.

The main point of this discussion is that technology is getting more complex, applications are becoming more sophisticated, and users are participating more heavily in the development of applications. The net result is that management of the process is becoming more complex and difficult as its importance increases.

A BETTER MODEL

Expanding the simple model gives us more guidance into managerial principles and tasks. We suggest a model with four principal elements:

1. A set of technologies that represent the IT infrastructure installed and managed by the IS department
2. A set of users who need to use IT to improve their job performance
3. A delivery mechanism for developing, delivering, and installing applications
4. Executive leadership to manage the entire process of applying the technology to achieve organizational objectives and goals

Let us look more carefully at each of these elements.

The Technologies

Several forces contribute to the increased importance and complexity of IT. One, of course, is the inexorable growth in computing and communications capacity accompanied

by significant reductions in cost and size of computers and telecommunications components. Another is the convergence of the previously separate technologies of computers, telephones/telecom/cable TV, office equipment, and consumer electronics. Still a third contributor is the ability to store and handle multiple forms of data—including voice, image, and graphics—and integrate them, resulting in multimedia. Here is a brief list of some rapidly growing technology areas:

- Handheld wireless devices and multifunction cell phones
- Web Services
- Wireless networks
- Integration of voice, data, and video
- Integration of consumer electronics and IT
- Green technologies

These technologies form products that are useful to employees, customers, suppliers, and consumers. No longer relegated primarily to automating transactions, information systems now fill major roles in management reporting, problem solving and analysis, distributed office support, customer service, and communications. In fact, most activities of information workers are supported in some way by IT; the same is becoming true of suppliers, customers, business trading partners, and consumers.

The Users

As IT becomes pervasive, user categories expand. The users of electronic data processing and MIS once were relatively easy to identify; they were inside the company. These systems performed clear-cut processes in specific ways. Now, though, many people want open-ended systems that allow them to create their own processes on the fly. They want systems that act as a tool, not dictate how to perform a task.

If we concentrate only on business use of IT, one helpful dichotomy divides the activities of information workers into two: procedure-based activities and knowledge-based (or goal-based) activities. The value of this model is that it focuses on the important characteristics of information workers—their job procedures and knowledge—rather than on the type of data (e.g., numbers versus text) or the business function (production versus sales), or even job title (managerial versus professional).

Procedure-based activities are large-volume transactions, where each transaction has a relatively low cost or value. The activities are well defined; therefore, the principal performance measure is efficiency (units processed per unit of resource spent). For a procedure-based task, the information worker is told what to accomplish and the steps to follow. Procedure-based activities mainly handle data.

Knowledge-based activities, on the other hand, handle fewer transactions, and each one has higher value. These activities, which can be accomplished in various ways, must therefore be measured by results, that is, attainment of objectives or goals. Therefore, the information worker must understand the goals because part of the job is figuring out how to attain them. Knowledge-based activities are based on handling concepts, not data. Figure 5 summarizes these two kinds of information-based work, giving several examples from banking.

Some authors use the words “clerical” and “managerial” to refer to these two types of activities. Looking at the attributes, however, it is clear that managers often do procedure-based work, and many former procedure-based jobs now have knowledge-based components. Furthermore, the distinction between manager and worker is blurring.

PROCEDURE BASED	KNOWLEDGE BASED
<ul style="list-style-type: none">• High volume of transactions• Low cost (value) per transaction• Well-structured procedures• Output measures defined• Focus on process• Focus on efficiency• Handling of data• Predominantly clerical workers• Examples<ul style="list-style-type: none">Back officeMortgage servicingPayroll processingCheck processing	<ul style="list-style-type: none">• Low volume of transactions• High value (cost) per transaction• Ill-structured procedures• Output measures less defined• Focus on problems and goals• Focus on effectiveness• Handling of concepts• Managers and professionals• Examples<ul style="list-style-type: none">Asset/liability managementPlanning departmentCorporate banking

FIGURE 5 A Dichotomy of Information Work

The most important benefit of this dichotomy is that it reveals how much of a firm's information processing efforts have been devoted to procedure-based activities, which is understandable because computers are process engines that naturally support process-driven activities. As important as they are, though, it is clear that procedure-based activities are no longer sufficient to sustain competitiveness. The wave of the future is applying IT to knowledge-based activities. For the task "pay employees" or "bill customers," the system analyst can identify the best sequence of steps. On the other hand, the task "improve sales in the Asian market" has no best process. People handling the latter work need a variety of support systems to leverage their knowledge, contacts, plans, and efforts.

System Development and Delivery

In our model, system development and delivery bridge the gap between technology and users, but systems for procedure-based activities differ from systems for knowledge-based information work.

The left side of Figure 6 shows the set of technologies that form the IT infrastructure. Organizations build systems on these technology resources to support both procedure-based and knowledge-based activities. The three main categories, called essential technologies, are computer hardware and software, communication networks, and information resources. We call the management of them infrastructure management, which includes operations, that is, keeping the systems that use these technologies up and running.

The right side of Figure 6 shows the two kinds of information work: procedure based and knowledge based. These two categories are not distinct or separate, of course, but it is helpful to keep their major differences in mind because they lead to different approaches, and frequently different teams, in the bridging of systems development and delivery.

In between the technologies and the information workers is the work of developing and delivering both procedure-based systems and support systems.

IS Management

The fourth component of this text model is executive leadership. IT leadership comes from a chief information officer (CIO) who must be high enough in the enterprise to influence organizational goals and have enough credibility to lead the harnessing of the

Information Systems Management in the Global Economy

technology to pursue those goals. However, the CIO, as the top technology executive, does not perform the leadership role alone, because IT has become too important to enterprise success to be left to one individual. Thus, CIOs work with their business peers, C-level executives—CEO, COO, CFO—and the heads of major functional areas and business units. The technology is becoming so fundamental and enabling that this executive team must work together to govern and leverage it well.

To summarize, this model of the IS function has four major components:

1. The technology, which provides the enabling electronic and information infrastructure for the enterprise
2. Information workers in organizations, who use IT to accomplish their work goals
3. The system development and delivery function, which brings the technology and users together
4. The management of the IS function, with the overall responsibility of harnessing IT to improve the performance of the people and the organization

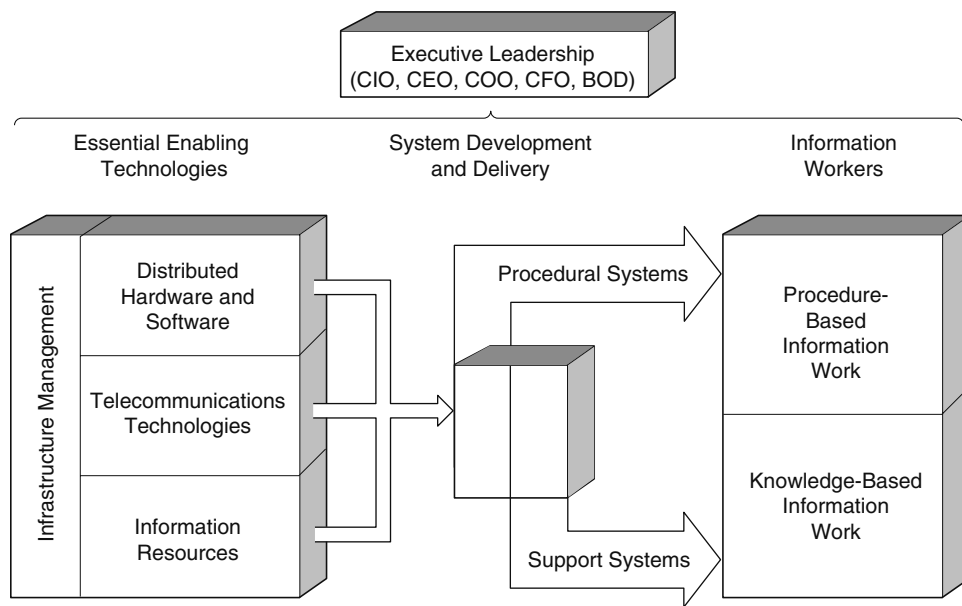


FIGURE 6 A Framework for IS Management

Information Systems Management in the Global Economy

Following is the case of MeadWestvaco. The evolution of the case study, first published in 1985, mirrors the changes that have taken place in many IS organizations over the past 20 years.

CASE EXAMPLE

MEADWESTVACO CORPORATION

www.meadwestvaco.com

MeadWestvaco, with headquarters in Stamford, Connecticut, is a \$7-billion global company that produces specialty and coated paper, packages specialty chemicals, and manufactures consumer and office products. It owns and manages

some 3 million acres of forest using sustainable forestry practices. The company operates in more than 29 countries, has about 24,000 employees around the world, and serves customers in approximately 100 nations.

Mead Corporation and Westvaco, two comparably sized forest products companies, merged in early 2002 to form MeadWestvaco Corporation. This case study begins in 1985 and follows the evolution of Mead's IT function up to the present time, in its merged form. In 2001, *InformationWeek* magazine listed Mead No. 193 in its top 500 of the most innovative users of information technology. The IT organization has remained in Dayton, Ohio, the former headquarters of Mead Corporation.

The 1960s and 1970s: Reorganization of Information Services

In the 1960s, Mead's corporate information services (CIS) department provided all divisions with data processing services. By 1967, the department's budget had grown so large that management decided to spin off some of the functions to the divisions. Divisions could establish their own data processing and process engineering groups or they could continue to purchase data-processing services from CIS. Many of the divisions did establish their own IS departments, but all continued to use the corporate data center for their corporate applications. In the late 1970s, the CIS department had six groups. The director reported to the vice president of operations services. The six groups under the director were:

- *Computer Operations* to manage the corporate data center
- *Telecommunications* to design the telecommunications network and establish standards
- *Technical Services* to provide and maintain systems software
- *Developmental Systems* to handle traditional system development

- *Operational Systems* to maintain systems after they become operational
- *Operations Research* to perform management science analysis

The 1980s: Focus on End-User Computing

In 1980, management realized that its CIS organizational structure would not serve the needs of the rapidly growing end-user community. Furthermore, to become an "electronic-based" organization, Mead needed a corporate-wide network. Therefore, the department reorganized so that the director of corporate information resources (CIR) reported directly to the company president. This change signaled the increased importance of information resources to Mead.

CIR was responsible for creating hardware, software, and communication standards for the entire corporation; it ran the corporate data center; and it operated the network. All the divisions used the network and corporate data center, and they followed the corporate standards; some operated their own small, distributed systems as well, which linked into the corporate network. The three departments within the new group were as follows.

Information Resources Planning and Control was responsible for planning future information systems and technology. This department grew out of the company's strong planning culture. The decentralization in the 1970s highlighted the need for a coordinating IT body. Although it was small, it had two important roles. First, it took the corporate perspective for IT planning to ensure that Mead's IT plans meshed with its business plans. Second, it acted

(Case Continued)

as planning coordinator, helping various groups and divisions coordinate their plans with corporate and CIR plans.

Information Services was responsible for most of the traditional IS functions from the old information services department—company-wide telecommunications support, data center operations, development of corporate-wide systems, database administration, system software support, and technical support for end-user computing.

Most divisions developed their own applications, following the guidelines created by this department. The IS steering committee—composed of the president and group vice presidents—established a policy that applications should be transportable among the various computing centers and accessible from any Mead terminal. The company's telecommunications network established the guidelines for making this interconnection possible.

Decision Support Applications (DSA) provided all end-user computing support for the company. At the time of the reorganization, DSA had no users, no products, no common applications among multiple locations, and only five staff members in operations research and two in office systems support. By 1985, they were serving 1,500 users in some 30 Mead locations with 10 staff members. DSA offered 14 products and 8 corporate-wide applications through the following 4 groups:

- *Interactive help center* provided hotline support and evaluated new end-user computing products.

- *Office systems* supported the dedicated word-processing systems and IBM's Professional Office System (PROFS), which Mead used as the gateway to end-user computing. Divisions were free to select any office system, but most followed the recommendations of this group to ensure corporate-wide interconnection.
- *Decision analysis* built a number of company-wide decision support systems, such as a corporate budgeting model and a graphics software system. It also used operations research tools to develop linear programming models and simulations for users needing such sophisticated analysis tools.
- *Financial modeling coordination and EIS* was in charge of Mead's integrated financial system. It also supported executive computing through IBM PCs used by corporate executives and an executive information system (EIS) accessed through PROFS.

Late 1980s: Structure Adjustment

The 1980 reorganization separated the more people-oriented activities under DSA from the more technical activities under the information services department. The technology was better managed, and relations with users improved. However, this split caused two problems. The first was that traditional programmers and systems analysts felt that DSA received all the new and exciting development work. The second problem was coordinating the two departments. A matrix arrangement evolved to handle both problems, with both information

(Case Continued)

services and DSA people staffing most projects.

The departmental structure implemented in 1980 remained essentially intact throughout the 1980s with only two major changes. In early 1988, the vice president of information resources began reporting to Mead's chairman and CEO. Second, the DSA group was reorganized.

As users became more sophisticated and less generic, the department created small groups with expertise in specific areas. By the end of the 1980s, they were supporting more than 5,000 users in three ways:

- The *service center* continued to introduce new users to technology and provide telephone hotline assistance to experienced users.
- The *application development consultants* helped users develop more sophisticated applications and guided maintenance of user-written applications, which had become a noticeable problem. They also updated traditional applications to permit end-user systems to access the data.
- The *local area experts* worked in the functional departments supporting users in their area. They reported directly to their area manager and indirectly to CIR. Due to the growing number of user-written applications, they, too, helped users keep their applications up to date.

During the 1980s, Mead found its end-user computing focus shifting from introducing new technology to making more effective use of the technology in

place. By the end of the decade, Mead was concentrating on harvesting its investment in IT by using it as a lever to change the way it was doing business.

1990: Leverage the IT Infrastructure

In 1990, CIR underwent another reorganization to bring it in line with a new strategy. We first discuss the reorganization, then the strategy.

Management realized that the end-user systems and large-scale business systems needed to cross-pollinate each other. Users needed one place to go for help; therefore, application development was placed in one group, which was renamed information services.

The emphasis of the reorganization was to strengthen Mead's mainframe-based infrastructure that the corporate-wide network depended on. Although the network had been created in 1983, its value in connecting Mead to vendors and customers had not been recognized until the late 1980s. Therefore, in 1990, CIR created a new group—network services—to handle computer operations, technical services, and telecommunications. The 1990 reorganization also consolidated administrative functions (such as charge-back) into the technology planning and control group.

Although the 1990 reorganization did not add any new functions, it shifted emphasis from end-user computing to building an infrastructure and integrating development of all sizes of applications.

1990 Strategy In the early 1980s, Mead installed its first information resources business plan, which emphasized networking and end-user computing. By the late

(Case Continued)

1980s, the objectives had been accomplished. In hindsight, management realized the 1980 plan had been a technology plan, not a business plan, because its goal had been to get control of IT. Having accomplished this goal, Mead decided to create a true business plan, one that addressed its employing IT resources.

Using the two-by-two matrix management realized that Mead had only been building systems that fit into the lower-right quadrant—systems to support traditional products and internal business processes. Rather than focus on company operations, management decided to shift emphasis in two directions: (1) toward reengineering company operations and (2) toward using IT to work better with suppliers and customers.

Business process reengineering—that is, significantly restructuring the internal operations in a business—became a major strategic direction, with the company-wide network playing a key role. Because IT removes many time and distance barriers associated with business processes, Mead decided to use IT to build new processes rather than simply accelerate existing ones.

One of the major processes carved out to be recentralized and reengineered was purchasing. The reengineering group discovered, for example, that 240 people handled accounts payable, mainly reconciling mismatches between goods received and purchase orders. By reengineering purchasing, the need for such reconciliations was eliminated. Mead outsourced the function while developing the new purchasing system.

Putting in the corporate purchasing system was Mead's first big venture into

reengineering. The company learned a lot from that experience. It also accomplished something few others had achieved: standard part numbers for all 800,000 MRO (maintenance, repair, and operations) parts. This excruciating data-cleansing exercise was done so that Mead could automatically consolidate parts orders from all 10 divisions and reap larger discounts due to the higher volumes. The result was large savings.

The second emphasis involved doing business electronically by extending current business processes and products to suppliers and customers. The motto was: "It is easy to do business with us," meaning that customers could specify the transaction format they wished to use, from electronic data interchange (EDI) for application-to-application transactions across company boundaries to terminals at customer sites linked to Mead's computers to the telephone using voice response. In essence, Mead installed various front-ends on its mainframe applications. For the purchasing system, Mead went to major parts suppliers and required them to use EDI as a condition of selling to Mead. The system was fully automatic. If a part was in stock, it was supplied; if not, an order was generated.

Thus, the basic strategy set forth in 1980 remained in force in 1990—to retain central control of the IT infrastructure and distribute responsibility for building and maintaining applications in the operating divisions. As the uses of IT changed, CIR reorganized to focus on those new uses: end-user computing in the 1980s and business reengineering and customer-oriented systems in 1990.

(Case Continued)

The 2000s: Technology Integration and Creation of a Global, Process-Based, Business-Driven Organization

In 1993, CIR management recognized that client-server computing was a paradigm shift in computing. In their new vision, applications would be of three types: enterprise-wide, division, and local; and they would use a global network that reached out beyond Mead.

CIR continued to focus on shared services (providing the infrastructure and supporting enterprise applications), whereas divisions would tailor systems to their customers and business. Users would not need to worry about where processing occurred, where data was housed, or how the mechanics of information processing were handled; CIR would handle all of these details. Data were to be viewed as a resource and managed accordingly, balancing access with integrity and security. Users would have greater geographic independence than in the past.

This vision is based on a demanding partnership in which the divisions buy into the infrastructure and its standards while CIR provides a flexible and responsive infrastructure.

New Organizational Structure Mead sought to absorb the new client-server paradigm into CIR's organizational structure. The core was the technology layer of the CIR organization—the four core technologies that provided the IT infrastructure on which Mead operated. Data Services provided data and information. Server Technology Services handled all servers on the network, from mainframes on down. Client Services handled all

devices that customers touched, which included desktop workstations, fax machines, and telephones. CIR defined their customers as Mead employees as well as others who interfaced with Mead. Network Services handled everything that tied these other pieces together, both voice and data communications, as well as the Internet, intranet, gateways, firewalls, and interactions with their ISP.

On the outside layer of the organization chart, closer to the customer, were the application groups. Division Support supported the applications developed by Mead's 10 operating divisions. Reengineering Support was concerned with a few company-wide business processes that had been recentralized and reengineered to improve efficiency and lower costs. These processes included Mead's financial systems and purchasing system, which did not touch customers. Enterprise Tools and Applications provided a common desktop toolkit to all Mead staff, which consisted of hardware and a suite of software products, such as spreadsheet, e-mail, word processing, graphics, browser, EDI, and knowledge tools (such as Lotus Notes). Corporate Center Solutions handled application development and maintenance of corporate applications. Technical Standards and Planning was a one-person thinktank devoted to future scenarios, whereas everyone else worked on the day-to-day issues. Finally, CIR Administration, shown beneath the circle, handled contracting and financials.

Like other companies, Mead encountered the typical staff problems of getting the mainframe staff to move into the client-server environment and getting new client-server talent to follow the

(Case Continued)

discipline needed to develop enterprise-wide systems.

The Internet had a large impact on Vision 2000 in that more and more of the vision was being served by it. For example, the vision foresaw storing lots of data on servers, so that CIR, not users, could handle backup. However, with so much information on the Internet, CIR did not need to acquire, install, or maintain as much public information as was originally planned. For instance, CIR had planned to install the U.S. telephone directory on a CD-ROM server. After it became available on the Internet, CIR simply added an icon to the standard desktop for quick access to the directory.

Mead learned that client-server computing was not cheaper than mainframe computing, as was touted in the early 1990s. In 1993, Mead placed the cost of a

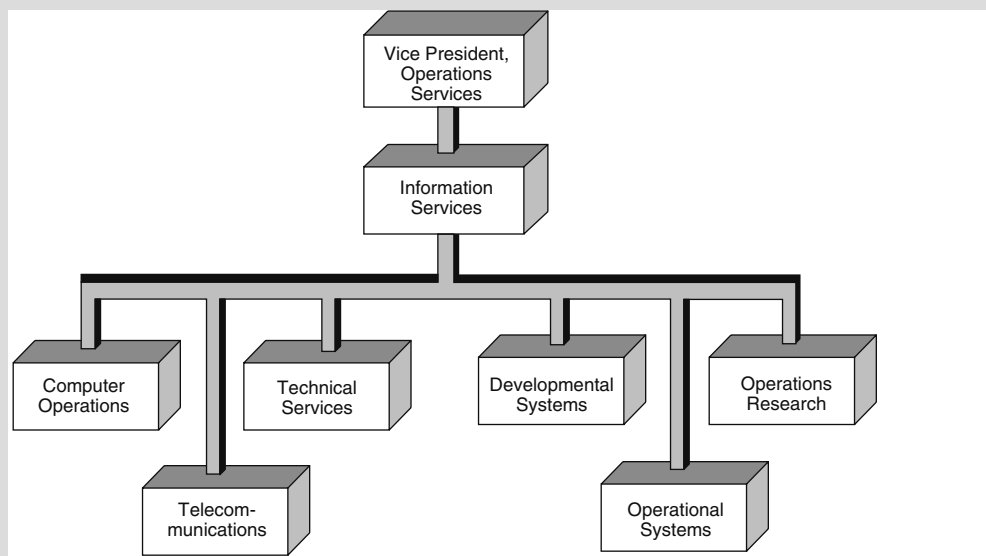
PC at \$9,024 a year (\$2,517 hard costs, \$6,507 soft costs). With the new standards, Mead believed the soft costs had been cut to \$3,005 a year.

The vision was conceived in 1993, implementation began at the end of 1994, and by 2000, right on schedule, the company rolled out 8,000 workstations. During that time, only one change was made to the organization structure: adding Vision Support Services to handle operations (Figure 7).

Into the 2000s: Leverage Centralization

By 2003, Mead would have spent \$124 million dollars on the endeavor. The first division went live in late 1999, the second in 2000, and so on. Thus, from the 1960s to 2000, Mead's Information Resources

FIGURE 7 Mead Corporation's Pre-1980 Information Services Department



Source: Courtesy of the Mead Corporation.

(Case Continued)

division would have moved from significant decentralization to significant centralization of systems.

Implementing ERP In the early 1990s, Mead looked at SAP, the leading ERP system, but decided that the software was not appropriate for the forest products industry. In 1995, Mead looked again, and although the software was better, management felt the company did not have the necessary companywide standards, so it declined to move forward on ERP again.

In 1997, though, management forced the issue. The company had increasingly been using a shared-services vision, where functions were taken out of divisions and centralized, making them best-of-breed. Logistics, purchasing, finance, and information resources were provided via shared services. This collaboration left the divisions with the customer-facing work. Management saw a train wreck coming once the first division wanted to install an ERP system. The company would then have to decide, "Do we want to be good at satisfying customers or have good shared services?" Management decided, "We have to do both." To do so, they had to put in the same ERP system companywide to leverage back-end shared services and be number one in customer satisfaction.

Mead spent 1998 determining the design of the enterprise-wide system and began implementation in the first division in 1999. From the reengineering work on the purchasing system in the 1990s, Mead learned that significant company change required business leadership, thus the SAP effort was led by a business executive, and 70 of the 100 team members also came from the business; only 30 came from CIR. In addition, some 80 IBM

consultants were involved. Mead chose IBM as its SAP implementation partner because IBM had helped Monsanto implement SAP and had created the IBM/Monsanto Solution Center. Mead was able to draw on that center and Monsanto's experience and even reuse 80 percent of Monsanto's business design, down to the general ledger, giving Mead a running start. ERP implementations are huge and expensive, and many have failed. Mead avoided those pitfalls by learning from others.

Mead used the entire suite of SAP modules except human resources, which was handled by PeopleSoft; it was installed in the mid-1990s and has worked well. Mead was one of the first to install a recent module, Advanced Optimization Planning (AOP), which handles all planning and scheduling. SAP was originally designed to support build-to-inventory manufacturing, which is 60 percent of Mead's business. AOP is for the other 40 percent, which is build-to-order manufacturing.

Lotus Notes, a sophisticated database/executive information system from IBM, was invaluable in providing the building blocks for defining the new ways of working under SAP. SAP required Mead to define 800 roles and describe the workflows and security flows among these roles. This task was not handled by SAP, so Mead used Lotus Notes for it and other SAP support work.

SAP unified the company, but it is a large and complex system. In addition, it requires strict adherence to its rules, which is its downside. A division can no longer tailor its own systems to meet its market's changing needs; in some instances, changes can be accommodated easily, but for major changes it must get concurrence from the

(Case Continued)

other seven divisions to change SAP. This could make Mead less nimble; it remains to be seen.

As SAP was turned on, old systems were turned off. In fact, SAP replaced the last generation of systems Mead built itself. Now, all software work is integrating packages, or systems integration. Nothing is coded from scratch. Once SAP was implemented, the development work done by the divisions went away through natural attrition. However, each division has an executive information officer, who mentors the division and coaches it on how to use IT. They focus on reengineering to leverage SAP. They are businesspeople with IT exposure and IT people with business exposure.

E-Commerce The greatest effect of the new implementation has been internal. Mead's intranet has become the way the company conducts its business processes. The homepage is employees' gateway to most of what they need to do at Mead. SAP is browser based.

Mead would have preferred to implement e-commerce on SAP because e-commerce exposes all of a company's legacy-system inefficiencies. However, the company could not wait until 2003, and because its legacy systems still functioned in 2000, it put browser-based front ends on its legacy systems. Once SAP was in place, only the system interfaces needed to change.

In some sense, Mead sees B2B e-commerce as old wine in new bottles. In 1986, Mead built a cluster terminal system for its paper business. The system was proprietary; it ran on Mead's network, and Mead gave proprietary terminals to customers to order paper. Even though the terminals were only character

based, with no graphics, customers could see Mead's stock levels, delivery times, and prices. One-third of its business came through this system. In 2000, the system became Internet based. All a customer needed was a browser to log into Mead's extranet to place orders.

However, Mead discovered that although it broke down its own internal silos in installing SAP, it encountered silos in customers' operations. True end-to-end e-commerce will not occur until these partners improve their internal operations.

Peering into the Future in 2000: Merger and IT Alignment In 2000, Mead's industry, like most others, was experiencing unprecedented global competition. To survive, a company needed to become larger or become a niche player. Mead expected to be one of the survivors, and management saw SAP aiding in achieving that goal. If, for example, Mead acquired another company, it would be able to merge operations within 90 days because of SAP. That capability made SAP a valuable acquisition tool.

"The CIO job has definitely changed since 1985," says Langenbahn. "In the 1990s, we always talked about IT being strategic, but it was really a wish. In 2000, it is reality. The role of the CIO has become more strategic and the role has grown, but at the end of the day, information technology is inherently valueless. Value is created by business change and true business change cannot be led by the IT side; it must spring from the business side. The major role of the CIO is to bridge the gap between the business and technology, and to have the enabling technology in place to deliver what the business requires, although the business might not as yet realize what it requires."

(Case Continued)

To be a leader in this fragmented market, Mead had to grow. One route would be to grow internally, but with too much capacity already in the market, this option made little sense. A second route would be to acquire companies and consolidate. Management declined this option because of its unfavorable economics, saying, “You always overpay when you buy another company.” The third choice was to merge with a competitor of comparable size. That was the route chosen; Mead and Westvaco combined their assets without taking on any debt in 2002.

John Langenbahn saw the merger through and then retired, turning over the CIO job to Jim McGrane. Langenbahn wanted to ensure that it was viewed as a business investment, not an IT investment. Therefore, the project lead, McGrane, worked for the business executive who chaired the SAP steering committee. Both McGrane and Langenbahn were on that committee. Their goal was to create a process-centered IT organization, because with the implementation of SAP and its focus on processes, CIR’s new role would be working on business process design enabled by IT. CIR was renamed Enterprise Information Solutions (EIS) to reflect its scope and its mission: process solutions, rather than systems.

Evolving to a New Process-Centered Structure Balancing centralization (and standardization) with local autonomy caused an age-old tension. McGrane dealt with this tension through a “strategic conversation between the corporation and EIS” to decide how MeadWestvaco would address it. The issue was governance: Who would be making which decisions? “Restructuring EIS is very akin to what the framers of the U.S. Constitution struggled

with,” noted McGrane, “instituting a federal government while preserving states’ rights. IT has moved from a mysterious, technical backroom activity into the mainstream, so we now need to hold this business-EIS conversation to do the same.”

As an interim step, McGrane put in place the outlines of a new EIS organizational structure, one that would facilitate the creation of a process-based, business-driven organization. He viewed the former Vision 2000 structure as taking a techno-centered view of the world—with a workstation in the center, surrounded by services, and then an application layer. The new structure took a process view.

The interim organization, as shown in Figure 8, included:

- *Planning and Administration*, which included an information standards and policy quarterback
- *Technical Services*, which was in charge of application design and staging processes
- *Chief Technology Officer*, who was in charge of architecture
- *Operations*, which was in charge of the deployment process
- *Manufacturing Solutions*, which built and maintained mill and manufacturing support systems
- *Business Solutions*, which included ERP, emerging solutions, and other business systems. Members of this group also handled sunrise/sunset systems, which means they were in charge of managing down (“sunsetting”) legacy systems as SAP was implemented in plants and replaced those systems and explored emerging (“sunrising”) technologies.

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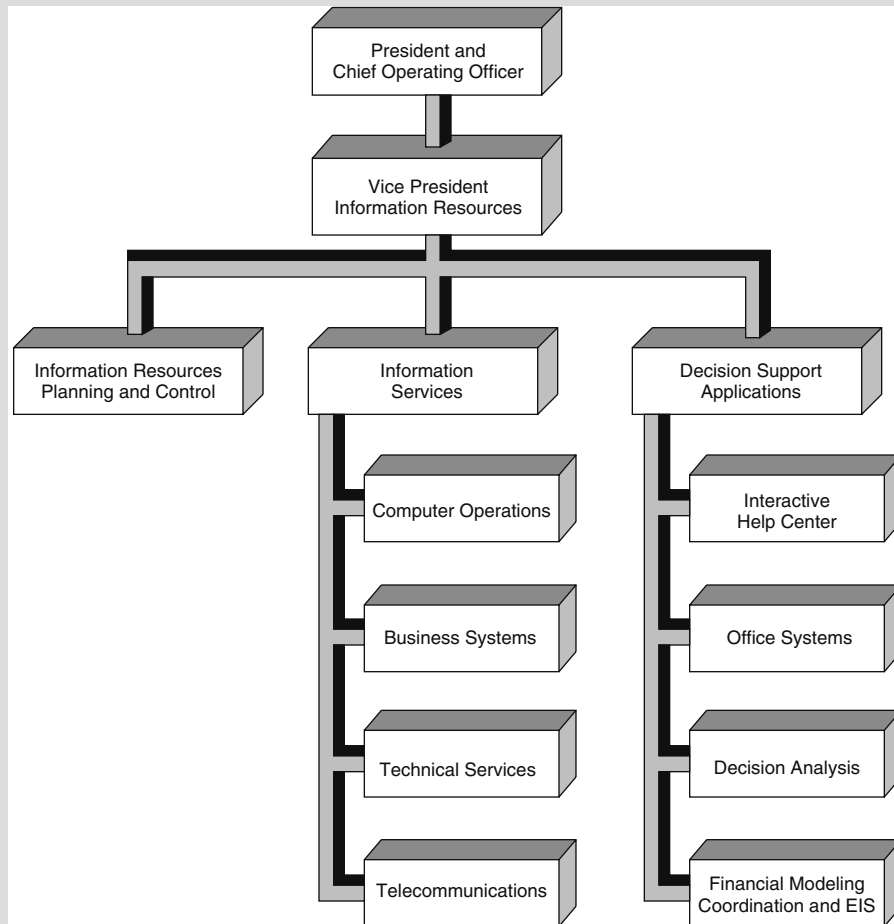


FIGURE 8 Mead Corporation's 1980 Information Services Department

Source: Courtesy of Mead Corporation.

McGrane's goal was eventually to evolve EIS along three major areas of focus:

1. *Business Processes and Applications* so that EIS was viewed as a business enabler
2. *Infrastructure* so that by designing and developing the right kind of

infrastructure, business processes could be automated using advanced software applications

3. *Administration* to ensure return on investments, end-user education and support, asset management, information security, and business continuity, to name just a few

(Case Continued)

Within these three areas, a series of processes needed to be defined. For example, one administrative process was security. Creating this process started with defining it, stating policies and procedures (that is, what was to be protected), and then creating tasks to ensure execution. Today, people who do security work reside in different functions throughout the company. The question McGrane asked was, "Do we organize them around a security process or use a matrix, with a security quarterback?" The business goal was end-to-end security and protection of vital information. To achieve that, the company had to move from viewing security as an activity to viewing it as a process. This was the organizational challenge.

This three-area focus had actually been in use since preplanning for the merger. The integration teams were organized around these three areas. Each team's objectives were to find synergies and adopt standards. Adopting Mead's SAP model, for example, shaved millions of dollars off future expenses.

During the first four months following the merger, the new EIS team closed down Westvaco's data center and migrated the systems to Dayton. Desktops, networks, and e-mail systems were migrated to one standard each. In integrating the two IS organizations, EIS saved additional millions of dollars and freed resources to focus on more strategic investments.

Creating a Governance Structure A major issue was investment. How could the company ensure that the EIS portfolio was aligned with the business strategy? And how could EIS engage the business units in constructive conversations about what to do next? How would the company decide between, say, an investment

in infrastructure and an investment in a Web-based application? Should they be measured the same way? What should the measurements be?

Based on research outside the organization, McGrane estimated that perhaps only 50 percent of an IT organization's investments were aligned with the business's goals because there have been few mechanisms for holding conversations with the business. MeadWestvaco knew it could not afford that level of misalignment. Now that EIS spending was more than 3 percent of sales (rather than 0.5 percent in the 1970s) and embodied how the business operated (such as how orders were filled), business-IT conversations had to become the norm. From the mechanisms used to hold these conversations, EIS's organizational structure would emerge.

Thus, EIS experimented with some governance structures. To govern overall IT investments, for example, an executive steering committee was formed. It consisted of the executive vice presidents of the business units, the CFO, CIO, and head of manufacturing research and development. These seven executives meet monthly to review and approve new investments and resolve conflicts. MeadWestvaco moved toward an IT investment portfolio with four "buckets":

1. **Infrastructure:** Value is measured by total cost of ownership (TCO) benchmarked against the world.
2. **Utility applications:** These included payroll, compliance software, and such; value is measured by benchmarked TCO.
3. **Business applications:** Value is measured by return on investment (ROI). The total cost of the

(Case Continued)

application will be made visible. Thus, if it requires modifying or expanding the infrastructure, that cost will be made visible.

4. **Emerging and experimental applications:** No expectations are made of these investments, which deal with technologies that might transform the business but have associated technology risks. ERP was experimental in 1995; reverse auctions and Web applications were experimental in 2002. This category is no more than 5 to 10 percent of EIS's budget.

Extending Standardization Administration of most of the development resources was centralized. Formerly, business units managed their own IT developers. "We are finding that as we engage in conversations that make total cost visible, and we provide alternatives that deliver equal value at lower cost, we have arrived at a point where the business units are willing to give centralization of development a try," says McGrane. SAP has actually driven this move; its development was centralized and its configuration is centrally controlled. As SAP replaces the legacy systems, the business units' need for local developers has gone away. EIS extended that central model to Web technology; most development was central.

To balance the tension between centralization and local needs, EIS worked with business leadership to create governing councils, which include business leaders. These councils "own" specific processes and direct the technology enhancements required to improve those processes. The benefit of these councils, notes McGrane, is that once a council approves an enhancement, that enhancement happens across

the corporation at one time. Thus, an improvement in plant maintenance occurs at all the plants; the businesses decide the priorities, and they occur company-wide.

Implementing ERP drove Mead-Westvaco to leverage resources to solve problems as a joint entity. The company came to see that a problem for one is generally a problem for all. Thus, central design is leveraged. The result is that a business unit that wants to make a change needs to have conversations with the others, and those conversations revolve around what is good for the whole.

"The answer might not be reached as quickly, but it is a more effective answer," states McGrane. "Our business does not change at Web speed. So needing to make a decision quickly is often a red-herring argument. Standardization has forced real business discussions to occur. And it is forcing our business leaders to become more technology literate, and those of us in EIS to become more literate about the business issues we are trying to solve. That's all for the good." McGrane was elected vice president in 2002.

2004: Creating the Process-Based, Business-Driven EIS Organization

In mid-2004, McGrane was two years into his five-year plan to turn EIS into a process-based and business-driven organization. "It's a bit tougher than I expected," he admits. According to McGrane:

It's essentially reengineering the organization from being functionally oriented to being process oriented. We are moving from managing work to managing outcomes.

We characterize our future state as "nimble," where IT is embedded in

(Case Continued)

our business strategies and we in EIS can support change without disrupting our operation, which is global, mobile, and always-open-for-business.

If you look at what it will take to survive, CIOs have to figure out (1) how to achieve better strategic alignment across the corporation, the business units, and IT investments; (2) how to deliver high-quality service while driving out costs; and (3) what the right organizational model for IS should be. We don't yet know the right organizational model for EIS, but we do know we must transition our skill set from managing subordinates to negotiating and delivering services.

During their due diligence on how to put the theory of process orientation into practice, McGrane's team discovered ITIL (Information Technology Infrastructure Library), a process-based framework for managing IT service delivery. Rather than start from scratch on defining IT processes, ITIL has been adopted.

"We chose ITIL because it supports our strategy. It focuses on service management—aligning services with future needs, improving service quality, and improving long-term costs—just the issues we need to solve," says McGrane.

ITIL ITIL was developed by the U.K. Office of Government Commerce (OGC) in the late 1980s to improve IT service delivery by the U.K. central government. The result was a set of books that describes best practices in IT service delivery. The books, edited by OGC, were written by numerous organizations and verified by others.⁶ An entire industry has grown up around ITIL, providing training, consulting, certification, and even trade associations.

The main tenet of ITIL is that the IT infrastructure—which includes not only hardware and software but also skills, communications, and documentation—supports the delivery of IT services and thus needs to be managed professionally. ITIL calls this management IT service management, and it has two main sets of IT management processes: service delivery and service support. The two ITIL books on these subjects describe the key components of these processes and provide guidance on how to create and operate them.

Service delivery is composed of five tactical processes, all aimed at the long-term planning and improvement of IT services:

- *Availability management* is the process of optimizing the capacity of the IT infrastructure.
- *Capacity management* is the process of managing resources at a time of high demand (such as a crisis) and predicting the need for extra capacity in advance.
- *IT service continuity management* is the process of managing the organization's ability to continue providing an IT service after a business interruption.
- *Service-level management* is the process of continually improving the quality of an IT service.
- *Financial management for IT services* is the process of being a good steward of the organization's money.

Service support is composed of one operational function and five operational processes. All aim to ensure that customers have access to the services they need to support their business. The

(Case Continued)

processes differ from the function in that they are measured by their outcome:

- *Service desk* (a function, not a process) provides one point of contact for users.
- *Incident management* is the process of restoring a disrupted service.
- *Problem management* is the process of diagnosing the causes of incidents and preventing them.
- *Change management* is the process of handling changes efficiently.
- *Release management* is the process of managing new versions of a service.
- *Configuration management* is the process of managing all the components of a service or the infrastructure.

The five other ITIL books deal with the processes of security management; infrastructure management (such as managing network services); application management; planning to implement service management; and three books for business managers on integrating IT into the business in times of change, dealing with transitions in the IT infrastructure, and understanding the role of managers in improving IT service delivery.

Implementing ITIL at MeadWestvaco The EIS structure McGrane implemented in 2002 has not changed. Four major steps toward the transformation of EIS have been to (1) put IT governance in place, (2) assign the first business relationship manager, (3) begin creating the service catalog, and (4) pilot test three ITIL-based processes.

IT Governance Is in Place. “In our industry, the economics dictate that we centralize IT to cut costs. We cannot afford

decentralization. To achieve business alignment, we are using IT governance structures,” notes McGrane.

The overall model is one of stewardship; that is, actively managing the assets that have been entrusted to us for the good of the organization. The three bodies handle IT governance.⁷

- The *EIS Steering Committee* acts as an internal board of directors for IT. It is chaired by the business, approves IT’s strategic direction, oversees IT investments, and resolves disputes.
- The IT Council represents the interests of the business units and the corporation. It is chaired by the CIO and includes information officers from the units. On the one hand, the members advocate projects that drive unique value for a particular business. On the other hand, they present decisions to their respective areas to ensure alignment. The council also drives standards, oversees service level management, and approves the IT infrastructure.
- Business Performance Teams represent the interests of business process teams. They are chaired by process owners or business leaders, they drive initiatives aimed at improving business performance, and they ensure that standards are being followed.

The First Business Relationship Manager Has Been Assigned. So far, one business relationship manager has been assigned to a MeadWestvaco business unit. This senior IT executive acts as both coach

(Case Continued)

and account executive for that unit—a step toward improving “the interface point” between EIS and the unit. Together, McGrane and the business unit’s head (who was very open to having such an intermediary) decided on the new appointment. He was chosen for his business–IT acumen. Others will be chosen for the same capability.

“The benefit of this new position is that the business unit gets a single point of contact,” says McGrane. “Later, these managers will become their unit’s advocate within EIS. The benefit to us in EIS is that we will get better information coming back to us from the business units. The goal is more efficient and effective relationships.”

The EIS Service Catalog Was Developed. The service catalog essentially documents the EIS–business conversation about what services EIS provides and what users and customers expect. It is a major part of the transformation, so EIS is going through formal planning stages to create it.

It contains a high-level listing of EIS’s services, productivity tools, connectivity options, applications, consulting, and application development services. Each service has a service-level agreement that tells users and customers what to expect, and the cost. To support these services, EIS puts in place the formal ITIL support processes noted earlier.

ITIL is actually very complex. Each process has subprocesses (activities and tasks). Tasks become roles. Roles are aggregated into jobs. Once defined, McGrane faces the challenge of introducing this process-based organization into his current function-based organization.

McGrane is spending about 50 percent of his time on this internal reorganization, 40 percent of his time on corporate and business unit issues, and 10 percent with MeadWestvaco customers. He says, “That’s not enough time outside the company. Once the internal reorganization is accomplished, I hope to be working more externally with our larger customers, to exploit supply-chain technologies. At the moment, that work is happening at a lower level.”

The Role of the Business “For business executives to be truly involved in guiding IT, they must have a fairly high level of IT maturity,” notes McGrane. He continues:

In essence, they need to know as much about using IT to run their business as they already know about finance. They must be able to judge the value of an IT investment and balance that value against the operational changes they will need to make (in processes, people, investments).

IT investment decisions are complex, and IT vendors’ commercials do not portray this complexity. I wish they would stop promising simple silver bullets—like “Just outsource everything to us and we’ll handle it for you”—because they are creating a hostile environment between IT and the business. In reality, we could not afford to outsource all IT to a vendor—nor would we.

The IT governance structure, the business relationship managers, and the process teams are creating the context for the in-depth IT–business conversations that need to take place for the business

(Case Continued)

executives to understand the IT issues and become truly involved in guiding IT. They are a start to MeadWestvaco's emerging ITIL model.

Thanks to the new IT infrastructure, MeadWestvaco has reinvented its cul-

ture, business practices, and innovation. Its ability to effectively manage customer relationships has led to new solutions. The global company has been recognized as the power behind the consumer package. ■

QUESTIONS AND EXERCISES

Review Questions

Review questions are based directly on the material in the chapter, allowing the reader to assess comprehension of the chapter's key principles, topics, and ideas.

1. What changes are taking place in the external business environment?
2. What changes are occurring in the internal organizational environment?
3. What are the goals of the new work environment?
4. Give two or three characteristics of the technology trends in hardware, software, data, and communications.
5. What is the mission for the IS organization recommended by the authors? How does it differ from earlier perceptions of the purpose and objectives of information systems?
6. Summarize the four main components of the model of the IS function (Figure 6).
7. List several attributes of procedure-based and knowledge-based information activities. Which do you think are most important? Why?
8. How did Mead focus on end-user computing in the 1980s?
9. What was Mead's 1990 strategy?
10. Why did Mead choose to implement ERP?
11. Give an example of a MeadWestvaco governance structure to govern overall IT investments.
12. What four "buckets" is MeadWestvaco moving toward to define its IT investment portfolio?
13. What has been the effect of ERP on MeadWestvaco's decision making?
14. As of mid-2004, what four steps had McGrane taken to transform EIS into an ITIL-like, process-driven organization? Briefly describe each step.
15. Describe the three IT governance bodies at MeadWestvaco and what each does.

Discussion Questions

Discussion questions are based on a few topics in the chapter that offer a legitimate basis for a difference of opinion. These questions focus discussion on these issues when the book is used in a seminar or classroom setting.

Information Systems Management in the Global Economy

1. Even though the PC dispersed control of processing power out of the IS organization, the Internet is returning control to the department. Do you agree or disagree? Discuss.
2. Do we really need a major change in the way the IS function is structured? Are the necessary changes just minor modifications to accommodate normal growth in computer uses? Discuss.
3. The procedure–knowledge dichotomy does not add much beyond the clerical–managerial distinction. Do you agree or disagree? Give reasons for your opinion.
4. The Internet-based economy is going to end up just like the old economy with the huge conglomerates controlling everything. Do you agree or disagree? Is this situation desirable or not?
5. Discuss the limits and boundaries of the Internet. How pervasive is it in our lives, as workers and consumers? How it will affect the business landscape in the next 10 years?

Exercises

Exercises provide an opportunity for the reader to put some of the concepts and ideas into practice on a small scale.

1. Show how MeadWestvaco's 2002 interim organizational structure compares with the model in Figure 6 by entering its functions on the figure.
2. Contact a company in your community and prepare a diagram and narrative to describe the structure of its IS function. Compare it with Figure 6 and with MeadWestvaco's current structure.
3. Find an article about how companies are melding the Internet with their traditional ways of working. Present those ideas to your peers.

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STRATEGIC USES OF INFORMATION TECHNOLOGY

INTRODUCTION
HISTORY OF STRATEGIC USES OF IT
WHITHER THE INTERNET REVOLUTION?
THE CHEAP AND DISRUPTIVE REVOLUTION
EPISODE TWO: PROFITABILITY STRIKES BACK
EPISODE THREE: INTERNET-ENABLED MASS CUSTOMIZATION
<i>Case Example: Grainger</i>
DOES IT STILL MATTER?
<i>The Debate Is On</i>
WORKING INWARD: BUSINESS-TO-EMPLOYEE
<i>Building an Intranet</i>
<i>Building Quality Web Portal</i>
<i>Case Example: GE Energy Power Systems</i>
<i>Fostering a Sense of Belonging</i>
WORKING OUTWARD: BUSINESS-TO-CUSTOMER
<i>Jumping to a New Experience Curve</i>
<i>Case Example: The Shipping Industry</i>
<i>Case Example: Cisco Systems and UPS Supply Chain Solutions</i>
<i>The Emergence of Electronic Tenders</i>
<i>Getting Closer to Customers</i>
<i>Being an Online Customer</i>
<i>Case Example: A Day in the Life of an E-lancer</i>
WORKING ACROSS: BUSINESS-TO-BUSINESS
<i>Coordinating with Co-suppliers</i>
<i>Case Example: General Mills and Land O' Lakes</i>
<i>Establishing Close and Tight Relationships</i>
<i>Case Example: Sara Lee Bakery Group</i>
<i>Becoming a Customer-Centric Value Chain</i>
<i>Case Example: Dell versus HP</i>
<i>Getting Back-End Systems in Shape</i>
<i>Mobile Computing as a Strategic Advantage</i>
CONCLUSION
QUESTIONS AND EXERCISES
REFERENCES

INTRODUCTION

Utilizing the Internet to conduct business has become a mainstream strategic use of IT, where strategic means having a significant, long-term impact on a firm's growth rate, industry, and revenue. In fact, many IT experts would argue that by now, if a company has not aligned its IT with its business, or used IT to create new added value, it will be out of business sooner rather than later. The issue is that no successful business can separate IT from its business strategy. The question is: What now? Does an even larger revolution loom? Does IT still matter? If so, what sorts of strategic uses are companies making of IT (especially the Internet)? How do we link business technology to financial results? These are the topics of this chapter.

HISTORY OF STRATEGIC USES OF IT

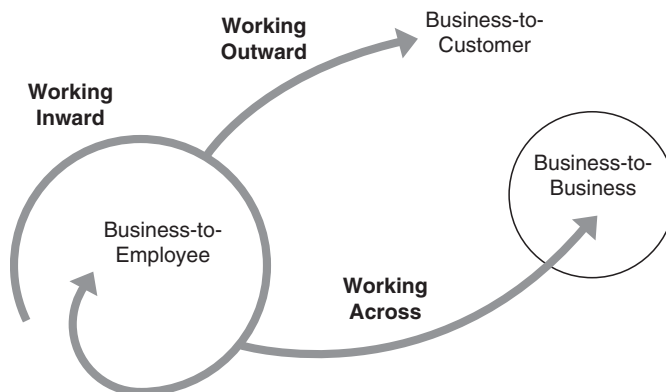
We have seen three strategic uses of IT in business, as shown in Figure 1:

- Working inward: Business-to-employee
- Working outward: Business-to-customer
- Working across: Business-to-business

We believe these types of uses continue today; thus, they form the structure for this chapter. To set the stage, we briefly review strategic uses of IT over the past 25 years by noting the changing emphasis in the strategic use of IT over the lifetime of this text.

In the mid-1980s, the hot topic in the first edition was end-user computing (working inward). IS departments established end-user computing departments to help employees learn about PCs and how to use programming languages, such as BASIC, Focus, and spreadsheets, to write their own computer programs.

FIGURE 1 Strategic Uses of Information Systems



Strategic Uses of Information Technology

Then, during the second edition, strategic use focused outward on using IT to gain competitive advantage. A prime example was Merrill Lynch's cash management account (CMA), which combined a stock account with checking and savings. It was developed in the late 1980s, even through the bleak times following the Black Monday stock market crash in October 1987. When CMA was introduced to the market, it gave Merrill a huge market share boost that other brokerage houses found difficult to take away. This IT-based offering gave Merrill a competitive edge.

In the 1990s, during the third and fourth editions, strategic use turned inward to reengineering business processes. The intent was not to automate existing processes, but to totally redesign how the enterprise operated. The notion had merit, but many efforts failed because they were seen as thinly disguised efforts to lay off staff. The introduction of ERP systems was also aimed at improving internal operations, specifically, providing single sources of data enterprise-wide.

In the mid-1990s, when the Internet's potential started to become evident, dot-coms looked at its outward use to gain a competitive edge. However, most established firms initially used the Internet technology internally, building intranets to improve company processes. Often, the first uses were publishing e-forms on the intranet with accompanying automated workflow processes.

By the late 1990s, the fifth edition showed that use of the Internet for business—e-business—was underway, as established enterprises countered their new, Internet-only dot-com competitors. Then came the bursting of the dot-com bubble, and with it the fervor of e-business slowed down. E-business has become more reality based. Not as many hare-brained ideas are being funded. However, the integration of the Internet into how companies work has proceeded.

In the sixth edition, the inward and outward strategic uses continued, but the strategic use emphasis has been placed on linking to suppliers, customers, and other parties in one's value chain or business ecosystem. The innovation unleashed by the dot-coms, and the competitive challenges they presented for brick-and-mortar firms, initiated a backlash: The Brick-and-Mortar Firms Strike Back (or Return of the Brick-and-Mortars, depending on whose side you are on). That was the theme of the sixth edition: leveraging traditional operations by using the Internet to work more closely with others.

The theme of the seventh edition was on positioning of the role of IT in corporate business and how IT can effect change, especially with regard to the use of IT for competitive advantage. A recent, highly influential article, to be discussed shortly, questions whether IT can be used for competitive advantage at all. It has caused quite a stir. But although some may question IT's ability to give companies a competitive edge, it is absolutely necessary for competitive parity (keeping up with competitors), and more than ever, it is being used strategically—inward, outward, and across.

In this edition, we focus on how IT can “take charge,” in an increasingly complex business environment. Recent reports by the *Wall Street Journal* suggest that many companies are spending about 70–80 percent of their IT budget on maintenance. Only a smaller percentage is allocated for developing new strategic projects and carry them out with sound project management. To set the context for discussing these three strategic uses, several opinions follow on just what has changed about the use of IT and where it might be going.

WHITHER THE INTERNET REVOLUTION?

Despite the dot-com burst in 2001, the Internet revolution continues to change the way we live, and the way businesses operates. Wikis, blogs, and instant messaging invade the office. According to a 2006 survey by the American Management Association and the ePolicy Institute, roughly one-third of U.S. employees use instant messaging at work. These new applications have slowly changed the way people work and communicate. Brian Arthur¹ predicts the buildout of the Internet revolution will last 10 to 20 years, and the developments that will matter most will be “arrangements of use,” that is, innovations that adapt the Internet to people and their use of it. The interconnection of business will be the revolution. It will be quiet compared to the frenzy of 1999 and 2000, but Arthur predicts it will be a giant revolution.

THE CHEAP AND DISRUPTIVE REVOLUTION

For the past several years, Rich Karlgaard,² a publisher of *Forbes* magazine, has been talking about what he calls “the cheap revolution.” Karlgaard believes we are in an inflection point in the IT industry where CIOs are shifting from buying expensive proprietary products to buying cheap generic products. He calls it “cheap tech,” and he sees the phenomenon occurring in more and more sectors of the IT industry.

E*TRADE, the online trading firm, replaced expensive Unix servers running Sun’s proprietary operating system with many cheap generic servers from IBM. Google runs its search engines on more than 350,000 inexpensive Linux-based servers. Furthermore, when one breaks, Google discards it, thereby bypassing expensive service contracts and in-house fix-it staff.

On the supply side, Dell sells generic versions of products at significantly lower prices because its direct-to-customers business model has lower costs. Dell has moved from selling PCs to also selling servers, printers, storage devices, handhelds, and LCD televisions.

The low-cost revolution exemplifies the globalization trend where “cheap” is occurring elsewhere. Companies are constantly looking for cheap labor with off-shoring. They look for free open-source software to reduce production costs, and take advantage of VoIP (Voice over Internet Protocol) to cut telecommunications costs. Being on the wrong side of this cheap revolution, in any industry, is not the place to be.

EPISODE TWO: PROFITABILITY STRIKES BACK

We would characterize the dot-com euphoria as the Internet’s Episode One: The Dot-Com Menace. We would characterize today’s leveraging of the Internet as Episode Two: Profitability Strikes Back. Unlike Episode One, which starred companies that only had an Internet presence, the sequel has starred those with a dual physical and Internet presence (initially called bricks-and-clicks firms) and that are profitable.

Strategic Uses of Information Technology

While it took these so-called “old-economy firms” longer to utilize the Web, they realized they had to do so in a profit-making manner. Interlinking the two worlds properly can increase their value proposition to customers.

But, says Michael Porter,³ the only way to sustain advantage through the Internet is to create a distinct value chain that offers unique value. This chain must be highly integrated, so that potential competitors must replicate the entire system to duplicate the value proposition. Porter recommends: Use the Internet to complement your strategy, not replace your past way of serving customers nor disintermediate your channels. Grainger, as described in the case example, has taken this approach.

EPISODE THREE: INTERNET-ENABLED MASS CUSTOMIZATION

Chris Anderson’s provocative and insightful book, *The Long Tail*,⁴ describes how the Internet has radically changed the world economy in the most fundamental way. Noting that the Internet is constantly changing our habits and behavior, Anderson shows how buying habits have been shaped by the economics of big business, creating the blockbuster culture. However, citing the success of eBay, Google, Apple’s iTunes, and Amazon, he demonstrates that the Internet has changed the culture of mass consumerism, allowing consumers to be more exploratory and specific about what they want and what they buy. In a knowledge economy where information drives reputation and allows niche cultures to blossom, the economy is shifting away from a concentration of a relatively small numbers of “hits” (mainstream products and markets) at the head of the demand curve (for example, most people use Tylenol or drive a Camry) and toward a huge number of niches in the tail (for example, consumers choose their individual songs or movies to download, and select wedding planners based on their unique wishes). There is less need to offer one-size-fit-all products or services. Instead, pervasive technology, in particular with the emergence of mobile computing, makes it possible to sell highly customized goods at attractive prices. As of September 2007, online music stores, in particular Apple’s iTunes store, sold more than 2 billion songs for a unique price of 99 cents.

Perhaps a dominant trend of Episode Three is the explosion of niche markets, thanks to the increased capability of search engines and filtering tools that allow consumers to discover and explore what interests them. A particular success of these niche markets is the phenomenal growth of social software services such as YouTube. With YouTube, anyone can create and share any homemade videos; many of them have been watched worldwide. Thus, the Internet revolution continues to change the nature of commerce and provides the consumer with a new sense of place and sense of belonging.

CASE EXAMPLE

GRAINGER

www.grainger.com

Headquartered in Lake Forest, Illinois, Grainger distributes nonproduction products to companies through stocking locations all over the United States. Its business model is to help customers save time and money by providing the right products to keep their facilities operating. As of 2007, Grainger works with more than 1,300 suppliers to give their customers access to more than 800,000 products ranging from adhesives to lighting, electronics, and test instruments. Grainger has a multiple-channel strategy:

- **Branch Network:** Customers can go to one of the 425 branches in the United States to pick up their order the same day. They have access to knowledgeable customer service associates at the branch, via phone and fax.
- **Paper Catalog:** The 2007 edition is the 80th edition.
- **Grainger.com:** Customers can order more than 300,000 products online and have them shipped directly, or to be picked up at the local branch.

“Grainger Internet strategy builds on this physical presence, tightly integrating the two,” states Porter.⁵ Grainger has found that customers who purchase on its Web site also purchase through its traditional channels, and these customers purchase 9 percent more than those who do not use its Web site.

Grainger has also discovered that its physical sites make its online presence more valuable, especially for customers who want fast delivery. They order online and pick up their order themselves at their nearby Grainger site. This combination cuts Grainger’s costs in two ways: online ordering is less expensive than over-the-phone ordering and shipping in bulk to its stocking locations is cheaper than small shipments to individuals.

Grainger also chose to continue publishing its paper catalog after putting its catalog on its Web site. It is pleased to find that it receives a surge of online orders every time it issues its paper catalog. The 2007 catalog offers customers a resource for more than 130,000 facilities maintenance products. The two are synergistic, it turns out. Grainger’s sales reached \$5.9 billion in 2006. ■

Porter cautions that companies must not only take into account the synergistic effects of conducting business online and off-line, but should also realize that there are secondary effects to having an online presence. For example, although order-taking costs may fall, costs in other areas may increase. For instance, online ordering often results in more requests for quotes and information.

Strategic Uses of Information Technology

That and other issues revolving around conducting a bricks-and-clicks business are now being debated and tested as old-economy firms e-enable themselves inside, outside, and across. E-enablement means digitizing where possible. The “e” comes from electronic, and it has been attached to all kinds of terms. For example, take the terms “e-business” and “e-commerce.” We see e-business as meaning conducting business using telecommunications networks, particularly the Internet. Thus it involves more than buying and selling electronically, which is e-commerce. Not all people agree with these distinctions.

At first, the rapid growth of e-business during Episode One (from 1994 to 2000) seems astounding. However, a closer look reveals some clear reasons for the rapid growth. The Internet provided three key components that accelerated online business:

1. Wide access to a public network
2. Standard communication protocol
3. Standard user interface

Earlier systems that linked firms with their customers or business partners required private networks with proprietary applications. Indeed, the private, proprietary nature of the systems was key to their strategic value. The high cost of implementation, training, and use of these systems locked in customers and created barriers to competitors building similar systems. However, the high cost also limited access to the systems, thus restricting their widespread use; only large firms could afford to build such systems. For example, pre-Internet data estimated that 95 percent of Fortune 500 companies in the United States used EDI, whereas only 2 percent of all U.S. companies used EDI. EDI was the main technology for transacting commerce electronically.

Because e-business applications run over a public network, the Internet, access and communications costs are drastically reduced. Furthermore, with standardized communication protocols and user interfaces, implementation and training costs are far lower. As a result, a much broader set of users and firms has access to the systems, allowing for rapid growth. Indeed, in just a few years, use of the Internet for e-mail and company Web sites became standard business practice in most companies, large and small.

DOES IT STILL MATTER?

Porter’s downbeat view of the Internet’s value to individual firms got attention, and arguments. But it did not generate nearly as much controversy as “IT Doesn’t Matter,” the provocative article in the May 2003 issue of *Harvard Business Review* by its former editor Nicholas Carr.^{4a} His article generated a firestorm of protest. Carr’s point is that IT doesn’t matter anymore, at least not strategically. He has since expanded his argument into a book.^{4b}

According to Carr, IT is an infrastructure technology, like railroads, electricity, and the telephone. Such a technology can create a strategic advantage for an individual firm only at the beginning of its life cycle, when its technology is expensive and risky. That is the only time a firm can create something proprietary that competitors cannot easily copy.

Strategic Uses of Information Technology

Carr contends that once an infrastructure technology reaches the end of its buildout—that is, when it is neither proprietary nor expensive—it becomes a commodity, available to anyone, and therefore will not yield competitive advantage to any single firm. To Carr, an investment must provide differentiation to give competitive advantage. Investments in commodity technologies cannot provide (nor sustain) such differentiation.

It appears that IT has reached the end of its buildout, says Carr, for five reasons. One, the power of IT now outstrips the needs of businesses. Two, IT prices have dropped; it's affordable. Three, the capacity of the Internet has caught up with demand. In fact, there's more fiber than can be used. Four, many computer vendors want to be seen as utilities (somewhat akin to an electric utility). And five, the investment bubble has burst.

When an infrastructure technology reaches the end of its buildout, it tends to become costly to keep it running. That is when people should care most about mitigating the business risks it poses (phones, electricity, or computer systems not working), rather than pursuing the innovations it makes possible. First-mover advantages cannot last when everyone has access to the same technologies at affordable prices.

Although IT is necessary for competitiveness, it's not sufficient. Competitive advantage comes from a firm's business model, not its use of IT.

IT has become part of the business infrastructure; therefore, its management needs to change, states Carr. Success hinges on defense, not offense. Management of IT should become “boring” and focus on three areas:

1. *Manage the risks.* Focus on vulnerabilities rather than opportunities. There will be plenty of risks because open systems are more risky than proprietary systems.
2. *Keep costs down.* The greatest risk is overspending, so only pay for use and limit upgrading (do not upgrade PCs when it's not needed, for example).
3. *Stay behind the technology leaders,* but not too far behind, because experimentation is expensive. Delay investments until there are standards and best practices and prices drop. Only innovate when risks are low.

Carr's diminutive view of IT's value deals with its innovative use by individual firms. Although they lose the possibility of gaining individual competitive advantage, the infrastructure technology brings its greatest economic and social benefits to all once it has become a shared infrastructure. That is what IT is becoming, he believes.

The Debate Is On

Following are just three of the many insightful pieces that have been written about IT's strategic value that refute Carr's article.^{4c} John Seely Brown and John Hagel,⁵ two well-known figures in the IT field, state that IT alone has not been a strategic differentiator, but it is “inherently strategic because of its indirect effects.” It enables firms to do things they could not do before. Firms that see these possibilities first, and act on them, can differentiate themselves. Although computers are becoming ubiquitous, the insight on how to use them is not, they contend. That's what provides strategic uses of IT.

Strategic Uses of Information Technology

In fact, Brown and Hagel believe the past has taught three lessons about how to use IT strategically:

1. Value comes from IT only when it is paired with concurrent innovations in business practices. Too many companies do not change their business practices when they implement IT. That is why studies have shown no correlation between IT spending and superior financial results. Executives who think of IT as a commodity have not explored the innovative business practices it makes possible, especially across enterprises.
2. IT's economic impact comes from incremental improvements, not a "big bang" IT project. Waves of short-term IT projects, built on each other and tied to business changes and specific performance metrics, yield value.
3. Strategic differentiation emerges over time. It does not come from specific innovations in business practices. It comes from "the ability to continually innovate around IT's evolving capabilities." The other infrastructure technologies noted by Carr did not sustain continued business-practice innovation as long as IT has. Furthermore, they reached a dominant design fairly quickly (such as standard railway gauges). In IT, innovations in one area (such as storage or bandwidth) combine with innovations in another, unleashing new capabilities and new generations of architectures. New skills are needed for these new architectures. IT does not yet have a dominant design, so there is still potential for individual firms to differentiate themselves using IT—if their short-term initiatives support their long-term goals.

Robert Hof⁶ states that although Carr may be right in the long run, he is not right about the current state of IT. In fact, like Brian Arthur,¹ he believes that we are now in the golden age of IT, where innovation is accelerating. IT might not matter strategically in 20 years or so, but now, it is still in flux and can provide differentiation. Witness the new developments in wireless technologies, miniaturization, and IP telephony, to name just three. Carr has jumped the gun in saying that IT has no strategic value, says Hof. And he's wrong in his follow-the-leader advice, because delaying the offering of a technology can lead to losing customers. He notes that hotels that offer wireless Internet access now differentiate themselves. Although that differentiation may not last long, at the moment, these hotels are getting his business, and he might stick with them. Hof believes that firms should both manage IT risks and look for opportunities.

Michael Schrage,⁷ co-director of MIT Media Lab's e-Markets Initiative, disputes Carr's underlying premise that scarcity is a resource's attribute that yields sustained competitive advantage. Not so, he says. There is no correlation between scarcity and strategic value. Capital is a commodity, but returns on capital vary significantly. Does capital matter? Of course it does.

It is not a resource's commodity status that matters; it is the way the commodity is managed that determines its impact. Capital matters. Talent Matters. IT matters. Last but not least, management matters. In fact, argues Schrage, the management matters more as IT becomes ubiquitous. IT's ubiquity does not override management quality.

Rather than compare running IT to running an electric utility, Carr should compare running IT to running a factory, suggests Schrage. But that comparison would undermine his premise because the way a factory is designed and run in the future will affect a manufacturer's competitiveness. "What Carr fails to recognize is that IT can

profoundly transform the economics of innovation, segmentation, and differentiation for most businesses. And in that recognition lies the CIO's ultimate opportunity," says Schrage.

Is Carr right? Some think so, some think not. Either way, his views have hopefully prompted important discussions in boardrooms, because executives need to understand the underpinnings of IT to know how to guide it. IT is one of their strategic resources, besides money and people, for working inward, outward, and across.

WORKING INWARD: BUSINESS-TO-EMPLOYEE

The essence of using IT strategically inside the enterprise has been, and continues to be, focused on improving business processes. Use of the Internet internally is no exception. It has revolved around building intranets.

Building an Intranet

An intranet is a private company network that uses Internet technologies and protocols, and possibly the Internet itself. The network is intended for employees only, and departments use them to disseminate information and policies, provide needed forms, and even permit online transactions of former paper-based processes (such as filling out an expense requisition or changing a benefit). Applications use the Web interface and are accessed through browsers; communications use several protocols, including Hypertext Transfer Protocol (HTTP) for addressing Web sites, Hypertext Markup Language (HTML) for Web content structuring, and Transmission Control Protocol/Internet Protocol (TCP/IP) for network routing. The result is open systems using low-cost, nonproprietary technologies.

When properly set up, the benefits of intranets have been significant: wider access to company information, more efficient and less expensive system development, and decreased training costs. By using an intranet's open-system architecture, companies can significantly decrease the cost of providing company-wide information and connectivity. One of the most important attributes of intranets is that they support any make or brand of user device—from high-end workstation to PC, to laptop, to hand-held device—as well as existing databases and software applications.

Furthermore, investments in a company-wide electronic infrastructure are significantly less than building a proprietary network. Companies only need the servers, browsers, and a TCP/IP network to build an intranet. If, in addition, the company wishes to use the infrastructure of the Internet to geographically extend its intranet, the only additional components needed are firewalls, which keep the public from accessing the intranet, and local access to the Internet. Figure 2 shows the basic architecture of an intranet. The link to the Internet allows the company to expand its intranet worldwide easily and inexpensively—a significant benefit that was unthinkable before the Internet.

Finally, because an intranet uses the browser interface, users do not need extensive training on different products. In addition, due to the HTML standard and the availability of easy-to-use Web page authoring tools, employees can easily create their own Web pages for whatever purpose they need. As a result, all employees are potential site

Strategic Uses of Information Technology

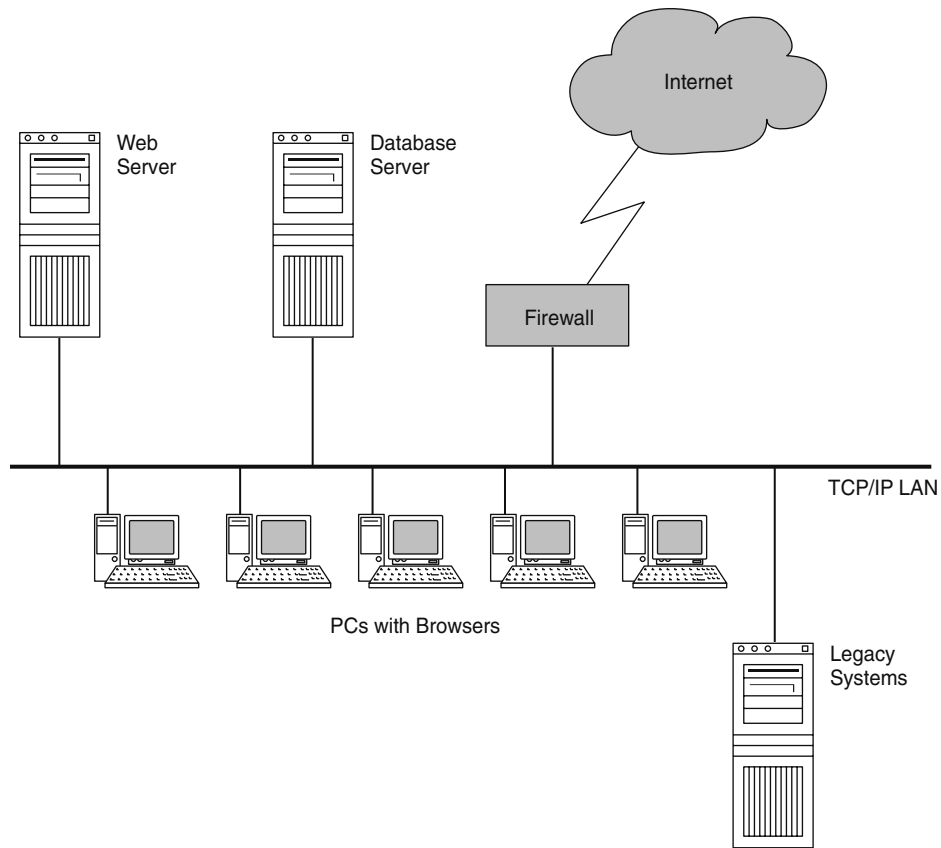


FIGURE 2 Intranet Architecture

creators, reducing the IS department's programming bottleneck, while adhering to company-wide standards. An additional benefit is that companies only need to record information in one place, where it can be kept up to date for access by all employees no matter where in the world they are located.

A critical success factor for an intranet is its ability to provide search capability that even external and powerful search engines cannot provide. For a given company, there are unique teams, tasks, products, and services. The intranet development team should use these specific artifacts to define metadata vocabularies so that the company search engines can help employees find them faster than any others. A related feature is shared bookmarking. Coupled with tagging, shared bookmarking allows intranet users to create, manage, and share information.

Below are a few design tips for building an effective intranet:

1. Think about tasks rather than documents. Employees should look at the intranet as a resource guide, a digital assistant that provides standard operating procedures or steps to do to accomplish a specific task. Required forms should be attached to these instructions.

Strategic Uses of Information Technology

2. Keep the technology simple at first using existing hardware and freeware. Do not do too much at once by starting with a few important features. Pick applications people need (e.g., file sharing, online expense reporting, bulletin board, classifieds) and make them fun to use.
3. Create virtual workgroups organized around the tasks. Provide calendaring features for teams to set up meeting. Use bulletin boards, or chat rooms, to facilitate team discussions. Invest in employee training and solicit feedback.
4. Think outside the box to help identify the unique features that your intranet can bring to the firm. The intranet reflects the company and the company reflects the intranet. Use the intranet to migrate the company, if not done so, to a process-centered organization that encourages collaboration.
5. Create a clear set of fair-use rules so that employees know the company's exact position on information policy. Find ways to encourage intranet use. Put into place effective security policy.
6. Don't expect miracles but do monitor intranet effectiveness. Do not underestimate the needed resources, especially when it comes to maintenance.

Due to the ease with which Web sites can be created and used, many employees have built their own, leading to a proliferation of sites with company information. To control the situation, IS departments have created corporate portals that act as gateways to firms' internal resources, information, and Internet services. This solution brings access to company data and applications together in a single site. Employees simply need a browser. At the same time, the portal provides IS management with a way to monitor and control the growth of internal Web sites, and the portal provides a link to Internet resources external to the company, such as sites for industry news, customers, and business partners.

Building Quality Web Portal

There have been many frameworks to measure the quality of a product, or the use of an IT product. From a user's perspective, a Web portal provides information products or services to its users. An information product is a highly interdependent package of information that can be transmitted and distributed in digital forms. In an intranet setting, the company's Web portal can store content-based products (online news, technical documentation, corporate policies, and administrative forms), tools and utilities (application software), and online services (search engines, online consulting, e-mail, chat rooms, bulletin boards). It is important that IT managers identify what to offer through the portal.

The quality of an information product can be assessed from a number of attributes, such as accuracy and applicability of the information content, the timeliness and speed of the physical medium, and the reliability and responsiveness of the product/service provider. It is important that basic quality features should be met when developing an intranet Web portal. Successful portals should be built based on people, not technology. As an intranet application, its design must find the roots from the company employees and the work they undertake during a typical workday. GE Power Systems is a case in point.

CASE EXAMPLE

GE ENERGY POWER SYSTEMS

www.gepower.com

GE is one of the world's largest companies selling products and services ranging from aircraft engines to consumer financing. It has global presence in 160 countries and employs more than 300,000 people worldwide. GE is made up of six major businesses. In 2006, the conglomerate earned \$163 billion in revenues. Being a marketing man, when Jeff Immelt became chairman of General Electric (GE) in September 2001, he surveyed the sales force. He found that they were spending more time in the office searching for information that they needed to sell GE products than out with their customers. He challenged all the business units to reverse the ratio, notes Anthes in his review of GE's use of Web servers.⁸

One business unit, GE Energy, is one of the world's leading suppliers of power generation and energy delivery technologies. Its energy solutions include gas, water, nuclear, and wind technologies. By 2006, it earned \$19.1 billion in revenues, and employed about 36,000 people in more than 100 countries. GE Energy sells multimillion-dollar turbines and turbine parts and services to energy companies. It answered the challenge by building a Web-based sales portal for its salespeople. In essence, the portal is meant to be their main source of information by linking them to numerous information sources—some inside GE, some outside—without requiring changes to the underlying systems.

- **Information Content:** The data that are fed to the portal are from the existing Oracle and Siebel databases on sales, parts, pricing, inventory, customers, and such. The portal also has a news feed from the outside.
- **Physical Medium:** The coordination of all the information is handled by portal software from Vignette. The software assembles dynamic portlets that present salespeople with personalized, up-to-date data views. The portlet might show, for instance, the status of the salesperson's customers' orders, recent news stories that mention the salesperson's customers, price changes, sales performance for the month, and so on.
- **Service:** Vignette's system manages the content and its presentation to the salespeople; a special Oracle data mart for the portal pulls the appropriate data from the other systems at the appropriate intervals. Some data, such as customer master file updates, are pulled in real time (when the update takes place), whereas other data, such as turbine installations, are updated weekly. The Web server aspects of the system are handled by BEA System's WebLogic Server, and SiteMinder from Netegrity handles security and user sign-ons. When a salesperson wants to access an

(Case Continued)

application through the portal, SiteMinder uses an authorization table that has access permissions to determine whether to grant the user access to the system. Formerly, salespeople had to enter a different password for each application. Now, they only enter one password to get into the portal.

Power Systems' IT organization was able to build this portal in just six months' time by following GE's rigorous

project management methodology and by using rapid prototyping ("launch and learn," they call it), building incomplete versions of the portal for salespeople to test out and critique at the annual sales conference and elsewhere.

The portal's architecture is flexible enough to be extended to include more types of information and to permit access to more applications. In short, the portal has greatly enhanced the usefulness of GE Power Systems' existing systems to its salespeople by giving them a single port of entry to them all. ■

Fostering a Sense of Belonging

Intranets are evolving into very important enterprise structures. In fact, in some enterprises, the intranet is seen as the enterprise. It houses videos of executives explaining the enterprise's vision and mission. It includes all the internal forms, rules, and processes. Need to file an expense report? Go to the intranet. Need to make travel reservations? Use the intranet. In short, the intranet embodies the company's processes and culture and can be accessed anywhere an employee has a connection to the Web.

Although this convenience can ease the life of employees, it can also feel colder and more impersonal than the traditional office setting. Frances Cairncross,⁹ author of *The Company of the Future*, believes the challenge for corporate management of widely dispersed enterprises today is maintaining cohesion, which takes a lot more effort than when employees are co-located. With so many employees working out of their homes, cars, hotel rooms, airports, or customer sites, she believes it is important to create a sense of belonging.

An intranet can provide the foundation for creating a sense of belonging by providing a means of communicating and creating communities. Whether enterprises use intranets to help employees feel part of the culture is up to them. Whether they are successful is yet another issue. Cairncross believes this goal should be a major use of intranets because the care of employees is one of the most important things enterprises do. Dienes and Gurstein¹⁰ reported a successful creation of online community using WebBoard, emails, real-time chat, and online videoconferencing, to support a rural community in Canada. The project using remote management has created a sense of belonging among far-flung remote sites that could not otherwise have been attained at a cost the initiative could afford.¹⁰

WORKING OUTWARD: BUSINESS-TO-CUSTOMER

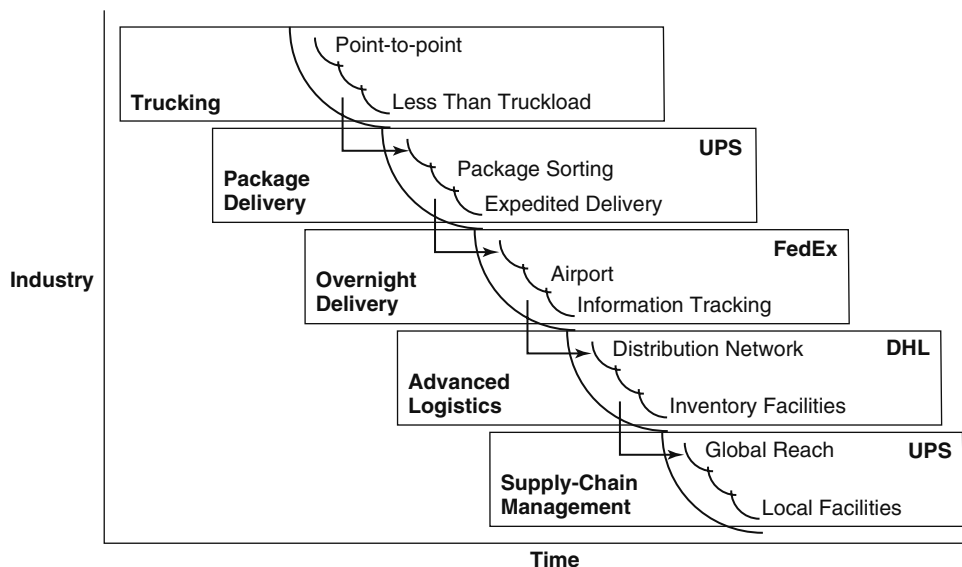
In most industries, companies need sophisticated computer systems to compete. For airlines, hotels, and rental car companies, a computer reservation system—either their own or someone else’s—is a must. In the drug and hospital wholesaling industries, those that had automated order entry and distribution systems gobbled up those that did not have such systems. In financial markets, computerized trading and settlement systems are replacing open-outcry systems. And the list goes on.

As industry leaders increase the sophistication of their systems to concurrently address the four hallmarks of competitiveness—quality, service, innovation, and speed—their competitors must do the same or find themselves at a disadvantage. Using IT (or any technology) as the basis for a product or a service can, in some cases, be viewed as moving up a series of experience curves.

Jumping to a New Experience Curve

The traditional view of an experience curve is that the cost of using a new technology decreases as the firm gains more experience with it. However, in *Strategic Choices*¹¹ Kenneth Primoizic, Edward Primoizic, and Joe Leben present the view that more experience leads to a set of connected curves, rather than one continuous learning curve, as shown in Figure 3.

FIGURE 3 The Shipping Industry



Source: Based on Kenneth Primoizic, Edward Primoizic, and Joe Leben, *Strategic Choices: Supremacy, Survival, or Sayonara* (New York: McGraw-Hill, 1991).

Strategic Uses of Information Technology

Each curve represents a different technology or a new combination of technologies in a product or service as well as in the product's manufacturing or the service's support. Moving to a new curve requires substantial investment in a new technology, and the company often must choose from among competing technologies, none of which is yet the clear winner. A firm that correctly identifies a new market and the technologies to exploit it can shift to the new experience curve and successfully open up a new industry segment. However, management sometimes has such an emotional attachment to the current experience curve that it fails to see the next one and thus loses its market share to swifter competitors. This has repeatedly happened in the computer field. Mainframe manufacturers ignored mini-computer firms. Then mini-computer firms ignored PC manufacturers (considering PCs to be toys). Then PC manufacturers ignored operating system firms, that is, Microsoft. And they, in turn, initially ignored the Internet.

To demonstrate this principle of experience curves and the need to keep up or lose out, consider the authors' example of the shipping industry.

CASE EXAMPLE

THE SHIPPING INDUSTRY

Primozic et al.¹¹ present an intriguing discussion of the shipping industry (which we have extended) to illustrate their concept of experience curves.

The Original Industry: Trucking

The trucking industry initially shipped two types of truckloads of goods: full point-to-point truckloads and less than truckloads (LTLs), as shown in the upper left of Figure 3.

New Industry 1: Package Delivery. Once United Parcel Service (UPS) based its entire business on LTL shipping, a new industry segment was born: package delivery. As a result of this new experience

curve, the shipping industry changed, and UPS actually became much larger than the trucking companies because it served a market with far more customers. The new technology that was key to UPS's success—and thus represented this particular experience curve—was the efficient sorting of packages at distribution centers in order to maximize use of its trucks.

New Industry 2: Overnight Delivery. UPS, however, did not guarantee a delivery time nor did it track packages. FedEx capitalized on these two missing functions, jumped to a new experience curve, and started yet another new industry segment:

(Case Continued)

overnight delivery. FedEx became larger than UPS because it tapped an even larger market. And for UPS and other package carriers to compete, they, too, had to invest in the technologies to guarantee delivery and track packages.

Needless to say, IT played a crucial role in this experience curve. In fact, the Internet began playing a role when UPS allowed customers to order package pickup online and when FedEx created a Web page that enabled customers to query the whereabouts of a package directly from its package-tracking database. That Web site, which went live in November 1994, had 12,000 customers a day doing their own package tracking, saving FedEx \$2 million just that first year.

New Industry 3: Advanced Logistics. In the late 1990s, a third industry emerged: advanced logistics. Due to their distribution networks and inventory facilities, overnight delivery services could handle inventory for large corporate clients and guarantee overnight delivery of these inventoried items. On this experience curve, client companies outsource not only their inventory, but also distribution to FedEx, Airborne Express, UPS, and other carriers. Clients include computer manufacturers, auto parts suppliers (to handle after-sales service), health care

diagnostic labs, retailers, even movie studios (to ship film to and from theaters). IT continues to play an integral role in the offered services.

New Industry 4: Supply-Chain Management. The industry has morphed again. Major players are becoming clients' supply-chain partners, providing all the services needed to get a client's product from the loading dock to the customer's premises. These companies have extended beyond advanced logistics by having the global reach and local presence (in far-flung locations) that their clients need to move their goods. In essence, these players become their clients distribution function, which requires all of the parties involved to work even more closely with each other.

New Industry 5: Global Positioning. The Global Positioning System (GPS) is increasingly becoming a tool to help businesses track in real time the location of the products or employees that want to monitor. This inexpensive navigation technology has facilitated the transportation logistics of the shipping industry. Equally important, it provides real-time feedback to the customers, allowing them to track the location of their order during shipment. ■

The following case example of Cisco and UPS illustrates this latest industry. Notice how Cisco taps UPS's global reach and experience with European carriers to complete its supply chain. Also notice how closely linked the companies are becoming, with UPS employees responsible for some of Cisco's inventory and for some of the data in Cisco's ERP system, thereby giving Cisco more visibility into its downstream supply chain.

CASE EXAMPLE

CISCO SYSTEMS AND UPS SUPPLY CHAIN SOLUTIONS

www.cisco.com; www.ups.com

In the late 1990s, Cisco committed itself to manufacturing products within two weeks of receiving an order, but it could not guarantee delivery. Cisco's shipping area in San Jose, California, typically suffered congestion with more than 150 transportation providers picking up finished goods. Customers were responsible for getting their products shipped from San Jose to their own premises. Shipping to Europe was especially taxing on customers.

To improve the situation, Cisco turned over its European supply chain to UPS Supply Chain Solutions (UPS SCS), a division of UPS, for reengineering and management.¹²

Some 90 percent of Cisco's products are configured and ordered over the Web. Within 24 hours of receiving an order, Cisco sends the customer an e-mail that states that the order has been accepted and that indicates when it will be produced.

When the product for a European customer is ready, Cisco notifies UPS SCS. Within 24 hours, UPS SCS picks up the order and books cargo space to move it to its European distribution center in the Netherlands, where it arrives two to three days later. In this shipping process, SCS handles customs clearance, documentation, billing, and carrier selection.

Once at the European distribution center, the order is shipped to the

customer in one of two ways. If it is a complete order or if the customer chooses to receive the order in several shipments, UPS SCS ships the product directly using its cross-docking facility. If the product is only part of an order, it is held until the rest of the order is received, then shipped. In some cases, fast-moving products are inventoried at the Netherlands site. UPS SCS personnel manage the site's inventory levels (meeting Cisco's specifications) and handle the last bill-of-material update in Cisco's ERP system once a product has been ordered for dispatch.

UPS SCS uses its own system to find the best shipper to move the package from the Netherlands center to the customer site. In essence, the system issues an electronic request for quotes to all approved shippers in the system. The system uses the information they supply to calculate the price, transit time, and service level for the shipment and then places a shipping order. The UPS SCS system also updates Cisco's system so that customers can find out their order status via Cisco's Web site. Until an order is filled, customers can even make changes, such as changing the delivery address.

The systems of the two companies have become increasingly linked. Each movement of a product is recorded in both systems.

(Case Continued)

UPS now handles over one million boxes a year for Cisco through its Netherlands distribution center. Because UPS can ensure reliable transit times, Cisco is able to now promise delivery times for its European customers. In

addition, these customers have only one point of contact for their shipments: the UPS SCS distribution center. And Cisco has online visibility into its downstream supply chain—to customer delivery in Europe—which it did not have before. ■

The Emergence of Electronic Tenders

An important development is occurring in the working-outward arena. Initially, IT was embedded in products and services because of its computational capabilities. For example, cars and elevators have computers that make them operate more efficiently. Toys have computers to make them more fun. Now, due to the Internet and wireless networks, the communication capabilities of computers are being extended and emphasized, often in these same products and services. These additions are literally transforming these goods. In essence, we would characterize these additions as adding electronic tenders.

An electronic tender is an electronic communication capability in a product or service that allows that product or service to be tended; that is, cared for, attended to, or kept track of by another computer. Electronic tenders open a seemingly unlimited set of possibilities for using IT in the working-outward arena. For example, consider a vehicle and its computers. Those computers can be programmed to perform diagnostics while the vehicle is running. Those diagnostics could be monitored by the car dealer (or an intermediary service provider), in real time, as a service to the owner. If something seems out of kilter, the owner could be notified, perhaps in real time. Likewise, packages and luggage with bar codes or other forms of identification can be tracked and found (if lost). The list of the uses of electronic tenders is endless.

Electronic tenders are occurring with services as well. A growing number of enterprises keep track of their customer interactions, culling them to understand clusters of customers and their buying patterns. Again, the options are endless. The goal is to get closer to the customer.

Getting Closer to Customers

The first wave of using the Internet in the working-outward arena involved the use of Web sites to sell products and services and manage customer relations. Many types of products can now be purchased online, from books, CDs, and flowers to automobiles, legal services, and wine. The advantages of selling online are numerous and seem obvious. Figure 4 lists some of these advantages. Indeed, it is not difficult to find success stories, such as Dell, E*TRADE, and Cheap Tickets. However, the potential problems are also numerous and have become more obvious since the dot-com bust. Figure 5 lists some of the potential problems faced in creating a B2C system.

Use of the Internet has now become much more sophisticated. CRM systems are used to learn more about customers (and perhaps noncustomers). Whether you visit a firm's Web site; call it from your home, office, or cell phone; or buy something from

Strategic Uses of Information Technology

Global accessibility: The Internet reduces the constraints related to geographic boundaries.

Reduced order processing: Automated order processing improves efficiency.

Greater availability: The company is available online 24 hours a day, 7 days a week.

Closer customer relationships: With a direct link to customers, the company can quickly address concerns and customize responses.

Increased customer loyalty: With improved customer service and personalized attention comes greater customer loyalty.

New products and services: With direct links to customers, the company can provide information-based products and services.

Direct marketing: Manufacturers can bypass retailers and distributors, selling directly to customers.

FIGURE 4 Advantages of B2C E-Business

it, the firm is keeping track and combining that information to create a profile of you. CRM systems for managing these profiles are the next wave of enterprise systems, following on the heels of ERP. ERP focused on internal data. CRM focuses on customer data.

CRM systems are both a boon and a bane, depending on how intrusive you think they are. You may be pleased when companies e-mail you offers that you want to take advantage of, such as a reduced-fare flight to a city you want to visit on the weekend. Or, you may see them as invading your privacy. In response to privacy concerns, some countries have passed privacy-protection laws to require companies to inform customers of whether and under what circumstances customer information is shared with others.

On the other side of the coin, IT and the Internet have changed what customers value. They now expect service to be fast; the key term is “on-demand”—personalization and instant gratification. Online business enables firms to respond quickly by drastically reducing the time needed to respond to customer requests for company, product, and price information; to process an order; and to get products to customers.

Customers also now expect convenience. They want more than one-stop shopping; they want a single point of contact in the company. CRM allows the gathering and

FIGURE 5 Potential B2C Problems

Technical: Information systems are not always reliable or may be poorly designed.

Logistics: Getting physical products to customers around the world in a timely manner brings physical barriers to the virtual business.

Personnel: Few people have expertise in dealing with the new environment, both in technical and business arenas.

Legal: Doing business across geographic boundaries means dealing with multiple legal systems.

Competitive response: The ease of creating a Web presence brings low barriers to entry for competitors.

Transparent prices: Customers can compare prices across Web sites, reducing profit margins.

Greater competition: The elimination of geographic boundaries means a firm must compete with competitors from around the world.

Instant gratification: Customers demand immediate satisfaction.

Strategic Uses of Information Technology

managing of customer information so that whoever interacts with the customer has all the relevant customer information at hand.

Customers further expect personalization of service. Online business allows direct, ongoing communication with customers; thus, preferences and buying patterns can be tracked and analyzed to provide individual service. By reducing the time to process orders, online business allows firms to customize products to individual customers. Thus, products from music CDs to PCs to bicycles to automobiles can be made to order online.

Online business forces companies to rethink their pricing of products and services. Customers now have access to a wide range of competitive prices and sellers for products, driving down profit margins and the price of products. Some observers have speculated that online business will drive profit margins to miniscule levels. Although some initial studies have confirmed the lower prices for goods purchased online, the highest-volume sellers do not always have the lowest prices. Prices are offset by branding, awareness, and customer trust.

The Internet is not used only to sell to customers online. It is also used to provide services to customers. In fact, sometimes it can be difficult to know which is more valuable, the product or the service. For instance, what is more valuable, a piece of machinery or the ongoing monitoring of that machinery and receiving an alert before it malfunctions?

The increasingly important focus is on staying in closer contact with customers, understanding them better, and eventually, becoming customer driven by delivering personalized products and services. As Frances Cairncross⁹ notes, the shift is taking place from running a company to keeping customers happy. This shift is having a profound effect on company structure and offerings.

To demonstrate a completely different side of the working-outward arena, we turn to the other side of the coin, from being a seller to being a buyer.

Being an Online Customer

Companies large and small are transacting business via the Internet. Some use it as their main means of business. Here is an example of one entrepreneur—Terence Channon, CEO of TerenceNet—who is a heavy user of the Internet as both a buyer and seller of services. The story comes from Gartner EXP.^{13a}

CASE EXAMPLE

A DAY IN THE LIFE OF AN E-LANCER

www.elance.com

TerenceNet is an online consulting, development, and research firm that delivers solutions to small and medium-sized businesses. A fair amount of its

work is procured from Elance (www.elance.com), a Web site that puts freelancers in touch with firms seeking bids for projects. Elance charges a commission

(Case Continued)

of 10 percent of the value of jobs set up through the service. The following is a typical day's journal for Channon's use of Elance.

8:15 A.M. My working day starts with e-mail and checking Elance. I signed up with Elance a few years ago to see what kinds of online work were being offered for freelancers. I think I was one of Elance's first customers. The site's first postings were mainly for online work—Web development and the like—just what my firm does. Recently, I have noticed engineers advertising for AutoCAD drawings, so the site seems to be broadening.

There are lots of freelance Web sites and online marketplaces, but I like Elance because it's where I got my first paid job. I won a job through another site—but never got paid. Elance is a very active site, with 30 to 40 new postings a day; others only have three to four.

This morning I bid on 10 projects.

11:05 A.M. I check Elance several times a day or when I get an e-mail notification that I have received a message, like right now. I've logged onto My-Elance—my own personal Elance Web page—that shows all the work I have bid on, which bids are open and which are closed, and all the projects where my bids have been declined or accepted. It also shows all the projects I have offered, the number of bids I have received, and so on.

A company is considering me for a job I bid on, so its new message to me is flagged. This company tells me it has set up a private message board on Elance for us to talk privately about the work.

At first, I used Elance to supplement my company's income. Now I can pretty much count on the site as a revenue source.

It may not be steady revenue, but there are enough postings on it, and I win enough of my bids that I can rely on it for work.

I put considerable thought into the bids I make. Some people just cut-and-paste a generic statement of what they do. I don't do that; I respond to a request by setting out exactly what we can do and pointing to examples of similar work. I think this shows commitment and knowledge.

3:00 P.M. When you sign up on Elance, it's like joining a community. Everything is very open. I can see who is bidding on a job, read their experience, look at the work they have done (such as Web sites they have developed), and see how they have responded to a posting. I can also see who has won a bid.

There's a lot of trust involved on both sides because we don't have contracts. I have to trust that the client will pay me. The client has to trust that I will do the work. Elance has a feedback board where I can see that I have a top rating from the companies I have worked for and from the people who have worked for me. Everyone can see these ratings.

I have found everyone to be very professional on Elance, cordial in fact. The bidders all feel as if we are in this together; we don't feel or act like competitors. Naturally, we promote ourselves and our work—but we do not talk down others. I've made some wonderful contacts on Elance. Some short jobs have turned into relationships. TerenceNet is now on retainer with one company because it liked our initial work.

Another company liked our development work and wanted more functionality on its Web site. We were busy at the time so I put a posting on Elance. I got

(Case Continued)

30 bids in five days. When I whittled them down to the bid with the best example of the kind of work I wanted, it was from a company in Bulgaria. This company did the work at a fair price and delivered on time, and I have since given it other work. I had to pay via Western Union, but Elance has a payment system where you can transfer funds between bank accounts.

7:30 P.M. One last check on Elance. Usually, there are not many new job postings in the evening, but I want to make sure I have responded to all my messages.

There are 10 new postings tonight—one for designing a business card, two for company logos, one for 1 million Web site addresses, one for writing a press release, and one for programming in Dreamweaver. None of them interests me.

I put out a posting for some Palm work a few days ago and gave it a five-day bid period. I'm surprised I have received nine bids so far. I did not know there were so many wireless developers out there.

There are not many job postings on the weekends, so I'm taking this weekend off to spend with my family. ■

A major point of the Semco and TerenceNet case examples is that both are very customer-centric. They keep themselves attuned to the market by continually asking what customers need. This customer-centricity is also changing the strategic use of IT in the working-across arena.

WORKING ACROSS: BUSINESS-TO-BUSINESS

Streamlining processes that cross company boundaries is the next big management challenge, notes Michael Hammer,¹⁴ a well-known consultant in the IT field. Companies have spent a lot of time and effort streamlining their internal processes, but their efficiencies generally stop at their corporate walls. The winners will be those that change their processes to mesh with others they deal with so that they have chains of activities performed by different organizations, notes Hammer. This is not a technical challenge, as most have viewed supply-chain management (SCM), but a process and management challenge, he believes.

Working across businesses takes numerous forms. Here are three. One involves working with co-suppliers; a second is working with customers in a close, mutually dependent relationship; and the third is building a virtual enterprise, in fact, one that might evolve into an e-marketplace.

Coordinating with Co-suppliers

Collaborating with noncompetitors is a type of working across. For example, two food manufacturers might have the same customers (supermarkets and other retailers) but not compete with each other. Hammer calls such companies "co-suppliers." Their form of working across is illustrated in this example.

CASE EXAMPLE

GENERAL MILLS AND LAND O' LAKES

www.generalmills.com; www.landolakesinc.com

The seven-largest U.S. food manufacturers have about 40 percent of the supermarket shelf space for dry goods. That volume is high enough to support their own fleet of delivery trucks, notes Michael Hammer.¹⁴ However, they have only 15 percent of the refrigerated goods business, which is not enough volume to fill up their refrigerated trucks for one supermarket. Thus, they use one truck to deliver to several supermarkets, which is less efficient because of traffic delays.

To address this problem, General Mills (maker of Yoplait yogurt) teamed up with Land O' Lakes to combine their deliveries on General Mills trucks. The

result is better use of the trucks and higher supermarket satisfaction (due to fewer late shipments). Land O' Lakes ships its butter to General Mills' warehouse, either for delivery on the same truck or for pickup by the customer. In fact, notes Hammer, the coordination has been so beneficial that the two are looking into integrating their order-taking and billing processes, again, because they have duplicate processes where they might be able to only have one. To fill their trucks even further, they are creating joint initiatives for customers to order more from both companies at the same time. ■

What has deterred co-suppliers from working together has been the lack of convenient ways to share information quickly and easily. The Internet takes away that deterrent. In fact, companies can reduce costs through sharing anywhere they use similar resources, such as warehouse space in the same city or shipping between the same two cities.

Hammer recommends companies begin working with co-suppliers by first making their own processes efficient, then collaborating on new joint processes (which is new territory for many companies). Eliminate duplicate activities, focus on customer needs, and let the work be done by the company in the best position, he suggests.

Deciding what type of relationship two enterprises want with each other in many ways determines factors regarding their relationship. Do they want a loose, close, or tight relationship?

Establishing Close and Tight Relationships

As noted earlier, the action in strategic use of IT and the Internet has moved to the most difficult area, working across companies. This means having relationships with various players in one's business ecosystem—investment banks, advertising agencies, specialist providers, suppliers, distributors, retailers, even competitors. Such relationships often have accompanying linking information systems. As Marcus Blosch and Roger

Strategic Uses of Information Technology

Woolfe point out, in the Gartner EXP report *Linking Chains: Emerging Interbusiness Processes*,^{13b} companies need to determine what level of system integration they want in each case: loose, close, or tight.

- In loose integration, one party provides another party with ad hoc access to its internal information. The information may or may not be confidential, and it is accessed when it is needed. An example might be a builder of small power units that lets suppliers and customers check specifications on its Web site. The business processes remain distinct. Such limited integration requires little risk or cost.
- In close integration, two parties exchange information in a formal manner. Some of that information is probably confidential, and although the two parties' processes are distinct, they do handle some tasks jointly. For instance, they jointly manage the sharing. An example is airlines sharing pricing data with each other so that they can provide more seamless service to customers using several airlines on one trip. This level of integration leads to greater benefits, so there is greater impetus to make the relationship succeed. However, risks do increase because confidentialities are shared. Costs of integration are also higher than in loose integration.
- In tight integration, two parties share at least one business process, as partners, in a business area that is important to them. Generally, high volumes of data are exchanged; the data can be highly confidential; and the data include key events, such as price changes. An example could be a supplier and retailer sharing a common inventory process. The intent is to synchronize operations to reduce costs and speed response time. Tight integration is the most risky because it is business critical and the most costly to integrate. In some cases, it may be difficult to identify where one organizational boundary ends and the other begins because the two become so intermeshed.

The point to note is that due to the high costs and risks, companies can only have a few tight relationships. Those would be where the benefits outweigh the costs and risks. That implies that tight relationships are the ones that encompass genuinely critical processes and where working tightly with another party adds significant value. Blossch and Woolfe thus see companies having a pyramid of inter-business relationships, as shown in Figure 6: a few tight ones, some close ones, and many loose ones. The loose ones have basic conformance to integration requirements (such as a negotiated agreement

FIGURE 6 The Integration Pyramid

	NUMBERS OF RELATIONSHIPS	POTENTIAL BENEFIT	COST OF INTEGRATION	RISK
Tight	Few
Close	Some
Loose	Many	.	.	.
• Basic conformance	•• Intermediate conformance		••• Advanced conformance with significant detail and ongoing maintenance	

Source: Marcus Blossch and Roger Woolfe, *Linking Chains: Emerging Interbusiness Processes*, Gartner EXP, August 2001.

and shared information). Tight ones have advanced conformance as well as significant detail and ongoing maintenance in their agreements.

To illustrate a close relationship that is becoming a tight one, consider the case of the Sara Lee Bakery Group, one of the first food manufacturers to use a specific information technology to establish close relationships with supermarket chains. Based on that experience, it has more recently moved to establish some tight relationships. The case comes from Blossch and Woolfe.

CASE EXAMPLE

SARA LEE BAKERY GROUP

www.saralee.com

Sara Lee Bakery Group (SLBG), formerly Earthgrains, with headquarters in St. Louis, Missouri, is the second-largest bakery in North America. It specializes in fresh-baked branded goods and private-label refrigerated dough and toaster pastries. Worldwide, SLBG has 26,000 employees.

Fresh-baked goods are delivered to retailers by direct store delivery. Delivery people stand in line at the retailer's back door to have their deliveries counted. To reduce labor costs, retailers have reduced the number of hours their back door is open. SLBG requires more trucks to accommodate the reduced hours. The lines become longer and more time is wasted.

Dealing with the Backdoor Bottleneck

SLBG was one of the first food manufacturers to introduce scan-based trading (SBT), selling bread on consignment. On the first day of the new arrangement, SLBG buys back the bread on the retailer's shelf, which moves the inventory value to the bakery group's balance sheet.

At the end of each day, the store sends the scan data from its point-of-sale check-out system for all SLBG products sold that

day to its retail headquarters, which then transmits the data to SLBG via EDI or the Internet. The retailer also uses that scan data to post sales to its accounts payable system, and SLBG posts to its accounts receivable system. The retailer pays SLBG electronically, based on the scan data.

More recently, SLBG has established a shared database with 100 stores, hosted by a third party, viaLink. This database facilitates price and item synchronization. Once SLBG has created an electronic connection to viaLink, it can easily expand to other trading relationships because viaLink handles translations between trading partners' systems.

Benefits of SBT

SLBG now has 2,143 stores at seven retailers across the United States on SBT. The retailers like SBT because they no longer have money tied up in inventory and they pay for bread after it is sold. SLBG likes the arrangement because it receives the scan data, which it uses to improve its merchandizing. SBT also saves time. Delivery people no longer line up at the back door to hand over

(Case Continued)

goods during the back door hours. They stock the shelves themselves.

SLBG uses the saved time to improve the quality of work for its delivery people (less stress in making deliveries), to reduce the number of delivery routes, and to reinvest the time in call-backs in the afternoon to restock the shelves to make the store look better for the before-dinner rush of shoppers.

The shared database eliminates “chasing deductions,” which is a huge non-value-added activity in the industry.

Seven Prerequisites for SBT

Over the years, SLBG has learned seven prerequisites for creating SBT relationships.

The first is to deal with the major point of contention—shrinkage—right up front. Shrinkage is the amount of product “lost” at the retail store due to theft, misplacement, or other reasons. SLBG deals with shrinkage by agreeing to split the loss 50-50 up to a maximum amount; thus, accountability is shared with the retailer.

Second, SLBG requires the retailer to have an SBT executive sponsor—an executive from headquarters who makes SBT a priority for the retailer. Individual stores cannot initiate SBT on their own because they do not have the authority or the money to create the necessary systems or interfaces.

Third, SLBG requires the retailer to assign a point person. SBT projects touch many people on both sides. SLBG has a project manager as its point person for the retailer. It only wants to have to contact one person at the retailer as well.

Fourth, to plan the relationship, SLBG asks the retailer to create a cross-functional group—the executive sponsor

along with people from purchasing (merchandising), finance, accounting, security, operations, and IS. IS is involved because converting existing systems costs a retailer between \$50,000 and \$100,000. One required change is the creation of a path between scan data and accounts payable, which is not a natural path. If the retailer has not been using EDI, SLBG provides a package for transmitting data securely over the Internet.

Fifth, SLBG asks the retailer to create an as-is process map of how its process currently works and a to-be process map of how it will work in the future. The two processes are vastly different. The data and money move on different paths, and in-store processes need to change. For example, the vice president of operations needs to allow SLBG staff in the retail store after noon.

Sixth, SLBG only works with retailers that have invested in achieving almost 100 percent accuracy in their point-of-sale system, because that system determines how much money SLBG is paid. A system that is only 95 percent accurate gives SLBG a 5-percent shrinkage from the outset, which SLBG will not accept.

Seventh, SLBG does not initiate SBT until prices have been synchronized with the retailer.

Managing SBT Relationships

SBT is managed by a 10-person team that is headed by a vice president. The group includes EDI coordinators who handle the technical aspects of receiving SBT data. Project managers integrate customer-driven projects, such as SBT. An analysis group monitors SBT data to ensure that each store is staying within its agreed shrink limits. The analysis

(Case Continued)

group also sends out quarterly invoices to reconcile shrink differences.

Rolling out SBT to a retailer's stores requires lots of coordination. Store employees need to know, "Next Monday everything is going to change." The SBT team works with SLBG's account manager for the retailer to make sure store employees understand the new routine. Store receivers need to understand that SLBG will no longer be standing in line. Store management needs to know delivery people may be tending shelves in the afternoon. SLBG delivery people

need to be much more careful about their record keeping—SLBG's income depends on those records.

SLBG's ordering process, in which counting items every day is an integral part, allowed it to move fairly easily to SBT. Manufacturers that do not count individual items, such as soft drink and snack food companies, have a more difficult time making the switch. This is one reason that SBT has not spread more quickly in the industry; it has not yet touched the 85 percent of the grocery items stocked from retailer warehouses. ■

Becoming a Customer-Centric Value Chain

A company's value chain consists of its upstream supply chain (i.e., working with its suppliers of raw materials and parts) and its downstream demand chain (i.e., working with its distributors and retailers to sell its products and services to end customers). Traditionally, most companies make-to-stock. They build vehicles or package mutual funds and then push them to customers. This is the supply-push world.

We are seeing the rise of the reverse—a demand-pull world—where a customer's order triggers creation of the customized product or service the customer has defined. The chain of events is reversed from supply-push to demand-pull, from running a company to keeping customers satisfied. Dell is a prime example of this customer-centric, demand-pull business model. In fact, it has become the model that many companies admire and would like to emulate. The case also illustrates the benefits of having a tightly integrated value chain.

CASE EXAMPLE

DELL VERSUS HP

www.dell.com; www.hp.com

Dell sells PCs, servers, handhelds, and other electronic equipment directly to customers, either individuals or

organizations worldwide. It is the largest seller of PCs in the world, mainly because of its prices, which are a

(Case Continued)

direct result of its customer-centric business model.

When a customer custom configures a PC online on Dell's Web site, the order information is fed into Dell's production schedule and an e-mail is sent to the customer stating when the computer will be shipped.

However, Dell does not make most of its product; its suppliers do. Some 30 of its 200 suppliers get close to 80 percent of Dell's business. That is very few suppliers, notes Cairncross;⁹ most PC manufacturers have thousands of suppliers. Dell created an extranet for its suppliers so that they can see order information and Dell's production schedule. In fact, they can grab this information and feed it into their own production systems.

In essence, Dell's extranet is moving toward becoming a private marketplace, where orders arrive from customers and are distributed to suppliers. In fact, Dell is working toward making the information available to suppliers of its suppliers—two tiers down. Its goal, says Cairncross, is transparency, giving the entire industry a clearer view of supply and demand so that they can see what is selling, and perhaps what buyers are paying, all the while maintaining the privacy of suppliers.

Because suppliers can see through this demand chain, and find out which of their components are being ordered and for what kinds of computers closer to real time, they can forecast better. The result is less inventory in the supply chain. Reduced inventory is very important in the PC business, notes Cairncross, because some 80 percent of the cost of a PC is in its components. Prices have dropped quickly in the industry; at least

1 percent every two weeks is not uncommon. So the fewer days they need to keep inventory, the less money they tie up in it, and the less money they lose.

Dell has a reverse physical value chain from other PC manufacturers. They have supply-push; Dell has demand-pull. Dell also has a demand-pull financial value chain. In the supply-push model, the manufacturer borrows money from a bank to build-to-stock. It then repays the bank, with interest, after the stock has been sold. In Dell's demand-pull financial model, customers pay for their PC when they place their order. Thus, Dell gets paid before it builds the computers. Hence, it borrows less money and pays less interest, lowering its costs and its prices.

Hewlett-Packard (HP) is another leading technology solution provider and one of Dell's most aggressive competitors. In 2006, HP leapfrogged over Dell to recapture the lead as the number-one PC maker worldwide for the first time in almost three years, according to Gartner. To counter Dell, HP adopts a different customer-centric model. On the technological side, HP develops a number of unique features that are highly demanded by consumers. HP computers are equipped with hardware that provides useful functions (such the LaserScribe DVD/CD drive allowing the user to engrave permanent and attractive labels on the disks), and are loaded with popular applications software such as multimedia applications. Furthermore, HP works with major retailers to sell its desktop and laptop computers. The use of distributors allows HP to deliver its products to the consumers immediately at the stores, after they have had a chance

(Case Continued)

to try them out. As such, the strategy to counter Dell's short delivery cycle with local store availability has worked for HP. The fight for the top position is fierce, and we expect these two giants to continue to come up with innovative supply-chain strategies. Both companies seek to

restructure their businesses to further streamline costs—one leadership position in which Dell is no longer ahead—and to look for new business models to remain in this ferociously competitive world of PC sales. This duel is certainly worthwhile keeping an eye on. ■

Pros and Cons of Demand-Pull

Value chain transparency is a much-talked-about concept. It should, for instance, reduce the number of duplicate orders. During the late 1990s, for instance, when a component was in short supply, manufacturers sometimes duplicated an order for the component with several suppliers just to ensure a steady supply. An order for 10,000 memory chips might appear as 30,000, greatly exaggerating the true demand. In late 2000, when both the dot-com and telecommunications bubbles burst, large amounts of back orders disappeared just about overnight, partly because of this duplicate ordering phenomenon, catching manufacturers unaware. Transparency about orders might prevent such drastic downswings.

Creating private exchanges, such as Dell is doing, changes the level of cooperation among firms as well. Information passes through the chain in a burst and is available to all parties at the same time, rather than sequentially over time. The result is that suppliers and even customers become collaborators in improving efficiency throughout the process. Working closely also introduces technological changes more rapidly. Suppliers would be hard-pressed to keep up without a close working relationship and electronic ties. In fact, some have implemented software that automatically notifies every relevant supplier when a change is made so that they are working from the latest specifications.

One disadvantage to demand-pull is the infrastructure. The manufacturer's infrastructure becomes its suppliers' infrastructure as well, binding them more tightly together. If the infrastructure is not robust, crashes can affect the entire ecosystem dependent on the exchange. Another drawback is that such close working requires trust. Divulging confidential information to suppliers, such as canceled orders, could hurt the company if it is passed to competitors or Wall Street (perhaps causing the stock price to fall). Furthermore, suppliers that provide parts to competing PC manufacturers must ensure that information from one does not leak to another. This containment of information within a company is often referred to as building "Chinese walls" between the groups that work for competing customers. However, no such containment can be absolute, notes Cairncross. Innovations that employees learn from one customer can naturally seep to another.

Becoming customer-centric is not straightforward, especially for supply-push companies. Their computer systems, processes, and people follow that model, essentially

casting the organization in electronic concrete. That is why the promise of Customer Relationship Management (CRM) is so alluring. It helps companies shift their attention from managing their operations to satisfying their customers.

Getting Back-End Systems in Shape

To have a hope of working across, internal back-end systems need to be fully operational. Most, if not all, B2B systems must integrate with these existing back-end systems, which has proven particularly challenging. Back-end systems cover a wide range of applications, including accounting, finance, sales, marketing, manufacturing, planning, and logistics. Most of these systems have been around for years, operate on a variety of platforms, and were not designed to integrate with other systems. Modifying these systems entails many risks, particularly when the integration must cross organizations. Luckily, most organizations have a head start on inter-organizational integration because they have been working for a number of years on internally integrating their systems.

Understanding the need for internal integration, many companies replaced, or are currently replacing, their old back-end systems with newer ones using database management systems (DBMS) and Enterprise Resource Planning (ERP) systems. The benefits of DBMS and ERP systems have always stemmed from their ability to provide integration. Recognizing the importance of online business, DBMS and ERP vendors have modified their products to integrate with Internet-based applications. In doing so, the vendors provide platforms for building B2B systems.

Another approach to establishing B2B integration is to create an extranet, as Dell has done. An extranet is a private network that uses Internet protocols and the public telecommunication system to share part of a business' information or operations with suppliers, vendors, partners, customers, or other businesses in a secure manner. An extranet is created by extending the company's intranet to users outside the company. The same benefits that Internet technologies have brought to corporate intranets have accelerated business between businesses.

Whatever the approach, the goal is to extend the company's back-end systems to reengineer business processes external to the company. Example activities include sharing product catalogs, exchanging news with trading partners, collaborating with other companies on joint development efforts, jointly developing and using training programs, and sharing software applications between companies. Initially, the benefits come in the form of greater cost and time efficiencies. Ultimately, the systems will change the structure of industries, and marketing strategies.

Mobile Computing as a Strategic Advantage

Mobility matters. The advent of wireless devices—from notebooks to smart phones, and from Wi-Fi connectivity to RFID—has enabled businesses to move data to where it is needed in real time. The idea here is that the processed intelligence follows the user, and not vice versa. This mobile business intelligence is critical in a competitive environment that requires timely decisions. The use of mobile computing for business is another case of the virtuous circle of the “new” economy shown in Figure 10. The use of innovative IT products leads to increased industry productivity and fiercer competition. The potential for mobile computing is virtually limitless, going beyond mobile e-mail and messaging. However, to take advantage of mobile technologies, an

Strategic Uses of Information Technology

effective plan is required for strategic purchasing, deployment, and support. What business processes that are currently in practice will benefit most from using mobile technologies? Can mobile computing help create some new business activities? How does the company deal with mobile security? These are some of the issues that corporate management needs to deal with to turn a mobile device deployment into a successful enterprise resource.

Another emerging trend on the business-to-customer side (working outward) in the rapid growth of mobile shopping. The cell phone has become a point of sales and a payment device. Consumers can use their mobile phones to order goods from a vending machine or trade stocks. According to a report by Jupiter Research in 2006, estimated market revenues for mobile would reach \$7 billion by 2008 and would jump to \$20 billion by 2010.

CONCLUSION

Over the years, a few innovative companies have achieved strategic advantage using IT. These firms served as models of what could be done, but most companies did not have the resources or skills to follow their example. With the growth of the Internet and the development of online business, IT has become a strategic tool in every industry.

As their employees become dispersed, enterprises are looking for ways to bring cohesion. Intranets and portals are ways to use IT strategically inside the firm. In working outward, enterprises are creating electronic tenders to provide services that make their products more valuable and help them better know their customers and develop more personal relationships with them. This customer-centric view, now so prevalent in the business world, is affecting the strategic use of IT in working across. Value chains are looking to shift from supply-push to demand-pull.

Perhaps the most promising technology in the near future is the adoption of mobile computing in supply-chain execution. As IT continues to evolve, so do its strategic uses.

QUESTIONS AND EXERCISES

Review Questions

1. According to Karlgaard, what is the “cheap revolution”?
2. Why does Brian Arthur compare the British railway and canal revolutions with today’s information revolution?
3. According to Michael Porter, what is the only way to sustain advantage through the Internet?
4. According to Carr, why does use of IT no longer matter strategically? How should the management of IT change?
5. According to Cairncross, what is the challenge for corporate management of widely dispersed enterprises?
6. What is an experience curve? Give examples.
7. How has the Internet changed consumer expectations?
8. According to Cairncross, what is the shift taking place today in running a company?
9. According to Terence Channon, why does Elance feel like a community?

Strategic Uses of Information Technology

10. What is the next big management challenge, according to Michael Hammer? Who will be the winners?
11. How do General Mills and Land O' Lakes cooperate?
12. Explain loose, close, and tight relationships.
13. According to SLBG, what are the prerequisites for it to implement SBT with a retailer?
14. What is a demand-pull value chain? How does Dell exemplify this concept?
15. Identify three potential applications of mobile computing. Highlight the benefits, and identify the challenges.

Discussion Questions

1. The British railway and canal revolutions are nothing like today's Internet revolution. For one thing, those were just machines that only augmented muscle power. Computers augment brain power. Brian Arthur is wrong in his predictions about the future. Argue both sides of this issue.
2. There have been so few instances of companies gaining competitive advantage from IT that Carr must be right; IT really does not matter strategically anymore. Carr is not right, and will not be right, because IT is not one technology (like electricity or railroading); it is many different technologies. New ones are constantly appearing. Choose a side and defend it.
3. Companies are using online applications to build profiles of customers. Privacy advocates consider this practice to be dangerous. Do you agree? Where do you draw the line? Discuss.
4. The prospect of electronic tenders is promising. The prospect of electronic tenders is frightening. Discuss both statements and state where you draw the line and why.

Exercises

1. Learn more about the debate Nicholas Carr has unleashed by finding seven arguments not in the text that convincingly argue that "IT does matter." Present these to the class.
2. Visit a local company and talk to a manager about the firm's intranet. What sorts of functions do they currently have on it? What do they plan for the future? Is it creating a sense of belonging among dispersed employees? If so, give some examples.
3. Describe your personal use of a product or service that has an electronic tender. What do you think of the electronic tender? How valuable is it to you? How could the vendor extend the tender in a way that would help you? How has the vendor stepped over the line in invading your privacy, if you think it has?
4. Visit a local company and talk to a manager about an inter-business system. Is it loose, close, or tight? Why was it built, what challenges did it present, and what benefits is it producing?

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STRATEGIC INFORMATION SYSTEMS PLANNING

INTRODUCTION

WHY PLANNING IS SO DIFFICULT?

Business Goals and System Plans Need to Align
Technologies Are Rapidly Changing
Companies Need Portfolios Rather Than Projects
Infrastructure Development Is Difficult to Find
Responsibility Needs to Be Joint
Other Planning Issues

THE CHANGING WORLD OF PLANNING

Traditional Strategy Making
Today's Sense-and-Respond Approach to IT Planning
Case Example: Microsoft
Case Example: Skandia Future Centers
Case Example: Shell Oil

EIGHT PLANNING TECHNIQUES

Stages of Growth
Critical Success Factors
Competitive Forces Model
Framework Example: Five Forces Analysis of the Internet
Beyond Porter—Downes' Three Emerging Forces
Value Chain Analysis
Case Example: An Automobile Manufacturer
E-Business Value Matrix
Case Example: Cisco Systems
Linkage Analysis Planning
Case Example: Electric Power Research Institute
Scenario Planning
Case Example: Scenarios on the Future of IS Management

CONCLUSION

QUESTIONS AND EXERCISES

REFERENCES

INTRODUCTION

IS management is becoming both more challenging and more critical, especially in strategic systems planning. On the one hand, the technology is changing so fast that it is tempting to say, “Why bother?” On the other hand, most organizations’ survival depends on IT, so planning its effective use is a matter of organizational life and death.

How can this apparent paradox be resolved? The good news is that a variety of approaches and tools have been developed to assist in systems planning. The bad news is that there is no universal solution. Thus, most organizations use more than one approach or tool to empirically uncover which approach that would best fit its organizational context or culture.

It is important to establish the appropriate mind-set for planning. Although some managers believe planning means determining what decisions to make in the future, this view is untenable today because the business environment is so turbulent, making the future unpredictable. A practical view is that planning is

developing a view of the future that guides decision making today.

This seemingly subtle difference significantly changes how managers approach and execute planning. In turbulent times, some executives think in terms of strategy making rather than planning. Our definition of strategy is

stating the direction we want to go and how we intend to get there.

The result of strategy making is a plan.

This chapter first describes the traditional view of planning, and then offers a current version of strategic systems planning, that is, strategy making, which is intended to synchronize with today’s faster-paced business world. Finally, some approaches that are used in strategic systems planning are presented.

WHY PLANNING IS SO DIFFICULT?

Planning is usually defined in three forms—strategic, tactical, and operational—which correspond to three planning horizons. Figure 1 summarizes these three planning types and some of their characteristics. This chapter emphasizes strategic planning—the top row. Strategic is defined as “having a significant, long-term impact on the growth rate, industry, and revenue” of an organization. Strategic systems planning deals with

FIGURE 1 Three Types of Planning

TARGET HORIZON	FOCUS	ISSUES	PRIMARY RESPONSIBILITY
3–5 years	Strategic	Strategic planning, business process reengineering	Senior management CIO
1–2 years	Tactical	Resource allocation, project selection	Middle managers IS line partners Steering committee
6 months–1 year	Operational	Project management, meeting time, and budget targets	IS professionals Line managers Partners

Strategic Information Systems Planning

planning deals with planning for the use of IT for strategic purposes. It attempts to form a view of the future to help determine what should be done now.

Some fundamental reasons explain why systems planning is so difficult. Here are a few of them.

Business Goals and Systems Plans Need to Align

Strategic systems plans need to align with business goals and support them. Unfortunately, if top management believes the firm's business goals are extremely sensitive, the CIO is often excluded in major strategic meetings by top management. The IS department can be left out of the inner circle that develops these plans. Fortunately, more and more CIOs are being made part of senior management. In addition, systems planning is becoming a shared responsibility among the CIO, CTO, and other members of senior management. The emergence of e-commerce and globalization caused CEOs and CFOs to realize they need to be involved in systems planning.

Technologies Are Rapidly Changing

How can executives plan when IT is changing so rapidly? One answer is continuous monitoring and planning the changes of technologies and how the industry would adopt this technology. Gone are the days of an annual planning cycle done the last few months of the year and then put aside until the following year. Rather, the planning process first needs to form a best-available vision of the future on which to base current decisions. Then the technology needs to be monitored to see whether that future vision needs alteration. When it does, adjustments in current decisions are made. Some organizations have an advanced technology group charged with watching and evaluating new technologies. It is important for organizations to pay particular attention to the impact of disruptive technologies or disruptive innovation. Sometimes, an emerging and inexpensive technology emerges and swiftly displaces incumbent technologies. A classic example is the Linux Operating System (OS). When it was introduced, its capability was inferior to other existing OSs like Unix and Windows NT. Linux was inexpensive, and thanks to continuous improvements, it has earned a significant market share for computer servers. In 2007, IBM announced it would use Linux with its new servers. The USB memory stick is another instance of disruptive technologies. This inexpensive storage medium has changed the way people share files, displacing disk storage. Many forecasters have predicted that Voice-over-IP will replace decades-old land-based telephony.

The planning issue here is for management to foresee the upcoming of innovation with superior technology potential and viable business applications. These new technologies can be a cost-effective addition to the existing technological infrastructure. Or, they can be a potential replacement that needs a carefully migration strategy.

Companies Need Portfolios Rather Than Projects

Another planning issue is the shift in emphasis from project selection to portfolio development. Businesses need a set of integrated and seamless technologies that work together. Project developments have had a history of building "stove-pipe" systems that result in applications that are not compatible with each other. A portfolio approach requires a more sophisticated form of planning because projects must be evaluated on more than their individual merits. How they fit with other projects and how they balance the portfolio of projects become important. The Internet Value Matrix described later is an example of this approach.

Infrastructure Development Is Difficult to Fund

People understand intuitively that developing an infrastructure is crucial. However, it is extremely difficult to determine how much funding is needed to develop or improve infrastructure. Often, such funding must be done under the auspices of large application projects. The challenge then is to develop improved applications over time so that the infrastructure improves over time.

Since the mid-1980s, companies have faced a continual succession of large infrastructure investments. First, they needed to convert from a mainframe to a client-server architecture to share corporate and desktop computing. Then they implemented ERP to centralize and standardize data so that everyone had the same information. Then they needed to create a Web presence and give users access to back-end systems. Now they are under pressure to implement Web Services-oriented architectures to work inter-company and draw on best-of-breed processes. Boards of directors have realized that they have to fund these huge multiyear projects just to remain competitive. Making these large-stakes bets increases the difficulty of systems planning.

Responsibilities Needs to Be Joint

It used to be easier to do something yourself than gather a coalition to do it. This is no longer the case. Systems planning initiated by and driven by the CIO has not proven as effective as systems planning done by a full partnership among C-level officers (CEO, CFO, CIO, COO) and other top executives. Systems planning has become business planning; it is no longer just a technology issue. Many large organizations set up an Information Systems Council (ISC) or committee to periodically review the effectiveness of the current strategic plan, assess the current technological environment, and develop an IT strategy based on the institution's mission and goals.

Other Planning Issues

Several other characteristics of planning make strategic systems planning difficult. There is always tension between top-down and bottom-up approaches, thus the planning process must strike a balance between radical change and continuous improvement. Furthermore, systems planning does not exist in a vacuum. Most organizations have a planning culture into which systems planning must fit. This sampling of issues illustrates why systems planning is a difficult but crucial task.

THE CHANGING WORLD OF PLANNING

This section discusses how strategic planning has evolved along with the rapid change of Internet-driven technologies.

Traditional Strategy Making

In its Tactical Strategies^{1a} report, Gartner EXP states that traditional strategy making followed the progression shown in Figure 2:

1. Business executives created a strategic business plan that described where the business wanted to go.
2. From that plan, IS executives created an IS strategic plan to describe how IT would support that business plan.

Strategic Information Systems Planning

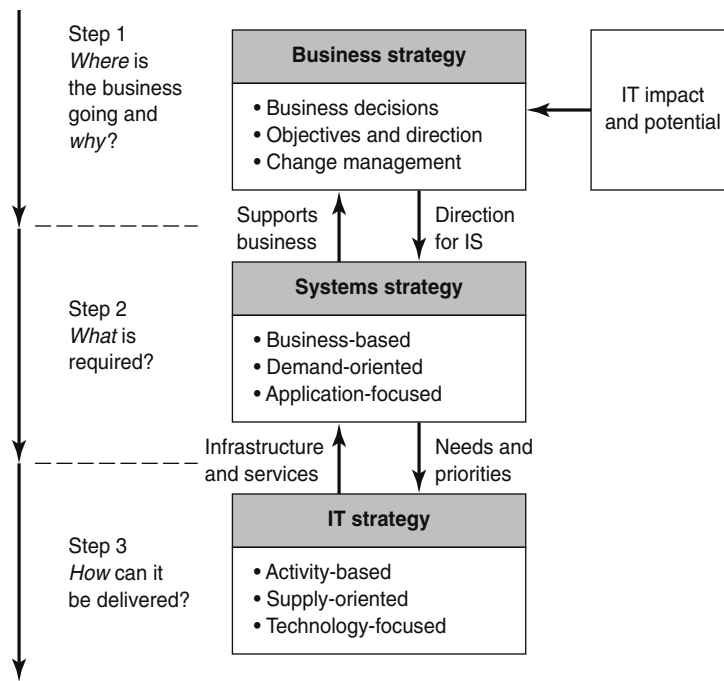


FIGURE 2 Traditional Strategy Making

Source: Adapted from and reprinted with permission from Roger Woolfe, Barbara McNurlin, and Phil Taylor, *Tactical Strategy*, Wentworth Research Program (now part of Gartner EXP, 56 Top Gallant, Stamford, CT 06904), November 1999.

3. An IT implementation plan was created to describe exactly how the IS strategic plan would be implemented.

Companies felt comfortable spending quite a bit of time, often a full year, creating a single strategic plan that they would implement over, say, the coming five years. That plan was created by top management. If the CIO was part of that group, then IS was involved in the planning; otherwise, IT considerations may or may not have been taken into account.

From the corporate strategy, IS staff developed the systems strategy, which described what was required to support the business plan. Finally, from that systems strategy, IS staff developed the technology-based IT strategy, which described how the company could deliver the needed capabilities.

This traditional planning stance was based on the following assumptions:

- The future can be predicted.
- Time is available to progress through this three-part sequence.
- IS supports and follows the business.
- Top management knows best, because they have the broadest view of the firm.
- The company can be viewed as an army: Leaders issue the orders and the troops follow.

Today, due to the Internet, these assumptions no longer hold true.

The Future Is Less Predictable

The Internet has caused discontinuous change, that is, change that can occur in unexpected ways. Industry leaders may not be able to use the same strategies they used in the past to maintain their superior market position. Unexpected and powerful competitors can emerge out of nowhere. For example, in the mid-1990s, how many book-sellers predicted Amazon.com's business model of selling only on the Web or the success it would have? Not very many. Likewise, how many top executives seriously considered eBay's online auction model as one that could transform the way they would buy and sell? Not very many. As firms incorporate the Internet into their business, even newer Internet-based business models will appear. Industry after industry is encountering discontinuous changes to the way they have traditionally operated.

Time Is Running Out

Due to the Internet, time is of the essence. Companies no longer have the luxury of taking a year to plan and several years to implement. Worse yet, the most time-consuming phase of the sequence—IT implementation—is at the end, which means the IS department is late in supporting the business' strategic plan from the outset. To move quickly, IT implementation planning actually needs to be ahead of business strategizing. Furthermore, it needs to be faster than it has been in the past.

IS Does Not Just Support the Business Anymore

IT has become the platform of business; it makes e-business possible. Marilyn Parker, Bob Benson, and Ed Trainor² have pointed out that IT can serve lines of business in two ways. As shown in Figure 8, one is by supporting current or planned operations, which they call "alignment." The second is by using systems to influence future ways of working, which they call "impact." To fulfill this second role, IS needs to get ahead of the business to demonstrate IT-based possibilities. At the very least, IS and the business need to strategize together, not follow the old model of business first, IS second.

Top Management May Not Know Best

When change occurs rapidly and when top management is distant from the front lines of the business (i.e., those interacting with customers, partners, and suppliers), having strategy formulated by top management limits it to what these few members of the firm can distill. Today's trend of customizing products and services to smaller and smaller niche markets, even to markets of one, requires diversity in strategy making. It may be best performed by those closest to customers—if not customers themselves—because they know their local environment. Hence, the former inside-out approach to strategy making needs to be shifted to be outside-in, as illustrated in Figure 3.

An Organization Is Not Like an Army

Industrial-era planning implicitly viewed companies as an army: Top management edicts rippled down through the organization to be implemented by the troops on the front line who dealt with customers. This metaphor is not holding true. Take, for example, the business process reengineering failures of the early 1990s. Executives learned

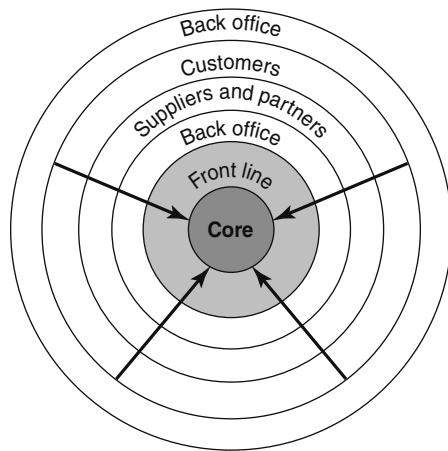


FIGURE 3 Outside-In Strategy Development

Source: Adapted from and reprinted with permission from Roger Woolfe, Barbara McNurlin, and Phil Taylor, *Tactical Strategy*, Wentworth Research Program (now part of Gartner EXP, 56 Top Gallant, Stamford, CT 06904), November 1999.

that their mandates to institute major changes in business processes, imposed from the top, often ended in disaster. Not only did the projects fail, but they ate up resources, burned out employees, created animosity, and even destroyed valuable company knowledge assets because experienced employees left.

A socio-biological view of information systems is to see systems as living entities that evolve, with self-interest, capable of mutation. They are not commanded; they can only be nurtured or tended. Means should be given to these entities so that they can improve themselves and their world. This new paradigm, if believed, obviously requires a different form of leadership, one that cultivates a context for knowledge to lead to innovations. Many futurists see the sense-and-respond approach as the “next big thing” to community-wide quality improvement.

Today's Sense-and-Respond Approach to IT Planning

If yesterday's assumptions no longer hold true, thus making yesterday's approach to strategy making less effective, what is appearing to take its place? The answer is a kind of sense-and-respond strategy making, as reported in Gartner EXP's Tactical Strategy Report.^{1a}

Let Strategies Unfold Rather Than Plan Them

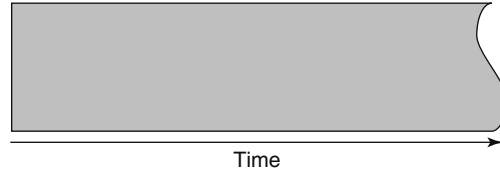
In the past, top management took the time to articulate one enterprise-wide strategy. In times of rapid change and uncertainty about the future, such as we are now experiencing, this approach is risky. If a bet proves wrong, it could be disastrous.

When predictions are risky, the way to move into the future is step by step, using a sense-and-respond approach. It means sensing a new opportunity or possibility and quickly responding by testing it via an experiment. The result is a myriad of small experiments going on in parallel, each testing its own hypothesis of the future, as illustrated in Figure 4.

A company that illustrates this sense-and-respond approach to developing strategy in the Internet space is Microsoft, say Shona Brown and Kathy Eisenhardt in their book, *Competing on the Edge: Strategy as Structured Chaos*.³

Strategic Information Systems Planning

Old-era strategy:
One big choice, long commitment



New-era strategy:
Many small choices, short commitments

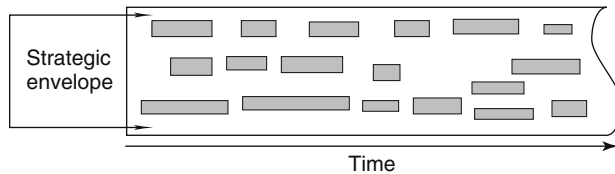


FIGURE 4 Sense-and-Respond Strategy Making

Source: Reprinted with permission from Roger Woolfe, Barbara McNurlin, and Phil Taylor, *Tactical Strategy*, Wentworth Research Program (now part of Gartner EXP, 56 Top Gallant, Stamford, CT 06904), November 1999.

CASE EXAMPLE

MICROSOFT

www.microsoft.com

Microsoft, the software giant in Redmond, Washington, has taken a sense-and-respond approach to creating its Internet strategy. Throughout its history, Microsoft has been slow to embrace some of the computer industry's most significant technology shifts and business chances. To adopt innovation, the company has often succeeded in using its financial might to acquire successful leaders (e.g., Lotus Development Corp. for office automation and Netscape Communications Corps for Web browsers). Microsoft moved on to buying Internet companies, aligning with Sun to promote Java (and create a proprietary version

of Java), and even forging an alliance with AOL. This catch-up-and-strive approach has worked rather successfully for Microsoft.

Over time, the software giant moved into a variety of technologies:

- BASIC programming language for PC
- MS-DOS (Microsoft Disk Operating System)
- MS Mouse
- MS Word
- MS Windows
- MS Office

(Case Continued)

- Internet Explorer
- MSN Web Portal and ISP (Internet Service Provider)
- Visual BASIC
- MS Windows XP
- MS Business Solutions (Financial Management, CRM, SCM)
- Tablet PC
- Windows Mobile OS
- Visual Studio .Net Enterprise Developer
- Xbox 360 and the multiplayer broadband gaming service, Xbox Live
- Vista Operating System

In parallel with these core products, Microsoft diversifies in a number of related sectors, to include:

Web-only magazine, Slate, Web News site with NBC, Cable news channel with NBA, digital movie production via Dreamworks, mobile application, .NET platform for Web Services, and search engines to compete with Google. As the company celebrates its 30th year anniversary, it is moving even more to applications areas (e.g., healthcare) while continuing to explore new software technologies (e.g., multi-core programming technology called “F-Sharp” to manage massive server computers).

Bill Gates has made defining announcements, to be sure, focusing the company on the Internet, security, and

Web Services. Each announcement has fostered even more explorations. However, the strategies have not always come from top management. The company’s first server came from a rebel working on an unofficial project. In addition, management mistakenly passed up some cheap acquisitions that later cost them much more via licensing agreements. Some of these moves could have been predicted, but others are surprising. In short, Microsoft has been sensing and responding to the moves in several industries, getting its fingers into every pie that might become important. Craig Mundle, Microsoft’s chief research-and-strategy officer, is designated to replace Bill Gates, who relinquishes his chairmanship in 2008, as the new long-term strategic thinker. In his quest to position the company in the post-Gates era, Mundle flies around the globe, nurturing dialogues with employees working at far-flung research facilities. He seeks to change the company culture so Microsoft no longer is missing on emerging technologies and businesses. He travels around the world to hear the opinions from entities whose work might be overlooked by top product executives who set the agenda. In a report to the *Wall Street Journal* (July 30, 2007), Mr. Mundle wants Microsoft units to constantly search for innovation: “This is something that should be stuck in the face of the people who still think this is science fiction.” ■

Formulate Strategy Closest to the Action

The major change introduced by the Internet is faster communication, not only within organizations but, more importantly, with others—customers, suppliers, and partners. Aligning corporate strategy with the marketplace in fast-paced times requires staying

in close contact with that marketplace. Hence, strategy development needs to take place at these organizational edges, with the people who interact daily with outsiders.

Furthermore, employees who are closest to the future should become prime strategizers as well. Today, this means including younger employees because they have grown up in an era of the Internet, PDAS, and cell phones. They take all three for granted; they wear them like clothing. One company that is taking this premise of downside-up strategizing to heart is Skandia Future Centers.^{1a}

CASE EXAMPLE

SKANDIA FUTURE CENTERS

www.skandia.com

Skandia Future Centers (SFC), located in Stockholm, Sweden, is an incubator for testing ideas on IT, social relationships, and networking for the Skandia Group, the 150-year old giant Swedish financial services company. The center acts as an inspirer and advisor to those who do the strategy making within Skandia.

The center was created in 1996 by Leif Edvinsson to give Skandia a laboratory to break out of its current ways of thinking and to provide a place where different generations can collaborate on on-the-edge projects. The mission is to explore five key driving forces of the business environment: the European insurance market, demographics, technology the world economy, and organization and leadership. The goal is to devise a vision of the company's future.

3-Generation Teams

One of the first concepts used at the center was 3G teams, getting three generations (25+, 35+, 45+) to work together. The teams were part-time and cross-cultural; coming from Venezuela, Germany, Sweden, and the United States. The

participants were chosen by peers as well as nominated from different parts of the company.

To get the generations to actually talk to each other, their mandate was to focus on questions rather than answers. "When you ask for answers, you get a debate. When you focus on questions, you get a dialog," says Edvinsson.

Based on their questions, participants arrived at a number of interesting contexts for the questions, such as the evolution of the financial community around the world and the evolution of IT. These contexts were presented to 150 Skandia senior executives, not through a report, but through scenarios of these five future environments performed by professional actors in a theater play.

Knowledge Café

The play led to the first knowledge café among the 150 executives. The café was created by one of the 3G teams and a few of the executives. At the café, the 150 gathered for one hour around stand-up tables at different Skandia sites. Each table had coffee and a laptop loaded with

(Case Continued)

groupware software from Ventana Software. During the hour, they discussed the questions presented in the play through anonymous entries. The discussion was spiked by the drama they had seen, then nourished and cultivated through the exchange.

The entire project was videotaped and sent to a larger community, along with the questions and a video of the play and the café. The goal of this project was to show the power of collective intelligence. The knowledge café accelerated innovation at Skandia, transforming it into an innovation company. The effect has been demonstrated by Skandia's growth, to become a global innovative financial service company.

Nurturing the Project Portfolio

Edvinsson thinks of the center as a garden, where some of the projects are growing and some are not. He tends them by looking at the level of interest surrounding each one and at the progress each has made, which he equates with gardening.

Ten years after the creation of the center, the head of the FSC was appointed as Chair Professor of Intellectual Capital at the University of Lund, Sweden. Looking at the future, Edvinsson reckons that the success of the firm of the future lies in its ability to create intangible value creation, through intense exchange of knowledge at the global scale. ■

Guide Strategy Making with a Strategic Envelope

Having a myriad of potential corporate strategies being tested in parallel could lead to anarchy without a central guiding mechanism. That mechanism is a strategic envelope, as shown in Figure 4. Creating and maintaining this envelope is the job of top management. Rather than devise strategy, they define its context by setting the parameters for the experiments (the strategic envelope) and then continually manage that context. Thus, they need to meet often to discuss the shifts in the marketplace, how well each of the experiments is proceeding, and whether one is gaining followership or showing waning interest.

They may perform this work by defining a territory, as Microsoft did. Or they may hold strategic conversations, as espoused by Brown and Eisenhardt.³ A strategic conversation is a regular, frequent meeting at which executives share the workload of monitoring the business environment and responding to it. Perhaps the vice president of operations might be charged with reporting on "today," such as the size of the company's mobile workforce. The emerging technologies director might be charged with reporting on "tomorrow," such as recent developments in Web Services or mobile or fixed wireless services. The HR vice president might be the team's eyes and ears on outsourcing. The purposes of each meeting are to stay in tempo with the marketplace (which may mean setting new priorities), spot trends in their infancy, launch new projects, add resources to promising ones, cut funding for others, and so forth.

Another way to create a strategic envelope is to meet regularly with the experimenters, as in the case of Shell Oil, described by Richard Pascale in an issue of *Sloan Management Review*.⁴

CASE EXAMPLE

SHELL OIL

www.shell.com

Steve Miller, then incoming general manager of oil products at Royal Dutch/Shell Group, believed change would only occur if he went directly to his front lines—employees at Shell gas stations around the world. He felt he had to reach around the middle of the company to tap the ingenuity of frontline employees at the gas stations, encouraging them to devise strategies that were best for their local markets.

He set aside 50 percent of his own time for this work and required his direct reports to do the same. His goal was not to drive strategy from corporate, as had been tried and failed, but to interact directly with the grass roots and support their new initiatives, thus overwhelming the old order in the middle of the company.

Action Labs. His technique was to use action labs. He invited six teams, each with six to eight people from gas stations in one country, to a week-long “retailing boot camp” at which they learned how to identify local opportunities and capitalize on them. The teams were then sent home for 60 days, each to develop a proposal of how to double their net income or triple their market share.

The following week, a fresh set of six teams came to headquarters.

After 60 days, the first six teams returned for a “peer challenge” at which they critiqued each others plans. They then returned home for another 60 days to hone their plans for the third action lab: approval or disapproval.

At this third lab, each team took turns sitting in “the hot seat” facing Miller and his direct reports, who grilled them for three hours on their plan. The teams, in turn, described what they needed from Miller as the other teams watched. The plans were approved, denied, or modified. If funded, the promised results were factored into an operating company’s goals. The teams then had 60 days to implement their plans, after which they would return for a fourth session with Miller and his reports.

The Results. These action labs had a powerful effect. They caused stress on Shell’s way of doing business, in effect, unfreezing the status quo. The corporate middle, which had not formerly seen good results from corporate efforts, saw solid plans and energized subordinates. In turn, they became energized. In addition, the labs led to much more informal communications up, down, and across Shell. The teams, for instance, felt comfortable calling up Miller and his staff—a significant departure from the past.

The labs also affected the way Miller and his staff made decisions. In the labs, these executives had to make on-the-spot decisions in front of the frontline teams rather than behind closed doors. They found they had to be consistent and straight with the teams. It was a difficult and trying experience for all, but humanizing for the teams.

(Case Continued)

In the various countries, “guerilla leaders” emerged and initiated innovative experiments. One, for example, was “the soft drink challenge.” Whenever a customer was not offered the full gamut of services at a Malaysian gas station, they received a free soft drink. The result: a 15 percent increase in business.

The projects spawned many more projects, and Miller learned that small local projects can have large effects. The focus was to tap the intelligence at the front lines, with controls and rewards supporting that goal. “We’re not going to tell you what to do. Pick a big-ticket business challenge you don’t know how to solve. Let’s see if we can do things a little differently,” told Miller to teams from Malaysia, Chile, Brazil, South Africa, Austria, France and Norway.

Formerly, top management had the illusion of being in control via their directives. Through the action labs, they

learned as their staff learned, they received much more feedback, and they knew far more about their customers and the marketplace. Guidance and nurturing came from the top, so there was not complete chaos. In fact, Miller believes the key is to get the right tension between chaos (at the team level) and order (at the managing director level). He sees it as treating the company as if it were a living system. Having retired from Shell, Miller reflects on his experience at Shell: “Top-down strategies don’t win many ball games today. Experimentation, rapid learning, seizing the momentum of success works better. The leader becomes the context setter, the designer of a learning experience, not an authority figure with solutions. Once the folks at the grassroots realize they own the problem, they also discover that they can help create the answer.” ■

Be at the Table

As noted earlier, IS executives have not always been involved in business strategizing. That situation is untenable today because IT is intrinsic to business. However, to have a rightful place in the strategizing process, the IS function needs to be strategy oriented. Many have been tactical and operational, reacting to strategies formulated by the business. To become strategy oriented, CIOs must first make their departments credible, and second, outsource most operational work to release remaining staff to help their business partners strategize and experiment.

Test the Future

To get a running start, as well as contribute ideas about the future, IS departments need to test potential futures before the business is ready for them. One mechanism for testing the future is to provide funding for experiments. Another is to work with research organizations. Yet another is to have an emerging technologies group.

Put the Infrastructure in Place

Internet commerce requires having the right IT infrastructure in place. Hence, the most critical IT decisions are infrastructure decisions. Roger Woolfe and his

colleagues^{1a} recommend that IT experiments include those that test painful infrastructure issues, such as how to create and maintain common, consistent data definitions; how to create and instill mobile commerce standards among handheld devices; how to implement e-commerce security and privacy measures; and how to determine operational platforms, such as ERP and SCM.

Experimentation is the new sense-and-respond approach to IS strategy making. It differs markedly from the traditional planning described at the outset of this chapter. In fact, it represents a revolution in planning. The following section describes some tools and approaches that can be used to both focus and broaden thinking during planning and strategy making.

EIGHT PLANNING TECHNIQUES

Due to the importance and the difficulty of systems planning, it is valuable to use a framework or methodology. Over the years, a number of techniques have been proposed to help IS executives do a better job of planning. The seven presented here take different views of IS planning, including looking at the assimilation of IT in organizations, defining information needs, understanding the competitive market, categorizing applications into a portfolio, mapping relationships, and surmising about the future. The eight planning techniques discussed are:

1. Stages of growth
2. Critical success factors
3. Competitive forces model
4. Three emerging forces
5. Value chain analysis
6. Internet value matrix
7. Linkage analysis planning
8. Scenario planning

Stages of Growth

Richard Nolan and Chuck Gibson⁵ observed that many organizations go through four stages in the introduction and assimilation of a new technology.

- **Stage 1: Early Successes.** The first stage is the beginning use of a new technology. Although stumbling occurs, early successes lead to increased interest and experimentation.
- **Stage 2: Contagion.** Based on the early successes, interest grows rapidly as new products and/or services based on the technology come to the marketplace. They are tried out in a variety of applications; growth is uncontrolled and therefore rises rapidly. This proliferation stage is the learning period for the field, both for uses and for new products and services.
- **Stage 3: Control.** Eventually it becomes apparent that the proliferation must be controlled. Management begins to believe the costs of using the new technology are too high and the variety of approaches generates waste. The integration of systems is attempted but proves difficult, and suppliers begin efforts toward standardization.

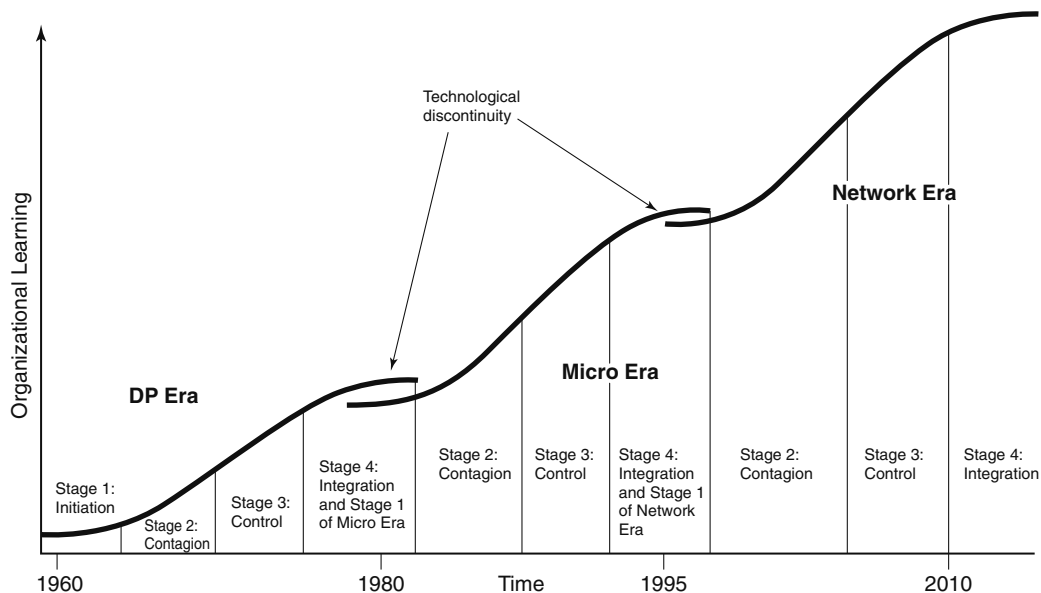
- **Stage 4: Integration.** At this stage, the use of the particular new technology might be considered mature. The dominant design of the technology has been mastered, setting the stage for newer technologies, wherein the pattern is repeated. An organization can be in several stages simultaneously for different technologies.

Nolan has since used the Stages of Growth theory to describe three eras, as shown in Figure 5.⁶ Underlying the three organizational learning curves pictured is the dominant design of each era. The DP (Data Processing) Era's dominant design was the mainframe, the Micro Era's design was the PC, and the Network Era's is the Internet. The eras overlap each other slightly at points of "technological discontinuity," states Nolan, which occur when proponents of the proven old dominant design struggle with the proponents of alternative new and unproven designs. Inevitably, one new dominant design wins out.

The importance of the theory to IS management is in understanding where a technology or a company currently resides on the organizational learning curve. If, for example, use of Web Services is in the trial-and-error Stage 2, where experimentation and learning take place, then exerting too much control too soon can kill off important new uses of the technology. Management needs to tolerate, even encourage, experimentation.

Because the management principles differ from one stage to another, and because different technologies are in different stages at any point in time, the Stages of Growth model continues to be an important aid to the systems planning process.

FIGURE 5 Stages of Growth



Source: Reprinted with permission from R. L. Nolan, "Information Technology Management from 1960–2000," in *A Nation Transformed by Information*, Alfred D. Chandler and James W. Cortad (eds.), Oxford, 2000.

Critical Success Factors

In 1977, Jack Rockart⁷ and his colleagues at the Center for Information Systems Research (CISR), Sloan School of Management, at the Massachusetts Institute of Technology (MIT), began developing a method for defining executive information needs. The result of their work is the Critical Success Factors (CSF) method. It focuses on individual managers and their current information needs, whether factual or opinion information. The CSF method has become a popular planning approach and can be used to help companies identify information systems they need to develop.

For each executive, critical success factors (CSFs) are the few key areas of the job where things must go right for the organization to flourish. Executives usually have fewer than 10 of these factors that they each should monitor. Furthermore, CSFs are both time sensitive and time dependent, so they should be reexamined as often as necessary to keep abreast of the current business climate. These key areas should receive constant attention from executives, yet CISR research found that most managers had not explicitly identified these crucial factors.

Rockart finds four sources for these factors. One source is the industry that the business is in. Each industry has CSFs relevant to any company in it. A second source is the company itself and its situation within the industry. Actions by a few large, dominant companies in an industry most likely provide one or more CSFs for small companies in that industry. Furthermore, several companies may have the same CSFs but, at the same time, have different priorities for those factors.

A third source of CSFs is the environment, such as consumer trends, the economy, and political factors of the country (or countries) in which the company operates. A prime example is that prior to, say, 1998, few chief executives would have listed “leveraging the Internet” as a CSF. Today, most do.

The fourth source is temporal organizational factors, or areas of company activity that normally do not warrant concern but are currently unacceptable and need attention. A case of far too much or far too little inventory might qualify as a CSF for a short time.

In addition to these four sources, Rockart has found two types of CSFs. One he calls monitoring, or keeping abreast of ongoing operations. The second he calls building, which involves tracking the progress of “programs for change” initiated by the executive. The higher an executive is in the organization, the more building CSFs are usually on his or her list.

One way to use the CSF method is to use current corporate objectives and goals to determine which factors are critical for accomplishing the objectives, along with two or three prime measures for each factor. Discovering the measures is time consuming. Some measures use hard, factual data; they are the ones most quickly identified. Others use softer measures, such as opinions, perceptions, and hunches; these measures take more analysis to uncover their appropriate sources. CSFs vary from organization to organization, from time period to time period, and from executive to executive. IS plans can then be developed based on these CSFs.

Competitive Forces Model

The most widely quoted framework for thinking about the strategic use of IT is the competitive forces model proposed by Michael Porter⁸ of the Harvard Business School, in his book *Competitive Strategy*. Porter believes companies must contend with five competitive forces, as shown in Figure 6.

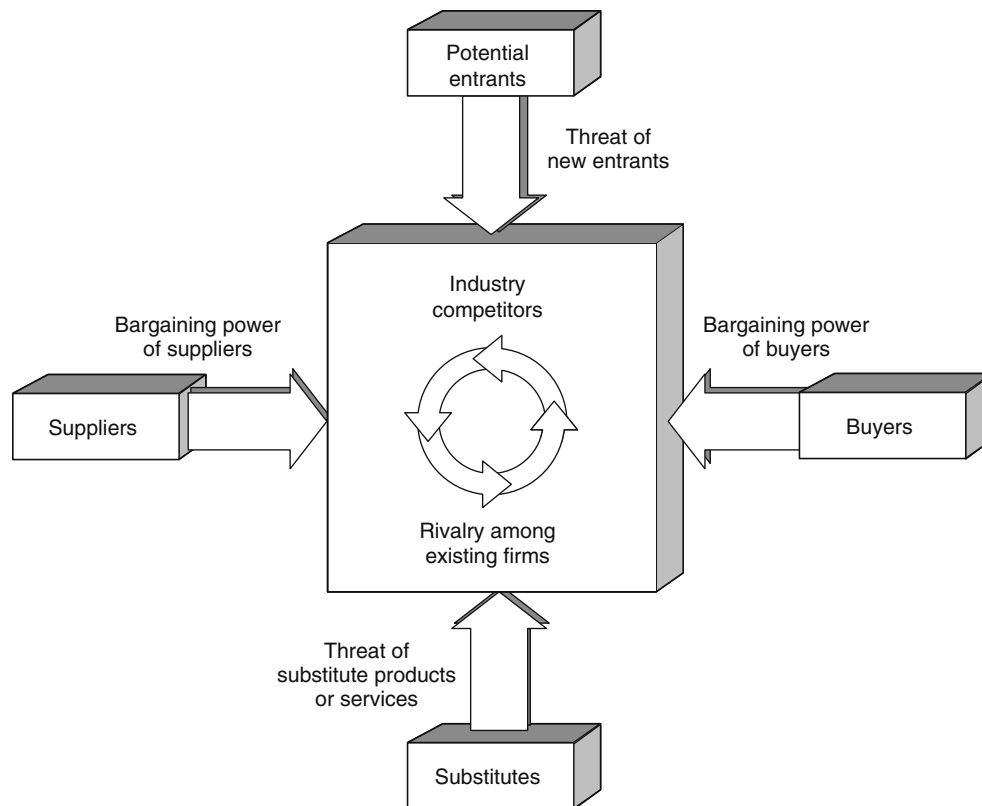


FIGURE 6 Michael Porter's Competitive Analysis Model

Source: Michael E. Porter, "The Five Competitive Forces That Shape Strategy," *Harvard Business Review*, January 2008.

One force is the threat of new entrants into one's industry. For instance, the Internet has opened up a new channel of marketing and distribution, which, in turn, has allowed all kinds of unexpected new entrants into numerous markets. Travel Web sites, for example, are threats to travel agencies.

The second force is the bargaining power of buyers. Buyers seek lower prices and bargain for higher quality. Web-based auction sites, shopping bots, and intelligent agents are all giving buyers more shopping options and more information about potential suppliers, thus increasing their bargaining power. In fact, much of the power of the Internet has to do with this force.

A third force is the bargaining power of suppliers. For example, the Internet enables small companies to compete against large ones in uncovering requests for bids and bidding on them—leveling the playing field.

The fourth force is substitute products or services. The Internet provides a myriad of examples here. E-mail is a substitute for paper mail. Music downloads are substitutes for CDs. Book and music Web sites are substitutes for book and music stores.

The fifth force is the intensity of rivalry among competitors. IT-based alliances can change rivalries by, for instance, extending them into value-chain-versus-value-chain competition rather than just company-versus-company competition.

Porter presents three strategies for dealing with these competitive forces. His first is to differentiate products and services. By making them different—that is, better in the eyes of customers—firms may be able to charge higher prices or perhaps deter customers from moving to another product, lower the bargaining power of buyers, and so on. It is probably the most popular of his three strategies.

Porter's second strategy is to be the lowest-cost producer. He warns that simply being one of the low-cost producers is not enough. Not being the lowest causes a company to be stuck in the middle, with no real competitive advantage.

His third strategy is to find a niche, such as focusing on a segment of a product line or a geographical market. Companies that use this strategy can often serve their target market effectively and efficiently, at times being both the low-cost producer and having a highly differentiated product as well.

This framework guides IS planning because all five forces and all three strategies can be enabled by or implemented by technology. Once management analyzes the forces and determines company strategy, the necessary information systems can be included in the plan. In a widely referenced 2001 article in the *Harvard Business Review*, Porter⁹ analyzes the Internet using this framework. Here are his main points.

FRAMEWORK EXAMPLE

FIVE FORCES ANALYSIS OF THE INTERNET

In the main, the Internet tends to dampen the profitability of industries and reduce firms' ability to create sustainable operational advantages, argues Michael Porter, because it has "a leveling effect on business practices." He reaches this sobering conclusion by looking at the effect the Internet can have on industry profitability using his five forces framework.⁸ Here are his points.

The Bargaining Power of Buyers Increases.

On the demand side of the value chain, the Internet opens up new channels for

companies to deal directly with customers, rather than through intermediaries. Thus, the Internet can decrease the bargaining power of the other channels and their intermediaries, thereby potentially increasing profitability.

However, the Internet gives buyers more information, both about competitors and products, strengthening their bargaining power and lowering industry profitability. The Internet can also decrease switching costs—the cost a buyer pays to switch from buying from one firm to buying from someone else.

(Case Continued)

This also increases buyer bargaining power. In total, the increase in buyer bargaining power decreases industry profitability.

Barriers to Entry Decrease. Due to the Internet's new channel to buyers, industries may not be so reliant on building up sales forces to sell their goods, making it easier for others to enter the industry because they can compete without having these high fixed costs. Furthermore, location need not be as much of a limiting factor. Small companies can sell to the world via a Web site.

On the other hand, network effects, which increase barriers to entry, are difficult to garner, argues Porter. A network effect occurs when the value of a product or service increases as the number of users increases. eBay illustrates this effect: the more buyers, the more eBay is a desirable marketplace for sellers. And the more sellers, the more eBay attracts buyers.

It is a virtuous circle. However, Porter argues that a self-limiting mechanism is at work. A company first attracts customers whose needs it meets well. The needs of later customers may be less well met—presenting an opening for other competitors. Thus, the network effect limits itself. Yet, where it exists, it presents a formidable barrier to entry.

The Bargaining Power of Suppliers Increases. On the supply side, the Internet can make it far easier for a company to purchase goods and services, which reduces the bargaining power of suppliers. This trend would seem to increase industry profitability. But, at the same time, suppliers can more easily expand their market, finding new customers, thereby increasing supplier

bargaining power. Lower barriers to entry also erode the former advantage of a company over its suppliers.

Electronic exchanges, which expand marketplaces, can benefit both buyers and suppliers. However, they can reduce the leverage of former intermediaries between suppliers and end users. This decrease gives companies new competitors (their former suppliers), which can reduce industry profitability.

Finally, in giving equal access to all suppliers, the Internet tends to diminish differentiation among competitors—again reducing industry profitability.

The Threat of Substitute Products and Services Increases. An industry can increase its efficiency by using the Internet, thereby expanding its market and improving its position over substitutes. For example, online auctions can decrease the power of classified ads and physical marketplaces because the online auctions may be more convenient to buyers. Online exchanges, especially those with many buyers and sellers, can thus discourage substitutes.

On the other hand, the Internet has opened up entirely new ways to meet customer needs. Thus, the threat of substitutes can increase significantly, probably greater than its ability to ward them off through increased efficiencies.

Rivalry Among Competitors Intensifies. Proprietary offerings are more difficult to sustain in the Internet's open-system environment, states Porter, because products and services are easier to duplicate. Hence, there can be more intense rivalry among competitors. Furthermore, due to the Internet's global nature, companies can extend their range of

(Case Continued)

competition, so there can be more competitors in a marketplace.

Also, the Internet can change the cost structure, emphasizing fixed costs (Web sites rather than call centers, for example) and reducing variable costs (serving one more customer can be much less expensive via a Web site rather than a call center). This change in cost structure can lead companies to compete on price (which hurts industry profitability) rather than on convenience, customization, specialization, quality, and service (all of which can increase industry profitability).

Even partnering with complementary products and services, while seeming to increase a market, may instead decrease profitability if it leads to standardized offerings. Microsoft's operating systems has had that effect on the PC industry. The industry now competes on price; its profitability has decreased.

Outsourcing, another form of partnering, can also depress industry profitability if the companies outsource to the same providers and their products thereby become more alike.

Overall, states Porter, the Internet tends to decrease industry profitability. But not all industries need to see this happen to them. It depends on how their companies react. They can react destructively by competing on price or compete constructively by competing on differentiating factors. It will be harder for them to distinguish themselves on operational efficiencies alone because the Internet can make duplication easier. Instead, firms should focus on their strategic position in an industry and how they will maintain profitability (not growth, market share, or revenue). Success depends on offering distinct value. ■

Beyond Porter—Downes' Three Emerging Forces

Porter's Five Forces Analysis is strongly rooted in applied microeconomics, taking into consideration the theories of supply and demand, production theory, and market structures. Developed late in the 1970s, the model reflects an era of strong competition with rather predictable developments. Larry Downes,¹⁰ of UC Berkeley, argues that the "new" economy needs to be considered in the analysis. The "old" economy looked at IT as a tool for implementing change. In the new economy, technology has become the most important driver of change. Focusing on the critical role of IT, Downes suggests three new forces:

- 1. Digitalization:** As technological innovation is accelerating new business models continue to emerge, disrupting the basis of competition in a market. With its online bookstore supported by a computer networked-supported supply chain, Amazon.com did dramatically change the bookstore market, forcing Barnes and Nobles to alter its century-old business. Skype is another example of using a new technology (VoIP) to disrupt the telecommunications industry. Apple's 99-cent iTunes songs has contributed to the exit of Tower Records. Downes recommends

that those who use Porter's Five Forces model should think beyond today's industry structure, and embrace digital technologies as their key strategic tools.

- 2. Globalization:** Cheaper telecommunications costs and faster transportation logistics make it possible for companies—large and small—to conduct cross-border trade. Outsourcing is now offshoring. Market dimension is no longer local but global. A local travel agent who does not do import-export himself is indirectly affected by Travelocity.com or Expedia.com. In addition to the quality and pricing strategies, analysts should look at the network effect at the global scale. A firm could achieve significant considerable competitive advantages if it can reach far-reaching networks of partners for mutual benefits. Sabre Holdings is a good example of using Travelocity.com to partner with similar online reservation systems around the globe.
- 3. Deregulation:** Under the auspices of the World Trade Organization (WTO), governmental influence on trade has diminished in many industries—telecommunications, banking, transportation, and utilities. Local monopolies are losing their market power. Thanks to IT and a deregulated market, geographically remote firms can impose anytime, anywhere presence, therefore forcing local businesses to revisit their strategy.

If anything, Downes' three forces should remind us that any strategy planning in the new economy is going to be less stable, less predictable, and more complex. In the information economy, certain products do defy the old theory of price elasticity. How can one estimate the demand of an iTunes song that is sold for a small and unique price of 99 cents? Likewise, Amazon.com sells digital books in a condensed version and in Acrobat's PDF format for 49 cents. The price is small and unique. There must be other factors that drive demand other than price for these microproducts, such as reputation or instant gratification.

If Porter's model was developed in the 1970s and popularized in the 1980s, and Downes formulated his digital strategies in the 1990s, the three emerging forces do mirror the context of this era. One should, however, expect that with the rapid rate of globalization and deregulation, the impact of these two forces will somehow fade away in the future. However, less can be said about the digitization trend.

Value Chain Analysis

Five years after proposing the Five Forces Model in 1980, Porter presented the value chain in *Competitive Advantage* in 1985; it, too, became a popular strategic planning tool. As shown in Figure 7, a value chain for a product or service consists of major activities that add value during its creation, development, sale, and after-sale service. According to Porter, primary activities and support activities take place in every value chain.

The five primary activities deal with creating a product or service, getting it to buyers, and servicing it afterward. These activities form the sequence of the value chain:

- 1. Inbound logistics:** Receive and handle inputs
- 2. Operations:** Convert inputs to the product or service
- 3. Outbound logistics:** Collect, store, and distribute the product or service to buyers
- 4. Marketing and sales:** Provide incentive to buyers to buy the product or service
- 5. Service:** Enhance or maintain the value of the product or service

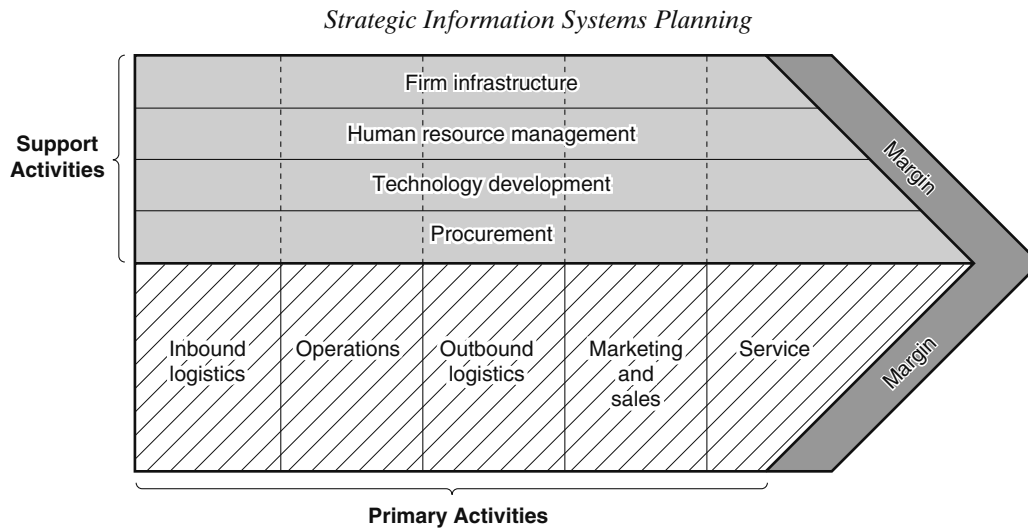


FIGURE 7 The Value Chain

Source: Michael E. Porter, *Competitive Advantage* (New York: The Free Press, 1985).

The four supporting activities underlie the entire value chain:

1. Organizational infrastructure
2. HR management
3. Technology development
4. Procurement

By studying how a firm performs the primary and support activities for a product or service, a firm can explore how it might add more value at every activity. Alternatively, it could determine where another company could add more value, and team up with that firm, outsourcing that activity to that partner.

Virtual Value Chains

Jeff Rayport and John Sviokla¹¹ distinguish between marketplaces, where physical products and physical location are important, and marketspaces, where information substitutes for physical products and physical location. In the world of Internet commerce, they ask, "How can companies create value in marketpace?" or "How can they create value in marketpace and marketplace concurrently, leveraging off each other?" They draw on Porter's value chain in their answer.

In the traditional value chain, companies treat information as a support element, not as a source of value itself. To compete in marketpace, companies need to use information to create new value for customers (such as FedEx and UPS did in opening up their tracking systems to consumers via their Web sites). Creating value in the marketpace also involves a value chain, but it is a virtual value chain, because the steps are performed with information and through information. At every step, value via information can be added in five ways: gather it, organize it, select it, synthesize it, or distribute it. The IS organization should therefore play a major role in marketpace.

Making operations visible. Firms seem to follow an evolution in using information to add value: first by making operations visible, then by putting in place mirroring capabilities, and finally by creating space-based customer relationships. Companies first create ways to see their physical operations through information. That is, they foster visibility of operations, generally through their production systems, allowing employees to coordinate activities across the physical value chain, sometimes in ways that lead to competitive advantage. Frito-Lay's field employees input information on store-by-store sales as well as information about competitors' promotions and new competitive products. With all this field data, managers can better schedule production to match demand, route trucks most efficiently, and tailor promotions to suit local buying patterns. Frito-Lay can more quickly react to marketplace changes. Visible flows of information lay the foundation for a virtual value chain.

Mirroring capabilities. Second, companies begin to substitute virtual activities for physical ones. Here is a case in point from a report by Roger Woolfe.^{1b}

CASE EXAMPLE

AN AUTOMOBILE MANUFACTURER

This auto manufacturer has dealerships around the United States. Many of the dealerships have satellite dishes, as do headquarters. In addition to other uses, these dishes are used by the manufacturer's rental car subsidiary to auction off good, clean used vehicles (with fewer than 10,000 miles) to dealers to sell.

For 30 minutes at a specified time, an auctioneer is able to sell 60 vehicles online. As a car comes up for bid, the dealers view it on a monitor at their premises. They can see it from several directions, read its ratings (on cleanliness and condition), and use a mouse to bid

against the other dealers online. Headquarters staff monitors the progress of the auction and advises the auctioneer on, say, lowering minimum bids to ensure that every vehicle is sold. The auctions are held once or twice a month.

The dealers have been extremely satisfied with this system because it saves them from having to travel to auctions, and they can get good-quality used cars without much effort. In addition, the manufacturer guarantees satisfaction. If, after taking delivery of a vehicle, the dealer decides he does not want it, he can send it back. ■

Another example is virtual worldwide teams, such as design teams in the United States, Europe, and Asia that work on designs and prototypes in a virtual information space. Time and space are no longer limitations. The teams can be located anywhere, work can progress 24 hours a day, and many more virtual designs can be created and

tested in a shorter time and for less cost than in the physical world. This mirroring of capabilities, note Rayport and Sviokla, marks the beginning of creating a parallel virtual value chain.

Space-based customer relationships. Third, companies draw on their flow of information to deliver value to customers in new ways. In essence, they create new space-based customer relationships. USAA, the insurance company for military officers, exemplifies this third step, note Rayport and Sviokla. For many years, USAA collected information about customers and made it available company-wide so that employees could provide advice and answer questions anytime a customer called (visibility). The company then discovered it could create customer risk profiles and customize policies. From that point, it created new product lines, such as insurance for boat owners (mirroring capabilities). From there, USAA expanded to new areas, such as offering financing to boat purchasers. In fact, it even offers to replace stolen items in a theft claim, rather than send the insured a check, a service many seem to prefer. USAA is managing its information to create new value for customers.

When searching for strategic uses of information, Rayport and Sviokla point out that many of the rules differ from those of the physical marketplace. Digital assets are not used up in consumption; therefore information can be reused in many forms at a low cost. New economies of scale are present, so small companies can effectively compete against large ones, due to lower overhead, while still covering large geographic areas. New economies of scope allow insurance companies to offer financing and even discount buying programs to policyholders, as USAA is doing, for example. Finally, transaction costs are lower in market space; thus, companies can capture information that they were not able to capture in the past, as Frito-Lay is doing.

To take advantage of these four changes, though, a significant mind shift is required from supply-side thinking to demand-side thinking. That is, companies need to sense and respond to needs rather than make and sell products and services. That shift appears to be a significant strategic opportunity for companies, and IS should play a role in identifying and helping the company take advantage of it.

E-Business Value Matrix

It can be difficult for executives to prioritize projects, said Peter Alexander,¹² because of the wealth of opportunities. Alexander describes a portfolio planning technique used at Cisco to ensure it develops a well-rounded portfolio of Internet-centric IT projects. The approach is further described in Hartman et al.'s *Net Ready*.¹³

A portfolio management approach is of great value to senior and functional executives to ensure that they are working on a broad front that will lead to success in the Internet economy.

The portfolio management approach Cisco uses is called the e-business value matrix, and every IT project is meant to be placed in one of four categories to assess its value to the company. As shown in Figure 8, the value of each project is assessed as high or low in two categories: criticality to the business and newness of the idea (newness not just to the company, but to the world). The result is four categories of projects: new fundamentals, operational excellence, rational experimentation, and break-through strategy.

	CRITICALITY TO BUSINESS	NEWNESS OF IDEA
New fundamentals	Low	Low
Operational excellence	High	Low
Rational experimentation	Low	High
Breakthrough strategy	High	High

FIGURE 8 E-Business Value Matrix

Source: Adapted from a speech by Peter Alexander and *Net Ready: Strategies for Success in the E-economy* by Amir Hartman, John Sifonis, and John Kador (New York: McGraw-Hill, 2000).

New Fundamentals

These projects provide a fundamentally new way of working in overhead areas, not business-critical areas. They are low risk and focus on increasing productivity. They can provide significant cost savings by measurably improving operations. An example is Web-based expense reporting, described in the Cisco case example on pages 157–159.

These projects should be managed as quick hits: Implement a project to increase productivity in finance within three to six months, said Alexander, then move on to another area. Often, such projects can be implemented by IS with little user involvement during development. However, an important point to remember is that these systems aim at the grass roots of the company. Thus, they can lead to a cultural shift, such as shifting to working via an intranet.

Operational Excellence

These projects are of medium risk because they may involve reengineering work processes. They do not aim for immediate returns, but rather intend to increase such areas as customer satisfaction and corporate agility. In essence, they revolve around providing faster access to information. These projects can be important in improving IS credibility because of their high visibility. An example is an executive dashboard for quickly viewing operational metrics. Such a system is highly visible to executives.

These projects have about a 12-month horizon. They should involve cross-functional teams (to ensure that the reengineering does indeed take place), and they should use tested technology.

Rational Experimentation

These projects test new technologies and new ideas. Hence, they are risky. However, every company needs some of these projects to hope to move ahead of competitors. When described as experiments, they set the realistic expectation that they may fail. The goal is to prove the concept in, say, several months' time or less. One example could be Web Services; another could be desktop video conferencing. When treated as experiments, these projects will not hurt the company if they fail. If they do pan out, however, they could prove a new business or IT model and thus become one of the other three types.

These incubator-type projects should be managed as experiments with short time frames and incremental funding. The team may be full-time, but it does not need to move out of IT. Participants should not be penalized if one of these projects fails.

Breakthrough Strategy

These projects potentially have a huge impact on the company, and perhaps even on the industry, if they succeed. They capture the imagination, but they are high risk. The typical response, once someone sees the potential, is, “If this works, it would change. . . .” An example of a breakthrough strategy is eBay. Its auction business model altered people’s thinking about global buying and selling. Another example is extranets for customers. When successful, they move to the operational excellence cell.

Breakthrough strategy projects require strong functional buy-in. One way to get this commitment is to brainstorm with functional partners on the possibilities. Because they are generally bet-the-farm types of projects, they need to be managed like start-ups. They need venture-capital-like funding, not month-to-month milestones. For example, the project may request \$10 million with the possibility of failure, but also offer the possibility of huge upside returns.

Key steps of a breakthrough strategy consist of the following:

- Brainstorming on markets and services: Identify as many fundamental changes as possible that occur in the industry—changes in product types, manufacturing, distribution, customer services, regulations, and the like; discuss the extent to which the company can fit in these trends.
- Create a list of creative marketing ideas: Make a list of services that the company has not provided and search for clever ideas.
- Break the rules: List all the existing rules that govern the marketing of existing goods and services that the company currently sells, and try to envision a new world without these rules.

To attract top talent and foster the intense communication and collaboration needed among the team members, they probably need to be housed in a “skunk works” setting by being set apart organizationally and reporting to the CEO or CFO, who protects them from corporate politics and from the “but this is the way we’ve always done it” mind-set. Finally, the skunk works team needs to be given financial incentives if the project succeeds. To practice a breakthrough strategy, management should encourage risk and accept failure of the right kind. Because C-level involvement is key, executives may need to be educated on their roles.

To illustrate this portfolio approach, here are examples of Cisco IT projects.

CASE EXAMPLE

CISCO SYSTEMS

www.cisco.com

Cisco Systems Inc. is a global leader that designs and sells networking and communications technology and services under four brands: Cisco, Linksys, WebEx,

and Scientific Atlanta. Cisco uses the e-business value matrix described by Alexander¹² to manage its portfolio of IT projects, placing a value on each project

(Case Continued)

based on the newness of the idea it employs and the criticality of the system to the company.

Here are examples of systems in each of the four cells in the matrix: new fundamentals, operational excellence, rational experimentation, and break-through strategies.

New Fundamentals

Completing a travel expense report is a chore for many business executives. Cisco assembled a team of 15 employees to include eight from the IT department to build an easy-to-use Management Expense Travel Reports Online, or Metro for short. Metro is a fundamentally new way of handling expense reporting.

To submit an expense report, an employee goes to a Web page to build the report online. As the report is filled in, the system checks to see whether the employee has adhered to company policy, and consults with the company's treasury department for exchange rates and payroll to find the employee's bank information for electronic reimbursement transfers. When submitted, the system routes the report to the employee's manager and explains the purpose of the expense report, the total expenses, and whether any policies were violated. If the manager does nothing, the employee's credit card account and personal account are credited in two days' time.

This system quickly earned employees' adoption (more than 86 percent right after the system went live in 1997). In addition, the system delivered major cost savings, since Cisco now only needs three employees to manage expense reports for more than 56,000 employees. Although abuse is possible, the cost of potential losses from questionable

charges is a fraction of the cost of having a larger administrative staff.

Operational Excellence

Cisco's executive dashboards for each functional area are seen as operationally differentiating the company from its competitors. In fact, Cisco executives have claimed, "I cannot live without this system because . . . it allows me to model sales programs, . . . it allows me to manage the supply chain, . . . it allows me to do trend analysis on component availability, and so on."

Each dashboard is a Web front end to the company's data warehouse. The dashboard provides just enough and instant data to meet the information needs of the busy executive. It is an executive information system that allows executives to drill down into the data to pull up a snapshot of, say, the company's revenues, bookings, or margins (the fundamentals of the company) at a point in time by business unit, region, entire enterprise, product line, and so on. For example, executives can see how well a division is progressing in meeting its forecasts.

Furthermore, the system allows the CFO to close the company's books within one day of the end of each quarter, and the company expects to reduce this lag to just two to three hours.

Such a system is not excellence in product, it is excellence in IT; and it is operational excellence, said Alexander.

Rational Experimentation

To keep information flowing and strategic skills sharp within the company, CEO John Chambers and his CIO and vice president of the Internet Learning Solutions teamed up to create a Delta Force. The triangular model seeks to apply more expertise to

(Case Continued)

serving business. The idea is to avoid having businesspeople come up with a sound business application, but IT engineers cannot develop an information system to support this application. Conversely, there are situations where the IT department can build technically sound solutions but they might not be adequate for business use. In search for a winning application, the approach is to start experimenting. Cisco has a continual stream of such experiments going on in IT. One experiment has been multicast streaming video. Executives are watching to see the business value of this new technology to the various functional areas. For example, they have made all-company meetings available online to employees through IP TV. If this technology proves useful, it could be used for new-product training.

Breakthrough Strategy

Cisco views its development of a virtual supply chain as a breakthrough strategy.

Of the 26 factories that build Cisco products, only 5 are owned by Cisco. Thus, the company's ability to sense and respond is not tied to capital assets. It is a function of their building an effective supply chain. Although not easy, they believe it is critical to their business. If their gamble on virtual manufacturing goes awry, it would present an enormous problem. However, they see it as worth the effort because the returns will be extremely high if they succeed.

Cisco takes its portfolio of IT projects and Internet initiatives so seriously that CEO John Chambers holds a review of leading Internet capabilities each quarter. At these reviews, each functional area describes how it is implementing Internet capabilities that are ahead of its peers in the industry. Most company CEOs do not make this effort, said Alexander. If they did, they would see spectacular returns, he believes. ■

Linkage Analysis Planning

Linkage analysis planning examines the links organizations have with one another with the goal of creating a strategy for utilizing electronic channels. This approach to strategic systems planning is espoused by Kenneth Primožic, Edward Primožic, and Joe Leben, in their book *Strategic Choices*.¹⁴ The methodology includes the following three steps:

1. Define power relationships among the various players and stakeholders.
2. Map out the extended enterprise to include suppliers, buyers, and strategic partners.
3. Plan electronic channels to deliver the information component of products and services.

Define Power Relationships

To create a strategy for building electronic links among enterprises, Primožic's team believes that management must first understand the power relationships that currently exist among these various players. For this analysis, they begin with Michael Porter's⁸

classic model of competitive forces. To this model, they add technology, demographics, global competition, government regulations, and “whatever is important in your environment.” The goals of this step are to identify who has the power and determine future threats and opportunities for the company.

The analysis begins by identifying linkages, which are relationships the organization has with other entities. Figure 10 is a good illustration. The links are represented by lines between organizations (shown in boxes). Once identified, management needs to determine who is managing each link. Oftentimes, no one is, which should be of concern. From here, the team picks the most important link and decides how the firm can control that link. The authors believe that successful organizations will be those that control the electronic channels or the electronic linkages among enterprises.

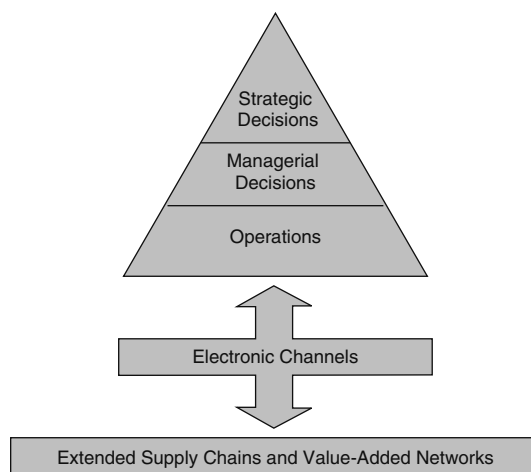
The discussion of how to gain power within one’s world of linkages brings up a host of questions. Two important ones are: How might alliances with other firms across industries or even with competitors help us? How do we need to restructure ourselves to seize an opportunity or ward off a threat?

Map Out Your Extended Enterprise

These questions lead to the second step in this approach to planning—mapping the extended enterprise. An extended enterprise includes all of one’s own organization plus those organizations with which one interacts, such as suppliers, buyers, government agencies, and so forth in the extended supply chains and value added networks (see Figure 9).

The purpose of this step is to get management to recognize the existence of this extended enterprise and then begin to manage the relationships in it. Primožic and

FIGURE 9 The Extended Enterprise



Source: Adapted from K. I. Primožic, E. A. Primožic, and J. F. Leben, *Strategic Choices: Supremacy, Survival, or Sayonara* (New York: McGraw-Hill, 1991).

Strategic Information Systems Planning

colleagues believe successful managers will focus on extended enterprises. They see two fundamental principles to managing these relationships:

1. The enterprise's success depends on the relationships among everyone involved, which includes employees, managers, suppliers, alliances, distribution channels, and so forth.
2. Managing information as a strategic tool is crucial because some 70 percent of the final cost of goods and services is in their information content.

An extended enterprise diagram might deal only with external players, such as the government, stockholders, traditional competitors, the financial community, and so forth. Such a chart includes everyone whose decisions affect the organization or who are affected by its decisions. The analysis then moves to discussing how the links might change and how each link should be managed.

In the extended enterprise, each relationship will prosper only when it is win-win, say the authors. For example, in return for maintaining a buyer's parts inventory and providing just-in-time delivery, a supplier should be paid electronically upon delivery of goods. Such an arrangement profits both parties.

Competitive advantage will depend increasingly on being able to exploit the collective resources of one's extended enterprise, say Primozić and colleagues. Such enterprises often require electronic channels to execute business transactions, which leads to the third step in their planning approach—planning the electronic channels.

Plan Your Electronic Channels

An electronic channel is an electronic link used to create, distribute, and present information and knowledge as part of a product or service or as an ancillary good. These channels focus on the information component of products. The authors believe that those who control the electronic channels will be the winners because they will be able to address new niche markets as they arise. Furthermore, as use of IT leads to a faster-paced world, organizations with the longest electronic reach into their extended enterprise will have the advantage.

The authors use linkage analysis charts to help executives conceptualize the key issues they face in an extended enterprise and focus on the factors that are critical to their future success. This methodology has been used by the Electric Power Research Institute, whose story is told next.

CASE EXAMPLE

ELECTRIC POWER RESEARCH INSTITUTE

www.epri.com

Founded in 1973, the Electric Power Research Institute (EPRI), with headquarters in Palo Alto, California, is a large,

private research firm serving members that collectively provides more than 90 percent of the electricity generated in the

(Case Continued)

United States. EPRI's 350 staff scientists and engineers manage some 1,600 R&D projects at any one time. The projects, which study such subjects as power generation, superconductivity, electronic and magnetic fields, and acid rain, are conducted by more than 400 utility, university, commercial, government, and other R&D contractors on behalf of the members.

The Challenge

EPRI's mission is to deliver the information and knowledge from its research projects to the 400,000 employees in the 768 member utilities to help them be more competitive. Management realized EPRI had to compress the "information float," the elapsed time from the availability of research findings to the use of those results in industry.

The institute was suffering from "info-sclerosis," the hardening and clogging of its information arteries. Due to the volume of research findings—gigabytes of information—moving information in and out of EPRI was extremely difficult. In addition, because of the documentation and publishing process, the results often were unavailable for up to 24 months, so the reports were not as timely as they could be. Nor were the results accessible, because they were in massive reports. Solving this information delivery challenge was critical to EPRI's survival.

The Vision

The vision was to assist members in exploiting EPRI's product—knowledge—as a strategic business resource, whenever and from wherever they choose. To accomplish this vision, EPRI built an electronic information and communication service.

As described by Marina Mann and her colleagues,¹⁵ their delivery vehicle

is EPRINET, an online channel that includes

- A natural-language front end for accessing online information
- Expert system-based products that contain the knowledge of their energy experts
- E-mail facilities for person-to-person communications
- Video conferencing to foster small-group communications

Using Linkage Analysis Planning

To focus the EPRINET effort and to identify the services and products that would offer strategic business advantages to members, EPRI used linkage analysis in a three-day workshop led by Kenneth Primoic. The workshop began with management stating that (1) EPRI was both an R&D organization and a knowledge provider and (2) the goal was to leverage knowledge as a strategic asset.

From this starting point, Primoic asked, "Who is linked to EPRI in creating and distributing knowledge?" The participants identified the co-creators as contractors, research firms, universities, the government, and technology firms. They identified the recipients as the utility industry, universities, research labs, government policies, and knowledge as capital—as shown in Figure 10. Each represented a link to EPRI; therefore, the group then studied the present and future power relationships in each buyer-seller link. During these discussions, they saw how some current customers, such as universities or research labs, could become future competitors and change the power relationship in a link.

Management's goal was to leverage knowledge, so the group listed all the

(Case Continued)

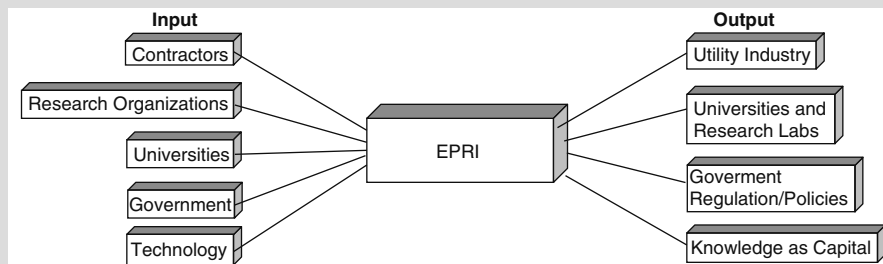
ways leverage could be achieved. Then they focused on the most important way, which turned out to be treating knowledge as capital. During this analysis, management defined the following CSFs for giving EPRINET a sustainable competitive advantage:

- Establish the right mix of product offerings, a mix that allows people to pick, choose, and combine at the lowest possible cost.
- Keep all customers in mind, including utility executives, research engineers, and operations people.

- Use IT—specifically expert systems and natural language—to make the system easy to use and access.
- Create a range of “knowledge packages” targeted to specific audiences.
- Establish a timely, reliable, secure global distribution channel.

Once EPRINET was made available, a marketing campaign began. The number of users has climbed steadily since. Frequent users report that the system is indeed broadening the number of people they can stay in contact with and allowing them to uncover EPRI research findings that they would not have found otherwise. ■

FIGURE 10 EPRI's Linkage Analysis



Source: M. M. Mann et al., “EPRINET: Leveraging Knowledge in the Electric Utility Industry,” *MIS Quarterly*, September 1991, pp. 403–421.

Scenario Planning

The final strategic planning approach is scenario planning. Peter Schwartz, who has written the definitive book on scenario planning, *The Art of the Long View*,¹⁶ states that scenarios, which get their name from the theatrical term for a script or a play, are stories about the way the world might be in the future. Such stories can help people spot and adapt to aspects of their lives that are actually changing today. They help people find appropriate paths to each of the plausible futures described in the scenarios.

The goal of scenario planning is not to predict the future (because that is hard to do), but to explore the forces that could cause different futures to take place and then decide on actions to take if those forces begin to materialize.

M. Lynne Markus¹⁷ points out that long-term planning has traditionally extrapolated from the past and has not factored in low-probability events that could significantly alter trends. Thus, these straight-line projections have provided little help.

Markus identifies four steps in scenario planning:

- 1. Define a decision problem and time frame to bound the analysis.** In thinking about the future of IS, for instance, IS management might ask, “How will IS be managed 10 years from now?” An individual IS employee might then ask, “What skills would I need to succeed in that organization, and what do I need to do to get those skills?”
- 2. Identify the major known trends that will affect the decision problem.** Generally, scenario planners think about trends in categories: the business environment, government and regulations, societies and their concerns, technologies, financial considerations, the global environment, and such. Each trend is then judged by asking, “What impacts will this trend have on the decision problem?” “What are the directions of each impact?” Trends with unknown impacts or contradictory impacts are classified as “uncertain.”
- 3. Identify just a few driving uncertainties.** Driving uncertainties are those around which others tend to cluster. Often scenario analysts choose just two, with two possible states for each, leading to four scenarios. The goal is to explore quite different futures, not the most likely future, notes Markus.
- 4. Construct the scenarios.** Each scenario, based on a driving uncertainty, needs to be plausible. To create this plausibility, scenario writers include a “triggering event,” something that redirects the future into the desired space. For example, a triggering event could be a world event (the September 11, 2001, tragedy certainly qualifies), an action by a group (a major court decision), or a business event (the collapse of a large company). The scenarios depict the end state (at the selected point in time) and how that path was taken.

With these scenarios in hand, executives and planners then decide how well their current strategies would fare in each case. Then they ask, “Is there a better strategy, perhaps one that would cover more bases?” Also, they should determine what factors they should monitor closely to quickly spot changes in trends.

To give a brief glimpse of a scenario effort, here are four scenarios Markus created around the question, “What will in-house IS management look like in 10 years?”

CASE EXAMPLE

SCENARIOS ON THE FUTURE OF IS MANAGEMENT

The question M. Lynne Markus¹⁷ pondered in developing her scenarios was, “What will IS management look like in 10 years?” In studying IT and IT industry

trends, business management trends, and societal trends, she noted that a straight-line extrapolation of the trends would have all organizations acquiring their

(Case Continued)

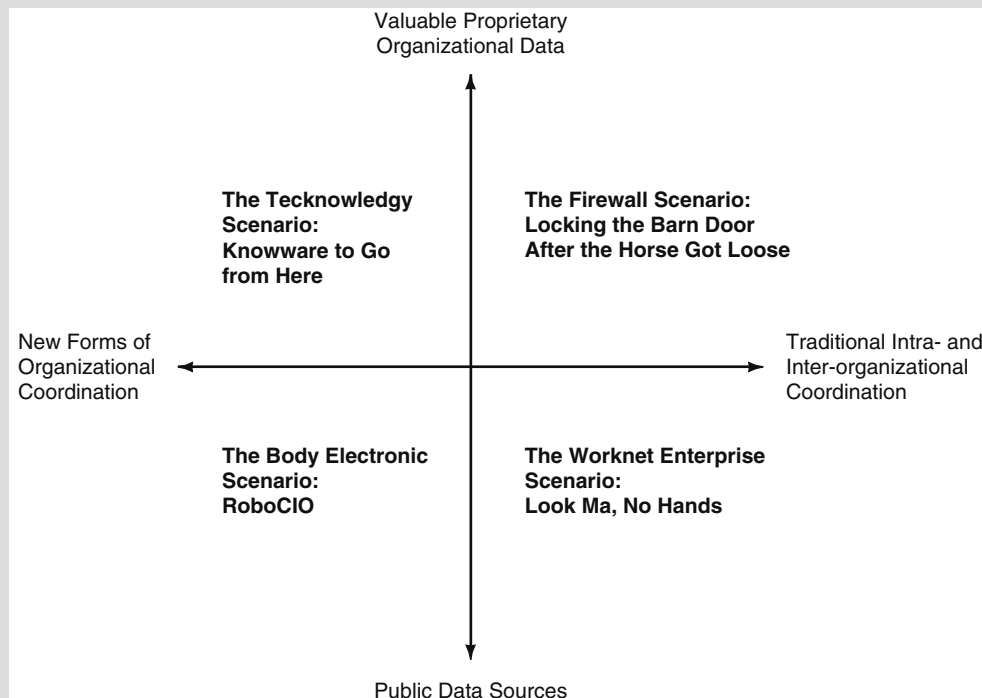
IT-enabled products and services from external providers through a variety of arrangements, including partnerships, long-term contracts, and spot transactions. To explore the future of IS management, she settled on two driving uncertainties:

- How will companies coordinate IT? Will they use traditional hierarchical coordination mechanisms or pooled organizational forms?
- How will companies manage their data or content? Will they benefit from managing their own proprietary data or will content be managed by fee-charging external service providers? These lead to

four possible scenarios, as shown in Figure 11.

Scenario 1: The Firewall Scenario—Locking the Barn Door After the Horse Got Loose. Organizations maintain traditional arm's-length relationships with suppliers and customers, and they believe data is proprietary. After a defining event, in which several companies go out of business from crashes in their computer systems that bring their business to a standstill, corporate managements take a concerned look at their IT operations. Many take on a bunker mentality; their main concerns are security and control. If they outsource their infrastructure to

FIGURE 11 Four Scenarios on the Future of IS Management



Source: M. Lynne Markus, "The Futures of IT Management," *The Data Base for Advances in Information Systems*, Vol. 27, No. 4, 1996, pp. 68–84.

(Case Continued)

highly regarded outsourcers, they retain tight control over the vendors. All software is off-the-shelf and integrated by professional services firms. All data is housed in virtual bomb shelters. In essence, IS staff become general contractors and enforcement agencies.

Scenario 2: The Worknet Enterprise Scenario—Look Ma, No Hands. In this scenario, tough privacy legislation is enacted following highly publicized information leaks. Most companies then outsource data management to specialist service providers who comply with the new laws. However, the promised global network does not materialize, so companies cannot turn over their entire IT infrastructures to providers.

Companies continue their traditional arm's-length relationships with other firms, but they use IT to mediate workflows between organizations. The result is that competition shifts to networked value chains, called worknets. Within these worknets, data are shared, generally through service providers that run inter-enterprise software packages for the worknet. Thus most IS organizations have handed over their IT work to their worknet's technology consortium, significantly reducing the costs of interworking with these partners. These consortia, themselves, are like self-managing virtual IS departments, so the IS staff in the contracting firms are mainly either change agents or information brokers tasked with helping the business uncover new uses of IT and implementing them.

Scenario 3: The Body Electric Scenario—RoboCIO. The triggering events in this scenario are availability of cheap, integrated networking services, plug-and-play

computing devices, and portable health and pension plans (due to new legislation). As a result, new forms of organizations flower and data are more likely shared than guarded. In general, people own parts of the small, independent work units (cells) in which they work. Some work under a corporate umbrella; but many are autonomous, combining to deliver goods or services and then disbanding.

The standards for the global IT infrastructure that allow this interworking were created by a global consortium, and vendors adhere to the recommendations. The result is a highly flexible plug-and-play network of interconnected service providers and their services, called Technoos. Cells do virtually no IT work themselves, but they do need to find appropriate IT products and services. This searching is fairly automated and is called "value questing." The other piece of IT work is "IT facilitation," which involves helping cells change how they work when they either form a new alliance or adapt to a new type of software that changes their processes. Specialists can offer both services or they can be handled in-house as part of other jobs.

Scenario 4: The Tecknowledgy Scenario—Knowware to Go from Here. The growth of the Internet and the Web lead to an open information society. Any kind of information is available, for a price. People specialize in having (or knowing how to get) certain kinds of knowledge. Various kinds of intellectual capital have different, well-publicized value. Companies organize themselves to best develop and share knowledge. Those that learn fastest and share best are the most successful.

Knowware (advanced groupware) flourishes because it helps people and

(Case Continued)

organizations share knowledge. In fact, knowware is the information technology most people use. It is part of organizational processes; it is how they work. Vendors maintain knowware, which handles administrative work as well, so few companies have IS departments. They rely fully on external providers. The downside is that changing knowware

packages is unthinkable because the one that a company adopts forms the foundation of its business. Many jobs even require prior knowledge of the knowware product in use in a company. Thus, the main IS job within companies is facilitation, ensuring that knowledge processes are maintained and employees understand them. ■

CONCLUSION

Based on the successes and failures of past IS planning efforts, we see two necessary ingredients for good strategic planning efforts. One is that the plans must look toward the future. This point may seem obvious, but in turbulent times, the future is not likely to be an extrapolation of the past. Therefore, a successful planning effort needs to support “peering into an unknown future”—most likely in a sense-and-respond fashion. This future will undoubtedly impact us.

A second necessary ingredient is that IS planning must be intrinsic to business planning. This point may also seem obvious, but, again, unless the planning process specifically requires joint development, the systems plans may not be relevant because they do not align with corporate strategy. A misalignment is not so likely with the advent of Internet commerce, but it is also not yet natural in many companies.

In this chapter, we have described an approach to strategic systems planning and a number of the most popular techniques. No single technique is best, and no single one is the most widely used in business. In fact, many companies use a combination of tools because each deals with different aspects of planning. The main goal these days is to meld speed with flexibility. That goal can best be achieved by creating an overall strategic envelope and conducting short experiments within that envelope, moving quickly to broaden an experiment that proves successful. Sense-and-respond is the new strategy-making mode.

QUESTIONS AND EXERCISES

Review Questions

1. What are the primary differences between operational planning, tactical planning, and strategic planning?
2. Identify and describe several reasons why strategic systems planning is so difficult.
3. What assumptions in traditional strategy making no longer hold true?
4. What is a sense-and-respond approach to planning?

Strategic Information Systems Planning

5. Describe Skandia Future Centers' 3G teams.
6. What is a strategic envelope?
7. Describe Shell Oil's action labs.
8. What is the main contribution of the stages of growth theory to IS planning?
9. What are critical success factors (CSFs)? How do they contribute to the systems planning process?
10. Describe Porter's five competitive forces.
11. Describe the components of Porter's value chain.
12. What is the evolution of ways companies use information to add value, according to Rayport and Sviokla?
13. Describe the four types of applications in the e-business value matrix.
14. Briefly describe the goal of linkage analysis planning. List the three steps involved in conducting such an analysis.
15. Briefly describe the four steps in scenario planning, as described by Markus.

Discussion Questions

1. Which of the frameworks for systems planning seem most useful to you? Why?
2. If you were in charge of systems planning for a small firm, what questions would you ask company officers to determine which planning approach(es) would be most appropriate?
3. Strategies are out and visioning is in because no one can plan in turbulent times. This chapter states that planning is crucial. How would you reconcile these two viewpoints?

Exercises

1. Survey the current literature on systems planning. What other approaches or frameworks are not mentioned in this text? What automated products are available on the market to assist IS executives in the planning process?
2. Visit the CIO of a local organization. What planning process is used? What is the planning horizon? To what degree do the systems plans and the business plans relate to each other?
3. Create a simple information linkage analysis chart of your current personal relationships. Put yourself in the middle box and each relationship in its own box around you, with a line from you to each of them. Who has the power in each link? How might that power shift in the future? Which is the most important relationship to you? How could you make it more win-win?
4. Ask the CIO of a nearby company what electronic channels his or her firm has in place. Ask about the benefits both parties receive in each link.

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DESIGNING CORPORATE IT ARCHITECTURE

INTRODUCTION

The Evolution of Distributed Systems

ATTRIBUTES OF ENTERPRISE DISTRIBUTED SYSTEMS

Distributed Processing

Connectivity Among Processors

Systemwide Rules

CORPORATE POLICY FOR DISTRIBUTED COMPUTING

Are the Operations Interdependent?

Are the Businesses Really Homogeneous?

Does the Corporate Culture Support Decentralization?

TYPES OF ENTERPRISE DISTRIBUTED SYSTEMS

Host-Based Hierarchy

Decentralized Stand-Alone Systems

Peer-to-Peer LAN-Based Systems

Hybrid Enterprise-wide Systems

Client-Server Systems

Case Example: An Aerospace Company

Internet-Based Computing

Case Example: IBM, Nokia, and SABRE: Pervasive Computing

Case Example: 3i

Web Services

Case Example: General Motors

The Future of Distributed Computing

DEFINING THE OVERALL IT ARCHITECTURE

An Enterprise Architecture Framework

Case Example: FMC Corporation

Service-Oriented Architecture

Case Example: Credit Suisse

INTER-ORGANIZATIONAL IT ARCHITECTURE AND DIGITAL SOCIETY

The Structure of the IT Infrastructure

Three Views of Infrastructure

The Digital Economy

Corporate IT Infrastructure in the Digital Economy

CONCLUSION

QUESTIONS AND EXERCISES

REFERENCES

INTRODUCTION

Way back in 1964, Paul Baran at the Rand Corporation wrote a paper about distributed systems. At the time, computing meant mainframes and hardwired terminals; distributed systems were just theory. Driven by sophisticated computing needs of business users, distributed systems have today become the corporate architecture of choice, and oftentimes, by necessity, in an increasingly interconnected world.

To start, we need to point out that the two terms, “architecture” and “infrastructure,” are often used interchangeably, which can make discussions of distributed systems confusing. In this text, we make the following distinction:

An IT architecture is a blueprint. A blueprint shows how a system, house, vehicle, or product will look and how the parts interrelate. The more complex an item, the more important its architecture, so that the interrelationships among the components are well defined and understood.

An IT infrastructure is the implementation of an architecture. In a city, the infrastructure includes its streets and street lighting, hospitals and schools, utilities, police and fire departments, and so on. In a corporation, the IT infrastructure includes the processors, software, databases, electronic links, and data centers, as well as the standards that ensure that the components seamlessly work together; the skills for managing the operation, and even some of the automatic electronic processes themselves.

At the end of this chapter, we delve into both architecture and infrastructure in a bit more depth, after looking at the various kinds of distributed systems.

The Evolution of Distributed Systems

In the first IT architecture—mainframes doing batch processing—some data get inputted into “dumb” terminals and, after some remote processing, some output is sent to these “dumb” terminals. These “slave” user devices had no processing capabilities. All the processing was done by the “master” (the mainframe), and most were for corporate needs, such as payroll and billing. With the advent of minicomputers (a scaled-down version of the large mainframe), computers moved into departments, but the master–slave model persisted. Processing was centralized, although gradually distribution or sharing of processing among mainframes and minicomputers began to occur.

With the microcomputer, though, the model changed significantly because processing power moved first onto desktops, then into notebooks, and now into handhelds, game consoles, cell phones, and so on.

Throughout this evolution, stand-alone processors were gradually linked to other computers. As that happened, the notion of a distributed architecture developed. Thus, distributed systems are systems where the processing is spread over several computers. All large computer systems are typically distributed. This configuration brings many advantages:

- Increased processing power: Running many processors concurrently provides more computing power, with some processing used for managing them (e.g., grid computing, *seti@home*)

- Increasing access to large and geographically dispersed databases
- Resource sharing (e.g., e-mail servers, databases, high-performing printers)
- Scalability: The system can be upgraded or downgraded whenever needed (e.g., the World Wide Web)
- Fault tolerance: Errors in one part of the system do not necessarily affect other parts of the same system

The Internet has become the center of a worldwide distributed system. It is because of this global electronic infrastructure that the e-business revolution is taking place. The client-server concept of requesting services continues today and will be more important in the future as Web Services continue to develop, allowing a large number of service providers and an equally large number of service users to sell and buy processing and data over the Internet (as discussed later in this chapter).

To get a grounding in this important notion in computing, we now delve into the basic concepts of distributed systems.

ATTRIBUTES OF ENTERPRISE DISTRIBUTED SYSTEMS

The degree to which a system is distributed can be determined by answering four questions:

1. Where is the processing done?
2. How are the processors and other devices interconnected?
3. Where is the information stored?
4. What rules or standards are used?

Distributed Processing

This is a method to run a computer program with more than one processor located at different locations. The goal in distributed processing is to move the appropriate processing as close to the user as possible and to let other machines handle the work they do best. For example, when a travel agent uses his computer to book a flight that requires more than one airline, the ticket reservation system connects different airline computers together to set up the itinerary. The reservation process is made possible thanks to the simultaneous execution of the computers, likely with separate databases, according to a specific requirement of the customer.

Distributed processing requires interoperability, which is the capability for different machines using different operating systems on different networks to work together on tasks. Interoperability allows exchange of data and processes in standard ways without requiring changes in functionality or physical intervention.

Charlie Bachman, a pioneer in the database and distributed systems fields, pointed out that two major forms of interoperability are possible. One is the transparent communication between systems using system protocols. In this form, the systems decide when to interoperate. To use the Internet, companies have developed protocols for standard file and job transfers to permit this form of interoperability. The second form of interoperability is the interactive or two-way flow of messages between user applications. In this form, user applications can be activated by receiving messages; this activity, of course, is supported on the Internet.

Connectivity Among Processors

This type of connectivity means that each processor in a distributed system can send data and messages to any other processor through electronic communication links. A desirable structure for reliable distributed systems has at least two independent paths between any two nodes, enabling automatic alternate routing in case one node goes down. Planned redundancy of this type is critical for reliable operation. Such redundancy has not been implemented in many LANs, which is one reason they have been so fragile. It is, however, a major feature of the Internet as well as most corporate WANs.

Distributed Databases

In many situations, a central database might not be possible (e.g., proprietary data are owned by different organizations) or desired (e.g., maintenance and security). A distributed database is a database that is stored in more than one physical location. There are at least two ways to set up a distributed database. One divides a database and distributes its portions throughout a system without duplicating the data. Any portion is accessible from any node, subject to access authorization. Users do not need to know where a piece of data is located to access it, because the system knows where all data are stored.

The second type of distributed database stores the same data at several locations with one site containing the master file. Up-to-date synchronization of data is a significant problem in this approach, which is why it has not been the preferred way to distribute data.

An interesting development in this area is edge servers on the Web. An edge server is defined as being on the edge of the Internet, which means it is close to a set of users (such as a city). It holds a copy of an organization's Web site. Many edge servers, located strategically around the world, hold the same information. The edge server concept arose to accelerate Web page downloads to site visitors so they would not leave the site because they had to wait too long to see a page appear on their screen. Edge servers—essentially distributed databases—have become an integral part of the Internet.

Systemwide Rules

These rules mean that an operating discipline for the distributed system has been developed and is enforced at all times. These rules govern how distributed computing units communicate between them: How do processes get distributed between computers? What and how can data be exchanged? What are the operating procedures to ensure proper business processes or to warrant an acceptable level of security? Since the 1990s, these systemwide rules have been increasingly based on the open-system concept. Products using open standards can operate together in one or more distributed systems, such as the Internet. The initial idea was to avoid being locked into the proprietary products of one vendor or a few vendors. Generally speaking, the more complex the distributed system, the more complicated the rules.

In the 1980s, open systems referred mainly to telecommunication and meant that a company intended to implement products that followed the OSI (Open Systems Interconnection) Reference Model whenever they became available. At that time, OSI implementation was not a reality, just a target.

About 1990, the definition of open systems expanded to include operating systems, specifically UNIX, because it runs on more platforms than any other operating system and is not owned by any one company. At that time, UNIX was tentatively seen as

appropriate for mainline business computing. Today, it is an important operating system for servers on the Internet. In business computing, it has gained a foothold, but it has not displaced proprietary operating systems, such as Microsoft's Windows.

At the same time, in the data world, open meant structured query language (SQL), the standard intermediary language for accessing relational databases. SQL remains the standard today.

In the early 1990s, the definition shifted to the interfaces between applications. Open meant standardized interfaces that would allow products to interoperate across multivendor networks, operating systems, and databases. Application Program Interfaces (APIs) came into being. They define the way data are presented to another component of a system—a machine, a database, even an e-mail system. APIs allow individual products to be innovative, yet connectable, and they have made writing distributed systems far easier.

Today, the term “open” includes the already mentioned definitions and stresses interconnectivity. In this realm, the OSI reference model remains the definition of open. Most people, however, are only familiar with its widest implementation: the network protocol used in the Internet, TCP/IP. Corporate networks, both LANs and WANs, now use TCP/IP to ease interconnection to the Internet.

An interesting twist on the term “open” hit critical mass not long ago. At the beginning, an open system allowed programmers to offer software for free (or for a small donation), which many did. This freeware has come to be called “open source,” which means the source code can be downloaded by anyone and can be modified. (In purchased software, the code is compiled, thus undecipherable.) The open-source movement led to developers taking some freeware, improving it, and reposting it to the Internet. In the 1990s, Linus Torvalds offered his operating system, Linux, as open source; he has since gained a huge following. Developers around the world have contributed to it, improved it, and extended it. Because it is free, it is being used in a growing number of companies.

The term “open systems” keeps expanding because it truly is the crux of distributed systems, allowing products from multiple vendors to work together.

Although some people see the main reason for distributing systems as improving the use of computer resources, that is just technical interoperability, portability, and open software standards. The organizational impetus behind distributed systems is to move responsibility for computing resources to those who use them in an interconnected world.

Recently, many major vendors such as IBM and Hewlett-Packard have begun to adopt Linux as part of their overall sales strategy. With open-source software, these vendors pass on the savings to their customers, and concentrate on developing specific business solutions. This movement is critical to the computing world. First, it helps connect business computers faster and more cost effectively. Second, it will likely help speed up the necessity of finally having a “standardized” open source.

The next section briefly addresses the business reasons for distributing applications and the responsibilities that go with them.

CORPORATE POLICY FOR DISTRIBUTED COMPUTING

IS management needs a corporate policy for deciding when the development, operation, and maintenance of an application should be distributed. Individual end users and departments should not be left on their own to make these decisions, especially when

enterprise connectivity and inter-enterprise connectivity are important. Although technical considerations are critical, the major reason for choosing a particular distributed system architecture hinges on: Who should make the key management operating decisions?

Decision-making responsibilities are being pushed down and out in organizations, with local sites and teams being given more autonomy and responsibility for the resources they use. Teamwork between IS management and business management is important in designing a distributed processing architecture that supports the business's goals.

Francis Wagner, a computing pioneer, once said he believes people perform best when they are responsible for their own mistakes. If they have no one to blame but themselves, then the quality of their performance increases. The result is a more effective use of corporate resources. Therefore, a driving force behind distributed processing is the desire to give more people more control over their work. This autonomy can happen at any of seven levels: ecosystem, company, division, site, department, team, or individual.

James Wetherbe¹ suggested asking the following three business questions before distributing IT functions and the responsibilities that go with them. Systems responsibilities can be distributed unless the following are true.

Are the Operations Interdependent?

When it is important for one operation to know what another is doing, those operations are interdependent; thus, their planning, software development, machine resources, and operations need to be centrally coordinated to synchronize their operation. Two industries in which interdependency is mission-critical are manufacturing and airlines, which is why they have continued to have large centralized systems even in this era of distributed systems.

Are the Businesses Really Homogeneous?

If the operations do not need to know what the others are doing, then many systems functions can be decentralized, unless the operations truly have a lot in common.

For example, in the fast-food business, each franchise has the same information-processing needs, which makes them homogeneous. But they do not need to know what the other is doing; thus, they are not interdependent. Under these circumstances, processing may be distributed, but planning, software development, and hardware selection should be centralized, to keep processing costs down and to more easily migrate to new systems.

Deciding whether the information processing in two parts of a business is truly homogeneous is not always obvious. For instance, not all retail chains are the same. One major retailer found that it needed to create two information systems for handling credit charges—one for its upscale stores and one for its discount stores. The needs of the two types of stores were so different that a single system would not suffice. However, corporate IS does control planning, which gives the retailer the ability to seize marketing opportunities quickly when it can reuse systems built by either operation. Many large organizations practice centralized planning for their distributed systems, but allow execution to be decentralized at the users' level.

Does the Corporate Culture Support Decentralization?

Even if the business units do quite different things and do not need to know what the others are doing, corporate culture might dictate that some functions be centralized.

Wetherbe cites the example of a large company with 60 widely diverse business units. Although it might appear logical for this company to distribute all functions, management chose to centralize finance, HR, and systems planning. They want to offer corporate-wide career opportunities with as little retraining as possible. With central staff doing systems planning and coordination, the company can more easily move people and reuse systems.

If none of these three criteria—interdependency, homogeneity, or corporate culture—forces centralization, each business unit can direct its own IT activity, with the central organization coordinating the plans.

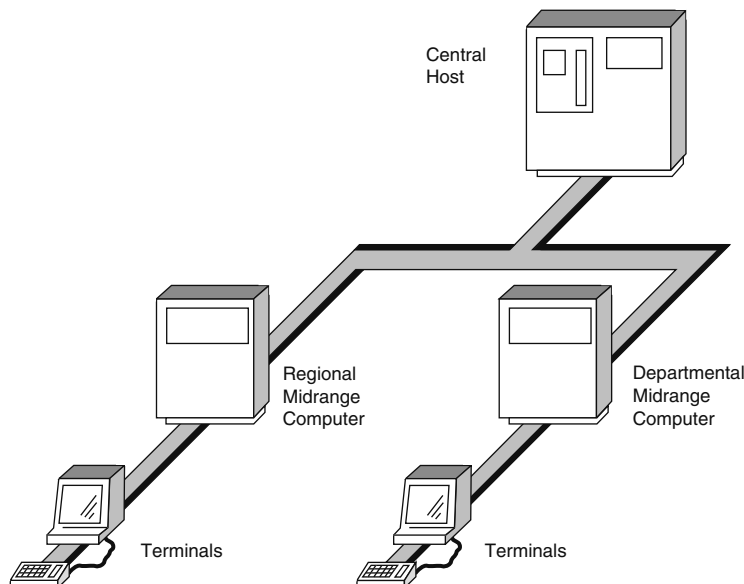
TYPES OF ENTERPRISE DISTRIBUTED SYSTEMS

As noted earlier, the distributed systems field has been continually evolving. The seven forms of distributed systems basically developed as follows.

Host-Based Hierarchy

A hierarchy of processors was the first distributed system structure. It was favored by mainframe vendors because the large host computer at the top controlled the terminals below. It is a master–slave relationship. More than one level of processor can be part of this hierarchy, as shown in Figure 1, with the total workload shared among them. The important characteristic of this structure is that the host computer is the central and controlling component. The other important characteristic is that the processing is done on the computers. The terminals are simply access (input/output) devices; they are designed to have no processing or data storage capabilities.

FIGURE 1 Host-Based Hierarchy



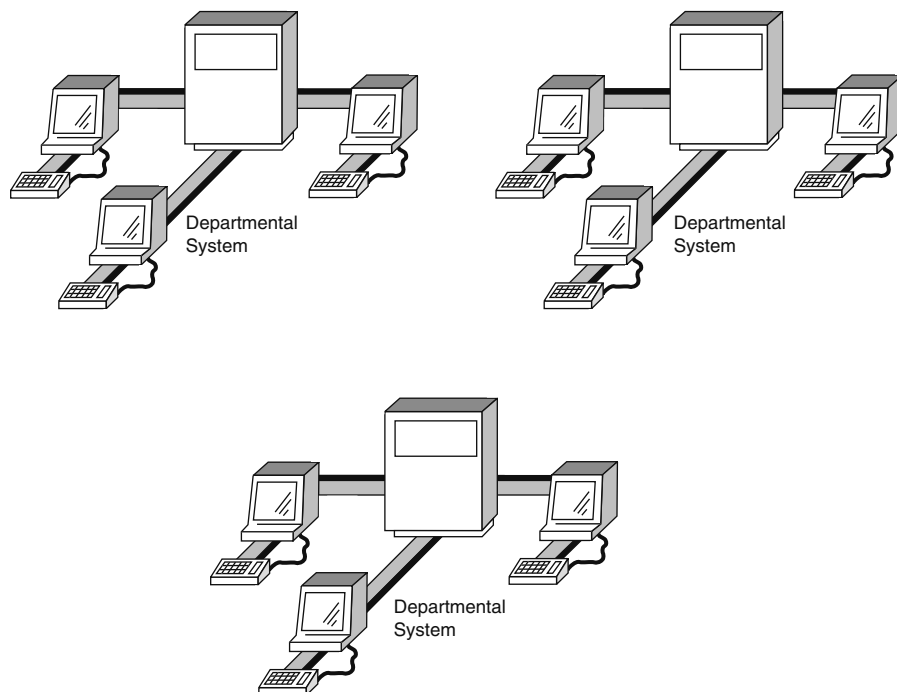
It is not always clear just where to store the data in such a system. One view is to centralize all data at the top level, such as at the headquarters. Another is to have the master records at the top but selected subsets at intermediate levels; the master records are then updated periodically and revised records are sent to the intermediate files. Still another view is to store master records where they are most used, and periodically provide updated records to the top for backup purposes. In any of these views, though, it is assumed that any processor can access any data record in the hierarchy, as long as it is authorized to do so.

In a private network or over the Internet, thin clients are diskless computers meant to obtain their applications from a server. They are an intriguing flashback to distributed computing, but they have two important distinctions from the terminals of old. One, they initiate requests; terminals of old did not. Two, they can do local processing; terminals could not. It is not the same master-slave relationship as with mainframes and terminals.

Decentralized Stand-Alone Systems

Decentralized stand-alone systems do not really form a distributed system at all. They are basically a holdover from the 1960s, when departments put in their own minicomputers with no intention of connecting them to the corporate host or to other departmental systems. Hence, they are decentralized, not distributed (see Figure 2). Over the years, many such “islands of computing” have been developed and are still in use. Their architecture is monolithic in that processing routines, data, and interface all

FIGURE 2 Decentralized Stand-Alone Systems



reside in the same system. They have been connected to allow a little data to flow, but this flow has been mostly upward to the corporate host.

Many IS professionals refer to these systems as legacy systems or antiquated systems. The business world in developed economies has a load full of legacy systems in large and well-established industries—banking, airline reservations, accounting. These systems are expensive to maintain; they are expensive to replace. Yet, they have run well and are still running. A short-term solution is to install new systems with backward compatibility. A long-term solution is to migrate them to an enterprise-wide system. A major goal in introducing ERP systems was to replace such disparate systems—in finance, manufacturing, administration—with a single platform of interconnectable modules to serve these various functions.

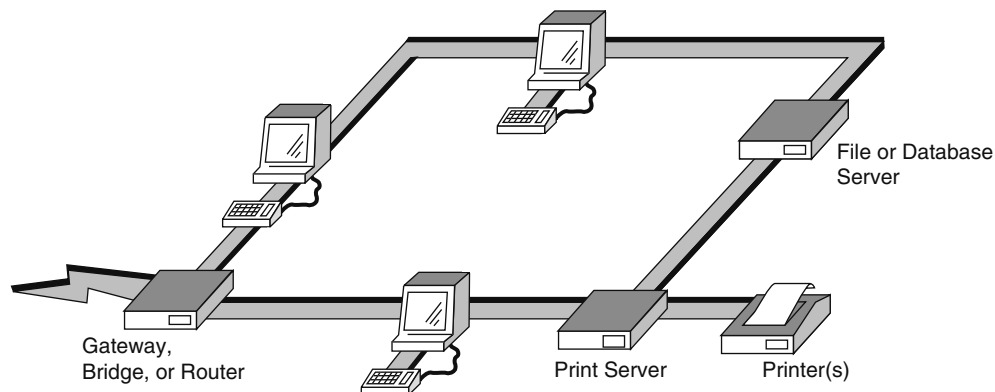
Peer-to-Peer LAN-Based Systems

Local Area Networks (LANs) have been the basis for distributed systems of desktop machines since the 1980s. This approach began in the office system arena with LANs providing the links between PCs, print servers, and gateways to other networks. Computers in peer-to-peer (P2P) networks typically have equivalent capabilities and responsibilities. This differs from client-server configuration, in which some computers are designed to serve the others. One type of P2P application is to have computing units situated physically near to each other and to run similar networking protocols and software. An example of this is when two PDAs try to exchange data on appointments or business addresses. As shown in Figure 3, this structure has no hierarchy or top-down dependencies. Another type of P2P application is data exchange using the Internet Protocol (IP). Perhaps the most popular form of P2P is file sharing. A new development in this area is peer-to-peer wireless LANs.

Hybrid Enterprise-wide Systems

The typical structure of distributed systems today draws on these three forms of distributed systems, linking them via three kinds of networks: LANs, WANs, and the Internet. This system is illustrated in Figure 4. Today's distributed systems mix and match

FIGURE 3 Peer-to-Peer LAN-Based System



Designing Corporate IT Architecture

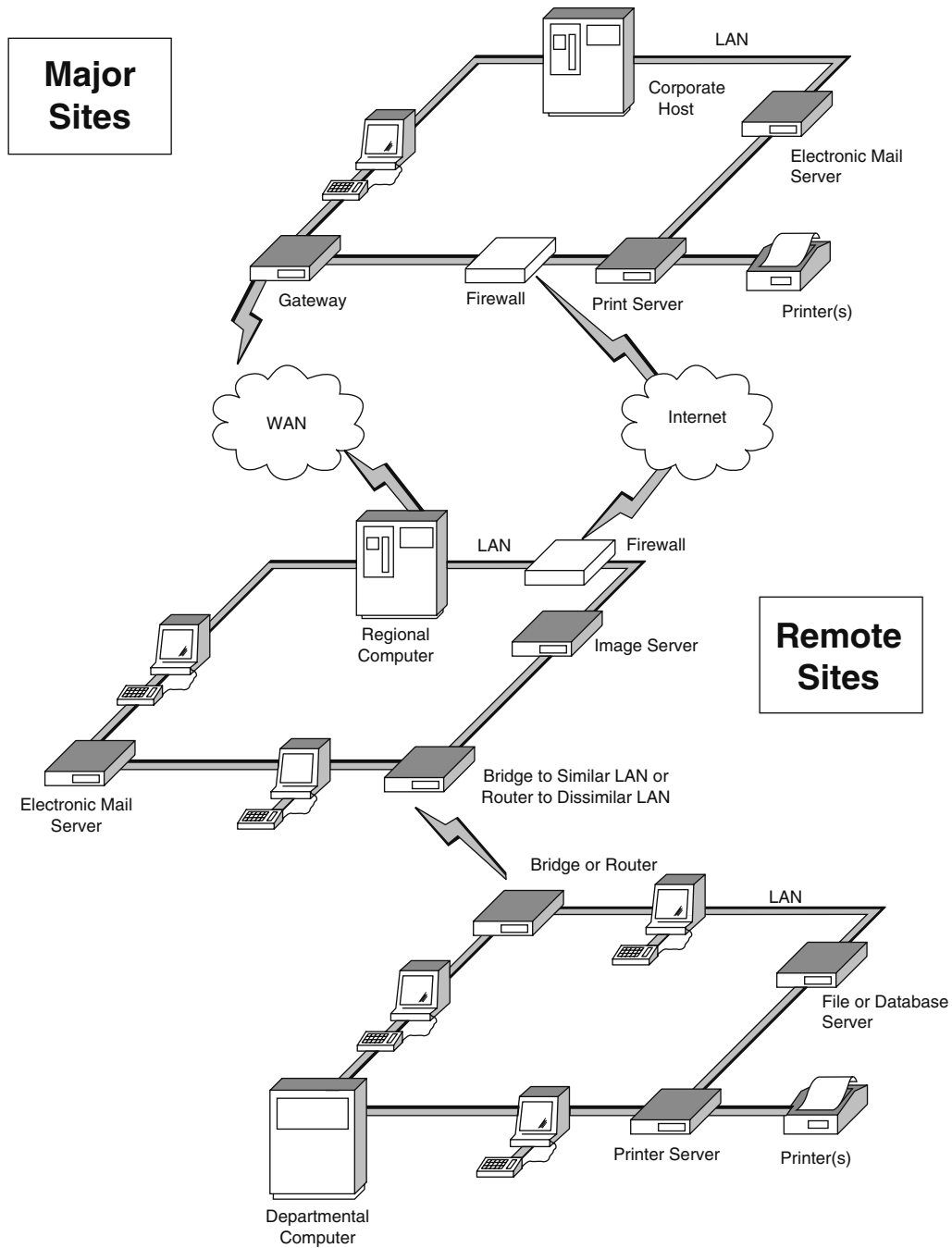


FIGURE 4 Hybrid Enterprise-wide System

hierarchical host-based processing favored for corporate and Web site computing with departmental processing favored by departments, such as manufacturing and engineering and the LAN-based systems used in offices. This hybrid structure is likely to be the structure of choice for many years as companies link their various islands of automation and increasingly link to systems in other organizations.

One important point is that this hybrid approach does not necessarily put all the machines under the aegis of a host mainframe computer. In fact, a number of companies have replaced their central computer altogether, dispersing applications to departmental machines and servers. A host computer is shown in Figure 4, but it is not the central control. For some applications, it could be the host; for others, it could be merely just another server.

A second important point is that this structure allows companies to automate business processes that span several functions within the organization or work cooperatively with systems in other enterprises. Inter-enterprise computing is the tenet of e-business. For example, Expedia.com links its B2C hotel booking system to its suppliers, allowing their customers to access a large selection of hotels.

Such cooperating processes allow companies to take advantage of specialized computer programs, while at the same time extending the usefulness of some legacy systems. The process of pulling together such individual applications or components is called system integration.

Client-Server Systems

In the 1990s client-server systems arose to take advantage of the processing capabilities of both host machines and PCs in the same system. Even though the host could handle huge databases and order processing, the PCs, laptops, and smaller devices could handle graphics, sound, and even video, which were important in some applications.

Client-server computing splits the computing workload between a client, which is a computer that makes a request, and a server, which answers the request. A request might be to print a document (handled by the print server on the LAN) or it could be a request for the gate number of one's soon-to-leave flight—a request sent by an Internet-enabled cell phone from a taxi and handled by the airline's Web site.

The most widely recognized depiction of client-server computing comes from Gartner EXP.² It shows the possibilities for splitting work between clients and servers, as illustrated in Figure 5.

The network presents the dividing line between what is housed on a client and what is housed on a server. The three components being split are the HCI (Human Computer Interface), Applications, and the Info-Management. Briefly, from left to right, the spectrum is as follows:

- Distributed Man-Machine Interface puts all the data, all the application software, and some of the presentation software on a server. Only part of the HCI is on the client. This approach is one way to leave a mainframe-based legacy system in place while updating user screens, making them graphical rather than character based, for example. This approach is also appropriate for wireless Web-based computing.
- Remote Man-Machine Interface puts all the software on the client machine but leaves the applications and information (data) on the remote server. This

Designing Corporate IT Architecture

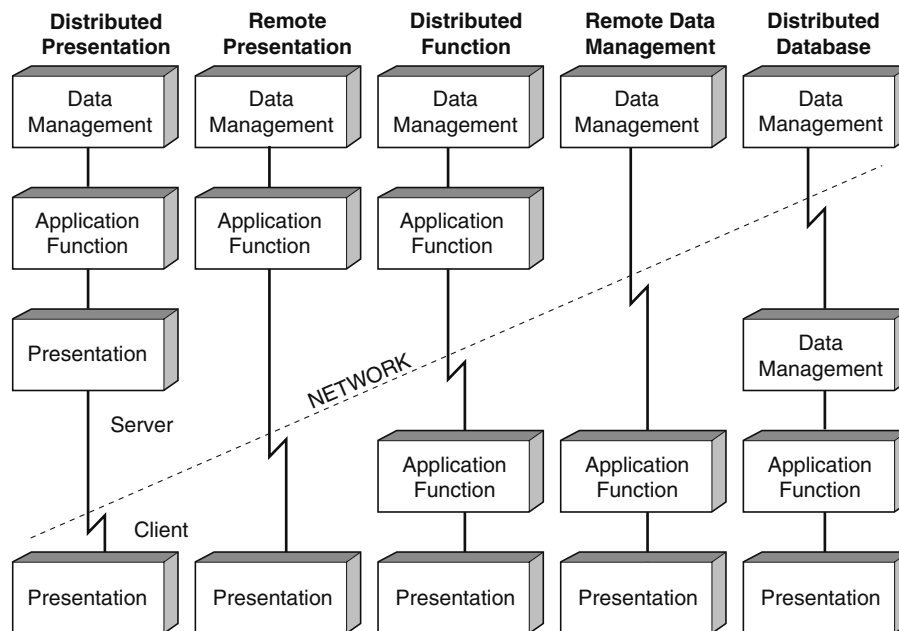


FIGURE 5 Client-Server Computing

Source: Adapted from Roger Woolfe, *Managing the Move to Client-Server*, Wentworth Research Program (now part of Gartner EXP, 56 Top Gallant, Stamford, CT 06904), January 1995.

approach also is a way to preserve a legacy system and simply update the interface it shows users. It has been used to put transaction processing behind Web sites.

- **Distributed Business Applications function** places all the software on the client, all the data on the server, and splits the application software between the client and the server. This option is quite complex, because splitting application processing between two machines requires coordination. However, it might be the most appropriate option for applications that run packaged software, such as spreadsheets or word processing, on a client in combination with corporate applications on a mainframe. It can also be appropriate for wireless computing and for major front-end applications, such as order entry, inventory inquiry, and so on. E-mail systems use this alternative: part of the processing on the client, part on the servers.
- **Remote Information management** places all software on the client, leaving only data and info management software on the server. This option is popular because it keeps all application software in one place (on a fat client) and takes advantage of the huge processing capacity of today's PCs. Although this solution is less complex, it has the disadvantage of requiring all the machines to be updated at the same time with a new release of the software. This level of coordination can be difficult unless all the machines are under a rigorous systems management system that routinely updates them when they connect to the corporate network.
- **Distributed database** places all presentation and application software as well as some of the data on the client. The remaining data are on the server. It is a complex solution, especially if the numerous databases are intended to remain

Designing Corporate IT Architecture

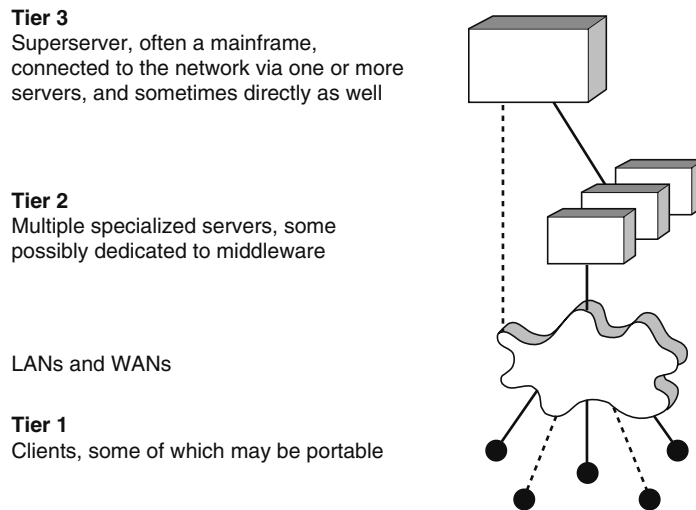


FIGURE 6 The Trend to Three-Tier Client-Server Arrangements

Source: Adapted from Roger Woolfe, *Managing the Move to Client-Server*, Wentworth Research Program (now part of Gartner EXP, 56 Top Gallant, Stamford, CT 06904), January 1995.

in sync. Even so, it is an important option used in mobile computing, where, for instance, each salesperson needs some data locally (probably the less dynamic data). Up-to-the-second data can be stored on the master database and accessed only when needed. This option also leads to fat client machines.

Another way to look at client-server systems is to view their architecture. The preferred architecture has been three tiered, notes Roger Woolfe.^{2a} As Figure 6 shows, tier 3 is the high-performance server, perhaps a mainframe or a cluster of Web site servers. It can be connected directly to an in-house client-server network or it may be routed through tier 2 servers to the network. Companies have chosen this latter option to extend the life of their old-but-still-good legacy applications. Short-lived and fast-changing data, as well as corresponding integrity rules, are also stored at this high-performance server level so that the data can be shared.

Tier 2 is specialized servers. Data specific to departments or work groups are stored here, as are data that do not change often yet require rapid retrieval. Tier 2 also houses middleware, or software that eases connection between clients and servers. Middleware became an important concept in client-server systems because it performs translations between disparate systems. With middleware, a major application written for UNIX can be quickly set up to support Windows or Linux without needing to be rewritten.

Tier 1 is the end-user computing, connected via some sort of network.

The alternative is two-tiered architecture, consisting of only clients and servers or clients and a mainframe. The three-tiered architecture reduces client complexity by decreasing the number of interfaces that need to be accommodated by client machines. The drawback is that clients are more complex and access to tier 3 data is slower than to tier 2. Woolfe presents a case of a company that uses two of Gartner's client-server approaches in a three-tiered architecture. Here is that story.

CASE EXAMPLE

AN AEROSPACE COMPANY

A corporate enterprise systems group develops systems for use across the company. The group's goal is to never again build monolithic applications. Instead, it intends to build systems—even million-dollar systems—from off-the-shelf hardware and software components.

The Software

All the client-server systems use the same structure, with application code on the clients, data on the servers, and communication middleware shared between them. The software is written using object-oriented technology, and most of it comes from an object-oriented component library.

The Data

The heart of the architecture is a repository, which allows reuse of objects. The repository holds metadata: information about the data being used. This repository lets developers build sets of common data under the auspices of an enterprise master database, so data elements have common definitions. When in use, data are split between operational data in production systems and data warehouses, which are updated daily via replication software.

The Network

The network is an integral part of this architecture. Each company site typically has three components: desktop machines, servers, and one or more site hubs. Each of these components uses standard, plug-in

equipment; thus, the architecture can be used anywhere in the world. To cope with the increased networking demands of client-server systems, the company is migrating from Ethernet to the higher-speed Asynchronous Transfer Mode (ATM) network. The conversion takes place at each site hub.

The applications communicate to a site hub (a gateway), which plugs into the public telephone network, forming a ring structure of ATM switches. The speed of the ring is 600 mbps. (See Figure 7.)

The Architecture

The client-server architecture is remote data management, to use the Gartner terminology.^{2a} Data reside on servers, and applications reside on clients. The company chose this approach because it discovered that only 5 to 6 percent of the average PC is utilized. The company plans to use the remaining 94 to 95 percent of spare desktop capacity for application code.

The company also uses the distributed function approach, but only on a few complex systems, because this approach requires more effort than remote data management.

The distributed presentation and remote presentation approaches do not take full advantage of the spare PC capacity, so they are not used. The company also does not plan to use the distributed database approach, where databases are housed on client machines, because it is just too complex. The client machines must be polled to get the data,

(Case Continued)

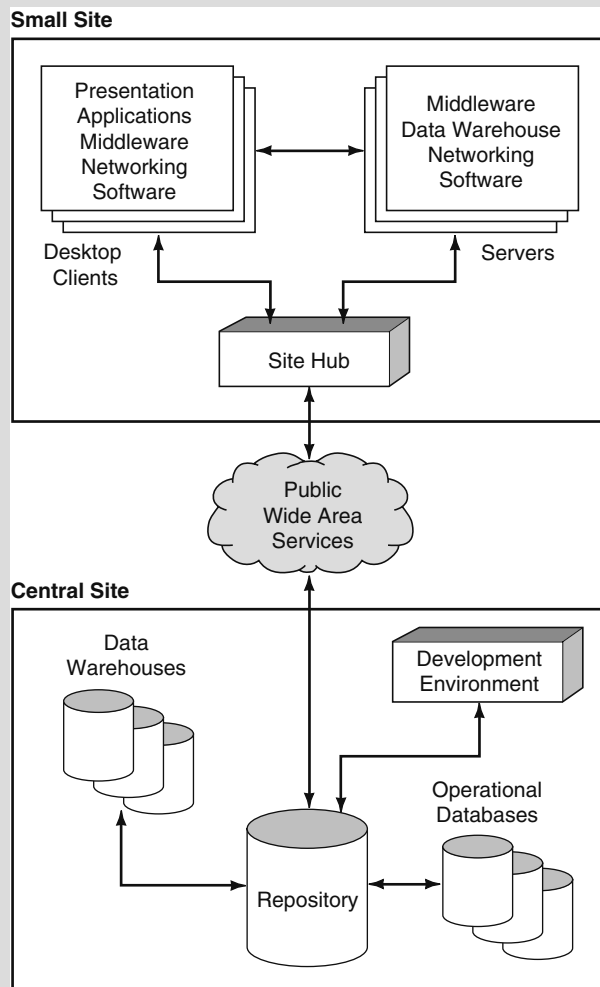


FIGURE 7 The Company's Distributed System Architecture

which is impractical except for highly structured workflow applications or conversation-oriented applications, such as IBM's Lotus Notes.

In short, the company uses the distributed function and remote data-

management configurations because they minimize total costs. The company's migration strategy has been first to build the architecture and then to build applications using as many reusable components as possible. ■

Benefits of Client-Server Computing

The benefits of client-server computing are well known. The primary ones include the ability to distribute the computing and data storage workload between client workstations and shared servers, improved customized graphical interfaces for users, and increased overall system performance and, in certain situations, reduced cost thanks to scalability.

Retail chains have also used client-server systems to look into their stores to see what is selling, what is in inventory, and what is on order. Greater precision helps them keep less stock on hand and replenish inventory more on a just-in-time basis. It also lets them more closely watch the market and react to changes faster. Client-server computing has shifted the focus of computing from keeping track of the business to using information to fulfill strategic objectives.

Client-server computing also blended the autonomy of PCs with the systemwide rules and connectivity of traditional systems. This combination reversed the role of the host and PCs. Whereas the host was previously the focus of attention, in client-server computing, PCs are. This change shifted the focus of computing to end users, empowering employees, especially those who directly serve customers.

Client-server systems have also been used to streamline workflows by encouraging people to work together via networks, giving them powerful local processing power as well as access to other people and internal and external information.

Most powerfully of all, client-server computing supports new organizational structures via its connectivity. By providing a platform that supports individuals and groups who are geographically dispersed, it allows companies to experiment with dispersed work groups. In fact, experience with these technologies and their infrastructure enabled companies to more easily take advantage of the Internet. It is like a big client-server system.

However, client-server systems have not been lower in cost than mainframe systems (as first touted), because they entail so much coordination and maintenance. What initially looked like simple connections between clients and servers has turned into large, often fragile, complex systems. Although client-server systems are easier for end users to use, day-to-day management is more complex, due to the following situations: the operating system software is distributed to hundreds of individual machines rather than a single monolithic system; the workstations are geographically dispersed with a variety of nonstandardized hardware (from scanners to desktop printers) and controlled by individual departments. There could be some additional indirect costs as well: loss of worker's productivity and exposure to additional security-related risks.

Large businesses have tried automated tools to administer workstations from a central location. Updated software modules can be installed automatically when a user is authenticated by the central servers. Also, workstations can be configured to deal with a variety of security concerns.

On a global client-server computing platform, the client-server computing can lead to organizational turmoil as the adopting organization deals with cross-boundary data, flow and cultural differences between people using the same data. The biggest challenge for effective client-server computing is thus often organizational and cultural.

Internet-Based Computing

Internet-based computing can be depicted as simply a computer that interacts with other computing devices via the Internet. Initially, it was expected that network computers—with no hard disk, just a browser, memory, keyboard, and a modem—would access the

Internet. When a network computer needed to perform a function, it would get it from the Internet. The concept of desktop network computers has not taken off, but the concept of utilizing programs on the Internet has taken hold in the handheld world. The computer field distinguishes between fat clients (typical PCs loaded with all the programs) and thin clients (devices that utilize remote programs). The thin-client concept often applies to the retrieval of small programs (applets) off the Web that are written in Java, a programming language created specifically for the Internet.

To illustrate the versatility of Java-based computing, following is a case study from IBM's Web site.³ IBM, like most vendors, has wholeheartedly embraced the integration of the Internet into business computing, using the Java language to do so. From a business perspective, Internet-based computing is the requisite for ubiquitous computing, offering new ways of doing business.

CASE EXAMPLE

IBM, NOKIA, AND SABRE: PERVASIVE COMPUTING

www.sabre.com; www.ibm.com; www.nokia.com

IBM has worked with the SABRE Group (the airline reservation company) and Nokia (the cell phone manufacturer) to create a real-time, interactive service delivered via cell phone using an open-standard, Wireless Application Protocol (WAP).

The service allows business travelers to not only receive updates from airlines (anytime, anyplace) but to even initiate changes. For example, if a meeting runs significantly over and the travelers realize they are going to miss their flight, they can request flight details using their Internet-enabled Nokia phone and make new travel arrangements. Travelers can also make or change hotel reservations, rental car reservations, and so forth. Likewise, if a flight is delayed or cancelled, the service notifies travelers so they can adjust their itineraries.

The service draws on SABRE's online corporate travel purchasing system and

Nokia's server, which transmits the travel information to a wireless network and to its Internet-enabled phones. The service utilizes XML (eXtended Markup Language), a language that allows objects to be identified by type, which is important for constructing a user's Web site screen on-the-fly, custom-tailored to that user. It also uses Java, a language for writing small applets used to deliver applications over the Internet. In this case, SABRE is using Java to translate its travel information into XML. Finally, it is using Wireless Markup Language (WML), a language for presenting XML information to Internet-enabled devices. Nokia has created an Internet micro-browser with its WAP phone.

This application of pervasive computing also illustrates the benefits of technology integration to deliver new business solutions, and the necessity of inter-organizational collaboration. Each

(Case Continued)

of the three players brings to the table a unique set of technological and business expertises—Nokia with its leading role in the Internet-enabled mobile phone technology and the creation of the WAP open standard, Sabre Holdings with its software expertise in providing travel-related information and reservation, and IBM with its application development tools capable of transporting targeted information from the Sabre system to a highly condensed form that is sent to the mobile phone. The project also has allowed IBM to release a number of new software that dynamically translates Web information—including text and images—to a format readable on a variety of Internet appliances. With virtually all new cellular phones equipped with some form of Internet access, and new technologies (e.g., mobile IPv6, IPSec for security), the application described here is just one of many potentials of pervasive computing.

Server-Based Computing. Server-based computing can be seen as a thinner-client computing style that puts all processing back onto the servers where they can be managed centrally. With more and more

employees carrying their offices with them on laptop computers, security and operational concerns have increased. Laptops do not have strong security features; updating them en masse is not easy, and even individual downloads can require help-desk support.

The solution companies are turning to is server-based computing, where applications and sensitive data reside on corporate servers rather than on the laptops. With server-based computing, applications can be securely accessed by any device, they can be updated directly on the server, and they do not have to be tailored to run on specific machines.⁴

As discussed earlier, the servers can be centrally managed, more securely, and implemented at a lower total cost than in a typical client-server configuration. However, there are fewer hidden costs in this architecture. This system design is appropriate for businesses that practice telecommuting or work-at-home when there is not much diversity in computing needs.

The following example illustrates server-based computing. ■

CASE EXAMPLE

3i
www.3i.com

Starting as a British company 60 years ago, 3i, which stands for “Investors In Industry,” is today an international venture capital firm, with a \$13.2 billion

market capitalization. By 2007, 3i had expanded its activities to buyouts, growth capital, and venture capital. To expand beyond England, the company needed to

(Case Continued)

give its investment professionals anytime-anywhere access to its systems. With this access, staff members could conduct business and complete a deal on the spot with just a laptop and a modem. To permit such location-independent remote and mobile working with up-to-date information on users' laptops, 3i turned to server-based computing.

3i called on Specialist Computer Centre in England to create new data centers in the United Kingdom and elsewhere. These centers consist of Citrix application server software installed on Hewlett-Packard servers.

Remote employees dial in to one of the centers through a secure modem service, which uses both authentication to verify their identity and encryption to jumble the messages. Using Microsoft

Windows terminal server software and Citrix software, the staff create their own virtual offices. They have secure access to 120 in-house applications, all of which are housed on a variety of devices. The sessions are managed by the Citrix software.

From the IS department's point of view, the applications are much easier to manage because the software is housed in one place. Thus, updates are made once and remote employees always use the latest version. If employees had the software on their machines, all laptops would need to be updated at once, which is a difficult task.

The arrangement has allowed 3i to expand globally and let its employees work wherever they happen to be. As of 2007, 3i had offices located in more than 14 countries. ■

Peer-to-Peer Computing

With P2P, tasks are distributed over a wide number of computers (peers) connected to the Internet. It is a grassroots movement, much like the open-source movement, but some corporations now take it seriously.

Perhaps the most controversial example of P2P was Napster, a central directory of music, and the PCs on which the music was located. Using Napster software, people could find music titles at the Napster site and then download that music from the listed PCs. Everyone swapped with everyone. Napster was infamous because the music industry contended it infringed on copyright laws by encouraging music piracy. It eventually closed down. Author Jeremy Rifkin⁵ says that the Napster dispute goes to the heart of two economies: the "old" economy that is made up of buyers and sellers and the "e-economy" that has clients and servers. Beyond Napster, practical and useful business P2P applications include file sharing, rich media sharing, instant messaging, and simulation.

A typical P2P system resides on the edge of the Internet or in ad hoc network.

- **Valuable externalities.** Many resources are pooled together through extremely low-cost interoperability, making the whole or collective information base more valuable than the sum of its isolated parts.
- **Lower cost of ownership and cost sharing.** The cost of interoperability is extremely low by using existing infrastructure and minimizing maintenance cost (or cost transferring to users).

- **Anonymity/privacy.** A P2P system can be designed to offer peers a high degree of autonomous control over their data and resources. Conversely, security is a real concern.

The issue has been how to make money in the P2P environment. Rifkin believes subscriptions will replace sales. People will pay for access rather than for ownership. Why buy one CD when you can have unlimited access to a continually growing gigantic music collection for a month? In physical markets, physical property is purchased. In networks, access to experiences is purchased. When hyperspeed and continuous change are the norm, it makes less sense to own and more sense to subscribe.

Web Services

The forms of Internet-based computing just described could be considered first-generation Internet-based distributed systems. Web Services are said to be the second generation. The term refers to software modules that have a URL, that is, an Internet address, so that they can be called upon to perform their function (as a service) via the Internet.

Drawing on object-oriented tenets, a Web Service is a computer program that makes a request of another Web Service to perform its task (or set of tasks) and pass back the answer. Gottschalk et al.⁶ call this the transactional Web, and they believe it will be dominated by program-to-program, business-to-business interactions. In essence, many Web Services calling upon each other form a highly distributed system. Such message-based systems will allow systems in one company to work with systems in many other companies without first having to hard code the links between each other. The firms can use software standards and communications protocols to make the interconnections.

Many technology experts predict that Web Services will be the ultimate form of market-driven distributed systems. Data-processing needs can be called upon on demand, and for an agreed-upon price, a sequence of Web Services can be put together to execute these needs. Traditionally, sequences of steps have had to be hardwired (pre-programmed) ahead of time. With the dynamic binding of Web Services, this decision can be made at execution time, making systems far more flexible. As such, the Internet becomes the hub of computing, which aims to ease inter-enterprise computing (something many enterprises want to avoid because of large infrastructure costs). Web Services can possibly release companies from having to build and maintain so much software in-house. The promise is that they can rent functionality via Web Services either on a subscription basis or as needed. Web Services will draw on existing systems.

Web Services can be used as a wrapper technology. Companies can wrap (encapsulate) some functionality from an existing application in an XML envelope and expose it for use by others by publishing its existence in a special directory. (Two new terms used in the Web Services world are “wrapping” and “exposing.”) Thus, a bank with a credit authorization system can publish it as a Web Service that others can use, for a fee. Or a company that allows customers to configure their own product online (e.g., a computer, a bicycle, a car) may actually be using a Web Service (built in-house or obtained from a third party) to offer that functionality on their Web site to people or to the computers of, say, their largest customers.

Needless to say, vendors are now vying to be the providers of the platforms on which Web Services run. Companies are experimenting with Web Services, either to test out this loosely coupled, service-oriented architecture in-house or with a trusted trading partner.

Web Services Standards

The world of Web Services will be possible because of three software standards (XML, WSDL, and UDDI) and three communication protocols (SOAP, HTTP, and TCP/IP), note John Hagel and John Seely Brown of 12 Entrepreneur⁷.

- **XML (eXtended Markup Language).** XML is a language for describing data in a standardized way so that different applications can use the same data. Web Services are created by wrapping XML around a piece of software that performs a function. The XML wrapper describes the services its bundle provides.
- **WSDL (Web Services Definition Language).** Web Services make themselves known by publishing their description in an XML document using WSDL. This service description describes the service, how to make a request to it, the data it needs to perform its work, and the results it will deliver. WSDL provides the standard language for creating these descriptions so that they can be understood by Web Services requestors.
- **UDDI (Universal Discovery, Description, and Integration).** The descriptions are stored in a UDDI registry, a “yellow pages” of Web Services. An application or a Web Service can find another Web Service by either knowing its URL or by searching UDDI repositories for services that meet the parameters it seeks.
- **SOAP (Simple Object Access Protocol).** Web Services communicate using SOAP, an XML-based communication protocol that works over any network and with any equipment. A Web Service interacts with another by sending a request for service to that other Web Service, “directly binding to it and invoking it,” state Gottschalk et al.⁶ The two do not have to be preprogrammed to work together. Web Services can be combined in any pattern of use.
- **HTTP (Hypertext Transfer Protocol).** Web sites have addresses that use the HTTP protocol. Web Services draw on this same protocol to indicate the address where they can be located.
- **TCP/IP (Transmission Control Protocol/Internet Protocol).** The Internet is true to its name; it is a network of networks because it uses a protocol that permits transmitting messages across networks. This protocol is TCP/IP, and it is the protocol used by Web Services as well.

The Significance of Web Services

Hagel and Brown,⁸ two leading thinkers in the IT field, believe Web Services offer the computing architecture of the future, and thus will significantly change the job of CIOs. Rather than own and maintain their own systems, companies will buy their IT as

services over the Internet. Thus, within the next few years, old assumptions about managing IT will be overturned.

Web Services offers a completely new IT architecture, one based on the Web and openness. Rather than build proprietary systems, companies can obtain the functionality they need from the Internet. Some Web Services will be proprietary, some public; some will be subscription based and others on demand.

Hagel and Brown see a three-tiered Web Services architecture:

1. Application services are the top tier. These perform specific business activities, such as credit card processing, shipment scheduling, or loan risk analysis.
2. The service grid is the middle tier. It provides utilities used by the application services. One type of utility is shared utilities, such as security utilities (to authenticate requestors and authorize access), and billing and payment utilities (to handle charges for using a Web Service). Another type of utility is service management utilities, which handle the management and billing of Web Services. Resource knowledge management utilities, a third type, provide directories and registrars for requestors and services to find one another and interact. Transport management utilities, a fourth type, handle messaging and transportation of files. Until this service grid is robust, though, companies will not use Web Services for their critical business activities because they will not have a trusted environment for running important systems.
3. Software standards and communication protocols (the six listed earlier) reside in the bottom tier. They provide the foundation for the utilities and the application services. Without these standards and protocols, Web Services cannot speak the same language nor connect.

To illustrate the potential of Web Services, consider a loan application. Rather than have one large, integrated, in-house application that handles all the steps in the loan approval and funding process, each step in a Web Services environment will be performed by a different Web Service. In fact, the Web Services will be so specialized that the most appropriate one can be chosen at each processing step in real time. Hence, the application data from a hospital will be sent to a Web Service specializing in risk analysis of hospital loans, whereas the data from a restaurant will be sent to the service that specializes in restaurant risk analysis. Each of these Web Services may draw on other specialized functionalities to do even more specialized processing, depending on the data in the application and the amount of the desired loan.

This feature permits the handling of a huge variety of possibilities by mixing and matching. In addition, it will allow easier cross-company system linking. As a result, companies only pay for the functionality they use when they use it, which reduces the number of IT assets companies need to house and maintain in-house. The providers handle the maintenance of their own services and are forced to stay abreast by the competitive nature of the Web Services marketplace.

Moving to Web Services will require organizational changes in IS. It will require the outsourcing of IT activities to providers (as they emerge) and the designing of their own Web Services offerings based on their enterprise's business acumen. Following is an example of what one enterprise is doing.

CASE EXAMPLE

GENERAL MOTORS

www.gm.com

General Motors formed eGM in 1999 to explore how it should interact with car buyers using the Internet. For three years, eGM was run by Mark Hogan, who gave innumerable speeches describing the progress his business unit was making. eGM was then folded into GM's IT organization and Hogan was promoted. Hagel and Brown point out that during his tenure at eGM, Hogan became a strong advocate of the Web Services architecture, going so far as to believe it could be used to move GM from its supply-driven, build-to-stock business model to a demand-driven, build-to-order business model. That change would be an enormous (some say impossible) feat.

eGM began modestly building Web sites to connect GM to both consumers and dealers. Moving to a demand-driven business model (where every vehicle is built for a specific customer after the customer orders it) would require GM and its 8,000 dealers to collaborate electronically and quite differently. There would be no way to shift the business this dramatically using conventional IT architectures because that would require standardizing the systems used by the dealers, which was too costly a task for GM and its dealers to consider.

However, Web Services provides a way to create such a new business platform without replacing the disparate systems the dealers use or trying to get them all to agree to standard new systems.

By exposing existing (and new) functionality in both GM and dealer systems using the Web Services standards, GM can roll out new business processes incrementally at a reasonable cost.

GM began the evolution by first enhancing its existing supply-driven model, state Hagel and Brown, offering new functions via a Web Services architecture. For example, it offers a locate-to-order Web Service to dealers, which allows them to easily find a specific car a customer might want in the inventory of other GM dealers. Another Web Service is order-to-delivery, which shortens the time to deliver a custom-ordered vehicle. Through such incremental steps, GM "paves the way," state Hagel and Brown, to eventually convert to a make-to-order business model.

By taking this incremental route on this new platform, GM can achieve payback with each new Web Service, hopefully avoiding the huge disruption that an abrupt traditional system change would cause, and evolve as the Web Services model evolves. Economically, achieving this goal brings enormous paybacks, note the two authors. GM could cut its \$25-billion inventory and working capital in half and potentially shave \$1,000 off the cost of each vehicle. Furthermore, by gradually evolving new processes and adopting shared terminologies and meanings, GM and its dealers can influence their parts suppliers as well, fostering industry-wide change. ■

The seven systems discussed in this section are the different types of distributed systems that have emerged. To conclude this chapter, we come back around to the beginning of the chapter and discuss the subjects of architecture and infrastructure.

The Future of Distributed Computing

Perhaps one of the most futuristic trends of distributed computing is that it lays the foundation for a possible global intelligence. The architecture of a global intelligent network will undoubtedly be quite convoluted. Many business applications will increasingly depend on external sources of knowledge (e.g., data and processes). The global intelligence will be compartmentalized, with many independent components, separated from each other by business ownerships, privacy, and security-related interests. However, most of the building blocks of this global structure already exist: Communication protocols, collaborative filtering schemes, authentication algorithms, and computational economies will help the world's computing platform evolve into an interconnected source of digital intelligence.

DEFINING THE OVERALL IT ARCHITECTURE

An architecture is a blueprint. It shows how the overall system, house, vehicle, or other product will look and how the parts interrelate. As Roger Woolfe and Marcus Bloch note in their Gartner EXP report "IT Architecture Matters,"^{2b} the intent of an IT architecture is to bring order to the otherwise chaotic world of IS by defining a set of guidelines and standards and then adhering to them. Designing a system architecture used to be considered strictly a technical issue. More and more, though, because the architecture needs to support how the company operates, it reflects the business strategy. Furthermore, as the business changes, the architecture needs to keep pace.

The Job of Chief Technology Officer

Due to the increased importance of IT architectures, the job title of chief technology officer (CTO) or chief architect has appeared. The CTO is generally the chief architect and reports to the CIO, who is in charge of the use of IT. In a few cases, CIOs have changed their title to CTO to emphasize their role as the technical head within their firm.

In the dot-com world, the title CTO was far more prevalent than CIO because these CTOs viewed CIOs as the executives who ran traditional IT organizations, including operations and maintenance. These CTOs preferred the title CTO to reflect their more strategic role as chief architect of the company's Web presence. Furthermore, most dot-coms began life outsourcing all or most of their IT operations, so the CTO title appeared more appropriate. The dot-coms that have survived, though, now have CIOs at the helm because the job has broadened beyond the architectural aspects of IT.

An Enterprise Architecture Framework

For more than 25 years, John Zachman,⁸ an independent consultant, has been preaching the value of enterprise architecture and the modeling of data, processes, and networks. He offers one of the most comprehensive views of this subject we have seen, so we briefly describe it here.

The real world (an airplane, an enterprise, or a skyscraper) is so complicated that we cannot get our brain around it at one time, so we abstract out single concepts and variables. To completely describe an IS architecture, we need to look at the roles people play and the components they deal with. Together, these create the rows and columns of a framework.

The Rows: Planner, Owner, Designer, Builder, Subcontractor, and Consumer or User

No single architectural representation is available for an information system because building complex products requires six roles: planner, owner, designer, builder, subcontractor, and consumer: six perspectives, six models. For instance, an airframe manufacturer needs a statement of the objectives for the planner, an architect's drawings for the owner, an architect's plans for the designer, a contractor's plans for the builder, and detailed representations for the subcontractors. The completed airplane is the consumer's view. The same is true in IT. An information system needs a scope statement, a model of the enterprise, a model of the information system, a technology model, and a description of the components to produce the finished functioning system. These components make up the rows in Zachman's enterprise architecture framework, shown in Figure 8.

Each role has its own constraints. For instance, the owner is constrained by the use of the end product. The designer is constrained by physical laws. The builder is constrained by the state-of-the-art and the technology available. For these reasons,

FIGURE 8 An Architectural Framework

	DATA (WHAT)	FUNCTION (HOW)	NETWORK (WHERE)
Scope Planner			
Enterprise Model Owner			
Information System Model Designer			
Technology Model Builder			
Components Subcontractor			
Functioning System Consumer or User			

Source: Adapted from John Zachman, Zachman International, 2222 Foothill Blvd., Suite 337, LaCanada, CA 91011.

Designing Corporate IT Architecture

FIGURE 9 Enterprise Architecture—A Framework

	Data	What	Function	How	Network	Where	People	Who	Time	When	Motivation	Why
Objectives/Scope (Contextual)		List of things important to the business		List of processes the business performs		List of locations in which the business operates		List of organizations/agents important to the business		List of events significant to the business	List of business goals/strategies	
Planner	Ent = Class of business thing		Function = Class of business process		Node = Major business location		Agent = Class of agent		Time = Major business event		Ends/Mean = Major bus goal/critical success factor	
Enterprise Model (Conceptual)	e.g., Semantic model		e.g., Business process model		e.g., Logistics network		e.g., Organization chart		e.g., Master schedule		e.g., Business plan	
Owner	Ent = Business entity Reln = Business relationship		Proc = Business process IO = Business resources		Node = Business location Link = Business linkage		Agent = Organization unit Work = Work product		Time = Business event Cycle = Business cycle		End = Business objective Means = Business strategy	
System Model (Logical)	e.g., Data model		e.g., "Application architecture"		e.g., Distributed system architecture		Agent = Role Work = Deliverable		e.g., Processing structure		e.g., Knowledge architecture	
Designer	Ent = Data entry Reln = Data relationship		Proc = Application function IO = User views		Node = I/S function (processor, storage, etc.) Link = Line characteristics		Agent = Human/technology interface		Time = System event Cycle = Processing cycle		Ends = Criterion Means = Business rules	
Technology Model (Physical)	e.g., Data design		e.g., System design		e.g., System architecture		Agent = User Work = Job		e.g., Control structure		e.g., Knowledge design	
Builder	Ent = Segment/Row/etc. Reln = Pointer/Key/etc.		Proc = Computer function IO = Screen/Device formats		Node = Hardware/system software Link = Line specifications		Agent = Security architecture		Time = Execute Cycle = Component cycle		Ends = Condition Means = Action	
Detailed Representations (out-of-context)	e.g., Data definition		e.g., Program		e.g., Network architecture		Agent = Identity Work = "Transaction"		e.g., Timing definition		e.g., Knowledge definition	
Sub-Contractor	Ent = Field Reln = Address		Proc = Language stmt IO = Control block		Node = Addresses Link = Protocols		Agent = Identity Work = "Transaction"		Time = Interrupt Cycle = Machine cycle		End = Subcondition Means = Step	
Functioning System	e.g., Data		e.g., Function		e.g., Network		e.g., Organization		e.g., Schedule		e.g., Strategy	

Source: Adapted from John Zachman, Zachman International, 2222 Foothill Blvd., Suite 337, LaCanada, CA 91011.

six models, rather than one, are needed, and they need to be kept in sync through configuration management.

The Columns: Data, Function, Network

Another significant factor is the lack of a single graphical representation for the components of a complex information system. As in engineering, systems need three components: data models (What is it made of?), functional models (How does it work?), and network models (Where are the components located?). These represent the physical manifestations of the system.

In addition, systems need a who (people), a when (time), and a why (motivation). These three elements represent the soft side of systems. Together, the six are all we need to know to build a complex system. So, the good news is that defining an enterprise architecture is not an infinite problem. The bad news is only a few might have done it. The entire enterprise architecture framework is shown in Figure 9.

Using the Framework

The cells in the framework contain models that can be used to describe any complex thing—an enterprise, an airplane, even a bicycle. All of these models exist; the question is whether an enterprise spends the time to make them explicit.

For instance, your organization has a data model, whether it has been explicitly defined or whether it just grew haphazardly without an underlying design. That model is intended to work as your enterprise works. A problem occurs, though, when IT or users bring in a package that follows a different data model. If the rules in that model are inconsistent with the rules in your company, you will either spend a lot fixing the package, says Zachman, or you will require people to change how they work to be consistent with the package. Models are important because they allow people to properly evaluate packages. They also help builders align with what owners want. And they can help companies realize what changes need to be made when they move to a new business model, such as deciding to reorganize around customer groups rather than around products.

The most important reason to make a firm's enterprise system architecture explicit is to be able to make changes to the enterprise and not disintegrate as those changes are made.

To better understand IT architecture development, consider the case of FMC, noted in Woolfe and Blosch's Gartner EXP report.^{2b}

CASE EXAMPLE

FMC CORPORATION

www.fmc.com

FMC, with headquarters in Philadelphia, Pennsylvania, is a global \$2.3-billion chemical manufacturer with 5,000 employees focusing on three areas: agricultural,

industrial, and specialty chemicals. It is first or second in the areas in which it competes, and half its sales come from outside the United States.

(Case Continued)

In 2000, FMC was a \$4-billion conglomerate. In 2001, it split into two equal halves: FMC (to focus purely on chemicals) and FMC Technologies. IS spent all of 2001 pulling the IT architecture apart. The deadline for establishing separate IS operations was January 1, 2002.

Designing Two New IT Architectures

FMC outsources its telecommunications, data networking, voice mail, Web hosting, virtual private networks, remote access, and some data-center operations. It worked with its outsourcers to pull the infrastructure apart and designed two new IT architecture infrastructures. Headquarters was moved from Chicago to Philadelphia, yet no IS staff moved; FMC now has 130 IS headquarters staff.

The CIO, Ed Flynn, created a new position to report directly to him: Architecture and Technology Director. During 2001, this director had a virtual organization. He led five subteams—data, applications, integration, desktop, and platform—each with five to six team members from FMC and FMC Technology IS staffs. In addition, he supervised an emerging technologies subteam to look out into the future. None of the team members was full-time on a team; they also had their day-to-day jobs.

The five teams' tasks were to

- Describe the "today architecture" (inventory their area)
- Define the "tomorrow architecture" (how their area would look on January 1, 2002)
- Detail the "next-minute steps" (how to get from today to tomorrow)

They accomplished their task in 2001 with only a few transition service

agreements on January 1 (where FMC and FMC Technologies would buy services from one another).

Lessons from the Work

"The split taught us we could get workable solutions by having subteams with subject matter experts define the technical architecture, and overlay them with an architecture steering team to add the enterprise and business viewpoints," says Flynn. The top team consisted of Flynn and some of his direct staff members. They implemented some of the recommendations from the subteams and took those requiring corporate action to senior management.

Another lesson from the effort was that the "today architecture" can be created by IS staff. However, it then needs to be put into a framework the business folks can understand, because they need to help define the "tomorrow architecture." Then the work continues as a joint effort to define the "next-minute steps."

"Before the split, we had already standardized on SAP as our transaction backbone and on Windows for our desktops and laptops. But getting those standards was a brutal fight—probably because we were our own worst enemy. We had not defined 'tomorrow,' so everyone's 'today' answer would work," says Flynn.

"When we have a tomorrow architecture, and everyone agrees on it, we have fewer next-minute battles because the architecture limits the choices. We saw this happen in the corporate split. Once we agreed on the tomorrow architecture, we were no longer the people who said 'no.' Being a purely chemical company now also helps us with standardization," says Flynn.

(Case Continued)

Because the chemical business is so cost competitive, FMC wants low-cost IT; therefore, the operating policy is to use common tools, common processes, and replicable solutions. “You have to architect to be able to do that,” says Flynn.

Designing the “Tomorrow” IT Architecture

Flynn’s organization is now using the same approach, starting with a clean slate, to architect a new tomorrow IT architecture. If they can pull the corporate architecture apart in one year, they believe they should be able to lay out a new tomorrow architecture in a year, even though the scope is broader. The new architecture will include applications in the operating units to include Voice-over-IP and Web Services.

The organization for the current architecture effort is the same as the one used for the split—the same subteams,

the same steering committee. In fact, some of the business folks who helped support SAP after implementation in the mid-1990s stayed in IS and have been on the architecture efforts, bringing their business knowledge with them.

Once the new architecture is defined and bought off by senior management, it will be communicated and implemented via FMC’s capital planning process. The expenditures must track the defined next-minute steps, some of which could have time frames attached to them. “We may even get to the level where we talk about standards, and all purchases will have to adhere to these standards,” says Flynn.

Flynn envisions this rearchitecting process as being ongoing. Each new effort will start with today as its reference point, draw on the work of the emerging technologies group to peer into the future, and create a new “tomorrow” architecture. ■

Service-Oriented Architecture

As noted, the importance of an architecture is that it spells out the relationships among the components of an airplane, bicycle, building, system, and such. In information systems, the architecture spells out how the software components interact with each other. In the past, these interactions have been hard coded point-to-point (one to another); this is efficient, but costly to maintain. Changing one component might require changing the others that interact with it.

An emerging system architecture has caught the attention of the field because it moves these interactions away from being hard coded and point-to-point: Service-Oriented Architecture (SOA). SOA is a form of distributed computing and modular programming. Its fundamentals parallels that of Web Services because it uses the same architectural concept and it can be implemented with Web Services.⁹

Rather than think about how to get information out of one system and into another, this architecture thinks about how to expose the data and functions in a way that other systems can easily use—as a service in a wrapper with a well-defined interface that performs a business process. The wrapping hides the technical complexities developers have had to incorporate in their point-to-point interfaces. Ideally, one service would open a new account, another would update a customer account, a third

would close an account, and so on. Applications that needed to provide one of these services would use the existing one, rather than their own version.

The current thinking is that an SOA might finally allow IT developers to create reusable code, which has long eluded IS organizations. The goal is to be able to quickly assemble a large set of software modules or functionalities, arranging them in such a way that they meet the needs of ad hoc applications.

An additional benefit of this architecture is that CIOs can leverage their past systems investments, because functions in legacy systems can be exposed as services and then used in new applications. Thus, SOA supports the integration of heterogeneous systems, which has bedeviled IS organizations for years. SOAs also can help CIOs converse with their business peers because the services are essentially business processes, rather than IT services. Discussions about systems are about the business, rather than the technology.

SOA also addresses the need for IS organizations to be more agile, that is, able to more quickly build systems to address new business needs. Each service can be upgraded to use a new technology without affecting the other services. Companies can build on the systems they already have and continually upgrade either technologies or the use of SOA piecemeal, rather than in one fell swoop. In short, SOA is evolutionary, not revolutionary. That is why it is attracting so much attention.

To briefly delve into the jargon, to achieve the much-desired code reusability an SOA must support loosely coupled, coarse-grained, standards-based interactions. This means, first, that a requestor of a service must simply know where to find it (loose coupling) rather than have a preprogrammed link to it (tight coupling). Second, the interactions must be at the business-service level (coarse grained), rather than at the technical-function level (fine grained). And third, the interactions must use interfaces based on industry standards that have been adopted by vendors so that they work across proprietary platforms (standards based).

An SOA can achieve loose coupling between services in several ways. The most recent is to create the services using Web Services protocols (discussed earlier). Although CIOs may eventually migrate to this option, Web Services is still so new that the pioneers have generally not taken this route. A second alternative is to use a publish-and-subscribe approach, which is what Delta Air Lines has done. A third is to implement messaging-and-integration middleware. Credit Suisse has used the concept of an “information bus” to build its SOA.

CASE EXAMPLE

CREDIT SUISSE

www.credit-suisse.com

Credit Suisse, with headquarters in Zurich, Switzerland, is a global financial services company with 45,000 employees operating in 50 countries. With the CIO

as a Group Board member, Credit Suisse has pioneered the implementation of enterprise-wide SOAs. Its former architecture depended on proprietary middle-

(Case Continued)

ware. Maintenance had become increasingly expensive, because as the number of computing platforms and technologies grew, so did the number of interfaces and the amount of time needed to change the interfaces when applications changed. To address this maintenance problem, Credit Suisse revamped its IT infrastructure to be a service-oriented architecture by implementing two “information buses”—a service bus and an event bus.

The Service Bus

The front-end bus, that is, the bus that integrates front-end and back-end applications, is the service bus. The architecture uses Orbix from Iona Technologies, which is a set of tools for integrating applications that run on mainframes, Unix, and Windows platforms.¹⁰ Through Orbix, Credit Suisse is reusing business procedures, business logic, and data formerly locked up in its applications.

The service bus takes a request-reply approach. Through Orbix, each business service is exposed by being stored in a central repository. When a front-end application has a request, it triggers a call to Orbix, which sends the request to the appropriate business service and waits for a reply (from a back-end application), which it then forwards to the requesting application. Thus, the bus uses a demand-pull model—the request from one application pulls the reply from another.

Credit Suisse took this approach so that it could integrate the software functions housed in the multiple generations of technology it has in-house, by presenting its core business applications as a collection of reusable business services. The SOA gives it a way to design new applications that draw on these business services using a documented interface. Because of

the interface, developers do not need to worry about the software or database underlying each business service.

The Event Bus

The event bus integrates the back-end systems. It also uses a service-oriented architecture, but it uses a supply-push mode of operation, implemented using publish-and-subscribe. When an event occurs in one system, it is “published.” All of the systems that need to know about that event are “subscribed” and are notified of the event that has taken place (the update is pushed to them). An event is a change in the state of an object, such as a customer. Credit Suisse has developed specific message types to run over the event bus; each is for a different type of event. The purpose of the event bus is to ensure that all systems are using the same up-to-date data. It connects all back-end systems: host applications, ERP systems, new nonhost applications, databases, data warehouses, and external data feeds.

A typical use of the event bus is to replicate the data in Credit Suisse’s customer information file from its legacy application (developed in-house) and to copy it to a trading application that stores its own copy of these data. The event bus also allows Credit Suisse to transform the data between applications (that is, convert it from the format used in one system to that used in another) and to route data based on their content. The event bus was built using IBM technologies (Websphere MQ/Integration Broker).

Benefits

The SOA effort began in 1999. By the end of the year, Credit Suisse had five SOA-based applications drawing on 35 business services that were being used by

(Case Continued)

800 users. The numbers have grown since then. Two years later, it had 50 applications running on the information bus, drawing on 500 business services and being used by 15,000 internal users. In addition, customers using Credit Suisse's online trading and Web-based e-banking applications generated some 15 million invocations of the SOA-based business services each week.

Soon after, well over 100 applications were using 800 services, invoking 800 million transactions per year on the service bus. Actually, it is no longer quite clear what an application is, but these figures give a feel for the high processing

volumes. The event bus, implemented in 2003, integrates over 32 back-end systems and handles over 1 million messages a day.

Credit Suisse was able to implement the architecture without disrupting applications. The effort was a major investment, but the company can now implement new applications much faster. In fact, it has found that some 80 percent of the business services needed in new applications are already in existing applications. Credit Suisse believes its development speed allows it to respond to customers' requests for new financial services faster than its competition. ■

INTER-ORGANIZATIONAL IT ARCHITECTURE AND DIGITAL SOCIETY

Peter Weill and Marianne Broadbent¹¹ describe the structure of the IT infrastructure; how local, firmwide, and public infrastructures mesh; and the different ways companies justify infrastructure investments. Such investments are a vital part of corporate IT portfolios, yet they are the most difficult to cost-justify beforehand and to measure benefits of afterwards.

The Structure of the IT Infrastructure

Weill and Broadbent define IT infrastructure as "the shared and reliable services that provide the foundation for the enterprise IT portfolio." The shared characteristic differentiates an IT infrastructure from IT investments used by just one function. On top of this infrastructure sit applications that perform the business's processes. Thus, infrastructure does not provide direct business performance benefits. Rather, it enables other systems that do yield business benefits, which is what makes infrastructure so difficult to cost-justify.

Weill and Broadbent divide the IT infrastructure into four layers, as shown in Figure 10, underlying local applications. Local applications are fast changing. They include such applications as an insurance claims system, a bank loan system, or a customer service support system. Due to their fast-changing nature, they are not part of the infrastructure, but they do draw on it.

It is easiest to understand their view of infrastructure reading from bottom to top because that order describes it from the technologists' point of view to the business users' point of view. Weill and Michael Vitale,¹² of the Australian Graduate School of

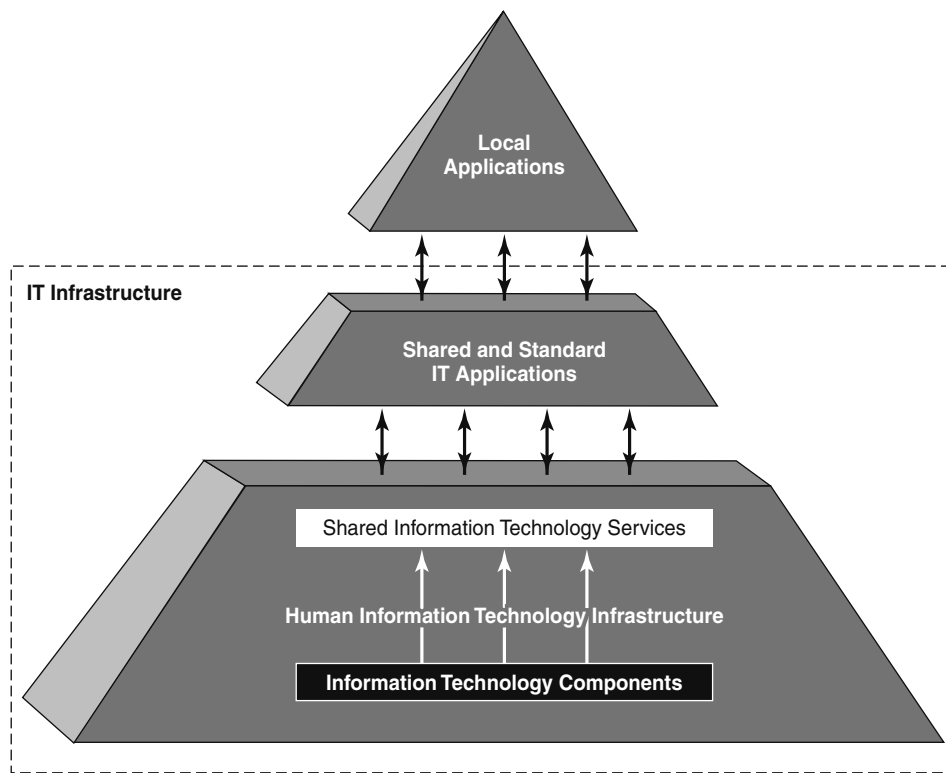


FIGURE 10 The Structure of the IT Infrastructure

Source: Adapted from Peter Weill and Marianne Broadbent, *Leveraging the New Infrastructure: How Market Leaders Capitalize on IT* (Boston: Harvard Business School Press, 1998).

Management, present the following description of the infrastructure layers, from bottom to top, which discusses the infrastructure capabilities needed by e-business models:

- **IT Components.** This layer is the foundation of a firm's IT infrastructure. It consists of technology components, such as computers, printers, DBMS packages, operating systems, and such. Whereas technologists understand the capabilities of these components, businesspeople do not. That is why IT and businesspeople have had such a difficult time talking about infrastructure at this level. They are not speaking a common language, note Weill and Vitale.
- **Human IT Infrastructure.** The translation of the IT component layer into business terms occurs at this layer and is handled by humans. This layer consists of experts' knowledge, skills, experience, and standards to bind IT components into services that businesspeople can understand.
- **Shared IT Services.** This layer is the business view of the IT infrastructure, and it presents the infrastructure as a set of services that users can draw upon and share to conduct business. Weill and Broadbent's recent refinement, working with Mani Subramani of the University of Minnesota,^{2c} identifies 70 infrastructure services grouped into 10 clusters. Examples of services are Web sites,

Designing Corporate IT Architecture

wireless applications, firewalls on secure gateways, and large-scale data-processing facilities.

- **Shared and Standard IT Applications.** These applications, which are at the top of the IT infrastructure, change less regularly than the fast-changing local applications above the infrastructure. They include such stable applications as accounting, budgeting, and HR.

Again, the importance of this four-level description of IT infrastructure is that it gives technologists and business users a common language. Business users can discuss where they need specific services, and technologists can translate those services into the technical components that underlie them.

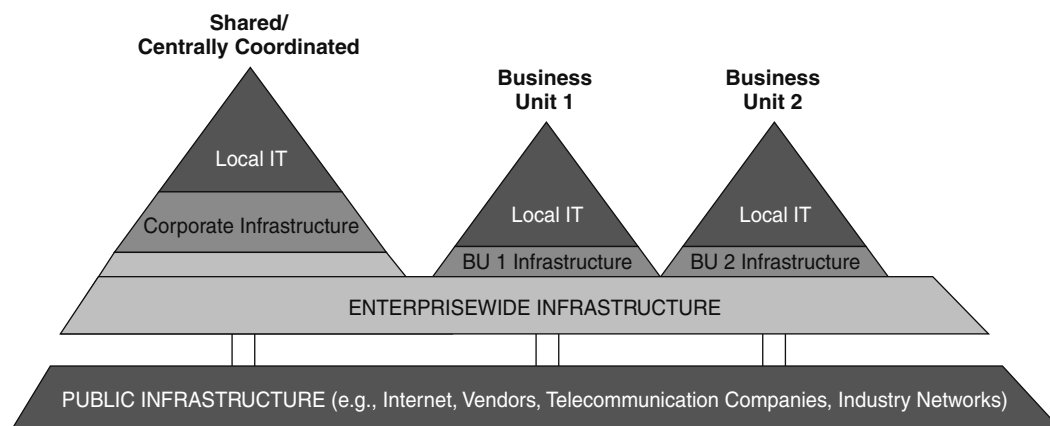
To take this infrastructure discussion a bit further, Weill and Broadbent note that it sits on top of the public infrastructure, as shown in Figure 11, that is, the Internet, industry networks, vendors, and telecommunications companies. Also note in this figure that in some cases the firmwide infrastructure provides corporate-wide services. In other cases, it provides infrastructure for individual business units.

Similar to Public Infrastructure

IT infrastructure is strikingly similar to public infrastructure, such as roads, hospitals, sewers, and schools, note Weill and Broadbent.

- Both are provided by a central agency and funded by some form of taxation.
- Both are long term and require large investments.
- A central agency provides an essential service that users are not motivated or able to provide.
- Both enable business activity by users that would otherwise not be economically feasible.
- Flexibility is valued in both because they must be in place before the precise business activity is known.

FIGURE 11 IT Infrastructure



Source: Adapted from Peter Weill and Marianne Broadbent, *Leveraging the New Infrastructure: How Market Leaders Capitalize on IT* (Boston: Harvard Business School Press, 1998).

- Both are difficult to cost-justify in advance as well as to show benefits in hindsight.
- Both require a delicate investment balance: Too little investment leads to duplication, incompatibility, and suboptimal use, whereas too much discourages user investment and involvement and may result in unused capacity.

Three Views of Infrastructure

The benefits a firm actually realizes from its infrastructure investments depend on its objectives for the infrastructure. A firm might invest in infrastructure for the following three reasons:

1. Economies of scale (utility)
2. Support for business programs (dependent)
3. Flexibility to meet changes in the marketplace (enabling)

Utility

Companies that view their infrastructure as a utility see it as a necessary and unavoidable service that must be provided by IS. Expected benefits are cost savings achieved through economies of scale. Normally, firms with this perspective treat infrastructure costs as an administrative expense, and they act to minimize these expenses. Therefore, they offer the fewest infrastructure services. For instance, they might promote use of networks for messaging but not as part of inter- or intra-organizational business processes. This objective requires the lowest investment, but it also only results in lowering costs (not in reengineering the business). Outsourcing may be viewed favorably because the IT infrastructure is not seen as strategic.

Dependent

A business that ties its infrastructure investments to specific, known business programs, takes the dependent view. The infrastructure is treated as a business expense because investments are tied to business plans, and its value is measured by short-term business benefits. Firms with this view include infrastructure planning in current business planning. They also see the network as critical. Furthermore, this view of infrastructure appears to smooth the way for simplifying business processes. In fact, Weill and Broadbent surmise that this view is a minimum requirement for successfully implementing business process reengineering.

Enabling

A firm that develops and continually modifies its infrastructure in co-alignment with its business strategy—where infrastructure influences strategy and vice versa—takes the enabling view of infrastructure. The primary benefit is long-term flexibility, thus the firm does not limit infrastructure investments to current strategy. The infrastructure is intended to provide the foundation for changing direction in the future, if need be. Thus, infrastructure costs are seen as business investments. For example, the firm might use networks extensively in business processes, both within the firm and with customers and suppliers.

Needless to say, the appropriate viewpoint is not a technical decision; it is a top management decision. It is IS management's job to make this clear to senior management and show them the options. Teamwork among the various levels of management is absolutely necessary to align technical investments with business strategy.

No view is superior, though; different views are appropriate for different strategies. Moving from utility to dependent to enabling increases up-front investments and the number of IT infrastructure services provided.

The Digital Economy

The three views of infrastructure discussed previously lay the foundation toward the creation of the digital economy. Driven by technological innovation, the digital economy is characterized by new business models, new products and services, new business processes, new means of communication, and new forms of community. The digitization of the global economy has evolved in three phases. First, the advent of computers revolutionized data processing and fundamentally changed the way most businesses operate. In the second phase, the increasing power of micro-processors and their diminishing costs have made it possible for engineers to develop a wide variety of electronic appliances—from low-cost notebooks for elementary schools to advanced Internet appliances. In fact, there are more chips installed in stand-alone applications (e.g., kitchen microwaves, treadmills, GPS navigation systems) than on computers. The third and current phase is the exponential growth of electronic commerce. According to the U.S. Census Bureau of the Department of Commerce, in 2005, e-commerce grew faster (17%) than total economic activity (8%) in three sectors: manufacturing, merchant wholesale trade, and retail trade. E-commerce sales in the first quarter of 2007 accounted for 3.2 percent of total sales (\$31.5 billion). This is a significant increase from two years before, \$19.8 billion during the first quarter of 2005.

With the growth of electronic commerce, businesses should expect faster productivity growth, increasing importance of immaterial assets (e.g., services in the knowledge-based economy), and fiercer competition in a global scale with less friction (shrinking distance and time). Thus, it is important that CIOs take into consideration the emerging digital economy to design and implement their IT corporate infrastructure.

Corporate IT Infrastructure in the Digital Economy

As discussed throughout this chapter, ubiquity and networking are important elements in the new economy. They are important for a firm to remain competitive. They are important for a firm that seeks cooperation on a global scale. The point here is that CIOs should help guide their organization to become a proactive entity of the networked economy. A proactive business is one that knows how to exploit Internet-enabled technologies to set up an IT infrastructure that best supports its business strategy in the digital economy. The strategies can be:

- **Extended enterprise:** An extended enterprise is one that is composed of not just its employees, managers, and shareholders, but its suppliers and customers. The IT infrastructure is an interconnected network of information to help all members make better decisions and coordinate business processes in such a way that improves the overall performance. Thus, the focus here is Internet-supported supply-chain management and value creation through effective information management.
- **Strategic alliance:** Alliances allow participating organizations to share resources, enhance their competitive position, and internalize the unique strengths of each of the partners. Alliances typically get created for research and

development, technical exchange, co-production, and sale distribution. While traditional ventures are asymmetrical, strategic alliances are more symmetrical in that collaboration. As many industries are getting mature and their prospects for growth become low, combined skills to foster innovation while sharing R&D costs are becoming pressing. Many giant organizations such as Boeing, General Electric, IBM, and Rockwell have formed strategic alliances. An enterprise IT solution is required to support collaborative work between partners. Shared data and processes must be seamless while protecting proprietary data of the members. CIOs should explore the use of knowledge management and infrastructure integration skills and adoption of embedded software, middleware, and business software to develop a project-specific, net-centric and integrated computer platform based on existing infrastructures.

- **Virtual Organization:** In a virtual organization, members are geographically apart, likely independent and legal entities, but working together as a single, productive, unified organization with a real physical location, seeking to achieve a well-defined task. Once the task is completed, and the mission is over, the virtual organization is dissolved until a new task is called for. Technology to support a virtual organization can be simple office automation tools (word processing, spreadsheet, databases, workflow management, project management software), communication software (e-mail, bulletin board, Web portal), and enterprise software (CRM, ERP). Beyond the normal business context, a well-documented and science-fiction-like example of a virtual organization is Second Life, launched in 2003 but known to the public only a few years later. A viewer (“residents”) can use a downloadable client program to see other people, socialize, participate in individual and group activities, and trade items and services. As of 2007, there were more than 8.5 million registered “residents” or accounts.

The concept of a virtual organization further illustrates the trend toward a dynamic world where speed and efficiency are key for survival, as well as profitability. Again, a network-enabled IT infrastructure is the essential technology.

CONCLUSION

Distributed systems dominate the computing landscape, with the Internet now at the heart. Distributing processing, databases, and communications allow companies to move more quickly because they can more easily snap in new products and services into their existing systems. The advent of Web Services is fueling the use of the Internet to extend the tenets of distributed systems even further.

The Internet turned attention outward because it provides the infrastructure for global distributed systems. Recent evidence has shown that while it is true that IT-enabled global alliances have opened up new cross-boundary opportunities, they have also considerably complicated strategic formulation and operational control. If not done so, IS managers should help top management turn its attention outward toward customers, suppliers, and its business ecosystem. With IT providing the foundation for electronic collaboration within such an ecosystem, CIOs are working, or should work, closely with top management to ensure that the firm’s IT infrastructure not only meshes with corporate strategy but is also flexible enough to support changes in strategy. Building a

comprehensive infrastructure is the challenge facing CIOs and CTOs. Even though they might outsource the operation of their infrastructure, they and their top-management peers must do the strategic thinking behind selecting infrastructure elements.

Effective implementation of any system architecture requires top-management commitment, realistic budgeting, and sound project management. With the overall technical framework for systems provided, we now turn to the essential technologies used in distributed systems—telecommunications, information resources, and operations.

QUESTIONS AND EXERCISES

Review Questions

1. What is the difference between an architecture and an infrastructure?
2. What are the four attributes of a distributed system?
3. What does open source mean?
4. List and briefly explain the questions that should be asked when deciding whether to distribute computing responsibilities.
5. What are the components of the guiding framework for distributed systems as provided by Stefferud, Farber, and Dement?
6. Give seven examples of system structures that can be called distributed.
7. What are Gartner's five types of client-server systems? Which two did the aerospace company choose and why?
8. What are server-based computing and peer-to-peer computing?
9. According to Rifkin, what is the Napster dispute really about?
10. What are the six standards underlying Web Services?
11. Describe the rows and columns in Figure 9.
12. What benefits has FMC received from having defined a "tomorrow" architecture?
13. What are the four layers of IT infrastructure, according to Weill and Broadbent?
14. In what three ways can companies view an IT infrastructure?

Discussion Questions

Discussion questions are based on a few topics in the chapter that offer a legitimate basis for a difference of opinion. These questions focus discussion on these issues when the book is used in a seminar or classroom setting.

1. Some people want all their programs and data stored locally on a PC. Others would be willing to get everything from a corporate portal. Which would you prefer? Why?
2. Web Services sounds way too complex to be viable. How are little chunks of code from many organizations really going to work together and provide a reliable and secure computing environment? Discuss.
3. Although it seems like a useful, albeit expensive, exercise to create an enterprise-wide IT architecture, computing has been going on too long for management to rein in legacy systems. Discuss the pros and cons of this argument.

Exercises

1. Find a recent article in the literature that describes a distributed system.
 - a. Describe it using the four attributes given in this chapter.
 - b. What benefits are claimed for the system?
 - c. Describe its infrastructure.
2. Identify a company in your community that is using what it calls a distributed system. What was top management's or the business unit management's involvement in justifying the system? How do the system's characteristics compare with those given in this chapter? What challenges has the IS organization encountered in building the system, and how has it dealt with these challenges?
3. Identify a company in your local community that has an IT infrastructure. Does management see it as utility, dependent, or enabling? Explain their rationale.
4. Find a description of a Web Service. Why was this approach taken? What benefits are being received or expected?

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MANAGING TELECOMMUNICATIONS

INTRODUCTION

THE EVOLVING TELECOMMUNICATIONS SCENE

125 Years of Technological Innovation and Industrial Revolution

The Future of Telecommunications

TELECOMMUNICATIONS FOR BUSINESS

The Internet and Telecommunications Services

Case Example: XYZ Company

Case Example: National Semiconductor

Digital Convergence

Case Example: Toronto Pearson International Airport

The OSI Reference Model Underlies Today's Networks

The Rate of Change Is Accelerating

Bandwidth Abundance?

The Wireless Century Has Begun

Case Example: BMW

Case Example: American Greetings

Is Wireless Secure?

Is Wireless Safe?

Messaging Is a Killer App

Case Example: Keebler

An Internet of Appliances, Traffic Prioritization, and Network Neutrality

THE ROLE OF THE IS DEPARTMENT

Planning and Creating the Telecommunications Architecture

Managing Telecommunications

Keeping Abreast of Telecommunications Technology Policy

CONCLUSION

QUESTIONS AND EXERCISES

REFERENCES

INTRODUCTION

For most businesses, they use outside service providers (a phone company, an Internet Service Provider (ISP)) for their telecommunications needs. As the business

environment is becoming more Internet-centric with VoIP, WAN, and wireless networks, it is important for managers to understand the basic concepts underlining telecommunications technologies that are needed to support the network-centric strategy of the organization.

Telecommunications is also a fast-paced industry that affects every aspect of our lives, including voice telephone calls, Internet access, high-speed data communications, satellite communications, the World Wide Web, and rich-media communications. This knowledge is critical for designing cost-effective telecommunications that enable new business models in a fast-changing economy.

This chapter examines telecommunications in the broadest sense: electronically sending data in any form from one place to another between people, machines, or objects. In this view, the telecommunications system is an electronic highway system. Generally, IS departments have been responsible for designing, building, and maintaining that information highway in the same way that governments are responsible for building and maintaining streets, roads, and freeways.

Once built, the network, with its nodes and links, provides the infrastructure for the flow of data, information, and messages. This flow is managed not by IS professionals, but by users, just as users manage the flow of vehicles on physical highways. Government agencies provide standards and laws for the flow of highway traffic that are enforced by the police and highway patrol. In the same way, IS departments select and enforce telecommunications standards for information traffic while governments divvy up the spectrum for different wireless uses. This analogy could be pursued in more detail, but the point is clear: Telecommunications are the basis for the way people and companies work today. It provides the infrastructure for moving information, just as a transportation system, such as shipping lanes, railroad right-of-ways, and the airspace, provides the infrastructure for the movement of people and goods.

This analogy presents telecommunications as a linking mechanism, which it is. However, the Internet has also opened up a different view of telecommunications, that of providing a cyberspace, a place where people can “exist” in a virtual world, where organizations can conduct business, and in fact, a place where organizational processes exist. It is an online world, a sort of cybercity. This view, too, is providing the foundation for the online economy.

However, even more is happening. Just about everything in telecommunications is shifting, from the industry itself to the protocols (the languages networks use to communicate with each other).

THE EVOLVING TELECOMMUNICATIONS SCENE

125 Years of Technological Innovation and Industrial Revolution

The history of telecommunications began with smoke signals and drums in early generations. However, it was not until 1844, when Morse’s electric telegraph was first shown to the public from Baltimore to Washington, that the era of global telecommunications actually began. Less than 20 years afterward, telegraph communication was completed coast-to-coast in the United States (1861), and from the United States to Europe (1866). The innovation continued with the creation of the telephone by Bell and Watson in 1875. These were the first technological inventions that changed the world

and triggered the invention of the telephone, telewriter, coaxial cable, broadband carrier for simultaneous calls over a single pair of wires, magnetic tape machine with transmission capacity of 1,000 words per minute, communication satellites, fiber optics, cable modems, DSL Internet services, and cellular wireless technologies.

From a business perspective, the oldest part of the telecommunications infrastructure is the telephone network, commonly called the public switched telephone network (PSTN), or affectionately called POTS (plain old telephone service). This global network was built on twisted-pair copper wires and was intended for voice communications. It uses analog technology (signals sent as sine waves) and circuit switching, which means a virtual (temporary) circuit is created between caller and receiver and that circuit is theirs alone to use; no other parties can share it during the duration of their telephone call. Although appropriate for delivering high-quality voice communications, circuit switching is inefficient because of all the unused space in the circuits when no sound is being transmitted.

The overhead of establishing a circuit was tolerable for voice calls because they lasted several minutes, notes an in-depth telecommunication study by PricewaterhouseCoopers (PwC),¹ before it became part of IBM Global Services. However, data traffic is sent in bursts that last less than a second. Opening and closing circuits at this rate is not economical, so the basic traffic-handling mechanism for data had to change.

PSTNs were also built on the premise of dumb voice telephones; therefore, they needed intelligent switches in the network to perform all the functions. Telephone company central offices house the intelligent switches that implement all the services, including call waiting, caller ID, call forwarding, conference calling, and so on.

The new telecommunications infrastructure being built around the world is aimed at transmitting data. The wired portion consists of fiber-optic links (glass fiber rather than copper wire) sending digital signals (ones and zeros instead of sine waves). The wireless portion consists of radio signals. Both use packet switching; messages are divided into packets, each with an address header, and each packet is sent separately. No circuit is created; each packet may take a different path through the network. Packets from any number of senders and of any type, whether e-mails, music downloads, voice conversations, or video clips, can be intermixed on a network segment. These networks are able to handle much more and a greater variety of traffic. Packet nets also can handle voice. The analog voice signals are translated into ones and zeros, compressed, and packetized.

Unlike voice-centric networks, data-centric networks assume intelligent user devices that provide the addressing information; therefore, the network only needs store-and-forward routers to route the packets. This architecture allows new kinds of services to be deployed much more rapidly, notes the PwC study, because the basic functions of the network need not be changed. Thus, for example, it was easy to add the World Wide Web as a new kind of layer on the Internet infrastructure. Other such layers are multiplayer gaming, e-mail, and file transfer. This infrastructure would not have been possible with PSTN.

The Internet can handle new kinds of intelligent user devices, including Voice-over-IP (VoIP) phones, personal digital assistants (PDAs), gaming consoles, and all manner of wireless devices. It can allow these devices to handle different kinds of services, such as voice, e-mail, graphics, gaming, and so forth. Thus, the global telecommunications infrastructure is changing from a focus on voice to a focus on data—both from a technical perspective and a revenue generation point of view.

With the increasing demand for high-speed multimedia mobile communications services to users, there are a number of ongoing initiatives to replace the current low-speed voice and data wireless networks by stratospheric communications systems or High Altitude Platform Station (HAPS). A HAPS is a station located at an altitude between 20 and 50 km and at a specified, nominal, fixed point relative to the earth. HAPS has a number of important advantages: flexibility of network planning and construction, wide bandwidth, wide coverage, ease of maintenance and operation, no need to deal with national and international regulatory issues. The technologies are still evolving. However, once they become proven, they would tremendously improve the performance of current telecommunications infrastructure.

The Future of Telecommunications

The early 2000s could be seen as a correction of the investment excesses of the late 1990s and the misreading of the market ability to adapt to technological changes. Corporate giants suffered losses (e.g., Covad, PSINet, JDA, and Nortel Networks to cite a few). Despite the significant financial downturn of the telecommunications industry, broadband subscription continues to increase steadily. According to OECD, the number of broadband subscribers in the OECD country members increased 26 percent from 157 million in 2005 to 197 million in 2006. Innovation is expected to accelerate. Thus, CIOs should expect changes in both technologies and market forces. If there is anything we can learn from history, the telecommunications industry will continue to surprise us with innovative inventions and disruptive technologies.

At the risk of making erroneous predictions, we do see a number of emerging trends:

- 1. Steady growth in telecommunications usage:** We discussed earlier the era of social computing. Communications are the requisite of the digital age. While communications usage in North America and Western Europe have been consistently high, demand for telecommunications services has exploded in the rest of the world, in particular Eastern Europe, Asia, and Latin America. Developing countries have been able to leapfrog into new digital technologies, avoiding otherwise significant replacement costs from legacy technologies. Also, thanks to the results of industry deregulations, the cost of telephony and telecommunications have significantly decreased.
- 2. Quick and global adoption of new telecommunications-based technologies:** Cellular telephony, GPS navigation systems, video programming, music and video download, wikipedias, blogs, and instant messaging have become major telecommunications applications. These new and ubiquitous applications will likely push significant pressures on both telecommunications providers (such as Verizon and AT&T in the United States), Internet Service Providers, and media networks to offer high-bandwidth, high-resolution, and inexpensive integrated services.
- 3. Competition in broadband markets is expected to accelerate:** One new market area is in the fixed-mobile convergence market, with fixed and mobile operators competing against each other.
- 4. Mass-individualization of real-time programming:** With the evolution of high-definition video on-demand, and the global adoption of video exchange (e.g., YouTube.com), the trend toward media-rich networks has started to take

off. It is now economically viable to dynamically offer individualized programs allowing real-time interaction with the users.

5. *The new economic model for financing the telecommunications industry has yet to be defined:* In addition to the corporate mergers among telecommunications giants, pricing of services will be an important issue for managers to watch carefully. On the one hand, the market continues to ask for low-cost or no-cost services—free e-mailing, free download, free access to GPS signals. On the other hand, the costs for establishing and maintaining a reliable, secure, and robust corporate telecommunications infrastructure are likely to go up. The deregulation, consolidation, and technological innovation in the telecommunications industry lead to complex pricing and billing schemes.

Indeed, the future of telecommunications depends on a number of factors that are beyond the control of a business: Due to conflicting interests among numerous stakeholders, regulators from many countries are still slow in making the industry more competitive. The telecommunications giants need to recapture the large amounts of capital they invested in current networks, and some are hesitant in adopting new technologies. Last but not least, many large user groups are reluctant to embrace new value propositions as they do not want to change their working habits. The inertia within the customer base could slow down the unstoppable evolution of telecommunications.

TELECOMMUNICATIONS FOR BUSINESS

In this section, we do not intend to provide the readers with a detailed technical description of the basic concepts and elements of telecommunications technologies. Any data communications book would do a more comprehensive job. Instead, we highlight here only a few aspects that we think any manager should be aware of when trying to understand the role and functions of telecommunications in today's business.

Visualize the world's networks as huge fire hoses, transmitting at the whopping speed of a terabit (10^{12} bits per second) over fiber-optic cable. Then visualize the twisted-pair phone line coming into your home or business as a straw, only operating at speeds of 56 kbps (104 bits for second) for a modem or 1.2 mbps (10^6 bits per second) for a digital subscriber line (DSL). DSL runs over the same copper wire but has improved electronics that boost the speed, allows simultaneous voice and data, and is always on, eliminating the need to dial in. The last-mile problem is the bridging of this fire-hose-to-straw gap. See Figure 1.

In the 1990s, the Regional Bell Operating Company (RBOC) began encountering competition for this last mile. So the jargon expanded. RBOCs became known as incumbent local exchange carriers (ILECs) and the new competitors became competitive LECs (CLECs). The importance of CLECs is the new kinds of connection options they have brought to businesses and homes, such as cable modems, optical fiber, wireless, satellite, and faster wire lines. In response, ILECs have bundled local phone access with Internet access, and ISPs use their brand-name recognition to expand into the local carrier market, becoming CLECs. You really need a scorecard to see who's who.

FIGURE 1 Telecommunication Technologies and Their Speeds

BITS PER SECOND (BPS)	NOTATION	ABBREVIATION	AMOUNT	TERM	TECHNOLOGIES
1,000,000,000,000	10^{12}	1 tbps	Trillion	Terabits	Optical fiber potential (and higher)
100,000,000,000	10^{11}	100 gbps			
10,000,000,000	10^{10}	10 gbps			Optical wireless local loop (20G), OC-768 (40G), WMAN (100G)
1,000,000,000	10^9	1 gbps	Billion	Gigabits	Microwave LANs (1.5G–2.0G), OC-48 (2.5G), ATM (2.5G), Gigabit Ethernet (1G), WMAN (24G)
100,000,000	10^8	100 mbps		Megabits	OC-12 (622M), ATM (155M to 622M), T4 (274.176M), OC-3 (155.52M), Faster Ethernet (100M), infrared (100M), WMB (100–400M)
10,000,000	10^7	10 mbps		Megabits	T3 (44.736M), E3 (34.318M), frame relay (10M), Ethernet (10M), WLANs (10M), cable modem (10M), Wi-Fi (11–54M)
1,000,000	10^6	1 mbps	Million	Megabits	T2 (6.132M), infrared LAN (4M), stationary 3G wireless (2M), E1 (2.048M), DSL (L544M to 7M), T1 (1.544M), Wi Max (1.5–10M)
100,000	10^5	100 kbps		Kilobits	Wireless local loop (428K), mobile 3G wireless (384K), ISDN (128K), 2G wireless (128K)
10,000	10^4	10 kbps		Kilobits	Modems (56K), 2.5G wireless (57K)
1,000	10^3	1 kbps	Thousand	Kilobits	2G wireless (9.6K to 14.4), infrared LAN (9.6K)
100	10^2	100 bps		bits	
10	10^1	10 bps		bits	

The Internet and Telecommunications Services

Although it may feel like old news now, the biggest telecommunications story of the past 15 years has been the Internet, the global packet-switching network that is the epitome of next-generation networks. What has surprised most people was the Internet's fast uptake for business uses and then the fast plummet of the dot-com and telecommunications industries. However, in both arenas, the crashes were needed reactions to the excesses of the late 1990s. In the mid-1990s, the Internet caught most IS departments by surprise, not to mention the hardware and software vendors that serve the corporate IS community. Many executives are relieved that the Internet pace of the late 1990s has now slowed down so that they can plan their online business strategies rather than feel the need to react quickly to dot-com invasions in their industry.

The Internet actually began in the 1960s; it was funded by the U.S. Department of Defense's Advanced Research Projects Agency and was called ARPANET. The network was intended for electronic shipment of large scientific and research files. It was built as a distributed network, without a controlling node, so that it could continue to function if some of its nodes got knocked out in a nuclear war. Much to the surprise of its creators, it was mainly used for electronic mail among government contractors, academics, researchers, and scientists.

In 1993, the Internet was still mainly a worldwide network for researchers, scientists, academics, and individuals who participated in news groups. It was all text, no graphics. It had e-mail for sending messages, maintaining e-mail lists, and interacting with news groups. It had file transfer protocol (FTP) for sending files, Telnet for logging onto another computer, and Gopher for searching and downloading files from databases.

That all changed in 1994 when the World Wide Web was invented by Tim Berners-Lee at CERN in Geneva. This graphical layer of the Internet made it much more user-friendly. Web sites had addresses specified by their URL. Its multimedia Web pages were formatted using HTML. The Web sites could be accessed via an easy-to-use browser on a PC. Hyperlinks hidden behind highlighted words on a Web page, when clicked, would jump to the linked page. Following the links became known as "Web surfing." This graphical electronic world was first populated by homepages of computer geeks and young people. The Web's use by businesses began skyrocketing a few years later, in the late 1990s.

The Internet has done for telecommunications what the IBM PC did for computing: It brought it to the masses. In 1981, when the IBM PC was introduced, its architecture was open; all the design specifications were published. This openness led to thousands of peripheral manufacturers, component makers, and clone makers producing compatible products. An entire industry developed around this open architecture. The same has happened with the Internet because it provides the same kind of openness, this time in the telecommunications arena. Vendors have a standard set of protocols to work with so that products can work with each other. Businesses do not need to commit to a proprietary architecture. Like the PC, this openness yields the most innovative solutions and the most competitive prices.

The Internet has three attributes that make it important to corporations: ubiquity, reliability, and scalability. It is global, thus it is ubiquitous. Enterprises, both large and small, potentially have global reach with a browser and global presence with a Web site. As noted earlier, the Internet was designed to survive computer crashes by allowing alternate routing. This capability makes it highly reliable. People might not be

able to access a crashed server, but they can still access all other nodes that are operating. The Internet has also been able to sustain incredible growth since its beginning. Specific Web sites can handle tremendous amounts of traffic, in the tens of millions of hits a day, if they have been properly designed. That is scalability!

Today, the protocols underlying the Internet have become the protocols of choice in corporate networks for internal communications as well as communications with the outside world. The norm is now end-to-end IP networks.

To illustrate how a company might build a corporate network from scratch utilizing the Internet, here is the fictitious example of XYZ Company.

CASE EXAMPLE

XYZ COMPANY

XYZ Company, which makes and sells widgets, is in the process of installing a corporate network. The CTO has a myriad of decisions to make. Of course he wants employees to be able to access each other, corporate data, and the Internet, so he will create an IP network using the Internet's standard protocol, TCP/IP, which packages data into packets, each with a header that tells where it is to be delivered.

The Internet will be the heart of XYZ's corporate operation. Hence the CTO will create an intranet for use by employees; an extranet for use by suppliers and some large customers; and of course, the Internet as the all-important central public network.

The CTO has a basic way of thinking about all the computer-based devices in his company: He sees them as either clients or servers. Computers, handhelds, cell phones, and wired phones used by the employees are clients; they make requests of other computers. Computers that respond to these requests are servers. They can act as storage devices for shared

files for teams or departments or even customers. They may house shared applications or shared peripherals or they can connect the client devices to a network, including the Internet. Now that IP phones offer good voice quality, he may opt for them as well.

Serving Remote Users

Every PC will be outfitted with a Network Interface Card (NIC) that lets it talk to the network. XYZ has four choices of communication wiring: twisted pair (the standard telephone line), coaxial cable (like cable TV), fiber optic (glass fiber that carries signals via light pulses), and wireless. Fiber carries tremendous amounts of traffic and is expensive; therefore, it is mainly used in backbone networks. Each NIC will support the medium the company will be using.

Each computer also needs a network operating system. These days, it is part of the computer's operating system. Furthermore, some of the machines need a modem to convert (modulate) the digital signal

(Case Continued)

from the computer to an analog signal for the telephone or cable system, and vice versa.

For employees working from computers in their homes, who need to transmit larger and larger files such as PowerPoint presentations, the CTO could choose DSL modems, which communicate at 1.2 mbps (10^6). Or he could choose cable modems, which communicate at a whopping 10 mbps. Like DSL, cable modems are not available everywhere. Also, like DSL, they are always on; no dial-up is needed. However, this convenience can present security problems because the session code does not change as it does with dial-up sessions.

The CTO needs to decide how to connect these remote users to the corporate network and provide the speed and security they need. The salespeople, for instance, no longer have company-supplied offices; their offices are in their homes. They have company-supplied laptops and PDAs; they dial in from hotels, client sites, or their homes or use an always-on personal communication service (PCS) for e-mail.

Serving Local Users

In the office, all the computers and telephones will be connected directly to an always-on LAN.

The various LANs in XYZ's offices will use three types of computers to route traffic.

- Hubs are repeaters; they forward packets of data from one machine to another. When a number of computers share a hub, data sent from one goes to all the others. This configuration can get congested with many computers, so

hubs will only be used within a work group.

- Switches are smarter; they only forward packets to the port of the intended computer using the addressing information in each packet's header. Switches will be used to connect work groups.
- Routers are smarter still; they use a routing table to pass along a packet to the next appropriate router on a network. Thus, they can direct packets via the most efficient route or relay packets around a failed network component. Routers also link network segments that use different protocols, such as linking an Apple-Talk network with an Ethernet network. Routers also can connect to WANs. XYZ will use routers to connect its LANs to a WAN.

The CTO will likely choose the Fast Ethernet Protocol for his IP-based LANs. It has a speed of 100 mbps (10^8) to accommodate employees' multimedia and video needs. Using Ethernet, when a computer has a message to send, it broadcasts the stream of packets and then listens for an acknowledgment of receipt. If it does not receive a reply within a specified time, it rebroadcasts, presuming the packets collided with packets from other computers and did not reach their destination.

The LAN will give in-office employees an always-on connection to the company's intranet, its employee-only Web site that is protected from the outside world by a firewall. The firewall is a server that lets in e-mail but does not permit access to applications or executable code. The intranet will essentially

(Case Continued)

be “the office” for XYZ, because it will house all the firm’s forms, processes, and documents. It will also be accessible by remote employees.

Intranet—Communicating Between Offices

To help XYZ employees communicate between sites using WAN, the CTO set up a high-speed asynchronous transfer mode (ATM)—up to 622 mbps (10^8). ATM is used by telephone companies for their network backbones; they then offer ATM services to companies like XYZ for their WANs. However, due to the high cost of

ATM long-distance bandwidth, the CTO might not be able to afford it.²

A fairly new option to link several offices in a city or to link floors within a building is Gigabit Ethernet, which operates at speeds of 1 gbps (10^9 bits per second). One hundred gigabit Ethernet (10^{11}) is on the horizon. Gigabit Ethernet has been outselling ATM because it is less costly. It is definitely the option the CTO would prefer.

These issues are some of the major considerations for the CTO. He is definitely going to base all his decisions on being IP-centric. ■

Extranets

Not long after creating intranets for employees, businesses realized they could extend the concept into extranets—a special part of the intranet for use by trading partners, customers, and suppliers for online commerce. The following case of National Semiconductor illustrates the use of an extranet and shows how the company tackled the challenge of conducting business online globally.

CASE EXAMPLE

NATIONAL SEMICONDUCTOR

www.national.com

Founded in 1959, National Semiconductor, with headquarters in Santa Clara, California, designs and manufactures semiconductor products used in personal computers, consumer electronics products (cars, cameras, cell phones, and so on), and telecommunications systems. With reported sales of more than \$2.6 billion

in 2006, National is focusing on its key competency—advanced analog and mixed analog/digital signal technologies—for use in the newest breed of electronic devices, information appliances, which are low-cost, easy-to-use, wireless devices that interact with the Internet without the use of a PC. In 2007, National employed some

(Case Continued)

7,600 people around the globe, held 2,916 unexpired U.S. patents, and offered more than 15,000 products.

To gain market share and move into new markets in Europe, South America, and Asia, National looked to the Web. It created an *intranet* that the sales force could access to keep up to date on products and place orders. It created the “National Advisor” using Internet-based push technology to electronically send news, sales reports, and customer information to the sales force and its management.

National also created an *extranet* for distributors and channel partners and a Web site for design engineers who use its components in electronic and telecommunications products. This Web site contains descriptions of more than 15,000 products in the form of PDF databooks. Design engineers can view these databooks and order samples either via the Web or through distributors.

To give far-flung engineers decent download times of these 10k-to-200k-size files, National initially installed mirrored servers in Germany and Hong Kong and planned for eight more sites. However, management discovered that the logistics of maintaining 10 such sites would be a nightmare as well as cost prohibitive at approximately \$4 million a year.

They thus turned to outsourcing to a company with data centers around the globe that offers hosting and other Internet infrastructure services. It replicates Web sites on edge servers, which are servers close to users (on the edge of the

Internet), so that download speed is fast. Some servers even perform language translation so that when a request is made, the closest edge server detects the type of user device, type of network, and country (and its regulations) and adapts the content to those conditions.

The cost would be \$400,000 a year, or one-tenth the in-house cost. More importantly, performance was so much better that National could reach markets in Asia, Eastern Europe, Indonesia, and Latin America, where Internet service was generally slow. In addition, the company could distribute daily customer data and market information within 24 hours, which would speed product development and responses to design engineers’ queries.

National’s Web site now supports 1 million design engineers around the globe who download more than 10,000 databooks a day, in about two seconds each. The company only needs to replicate its site once; the hosting company takes care of the global coverage. Finally, National receives reports on which pages are being accessed in each part of the world, which is important information to the sales and marketing staff. National’s *extranet* application, which won the “Business on the Internet (BOTI)” award given at Internet World and *CIO Magazine*’s “CIO Web Business Award for Online Business Excellence,” has thus been able to use the Internet to create business advantages, improving its customers’ ability to make faster decisions. ■

Digital Convergence

Almost any type of information content can be converted into a digital form and then exchanged over the Internet, via fixed or mobile connections and using multiple platforms.³ Digital convergence is the intertwining of various forms of media—voice, data,

and video. All the separate media—books, newspaper, TV, radios, telephone, personal computers, etc.—will be replaced by integrated digital appliances. When all forms of media can be digitized, put into packets, and sent over an IP network, they can be managed and manipulated digitally and integrated in highly imaginative ways. IP telephony and video telephony have been the last frontiers of convergence—and now they are a reality.

IP Telephony

Recently, enterprises have been investigating the use of the Internet to transmit voice to replace their telephone systems. This new Internet use is called Voice-over-IP (VoIP), Internet telephony, or IP telephony. According to James Cope,⁴ it works in the following manner: A special IP phone with an Ethernet jack in the back instead of the standard telephone jack is attached to a company LAN, perhaps through a PC. Rather than the analog signals sent by traditional phones, the IP phone generates a digital signal. That signal is routed over the LAN just like any other data in packets either (1) to another IP phone on the LAN, (2) through the company's WAN to a distant IP phone on another of the company's LANs, or (3) through an IP voice gateway to the PSTN to a standard telephone.

Few companies have yet given up their telephone networks for a VoIP network, but as the cost differential continues, more will switch. Like other devices on a network, IP phones have an IP address, so they can be easily moved to another location and still be located.

IP telephony became the hot telecommunications technology in 2004. Until that time, voice quality over the Internet was poor, so people were not interested in switching to digital IP phones. But by 2003, voice quality was sufficient for early adopters, and surprisingly, Cisco became the largest IP telephone company, shipping over 3 million IP phones by mid-2004 and purportedly shipping over 2 million in the third quarter of 2004 alone. (As the primary supplier of Internet routers, Cisco also expects to sell lots of its routers to telecommunications companies as they switch their networks from analog to digital networks.)

Voice has become another digital medium that can be managed electronically, from one's PC, for example. One new possibility this digitization presents is ad hoc conferencing (or just-in-time collaboration, as it is also called). For instance, with the appropriate VoIP infrastructure, two people instant messaging with each other via their computers could seamlessly switch to a voice conversation, talking rather than typing. Furthermore, because each person's telephone, instant messaging, and e-mail share one address book, they can instant message, phone, or e-mail others to join their call just by clicking on their names. Anyone in the conference can pull up a PowerPoint slide or a spreadsheet to discuss a point on it—or even scribble on it—or view a new video clip. They can even archive the call and send it to other people.

Video Telephony

The same is happening with video telephony, which is not video conferencing via a PBX, but rather video over IP. With the appropriate IP infrastructure, video telephony can be, say, launched from an instant-messaging conversation. IP phones with cameras also facilitate it, phone to phone.

Oodles of new converged products are flooding the marketplace now that high-quality voice has become IP based. In fact, when VoIP is mentioned these days, it is

done so in the context of collaboration. The point is not so much that VoIP offers essentially free voice calling worldwide over IP networks. The point is that VoIP now permits cost-effective, full-media collaboration worldwide. That is a new paradigm, which can change how businesses work. One early effect has been the boom in offshore outsourcing.

In addition, some new converged offerings add presence, by indicating how someone can be reached at a particular moment, often through a green indicator beside the appropriate contact option in the converged address book. Such a system then automatically dials that option. Presence will likely become a major feature of converged IP systems.

Skype.com is a prime example of successful use of IP for telephony and beyond. It is a peer-to-peer telephony network. Unlike typical VoIP clients that are under a client-server model, Skype has a user directory that is entirely decentralized and distributed among the nodes in the network, allowing scalability, without a complex and expensive centralized infrastructure. Launched in 2003, adoption of Skype technology was nothing but phenomenal. By 2006, there were more than 100 million registered users. eBay purchased Skype in 2005, hoping to use this technology to bring its online trading business to the next level: allowing users to use voice and video in their online trading process. Skype.com introduced videophony in December 2005 and continues with a number of telecommunications innovations, in particular, the inclusion of video content in chat. The explosive growth of the service is not without glitches. In August 2007, due to heavy traffic and technical complications, millions of Skype users were unable to connect to the networks for a few days.

At the business level, digital convergence can also change the way business is operated. The Toronto Pearson International Airport illustrates the reality of digital convergence via IP.

CASE EXAMPLE

TORONTO PEARSON INTERNATIONAL AIRPORT

www.gtaa.com

Toronto Pearson International Airport is Canada's busiest airport, with 31 million passengers in 2006. It handles more than 1,200 arrivals and departures every day. In April 2004, a new terminal opened that Cisco touts as a next-generation showcase because its infrastructure is a single, common-use IP network.⁵

The network is common use because its infrastructure is shared by all the airport tenants. Its backbone is two independent high-speed rings for reliability and growth, with over 100 network switches, 1,000 IP phones, and 1,000 wireless access points. There is no separate telephone network, just one IP network

(Case Continued)

that combines 14 communications systems and that supports integrated voice, data, and video.

Each tenant has a private LAN for its own voice, data, and video applications. The LAN is accessed via virtual private networking (VPN) technology so that it is private and secure. Yet each network can be accessed from anywhere in the terminal with the appropriate authorization by just plugging in, either via a wired or a wireless access point. The wireless network is highly restricted and tightly controlled so that the data traveling over it are also private and secure.

In essence, the airport authority acts as a service provider to the airlines, tenants, and passengers. The network is used for all applications. For passenger check-in, for instance, the gates have IP phones as well as data connections. Each gate can

be used by any airline; the gate crew just plugs in to access the airline's voice and data services. Passengers can also check in at any kiosk for any flight for any airline, which has reduced congestion.

Baggage tracking is integrated with passenger reconciliation via the network, improving security. The network also supports security systems, emergency responses, video surveillance, and network security.

The network and the interlinked applications it permits have reduced network operations costs, consolidated network support (because there is only one network), increased operational efficiency in the terminal (in baggage handling and check-in), enhanced security and made it consistent, and increased capacity (handling 15 percent more passengers soon after the terminal opened). ■

Digital convergence is setting up a collision among three massive industries, state Stephen Baker and Heather Green.⁶ The first is the \$1.1-trillion computer industry, led by the United States. The second is the \$225-billion consumer electronics industry, which has Asian roots and new, aggressive Chinese companies. The third is the \$2.2-trillion telecommunications industry, with leading wireless players in Europe and Asia and data networking leaders in Silicon Valley. These industries need each other to offer converged services. Innovative offerings and services are now being released by large and small companies alike. It is not yet clear which business models or offerings will emerge as the big winners. It is only clear that this is a disruptive time for all three industries, note Baker and Green, as it likely is for a host of other industries as well, such as the music, television, gaming, and movie industries, to name just four.

The Internet and its protocols are taking over. To understand the complexity of telecommunications, we now look at the underlying framework for the Internet: the OSI Reference Model.

The OSI Reference Model Underlies Today's Networks

The worldwide telephone system has been so effective in connecting people because it is based on common standards. Today's packet-switching networks are also following some standards. The underpinning of these standards is the OSI Reference Model.

Closed Versus Open Networks

The first concept that is important to understand is the difference between closed and open networks. A closed network is one that is offered by one supplier and to which only the products of that supplier can be attached. Mainframe and mini-computer manufacturers used this approach for years to lock in their customers. Closed networks were originally adopted for corporate, regional, and site levels of computing. Companies generally used the proprietary network offered by their mini-computer or mainframe manufacturer. In the Internet world, the first commercial offerings (CompuServe, Prodigy, America Online, and Microsoft Network) also used proprietary software initially. However, as direct connection to the Internet spread, these firms all finally embraced the Internet's open network approach.

An open network is based on national or international standards so that the products of many manufacturers can attach to it. Open networks have been favored by suppliers serving ecosystem, department, work group, and individual levels of computing. Today, proprietary networks are out and open networks are in because no provider is large enough to serve all of a firm's telecommunications needs—to say nothing of connecting the firm to other enterprises and people.

We now live in an open-systems world, and the most important telecommunications architecture is the OSI Reference Model.

Why Is It Called a Reference Model?

The International Standards Organization (ISO) and other standards bodies have adopted the seven-level OSI Reference Model to guide the development of international standards for networks of computers. It is called a reference model because it only recommends the functions to be performed in each of the seven layers; it does not specify detailed standards for each layer. Those details are left up to the standards bodies in the adopting countries. OSI is used by suppliers to make their products interconnectable. Understanding the OSI Reference Model is a step toward understanding how telecommunications systems actually work.

An Analogy: Mailing a Letter

In the model's layered architecture, control information is used to route messages to their destination. The following is a four-level analogy of an executive mailing a paper document to another executive (Figure 2). Although mailing letters is old-fashioned, this example makes the intricacies of message passing understandable. Notice that control information—the address and type of delivery—is on the envelope or mailbag. This control information determines the services to be provided by the next lower layer, and it contains addressing information for the corresponding layer on the receiving end. It defines the interfaces between the layers as well as the dialog within a layer.

- At layer 4, the business executive writes a letter and gives it to a secretary.
- At layer 3, the secretary puts the letter into an envelope, addresses the envelope, puts the return address on the envelope, stamps it, and then mails it.
- At layer 2, the mail carrier takes the letter to the postal sorting office where all mail for the same postal district is put into one bag with the destination postal office name on it. Mail of different types—express mail, first-class mail, third-class mail—have their own bags.

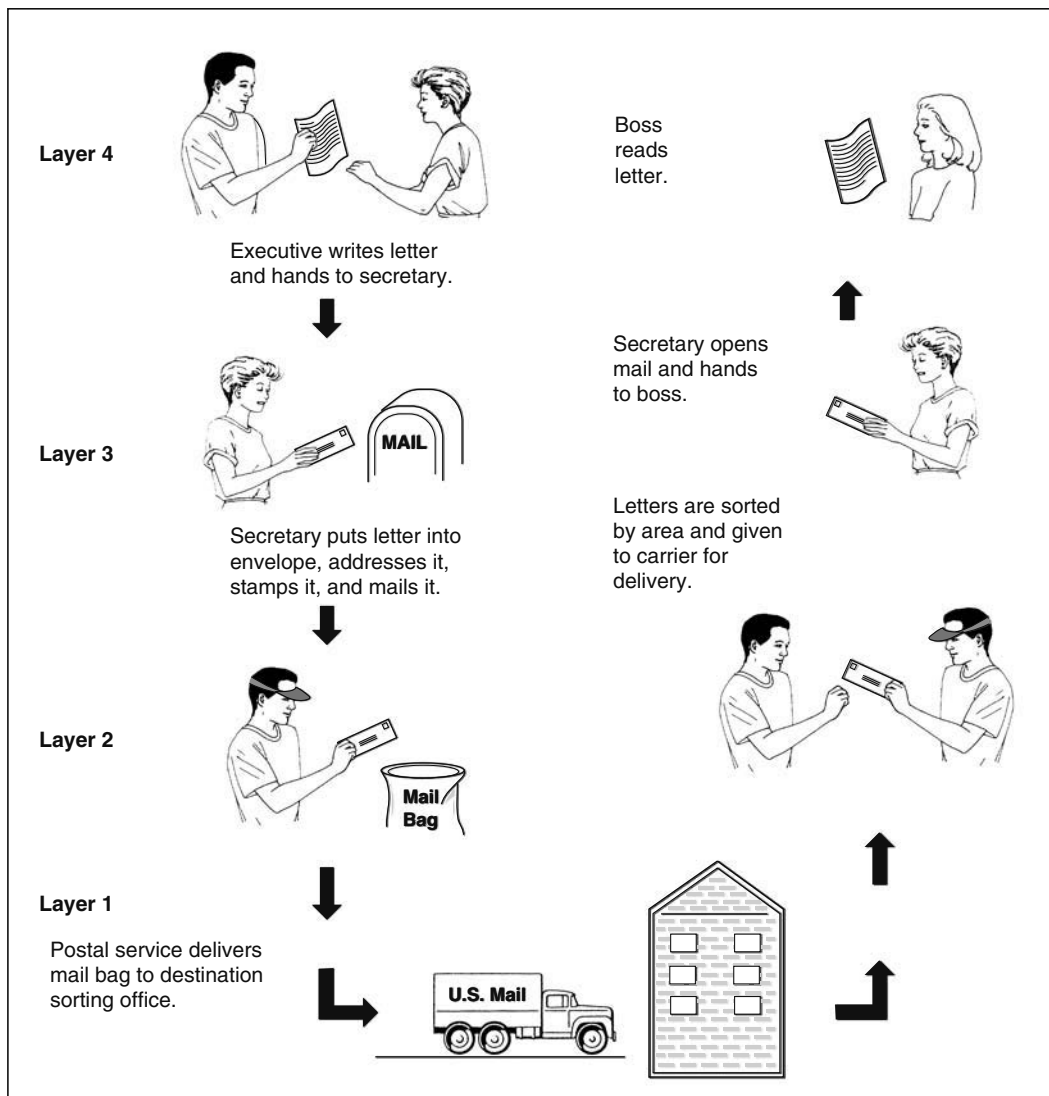


FIGURE 2 How Control Information Is Used to Route Messages

- At layer 1, the postal service delivers the mail bag to the destination sorting office.
- At layer 2, the sorting office checks that the bag has been delivered to the right office. Then the letters are sorted by area and passed on to the individual carriers who deliver them.
- At layer 3, the recipient's secretary rejects any mail delivered to the wrong address, opens the letter, and passes it to the recipient, saying, "Here's a letter from . . ."
- At layer 4, the recipient takes the letter and reads it.

LAYER	NAME	JOB	PROTOCOL EXAMPLES
7	Application Layer	Interface to application	HTTP, X.500, X.400, ODA, Internet key exchange (IKE), Postscript
6	Presentation Layer	Translates data to and from language in layer 7	NetBIOS
5	Session Layer	Controls dialog, acts as moderator for a session	Secure Sockets Layer (SSL)
4	Transport Layer	Controls flow, ensures reliable packet delivery	TCP
3	Network Layer	Addresses and routes packets	IP, X.25, Packet-level Protocol
2	Logical Link Layer	Makes sure no data are lost or garbled	Ethernet, Token Ring, FDDI, ISDN, ATM, Frame relay
1	Physical Layer	Defines physical connection to network	Ethernet 50-ohm coaxial cable, IOBaseT, twisted pair, fiber-optic cable

FIGURE 3 The OSI Reference Model

When a layer receives a message from the next higher layer, it performs the requested services and then wraps that message in its own layer of control information for use by the corresponding layer at the receiving end. It then passes this bundle to the layer directly below it. On the receiving end, a layer receiving a bundle from a lower layer unwraps the outermost layer of control information, interprets that information, and acts on it. Then it discards that layer of wrapping and passes the bundle to the next higher layer.

The Model's Seven Layers

In a similar way, the OSI Reference Model describes the types of control data produced by each layer. See Figure 3.

Starting at the top of the model, or the layer closest to users, here are the layers and what they basically do.

- **Layer 7 is the Application Layer.** This layer contains the protocols embedded in the applications we use. One familiar protocol at this level is HTTP, which anyone who has surfed the Web has used to locate a Web site. Other TCP/IP protocols at this level are FTP, for transferring files on the Internet, and Telnet, for logging onto and using a remote computer on the Internet. Other protocols at this level permit worldwide communication in various ways. For instance, ISO's X.500 directory services protocol is for creating distinct Internet (or other) mailing addresses. OSI's X.400 mail handling service is for permitting e-mail systems to handle e-mail created and sent from dissimilar systems.
- **Layer 6 is the Presentation Layer.** The telecommunication protocols in this layer translate data to and from the language and format used in layer 7. This layer does not have many familiar protocols.
- **Layer 5 is the Session Layer.** Telecommunication protocols in this layer control the dialog for a session and act as a moderator, seeing that messages are

sent as directed and interrupted if necessary. An important protocol in this layer is Secure Sockets Layer (SSL), which provides Internet security. It uses a combination of public key and other cryptography to provide confidentiality, data integrity, and authentication.

- **Layer 4 is the Transport Layer.** This layer ensures reliable packet delivery. Protocols in this layer handle flow control and ensure the integrity of each message, resequencing portions if necessary. A main protocol at this level is Transmission Control Protocol (TCP), which is the TCP found in TCP/IP. TCP manages the connections made by IP in the next lower layer, layer 3.
- **Layer 3 is the Network Layer.** Protocols in this layer address and route packets to their destination. Here resides the all-important IP, which allows packets to traverse an Internet—that is, a network of networks.
- **Layer 2 is the Logical Link Layer.** Protocols at this layer mainly do error correction, making sure that no data is lost or garbled. LAN protocols, such as Ethernet and Token Ring, work here.
- **Layer 1 is the Physical Layer.** Protocols at this level are responsible for defining the physical connection of devices to a network. This level is the most basic and actually defines the electrical and mechanical characteristics of connections. Thus, these protocols describe modem standards as well as the characteristics of transmission wires, such as Ethernet 50-ohm coaxial cable, 10BaseT twisted-pair wire, and so on.

These layers define the OSI model, which has provided the world with a map for implementing today's telecommunications architecture.

The Rate of Change Is Accelerating

Although no one seems to know for sure, many people speculate that data traffic surpassed voice traffic either in 1999 or 2000. Changes are still moving at a fast clip, even with the retrenching in the telecommunications industry. Author George Gilder⁷ explains why he believes the pace of IT change is picking up, and even more importantly, why it will increase faster still.

Gilder notes that the technologies of sand (silicon chips), glass (fiber optics), and air (wireless telecommunications) are governed by exponential rules. Mead's Law, named after Carver Mead of California Institute of Technology, says that N transistors on a sliver of silicon yield N^2 performance and value. It is the rule of semiconductors, which is why this technology has been so powerful. This law of semiconductors now is joined by the law of the telecom—networking N computers yields N^2 performance and value. Combining the two laws leads to the compounding force of exponentials that have been sweeping through the world economy.

Gilder presents the following astounding facts: In 1995, exactly 32 doublings of computer power had occurred since the invention of the digital computer after World War II. Therefore, since 1995, we have been on “the second half of the chess board,” and a stream of profound developments has taken place. E-mail outnumbered postal mail for the first time in 1995—95 billion external e-mails to 85 billion postal mails. The number of PC sales overtook the number of TV sales in late 1995. And on and on. Such changes will only accelerate, he predicts. For this reason, everyone in business must become comfortable with technology to cope with a world of ever-increasing technological change.

Bandwidth Abundance?

Gilder also predicts an abundance of bandwidth around the world. He notes that an economic era is defined by the plummeting price of the key factor of production. During the industrial era, that key factor was horsepower, as defined in kilowatt hours, which dropped from many dollars to 7.5 cents. Since the 1960s, the driving force of economic growth has been the plummeting price of transistors, translated into MIPS and bits of semiconductor memory. The latter has fallen 68 percent a year, from \$7 some 35 years ago to a millionth of a cent today.

We are now at another historic cliff of cost in a new factor of production: bandwidth. "If you thought the price of computing dropped rapidly in the last decade, just wait until you see what happens with communication bandwidth," says Gilder, referencing a remark by Andy Grove, CEO of Intel. Up to this point, we have used MIPS and bits to compensate for the limited availability of bandwidth, but now we are moving into an era of bandwidth abundance.

Fiber-optic technology is just as important as microchip technology. Currently, 40 million miles of fiber-optic cable have been laid around the world. However, half of it is dark; that is, it is not used. The other half is used to just one-millionth of its potential, because every 25 miles it must be converted to electronic pulses to amplify and regenerate the signal. The bandwidth of the optical fiber has been limited by the switching speed of transistors, 2.5 to 10 billion cycles per second.

The intrinsic capacity of each thread is much greater. There is 10 times more capacity in the frequencies used in the air for communication, from AM radio to KU-band satellite. The capacity of each thread is 1,000 times the switching speed of transistors—25 terahertz. As a result, using all-optical amplifiers (recently invented), we could send all the telephone calls in the United States on the peak moment of Mother's Day on one fiber thread. Putting thousands of fiber threads in a sheath creates an era of bandwidth abundance that will dwarf the era of MIPS and bits. Or to give a more personal example from *Business Week*,⁸ downloading a digital movie, such as *The Matrix*, takes more than 7 hours using a cable modem and 1 hour over Ethernet; it would take 4 seconds on an optical connection.

Over the next decade, bandwidth will expand 10 times as fast as computer power and completely transform the economy, predicts Gilder. The issue is whether or not this increase in bandwidth can satisfy new data-intensive applications. The race between supply and demand remains as keen as it has always been.

The Wireless Century Has Begun

The goal of wireless is to do everything we can do on wired networks, but without the wire, says Craig Mathias of Farpoint Group, an expert on wireless telecommunications.^{9a} A better term than wireless would be "radio," because most wireless is over-the-air radio signals—for nationwide networks as well as LANS.

Wireless communications have been with us for some time in the form of cell phones, very small aperture terminals (VSATs), pagers, building-to-building microwave links, infrared networks, and wireless LANs in warehouses. Tomorrow's uses span a vast spectrum.

Frank Dzubeck, a long-time telecommunications consultant,¹⁰ agrees, stating that whereas the twentieth century was the Wireline Century, the twenty-first century will

be the Wireless Century. The motivation for laying copper wire, cable, and fiber throughout the twentieth century was voice communications. The motivation for wireless is data. Dzubeck sees wireless equivalents arriving that rival today's wireline technologies. But before delving into these alternatives, it's important to understand the distinction between licensed and unlicensed radio frequencies.

Licensed Versus Unlicensed Frequencies

Some frequencies of the radio spectrum are licensed by governments for specific purposes; others are not. The distinction has become very important in the wireless arena because it has led to the rapid innovation, and resulting tumult, the telecommunication industry is currently experiencing.

Anyone can create a wireless device to operate in unlicensed frequencies without first getting a license from the government, notes Heather Green.¹¹ Wi-Fi and other technologies mentioned here use unlicensed frequencies. This has led to greater competition, more innovation, and faster changes in unlicensed technologies than in those using licensed frequencies. The licensed portions of the spectrum are owned by large companies that can afford government licenses that give them a monopolistic hold on specific frequencies. In the absence of competition, these companies have tended to be more plodding in introducing new innovations. But now they face more fleet unlicensed competitors.

The devices that tap unlicensed frequencies are cheaper than their licensed counterparts because they do not need to absorb the huge billion-dollar licensing fees. This discrepancy has caused major pricing disparities, which is good for consumers, but not for licensees.

The downside of the unlicensed frequencies, though, is the possibility of collisions between signals in these parts of the radio spectrum. That is why there is so much lobbying in the United States for the U.S. Federal Communications Commission to take away frequencies from the major TV broadcasters and open it up for unlicensed uses.

This section discusses wireless technologies for networks that cover different distances, from a few feet to thousands of miles, as shown in Figure 4:

- **Wireless Personal Area Networks (WPANs).** Networks that provide high-speed connections between devices that are up to 30 feet apart.
- **Wireless Local Area Networks (WLANs).** Networks that provide access to corporate computers in office buildings, retail stores, and hospitals, or access to Internet "hot spots" where people congregate.
- **Wireless Metropolitan Area Networks (WMANs).** Networks that provide connections in cities and campuses at distances up to 30 miles.
- **Wireless Wide Area Networks (WWANs).** Networks that provide broadband wireless connections over thousands of miles.

WPANs

For distances of a few feet, the high-bandwidth wireline technology is USB—the ubiquitous port on PCs for fast connections to printers, monitors, DVD drives, and the like. The equivalent wireless technology, notes Dzubeck, is IEEE 802.15, which is also known as ultrawideband (UWB) and 802.15.3 (WiMedia). It can transmit from 100 to

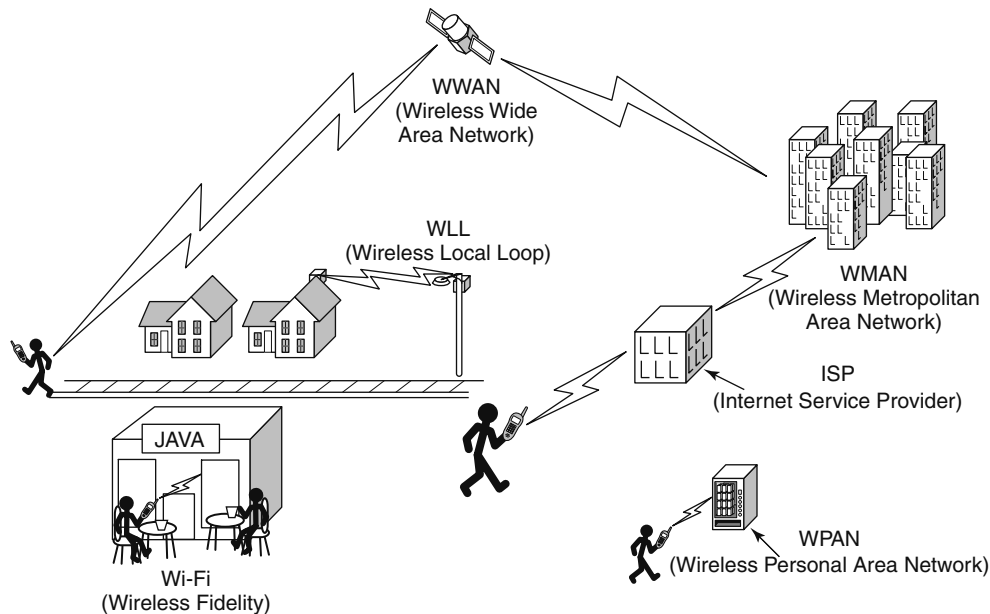


FIGURE 4 The Span of Wireless

400 Mbps (or higher), and it uses unlicensed bandwidth. Green foresees UWB being used to transmit huge files from a laptop sitting in the trunk of a salesperson's car to the PDA being held in the front seat. However, standards are not yet in place.

WLANs

For distances greater than several hundred feet, the high-speed wireline technology has been Ethernet, transmitting from 4 to 10 Mbps. Its wireless counterpart is IEEE 802.11, also known as Wi-Fi. Some people call Wi-Fi the wireless technology for the last 100 feet. Using a wireless modem card, which is essentially a radio transmitter, a laptop or PDA can transmit at 11 Mbps. Newer 802.11 standards are increasing speed and distance.

Wi-Fi is replacing wired LANs in offices and creating wireless LANs where none previously existed—hot spots. A hot spot is an area around a Wi-Fi relay antenna that transmits the wireless signal from a laptop or PDA to a nearby computer or to an ISP to link to the Internet. Some hot spots are public; some are private; some are free; others charge by use or subscription. They are now found wherever people congregate—in restaurants, airports, hotel lobbies, parks, convention centers, and so on.

One private use of Wi-Fi is in cash registers so that salespeople can check inventory and prices at the register rather than having to check the racks. Such uses will grow, Heather Green believes, especially for people who must be on the move in an area, such as a hospital, a construction site, a warehouse, an airport terminal, and such.

The following example is a fairly typical use of a WLAN in manufacturing. The importance of this example is that the LAN is used to provide visibility into manufacturing operations, which is a crucial first step that companies need to make internally to take advantage of online commerce.

CASE EXAMPLE

BMW

www.bmw.com

BMW builds more than one million vehicles a year in Germany and the United States. It opened a facility in South Carolina, and more than 30 suppliers have built facilities nearby to work with BMW. When this plant was slated to take on the manufacture of the company's sport-utility vehicle, BMW wanted to implement the new assembly line quickly, which meant helping its suppliers scale up quickly as well.

Real-time delivery of data to the suppliers was one key to moving quickly. Suppliers needed accurate inventory data on the components they were supplying to BMW so that they knew when to make just-in-time deliveries to the plant. BMW uses SAP's ERP system to track parts inventory. To gather the inventory data that needed to be fed into the ERP, BMW decided to place bar codes on each part. The bar codes could then be scanned as the parts moved through the assembly process so that BMW's planners, operations personnel, and suppliers would know the current status of all parts.

Originally, BMW used Intermec bar code scanners attached to hardwired data terminals at different locations on the plant floor. But more recently, it upgraded to Intermec's wireless scanning system. The scanner terminals transmit the data from the bar code readers to the SAP ERP via a wireless network that covers the entire 2-million-square-foot plant. The system uses radio frequency (RF) technology. The move to wireless allows BMW to more quickly reconfigure or expand the data-collection system. Stations are simply moved; they do not need to be rewired.

A number of BMW's suppliers have followed suit and have implemented wireless data-collection networks in their operations. As a result, the supply chain—from supplier to supplier warehouse to BMW's production line to shipment to a dealer—is supported by a flow of data that travels over interconnected wireless and wired networks. ■

WMANs

For distances of 10 to 30 miles, three wireline technologies have been used for local-loop connections and access to cable networks: T-1, cable modem, and DSL.

The wireless equivalent to these wireline technologies is 802.16, which can deliver speeds of 5 to 10 Mbps over these distances. The stationary version is called WiMax (Worldwide Interoperability for Microwave Access). Like Wi-Fi, WiMax creates a hot spot around its radio antenna. It is perfect for aggregating 802.11 hot spots, notes Dzubeck, giving them access to a long-distance carrier network. Proprietary broadband microwave transmission capabilities have been around for years, notes Green, connecting

buildings on a campus, for example. What is new with WiMax is that it is attempting to standardize the technology. Once it no longer uses proprietary technology, equipment costs will plummet.

The mobile version of 802.16 (also called WiMax) could replace cellular technologies, such as GSM, which is used in cell phones, notes Dzubeck. As yet, though, there are no standards for mobile WiMax. It also has a competitor in the licensed spectrum, notes Green, called Mobile-Fi. It, too, lacks standards. Green envisions both technologies eventually providing high-speed (1.5 Mbps) connections to devices being used in moving vehicles and trains.

Cellular companies offer a third option called 3G (third generation), which also uses licensed spectra. The new 3G networks are slower (.3 to .5 Mbps), notes Green, but they are reliable and widely available, unlike Mobile-Fi or WiMax. Some cities already have wireless broadband Internet access via a 3G mobile phone network. Another noted example of adoption of this technology can be found in Owen's case study of the sewers of Jefferson County.¹²

Wireless local loop. Within the WMAN category is the local loop, or "the last mile," where individual homes and offices are connected to a telephone company's central office a few miles away. Eventually, high-speed wireless will be available for the last mile, notes Dzubeck. Newly released spectra (71 to 76 GHz, 81 to 86 GHz, and 92 to 95 GHz) will enable high-speed connections of 2.48 Gbps and 100 Gbps (in its next generation) for up to one mile. This speed is carrier-grade quality, so it will be used to replace fiber in the last mile.

WWANs

Whether the subject is wireless WANs or LANs, the only two wireless technologies are infrared light and radio airwaves (sine waves at specific frequencies) up into the microwave range. Figure 5 shows the electromagnetic spectrum and the broadcast frequencies where the different technologies lie.

The most familiar wide area mobile wireless technology is cell phones, where cell refers to a geographic area with a radio transmitter and receiver. The range of a cell explains why a cell phone used in a moving car fades in and out: As the call is passed from one cell to another it fades out of one range and into another. In essence, a cell phone is like a miniature radio station, says Roth, broadcasting on a certain bandwidth. With the cellular structure, a phone only needs to compete for bandwidth with other phones in the cell. Cell phones operate in the upper radio waves in the microwave frequency band of 2.4 to 5 GHz.

1G cellular. First-generation (1G) cell phones used analog technology and circuit switching. Callers were charged for the amount of time they used the circuit, not for the amount of information transmitted. And, like a telephone or modem, users dialed in.

In the early 1980s, Europe had nine cell phone standards. But seeing the need for one standard to allow continent-wide communication, the European countries developed a digital standard called Global System for Mobile Communications (GSM). GSM operates at a slow 9.6 kbps, but it has encryption to prevent eavesdropping. GSM has become the mobile telephony standard, even in the United States. Unlike the computing industry, a number of the leading global telecom manufacturers are outside the United States. NTT is in Japan, Ericsson is in Sweden, and Nokia is in Finland.

Managing Telecommunications

FREQUENCY	FREQUENCY NAME	TECHNOLOGIES	SPECTRUM USES
3,000 EHz 300 EHz 30 EHz 3 EHz 300 PHz 30 PHz 3 PHz		Gamma rays	
		X-rays	
		Ultraviolet radiation	
		Visible light	
300 THz 30 THz 3 THz		Infrared radiation	
300 GHz 30 GHz	Extra high frequency	Microwave	Wireless Local Loop (71–95 GHz) Terrestrial microwave
3 GHz	Super high frequency		Satellites (0.5–51.4GHz)
	Ultra high frequency	Radio waves	Wireless LANs (2.4–5.0 GHz) 3G wireless (1,800–2,200 Mhz) 1G cellular (800–900 MHz) UHF TV (500–800 Mhz)
300 MHz	Very high frequency		VHF TV (175–216 MHz) FM radio (88–108 MHz)
30 MHz	High frequency		
3 MHz	Medium frequency		Wireless local loop (1.25 MHz) AM radio (540–1800 KHz)
300 KHz	Low frequency		GSM 2G wireless (200 KHz)
30 KHz 3 KHz 300 HZ 30 HZ 7.5 HZ	Very low frequency		
	Earth		

FIGURE 5 The Electromagnetic Spectrum and Broadcast Frequencies

2G cellular. Second-generation (2G) cellular, which predominates today, uses digital technology, but is still circuit switched. Although not developed to provide data transmission, 2G phones can carry data. Anyone who has used a laptop computer with a wireless modem to communicate is familiar with 2G data transmission.

2G also can carry messages using short messaging service (SMS). SMS is packet based and is used for paging and short messages, often from one cell phone to another. SMS is a large driver of wireless data services. It has been hugely popular with Scandinavian teens who use it for instant messaging. And in Japan, NTT DoCoMo introduced i-mode phones for Internet services and e-mail in 1999. Within a year, NTT had 6 million subscribers and some 12,000 i-mode sites. Many were for consumer uses, such as banking, ticketing, weather reports, paying bills, and so on.

3G cellular. The goals of third-generation (3G) technologies are to provide WANs for PCs and multimedia devices to access the Internet or to tap other wireless services at data rates of 384 kbps for mobile and 2 mbps fixed. These speeds are orders of magnitude greater than 2G wireless services. They could support multimedia and video. Some believe that low-bandwidth wireless services, such as the BlackBerry e-mail pager and SMS, are still the true killer applications.

It is too early to tell what the killer apps of wireless will be, because the promise of 3G networks is alluring. As Peter Howe notes, “Coming soon to your cell phone: Everything!”¹³ Cell phones have gone from just being telephones to being cameras, camcorders, televisions, messaging and gaming devices, Etch-A-Sketch art screens, flash cards, small computers, and digital wallets. They may become whatever consumers want in the future, he notes. The uses truly are exploding. South Korea’s SK Telecom even claims to have ring tones that are silent mosquito repellents. Another claims to be a smoke detector. Phones that can send signals to devices remotely, such as starting the home air conditioner so the house is cool when the owner arrives, are being called smart phones.

Of course, one mitigating factor with cell phones is battery life. Companies are investing lots of resources to resolve this issue. Another mitigating factor is input, due to the tiny keyboards found on most cell phones. Speech recognition has long been hailed as the solution to the input problem. Time will tell whether that’s what consumers will want, notes Howe. It’s part of the digital convergence noted earlier.

Cell phones are also becoming multimodal, supporting 802.11 as well as cellular technology. With this development, notes Mathias,^{9b} the cell phone can become the relay point between the Internet (via Wi-Fi) and other devices, such as a notebook computer, PDA, camera, or some other device. The next generation of cell phones with Wi-Fi will act as a type of router, because it is a far cheaper solution than installing a WAN radio in every device, each with its own WAN service (and monthly fee). An example of this technology is Apple’s iPhone that was introduced in July 2007. The unit is an integrated digital appliance that can be used as a cell phone, a Web browser, a music and video player, a digital camera, a GPS navigation system, and a Personal Digital Assistant. Apple sold 270,000 units in the first two days of its market entry. Market analysts predict that 45 million iPhones could be sold by 2009 and the integrated technology would redefine the wireless market.

Wireless mesh networks. Mathias^{9c} goes so far as to say that wireless mesh networks will become very important. A mesh network is a type of network in which many nodes are both end points and relay points. That is, each node can generate traffic, receive traffic, or pass traffic along to a nearby node.

What’s important about a wireless mesh network, notes Mathias, is that it is far more flexible than a wired mesh network because its links are radio signals, not wires.

Paths through a wireless mesh can change, depending on traffic loads, transmission conditions, and such. He believes they are the most flexible network structure ever created. Furthermore, the more users, the more capacity. The downside, though, is that it uses a lot of battery power (a precious commodity these days). Even so, he believes they will influence the future of wireless.

VSAT (Very Small Aperture Terminal). Stationary wireless broadband is best provided today by VSAT, which is why this technology has taken off, notes Mathias. Just look on the roofs of gas stations and chain stores. They all have small VSAT dishes. The speed is 0.5 mbps. Hughes, for instance, provides two-way satellite at hundreds of bits per second—better than dial-up. Numerous wideband VSAT-based services will come online in the next couple of years, he predicts.

Obviously, companies use the Internet to sell their products and services. One company that was an early Internet user has also become an early wireless user, extending its Internet presence to cell phones. That company is American Greetings. Here is the history of its use of the Web.

CASE EXAMPLE

AMERICAN GREETINGS

www.corporate.americangreetings.com

Founded in 1906, American Greetings is the world's largest publicly owned creator, manufacturer, and distributor of social expression products—from greeting cards to giftware. In 2007, it employed approximately 18,000 full-time employees around the world, and serviced about 70,000 stores in the United States and 125,000 worldwide; a \$1.7-billion greeting card company, it was a pioneer in utilizing the Web. It launched its Web site in 1996, featuring paper greeting cards, electronic greeting cards, flowers, and gifts.

At Business OnLine97, a conference sponsored by Giga Information Group,¹⁴ the director of electronic marketing for American Greetings described how his firm decided to take advantage of the Web to sell its greeting cards.

The First Web Site

The director noted that his team began its thinking by asking, “Who is our biggest competitor?” The answer was not the other paper-and-ink greeting card competitors. The answer was “forgetfulness.” People forget to buy greeting cards. The people who forget the most are those who are on the Internet—men. Although the team could not address forgetfulness at the retail store level, they could address it via the Web—to a potentially huge market—on a self-serve basis.

The company created a Web-based reminder service whereby a consumer can sit down for one-half hour and enter six months' worth of upcoming events that require greeting cards, such as

(Case Continued)

birthdays and anniversaries. Once American Greetings has this list, it will send the consumer an e-mail reminder to buy a card shortly before each event. Or, the consumer can select a card on the Web site, and American Greetings will address and mail it and send a follow-up e-mail to the consumer stating when the card was mailed.

The electronic marketing group then realized that being able to talk directly to consumers could be used as a value-added service. As a promotion, they sent 50,000 e-mail messages to people who had asked to be reminded of Mother's Day. But rather than simply send the reminder, they offered free postage for any Mother's Day card bought online. The response was overwhelming. In fact, it was far more successful than the group expected. An even more recent Mother's Day promotion swamped the site.

To build brand loyalty, the electronic marketing group went further by taking advantage of a unique attribute of the Web—personalized marketing. American Greetings has some 35 licenses with well-known brands. One, for instance, is with the National Football League. The electronic marketing group has leveraged these 35 licenses using the profile each consumer fills out for the reminder service. For instance, if a consumer notes in his profile that he is a football fan, he may receive a special promotion to buy a specific NFL card when he visits AmericanGreetings.com.

The manager's goal for all of these services—reminder service, electronic cards, and personalized online marketing—has been to build brand loyalty and establish switching costs so that customers will purchase all of their greeting cards from his company.

Not only is he targeting the consumer market, but he is also aiming at the enterprise market, especially salespeople and bosses. These people are likely to see greeting cards as a nice gesture, which will help them maintain and improve relationships with customers or subordinates.

Forming an Online Alliance

The demographics of card buying have changed over the past 20 years. Twenty years ago, 65 percent of greeting cards were bought in specialty card shops. Today, 66 percent are bought in mass retail chains, where the buyers are younger. American Greetings is the leader in this mass retailing channel. To continue as a leader, the company had to find new ways to offer greeting cards. The Internet is one possible channel.

To tap that channel, the electronic marketing group extended American Greetings' alliance with Wal-Mart to the Web. When consumers visit Wal-Mart's online greeting card section, they are actually sent to American Greetings' Web site through a special side-door Wal-Mart entrance. American Greetings then gives Wal-Mart a percentage of sales from these consumers' online purchases.

By using the side-door approach to link the two sites, American Greetings can track the origin of the purchaser and thereby pay Wal-Mart the agreed-on percentage. In addition, American Greetings can make its site appear to be part of Wal-Mart, strengthening Wal-Mart's brand. In reinforcing Wal-Mart's Web-based distribution channel, American Greetings also becomes a value-added partner, which is important if Wal-Mart decides to consolidate greeting-card suppliers.

In addition, to spur purchasing on the Web as well as at Wal-Mart's stores,

(Case Continued)

American Greetings has given online purchasers of greeting cards a money-off coupon that they can print out on their printer and take to a Wal-Mart store. Thus, each partner hopes to increase the traffic of the other. In so doing, they tighten their alliance, both in the marketplace and the Web marketplace.

Consolidating Its Online Presence

AmericanGreetings.com is the online greeting and personal expression subsidiary of American Greetings. Its network of sites in early 2002 was one of the world's top 15 Web sites, with more than 16 million unique monthly visitors. The company says it offers the largest selection of online greetings. To achieve that status, the company has acquired BlueMountain.com, Egreetings.com, BeatGreetings.com (featuring musical greetings from over 200 artists), and Gibson Greetings.

American Greetings sees its mission as helping "people everywhere express their innermost thoughts and feelings, enhance meaningful relationships, and celebrate life's milestones and special occasions."

Moving to Wireless

Today, members of American Greetings' online card club, who pay \$14 a year for membership, receive a choice of thousands of greeting cards, and they can create and print paper cards, invitations, package decorations, business cards, newsletters, stickers, and more on their color printers. Their personalized site contains their profile, favorites list, address book, list of cards sent and to whom, and a reminder list.

To extend the usefulness of membership, American Greetings teamed up with Nokia in 2002 to create a wireless Web presence. Using the WAP browser built into a Nokia phone, members can access American Greetings' WAP-based Web site to send an electronic greeting, either to another phone or to a computer. The company reasons that when people have idle time, besides checking e-mail or playing a game using their cell phone, they also might want to send a funny animated card to someone. ■

Is Wireless Secure?

Security is a major issue today. Security analysts have long assumed that hackers who have been intruding computers would soon attack smart phones, whose advanced network connections and operating systems continue to become more interoperable with computer networks and servers. When both wireline and wireless use the IP protocol, both will rely on the same kinds of security. Until that happens, though, different approaches are needed. Wireless security is not really a major additional concern, notes Mathias, because signals fade fast when they travel through the air. Eavesdroppers need special equipment to pick up radio signals from far away. Radio scrambling and spread-spectrum technologies add security, encryption protects data, and eventually, 802.11i will provide a framework for security.

However, the network is often not the main problem. Security leaks happen at the end, in the notebook computers or the smart phones. Therefore, users of wireless

appliances should only visit Web sites that they know, use the Wi-Fi network they trust, try not to open Web links from e-mails, and, if needed, encrypt the data before they send them out.

Is Wireless Safe?

Although a lot of attention is focused on wireless services, a troubling question has not yet been answered: Are these transmissions safe for humans? The higher-frequency services are in the microwave range. They use almost the same frequency as microwave ovens. Microwave frequencies are more dangerous than lower-frequency radio waves because they cause molecules to vibrate faster, causing heat as the molecules rub against each other. This is how microwave ovens cook food. The power limits on cell phones, wireless modems, and WLANs (3 watts) aim to protect people from this short-term microwave heating phenomenon, says Roth.¹⁵ Microwaves operate at 500 watts. Long-term effects from low-level vibrations that do not raise body temperature are still possible, though. Some studies on rats showed damage to DNA, which can cause diseases such as cancer.¹⁶

Although such health concerns have been dismissed by many scientists and scientific studies, their confidence has not settled the issue. Many have long believed that electromagnetic radiation from power lines, electrical appliances, and computers can interfere with the body's bioelectromagnetic field, causing an imbalance.¹⁶ These imbalances leave people feeling drained, fatigued, and stressed out. Although it is likely that our bodies can rebalance disruptions caused by occasional exposure to electromagnetic radiation (EMR), frequent bombardment likely has an effect. It is probably difficult to directly link exposure to disease; it is more likely that exposure will gradually lower a body's immunity.

The amount of radiation emitted by cell phones is limited by governments, but these limits are averages. Spikes are possible, and these are known to kill cells; therefore, holding a cell phone next to one's head for prolonged periods of time is not wise. Voice use of cell phones by young people is especially disturbing. Thus, it is quite possible that there could soon be a backlash against wireless devices similar to the protests against genetically modified organisms.¹⁶ Objective research is needed and protection could become a hot topic. Anyone care for metal-lined hats?

In conclusion, the success of wireless is guaranteed. People will not give up being mobile. There is no substitute technology, but we advise prudent use.

Messaging Is a Killer App

What has proven true with data-communication technologies over and over again is that the killer application is messaging. As noted earlier, the original inventors of the Internet expected it to be used by researchers to send files back and forth. Instead, researchers used it mainly for e-mail. And e-mail has remained a major use. In the wireless arena, the BlackBerry messaging service is indispensable to many people, and the driving force for wireless data services using 2G phones in Scandinavia and Japan has been SMS.

Likewise, instant messaging (IM) has become an important mode of communication. Importantly, it appears to be the current preferred mode of communication among young people. In his 2004 keynote address at Networld + Interop, Andy Mattes,¹⁷ president and CEO of Siemens Information and Communications Networks,

USA, included two brief video clips of five children, ages 8 to 11, talking about how they communicate with their friends. Behind several of them was a computer screen, often showing a couple of rows of open IM chat boxes, lined up side by side. As the children explained, they use IM to chat with all of their friends at the same time. One boy only uses the phone once a day, to call his Mom (who works in the computer industry). Another girl says that she does not use the phone because then she can only talk to one friend at a time. And she does not use e-mail because it is like regular mail—slow. In short, they prefer to chat with many friends at once. IM gives them this capability.

Many see IM as the killer app of wireless as well, not just for teenagers, but for businesses. Steven Cherry¹⁸ points out that the U.S. Navy's Office of the Chief of Naval Operations turned to IM to communicate with its displaced employees who could not use the secure telecommunications system following the September 11, 2001, terrorist attacks. Top naval officers now use this specially designed and secured IM system routinely to communicate with each other and with their staffs. In addition, the U.S. Navy has connected 300 ships at sea with IM. Whereas teenagers use IM to chat, corporations and other enterprises are using it to quickly ask a question of someone, to share documents, and to exchange notes, says Cherry.

Newer technologies will allow messaging to become even more personal. This is one reason why camera phones have become so popular: a picture is often more personal than a voice description. Photo messaging will add to voice and text messaging. Video messaging is more personal still. Video phones will allow others to be there—a sick grandparent will be able to attend a graduation, a traveling mom will be at a grade school play, and a far-off relative can help celebrate a birthday party.

The key attribute of IM is that it provides presence, which means that a person on your buddy list can see when you are using a computer or device (if it has the appropriate IM software and service) and therefore knows that you are present and available to receive an instant message. Presence is being built into collaboration software, Webcasts, and online games as well. The downside of presence, of course, is that people with large buddy lists can be deluged with instant messages whenever they have their phone or computer on.

Always on is the communication mode of the future because it allows instant notification. For example, a sales team may ask to receive news releases and intranet entries about their specific clients or their main competitors, so they are always up to date. If the team's devices support a team calendar, team members might be able to schedule a quick telephone conference call if they receive important news, such as a competitor trying to snag an important customer or information about a market test. Or, they might just collaborate asynchronously via SMS. On-the-go multiparty collaboration is an important use of low-bandwidth wireless devices, and it could become the same with high-bandwidth devices. Or, a collector might ask for instant notification when specific items within specific price ranges come up for auction. The service might give the collector one-click transaction capabilities so the collector can bid on an item once he or she receives notification.

Mei Chuah, a researcher at Accenture Labs,¹⁹ foresees cell phones, their IM capabilities, and online commerce commingling physical and virtual worlds. She believes the cell phone will become a person's portal to other people, physical things, and virtual entities as well. All will be part of a person's social network. Personal devices (including our cars) will be "socialized" by having communication capabilities and will

potentially communicate wirelessly with each other. Phones will have sensing and even control capabilities. For example, a software robot in the phone will “sense” what friends are doing, and connect those who are, say, watching the same TV program or downloading the same song. Once companies realize they can sell more products and services to consumers by creating social activities (including virtual ones) around their products or services, even more types of things will be given communication capabilities.

Furthermore, Chuah sees the physical and virtual worlds interconnecting, with social networks in one moving to the other. People in virtual worlds already hold parties over the Internet. Such socializing in one world will flow to socializing in the other. Furthermore, items in one world will move to the other. Chuah cites the example of the virtual sword won by an advanced player in the online game Everquest being sold on eBay. Wireless communications will eventually link both worlds, she believes, and the nexus will be the cell phone.

A current-day example of using IM to sell products is Keebler’s RecipeBuddie.

CASE EXAMPLE

KEEBLER

www.keebler.com

Founded in 1853, Keebler is today the second-largest cookie and cracker manufacturer in the United States, and a subsidiary of Kellogg’s. In September 2002, Keebler launched RecipeBuddie on its Web site, notes Gordon Bass.²⁰ “She” is an instant-messenger bot that converses with people who IM her. But she only talks about recipes, using her database of 700 recipes to, say, help someone figure out what to cook for dinner. Keebler’s goal, of course, is for her to get people to buy more Keebler products. She has been given the personality of a humor-filled suburban housewife, which seems to best fit the demographics of Keebler’s audience: suburban women ages 25 to 54.

Her origin is ActiveBuddy, a company founded by Timothy Kay that builds interactive agents (bots) to run on IM networks, private networks, and wireless

networks. RecipeBuddie, for example, sits on someone’s AOL IM buddy list and can answer natural-language questions about recipes. She can be accessed at www.keebler.com.

Emedia, the developer of Keebler’s Web site, built RecipeBuddie using the scripting language BuddyScript (from ActiveBuddy). Development entailed writing scripts to reply to user questions. For RecipeBuddie, each natural-language response acknowledges the other party, repeats the request, and makes a suggestion, which is often one or more recipes. Scripting entailed making the link between what people might ask about (cooking dinner for the kids, a picnic lunch, no onions, feeling sad, etc.) and recipes in the database. Emedia initially wrote 2,000 pieces of dialog for RecipeBuddie, notes Bass.

(Case Continued)

Once developed, Emedia had to get permission to launch RecipeBuddie on the three major IM networks: AOL, MSN, and Yahoo! ActiveBuddy receives a fee every time RecipeBuddie is accessed. Keebler tracks the number of people who put RecipeBuddie on their buddy list, the number of messages exchanged with RecipeBuddie, and the number of recipes viewed and printed.

RecipeBuddie has been very successful, exceeding Keebler's expectations. The main developer, Anna Murray of Emedia, notes three lessons she learned from building the bot. One, users

really like to converse with bots, so a lot more can be done with them. Two, scripting is like writing a novel, so it needs to be done by just a couple of people, and they need to work together very closely. And three, others, besides the original scripters, should be able to add their own content, such as answers to frequently asked questions.

In 2006, Kesebler launched another similar concept. HollowTree4Kids, an interactive online game, is an entertainment platform for children, and, along the interaction, promotes Keebler's line of products. ■

An Internet of Appliances, Traffic Prioritization, and Network Neutrality

Wireless communications are not just for people, of course. A machine-to-machine Internet is coming, notes Andy Reinhardt²¹ and Heather Green.¹¹ Machines will likely use Wi-Fi as one wireless communication protocol. Another protocol is ZigBee, a radio-based communication standard used by tiny sensors. Such sensors might monitor the main systems in a vehicle; the inventory of ice cream in vending machines; a building's HVAC system; or the soil moisture, nutrients, and temperature in a field as well as a myriad of other uses.

The sensors are designed to send specific bits of information, be long lasting, require little energy, and communicate efficiently. With ZigBee, the sensors pass their information on to the next sensor in a sort of bucket-brigade fashion, with the last one passing the data to a computer for analysis or communication, notes Green.

Yet another protocol that involves communication among things is radio-frequency identification (RFID). Like the bar code, it is a technology that involves small tags affixed to objects that provide information about the object. For example, an RFID tag on a package could tell a scanner where it is going, where it has been, the temperature range it has experienced (if that is important to the contents), and so on.

The problem CIOs face is tying such new sensor-based systems into their corporate databases. It is likely that the communication systems will use a mix of wired and wireless technologies, as appropriate. That is just one challenge.

Another challenge is Internet traffic prioritization. When Internet traffic loads exceed the routing and transmission capabilities of the networks, network administrators

must manage data traffic flows by changing the queuing procedures—likely from a “first come, first served” basis to some prioritization policy. Initially, the open architecture concept is based on the principle of equal priority in transmissions or Internet Neutrality. However, with the increased demand on bandwidth, many stakeholders in the telecommunications industry, such as network providers, argue that users (private citizens and business organizations alike) should pay to increase the priority of the transmissions over other users. Customers who pay would get data transmission faster and with higher quality. Those who do not may see their Internet use delayed. For example, a large bank that pays a premium Internet service would be able to transfer data faster than would its smaller competitors that just subscribe to a basic service. To say the least, this view is not universally accepted. Many user groups and policy makers see the concept of charging a fee for prioritized data handling over the Internet as a distortion of the basic elements of equality and openness promoted by the Internet.

The issue is not new, and the industry knew it would eventually surface. It did in 2006, when new software and hardware have made traffic management possible. Technically, network administrators can now prioritize Internet traffic at the router level by examining the destination IP address, port, and contents of the IP packet to determine its payload before passing it over the networks. The new technology allows them to regulate the traffic according to configurable rules.

THE ROLE OF THE IS DEPARTMENT

This long discussion of telecommunications gives just a glimpse into its complexity as well as its increasing importance. Given this central role of telecommunications networks, what is the IS department’s role? We believe IS has three roles: create the telecommunications architecture for the enterprise, run it, and stay close to the forefront of the field.

Planning and Creating the Telecommunications Architecture

A network architecture needs to contain a set of company policies and rules that, when followed, lead to the desired network environment. The key challenge in network design is connectivity to improve productivity and business opportunities. Technically, connectivity means allowing users to communicate up, down, across, and out of an organization. The goal is not a single coherent network, but rather finding the means to interface many dissimilar networks. One guiding principle is to build systems that are coherent at the interfaces so that users think they are only dealing with one network. As discussed in this chapter, telecommunications services include voice and data, and the architecture is a portfolio of services to include local voice mail, domestic and international long distance, mobile voice mail, calling cards, home broadband, high-speed data such as frame relay, remote access VPN, and wireless e-mail and data services.

The second key concept in architecture design is interoperability, which means the capability for different computers, using different operating systems and on different networks, to work together on tasks—exchanging information in standard ways without any changes in functionality and without physical intervention. A truly interoperable network would allow PCs, laptops, handhelds, devices, and objects to interoperate, even

while running different operating systems and communicating over IP networks. This interoperability is the goal of architecture and is the main job of the IS department.

Managing Telecommunications

The second job of the IS department is to operate the network. Here, we focus on some business challenges that are specific to telecommunications.

An increasing area of concern for top management is to manage telecommunications expenses. As usage spreads out beyond corporate boundaries to suppliers and customers with multiple providers, errors related to the billing of telecommunications charges are becoming more common. Numerous industry reports suggest that poorly controlled telecommunications expenses can reach between 10 percent of a large organization's IT budget, or 30 percent of a highly distributed organization.

The major causes of excessive telecommunications costs include:

- **Fragmentation of procurement:** Many companies allow their business units to independently contract telecommunications services. The policy makes sense since units are geographically distributed, and operated in different countries or states. However, the fragmentation of procurement often leads to less than optimal procurement.
- **Service usage:** Service plans do not match actual use. For example, an organization unit leases a high-speed WAN, and the network is consistently underutilized. Conversely, other departments do not buy enough airtime in their monthly rate plans for mobile subscribers, and incur additional surcharges.
- **Unauthorized use:** Excessive or unauthorized use by employees or business partners increase costs. Furthermore, it could also decrease the overall performance of the communications systems. Examples include unnecessary use of directory assistance, long-distance charges, heavy download of non-work-related files, and Internet access from mobile devices.
- **Billing inaccuracies:** Software bugs have been criticized for many billing errors. Lack of rigor in managing auto-payment lets the organization to continue paying the service providers while the employee-subscribers did cancel the services.

CIO's can help develop a telecom management information system that uses a portfolio approach to maximize telecommunications resources while minimizing the overall costs. Communication needs change along with business activities. Communication costs depend on the competitive situation of the industry. Therefore, a telecommunication MIS can help identify, report, and audit costs between locations, allocating resources based on changing needs and cost schemes (for example, promotional discounts, or volume discount from a telecommunications provider). Suffice it to say here that many companies are outsourcing this work to companies that specialize in network management because the issue is so complex, and there are too few network specialists to go around, and network infrastructures are costly investments.

Managing voice and data security should be another top priority for the CIO. By their very nature, telecommunications expose the business to its external world. Maintaining security outside the firm's boundary is difficult. Also, the organization should put into place disaster recovery planning to minimize possible disruption of

business activities should the systems stop working. Network redundancy practices and disaster plans are critical but expensive. Management should carefully weigh the benefits and costs. It should also revisit their decision periodically.

Keeping Abreast of Telecommunications Technology Policy

The third job of IS is to stay current with the technology, and explore new business models to use new technologies for competitive advantages. As an example, if an IS department is not already experimenting with how handheld devices can interact with its Web site, they are behind competitors who are. Keeping abreast of new development requires continually peering into the future and testing out new ideas. It is a crucial job of IS departments, even when budgets are tight.

We alluded the current debate on network neutrality. The issue is rather complex involving social justice, business competitiveness with Internet prioritization seen by some as barriers to entry, technological innovation, and investment. It is important for IS to watch the political debate carefully. Any decision made will ultimately affect the impact of telecommunications on the performance of the organization.

CONCLUSION

The telecommunications world is big, and getting bigger by the day. It is complex, and becoming more complex. Some see it as a global electronic highway system where the goal is to establish links and interoperability. Others see it as a cyberspace where commerce is conducted and businesses operate.

The business world of old depended on communications, of course, but not to the extent of online commerce. The Internet unleashed e-mail, then Web sites for getting noticed globally, and now it is used for transactions and business. Although worldwide communication over the Internet enables global business, it also has the opposite effect: customized personal service to individuals anywhere, anytime.

For many companies, telecommunications services account for some of the largest expenses. For many reasons presented in this chapter, managing these expenses is a real challenge for management.

QUESTIONS AND EXERCISES

Review Questions

1. What are the two ways to view telecommunications?
2. What is the Internet? What three attributes make it important to businesses?
3. Describe the functions of hubs, switches, and routers.
4. What is digital convergence and why is it important?
5. Briefly describe each layer of the OSI Reference Model.
6. Why are unlicensed frequencies important?
7. What are four types of wireless area networks?
8. How is American Greetings moving into wireless?

Managing Telecommunications

9. Why might wireless devices not be safe for humans?
10. What is presence and why is it important?
11. Why is always on important?
12. What is RecipeBuddie and what does she do?
13. What is ZigBee?
14. What are the three roles of the IS department with respect to telecommunications?

Discussion Questions

1. The chapter implies that a company should stay at the forefront of telecommunications technology lest it fall seriously behind. On the other hand, it might be better to let others go first and then learn from their mistakes. When is each approach most appropriate? Why?
2. None of us needs a phone at home and a phone at the office. All we need is one phone that we always carry around. Such a practice would relieve the pressures on the telephone system for so many additional phone numbers and area codes. Better yet, each phone should have an IP address. Discuss the pros and cons of these ideas.
3. Although having a wireless device is handy, it is also an intrusion. People need some privacy. They should not always be reachable. Discuss.

Exercises

1. Read five articles on telecommunications.²² What developments not discussed in this chapter do they see as important and why? Present a short briefing on these issues to the class.
2. Contact the CIO of a company in your community. What is the company's telecommunications architecture? What telecommunications standards does it use? How is it using the Internet? What is it doing about wireless?
3. Find one article that discusses senior management's or line management's role in either telecommunications, the use of the Internet, or online commerce.²³ What role do they play? Are they in partnership with IS? Discuss.

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MANAGING CORPORATE INFORMATION RESOURCES

INTRODUCTION

MANAGING DATA

The Three-Level Database Model

Four Data Models in Business

Getting Corporate Data into Shape

Enterprise Resource Planning (ERP)

MANAGING INFORMATION

Four Types of Information

Data Warehouses

Case Example: Owens & Minor

Document Management

Case Example: Tapiola Insurance Group

Case Example: Tennessee Valley Authority

Content Management

Case Example: Eastman Chemical Company

Managing Blogs

Case Example: Groove Networks

CONCLUSION

QUESTIONS AND EXERCISES

REFERENCES

INTRODUCTION

In today's organizations, IS has been continually managing new forms of information resources in addition to the ones it has already been managing.

- Corporate databases are still a major responsibility of IS organizations, and management of data has gotten increasingly complex as it has become distributed and more prone to security problems. Not only are data now global in some cases, but the data are housed in a variety of database models, such as hierarchical, relational, and object-oriented ones. Data related to daily transaction processing grow at an exponential rate, and are stored in data warehouses.

Managing Corporate Information Resources

- Information, in the form of documents (electronic or paper) and Web content, has exploded the size of the databases that organizations now manage. With the digitization of sound files, photographs, video, and 3D models, file sizes are growing at a fast clip. Unlike structured data, these unstructured forms of information are not easy to index for retrieval purposes.
- Knowledge management is becoming a key to exploiting the intellectual assets of organizations. The types of knowledge organizations are attempting to manage include explicit knowledge (know-what), which can be housed in a file or a process, as well as tacit knowledge (know-how), which is generally in people's heads and is difficult to make explicit.

This chapter deals with all three areas. Data and information (in the form of documents and content) are discussed in this chapter. We begin by discussing managing data.

Managing information resources initially meant managing data, first in files or archives, then in corporate databases that were well structured, carefully defined, and generally under the jurisdiction of the IS department. Next, the term expanded to include information; that is, data that has meaning to those who use them. These include, but are not limited to, corporate reports, discussion minutes, e-mail archives with subject threads, etc. There also has been much talk of managing knowledge. With the emergence of the Internet, talk has turned to managing content, which includes text, graphics, sound, video, and animation. Managing them all is now included in our discussion of information resources in this chapter.

To begin, a few definitions are in order:

- Data consist of facts devoid of meaning or intent, where meaning and intent are supplied by a particular use.
- Information is data in context, which means the data have been given an explicit meaning in a specific context. In this text, we will often use the term “content” to refer to information. This term arose with the emergence of the World Wide Web. Content includes information presented electronically in a variety of media: charts, text, voice, sound, graphics, animation, photographs, diagrams, and video.
- Knowledge is information with direction or intent, where intent is derived from strategies or objectives.

As an example, consider two pieces of data: 1 and 121. They are just two numeric data that do not mean much. However, when put into context—U.S. \$1 = Yen114 on August 17, 2007, the two numbers represent the currency conversion between the U.S. dollar and the Japanese yen. Furthermore, when the daily exchange rates are plotted on a chart, say, between March 15 and June 15, 2007, showing a consistent appreciation of the dollar against the Japanese yen, a foreign currency exchange analyst may reason and argue that the American currency is likely to continue to appreciate in the next coming days. The necessity to transform “meaningless” data into useful knowledge is well understood by businesses that invest significant resources into data analyses or business intelligence.

As the breadth and volume of the kinds of information resources have expanded, so has the job of managing them. This task is commonly known as data management, with data as a valuable resource. Data management encompasses development of computer

architectures and policy and procedures in order to collect, store, manipulate, and distribute data to those who need them. Oftentimes, that job of managing data ends up in the IS organization, even though it may not have started there. For example, when PCs came on the scene, people created their own personal files to do their work. They depended on these files, but no one else did until they were shared. Then, when shared files were destroyed and had no backup, all of a sudden a department might not be able to function. Therefore, users asked IS to back up the file or house it on a computer that was regularly backed up. Thus, IS became involved. The same has occurred with Web content. When departments and field offices initially created their own Web sites, IS often was not in the picture. However, as the need for recovery, version control, corporate consistency, and such appeared, people again looked to IS to put in the necessary management procedures.

MANAGING DATA

To manage data, it is important to define in a structured way how data are represented, stored, and retrieved for use. A well-designed data structure helps reduce problems related to data storage (e.g., undesired duplication of records, multiple updating of records) and allows efficient manipulation of data (e.g., combined daily data into annual data). Ideally, each data item should be entered in the database only once. For example, for a company, an employee's name should be recorded and stored at a single location, and that database administrator should be able to retrieve to whomever needs this information, either for payroll, production, or social activities. Also, if daily data are stored, there is no need for storing weekly, monthly, or annual data, since the latter can be computed from the daily records. Thus, storage is likely less wasted and data retrieval for computation is faster.

Next, it is important that data adhere to a set of rules or constraints to ensure their integrity or correctness. For example, a business can define a business rule—“If a bank withdrawal is more than \$500, then the balance of the account must be at least \$700,” or “The authorized discount must not exceed 20 percent.”

Since the 1960s, Database Management Systems (DBMS) are the main tools for managing these entities in the business world. Data are valuable resources and, throughout the evolution of computer technology, companies have adopted many types and versions of DBMS to manage data to support daily business. Over the years, major mission-critical DBM applications were built in many sectors of the economy from manufacturing to services, creating legacy applications. DBMS are based on two major principles: a three-level conceptual model and several alternative data models for organizing the data. We briefly describe them here, from the perspective of the managers seeking to understand the fundamentals of DBMS. Interested readers should seek more detailed materials.

The Three-Level Database Model

One of the easiest-to-understand discussions of database technology is by James Bradley¹ in his description of the three-level database model. The concept is still an underpinning of the DBM field. The following discussion is based on Bradley, Martin,² and Atre.³ It begins with the level that the application developer sees.

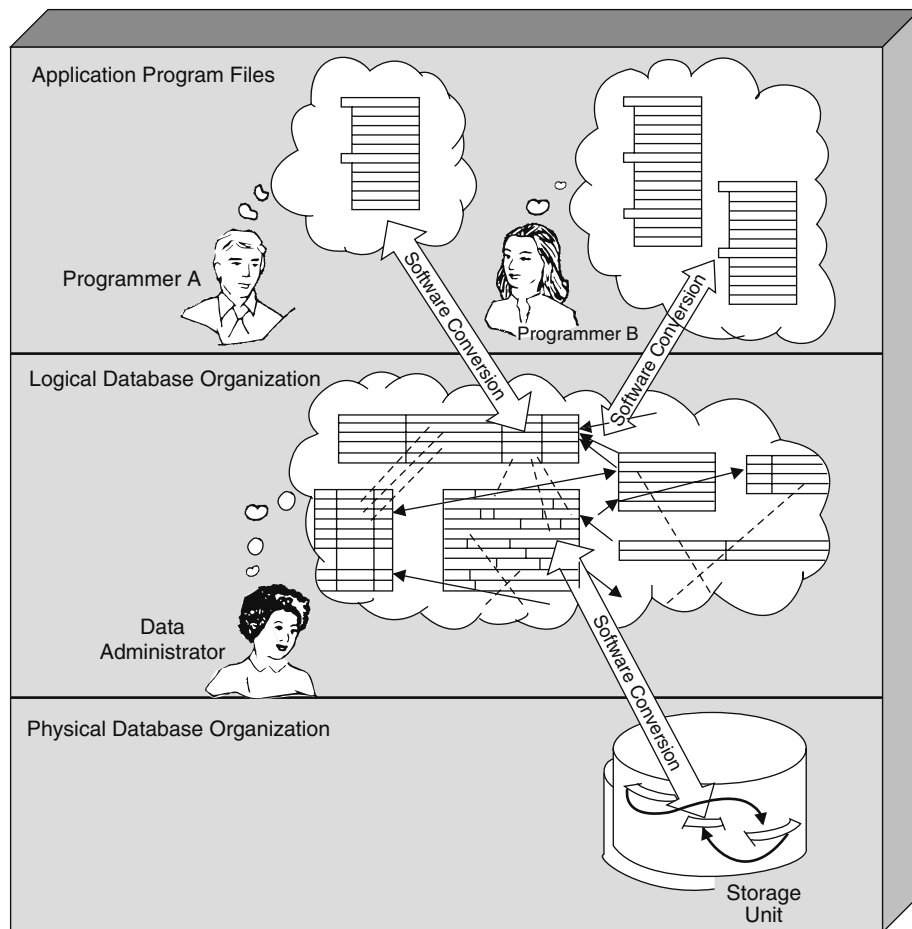


FIGURE 1 The Three-Level Database

Source: James Martin, *Principles of Database Management* (Upper Saddle River, NJ: Prentice Hall, 1976).

- Level 1 is called the external, conceptual, or local level. As Figure 1 illustrates, this level contains the various user views of the corporate data. Each application program has its own view. This level is not concerned with how the data are physically stored or what data are used by other applications.
- Level 2 is called the logical or enterprise data level. It encompasses all an organization's relevant data under the control of the data administrators. Data and relationships are represented at this level by the DBM. This level contains the same data as Level 3, but with the implementation data removed.
- Level 3 is called the physical or storage level. It specifies the way the data are physically stored. A data record consists of its data fields plus some implementation data, generally pointers and flag fields. The end user, of course, need not be concerned with these pointers and flags; they are for use by the DBM only.

The advantage of this three-level model is that Level 2 absorbs changes made at Level 3, such as using a new physical storage method, so that individual application programs in Level 1 do not need to be changed when the physical layer changes. Furthermore, data only need to be stored once in Level 2, and different programs can draw on it and vary the relationships among the data.

Four Data Models in Business

The second major concept in database management is alternative ways of defining relationships among types of data. Data models are methods to structure data to represent the real world and the way data are accessed. Five main data models are in use today: hierarchical, network, relational, and object.

Hierarchical Model

In this model, each data element is subordinate to another in a strict hierarchical manner, like the boxes on an organization chart. This model uses the terminology parent and child to represent these relationships, and each data item can have only one parent. For example, a company (a parent) has many departments (children). Next, a department (parent) has one or more than one unit (child). Then, in the third level, each unit (parent) has employees (children). Therefore, data related to the company, departments, units, and employees are structured like a tree, and to look for data, the user “navigates” through that hierarchy; no shortcut is allowed. This model is intuitive to the users as it reflects the hierarchy of most organizations.

Network Model

Invented by Charles Bachman, and officially developed into a set of standard specification by the Conference on Data Systems Languages (CODASYL), the network model seeks to provide a more flexible, less hierarchical approach to store data items. Instead of having a tree of records, the network model allows each record to have multiple parent and child records, forming a lattice structure. Assembly parts lists illustrate this structure; the same part can be used in more than one assembly. In both the hierarchical and network models, the data relationships are stated explicitly, generally by pointers stored with the data. These pointers provide the means by which programs access the desired data records. Compared to the hierarchy model, the network configuration allows more direct access to data. However, it can appear messy because the files are pointed to others. In the 1970s, Bachman combined the network model (to allow for fast data access) with the hierarchy model (to allow for easier use). This technique is called navigational since Bachman sees the computer programmer as the “navigator” who uses computer commands such as “next,” “previous,” “first,” “last,” “up,” “down,” etc., to search for stored data. Except for hierarchical file systems, navigational systems lost its importance in the 1980s in favor of the relational model. However, similar concepts are being reused in object-oriented programs and XML.

Relational Model

Edgar F. Codd of IBM⁴ proposed the relational model in 1970. The idea is to find a way to store data in a form that is intuitive to the users, while improving database management efficiency.

Relational databases store data in tables like spreadsheets that represent entities. An entity is a real-world thing or a business object like “client,” “part,” or “factory.” Each row of the table, called a tuple, represents a particular entity or instance (Mr. Smith, North East, 202-555-1234). Each column represents an attribute of the entities; For client, client (last name, region, phone number); part (part number, part description, part location). For each record, there is a “key” that uniquely defines a particular record.

For example, for the client record, the client account number would be unique, and can be used as a key. Instead of creating large tables that could create many storage problems (e.g., empty or redundant values), the relational model allows tables to be decomposed into “normalized” (or in nontechnical terms, optimal) tables that can be joined whenever needed through algorithms or “tuple calculus.” With tuple calculus, various kinds of operations can be performed on the data, such as selecting one or more columns, projecting one or more rows, joining rows from several tables by matching column values, and such.

Relational systems are not as efficient as hierarchical or networked database systems, where navigational maps through the data are predefined. However, because relational systems allow people to create relationships among data on the fly, they are much more flexible. Thus, they were first used to handle end-user queries and they are now widely used in high-volume transaction systems with huge files. Relational has become the database technology of choice in business. All major software developers, to start with IBM (System R), and later, Sybase, Informix, Oracle, Microsoft SQL Server and MS Access, and many others, have made SQL (Structured Query Language) a standard database management language in business applications, large and small.

Object-Oriented Database Model

The term “object-oriented database systems” first appeared in the mid-1980s. The concept is the combined result of a series of research initiated a few years earlier (Brown University, University of Wisconsin, MCC, Hewlett-Packard, Texas Instruments, IBM, and others). The object-oriented approach expands the view of data by storing and managing objects, each of which consists of the following:

- A piece of data
- Methods, or procedures that can perform work on that data
- Attributes describing the data
- Relationships between this object and others

Objects are important because they can be used with any type of data, whether a traditional name or address, an entire spreadsheet, a video clip, a voice annotation, a photograph, or a segment of music. A collection of objects is called an object database.

Object-data-management (ODM) techniques draw from the past. They retain traditional DBMS features, including end-user tools, high-level query languages, concurrency control, recovery, and the ability to efficiently handle huge amounts of data. They include two other important concepts as well. One is object management, which is the management of complex kinds of data, such as multimedia and procedures.

The other concept is rule management, that is, managing large numbers of complex rules for reasoning and maintaining integrity constraints between data.

Benchmarks between ODBMS and relational systems suggest that ODBMS perform better for certain types of database manipulation, especially in scientific and engineering applications. To date and with the exceptions of a few niche applications such as financial and telecommunications services, ODBMS have made little progress in mainstream business applications. Relational systems with SQL technologies remain dominant. Perhaps the most fundamental reason for the slow adoption of ODBMS, despite its proven benefits, is the philosophical difference between the legacy RDBMS and new object-oriented programming.

Stonebraker and Kemnitz^{5a} provide an example of an application that requires object management as well as data management and rule management. It is a newspaper application that needs to store text and graphics and be integrated with subscription and classified ad data. In this application, customer billing requires traditional data management, whereas storage of text, pictures, and the newspaper's banner require object management. Finally, it needs the rules that control the newspaper's layout. One rule might be, "Ads for competing retailers cannot be on facing pages." Stonebraker and Kemnitz believe that most data-management problems in the future will require all three dimensions: data, object, and rule management.

The tenets of objects become even more important in the world of Web Services because the XML modules utilize object principles. You can think of objects as little black boxes. They tell you what data they need to perform their function and what output they will give you. However, they will not tell you how they perform their function. If they need help performing their work, they send a request to another module. So, in addition to handling all varieties of data, objects provide a programming discipline to Web Services.

Silberschatz, Stonebraker, and Ullman^{5b} give the following examples of typical, yet complex, database applications that may require objects.

- CAD data for a large office building must maintain and integrate information from the viewpoints of hundreds of subcontractors. For example, when an electrician drills a hole in a beam to run an electrical wire, the system should, ideally, recalculate the stresses on the beam to ensure that its load-bearing capabilities have not been compromised.
- Large retail chains record every product code scanned by every cashier in every store. Corporate buyers explore this data using ad hoc queries to uncover buying patterns. This procedure, called data mining, is growing, not only in retailing, but also in medicine, science, and many other fields.
- Databases of insurance policies now store photographs of damaged property, hand-written claim forms, audio transcripts of appraisals, images of insured objects, and even video walk-throughs of houses. These images contain so much data that these databases are enormous.

Just as there is essentially one worldwide telephone system and one worldwide computer network, some believe there will eventually be one worldwide file system. Achieving this vision requires collaboration among nations, which is actually happening in some areas. The Human Genome Project is one example. Defense contractors want a

single project database that spans all subcontractors and all portions of a project. Auto companies want to give their suppliers access to new car designs. Both of these applications require inter-company databases. The challenge is making these databases behave as though they are part of a single database. This interoperability is the main challenge of distributed systems.

Finally, security is of major importance in today's DBMS. Distributed, heterogeneous Internet-linked databases exacerbate the problem. Companies may want to permit access to some portions of their databases while restricting other portions. This selective accessibility requires reliably authenticating inquirers. Unless security and integrity are strictly enforced, users will not be able to trust the systems.

Getting Corporate Data into Shape

Attempts to get corporate data under control began in the late 1960s and early 1970s with DBMS. Not long after that, the database administration function appeared to manage DBMS and their use. Then, in the 1970s, the broader role of data administration was created to manage all the computerized data resources of an organization. These two functions have remained important.

The Problems: Inconsistent Data Definitions

In a nutshell, the problem has been incompatible data definitions from application to application, department to department, site to site, and division to division. How has this inconsistency happened? Blame expediency. To get application systems up and running quickly, system designers have sought the necessary data either from the cheapest source or from a politically expedient source, that is, using data from existing files and adding other new data. In effect, data have been dribbled from application to application. The result has been data showing up in different files, with different names, or the same name for different data items, or the same data in different files with different update cycles.

Use of such data may be acceptable for routine information processing, but it is far from acceptable for management uses. Management cannot get consistent views across the enterprise with such variations. Also, changes in data and programs are hard to make because a change can affect files anywhere in the organization. Furthermore, such inconsistency makes it difficult to change the tracking and reporting of the organization's products, markets, control structure, and other elements needed to meet changing business conditions.

If a major role of the IS organization had been managing data rather than getting applications running as quickly as possible, then a quite different scenario would have occurred. All the types of data of interest would first be identified. Then the single source of each data type would be identified, along with the business function that creates those data. Finally, a transaction system would be built to collect and store those data, after which all authorized users and applications would have access to them.

This data-driven approach does not result in one huge database to serve the entire enterprise, but it does require administrative control over the data as well as designing databases to support users from the outset. It starts out by describing the data the enterprise needs. Then the approach is selected that provides the data that

gives a good balance between short-term, application-oriented goals, and long-term, data-oriented goals.

Proliferation of Heterogeneous Databases

Typical to many organizations over the years, DBMS have been developed to meet a variety of specific tasks. Some are large, using mainframe computers. Others are small and are populated across the organizations in hundreds or thousands of desktop computers. This practice leads to a proliferation of independent applications, using different data structures, naming conventions, and administrative procedures. The existence of “islands” of incompatible databases makes it difficult for IS department to manage them seamlessly. Indeed, many organizations are still using paper-based documents as a means to exchange data between computer applications. The problem is further compounded with inter-organizational systems or cross-border applications.

Data Availability, Integrity, and Security

Despite the fact that terabytes of data stored throughout the organization, users might not be able to get the right data at the right time. The needed data may exist but they are distributed and not reported to the IS department.^{6a} Data should be entered correctly, and once in the system, they should be protected. This sounds like a simple requirement, but enforcing it is not a trivial effort. Data security is one of the top concerns of any database administration.

The Role of Data Administration

Not too long ago, the use of DBMS reduced, to some extent, the problems of inconsistent and redundant data in organizations. However, installing a DBMS is not sufficient to manage data as a corporate resource. Therefore, two additional thrusts have moved organizations in this direction: broader definition of the data administration role and effective use of data dictionaries.

Database administration concentrates on administering databases and the software that manages them so users have the information they need, when they need it, and in the form they need to do their jobs. One of its main purposes is determining what data are being used outside the organizational unit that creates it. Whenever data cross organizational boundaries, their definition and format need to be standardized under the data administration function.

The data dictionary is the main tool by which data administrators control standard data definitions. All definitions are entered into the dictionary, and data administrators monitor all new definitions and all requests for changes in definitions to make sure that corporate policy is being followed. The following is some of the information found in a data dictionary:

- Definition of data elements (e.g., last_name is used for defining a person’s last name in computer programs, and must be declared as an alphanumeric object with a length of 20 characters).
- Schema. A schema is a collection of schema objects such as tables, views, indexes, clusters, links, procedures, and functions.
- Description of integrity constraints.

Managing Corporate Information Resources

- General database structures.
- User names, roles, and privileges.

As can be seen, a data dictionary is more than a glossary of definitions. It should serve as a tool to help programmers create a corporate-wide consistent data structure.

Most organizations have a database administrator (DBA). A typical job description of the database administrator (DBA) is provided below:

- Analyze data to ensure that the organization has the data it needs, and that the data are managed in the most cost-effective manner.
- Design database, at least at the first phases of the life cycle, and interface between management and IT specialists.
- Oversee and monitor DBMS development (either by in-house teams or by outside contractors).
- Help integrate DBMS with applications software.
- Monitor and administer DBMS security (access authorization, backup, auditing, recovery).
- Work with CIO and system administrator to configure hardware and software for optimal deployment of DBMS.

Enterprise Resource Planning (ERP)

To bring order to the data mess, data administration has four main functions: clean up the data definitions, control shared data, manage data distribution, and maintain data quality. Interestingly, many companies did not take these four jobs seriously until the mid-1990s when they needed consistent data to either install a company-wide ERP package, such as SAP; support a data warehouse effort; or, in some instances, consolidate country-based databases on an intranet so that everyone in the company, world-wide, could draw from the same data pool.

Enterprise Resource Planning (ERP) is a multi-module application software that seeks to integrate all data and business processes of an organization into a corporate-wide unified system. Initially targeted to manufacturing, many ERP are developed to be used across an enterprise. Technically, a well-designed ERP helps a business seamlessly integrate key computer applications—product planning, procurement, inventory, supplier management, customer management, accounting and finance, and human resources. Most ERP in the market today uses relational database systems to feed data to application software. In particular, ERP has been the main driving force for getting some data into shape in many companies. It replaces many independent applications within the organization, thus avoiding the need for creating external interfaces to allow these applications to communicate.

ERP deployment is rather expensive. It requires top management to use the adoption of an ERP as an opportunity to improve or reengineer the company's business processes. CIOs have, in essence, two options to develop an ERP. They can purchase packages offered by major software giants (SAP, Oracle, IBM) and work with the vendors to implement the system to fit in the company's IT infrastructure. This option allows the company to tap in the knowledge and experience of the vendor. The issue is the company might be locked in with the proprietary system. The second option is to

adopt an open-source solution. With open-source ERP, CIOs have access to a larger number of consultants or system integrators. With proper training, in-house teams could take the lead in developing the software as well.

One of the benefits of ERP is that it gives companies a ready-made IT architecture. But, as John Langenbahn of Mead Corporation wondered, does it reduce flexibility because divisions of a company need to move in concert with each other? McGrane of MeadWestvaco, Langenbahn's successor, thinks not, because once a decision is made it can be implemented quickly and across the entire corporation. However, the question of flexibility of ERP still remains.

Once enterprises get their data in shape, those data can more easily be turned into information. That is the next subject in this chapter.

Selecting Enterprise Resource Planning (ERP) Systems

The philosophy behind a corporate-wide ERP is to use IT to break down organizational silos, replacing them with a seamlessly connected and integrated horizontal structure to allow business strategy, organizational structure, and technologies to work together. Many ERP are manufacturing oriented with a focus on demand forecasting, procurement, activity-based costing, materials management, scheduling, quality control, report writing and technical documentation, distribution, and so on. Most ERP software is component-based. The components may include basic functional modules, such as accounting (general ledger, accounts receivables, accounts payable, order entry, inventory, standard costing), human resources, contact management, purchasing, shipping, etc. High-end packages include supply-chain management and customer relationship management (CRM). ERP pricing ranges from a few thousands to millions of dollars for purchase and installation.

As an ERP covers all accounting functions, many think it is an accounting system. There is a difference though. An accounting system is typically a single system that is centralized and located in a single platform. An ERP focuses on enterprise-wide distributed computing with accounting modules as a part of the integrated platform. ERP are much more expensive than a typical accounting system.

MANAGING INFORMATION

As noted earlier, information is data in context, which means the data have been given an explicit meaning in a specific context. We often hear such statements as "Information is power" or "We are in the information age." These and similar statements would lead you to believe that managing information is a key corporate activity. Indeed it is, and it is becoming increasingly so. In fact, some believe that information management, rather than technology management, is the main job of the IS department. We believe both are important. The technology can be viewed as the infrastructure and the information as the asset that runs on that infrastructure. Yet, information is just an intermediary—an intermediary for action. In this important intermediary position, the management of information is important. We begin this discussion by discerning four types of information.

Managing Corporate Information Resources

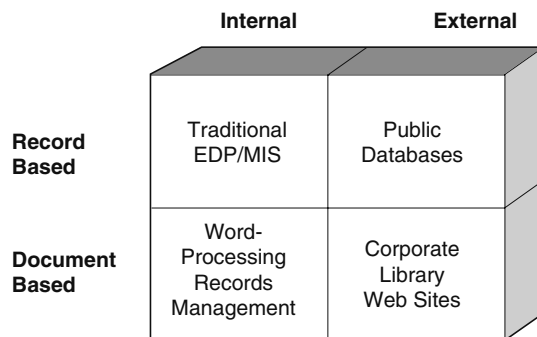


FIGURE 2 Four Types of Information Resources

Four Types of Information

One view of information resources is shown in the 2-3-2 matrix in Figure 2. The rows depict two structures of information—record based and document based—and the columns depict two sources of information—internal and external. Record-based data contain mainly facts about entities, such as patients, vehicles, and parts, and are housed in data records. The discussion up to this point in this chapter has dealt with record-based data. Document-based information, on the other hand, deals with concepts, such as ideas, thoughts, and opinions, and is housed in documents, messages, and video and audio clips. Figure 3 lists various differences between the two.

Internal record-based information was the original focus of IS organizations, because it is the type of information that computer applications generate and manage easily. External record-based information can now be accessed over the Internet or through other electronic means via public databases. End users themselves have generally handled the procurement of this kind of data by subscribing to database services.

However, internal and external document-based information have received little attention from IS organizations until recently, because it has been so difficult to manipulate in computers. Intranets changed that. Documents are now an integral part of information on these sites. Even in companies where the administrative vice president or the corporate librarian believe documents are their realm, after a short time, they gladly turn over responsibility for the technical issues to IS.

FIGURE 3 Structure of Information

	DATA RECORDS	DOCUMENTS
Item of interest	Entity	Concept or idea
Attribute of item	Field	Set of symbols
All attributes for item	Record	Logical paragraph
All related items	File	Document
A group of related files	Database	File cabinet
A collection of databases	Application system	Library, records center
Data models (representational approaches)	Hierarchical, relational, rule-based	Keywords, hypertext, metadata, Standard Operating Procedures (SOP)

Managing Corporate Information Resources

	TYPICAL CORPORATE AUTHORITY	INFORMATION SOURCES	TECHNOLOGIES USED
Internal record-based information	Information systems department	Transaction processing Organizational units	DBMS Data dictionaries Enterprise data analysis techniques
Internal document-based information	Administrative vice president Word-processing center Records management	Corporate memos, letters, reports, forms, e-mail	Word processing Micrographics Reprographics Text-retrieval products
External record-based information	End users Corporate planning Financial analysis Marketing	Public databases	Internet-based services Public networks Analysis packages
External document-based information	Corporate library	Public literature News services Catalogs and indexes Subscriptions Purchased reports Internet (Wikipedia)	Bibliographic services Environmental scanning Public networks

FIGURE 4 The Scope of Information Management

In short, in the past, these four realms of information have been the responsibility of different functions, as shown in Figure 4. Today, the IS organization is likely to be involved in some way in each area. In fact, because the two types of information have such different characteristics, they are being managed in quite different ways. The following discussion notes that division. Managing record-based information is illustrated by the use of one technology: data warehouses. Managing document-based information is illustrated by two technologies: document management and Web content management.

Data Warehouses

Data warehouses appeared in the early 1990s, a bit before ERP systems. Like ERP systems, they, too, spurred getting record-based data into shape.

Data warehouses differ from operational databases in that they do not house data used to process daily transactions. Operational databases are meant to be updated to hold the latest data on, say, a customer's flight reservation, the amount of product in inventory, or the status of a customer's order. Data warehouses are not. The data are generally obtained periodically from transaction databases—five times a day, once a week, or maybe just once a month. The warehouse thus presents a snapshot at a point in time. They are not updated as events occur, only at specific points in time. In addition,

unlike transaction databases, data warehouses are used with tools for exploring the data. The simplest tools generate preformatted reports or permit ad hoc queries. Yet warehouses are reaching beyond reporting on internal data. They are being combined with purchased data, such as demographic data, late-breaking news, and even weather reports, to uncover trends or correlations that can give a company a competitive edge. For example, a retailer might put the umbrellas and raincoats by the front door because a surprise storm is moving in.

The most common type of data in a warehouse is customer data, which is used to discover how to more effectively market to current customers as well as noncustomers with the same characteristics. As a result, the marketing department has, in large part, been the driving force behind warehouses. They want to use customer data—from billing and invoicing systems, for example—to identify customer clusters and see the effect different marketing programs have on these clusters.

Data warehouses are seen as strategic assets that can yield new insights into customer behavior, internal operations, product mixes, and the like. However, to gain the benefits, companies must take the often-delayed step of reconciling data from numerous legacy systems. When the perceived benefits appear to outweigh the costs, companies tackle the tremendous task.

Due to the strategic nature of such uses of data, warehousing projects need sponsorship from top management, not only to provide funding and guide the project in truly strategic uses, but also to ensure that departments cooperate and yield up their data for cross-correlations.

Key Concepts in Data Warehousing

As with all other areas of IT, data warehousing has its own set of terms and concepts. Here are few of them.

Metadata: Defining the data. One of the most important elements in a data warehouse is its metadata; that is, the part of the warehouse that defines the data. Metadata means “data about data.” Metadata explains the meaning of each data element, how each element relates to other elements, who owns each element, the source of each element, who can access each element, and so on.

Metadata sets the standard. Without it, data from different legacy systems cannot be reconciled, so the data will not be clean; that is, comparable. Without comparable data, the warehouse is not of much use. So an important aspect of data warehousing is creating and then enforcing common data definitions via metadata definitions.

Because the world continues to change, so, too, does the metadata. Thus, a metadata librarian is needed to keep it up to date, to enforce the standards, and even to educate users about metadata features of the warehouse. Metadata can be used not only to understand the data in the warehouse, but also to navigate through the warehouse.

Quality data: The biggest challenge. Once metadata definitions have been established, the largest job of data-warehousing teams is cleaning the data to adhere to those standards. This cleaning process is onerous, lament warehousing teams, because legacy data often have definitions that have changed over time, gaps, missing fields, and so on. Sometimes, the source data were not even validated properly, for instance, to ensure that the postal code field contained the right number and type of characters.

The older the data, the more suspect their quality. However, because users want to track items over time, even with poor quality, data-warehousing teams cannot discard the old, poor-quality data. They must find ways to align it with the more recent data, generally by estimating the data that should be in the missing fields, realigning figures based on the newer formulas, and so forth. This grueling manual task is one of the largest the warehousing team must perform.

Data marts: Subsets of data warehouses. When data warehousing was first espoused, the ideal was to build one huge, all-encompassing warehouse. However, that goal has not always proved feasible or practical. For one thing, search times can be excruciatingly long in huge warehouses. For another, the cost may be too high.

Thus, the concept of data marts became popular. A data mart is a subset of data pulled off the warehouse for a specific group of users. A data mart is less expensive to build and easier to search. For these reasons, some companies have started their data-warehouse work by first building data marts. Then they populate the data warehouse by drawing from these marts. This approach is the reverse of what was espoused just a few years ago when purists believed that data should go from a data warehouse to data marts.

The main challenge in following this mart-to-warehouse approach is that the company must have unifying metadata, so that the data in all the marts use the same definitions. Otherwise, the data cannot be meaningfully correlated in the warehouse.

Steps in a Data-Warehousing Project

A typical data-warehousing project consists of five main steps.

1. Define the business uses of the data. Warehousing projects that are run solely by IS departments without a sponsoring user department are generally unsuccessful. The data need a business use to demonstrate payback.
2. Create the data model for the warehouse. This means defining the relationships among the data elements. This process can be quite a challenge, especially when commingling data from a number of systems.
3. Cleanse the data. This notorious step requires moving the data out of the operational systems and then transforming them into the desired standardized format. Specific tools can help cleanse standard kinds of data, such as names and addresses, but defining the transformations is often manual, as is filling in gaps.
4. Select the user tools. Consider the users' point of view and then select the tools they will use and train them to use them.
5. Monitor usage and system performance. Warehouse teams need to be particularly alert to changes in use. In many cases, usage begins slowly. But when it catches on, performance can degrade seriously as the system and the team are swamped with requests. If, however, the team monitors use and create standard queries that serve groups of users rather than individuals, the team can reduce its workload and speed up system response time as well.

The following case example illustrates numerous ways one company is using its data for competitive advantage. The case illustrates use of ERP, data warehousing, and the Web, not only for internal use of data, but as the basis for new revenue-generating services to customers and suppliers. It shows how innovative companies can use

advanced information management technologies. This case is based on a paper that won one of the awards in the Society for Information Management's⁷ annual paper competition. This competition attracts some of the best in-depth descriptions of IS management in practice. The company is Owens & Minor.

CASE EXAMPLE

OWENS & MINOR

www.owens-minor.com

Owens & Minor (OM), headquartered in Mechanicsville, Virginia, is a supply-chain solutions company that distributes name-brand medical and surgical supplies from 14,000 suppliers to over 4,000 hospitals, integrated health care systems, and group purchasing organizations throughout the United States. OM employs 2,700 people and had sales of \$5.32 billion in 2006.

As Don Stoller, Director of Information Management,⁷ and his coauthors point out, OM is in the middle of its value chain. The supply side begins with raw material suppliers who sell to manufacturers (such as Johnson & Johnson), who sell to OM (the distributor), who then sells to health care providers (such as hospitals), who sell to patients. In this field, distributors compete for contracts between manufacturers and health care providers.

In the mid-1990s, OM bought a competitor, doubling OM's size to \$3 billion. However, merging the two cultures proved so difficult that OM recorded its first loss. This loss spurred management to implement a new three-part strategy:

1. Achieve operational excellence
2. Follow and support patient care
3. Turn information into knowledge and then into profit

This strategy depended on building a leading-edge IT infrastructure and an IT R&D culture, which it did. Here is what OM has done.

Achieving Operational Excellence with e-Business Solutions

OM augmented its ERP system to automate order forecasting, which improved inventory turns, reduced ordering rates from five times a week to once a week, and improved customer service. OM also installed an activity-based costing system to separate the cost of its products from the cost of delivery. Thus, customers, such as hospitals or purchasing groups, could pay just for the delivery service they wanted. Some wanted delivery to a loading dock; others wanted delivery to an emergency room. Some customers saved large amounts of money with this new option, and OM increased its sales. A new warehouse management system that uses handheld devices also increased OM's operational efficiency.

Following and Supporting Patient Care

OM implemented an Internet-based order entry and product information tool for hospitals and health systems, called OM-DIRECT. Customers could order

(Case Continued)

online, even using handheld devices. For example, when a hospital signs up for this service, it can ask OM to place bar codes on the products and establish replenishment levels. Then, when a hospital employee scans the bar code with, say, a Palm device, enters the on-hand inventory of that product, and uploads the data to OM's system, the system automatically reorders the product, if needed. Some 1,100 customers signed up for OM-DIRECT during its first two years.

To serve smaller customers and suppliers, such as physicians' offices, small hospitals, and small specialist suppliers, OM teamed up with trading exchanges to provide online marketplaces for these members to buy and sell products and even use OM-DIRECT. The exchanges have encouraged these customers to start using the Internet for ordering, even though they only offer 1,700 of OM's 150,000 products.

Turning Information into Knowledge and Profit

Most interestingly, OM initiated a data-warehousing and decision-support initiative, building one subject area at a time (sales, inventory, accounts receivable, and so on), and permitting queries across the subject areas. During the first year, much of the work was handled by a system integrator familiar with building data warehouses. After that, it became the responsibility of a 12-person OM team that included a director, a manager, three developers who add new subject areas and load data, one data administrator, and six business analysts, who work with the users.

Initially, the warehouse was for internal use only. Within the first 30 months,

some 500 OM employees in sales, marketing, supply-chain management, finance, and other departments had learned to use the Business Objects tool to make queries or create reports from the warehouse, report Stoller et al.⁷

For several reasons, the warehouse team then investigated offering decision support over the Web. Customers were asking sales reps for more information; some requesting up to 30 reports a month. Why not let the customers serve themselves? Also, the Web would allow casual users, such as customers or executives who do not want to learn Business-Objects, to access the data in the data warehouse. Furthermore, OM realized that customers and suppliers were asking for information to run their own businesses because they did not have the systems or technology in-house. Delivering this information over the Web could give OM a competitive advantage by strengthening its relationships with trading partners, giving it a market-leading feature to entice new customers, and even turning the data warehouse into a new service; in fact, a new source of revenue.

To assist its trading partners, OM created an extranet and asked a pilot set of customers and suppliers to list the kinds of information they needed to, say, reduce their costs or better manage their inventories. From these lists, the OM warehousing team created queries and let these partners pilot test the system for four months. During that time, OM debated whether to offer this service for free or for a fee. It decided to charge money, reasoning that the information would appear more valuable if it had a price. Furthermore, the fees would be reasonable, especially compared with the

(Case Continued)

up-front data-warehousing costs partners would be able to avoid.

When the service, called WISDOM, was rolled out, it became the first “e-business intelligence application” in the medical and surgical supply distribution industry, state Stoller et al.

All users have a profile of the information they can access. Every access is checked by the security system. Every query contains the user’s account number so that the system knows which information can be used to answer the query. The browser interface is easy to use; people point and click on over 50 predefined queries, or, more recently, make ad hoc queries.

OM has continued to improve the service. Suppliers and customers can now add external data, such as data from other manufacturers, into OM’s data warehouse so they can study more relationships and perform more “what if” investigations.

For example, a typical-size hospital spends \$30 million a year buying all its medical and surgical supplies. Hospital groups can have a difficult time analyzing purchases across all their hospitals, because each has a disparate system. Rather than invest in consolidating the systems themselves, hospital groups would rather purchase data about their own transactions from, say, a distributor, who is well placed in the value chain to have that information.

OM has thus become an important “infomediary,” note Stoller et al., because hospital purchasing staffs may have a much easier time getting the purchasing information they need from OM than from their own hospital. They can then discover, for instance, which purchases

were “on contract” with OM, and thus had the lower contract price, and which were not. Oftentimes, up to 40 percent of hospital purchases are off-contract, which costs these hospitals money they need not spend. Furthermore, purchasing managers can see how many suppliers they use for the same product and negotiate higher-volume discounts from just one or two. They can also see ordering frequency and optimize it by increasing order volumes, perhaps. In addition, they can more easily spot delivery problems.

OM’s WISDOM service turns out to be equally valuable to suppliers, such as Johnson & Johnson. WISDOM has over 30 queries and 90 exportable reports for suppliers to watch their products move out to consumers. They can analyze their market share in specific regions, analyze product shelf life, coordinate shipping from several locations, see on-contract purchasing (and help customers increase the levels), analyze drop shipments (which are more expensive than OM distribution), and so forth.

WISDOM has become a valuable service to both OM suppliers and customers, and it becomes more valuable the more sales or purchases go through OM rather than through other distributors. In fact, WISDOM led to over \$60 million in new business in one year because it is providing visibility throughout OM’s value chain. Because partners pay for its use, there is constant pressure to keep it market leading, note Stoller et al.

The next step is to turn the data warehouse into an industry-wide warehouse by asking suppliers and customers to place all their data there. If this occurs, conceivably, other distributors might become paying customers of WISDOM

(Case Continued)

as well. Or, as OM and three competitors have agreed, they will establish an independent, neutral health care information exchange.

With DIRECT, WISDOM, and a number of new online solutions, MediChoice, OM-Solutions (supply-chain consulting and outsourcing solutions), CostTracks (activity-based management

for healthcare providers), and others, Owens-Minor earned distinguished recognitions from the IT industry. In 1999, it won an award for its industry-leading e-business infrastructure. In 2001 and 2003, *Information Week* magazine ranked OM first among the Top 500 Technology Innovators & Influencers across all industries. ■

Document Management

Now we turn to managing document-based information. Management of internal document-based information has traditionally rested with the vice president of administration, who has traditionally overseen records management (document records, not data records). Technologies used to manage documents have included micrographics (microfilm and fiche) and computer output microfilm (COM), generally in stand-alone systems. That is, until the Internet arrived. Now corporate intranets house many former paper-based internal documents.

External document-based information, on the other hand, has generally been the responsibility of corporate librarians. Yet, as the amount of such external information grows and as more of it has become computerized, it is increasingly being included in IS executives' jurisdiction. Again, it has been the Web that has brought these external documents to the attention of CIOs, yet many of them consider documents to be the least manageable form of information.

Even in today's Internet-rich world, paper still plays a major role in most enterprises. And while paper is around, there is a need to move seamlessly between digital and printed versions of documents; hence the importance of document management. The field of electronic document management (EDM) uses new technologies to manage information resources that do not fit easily into traditional databases. EDM addresses organizing and managing conceptual, descriptive, and ambiguous multimedia content.

Using IT to manage documents is a challenge for enterprises because most of their valuable information is in documents, such as business forms, reports, letters, memos, policy statements, contracts, agreements, and so on.⁸ Moreover, most of their important business processes are based on or driven by document flows. While computer systems have mostly handled facts organized into data records, far more valuable and important are the concepts and ideas contained in documents. Reports drawn from computerized databases fill important roles in status assessment and control. Oftentimes they must be accompanied by a memo or textual report that explains and interprets the report. Meetings, phone conversations, news items, written memos, and noncomputerized

reports are usually rated more important by managers. Technology applied to handling documents promises to improve these forms of communication.

A document can be described as a unit of “recorded information structured for human consumption.”⁹ It is recorded and stored; therefore, a speech or conversation for which no transcript is prepared is not a document. This definition accommodates “documents” dating back to cuneiform inscriptions on clay tablets. What has changed are the ways information is represented and the ways documents are processed. Information previously represented primarily by text is now also represented by graphical symbols, images, photographs, audio, video, and animation. Documents previously created and stored on paper are now digitally created, stored, transported, and displayed.

Applying technology to process traditional documents changes what documents can accomplish in organizations. A definition more oriented to technology comes from *Byte* magazine.¹⁰

A document is a snapshot of some set of information that can

- *incorporate many complex information types;*
- *exist in multiple places across a network;*
- *depend on other documents for information;*
- *change on the fly (as subordinate documents are updated);*
- *have an intricate structure or complex data types such as full-motion video and voice annotations; and*
- *be accessed and modified by many people simultaneously (if they have permission to do so).*

It is hard to think of anything more pervasive and fundamental to an organization than documents. The impact of applying emerging technologies to document management is potentially significant. EDM promises to advance the management of conceptual information, thereby improving the levels of support and productivity for managers and professionals. With documents as the primary vehicle for business processes, EDM contributes to business process redesign and quality improvement. Numerous EDM applications generate value. In this section, we will examine three:

1. To improve the publishing process
2. To support organizational processes
3. To support communications among people and groups

The concept of just-in-time (printing, publishing, and forms processing) pervades the design philosophy in all three areas.

Improving the Publishing Process

Technology enables a major restructuring of the process of publishing and distributing paper documents. For those organizations that produce documents as a product or as support for a product, this change is reengineering their document production processes. The stages of the traditional process, designed primarily for high-volume and high-quality documents, are shown in Figure 5. The document is created, generally with the use of electronic tools, and a photographic plate is made for an offset printing press. The offset press requires long print runs to amortize the extensive setup costs.

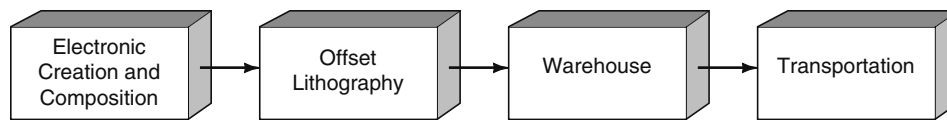


FIGURE 5 Traditional Publishing Process

Thus, a large quantity of documents is produced and stored in a warehouse and then documents are shipped to their destination when they are required. R. R. Donnelley & Sons Company, the country's largest publisher, estimates that 60 percent of the total cost of delivering these documents is in storage and transportation.

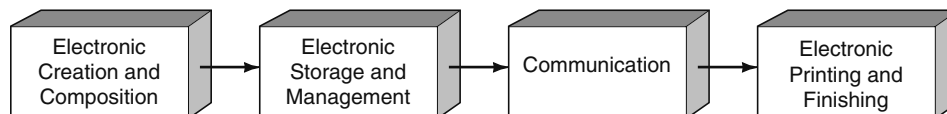
Figure 6 shows the steps in the revised publishing/distribution process using newer technologies. Documents are stored electronically, shipped over a network, and printed when and where they are needed. The major benefits result from reducing obsolescence (revisions are made frequently to the electronically stored version), eliminating warehouse costs, and reducing or eliminating delivery time.

Here is an example of how a traditional printing process has been changed by emerging technologies.

Supporting Communications Among People and Groups

The value of documents is that they transfer information across time and space. Of course, the Internet can handle such communication, but when all members of a group do not have Internet access, or do not use it frequently, companies may need to continue to rely on paper documents. EDM can be used to facilitate such communications among people and groups. In the broadest sense, all EDM applications support this function. The following case illustrates using various technologies to communicate with customers via paper and ensure that each customer gets the right pieces of document.

FIGURE 6 Reengineered Publishing Process



CASE EXAMPLE

TAPIOLA INSURANCE GROUP

www.tapiola.fi

Tapiola is a customer-owned group of four companies with headquarters in Espoo, Finland, a suburb of Helsinki. By

Finnish law, an insurance company can sell only one type of insurance; therefore, each of Tapiola's four companies sells

(Case Continued)

either life, nonlife, pension insurance, or asset management. Tapiola calls itself “an insurance department store.” Its 2006 insurance premium income reached 623 million Euros.

Some 90 percent of insurance in Finland is sold by five insurance groups; Tapiola is the fourth-largest group. It has 14 percent of the market with 1.5 million customers and 3 million policies. Each year its mailroom sends out 4 million letters, so printing is an important and expensive part of its operation.

Formerly, the Tapiola group offered 150 kinds of insurance policies and had 300 different insurance policy forms. Half of the forms were in Swedish and half were in Finnish because both are official languages in Finland. The policy forms were preprinted by an outside print shop, generally on sprocket-fed computer paper. Then the forms were filled in by printers connected to their IBM mainframes.

This mode of operation presented several problems. If a change was made to a form, the inventory of old forms had to be discarded. Reprinting new forms often took weeks. That time represented possible lost revenue. Also, the computer printers could print on only one side of each sheet of paper. Finally, for more complex policies, Tapiola had to use large-size computer paper that was often unwieldy to handle and mail.

Document-Processing Goals

The production manager and the insurance applications development manager looked around for an alternate way to print policies and statements. They had several goals. One was, of course, to reduce costs. A second goal was to stop

using preprinted forms. Their third goal was to give Tapiola marketing people new ways to advertise insurance products by making computer-generated letters to customers more flexible. The fourth and most important goal was to make Tapiola “the most personal insurance company in Finland.” These two systems managers wanted their computer-generated correspondence to prospective and current policyholders to appear more “human,” as if a Tapiola employee had used a typewriter to write a personal reply to an inquiry or request for information.

Centralized Solution

To overcome the computer-generated appearance of their output, they switched to plain paper printers from Rank Xerox, the European subsidiary of Xerox Corporation. Xerox is best known for its photocopiers, but it is increasingly creating products for electronic document processing where a document can include text, data, images, and graphics. Conversion of the output equipment at Tapiola took 15 months, during which time it reduced its 300 preprinted forms to 4.

Four New Forms

The four new forms are actually four types of standard European A4-cut paper. (In the United States, the equivalent would be the 8½ × 11 sheet of paper.) The first form is a plain white A4 sheet of paper. It is used for internal communications within Tapiola.

The second form is the same blank white paper with four holes punched along the left-hand side to fit in the standard European four-ring binder. (In the United States, the standard is a three-ring

(Case Continued)

binder.) This form is also mainly for internal use.

The third form has the Tapiola logo preprinted in green in the upper left-hand corner, and both sides of the paper have the word “Tapiola” printed in tiny, faint green letters over most of the page. This form is the standard company stationery, and it has become one of Tapiola’s standard computer printout forms for communicating with the outside world.

The fourth form is the same as the third except that it has a 4 × 6-inch (10 × 15-cm) perforated area in the lower right-hand corner. This form is used for all their insurance policy bills. The tear-off portion can be paid at any bank; the money and information about the payment go directly from the bank to Tapiola.

Programming and Conversion

Reprogramming the IBM applications was extremely easy, because only the output routines needed to be changed. That programming took two work years of application programmer time. In addition, one systems programmer spent six months working with Xerox on the IBM-to-Xerox system software interfaces. One forms designer spent 15 months redesigning all 300 preprinted forms into 240 printing formats for the application programmers. About 60 forms disappeared altogether because they were found to be unnecessary; the remaining 240 forms are not all different because one-half of them are in Swedish and the other half are in Finnish.

The conversion was done in two stages. First, customer policy statements were printed in a form-like manner on two sides of the new-size paper. These looked

somewhat like the old forms so that policyholders could understand the changeover. Then, the terse, table-like data was replaced with text to make the statements look more like personal letters.

Envelope Stuffing

Interestingly, these redesigns of customer documents were the easy part of the conversion. The more difficult and sensitive part was making sure that each envelope contained the correct pieces of paper. Because Tapiola was now using smaller sheets of paper, each envelope often needed to include several sheets, and, of course, Tapiola did not want to put a cover letter for one policyholder into the same envelope as a statement for another policyholder.

To solve this problem, the company found an envelope insertion machine made by PMB Vector in Stockholm, Sweden. This machine contains a microprocessor that can read an eight-dot code printed at the top of each sheet of paper. Thus, the Xerox printer not only prints the correspondence but, at the same time, it prints a code at the top of each sheet of paper—one code for all pages to go in one envelope. The Vector insertion machine makes sure that each envelope only contains pages with the same code.

Decentralized Expansion

This document-processing conversion was just one part of the effort to improve and humanize customer correspondence. In the midst of the document redesign, Tapiola also decided to move some printing of customer correspondence to its 62 branch offices.

To illustrate how a remote printer is used, consider the case of a female

(Case Continued)

policyholder who has received medical care. She can mail the medical bills to Tapiola or visit her local office in person. If she visits them and presents her bills to a Tapiola employee, that employee uses a desktop machine to access the policyholder's data from the central database. If she has brought all the proper documents needed for reimbursement, the employee can initiate a direct electronic payment from a Tapiola bank account to her personal bank account, no matter which bank they both use.

Once a day, Tapiola transmits all such electronic transactions to its bank, and those transactions are cleared that same day. (The five major Finnish banks have collaborated and created a sophisticated and fast banking system.) The employee then gives the policyholder a letter verifying the transaction. That letter is generated by the central IBM

computer but is printed on the local Xerox printer. If the policyholder is missing some information, the employee can create a personalized letter explaining what is missing by assembling phrases stored in the central database and then printing the letter on-site.

The people at Tapiola Data recommend that other IS organizations become involved in electronic document management by first looking at the output their computers are generating. It was not difficult to mix traditional host computing with document processing technology.

A poll of Finnish citizens showed that Tapiola is seen as a dynamic company, and it has the best reputation among young people of all the insurance groups. The people at Tapiola Data believe their use of document-processing technology is helping to build and reinforce this image. ■

Supporting Organizational Processes

Documents are still the vehicle for accomplishing many processes in organizations. Typical examples include processing a claim in an insurance company, hiring a new employee, or making a large expenditure. The documents are primarily forms that flow through the organization carrying information, accumulating input and approval from a sequence of people. Many such workflow systems still rely heavily on the physical circulation of paper forms.

Using IT to support these processes generates significant value in reducing physical space for handling forms, faster routing of forms (especially over geographical distances), and managing and tracking forms flow and workload. Two trends in organizations have increased the importance of workflow systems: total quality management and business process reengineering.

In addition to improving transaction-oriented business processes with EDM, many organizations are improving the management processes of reporting, control, decision making, and problem solving as well. Several EIS now supply documents to supplement the more traditional data-based reports. Organizations with a custom-developed EIS also add so-called soft information in the form of documents.¹¹

To give an example of how one organization improved a work process via a new document management system, consider the Tennessee Valley Authority.¹²

CASE EXAMPLE

TENNESSEE VALLEY AUTHORITY

www.tva.gov

The Tennessee Valley Authority (TVA) is the largest public supplier of power in the United States, serving some 8.7 million customers in seven southeastern United States by generating energy using fossil, hydroelectric, and nuclear fuels. Its total operating revenues for the first nine months of the 2007 fiscal year were \$6.6 billion. Not long ago, the nuclear division, which has three facilities, revamped its maintenance management system—a system that relies on documents, such as manuals from vendors, drawings, and work instructions, that are regulated by government.

TVA spends more than \$48 million a year creating maintenance work orders and then planning and performing the work. One plant alone annually processes 14,000 work orders and approximately 5,000 procedure changes. Government regulations that oversee the documentation of this work contribute significantly to TVA's high maintenance costs.

The improvement project was handled by a team from various parts of the nuclear operation. They analyzed and charted the existing work processes, determined which improvements were most needed, and investigated how those improvements could be achieved. They spent 350 hours interviewing people and

looked at 15 other utilities. The improvement process was as follows:

- **Identifying reasons for improvement:** The paper-based manual system was too labor intensive and costly.
- **Analyzing workflows and exploring ways for improvements:** Total cycle time was studied to eliminate inefficiencies, and all related workflows, business practices, and application software were scrutinized.
- **Researching new paradigms or ideas:** The maintenance management, procedures management, and workflow system need to be integrated. All hard-copy procedures must be converted to electronic media.
- **Redesigning the process:** Data flow diagramming techniques were used to map out more effective workflows with improved review and approval routing procedures.
- **Piloting the redesigned process:** Intensive testing of retrieval times, routing efficiencies, and data transmission rates on a test network at a site was conducted to resolve problems before implementation.

(Case Continued)

- **Implementation:** Detailed implementation plans were developed for hardware installation, document conversion to electronic format, data migration from mainframe to a client/server architecture, procedure revision, and user training.

One thing they discovered was that the work orders were inextricably linked to document workflow and the ways procedures were managed. Previously, the three areas—work order management, document workflow, and procedure management—had been viewed as separate, and thus managed separately. Upon investigation, the team realized that every work order included accompanying diagrams, documentation, and procedure instructions. However, the three were not always in sync. For example, a work order might be planned several months in advance, but in the meantime, procedures might be changed, yet those changes were not noted when the work order was about to be performed.

The redesigned Procedures Control Process uses IT to store all procedures on-site, and routes them to authorized personnel. The electronic document management system also allows users to make changes or markups at their desks using conventional editing practices—readlines, highlights, lineouts, and parallel routing. The new process designed by TVA electronically combines maintenance orders in one system with procedural document management in another system and eliminates a number of existing systems that did not talk to one another. Maintenance workers can now access documentation on equipment, parts, and records as well as work instructions

from desktop machines. Work orders are generated electronically and then routed for approval with the most current drawings and procedures electronically attached. Electronic signatures are used for approvals. In addition, the documents are indexed by, say, piece of equipment, and the three plants now use the same systems. Thus, maintenance people can review past activity and better plan for the future.

When the system was first introduced, it ran on a relational database with 3,500 users at three different locations. The system later was upgraded to a three-tier LAN and WAN environment with more than 800 PCs.

The system has been successful. Lost work documents were reduced to near zero. Duplicate work order preparation was eliminated. There were fewer stand-alone databases. The average amount of human time spent processing a work order has decreased by almost half, from 39 hours to 23 hours; labor savings are large. More importantly, maintenance workers now have captured data for improving processes. However, the team underestimated the change management effort needed. They did not realize they had to bring many employees up-to-speed on using computers; some had not used keyboards. In addition, the team realized they should have set expectations differently. Rather than emphasize the benefits of the new systems to each employee (because sometimes the new systems required more work of some employees), the team should have emphasized the benefits of the system to TVA, which were significant. Overall, the effort realized 42 percent cost reduction and 53 percent cycle time savings. Perhaps the most beneficial

(Case Continued)

and intangible benefit of an effective document management system for a public company is the ability to make its

operations transparent to the public thanks to a well-organized, well-documented workflow. ■

Content Management

We now turn to the other form of document-based information: content management.

To create a content management strategy, states Tucker in a Gartner EXP report,^{6b} companies need to understand the three phases of the content management life cycle and the goals for each one. As shown in Figure 7, the three phases, which can be viewed as input–process–output, are:

1. Content creation and acquisition
2. Content administration and safeguarding
3. Content deployment and presentation

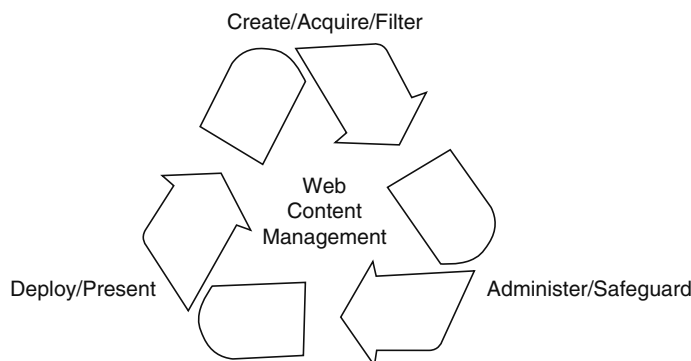
Managing Content Creation and Acquisition

Each phase needs a different emphasis to be effective. Content creation and acquisition, for instance, needs to focus on creating content quality. That is why it might be wise to buy some content from specialists, which is called syndicated content, rather than create it in-house. For example, why create a stock ticker or a weather report or a news feed? Draw on the ones that already exist.

High-quality in-house content comes from subject matter experts and local employees. Thus, the best organizational structure is to distribute content creation and maintenance to employees in HR, marketing, sales, and field offices. They should be responsible not only for creating their content, but also for keeping it updated and fresh.

To avoid anarchy, though, these dispersed experts should be directed centrally and use centrally created formats and an automated workflow system that moves their

FIGURE 7 The Web Content Management Life Cycle



Source: Adapted from Chuck Tucker, *Dealing in Web Currency*, Gartner EXP, 56 Top Gallant, Stamford, CT, June 2001.

work along. The system might even send them reminder e-mails of publishing deadlines. Finally, to improve content quality, it is wise to create a feedback loop so that comments from Web site visitors reach these content creators. Then these creators know what types of content attract visitors and customers.

Content Administration and Safeguarding

The emphasis in this phase, like any operational phase, is efficiency, states Tucker. The goal is to achieve the most with the least effort. As discussed later, content management software tools can help. These tools are used to identify types of content and the business rules that apply to each type. For example, publication of press releases on a Web site should follow business rules that state that each release will first be approved by the manager of corporate communications, each press release will use the standard press release format, and each release will move to the archive file one month after being published. Business rules form the heart of content administration. They present the parameters for the automated workflow for each type of content, thus relieving the Webmaster bottleneck.

So, whereas content creation should be distributed, content administration should be centralized. This structure permits overall central guidance of distributed creative efforts. However, it does present some vexing challenges. One involves the approval process of foreign-language content. Companies that create an approval process believing that all content will be in, say, English, create translation bottlenecks for themselves if they expect all drafts to be translated into English for approval and then translated back into the original language once the document is approved. Companies need to consider multilanguage issues when creating their workflows, selecting their content management software, and designing their Web sites.

Content Deployment and Presentation

The third phase of the content management life cycle is the output phase, distributing content to Web site visitors. The emphasis in this phase should be on effectiveness, that is, presenting the content so that it attracts visitors, allows them to navigate the site easily, and leads them to the desired actions.

Because this phase can determine the success of a firm's e-commerce efforts, it is best to design a Web site beginning with this phase, then move on to ensuring content quality and processing efficiency. The Eastman Chemical Company example that follows illustrates this outside-in viewpoint; most companies take an inside-out view. Eastman redesigned its site to take its customers' point of view rather than its internal organizational point of view. The change had a major positive impact.

Web Content Management

Using the World Wide Web, managing Web content typically consists of the following tasks: create, store, publish, control, manage versions of documentation over the Web. The documentation may include press releases, news articles, users' manuals, technical manuals, and third-party reviews. As noted earlier, many corporate intranets now house documents that used to be paper based. In some cases, these documents appear in PDF form on the intranet, which is like taking a photograph of the pages so that the pages cannot be changed.

The question for CIOs has become: How should we manage all the internal and external contents on our Web sites? The field that addresses this question is called content

management. It deals with managing Web-based content of all types, writes Chuck Tucker in the Gartner EXP report entitled *Dealing in Web Currency*. A major reason content has become important to CIOs, he notes, is because it is a core management discipline underlying online business. Without production-level Web content management processes and technologies, large-scale online business is not possible. The content on Web sites attracts customers, answers questions, and handles transactions. If the content is not refreshed frequently, perhaps as news occurs, or if it is full of errors, or if it cannot handle transaction volumes, a company's Web channel will stave off rather than attract customers.

Content is no longer static; it is active or live and action-driven. An underlying reason is the adoption of XML. XML is used to put tags on data that give that data meaning. Computers use the meanings to manipulate the data and perform work. In essence, use of XML moves Web content from being in a human-only readable format to being in a computer-readable format. Thus, the content can be passed to back-end transaction processing systems and cause an action to take place, such as ordering a book or configuring a recently ordered computer.

The IS department should put together an editorial staff, one that is similar to that of a newspaper organization or a television station, although at a much smaller scale. The staff should develop a publication workflow and use a document management system that can handle multimedia content.

Two Web development features, personalization and localization, are used to attract and keep visitors. Personalization means allowing Web site visitors to customize how they view the page. For instance, some visitors to consumer sites may want lots of sports news but little international news. On the other hand, business visitors to corporate sites might want the site to open to the products they buy or recent news pertinent to their industry. Web content software gives site builders the ability to offer site visitors viewing options. Once selected, the choices are stored in the users' profile and referenced every time they visit the site. Companies can also use personalization to offer complementary products, such as corkscrews to wine buyers or take into account a customer's past buying record.

Localization, on the other hand, means tailoring a site to a culture, market, or locale. For instance, a site may be designed to present its content in the language of the country or region of the visitor. Likewise, localization may mean making appropriate currency conversions automatically. Localization is crucial for companies involved in global e-commerce.

Finally, a growing issue in deployment is multichannel distribution; that is, being able to display the site in the manner appropriate to each type of device, from PC to cell phone. Ideally, the information comes from a common repository, rather than existing in several places, and is put in the appropriate form when requested. Otherwise, if the same content is stored in several places, it can get out of sync. Central storage is important to maintain content quality.

In summary, the way to manage content is to understand the goal of each phase of the content life cycle—quality, efficiency, or effectiveness—and design the phase with that goal in mind. In addition, there should be a feedback loop, so that Web site visitors can tell Web site content creators which content is most useful to them. Such a loop can then drive continual improvement on the Web site.

To illustrate how one company is managing its Web content, consider Eastman Chemical, whose story appeared in Tucker's report entitled *Dealing in Web Currency*.

Selecting Web Content Management Tools

Content management software has much improved since Eastman Chemical's effort. Earlier practice required handcrafted HTMC code on text editors and FTP transmission to the Web site. Content was mostly static text, links, and graphics. Today, there is a wide range of off-the-shelf software, from free and open-source software to commercial systems with prices starting from a few to dozens of thousands of dollars. Despite some overlapping features, content management products vary in functionality and price. We propose below a few important selection criteria to consider.

- **Digital asset management:** The system should be able to help keep track of media assets, such as documents, graphics, and videos.
- **Information rights management:** Some sensitive or proprietary documents should be encrypted and made available only to authorized users.
- **Ability to handle full range of digital content types:** The product should support all the current and planned content types, from graphics to Java code.
- **Versioning:** Content updates should be tracked easily, with roll-back features to go back to the previous versions.
- **Workflow and approval routing:** Before content is posted, it needs to be created, reviewed, and approved by many people located at different locations.
- **Web publishing platform:** The most common publishing platform is the Web site. For large and complex deployment of content, the content management software should be able to connect with the organization existing file or database-management systems (MySQL, SQL Server, Oracle, Informix, etc.), and to deploy the information through multiple sites. Other platforms include PDAs, Web-enabled phones, and other dedicated wireless appliances.

As discussed earlier, the goal is to provide the right information to the right user at the right time and in the right format. The ideal Web-based content management system is one that simplifies the operations to greatest extent possible: maintain control over the creation, update, access, and destruction of documents. High-end tools support integrated site visualization and customization, allows three-tier architecture (Web developers, site managers, and contributors), rapid site deployment with reusable templates, and multilingual support for multinational sites.

CASE EXAMPLE

EASTMAN CHEMICAL COMPANY

www.eastman.com

Eastman Chemical Company, which is located in Kingsport, Tennessee, is a global manufacturer of chemicals, fibers, and plastics. Founded in 1920 to make chemicals for

Eastman Kodak, it was spun off in 1994. As a Fortune 500 company and the world's largest producer of PET polymers for packaging and major supplier of cellulose

(Case Continued)

acetate fibers, Eastman employs approximately 11,000 employees with an annual sales of \$7.5 billion in 2006.

Management considers the company a leader in using IT. Eastman.com was operational in 1994, several years before most companies had Web sites. Originally the site was used for HR and recruiting. Over time, as more content was added, the site became a hodge-podge of different sections targeted at different audiences, structured like Eastman's organization chart. The site posted excess content, with many duplicate descriptions of chemical products, and had inconsistent navigation making it difficult to find the desired information. The content management process was cumbersome and scattered.

Redesigning the Web Site to Take the Customer Viewpoint

In mid-1999, Eastman initiated a company-wide effort to become more customer focused and launched a major e-commerce program. This was the catalyst for rethinking the Web site design. The redesign was championed by the vice presidents of e-commerce and corporate communications because their departments jointly managed content.

The e-commerce group provides the tools and processes for employees to create and update Web content. The corporate communications department enforces corporate content policy and approves all Web content for correct use of trademarks, brands, terminology, and so on.

In line with the corporate refocus, the two groups decided to change the Web site structure from presenting an inside-out view based on Eastman's corporate structure to presenting an outside-in view

with sections devoted to the markets the company serves.

A packaging customer who bought plastics from two Eastman operations formerly had to search the site to find who supplied plastics. Once found, each section had a different navigational system. In the redesign, a single section on food packaging was created for all Eastman operations dealing with packaging.

Eastman worked with a Web design company on the new site architecture, site map, and layout. Later, it added innovative features—that have become today a design standard—such as technical help, FAQs, and localized contents.

Upgrading the Content Management Software

At the same time, Eastman searched for content management software to replace home-grown software in use since 1994. The flat HTML files created a maintenance bottleneck because each page had to be updated separately and required a programmer to translate the content into HTML.

Eastman selected a content management product to create preapproved templates for employees to use, then forward the pages to corporate communications for approval. This approach eliminated the manual process, thus reducing the programmer bottleneck. The software manages employees' rights to update, add, and publish content. Each user ID has a security level and permissible functions associated with it.

Pulling all the business content together for the new site turned out to be a massive effort. Once the content had been compiled, cataloged, and approved, moving from the old system and server to

(Case Continued)

the new system and new content proved to be a second major undertaking.

Benefits of the Site Redesign

The benefits of the redesign were far greater than expected. Within six months, overall traffic doubled, and hits to the new market sections, where Eastman sells its products, increased from 30 percent to 60 percent of total hits. Today, traffic has tripled, and 70 percent of the hits are in the market sectors. Adding new content significantly helped increase traffic, but so, too, did the customer focus.

Eastman underestimated the value of the technical product data sheets published on the site, especially to people outside the United States who previously were unable to get this information easily or quickly. More than 50 percent of the site traffic is from outside the United States. Customers report that the technical data have also significantly accelerated their internal decision-making processes.

To manage the technical data, Eastman uses an internally developed product catalog. Formerly, a data sheet could exist in multiple locations, which led to quality problems, because each had to be updated separately. With the product catalog, the data are stored once and are pulled into a data sheet when needed. Thus, Eastman can ensure that everyone sees the same data on a chemical, even in two different markets.

The site has a public part that anyone can access and a protected part for customers only. Once customers are registered and have a user name and password, they can place orders, look at their order history and status, and browse the product catalog in this protected part. They can also personalize their view of

the site to some extent and create their own catalog of the products they normally order.

Since the redesign, Eastman has continued to expand the site. It improved search capabilities and added a synonym directory, which has proven important because site visitors often use different names for the same product.

Moving Forward: Globalization and Localization

Globalization and localization are major issues. Eastman has a presence in more than 30 countries and sells in all major regions of the world. A significant portion of sales comes from overseas, so the company wants to allow a site visitor to choose one of, say, eight languages and see the relevant content in that language. If it had treated English as a foreign language during the 1999 redesign, it could add other languages easily. Thinking globally in all content management decisions is a necessity.

Another major challenge is finding a workable global approval process. Checking for adherence to content policies by corporate communications is quick today because all content is in English. However, translation into multiple languages and adaptation to local cultures can significantly complicate and lengthen this approval process. Retranslation into English for corporate approval is too expensive to be feasible. The e-commerce and corporate communications departments are currently working on creating a workable translation and approval process for content originating in other languages.

Eastman has learned that it is best to push content management to the source as

(Case Continued)

much as possible so as not to create bottlenecks at central control points. It also learned the value of consistent organization throughout the Web site. This helps present

a cohesive image of the company to site visitors. Having the content management system pull information from the product catalog also ensures data consistency. ■

Managing Blogs

The term “blog” is short for “Web log” or “Weblog.” A blog is a Web site where an individual makes intermittent Web postings. It is akin to a personal online journal. People write and post on blogs as a form of self-expression. What do they write about? They write about whatever comes to mind. They may write about their private life or their work life. Most blogs also invite comments from others, which appear on the blog as well. Blogs are a different form of Web content, but they still need to be managed. Enterprises need to establish guidelines for employees who choose to blog.

Blogs are powerful tools for democratizing online expression, notes Dan Farber.¹³ According to Farber, “Combine blogs with social networks and presence services (such as instant messaging and global positioning), and you have a new person-to-person, information-sharing connection fabric.” In short, individuals can compete with major media via blogs, and they can have major impacts such as influencing politics or company policies. Some forward-thinking companies have recognized the power of this immediate form of publishing and communication. One corporate use of blogs is for crisis management. A blog can be more appropriate than e-mail in managing a crisis.

What readers seem to trust about blogs that they do not trust about conventional media, is their opinionated and personal nature. These characteristics present both opportunities and challenges to organizations.

Employees who are not careful about the information they blog can find themselves in trouble. A hypothetical case study of a blogger who works for a disposable-glove manufacturer is presented in the September 2003 issue of the *Harvard Business Review*.¹⁴ Known as “Glove Girl,” her highly popular blog has increased sales of a company glove, but she has also talked about competitors’ products, potential deals, and industry statistics—all from her own point of view, not the company’s. This case poses the question to four experts: “What should company management do about Glove Girl?” It’s a question all top management teams should be asking themselves.

One of the experts is Ray Ozzie, chairman and CEO of Groove Networks, a company that provides software for group collaboration. He notes in his comments that he believes employee blogs are “more often than not” good for companies. But companies need policies to guide employees in expressing themselves via Weblogs or Web sites, while both protecting the company and reflecting positively on it. He notes that in 2002 his company developed such a policy, shown in the following case example, to address four concerns:

1. That readers would see blogs as official company communications rather than personal opinions
2. That confidential information would be disclosed, intentionally or not
3. That a party—the company, an employee, a customer, or other—could be disparaged on a blog
4. That a blog might violate the quiet period imposed by securities regulations, during which time a company cannot discuss an upcoming securities-related event

Ozzie's advice in the case, and to executives in general, is to create a policy for their firm and to become more familiar with blogging—even perhaps write their own blog, as he does at www.rayozzie.spaces.live.com, to “communicate convincingly with employees, markets and shareholders.”

Understanding the value of informal information exchange in organizations, IBM adds blogging capabilities to its workplace collaboration and development software. The software allows blogs to add links to other Web pages, posting comments and forwarding specific documents to other people. With advanced search functions, IBM also promotes management for multiple blogs, with customized security functions, and the ability for customers to subscribe to their favorite blogs. Today, most blogging software has, more or less, the same capacity—one that allows users to express their thoughts in free format.

CASE EXAMPLE

GROOVE NETWORKS

www.groove.net

Employee Guidelines for Personal Web Site and Weblogs¹⁵

In general, the company views personal Web sites and Weblogs positively, and it respects the right of employees to use them as a medium of self-expression.

If you choose to identify yourself as a company employee or to discuss matters related to the company's technology or business on your Web site or Weblog, please bear in mind that, although you and we view your Web site or Weblog as a personal project and a medium of personal expression, some readers may nonetheless view you as a de facto spokesperson for the company. In light of

this possibility, we ask that you observe the following guidelines:

- Make it clear to your readers that the views you express are yours alone and that they do not necessarily reflect the views of the company. To help reduce the potential for confusion, we would appreciate it if you put the following notice—or something similar—in a reasonably prominent place on your site (e.g., at the bottom of your “about me” page):

The views expressed on this Web site/Weblog are mine alone and do not necessarily reflect the views of my employer.

(Case Continued)

If you do put a notice on your site, you needn't put it on every page, but please use reasonable efforts to draw attention to it—if at all possible, from the home page of your site.

- Take care not to disclose any information that is confidential or proprietary to the company or to any third party that has disclosed information to us. Consult the company's confidentiality policy for guidance about what constitutes confidential information.
- Please remember that your employment documents give the company certain rights with respect to concepts and developments you produce that are related to the company's business. Please consult your manager if you have questions about the appropriateness of publishing such concepts or developments on your site.
- Since your site is a public space, we hope you will be as respectful to the company, our employees, our

customers, our partners and affiliates, and others (including our competitors) as the company itself endeavors to be.

- You may provide a link from your site to the company's Web site, if you wish. The Web design group has created a graphic for links to the company's site, which you may use for this purpose during the term of your employment (subject to discontinuation in the company's discretion). Contact a member of the Web design group for details. Please do not use other company trademarks on your site or reproduce company material without first obtaining permission.

Finally, the company may request that you temporarily confine your Web site or Weblog commentary to topics unrelated to the company (or, in rare cases, that you temporarily suspend your Web site or Weblog activity altogether) if it believes this is necessary or advisable to ensure compliance with securities regulations or other laws. ■

CONCLUSION

We live in an era of information abundance, with terabytes of data and billions of Web pages. As can be seen by the wide-ranging discussion in this chapter, the job of managing information resources is widening significantly. Not only must IS departments get corporate data in shape, but they must also create and build an infrastructure for managing the full range of information types. In some ways, the Internet helps because it gives companies an easily accessible place to store information. On the other hand, the Internet contributes mightily to the information glut we all face. That is where we discuss managing knowledge and issues surrounding intellectual capital. What readers seem to trust about blogs, that they do not trust about conventional media, is their opinionated and personal nature. These characteristics present both opportunities and challenges to organizations.

QUESTIONS AND EXERCISES

Review Questions

1. How do data, information, and knowledge differ?
2. Describe the three-level database concept. What are its advantages?
3. What are four database models?
4. What is the main problem in managing data?
5. Why was ERP a driving force in getting data into shape in many companies?
6. What are the four types of information?
7. What is a data warehouse?
8. What is metadata?
9. Why is O&M's WISDOM service valuable to suppliers?
10. What three electronic document management applications generate value?
11. Give the four goals of Tapiola Insurance Group's EDM project.
12. Why is XML important?
13. What are the three phases of the content management life cycle, according to Tucker, and what are the goals of each one?
14. Why did Eastman Chemical Company redesign its Web site?
15. What are the Weblog guidelines Groove Networks gives its employees?

Discussion Questions

1. In this chapter, the assertion is made that IS departments should concentrate on getting data right rather than getting systems up and running quickly. Discuss the pros and cons of this argument.
2. Technology does not change culture. Agree or disagree? Explain your point of view.
3. Do you agree that the IS department should take the lead in developing EDM? Why or why not?
4. If your answer to question 3 was yes, how can IS motivate other departments? If no, who do you think should coordinate the development of the systems and how?

Exercises

1. Find two articles on data management. Present any new ideas in these articles to the class.
2. Find an example of each of the four kinds of information presented in Figure 3. They may be from company documents, the Web, or public publications. What new ideas on the (a) corporate authority, (b) technologies used, and (c) information sources did you gain from where you found these items? Did you find any evidence of a merging (or a diverging) of the management of these different types of information?
3. Visit a local company with a data administration function. Talk to the data administrator and find out:
 - a. What kinds of data does the IS organization control and not control?
 - b. What types of data problems is the group trying to solve?
 - c. What progress is the group having in bringing data under control?

4. Visit a local company with a Web site and talk to the person who oversees content management and find out:
 - a. What information technologies are used to store, catalog, and retrieve content?
 - b. What kinds of information sources are used to supply the content?
 - c. What is the organizational structure for managing content?
 - d. What are the main content management issues today?

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MANAGING PARTNERSHIP-BASED IT OPERATIONS

INTRODUCTION

SOLVING OPERATIONAL PROBLEMS: A PORTFOLIO APPROACH

Operational Measures

The Importance of Good Management

What's New in Operations?

Case Example: Microsoft

OUTSOURCING IS FUNCTIONS

The Driving Forces Behind Outsourcing

Changing Customer–Vendor Relationships

Outsourcing's History

Case Example: ANZ Banking Group Ltd.

Managing Outsourcing

Case Example: Eastman Kodak Company

Offshoring

Case Example: Hewitt Associates

Insourcing

CONCLUSION

QUESTIONS AND EXERCISES

REFERENCES

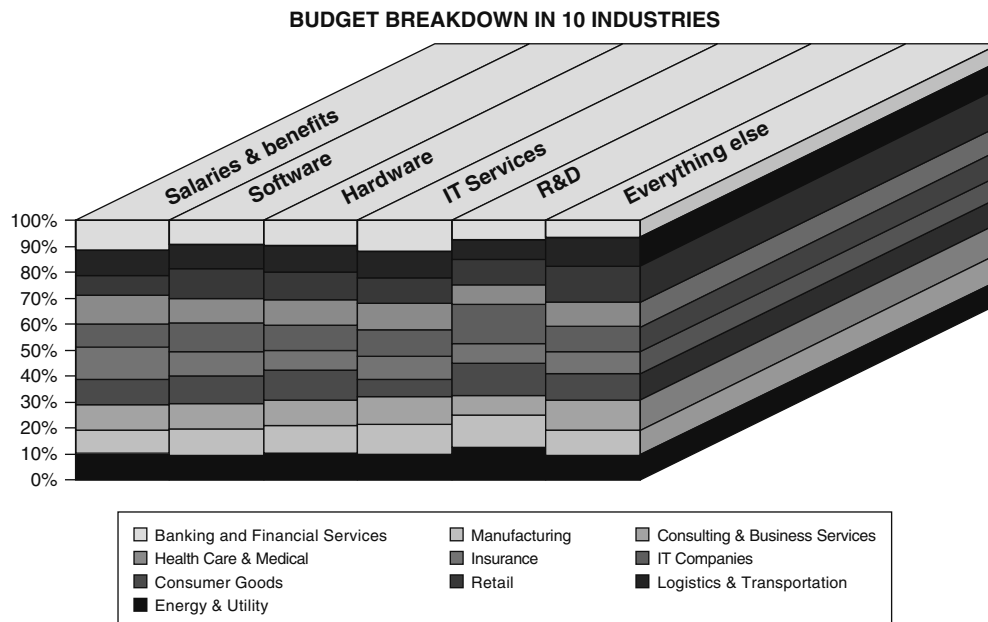
INTRODUCTION

According to itmweb.com, a Web site that runs an online IT budget allocation scoreboard based on major and credible industry source, the “typical” budget of an IT department looked as follows, in 2003:

- Administrative and planning: 20%
- Systems development: 16%
- Systems enhancement: 9%
- Maintenance: 11%, and
- Technology, networks, PCs, etc.: 44%

In 2006, InformationWeek.com ran a national survey involving 500 major firms in 10 industries. As shown in Figure 1, salaries and benefits, new hardware and software acquisition, and activities to support IT services are, on average, more or less evenly split on the budget; each category accounts for about one-third of the budget. The survey also indicated that U.S. companies planned to devote between 25 and 79 percent of their IT budget to new projects. It is also worth noting that the manufacturing, retailing, IT, and health care sectors allocate a significant amount of resources for global supply chains. As the U.S. economy is expected to perform slightly better, IT industry analysts predict that the 2008 budget will be approximately 7 percent higher than the previous year, with a similar budget breakdown. Salaries and benefits remain high, and

FIGURE 1 Budget Breakdown in 10 U.S. Industries, 2006



Source: Information Week Records Survey, 2006.

Managing Partnership-Based IT Operations

many organizations plan to upgrade their hardware/software platform following the usual replacement cycle.

Of course, these numbers are only benchmarks or references. They do, however, indicate the importance of cultivating a culture of best practices in IT management in a number of critical and diverse areas. The job of IT management is to ensure that the IT infrastructure runs cost effectively, and to participate in the organization's quest for technology-enabling business opportunities. This task is even more challenging nowadays because of demanding requirements and expectations from users, and budget constraints for IT spending.

In this chapter, we recommend that, in order to effectively manage IT operations, management should:

- Consistently apply management practices to manage IT portfolio. Any spending on IT should show credible return based on sound investment principles; any IT project should be managed according to rigorous project management principles. The focus should be on improving the productivity, timeliness, and quality of IT products and services.
- Involve all interested in IT-related operations and hold them accountable for their decisions and actions. With limited resources and the variety of organizational IT needs, managing operations requires facilitation, mediation, trade-offs, and consensus within and beyond the IT department. Collaboration is a critical success factor and accountability is also required to ensure that IT-related investments yield satisfactory returns to the organization.

Another theme in this chapter is to look at managing operations from a partnership perspective. The move toward open-source computing, multiplatform collaborative systems, cross-border supply-chain management, and insourcing and outsourcing dictate for a fresh view of dealing with daily management of IT resources and assets. The organizational boundaries have become transparent, and management should look at operations management from a global perspective where tasks can be performed by teams of partners in the most cost-effective manner.

SOLVING OPERATIONAL PROBLEMS: A PORTFOLIO APPROACH

Systems operations problems are obvious to the entire company: Response times are slow, networks are down, data are not available or inaccurate, and systems are prone to malicious attack. What can be done to improve operations? To increase response time, one solution is to buy more equipment. As equipment costs drop, this solution might appear the most cost effective, unless you run out of room for the equipment. Another option would be to regulate the workload by rearranging priorities, allowing mission-critical activities to get executed first. However, this solution only moves the problem of poor management from one hot spot to another. The third solution is to continually document and measure what you are doing to find out the real problems, not just the apparent ones. Then redesign business processes set standards and benchmarks for operations. It is needed no matter who runs operations, the in-house staff or an outsourcer, and no matter whether the systems are legacy transaction systems or new Web-based front ends.

Operational Measures

Operational measures can be both external and internal. External measures are what customers see: system and network uptime (or downtime), response time, turnaround time, and program failures. These aspects directly relate to customer satisfaction. Internal measures are of interest to IS people: computer utilization as a percentage of capacity, availability of mission-critical systems, resource utilization (e.g., disk storage, printer paper, ink, personnel time), job queue length, number of jobs run, number of jobs rerun due to problems, age of applications, and number of unresolved problems.

Problems reported by the external measures can generally be explained by deviations in the internal measures. To help uncover problems related to equipment capacity, quality of applications, or improper use of systems by users, numerous vendors sell monitoring software and devices. Other measurement systems log performance of computer and telecommunications equipment. Storage management systems manage space more efficiently. Schedulers schedule jobs. Library management systems keep track of versions and backups of files and programs. Plenty of tools are available to help IS organizations measure how their equipment is being used.

Operational measures should be based on the concepts of efficiency and effectiveness. In simple terms, efficiency refers to “doing the thing right” (for example, minimizing the operations costs by using low-performance processors), and effectiveness to “doing the thing right” (for example, setting an application system to support the mission of the organization). Indeed, being efficient does not necessarily lead to being effective.

Another important concept to set up operational measures is the trade-off between local optimization versus global optimization. When a business unit within an organization acts to optimize its own business objective, it could reduce the effectiveness/efficiency of another unit.

The Importance of Good Management

Tools are useless, however, unless IS management has created a culture that recognizes and values good operations. It is hard to find good computer operations managers because the absence of prestige (and sometimes pay) does not attract individuals with the proper combination of skills and training. This reality is unfortunate, because in a good environment, an operations job can be particularly rewarding, both financially and professionally.

The skills required of an operations manager are similar to those needed in a factory or oil refinery. The factory manager must schedule work to meet promised delivery dates, monitor performance as work flows through the key pieces of equipment, and respond quickly to production breakdowns. In a well-run factory, the manager can usually recover from one or two individual problems. In a badly run factory, a manager faces many little problems and often does not know where to start to fix the problems. The same is true in computer and telecommunications centers where the “factory equipment” is the disk drives, database machines, host computers, servers, network gateways, network routers, and the like.

In conclusion, CIOs need to be concerned about operations by putting the proper operations environment in place. The key to managing operations is the same as in any management job: Set standards, or better yet, desirable goals, and then manage to those standards by finding an outstanding operations manager.

What's New in Operations?

Over the past few years, several changes have taken place in operations.

Companies Have “Cleaned Their Operational House”

Y2K and the Internet forced companies to “clean house” in their data and network center operations, says Rosemary LaChance of Farber/LaChance,¹ a company that provides consulting on automating data-center operations.

In the late 1990s, companies were fearful that their old computer applications could not handle processing in the year 2000 because many of the programs left out the digits “19” in, say, “1993.” Once the millennium hit, these programs would think the year 2000 was the year 1900, yielding erroneous results.

Y2K forced companies to not only look at their existing software, but also their computer operations; in particular, their standards and policies. Formerly, operations were managed reactively. They upgraded hardware but they rarely updated processes. Companies would not spend the money to improve procedures, thinking, “If it ain’t broke, don’t fix it.”

Y2K, and then the Internet, required management to think about the processes that computer operations supported and ask, “How are we going to do what we say we will do? How will we be able to add services or outsource operations? Will we be able to support e-commerce?” The resulting changes have led to far better operational structures because management took the time to define the rules for operations and put better policies and procedures in place.

“Had they not gone through Y2K, most companies would not have been operationally prepared for the Internet,” says LaChance. Although automation provides discipline, the rules must be in place to automate. Y2K forced companies to define such rules as how to gain access to systems. They also got rid of such outdated procedures as transferring data via tapes (moving to more efficient and less costly online data transfers), and distributing reports on paper (moving to making them available via the company intranet).

In short, Y2K gave computer operations the attention it needed but had not gotten. Companies were forced to move from a survival mode (“Let’s just get this job run”) to a planning mode (“What do we need to support e-enablement?”). The very fact that there was no widespread disruption caused by the Y2K bug is a success of the IS community in dealing with a potential harmful situation. However, challenges remain. Computer operators still cannot link identified problems with changes, so they still have integration and change management problems. That piece of the operations structure is still missing.

Managing Open Source

Open source can give businesses new options to develop cost-effective applications thanks to cost sharing across the user community. Popular technologies include Linux, Apache, and MySQL. However, a major issue with open source is to deal with the existence of multiple versions of open source technology. As it is rather challenging to predict which version of open source will survive in the near future, it is important for the organization to carefully select an open source project. Free technology is not exactly free. Best business practices for system development should be enforced: good documentation, professional technical support, and thriving and stable user community.

Getting Serious with Security

With the proliferation of insecure networked-based systems, hacking tools are becoming more prevalent and easily available. Corporate servers where databases are installed have been a favorite targets for attackers. Over the last few years, popular database management systems (DBMS) such as Oracle have reinforced their security features. In the meantime, hackers relentlessly work on new tools. Furthermore, recent adoption of VoIP or Internet telephony has raised a new area of concern for security experts. The big black hole in the current technology seems to be in the Session Initiation Protocol (SIP) trunking area. SIP trunking allows an organization to bypass the public switched telephone network and use the corporate Internet connection to hook up with a VoIP service provider. Due to the new technology, the SIP trunking is a newly found area of security vulnerability.

Large-scale Data Warehousing

Less than a decade ago, a common measure of business intelligence was the size of data warehouse. For a business, the larger its data warehouse, the more “intelligent” it can be. Only large multinational firms had single-digit terabytes of data in their repositories. Only a few — AT&T, Bank of America, Visa, Wal-Mart, and the likes — belonged to the “1-terabyte club.” Today, a terabyte drive costs less than \$300, and commercial data warehouses contain several hundreds of terabytes of data. Hewlett-Packard has over 500 terabytes of distributed in 750 data marts. Some U.S. federal agencies process more than a petabyte (1,000 terabytes) of data. The issue is therefore not the lack of data, but the quality and usefulness of available data with respect to a variety of information needs spanning across several business units. Content management will become a critical daily operation that requires sound management. Like most of cutting-edge technologies, large-scale data warehousing could become a bleeding technology, one that might end up expensive and counterproductive.

Enforcing Privacy

We emphasize the need to enforce privacy in a networked economy. The issue here is for the business to strike a right balance when disseminating data within its organizational structure. On the one hand, it is critical to provide the right information to the right employee at the right time to help support his decision making. On the other hand, untraced information release could expose the business to privacy-related problems.

Dealing with Talent Shortage

With the globalized economy as the backdrop, tight immigration policies in many countries and inadequate quality of local education could negatively affect the quality of domestic IT workers. The supply of IT workers has also become an increasing area of concern in developed countries, in particular, the United States. Due to the uncertainty of the labor market (i.e., offshoring, stress due to constant technological innovation), many college students are advised not to choose an IT career. Companies should take a proactive approach to deal with their IT human capital. They need to invest in continuing training to retain talented workers. They also need to constantly redefine the job description of IT personnel to take advantage of new skills, possibly new employees' locations and new supporting industries.

More Operations Managers Are Managing Outward

The 2007 survey by *InformationWeek* suggests that the “inward” view remains by and large critical for most businesses. However, as the next section on outsourcing points out, a growing number of companies are turning to a third party to run their data centers. Even more are contracting with a network provider to manage their networks. These changes do not mean that CIOs relinquish responsibility for operations. It just means they need to ensure that their people are properly managing the selected service providers.

Even for companies keeping their own data centers, an increasing number are taking advantage of operational services provided by third parties, especially for Internet-based operations. For example, some host their Web site at a company that specializes in Web hosting. Offloading Web operations allows enterprises to forgo large equipment and facility investments, expensing operational costs instead. Furthermore, they offload the job of finding the needed talent to the specialist. Finding qualified employees can be an acute problem in the IT field. It is easier to attract and retain IT talent when a company’s core business is IT because staff can see a career path, the company is more likely to buy the latest tools and equipment, and the culture is more likely to be IT-friendly.

Operations Are Being Simplified

Another trend is to simplify operations by centralizing applications in one place rather than distribute them on PCs. Programs are then downloaded when requested. This practice is called server-based computing.

Certain Operations Are Being Offloaded

Yet another trend in operations is to offload certain kinds of operations or certain aspects of computer and network operations. Often, these relate to the Internet. For example, a relatively new area is Web-event management, which means hosting a real-time event on the Web. When successful, such events, called Webcasts, lead to huge spikes in Web site hits. To avoid being swamped and having the Web site crash, companies offload the operational aspects of these events to third parties that specialize in hosting such activities. Here is an example of such a Webcast.

CASE EXAMPLE

MICROSOFT

www.microsoft.com

When Microsoft officially announced a new version of Windows, it did so not only at a major launch event in San Francisco, California, but also via a public Internet broadcast and a private Webcast

to 6,000 original equipment manufacturer (OEM) system builders in 83 countries.

This private global Webcast to OEMs was handled by Akamai. Akamai specializes in providing e-business infrastructure

(Case Continued)

through 12,000 edge servers in 66 countries. They are called edge servers because they are at the edge of the Internet; that is, close to end users. This approach gives users in far-flung locations fast downloads of Web content, streaming media, and applications from Web sites hosted on these servers. Like the Internet, Akamai's global distributed system has no central control; therefore, if a server, data center, or even a major network link (a backbone) fails, data can be routed around these failures. Having no single point of failure makes the network fail-safe.

Akamai has also gotten into hosting broadcasts of live events via its customers' Web sites—Webcasting—which requires high-bandwidth capabilities to accommodate streaming media; that is, live audio and video. In addition, Akamai's Netpodium service allows such events to be interactive with dispersed audiences.

The Microsoft Webcast for the system builders was the largest online seminar Microsoft had held. It originated at Microsoft's headquarters in Redmond, Washington, and began with an introduction by Microsoft's OEM team. The Webcast then joined the San Francisco

event with an on-site commentator and special presenters.

At their sites, the system builders could use Netpodium to send questions to the presenters. They sent some 1,800 and received real-time responses. In addition, Netpodium was used by the presenters to poll the system builders at several points during the event.

Microsoft was pleased with the private Webcast because it set a record for attendance, global reach, and audience participation.

According to a survey by ON24.com, a provider of Webcast solutions to B2B media companies, the number of live Webcasts continues to increase for online publishers. A 33 percent increase in 2006 from the year before. The 2007 survey also reports that video Webcasts grow faster than their audio-only counterparts. The next push is the use of mobile technologies, such as the iPod or the Internet-based mobile phone to broadcast information to interested parties. Today, many large organizations join Microsoft in using Webcast as an Internet-based broadcasting medium to reach out to their business partners. ■

In conclusion, the focus of CIOs in operations is changing. Their attention used to be focused on ensuring that they had the in-house expertise to keep systems and networks up and running. Their attention now is toward determining where best to perform the various kinds of operations, in-house or with a third party, and then manage accordingly. In an increasing number of cases, the choice is to use an outside specialist; that is, outsourcing IS functions.

OUTSOURCING IS FUNCTIONS

In the IT world, *outsourcing* means turning over a firm's computer operations, network operations, or other IT function to a provider for a specified time; generally, at least a few years. In 1989, outsourcing became a legitimate management strategy by CIOs.

Managing Partnership-Based IT Operations

Until that time, the only companies that outsourced their IS operations were those that were poorly run. However, in 1989, Kodak outsourced its well-run IS operations to become a more competitive company. That surprising move caused top executives around the world to consider the use of outsourcers, and has become a classic case study of IT outsourcing. Today, CIOs are expected to investigate outsourcing sufficiently to satisfy executive management that their IS operations are as efficient and effective in-house as they would be if they were outsourced; otherwise, they should outsource what they do not do well. According to a online report by Forrester Research (forrester.com accessed 7/9/2008), companies that outsource IT functions save between 12 and 17 percent of the cost of doing the work in-house. As discussed below, this appears to be the first driving force.

Another significant trend is the reverse direction in outsourcing. In 2007, Wipro Technologies, a \$4-billion-a-year company, best known for offshore application development services and India's third-largest IT outsourcing company, paid \$600 million to a U.S.-based infrastructure management provider and planned to open a software development center in Atlanta that could employ 1,000 people in the near future. Wipro is looking for higher-value, higher-margin work, and its management argues that, the United States is an innovative economy capable of providing the type of labor force it needs. Infosys and Tata Consultancy Services, Wipro's most important competitors, employ about 15,000 non-American citizens in the United States. This is more evidence of a global and mobile trend in the IT labor market.

The Driving Forces Behind Outsourcing

According to Mel Bergstein of DiamondCluster Int'l.,² outsourcing descended on IS departments as a follow-on to the merger and acquisition activities in the 1980s. In the 1960s, only 10 percent of the U.S. economy had global competition. In the 1970s, that rose to 70 percent. In response, companies had to focus on core businesses in the 1980s, which led to the huge amount of merger and acquisition activity. This activity was also driven by a new market for corporate control. High-yield bonds allowed a few people to buy a company and leverage it with debt. Companies were priced based on their shareholder value; that is, their discounted cash flow.

These two drivers—focus and value—are still leading companies to restructure and focus on core businesses by asking themselves, “Where do we really add value?” As examples, some apparel companies no longer cut, sew, manufacture, or distribute goods because they see their core businesses as design and marketing. Likewise, some publishers no longer manufacture books. They manage and finance projects, and outsource everything else.

Thus, outsourcing is part of the drive for focus and value, and it is not solely an IT issue, says Bergstein; it is a business issue. Because top management must stress value, they must consider outsourcing in all their functions. Another view is from Paul Strassmann. In his 1995 financial study of the top U.S. firms that pioneered outsourcing, most of them were in financial trouble. From the period prior to the outsourcing decision (1991–1994), their Economic Value-Added index (i.e., profit-after-tax minus compensation to shareholders for equity capital) decreased significantly while personnel layoffs were massive. In retrospective, the major motivation for outsourcing in the 1990s was to save costs and get out of financial trouble.

Changing Customer–Vendor Relationships

IS outsourcers perform the same activities for a company that an IS organization performs in-house. Over time, the amount of work done by outsiders has increased, says Bergstein, as the following expansion in customer–vendor relationships illustrates.

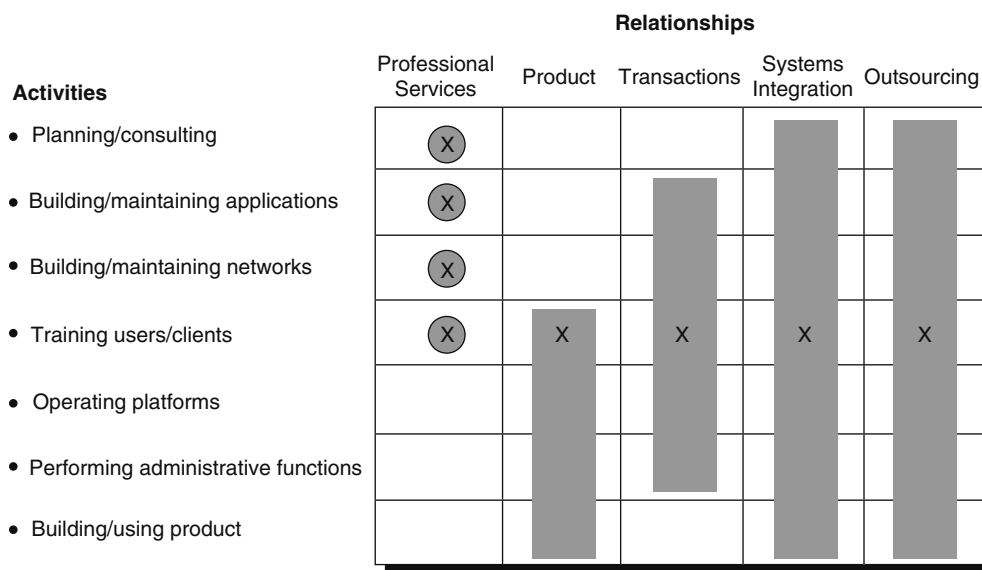
Traditionally, IS organizations bought professional services, such as planning (or consulting), building or maintaining applications, building or maintaining networks, and training. They also bought products, which may or may not have included training. They also bought transactions, such as payroll check processing from a service bureau or credit reports from a credit rating service. Purchasing transactions allows buyers to shift fixed costs to variable costs and gives sellers higher margins because they take on the risks.

With the high use of packages and the need to integrate them to create integrated systems, companies have contracted with systems integrators. They generally handle the entire life cycle—planning, development, maintenance, and training—for major systems projects. Finally, the most bundled approach to contracting for IT services is outsourcing, where the outsourcer contracts to handle all or most of certain IT activities. The main difference between the latter two options is that systems integration is project based, whereas outsourcing is time based.

This five-option continuum, shown in Figure 2, demonstrates how the IT field has moved, says Bergstein. As the organization moves from the more traditional professional services category (on the left) to outsourcing (on the right), four changes occur in the vendor–customer relationship:

1. IS management loses an increasing amount of control because more of the activities are turned over to outsiders.
2. Providers take more risks as they offer options on the right.

FIGURE 2 Customer–Vendor Relationships



Source: Mel Bergstein, DiamondConsultants.com.

3. Providers' margins improve as they offer services on the right.
4. The importance of choosing the right provider becomes more important to the right, because more is at risk in using an outside source.

Outsourcing's History

In 1989, essentially only one kind of outsourcing involving IT was available. Since then, the field has expanded significantly. Here is a glimpse of its history, based largely on attendance at the semiannual conferences of the Sourcing Interests Group, founded and led by Barry Wiegler since 1991.^{3a,b}

IT Outsourcing

IT outsourcing essentially began with “big bang” deals, or mega-deals, which consisted of outsourcing all of a company's data center operations for up to 10 years. These deals involved selling existing equipment to the outsourcer, transferring all software licenses, moving significant numbers of in-house IS personnel to the outsourcer's payroll, negotiating how the outsourcer would help in the transition and which party would carry which costs, establishing desired service levels and ways to measure performance, and specifying every single service to be provided—because if it was not in the contract, it would be an added cost.

In those early days, the goal of these large data-center contracts was purely financial. Companies wanted to remove the huge IT infrastructure investments from their books and shift those fixed costs to variable costs; and they wanted to save money, generally about 15 percent. The deals were front loaded, with the outsourcers losing money or breaking even the first year or two, but then becoming profitable after that as the costs of technology dropped, as they leveraged licenses across clients, as they shared expertise across clients, and as they invested in productivity tools that made them more efficient.

Several problems occurred, though. An “us versus them” mind-set often set in because neither the clients nor the outsourcers handled the transition well. A lot of finger-pointing took place as outsourcers tried to charge for services clients thought were included in the contract. In addition, service levels did not always live up to expectations or interpretations of the contract language differed.

Furthermore, cultures clashed. Former employees might have kept their same desk, but once they became an employee of the outsourcer, they became a provider and were treated differently. Users had higher expectations of outsourcers than of their IS organizations. In short, companies learned that managing the relationship was really the tough job. Formerly, they had thought that negotiating the deal was the difficult part, so they had not carefully defined governance structures; that is, how the relationship would be managed.

Today, the IT outsourcing industry has matured. Providers have learned that heavy-handed treatment of clients can backfire. They are much more careful in transition planning. Clients' attorneys have learned what is important in a contract and where the pitfalls lie. Those early contracts have been renegotiated, and although the clients may not have changed providers, they have generally become more adept at renegotiating because they now know what they really need.

Of course, not all outsourcing deals were mega-deals, but even the small deals felt like a big bang to the employees who moved to the outsourcer.

Transitional Outsourcing

In the early 1990s, a new type of computing arose: client-server computing. IT outsourcing had been around for a few years, so CIOs with their hands full supporting legacy systems looked into using outsourcing to transition to client-server computing. They chose one of two routes. Either they outsourced maintenance of their legacy systems so their staff could concentrate on building new client-server systems or they outsourced client-server development to specialists and kept maintenance in-house. In either case, once the new systems were brought in, the legacy systems they replaced were shut down.

Then, in the late 1990s, when the immense size of Y2K compliance surfaced—to retrofit old applications so they would work after the year 2000—most companies outsourced as much of their Y2K work as they could. Because of the enormous volume of work, offshore outsourcing to India, Ireland, and other countries grew significantly. Unlike traditional IT outsourcing, however, contracts were generally shorter and did not include operations. This project-based outsourcing has been called transitional outsourcing.

Best-of-Breed Outsourcing

All through the 1990s, IS departments outsourced different pieces of their work, mainly infrastructure support. However, CIOs learned that although selecting one outsourcer with broad capabilities might be easiest to manage, no single company was best in class in all areas. Thus, selective outsourcing began, where one outsourcer handled desktop operations, another data-center operations, and a third network management. Even though the concept was good for getting best-of-breed providers, coordination among the multiple providers became a nightmare.

A more recent trend has been collaborative outsourcing, where one company becomes the prime contractor for numerous facets of IS operations but some of the work is provided by other ESPs. Often an operations partner, a development partner, and a telecommunications partner collaborate to bid on the work, but one is the prime partner. Thus, teams of large ESPs bid against other teams for contracts. In some cases, these contracts take on quite a bit more than simply operations; the work includes development of new systems as well. Best-of-breed outsourcing has perpetuated the tradition of long and complex outsourcing contracts.

Shared Services

When IT outsourcing began to gain credibility, executives wondered, “Can we get the same economies of scale by pulling disparate noncore functions together into one shared services group?” In many cases, they felt they could. So they “insourced” to themselves, creating a shared services organization to handle such functions as IT, legal, facilities management, real estate, mail room, finance, and on and on. The goal was to improve efficiencies and save money. Generally, companies created a center of expertise in each area, with all the centers reporting to one shared services vice president.

IT was not always included, but, as in the case of MeadWestvaco Corporation, it was. Some executives believe having IT in shared services gives them the

ability to leverage the IT underpinnings of the other services. Shared services also centralize the management of outsourced functions because, in many cases, the functions are centralized and then outsourced. Shared services groups have become adept at negotiating and managing contracts and supplier relationships because these tasks are a main part of their job.

Business Process Outsourcing

As the IT outsourcing field matured, data-center outsourcing, desktop outsourcing, and other standard IT outsourcing areas have become commodity services; hence, profit margins dropped as the number of competitors rose. To move into higher-margin services, ESPs began specializing in specific functional areas, offering to handle specific business processes as well as their IT underpinnings. This business process outsourcing (BPO) is defined as outsourcing all or most of a reengineered process that has a large IT component.

Improving a noncore process by tapping the expertise and investments of a provider that focuses solely on that process (rather than cut costs) has been the main goal in BPO. Companies are outsourcing logistics, customer service, and many other essential, yet peripheral, functions to the experts.

Balboa Travel,^{3a} a travel agency in San Diego, California, handed over its ticket accounting to Unisys. Each week, travel agencies must report the tickets they have sold to the Airline Reporting Corporation. The process is important, yet burdensome, and the president of Balboa Travel did not want to hire a programmer to maintain such a reporting system, which is what he would have had to do if he had not outsourced the work. Unisys provides him a more sophisticated service than he could afford in-house. It lets him offer his clients—corporate travel departments—reports about their employees' travel habits via an extranet. Balboa is also able to do data mining on its ticket sales to uncover trends that will help it offer new and better travel services.

As is obvious, BPO moves IT-based outsourcing out beyond the IS organization; it involves business units as well. BPO outsourcing is often quite a bit more complex than IT outsourcing because it requires clients to change their business processes to fit with the processes of the service provider. Furthermore, some clients want to retain parts of a process, so complex coordination may be necessary between the two firms as well.

BPO has brought a mind-set change to the field. Whereas IT outsourcing moves suppliers and customers closer to one another in terms of working together, the two parties still do not have the same goals. Clients want to save more money, whereas out-sourcers want to make more money. In BPO, though, when providers take over an entire process, they can be measured and paid based on outcomes rather than transactions. Outcome-based outsourcing gives the two parties common goals. The client focuses on “what” needs to be done; the provider focuses on “how” to do it. Trust, joint financial investments, and partnering are part of the deal.

As an example of BPO, consider ANZ Banking Group and its outsourcing of its procurement function, as described in a Sourcing Interests Group research report.^{3b}

CASE EXAMPLE

ANZ BANKING GROUP LTD.

<http://anz.com.au>

ANZ is Australia's third-largest bank, and is among the top 50 banks in the world. With AU\$335.7 billion in assets, ANZ devises a unique geographical presence in Asia Pacific. It targets markets with high economic growth, yet "under-banked." By 2007, ANZ was operating in 28 countries and had approximately 13,000 staff.

To get to its competitive position today, the bank's challenge in outsourcing procurement was not to improve service levels to its widely dispersed client base and increase the operations scale, without adding costs. ANZ outsourced its entire procurement operation, except strategy, in Australia and New Zealand, to PwC (now part of IBM Global Services) in May 1999 for five years, with a two-year option to continue. ANZ moved fixed asset management and accounts payable into strategic sourcing at the time; neither of them has been outsourced yet. The contract was worth AU\$850 million in 1999; as of 2002 it was worth AU\$950 million.

The benefit objectives of outsourcing to PwC were to leverage PwC's already global capability, reduce transaction costs (which has occurred), and better manage ANZ's spend information (which was poor at the time).

Lessons Learned

Peter Donald, general manager of Strategic Sourcing at ANZ, recounts a number of lessons he has learned in outsourcing procurement.

Be Prepared to Change the Contract As Your Environment Changes. At ANZ, the total number of contracts managed by procurement has risen from 600 to 900, and could well rise to over 1,000. Furthermore, a new goods and services tax in 2001 has forced new issues into the relationship.

Originally, ANZ and PwC had the stretch goal of saving AU\$100 million over the five years. That goal changed to save AU\$130 million over just two years' time—a substantial change. Donald thus recommends reviewing the arrangement regularly and being prepared to change it.

Make Step Changes in Technology and Processes to Save Time and Money. ANZ moved to Web-enabled PeopleSoft; 50 percent of the activity now goes through this e-procurement system. This step change was made easier because ANZ had outsourced to PwC, giving ANZ management the time to concentrate on strategic issues. Formerly, the bank had spend leakage of AU\$50 million to AU\$100 million a year to maverick buying and such. Over the next 12 months, due to the PeopleSoft front end and PwC's operations, ANZ stopped much of that leakage.

Focus on Having an Effective Transition. The transition should be managed so that there is little or no noise from the business units. Some people look for ways to make noise. ANZ experienced some early problems, but PwC recovered

(Case Continued)

quickly, actually more quickly than Donald expected. The lesson was to understand beforehand how a provider can recover, so they can do so quickly.

Do Your Best to Make the Outsourced Group Appear Seamless to Employees.

Some employees look for ways to find fault. Seamlessness can be difficult to achieve if the provider's staff advertise themselves to employees. This is not a good idea. It is always nice to get a pat on the back, like the one Donald received from a line manager who had prepared a requisition for office supplies on his desk-top on Friday at 4:00 p.m. and received the supplies Monday morning. His note to Donald: "Congratulations."

Focus Early on What You Want, and Don't Get Sidetracked. Everyday operations are going well, so Donald is pleased with the service delivery. The outsourcing gives him and his staff more time to manage strategically to capture the AU\$130 million in savings. Thus, he wants more strategic input from PwC than he has been receiving. He wants PwC to push him and his staff to improve. His advice to others is to be sure global input is reaching you, if that is what you want.

Along the same strategic lines, Donald wants PwC to work closely with ANZ on large projects. Thus, PwC has moved its commodity management people closer to ANZ's business so that they better understand the procurement strategy being developed with the business units on large projects.

Keep Incentive Mechanisms Simple and Transparent. When incentive mecha-

nisms are excessively complex, too much effort is required from both sides. Complex incentives may also promote the wrong behavior. For instance, the provider may focus on the stretch targets rather than the daily bread-and-butter issues.

PwC receives a fixed but declining management fee over the term, so there is an incentive to lower ANZ's cost base. There are other incentives as well, which are working fine, says Donald. For instance, PwC risks 50 percent of its profits when it fails to meet the stated minimum service levels. This has only happened in one quarter of the last 19.

Be Able to Benchmark Performance.

Benchmark data are important in evaluating the outsourcing of procurement. Donald uses CAPS, which provides very good data. However, because he reports to the market every six months, he needs those data more frequently than once a year or once every two years.

Understand, to a Fair Degree of Detail, the Value Chain You Plan to Embrace.

Little things can catch you up. For example, information security issues need to be addressed so that third parties in ANZ's supply chain have access through its firewalls.

In 2004, the ANZ banking group wanted to expand its offshore outsourcing of technology in Bangalore and India despite the opposition of some local unions. Its cost-to-income ratio steadily improved from 63.1 in 1997 to 45.6 in 2006. Three years later, it is ranked as a leading global bank based on the Dow Jones Sustainability Index, and *Money Magazine* named it the 2007 Best Bank of the Year. ■

E-Business Outsourcing

With the arrival of business use of the Internet, outsourcing enabled companies to quickly get Web sites up and handling business. In large companies, e-business outsourcing started with marketing departments outsourcing the development of their corporate Web site. Once developed, IS took over operations. However, in dot-coms and Internet-based operations, outsourcing all or most of the IS function has been the preferred mode of operation for several reasons.

Outsourcing allows a company to move fast. When a firm cannot spend a year developing a system, outsourcing the e-business infrastructure can help it get a site up and running within months, perhaps weeks. Furthermore, companies can remain flexible, which means focusing only on a few mission-critical functions that they possess unique expertise and know-how. Generally, IT has not been seen as a core differentiating area when tailorable, off-the-shelf products and services have been available. Last but not least, outsourcing does not tie up a firm's funds in computer and networking equipment, which could become obsolete fairly soon. A company can rent rather than buy. It can draw on best-of-breed as well as change course quickly if need be, swapping out one ESP and swapping in another, to keep pace with the market.

Unlike traditional IT outsourcing, with e-business outsourcing, machines do not need to be purchased from the client, personnel do not have to be moved, and software licenses do not need to be transferred. The outsourcing starts from scratch. For the same reasons some large companies have followed this route as well to get into e-business. For small B2Cs, there are a number of e-commerce hosting services that provide a wide spectrum of e-business services at relatively low costs, from free Web hosting to fee-for-service e-commerce solutions. For example, Yahoo.com offers Web hosting services for less than \$40/month, with a free domain name, unlimited e-mail storage, virtually unlimited Web pages, and 24-hour toll-free customer support. More advanced e-business solutions include sponsored search, e-payment, traffic analysis, and the likes.

Utility computing. E-business outsourcing and IT outsourcing are combining into a new form of managed services outsourcing that is being referred to by various names: utility computing, on-demand computing, virtual data centers, autonomic (self-healing) systems, and grid computing (a take-off on the term "electricity grid"). The idea is that computing power can be treated like electricity: You plug in and only pay for what you use.

Numerous vendors, especially IBM, HP, and Sun, are promoting access rather than ownership. By supplying computer processing, network bandwidth, and applications on demand, they are selling the idea of turning clients' fixed IT costs into variable costs. Clients can then scale their IT infrastructure or handle spikes in computing demand without having to buy more IT assets.

Thus, in 15 years' time, IT outsourcing has expanded significantly, from outsourcing data-center operations to outsourcing business processes and from domestic outsourcing to offshoring, which is discussed shortly.

Managing Outsourcing

Numerous aspects to managing outsourcing need to be handled well to create a successful working relationship. Here are just four—organizational structure, governance, day-to-day working, and supplier development. All are based on research reports published by the Sourcing Interests Group.^{3c, 3d}

Organizational Structure

Managing outsourcing is different from managing internal staff because, for one thing, it is a joint effort between parties that may not have the same goals, as noted earlier. Therefore, during contract negotiations, the two parties need to figure out and negotiate how they are going to jointly manage the contract they sign. In fact, governance needs to be explicitly addressed in the contract.

Typically, parties establish layers of joint teams. A top-level team of a couple of executives from each firm generally has the final word on conflict resolution. An operational team with members from both companies oversees day-to-day functioning. They hold a formal meeting, say, once a week to once a month; but they are generally in daily contact. Also, some joint special-purpose teams may be created from time to time to deal with pressing issues. Some companies have ongoing standing committees, such as a pricing committee or a change management committee, to oversee the use of formal change management procedures.

Although joint committees are a common management structure, each side needs a single executive in charge of its side of the relationship. On the client side, this executive is the relationship manager. This job position has not been prevalent in IS departments, but we believe it is going to become the norm as companies move toward IS Lite. Needless to say, the skills of a relationship manager are far different from those of a data-center manager. A relationship manager needs to be good at negotiating, cajoling, and being an effective liaison between end users and service providers.

To illustrate how one company has managed its outsourcing, we look at Eastman Kodak Company because it created a thoughtful and effective governance structure. The following description comes from the Sourcing Interests Group; it focuses on the outsourcing between Eastman Kodak and IBM Global Services.^{3e}

CASE EXAMPLE

EASTMAN KODAK COMPANY

<http://kodak.com>

Eastman Kodak Company, with headquarters in Rochester, New York, is an international manufacturer of imaging and chemical products. In 1989, the company rocked the IS world by announcing strategic relationships with four suppliers to manage significant portions of its IS organization. Until that time, outsourcing had been viewed as a desperation move to improve poorly run IS departments.

Because Kodak's unit was well run, and benchmarked accordingly, its pioneering stance caused many IS executives—and a few CEOs and CFOs as well—to seriously reconsider outsourcing.

Kodak announced that one ESP would operate its data centers and networks, another would manage its telecommunications, a third would handle PC support, and a fourth would manage

(Case Continued)

voice messaging. Initially, the agreement with IBM to manage the data centers was U.S. based; it was later expanded to include Canadian operations, other U.S. divisions, and eventually six international sites. Kodak encourages IBM to leverage its data center for both Kodak and other companies' work for improved efficiencies. Due to efforts on both sides, the Kodak-IBM relationship has worked well. They developed trust and good processes. When issues arise, the relationship has effective processes to deal with them.

Outsourcing Management Structure

Kodak views its outsourcing management role as exercising leadership, staying in control, and managing the high value-added functions for flexibility. Kodak sets the tone for its key IT relationships. The key themes have been collaborative (not adversarial), long-term mutual benefits (not short-term), and making systemic improvements on a global basis (not local). The management structure has six elements: a management board, an advisory council, a supplier and alliance management group, a relationship manager for each relationship, ad hoc working groups, and client surveys.

Management Board. This board meets twice a year and includes senior management from both companies. It focuses on strategic issues in addition to any policies or practices on either side that are getting in the way of mutual success. It has dealt with international strategies, IT architecture, telecommunications directions, disaster recovery plans, and so forth.

Advisory Council. This council meets monthly and has 15 members. It handles technical and operational issues by

focusing on what Kodak wants, not on how the services currently are delivered. Kodak's trust in IBM has grown; thus it leaves more of the "how" details up to this ESP. The advisory council reviews service levels, usage measurements and forecasts, tactical plans, migration objectives, business recovery plans, and the like.

Supplier and Alliance Management Group.

This group manages the longer-term outsourcing relationships as well as other contracts with large IT suppliers. It works closely with IS management. This group of 10 people includes a manager, the relationship manager for each primary alliance, plus support staff and supplier management for other IT sourcing. Initially, this group managed only the alliances. Contracts with major vendors were handled in other groups. Eventually, all these functions were brought together to increase their focus, leverage global agreements, and align the management of alliances and suppliers. About one-half of the staff have IS backgrounds; the other half come from purchasing.

Relationship Manager. This manager is key to the success of a strategic relationship, Kodak believes, because this manager is the focal point between the company and its ESP. The job of each of Kodak's four relationship managers is to ensure that Kodak receives more than just delivery on the contract. Thus, they also manage value creation. The relationship managers negotiate, coordinate, and manage agreements and ensure that service level agreements (SLAs) are established. SLAs are very precise descriptions of each service to be delivered, when, by whom, for what price, and such. Relationship managers also assist in pricing and billing strategies.

(Case Continued)

Working Groups. These groups were not part of Kodak's original outsourcing management structure; they were added to deal with specific technology areas. They are chartered by the advisory council. Their goals are to facilitate changes in processes, promulgate standards, achieve business recovery in case of disruption, and promote effective use of IS services. They have proven to be effective vehicles for talking about important issues, such as the timing and appropriateness of upgrading to new releases of software. The groups are represented mainly by operational staff. For example, database administrators from the major sites are in one working group.

Client Surveys. These surveys are sent out twice a year to nearly 5,000 internal users of the services. Feedback on quality, cycle time, and product and service

leadership are assessed and shared with the ESPs. Improvement plans are mutually developed to close perceived performance gaps.

Because Kodak's outsourcing has such a large scope, draws on four main suppliers, and covers a large geographic area, the company has discovered that it needs all of these forms of coordination for effective supplier management.

From a strategic perspective, Eastman Kodak has now seen outsourcing as a means to effectively engage its partners in executing the firm's daily operations. As another example of partnership-based operations management, the New York film and camera company renewed its outsourcing deal with Nortel Network in 2006. Started in 1995, Nortel will continue to manage Kodak's network of PBXs and telephone services through 2008. ■

Governance

The foundations of governing an outsourcing relationship are laid out in the contract, which can be hundreds of pages long (with appendices). A major governance item in the contract is the service level agreements (SLAs) because they are used to gauge supplier performance. For every contracted service, its SLA spells out responsibilities, performance requirements, penalties, bonuses, and so on. Completeness is an important attribute of good SLAs; generally everything should be detailed, perhaps even with times of deliveries, who will deliver what to whom, and so on.

Another important component of SLAs is metrics. An SLA needs to be measurable to be of use. Establishing metrics can be tricky because, in many cases, IS departments have not kept good measures of their own performance. In BPO, the situation is even worse; companies do not know how many people are in the process, departmental costs do not reflect overhead or IT costs, and so on. Measures are needed to establish benchmarks against which vendors want to demonstrate improvements. Clients also need metrics to negotiate better deals. Clients who do not know their own performance levels negotiate from weakness; they know less than the vendor because they have not tracked details, and vendors are not apt to correct mistaken impressions. Furthermore, clients are likely to overlook important details, which will later cost them money.

- Service levels must stay in the top 25 percent as benchmarked against the client's peers.
- Escalation of problems becomes more painful as it goes higher to encourage early resolution.
- The supplier is the grand project manager and is responsible for managing multiple vendors.
- Work style is based on respect and confidence; there should be no personalization of problems.
- Add significant value.
- Aim to operate in an "open book" manner, sharing key operating information with each other.
- New services can be put out for bid.
- No exclusive agreements.
- Meet our standards.
- Let us know about potential problems before they happen.
- Spend our money as if it were your own.

FIGURE3 Examples of Outsourcing Governance Rules

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In addition to SLAs, parties establish governance rules to be used when either party is making a decision so that both are "singing from the same hymnal." Most parties in strong relationships say they put the contract in the drawer after it has been signed and work from trust and agreed-upon rules. It is only when trust in one another breaks down that they turn to the contract. Figure 3 lists some governance rules from a number of different enterprises.

Day-to-Day Working

The Sourcing Interests Group^{3c,d} reports provide advice from outsourcing executives on how to manage day-to-day interactions between two parties. Here are a few of those recommendations.

Manage expectations, not staff. The outsourcer's staff is no longer under the purview of the client, so command-and-control is not a wise option—it only results in an acrimonious relationship. Facilitation becomes the mode of working. Rather than say "do this," the approach becomes "how can we solve this together?" Furthermore, relationship managers have the important role of influencing users' expectations so that delivery meets business objectives.

Realize that informal ways of working may disappear. More formality is inevitable as outcomes are measured and are more tightly controlled, especially if the relationship is handled strictly by the book, which happens in some cases. This increased formality can be a shock to people who are used to, say, getting a small job done by calling their friend "Joe" in the IS department. Once Joe works for the ESP, he may no longer be able to provide that service; he must follow the work authorization process defined in the contract. This change can cause unhappiness as users see providers as "them," making them the scapegoat. The two parties need to find ways to reduce this tendency.

Loss of informal ways of working can add rigor. Rigor frequently improves work quality. Users may think twice before requesting changes and prepare better definitions of what they want. Furthermore, better processes can streamline work, improve

effectiveness, and potentially reduce unnecessary work. Service providers do introduce new discipline; the client should prepare employees for this change and assist them in adapting because it is generally best to use the provider's processes. This is one reason why transition planning is so important: to help client personnel move to new procedures with the least disruption and disgruntlement.

Integration of the two staffs requires explicit actions. Integration does not happen naturally. Explicit policies are likely to be needed. Some examples are to (1) grant outsourcing staff access to appropriate work areas, not unduly restrict them; (2) hold joint celebrations and social events; (3) invite each other to meetings; and (4) perhaps even have a client executive move to the provider for two years to learn how they work internally. However, integration generally can only go so far; the client still needs to remain in control and guide the relationship. Furthermore, the more side-by-side the parties work, the more likely they will experience scope creep in which the provider takes on more work.

The best way to manage day-to-day is to communicate frequently. One executive said he carried around a top-10 list in his shirt pocket, which he revised every week. They were the most important items he had to handle. The list kept him on focus and turned out to be his best informal management technique.

Supplier Development

A topic that is receiving increased attention in the production sourcing arena—that is, buying parts and services that go into one's own products and services—is supplier development. It means assisting one's suppliers to improve their products and services, generally by improving their processes. Although supplier development has not been prevalent in IT outsourcing, we think it will be. It will likely be prevalent in BPO.

Offshoring

In the late 1990s, when labor markets were especially tight and IS organizations needed to retrofit their systems to make them Y2K compliant, the use of offshore outsourcers to maintain IT applications grew dramatically. Offshore, of course, is relative. For U.S. companies, near-shore means outsourcing to Canadian and Mexican companies, whereas offshore means Ireland, India, the Philippines, and other countries. For European companies, near-shore is Ireland, Poland, and other Eastern European countries.

Companies turn to offshoring to tap lower labor costs and an ample supply of qualified people. During the recent economic downturn, and now with increased global competition, offshoring give companies a way to cut costs. The trickle of IT jobs in the late 1990s has turned into a steady stream of white-collar work going offshore. Application maintenance and development, call centers, customer service, back-office processing, BPO, claims processing, and other functions can all be moved offshore.

Offshoring has become a political issue, because companies are not expanding their domestic labor force as rapidly as some had expected. There's an outcry that offshoring is taking jobs away from domestic workers. Politicians are trying, at the very least, to "shame" companies into not moving domestic work abroad. But as with manufacturing jobs in the 1980s, offshoring is unstoppable because the economics are so strong. Once one company in an industry lowers its costs by moving work to lower-wage countries, its competitors need to reduce their costs as well. That may mean that

they, too, need to offshore. India, for example, has recently outsourced many of its programming activities to China and Vietnam, where labor cost is significantly lower than that of the Bangalore area.

For all the “this is terrible” talk, offshoring might actually be good for developed countries, because increasing the living standards in other countries increases their citizens’ demands for consumer products that can, in turn, be supplied by highly efficient companies in developed countries.

Furthermore, white-collar offshoring has been inevitable, argues author Daniel Altman,⁴ because service sector productivity in the United States has not kept up with manufacturing sector productivity. In the early 1950s, each service sector employee produced about \$39,000 in output (in 2000 dollars), he notes; in manufacturing, the output was \$48,000. Now, 50 years later, service productivity has increased to \$54,000 (a 47 percent increase), whereas manufacturing productivity is at \$207,000 (a 330 percent increase)!

Manufacturers have faced international competition, whereas service firms have not. Manufacturers have been forced to increase their productivity to stay in business—mainly by increasing the quality of their products, notes Altman. It should come as no surprise that service companies are tapping cheaper sources of labor now because of globally available telecommunications technology, he notes. This global competition in services will force American companies to increase the productivity of their workforce in the same way and increase the quality of their services, Altman believes.

Offshore outsourcing differs in some unique ways from domestic outsourcing. In two reports, the Sourcing Interests Group (SIG) explores IT offshoring and the areas CIOs and their staff need to consider.^{3f} Here are four points from those reports.

Offshoring Options Are Broadening

India has become the premier IT and BPO offshoring country because its huge, highly educated workforce speaks English and is hard working. College graduates in India apply for jobs that only high school graduates will apply for in the United States, such as working in a customer service center. Hence, the quality of work is often higher, while the labor costs are lower. Furthermore, in IS, all of the major IT outsourcers in India have achieved the highest level (Level 5) in the Capability Maturity Matrix, which means their processes produce high-quality software. Most IS organizations in the United States and in other developed countries are not even up to Level 3. So the quality of software from these Indian firms is very high—as long as the specifications for the work are clear and truly what the customer wants.

After having good initial IT experiences in India, client companies are offshoring higher-value, white-collar work beyond short-term software maintenance projects to ongoing software maintenance work, new development projects, and even BPO. The types of firms offering offshore options are also broadening. The United States outsourcers are building their own offshore capabilities or acquiring existing offshore providers, often in India, sometimes in China, to lower their own costs. Client companies not wanting to deal directly with unfamiliar overseas providers can now tap offshore resources through onshore outsourcers. In fact, as noted in the SIG reports, all large IT outsourcing deals will likely have an offshore component. Global sourcing is becoming the norm. As offshoring activities mature, many U.S. companies acknowledge

that they start to see benefits of outsourcing beyond cost-savings. Partners in offshoring countries are getting more sophisticated. The level of education and business background is at par with their partners, and innovative ideas have emerged more frequently.

Both Parties Need Cultural Training to Bridge Cultural Differences

Offshoring does bring cultural differences into sharp relief, which can hinder success unless properly handled. Outsourcers and offshore advisory firms (who advise clients on the offshore marketplace) now realize that both parties need cultural training to overcome management and communication gaps.

For clients, offshorers now routinely put client employees who will deal with the offshore employees through a cultural integration program. Here is a brief description of the program at Syntel, a large U.S.-based IT provider that uses an offshore (India) model, as recounted in one of the SIG reports:^{3f}

We initially hold a 1.5-day workshop, and then a follow-up orientation a few months later. We find that clients often restructure their operations during the first few months, sometimes bringing in new people. These new people need the orientation, also, which is why we repeat the orientation.

In the workshop we talk about how lifestyles and cultures differ between the U.S. and India. In fact, we tailor each workshop to the client's location because Midwest employees differ from New Yorkers, for example. We illustrate, for instance, how the same words have different meanings in the two countries. We point out differences in dress, foods, even eating times. We show a video of these differences, we have people wear the native dress, and we demonstrate how Indians prepare a lunch, which we then serve. We have learned that U.S. employees often have a third-world view of India that is not accurate. Our goal in the orientation is to familiarize them with today's modern India.

On the provider side, offshorers often put their own employees through an accent neutralization program if they have an accent the client country will find difficult to understand. This practice is especially prevalent for Indian providers with American clients. Providers also teach their employees about the client's company culture (going so far as to hang the same posters on the walls as the client has on its walls) and the client country's culture (going so far as to familiarize employees with holidays and keep them up to date on sports teams and major sporting events).

Communication Issues Need to Be Addressed from the Outset

Different cultures have different communication norms, even when they speak the same language. These differences show up immediately when people from two cultures try to negotiate an offshore contract. The differences need to be addressed, beginning with the negotiations.

Here is just one example. The word "yes" in Asia typically means, "I hear what you are saying," whereas in the United States it means "I can do what you ask" or "I agree with you." When conversing, an Indian might nod his head "yes," which an American

Managing Partnership-Based IT Operations

might misinterpret as an agreement. The American is then surprised at the next meeting when there has been no agreement after all.

There are substantially more risks in negotiating offshore than onshore contracts because of such communication misunderstandings, notes the global law firm of Mayer, Brown, Rowe & Maw LLP in a SIG report.^{3f} The firm uses many mechanisms to mitigate these risks. Here are just five:

- Avoid colloquialisms, such as sports analogies (“we’ve got to punt on this”), because these statements do not bridge cultures.
- Simplify communications by using short, concise sentences with common words, rather than the typical legal practice of lengthy, convoluted sentences and paragraphs.
- Have the offshore provider write a “statement of work,” to gauge their understanding of what they think they are being asked to do.
- Get all commitments in writing.
- Include a person on the client negotiating team who knows the offshore country culture so that he or she can explain the country’s norms to the client team as issues arise and prevent the offshorer’s team from holding side discussions in their own language at the bargaining table. A “country-wise” member can significantly change negotiating dynamics.

Communication Issues Continue Throughout Offshore Relationships

This is why migrating the work, which is often fairly quickly defined in onshore contracts, can require lengthy discussions in offshore deals. Common understandings do not exist, so every step in moving work from one country to another, and who pays for what, must be agreed upon. Furthermore, country laws and norms must be taken into account.

Country Laws Need to Be Followed

Offshoring contracts must bridge a myriad of differences between cultures. To preclude dealing with some legal issues, offshore vendors now typically sign their contract in the client’s country. For example, as noted earlier, Syntel is a U.S. company. Its contracts with U.S. clients are signed in the United States, and are governed by U.S. law.

Even so, clients need to be aware of data privacy laws, which may not allow customer data to leave its home country or enter certain other countries. The European Union (EU), for instance, does not allow personal data to be moved outside of EU countries. Likewise, clients need to understand the enforceability of intellectual property laws in the outsourced country. Lack of enforceability may preclude moving some IT work to a country, such as China, which does not have enforceable intellectual property laws. Likewise, taxation, employment, immigration, and other laws can significantly affect an offshoring arrangement. All of these must be taken into account.

The list of issues in offshoring can be truly mind-numbing. However, as the trend continues to grow, common practices are arising that make the negotiating task less daunting and the resulting arrangement less risky and more likely to succeed. As an example from the SIG report^{3f} of a company using offshoring for its IT maintenance work, consider Hewitt Associates, which is itself an example of a BPO company. It manages human resources for other firms.

CASE EXAMPLE

HEWITT ASSOCIATES

www.hewittassociates.com

With more than 70 years of experience, Hewitt Associates is the world's largest global provider of multiservice human resources outsourcing and consulting services. The firm consults with more than 2,300 companies and administers human resources, health care, payroll and retirement programs. Located in 35 countries, Hewitt employs approximately 24,000 employees. In 2003, Hewitt acquired Exult Inc., to strengthen its lead in the human resource provider industry. Before the merger, Exult Inc. provided full-service human resources (HR) outsourcing to Global 500 companies. In this case example, we briefly describe how this Human Resource Business Process Outsourcing provider became a leader in the field. The range of administrative processes Exult provided can be grouped into four main areas. One, Exult maintains and manages employee data and HR records, thereby facilitating various HR functions for clients. Two, Exult manages clients' payroll, compensation, and benefits processes. Three, it provides recruiting and flexible staffing services. Four, Exult provides learning, global mobility, and relocation services to help clients deploy their people most effectively.

Exult is mature in outsourcing relationships because outsourcing is its primary business. Furthermore, most Exult executives were either on the buyer or seller side of outsourcing before joining the company.

In October 2001, Exult signed two contracts with two Indian companies to maintain its core HR computer systems, which include both PeopleSoft and SAP platforms as well as systems built on those two platforms. This was the first time Exult outsourced any IT services.

"We chose to outsource application maintenance to India for three reasons: to garner cost savings, to increase system quality, and to achieve scale (that is, increase our access to resources as we grow our business)," says Steve Unterberger, executive vice president of business model architecture at Exult. He is responsible for Exult's service delivery model.

Exult chose two providers rather than one to ensure that resources could be scaled up as needed. Having only one provider could constrain growth. Management also wanted a fallback position, so that one provider could back up the other if need be. Finally, having two providers would let Exult migrate work offshore faster, moving one client to one provider and another client to the other provider. There would be no single point-of-capacity limit.

Choosing the Providers

"We led the project, but we called on two advisors: neoIT to do the detailed review and content, and TPI to structure the contract," says Unterberger. He continues, "We contracted with neoIT because of their experience contracting with

(Case Continued)

Indian firms. Our goal was to get the best arrangement for ourselves and our clients. To do that, we needed to understand the Indian market and its practices. NeoIT helped us achieve that.”

The Exult internal outsourcing team was composed of Unterberger and Exult’s top people in sourcing, IT management, application management, IT connectivity and infrastructure, and IT security and privacy.

Early in the considerations, Exult and neoIT made a four-day trip to India and visited nine providers. “Our goal for that first trip was to meet as many companies as we could, to see first-hand how they compared. We knew the only way we could expect to have a clear view of the Indian marketplace was to personally visit India. There are five or six main cities where the major providers are located, so it’s easy to see many companies in a short time. We met management, walked around operations, and chose employees at random and talked to them. They showed us real customer service reporting, work processes, and quality measures. We were able to accomplish a lot very quickly because we were clear about what we needed. We knew the specific skills, competencies, and commitments we needed because these are spelled out in our contracts with our clients. So we were able to quickly direct conversations to get to the points we wanted to cover. We looked for a demonstrated ability to scale, a track record for managing people, and good IT maintenance processes,” says Unterberger.

He continues: “That trip taught us that India has an incredible number of people who are very disciplined and highly motivated. In the end, we came away

convinced that many companies could satisfy our needs. I returned from that trip with a real zeal, believing that anyone who is not investigating Indian providers is doing their company a disservice.”

Following the trip, neoIT and Exult ranked the providers and selected two using neoIT’s neoQA process. “NeoIT was a very good advisor during this whole process, in two ways. First, they suggested other companies for us to consider—companies not typically on the big list. That was helpful because it kept everyone on their toes. Second, they knew where to push and not push, and they were able to distinguish for us the areas specific to Indian-based firms that we might have overlooked without their guidance,” says Unterberger.

Negotiating the Deals

The negotiations were straightforward, and neoIT did help Exult avoid some pitfalls in pricing, taxes, staffing commitments, and telecom. “The providers have standard things they will do, but they do not volunteer them. You have to know to ask,” says Unterberger. He states, “Telecom is one of those areas because, while the people costs in India are lower than the U.S., telecommunications costs are on a par with the U.S. We had also been forewarned that interconnecting would be the pacing factor in getting up and running—and, in fact, it was.”

The agreements with the two providers are expected to be for five years, but each statement of work aligns with an Exult client and that client’s agreement with Exult. These client relationships range from 5 to 10 years in length. The contracts specify service level commitments.

(Case Continued)

“All the companies have a similar model for training and knowledge transfer, so there is a well-known discipline in migrating the work. Our transition went according to plan. We transitioned client by client; some clients went to one provider, some to the other,” states Unterberger.

“Data privacy was managed through extensive planning and review. We built upon the commitments in our own client contracts. The data is only accessed remotely from India, and the development environments work only with encrypted data. Backup data is stored in the client country, as are business resumption facilities. We spent a lot of time working through these data privacy issues to ensure there were no misunderstandings,” says Unterberger.

Migration and Ongoing Management

The current split of IT maintenance work is as follows:

- Seventy percent of the staff members are offshore in India; they handle most of the ongoing maintenance of the HR systems.
- Fifteen percent are provider employees and work onshore at Exult; they handle quick turnaround work and coordinate change control and testing with the offshore staff.

- Fifteen percent are Exult employees who work onshore; they handle client communications and specifying system requirements.

Exult has the ability to influence key positions, and the providers are quick to rotate people when issues arise.

“The offshore companies are very good at engineering discipline. Taking advantage of that capability, though, requires U.S. buyers to work within those highly disciplined Indian maintenance processes rather than try to change them,” says Unterberger. Exult had to transition its retained IT managers to:

1. Shift from managing people to managing outcomes
2. Take the time to learn how the Indian staff work and think
3. Be open to suggestions from the Indian staff on how to improve the quality of our HR software

“Transitioning IT managers to manage offshore work requires new skills because they are familiar with having direct control over their people. They need to become more general managers and know which levers to pull to obtain results from afar. Exult also draws on neoIT in managing the relationships day-to-day. NeoIT has a person who acts as our eyes and ears in India because we are not there every day,” says Unterberger. ■

Use Offshoring to Advantage

A main criticism of offshoring is that it decreases the skills and know-how of the client’s IS organization. This need not be so. Kate Kaiser of Marquette University and Stephen Hawk of the University of Wisconsin-Parkside⁵ describe an eight-year arrangement between an unnamed financial services firm in the United States and an

unnamed IT outsourcer in India. In their recent article in *MIS Quarterly Executive*, the two authors note that the U.S. firm wanted to reduce its system development costs but also increase its in-house IS staff's knowledge—a fairly unusual dual goal. To do so, the two firms have evolved their relationship to “IT cosourcing,” which Kaiser and Hawk define as “when the vendor and client collaborate so closely that the vendor can replace or augment the client's IT competencies.” In essence, resources from both firms are used to meet the client's needs. Project teams are mixed, and team leadership can come from either firm—both of which require the vendor to have a large on-site presence. Two mechanisms, in particular, have ensured that the U.S. firm's IS staff gain competencies rather than lose them: formalized knowledge transfer between the two firms and a dual project-management hierarchy.

To formalize knowledge transfer from the Indian staff to the U.S. staff, U.S. staff members are sometimes formally assigned to projects to learn from an Indian mentor. The two firms initially made such assignments informally, but that approach did not improve skills. So the two firms formalized learning-oriented mechanisms, such as mentoring. At the U.S. firm, each IS employee has a development plan, which includes career goals and steps to achieve the needed skills. For the Indian firm, job assignments with the U.S. client include such tasks as mentoring a specific U.S. team member in specific areas. The cost of mentoring is included in the cost of the project.

To create the dual project management hierarchy, the hierarchies of the two firms now mirror each other to improve communication across them. Furthermore, the tiers of leadership in projects can come from either firm, depending on the circumstances. The Indian firm may lead to provide mentoring. The U.S. client may lead for business reasons. Again, the roles of each job are formally agreed upon, and mentoring or other knowledge-transfer skills are part of the cost of the project.

Both mechanisms increase the cost of outsourcing, note Kaiser and Hawk, because, for one thing, dual leadership requires more Indian staff to be located in the United States. But the additional cost improves the in-house staff's technical and application skills, which the firm believes is well worth the added expense, because they highly value their employees' career development.

Redefine Services Using Offshoring, Automation, and Self-Service

Uday Karmarkar,⁶ research director of UCLA's Center for Management in the Information Economy, like author Daniel Altman,⁷ believes that outsourcing of services is inevitable and that the real concern of service firms should be their loss of competitiveness, not the loss of jobs in their own country. He believes that the service economy is in the midst of restructuring itself, which is terribly painful when it happens in any industry. Offshoring, automation, and self-service are all combining to cause “the industrialization of services,” he believes. Like manufacturing firms before them, service firms therefore need to find new ways to add value. He suggests looking in five places for determining new strategies for surviving and using offshoring, automation, and self-service to execute these strategies.

Understand customers. Companies that understand niches of customers, and serve them well, will themselves do well, believes Karmarkar, especially as they move their services to the Web. Edmunds, a company that has published books for car buyers for

many years, now focuses on its car-buyer Web site. The site has been so well designed that it has won numerous awards. Edmunds understands its customers and caters to them, states Karmarkar.

Understand demographics. Look for underserved niches, like Wells Fargo Bank has done in offering specific services to the Hispanic population in the western United States. The bank opens 22,000 Hispanic accounts a month by understanding and catering to this growing group, notes Karmarkar.

Stay in touch with customers. Do not outsource customer service. Many have done it and found that they lose touch with their customers. Some have realized the effect and brought the function back in-house. A far better strategy is to deliver responsive and error-free service, he believes.

Offer end-to-end service. Customers are most interested in buying services from firms that offer end-to-end services. For example, Virgin Atlantic Airways provides its business-class passengers with limousine service to the airport and drive-through check-in. People are willing to pay for such pampering to relieve themselves of hassles. This is an important strategy some service firms are delving into by using data mining to understand preferences of customer clusters and then catering to those preferences.

Dominate the screen. As information moves online, companies are vying to control “the screen,” that is, where the information ends up. Service companies have a shot at dominating the screen, because the design of the service and the interface (rather than the technology or the appliance) will determine success, states Karmarkar. For example, NTT DoCoMo, the telecommunications company in Japan, knows how to sell content on cell phones and appliances—from service providers to consumers. Due to this skill, NTT has claimed a disproportionate degree of control over the information chain; it dominates the screen. In short, service companies need to understand what kinds of information various clusters of customers want and cater to them. For many service firms, that catering will be via the Web and mobile devices, using offshoring, self-service, and automation where each can contribute the most value.

In conclusion, outsourcing has become a strategic alternative. With the rapid pace of business change, the best hope of many enterprises is to tap the expertise of companies that are keeping pace rather than trying to do everything themselves. That is why so much inter-company collaboration is taking place. However, outsourcing does not mean relinquishing responsibility. In fact, taken to its extreme, it can mean devoting resources to assist suppliers in improving their processes. We believe it is a coming focus in the world of IS Lite.

Insourcing

We could not finish this chapter without discussing an opposite phenomenon of outsourcing. Insourcing is widely understood as the delegation or contracting of operations or jobs within a business to an internal—mostly independent—entity as a subcontractor. The company sets up its own IT unit as a subsidiary in another country, and “outsources” its IT operations to this offshore unit. The key motivation is for the business to maintain tight control of the execution of the contracted jobs, both from the point of view of product quality and organizational processes while taking advantage

Managing Partnership-Based IT Operations

of the benefits of offshoring. Another key reason for insourcing is to protect the organization's intellectual property and business know-how. Many American banks and high-tech companies set up the independent offices in India and the Philippines to take care of the call centers or customer services. The overseas subsidiaries are under control of their parent company.

As such, insourcing can be seen as a different form of partnership-based management of operations. Most of the best practices related to offshoring remain relevant though.

CONCLUSION

In this chapter, we highlighted a number of important issues related to the management of IT operations. We started the chapter with a summary of three fundamental principles:

- While it is important to align the resources of the IT department to the overall mission of the organization, it is important for CIOs and CEOs to encourage a substantial part of IT resources for creating or assisting the creation of new and high-impact strategies.
- Management should strike a balance between efficiency and effectiveness when deploying its IT assets, and
- Given a variety of activities from network management to customer support, management should monitor IT operations so that local optimizations do not take precedence over global (organization-wide) optimization.

The subject of managing computer operations is, perhaps surprisingly, at an all-time high because of the emergence of e-commerce, the increasing use of outsourcing, news-grabbing computer viruses, attacks on major Web sites, and terrorism. Outsourcing, security, business continuity—all are important operational issues. As enterprises increasingly rely on computing and telecommunications to work closely with others, they open themselves up to more threats by electronic means. In short, the view of operations is shifting from managing inward to managing outward, on all fronts. Whether operations take place in-house or are being outsourced/insourced to an overseas location, the mode of operations of an IT department is complex and based on partnership. The success or failure of managing IT operations depends on how well management can manage and control the relationships between units involved in the daily management and use of IT resources.

QUESTIONS AND EXERCISES

Review Questions

1. What has been the main shift in the operations viewpoint?
2. What are three solutions to operations problems?

Managing Partnership-Based IT Operations

3. How did Microsoft manage its special OEM Webcast?
4. How thoroughly are CIOs expected to investigate outsourcing?
5. What are the driving forces of outsourcing, according to Bergstein?
6. What are IT outsourcing, transitional outsourcing, best-of-breed outsourcing, shared services, business process outsourcing, and e-business outsourcing?
7. What management elements has Kodak put in place to manage its outsourcing relationships?
8. What is supplier development?
9. What are five ways to reduce miscommunications in negotiating an offshore outsourcing contract?

Discussion Questions

1. Discuss the qualifications of the operations managers in the IT department.
2. Outsourcing offloads a burdensome technical responsibility and allows management to focus on its core business. Outsourcing strips a company of an important core competence—IT know-how. Which statement do you agree with? Why?
3. Discuss the role and impacts of cultural differences when a company adopt offshoring.

Exercises

1. Read a few articles about outsourcing. What did you learn about outsourcing that is not mentioned in this chapter? Relay your findings to the class.
2. Read three articles that describe the negatives of offshore outsourcing and three that present the positives. Present both sides to the class.

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TECHNOLOGIES FOR DEVELOPING EFFECTIVE SYSTEMS

INTRODUCTION
SOLVING THE SOFTWARE CRISIS
FOUNDATIONS OF SYSTEM DEVELOPMENT
<i>Structured Development</i>
<i>Fourth-Generation Languages</i>
<i>Software Prototyping</i>
<i>Computer-Aided Software Engineering</i>
<i>Case Example: DuPont Cable Management Services</i>
<i>Object-Oriented Development</i>
<i>Client-Server Computing</i>
<i>Case Example: MGM</i>
SYSTEM INTEGRATION
<i>ERP Systems</i>
<i>Case Example: Colgate-Palmolive</i>
<i>Middleware</i>
INTER-ORGANIZATIONAL SYSTEM DEVELOPMENT
<i>Case Example: How Should ExxonMobil Leverage Its IT Asset?</i>
<i>Case Example: Hong Kong Exchanges and Clearing</i>
INTERNET-BASED SYSTEMS
<i>Application Servers</i>
<i>Java</i>
<i>Web Services</i>
<i>Case Example: Building a Web Service</i>
<i>Case Example: Bekins HomeDirectUSA</i>
CONCLUSION
QUESTIONS AND EXERCISES
REFERENCES

INTRODUCTION

One of the toughest jobs in IS management is developing new systems. Given that each organization has its own culture and way of conducting business and the need of differentiating the use of IT to achieve competitive advantage, it is virtually impossible to

have a universal commercial-off-the-shelf system that is ready to deploy. Developing new business systems seems to be an area in which Murphy's Law—if anything can go wrong, it will—reigns supreme. In spite of the increasing complexity of system development, the IT field has made significant progress in improving the process of building systems. The traditional approach, with variations, of course, appears in many textbooks and professional books.

During the 1970s, a relatively well-defined process called the system development life cycle emerged. This life cycle improved the development process significantly. However, continued backlogs, cost overruns, and performance shortfalls underscored the difficulty and complexity of the system development process.

The 1980s saw progress in more friendly languages and automation of portions of development, such as code generation. Yet, maintenance continued to eat up 70 to 80 percent of the system development resources in most companies.

The 1990s began with the promise of significantly increasing developer productivity and reducing maintenance by relying more on packages and by building systems by linking together components. The business process reengineering movement spawned the growth of integrated enterprise systems and the widespread adoption of ERP systems. Then, all of a sudden, in the late 1990s, e-business and Internet-based systems appeared.

In the 2000s, the Internet brought the need for faster system development and integrated enterprise systems; that is, systems that pull together various aspects of the enterprise. New tools for rapid development became available; they relied on reusable components and open systems architectures. As a result, application development projects became application integration projects; systems were built by integrating pre-built components.

Every application today is a network application. The network is becoming the system. Web-based applications were the first generation of Internet-centric computing. The new field, Web Services, is touted as the second. In it, small modules of code perform specific functions and can be called by other modules to perform that work, all via the Internet. The Web Services world is upon us. In addition, the trend toward increasing the interconnectedness of supply chains is leading companies to build inter-organizational systems, which is a far more complex undertaking than single-company systems. This chapter reviews the evolution of system development to provide an understanding of the underlying principles of building applications.

SOLVING THE SOFTWARE CRISIS

During the last two decades, organizations have witnessed a phenomenon now known as the software crisis. Software costs continue to have spiraled dramatically, becoming the largest cost item in IT. Delivery schedules are seldom kept. As software grows rapidly to meet more complex requirements and tight delivery deadlines, quality has become a nontrivial issue. Academic researchers and software vendors have long sought for solutions to the software crisis.

First, programming language has significantly evolved. From the first generation of programming language that consists of machine code—a system of step-by-step instructions and data that tell the computer's Central Processing Unit (CPU) how and what to

execute—today’s organizations are provided with highly integrated software development platforms at a significantly high level of abstraction. Thus, instead of given a step-by-step instruction to the computer (e.g., go to a memory cell, get the data stored in this memory cell; and go to another memory cell, get another data store in there, do an addition, put the result of the addition to another memory cell, and print the result in the display at a certain location), software developers develop databases at the high level and use screen and report generators to create customized inputs and outputs (e.g., DBMS and advanced e-commerce applications). Thus, development productivity has increased significantly.

Second, developers have adopted a number of new approaches to systems development. From the most popular versions of systems development approach is the waterfall model, many organization are exploring with prototyping to agile software development.

The search for the best practices is still on, however. The software crisis continues, now at a different level. Technology is a moving target, with likely more disruptive technologies. Organizations will continue to be faced with issues related to multigenerational systems: interoperability, training, maintenance, and replacement. Applications are getting more complex in an open platform environment. Security has become more critical. The issue for IT management remains the same though: Are we producing the software right (that is, is it built efficiently and on time)? And, are we developing the right application software (that is, is it useful to the users)?

FOUNDATIONS OF SYSTEM DEVELOPMENT

In the early years, system development was considered a “craft.” Application software was created by a single person, or a team led by a strong, charismatic project leader. No system looked alike. Developing a system was more like art than science. Since then, the goal has been to make it more scientific. In the 1970s, structured system development emerged to make the process more standard and efficient. It was characterized by the following elements:

- Hand coding in a third-generation language (3GL) such as COBOL, C, Java
- A structured-programming development methodology
- An automated project management system
- A database management system
- A mix of online and batch applications in the same system
- Development of mostly mainframe applications
- Programming by professional programmers only
- Various automated, but not well-integrated, software tools
- A well-defined sign-off process for system delivery
- User participation mainly in requirements definition and installation phases

This development approach supposedly followed the famous “waterfall” approach, shown in Figure 1. However, says Bob Glass,¹ this unidirectional waterfall was much touted but rarely used in its literal sense. Development did not proceed in a straight line from requirements through operation; a lot of backtracking and iteration occurred. Developers really always followed the spiral approach which is generally attributed to Barry Boehm.

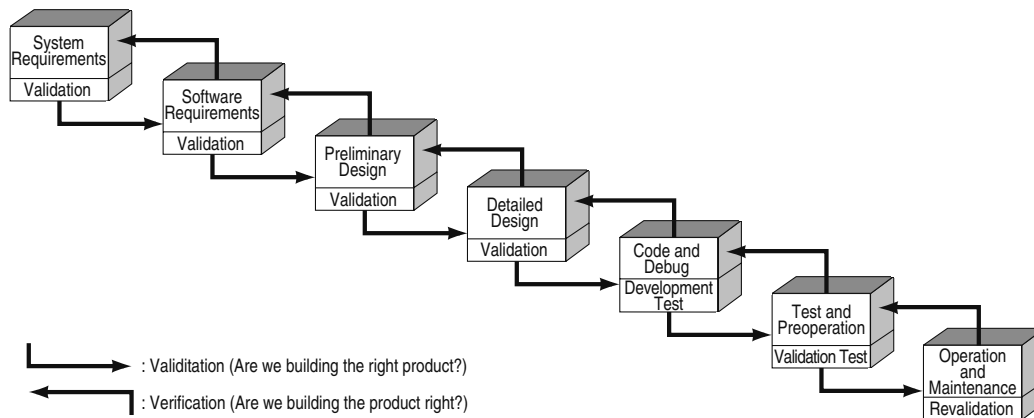


FIGURE 1 The “Waterfall” Development Life Cycle

Source: Barry Boehm, *Software Engineering Economics* (Upper Saddle River, NJ: Prentice Hall, 1981).

Structured Development

Structured development methodologies accompanied this system development life cycle and were meant to handle the complexities of system design and development by fostering more discipline, higher reliability and fewer errors, and more efficient use of the resources.

More Discipline

By establishing standards for processes and documentation, the structured methodologies attempted to eliminate personal variations. At first they seemed to threaten programmers' creativity, but their discipline did increase productivity and permit developers to deal with greater complexity. The complexity was handled through successive decomposition of system components, coupled with preferred practices for conducting analysis, design, and construction. The result was a more disciplined system development process.

More Modularized

As the scope of applications gets bigger, developers decompose the software applications in interconnected but independent modules. This divide-and-conquer approach helps notably reduce the complexity of the development process.

Higher Reliability and Fewer Errors

The structured methodologies recognized that mistakes of both omission and commission were likely at all stages of system building. One of the main tools for coping with this tendency was (and still is) inspections, performed at every development stage and at every level of system decomposition. The goal has been to catch errors as early as possible. The methodologies also recognized that iteration would be required to redo parts of a system as mistakes were uncovered.

More Efficient Use of Resources

The project management approaches usually included in the structured methodologies contributed to cost savings, increased productivity, and better allocation of human

resources. By imposing a time and cost control system, the classic approach decreased (but did not eliminate) the tendency for system development efforts to incur cost and time overruns.

Fourth-Generation Languages

In the early 1980s, two major developments occurred. One was the availability of fourth-generation languages (4GLs); the second was software prototyping. Fourth-generation languages are really more than computer languages; they are programming environments. 4GLs are created to reduce programming effort, the time it requires to develop it, and more importantly, to allow developers to focus more on problem solving (for example, creating a report, or implementing a business heuristics such as customer's management policies). 4GLs let the developers focus more on the system design and attempt to minimize the coding effort. Their major components are listed in Figure 2.

The heart of a 4GL is its DBMS, which is used for storing formatted data records as well as unformatted text, graphics, voice, and perhaps even video. Almost as important is the data dictionary, which stores the definitions of the various kinds of data. The language that programmers and users use is nonprocedural, which means that the commands can occur in any order, rather than the sequence required by the computer. The commands can be used interactively to retrieve data from files or a database in an ad hoc manner or to print a report (using a report generator). The screen generator allows a user or programmer to design a screen by simply typing in the various data input field names and the locations where they are to appear or by choosing graphics from a menu.

To further improve the speed of developing systems and reduce the tendency to "reinvent the wheel," most 4GLs are domain specific, a common practice in software development. These are built to be used in specific application areas. Some 4GLs

FIGURE 2 Features and Functions of Fourth-Generation Languages

- Database management systems (DBMS)
- Data dictionary
- Nonprocedural language
- Interactive query facilities
- Report generator
- Selection and sorting
- Screen formatter
- Word processor and text editor
- Graphics
- Data analysis and modeling tools
- Library of macros
- Programming interface
- Reusable code
- Reusable software components and repositories
- Software development library
- Backup and recovery
- Security and privacy safeguards
- Links to other DBMSs

include statistical packages for calculating time series, averages, standard deviations, and correlation coefficients. Some others are specially dedicated to data analysis and reporting.

Previously, developers only had third-generation languages, such as COBOL, ALGOL, PL/1, or C. The advent of 4GLs allowed end users to develop some programs and programmers to use a different development method: prototyping. Formerly, system requirements were fully defined before design and construction began. With prototyping, development could be iterative.

Software Prototyping

“A prototype is a software system that is created quickly—often within hours, days, or weeks—rather than months or years.” Franz Edelman, a pioneer in the use of software prototyping, described the process of software prototyping as “a quick and inexpensive process of developing and testing a trial balloon.” Its purpose is to test out assumptions about users’ requirements, about the design of the application, or perhaps even about the logic of a program.

With only conventional programming languages, such as COBOL, it was much too expensive to create both a prototype and a production version. Therefore, only production systems were developed. With end-user tools, people can get prototypes up and running quickly. The prototype is relatively inexpensive to build because the language creates much of the code.

Prototyping is an iterative process. It begins with a simple prototype that performs only a few of the basic functions. Through use of the prototype, system designers or end users explore new requirements using a working model, experiment with ways to satisfy them, and continue to refine or incorporate more requirements in each succeeding version. Each version performs more of the desired functions and in an increasingly efficient manner.

A typical prototyping methodology consists of the following steps:

- Form a users team consisting of experienced personnel to work with the software developers.
- Establish in-house development teams to work closely with experienced users.
- Decompose “to-be” systems into functional subsystems and development increments.
- Gather iterative requirements using simulated screens and interface requirements focusing on user-friendliness and extensive online help.
- Perform quick design with all the simulated screens put logically in sequence to provide users with a complete walk-through of the intended system functionalities.
- Build prototype using a database-driven or model-driven application generator.
- Evaluate and refine requirements involving the users team.
- Engineer the product through an adaptive process that eventually converges on a production version that closely meets the users’ needs.
- Gather users feedback from a larger base of users.
- Maintain product by using the same process used in the initial development with adaptive change along user needs.

Both 4GLs and prototyping have proven to be important underpinnings for today’s application development world. Prototyping enables systems to exceed “pre-defined”

functional requirements. It has proved to be faster and less expensive than classic software engineering practices.²

Computer-Aided Software Engineering

Even though the structured programming and analysis techniques of the 1970s brought more discipline to the process of developing large and complex software applications, they required tedious attention to detail and lots of paperwork. Computer-aided software engineering (CASE) appeared in the 1980s with the attempt to automate structured techniques and reduce this tediousness and, more importantly, to reduce maintenance costs.

Definition

As a development approach, CASE is the use of software tools to help quickly design, develop, deploy, and maintain software. Typically, these tools include data modeling, object modeling (using UML), code generation, and configuration management for revision and maintenance. As a development platform, CASE can be any automated tool that assists in the creation, maintenance, or management of software systems. In general, Carma McClure³ suggests that a CASE environment includes:

- An information repository
- Front-end tools for planning through design
- Back-end tools for generating code
- A development workstation

Often not included, but implied and necessary, are a software development methodology and a project management methodology.

An information repository. A repository forms the heart of a CASE system and is its most important element, says McClure. It stores and organizes all the information needed to create, modify, and develop a software system. This information includes, for example, data structures, processing logic, business rules, source code, and project management data. Ideally, this information repository should also link to the active data dictionary used during execution so that changes in one are reflected in the other.

Front-end tools. These tools are used in the phases leading up to coding. One of the key requirements for these tools is good graphics for drawing diagrams of program structures, data entities and their relationships to each other, data flows, screen layouts, and so on. Rather than store pictorial representations, front-end tools generally store the meaning of items depicted in the diagrams. This type of storage allows a change made in one diagram to be reflected automatically in related diagrams. Another important aspect of front-end design tools is automatic design analysis for checking the consistency and completeness of a design, often in accordance with a specific design technique.

Back-end tools. These tools generally mean code generators for automatically generating source code. A few CASE tools use a 4GL. Successful front-end CASE tools provide interfaces to not just one, but several, code generators.

Development workstation. The final component of a CASE system is a development workstation, and the more powerful the better, to handle all the graphical manipulations needed in CASE-developed systems.

Timeboxing

One of the most intriguing approaches to system development in the 1980s was the “timebox,” a technique that uses CASE to guarantee delivery of a system within 120 days or fewer. Today, IS departments that aim for speed turn to a development technique known as rapid application development (RAD). The following case illustrates the use of timeboxing and RAD.

CASE EXAMPLE

DUPONT CABLE MANAGEMENT SERVICES

www.dupont.com

DuPont Cable Management Services was formed to manage the telephone and data wiring in DuPont’s office buildings in Wilmington, Delaware. AT&T had owned and managed the wiring for DuPont’s voice networks, but then responsibility passed to DuPont’s corporate telecommunications group. At DuPont’s Wilmington headquarters campus, cabling is complex and wiring changes are continual. The average telephone is moved one and a half times a year. Much of the telephone moving cost is labor to find the correct cables and circuit paths.

When the cable management services group was formed, the manager realized he needed a system to maintain an inventory of every wire, telephone, modem, workstation, wiring closet connection, and other pieces of telephone equipment. Technicians could then quickly locate the appropriate equipment and make the change. Although several cable management software packages were available, none could handle the scale or workload required by DuPont. The only option was to build a custom system.

The system had to be flexible, because the company’s telecommunications facilities would need to handle new kinds of equipment for data and video. Furthermore, because cable management services were not unique to DuPont, the manager believed he could sell cable management services to other large companies. Therefore, the system needed to be tailorable. So that he did not have to hire programmers, the manager decided to use DuPont Information Engineering Associates (IEA), another DuPont business service unit, to build the system.

DuPont Information Engineering Associates (IEA)

IEA believed it could significantly speed up development by combining a code generator with software prototyping and project management. The resulting methodology was called rapid iterative production prototyping, or RIPP.

Using RIPP, a development project could take as few as 120 days to complete; it had four phases.

- **Phase 1: Go-Ahead.** Day 1 is the go-ahead day. IEA accepts a

(Case Continued)

project, and the customer agrees to participate heavily in development.

- **Phase 2: System Definition.**

Days 2 through 30 are spent defining the components of the system and its acceptance criteria. At the end of this phase, IEA presents the customer with a system definition and a fixed price for creating the application.

- **Phase 3: The Timebox.** The following 90 days are the “timebox,” during which the IEA–customer team creates design specifications, prototypes the system, and then refines the prototype and its specifications. The final prototype becomes the production system.

- **Phase 4: Installation.** On Day 120, the system is installed. The customer has three months to verify that the system does what it is supposed to do. If it does not, IEA will refund the customer’s money and remove the system.

Cable Management’s Use of IEA

The cable management group contracted with IEA to develop the cable tracking system. After spending the first 30 days defining the scope of the project, IEA estimated that the system would require two timeboxes to complete, or about 210 days.

During the first timebox, IEA developed those portions that the cable management group could concisely define. During those 90 days, one cable management engineer worked full-time on the project, another worked part-time, and IEA had a project leader and two developers. The system they developed included display screens, the relational database, basic system processes, and reports.

At the end of the 90 days, IEA delivered a basic functional system, which DuPont began using. The second timebox added features uncovered during this use. Both parties agreed that this phase was ambiguous, which might affect the 90-day limitation. So they extended the project to 110 days. By that time, the development team had entered DuPont’s complete wiring inventory, enhanced the basic system, and delivered a production version.

In all, the system took about nine months to develop. The department manager realized that was fast, but he did not realize how fast until he talked to other telecommunications executives who told him their firms had spent between two and three years developing cable management systems.

The cable management group was pleased with its system. It was initially used only to manage voice wiring, but has since been extended to handle data communications wiring. ■

Object-Oriented Development

Just as 4GLs were a revolutionary change in the 1970s, object-oriented (OO) development was a revolutionary change in the 1980s. In fact, companies had a choice. They could choose the evolutionary approach of CASE or the revolutionary approach of OO development. OO development caught on in the early 1980s because of the PC and only became more popular in the 1990s; the graphical user interfaces were developed using objects. Developers just needed to point and click at generic items—menus, dialog

boxes, radio buttons, and other graphical components—and then rearrange them to create a screen. This form of programming has come to be known as visual programming.

By the end of the 1980s, OO development was beginning to be noticed in IS departments for business applications. That trickle became a tidal wave when client-server systems appeared in the early 1990s, as developers attempted to simplify these extremely complex systems by reusing objects. In the early 1990s, OO system analysis and design techniques began to appear that could be used in conjunction with OO languages such as C++ and Smalltalk.

OO development is not so much a coding technique as a code-packaging technique, notes Brad Cox,⁴ an OO development pioneer. An object contains some private data (that other objects cannot manipulate) and a small set of operations (called methods) that can perform work on those data. When an object receives a request in the form of a message, it chooses the operation that will fulfill that request, it executes the operation on the data supplied by the message, and then it returns the results to the requester.

Combining data and procedures in an object, which is called encapsulation, is the foundation of OO development. It restricts the effects of changes by placing a wall of code around each piece of data. Data are accessed through messages that only specify what should be done. The object specifies how its operations are performed. Thus, a change in one part of a system need not affect the other parts. As you might expect, even though OO development promised significant benefits, it does have costs, especially at the outset. OO projects have gotten stuck in the mire of defining and redefining objects. Once defined, objects can be reused, another of OO's attractions. There are many other aspects of OO development, but this very brief description of objects suffices here. As will be seen later in the chapter, OO is a significant foundation for today's development efforts.

Client-Server Computing

Client-server systems generated a lot of excitement in the early 1990s because they promised far more flexibility than mainframe-based systems. The desktop and laptop client machines could handle graphics, animation, and video, whereas the servers could handle production updating. It was a clever way to meld the pizzazz of the PC world with the necessary back-end production strengths of the mainframe world, even though mainframes were not always in the picture. The following is a typical example of the allure of client-server systems and how one company—MGM—developed its first client-server system.⁵

CASE EXAMPLE

MGM

www.mgm.com

Metro-Goldwyn-Mayer (MGM), the movie studio in Hollywood, has an extremely valuable asset: its library of TV shows

and movies. The studio's first client-server application was built at the urging of end users to leverage this asset. The

(Case Continued)

vice president of IS knew that the only way to meet the users' expectations for a multimedia, laptop-based system with a graphical interface was to employ client-server technology.

Previously, more than 26 disparate systems on PCs, mini-computers, and the corporate mainframe were used to maintain the rights to show MGM's films. As a result, it was not possible to get a consolidated, worldwide view of which films were being leased. The client-server system—the largest IS project in Hollywood at the time—collected and consolidated all data on the film library so that MGM would know what films it has the rights to license and to whom.

Client-server technology was chosen because it could empower MGM's 20 worldwide film-rights salespeople. They could visit the head of a cable TV network anywhere in the world with an SQL database on their laptop and built-in CD-ROM capabilities to play 20- to 30-second clips of their films. They could browse the laptop's inventory database to verify availability of films and then print the licensing deal memo on the spot. Details of the deal could then be transmitted to headquarters when convenient. Only a client-server system would provide this flexibility.

The System's Three-Level Architecture

The system's architecture had three layers. At the core was an AS/400, which acted as the central processor for the database that contains descriptions of 1,700 TV shows and movies, an index, the availability of movies in different regions, license time periods, status of bills, and so forth. MGM deliberately chose a

tried-and-tested rights licensing software package to manage the database because it provided the needed processing; however, it did not support graphical interfaces, laptops, or decision support. Therefore, MGM surrounded the package with the most tested technology possible for the client-server components. In fact, wherever possible, MGM minimized technical risk by using proven products.

The second layer was an HP9000 server, which contained data and processing, but no presentation software. The Unix front end was built using PowerBuilder. In one hour with PowerBuilder, developers could do 8 to 10 hours of COBOL-equivalent work.

The third layer was the client machines, either desktop or laptop. They contained local processing, local databases, and presentation software. The laptops also had a database for the salespeople. They could upload and download information from their laptops via dial-up lines.

The premier skill required in this environment was systems integration. The developers needed both hardware and software expertise for Unix and NT, PowerBuilder, and SQL Windows.

The Development Environment

Even though partnering was always possible in the mainframe era, it was mandatory with client-server computing. With tools like PowerBuilder and a development life cycle that relied on prototyping, developers had to constantly interact with users. They could not seclude themselves for months. Moreover, client-server teams had no boss. The users and developers were equal; neither told the other what to do.

(Case Continued)

The role of IS at MGM changed from system development and delivery to one of cooperating and partnering. This change required a huge cultural shift in the roles and attitudes of the IS staff. Developers who formerly buried themselves in code had to conduct meetings and work side-by-side with users. In short, they had to learn people (interpersonal) skills and the business. Interestingly, the CIO felt that women had an edge

because, generally speaking, they had better interpersonal skills.

With client-server systems, the hardware was cheaper than with mainframe systems, development was faster, and software support was cheaper—all by orders of magnitude. Operating costs were more expensive than MGM expected because version control of client-server software and service and systems management were more costly. ■

These technologies—structured development, 4GLs, prototyping, CASE, OO development, and client-server systems—have all proven to be foundations of today's system development environment. We now turn to that environment, beginning first by discussing the main method of building systems: system integration.

SYSTEM INTEGRATION

Integration is by far the biggest software problem CIOs face. With the increased need for supporting inter-organizational supply chains, the level of complexity becomes exponential. That is why offerings that integrate systems generate so much interest. The increasing complexity of IT, with systems from various eras and technologies that must coexist and even work together, makes the integration challenge even more difficult to solve. That is why large, integrated enterprise-wide systems have been adopted: to replace the myriad “silo” systems with one interconnected one.

CIOs have long strived to integrate the information systems in their organizations so that they work together. However, integration is complex and expensive, and it can cause systems to crash. But competitive pressures have raised the importance of integrating business processes and, thus, the underlying information systems. The trend away from in-house software development toward the use of off-the-shelf software has furthered the need for integration. Online business requires integrating systems across organizations. Technology vendors have responded with a number of products to facilitate the integration of systems.

Three main approaches to integration are:

- DBMS
- ERP systems
- Middleware

The DBMS approach takes a data-oriented view to integration. DBMS allow applications to share data stored in a single or distributed database. The applications can come from a number of sources, but they employ a common DBMS. This approach is particularly appropriate when business applications tend to use the same set of data, even if these data are physically stored at different locations. This is true for most management information systems dealing with bookkeeping, production, procurement, inventory, cash management, and the like.

The ERP approach, takes an application view of integration. All applications come from a single computing platform and are specifically designed to communicate with each other. The ERP approach provides a more flexible approach to integrating application systems. Systems in ERP tend to serve more diverse applications, yet, ensuring a seamless integration of data and algorithms whenever the users need to.

The middleware approach takes a third-party approach; applications communicate with each other through third-party translation software.

Each of the three approaches has advantages and disadvantages, depending on the conditions in the enterprise. Typically, organizations use a combination of the three. Indeed, a quick look at vendor strategies reveals a mixture of the approaches. Oracle, firmly in the DBMS market, has moved toward offering enterprise applications. SAP, a major ERP vendor and long a competitor of Oracle, has modified its products to use standard DBMS, including that of Oracle. The three approaches are not mutually exclusive.

ERP Systems

An ERP system aims to integrate corporate systems by providing a single set of applications from a single software vendor operating with a full interoperable database. The goal is to provide the means to integrate business departments and functions across an organization or multiple organizations. ERP vendors offer a complete set of business applications, including order processing, HR management, manufacturing, finance and accounting, and CRM at additional costs. By automating many of the tasks involved in business processes and standardizing the processes themselves, the ERP system can provide substantial payback to a company if the system is installed properly, despite a high starting cost.

The history of ERP contains both successes and failures, though the failures have been especially notable. Scott Buckhout and his colleagues⁶ reported on a study of ERP implementations in companies with more than \$500 million in revenues. The average cost overrun was 179 percent, and the average schedule overrun was 230 percent. Despite these overruns, the desired functionality was 59 percent below expectations, on average. Only 10 percent of the implementation projects actually finished on time and within budget; another 35 percent of the projects were canceled. Even IT companies have had problems. Dell canceled its ERP project after two years and expenditures of more than \$200 million.

Some of the failures can be attributed to factors common to other IS projects, such as the system's large size and complexity. However, ERP systems differ in a significant way from other systems, which is not always recognized. Because they are designed to integrate and streamline numerous business functions, they have significant implications for

the way the firm is organized and operates. Many failures result from too much attention being given to the technical aspects of the system and too little attention being given to its organizational impacts.

An ERP system contains a model of the business that reflects assumptions about the way the business operates. The vendor makes these assumptions and designs the system to reflect the vendor's understanding of business processes in general. As a result, the business model embedded in the ERP system may be different from the way the business actually operates. Even though the ERP system can be customized to some degree, configuring the system entails compromises. The company must balance the way it wants to operate with the way the system wants the company to operate.

To realize the benefits of ERP—integrated systems and integrated business processes—a company must therefore change its organizational structure and culture. From his extensive studies of ERP, Thomas Davenport⁷ stresses that companies that have derived the greatest benefits have viewed ERP (he prefers the term “enterprise system, ES”) primarily in strategic and organizational terms, not in technical terms; they “stressed the enterprise not the system.” The managers have asked: “How might an ES strengthen our competitive advantages? How might it erode them? What will be the system's effect on our organization and culture? Do we need to extend the system across all our functions, or should we implement only certain modules? What other alternatives, if any, for information management might suit us better than an ES?”

As an example of a successful implementation of ERP, consider Colgate-Palmolive.

CASE EXAMPLE

COLGATE-PALMOLIVE

www.colgate.com

Colgate-Palmolive Company is a 190-year-old consumer products leader. In the mid-1990s, it faced a competitive crisis. Sales of personal care products dropped 12 percent and operating profits dropped 26 percent in North America. Colgate-Palmolive had a decentralized structure, with national or regional control in more than 200 countries. This structure produced independent operations that were expensive to coordinate, slow to respond to market changes, and constrained company growth. Management needed to develop new products, reduce product

delivery cycles, and reduce the cost of operations.

Management's vision was to abandon the decentralized structure and become a truly global company with an integrated business environment and standardized business processes. Their first step toward this vision was to integrate their supply chain in 80 countries and distribution to 200 countries. The goal was to reduce the annual cost of the supply chain by \$150 million and to standardize business processes. A key element to achieving this integration was a global ERP system.

(Case Continued)

After setting up a prototype environment in the United States, Colgate was convinced that the SAP R/3 modules for sales and distribution, materials management, finance, and HR would provide the functionality and flexibility it needed worldwide. Management also decided on Oracle's relational DBMS and a Sun hardware platform running the Solaris operating system. The current network has 270 servers, 11 terabytes of data storage, and can support 3,000 concurrent users accessing the network from PCs around the world. The global ERP implementation took five years and cost \$430 million.

The company quickly met its goals, realizing savings of \$50 million the first year and \$100 million the second. These savings were invested into creating and marketing new products, including the successful Target toothpaste, which allowed Colgate to regain the number-one market position for toothpaste in the United States that it had lost 34 years earlier. The company also reduced the product delivery cycle by more than 60 percent. Integration allowed regional cooperation on purchasing, resulting in larger contracts with fewer suppliers, which saved \$150 million the first two years.

Colgate also accrued substantial savings in IT operations. The old, highly complex, decentralized IT infrastructure, which had many data centers and local applications, was streamlined. Data centers around the world were consolidated from 75 to 2. The complexity of the global data networks was also simplified. SAP's R/3 provides a standard for applications, although the core support for the applications remains with each division.

The success of Colgate's ERP project stems from senior management convincing all employees that the company faced a crisis that only a dramatic change in strategy and organization could solve. The need for global restructuring of strategies and operations drove the need for a global, integrated IT infrastructure. The initial focus on the supply chain led to immediate positive results, validating management's strategy and providing support for the organizational changes. Colgate was also under pressure to integrate its operations from its larger customers, who had already begun to integrate their own operations. The ERP project was actually part of a larger project to rethink and realign Colgate's business strategies, structures, processes, and systems. ■

Middleware

Most organizations have a wide range of applications, new and old, from a variety of vendors, running on numerous platforms that use or require different data formats and message protocols. Replacing or rewriting these applications is not feasible due to cost or lack of time. One option is to employ a class of development products known as middleware. As its name implies, middleware is a wide spectrum of software that works between and connects applications, allowing them to share data. Without middleware, applications would have to be modified to communicate with each other,

usually by adding code to each application, perhaps causing unintended negative effects. Middleware acts as a translator between the applications so that they do not need to be changed.

As Woolfe⁵ points out, middleware simplifies development by acting as the glue that binds the components, allowing them to work together. A plethora of middleware is available. Some are for communicating among applications; others are for managing transactions across platforms; and still others provide general services, such as security, synchronization, or software distribution.

One type of middleware that has gained popularity is Enterprise Application Integration (EAI) products. EAI tools typically use a message broker to transfer data between applications. They allow users to define business processes and make data integration subject to rules that govern those processes. As an example, a rule might state that data moves automatically from the purchasing application to the accounts receivable application only after the appropriate person has signed off on the purchase. Companies acquire a central module plus the interfaces needed to connect the applications. To handle unique integration needs, EAI vendors provide custom programming to modify the EAI modules to fit the company's requirements.

Another emerging trend in middleware is to link large and distributed mainframe systems with mobile devices in real time. Examples of such architecture includes mobile payments involving more than one bank, and a large chain of retail stores using RFIDs to locate items in store shelves. Middleware provides fast, scalable, and even disposable solutions. However, it calls for careful planning, costing, and performance monitoring. An uncontrolled proliferation of middleware could lead to unexpected expenses and slower overall system performance. Another potential area of concern is the unpredictable single point of failure. In a complex network of middleware, a faulty middleware can bring that entire system to a halt.

INTER-ORGANIZATIONAL SYSTEM DEVELOPMENT

One of the main business trends is the appearance of business ecosystems; that is, groupings of businesses that work closely together. This trend is obviously affecting the kinds of systems being built and how they are built. Systems that integrate supply chains, supply-chain management (SCM) systems, are now a major trend, as supply chains compete against one another on their ability to reduce costs and time across their entire chains. Needless to say, development of these inter-organizational systems, which cross organizational lines, requires teams from the different organizations to work together.

Another type of inter-organizational system is a platform, which provides the infrastructure for the operation of a business ecosystem, a region, or an industry. In fact, platform development is a major trend in an increasing number of industries. One example, albeit an old one, is American Airlines' development of its SABRE computer reservation system. Originally, American developed SABRE for its own use. But the system was so leading edge, and so expensive to build, that other airlines paid American to use it. SABRE became a platform for the airline industry. Today,

the video game industry has intense competition among platform developers Sony (PlayStation 2), Nintendo (GameCube), and Microsoft (Xbox). Following are two examples of platform developments. The first one, yet to become a platform, is in the following two Case Examples; they point out the types of coordination needed to develop an inter-organizational system for a business ecosystem.

CASE EXAMPLE

HOW SHOULD EXXONMOBIL LEVERAGE ITS IT ASSETS?

www.exxonmobil.com

In 1996, Mobil Corporation created Mobil Speedpass, a system that uses a 1.5-inch-long wand that motorists can attach to their key chain and wave at an electronic reader on a Mobil gas pump to pay for gas. Mobil's goal was to speed motorists in and out of its stations. It calculated that Speedpass would save motorists one-half minute off of a 3.5-minute transaction, states Hammonds.⁸

The device caught on. Mobil, now part of \$230-billion ExxonMobil, has 5 million Speedpass holders. Furthermore, these customers buy more Mobil gas than non-Speedpass customers, they visit Mobil stations one more time per month, and they spend 2 to 3 percent more money at the stations that have paid \$15,000 for the Speedpass scanner, notes Hammonds.

Speedpass is free to motorists. It uses radio frequency identification (RFID) technology from Texas Instruments to store the driver's credit card information and transmit it to the scanner. It is easy to use. No keyboard, no swiping.

ExxonMobil's Dilemma

The RFID technology is easy to replicate, so other gas station chains are testing competitive systems. Mobil has been in this situation before. In the early 1990s, the company invested early in pay-at-the-pump technology so that motorists could just swipe their credit card to buy gas. But competitors quickly caught up, and Mobil's first-mover advantage disappeared.

From that experience, Mobil learned it could lose its competitive advantage by keeping its technology proprietary. So with Speedpass, management is taking the opposite approach. Mobil now sees the value of Speedpass as being its relationship with its 5 million users—not the Speedpass technology.

How should Mobil leverage this customer relationship? To start, it has changed the name from Mobil Speedpass to simply Speedpass to eliminate the exclusivity aspect. It also has teamed up with McDonald's restaurants in Chicago to test the use of Speedpass to pay for food.

(Case Continued)

Mobil also plans to create similar deals with a U.S. drugstore chain, a supermarket chain, and other chains, notes Hammond.

The goal is to create a network effect: The more motorists sign up for Speedpass,

the more attractive it becomes for retailers. The more retailers Mobil signs up, the more consumers will be attracted to Speedpass. It forms a vicious circle; see Figure 3. ■

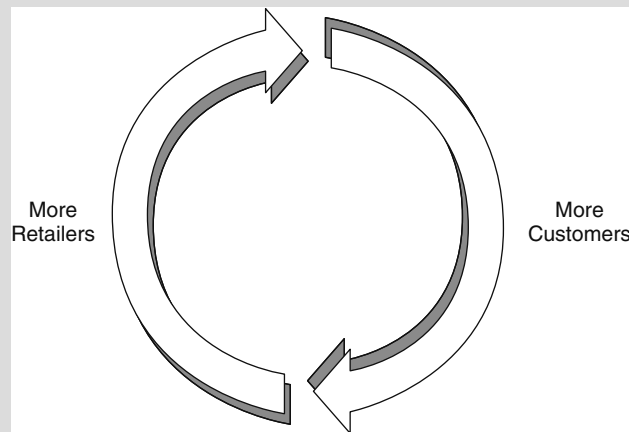


FIGURE 3 Speedpass's Potential Virtuous Circle

CASE EXAMPLE

HONG KONG EXCHANGES AND CLEARING

www.hkex.com.hk

Hong Kong Exchanges and Clearing (HKEx) is Asia's second-largest, and the world's ninth-largest, stock market. Due to the globalization of stock markets, stock exchanges now compete against one another for investors. And investors have become very demanding. They want more features from exchanges; more flexibility in how they trade securities; and faster,

cheaper, and more cross-border trading. Furthermore, there has been much talk about exchanges forming global alliances.

Aiming for an Inter-organizational System, AMS/3

To put itself in a stronger competitive position, HKEx decided to embed its business processes in an open-trading

(Case Continued)

architecture, notes David Lo, vice president of trading and participant services at HKEx, and his coauthors,⁹ so that it can extend its market reach beyond Hong Kong, handle greater trading volumes, and more easily interconnect with business partners' systems. This architecture underlies HKEx's third-generation automatic order matching and execution system, called AMS/3, which is the system that handles securities trading at HKEx.

The first-generation system, a closed system, allowed brokers to enter orders, but only from special terminals on HKEx's trading floor. The second-generation system allowed orders from dedicated terminals in brokers' offices. However, it still did not connect to external networks or to the computer systems of HKEx's 500 brokerage-house members.

In planning for AMS/3, HKEx wanted to improve the efficiency of the exchange, open up the system to individual investors, and lay the foundation to eventually automate the entire trading process so that it could offer "straight-through processing." In short, HKEx's goal is integrated end-to-end computerized trading processes from investors through brokers to markets.

AMS/3 permits brokers to enter orders as they have in the past, using dedicated terminals on and off HKEx's trading floor. Or they can use a new option: accessing AMS/3's trading host through an "open gateway." Thus, data can flow back and forth between a broker's back-office system and AMS/3, which gives those back-office systems the data to perform, say, market analyses not feasible before.

Furthermore, individual investors can make online inquiries or order requests using their mobile phone or the

Internet once their broker has registered them with HKEx. Of course, each transaction is safeguarded with an authentication check.

Due to the flexibility of AMS/3, HKEx can now offer members and individual investors customized services, such as bundled products or distinctive trading processes. It has also made the market more transparent by providing more timely information to members and investors. It also gives trading service partners, such as software developers and mobile phone operators, a new market for their services.

Building AMS/3

The project was daunting, involving both internal and external people—40 staff from different departments, 150 consultants, and 500 brokerage firms. The project had five development teams, for the network, the host and open gateway systems, the multiworkstation system (for brokerages wanting to use HKEx's system instead of their own back-office system), the order routing system (for access via the Internet or mobile phones), and user-acceptance testing.

PCCW (formerly Cable & Wireless HKT) built the trading network, the order routing system, and the multiworkstation system. Compaq supplied the host and the open gateway systems. Accenture, the large consulting firm, designed the architecture, managed user-acceptance testing, coordinated the 500 critical project activities, managed the interdependencies among the numerous project segments, and oversaw the work of the contractors through a project management office of 10 people.

Each week the project management office reported to the project steering

(Case Continued)

group, which included senior HKEx executives from the various business and IT areas.

Another group, the trading and settlement committee, had members from brokerage firms and other organizations involved in HKEx's market, such as accountants, solicitors, Hong Kong's Monetary Authority (which manages Hong Kong's fiscal policy), the Securities and Futures Commission (which regulates the brokerage industry), and the Financial Services Bureau (which regulates Hong Kong banking). This committee reviewed development of the system, offered opinions on the planned trading mechanisms, and made sure their firms (and the market) were on schedule to be ready to use the new system when it was launched.

Throughout the two-year development, HKEx maintained a dialog with all interested parties to be sure they accepted the plans, contributed ideas to improve them, put the appropriate regulations in place, and got their own systems and processes ready to use AMS/3. Furthermore, they held open forums and used the media to educate investors about their coming new trading options.

Testing the System

To guard against system failure, HKEx conducted three levels of system testing. The first was single-component testing, where each component was tested on its own until it reached the needed performance level. Then came partial integration tests between components to catch as many interconnection problems as possible. Third was integration testing, which tested end-to-end processes. Overall, testing was 40 percent of the project. One

thousand errors were found, mainly during integration testing, because vendors had made different assumptions during development.

Some of the major system specifications were that AMS/3 be able to process 200 orders per second (higher than American and European exchanges), process 150 orders per second on an individual stock (a "hot stock"), handle off-hour orders transmitted all at once from 1,000 systems, accommodate new computers easily, and have a "flood control" mechanism so that no hot-stock activity can destabilize the system. AMS/3 has achieved all these requirements, and HKEx has recovery procedures for all the system-failure scenarios that people could dream up.

About 100 brokerage firms have built their own systems to interface with the open gateway. These could inadvertently interrupt AMS/3's processing and disrupt the market, so HKEx opened up an AMS/3 testing environment every Saturday for six months for the brokers to perform end-to-end testing. Some 35 brokers at a time had 5 consecutive weeks to perform their tests. In addition, HKEx inspected brokers' offices, and only allowed those that passed the tests to move into production mode, either when AMS/3 went live or at successive rollout times. Finally, HKEx also held marketwide network tests to test the system fully loaded.

Rolling out AMS/3

Once acceptance testing was complete, HKEx and its many partners followed a detailed, nine-month-long, three-layer migration plan, state Lo et al. Each change was high risk, so to mitigate the possibility

(Case Continued)

of disrupting Hong Kong's stock market, enough time was given between each layer to stabilize the environment before adding the next layer.

In preparation, applications were moved from their development environment to the production environment, and data were converted from AMS/2 to AMS/3. Then, the infrastructure layer was implemented first: The AMS/2 terminals were migrated in batches to the new AMS/3 trading network. Second came the accessibility layer: The access portions of the system—the new terminals, the multiworkstation system, the broker-supplied systems, and the open gateway—were launched in batches. Third came the functionality layer: New trading functions were introduced one-by-one so that the brokers had enough time to learn each one before being presented with another.

Some 300 of HKEx's broker-members have implemented new trading devices; 60 have even made order routing system connections to allow online trading by investors via mobile phones or the Internet. The 200 smaller brokers continue to use HKEx's traditional terminals to access AMS/3.

AMS/3 came in on time and on budget. It has not gone down, and the number of hotline calls has not increased, which is a real achievement. HKEx appears to have fully prepared its market.

The Results

Due to its new capabilities, HKEx is now open 20 hours a day and allows

trading on several markets concurrently (adhering to the trading rules, hours, etc., of each one). It launched a South Korean and a Taiwanese index fund to boost local trading in these funds. Both funds are also traded in the United States, but the U.S. market is not open when these two Asian markets are open, note Lo et al.

With 500 exchange participants, HKEx is the world's largest networked trading system, so it is attracting interest from other countries that want foreign investment. Its 20-hour trading window and its ability to handle online trading allow brokers and investors to access overseas markets directly through AMS/3.

Furthermore, by providing brokers with the infrastructure to offer more services and better security, HKEx enhances its market position. Individual investors also have more online capabilities. They can place, modify, and cancel order requests, check the status of requests, see real-time stock prices, and obtain other information.

HKEx is also adding new kinds of participants, such as financial information service providers, proprietary networks, and the Hong Kong Post, the authority that issues and manages public key encryption certificates.

In short, HKEx now has the foundation for its industry ecosystem, with processes built on an open architecture and an inter-organizational system with components from numerous sources and participants of many kinds. ■

INTERNET-BASED SYSTEMS

HKEx's system is actually a good introduction to Internet-based systems. AMS/3 is not Internet based, but it allows Internet access for online trading as well as other actions. The Internet has opened up the options HKEx can offer. Internet users have become so sophisticated that Internet-based systems must now be scalable, reliable, and integrated both internally and externally with the systems of customers and business partners. In developing such systems, companies have learned they must negotiate programming language differences. For example, a system may have to port old COBOL applications to Java; reconcile interface discrepancies; and interface with back-end legacy applications, often without documentation or past experience with those systems.

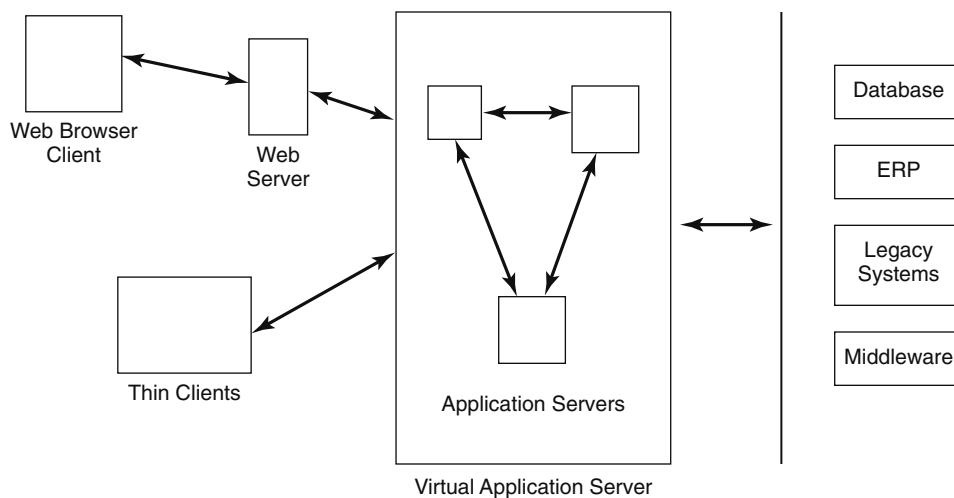
Internet-based systems are where the system development action is occurring. This section discusses three aspects of Internet-based systems: a framework, a language, and an environment. We examine these aspects for the following reasons:

- Application servers because they appear to provide the preferred framework for developing Internet-based systems
- Java because customers are demanding open systems; they do not want to be tied to a single vendor's proprietary technology. Java is a fairly open language that has evolved from client-side programming to being a server-side application development standard.
- Web Services because they are touted as the development environment of the future

Application Servers

Originally conceived as a piece of middleware to link a Web server to applications on other company systems, the application server has grown into a framework for developing Internet-based applications. Figure 4 illustrates the basic application server architecture. A set of application servers is connected to create a single virtual application server. This virtual server takes requests from clients and Web servers (on the left), runs the necessary business logic, and provides connectivity to the entire range of back-end systems (on the right).

FIGURE 4 An Application Server Architecture



In addition to providing middleware and integration functions, application servers have become application development platforms, with a wide range of development and automatic code generation tools. They can provide common functions, such as security and database connectivity, notes Radding,¹⁰ they can store business logic components (forming the building blocks for applications), and they provide development capabilities inherited from CASE [now called integrated development environments (IDEs)]. In short, they aim to increase programmer productivity by automating and managing many of the technical tasks in developing and running Internet-based applications. They also provide scalability. As demands on applications grow, a company can increase the power of its virtual application server by either installing more servers or replacing smaller servers with larger ones. The application server also provides automatic load balancing among the multiple servers.

Java

If companies are to develop Internet-based systems quickly, as the e-business environment demands, they need component-based development tools. In addition, to develop portable and scalable systems, companies need to employ an open-system architecture. For both component-based tools and open systems, industry standards are necessary. Currently, some of the most widely used standards for Internet-based systems development have evolved from Java.

Java was originally developed to provide applets that run on Web clients. However, it quickly evolved into a full programming language with the goal of providing platform independence; that is, Java applications could run on any system through a Java virtual machine. This promised application portability was dubbed “write-once, run-anywhere.” That promise has not been met, though. Java performed poorly relative to other languages, such as C++. Therefore, companies have not converted their client applications to Java. However, Java has evolved into a standard platform for developing server-side applications.

The two major components in the Java server-side platform are Enterprise JavaBeans (EJBs) and the Java 2 Enterprise Edition (J2EE) software specification. EJBs emerged on the developer scene in 1998 when Sun Microsystems unveiled a specification for creating server-based applications using software components. EJBs are preconfigured pieces of code that IS staff no longer have to build from scratch. They can be as simple as an order entry form or as complicated as a virtual shopping cart that even protects shopper privacy. Use of EJBs can greatly enhance programmer productivity. Microsoft competes with its own version of components called COM (Component Object Model) components. (Note the term “object.” OO programming has become increasingly important in system development.)

J2EE defines a standard for developing Internet-based enterprise applications. It simplifies enterprise application development by basing it on a collection of standard server-side application programming interfaces (APIs), providing a set of services to modular components, and handling many of the core functions for the applications. Components include an API for database access, security modules that protect data in the Internet environment, and modules supporting interactions with existing enterprise applications. J2EE also supports XML.

Together, J2EE and EJBs provide an alternative to building online business systems from scratch or buying packaged online business systems because of their multivendor platform capability and pre-built, reusable components.

Web Services

As inter-organizational computing has become more and more diverse and pervasive, the need for supporting cost-effective and just-in-time interoperability on the World Wide Web has led to the idea of making Internet-based software components available to their users. Known as Web Services, these software programs have emerged in the IT ecosystem in an overhyped and somewhat chaotic way. Web Services mean different things to different people. Back in 1998 and 1999, business executives were fired up with the transformational potential of business-to-business interactions, but the technology was not ready and the notion of Web Services proved too inefficient to be commercially viable at that time. Several years after the disappointing first wave of hype, business integration technology is finally maturing in the form of Web Services. In an attempt to provide an industry-wide consensus to the concept of Web Services, the W3C Web Services Architecture Group managed to agree on the following working definition of a Web Service: “A Web service is a software system designed to support interoperable machine-to-machine interaction over a network. It has an interface described in a machine-processable format (specifically WSDL3).”

To interact with other systems on the Internet, software applications could call Internet-based software components—called Web Services—to perform just-in-time specific tasks. To ensure interoperability, Web Services use SOAP4, a protocol for exchanging XML-based messages, typically conveyed using HTTP with an XML5 serialization in conjunction with other Web-related standards.” In a service-oriented environment, Web Services providers use UDDI6 as a mechanism to publish service listings and discover each other and define how the services or software applications interact over the Internet. A UDDI business registration consists of three components:

- White Pages—address, contact, and known identifiers;
- Yellow Pages—industrial categorizations based on standard taxonomies; and
- Green Pages—technical information about services exposed by the business (Curbera et al. 2002).

The service provider (or supplier) publishes a Web Service by creating it on an appropriate platform and generating a WSDL document that describes it. The provider then sends service details to the service broker for storage in a repository. The service requester (or client) registers with the broker, searches and finds the appropriate Web Service in the broker’s repository, retrieving the WSDL descriptor. It then negotiates with the provider to bind to the provider’s Web Service. We argue that the current features of Universal Discovery Description & Integration (UDDI) function currently provided by the WD (www.uddi.org) as a “metaservice” for locating Web Services by enabling robust queries against rich metadata is a rather limited one and additional functions are required to allow market transactions to occur.

In sum, Web Services have the potential to be the next stage of evolution for e-business—the ability of deploying systems from a service perspective, dynamically discovered and orchestrated, using messaging on the network. The fundamental roles in Web Services are service providers, service requesters, and service brokers. These roles have operations: publish, find, and bind. Operation intermediation occurs through environmental prerequisites, and it introduces aspects such as security, workflow, transactions, billing, quality-of-service, and service level agreements. The mechanism of service description language is key to fundamental operations in Web Services. Technically, a complete description of a Web Service appears in two separate documents: a Network-Accessible

Service Specification Language (NASSL) document and a Well-Defined Service (WDS) document. According to IBM Services Architecture Team (www.us.ibm.com), Web Services architecture provides four major benefits:

- Promoting interoperability by minimizing the requirements for shared understanding
- Enabling just-in-time integration
- Reducing complexity by encapsulation
- Enabling interoperability of legacy applications

John Hagel III and John Seely Brown¹¹ point out that this is what Citibank has done. In the late 1990s when online exchanges were popping up like weeds, Citibank noticed that although the purchasing process was handled electronically, the actual exchange of money was generally handled manually or through special banking networks. Citibank had expertise in electronic payments, so it created a payment processing Web Service called CitiConnect.

When a company plans to purchase, say, office supplies through an online exchange, the company can utilize CitiConnect by first registering with CitiConnect the bank accounts to withdraw funds from as well as the purchasing employees and their spending limits. When a purchase is made, the buyer clicks on the CitiConnect icon on the screen. That click automatically assembles an XML-wrapped message that contains the buyer's ID, the amount of the purchase, the supplier's ID, the withdrawal bank account number, the deposit bank account number, and the timing of the payment. Using predefined rules, that message is then routed to the appropriate settlement network to perform that financial transaction.

The benefits of this Web Service are substantial, note Hagel and Brown. Settlement times are 20 to 40 percent shorter, and settlement costs are half or less. In addition, Citibank has extended its brand into a new market, and the exchanges have happier customers.

This arrangement also illustrates the second way to build a Web Service: use one someone else has already exposed. Commerce One drew on Citibank's Web Service, allowing Commerce One to focus on the other aspects of its business. Hagel and Brown believe companies will couple their own Web Services with those of others to create complex, yet flexible, best-in-class systems. To illustrate the basics of building a Web Service, consider the following simplified example, followed by a case about Bekins.

CASE EXAMPLE

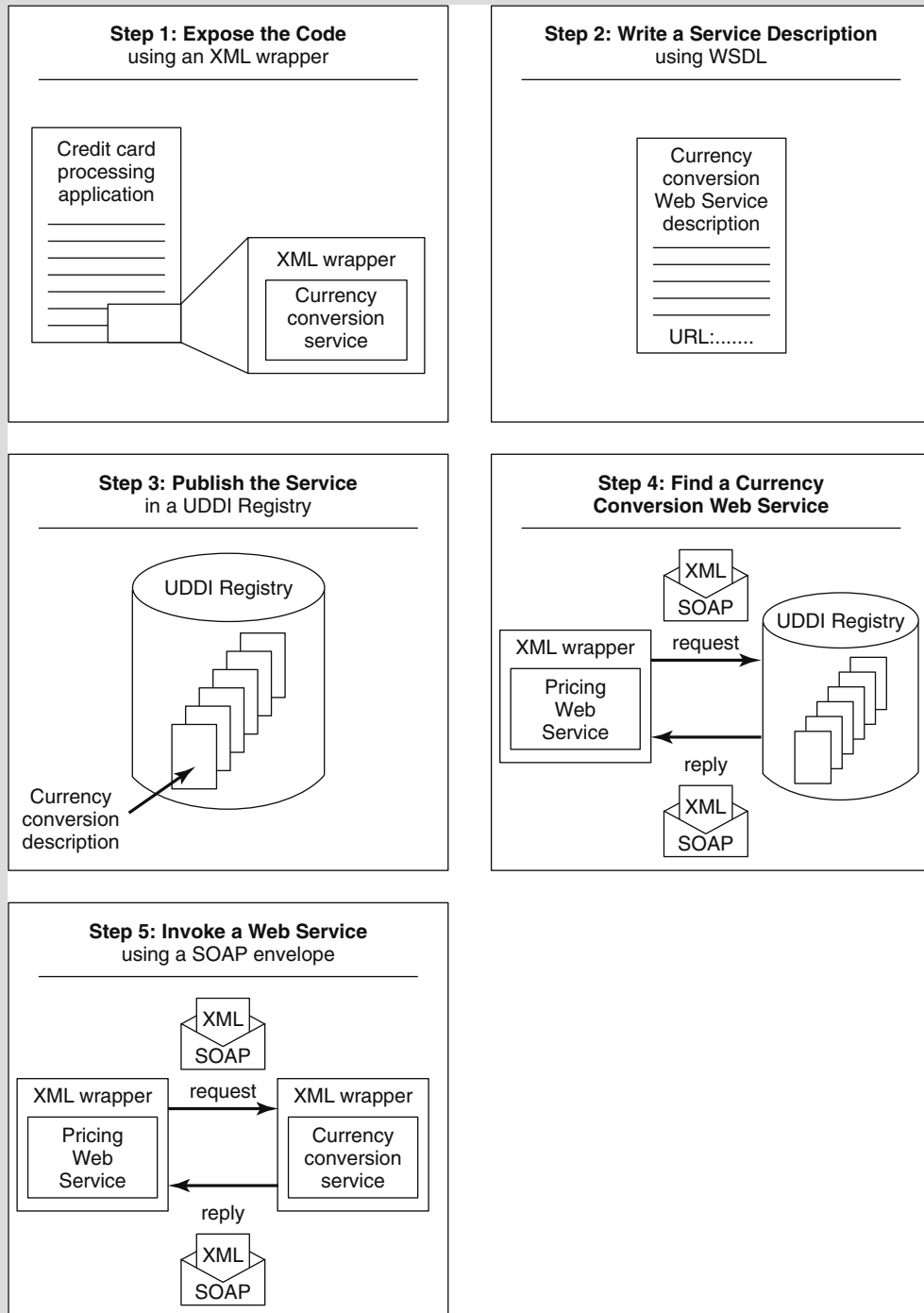
BUILDING A WEB SERVICE

A graphical example of building a Web Service from an existing in-house application is shown in Figure 5. Following is a much simplified description of that process.

Step 1: Expose the Code. A currency conversion Web service is created by exposing the currency conversion code of a credit card processor by encapsulating it in an XML wrapper.

(Case Continued)

FIGURE 5 Building a Web Service



(Case Continued)

Step 2: Write a Service Description. A description of the currency conversion service is written using WSDL (Web Services Definition Language). Housed in an XML document, this description describes the service, how to make a request to it, the data it needs to perform its work, the results it will deliver, and perhaps the cost to use it.

Step 3: Publish the Service. The currency conversion service is then published by registering it in a UDDI (Universal Discovery, Description, and Integration) registry. Publishing means that its service description, along with its URL (its address), is housed in the registry for others to find. The registry is essentially a Web services Yellow Pages.

Step 4: Find a Currency Conversion Web Service. The currency conversion service can now be found by, say, a pricing Web

service. The pricing Web Service sends a request in the form of an XML document in a SOAP (Simple Object Access Protocol) envelope to one or more registries. This special envelope is also based on XML. This particular request of the UDDI registry asks for a listing of currency conversion Web Services. The reply is sent in an XML document in a SOAP envelope back to the requestor.

Step 5: Invoke a Web Service. The pricing service can now bind to and invoke the selected currency conversion service by sending it an XML message in a SOAP envelope asking it to, say, convert US \$1,250.25 into Australian dollars. The currency conversion service performs the task and returns the answer in an XML document in a SOAP envelope and quite likely invokes a payment Web Service to be paid for performing that conversion service. ■

CASE EXAMPLE

BEKINS HOMEDIRECTUSA

www.bekins.com

Bekins, the moving company, is using Web Services in its HomeDirectUSA business unit, which specializes in the home delivery of household appliances; large-screen televisions; and other large, expensive furniture. Bekins uses some 1,000 independent moving agents across the United States to move furniture when Bekins' own fleet cannot.¹²

Formerly, Bekins faxed or phoned these agents to arrange deliveries, but the process was slow and not equitable to all the agents. To automate the process, Bekins used Web Services technology to create an online brokering system called Tonnage Broadcast Exchange (TBE). When Bekins receives an order to deliver, say, a refrigerator, that its centrally managed fleet cannot

(Case Continued)

handle, it uses TBE to “tender” that job to its agents (and perhaps other shippers). All agents are sent the tender at the same time based on pre-established criteria; so the system is fair. Once an agent accepts a job, it becomes unavailable to the others. The results have been lower tendering costs, faster customer service, and better utilization of agents’ trucks. Furthermore, because the system is so efficient, Bekins can offer lower-margin jobs to the agents, increasing its shipping volume and revenues.

Bekins’ E-Commerce Platform

In 1990, Bekins made two key IT decisions about how it would develop future systems. One, it chose Java, rather than Microsoft’s .NET, as its e-commerce platform. Two, it chose IBM’s WebSphere to develop and deploy future applications. TBE uses two systems that initiated Bekins’ new e-commerce environment. The first system was the Shipment Tracking System, which lets Bekins’ customers (such as manufacturers and retailers) and consumers track shipments via the Web. Retailers like this system because its accuracy lets them bill their customers for home delivery faster. The second Java-based system was the Customer Order Management and Inventory System, which lets customers and shipping agents enter shipping orders via the Web. This system improved order accuracy up to 40 percent and allows customers to see the inventory Bekins is holding.

The TBE system, which is also based on the Java platform and built using WebSphere, advances Bekins’ e-commerce platform by adding Web Services technologies. These technologies allow Bekins to link an agent’s transportation management

system into TBE almost instantly once the agent has readied its system to exchange messages using the Web Services standards: XML, SOAP, WSDL, and UDDI.

TBE runs on Bekins’ mainframe. Each business partner has a client-side Java application running on one of its servers. When an agent wants to accept a tender from Bekins, its client-side application accesses the private TBE UDDI registry to find out how to communicate with the SOAP servlets. The SOAP servlet transmits the acceptance message to Bekins, where an XML parser translates it. A Java interface then passes it to Bekins’ customer order management system, where it is booked as an order in the DB2 database.

Building TBE

The TBE development team consisted of an XML expert, two Java developers (one senior and one junior), an architect who knew IBM’s WebSphere and DB2 database, and two COBOL programmers. They developed TBE in just five months’ time, partly due to their experience and partly due to WebSphere, which provided the framework and sample code they built upon.

The team followed a formal development methodology with the developers focusing on creating TBE’s components and the architect helping put the pieces together. The project was divided into five phases:

1. Code the core of TBE in Java (to be hosted on a Bekins’ mainframe)
2. Convert the Java objects to Web Services
3. Deploy the Web Services

(Case Continued)

4. Code the client side of TBE (to be run on each agent's server)
5. Test the integration of the various parts of TBE

Building TBE required commitments from several moving partners because it was to be an inter-organizational system. Three partners were readying their companies to use Web Services technologies internally to integrate their own systems. Another seven acted as beta test sites for TBE using actual data. The tests gave Bekins confidence that TBE met its partners' requirements. TBE went live with 10 percent of the agents. Agents have been coming online since. Agents not ready to participate in TBE using Web Services technologies can access the system through a Web portal. Involving its partners in the development proved important, but equally important was their comfort with the new Web Services environment.

Real-time Information about Delivery Status

In 2005, Bekins decided to provide their customers with real-time information about delivery status using a system called STARS. About 600 Bekins agents are now equipped with handheld devices using the STARS application to track the location, status, project arrival time, and eventual customer receipt of every piece of furniture or goods they are delivering. Bekins agents have their Intermec handheld connected to the central DB2 databases from IBM. Using handheld sets from a different vendor, Bekins had to find a solution to link them to the mainframe. The company used a third-party company to create JDBC (Java Database Connectivity) middleware. The use of the JDBC driver from a third-party company helped save development staff and time. ■

Preparing for On-the-Fly Web Services Development

Although Web Services can help enterprises develop systems faster, the technology might have other ramifications as well—ramifications that CIOs would do well to prepare for, before they actually happen. One possibility is end-user development of Web Services, believes Jonathan Sapir, of InfoPower, a company that offers an SOA-based development platform.¹³ He believes that companies are experiencing a crisis in software development because their IS organizations cannot keep up with users' requests for changes to applications. Due to the increasingly volatile business environment, systems need almost continual enhancement. When they do not get it, they do not change as fast as the business environment.

This "crisis" situation has occurred before. When corporate databases first appeared, only programmers had the tools and know-how to generate reports from them. But those reports did not solve individuals' needs. When report writers and query languages appeared, end users eagerly learned them to query the databases on their own, reducing the time needed to answer their questions. Likewise, programmers wrote large financial programs to manage corporate finances, but those programs did not meet the needs of individual accountants. Thus, when spreadsheets

arrived in the 1970s, accountants (and others) eagerly used them to write personal applications. In fact, the spreadsheet was the “killer app” that drove the initial growth of the PC industry.

Today, Web Services and service-oriented architectures have set the stage for yet another round of even-more-powerful, on-the-fly end-user development, believes Sapir. The need is here; so is the IT savvy. Many people have been using computers for at least 20 years—some, for their whole life. They play games, manage their finances, buy stock, and perform other online tasks that are a form of programming. They would develop their own personal programs if they had the tools. End-user tools based on Web Services and SOA are coming, and they will again let users write personal applications. The difference this time is that these applications will use Web Services standards, so they will be packaged as services that others can find, use, and even build upon.

Sapir foresees people computerizing their part of the business on their own with these user-friendly tools, thereby shifting computerization from top-down to bottom-up. To do so, though, people will need to view business needs as a series of small events that are handled throughout the day as they occur, rather than consolidated and addressed after-the-fact in one large development effort by the IS organization.

This bottom-up shift has come before, as noted, with mini-computers, then PCs, as well as with spreadsheets and fourth-generation languages. Each time, most IS organizations were caught unprepared. They had not laid down an infrastructure, provided tools or training, nor established principles for end-user development using the new technologies. Companies ended up with “personal silos of data and apps” that were difficult to share and were not maintained nor backed up. IS departments had to catch up to bring order to the chaos. It behooves CIOs to respond to users’ current requests for changes to applications by piloting a company-wide Web Services platform and tools that users can use to get ahead of the curve.

Most importantly, IS management needs to implement a management system to manage the eventual intertwining of Web Services—before it happens. Without a Web Services management system, it is going to be awfully difficult to know which applications depend on which Web Services. Corporate executives will not want their major business processes to be based on applications that are not well managed. This management aspect of Web Services is a looming issue CIOs need to address, believes Sapir, before users take development into their own hands, as they have done so eagerly in the past.

The future of Web Services is yet to define. Web Services are more than just new technologies. They open up new and creative ways of doing business. Bui, Gachet, and Sebastian,¹⁴ for example, have provided a framework to facilitate the market transactions of Web Services. Their concept is to have a broker service that goes beyond the posting service currently offered by UDDI. Web Services can indeed be used to support a complete spectrum of typical processes found in negotiation and bargaining. Under a well-defined and structured environment—such as e-procurement of any goods and services—electronic markets can be facilitated with supporting Web Services that serve as intermediaries or value-added service providers to buyers and suppliers of goods and services. As a market broker, these Web Services would help (a) discover the supply/demand of Web Services in e-marketplaces; (b) find the most appropriate available service for a specific request; (c) facilitate that services be

modified if needed to satisfy user's needs; (d) arbitrate the pricing mechanism with the recourse to bargaining whenever necessary; and (e) generate a contract. Very likely, Web Services will further support the global aspect of business computing systems.

CONCLUSION

The traditional approach to system development from the 1960s evolved to give the process more discipline, control, and efficiency. It was valuable in moving programming and system analysis from pure free-form "art" to a better defined "craft." Problems remained, though, with long development times, little user involvement, and lack of flexibility in the resulting systems. The tools and methods of the 1970s and 1980s—4GLs, software prototyping, CASE, and OO development—permitted more rapid development and even experimental development; some were seen as revolutionary techniques to conventional developers.

The 1990s brought the need for integrated enterprise systems and Internet-based systems. Both required more flexibility and speedier development with a significant amount of integration, both internal and external to the company. With the integration efforts, companies realized the importance of focusing less on technical issues and more on the impacts of IT on business strategy, organization, and people. Widely reported failures of large ERP projects reinforced this need to concentrate on the business.

Most recently, the IT industry has responded with new tools and approaches. Application servers support integration across a wide range of new and legacy systems, Java supports Internet-based application development, and Web Services promise to make the Internet the heart of systems building. We have indeed entered a new era of application development where the focus is on the Internet, inter-organizational development, and ecosystem applications.

QUESTIONS AND EXERCISES

Review Questions

1. What are the goals of the traditional system development life cycle approach?
2. Refer to the list of features and functions of 4GLs in Figure 3. Briefly explain each.
3. What are the main characteristics of the prototyping approach?
4. Define the components of a computer-aided software engineering system.
5. What is unique about DuPont Cable Management Service's use of CASE?
6. What are the basic characteristics of an ERP system?
7. Why have so many ERP implementation projects failed?
8. Describe Colgate-Palmolive's approach to implementing their ERP.
9. What is a platform inter-organizational system? Give a few examples.
10. In a nutshell, what does HKEx's AMS/3 system do?
11. Describe HKEx's testing procedure for AMS/3.
12. What is Java and why is it important?
13. What are five steps in building a Web Service?
14. What does Jonathan Sapir foresee with regard to Web Services?

Discussion Questions

1. IS organizations will no longer need to develop a proprietary infrastructure; they can just rely on the Internet. Therefore, they will again focus mainly on developing applications. Discuss.
2. The field is moving too fast for companies to keep developers abreast of the state-of-the-art. To keep up, they should outsource application development to the experts, providers who specialize in development. Discuss.
3. How do you think ExxonMobil can leverage Speedpass?

Exercises

1. Find a description of an Internet-based application. What features does it have? What approach did the company choose to develop the application?
2. Visit a company in your community with an IS department with at least five professionals. Prepare a short case description to summarize the company's current approach to developing systems. Does it have one standard approach or a combination of several? Is it developing Web Services? If so, describe one or two. Is it participating in inter-organizational system development? If so, describe the development.
3. Visit the Web sites of three vendors of Web Services tools. What are they selling? Relay some client successes to the class.
4. Prepare two scenarios of what ExxonMobil could do with Speedpass. What are the crucial differences in assumptions between the two?
5. Given that ExxonMobil has a head start, what actions should management take to make Speedpass an ecosystem platform?

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MANAGEMENT ISSUES IN SYSTEM DEVELOPMENT

INTRODUCTION

Infrastructure Management

Customer Relationship

Product Innovation

PROJECT MANAGEMENT

What Is Project Management?

The Job of a Project Manager

Case Example: A Day in the Life of an IT Project Manager

Change Management

Case Example: The BOC Group

Change Management Process for IT Systems

Risk Management

Case Example: Dow Corning

Tips for Good IT Project Management

MODERNIZING LEGACY SYSTEMS

To Replace or Not to Replace?

Options for Improving a Legacy System

Case Example: Verizon Directories

Case Example: Amazon.com

Case Example: Toyota Motor Sales

Case Example: Wachovia

MEASURING SYSTEMS BENEFITS

Distinguish Between the Different Roles of Systems

Measure What Is Important to Management

Assess Investments Across Organizational Levels

Case Example: A Trucking Company

Do Investors Value IT Investments?

CONCLUSION

QUESTIONS AND EXERCISES

REFERENCES

INTRODUCTION

This chapter looks at the issues surrounding system development. The context for this discussion is set by the ideas of John Hagel III and Marc Singer while they were at McKinsey & Company.¹ They see companies as being in three businesses:

1. Infrastructure management
2. Customer relationship
3. Product innovation

Traditionally, companies have bundled the three, which leads to compromises because the three have conflicting agendas. The Internet allows companies to unbundle them, say the authors, by specializing in one business and optimizing it.

IS departments can be viewed as being in the same three businesses. Operations are infrastructure management. The help desk is the customer relationship business. System development is product innovation. The three need to be managed differently.

Infrastructure Management

The goal of infrastructure management is to reduce costs. Providing necessary infrastructure, such as hospitals, roads, wireless networks, and such, involves high fixed costs, so the goal is to build scale. High barriers to entry also mean that only the few largest players will dominate, which explains the huge battle now ensuing among telecommunications companies, handset makers, and others to become wireless service providers. Management focuses on efficiency and standards, which is just what we have been seeing in network and computer operations. Companies outsource their network management and data centers to large ESPs such as IBM, CSC, and EDS to lower costs through cost sharing for both labor and infrastructure.

Customer Relationship

The goal of the customer relationship business is service. Here the goal is scope, by having lots of custom offerings to increase the company's "wallet share" of each customer. In this business, the customer is king, and developing relationships with customers requires large investments. Hagel and Singer see only a few large players dominating. In the IT arena, PC support and help desks are often outsourced to specialists, especially in Europe, where multilingual support is needed. Outsourcing off-shore is also increasing dramatically in the customer service arena.

Product Innovation

The goal of product innovation is speed, because it provides nimbleness. Low barriers to entry mean many small players. The key to success is talent. In IT, developers are king, so software companies give them the coolest tools, allow them to work day or night, permit their pets at work, always have a stash of free Jolt Cola on hand, and so on. Software companies are always on the lookout for talent, and they reward stars generously, which is one reason IS departments can have a hard time attracting the talent they need.

One of the most sought-after skills in system development today is project management. This chapter begins with a discussion of project management and then moves on to discussions of how to improve legacy systems and how to measure the benefits of systems.

PROJECT MANAGEMENT

Today, much organizational work is performed via projects. In IS as well as other functions, being able to manage a project to completion, and deliver the expected outcome within the allotted time and budget, has become an increasingly valuable skill. This section explores six aspects of project management:

1. What is project management?
2. The job of a project manager
3. A day in the life of an IT project manager
4. Change management (an area IS teams have not always handled well)
5. Risk management (another area IS teams have not always handled well)
6. Some tips for good IT project management

What Is Project Management?

Project management is simply the management of a project, notes Michael Matthew of Matthew & Matthew consulting firm in Sydney, Australia.² This definition may sound simple and self-evident, but that does not make it easy. Many people get confused or concerned about IT project management because it involves the “T” word: technology. In reality, IT project management is not much different from other forms of project management, such as those used to construct an office building or a bridge.

A project is a collection of related tasks and activities undertaken to achieve a specific goal. Thus, all projects (IT or otherwise) should:

- Have a clearly stated goal
- Be finite, that is, have a clearly defined beginning and end

It has been said that IT project management is 10 percent technical and 90 percent common sense, or good business practice. Indeed, many of the best IT managers do not have a background in IT at all, but they possess the important skills of communication, organization, and motivation. Perhaps the most difficult component of IT project management is keeping in mind, and under control, all the interdependencies of the numerous tasks being undertaken.

“A project is a temporary endeavor undertaken to achieve a particular aim and to which project management can be applied, regardless of the project’s size, budget, or timeline,” states the Project Management Institute (PMI).³ Project management is “the application of knowledge, skills, tools, and techniques to project activities to meet project requirements,” states PMI’s 2000 edition of *A Guide to the Project Management Body of Knowledge* (PMBOK, 2000 Edition).

PMI, which was founded in 1969 in Philadelphia, Pennsylvania, has established the standard for project management and is the leading association in educating project managers in all fields, including IT. It has some 125,000 members in 240 countries and over 10,000 Project Management Professionals (PMPs) who have passed its rigorous set of tests and been certified as PMPs. PMI views project management as encompassing five processes (initiating, planning, executing, controlling, and closing) and nine

Management Issues in System Development

knowledge areas. To become a certified PMP, a person must pass tests covering all nine knowledge areas:

1. Integration, which involves ensuring that the various elements of a project are properly coordinated
2. Scope, ensuring that the project includes all the work required, and only the work required
3. Time, ensuring timely completion of the project
4. Cost, ensuring that the project is completed within the approved budget
5. Quality, ensuring that the project satisfies the needs for which it was undertaken
6. Human resources, making the most effective use of the people involved
7. Communication, ensuring timely and appropriate generation, collection, dissemination, storage, and disposition of project information
8. Risk, identifying, analyzing, and responding to project risks
9. Procurement, acquiring goods and services

To explore project management in a bit more detail, here is one view of the job of a project manager.

The Job of a Project Manager

Project management was once viewed as a specialty, with roots in construction, engineering, and IT, note Craig Anderson, a practice leader in KPMG's Queensland, Australia, office, and Michael Matthew.⁴ But now, business managers need project management skills to implement change in a disciplined and successful manner. Business project management is evolving from IT project management. Both IT and business project managers are responsible for the following tasks:

- Setting up the project
- Managing the schedule
- Managing the finances
- Managing the benefits
- Managing the risks, opportunities, and issues
- Soliciting independent reviews

Setting Up the Project

Each project needs a project charter or document to serve as the one source of truth for the project and the first point of call when there are differences of opinion in the project, note Anderson and Matthew. It should spell out the following:

- **Why.** A brief background of the project (i.e., the result of a strategic review) and the business objectives to be achieved.
- **What.** A description of the nonfinancial benefits to flow from the project and a list of the key outputs to be produced.
- **When.** A list of the milestones and expected timing (a high-level project plan).

Management Issues in System Development

- **Who.** A definition of the project team and an analysis of the stakeholders of the project and their expectations.
- **How.** A definition of the work that needs to be undertaken to achieve the project, its scope, and specific exclusions. This definition also needs to address how much the project is expected to cost (a detailed financial breakdown) and expected benefit.

Risks, opportunities, prerequisites, assumptions, and the communications plan also should be included. Then this document needs to be approved.

Managing the Schedule

The schedule or project plan is the heart of a project because it communicates the activities that need to be completed to achieve the benefits, when they need to be completed, and who needs to complete them. First, develop a high-level plan of the entire project. Next, break down the business objectives into deliverables and then into the pieces of work to produce these deliverables (and the time required). Do not plan the details of the entire project at the outset because that is too difficult and the project will change. Instead, plan the details of a stage at its outset based on the work completed and the deliverables yet to be achieved.

Then baseline the schedule, affixing a starting point so that you can gauge progress. Tracking is essential for anticipating completion and taking corrective actions when issues arise. Many automated tools are available to help project managers manage the schedule.

Anderson and Matthew make four recommendations on managing the schedule:

- Focus on the date that tasks are completed rather than the percentage of the overall project that has been completed.
- Review progress at least monthly, preferably weekly or fortnightly for shorter projects.
- Focus on tasks to be completed, not those that have been finished.
- Reforecast when new evidence comes to light.

Managing the Finances

At its most basic level, the financial plan describes the project's costs, who is accountable for them, the expected financial benefits from the project, and the cash flow. These projections flow from the project plan and are determined by the resources committed to the project, when these resources are committed, and external costs, such as contractors or general expenses.

The greatest areas of contention in most projects are project costs and benefits. Whereas outsiders may focus on deliverables, insiders will focus on financials. Just as with the project plan, once authorizations have been obtained, it is a good idea to baseline the costs and track them because the approved figures are only estimates. They will change over time. As the project manager, you will need to know how much has been spent and how much money is left.

Managing the Benefits

Four benefits can emerge from IT and business projects: profitability, cost reduction, changes to working capital, or adherence to legal or regulatory reform. Benefits are

much more difficult to estimate than costs. Anderson and Matthew offer four suggestions for managing benefits:

- Be realistic (most people overestimate benefits).
- Make sure the benefits are greater than the estimated costs.
- Base costs and benefits on the same assumptions.
- Forecast for various scenarios.

It also is important to forecast the timing of benefits. Discounted cash flow is one technique to compare the timing of benefits and costs. Again, a project manager should track benefits throughout the life of the project by asking, “Why are we doing this?” The answer might need to change if the business environment changes, as often happens in long-term projects.

Managing Risks, Opportunities, and Issues

Every project encounters the following:

- **Risk.** A potential threat or something that can go wrong that may prevent the project from achieving its business benefits
- **Opportunity.** A project going better than planned
- **Issue.** Something that threatens the success of the project

All possible risks and opportunities should be listed at the project outset and then analyzed to determine each one’s likelihood and impact. Risk mitigators for high risks need to be built into the project plan. Likewise, major opportunities need to be built into the plan to maximize potential benefits. Both risks and opportunities need to be monitored.

Ongoing monitoring of risks and opportunities is one of the weakest areas of project management, note Anderson and Matthew. A good project manager continuously monitors the risks and opportunities along with the schedule, costs, and benefits. One of the most effective tools for monitoring risks and opportunities is a risk log.

Likewise, issues management is an ongoing task. Once an issue is identified by a project team member, it should follow a standard resolution process. An issue should be brought to the project manager’s attention, its impact assessed, and then it should be assigned to a team member for resolution and its resolution monitored.

Soliciting Independent Reviews

Reviews help the project manager and project sponsor assess the “health” of a project. As the project progresses, team members often focus on delivering on specific objectives. They lose sight of the overall project benefits. An independent review can identify overlooked opportunities and risks. However, this review is not the same as a progress report. It should look at whether the project is still appropriate, whether its approach is the most effective, whether the deadline will be achieved, and if the costs are as expected.

To give a flavor of what project management work actually entails, here is an example of a day in the life of a project manager, excerpted from a blog on ITToolbox’s Web site (www.Ittoolbox.com).⁵

CASE EXAMPLE

A DAY IN THE LIFE OF AN IT PROJECT MANAGER

www.ittoolbox.com/profiles/conelarry

Larry Cone is VP Software Development. He has managed over 100 IT projects. On January 28, 2004, Cone began a highly informative and entertaining blog about his day-to-day experiences, starting with his managing a project to implement a content management system for a medical publisher. He describes himself as a motivator, problem-solver, business process analyst, and technologist.

The blog appears on ITToolbox.com, a Web site for IT professionals that features blogs from IT professionals, providing site visitors a look at the day-to-day challenges these professionals face and how they address them. The following are brief excerpts from Cone's blog.⁵

September 18, 2007: Learning from Failure—Question Assumptions

Failure is not useful if the act of failing doesn't help us move ahead. What is most important when declaring a project a Failure is: What you do next? Upon failure, several doors open.

One door is the door of analysis—with Failure, it is natural to try and figure out what went wrong. Actions are questioned, assumptions reviewed, and goals are thrown out. It is a natural time to question our methods, and to review our assumptions.

A common source of failure is the discovery of key factors in the environment which had not been considered.

This is a failure of assumptions. Often, there are unspoken assumptions that are found to be wrong.

Some common unspoken assumptions are:

- Performance won't be affected by these changes.
- The users have a stake in this project.
- Reporting won't be impacted by the data structure changes in this release.
- Our conversion processes will retain all needed data.
- The source interface system has accurate, timely data.
- The client can make needed updates to downstream systems.
- The whole business process must be addressed before any benefits can be gained.
- Senior Management supports the system.
- A comprehensive, normalized data model must be developed before we do anything.

This is far from a comprehensive list, just the first set of unaddressed issues that came to mind from projects that I've been associated with.

In most of these cases, the project went to completion, the damage was done, and the project was extended or compromised to deal with the results of these

(Case Continued)

unaddressed assumptions. In several cases, the project never got out of pilot.

The lesson is, better to declare a small, early failure than wait until you are too far in to adjust.

So the first door that opens is the opportunity to rethink what you are doing, specifically to question and reassess any hidden project assumptions.

The second door that opens is the opportunity to try again.

May 24, 2007: Everything You Need to Know about Software Architecture in Kindergarten

Designing and building software can be easier than you think. What makes it easy is having a set of rules any decision can be tested against so the rules may design the system for you.

The idea isn't so crazy. In 1986, Craig Reynolds simulated the behavior of a flock of birds using only three rules. What was previously thought too complex to program without great effort was suddenly not just easier for programmers to construct, but easier for nonprogrammers to understand. [...]

When all a system's code is is the result of a small set of rules, its behavior is more easily predicted and its complexity more easily comprehended. Knowing what a system does and what it will do, and knowing the rules that created it, make extending and adapting it in unanticipated ways much easier, even by new programmers.

To really pick up development momentum the staff also shares a common metaphor. Few systems are truly *ex nihilo* and without precedent either man-made or natural. Inspiration for working software models can come from physics, biology,

dams, post offices, or dry cleaners. When everyone understands the metaphor then everyone knows how to marshal their efforts toward that goal without consulting a single oracle they would otherwise depend on.

So the first rule we learned in kindergarten: sharing. Share your rules and share your inspiration.

October 10, 2006: To the User, Definitions are Key

We are discussing some of the things that can be missed without effective prototyping and iteration.

In my friend Don's case study, there was another item missed, one more subtle, but a potential show stopper. It was: "What is a Customer?" To the back-office guys who sat in the room for several months, a customer was an aggregate of ship-to locations with the same bill-to address. The system was designed to break down and roll-up volume and margin by product by customer.

To the sales guy, the customer was the person he called on in Schenectady, or Sausalito. This customer might control multiple bill-to's, or just one ship-to. The sales guy's customer was a product of the back office operation as seen through the lens of Sales Geography, that arbitrary and ever-changing map that the sales force management group draws. Clearly, the customer in the system had to be aligned with the sales guy's customer in order to give the sales guy actionable information.

The lesson here is that the definitions of core components of your system are very important, and that even subtle differences between your systems definitions and another systems definitions can cause confusion to the point of unusability.

(Case Continued)

A user usually won't make a leap of faith—this is someone's job, after all, and faith doesn't figure into it. A user won't use a system that doesn't make sense, and one way to not make sense is to change the core definitions.

The result? After a few minor tune-ups, the system was a big success. Due to the system's ability to communicate information about both volume and margin, the sales force became aligned with the goals of the group (more profit, not more volume) via access to margin information from the newly improved transaction system. Promotional costs, basically money handed out by the sales force to make deals, dropped dramatically. Overall profit margin increased dramatically, and volume increased, too.

The icing on the cake for me is the story Don related about witnessing one sales guy showing another sales guy from a different division how the new system helped him make more in commissions. When you can get one user training another, you know that you got most of the system right.

Without an iteration or pilot phase that included real users with production data, this system which had so much right, and delivered such significant benefits, might have failed right out of the box.

September 5, 2006: Don't Do the Wrong System

In starting a new project, I try to identify the main risk, and structure the project accordingly. Most of the time though, it is the same risk.

I do a wide range of projects in a wide range of industries, and I often participate in a project that is something new for the

organization. If it is an incremental project on an existing system, they usually don't need me. So I'm often doing a project in a new functional area, or applying a new technology (mobile, data mart, etc.) to an existing functional area. And these are usually operational systems, rather than administrative systems, in that someone is trying to improve a business process through automation.

In these types of projects, the primary risk is always the same—the risk of doing the wrong system.

By the wrong system I mean successfully implementing the wrong feature set. By wrong feature set I mean missing that subset of all possible functions and features which are the minimum necessary for an operationally viable system.

Simply put, the primary project risk is that the feature set you deliver doesn't match or support enough of the business function to be viable.

Does this sound unlikely to you? Are you confident in your ability to understand a business function and implement a feature set to support it? So am I, but when I look at the projects that I've been involved with, the record tells a different story.

My guesstimate is that approximately half of the hundred-plus implementation projects that I've been involved with were ultimately not operationally viable. There were a wide range of reasons—sometimes the technology just wasn't appropriate or ready. But often, the feature set we identified and implemented didn't support enough of the business process.

Sometimes the needed scope was way beyond the available time or budget. But often it was possible. In short, we implemented the wrong system. ■

Change Management

IS staff members are often so enthralled with the technical aspects of a new system that they presume a technically elegant system is a successful system. However, many technically sound systems have turned into implementation failures because the people side of the system was not handled correctly. IT is all about managing change. New systems require changing how work is done. Focusing only on the technical aspects is only half the job. The other job is change management.

Change management is the process of assisting people to make major changes in their working environment. In this case, the change is caused by the introduction of a new computer system. Management of change has not always been handled methodically, so choosing a change management methodology and using it is a step toward successfully introducing new computer systems.

Change disrupts people's frame of reference if it presents a future where past experiences do not hold true, says ODR, a change management firm in Atlanta, Georgia.⁶ People resist change, especially technological change, when they view it as a crisis. They cope by trying to maintain control. In the case of an impending new computer system that they do not understand fully or are not prepared to handle, they may react in several ways. They may deny the change; they may distort information they hear about it; or they may try to convince themselves, and others, that the new system really will not change the status quo. These reactions are forms of resistance.

ODR offers a methodology to help companies manage technological change. They use specific terms from the field of organizational development to describe the types of people involved in a change project.

- The sponsor is the person or group that legitimizes the change. In most cases, this group must contain someone in top management who is highly respected by the business unit because change must be driven from the business unit.
- The change agent is the person or group who causes the change to happen. Change agents are often the IS staff. They can introduce the change but they cannot enforce its use.
- The target is the person or group who is being expected to change and at whom the change is aimed.

Using surveys completed by a project's sponsors, change agents, and targets, ODR aims to:

- Describe the scope of the change
- Assess the sponsors' commitment to the project
- Assess the change agents' skills
- Evaluate the support or resistance of the targets

The goal of these initial evaluations is to determine whether the change can be made successfully with the current scope, sponsors, change agents, and targets. By evaluating each area, the change agents can determine (1) whether the scope of the project is doable or whether the organization is trying to change too much at one time, (2) whether the sponsors are committed enough to push the change through or whether they are sitting back expecting the organization to change on its own, (3) whether the change agents have the skills to implement the change or whether they are not adept at rallying support, and (4) which groups are receptive to the change and which are resistant. Once

these assessments have been made, ODR assists IS project teams to understand the risks their project faces and what they can do to mitigate those risks.

As an example of an organization that used this approach and successfully implemented nine change management projects, consider BOC Group, as described by Neil Farmer.⁷

CASE EXAMPLE

THE BOC GROUP

www.boc.com

The BOC Group is an industrial gas manufacturer with global headquarters in Windlesham, England, and U.S. headquarters in Murray Hill, New Jersey. The company operates in 60 countries and sells industrial gases such as oxygen for steel making, carbon dioxide for food freezing, and so on.

The industry is mature and highly competitive, so companies compete on price and service. To improve the company's competitive position, management committed \$35 million to reengineer BOC's core processes. In all, nine reengineering projects were initiated. All succeeded over a 30-month time frame—a significant achievement.

The company established nine full-time teams, each to improve a selected process. Following completion, all team members were guaranteed a return to their former (or equivalent) job. Each team was co-led by a business and information management (IM) process leader because IT was a major component of most of the projects. Each team also sat together in a bullpen setting.

For the first six months, each team studied its chosen business process. The research was not parceled out among

team members; every team member studied everything. Thus, IM team members were like all the other members. They studied the existing processes and then had a say in how implementation should be handled, they supplied input into the training plan, and they helped devise the customer communication plan. They were often significant influencers because the other team members respected their opinions and their technical knowledge.

Garnering True Executive Sponsorship

Although the president was the executive sponsor for all the teams, he was not intimately involved in each project. Thus, the real executive sponsors were vice presidents and directors. Although they understood the need for the changes and were committed to the concepts behind them, day-to-day operational pressures put a strain on true sponsorship. To address this problem, BOC called on ODR to teach sponsorship to the nine sponsors in a two-day event.

The sponsors were reticent to go off-site for two days to talk about managing change. They believed employees did

(Case Continued)

what they were asked to do. The sponsors did not understand the full impact of the changes on employees nor how employees would be assimilating the changes. They also did not realize their sponsorship job included building sponsorship down through company levels.

During events, the ODR facilitator described the sponsorship job in basic here's-what-is-needed terms, and he challenged the nine sponsors to ask the important questions, such as: "What in our culture might make our project not work? What has failed in the past at BOC? Are we asking too much? Is this realistic?" The facilitator pressed the sponsors to question the company's capacity to assimilate change. He got them to be honest and identify obstacles. They were, indeed, challenged. Up to that point, they had not addressed these questions.

The workshop did the job. It opened their eyes to their sponsorship role, which turned out to be crucial to the success of all the projects. They had underestimated the involvement required from the total organization. They had been sitting back expecting their teams to make change happen. But the teams could only put the tools in place; the organization had to make change happen. The workshop taught the sponsors the difference. They left understanding how they needed to drive change through the organization. The facilitator led them into planning their own strategies and examining possible consequences.

One Change Project

One of the reengineering projects changed the way BOC processed the paperwork for delivering gas products and invoicing customers. Previously, drivers received a

batch of shipping tickets each morning from a clerk. These tickets described their route for the day. When they dropped off a cylinder of gas or picked up an empty one, they marked it on a full-size sheet of paper and handed it to the customer. They also returned hand-written notes to the clerk for entry into the system.

The solution was to replace the paper with a point-of-delivery handheld device (PODD). Schedules would be made at night and downloaded electronically to the PODDs. Loaders would use this information to load the trucks during the night. In the morning, the drivers would pick up their PODD, which contained their route for the day. When they delivered a cylinder, the PODD would accept the customer's signature and then print out a delivery document the size of a grocery store receipt. At the end of the day, the driver hung the PODD back on the rack and the billing data were automatically transmitted to headquarters.

To arrive at this solution, the team, as a whole, studied the process from order to delivery to billing. In working as a unified team, the IM folks began to act as business folks, and vice versa. At the end, the two were indistinguishable because they had absorbed each other's knowledge.

This interaction was a much-appreciated by-product of the process. Once the entire team devised the solution, the IM staff built the technical infrastructure.

Involving Middle Management. To engage middle managers in the nine reengineering projects, BOC established an advisory council for each one. Each advisory council's job was twofold, upward and downward. The upward job was to give feedback on recommended changes, pointing

(Case Continued)

out implementation issues. The downward job was to describe the recommendations to employees and get their buy-in.

The PODD advisory council had 11 members, which included drivers, logistics, IM, field people, and managers. They met several times, and they had more influence than they realized. Their upward feedback significantly affected the PODD team's decisions and their downward communication gave the field people a way to be heard. Through all the advisory councils, BOC created a cascade of influencers, which was a key contributor to their success.

Training the Drivers. The PODD team developed a handheld device that was so logical and intuitive that little training was needed. However, to make the drivers comfortable and ensure success of the project, the team created a six-hour training program.

The training theme was "A day in a driver's life," and the purpose was to show the truck drivers how to use the PODD to do their job. The lead trainer (a former truck driver) first led the drivers through "A perfect day" scenario where nothing went wrong. With PODD in hand, each driver followed the lead trainer in going through an entire day's use of the PODD, from loading cylinders into the truck to dropping off the PODD at night. This rapid scenario gave them the overall feel of its use. The drivers made mistakes, but as they corrected their own mistakes, they

became more and more comfortable with the PODD.

The drivers then worked at their own pace through three successively harder scenarios following a laminated sheet of instructions that included cylinder bar codes and other pertinent information. The drivers who got through all three had no problem with the PODD. Those who got through two might need a little support. Those who struggled would need a trainer to ride with them for a day or two.

To ensure that the drivers were fully comfortable with the PODD, the PODD team offered to ride with any driver for a day. Many accepted, not just to build their confidence, but because they enjoyed the company of another person. Whenever the driver raised a question during that day, the team member usually responded, "What do you think you should do?" Generally the driver's answer was right, which built self-confidence.

Due to all the training, the PODD team encountered little resistance from the drivers. In fact, the drivers were so pleased the company was investing in them that they proudly showed their PODD to their customers; they were the only drivers in the industry to have them.

The project was successful because the PODD team had assessed its people aspects at the outset and mitigated the identified risks by holding the sponsorship event, involving middle management via the advisory council, and thoroughly training the truck drivers. ■

Change Management Process for IT Systems

We discuss here the process that is required to change or modify an existing IS. Change management here refers to the use of methods and procedures, typically standardized, to handle change request in a responsive and least intrusive manner to the organization's

daily operations. Change management affects hardware, software, data, and procedures. Often, changes are initiated by incidents reported by users—use problems, needs for new system functionalities, etc. The IT staff is in charge of raise and document change requests, assessing the impacts, cost, benefits, and risks of proposed changes. In many IT departments, there is a responsible staff—the change manager—whose function is to coordinate change implementation. The change manager provides justification to get change approval from management, and monitors and reports the status of the change process. A task that requires close attention is to set up test environments to make sure that all is working as expected before the new version is released for production. In large organizations, a Change Advisory Board (CAB) is formed to oversee the change management process.

Risk Management

Not all IT-based projects succeed. In fact, many fail—especially the really large projects, such as those implementing ERP or CRM systems. Thirty to 70 percent of IT projects fail. Why do IT projects fail? Because they do not overcome their risks, either technical or business ones, notes Chuck Gibson.⁸

Technical risks might be a vendor package not scaling up as expected or the project's scope creeping so much that the project becomes too complex to implement. Although technical risks cannot always be anticipated, they can be contained with the right technical corrections. Business risk, on the other hand, is the risk that the business does not change properly to use the new system. Business change is necessary to achieve business results from IT. Lack of business change can come from the appropriate new work environment not being put in place or people's skills and attitudes not being updated to take advantage of the new environment.

Business risks are not as easily righted as technical risks, notes Gibson. Instilling the right business changes requires using the project management approach that reduces the main risks. When the risks change, the project management approach probably needs to change to keep the project on track. Gibson proposes eight project management approaches, from the Big Bang approach (which is appropriate when all the main business risks are low) to the Mitigate or Kill the Project approach (which is appropriate when all the main risks are high).

To ascertain which project management approach is most likely to yield the needed business changes, Gibson proposes using a three-step process whenever the main risks in a project change: assess the risks, mitigate the risks, and adjust the project management approach.

Step 1: Assess the Risks

The business case for an IT project should include the business risks. Based on his experience and research, Gibson believes the three predominant risk factors are leadership of the business change, employees' perspective on the change, and the scope and urgency of the change.

To visually see a project's overall risk from these three factors, a decision tree can be created. It shows the eight possible combinations of the three factors (Figure 1). A plus sign (+) on a factor means "positive support for the business change"; it increases the likelihood of success by reducing the risk. A minus sign (2) on a factor means "negative support for the business change"; it decreases the likelihood of success by increasing

Management Issues in System Development

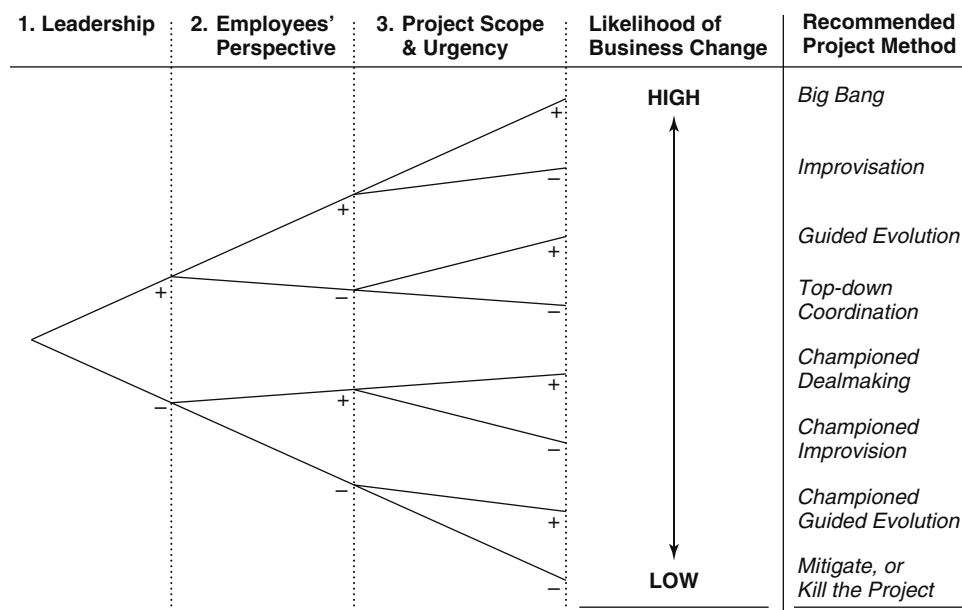


FIGURE 1 Risk Management Decision Tree

Source: C. Gibson, "IT-Enabled Business Change: An Approach to Understanding and Managing Risk," *MIS Quarterly Executive*, Vol. 2, No. 2, September 2003, pp. 104–115. Used with permission.

the risk. The factor that is the greatest contributor to project success or failure should be placed on the left. In this example, it is leadership, which is often, but not always, the case. On the far right are the eight project management approaches, one for each path through the decision tree.

A project leader is the executive (or executives) responsible for the change. The project leaders should be business executives, not IT executives, notes Gibson, because the business (not IS) is being required to change. To assess whether a project's leadership contributes to success or failure (whether it is a plus or a minus on the decision tree), Gibson recommends asking six questions:

1. Are they committed to the business case?
2. Do they understand the extent of change in work behavior required for the project to succeed?
3. Are they formally motivated to pull off the change, such as building it into their performance goals?
4. Are they at the appropriate organizational level and do they have the formal power to influence the needed changes in work behavior?
5. Do they have experience with a project of similar scope, urgency, and people impact?
6. Do they have informal power, such as respect and credibility?

The answers are likely to be mixed, notes Gibson, so give each a weight to ascertain whether the leadership factor should be a plus or minus on the decision tree.

To assess employees' perspectives, he recommends asking two questions. One, "How will the affected people react?" Will they embrace the change, follow orders, follow others, wait and see, resist, or sabotage the change? Two, "Why are they likely to react this way?" This assessment should also yield a single plus or minus on the decision tree.

To assess the project's scope and urgency, Gibson suggests asking three questions: "Is the scope wide?" (A wide scope is a minus.) "Is the change scope deep and severe?" (A major change in processes is a minus.) "Is there urgency?" (Urgency is a minus because it increases risk.) Overall, the scope and urgency factor on the decision tree gets a plus or a minus. The result of these three analyses yields a path through the decision tree that indicates both the project's level of risk and the appropriate project management approach.

Step 2: Mitigate the Risks

Mitigation involves identifying, evaluating, prioritizing, and implementing counter-measures to reduce risks. The decision-making process should reflect the attitude of the organization toward risks. Some organizations use the least-cost approach to identify the most cost effective and acceptable controls. Some others give more importance to minimizing adverse impact on the organization's resources and mission.

Risk mitigation includes the following options:

- Risk avoidance by eliminating the source of the risk (for example, sacrifice certain functions of the computer systems to avoid hacking)
- Risk limitation by implementing controls that keep the risk to an acceptable level (for example, implement some monitoring to prevent a major disaster)
- Risk transfer by letting others assume the risk (for example, outsource a vulnerable system), or by buying insurance to recover possible loss

Step 3: Adjust the Project Management Approach

Gibson divides project management styles into whether they are authoritative or participative and whether the project's budget and time frame are rigid or adjustable; see Figure 2. The resulting four project management approaches are appropriate for the least risky projects, he believes, which are the four top paths in the decision tree.

The Big Bang approach is authoritative and has a fixed budget and deadline. This approach is only appropriate when all three factors are positive. Improvisation is participative and has an adjustable budget and deadline. This is the approach to use when leadership and employee perceptions are positive, but scope or urgency place the project at risk, because the committed workforce can adapt to difficult tasks. The Guided

<i>Project Budget and Deadlines</i>	<i>Management Style</i>	
	Authoritative	Participative
Fixed	Big Bang	Guided Evolution
Adjustable	Top-down Coordination	Improvisation

FIGURE 2 Four Approaches to Project Management

Source: C. Gibson, "IT-Enabled Business Change: An Approach to Understanding and Managing Risk," *MIS Quarterly Executive*, Vol. 2, No. 2, September 2003, pp. 104–115. Used with permission.

Evolution approach is participative, but it has a fixed budget and deadline. This is the project management approach to use when only the employee-perception factor is negative, because that negativity can be overcome by involving the employees through strong leadership, motivating them to accept the change. Top-down Coordination is an authoritative approach with an adjustable budget and deadline. This method only works when the leadership factor supports the business change and when the leadership is respected, full-time, and highly experienced in leading business change.

The projects on the bottom half of the decision tree, where the leadership factor is negative, are the riskiest. The only project management approaches that will lead to the success of such projects are those that have a champion in the user organization. These champions generally have to be willing to bet their job on the project's success. In actuality, these four options "are not in the realm of responsible senior management," notes Gibson, but they do happen. And champions can pull them off, generally by gaining adherents through informal channels—except when all three factors are negative. That's when Mitigate, or Kill the Project is the only option.

To illustrate effective choices in project management, Gibson presents the successful implementation of ERP at Dow Corning from 1995 to 1999. Each project phase had different business risks. Realizing this, the project executive took a different project management approach in each phase. The project management terms used in the case are Gibson's.

CASE EXAMPLE

DOW CORNING

www.dowcorning.com

In 1995, Dow Corning gained a new CEO, Dick Hazelton, who led his operating committee through a strategic review to decide the company's strategy for the next 10 years.⁸ They decided to leave the business strategy intact, but use IT to foster business process change.

Phase 0: Get Ready

The operating committee viewed business process change as highly risky, for the following reasons (to use Gibson's framework):

- Leadership of business change: High risk, because the IT organization

had recently failed to implement a global order-entry system.

- Employee perception of business change: High risk, because the company had never experienced a major change and its culture was long employee tenure and adherence to existing practices.
- Scope and urgency of business change: High risk, because the scope was wide (company-wide); it was deep and severe (new processes, new jobs); and it was urgent (which actually was the only positive factor because it got people's attention).

(Case Continued)

According to Gibson's decision tree, this was the riskiest type of project: Mitigate, or Kill the Project.

To change the leadership from negative to positive, Hazelton appointed a 30-year Dow Corning veteran, Charlie Lacefield, to be in charge of both IT and the business change. Lacefield would report directly to Hazelton. To mitigate the other two risks, the operating committee followed Lacefield's recommendation of using a package, SAP's R3 ERP suite, and minimizing changes so that the company could focus on the business changes, not the technology changes.

Phase 1: Understand the New System

Use the Improvisation approach of participative management and flexible deadlines. In the first phase, Lacefield was most concerned about employee reticence in the later phases, so he focused this phase on building commitment to the SAP ERP system by getting 40 of the most respected managers in Dow Corning on his implementation team full-time and having them work closely with his IT staff. They used the traditional Dow Corning approach of consensus and flexible milestones to understand the SAP ERP system and to redesign work processes to match it.

Phase 2: Redesign the Work Processes

Use the Guided Evolution approach of participative management with fixed deadlines. Although the Improvisation approach worked in phase 1 to get the 40 managers deeply committed, it did little to get the work processes redesigned. As a result, Dow Corning employees were seeing little progress (but hearing that big changes were coming), so their

perception turned negative. In response, Lacefield changed his project management approach. He appointed a new project manager, a man who was comfortable with IT and had a highly respected track record in manufacturing at the company. Lacefield also set firm deadlines so that employees would see progress. This Guided Evolution approach continued through the pilot—a cutover to the SAP ERP at a newly acquired European business.

Phase 3: Implement the ERP Worldwide

Use Top-down Coordination with its authoritative management style and flexible timelines. The pilot's success demonstrated management's determination and shifted employee perception to positive. But the scope of the rollout in this third phase shifted to negative, because it was company-wide. Lacefield thus changed his project management approach in response, to authoritative, but permitted flexibility in deadlines because the three risk factors at Dow Corning sites varied widely. During this phase, Lacefield traveled extensively for a year, negotiating and cajoling executives at the company sites to stick to their commitment to change to the new ERP-based work processes. He even made project success one of his performance goals for the year.

Phase 4: Complete Implementation

Use the Big Bang approach of authoritative management and firm deadlines. By the end of 1998, most of the company sites had implemented the SAP ERP system, so all the risk factors had turned positive. So Lacefield opted to

(Case Continued)

implement the system in the few remaining pockets of resistance by setting firm deadlines. Initially, site conversion took 18 months. In these remaining sites, though, Lacefield required that it take only four months.

In 1999, Dow Corning became the largest successful single-database implementation of SAP's ERP. Gibson attributes the success, in part, to the adroit use of four project management approaches, each fitting the circumstances at hand. ■

Tips for Good IT Project Management

Most people would agree that a successful project has the following characteristics, notes Michael Matthew:²

- It is delivered on time.
- It comes in on or under budget.
- It meets the original objectives.

However, some people do not realize that success also means that the project meets users' and the organization's needs, which may have changed since the original objectives were stated. Projects that do not give users what they want cannot be deemed a success. Following are some tips from Matthew on how to better assure IT project success.

Establish the Ground Rules

Define the technical and architectural specifications for the systems following four guidelines:

- Adhere to industry standards.
- Use an open architecture.
- Web-enable the system.
- Power with subsystems.

These principles should help ensure no nasty surprises along the way, as well as provide the ready ability to update/switchover systems in the future. The basic tenet is that the systems should be as simple as possible while fulfilling all of the (reasonable) user requirements.

Foster Discipline, Planning, Documentation, and Management

In many respects, these elements are what project management is really all about. It does not matter how well the requirements have been specified or whether the "perfect" solution has been selected; if the process is not controlled properly, anything can happen or, more realistically, potentially nothing will happen.

A firm timeline for system rollout needs to be formally established and signed off. Once this task has been done, the project team needs to work backward from the critical dates and map out the timing for the intermediate steps and include any interdependencies. Teams should take the critical date and subtract some time to factor in

unforeseen contingencies. The project must progress with the target critical date in mind, which requires strong discipline.

The project also needs to follow a sound methodology and have key points planned and documented (and reported on) using a product such as Microsoft Project. All members of the team need to be aware of their responsibilities and timelines. Nothing should be left assumed. In addition, regular meetings and updates of the project plan are needed, along with proper documentation of the system development effort. Senior management needs to be able to see this documentation whenever they want. Management, key users, and even vendor personnel should be included on project steering groups, which should meet regularly to make sure the project continues on track. Such meetings also provide a venue for airing problems and raising issues that might affect others.

In addition, it is desirable to have an overall IT project steering committee. Regular project manager meetings from the various projects are key to keeping each other informed of their progress and for raising issues that might affect other projects.

Obtain and Document the “Final” User Requirements

Documenting user requirements is critical because it is the only way the team can evaluate the project outcome. Scope creep (users asking for more and more functions) causes many system failures. Documenting requirements helps lock in the scope of the work and reduce the possibility of costing problems and time overruns due to additional requests. Documenting user requirements can be done via a variety of methods, including facilitation sessions and one-on-one interviews.

A common mistake is writing user specs in technical jargon, notes Matthew.⁸ Some IT consultants make this mistake to “maintain the IT mystique.” However, this approach can do harm. Similarly, IT project teams should not accept overly technical sign-off requests from software houses. These developers need to prove they can fulfill the users’ requirements.

Obtain Tenders from All Appropriate Potential Vendors

Today, much software is bought rather than built in-house. This option needs to be considered when beginning a project, notes Matthew. In fact, companies that do not have expertise in the area under consideration might want to call in consultants to make a recommendation. Their extensive contacts in the IT community can significantly improve selection of the package or packages. Or consultants may simply help the IT project team create the selection criteria for evaluating bids and selecting a winner.

Include Suppliers in Decision Making

If development is to be handled by an outside firm, then create a joint project team. The supplier, or suppliers, will undoubtedly appoint their own project managers for their respective assignments. They need to be part of the governing team.

Convert Existing Data

Data conversion needs to be properly planned to make sure that the output data are complete and accurate. Although this task might appear quite simple, it is often the area that creates the biggest headaches. Here, perhaps, the oldest maxim in the IT industry applies: garbage in, garbage out.

Follow Through After Implementation

After successfully implementing the systems, project managers need to cross their t's and dot their i's in terms of documentation, future maintenance processes, and so on.

The bottom line is that IT project management is no different from any other form of project management. Success requires good planning, along with good communication, and ensuring active participation of all appropriate parties. These elements, along with some hard work, will better ensure a successful system.

Thus far, this chapter has dealt with managing system development projects. We now shift to an issue that repeatedly comes around: how to improve legacy systems.

MODERNIZING LEGACY SYSTEMS

Legacy systems are business applications that were developed in the past to help support the critical mission of the organization. For example, airline reservation programs represent the mission-critical legacy system of the airline industry. Most IS executives feel trapped by the past. They have thousands of legacy programs and data files they want to replace. CIOs may not have the resources to replace all the remaining legacy systems. Replacement is not the only option, though. In many cases, it may not even be the wisest option. Legacy systems embed significant business knowledge that the organization has accumulated throughout its development and maintenance. In the process of improving legacy systems, it is important not to lose this corporate asset. The challenge of modernizing legacy systems is to systematically migrate old systems to newer ones in the least disruptive way possible. Large organizations should have well-laid-out migration strategies.

To Replace or Not to Replace?

To replace or not to replace? That is the question studied by the Boston Consulting Group (BCG)⁹ in 18 manufacturing companies, service firms, and government organizations in North America, Europe, and Japan that had either just replaced or upgraded legacy systems or were in the process of replacing or upgrading. Of the 21 projects compared, 12 were successful in that they worked and had a bottom-line impact. However, the other nine were either unsuccessful or did not deliver the anticipated results.

From these findings, BCG concluded that upgrading (rather than replacing) made more sense in most cases, even if it was difficult and not seen as being as exciting as a totally new system. They noted that people get seduced by a new technology and want to rush out and replace old systems with it. However, most of the replacement projects that failed could have been upgrade projects. In fact, in some cases, the company reverted to upgrading the old system anyway.

When a system's technology is so obsolete that it does not exist in many places, then replacement is probably the only choice. Otherwise, BCG recommends that companies perform three analyses:

- Rigorously analyze the costs and benefits of the new system. Most companies underestimate the cost of replacing a system and overestimate the achievable business value, even on the successful projects. Furthermore, they do not factor in the risk of failure.

Management Issues in System Development

- Determine how specialized the new system really is. Sometimes companies think they need a made-to-order system when a purchased solution would do just fine. Their requirements are not as unique as they think.
- Assess the IS staff's capabilities honestly.

Several companies in the study failed to develop replacement systems because management had overrated the staff's skills. It is important to know that the IT staff is able to decipher the legacy system, and fully understand the desirable features of the target system. In conclusion, BCG recommends that the burden of proof lies with those who advocate replacement of a legacy system rather than with those who advocate an upgrade, especially for mission-critical systems.

Options for Improving a Legacy System

With this insightful study as a backdrop, here are seven choices for creatively dealing with legacy systems from least to most amounts of change (Figure 3).

Enterprises use a variety of approaches in these options. In moving to a totally new platform, such as ERP, for example, companies have taken one of two strategies in using outsourcing firms. The first has been to keep the legacy maintenance work in-house, hiring the third party to implement the new system and then phasing out the legacy maintenance work. Others have opted for the opposite. They have outsourced maintenance of the legacy systems so that the in-house staff could focus on developing the ERP system. As the new system has come online, the outsourcer has turned off the legacy systems. Companies take this transitional outsourcing approach when they feel they have (or can get) the in-house expertise required by the new platform. As BCG found in its survey, in-house skill levels can be the main determinant in deciding whether this second approach is even feasible.

Here, then, is the spectrum of options for improving legacy systems. As shown in the figure, it may be useful to compare these seven options to fixing up a house.

Restructure the System

In fixing up a house, restructuring is akin to updating the look of a room or the house, perhaps by repainting or getting rid of clutter so that it "feels" better to live in. In IT, if an application program is basically doing its job but it runs inefficiently or is "fragile" or unmaintainable, then it may simply need to be restructured.

Computer applications that were developed in the 1970s and 1980s are typically hardware dependent (for example, the software is built for a particular computer monitor or printer). Also, the data and the business algorithms are tied together in the same set of codes, making any modification difficult. For years, vendors have offered software products to help separate data from codes, and business algorithms from hardware.

A noted area of improvement is the improvement of the code itself. Old programs were written in second-generation programming language (such as COBOL) that had little structure with thousands of illegible lines of nested code. The most popular ones use automated restructuring engines to turn this "spaghetti code" into more structured code. The process involves the following seven steps.

1. Evaluate the amount of structure in the current system, including the number of layers of nesting, degree of complexity, and so forth. Use the tools to present a trace of the program's control logic. Subjectively evaluate the code to determine

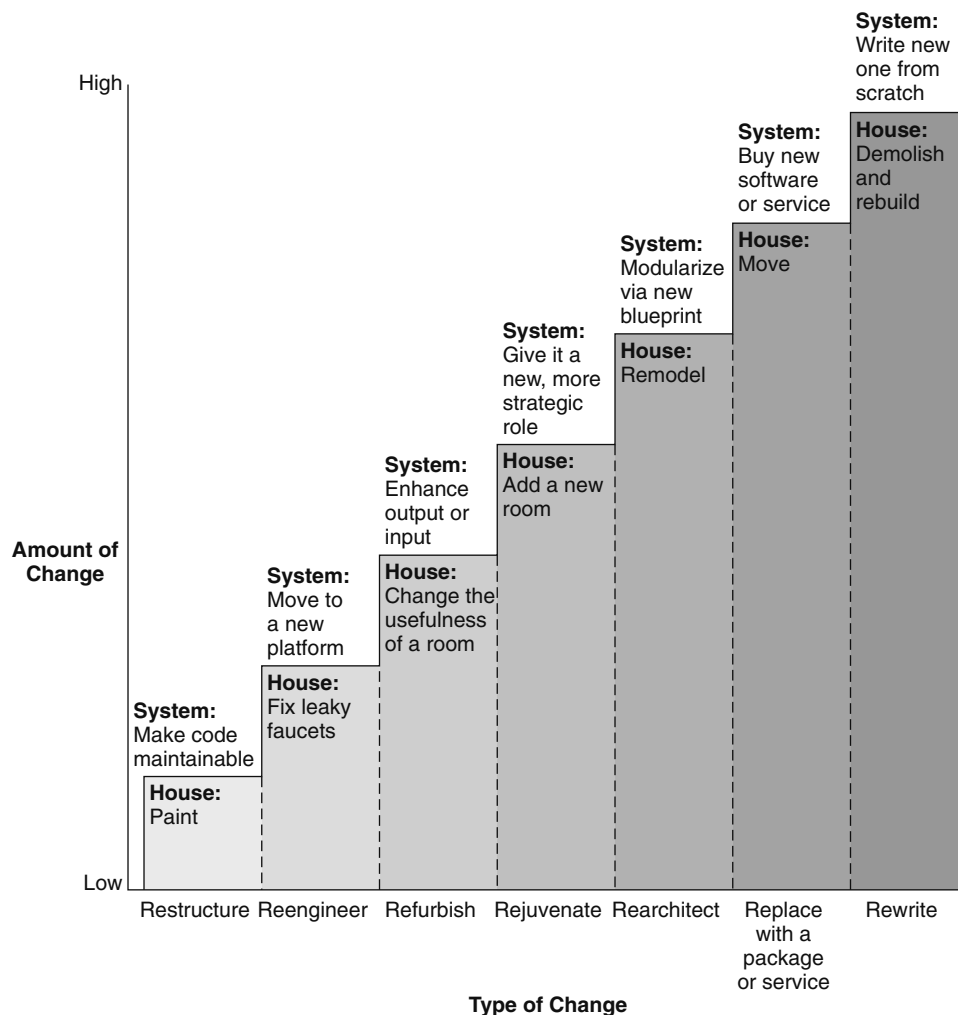


FIGURE 3 Options for Improving a Legacy System with Home-Improvement Analogy

- whether restructuring is warranted at all or if more extensive change is required; this task can only be performed by people.
2. Compile the program to be sure it is in working order. A code restructuring tool will not make a nonoperative program run.
 3. Clean up and restructure the code by running the program through a structuring engine. This automated process does not change the logic of the program; it simply replaces poor coding conventions with structured coding conventions, such as reducing the number of GOTOs, removing dead code and altering statements, highlighting looping conditions, and grouping and standardizing input-output statements. It uncovers the structure hidden inside the convoluted code.
 4. Reformat the listing, making it easier to understand, by using a formatting package.

5. Ensure that the old and new versions produce the same output by using a file-to-file comparator.
6. Minimize overhead introduced by restructuring by using an optimizer package. After optimization, restructured programs generally require between 5 percent less and 10 percent more run time than the unstructured versions.
7. “Rationalize” the data by giving all uses of the same data one data name. This step is optional.

These seven steps can be used to restructure a functional system or to get it in shape to be reengineered.

Another quick fix is to add a new, more user-friendly interface to the legacy system. One popular technique is called black-box optimization. The old computer program is seen as a black box with undecipherable source code and is “wrapped” by a layer of new code to allow it to interface with other applications, such as new report generators, or new screen generators.

Reengineer the System

In fixing up a house, reengineering is akin to fixing what isn’t working, such as replacing broken door handles, repairing leaky bathroom fixtures, adding more insulation in the attic, and even feng-shui-ing the house to put furniture in more harmonious locations. In IT, a step beyond restructuring is reengineering, which means extracting the data elements from an existing file and the business logic from an existing program and moving them to new hardware platforms. This use of the term “reengineering” should not be confused with the term “business process reengineering.” The term “system” or “application” reengineering is much narrower and refers only to software. The other term refers to redesigning business processes. Like code restructuring, reengineering requires automated tools because the process is too complex to be cost-justifiably done manually. Database reengineering tools began appearing on the market in the late 1980s.

According to Charles Bachman, a pioneer in the database field, the major problem in the computer field is that people consider existing systems as liabilities that must be maintained, taking resources away from developing new and exciting applications. Instead, management needs to see existing systems as assets from which to move forward.

If developers can reverse engineer a system, that is, extract the underlying business logic, they can forward engineer that business logic to a new system platform. With this approach, existing systems become assets. Developers can extract the intelligence in them rather than start over from scratch.

Bachman believes a new system development life cycle can use automated products to help perform the reverse engineering. It encompasses all four basic development activities: maintenance, enhancement, new development, and migration. This life cycle is circular rather than linear, as shown in Figure 4.

- Reverse engineering—where existing programs, along with their file and database descriptions, are converted from their implementation level descriptions that include records, databases, code, and so on, into their equivalent design-level components of entities, attributes, processes, messages, and so on.
- Forward engineering—which goes the opposite direction, moves from requirements-level components to operational systems. Design items created by reverse engineering are used to create new applications via forward engineering.

Management Issues in System Development

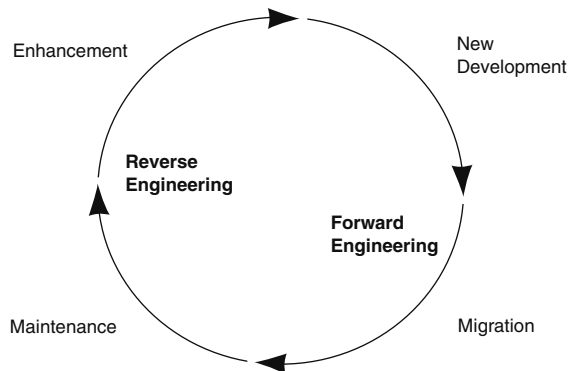


FIGURE 4 The Reengineering System Development Life Cycle

Source: Courtesy of Charles Bachman, founder of Bachman Information Systems, Cambridge, MA.

The cycle continues because as new applications go into operation; they become candidates for reverse engineering whenever they need to be changed. Neither people nor automated tools can use this new life cycle by themselves, notes Bachman, but together, it becomes feasible. Verizon Directories is an example of a company that used such reengineering tools.

CASE EXAMPLE

VERIZON DIRECTORIES

www.verizon.com

Verizon Directories produced, marketed, and distributed more than 1,500 different telephone directories in some 14 countries. To accelerate their response to changing markets, Verizon Directories began automating its telephone directory publishing business.

The directory publishing system had four main databases. The largest supported all of the administrative functions for creating and selling Yellow Pages advertising, from sales to photo composition. The second was used by representatives to sell Yellow Pages advertising for non-Verizon Directories. The third database handled billing. The fourth database

provided order entry for independent telephone companies for whom Verizon produced telephone books.

The databases were originally designed application-by-application. The result was records that contained data elements with no business relationship to each other, making them difficult to reuse, enhance, and change. The data administration group acquired reverse engineering tools to help them improve these databases.

To reverse engineer the database, a designer used a design administrator to display the existing database definitions graphically. The designer made changes by manipulating the graphical icons. The

(Case Continued)

tool helped draw complete and consistent relationship diagrams because it had the intelligence to identify inconsistencies and incomplete structures.

Once the new database design had been created, the designer forward engineered the database design and ran the physical implementation design rules. When the design was satisfactory, the new database statements were automatically generated.

Such database reengineering was used on two projects.

The Blueprint Project

The largest database had not been properly designed, so the data administration group used the toolset to create a blueprint of what the database should look like. They reverse engineered the existing database from its physical to its data model from which they created a new, properly designed data model using entity-relationship modeling techniques. By experimenting with this model, they created a design that was more adaptable to change. It became their blueprint for the future and was used to guide maintenance work. As the database administrators maintained the database, they made changes to align it more closely with this blueprint. Without the reengineering tools, they would not have even attempted this project because they could

not have done the “what if” modeling necessary to create the blueprint.

A Reuse Project

The database administrators reused some of the data elements in the largest database for a new production scheduling system. The company had scheduled production of their 1,500 directories among their three printing plants using a 15-year-old system. Some scheduling data were in the system; some were in the new administrative system.

The company created a new scheduling system, drawing some scheduling-related data from the administrative database. Again, they used reengineering tools to create the design models for the new scheduling databases. From these models, they used a tool to generate the necessary database statements. With the new system, salespeople no longer had to interrogate both the 15-year-old publishing system and the administrative system—which had different sets of data—to see directory publishing schedules.

Because maintenance was the bulk of the work of the database administration group, the tools became invaluable in helping them redesign old databases, design new databases using portions of existing ones, and create their blueprint for the future. ■

Refurbish the System

In fixing up a house, refurbishing is akin to enhancing the usefulness of the house, perhaps by replacing old furniture in a room, relandscaping the yard to improve its curb appeal, or turning a college graduate’s bedroom into an office. In IT, if an old system is maintainable and is causing no major problems, it may be worthwhile to add some extensions. Potential extensions would supply input in a new manner, make new uses of the output, or allow the programs to deal more comprehensively with data.

Refurbishment is actually occurring quite a bit these days because of the Web. Companies are leaving existing systems in place but adding a Web front end, along with accompanying query translation software, so that the system can be accessed directly by employees, suppliers, or even customers. Witness FedEx's Web site, which allows customers to directly access the company's tracking database. In such cases, companies generally follow a "surround" strategy, where they treat the old system as an untouchable black box and surround it with new facilities. This approach has been a popular way to upgrade legacy systems, even before the Web's appearance.

Rejuvenate the System

In fixing up a house, rejuvenating means adding new functions, such as adding a room, a porch, or a swimming pool. In IT, rejuvenating an old system is a step beyond refurbishing the system because it adds enough new functions to a system to make it more valuable to the firm. The first step is to recognize a system's potential. The second is to clean up the system, perhaps using restructuring tools. The third step is to make the system more efficient, perhaps using the reengineering approach mentioned earlier, then port the system to a new operating environment and database structure. The fourth step is to give the system a more strategic role, such as allowing it to feed a data warehouse so that people in field offices can access data far more quickly. Another possibility is to give it a role in a company's e-commerce strategy by using it as a back-end system accessible via the Web.

As an example, consider Amazon.com, the online retailer, which is using Web Services technology to give third-party developers access to its data and content to use in their software, hardware, or services. Amazon's goal is to use its information to increase the company's market share.

CASE EXAMPLE

AMAZON.COM

www.amazon.com

In 2002, Amazon.com initiated its Web Services program where anyone can receive a license to access Amazon's data and content via XML feeds—for free. The licensees must agree, though, to not use any of the logos on Amazon.com's site or use any of the restricted or copyrighted material on the site (such as copyrighted reviews).¹⁰

Over 27,000 people have obtained licenses, some for their personal use, some to offer free software to Amazon.com users, others to build hardware for use

with Amazon.com's site, and still others to sell software or services related to the site. Examples of these third-party offerings include:

- Software for people to download their Amazon.com wish list onto their cell phone to use when shopping in stores
- Software to help merchants offer their products on Amazon.com, with the merchant paying a

(Case Continued)

percentage of each sale to the software developer

- A small bar code reader for scanning UPC codes of inventory to be sold via Amazon.com
- Software to add a “real-time scrolling ticker tape” of Amazon.com-based data to a Web site
- Software that links Amazon.com’s music offerings to radio play lists so that listeners can buy a song when they hear it

Amazon.com takes the risk of not controlling how others use its information, but in return, others are creating gadgets, links,

services, and software that Amazon.com could not build itself, increasing the value of its site to consumers. Amazon.com is using its data to create an online ecosystem of businesses and services that rely on its marketplace and the vast amount of data it collects. In so doing, Amazon.com seeks to transform itself from a retailer into an e-commerce platform where “buy” buttons on many, many Web sites take buyers to Amazon.com. Furthermore, Amazon.com now handles content hosting and order fulfillment for many retailers, large and small. In short, it is using Web services to rejuvenate its data, giving it a strategic role via XML. ■

Rearchitect the System

In fixing up a house, rearchitecting is akin to rethinking the use of its space by perhaps gutting a major portion of a house and remodeling it by combining the kitchen, dining room, and family room into a great room. In IT, the step beyond rejuvenating a system is the newest option—rearchitecting it. This option involves having a to-be architecture for new systems, and then using that architecture to upgrade legacy systems. Due to the increasing complexity of enterprise systems, the advent of inter-enterprise systems, and the dependence of interlinked systems in supply chains, CTOs are devising enterprise IT architectures. In the past, IT architectures were not seen as necessary. They now are seen as mandatory because they show how systems are interconnected. Where possible, CTOs work hard to migrate their enterprise to that desired- to-be architecture, generally one system at a time. Following is the example of Toyota Motor Sales. As Roger Woolfe and Marcus Blosch^{11a} of Gartner EXP point out, a main use of Toyota’s IT architecture is to remediate legacy systems.

CASE EXAMPLE

TOYOTA MOTOR SALES

www.toyota.com

Toyota Motor Sales, headquartered in Torrance, California, handles U.S. sales of

Toyota and Lexus vehicles for its parent, Toyota, in Japan. In 1998, Barbra Cooper

(Case Continued)

became CIO and found no IT architecture, no development methodology, no application integration, and no standards. Each part of the business had its own applications, information, and technical architectures. Cooper thus formed an architecture group, drawing from her applications group, headed by her most senior technology manager and reporting directly to her.

The Business Environment

One of the dilemmas Karen Nocket, chief architect, faced as head of the new group was the shrinking business cycle. In the 1970s and 1980s, Toyota's business cycle was five to seven years, thus its IT cycle time could be three years. In the 1990s, though, Toyota's business cycle time plummeted to 9 to 12 months, so IT's had to shrink likewise, to 6 to 9 months. For 2002 to 2010, Nocket sees the business cycle time shrinking to three to six months, so IT's plans must be one to three months. "How do you optimize 3-month plans into an IT plan?" she asks.

Nocket notes that competitors are addressing the shortened business cycle and other changes in the business environment by emphasizing online sales, moving to shorter delivery times, letting customers configure their own vehicles, and moving toward a "no hassle" sales experience.

Another issue facing the architecture group was IT's approach to building systems the old-fashioned way: supporting silos (sales and marketing, parts, accessories, warranty, HR, finance, and so on). Costs were higher because functions were duplicated in numerous systems rather than drawing from common systems.

Creating an Architecture

Nocket's group chose six initial projects: create a first iteration of an enterprise IT architecture, review it, then review development tools, look for infrastructure patterns, create an e-commerce architecture, and work on security.

In creating the first iteration, the architecture team quickly discovered that Toyota's most immediate need was a standard, integrated application development environment so that all systems would be developed using the same methodology. Nocket's team chose a methodology that includes tools as well as a development process. The process gives Toyota a way to move from business requirements to IT standards and strategies. This link is important because it helps business folks understand how IT supports them and why an enterprise architecture is important to them.

The architecture group then developed a global reference architecture. This architecture defines the current goal: Toyota's to-be IT architecture. It consists of enterprise services and products that support five tiers of services:

1. Presentation services: user interface, Web servers
2. Application services: logic specific to a business unit
3. Business services: reusable enterprise components
4. Integration services: access to legacy data sources; mapping to a common XML structure
5. Resource services: data resource managers, relational DBMS?

To develop this to-be architecture, Nocket used her budget to have her group

(Case Continued)

describe the as-is architecture of Toyota's six largest systems. From these six, the group defined Toyota's as-is enterprise architecture. From it, they defined the global to-be architecture.

Nocket and her group have also carefully defined their focus (they do not build systems), understood the true business benefits of having an architecture (discussed later), and promulgated an architecture-first approach to developing systems.

Nocket has learned that a key to success in IT architecture is having a domain architect for each domain to create the plans to migrate their domain to the to-be architecture and then see that everyone follows the plans. "Having domain architects assigns accountability to a single leader," says Nocket. However, having only technical people on the architecture staff has not fully gotten the message out, so she recently hired a project manager whose job is to foster communication among the numerous parties in a project. "He's our communication link to the world. He brings people together," she says.

Benefits of the Architecture

Through the development and use of the architecture, Nocket and her group have come to understand that the architecture can bring the following kinds of value to Toyota.

Rearchitect Legacy Systems. Both the as-is and to-be architectures have proven valuable in remediating legacy systems. Using a system's as-is architecture, Nocket's group can give business units alternatives to totally replacing a system. Her architects can show, for instance, how the user interface tier is separate from the data

and application tiers. Pieces of code can be remediated, for example, by being rewritten in Java, to migrate the legacy system toward the new architecture, leaving the rest of the system as is. One business unit recently accepted this approach to upgrading a major legacy system. The architects are now detailing the as-is architecture to determine which code needs to be replaced. They will then write it to fit the new architecture.

Keep System Designs Robust. Using the new architecture-first approach to building systems, integration between the new system and other systems must be demonstrated in the design stage (rather than uncovered in the final system-integration stage). The new approach forces design breaks in the design phase, where errors can be fixed by redesign. When such errors are not caught until system integration testing, after the system has been built, the only solution is patching, which often destroys the system's original design. The architecture-first approach thus results in a much more coherent and maintainable design, and the architecture risk areas are addressed first, which is the only way to keep an architecture relevant.

Deliver Applications Faster. In understanding the patterns of applications to create the architecture, Nocket and her group are using the patterns to develop new applications much faster because they have turned silo infrastructure elements into services that can be reused. The global reference architecture thus addresses a major business pain point—applications not being delivered fast enough—thereby demonstrating the architecture group's value to both business folks and to IT project teams. To shift to a new

(Case Continued)

development approach, the architecture-first approach, both groups must see the value of an architecture. That value has been devilishly difficult to demonstrate in most companies.

Permit Future Flexibility. Nocket's group has successfully architected Toyota's three e-commerce Web sites—Toyota.com, Lexus.com, and Financial.com—using the “UNIX pattern” in its new architecture. Because the three sites share the same infrastructure, Toyota can easily bring the one hosted outside back in-house, if desired. Furthermore, the company will

be able to more easily integrate other systems in the future; for instance, allowing vehicle owners to manage their own vehicle warranty from the Web site.

More recently, IT architects from the three Toyota regions (Europe, North America, and Asia) have worked together to develop a second iteration of the architecture as well as review, as a group, the architecture of two Japanese applications. Nocket believes that the move to standardization and architecture on a global basis, which these two recent efforts demonstrate, will give Toyota a real competitive advantage. ■

Replace with a Package or Service

In fixing up a house, replacement with a package or a service is akin to realizing that the house no longer works for you, so you move to another house. In IT, many old systems built in-house have been replaced by a package developed by a third party. In fact, this alternative has become the norm. One widely chosen use has been to replace many old and disjointed applications with one corporatewide system, such as SAP or a smaller commercial off-the-shelf (COTS) product. The other popular option is to distribute an application's workload among a host computer, some servers, and many PCs and laptops. An increasing number of commercial packages permit such three-tiered processing. These packages not only support communication among the three types of machines, but they also split the processing job and facilitate downloading and uploading of files.

Another reason to consider replacing an old system with a commercial package is that packages are becoming more versatile. Many offer selectable features that allow purchasers to tailor the package to their work style. The options can be turned on or off using control files, so no programming is necessary. Even end users can specify some of the operating instructions. Even so, replacing one or more applications with a package is not a trivial task, especially for large systems. Just ask people who have installed an ERP system.

Another option, one being touted as “the future,” is to replace a system with a service delivered over the Internet. Now that software vendors have a ubiquitous delivery mechanism—the Internet—they can sell a per-seat, per-month service in place of leasing a package. Companies may reap several benefits from choosing this option. One, the software will be available quickly. Two, the cost can be expensed rather than be a capital expenditure. Three, the software is run and maintained by the vendor.

Four, it is centralized in that it is handled by the vendor, but it is distributed in that it can be accessed from anywhere. Companies are even considering creating corporate portals where commonly used software is accessed via the Web rather than housed on PCs. That software can be located anywhere. The promise of Web services fits in to this replacement option. As an example of replacing a system with a service, consider what Wachovia did.

CASE EXAMPLE

WACHOVIA

www.wachovia.com

Wachovia is a large U.S. bank with headquarters in Charlotte, North Carolina.¹² Its capital management group was growing so fast a few years ago that it outgrew Wachovia's contact management system, which had been written in-house when the sales team was one-third the size.

The system was used by the sales reps to support existing clients and identify and pursue new prospects. But the original programmers had left the bank, so the system was being maintained by consultants. The system did not work with newer bank systems, and it was so inflexible that it did not support the bank's newer sales processes. Furthermore, no one could ensure that remote entries actually updated the database, so the data were not seen as reliable. As a result, the sales force only used the system to record basic customer information once they closed a sale. They used their PDAs and other means—not the system—to keep track of prospects. Hence, the system did not give management the data needed to forecast sales or spot trends that could be useful in setting bank strategy.

Management decided to replace the contact management system with a full CRM system with a central repository of

real-time data so that the sales reps could manage all their customer dealings online. Management looked at various CRM packages, but found them to be very expensive and time-consuming to implement. At the time, the national sales director happened to see an article in a business magazine about Salesforce.com, which offers a Web-based, pay-by-use CRM system. The director realized that the money he was spending on consultants to keep the old system barely alive would almost cover his use of Salesforce.com. So he opted for it. The system was installed in six weeks, which included customizing the service to Wachovia's processes and training all the employees who would use it.

Using the system, the sales reps have at least 30 more hours a month to spend on selling—time they used to spend on administrative work. The system also gives management the data it needs to identify the most valuable clients and its own highest yielding work.

The sales director uses Salesforce.com to coach his salespeople. He reviews their notes about their sales calls to see whether they are using the right approach and following up using the correct strategy. He coaches them on how to improve their

(Case Continued)

approach. And when potential clients have a wide geographic spread, the sales reps can now collaborate on their sales calls. Formerly, they were not able to see who

was selling what to whom. Now, they can collaborate and present more valuable combined offerings to their potential clients. ■

Rewrite the System

In fixing up a house, rewriting is akin to realizing the house no longer is appropriate for the family but the location is perfect, so the house is demolished and rebuilt with a new one. In IT, in some cases, a legacy system is too far gone to rescue. If the code is convoluted and patched, if the technology is antiquated, and if the design is poor, it may be necessary to start from scratch. Today, few companies write new applications from scratch. It is just too time consuming and too expensive. Rewriting a system now means system integration; that is, finding packages that do pieces of the work and then using middleware tools to link them together.

Whether a system is new or a replacement, or anything in between, the question that is always asked is, "What is this system worth to us?" It is a question all executives need to be able to answer because investment in IT has become such a large part of corporate expenditures.

MEASURING SYSTEMS BENEFITS

Measuring the value of information systems is a continuing request. Never mind that the Internet has changed the world or that e-commerce and e-business are impossible without computers. Executives want specific links between new systems and corporate financial measures, such as increases in revenue, stockholder value, or earnings. Achieving this link is devilishly difficult because IT is only one of the factors contributing to successful use of systems.

The value of decision support systems and data warehouses, for example, is difficult to measure because they are intended to change such unmeasurable actions as improved decisions, better identification of opportunities, more thorough analysis, and enhanced communication among people. E-commerce systems, which aim to improve a firm's competitive edge or protect its market share, also elude measurement. It makes no sense to determine their return on investment (ROI) in terms of hours saved when their intent is to increase revenue or help the firm enter a new market. Finally, infrastructure investments upon which future applications will be built cannot be justified on ROI because they have none. Only the subsequent applications will show a ROI, which has caused the measurement conundrum.

In *Uncovering the Information Technology Payoffs*,¹³ Walter Carlson offers the following three suggestions, as well as numerous others, on how to deal with these measurement dilemmas.

Management Issues in System Development

1. Distinguish between the different roles of systems.
2. Measure what is important to management.
3. Assess investments across organizational levels.

Distinguish Between the Different Roles of Systems

Paul Berger,¹⁴ a management consultant, believes that companies can measure the value of IT investments by using many of the management measures now in place. Information systems can play three roles in a company, Berger told Carlson.

1. They can help other departments do their job better. Berger calls these “support systems.” Their goal is to increase organizational efficiency.
2. IS can carry out a business strategy. Examples are CAD systems that customers and suppliers can use together to design custom products. Web-based systems and other such strategic systems need to be measured differently from support systems because they are used directly by customers, suppliers, and clients; support systems are not.
3. Systems can be sold as a product or service or as the basis for a product or service. Many Web-based information services fall into this category.

The benefits of these three kinds of systems are measured in different ways.

Measuring Organizational Performance

Organizational performance has to do with meeting deadlines and milestones, operating within budget, and doing quality work. Performance measures the efficiency of operations.

A number of years ago, Berger worked on developing a large HR system with decision support capabilities and then tracking its benefits. To measure the value of the system, the development team compared the productivity of people who used it to the productivity of people who did not. Data were collected on the cost of operating the system and the total costs of running the HR departments.

Operating costs did not rise as fast in the HR department where the system was used, the team found. By the fifth year, the using department had a cost of \$103 per work unit (up from \$82), whereas the nonusing department’s cost was \$128 per work unit (also up from \$82). During those five years, the unit costs in the department using the system rose about 25 percent; the nonusing department’s costs rose more than 56 percent.

Measuring Business Value

Measuring business unit performance deals with internal operational goals, whereas measuring business value deals with marketplace goals. Systems that are part of a business plan can be measured by their contribution to the success or failure of that plan. However, for systems to be measured on their business value, they must have a direct impact on the company’s relationships with its customers, clients, or suppliers, says Berger.

Berger’s HR system was measured on departmental performance. It could not be measured on business value because its effect on the corporate bottom line was indirect. No direct link to increased revenue could be identified. This distinction is important in measuring the value of IT investments.

In another firm, several information systems were developed to help marketing people analyze their customer base, both current and potential customers. The goal was

to improve the quality of their customer base so that sales per customer would increase, while, at the same time, decreasing sales and promotion costs.

After implementing the systems, advertising and customer service costs did decrease. The company also experienced higher customer retention and lower direct sales costs compared to industry standards. By being able to equate the particular information system expenditures to marketing, they could identify a direct correlation between system costs and sales revenue. They could measure business value. The information systems affected their sales directly through the marketing decisions the system supported, thus the value of the investment could be stated in business terms.

Measuring a Product or Service

An information system can be offered as a product or service or it can contribute to a product or service intended to produce revenue. In these cases, its value is measured as is any other business venture, by its performance in the market. The measures are typical business profitability measures, such as ROI, return on assets, and return on equity.

Measure What Is Important to Management

Charles Gold,¹⁵ an IT consultant, recommends measuring what management thinks is important. Information systems support can only be linked to corporate effectiveness by finding all the indicators management uses, besides the traditional financial ones. Relating proposed benefits to these indicators can make it easier to sell a system at both the individual and aggregate levels.

Gold suggests trying to assess benefits in terms of customer relations, employee morale, and cycle time or how long it takes to accomplish a complete assignment. Each measure goes beyond monetary terms, which few executives deny are vital to a company's success. He gave Carlson two examples.

As a measure of customer satisfaction, one power company kept a log of how many complaint letters customers sent to the Public Utilities Commission each month; this commission regulates the utility companies within its state. The power company installed a computer system for its customer service representatives, giving them online access to the information they needed to answer customers' questions. When the system was in operation, the number of complaint letters decreased; when the system was down, the number of letters increased. Thus, one aspect of the effectiveness of this system was measurable in terms of public opinion.

A second possible measure is cycle time. Faster cycle times can mean much more than saving hours. It can mean higher-quality products, beating competitors to market, winning a bid, and so on. The benefit may have nothing to do with saving money. Rather, it may focus on making money.

So, concentrating only on cost and monetary measures may be shortsighted. Other measures can be even more important to management.

Shenhart and Dvir¹⁶ emphasize the necessity of balancing risks and benefits. They suggest that any organization should consider at least the five following metrics:

- Project efficiency: meeting time and budget targets
- Impact on the customers: meeting requirements and providing customers satisfaction, benefits, and loyalty

- Impact on the development team: job satisfaction, retention, and personal growth
- Business results: return on investment, market share, and growth
- Preparation for the future: new technologies, new markets, and new capabilities

Assess Investments Across Organizational Levels

Kathleen Curley, at Lotus Development Corporation and John Henderson, at Boston University,¹⁷ recommend measuring IT benefits at several organizational levels. They developed the Value Assessment Framework to do just that.

The Value Assessment Framework

Potential benefits of IT investments differ at various organizational levels. Curley and Henderson believe that companies need a systematic way to separate these benefits by organizational level. They see three organizational levels, or sources of value, as benefiting from IT investments: the individual, the division, and the corporation. Furthermore, the impact focus of an IT investment extends beyond business performance measures to encompass three dimensions:

1. Economic performance payoffs (market measures of performance)
2. Organizational processes impacts (measures of process change)
3. Technology impacts (impacts on key functionality)

Combining the two views creates a 3×3 matrix that can be used to systematically assess the impact of a potential IT investment in nine areas. This framework was used by a trucking company, and its use uncovered benefits that otherwise would have gone unrealized.

CASE EXAMPLE

A TRUCKING COMPANY

A medium-size company in the refrigerated carrier business has been around since the 1920s. When the Motor Carrier Act deregulated trucking companies, competition increased. Midsize truckers like this one were hit the hardest. Even though it had been one of the top five refrigeration trucking firms, its share of shipped tons fell to less than one-half the former level because national and regional carriers took away its business. In response to the crisis, management made two decisions: First, they would

manage the company by information, transforming company procedures and tracking success via a large suite of measures. Second, management would use IT to differentiate the firm from other refrigeration trucking firms, initially with a \$10-million investment in a state-of-the-art satellite system and a computer in every truck cab so that drivers could be in constant voice and data communication with the company and customers.

The results were remarkable. Tons shipped increased from 300,000 tons to

(Case Continued)

1,100,000 tons, and the trucker became an industry leader in the innovative manipulation of information. It introduced groundbreaking information services that provided superior levels of customer service.

Their Measurement Program

On the measurement front, the company developed world-class goals for each of its three mission statement objectives:

Our mission is to exceed the expectations of our customers, earn a return on investment that is the best in the industry, and provide our employees an opportunity to attain fulfillment through participation.

Overall performance was measured in three ways:

1. Customer satisfaction—determined by “moment of truth” questionnaires filled out by customers to rate the company’s service performance
2. Return on investment—measured by an operating ratio
3. Employee satisfaction—from questionnaires that captured employee sentiments and charted them on an index

The company established interim performance improvement goals for the company as a whole and for each department to be achieved by specific dates. These interim measures were to see how fast and how well it was progressing toward its world-class goals. As performance improved, the goals were raised so that performance improvement was built into its measurement system.

After studying its measurement and tracking processes, Curley said, “They have one of the most detailed sets of measures I have ever seen.”

Measuring the Value of the Satellite System

Following IBM Consulting’s recommendation, the trucker used the Curley and Henderson Value Management Framework to evaluate the satellite investment after-the-fact, with eye-opening results. The trucker began by identifying the specific process improvements made possible by the system, entering them into the framework along with an outcome and outcome measure for each one.

- At the individual level, the company estimated that improved communications from the truck cab would increase driver production time by one-half hour a day. The result: a savings of \$59.60 a month per driver.
- At the work group level, it estimated that improved truck-to-load or vice versa matching would save 1 percent deadhead time: a \$49.68 savings per month per truck.
- At the business unit level, it estimated that improved customer service would increase market share, but it could not pin down a dollar amount for this increase.

Once these figures were calculated, a manager was assigned to assess the savings targets, allowing the company to evaluate whether it was realistically estimating the investment. It intended to manage the value it was receiving from its investment, not just make the investment and hope it paid off.

The most interesting piece of the Value Management Framework analysis, Curley said, was not the identifiable cost savings, but the large, unexpected revenue benefits. Due to the analysis, management discovered that customers were willing to

(Case Continued)

pay a premium price for the ability to call a truck driver directly from their warehouse. Constant communication with drivers was worth a lot—much more than management thought. This discovery gave management even more confidence in

their decision to bet on technology and in their ability to sell information-based services. Due to the sophisticated and ingrained measurement system, management was even able to see the effect of pricing on market share. ■

Do Investors Value IT Investments?

An even more intriguing question than how business executives value IT investments is how investors value IT investments. As reported in the recent Gartner EXP report *Getting Shareholder Credit for IT*, by Andrew Rowsell-Jones and Marcus Bloesch,^{11b} three researchers recently performed a study to see whether or not a company's stock market valuation correlated with the size of its computer investments and with its organizational practices. Their results show that investors do indeed value IT investments.

Erik Brynjolfsson of MIT's Sloan School of Management, Lorin Hitt of University of Pennsylvania's Wharton School, and Shinkyu Yang of New York University's Stern School¹⁸ found that every \$1 of "installed computer capital" yielded up to \$17 in stock market value, and no less than \$5. Whereas, \$1 in property, plant, and equipment (book value) only yielded \$1 in stock market value; and \$1 in other assets (inventory, liquid assets, and accounts receivables) yielded only 70 cents.

The researchers reason that investors value \$1 spent on "installed computer capital" more than the other investments because it leads to organizational changes that create \$16 worth of "intangible assets"—know-how, skills, organizational structures, and such.

To reach these conclusions, the three researchers compared eight years' worth of stock market data for Fortune 1000 companies between 1987 and 1994 (importantly, before the dot-com bubble) with these firms' IT investments and organizational practices (from studies in 1995 and 1996). They were able to correlate all three kinds of data for 250 companies, with a total of 1,707 observations.

They found that variations between companies were more important than variations over time in the same company. Firm-specific factors accounted for most of the firms' higher market values.

Past IT investments correlated with higher current market value, but not vice versa. The reasoning is that firms continue to build up complementary intangible assets from these IT investments, say Brynjolfsson, Hitt, and Shinkyu; investors value these additional assets.

Earlier research by Brynjolfsson and Hitt showed that four organizational factors correlate to and complement IT investments: (1) use of teams and related incentives, (2) individual decision-making authority, (3) investments in skills and education, and (4) team-based initiatives. They found that firms making the highest IT investments not only invest in the information systems but also invest in making organizational changes to complement the new systems.

These investments in “organizational capital” generally lead to the adoption of decentralized work practices. The firms (1) use teams more often, (2) give employees broader decision-making authority, and (3) offer more employee training, no matter the size or industry of the firm.

In the latest study, the three researchers found that firms with these three decentralized work practices had a market value 8 percent higher than the mean. They state, “Investors appear to treat organizational capital much like more tangible types of capital by recognizing its contribution to the market value of a firm.”

Furthermore, the researchers found that the companies with the highest market valuations, in fact, disproportionately higher than their Fortune 1000 peers, had both the largest IT investments and decentralized work practices. Investors drove up their stock price more than firms with smaller IT spending and centralized work practices.

They conclude that the market value of investing in IT is “substantially higher” in firms that use these decentralized practices because each dollar of IT investment is associated with more intangible assets because the IT investments complement the work practices. Centralized, low-skill firms do not reap as much increase in intangible assets from their IT investments as team-oriented, highly skilled, decentralized-responsibility firms.

Investors apparently sense that investments in training, organizational structures, and work practices create new assets. Even if intangible, these assets will contribute to higher firm performance in the future, hence higher stock prices today. Yet investors cannot see these intangible assets directly; they can only surmise them through “installed computer capital,” hence the link between IT investments and stock price.

CONCLUSION

Managing projects has always been one of the most important, and toughest, jobs in the IS organization. Even with outsourcing and software packages, project management belongs in-house because responsibility for project success remains in-house. In fact, project management skills have grown more important because of the complexity of integrating systems and the need to assess who does and does not support the project, to turn nonsupporters into supporters, and to guide the organization in making the needed changes in business processes and work. As shown in this chapter, managing a project requires a plethora of skills. This is one reason CIOs are now emphasizing project management skills in their staffs.

Most software is devilishly difficult to keep up to date. As a result, at some point in time, management needs to decide what to do with aging software. Among the various options, the most common these days is to replace it with a package. One new alternative is to rearchitect the system to move the company toward a desired architecture. Another new option is to rent the software from a vendor on a per-seat, per-month basis over the Web. Some contend this option is the wave of the future.

Finally, the question continually asked about applications is, “What is it worth to us?” Because IT is not the only contributor to corporate operational improvements, a direct link can be difficult to establish. However, the process of justifying a new system can uncover what is important to management, and measuring benefits afterward can help companies spot benefits they had not originally planned. Furthermore, even

though investors cannot see how well or poorly public companies invest in IT, they do more highly value companies with higher IT investments and more distributed work practices. Thus, the value-of-IT question is gradually being answered.

QUESTIONS AND EXERCISES

Review Questions

1. What three businesses is the IS department in, using Hagel and Singer's framework?
2. According to the Project Management Institute, what are the nine areas of knowledge a project manager needs to know well to successfully manage a project?
3. What are the six things a project manager needs to do, according to Anderson and Matthew?
4. When Cone is interviewing people, what three things does he keep an ear open for?
5. Describe three tools in Cone's project manager's toolbox.
6. Describe the three types of people involved in a change project, according to ODR.
7. How did the BOC Group involve middle management?
8. Describe the decision tree that Gibson uses to assess the business risk of a project.
9. Which does the Boston Consulting Group recommend, replacing or upgrading a legacy system?
10. List the seven ways to improve a legacy system.
11. How is Amazon.com promoting third-party Web Services offerings that relate to Amazon.com's Web site?
12. What four benefits does IT architecture bring to Toyota Motor Sales?
13. How does Wachovia benefit by replacing a system with a service?
14. What are the three roles of systems, according to Berger?
15. What benefits did the trucking company realize at the individual, group, and business levels?
16. What three decentralized work practices were found at companies with higher market valuation in research by Brynjolfsson, Hitt, and Yang?

Discussion Questions

1. IS staffing should become easier as more people gain experience in e-business or move from failed dot-coms. Do you agree or disagree? Discuss.
2. If companies are moving toward providing corporate portals and Web Services where software is rented from a third party over the Internet, IS departments can get out of the application development business. Do you agree or disagree? Discuss.
3. The strategy of minimum maintenance until a system must be completely redone is still best for challenging and developing the programmer/analyst staff. The few people that like nitty-gritty maintenance activities can take care of the programs that need it, while the majority of the development staff can be challenged by the creativity of new development. The seven options turn most developers into maintenance programmers. Do you agree or disagree? Discuss.
4. Management has no way to estimate the benefit of a system that is intended to generate new revenue, so it must build the system on faith, not estimates. Do you agree or disagree? Discuss.

Exercises

1. In April 2004, Cone's content management project had issued an RFP and was waiting for proposals to arrive. Please visit his blog at blogs.ittoolbox.com/pm/implementation and answer the following four questions: (1) What has happened since then on that project? (2) What problems did Cone encounter? (3) How did he solve them? (4) What did you learn from this blog?
2. Find three articles on IS departments that have established a project management office (PMO). Why did they establish a PMO? How is each staffed? What benefits did the PMO generate? What did you find most interesting about the PMOs?
3. Find a company in your community with more than 20 years' experience using computer systems. Develop a descriptive case study for that company showing how it deals with its legacy systems. Include an inventory of major systems and the company's strategies for maintenance and modernization. How does the company decide which applications to upgrade and which approaches to use? Explain how top management and line management get involved in application portfolio decisions. If they do not, why not?
4. Use the Gibson decision tree to assess the business risks of a project you are involved in or know a great deal about. Present your assessment to the class. What are the three main risk factors in the project? Describe which ones support success and which do not. Based on his decision tree, which project management approach should you use? What have you learned from this analysis?

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MANAGING INFORMATION SECURITY

INTRODUCTION

INFORMATION SECURITY

The Threats

Data Thefts: The Biggest Worry and Insider Threats

Scope of Security Management

Case Example: Credit Card Fraud

An Array of Perils

Security's Five Pillars

Technical Countermeasures

Playing Cat and Mouse: Tools for Computer Security

Management Countermeasures

Case Example: An Internet Services Company

PLANNING FOR BUSINESS CONTINUITY

Using Internal Resources

Using External Resources

Case Example: UT Austin Responds to Data Thefts

SECURITY IS A CORE COMPETENCY

CONCLUSION

QUESTIONS AND EXERCISES

REFERENCES

INTRODUCTION

This chapter is dedicated to one of the biggest challenges in IT management—managing information security. We live in an unprecedented era in which organizations are dependent on Internet-based technology to accomplish their business missions. Consequently, issues related to IT security have increased significantly in complexity and the potential harm caused by malicious attacks could just bring the entire organization to a halt. Management must overcome a number of technological, business, and legal issues to effectively deal with never-ending information security threats.

The overarching goal of information security is to ensure data integrity, availability, and confidentiality. Data should be entered in the system in a secure and accurate manner, and cannot be modified without authorization. Also, they should be made available only to authorized users whenever and wherever they need it. Therefore, managing security refers to a comprehensive set of activities that develop, implement, direct, and monitor the organization's security strategy and activities.¹ The core challenge of security management is how to find the right balance between shielding the organization's main assets and processes from potential harm, and enabling them to do their jobs.

INFORMATION SECURITY

Information security used to be an arcane, technical topic, but today even CEOs are concerned about it due to the importance of IT in running their businesses. All business executives now need to understand Internet-based threats and countermeasures and continually fund security work to protect their businesses.

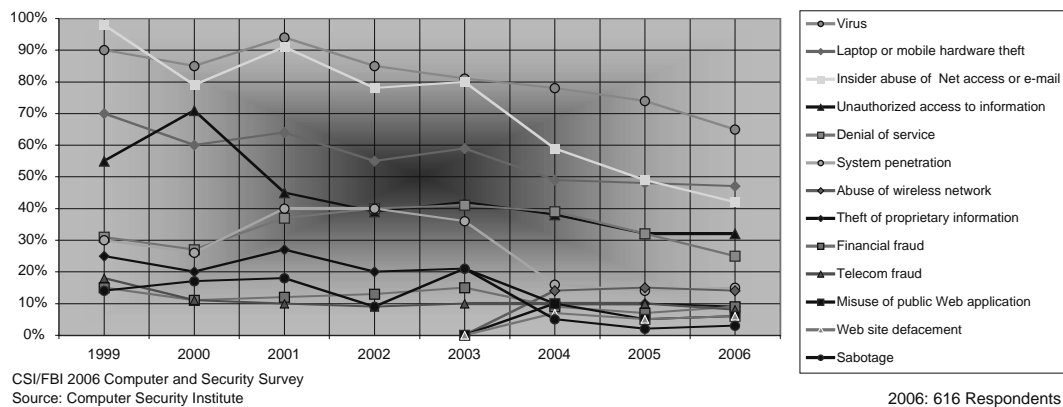
As one security officer told us:

If I were an e-tailer, I might not call the Internet a bad neighborhood, but I would certainly "watch my back." My equivalent brick-and-mortar store would have automatic locks on the doors, cameras watching every aisle, and only \$20 in the safe, because I would never know what kinds of thieves might show up or what kinds of attacks they might launch—from anywhere in the world. Furthermore, as an e-tailer, I would need more security than a brick-and-mortar store manager because customers can get a lot closer to the guts of my business.

The Threats

Perhaps one of the most talked about security incidents in 2007 was the Skype Trojan Horse that froze Skype's entire network of servers, depriving millions of users from temporary access to the popular VoiP provider massive electronic system. McAfee Labs reports that, as of June 2007, there were more than 217,000 types of known security threats, not to mention those that are yet to be discovered by cybercrime prevention specialists. With the convergence of computer and communication technologies, security risks grow even greater. To take advantage of the explosive demand for social computing (such as instant messaging, video sharing, etc.), mobile viruses become more prevalent. Since 1996, the Computer Security Institute and the San Francisco Federal Bureau of Investigation Computer Intrusion Squad¹ have conducted an annual survey of U.S. security managers to uncover the types of computer crimes committed, the countermeasures being taken, and other aspects of cybercrimes.

FIGURE 1 Types of Attacks or Misuse Detected in the Last 12 Months
By Percent of Respondents



Source: Reprinted with permission of Computer Security Institute, 2006 CSI/FBI Computer Crime and Security Survey, Computer Security Institute, San Francisco, CA; www.gosci.com, 2006.

The 2004 CSI/FBI survey report^{1a} contains responses from 494 computer security practitioners from a wide range of enterprises—government and private industry and from those with fewer than 99 employees to those with over 50,000 employees. Two of the report's key findings relate to threats: the unauthorized use of computers is declining, and the most expensive cybercrime was denial of service.

This good news is unfortunately short-lived. The 2006 CSI/FBI raises a new level of alert. Figure 1 reports the types of attacks or misuse detected from 1999 to 2006. In addition to the already known array of perils related to e-mail attachments—such as viruses, worms, spyware, spams—, wireless and VoIP applications introduce new security threats. In 2007, Symantec (symantec.com) released its eleventh Internet Security Threat Report. It reported more than 6 million bot-infected computers worldwide during the second half of 2006, representing a 29 percent increase from the previous period. As discussed more in detail later, the article noted an increase in data breaches. Just to emphasize the severity of security threat, Symantec also observed a rise in sophisticated spam and online fraud schemes, with high levels of coordinated attacks combining spam, malicious code, and online fraud.

Data Thefts: The Biggest Worry and Insider Threats

Simply stated, a data theft occurs when information is illegally copied or taken from a business or an individual. Passwords, social security numbers, credit card and bank information, and other personal information are often reported in the local media. The Credit Card case example offers a typical situation. It also provides a few tips to deal with this type of fraud.

With the proliferation of terabytes of data, data thefts have become one of the top security concerns, across all organizations, large or small, private or public. When stolen

data are used to steal people's identities, the potential harm is enormous, with major economic and legal implications. The worst thing about the data theft is that they can remain undetected.

The complexity and impacts of data thefts are such that, despite the billions of dollars spent on information security products, a survey released by *InformationWeek* (informationweek.com) and Accenture in July 2007 indicated that 89 percent of the 1,010 U.S. companies still felt vulnerable. Dealing with computer hackers is like playing cat and mouse. On the one hand, security technologies are getting better (for example, vein-viewing technology in biometrics to replace signatures, keys, and passwords). On the other hand, threats are getting more sophisticated (for example, SQL injection, botnets), while the Internet-enabled architecture and wireless applications offer more opportunities for attacks, and hackers are more creative in their malicious acts.

However, confidential corporate information is becoming a much-sought-after target for hackers, and the damage of stolen data could be far-reaching. *InformationWeek.com* (July 2007) reported the case of a former employee of Boeing who illegally downloaded 320,000 pages of sensitive business documents to his home computer. Boeing estimated that if some of these documents had gotten into the hands of its competitors, it could have cost the industrial giant \$5 to \$14 billion.

The issue of insider threat is quite a challenge. According to Greenemeier,² criminals inside the organization are not the most common security problem. However, attacks by insiders can be among the most expensive and most damaging to the organization's reputation. An estimation by the Computer Security Institute (csi.com) suggests that losses caused by insider attacks account for between 20 and 80 percent of the entire organization's losses related to computer crimes.

Here are a few examples of possible criminal acts from an insider of a company:

- A computer staff illegally accesses employees' e-mails to steal information that could be used for malicious intent.
- An employee who is angry about the low bonus he receives brings down the entire company's computer system by deleting sensitive data records.
- A system administrator is not happy with his life and decides to change the code of legacy systems, creating bad data.
- A marketing salesperson steals sensitive data and sells them to a competitor.

As discussed later in this chapter, the IT security staff needs to work closely with other organizational units—in this case, the HR department, to deal with data security caused by personnel within the company. Most of the warning signs are not related to IT problems. Common profiles of an insider criminal may include: mental health disorders, personalities that conflict with authority, history of behavioral violations in the workplace, or personal financial problems.

We will discuss, however, a number of technology solutions that can help thwart insider attacks. These consist of limiting the level of authorized access to the employee's job responsibility, promoting the use of encryption, and enforcing the most stringent audit policy for mission-critical data.

Scope of Security Management

To maintain a safe computing environment, security must be applied to all possible areas that are exposed to security threats.

- **Personnel security:** The organization should have a policy that clearly identifies who has the authorization to enter, modify, and access data. Adequate checks, such as passwords, must be completed to grant role-based access to data. The risk here becomes increasingly important with the size of the users. Security checks on critical personnel are common in many large organizations.
- **Application security:** All mission-critical (software, hardware, firmware) applications are secure from unauthorized access. This includes all possible means, from password protection to secured physical vaults.
- **Operating systems security:** From personal laptops to highly distributed operating systems, major functions of the operating systems should be secured: memory management, access to I/O devices, file management, and hardware configuration. The IT staff should make available to all users a security guide for every operating system used in the organization. Guides include steps to set and reset passwords, policy for file access authorization, and procedures to set certificates. A certificate is a mechanism to verify an identity on a computer system over a computer network. Most people only need a personal certificate for the secured system to recognize their ID entity and access privilege. When many restricted Web servers are involved, certification at the host/server level is required.
- **Network security:** Unauthorized viewing and tampering of networks is a much-sought-after target for hackers. Particular attention should be paid to communication devices that serve as a gateway to the organization's computing platform. Network bridges are simple devices that transparently connect two or more LANs. The bridges can also be used to enforce access restrictions, and localize where spoofing attacks can occur.
- **Middleware and Web Services security:** With the proliferation of open-source applications, middleware affords more possibilities for security breaches. A recent technology makes it possible to implement code-based access control. This technology allows authorized users to access data concurrently from numerous devices in a fast and secure manner. IT security staff should frequently review the middleware architectures and define a unified view of security across heterogeneous middleware systems, and provide a basis for decentralized policy for middleware security.
- **Facility security:** All physical rooms where information systems are installed should be fully protected with entry locks, security guards, and cameras. White-collar workers often leave their desktop computers unattended, and password information is left next to the computer. Local system administrators should be appointed to help with security.
- **Egress security should be enforced:** Policy for taking out sensitive documents should be clearly given to personnel. Sensitive data printed on paper should be stored in safes. Unused documents should be shredded. When sensitive equipment is sent out for maintenance or repair, proper security procedures must be enforced to ensure that the components are not modified without permission.

CASE EXAMPLE

CREDIT CARD FRAUD

A major problem is the theft of large numbers of credit card records. “Credit card fraud” is a broad term for theft and fraud by a criminal who uses someone else’s credit card for unauthorized financial transactions.

A common credit card fraud is called “application fraud.” The wrongdoer uses the stolen or fake documents to open an account in someone else’s name, to build up information about this person for further malicious intent. Another type of credit card fraud is known as “account takeover.” The criminal first gathers information about the target victim. He next contacts the victim’s financial institutions to falsely report that the credit card was lost and requests a replacement. He then uses the real card for unauthorized consumption.

Here are two examples from the 2002 CSI/FBI report.^{1b}

One Bug in a Software Package

In one case, MSNBC reported that a bug in one shopping cart software product used by 4,000 e-commerce sites exposed customer records at those sites. The FBI issued a public warning, but one small e-commerce site did not receive this warning message because it had bought the software through a reseller.

Within days, cybercriminals charged thousands of dollars on the credit cards of users of this small site, buying phone cards, gambling at gambling sites, and buying software off the Web. Instructions on taking advantage of the flaw circulated on

the Internet underground, the URLs of other companies that did not obtain the patch were posted on chat rooms, and cybercriminals could even pick up the URLs using search engines.

Two Foreign Cybercriminals

The U.S. Department of Justice has a Web site that describes past cybercrimes. One involves two Russians who committed 20 crimes against two U.S. banks that offer online banking and a U.S. online credit card company. The two stole 56,000 credit card numbers, bank account information, and other personal financial information. Then they tried to extort money from the cardholders and the banks, threatening to publicize the sensitive information they had unearthed.

They also used the stolen credit card numbers to establish fake e-mail accounts, which they used to act as fake sellers and fake winning bidders on online auctions; they paid themselves using the stolen credit card numbers.

They gained access to this information by taking unauthorized control over many computers, including one belonging to a school district. They then used these compromised computers to commit their crimes. The Moscow computer crime unit worked with the FBI to apprehend these cybercriminals. It often takes such international cooperation to fight cybercrime. Power, from the Computer Security Institute 1b, notes that this one case is just an indication of what is happening.

Simple Steps to Protect Credit Cards

Fortunately, there are simple steps that can be taken to protect from credit card fraud:

1. Do not lend the card to someone else, or make it easy for people to have access to your card.
2. Do not write the PIN (Personal Identification Number) on the card.
3. Do not carry too many cards at the same time.
4. Write down telephone numbers of credit banks and keep them in a separate, safe, and handy place, and use them to report lost or stolen cards.
5. Immediately report lost or stolen cards.
6. Check your credit card receipts to make sure that the right amount is charged.
7. Check monthly statements carefully, or online statements regularly. Shred them.
8. Set automated notification via e-mail or mobile phone for large transactions. ■

An Array of Perils

In this section, we briefly describe a few most common approaches used by hackers. RSA Security Inc.,³ a prominent network security firm, and the Security Division of EMC since June 2007, notes that it is easier to guard a bank vault than to guard every house in town. That is why many companies are outsourcing their data-center operations to data-center specialists with vault-like security.

Mobile computing and telecommuting also increase the possibility for cybercrime because the greater number of network openings provides more opportunities for illegal entry. E-commerce sites are also open to everyone, including hackers. And because the Internet does not have intrinsic security protocols, this public space is vulnerable.

In addition, the hacker community has become “a public club,” says RSA, with hacker Web sites and newsgroups available to anyone who wants to learn hackers’ tricks. Furthermore, hacker tools are becoming increasingly sophisticated and easier to use; and they are continually being revised to outsmart the countermeasures used by companies to protect themselves. It has become a cat-and-mouse game of continual one-upmanship. Securing an online business is not a one-shot deal; it requires constant vigilance.

RSA describes the following nine approaches hackers use:

1. **Cracking the password:** Guessing someone’s password is easier than most people think, says RSA, because some people do not use passwords, others use the word “password,” and still others use easy-to-remember words such as their child’s name, a sports team, or a meaningful date. Hackers also use software that can test out all combinations, which is called “brute force” password detection.
2. **Tricking someone:** To get users to divulge their passwords, a con artist calls up an employee posing as a network administrator who needs the employee’s password to solve an immediate (fictitious) network problem. It happens more than you think, says RSA.

- 3. Network sniffing:** Hackers launch software that monitors all traffic looking for passwords or other valuable information. Because most network traffic is in clear text rather than encrypted (appearing as gibberish), sniffing can find information and write it to a file for later use.
- 4. Misusing administrative tools:** Helpful tools can be turned against a network. For example, a well-known program written to uncover weak spots in a network, which is important for network administrators, has been used by hackers to find weak spots in target companies' networks. Interestingly, the program's name is Satan.
- 5. Playing middleman:** Placing oneself between two communicating parties and either substituting one's own information in place of one of the parties' information or denying one party access to a session, such as denying a competitor access to an important online auction, is another common ploy.
- 6. Denial of service:** This tactic floods a party, such as a Web site, with so much useless traffic that the site becomes overwhelmed and freezes. Legitimate messages are locked out, essentially shutting down the business for a period of time.
- 7. Trojan horse:** A malicious program can be housed inside an innocent one or, worse yet, one that appears to be helpful.
- 8. Viruses or worms:** These pieces of software run without permission. Their most common entry point has been as e-mail attachments. Once such an attachment is opened, the program is released and performs its task, such as destroying files (a worm) or replicating itself in e-mails sent to everyone in the e-mail directory. Internet-based viruses have attracted lots of attention, not just for PCs, but for wireless devices as well.
- 9. Spoofing:** By masquerading as a legitimate IP address, hackers can gain access to a site. A site can masquerade as another Web site and redirect traffic to a fraudulent look-alike site that, for example, allows credit card information to be captured for later use.

Security's Five Pillars

To deal with this array of perils, setting up countermeasures for information security relies on five pillars that make up today's security techniques, according to RSA.³

- 1. Authentication:** Verifying the authenticity of users
- 2. Identification:** Identifying users to grant them appropriate access
- 3. Privacy:** Protecting information from being seen
- 4. Integrity:** Keeping information in its original form
- 5. Nonrepudiation:** Preventing parties from denying actions they have taken

Authentication

Authentication means verifying someone's authenticity: They are who they say they are. People can authenticate themselves to a system in three basic ways: by something they know, something they have, and something they are. "Something they know" means "something only they know," generally a password or a mother's maiden name, for example. "Something they have" means "in your possession." In computer security, one possibility is a token that generates a code a user enters into the computer to gain access to, say, an e-mail system. Users just have to remember not to lose the token.

Or they may have a digital certificate, which will be discussed shortly. “Something they are” generally means a physical characteristic, such as a fingerprint, retinal scan, or voice print. These characteristics fall under the area called biometrics. Each type of user authentication has its strengths and weaknesses. RSA recommends choosing two of the three, which is called two-factor authentication.

Identification

Identification is the process of issuing and verifying access privileges, like being issued a driver’s license. First, the user must show proof of identity to get a driver’s license. Once the driver receives the license, it becomes the proof of identity, but it also states the driving privileges (able to drive an automobile but not a truck or a bus). Therefore, identification is like being certified to be able to do certain things.

In the Internet world, identification is moving toward application-level security; that is, authentication for each application. It requires users to sign on for each application, which many feel is a large burden. Some companies are taking a single sign-on approach. A more common trend now is to periodically check the identity of the users by asking additional personal questions (such as, in what city did you attend high school?) before letting the user enter the password.

Data Privacy and Data Integrity

These mean keeping information from being seen or disseminated without (privacy) or changed (integrity) prior consent. Both are especially important when information travels through the Internet because it is a public space where interception is more possible. The most common method of protecting data is encryption, to be discussed shortly.

Nonrepudiation

Nonrepudiation is a means of providing proof of data transmission or receipt so that the occurrence of a transaction cannot later be refused. Nonrepudiation services can prove that someone was the actual sender and the other the receiver; no imposter was involved on either side.

Technical Countermeasures

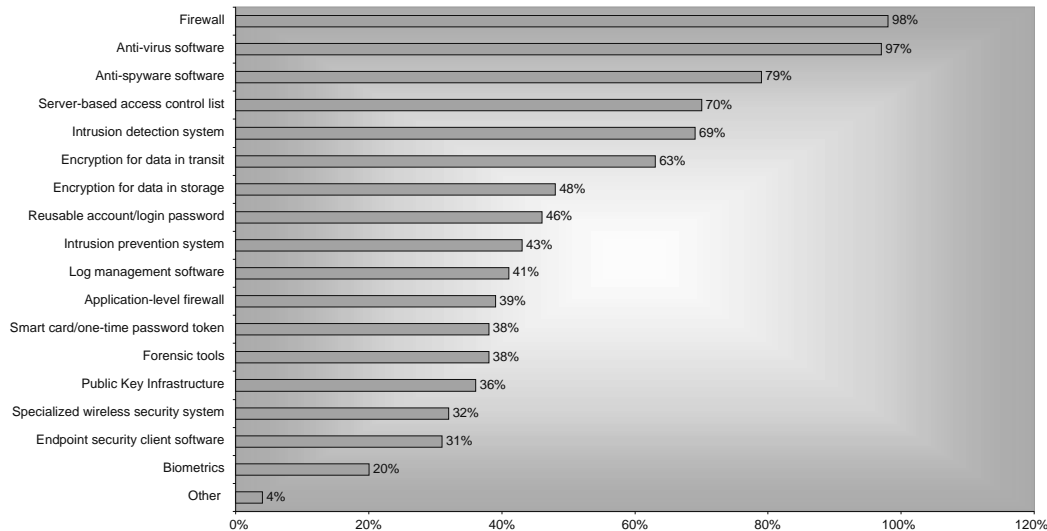
Figure 2 shows the types of security technologies used by the 616 security managers in the 2006 CSI/FBI survey. Some 98 percent used firewalls, 97 percent used antivirus software, and 79 percent used anti-spyware software.

To explain a bit more about countermeasures, following are three techniques used by companies to protect themselves: firewalls, encryption, and virtual private networks (VPNs).

Firewalls

To protect against hacking, companies install firewalls, which are hardware or software that controls access between networks. Firewalls are widely used to separate intranets and extranets from the Internet, giving only employees or authorized business partners access to the network. Typically implemented on a router, firewalls perform their job by filtering message packets to block illegal traffic, where “illegal” is defined by the security policy or by a proxy server, which acts as an intermediary server between, say, the Internet and the intranet. Proxy servers can look deeper into traffic than do packet filters, which just look at the header information on each packet. However, proxy servers

FIGURE 2 Security Technologies Used by Percent of Respondents



Source: Reprinted with permission of Computer Security Institute, 2006 CSI/FBI Computer Crime and Security Survey, Computer Security Institute, San Francisco, CA.

are slower than packet filters. Some products perform both. Without policy management, says RSA, firewalls may not be effective because they may just be treated as stand-alone devices. The most effective security programs create layers of security.

Encryption

To protect against sniffing, messages can be encrypted before being sent over the Internet. Two classes of encryption methods are in use today: secret key encryption and public key encryption. The most common secret key method is the Data Encryption Standard (DES) developed by IBM, the National Security Agency, and the National Bureau of Standards. Using this method, sender and receiver use the same key to code and decode a message. The level of security is a function of the size of the key. DES is widely used and available in many software applications.

The most common public key encryption method is RSA, named for the three developers: Rivest, Shamir, and Adleman. To send an encrypted message using RSA, two keys are necessary: a public key and a private key. As its name implies, the public key is known to many people and is not kept secret. However, the private key must be kept secret. The two keys are used to code and decode messages; a message coded with one can only be decoded with the other.

Figure 3 shows how an encrypted message is sent. First, the message is encrypted using the receiver's public key. The message is now secure—it can only be decoded using the receiver's private key, which is only known to the receiver. Note that the sender uses the receiver's public key, not a key belonging to the sender. If a secure message is to be sent back to the original sender, then the public key of the original sender would be used. Thus, for two-way secure communications, both parties must have a set of keys.

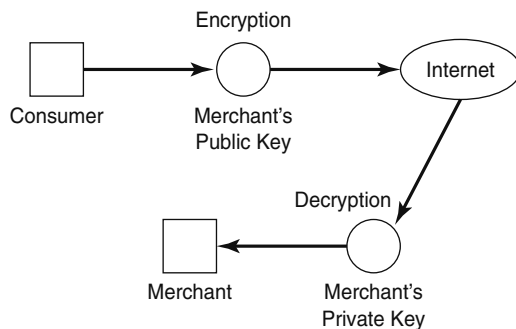


FIGURE 3 Sending an Encrypted Message

The RSA method is incorporated into all major Web browsers and is the basis for the Secure Socket Layer (SSL) used in Internet communications. However, full two-way secure communication requires all parties to have a public and private key. Most individuals do not have such keys, so most B2C applications requiring encryption, such as for the transmission of credit card numbers; these are only secure from the consumer to the merchant, not from the merchant to the consumer.

To protect against spoofing, firms need a way to authenticate the identity of an individual. This verification requires a form of digital ID. The most common form of digital signature uses the RSA encryption method. Because the private key is known only to one person and a message encrypted with that key can only be decoded with the matching public key, the private key provides a way of verifying that the message came from a certain individual. Figure 4 shows the basic process.

For digital signatures to work, though, a trusted third party must issue the keys to individuals and firms. These parties are called certification agencies and can be government agencies or trusted private companies. The agency issues a digital certificate containing the user's name, the user's public key, and the digital signature of the certification agency. See Figure 5. The digital certificate can then be attached to a message to verify the identity of the sender of the message.

Virtual Private Networks (VPNs)

Most offices now have a local ISP, so no matter where they are located in the world, the least costly way to create company-wide networking is to utilize the Internet and its TCP/IP protocols. However, the Internet is not secure because, for one thing, none of the TCP/IP protocols authenticate the communicating parties.

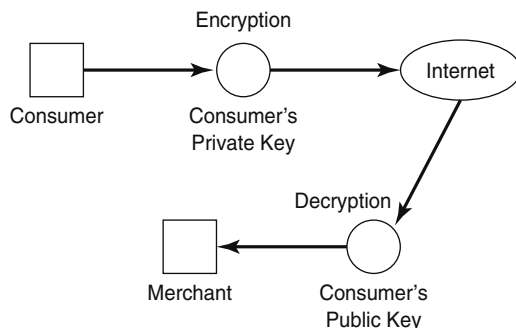


FIGURE 4 Sending a Digital Signature

User's name	FIGURE 5 A Digital Certificate
User's public key	
Digital signature of certificate issuer	

One approach to security has been to obtain a VPN from a CLEC or an ISP. A VPN runs over a private IP network, so it is more affordable than leased lines, and it is secure. VPNs use tunneling technology and encryption to keep data secure as they are transmitted.

Tunneling creates a temporary connection between a remote computer and the CLEC's or ISP's local data center, which blocks access to anyone trying to intercept messages sent over that link. Encryption scrambles the message before it is sent and then decodes it at the receiving end. While in transit, the message cannot be read or changed; hence, it is protected.

VPNs can be used in three ways:

1. **Remote access VPNs** give remote employees a way to access an enterprise's intranet securely by dialing a specific ISP, generally a large one with local telephone numbers in many cities. The ISP establishes a secure tunnel through its network to the corporate network, where the user can access e-mail and the intranet. This option offloads network management to the ISP, something most IS executives want to do.
2. **Remote office VPNs** give enterprises a way to create a secure private network with remote offices. The ISP's VPN equipment encrypts all transmissions.
3. **Extranet VPNs** give enterprises a way to conduct e-business with trading partners, advisers (such as legal firms), suppliers, alliance partners, and customers. These partners dial a specific ISP, which then establishes a secure link to the extranet.

Playing Cat and Mouse: Tools for Computer Security

With the increases in number and sophistication of computer attacks, the IT industry is also active in finding tools for computer users. The tools for computer security can be categorized in two ways:

- **Hardware tools:** These include locks, network cables with special coating to prevent cuts or interceptions, safes, and so on to physically secure the computer system.
- **Software-driven tools:** There are hundreds of kinds of software that are commercially available for organizations to implement into their existing computer environments. A proactive approach would be to install security scanners throughout the computer platform. The vulnerability scanner provides local and remote authentication. Another technology is called intrusion detection and packet sniffer. A packet sniffer analyzes the data traffic in a network. Through

Managing Information Security

protocol analysis, content searching, and various checkpoint routines, a typical intrusion detection system captures a packet of data from data streams being transported and analyzes its content. The sniffer searches for worms, looks for vulnerability points before the intruders find them, and scans all the network entry ports. To avoid slowing down the system performance with too much network monitoring, the IT staff can instruct the system how to monitor the organization's computing platform using policy-guided rules. A reactive approach is to use recovery tools after an attack is committed. A common tool is password crackers. These tools decode passwords that are scrambled by intruders or encrypt users' passwords for added security, record VoIP conversations, and analyze routing protocols.

The challenge for the organization is to keep up with the latest technologies that are available. The IT security staff needs to keep abreast of the latest developments and be able to understand the effectiveness of the new tools vis-à-vis the perceived threats to the organization. A key operational problem is to deal with a variety of specific and disparate tools for a wide variety of components that are part of the entire computing environment (such as operating systems, applications, databases, etc.). The issue is to find the most cost-effective combination of tools to maximize the overall protection. Furthermore, this combination must be constantly reconfigured to deal with the emergence of new threats.

Management Countermeasures

The trend in computer security is toward policy-based management: defining security policies and then centrally managing and enforcing those policies via security management products and services. Hence, for example, a user authenticates to a network once, and then a rights-based system gives that user access only to the systems to which the user has been given the rights. A finance employee might have the rights to company finance records, but a manufacturing employee might not.

The major problem these days is that enterprises cannot have both access to information and airtight security at the same time. Due to online commerce, companies want unimpeded information flow among a complex set of alliance partners. Thus, it is no longer feasible to define good as "inside the network" and bad as "outside the network," as in the past. Today, companies must make trade-offs between absolute information security and efficient flow of information. Although they might think technology can solve security loopholes, the human dimension is equally important—making employees cognizant of security threats they may encounter and teaching them how to strengthen the company's security measures. Today, due to the importance of computers in company operations, security decisions are not just technical; they are being influenced by business managers, which affects the bottom line.

Before any countermeasure can take place, companies must set up a sound mechanism for computer auditing. Audit logs can be used to help detect a security breach, or when a breach has been discovered, the security staff can trace how the incidents occurred.

The 2006 CSI/FBI Computer Crime and Security Survey^{1a} had five key findings that relate to how companies are managing security and the security management policies they have put in place.

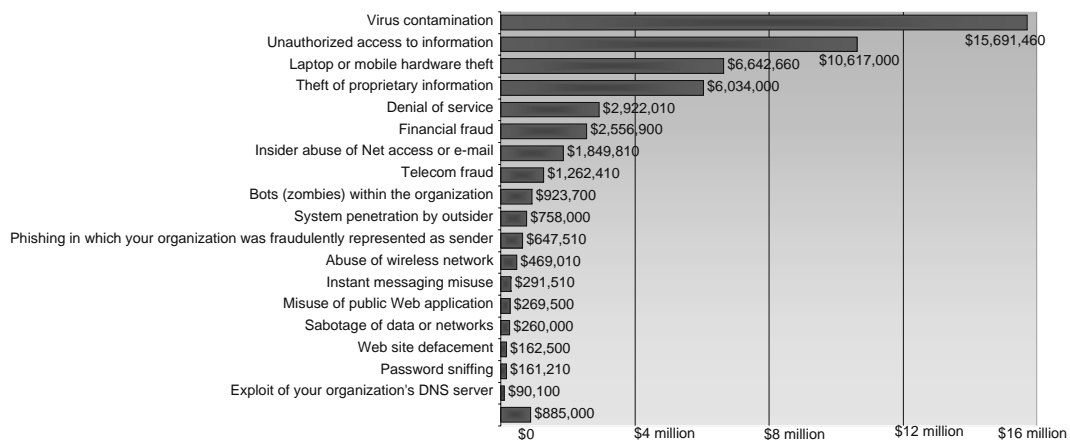
Managing Information Security

- Most organizations conduct some form of economic evaluation and business analysis of their security operations using conventional tools such as Return on Investment (ROI), Internal Rate of Return (IRR), and Net Present Value (NPV).
- The compliance of the Sarbanes-Oxley Act raises the threat of information security.
- Over 80 percent conduct security audits.
- Virus attacks remain the source of the largest financial losses. Unauthorized access, damages related to mobile hardware, and theft of proprietary information are other key causes of economic losses.
- Most do not outsource cybersecurity, but the percentage of security activities outsourced is low.
- Cyberinsurance continues to be insignificant.
- Most respondents view security awareness training as important.

The CSI/FBI survey found that many organizations do not report a cybercrime to law enforcement because the negative publicity would hurt their stock price or their corporate image. Some do not report incidents because they believe a competitor will use that information to its advantage. Only a few see a civil remedy as the best course to take (hence, a reason to report a crime). And even though organizations may be aware of law enforcement's interest, they do not see that as sufficient reason to report a security breach. So there is not as much sharing of cybercrime information as some would hope.

Because airtight security is not possible, companies need to prioritize their risks and work on safeguarding against the greatest threats. To give an example of one company's approach to overall network security, consider this case from a Gartner EXP report.^{4b}

FIGURE 6 Dollar Amount Losses by Type



Source: Reprinted with permission of Computer Security Institute, 2006 CSI/FBI Computer Crime and Security Survey, Computer Security Institute, San Francisco, CA; www.gosci.com, 2006.

CASE EXAMPLE

AN INTERNET SERVICES COMPANY

This firm provides services to Internet professionals and performs security assessments.

Planning and Building for Security

When establishing network connections, the firm's starting point is to deny all access to and from the Internet. From there, it opens portals only where required, and each opening has a firewall and only permits specific functions, such as FTP or e-mail.

In essence, the company has put a perimeter around itself. It determines the worth of the information inside and spends the appropriate level of money to protect those assets. It can be hard to define the perimeter, though. For example, the company does work from client sites and that work needs to be protected as well.

It recognizes that it must also stay vigilant within the perimeter to avoid having a "soft chewy center." It uses a layered approach with numerous ways to protect each layer and some redundancy. For example, it worries about telephone hackers as well as computer hackers.

The IS organization is responsible for all in-house systems and all security. A central authority oversees all servers and workstations. In addition, all machines run the latest virus-detection software. When a system reboots, it accesses the central server where its virus definitions are checked. If they are not the latest ones, the newest versions are downloaded.

Finally, the company has disaster recovery plans that include having servers geographically separated. It recommends that clients do the same so that e-business sites can remain operational, at least partially, if some of the servers are hit by an attack or become overloaded.

Monitoring

The company views security on the Internet as a war of escalation. Every few weeks someone finds a clever new way to penetrate software, and a new type of attack is launched. Once the security team has closed one hole, attackers will find and attack another. The best the security team can hope to achieve is to deter attackers by closing more and more holes.

The security team therefore believes it needs to constantly "check the locks," which it does in the following ways:

- The team keeps track of the latest bugs found in systems. The company belongs to suppliers' bug alert communities. When it receives an alert, the team looks to see whether it applies to the company's systems. If so, the team assesses the vulnerability and takes the needed action.
- The team keeps up to date on the latest security attacks that have taken place around the world by subscribing to security organizations and constantly visiting their Web sites for the latest news.

(Case Continued)

- The team subscribes to hacker e-mail lists and bulletin boards to see what the bad guys are doing and talking about. The security team believes it must think like the enemy.
- Team members personally explore some threats by setting up a test system and trying various attacks on it—attacks they have read about on the e-mail lists and bulletin boards. It is fun for the security staff, it provides a break from the normal work, and it presents a welcome technical challenge.
- The team logs and monitors all incoming and outgoing traffic. A dedicated team manages the firewalls.
- A senior security person scans the company's Web sites monthly from a remote site, comparing the services being run on the servers with the official inventory of services that should be running on the servers. Major surprises are investigated. This person also checks to ensure that no servers are running known compromised software.

Education: The Key to Improving Security

The greatest security challenge is employee and customer apathy; they always say, "This cannot happen to us." Hence, the greatest security need is employee and customer education. The company tries to balance education with

a taste of what could happen so that its security message is taken seriously without frightening employees and clients so much that they think any countermeasure is useless. Management has learned that fear-mongering becomes counterproductive if it is too scary or used too often.

Education is a two-way street, though. Businesspeople need to determine the value of the assets, but they also need input from IS on what is technically feasible to guard specific assets. For example, the company has alerted all its high-profile clients about the possibility of denial-of-service attacks. The bigger and more well-known the company and its Web site, the more it needs to be prepared for such attacks by having the technology and plans in place to identify and deal with attacks when they occur. Management warns, "If you have a determined adversary, they are going to keep trying until they get you."

The company has found that businesspeople do understand security when it is related to money. They understand that they, not the technicians, are the ones who need to justify security expenses because only they understand the worth of protecting different kinds of information. For example, they understand that protecting Web servers that contain public information requires keeping the servers from crashing. That type of protection costs less than safeguarding servers that house proprietary company or confidential client information, which must also protect the data from prying eyes; not every one can access it. ■

PLANNING FOR BUSINESS CONTINUITY

There is a big difference between disaster recovery and business continuity. In the past, executives expected their IS organization to focus on disaster recovery; that is, getting computers and networks up and running after a hurricane, flood, fire, or other disaster. September 11 taught them a broader issue—business continuity—that is, getting the business back up and running. Business continuity involves far more than IT equipment, notes Chuck Tucker in the Gartner EXP report, “September 11: Business Continuity Lessons.”^{4c}

Business continuity broadens the discussion to include safeguarding people during a disaster, documenting business procedures (instead of relying on certain employees who may become unavailable), and giving employees the tools and space to handle personal issues first so that they can then concentrate on work. Tucker notes that business continuity includes:

- Alternate workspaces for people with working computers and phone lines
- Backup IT sites that are not too close but not too far away (to be within driving distance but not affected by a regional telecommunications disaster)
- Up-to-date evacuation plans that everyone knows and has practiced
- Backed-up laptops and departmental servers, because a lot of corporate information is housed on these machines rather than in the data center
- Helping people cope with a disaster by having easily accessible phone lists, e-mail lists, and even instant-messenger lists so that people can communicate with loved ones and colleagues

In short, business continuity is a business issue. IT disaster recovery is just one component of it. Disaster recovery practitioners agree that (1) disaster contingency planning needs to be an integral part of doing business and (2) commitment of resources to a disaster recovery process must be based on an assessment by top management of cost versus risk. Companies essentially have two options for disaster recovery: use of internal or external resources.

Using Internal Resources

Organizations that rely on internal resources for disaster recovery generally view this planning as a normal part of systems planning and development. They cost-justify backup processing and telecommunications based on company needs during foreseeable emergencies. Companies use the following approaches to backing up their computer systems, data, and communication links with company resources:

- Multiple data centers
- Distributed processing
- Backup telecommunications facilities
- LANs

Multiple Data Centers

Over the past few years, to save money organizations have consolidated their multiple computer centers or outsourced them to a provider operating mainly from one data center. September 11 caused many executives to rethink the wisdom of having all corporate computing in one location. Multiple centers can provide emergency backup for critical services.

For backing up data, companies create protected disk storage facilities, sometimes called direct access data storage, or DASD farms. These farms are regularly refreshed with current operating data to speed recovery at an alternate data center. They are normally company-owned, unattended sites and remote from the primary data center. They house disk controllers and disk drives that can be accessed either online or in batch mode.

Distributed Processing

Other organizations use distributed processing to deal with disaster recovery. They perform critical processing locally rather than at a data center so that operations can continue uninterrupted when a disaster hits a data center. Companies that use this approach standardize hardware and applications at remote locations so that each local processing site can provide backup for the others.

Distributed processing solutions to disaster recovery can be quite costly when data redundancy between central and remote sites is required. Therefore, this alternative is most commonly used for applications that must continue to operate, such as order entry and financial transaction systems.

Backup Telecommunications Facilities

Companies appear to be handling telecommunications backup in two ways: (1) by utilizing duplicate communications facilities and (2) by using alternate technologies that they redeploy in case of an emergency. However, as Tucker notes, in New York City, companies signed up with different telecommunications carriers (without checking their carriers' routing), thinking that they had alternate communication routes. Then they discovered that 30 percent of Manhattan's telecommunications traffic, from many different carriers, went through Verizon's West Street switching office, which was destroyed on September 11.

Some companies turn to alternate communication technologies when their communication links fail, such as when the infamous Hinsdale fire destroyed the Hinsdale Illinois Bell Telephone Company central office switching station. The station handled 118,000 long-distance lines, 30,000 data lines, and 35,000 local voice lines, reports Jeff Bozman.⁵ It served as a hub for some 30 local exchanges in northeastern Illinois. The fire disrupted telephone service to the area for four weeks. Local companies used at least two alternative technologies to handle their telecommunications needs during this emergency.

MONY Financial Services in Syracuse, New York, switched a satellite link from its smaller San Juan, Puerto Rico, office to its large Hinsdale office by installing a VSAT dish on the roof, reports Crockett.⁶ It was used to communicate via satellite to a communication hub in New York City and from there via land lines to Syracuse. The San Juan office then instituted its own communication backup plan, using terrestrial lines to communicate to Syracuse.

Zurich Insurance Company, in Schaumburg, Illinois, established a line-of-site microwave link between headquarters and an AT&T switching office located about two miles away, reports Crockett. In fact, 38 temporary microwave links were established in the Chicago area.

September 11 taught the importance of restoring or relying on more personal forms of communication—e-mail, handhelds, instant messaging, intranets, and even paging systems. Business no longer relies just on data in data-center computers; much

of it is now stored in laptops, departmental servers, and e-mail. Before September 11, few IS organizations had disaster recovery plans for these computers and systems.

LANs

Servers on one LAN can be used to back up servers for other networks. As with mainframe DASD farms, data servers used for such a backup need to be refreshed regularly to keep their data up to date. Keeping up to date is accomplished by linking the networks. Network master control programs permit the designating of alternate devices when primary ones fail.

Using External Resources

In many cases, a cost-versus-risk analysis may not justify committing permanent resources to contingencies; therefore, companies use the services of a disaster recovery firm. These services include:

- Integrated disaster recovery services
- Specialized disaster recovery services
- Online and off-line data storage facilities

Integrated Disaster Recovery Services

In North America, major suppliers of disaster recovery services offer multiple recovery sites interconnected by high-speed telecommunications lines. Services at these locations include fully operational processing facilities that are available on fewer-than-24-hours notice. These suppliers often have environmentally suitable storage facilities for housing special equipment for their clients.

Subscription fees for access to fully operational facilities are charged on a per-month basis. Actual use of the center is charged on a per-day basis. In addition, a fee is often charged each time a disaster is declared. Mobile facilities, with a mobile trailer containing computer equipment, can be moved to a client site and are available at costs similar to fully operational facilities. Empty warehouse space can be rented as well.

Recognizing the importance of telecommunications links, major disaster recovery suppliers have expanded their offerings to include smaller sites that contain specialized telecommunications equipment. These sites allow users to maintain telecommunications services when disaster recovery facilities are in use. They house control equipment and software needed to support communication lines connecting recovery sites with client sites.

Needless to say, companies now in the business of hosting corporate Web sites also handle disaster recovery for those sites.

September 11 pointed out a shortcoming of regional disasters: The backup sites fill up fast. In fact, one firm located in the World Trade Center declared a disaster with its provider four minutes after the first plane hit and was told that the closest available workspace facilities were hundreds of miles away. This company resorted to triage instead, notes Tucker, asking some employees to work from home and giving their workspaces at other locations to the displaced employees.

Specialized Disaster Recovery Services

Some suppliers of backup services can accommodate mainframe clients who also need to back up midrange machines. Others provide backup solely for midrange systems. Some will even deliver a trailer with compatible hardware and software to a client location.

Telecommunications firms also offer a type of recovery service, through network reconfiguration, where network administrators at user sites can reroute their circuits around lines with communication problems. Specialized telecommunications backup services also exist. Hughes Network Systems, in Germantown, Maryland, helped a company that had 49 of its pharmacies affected by the Hinsdale telephone switching station fire. Within 72 hours, Hughes installed a temporary network of VSATs at 12 sites. The 37 remaining sites had small satellite dishes installed within two weeks. Other firms offer data communications backup programs, where they will store specific telecommunications equipment for customers and deliver that equipment to the customer's recovery site when needed.

Online and Off-Line Data Storage

Alternate locations for storage of data and other records have long been a part of disaster planning. Services generally consist of fire-resistant vaults with suitable temperature and humidity controls. Several suppliers offer "electronic vaulting" for organizations that need to have current data off-site at the time a disaster occurs. These suppliers use two methods to obtain current data from their clients. One method uses computer-to-computer transmission of data on a scheduled basis. The other uses dedicated equipment to capture and store data at a remote location as it is created on the client's computer. This latter method assures uninterrupted access to data from an operationally ready disaster recovery facility selected by the client.

In summary, when disaster recovery needs do not shape the architecture of an enterprise's computer systems, the cost of reconfiguring the systems to provide the needed redundancy and backup can be prohibitive. In these cases, external backup alternatives may be a more cost-effective form of insurance. For e-business, however, mere backup capability does not suffice. Disaster recovery must be an integral part of system design, because companies need immediate rollover to backup facilities when operations are interrupted.

CASE EXAMPLE

UT AUSTIN RESPONDS TO DATA THEFTS

www.mcombs.utexas.edu; www.mcombs.utexas.edu/datatheft/

On April 23, 2006, officials at the University of Texas at Austin reported that an unknown person or persons had gained entry to the McCombs School of Business computer and gained unauthorized access to a large number of the school's electronic data. The incident

occurred two days earlier with an estimated 197,000 records unlawfully accessed. The university conducted an investigation and discovered a security violation on Friday, April 21. Information that was accessed included social security numbers and possibly other biographical data

(Case Continued)

of alumni, faculty, staff, current and prospective students of the business schools, and recruiters.

The university swiftly made the news public and took immediate steps to deal with the security breach.

Executing Remediation Plan

The university put into place countermeasures to reduce vulnerabilities. It contacted almost 200,000 people who were determined to have been either directly or potentially affected by the incident. Whenever possible, 45,000 e-mails, followed by 80,000 letters, were addressed to those whose SSNs were compromised. Another additional 60,000 letters were sent to people who might have had nonsensitive information unlawfully accessed.

A Web site and an information call center with a toll-free telephone number were set up to assist people potentially affected by the data theft. There were more than 9,000 calls from concerned citizens, and the response teams followed up about 6,000 other calls. They addressed specific questions and provided updated information. Cautionary steps to deal with further identity theft were provided. The intention here was to do more than what was required by legal notification requirements.

The computer center disabled several administrative programs. Sensitive data such as social security numbers were removed from the affected server and many administrative programs containing personal information were disabled. Additional security resources were increased to implement the recommendations that resulted from the security audits.

For sure, this security breach was a data theft, since intruders stole important pieces of people's personal identifying information. However, at the time of discovery, there was no assurance that it was an identity theft. An identity theft occurs when the stolen information is used for any fraudulent or other unlawful purpose. To assist individuals who sought to respond to identity theft, the university set up a Web site with specific step-by-step instructions. Individuals were advised to place a free "fraud alert" on their files with one of the three major credit bureaus in the United States (Equifax, Experian, and Transunion). A list of additional resources is also provided:

- Federal Trade Commission; www.consumer.gov/idtheft/
- Also see from the Federal Trade Commission, the booklet "Take Charge: Fighting Back Against Identity Theft"; www.ftc.gov/bcp/online/pubs/credit/idtheft.htm
- Social Security Administration
- www.ssa.gov/oig/index.htm
- Social Security Fraud hotline (800-269-0271)
- www.ssa.gov/pubs/10064.html
- Department of Justice; www.usdoj.gov/criminal/fraud/idtheft.html
- U.S. Postal Inspection Service; www.usps.com/postalinspectors/id_intro.htm
- Identity Theft Resource Center (858-693-7935); www.idtheftcenter.org/index.shtml
- Privacy Rights Clearinghouse—Identity Theft Resources; www.idtheftcenter.org/index.shtml

(Case Continued)

- Internet Crime Complaint Center; www.IC3.gov
- National Fraud Information Center Hotline: 800-876-7060

Improving Overall Information Security

The IT center of the business school set up a Data Theft Information Center and explained how the college has dealt with the incident:

- Security audit: The University of Texas Information Security Office conducted a full security audit. Independent consultant and major IT firms were hired to perform a comprehensive evaluation of the campus computer systems and application software.
- Countermeasures to reduce vulnerabilities: Many security steps were taken to secure the information stored on the computer servers.
- Cooperation with law enforcement authorities: The University involved the Cyber Crimes Unit of the Texas Attorney General Office, the Federal Bureau of Investigation, and the University Police Department. ■

SECURITY IS A CORE COMPETENCY

In a conventional sense, core competency refers to the ability of an organization to do well what it is meant to do to secure sustainable competitive advantage. A typical and direct measure of competency of a firm is the competitiveness of its products or services, those that provide benefits to customers and are hard for competitors to copy. With the pervasiveness of security threats, all organizations should look at security resources as a strategic investment. Appropriate security tools should be acquired, and skilled security personnel should be retained.

Security is often thought by many as a mere technological problem. This narrow view could do much disservice to the organization. Any business should look at security as a business problem, with threats that could bring to a halt any critical activity at any time. IT-related security should be a discussion item in every single business process within the organization.

Many businesses—such as banks, insurance firms, and health care providers—are required by law to adopt a number of security measures to protect the interests of the customers. John Steven⁷ notes that businesses are now being held accountable for the security of their business applications by their customers, business partners, and the government.

RSA,³ just to name a few leading security solutions providers, suggests that few necessary steps are required to reach an information-centric strategy:

- **Create and communicate an enterprise software security framework:** The roles, functions, responsibilities, operating procedures, and metrics to deal with security threats and attacks must be clearly defined and communicated to all

involved staffs. A security administrator should be created. This is a critical position in the IS department. The role of the security administrator is to be the champion of security in his/her organization, work with all IT units, from infrastructure engineering to incident management, and to deal with both structural and incidental aspects of security threats.

- **Knowledge management training:** To create a culture for enforcing IT security, an organization should improve the security knowledge of its IT staff and community of users: security policy, standards, design and attack patterns, threat models, etc.
- **Secure the information infrastructure:** Along the IT-enabled business process or workflow, security checks using external programs should be identified to allow for monitoring and controls.
- **Assure internal security policy and external regulator compliance:** The organization should make sure that, based on IT risk assessment, security requirements are translated into features of the software design to resist attack. There are tools available to conduct penetration-testing risks. Regular audits and monitoring exercises should be conducted, with precise measures of effectiveness. It is crucial that the assurance effort comply with internal policies and external regulations.
- **Governance:** In any project that involves security, security experts must be called upon to participate in the design and implementation process of the system development or maintenance. Proper procedures should be clearly defined before any security breach occurs.

CONCLUSION

Information security has become an important management topic, yet it has no definite answers. It is too costly to provide all the security a company wants, and performing security checks on packets takes a lot of processor power, which can slow performance. Even with world-class technical security, management needs to make sure that all employees follow security policies, because companies are only as safe as their weakest link. In fact, that weakest link could be a supplier or contractor with secure access to a company's systems, yet poor security of its own. As repeated often in this chapter, security is as much a human problem as a technical problem.

The complexity of information security is pervasive, and is no longer the problem of the IT department. The CIO must mobilize all organizational units to enhance the organization's ability to withstand threats and to adapt to new risk environments. Security is not just a technological problem. It is a business problem, since all activities in a network-enabled world inherently carry some degree of security threat.

The biggest security challenges include managing the increasing complexity of security, assessing potential risks, raising the level of user awareness, enforcing security policies, and protecting against breaches.

The effectiveness of security management also depends on factors that are external to the organization. Technology vendors should provide products and services with embedded security features. Business partners should take security equally seriously. Security is also a regulatory problem with compliance requirements. Different countries have different ways of looking at the severity of information security.

Managing Information Security

Implementing an effective information security strategy requires substantial resources. Forward-looking organization should view security management as part of the core competency of the organization. As suggested by the National Institute of Standards and Technology (NIST), all businesses should put into place an information security governance that allows management structure and processes to establish information strategies that:

- are aligned with and support business mission and objectives
- are consistent with applicable laws and regulations through adherence to policies and internal controls
- hold people accountable for the security effort they are responsible for

Information is a critical and invaluable resource, and should not be an area of risk. The ultimate goal of information security management is to nurture and sustain a culture of security in the organization.

QUESTIONS AND EXERCISES

Review Questions

1. What would be the most threatening security threats for the next five years?
2. Why are wireless applications becoming a new target for hackers?
3. Describe the five pillars of information security.
4. How does the Internet services company “check its locks”?
5. How did the University of Texas at Austin deal with a computer attack? Expand the notion of disaster recovery.
6. Discuss the human side of computer security.

Discussion Questions

1. Security is such an important area that every employee should be required to carry around a security token that generates a new password every time he or she logs on. Security threats are overblown; imposing on employees to carry a security token is too much to ask. Discuss both sides of this issue.
2. The Internet provides all the redundant routing and alternate sites an enterprise needs. It need not contract with a backup and recovery firm as Household International did. Present arguments against this belief.
3. Do an Internet search on “tools for computer security.” Identify the latest products. Describe the organization that you are currently working for. Are these new tools useful for your organization. How would you convince your organization to adopt them.
4. Visit an organization Web site that has a plan for managing information security. A suggestion: The Fermi National Accelerator Laboratory (<http://security.fnal.gov/reporting.html>) (accessed May 2008). Examine the way the organization sets up its security procedures. Discuss the effectiveness of the site.

Exercises

1. Search articles about e-commerce security. Discuss with your teammates how e-commerce security differs from general information security. Are there any particular countermeasures that are unique to e-commerce? Relay your findings to the class.
2. Read several articles on Internet security. Present any new information to your class.
3. Visit a company in your local community. Learn about its disaster recovery and business continuity plans. Which threats are they aimed at? Which threats are not dealt with? What is it doing about Internet security?

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SUPPORTING INFORMATION-CENTRIC DECISION MAKING

INTRODUCTION

Case Example: A Problem-Solving Scenario

TECHNOLOGIES-SUPPORTED DECISION MAKING

Building Timely Business Intelligence

Decision Support Systems

Case Example: Ore-Ida Foods

Case Example: A Major Services Company

Data Mining

Case Example: Harrah's Entertainment

Executive Information Systems

Case Example: Xerox Corporation

Case Example: General Electric

Expert Systems

Case Example: American Express

Agent-Based Modeling

TOWARD THE REAL-TIME ENTERPRISE

Enterprise Nervous Systems

Case Example: Delta Air Lines

Straight-Through Processing

Real-Time CRM

Case Example: A Real-Time Interaction on a Web Site

Communicating Objects

Vigilant Information Systems

Case Example: Western Digital Corp.

Requisites for Successful Real-Time Management

CONCLUSION

QUESTIONS AND EXERCISES

REFERENCES

INTRODUCTION

Inspired by the work of H. Simon in the late 1950s, and other noted scholars—J. March, R. M. Cyert, A. Tversky, and D. Kahneman, just to name a few—organizational decision making has been a fertile area of research in cognitive science and organizational behavior. Thanks to these authors, we have gained more insights on how decisions are made in organizations. For some time, decision making in organizations has often been seen as a rational and coherent process. Relevant information is gathered. Problem issues are well understood. Objectives and preferences are well laid out. Alternative interests and perspectives are fully considered. As a result, an optimal solution is derived. Following Simon's theory of bounded rationality and heuristics of reasoning, decision makers are now recognized as not as rational. Their decisions are often influenced by power, incentives, and even ambiguity. Their information-processing capacity is limited. Their cognitive ability is reduced under stress or time pressure. More importantly, quite a few decision makers cannot even clearly formulate their own objectives or preferences. While it is important to admit these less-than-ideal realities, the role of scientific management is to identify ways that can enhance the quality of the decision-making process and outcome.

From an IT-supported decision perspective, the issue here is to figure out what and how IT can be used to help the decision maker get the information he needs, better formulate the problem, clarify his preferences, process complex reasoning, and better appreciate the impacts of the decision before it is being made.

Generally speaking, most of today's computer systems have some built-in features that help their users make decisions. The latest financial statement stored in a spreadsheet can help the CFO decide on this month's cash flow. A report on inventory printed from a DBMS can help the production manager decide on the next supplies order. In the mainframe era, the earliest commercial uses of computers aimed to automate such decisions as analyzing sales, updating accounts payable, calculating payroll payments, and recording credit card charges and payments. Since those early days of the 1950s and 1960s, the use of computers to support decision making has become increasingly sophisticated, either completely taking over complicated decisions (for example, automated stock trading systems), or supporting people who make complex decisions (for example, firm acquisition). A whole host of technologies has been aimed at the use of information systems. This chapter first discusses the basic principles of Business Intelligence, and elaborates on five of these technologies:

1. Decision support systems (DSSs)
2. Data mining
3. Executive information systems (EISs)
4. Expert systems (ESs)
5. Agent-based modeling

The chapter then concludes with a discussion of the hot topic of moving toward the real-time enterprise; that is, the pros and cons of being able to gauge the current state of affairs and make decisions nearer to when an event occurs.

Decision making is a process that involves a variety of activities, most of which deal with handling information. To illustrate such a process, here is a scenario about a vice president with an ill-structured problem and how he confronts it using a variety of decision-making technologies.

CASE EXAMPLE

A PROBLEM-SOLVING SCENARIO

Using an Executive Information System (EIS) to compare the budget with actual sales, a vice president of marketing discovers a sales shortfall in one region. Drilling down into the components of the summarized data, he searches for the apparent causes of the shortfall, but can find no answer. He must look further, so he sends an e-mail message to the district sales manager requesting an explanation. The sales manager's response and a follow-up phone call also reveal no obvious single cause, so he must look deeper.

The vice president investigates several possible causes:

- **Economic conditions.** Through the EIS and the Web, he accesses wire services, bank economic news letters, current business and economic publications, and the company's internal economic report on the region in question. These sources, too, reveal no serious downturn in the economic conditions of the region.
- **Competitive analysis.** Using the same sources, he investigates whether competitors have introduced a new product or launched an effective ad campaign or whether new competitors have entered the market.
- **Written sales reports.** He then browses the reports of sales representatives to detect possible problems. A concept-based text retrieval system allows him to

quickly search on topics, such as poor quality, inadequate product functionality, or obsolescence.

- **A data mining analysis.** He asks for an analysis of the sales data to reveal any previously unknown relationships buried in the customer database and relevant demographic data.

The vice president then accesses the marketing DSS, which includes a set of models to analyze sales patterns by product, sales representative, and major customer. Again, no clear problems are revealed.

He thus decides to hold a meeting with the regional sales managers and several of the key salespeople. They meet in an electronic meeting room supported by Group DSS (GDSS) software such as GroupSystems by Ventana Corporation. During this meeting they examine the results of all the previous analyses using the information access and presentation technologies in the room, brainstorm to identify possible solutions, and then develop an action plan.

No discernible singular cause has led to the shortfall in sales, so the group decides that the best solution is to launch a new multimedia sales campaign that sales representatives can show on their laptop computers when they visit customers.

The vice president then enters a revised estimate of sales volume into the financial planning model, taking into account the new sales promotion plan,

(Case Continued)

and distributes it to the sales force in the region.

He holds a sales meeting in the GDSS room and by video conference

launches the new campaign and trains sales personnel in the use of the multi-media presentation. ■

This scenario illustrates the wide variety of activities involved in problem solving. Where does the decision making start and stop? Which are the crucial decisions? It really does not matter because all the activities are part of the overall process of solving the problem. The scenario also illustrates the wide variety of technologies that can be used to assist decision makers and problem solvers. They all aim to improve the effectiveness or efficiency of the decision-making or problem-solving process.

TECHNOLOGIES-SUPPORTED DECISION MAKING

Building Timely Business Intelligence

Coined and popularized by the Gartner Group in the early 1990s, Business Intelligence (BI) is a broad set of concepts, methods, and technologies to improve context-sensitive business decision making by using information-centric support systems. The rapidly changing world of demand and supply requires businesses to act more proactively and swiftly. Managers should be able to gather, filter, and analyze large quantities data from a variety of sources in real time, or near real time, mode. They should be able to navigate through these terabytes of data to assess current market conditions and explore future business scenarios.

According to IDC, the worldwide market for analysis tools was \$4.5 billion in 2005. Tools for advanced analytics reached \$120 million in the same year. The market is still growing as *InformationWeek.com* indicated in its 2007 survey of 500 largest companies in the United States. Most of the BI software currently available in the market provide tools for metadata management, data transformation and integration, data quality, data analysis, analytics applications, financial planning and performance management, and enterprise reporting.

Central to BI Is the Notion of Sense Making

Sense making refers to the ability to be aware of and assess situations that seem important to the organization. With ambiguous and disparate data extracted from multiple sources, situation awareness implies an inductive and constructive process. On the other hand, situation assessment is the process of fitting observed data into a predetermined model. To assess the competitiveness of the company, the manager will try to gather data and feed them in Porter's framework. While situational awareness is driven by the discovery of events or facts, assessment is bounded by the manager's education and training, past experiences, and cognitive capabilities.

Supporting Information-Centric Decision Making

In the context of an organization, the notion of sense making is extended to shared awareness and command and control. To achieve situation awareness, BI seeks to design an IT-enabled infrastructure to enhance collaboration among employees, and support them in the planning, execution, and monitoring of decisions. Operationally, the goal of BI is to help its user generate actions to control the assessed situation. BI models allow identification of business objectives, definition of constraints, evaluation of alternate solutions, and decision making. They include, but are not limited to, data and document warehousing, data and document mining, Web mining, scoreboarding, visualization, trend analysis and forecasting, multidimensional analysis, and neural networks.

Whereas the purpose of tractors, jackhammers, and steam engines has been to enhance humans' physical capabilities, the purpose of computers has been to enhance our mental capabilities. Hence, a major use of IT is to relieve humans of some decision-making tasks or help us make more informed decisions. At first, IT relieved us of procedure-based decisions—those that involved easily discernible procedures, such as data manipulation, sorting, and what-if analysis. Software now has progressed to the point where computers can make what-if analysis and goal-based decisions using integrated data-intensive systems with online analytical processing (OLAP) capacities. The following are five technologies that support decision making: DSSs, data mining, EISs, ESs, and agent-based modeling.

Decision Support Systems

The definition of DSSs that prevails today was described in *Building Effective Decision Support Systems*, by Ralph Sprague and Eric Carlson.¹ They define DSSs as computer-based systems that help decision makers confront ill-structured problems through direct interaction with data and analysis models. For example, the owner of a bank needs to select a Certified Public Accountant from a list of 30 candidates. Since none of them clearly stands out as the best candidate, the choice appears to be ill-defined. With the use of a DSS that helps list all the selection criteria, prioritize these criteria, input the evaluation of the banker, and rank order the candidates based on different points of view, the banker is getting a better appreciation of the role of the future CPA and how to look for the CPA who would best meet his expectations.

During the 1970s and 1980s, the concept of decision support systems (DSSs) grew and evolved out of two previous types of computer support for decision making. One was management information systems (MISs), which provided (1) scheduled reports for well-defined information needs, (2) demand reports for ad hoc information requests, and (3) the ability to query a database for specific data. The second contributing discipline was operations research/management science (OR/MS), which used mathematical models to analyze and understand specific problems.

The last two items have become the basis of the architecture for DSSs, which Sprague and Carlson call the Dialog-Data-Model (DDM) paradigm: the dialog (D) between the user and the system, the data (D) that support the system, and the models (M) that provide the analysis capabilities. They make the point that a good DSS should have balance among the three capabilities. It should be easy to use to support the interaction with nontechnical users; it should have access to a wide variety of data; and it should provide analysis and modeling in numerous ways.

The Architecture for DSSs

The model in Figure 1 shows the relationships among the three components of the DDM model. The software system in the middle of the figure consists of the database management system (DBMS), the model base management system (MBMS), and the dialog generation and management system (DGMS).

The dialog component. The dialog component links the user to the system. It can take any number of styles. A spreadsheet screen, a database window, an instant-messaging dialog box, a Web page to browse, and an online catalog are examples of input/output handled by the dialog component. One dialog style uses a mouse and a keyboard to access pull-down menus and move icons on a color screen to get a graphical presentation of analysis results. The Apple Macintosh introduced this style in the 1980s. Another one is to use a touch screen or a pen.

The current standard is the browser interface, with multimedia features embedded in the Web page. Lots of researches have been dedicated to the design of an effective man-machine interface. For example, when a computer screen is used for the computer system to dialogue with the user, certain basic design principles should be followed. These include, but are not limited to:

- The language shown on the computer screen should be clear, concise, and unambiguous.
- Not too much information is provided at the same time to avoid information processing overload.
- The choice of fonts and colors should not be so busy that they might distract the user from focusing on the task at hand.
- Screen navigation should be logical from the user's viewpoint, or better yet, customized to his/her particular needs.

With the growing integration of systems—from conventional use, window-based screens and the Web browser to a mobile device such as the cell phone or a personal digital assistant (PDA)—finding a seamless and uniform interface that optimizes the interaction between the system and the user is a challenge. The large computer screen can display a rather large amount of information at the same time. Conversely, a two-inch mobile phone can only display a few pieces of information at the same time. The challenge for the IS department is to help developers define an organization-wide general set of design principles to enhance the quality of interaction between the user and the system.

The data component. The main purpose of this component is to help the user select a set of data relevant to his decision problem. Data are either accessed directly by the user or are an input to the model component. Typically, summarized data, rather than transaction data, are used and put into extract files. Extract files are used for security, ease of access, and data integrity reasons. They keep the all-important transaction systems away from end users. Another important feature of this component is to retrieve selective data from external sources of information (for example, economic data from a research firm, or production data from a supplier). Most recently, the data component has taken the form of data warehousing and data mining (discussed shortly). The rationale of having a data component is that the greater the data the better the ability of the decision to comprehend the problem at hand.

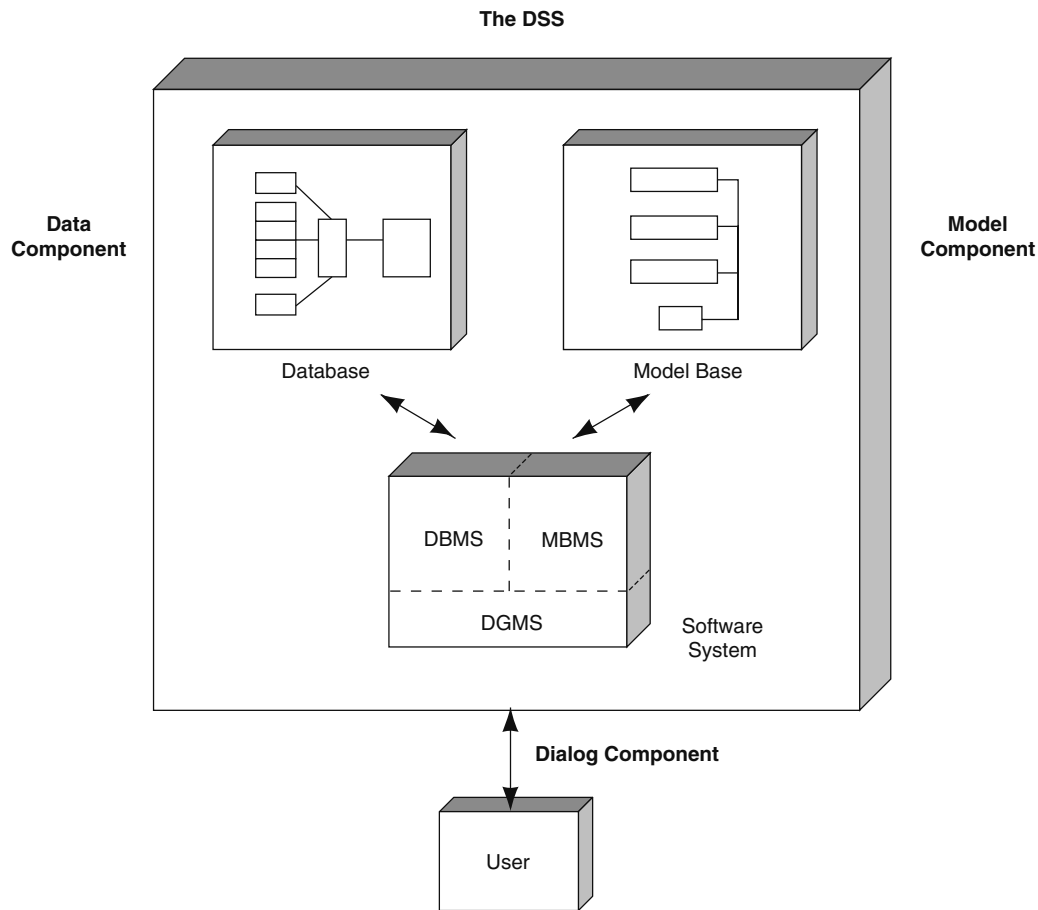


FIGURE 1 Components of a Decision Support System (DSS)

The model component. Modeling is the process of building a model of reality based on a situation that we know the answer, and try to apply to another situation that we have yet to find the solution. The model component stores a family of analytical models in a model base (a concept germane to a database for data) that the user can choose, and possibly integrate them together, to solve his decision situation. For example, the user can request a simulation model from the model base to weigh different market forces, and transfer the results of the simulation to a forecasting model that calls regression algorithms to predict sales. Models need to fit with the data, they need to be kept up to date; users need to understand and trust them; and if several models are used, they need to work together.

Basically, there are two kinds of DSSs: institutional and “quick hit.” Institutional DSSs are generally built by professionals, often decision support groups. They are intended for organizational support on a continuing basis, and they are generally written using a dedicated computer language for business modeling. The following case example illustrates an institutional DSS.

CASE EXAMPLE

ORE-IDA FOODS

www.oreida.com

Ore-Ida Foods, Inc., is the frozen-food division of H. J. Heinz and has a major share of the retail frozen potato market. Its marketing DSS must support three main tasks in the decision-making process.

- **Data retrieval**, which helps managers find answers to the question, “What has happened?”
- **Market analysis**, which addresses the question, “Why did it happen?”
- **Modeling**, which helps managers get answers to, “What will happen if . . .?”

For data retrieval, a large amount of internal and external market data are used. External data, such as economic indexes and forecasts, are purchased. However, the company makes limited use of simple data retrieval. Only about

15 to 30 pages of predefined reports are prepared each sales period.

Market analysis is the bulk (some 70 percent) of Ore-Ida’s use of DSS and is used to analyze, “Why did such and such happen?” Data from several sources are combined, and relationships are sought. The analysis addresses a question such as, “What was the relationship between our prices and our share of the market for this brand in these markets?”

Modeling for projection purposes offers the greatest potential value to marketing management. The company has found that, for successful use, line managers must take over the ownership of the models and be responsible for keeping them up to date. The models must also be frequently updated, as market conditions change and new relationships are perceived. ■

As this example illustrates, an institutional DSS tends to be fairly well defined; it is based on predefined data sources (heavily internal, perhaps with some external data), and it uses well-established models in a prescheduled way. Variations and flexible testing of alternative what-if situations are available, but such tests are seldom done during interaction with the ultimate decision maker.

A “quick-hit” DSS, on the other hand, is developed quickly to help a manager make either a one-time decision or a recurring decision. A quick-hit DSS can be every bit as useful for a small company as for a large one. One type of quick-hit DSS is a reporting DSS, which can be used to select, summarize, and list data from existing data files to meet a manager’s specific information needs, such as to monitor inventory in a region, compare actual to planned progress on a project, or follow a trend. A second type of quick-hit DSS is a short analysis program, which can analyze data and print or display the data. These programs can be written by a manager, they generally use only

a small amount of data, and they can be surprisingly powerful. Finally, a third type of quick-hit DSS can be created using a DSS generator, which builds a DSS based on the input data. As an example of a powerful short analysis that shows quick-hit DSSs in practice, consider the DSS used by the vice chairman of a services company with offices throughout the United States and Europe.

The typology of DSSs described previously has practical implications to top management. An end-user or a small group of people who need to quickly put together a decision tool to solve a particular problem typically initiates a quick-hit DSS. As such, the project scope is limited and likely ad hoc; it could be a one-time use and is developed by the end user. Development cost tends to be small and the benefits are derived from the learning process while the DSS is being developed and used. An example of this could be an Excel-based budgeting program over a period of five years. On the other hand, an institutional DSS requires full planning and budgeting. Its development can be expensive and requires a full approach to software development.

CASE EXAMPLE

A MAJOR SERVICES COMPANY

The vice chairman of the board at a major services firm was considering a new employee benefit program: an employee stock ownership plan (ESOP). He wanted a study made to determine the possible impact of the ESOP on the company and to answer such questions as: How many shares of company stock will be needed in 10, 20, and 30 years to support the ESOP? What level of growth will be needed to meet these stock requirements?

He described what he wanted—the assumptions that should be used and the rules that should be followed for issuing ESOP stock—to the manager of the information services department. The information services manager herself wrote a program of about 40 lines to perform the calculations the vice chairman wanted and then printed out the results.

These results showed the impact of the ESOP over a period of 30 years, and the results contained some surprises.

The vice chairman presented the results to the executive committee and, partially based on this information, the ESOP was adopted. Some of the other executives became excited about the results of this analysis and asked if the computer program could be used to project their individual employee stock holdings for 10, 20, and 30 years. The results of these calculations aroused even more attention. At this point, it was decided to implement the system in a more formal fashion. The company treasurer became so interested that he took ownership of the system and gradually expanded it to cover the planning, monitoring, and control of the various employee benefit programs. ■

This example shows that simple programs of 100 lines of code are indeed practical and can be used to support real-life decisions. In this case, a 40-line program was adequate for the initial evaluation of the ESOP. Eventually, of course, the programs for this system became much larger, but the 40-line program started everything. This example also illustrates the concept of iterative development (a form of prototyping), which is a key concept in DSS development. Other examples of DSSs are given by Sprague and Watson in *Decision Support for Management*.²

Data Mining

The data component of the DSS architecture has always been a crucial part of the success of DSSs. Recently, however, many of the advances in DSSs have been in the area of data warehousing and data mining. The trend is just natural. Today's computer processing power is able to process reasonably fast terabytes of data. Data mining—sometimes known as data or knowledge discovery—is a technique that processes large amounts of data from different perspectives with the hope to discover some business patterns that are embedded in the data. For example, Oracle, one of the world's largest software providers, reports that one of its customers, a grocery store, uses its data-mining software to discover business patterns and predict sales. The business was able to find an association relationship of co-occurring buying pattern: Men who visited the store to buy diapers on Thursdays and Saturdays, also tended to buy beer. Later the store analyzes the data and discovers that grocery goers typically shop on Saturdays, and perhaps because they have a lot to buy for the upcoming week, beer was not a popular buy on Saturdays. These discoveries were not based on theories of consumer behavior. They emerge from data analyses. One possible application of this consumption pattern is for the store to place beer next to the diapers on Thursdays.

Data warehouses hold gigantic amounts of data for the purpose of analyzing that data to make decisions. The most typical use of data warehouses has been users entering queries to obtain specific answers. However, an even more promising use is to let the computer uncover unknown correlations by searching for interesting patterns, anomalies, or clusters of data that people are unaware exist. Called data mining, its purpose is to give people new insights into data. For example, data mining might uncover unknown similarities within one customer group that differentiates it from other groups. Data mining is an advanced use of data warehouses, and it requires huge amounts of detailed data. The most frequent type of data mined these days is customer data because companies want to know how to serve their customers better. Here is such an example: Harrah's Entertainment.

How does data mining work? Given access to a large set of data (for example, sales per items, per regions, weather conditions, holidays, sports events, etc.), a data-mining technique can use the following types of relationships and pattern recognition approaches:

- **Classes:** Data regarding a predetermined group are retrieved and analyzed. For example, a retail chain sorts sales data according to the time customers visit the store, and the types of goods they bought. This information could be used to develop customer profiles.
- **Clusters:** Data are grouped according to logical relationships or consumer preferences. For example, data can be mined to look for market segments or

consumer affinities. An airline could mine customer purchase data to determine what type of duty-free goods travelers would buy when they fly business class during business days. This information could be used to have a better selection of duty-free items for sale.

- **Associations:** Data are mined to find associations between them.
- **Sequential patterns:** Data are used to anticipate behavior patterns and trends. For example, a store discovers from its data that customers who bought sun-screen products also bought sunglasses.

Without getting bogged down in technical details, there are a wide variety of algorithms that could be used for data mining. A simple approach is to use advanced graphics tools to allow the business analyst to visualize data. Another technique is to use if-then rules to sort databases from certain business ideas. More advanced techniques include decision trees, neural networks, and genetic algorithms. Today, most providers of database management systems (DBMS) do provide an add-on data-mining module. The costs range between a few hundreds to millions of dollars.

CASE EXAMPLE

HARRAH'S ENTERTAINMENT

www.harrahs.com

Harrah's Entertainment of Memphis, Tennessee, is owner of 26 casinos around the United States, including the Rio in Las Vegas, Harrah's at Lake Tahoe, and Harrah's North Kansas City on a riverboat on the Missouri River.

To better know its customers, Harrah's encourages them to sign up for its frequent-gambler card, Total Rewards. In return for inserting the card in a gaming machine when they play it, gamblers can receive free hotel rooms, free shows, free meals, and other giveaways.

Some 25 million Harrah's customers have a Total Rewards card, reports Joe Nickell,³ just by filling out their name, age, address, and driver's license number. When they insert the card in a machine, it tracks what they do. Thus, on Nickell's 4-hour-and-40-minute visit to the Rio in

Las Vegas, Harrah's learned that he placed 637 wagers on nine slot machines, his average bet was 35 cents, and he lost \$350.

Until its Total Rewards program began in 1998, Harrah's only knew how much money each of its 40,000 machines made, notes Nickell, not which customers were playing them. Furthermore, each casino operated independently. Customers might receive VIP treatment at one casino, but not at another.

When competition among casino owners increased in the late 1990s due to legalization of gambling on Indian reservations and riverboats, Harrah's realized it needed to reward its best customers to keep them coming back. But first it had to find out who they were, which was the rationale behind its Total Rewards program.

(Case Continued)

Harrah's estimated it was getting 36 percent of its customers' gambling money in 1998. It further calculated that a 1 percent increase would equal \$125 million in more revenue, states Nickell. Thus, Harrah's goal has been to increase the gambling "wallet share" of each of its customers. During 2001, Harrah's calculated its share had increased to 42 percent.

Using Data Mining to Understand Its Customers

Harrah's mined its Total Rewards database to uncover patterns and clusters of customers. It has created 90 demographic clusters, each of which is sent different direct-mail offers—a free steak dinner, a free hotel room, and such—to induce them to pay another visit to any Harrah's casino.

Harrah's has gotten to know its customers well. From just a person's gender, age, distance from any casino, gaming machines played, and amounts of bets, it can fairly accurately estimate the long-term value of that customer. The company creates a gaming profile of each customer and a personalized marketing campaign, offering giveaways appropriate to that customer's cluster, all with the goal of encouraging customers to spend their gambling time at Harrah's rather than at competitors' casinos.

Over time, Harrah's compiles a profit-and-loss for each customer to calculate how much "return" it is likely to receive for every "investment" it makes in that customer. It also tracks how each customer responds to its direct-mail offers, ratcheting up or down its giveaways based on changes in that customer's expected long-term value.

Harrah's goes to this much trouble to know its customers, says Nickell, because it

learned from mining its Total Rewards database that much of its \$3.7 billion in revenues (and 80 percent of its profit) comes from its slot-machine and electronic-gaming-machine players. It is not the high rollers who are the most profitable. In fact, Harrah's discovered that only 30 percent of those who spend between \$100 and \$500 on each visit bring in 80 percent of Harrah's revenue and close to all its profits. These slots and gaming players are the locals who gamble often.

Using Data Mining to Improve Its Business

"Harrah's Entertainment has the most devoted clientele in the casino business," writes Gary Loveman, CEO.⁴ That loyalty is reflected in its bottom line: Its 26 casinos increased their same-store revenues 16 quarters in a row. Data mining has shown Harrah's the link between revenue and customer satisfaction. Customers who report being "very happy with their experience at Harrah's" have increased their spending by 24 percent, whereas those who report being "disappointed" decreased their spending by 10 percent.

Harrah's strategy is to increase loyalty by treating its best customers well. In so doing, Loveman and his predecessor have followed a decidedly different strategy to the casino business than competitors. Others have built lavish facilities and amenities—dazzling attractions in their buildings, high-end shopping malls, spas, and such—to attract new kinds of customers, not just gamblers.

Harrah's has focused on its most lucrative customers—its local slots players—using what Loveman calls a "data-driven marketing" strategy. Rather than devise a marketing strategy first, Harrah's has

(Case Continued)

let the data suggest the marketing ideas based on its mining of customer satisfaction surveys and reward-card data. The data suggested that Harrah's could increase loyalty by focusing on same-store revenue growth by encouraging locals to visit their nearby Harrah's casino often using appropriate incentives. Data mining also showed that most locals prefer \$60 in casino chips over a free hotel stay with two free dinners and \$30 in chips.

To hone customer service even more, Harrah's has divided its Total Rewards program into three tiers—Gold, Platinum, and Diamond—with Diamond customers receiving the highest level of customer service, because they have the highest value. Through mining its customer satisfaction surveys, Harrah's discovered that these gamblers value fast service and friendliness. So Harrah's does its best to make sure they do not wait in line to park their car, check in at the hotel, or eat in the restaurant. And to encourage non-Diamond card gamblers to aspire to receive these same perks, Harrah's makes the differences in service obvious. Marketing to customer aspiration is working “wonderfully,” notes Loveman.

Furthermore, because Harrah's sees customer satisfaction as being so important to increasing revenue, it links employees

rewards to customer-satisfaction scores on the two important metrics: speed and friendliness. When a casino's rating increases 3 percent on customer satisfaction surveys, every employee in that casino receives a bonus. In 2002, during the recession, when gambling revenues only increased by 1 percent in one city, the Harrah's casino increased its customer satisfaction rating by 14 percent.

In addition, the company is using data mining to understand its individual slot machines, such as why customers prefer some machines over others. From what it has learned, Harrah's has reconfigured its casino floor.

In all ways possible—from the parking valets to the telemarketers to the individual slots themselves—Harrah's is using insights from its data-driven strategy to treat its best customers the way they say they want to be treated and thereby gain their loyalty and more of their gambling wallet share.

Within the first two years of operation of Total Rewards, revenue from customers who visited more than one Harrah's casino increased by \$100 million. Due mainly to this program, Harrah's has become the second-largest casino operator in the United States, and has the highest three-year ROI in its industry, notes Nickell. ■

Executive Information Systems

As the name implies, executive information systems (EISs) are systems for use by executives. Originally, some people argued that CEOs would not use computers directly and quoted CEOs who agreed with them. But that has not been the case. Many senior managers have realized that direct access to organizational and external data is helpful. EIS is a particular type of application software that is dedicated to help executives:

- Gauge company performance: sales, production, earnings, budgets, and forecasts

Supporting Information-Centric Decision Making

- Scan the environment: for news on government regulations, competition, financial and economics developments, and scientific subjects
- While easing information overload

Using the DDM model described earlier, an EIS can be viewed as a DSS that:

- provides access to (mostly) summary performance data
- uses graphics to display the data in an easy-to-use fashion
- has a minimum of analysis for modeling beyond the capability to drill down in summary data to examine components

For example, if sales in a region are denoted as “red” (meaning, below planned targets), the executive can perhaps drill down by country, sales office, and maybe even salesperson to better understand where the shortfall is occurring (as in the opening scenario in this chapter). The experience at Xerox is an example of the successful development and use of an EIS. In many companies, the EIS is called a dashboard and may look like a dashboard of a car.

CASE EXAMPLE

XEROX CORPORATION

www.xerox.com

Paul Allaire became the executive sponsor of Xerox’s EIS project while he was corporate chief of staff. Although he felt that an EIS would be valuable to the executive team, he insisted that it earn its usefulness, not that it be “crammed down their throats.” In fact, the system began small and evolved to the point where even skeptical users became avid supporters.

Improved planning was a clear objective from the start. For example, Allaire describes the problem of getting briefing information to executives before regular executive meetings. Due to the time required to prepare the materials and mailing delays to international offices,

many executives ended up reading 100 pages or more the night before a meeting without access to related information or time for discussions with staff. When the materials were put on the EIS, the executives had enough information or preparation time to make the necessary decisions.

The EIS helped make strategic planning more efficient and resulted in better plans, especially across divisions. Instead of each division preparing plans that were simply combined, the EIS allowed the executives to explore interrelationships between plans and activities at several divisions. The EIS played an important role at Xerox during Allaire’s tenure. ■

Stories like the Xerox case appear frequently in the public and trade press. The implication is that computers are finally being used by executives to help them perform their job better. The underlying message is that executive use is just a matter of

installing popular software packages, and the only reason more executives are not using computers is their timidity. However, the situation is not that simple. Successful IT support of executive work is fraught with subtle pitfalls and problems. Consider the following description of a failure.

Doing It Wrong

Hugh Watson, a professor at the University of Georgia, has worked with many corporations in the development of EISs. Watson describes a (hypothetical) company and its well-intentioned effort to develop and install an EIS.⁵ The IS director at Genericorp had heard of successful EIS experiences. He thought that such a system would be valuable to his company, so he arranged for a presentation by a DSS vendor, which was well received by the executive team. After some discussion, they decided to purchase the product from the vendor and develop an EIS. The allocated budget was \$250,000.

They assembled a qualified team of IS professionals who interviewed executives concerning their information needs (whenever the executives could find the time) and developed an initial version of the system consisting of 50 screens to be used by five executives. The response from these executives was quite good, and in some cases enthusiastic. Several of them seemed proud to finally be able to use a computer, says Watson.

With the system delivered, the development team turned it over to a maintenance team and moved on to new projects. The maintenance team was to add new screens and new users—in short, to evolve the system. Nine months later, little had happened, apparently because other systems maintenance projects had become more urgent. About this time, a downturn in revenue generated cost-cutting pressures on nonessential systems; the EIS was discontinued.

What went wrong? Watson identifies five problems that serve as a guide to the “hidden pitfalls” in developing a successful EIS.

- 1. Lack of executive support.** Although it has been listed as a potential problem in system development for years, executive support is crucial for EIS for several reasons. Executives must provide the funding, but they are also the principal users so they need to supply the necessary continuity.
- 2. Undefined system objectives.** The technology, the convenience, and the power of EISs are impressive, maybe even seductive. However, the underlying objectives and business values of an EIS must be carefully thought through.
- 3. Poorly defined information requirements.** Once the objectives of the system are defined, the required information can be identified. This process is complicated because EISs typically require nontraditional information sources, such as judgments, opinions, and external text-based documents, in addition to traditional financial and operating data.
- 4. Inadequate support staff.** The support staff must have technical competence of course, but perhaps more important is that they have an understanding of the business and the ability to relate to the varied responsibilities and work patterns of executives. A permanent team must manage the evolution of the system.
- 5. Poorly planned evolution.** Highly competent systems professionals using the wrong development process will fail with EISs. An EIS is not developed, delivered, and then maintained. It needs to evolve over time under the leadership of a team that includes the executive sponsor, the operating sponsor, executive users, the EIS support staff manager, and IS technical staff.

Although EIS development is difficult, many organizations report that it is worth the effort. Avoiding the pitfalls identified by Watson improves the probability of a successful EIS. Many questions must be answered when considering an EIS. Some of the answers are specific to the organization—who it will serve, where and when it will be developed—so it would serve no purpose to discuss them here. However, the other questions—why, what, and how—have more general answers.

Why Install an EIS?

There are a range of reasons for wanting an EIS. The following motivations are listed in the sequence of strongest to weakest, as far as probable project success is concerned.

- ***Attack a critical business need.*** An EIS can be viewed as an aid to deal with important needs that involve the future health of the organization. In this situation, almost everyone in the organization can clearly see the reason for developing an EIS.
- ***A strong personal desire by the executive.*** The executive sponsoring the project may want to get information faster or have quicker access to a broader range of information. Or the executive might want the ability to select and display only desired information and then probe for supporting detail. Or the executive might want to see information presented in graphical form. Within divisions, once corporate management begins using an EIS, division management feels at a disadvantage without one.
- ***“The thing to do.”*** An EIS, in this instance, is seen as something that today’s management must have to be current in management practices. The rationale given is that the EIS will increase executive performance and reduce time wasted looking for information.

A strong motivation, such as meeting a critical business need, is more likely to assure top management interest in, and support of, the project. At the other extreme, a weak motivation can lead to poor executive sponsorship of the project, which can result in trouble. Thus, motivation for the EIS is fundamental to its success because it helps determine the degree of commitment by the senior executives.

What Should the EIS Do?

This question is second only to motivation as a critical success factor. It determines the extent to which executives will make hands-on use of the system. It is important that all the people associated with the project have the same understanding of just what the new system is expected to do and how it will provide executive support.

In general, EIS and dashboards are used to assess status. At their heart, both should filter, extract, and compress a broad range of up-to-date internal and external information. They should call attention to variances from plans and also monitor and highlight the critical success factors of the individual executive user. Both are a structured reporting system for executive management, providing them with the data and information of their choice in the desired form. Both are for monitoring what is going on in the company and in the outside world. With this information at hand, executives can work to resolve any problems they uncover.

An EIS or a dashboard can start small and quickly with this data-and-information approach and still accomplish something useful. For example, EIS developers asked

the company president of one large insurance company the 10 things he would look at first after returning from vacation. He gave them this list. Two weeks later, they gave him an EIS “system” with those 10 items listed on the main menu as the first iteration of the EIS. The president was delighted and was soon asking for more!

This data-and-information approach uses information the executives already get or would like to get. But the EIS provides it faster, in more convenient form, pulling information together that previously had to be viewed separately and using graphics to aid comprehension. Here is another example of an EIS in the form of a dashboard.

To sum up, the main purpose of an EIS is to help managers learn about their organization, work processes, and how their business is related to the external environment. Another key feature of an EIS is the ability to get data in a timely manner, if not in real time. A major difference between an EIS and a management information system (including personnel management, inventory management, sales, marketing, and production) is not the focus on micro-management. EIS should not be used for the user to gain competitive power. Information should be shared along a team-based structure. EIS should not be used for the user to identify problems and finger-point at colleagues or subordinates. The intent is to promote proactive management as opposed to reactive management with learning, continuous improvement and informed decision making.

Therefore, an organization should select an EIS that facilitates the job of its executives, one that consists of achieving the business mission and objectives.

Like data-mining software, most commercial EISs are available as an add-on to an existing corporate-wide DBMS or ERP. In many industries (for example, pharmaceuticals or food), vendors are selling application-specific EIS to track predetermined trends of a particular industry.

CASE EXAMPLE

GENERAL ELECTRIC

www.ge.com

In Spring 2001, the CIO of General Electric (GE) received the first executive dashboard.⁶ Now, most senior GE executives have a real-time view of their portion of GE. Each dashboard compares expected goals (sales, response times, etc.) with actual, alerting the executive when gaps of a certain magnitude appear. The CIO’s dashboard, for instance, shows critical GE applications. Green means the system is up and running OK, yellow means there is a problem, and red means

the system is down. When systems remain red or yellow for a given time, the CIO can have the dashboard system send an e-mail to the developers in charge. The CIO can also pull up historical data to see whether the event appears to be one-time or recurring.

GE’s goal is to gain better visibility into all its operations in real time and give employees a way to monitor corporate operations quickly and easily. The system is based on complex enterprise

(Case Continued)

software that interlinks existing systems. GE estimates that it saves \$1.6 billion a year from the system.

GE's actions are also moving its partners and business ecosystem closer to real-time operation. For example, GE has installed online kiosks at some Home Depot stores. Customers can order an appliance; choose a delivery date and time; and learn, at that moment, whether that delivery can be made.

Likewise, GE has installed sensors on a number of its products—turbines,

aircraft engines, and locomotives, to name a few. These sensors record what is happening on its attached object and transmit that data via satellite to a GE remote monitoring center. If, for instance, there is something wrong with a jet engine, GE learns of that event in real time from the sensor, uses its systems and people to determine a probable cause, and notifies the airline. Likewise, GE can tell its customers how efficiently a GE turbine is running, in real time, and work with the customer on improving that efficiency. ■

Expert Systems

Expert systems (ESs) are real-world applications of artificial intelligence (AI). AI is a group of technologies that attempts to mimic our senses and emulate certain aspects of human behavior, such as reasoning and communicating, says Harvey Newquist,⁷ a well-known consultant and columnist in the field. Unlike conventional economic theories or operations research that uses mathematics to model decisions, AI uses reasoning. For example, to predict sales of a product, a manager can use a regression equation to plot the time series of past sales and tries to extrapolate sales for the next period. Also, he can apply a market demand model to estimate the impact of a possible price increase on sales. In the AI world, the manager can implement a business rule that says, "If sales continue to grow for 12 months in a row, then inform management that sales will likely go up for the next period."

Alternately, the manager can build a network of arguments to represent a chain of business reasoning: "If the competitor increases its sales price, the company may follow; if price is increased by more than 25%, sales volume can decrease significantly." In the AI jargon, the relationships between sales, sales price, volume, market demand, etc., is called a semantic net. AI technologies include other applied techniques such as fuzzy logic (approximate reasoning versus precise reasoning), natural language processing (interacting with the computer using a human language), and neural networks (inferring a pattern from seemingly unrelated and related observations).

AI has been a promising technology for at least 40 years. In the early 1990s, that promise finally began to unfold, quietly. In particular, ESs, also called knowledge-based systems, became one of several system development methodologies. They have become a prolific application of AI. The auto industry uses them to troubleshoot robots and check cars for noise and vibration. Telecommunications firms use them to diagnose switching circuits. Financial services firms use them to choose financial planning and tax planning alternatives. And the list goes on.

ESs are not new. The first was the Logic Theorist developed in 1956 by Allen Newell and Herbert Simon of Carnegie-Mellon University together with J. C. Shaw of the Rand Corporation. The field changed in the 1970s with the introduction of two AI languages, LISP and Prolog, which made the systems easier to develop. They brought ESs out of the lab and into businesses. The field changed again with the introduction of PC-based tools, called shells, that used conventional languages, such as C. Today, under the term “intelligent systems,” many application-specific systems embed AI features. These include computers installed in vehicles that automatically stabilize the wheel traction in a dangerous turn, washing machines that use fuzzy logic to make sure that linen is not damaged, health care appliances that can interact with a central computer at the hospital when it is needed, and production machines that find the most cost-effective mix of raw materials.

The Components of an Expert System

An ES is an automated analysis or problem-solving model that deals with a problem the way an expert does. The process involves consulting a base of knowledge or expertise to reason out an answer based on the characteristics of the problem. Clyde Holsapple and Andrew Whinston⁸ define an ES as a computer-based system composed of:

- A user interface
- An inference engine
- Stored expertise (in the form of a knowledge base)

Note that this definition looks a lot like the description of a DSS given earlier in the chapter.

The user interface is the interface between the ES and the outside world. That outside world could be another computer application or a person. If a person is using the system directly, the user interface contains the means for the user to state the problem and interact with the system. Some systems use multiple-choice graphics, voice, and even animation in the interface. When the system is interacting with another application, though, the interface is the program that presents the facts to the expert system.

The inference engine is that portion of the software that contains the reasoning methods used to search the knowledge base and solve the problem. The knowledge base consists of a set of logics or rules and facts. An example of facts is: sales are low, number of complaints is high. An example of a rule is: if sales decrease and customer complaints increase, then quality may be an issue. The inference engine links different facts and reasoning to reach a solution. When data are needed for inference, and the inference engine cannot find any facts or derived thoughts from the knowledge base, it asks the user questions or attempts to connect to other systems. Furthermore, and unlike conventional systems, ESs can deal with uncertainty. Users can answer, “Yes (0.7),” meaning, “The answer is probably yes, but I’m only 70 percent certain.” In these cases, the system may produce several possible answers, ranking the most likely one first.

Knowledge Representation

Knowledge can be represented in a number of ways. Following are three possibilities: cases, nodes in a network, and rules.

Case-based reasoning (CBR). One way to represent knowledge is as a case. ESs using this approach draw inferences by comparing a current problem (or case) to hundreds or thousands of similar past cases. A negotiator who engages in a labor dispute using his experience with an earlier and similar case is using case-based reasoning. CBR is best used when the situation involves too many nuances and variations to be generalized into rules.

Evan Schwartz and James Treece⁹ provide an excellent example of a CBR system: the Apache III system used by the intensive care unit at St. Joseph Mercy Hospital in Ypsilanti, Michigan. When 35-year-old Sharon entered the hospital with a potentially fatal respiratory disease, the physicians and nurses in intensive care entered her vital statistics and medical history into a workstation running Apache III. The system drew on records of 17,448 previous intensive care patients to predict whether Sharon would live or die. Its first prediction was that she had a 15 percent chance of dying.

As the statistics were entered daily, the system compared her progress to the base of previous cases. Two weeks later, the prediction of death soared to 90 percent, alerting the physicians and nurses to take immediate corrective action. Then, literally overnight, her chance of dying dropped to 60 percent, and 12 days later to 40 percent. She did recover. The intensive care unit's director credits the system with catching the increased likelihood of death days before his staff would have seen it. The Apache III system is helping the unit respond faster and control costs better.

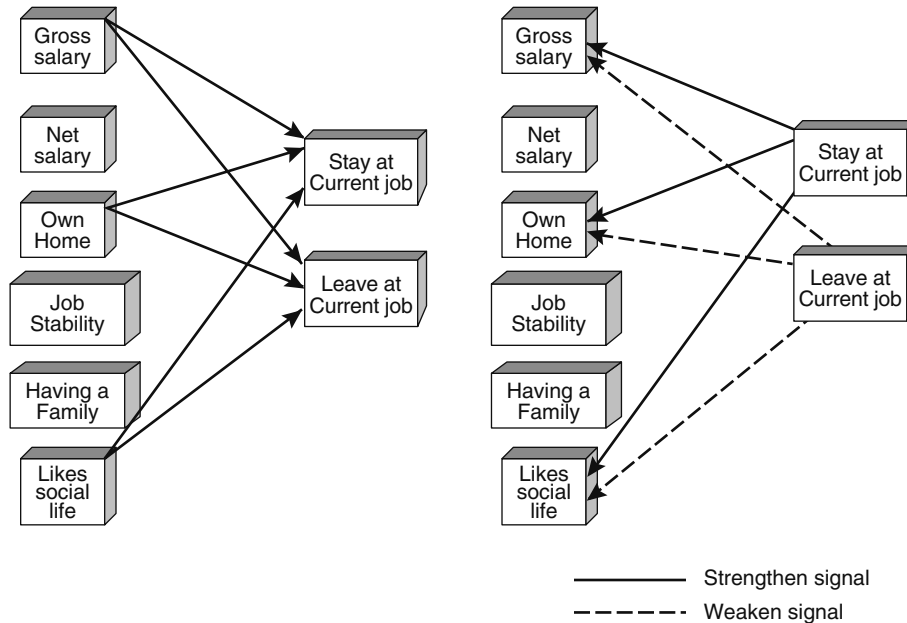
Neural networks. A second way to store knowledge is in a neural network. Although they are not seen as expert systems, neural networks are a type of decision-making system. They are organized like the human brain. The brain is a network of neurons—nerve cells—that fire a signal when they are stimulated by smell, sound, sight, and so forth. As Brian O'Reilly¹⁰ explains, scientists believe that our brains learn by strengthening or weakening these signals, gradually creating patterns. A neural network contains links (called synapses) and nodes that also fire signals between each other. Neural networks are more intelligent than the other forms of knowledge representation discussed here because they can learn.

We present a good description of how a neural network learns by describing how a simple one might evaluate credit applications. As shown in Figure 2, the first layer of this neural net has six “neurons” that represent the criteria for distinguishing good credit risks from bad credit risks. The six criteria are gross salary, net salary, own home, job stability, having a family, and likes social life. Each of the six is connected to the two neurons in the second layer: stay at current job and leave current job.

To train the system to distinguish between the two, the network is fed the example of an applicant with a gross salary who owns a home and likes social life. Each of these three neurons sends a signal of equal strength to both the stay at current job and leave the current job neurons because it has not been trained.

The network is trained by telling the two second-level neurons the outcome of this previous loan: It was paid back. The profitable neuron sends a signal back to the three saying, in effect, “You are right, send a stronger signal next time.” The leave the current job neuron, on the other hand, replies with, “You are wrong, send a weaker signal next time.” The network is then given many more examples so that it learns the predictors of stay at the current job and leave the current job, readjusting its signal strengths with each new case.

FIGURE 2 Training a Neural Network



Source: Brian O'Reilly, "Computers That Think Like People," *Fortune*, February 27, 1989, pp. 90–93.

Once the network is trained, the gross salary neuron might send a signal worth 10 points to the stay at the current job neuron, whereas the home-owner neuron might send only 2 points. And the job stability neuron may send 2 points to the leave the current job neuron and a minus 2 points to the stay at current job one. Because liking a social life is irrelevant, it will send zero points to both. New applications will be evaluated based on these learned patterns.

Neural networks have been used by an automaker to detect defective motors, by oil drillers to describe the progress of underground rock cracking based on sensor data, by a manufacturer to track manufacturing variations to determine the optimum manufacturing conditions, and by computer manufacturers to recognize hand printing.

Rule-based systems. A third way to store knowledge in an ES knowledge base is through rules. In fact, this is the most common form of knowledge representation. The rules are obtained from experts who draw on their own expertise, experience, common sense, ways of doing business, regulations, and laws to state the rules. Rules generally present this knowledge in the form of if-then statements. The number of rules determines the complexity of the system, from a few to many thousands. Rules are appropriate when knowledge can be generalized into specific statements. Knowledge acquisition is a tedious and expensive process. However, once transferred to the ES, and validated with real-life situations, the knowledge in the expert system can be deployed to automate a number of highly structured and well-defined decisions that would have been taken by human experts, an expensive resource that can be used for more productive tasks.

One of the first commercially successful ESs was built by American Express. It is still in use today and is actually a fundamental part of the company's everyday credit card operation. It is a rules-based ES. Here is that story.

CASE EXAMPLE

AMERICAN EXPRESS

www.americanexpress.com

In 1988, American Express (AmEx) implemented the Authorizer's Assistant, an ES that approves credit at the point of sale. It started as an R&D project, took two years to develop, and was put into production with 800 rules. Today, it has over 2,600 rules and supports all AmEx card products around the world. Its purpose is to minimize credit losses and catch fraud. It saves the company millions of dollars a year and has been a phenomenal success.

Whenever an AmEx card is run through a point-of-sale device, the transaction goes into AmEx's credit authorization system (CAS), which is a very important system for AmEx because, in essence, it gives away money. CAS is implemented worldwide and operates 24/7. It is such a significant system that the company president is notified if it is down for 45 minutes or more.

Co-processor systems, such as the Authorizer's Assistant, have been added to CAS. The Authorizer's Assistant authorizes credit by looking at whether cardholders are creditworthy, whether they have been paying their bills, and whether a particular purchase is within their normal spending patterns. It also assesses whether the request for credit could be a potential fraud. Before deploying Authorizer's Assistant, transactions

that were not automatically approved by CAS were referred to a person for analysis and a decision. The most difficult credit-authorization decisions are still referred to people, but the Authorizer's Assistant has automated judgment to raise the quality of authorization decisions.

Authorization decisions are driven by the type of credit charge—store, restaurant, and so on. They are also influenced by whether cardholders are in their home city, on vacation, or traveling. A hotel bill or charges in a city other than where they reside would point to the latter. To detect fraud while someone is on vacation, the credit authorizer looks at the number of charges per day. An appropriate question for the system to ask would be, "Is the cardholder's spending velocity 'in pattern' (following his or her typical spending pattern)?" Customer-servicing issues and credit policies are also taken into account in the authorization decision. For example, a restaurant charge needs to be handled differently from a camera store charge, because the restaurant charge happens after the service has been rendered and the purchase, unlike a camera, cannot be resold. AmEx also does not want to embarrass a cardholder in the social setting of a restaurant.

(Case Continued)

Development of the System

The Authorizer's Assistant is a rule-based expert system, and in creating the rules, AmEx had to refine its company policies. One example was the commonly used phrase "sound credit judgment." Before the system was built, this phrase was often used but never defined. Developing the system forced the company to define the phrase in quantifiable rules.

A rule might be framed in terms of the question, "Does this person shop at this store or often buy this kind of merchandise?" If the answer is "yes," the charge would be "in pattern." If the amount is high, another rule might ask, "Does the cardholder pay his or her bill on time and is his or her 12-month credit history good?"

The rules were generated by interviewing authorizers with various levels of expertise. Five were assigned to work with the developers. Some were the top experts (who made correct decisions at least 90 percent of the time); others had a track record of being right only 80 to 89 percent of the time. Both types of experts were used so that the developers could compare good and not-so-good decisions.

To codify the experts' knowledge, the developers studied individual charge histories in detail, broke down the decision process into its components, and focused on each one to refine it. Sometimes they also proposed cases to the experts and recorded the information they asked for to make a decision.

Two kinds of knowledge are captured in the Authorizer's Assistant: policy knowledge and judgment knowledge. Policy knowledge is like textbook knowledge. Judgment knowledge is applied to bend the rules set down in the policy to benefit

the cardholder (and keep his or her business). This type of knowledge is very important because it enhances customer service in the eyes of cardholders. Thus, the rules in the system protect the company against loss and the cardholder from embarrassment.

The seven developers also spent several weeks working in the credit authorization environment so that they could understand what the experts were talking about. The system was designed to mimic how people made credit authorization decisions. The knowledge engineers (developers) thus had to develop expertise in credit and fraud as well as in the analysis of cardholder charge patterns. In essence, they acted as credit authorizers for a short time, talking to real cardholders and making authorization decisions on the telephone on the fly. This experience helped them realize how time-sensitive authorization decisions can be. The cardholder may be waiting at an airline counter to get the charge approved; a delay could cause the cardholder to miss the flight. The system had to be designed to deal with this type of customer-sensitive situation; AmEx does not want to embarrass a cardholder by bringing him or her to a telephone unnecessarily.

The vice president of risk management states that the system can be adapted quickly to meet changing business requirements. For example, if a large manufacturing company falls on hard times, AmEx can change the rules that apply to the cities where that company is a major employer so that it can respond compassionately and quickly to credit issues that inevitably will arise. In all, management reaction to the Authorizer's Assistant has been very positive. ■

Degree of Expertise

The degree of expertise in an ES can be characterized by the kind of assistance it might provide to a person. It might function as an assistant, a colleague, or a true expert.

As an assistant, the lowest level of expertise, the ES can help a person perform routine analyses and point out those portions of the work where the expertise of the human is required. The Dipmeter Advisor, developed by Schlumberger Ltd., falls into this category. It reads charts produced by instruments that have been lowered into an oil well that is being drilled. Reading such charts, looking for a small amount of significant data, is a tedious job for humans. The ES reads the charts and indicates those portions where human experts should concentrate their attention.

As a digital co-worker, the second level of expertise, the system and the human can “talk over” the problem until a “joint decision” has been reached. In this use, the human may employ the “why” and “how” features of the ES to understand the system’s train of logic. ESs move beyond the capabilities of DSSs because they are not only able to solve a problem but also explain to some extent how they solved the problem, and provide a reliable means of solving similar problems. When a colleague system seems to be going down the wrong track, the human can put in more information to get it back on track to reach a joint decision.

As an expert, the highest level of expertise, the system gives answers that the user accepts, perhaps without question. This means that the system performs as well as the top 10 to 20 percent of the human experts in the field.

Agent-Based Modeling

Agent-based modeling is a simulation technology for studying emergent behavior; that is, behavior (such as a traffic jam) that emerges from the decisions of a large number of distinct individuals (drivers), notes Eric Bonabeau, president of Icosystem, which builds such modeling systems.¹¹ Each driver is an agent with his decision-making ability that helps him drive the car. When all drivers are involved in a heavy traffic, without having to talk to each other, they collectively manage the traffic in a “self-organized” manner. Concurrently, they negotiate turn, decide when to change lane, when to reduce speed to let other take over, etc. Somehow, the traffic flow is rather satisfactory.

In agent-based modeling, the simulation contains computer-generated agents, each making decisions typical of the decisions an individual—the drivers in the example above—would make in the real world.

A software agent is a program that performs a specific task on behalf of a user, independently or with little guidance. Like a human agent, a software agent possesses certain skills and knowledge to interact with the user(s) or other applications (cooperation, communication, command and control). A software agent consists of the following components:

- User-agent interface to interact with the user or another software application or software agent
- Processing engine to perform the intended task
- Procedure repository that store data that are needed to run the intended task

Agents are the result of a paradigm shift in developing application software. Software is no longer regarded as a preprogrammed, predetermined tool. Rather, it is considered as an autonomous assistant to the users—simulating a human relationship, hence the word “Personal Assistant” in the software development literature.

Supporting Information-Centric Decision Making

Here are some examples. If modeling a day at a theme park, the agent representing a family of four would make different decisions than the agent representing teenagers on a date. Bonabeau believes modeling the confluence of a huge number of individual behaviors underlies understanding the mysteries of why businesses, markets, consumers, and other complex systems behave as they do. In modeling the behavior of highly complex systems via individual agents, agent-based systems often arrive at counterintuitive results. He states that this decision-making technology can be used to predict the unpredictable, and he gives numerous examples of how it has been used. Here are just a few.

- Nasdaq was going to switch its tick size from eighths to decimals, believing that the change would allow stock buyers and sellers to negotiate more precisely and decrease the buy–ask price spread. Using agent-based modeling, with agents representing all the players in its stock market, each making decisions based on real-world strategies, Nasdaq found that the smaller tick size would actually increase the buy–ask price spread because it reduced the market’s ability to do price discovery.
- A European retailer wanted to redesign its incentive plan for its country managers. At the time, incentives were based on having the fewest stock-outs (a product running out of stock on the shelves). However, this incentive encouraged hoarding, spoilage, and high-cost rush orders. Agent-based modeling recommended basing incentives both on low stock-outs and on storage costs, because it would connect managers’ local behavior with the organization’s global performance.
- Southwest Airlines wanted to revamp its cargo operations. The dispatchers loaded cargo onto the flight that would reach the destination soonest. But the result was piles of packages at the end of the day, high security costs, and endless loading and unloading of packages. Agent-based modeling found that costs would be lower and packages would arrive just as quickly by putting them on a plane that would eventually land in the destination city.¹²
- A company planned to change its recruiting practices from hiring college graduates who fit its company culture to hiring experienced people. Agent-based modeling demonstrated that this change would lead to higher staff turnover (which the company had expected) and a decrease in the company’s knowledge base (which the company had not expected). Thus, if it was to change recruiting practices, it would need to find ways to capture the knowledge of experienced employees before they left.

These five seemingly competing technologies that support decision making often overlap and combine. For example, some DSS products incorporate tools and techniques from AI. In the form of agents, DSSs are providing the delivery vehicle for ESs, knowledge representation, natural language query, and voice and pattern recognition. The result is intelligent DSSs that can suggest, learn, and understand managerial tasks and problems. Likewise, data mining is often part of a DSS or EIS. The next section demonstrates how these decision support technologies and other technologies are being mixed and matched to form the foundation for the real-time enterprise.

TOWARD THE REAL-TIME ENTERPRISE

The essence of the term “real-time enterprise” is that organizations can know how they are doing at the moment rather than waiting days, weeks, or months for needed information, as has been the case. It is often equated to an airline pilot trying to fly the plane using time-delayed sensors or trying to drive a car without split-second information about what is happening on the highway. The real-time enterprise would be one that is able to function based on real-time information.

Through IT, organizations have been able to see the status of operations closer and closer to real time. The Internet is giving companies a way to disseminate closer-to-real-time information about events, such as a large customer order or cancellation, a supply-chain disruption, weather or governmental disruption, important news, and so forth.

The notion has gotten to the hype point. It is prominent in vendor advertising. That means the notion has some validity, but it is not as easy to achieve as vendors might lead you to believe. This real-time reporting is occurring on a whole host of fronts. Following are just five of those fronts: enterprise nervous systems (to coordinate company operations), straight-through processing (to reduce distortion in supply chains), real-time CRM (to automate decision making relating to customers), communicating objects (to gain real-time data about the physical world), and vigilant information systems (to move to a sense-and-respond culture).

Enterprise Nervous Systems

One approach to the real-time enterprise is to build an enterprise nervous system. In an interesting white paper from Tibco and Gartner,¹³ the two companies state that an enterprise nervous system (the technical means to a real-time enterprise) is a kind of network that connects people, applications, and devices. This system differs from many past systems in four ways:

1. It is message based, which means that applications, devices, and people communicate with each other via messages. As the Internet has shown, sending messages is a very efficient and effective way of dispersing information among huge numbers of parties.
2. It is event driven, which means that when an event occurs—a car arrives at a dealer’s lot, a passenger boards a plane, a factory ships a truckload of parts—that event is recorded and made available.
3. It uses a publish-and-subscribe approach, which means that the information about the event is “published” to an electronic address and any system, person, or device authorized to see that information can “subscribe” to that address’s information feed, which is automatically updated whenever a new event occurs. Portal technology has a similar self-service characteristic. A company posts information on its portal, and if you are authorized to see that information, you can access it when you want, or subscribe to receive it automatically in real time. This approach is one way to inform hundreds, thousands, or millions of people or systems of an event in real time in a format customized to their system or device.

4. It uses common data formats, which means the data formats used in disparate systems are reduced to common denominators that can be understood by other systems and shared.

Here is an example of one such nervous system.

CASE EXAMPLE

DELTA AIR LINES

www.delta.com

Delta Air Lines has implemented an enterprise nervous system that is, over time, incorporating the disparate systems the airline had in the late 1990s. At that time, Delta had 60 million lines of code, 70 databases, and 30 technology platforms, most of which did not communicate with each other or share their data, notes Tom Stewart.¹⁴

Now, Delta has a nervous system that has gotten rid of over 30 of the databases and one-fourth of the code, and the consolidation is continuing. This system manages the airline's gate operations. Delta has 2,200 flights a day, one every 39.3 seconds, says Stewart. Each is managed by the system, in real time. When a flight has a gate change, for example, everyone who needs to know about that change—gate attendants, baggage handlers, caterers, passengers—gets the data in the appropriate way. Passengers, for instance, receive the information on screens above each gate.

The system was installed by the Feld Group, notes Stewart, led by Charlie Feld, the former CIO of Frito-Lay, who installed a real-time system at Frito-Lay and has gone on to do the same at a number of

other companies. At Frito-Lay, all of the sales force had laptops to record every sale in real time; all the executives had PCs to see the sales. As a result, Frito-Lay took back \$40 million less in stale product each year, sales force paperwork dropped by 40,000 hours a year, and Frito-Lay's revenue increased from \$3 billion to \$4.2 billion in just three years.

At Delta, Feld drew on software from Tibco, which provides the foundation for the enterprise nervous system. Feld believes the best way to get a real-time enterprise is to use a publish-and-subscribe approach using EAI products. Using the Tibco products, which include a type of messaging middleware, disparate applications can talk to each other. The software puts the data in these systems into common forms so they can be understood by the numerous applications.

Generally, to start down this EAI path, a company needs a system that is large enough to affect customers, impress the CEO, and intrigue the IT organization, states Stewart. At Delta, this first system was a new gate-and-boarding system. The system is big, it is used by

(Case Continued)

60,000 Delta employees and 100 million customers, and it affects everything from maintenance crews to reservation clerks to Delta's frequent flyer program. Formerly, the various functions had their own systems and databases. The

new system replaced them all with one set of data. Now, when an event occurs, it ripples to everyone. Delta is now expanding those ripples out to its partners who also serve its passengers: caterers, security companies, and such. ■

Straight-Through Processing

The notion of a real-time enterprise has generated two buzzwords worth knowing. One is zero latency, which, according to Gartner EXP, was coined in 1998 and means reacting quickly to new information (with no wait time). The premise is that faster action leads to a competitive edge.

The second term is straight-through processing, which means that transaction data are entered just once in a process or a supply chain. The Delta example shows straight-through processing within an enterprise. The notion applies even more in supply chains. In fact, reducing lags and latency in supply chains is a major goal these days.

As the *Economist* points out, supply chains experience a bullwhip effect when they do not have straight-through processing. A customer order can trigger a company to generate an order to its supplier, who, in turn, generates its own orders to its suppliers. But generally, these orders are larger because the supplier wants to compensate for unforeseen events. Those upstream suppliers, in turn, order from their suppliers, and their orders are often larger as well. Moving upstream through the supply chain there is increasingly greater variance from the original order. If the customer then cancels the order, that cancellation ripples through the supply chain with the upstream firms experiencing the bullwhip effect (a small change by a customer results in a huge change upstream).

Real-time information through the supply chain would likely reduce that ever-growing discrepancy from reality and thus reduce the bullwhip effect. In short, if this supply chain had straight-through processing, the original customer order would be entered only once and all suppliers at all levels in the chain would see the original order and respond accordingly. This is a tall task, but the approach being used is similar to the enterprise nervous system with events, messaging, and publish-and-subscribe features.

Real-Time CRM

Another view of a real-time response might occur between a company and a potential customer, perhaps via a customer call center or a Web site. Following is an example of real-time automated decision making using some of the technologies discussed in this chapter.

CASE EXAMPLE

A REAL-TIME INTERACTION ON A WEB SITE

www.ssaglobal.com

As an illustration of a real-time interaction via a Web site, consider an example from E.piphany,¹⁵ a company that sells real-time CRM software as a component of its suite of CRM products. E.piphany was acquired by INFOR SSA Global. Its CRM software is now called an Infor CRM Solution. Following is the sequence of events (1 to 11), as noted in Figure 3:

1. A potential hotel guest visits the Web site of a hotel chain that uses CRM software.
2. The site visitor clicks on a hotel in the Orlando area. Information on that real-time event flows to the real-time server powered by the software.
3. The server initiates a number of requests to create a profile of that customer.
4. It may request past history of interactions with that customer from the data mart. Those interactions would include not only Web site interactions but also call center interactions, hotel stays, and so on.
5. The server may request past billing information from the chain's ERP system.
6. It may want past purchase history from the hotel's e-commerce system.
7. Using all those pieces of information, the server then uses its analytics to make some real-time offers to the Web site visitor.
8. If it is off-season in Orlando, hotel management may have created a business rule that says, "For any repeat customer considering booking at least a 2-night stay at this hotel in off-season, offer a 20 percent discount." If, indeed, this customer has stayed at the chain before, the server can make that offer on the spot, probably in a very noticeable pop-up box on the Web site.
9. Or the server might use the real-time mining tool to make an offer based on the customer's past stays at the hotel, having mined that information from the compiled profile. For instance, it might ask if the customer still wants a king-size bed in a nonsmoking quiet room, as in the past.
10. Or, using the collaborative filtering technology, based on preferences of other hotel guests with a similar profile, the system might offer three special choices: a laptop computer in the room, a bottle of wine, or a half-hour massage at the hotel's spa. Generally, the real-time

(Case Continued)

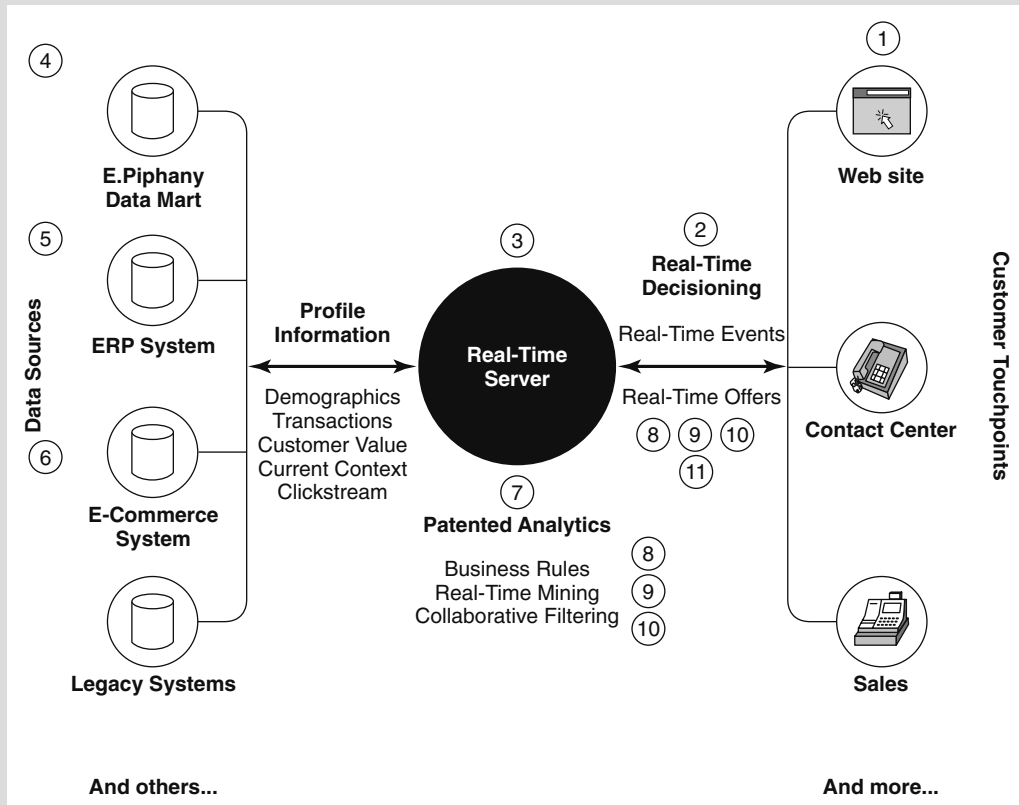


FIGURE 3 A Real-Time Interaction on a Web Site

Source: Reprinted with permission of E.piphany, Inc.; www.epiphany.com (now www.ssaglobal.com).

mining and collaborative filtering tools are used together.

11. The Web site visitor's responses to all the offers are recorded and taken into account by the software and used when making offers to other Web site or call center visitors.

In a call center, the call center representatives would have the same kinds of

technology support for making decisions and verbally making these offers (and recording responses) over the phone.

Besides the real-time nature of this interaction, another feature is that the system learns from each interaction. Thus, it includes the latest responses in its real-time decision making and offers, keeping up with trends and honing its knowledge of clusters of customers and noncustomers. ■

Communicating Objects

The notion of the real-time enterprise is intriguing for yet another reason. The *Economist* articles on the subject mention sensors and tags that provide information about the physical world via real-time data. We take the editorial freedom of calling them communicating objects.

A communicating object can tell you what it is attached to, where it is located, where it belongs, and a lot more information about itself. Technically speaking, such an object is a radio frequency identification device (RFID). It is a small chip that contains information about the object it is attached to, such as a jet engine, a hotel uniform, or a package—anything someone wants to keep track of.

As Glover Ferguson¹⁶ of Accenture explains, communicating objects are also called smart tags. They can be as small as a match head, and they are implanted on a wafer surrounded by a coil of wire that serves as the tag's antenna. The antenna allows the tag to be polled by a reader that passes within a few feet. The tag can be passive (read only) or active (send out signals). Those that are larger can be read from farther away. Any number of tags can be read by a reader at once, so multiple items on a pallet can be read simultaneously, not one at a time, even in harsh weather conditions. Most importantly, these tags can carry far more information than their predecessors' bar codes. They can carry the history of an item, not just its ID code and price.

In 2003, RFID became a hot technology because Wal-Mart announced that by January 2005 it wanted its top suppliers to place RFID tags on all pallets, cases, and high-ticket items. (Wal-Mart's schedule has since been extended.) The U.S. Department of Defense announced its own initiative the same year. Foreseeing the impact of RFID technology in 1997, the Uniform Product Council (UPC) began an initiative called "Sunrise 2005" to encourage retailers to make their systems RFID compliant by that time. The UPC recognized that bar codes have 11 digits, but that the electronic product codes (EPCs) used by RFID have 13 digits. Retrofitting legacy systems to accommodate the two additional digits is akin to the Y2K challenge CIOs faced in the late 1990s. Efforts to retrofit the old bar code system to the new EPCs required for RFID will be mammoth.

RFID presents a number of potentially other large costs to CIOs. The tags can accumulate histories of products. How much more storage and bandwidth will a company need to capture and communicate all these data? Where should the data be stored and for how long? What sorts of new programs will be needed to analyze the data? In short, CIOs need to understand how well their existing architectures and infrastructures can accommodate RFID and the changes that will be needed, notes Levinson, a writer for cio.com.¹⁷ And advocates of consumer privacy are concerned about RFID tags placed on individual products.

Ferguson believes smart tags are going to transform industries because one day they will talk to one another, which will change how work is handled. For example, Seagate, the disk drive manufacturer, has a smart tag on each individual disk it manufactures. Each type of disk must go through a specific sequence of processes, depending on its type. The checklist on the tag directs it through the correct sequence and ensures that each step is completed before the next one begins. The tags have allowed Seagate

to uncover more sources of production errors than in the past, notes Ferguson. A key is the object's ability to capture new information.

Communicating objects are also major theft-prevention devices because they are cheap enough to affix to often-stolen items, such as cartons of liquor and PC motherboards. In the case of motherboards, when one is illegally taken off-site, it can automatically be disabled by the owner, thereby preventing its use. Tags can even be more effective than a set of keys in safeguarding a location, notes Ferguson. People entering an area may be required to wear an RFID wristband. Likewise, these tags can keep people with Alzheimer's disease in appropriate areas, sending out a warning when they are beyond the bounds of their facility or are near a dangerous area, such as a staircase.

Ferguson notes that this technology gets really interesting when objects begin communicating with each other, which he calls object-to-object communication. Theft prevention is a stand-alone application, and new forms of inventory management (say, by a business partner) are a "four walls" application. At first, PCs were stand-alone and used within companies. But the Internet unleashed entirely new uses of PCs and their successors. The same will happen with smart tags, predicts Ferguson.

With these objects, a whole new "silent commerce" will emerge. "Fresh" fish will be able to tell you if they are really fresh, because their smart tag can tell you whether they have been frozen at any time since being caught. Variable pricing could become more of the norm. In Singapore, for instance, cars carry smart tags, and drivers are charged variable prices for where they drive in the city and when. The prices are set to encourage or discourage driving at different places at different times. It is an example of real-time traffic control.

Vigilant Information Systems

The premise of the real-time enterprise is not only that it can capture data in real time, but also that it has the means to act on that data quickly. One theory for how to act fast was espoused in the 1950s by Colonel John Boyd, a U.S. Air Force fighter pilot.¹⁸ He believed he could win any dogfight in 40 seconds (or less). In fact, he put money on his ability. He challenged any fighter pilot, stating that starting from any position of disadvantage he would have his jet on the challenger's tail within 40 seconds or he would pay the other pilot \$40. He is said to have never lost a bet, even to pilots in superior aircraft.

He called his theory the OODA (Observe, Orient, Decide, Act) loop because it consisted of the following four actions:

- Observe where the challenger's plane is,
- Orient himself and size up his own vulnerabilities and opportunities,
- Decide which maneuver to take, and
- Act to perform it before the challenger could go through the same four steps.

Boyd's goal was to operate inside his challenger's loop, that is, to take the four steps faster. By outthinking other pilots, he could outmaneuver them, which often led to confusing them. An OODA loop is shown in Figure 4.

Western Digital has used this type of thinking to move itself closer to operating in real time with a sense-and-respond culture that aims to operate faster than its competitors.

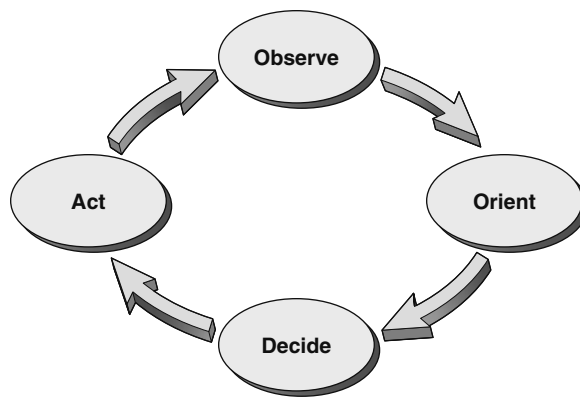


FIGURE 4 An OODA Loop

CASE EXAMPLE

WESTERN DIGITAL CORP.

www.westerndigital.com

Western Digital, with headquarters in Lake Forest, California, manufactures hard drives for PCs, storage systems, and home entertainment systems. It has nearly 17,000 employees, revenues of \$3 billion a year, manufacturing plants in Malaysia and Thailand, and customers around the globe.

The industry has short product cycles and experiences intense competition, which keeps product quality high and prices low. Western Digital's main challenge has been to keep up with customers' relentless demands for more storage and faster access while keeping its costs down.

Companies that have not kept up have not survived. Western Digital has survived, even excelled, notes Robert Houghton, Western Digital's CIO, and his coauthors.¹⁹ IT and OODA-loop thinking have been part of this success, providing management with integrated data to

manage enterprise-wide and the ability to respond to changes more rapidly.

The Underlying Vigilant Information System

Houghton's IS organization built what they call a vigilant information system (VIS), which Houghton et al. define as a system that is "alertly watchful." It is complex, and it builds on the firm's legacy systems. It essentially has four layers, as shown in Figure 5:

- **Raw data layer.** The first (bottom) layer consists of raw data from customer orders, customer payments, costs of drives, test data on drives, and so on.
- **Functional application layer.** The second layer, the observe layer, consists of the transaction systems (ERP, point of sale, logistics, etc.)

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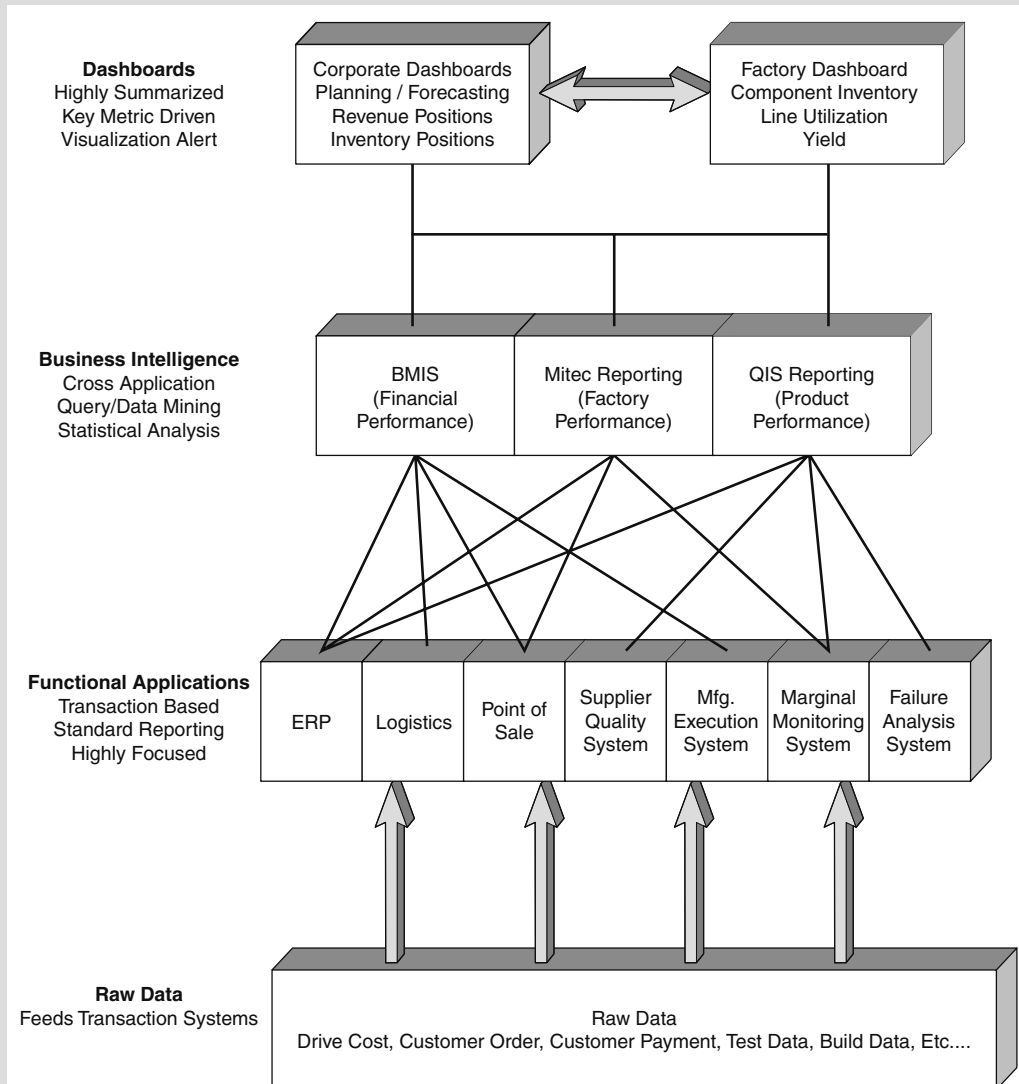


FIGURE 5 Architecture of Western Digital's Vigilant Information System

Source: R. Houghton, O. El Sawy, P. Gray, C. Donegan, and A. Joshi, "Vigilant Information Systems for Managing Enterprises in Dynamic Supply Chains: Real-Time Dashboards at Western Digital," *MIS Quarterly Executive*, Vol. 3, No. 1, March 2004, pp. 19–35. Used with permission.

that Western Digital uses to run its business. Each application performs its specific functions using the raw data from the first layer.

- **Business intelligence layer.** The third layer, the orient layer, consists of analysis and reporting systems that use data from the data

(Case Continued)

warehouse (drawn from the second layer systems) to analyze Western Digital's performance—financial, factory, and quality performance.

- **Dashboard layer.** The top layer, the decide and act layer, consists of two types of dashboards, one for use in factories (to optimize operations) and one for use by corporate (to plan and forecast). The dashboards display key performance indicators and metrics, they permit drill down, and they issue alerts when data are not within preset boundaries. Western Digital employees use this layer to decide what to do and, in some cases, initiate actions via the dashboard.

The dashboards give factory and corporate management real-time visibility into operations. Houghton et al. define real time as being “sufficiently vigilant for the process being monitored.” Thus, for the factory dashboards, real time means “as close as possible to real time.” For the corporate dashboards, real time means “after the data has been validated and synchronized among the data feeds so that all the noise has been filtered out.” It is the links between these four layers that have turned Western Digital's formerly disparate systems into a coordinated vigilant information system that funnels the appropriate real-time data to the dashboards.

The Changed Business Processes

As important as the underlying VIS is, it had to be complemented by appropriate business processes to give Western Digital a way to operate inside its competitors' OODA loops. Management knew that

new dashboards on their own would not change the company's decision-making culture. Therefore, three new company policies were drafted to leverage the VIS:

1. The company's strategic enterprise goals must be translated into time-based objectives and aligned across the company so that management has one set of metrics to manage.
2. Key performance indicators (KPIs) must be captured in real time, and be comparable, so that teams can compare operations across groups and business units, thereby improving performance company-wide.
3. Decision making should be collaborative, to coordinate actions company-wide. To achieve this new style of working, the dashboards have become the focal point in many regularly scheduled meetings, and teams have worked to ensure that people with different expertise are involved in the meetings, from afar, if necessary. It has taken teams quite a while to figure out what information others need to participate in decision making while being “virtually there” rather than in the room.

Each dashboard contains its appropriate real-time metrics and KPIs, and each metric and KPI has its own target level and a variance setting. When a variance is exceeded, the appropriate executive is alerted.

The Shop-Floor OODA Loop. The shop-floor supervisors in the factories, who manage closest to real time, operate on

(Case Continued)

the tightest OODA loop. They receive a page or a flashing light on their dashboard when one of their variances is violated. The time from alert to action is often minutes, rather than the former hours or days. Sometimes, they can diagnose and resolve the problem using their dashboard because the dashboards can be used to initiate actions.

The Factory OODA Loop. The production managers, who oversee multiple production lines, operate on an OODA loop that is not as tight as the shop-floor OODA loop. They, too, receive alerts, but a more important use of their dashboard is at their daily production meeting, where they assess yesterday's performance and discuss ways to improve operations. The "yesterday problems" already handled by the shop-floor supervisors are filtered out. So the production managers only see the unresolved issues, which reduces their information overload and quickens their OODA loop, note Houghton et al. As a result, their daily production meetings have dropped from 5 hours to 1.5 hours. These meetings involve 15 people, so the dashboard system provides production managers significant time savings in these meetings alone. The system has also reduced micro-management; there is no longer haggling about who has the right data because they all see the same data.

The production managers also use their dashboard in a learning mode, performing "health checks" of the operational aspects of the factory to see what is and what is not functioning well. Western Digital has learned that the shorter the OODA loop, the more frequent the health checks need to be, state Houghton et al.

The Corporate OODA Loop. Corporate executives receive alerts on their dashboards, and they find they can uncover root causes faster because of the dashboards, note Houghton et al. But they mainly use their dashboards to perform health checks for the enterprise as a whole. Their OODA loop is not as tight as the factory loop, but their decisions often affect the factories. Many decisions require consultation with others, so people routinely send screen shots or references to screens to others so that they all see the same data when discussing an issue.

Benefits of the VIS

The VIS has, indeed, quickened all three OODA loops and helped to link decisions across them. Management's goal is to be able to initiate a change in the factories in the same work shift as the company receives a change request from a customer. When it reaches this speed of responsiveness, it believes it will gain market share, note Houghton et al.

Corporate performance has already improved measurably. Margins have doubled since the dashboards were implemented over three years ago. Management attributes the increase, in part, to the dashboards because they have helped improve data visibility, supply-chain management, and demand planning.

The VIS is moving Western Digital toward a sense-and-respond culture where it learns and adapts quickly in a coordinated fashion. The sensing (observe and orient) is handled by the VIS, whereas the responding (decide and act) is handled by the people. In this environment, timing is important. There is no point in accelerating sensing if no action can be

(Case Continued)

taken, and there is no point in accelerating responding if there is no fresh information. The two need to be in sync, note Houghton

et al., which is how Western Digital's three-nested OODA loops now work. ■

Requisites for Successful Real-Time Management

Given the advantages of more real-time activities, what are the disadvantages? Glover Ferguson¹⁶ believes that object-to-object communication could compromise privacy. He asks, "At what point does an object's ability to track, record, and communicate with other objects invade an individual's rights?" There is no cut-and-dried answer; it depends on the circumstances. It is a political issue, not a technical one, and many CEOs are going to face this question in the future, Ferguson believes. Does knowing the exact location of a company truck every minute of the day and night invade a driver's privacy? Can citizens disable their smart cars to drive where they please without being tracked? The answers, notes Ferguson, lie in CEOs understanding the context of the use of smart tags and the sensitivities that can arise in those contexts.

Omar El Sawy¹⁹ points out that in the era of speed, a situation can become very bad, very fast—much faster than in a slower economy. He believes that speed must be balanced with caution. People in a high-speed environment need deep visibility into the workings of their environment and must watch constantly for signals that something bad is likely to happen.

It is worth noting that when the New York Stock Exchange allowed programmed trading (stock trading by computers rather than people), the exchange learned after a bad experience that it also had to introduce "circuit breakers" to stop deep dives in the market caused by the systems reacting so quickly to actions by other systems. Enterprises may need to introduce similar kinds of circuit breakers when they depend heavily on systems to make decisions and perform actions for them.

Keeping these disadvantages and challenges in mind, there are, however, a number of critical areas where a company can successfully deploy real-time management.

- **Real-time data and real-time performance indicators:** Management uses a variety of performance indicators to keep track of the organization's effectiveness. Not all metrics need to or can be in real time. Not all aspects of the organization need to be provided in full detail. Attention should focus on a few high value-added real-time data that could make a difference for the users. Cost information during a sales transaction would be an example. Therefore, the company should conduct an assessment to clearly identify what key activities need to have real time and what performance indicators are needed in real time to help users adjust their decisions.
- **Technology readiness:** Running a real-time platform requires substantial computing resources. Ideally, an inter-organizational ERP would be adequate

to feed the data into a system that is capable of selecting, filtering, and compiling data to send them in real time to the designated users. Without an integrated and seamless platform, creating real-time data may slow down other activities. Mobile and Web Services are a requisite for the real-time enterprises.

CONCLUSION

It is obvious from this discussion of diverse technologies that use of IT to support decision making covers a broad swath of territory. Some technologies aim to alert people to anomalies, discontinuities, and shortfalls. Others aim to make decisions, either as recommendations to people or to act on behalf of people. Handing over decisions to systems has its pros and cons; thus, their actions need to be monitored. CIOs need to alert their management teams to potential social and economic effects of computer-based decision making because errant computer-based decisions have devastated corporate reputations and cost a lot of money. Vendors are pushing toward the real-time enterprise. However, the use of IT for these purposes should give pause so that the ramifications can be explored.

It is also important for managers to comprehend the potentials and the limitations of technologies.

QUESTIONS AND EXERCISES

Review Questions

1. What is a DSS?
2. What is the architecture of a DSS, as suggested by Sprague and Carlson?
Summarize the attributes of each component.
3. What is an institutional DSS? Give an example.
4. Explain how Harrah's Total Rewards program works.
5. What is an EIS?
6. What are the pitfalls in EIS development identified by Watson?
7. Describe three kinds of knowledge representation.
8. What does the Authorizer's Assistant do and how does it do it?
9. What is agent-based modeling?
10. What is a real-time enterprise?
11. In what four ways does an enterprise nervous system differ from many past systems?
12. What is a smart tag and how might it be used?
13. Describe the four parts of an OODA loop. What is the goal of OODA-loop thinking?
14. Describe the three OODA loops at Western Digital.
15. Explain the potential dark-side aspects of a real-time enterprise.

Discussion Questions

1. Expert systems are dangerous. People are likely to depend on them rather than think for themselves. If the system contains bad logic, bad decisions will be made and lawsuits will result. Argue for and against this claim.
2. An enterprise cannot be managed from a computer, no matter how slick the executive dashboard. Do you agree or disagree? Discuss.
3. Smart tags intrude into people's lives. There is going to be a revolt against using them to track people's movements. Argue for and against this claim.

Exercises

1. If you have ever used a spreadsheet, an ES, or a DSS, describe one of your uses and what decisions the system helped you make.
2. Find one or more current articles on the real-time enterprise. Present new information in the articles to the class.
3. Visit a local company and find out if and how it uses the technologies in this chapter to support decision making: DSS, data mining, ESs, EIS, agent-based modeling, enterprise nervous system, straight-through processing, real-time CRM, and communicating objects (RFID).

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Supporting Information-Centric Decision Making

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SUPPORTING IT-ENABLED COLLABORATION

INTRODUCTION
TEAMS: THE BASIS OF ORGANIZATIONS
UNDERSTANDING GROUPS
<i>Groups in Organizations</i>
<i>Types of Groups</i>
<i>Communities of Practice</i>
<i>Case Example: DaimlerChrysler</i>
<i>Supporting Collaboration</i>
<i>Network Armies</i>
<i>Case Example: The Open Source Movement</i>
SYSTEMS TO SUPPORT COLLABORATION
<i>Supporting “Same Time/Same Place” Collaboration</i>
<i>Case Example: Texas Instruments</i>
SYSTEMS TO SUPPORT COLLABORATION
<i>Supporting “Same Time/Same Place” Presentations and Discussions</i>
<i>Case Example: HICSS</i>
<i>Supporting “Different-Place” Collaboration</i>
<i>Case Example: Boeing-Rocketdyne</i>
MANAGING IT-ENABLED WORKFLOWS
SUPPORTING NEGOTIATION
<i>The Wisdom of Difference</i>
<i>Negotiation Support Systems</i>
MANAGING CRISES AND EMERGENCY RESPONSE
<i>Crises: Perception and Cognition</i>
<i>Technology and Infrastructure for Organization Readiness</i>
MANAGING COLLABORATION IN VIRTUAL ORGANIZATIONS
MOTIVATING A VIRTUAL WORKFORCE
<i>Governing Virtual Organizations</i>
CONCLUSION
QUESTIONS AND EXERCISES
REFERENCES

INTRODUCTION

In her book, *The Company of the Future*, France Cairncross¹ states that the company of the future will be a collection of online communities, some internal, some that reach outside the organization's boundaries into its business ecosystem, some that are designed and formed outright, and some that just grow on their own. She believes that a main job of executives and managers is to foster these communities and the collaboration they engender. A major job of CIOs is therefore to provide the technology to support online communities and online collaboration. Cairncross is not alone in her thinking.

TEAMS: THE BASIS OF ORGANIZATIONS

In the *Harvard Business Review*, Peter Drucker's² article, "The Coming of the New Organization," became the most reprinted article in the article's first year. Apparently it struck a responsive chord. In that article, the late Drucker stated that organizations are becoming information based, and that they will be organized not like a manufacturing organization, but more like a symphony orchestra, a hospital, or a university. That is, each organization will be composed mainly of specialists who direct their own performance through feedback from others—colleagues, customers, and headquarters.

According to Drucker, this move is being driven by three factors. One, knowledge workers are becoming the dominant portion of labor, and they resist the command-and-control form of organization. Two, all companies, even the largest ones, need to find ways to be more innovative and entrepreneurial. Three, IT is forcing a shift. Once companies use IT to handle information rather than data, their decision processes, management structure, and work patterns change.

For example, spreadsheets allow people to perform capital investment analyses in just a few hours. Before this technology was available, these investment analyses generally had to be based on opinion because the calculations were so complex. With computing, the calculations became manageable. More importantly, the assumptions underlying the calculations can be given weights. In so doing, investment analysis changes from being a budgeting question to being a policy question, says Drucker, because the assumptions supporting the business strategy can more easily be discussed.

IT also changes organizational structure when a firm shifts its focus from processing data to producing information. Turning data into information requires knowledge, and knowledge is specialized. The information-based organization needs far more specialists than middle managers who relay information. Thus, organizations are becoming flatter, with fewer headquarters staff and more specialists in operating units. Even departments have different functions. They set standards, provide training, and assign specialists. Work is done mainly in task-focused teams, where specialists from various functions work together as a team for the duration of a project.

To Drucker, team-based organizations work like hospitals or orchestras. Hospitals have specialty units, each with its own knowledge, training, and language. Most are headed by a working specialist, not a full-time manager. That specialist reports to the top of the hospital, reducing the need for middle management. Work in the units is done by ad hoc teams that are assembled to address a patient's condition and diagnosis.

Symphony orchestras are similar. They have one conductor, many high-grade specialists, and other support people.

Drucker claimed that we have entered the third evolution in the structure of organizations. The first, which took place around 1900, separated business ownership from management. The second, in the 1920s, created the command-and-control corporation. The third, happening now, is the organization of knowledge specialists.

Why should IS executives be interested in supporting groups? Robert Johansen,³ of the Institute for the Future and an author of two books on group working, notes that systems that support groups are important because most people spend 60 to 80 percent of their time working with others. Yet, from informal polls he has taken, people seem to feel they are most productive when they are working alone. Thus, they are not happy about how they work with others. This finding reveals a need for systems that support groups.

Groupware—electronic tools that support teams of collaborators—represents a fundamental change in the way people think about using computers, says Johansen. The nature of the tasks people need to work with others are different from the typical tasks they need to work alone. Thus, groupware is different from typical individual office automation software.

Groupware that takes full advantage of IT needs to be just another part of corporate information systems. The products need to be built on existing platforms—e-mail systems, LANs, departmental systems, and public network services, such as the telephone or the Internet. Use of these technologies must advance beyond the “horseless carriage” stage and lead to new organizational structures, he believes.

Given these three opinions on the importance of group working and the need for systems to support such collaboration, we turn to exploring the kinds of groups that exist and the kinds of systems that support their collaboration.

UNDERSTANDING GROUPS

Collaboration is all about getting work done in a group, rather than individually. However, groups differ from one another, and their work styles vary, depending on a number of factors. Here are some characteristics of groups.

Groups in Organizations

Not all groups are the same. Different types emerge for different tasks. Some of the characteristics that differentiate groups include membership, interaction, hierarchy, location, and time.

Membership

Groups can be open, where almost anyone can join. Or they can be closed, where membership is restricted. Actually, a gray scale between open and closed indicates the degree of difficulty in gaining membership.

Interaction

The group can be loosely coupled, where the activity of each member is relatively independent of the other members. Salespeople who have their own sales territories often fall into this category. Or the group can be tightly coupled, such as a project team where

the work of each member is tied closely to the work of the other members. As in the case of gaining group membership, group couplings range widely from loose to tight.

Hierarchy

A group can be just one part of a chain of command. Large public events, such as at the Olympics or the Rose Parade, for instance, are planned and conducted by a hierarchy of committees. At the top is an ongoing committee that sets the general plans years in advance and selects the site and the top people for putting on each event. The top committee then oversees the work of the various detail committees. In addition, each of the detail committees may have subcommittees working on specific portions of their responsibility. This same hierarchy of committees occurs in large IT projects, such as implementing ERP, or in defining IT policies, such as an enterprise's overall IT architecture.

Location

Group members may be collocated or dispersed. In the past, location influenced how they collaborated. When collocated, they could meet face-to-face. When dispersed, they either had to travel or use video conferencing to read each others' body language. But IT is making long-distance personal contact easier. More and more, teams and groups can work together effectively while remaining dispersed. In some cases, groups in Asia perform their work on a project and then pass that work on to a European group when their Asian workday ends. The European group progresses the work, then passes it to a group in the Americas when the European workday ends. In this type of group working, location allows round-the-clock work. This work style has become a common phenomenon.

Time

There are two aspects to the time dimension of group work: duration of the group and time intensity of the work. The work of some groups is short-lived. An ad hoc committee might be formed to uncover the root cause of a recurring problem, for instance, and then disband once that cause has been found. Other groups last for a long time; functions in an organization, such as HR or finance, are examples.

On time intensity, some groups' members work full-time on the group's work. Other groups only require intermittent work by their members. Of course, time intensity usually varies—high intensity at times interspersed with low intensity at other times.

These characteristics illustrate that providing computer-based support for groups is not uniform because of the many variations in group work. Initially, support was for intra-company groups. However, the Internet has led to the ability to provide worldwide support for global teams that cross organizational lines. The main issues are what types of groups need support and why.

Types of Groups

Here is a list of just a few of the many, many kinds of groups. Each group has a different need for IT-enabled collaboration support.

- Authority groups involve formal authority (and often hierarchy), such as boss and subordinates or team leader and team members. Membership is closed and coupling is tight, but location is irrelevant in more and more cases, and generally these groups work full-time. In matrix management, people may have two bosses, one technical and one administrative.

Supporting IT-Enabled Collaboration

- Intra-departmental groups can have members all doing essentially the same work, full-time, often under the same boss. Membership is closed, seniority generally exists, and interaction can range from tight (only do one job, on their own) to loose coupling (work with their neighbor). Location is generally close, but, as in the case of globally dispersed departments serving different parts of the world, they can be dispersed. These groups generally rely on LANs, departmental computers, and intranets to collaborate.
- Project teams generally have members who work full-time to accomplish a goal within a specific schedule. Generally, membership is closed, coupling is tight, and a hierarchy can exist. To obtain the expertise they need, these teams often have dispersed membership. They also have a limited duration: to the end of the project. Some teams bring in experts to fill special needs. For instance, a team creating a document might call on an editor near the end or a graphics person to add diagrams and handle document formatting.
- Interdepartmental work groups pass work from department to department (purchasing, receiving, accounts payable) in a chain, forming a super group. Membership is closed, coupling is tight, and hierarchy tends not to be present. In support areas, such as finance, HR, and even IT, companies have been creating shared services departments that collocate people doing similar work. Formerly, these people were in remote offices, perhaps performing several jobs. Now they work full-time on one job in a center of expertise. In some cases, the function has been outsourced, which generally moves the entire function to the provider's site.
- Committees and task forces are formed to deal with a subject area or issue. Generally, neither requires full-time participation. Committees are usually ongoing; task forces just deal with the issue and disband. Membership may not be quite as closed as a project team, and interaction might not be as tightly coupled. Generally, the work is not full-time; although, in the case of a merger, an IT architecture team may need to temporarily work full-time to design the IT architecture of the merged enterprise.
- Business relationship groups are relationships with customers, groups of customers, suppliers, and so on. Membership often is closed in that a new organization may have to earn acceptance. Interaction is loosely coupled. A hierarchy is not likely, but favored customers and suppliers can have dominating influences. Generally, these are meant to be long-lived, but that may or may not be true, depending on changes in the business ecosystem.
- Peer groups meet to exchange ideas and opinions. Examples are fraternal organizations, repairmen who call on each other for help, and prospects called together for a sales presentation. Membership can range from relatively open to closed, and the interaction tends to be loosely coupled. Hierarchy usually is not much in evidence. Often the group has dispersed members who meet face-to-face rarely but may keep in close contact electronically.
- Networks are groups of people who socialize, exchange information, and expand the number of their personal acquaintances.
- Electronic groups include chat rooms, multi-user domains, user groups, and virtual worlds, all formed on the Internet to socialize, find information, entertain themselves, gain comfort, or just experiment with the online world. Membership is

generally wide open, interaction is loosely coupled, there is usually no hierarchy, and the members are widely dispersed and most likely never meet face-to-face.

- “Communities of Practice” (CoPs) is a term coined by the people at the Institute for Research on Learning⁴ to refer to a group of people who work or socialize together for so long that they have developed an identifiable way of doing things. Such communities arise naturally at school, at work, in volunteer organizations, and in sports clubs. Some CoPs form as a way to share ideas about a technology they all use. Others form as a way to get work done faster and more easily; they informally devise shortcuts and practices. Generally, CoPs have open membership. They last as long as their members see them as useful.
- “Network armies” is a term coined by Richard Hunter of Gartner EXP⁵ in his book *World Without Secrets: Business, Crime, and Privacy in the Age of Ubiquitous Computing*, to mean a widely dispersed group of people that forms to further a cause. Hunter sees the open source movement as a network army. So are most grassroots movements, such as groups opposed to globalization, terrorist organizations, and animal rights activists. Leaders emerge and membership is usually open. Network armies increasingly use electronic means to further their agendas.

These final two types of groups—communities of practice and network armies—are probably unfamiliar because they have only recently been identified. They are likely to increase in the future because they take advantage of IT, they have the flexibility to form and act quickly (which is an advantage in our faster-moving world), and they could increasingly wield power. Thus, we delve into each a bit more.

Communities of Practice

The “father” of CoPs is Etienne Wenger, who identified them and has studied them since authoring the definitive book on CoPs, *Communities of Practice: Learning, Meaning, and Identity*.⁶ In an article with William Snyder of Social Capital Group,⁷ Wenger and Snyder point out that CoPs are all about managing knowledge; that is, capturing and spreading know-how, ideas, innovations, and experience. CoPs are an organizational form that complements other means for sharing knowledge. In fact, in some enterprises, CoPs form the foundation of their knowledge management efforts. Wenger and Snyder define them as informal groups that form around a passion for or expertise about something. This “something” can vary from deep-water drilling to check processing, they note. The subject matter really does not matter; the goal in forming a CoP is to share members’ experiences, expertise, and problems.

Though informal, some CoPs have had a profound effect on their enterprise by driving strategies, creating new lines of business, spreading best practices, solving seemingly intractable problems, retaining people, and increasing the level of expertise in some areas. To date, few enterprises have formally recognized CoPs or supported them. Without support, CoPs can be difficult to organize and then sustain.

Being informal, CoPs resist being managed. However, some enterprises have seen their value and have learned how to nurture them. Wenger and Snyder believe these enterprises are the forward-thinking ones. They have learned how to provide the

infrastructure and climate for these self-organizing entities to form of their own volition, meet and share via numerous channels (face-to-face, e-mail, IM, video conferencing), and even strengthen the organization's formal mechanisms. As an example, consider DaimlerChrysler and its support of CoPs, which began in the Chrysler Corporation in the late 1980s.

CASE EXAMPLE

DAIMLERCHRYSLER

www.daimlerchrysler.com

In the late 1980s, when Chrysler Corporation was about to go out of business because of competition from Japanese auto companies, CoPs played a large role in its survival, write Etienne Wenger, Richard McDermott, and William Snyder in their book *Cultivating Communities of Practice*.⁸ In the late 1980s, it took Chrysler five years to bring a vehicle to market; competitors took as little as three. To compete, management had to reinvent how the company worked. Its organizational structure at the time was functional, with design units passing vehicle designs to manufacturing units that then passed back the designs after modifying them for manufacturability.

To reduce this iterative process, which added significant time to development, the company reorganized into “car platforms,” such as Jeep, minivan, truck, or small car. Engineers and other workers reported to only one platform. This change reduced development time to 2.5 years—a significant improvement. However, it also led to multiple versions of parts, uncoordinated relationships with suppliers, and mistakes repeated among the platform groups, write the authors.

Employees with similar jobs needed to communicate across the platforms, but the new structure did not foster that interchange. So, some began meeting informally. Rather than formalize these cross-platform groups, they became known as Tech Clubs; in essence, CoPs that were supported and sanctioned by top management.

They began to take responsibility for their area of expertise by conducting design reviews. They even revived the old idea of creating “engineering books of knowledge,” which are databases that store the information engineers need to do their job, such as compliance standards, lessons learned, and best practices. Such books only succeed when the users “own” them and naturally keep them up to date as part of their everyday work.

Once community members within Chrysler saw the value of their book to their work, ownership took hold. They now spend much of their meeting time debating the items that should be in the chapters, and the wording that should be used, to be sure what they state is correct. The books are intended to deal with the real problems they face. Wenger,

(Case Continued)

McDermott, and Snyder point out that the engineers find these debates and discussions to be just as important as the final documents because they learn a lot from interacting with their peers. Thus, while they are building practice standards they are also building a community. The two go hand-in-hand in successful CoPs, the authors note.

The Chrysler division now has over 100 Tech Clubs, and a team is introducing the concept to its parent, DaimlerChrysler. In fact, this team helps Tech Club coordinators in the United States and Germany launch their clubs, produce useful knowledge

resources for members, and keep their clubs vibrant and relevant. The Tech Club support team also helps ensure that the clubs are working on common technology platforms so that they can share knowledge across clubs.

Wenger, McDermott, and Snyder point out that these Tech Clubs provide DaimlerChrysler with the crucial matrix structure they need to have engineers focus on their platform yet share their knowledge across platforms without the administrative headaches that formal matrix structures have required. ■

Supporting Collaboration

Although CoPs cannot be designed, they can be nurtured. Wenger and Snyder⁶ believe companies need to perform three nurturing acts to garner benefits from CoPs: identify potential CoPs, provide them with an infrastructure, and measure them appropriately.

Identifying Potential CoPs

To identify potential CoPs, companies can provide the means and experience for developing them by providing CoP consultants. Thereby, an employee interested in forming a CoP can explore the possibility with someone who understands CoPs and can help the employee interview potential members to see what sorts of problems the community should address to provide real value to members. The employee and consultant can then plan an initial activity to not only address the identified problems, but also link them to the company's agenda. But to even get off the ground, the members need to personally "connect" to the group's intent; otherwise, people will not participate.

Providing a CoP Infrastructure

To provide a CoP infrastructure, executives need to give CoPs legitimacy because they lack resources and formal standing in the enterprise. Sometimes that means extolling the contributions of CoPs and the people who organize them, instituting compensation systems that reward collaboration, and budgeting money to build IT systems that CoPs need. In some instances, membership is not open; an employee must be recognized as an expert to be invited to join. Thus, there is formal recognition of the esteem of belonging. Having executive sponsors also provides a kind of

CoP infrastructure, as does linking them to a corporate university, if one exists, or paying for them to participate in CoP activities. Providing support to organize events is also a form of infrastructure.

Measuring CoPs

To measure CoPs appropriately often means measuring their contributions in non-traditional ways because their effects may not be immediate. Their contributions may only show up in the formal organization (on a team or department's work), not in the community's work. It is not always possible to identify a good idea as originating in a CoP. To assess CoPs, note Wenger and Snyder, listen to the stories members tell about their CoP, such as how a comment at a CoP gathering spurred an idea, solved a major problem, or accelerated a project. Such anecdotes generally do not count in formal measurement programs, but collecting stories systematically can paint a picture of the kinds of contributions specific CoPs are making. In some cases, such collections of stories can even lead to estimates of money saved or revenues generated.

CoPs are emerging first in knowledge-based enterprises. But to flourish, executives need to understand their characteristics and how they work. Wenger and Snyder see CoPs as an emerging business form that will be as familiar in the near future as business units and business teams are today.

Network Armies

As noted earlier, Richard Hunter⁵ coined the term "network army," which he defines as a set of individuals and communities aligned by a cause. They have moral and intellectual influencers as opposed to formal leadership. Major differences may exist among members' overall beliefs. As an example, consider the civil liberties community in the United States, which includes members from both the left and right wings of the dominant political parties. Network armies are as permanent as their common agenda; their cohesive force is their value system. Their communications are in open forums that anyone can join. Modern communication technologies, including the photocopy machine, the fax machine, and most recently the Internet, have dramatically increased the reach of network armies.

Network armies have existed for a long time, but they can now appear suddenly with a lot of power because of three developments: (1) high-speed information flows due to a common language (English) and communication system (Internet), (2) the geometrically expanding power of networks (adding one person geometrically increases the number of interconnections), and (3) the international visibility now afforded just about any cause. Network armies go about their business in the open; anyone can join in or listen in to their discussions. As a result, says Hunter, the network army is the social and political structure that suits a world without secrets.

One of the intriguing observations Hunter makes about network armies is that hierarchies (like traditional businesses, governments, and armies) have a tremendously difficult time fighting network armies because they have no single leader; they are like a hydra with many heads. They are so dispersed and part of the fabric of society that they are difficult to find, let alone fight. Hunter believes network armies are on the rise. Here is an example of a network army.

CASE EXAMPLE

THE OPEN SOURCE MOVEMENT

Richard Hunter⁵ of Gartner EXP believes that the open source movement is a prime example of a network army. Open source means that (1) the complete source code must be distributed with any and all distributions, and (2) anyone can modify and redistribute the code to anyone to use. A prime example of open source software is Linux, the operating system whose kernel was written by Linus Torvalds. The opposite of open source is proprietary software, which is sold only in its compiled state (undecipherable by humans) and is not allowed to be changed except by the developer.

Open source is mainly about how software is developed, enhanced, and managed. The open source movement is a community with a shared culture, where people earn their membership by the quality of the code they produce. Members are volunteers; no one is paid. They do it for fun (they love to code), to hang around with other like-minded developers (“fiery brains,” says Hunter), and to be part of a worthy cause. Torvalds’ goal in developing Linux was to “write software that does not suck.” He reasoned that the best way to do that would be to let interested software developers chip in and improve any part that attracted them. Thus, it is a culture of mavericks who want lots of personal autonomy, guided by minimal conformance.

The movement has a massive flat structure with four “influencers” (including Torvalds), six to eight distributors who package versions, some 200 project leaders who manage active projects, and

some 750,000 volunteer developers (as of late 2001). The number is probably higher now. The developers follow the influencers because they have the same values. This flat structure is possible, says Hunter, because the Internet allows the influencers to communicate directly with the developers, and vice versa. Hence, the influencers know what the volunteers think, which can make it harder for them to lead as well as to mislead. In addition, all communications are open via bulletin boards, e-mail lists, and other Internet-based channels that anyone can join.

Hunter notes that when he and his Gartner colleagues critiqued the viability of open source software in 1999, they believed it would capture 15 percent of the server operating system market. “We did not realize this was a disruptive technology that could change the software world,” he notes. Less than two years later, after “getting it,” he and his colleagues significantly increased their assessment to predicting that open source would be used in 80 percent of businesses by year-end 2003.

Hunter believes it is not wise to underestimate the claims of network armies, as Microsoft apparently did. One of the grave mistakes a business can make is to become the nemesis of a network army, and that is what Microsoft did in 1998. Until that time, the open source movement’s only goal was to write useful software. However, in August 1998, Microsoft saw the open source movement as a threat and wrote an internal paper

(Case Continued)

that proposed ways to eliminate it. That study, of course, fell into the hands of an open source member, states Hunter, because this is a world without secrets. The open source movement always distrusted Microsoft, and that distrust hardened into rage once the study was published on the Web under the moniker “The Halloween Papers.”

Microsoft’s past tactics for addressing competitors are not appropriate for dealing with a network army, writes Hunter. There are no open source revenues, so Microsoft cannot undercut prices (as it did in bundling its browser into Windows and destroying Netscape). There is no one to negotiate with, so the movement cannot be bought and then taken apart (as many past competitors have been).

All “negotiations” with a network army must be in public, notes Hunter, and consist of actions, not words, which is what Microsoft is now doing. Its executives are arguing against the movement in public forums, hoping to dissuade executives from using open source software. But when it first denied, and then

acknowledged, that it was using such software itself to support Hotmail and other services due to the superiority of the open source software, Microsoft lost credibility. Open source members only believe actions. They want people to do the right thing because they see their cause as a moral one.

Hunter believes Microsoft thought it was up against a rival business and tried to use the tactics it used successfully against other businesses. However, a network army is more like a religion than a business, and you do not fight a religious movement by telling its members that they are worshippers of an evil, false god. Better to find some way to work with them on projects of mutual interest as a means of establishing personal trust. However, Microsoft did not want to coexist with anyone, so it has taken a different route. It is a dangerous route, Hunter believes. Businesses that face a network army cannot make it go away without addressing the underlying issues. Treating a network army like a business is bound to backfire. ■

Having explored types and characteristics of groups, we turn our attention to systems to support collaboration.

SYSTEMS TO SUPPORT COLLABORATION

The activities of groups can be divided into two generic categories. One is communication and interaction. Communication means transmitting information from one person to another or to several others; interaction means back-and-forth communication over time. Two, groups are involved in decision making and problem solving. The members reach a decision or form a consensus. Both types of group activities are needed in collaboration. Historically, systems supporting group work have originated from one or the other of these two major functions. Office systems, and in particular e-mail, support

people-to-people communication. Researchers in the area of computer-supported cooperative work generally have emphasized technology to aid communication, such as enhanced computer conferencing and systems to assist two or more people to work on the same project. On the other hand, group DSS work has evolved from the DSS community and focuses on reaching a conclusion, decision, or consensus, even though it includes technology to support communication.

A second way to view the work of groups is the way the late Geraldine DeSantis and Brent Gallupe⁹ did in one of the early frameworks. Their matrix has proximity of group members on one dimension (together/dispersed) and duration of interaction on the other (limited/ongoing). Note that their matrix is relevant for both communication and decision making. For example, decision making has been the intent of decision rooms, whereas LANs are usually perceived mainly as supporting communication.

Groups in close proximity and with a limited decision-making duration might use a decision room where every attendee uses a computer to participate in the group's deliberations. An example of such a room is presented shortly. Groups that are dispersed and have a limited decision-making duration might use decision rooms connected via video conferencing. Or, as at one highly advanced lab with two facilities, they might communicate via video walls. Standing by one wall allowed employees to converse in real time with someone standing by the wall at the other site. People would meet at the wall to make decisions or just to converse (as a person would when happening upon a colleague in a hallway).

Close-proximity groups with ongoing decisions could use a local decision network, IM, or perhaps a chat room on an intranet. Dispersed groups with ongoing decisions could also use an intranet, if appropriate, or a secure decision system. An example is presented shortly.

Yet a third way to categorize the work of groups uses a variation of the DeSantis-Gallupe matrix by having time on one dimension (same time/different time) and place on the other (same place/different place). This third view has become dominant, so it is used here. Bob Johansen of the Institute for the Future (ITF) is a leader in the field of groupware. He and his colleagues at ITF extended the DeSantis-Gallupe matrix to form the time/place framework shown in Figure 1.

The two values, either same or different, on each dimension designate whether the group members are communicating and interacting over time and/or distance. The "same time/same place" cell in the upper left, for example, includes electronic meeting support systems. The "different time/different place" cell in the lower right incorporates such communication-oriented systems as e-mail, computer conferencing, and use of Lotus Notes.

Until recently, there has been little integration among the systems in the cells, even though it is clear to researchers and developers that supporting collaboration must aim to permit anytime, anyplace group working. But that is changing. Systems used by individuals are also being used by groups, as demonstrated by Western Digital's use of digital dashboards. In addition, systems used in meetings are also being used to "extend" those meetings over time after the participants have dispersed. For instance, a IBM's Lotus Notes database might be used in a meeting as well as outside of it. Instant messaging is used in both settings, as are the dashboards at Western Digital. The Internet has aided in extending the use of systems among the cells.

Supporting IT-Enabled Collaboration

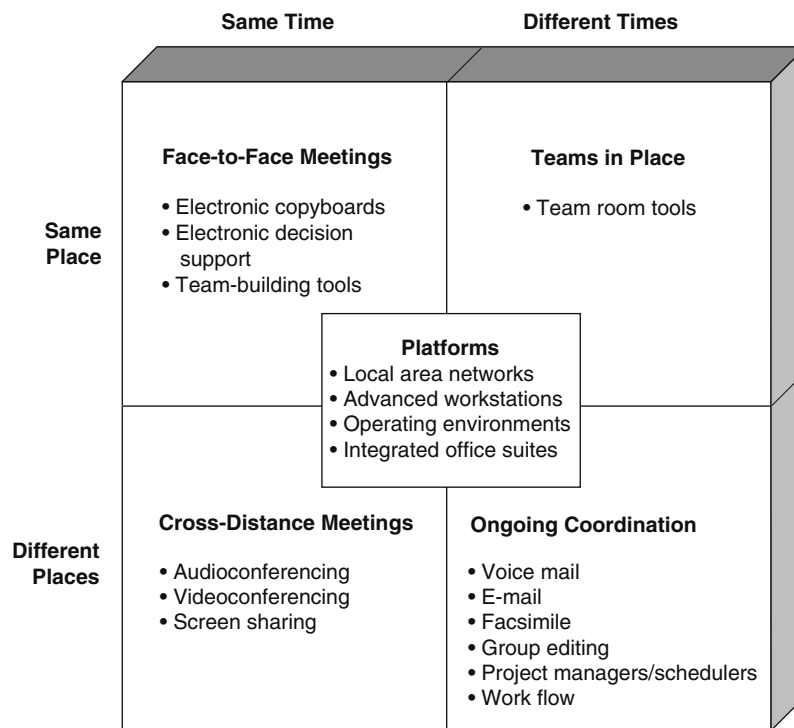


FIGURE 1 Groupware Options

Source: Courtesy of Robert Johansen of the Institute for the Future, www.iftf.org.

Supporting “Same Time/Same Place” Collaboration

Supporting “same time/same place” collaboration has generally meant supporting meetings, and a lot of work has focused on this area. One study found that the average executive in a U.S. company spends more than 800 hours a year in meetings. Not only does this figure represent a large portion of total work hours (on the order of 30 percent), but even worse, the executives reported that they considered about 240 of those hours to have been wasted in useless meetings.

The Problem with Meetings

From the many meetings we have attended, many shortcomings have been evident. Meetings often have no agenda or only a superficial one. No problems are clearly spelled out in advance, and no specific action items are proposed to address the problems. If actions (or motions) are proposed, alternatives are not fully considered. If documentation about the issues has been provided before the meeting, some members choose not to study it; they expect to be briefed at the meeting. The chairperson may do little or no follow-up between meetings to see that the members carry out their assignments.

Some meetings are doomed from the start. Key people arrive late or do not attend at all. Necessary information is not readily available. Some group members have forgotten to fulfill their assignments. Then the meeting chairperson may do a poor job of managing the meeting time. Discussion may be allowed to wander from the subject.

Time may be spent on briefing attendees or on routine matters—reviewing and correcting minutes of prior meetings, getting committee progress reports, and so on. Such meetings tend to run over their allotted time, with important items receiving poor consideration. Often, too, a few people dominate the discussion; not infrequently, these people are repetitious, saying the same things over and over. Conversely, some people do not speak up and contribute their ideas.

Finally, many meetings are wasteful from a cost standpoint. A meeting involving even a few managers and professionals costs hundreds of dollars per hour in salaries alone; large meetings can easily cost thousands of dollars per hour. If travel is required, costs are even higher. Add to these considerations the fact that the participants are unavailable for other activities while tied up in the meetings.

IT Can Help

The goals of systems for improving meetings are to (1) eliminate some meetings, (2) encourage better planning and better preparation for those meetings that must be held, and (3) improve the effectiveness of meetings that are held. Some of the typical supporting features include calendaring, scheduling, information gathering and filtering through database manipulation, spreadsheet applications that allow what-if analysis and goal seeking, group idea generation and prioritization, and interactive voting.

Eliminate some meetings. The most likely candidates for elimination are the meetings that do not call for a group decision or group action but are simply for group updating. Progress report meetings are an example, particularly if progress (actual progress versus planned progress) can be reported frequently by e-mail, the company Intranet, or an electronic team meeting place. Meetings where key people cannot attend or where needed information is not yet available can be canceled at the last moment. E-mail, voice mail, and IM systems allow the word to be spread rapidly. Intranets allow progress and status reports to be posted in a form that is easily available to everyone. In short, some of the work done in meetings can be shifted from the “same time/same place” cell to the “different time/different place” cell in the time/place matrix.

Better preparation for meetings. Computer conferencing can play a significant role in improving preparation for meetings. A computer conferencing system is actually a form of enhanced e-mail. Participants can log on at their convenience, read all entries made by others since they last logged on, and make their contributions. In the planning stage of a meeting, such a system can be used to obtain reactions to the proposed agenda, and those reactions might spur debate and alternatives. Furthermore, routine matters may be handled before the meeting, such as review and approval of minutes, receiving committee progress reports, voting on routine action items, and so on. Group members can give attention to these matters at their convenience, saving valuable synchronous meeting time for more important business. The chairperson can also use the conferencing system for follow-up activities. Finally, the system can provide a written record of pre- and post-meeting communications.

Improve the effectiveness and efficiency of meetings. One of the major benefits of meeting support systems is improved meeting efficiency and effectiveness. Meetings are more effective when the ideas generated by the group are more creative and everyone in the group is actively involved. Meetings are more effective when group commitment happens quickly. Following is a case in point.

CASE EXAMPLE

TEXAS INSTRUMENTS

www.ti.com

Before Burr-Brown Corporation merged with Texas Instruments, it was headquartered in Tucson, Arizona, and manufactured and sold electronics parts to other electronic manufacturers. It had about 1,500 employees and \$180 million in annual sales.

When the University of Arizona, also in Tucson, created a decision room in its IS department, the CEO of Burr-Brown decided to use it for management's three-day annual strategic planning meeting. He was so pleased with the results that the firm used it again the following year for the same purpose.

The Decision Room

The room has 24 workstations arranged in a semicircle on two tiers. Up to 48 people can use the room, two persons per workstation. In an adjacent control room is the file server, and at the front of the room is a facilitator's control station, as well as a rear projection screen for video, slides, and movies, and a white board. All the participants' workstations and the facilitator's workstation are connected by a LAN.

The university has developed a number of decision-room software tools, and more than 100 groups have used their decision room. That software is marketed under the name a family of tools such as ThinkTank and QuickVote by GroupSystems.com.

ThinkTank, a newer version of the Electronic Brainstorming System, is the most popular of the tools; it is used by

more than 70 percent of the groups. Like most of the tools, it allows participants to simultaneously and anonymously key in ideas on a specific question. After an idea is entered and sent to the file server, the participant can see the ideas entered by others.

After the brainstorming portion of a meeting, many groups use the Issue Analyzer to organize the ideas. A Voting Tool ranks ideas and a Topic Commenter attaches comments to ideas already in the system. Finally, the groups can use the Policy Formation software to study alternatives. Most group "discussions" using these tools are done via keyboards rather than by talking. However, some other tools do encourage face-to-face discussions.

Burr-Brown's Use of the Room

Burr-Brown's annual strategic planning meetings had always been held off-site, with some 9 to 10 executives attending. When they used the decision room, 31 executives attended. The IS department at the university provided a meeting facilitator to help plan the meeting and then facilitate it.

During the meeting, the facilitator explained each tool before it was to be used. The facilitator also kept participants on track and was the neutral leader of the meeting so that Burr-Brown's CEO could attend as a participant. In addition, an assistant facilitator and three other assistants also were present. They helped the

(Case Continued)

participants use the hardware and software, made copies of the documents generated by the system, and so on.

Before the meeting, several planning meetings were held to settle the meeting agenda. Each of the 11 divisions was asked to prepare a document to describe its one-year action plan and rolling five-year plan, including objectives and projected budgets. Participants received these plans before the meeting.

The agenda for the three-day meeting was:

- Day 1: Long-term strategy planning
- Day 2: Short-range action planning
- Day 3: Wrap-up in both areas

The meeting began with the group using the workstations to generate ideas about expected corporate performance in the coming years. They then organized these ideas to create the framework for discussing each division's plans.

For the next day and a half, they entered comments on the five-year strategic plans and one-year action plans of each division, one division at a time.

They also spent some time brainstorming ways to accomplish the year's objectives and then ranking the ideas. The group settled on specific actions they would take on the top seven issues.

On the last afternoon, they divided into four groups to discuss important topics face-to-face. The planning meeting ended with the four groups presenting their recommendations.

Executives' Reactions

After the three-day session, the participants were asked to summarize their reactions to the decision room. They reported the following.

- It increased involvement. One senior vice president commented that the decision room allowed them to do in three days' time what would have taken months. The CEO noted that the past sessions could not be larger than 10 people to be manageable; and in those sessions, only two or three people really spoke up. With the decision room, 31 people were able to attend without hampering deliberations, and the group's comments were much more open than in the past.

During one one-hour electronic brainstorming session, 404 comments were made, with the fewest number of comments from any of the 24 workstations. Seven workstations contributed more than 20. Thus, contributions were relatively evenly distributed across the group.

The group had mixed reactions about the efficiency of the system. In a post-session questionnaire answered by 26 participants, 11 stated that it was more efficient than past meetings, 9 said it was not, and 6 were neutral. However, the majority agreed that the facilitator was important in helping them use the room.

- The planning process was more effective. Several executives mentioned two aspects of the session that enhanced its effectiveness. The main one was anonymity. Due to anonymity, more people asked more questions and made more suggestions than they did in the former meeting format where all discussion was verbal, which identified the contributor.

(Case Continued)

Second, the planning process itself was extremely educational, said the CEO. "People walked in with narrow perceptions of the company and walked out with a CEO's perception. This is the view that is sought in strategic planning, but is usually not achieved," he commented three months after the session. This type of education had not happened at previous planning sessions.

One Year Later

One year later, 25 executives participated in a two-day session. About 16 had attended the year before. This year, the intent of the meeting was different. It was to critique plans so that their impact on others and the support they needed from others were more explicit.

After the CEO described the firm's objectives and the economic climate, the planning session began with the group critiquing the previous year's results, company-wide. The two-day session ended with each business unit manager commenting on the ideas received about his or her particular unit and how those ideas might affect the unit's action plan.

From the previous year's session, they learned that brainstorming is effective if the groups are structured properly. A large group can consider a few issues, such as corporate objectives, and present

ideas on those topics. But a large group cannot "converse" because of the large number of ideas to consider.

For "dialogs," Burr-Brown found it best to form several small groups, with each group addressing a few issues. One person puts in a statement, another person comments on it, then someone else comments, and so on. In the second year, they conducted small-group dialogs and found them effective.

The company also learned that the discussion room is not a substitute for a planning process. It is excellent for generating many ideas in a short time. However, because face-to-face interaction is reduced, people are less likely to make commitments and agree on courses of action than in a face-to-face setting. Therefore, Burr-Brown does not use the room to reach consensus.

The communications manager recommends that others planning to use such a room tell the participants about the room beforehand. Just send them an e-mail that describes the room and includes a photograph, he suggests. Also, explain to participants how their comments will be used because the use probably will affect how they answer questions.

In all, Burr-Brown participants were pleased with the candor and objectivity the decision room elicited. They believe its use has enhanced their annual planning meetings. ■

SYSTEMS TO SUPPORT COLLABORATION

Supporting "Same Time/Same Place" Presentations and Discussions

A second "same time/same place" situation that can benefit from group support tools is traditional presentation-discussion sessions found in classrooms, conference sessions, and business meetings. Robert Davison and Robert Briggs¹⁰ explored the

advantages of using a Group Support System (GSS) in a presentation-discussion session held in a workshop setting. The system was similar to the one used by Burr-Brown. Each member of the audience had a workstation, all interconnected by a LAN, with a public screen to show the group's interactions. The presenter had a separate screen for audiovisuals used in the presentation.

To begin their exploration, Davison and Briggs made the following seven hypotheses about the potential advantages and disadvantages of attendees using a GSS at the workshops:

- **More opportunities for discussion.** Using a GSS would eliminate the need to divide available airtime among potential speakers because participants could contribute simultaneously. The parallel, non-oral communication channels would multiply the time available to the audience. In addition, because they would be communicating online, the participants could interact with each other during the actual presentation, which further multiplied available airtime.
- **More equal participation.** Because the GSS provides many parallel communication channels, loud or strong personalities probably would not dominate the discussion. Unlike oral discussions, the amount contributed by one person was expected to be independent of the amount contributed by others. This expectation was more likely to lead to a more equal distribution of discussion among the attendees.
- **Permanent record of discussion.** The GSS would capture a permanent electronic transcript of the online discussion. Thus, both participants and presenters could access the details long after the discussion was over.
- **Improved feedback to presenters.** With unrestricted airtime for audience members and a permanent record of their discussion, presenters anticipated more comments as well as more detail in those comments. Furthermore, the anonymity allowed by the GSS would reduce some participants' concerns about negative repercussions if they contributed unpopular, critical, or new ideas. Thus, the presenters could receive more unfiltered critical analysis of their work using the GSS.
- **Improved learning.** The GSS was also expected to reduce attention blocking; that is, the loss of attentiveness caused by people trying to remember what they want to say during the presentation. Working in parallel, participants could record ideas when they occurred, then return their attention to the presentation. With more discussion time, reduced attention blocking, increased participation, improved feedback, and a permanent record, GSS users would retain more knowledge from a presentation than when they used conventional methods.
- **Remote and asynchronous participation.** In addition, people who do not attend a presentation could still benefit by reading and contributing after the event. However, this opportunity does not mean replacing all face-to-face conferences and presentations with distributed online interaction. Many people find casual conversations in hallways and over meals to be as valuable as formal presentations.
- **Potential negative effects.** Despite such benefits, Davison and Briggs were concerned that online discussions during presentations might be a mixed blessing. Human attention is limited, so online discussions might distract participants to the point where they lose the thread of the presentation. Such distractions could

outweigh other benefits. Furthermore, the online discussions could digress from the concepts in the presentation or even devolve into flaming. In addition, the anonymity of online discussion could hinder the evolution of a social community among the participants.

To explore these hypotheses, Davison and Briggs conducted some experiments at a conference known for its interactive workshop-like sessions.

CASE EXAMPLE

HICSS

www.hicss.hawaii.edu

As part of the annual Hawaii International Conference on System Sciences (HICSS), 43 participants attended a three-hour tutorial on business process reengineering. The workshop had 24 laptops placed around two sets of tables, along with two large screens—one to show the PowerPoint slides for the presentation and the other to show the contents of the electronic discussion. To overcome concerns about politeness, the presenter encouraged the participants to use the equipment by saying that he considered typing while he was talking to be both polite and desirable. However, only eight comments were submitted during the three hours. Similarly low levels of participation occurred in two later nine-minute paper presentation sessions. Again, informal interviews revealed a widespread fear of rudeness.

Davison and Briggs hypothesized that because the attendees had not used a GSS during a presentation, they might not imagine how nonintrusive it could be. They also hypothesized that participants might not realize how easy the software was to use. Therefore, the following day,

they used the GSS for three 90-minute sessions. Each session had three paper presentations.

As each session began, the moderator asked participants to use the GSS to respond to the question, “What are the most pressing research issues facing the technology-supported learning research community?” Everyone contributed an idea and then responded online to an idea contributed by someone else.

The first presenter told the group that the oral discussion following the presentations would draw from the online discussion. Two subsequent speakers asked for online responses to specific questions. All others asked for critical feedback about their presentations. As soon as the first speaker began, members of the audience started typing. Participants contributed 275 comments during the three sessions, ranging from 20 to 54 per presentation. About 94 percent of comments were presentation related, with no instances of flaming. Furthermore, during other sessions with no GSS, oral contributions to the post-presentation discussions came from no more than four people.

(Case Continued)

Observations in the GSS-supported sessions showed that contributions came from all over the audience.

One Year Later

During the following year, Davison and Briggs refined both their GSS methods and their questionnaire. They then conducted a more rigorous follow-up study at the next HICSS conference. The study addressed three primary research questions: What effect would GSS have on participation and perceived learning? Would the GSS be perceived as a detrimental distraction? What effect would GSS use have on the perceived value of the presentations and discussions?

At this conference, 34 laptops in a workshop setting let participants have a clearer view of the large public screen. All GSS-supported sessions began with a brief hands-on activity related to the session topic. A moderator invited online participation at the beginning of each presentation, and most presenters added their encouragement. Participants were urged to raise key issues from the online discussions during the post-presentation discussions. After the sessions, Davison and Briggs administered their survey questionnaire. They received data from 173 participants. Of those, 73 reported having used GSS, whereas 70 reported they had not.

Results of the Survey

From the survey, Davison and Briggs learned that GSS users were significantly more willing to participate in the discussions than non-GSS users, and they reported doing so at significantly higher levels. The participants in both the GSS-supported and standard presentations

had equal opportunity to contribute to oral discussion and did so at approximately equal rates. However, the participants who used the GSS also contributed hundreds of comments to the online discussions, so their overall participation was substantially higher. Furthermore, a much higher percentage of the audience got involved in the GSS discussion than in the oral discussion. Thus, it appears that the GSS may have accomplished its primary purpose: to increase participation and learning. But at what cost?

Overall, participants were comfortable with the amount of distraction and digression in the sessions. Only three GSS users and four non-GSS users reported negative reactions—too few for meaningful statistical analysis. Thus, the GSS did not appear to create widespread perceptions of undue distraction or digression.

No online flaming occurred, and nearly all the online contributions were relevant to the presentations. Content analysis of the online transcripts suggested that participants grasped the key concepts of the presentations, which is further evidence the GSS did not distract them from the oral delivery of information.

Overall, the respondents also reported receiving positive value from the conference sessions and the GSS. This response suggests that the GSS enabled the groups to increase the quantity of something they valued—the discussions and feedback—without reducing its quality. Many participants chose to take electronic transcripts with them at the end of each session, whereas others downloaded transcripts from the Internet. Thus, the value derived from the discussion was extended beyond the walls of the presentation hall. ■

Supporting “Different-Place” Collaboration

One of the most promising uses of groupware is ongoing coordination by groups who work in different places, and perhaps at different times. With the increasing marketplace emphasis on cycle-time reduction, companies can use the globe and its three main regions (Europe, Asia, and the Americas) to extend their workday to round-the-clock by passing work from groups in one region to the next at the end of each one’s workday, as the following personal example attests.

I had that experience for the first time a few years ago. On one of my first writing projects, the author of the report, who worked in England, e-mailed me his thoughts and questions on the topic at the end of his workday. During my workday, while he was sleeping, I did some thinking and research on the topic, and e-mailed my thoughts and findings back to him at the end of my day. While I slept, he worked. He and I worked this way, swapped long e-mails, for about 1 week. But we got at least 2 weeks’ worth of work done. It was tremendously exhilarating and productive without either of us having to work long hours.

One of the results of using IT to support collaboration is the formation of virtual teams; they exist in space, but not in one place. Some never meet face-to-face. These teams often form to handle a project, then disband after the project is complete. They tend to operate in three cells of Johansen’s matrix.

- **Same time/same place.** Typically, the team meets face-to-face initially to develop the basic plan and objectives.
- **Different time/different place.** They then communicate by e-mail and do data gathering and analysis separately.
- **Same time/different place.** If their technology is strong enough, they may have audio or video conferences to discuss developments and progress toward goals.

Following is a case example of a successful virtual team, as described in the award-winning paper to the Society for Information Management by Carman et al.¹¹

CASE EXAMPLE

BOEING-ROCKETDYNE

www.boeing.com

Boeing-Rocketdyne is the major U.S. manufacturer of liquid-fueled rocket engines, which are used to launch communication satellites. When the company faced significant competition and price pressures from Eastern European companies, it initiated a

project called SLICE (Simple Low-Cost Innovative Engine). SLICE’s business objectives were dramatic: Reduce the cost of the rocket engine to one-tenth, get the engine to market 10 times faster than the Space Shuttle’s main engine, and increase

(Case Continued)

the useful life of the rocket engine by 300 percent. In short, it was a breakthrough project. So much so that none of the senior technical managers thought the goals were possible, and these managers, as a group, had hundreds of years of experience designing rocket engines. Only one advanced program manager was willing to give the project a try.

The team faced many challenges. The first was work style. To get the best people on the project, they needed to come from different disciplines and different organizations. Management would not allow them to be taken off their regular work, so they could not be collocated. They had to work virtually, using electronic collaboration technology, without holding face-to-face meetings. Furthermore, the members had not worked together as a team, so they had different product experiences and used different design processes. Finally, they had to submit only one design, a design that Rocketdyne's conservative senior management would accept.

Despite these challenges, the project was a tremendous success. It lasted 10 months, during which time the team held 89 online meetings using a collaborative technology called the Internet Notebook. The members created and critiqued 20 designs and submitted more than 650 entries into the notebook. The seven senior technical managers who reviewed the project at its conclusion stated that it had surpassed its objectives. The design was approved for the next phase: testing the assumptions about how the liquid would flow through the components.

The design accomplished the following:

- The engine's thrust changer had only six parts, down from more than 450.

- The manufacturing cost was estimated to be \$1.5 million, down from \$20 million.
- Quality was predicted to be Nine Sigma, up from the industry standard of Six Sigma, which meant one failure in 10 billion.
- Development cost was \$47,000, down from \$4.5 million.

The team was awarded the Department of Defense's Advanced Research Program for "validating a process for virtual collocation teams."

In addition, none of the team members spent more than 15 percent of his or her time on the project, the team stayed within its budget (even though the project took longer than expected), and the total engineering hours were one-half normal using the collaborative technology.

Lessons Learned

Why was the team so successful? Carman and his colleagues studied the life of this project and suggested the following success factors.

A Prior Formal Agreement on Sharing Intellectual Property Was Crucial. Boeing-Rocketdyne anticipated the need for close cooperation on some significant projects well before the SLICE team was formed. Therefore, they began developing a partnership agreement to govern such teams. It turns out that the legal aspects of intellectual property are complicated, so they need time to be defined. Because this agreement was in place when the SLICE team began its work, the team members could move ahead quickly without being concerned about who was able to know what.

The Technology Had to Fit the Team's Virtual Meetings. The team's collaborative

(Case Continued)

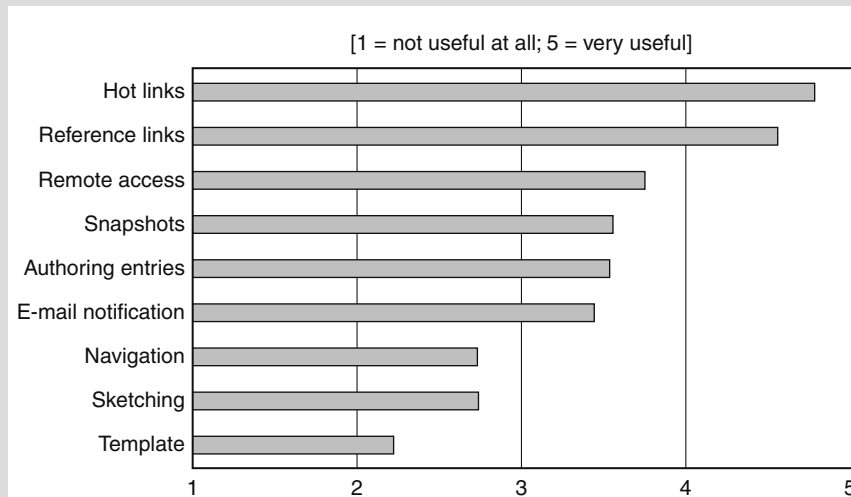


FIGURE 2 Ratings of Notebook Features for Information Retrieval

Source: Reprinted with permission of R. Carman et al., "Virtual Cross-Supply Chain Concept Development Collaborative Teams: Spurring Radical Innovations at Boeing-Rocketdyne," first-place winner of 2000 paper competition of the Society for Information Management.

technology—the Internet Notebook—was developed by a third party based on the list of requirements drawn up by several of the team members. The technology allowed the team members to

- Access the notebook from anywhere.
- Create, comment on, reference-link, search, and sort entries that could consist of sketches, snapshots, hotlinks to desktop applications, texts, or templates.
- Use an electronic white board for near-instantaneous access to entries.

Thus, from the outset, the team had a technology suited to its needs, at least as the team initially defined them. The team focused its early discussions on creating a coordination protocol for facilitating its collaborative use. Figure 2 shows how the team members rated these features.

The team adapted ways of working that required it to change the fundamental way the members were used to collaborating: from face-to-face discussions to complete reliance on technology, from sharing information sparingly (only when someone needed to know the information) to sharing all information with everyone all the time, and from using personal collaborative tools (such as company-specific e-mail systems) to using a single system. Initially, the team believed that all information would be captured and shared among all members all the time. The result would be a much greater emphasis on knowledge management and retrieval, beyond just communication.

Being Creative Required New Rules of Engagement. The team learned that its ability to be creative required meeting three requirements:

(Case Continued)

1. Jointly understand problems, possible solutions, analysis methods, and language.
2. Interact frequently as a team, with all members “present,” to share work-in-progress, brainstorm ideas, and test out solutions.
3. Be able to create new information quickly based on a particular conversation or problem, and then equally quickly discard information that was no longer needed.

The team members discovered they needed to adapt the traditional work practices of a collocated team to function as a creative body. Figure 3 shows how the need to be creative is accommodated in collocated teams, and what the SLICE team members learned they would need to do to adapt these needs to their non-collocated situation.

The Focus of the Team’s Effort Changed over Time. As the project evolved, the team learned that it had to shift its thinking

FIGURE 3 Structuring Core Processes for Virtual Teams

<i>Core Needs of Creative Teams</i>	<i>Practices of Collocated Teams</i>	<i>Practices Adapted by Virtual Teams</i>
Development of shared understanding	<ul style="list-style-type: none"> • Lead engineer is “spoke-in-the-wheel” for coordinating information and consolidating ideas into new design proposals, which constitute the shared understandings of the team. 	<ul style="list-style-type: none"> • From spoke-in-the-wheel coordination (with lead manager/engineer in center) to democratic coordination • Encourage development and use of common-language metaphors
Frequent opportunities for interaction with team members	<ul style="list-style-type: none"> • Colocation allows for frequent and spontaneous interaction. 	<ul style="list-style-type: none"> • Coupling use of knowledge repository with frequent teleconferences • Allowing one-on-one discussions when need arises but documenting results for everyone
Rapid creation and sharing of context-specific transient information	<ul style="list-style-type: none"> • Most discussion is verbal and undocumented, and it is hard to capture the context. 	<ul style="list-style-type: none"> • Promote only minimal cataloging of new information, even to the extent of restricting it to “touchstones” and “placeholders” • Timely and frequent discussions of new entries in knowledge repository to enable members to learn the context

Source: Reprinted with permission of R. Carman et al., “Virtual Cross-Supply Chain Concept Development Collaborative Teams: Spurring Radical Innovations at Boeing-Rocketdyne,” first-place winner of 2000 paper competition of the Society for Information Management.

(Case Continued)

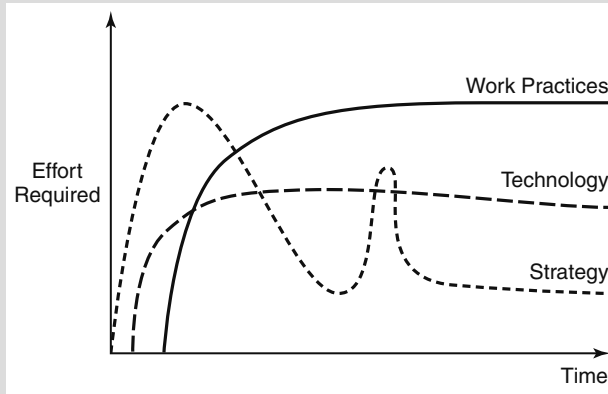


FIGURE 4 Effort Distribution over the Team's Life Cycle

Source: Reprinted with permission of R. Carman et al., "Virtual Cross-Supply Chain Concept Development Collaborative Teams: Spurring Radical Innovations at Boeing-Rocketdyne," first-place winner of 2000 paper competition of the Society for Information Management.

among three components, from thinking about strategy (how to fulfill the partnership agreement), to implementing a technology that would support collaboration of the dispersed team structure, to actual work practices that would leverage the technology. It learned that the strategy practices needed to be in place before the work or technology practices so that members did not have to be concerned with both doing the work and negotiating information-sharing arrangements at the same time.

Furthermore, the team discovered it needed the technology in place before it could think about work practices because the work style depended on the support technology. Along the way, members also learned that the technology had to be flexible enough to be adapted to different ways of working because some of their initial work practices did not work as well as hoped. So, over the course of the project, they evolved their practices, and the tool had to support this evolution.

Figure 4 shows the allocation of effort over the course of the project among these three components of the project: strategy, technology, and work

practices. As can be seen, the team needed to focus on both the technology and its own work practices over the entire span of the project. For example, a technology facilitator was required to attend all teleconferences so that problems could be fixed immediately. Members never knew when someone would not understand how to perform a particular operation or a server would go down and communications would need to be rerouted. In addition, throughout the project, as the team found work practices not working, members devoted some effort to decide on better ways of working. In the end, this attention paid off.

As noted, the SLICE team at Boeing-Rocketdyne was immensely successful, in large part due to the advanced collaboration technology it used. As usual, though, the technology was necessary but not sufficient. The team also needed a carefully developed partnership agreement in place before work began and work practices to leverage the technology, which needed to evolve as the team members discovered a technology's usefulness. ■

As this discussion of systems to support collaboration has shown, there is a spectrum of group working situations and many types of IT-based support. Furthermore, use of collaboration software can change structure within one enterprise, working relationships between enterprises, and working relationships between people in different parts of the world.

MANAGING IT-ENABLED WORKFLOWS

From a strict operational perspective, workflow deals with the automation of business processes. A workflow can be a one-time-only process. Also known as ad hoc workflow, this is a collaborative process that coordinates a team that works together to achieve a task. A more common form of workflow is one that is set up to enhance the efficiency of transaction-oriented and mission-critical tasks such as production and manufacturing and order processing.

A workflow management application defines all the business processes, from the start to finish, including all exception conditions, tracks process-related information and the status of each instance of the process as it gets executed. This definition requirement already constitutes an opportunity for the company that uses workflow to examine or reexamine their business procedures and ways to enhance their efficiency. An efficient workflow is one that is capable of identifying the best procedural routes (either serial, parallel, or conditional), and is able to document and make use of business rules to ensure the proper load balancing.

Among different approaches to modeling a workflow, Winograd and Flores¹² focus on coordination and communication. For every workflow loop, there is a “customer” and a “performer.” The performer executes a task for a customer, and the customer will move on to become the performer in the task that follows. The loop is defined as coordination between the customer and the performer is sequence of actions: proposal, agreement, performance, and satisfaction. Tasks are defined by the requests and commitments expressed in the loops. A workflow process is a collection of these loops with links between them. Procedurally, this is how the mechanism works. In the first phase (request), a customer asks the performer for an action. Based on the pre-approved task description, the performer agrees to the request in the second phase (commitment). In the third phase (performance), the performer fulfills the task and reports its accomplishment. In the fourth and final phase (satisfaction), the customer receives the outcome of the task, accepts the report, and expresses his/her satisfaction or dissatisfaction. The ultimate goal here is customer satisfaction.

Workflow management technology provides a mechanism for planning and controlling how teams work together. There exist a variety of computer-supported tools to manage workflows in organizations. Some are PC-based and grow out from the project management technologies. At the other end of the spectrum, sophisticated workflow systems are installed on client-server platforms. They are capable of supporting highly distributed work environments, with a massive integration of technologies.

What should management expect from an IT-enabled workflow? First and thanks to its automation and coordination capacities, the system should significantly improve the efficiency of business processes. Since the sequencing of processes is predetermined with a proper and timely routing of electronic information, time savings can be significant. The development of automated business rules should also eliminate the

majority, if not all, of the ambiguities in executing business policies. Second, workflow systems should help enhance the effectiveness of the organization. With all well-defined tasks structured and automated, employees are now given more time to focus on other tasks that need more context-dependent decision making. Advanced workflow technologies have decision support technologies embedded, such as visualization, decision modes, and simulation. An example of workflow applications is reported by Mak et al.¹³

SUPPORTING NEGOTIATION

The Wisdom of Difference

According to Tung Bui from the University of Hawaii and Melvin F. Shakun¹⁴ from New York University, negotiation may be characterized as a motivated process by which antagonists, with some initial conflict or disagreement, seek to find an agreeable solution that make all of them better off. As such, negotiation involves both cooperation and conflict—cooperation to create value (increase the size of the pie) and conflict to claim it (take as big a slice of the pie as possible). Typically, the negotiation process begins with a party's awareness of the conflict, either at the goal, judgment, or solution levels.

Goal conflict occurs when a party apparently seeks divergent or incompatible outcomes, if necessary, at the expense of the other parties. Entering a bargaining situation with the parties perceiving the existence of incompatible outcomes often leads to a distribute bias. This win-lose perception in turn tends to generate more hostility and mistrust. Hence, the chance of reaching a common solution is diminished.

Judgment conflicts differ from goal conflicts, in that, while parties may share the same goal, they disagree over the best way of achieving it. Differences often reside in deferent interpretations of the same factual information. First, parties may believe that they have information, which the others do not have, and thus they presume that others may have come to an incorrect assessment and conclusion. Alternatively, the very same parties may contend that, even if others possess the right information, they may make the wrong conclusion anyway. Research has shown that people who feel wronged by the other side due to misunderstanding or perceived differences in norms and goals could experience feelings of disapproval, blame, anger, and hostility. This negative feeling could trigger hostile actions resulting in deadlocks.

The acceptance of a solution is a function of the extent to which negotiation parties perceive that the proposed solution is a fair one. Again, fairness depends on the involved parties' judgment of the situation based on their own view of equity and justice, their needs to reach a solution, and their own understanding of what the others think about the problem. Furthermore, a party's perception of how they and the other parties are being treated may affect the decision outcome.

Given the characteristics of negotiation described above, the negotiation process is an evolving one. Session after session, negotiators fine tune, or even change completely, their initial goal, judgment or solution. Under the best conditions, this process is refined and validated through rounds of discussion until all parties accept the outcome. Supporting the negotiations entails providing means that could help antagonists find rightness in problem representation and negotiation solution.

Negotiation Support Systems

For almost two decades, Bui and Shakun have led a research mini-track on Negotiation Support Systems at the Hawaii International Conference on System Sciences. The purpose of the annual meetings is to gather researchers interested in using technology to support negotiation. Computerized models of negotiation derive from a number of disciplines. These include, but are not limited to, economics, operations research, management science, applied psychology, organization science, and applied artificial intelligence. Negotiation Support Systems (NSS) are computer assistance for negotiations. Their design and use have centered on key foci:

Group decision and/or conflict resolution models to help negotiators reduce discord and increase the chance of reaching consensus. Models found in the NSS-related literature include those derived from game theory, multiple objective optimization, theory of social choice and voting, and rule-based advisory system. A recent trend is to use negotiating software agents. In a decision environment under intense data processing and time pressure, autonomous agents negotiate with others. Bui¹⁵ describes a model of tele-medicine where a software agent from a hospital negotiates with software agents of insurance companies to find the most cost-effective insurance coverage for its patients. Another example is the use of automated Web Services to negotiate shipping costs on B2C e-commerce.

Rich communications media to enhance information and communication exchange between antagonists. It is important for the party to have all the relevant information during the negotiation process. It is also important to share some of this information to the other side. Sometimes, data need to be aggregated or reformatted before they can be sent. Some other times, past documentation, including past agreement, audio/video clips, or archived photos, needs to be presented.

Perhaps the most useful contribution of NSS is its ability to assist the negotiators in interactive information elicitation and in processing it in a transparent and structured manner. Transparency refers to the ability of the decision maker to define, understand, and assess the problem correctly. Via user-friendly interface and structured modeling and representation, the decision maker has a better opportunity to clarify, for him, the problem, and present it in a more systematic manner to the other side. Like the feature of DSS, structuredness refers to the extent to which the problem is formulated in a systematic manner (for example, using tables to lay out and display prioritized goals, graphical representation to visualize preferences, and formula to allow what-if analysis). By imposing a certain level of structured in problem formulation, NSS can also be used as a shared and common language for mutual understanding. A joint and open modeling effort may be to the advantage of all parties.

Another critical benefit of NSS is its ability to provide continuity to negotiation. Observations of real-life negotiations that have ended with successful outcome suggest that temporary interruptions of the negotiation process can help to enhance the chance of reaching a final agreement. A break can be useful in allowing highly emotional parties to calm down, thus bringing them back to a more rational mind-set. However, discontinuities of negotiation, in particular those that are rather long and tedious, can be detrimental to negotiation outcomes. Motivation is waning, problems and issues are forgotten, and the urgency of seeking a consensus is gone. In an NSS environment, thanks to Internet-based connectivity and advanced modeling, information access and exchange can be sustained and interactive processing is near real time.

This ability not only helps negotiators increase the chance of finding a compromise, but also frequently guides them in reaching a better-than-expected solution. An example of using negotiation software for labor negotiation can be found in Bui and Shakun.¹⁴

MANAGING CRISES AND EMERGENCY RESPONSE

Crises: Perception and Cognition

A crisis is an event that has either occurred or impending to occur. A crisis is characterized by the fact that it occurs as a surprise, threatens one or more valued goals, and leaves little time for response. It threatens life or property or both on a wide scale. It can be limited to a small locale or may extend over a large area, and is not necessarily limited within national boundaries. As an example, the tsunami of 2004 in Southeast Asia was never thought of as a possible natural disaster by the inhabitants or the governments in the region. Even governments with vast resources are victims of surprise when they fail in their intelligence and planning. In a global context, the process of intelligence gathering, information sharing, and coordinated planning have proved to be of a close to insurmountable level of complexity.

According to Billings,¹⁶ the three factors influencing the extent of perceived crisis are (1) perceived value of possible loss (high importance), (2) perceived probability of loss (high uncertainty), and (3) perceived time pressure (immediacy). These three elements themselves are determined by technological, cultural, social, and economical factors. They have imperative implications when dealing with a crisis of global proportion. It is possible that an untrained decision maker may misjudge an event and not pay adequate attention to the severity of an emergency. If the theater of a crisis is far away and the network systems to monitor the events are nonexistent or rudimentary, the crisis management team may not fathom the seriousness of a situation.

Despite all the training, in during a real emergency team members may experience (1) reduced attention span both across time and space, (2) loss of memory and abstract ability, (3) diminished tolerance for ambiguity, (4) deterioration of verbal performance and visual motor coordination, (5) regression to simpler and more primitive mode of responses, and (6) increased stress leading to random behavior and rate of error. If the decision protocols are committee-based, they may be time consuming and ineffective. In this chapter, we limit our discussion to three of these: (1) information, (2) technology, and (3) coordination.

Information Quality, Transparency, and Distortion

A common denominator of all the activities in connection with a crisis prevention and response is information. Information exchange needs to be interoperable, standardized, and secure. During a complex emergency situation, whether by natural or technological disaster, an accurate, timely description of the event, its consequences, the needs, the response requirements, and the gaps in national capacity to handle the crisis are required. A major problem can arise if various involved agencies participating in the decision have conflicting information about the crisis, according to Bui and Sankaran, of PRIISM.¹⁷

During an emergency, information is likely to get distorted. If too much information flows into a few decision makers, the information overload may lead decision

TABLE 1 Mapping Path Modeling to ERS Requirements

<i>Support type</i>	<i>Phases of assistance and relief operation</i>		
	<i>Pre-crisis</i>	<i>Crisis response</i>	<i>Post-crisis</i>
Information	<ul style="list-style-type: none"> –Needs assessment (local and global) –<i>Information collection, compilation, filtering, analysis, and storage (Global remote sensing & warning, document management)</i> –<i>Integration of infrastructure system databases (Data standardization and interoperability)</i> –<i>Translation and certification</i> –<i>Adaptation to national information management policies</i> 	<ul style="list-style-type: none"> –Real-time Interactive Information center (access, share, exchange) –Real-time GPS-supported location information –<i>Global authentication of data</i> –Data security and standardization –Push-approach to information dissemination using voice communications (VoIP and multimedia) 	<ul style="list-style-type: none"> –Dissemination of activity results –Dissemination of lessons learned
Communication	<ul style="list-style-type: none"> –Electronic discussion group –Satellite network –Dissemination of help request to expert group worldwide 	<ul style="list-style-type: none"> –Knowledge-based information filtering –Teleconferencing 	<ul style="list-style-type: none"> –Evaluation of communication bottlenecks –Search for alternate technologies
Collaboration/coordination	<ul style="list-style-type: none"> –Group/event scheduling –<i>Coordination with regional/national network</i> –<i>Transnational scenario development (planned emergency responses)</i> –<i>Trust building among international agencies/teams</i> 	<ul style="list-style-type: none"> –Computer-assisted logistics (tracking, monitoring) –Just-in-time support –Group/event scheduling and coordination of planning –Security (VPN) –<i>Language translation</i> –<i>Special assistance to international rescue staff</i> 	<ul style="list-style-type: none"> –<i>International briefing of coordination</i> –Exchanging of lessons learned
Medical support	<ul style="list-style-type: none"> –Public health education –Information about major diseases –<i>Planning, training, stockpiling, and transportation of medical supplies</i> 	<ul style="list-style-type: none"> –<i>Remote diagnosis/patient monitoring</i> –<i>Information network to support health care teams</i> 	<ul style="list-style-type: none"> –<i>Review of international coordination procedures</i> –Follow up on ongoing medical situations
Decision focus	<ul style="list-style-type: none"> –Intelligence gathering, interpretation –Continuous update of directory of experts –<i>Universal visualization and multimedia</i> 	<ul style="list-style-type: none"> –<i>Supply-chain management support (sequencing of responses)</i> –<i>Global response tracking support</i> –<i>Distributed group decision support system</i> –Computer-assisted project management (modularity and scalability) 	<ul style="list-style-type: none"> –Review of effectiveness of decision outcomes –Update organization memory –<i>Assessment and improvement of global emergency management processes</i>

makers to focus only on selected sources. Another cause of distortion is loss of information over long distance.

Media usually provide breaking news. Local media tend to be nation-centric, focusing on national priorities and community interests. They can be short on analysis and tend to fail to provide all the data required for executive decision. A disaster assessment team should try to provide analysis based on a sound understanding of the facts so as to influence the strategic decision and the use of resources.

Emergency response operations should be transparent to everyone, including the local populace. Authorities involved in a disaster are reluctant to release information they deem critical to national security. The lack of sharing security information can threaten the lives of those who work among the local populace. As an example, in a recent rescue operation in Rwanda and Chechnya, emergency workers have been targeted and killed by rebel troops without proper protection or even awareness of the threat. These events have led to more efforts for better coordination on security issues.

Technology and Infrastructure for Organization Readiness

In a crisis, a crisis management support system is expected to help its users prepare, analyze, and resolve conflict. IT can help all involved parties access and filter data from large online databases to cope with information overload and data reliability. As discussed earlier, IT can provide expert system technology such as case-based reasoning to learn lessons from past crises, and use DSS and NSS to alleviate problems related to group pathologies, improve decision quality, and enhance the organizations' readiness to deal with catastrophes.

Information technologies that work well during normal times may get overloaded and become incapacitated of meeting the high volume of information processing. Incompatible communication devices represent a particularly serious problem. The use of widely accepted commercial communication systems, such as cellular telephone, could ease these problems. But the need for securing up-to-date information still exists. Thus, the information age is a double-edged sword for an organization that is under siege.

Even if all the emergency response participants try to do their best in exchanging information among themselves, cultural and technical incompatibilities constitute considerable barriers for a free information flow. They may use different languages and incompatible communication equipment. At the inter-agency level, incompatibilities related to organizational structures also hinder the quality of information processing. When military organizations are called in for help, their rigid communication hierarchy may clash with their nonmilitary counterparts that are relatively free of rank. The movement of relief supplies depends on transport arrangement made by particular organization. Backlogs in port are common. If possible, just-in-time supply of equipment will reduce the needs for inventory and loss due to looting and spoilage.

In order to achieve total asset visibility, extensive monitoring and tracking capability is required. Although much of these capabilities can be brought through international assistance, raising the region's own permanent capability will improve the chances of the country joining the global network of transportation and communication in the long run.

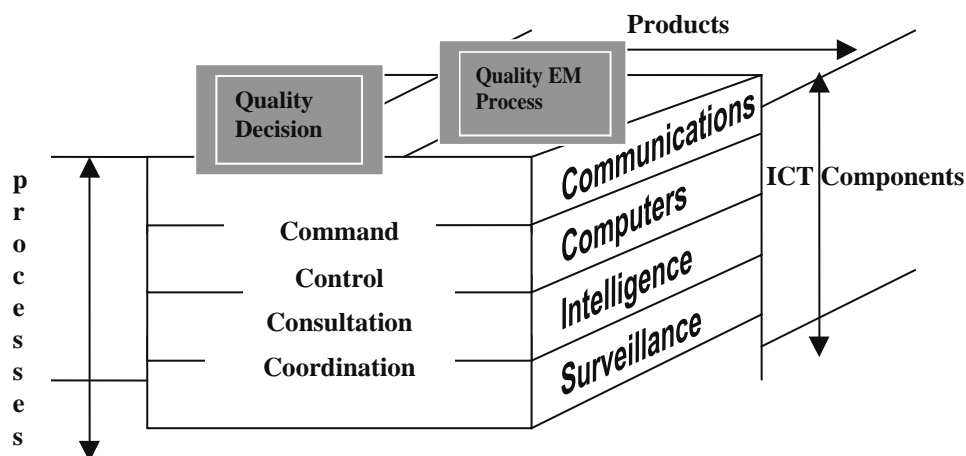
Another key issue is searching for a way to achieve unity of efforts and better coordination across the variety of organizations in emergency response operations. Coordination theory has proved to be useful in reducing time delay, from crisis planning, recognition, mobilization, and response.

There can be significant differences in perspectives between organizations involved in relief efforts during the emergency response process. For example, one organization may be more concerned about short-term rescue activities while another may be focused on long-term infra-structural development. It can lead to loss of coordination especially when short-term emergency response operations disrupt the long-term self-reliance of a specific region. Although minor disruptions are inevitable, if emergency response operations can be accomplished in a relatively short time before local situation is distorted, the disruptions can be minimized.

When quick and massive responses are required, no single organization has all the resources to alleviate the effects of a disaster. Supra-nationals, local government, and military units all must find some way to cooperate or at least not to disrupt others' activity. Because of the high number of participating agencies, command structure is often hard to achieve. The ad hoc mixture of participants is likely to lead to a situation where no one is in charge. Coordination should be planned prior to the occurrence of a crisis.

Putting all things together, we suggest that to improve the quality of decision outcome and processes, an ERS should be designed to enhance information, cognition, collaboration, and decision making. A high-level architecture should have three constituents: (1) system components, (2) products, and (3) processes to make these products. The ERS should be enabled by information and communications technologies for information, communications, and surveillance, and should be able to support the Command, Control, Consultation, and Coordination processes (see Figure 5). CIOs should have a emergency response plan that integrates well with this framework.

FIGURE 5 Structure of an IT-Supported Emergency Response System (ERS)



MANAGING COLLABORATION IN VIRTUAL ORGANIZATIONS

This chapter on collaboration has presented some intriguing glimpses into the dramatic changes occurring in organizational structures. Frances Cairncross, Peter Drucker, Etienne Wenger, and others believe that the organization of the future will be much more like networks of communities and teams than the hierarchical bureaucracies of the past. The question is: With CoPs, network armies, and global virtual teams becoming more predominant, how are such nontraditional collaborative structures to be managed?

Lynne Markus, Brook Manville of Saba Software, and Carole Agres¹⁸ explored this question by looking to the open source movement. Here is their thinking, which appeared in a *Sloan Management Review* article.

They, too, cite Drucker,¹⁹ who stated that the job of executives in managing knowledge workers is not to tell them what to do (manage them), but rather to tell them where the organization is going (lead them). It is akin to leading volunteers who, though unpaid, labor for a cause out of commitment and the expectation of having a voice in the operation. Markus et al. note that CoPs, self-employed freelancers, and industries experiencing the emergence of networked organizational forms all point to a workforce with a more volunteer-like mind-set—in spirit if not in fact. The authors researched the open source movement to help the managers of one knowledge-based organization that was having governance troubles. The traditional forms of governance were causing employees to feel distant and leave. The authors' research led them to two conclusions:

1. Executives of increasingly virtual organizations should think about expanding the kinds of motivators they use. The open source movement demonstrates that while money is a motivator for volunteers, gaining a high reputation among peers, taking pride in contributions, and being able to improve and use high-quality software are strong motivators as well.
2. Executives of increasingly virtual organizations should consider adopting a governance structure that fosters self-governance by employees. Although the open source movement appears to have all the trappings of chaos waiting to happen, it is actually very well disciplined because its governance mechanisms foster self-governance.

MOTIVATING A VIRTUAL WORKFORCE

Markus, Manville, and Agres¹⁸ suggest that managers in virtual organizations put in place motivators that reinforce each other. Open source contributors volunteer for many often-interlocking reasons. They love to build software. That is pure joy for them, states Eric Raymond,²⁰ who wrote "The Cathedral and the Bazaar," an online paper that has been influential in touting the benefits of open source development of software. They take pride in helping others and giving something back to society. They often believe that software should be given away, as it is in university computer science labs where open source flourishes. In addition, they receive the personal benefit of having better software for their own use. One obligation in this culture is to send software

enhancements to the author to be checked. Another is to make the enhancements widely available.

Like academia, open source is a “reputation culture,” note Markus et al. Reputation is the measure of success. Gaining a reputation for uncovering bugs and making good fixes spreads because open source contributions are highly visible. Every project includes a credit list of the people who have contributed. This culture is also a gift type of culture. Reputation is gained by what the contributors give away, rather than what they control (as in the exchange culture found in traditional business). In a gift culture, there is abundance. In open source, there is plenty of computing power, network bandwidth, storage space, and such. A good reputation can lead to a job or venture capital. Although money cannot be earned from the software, it can be earned by selling support or education.

Markus, Manville, and Agres thus recommend that reputation may be the symbol of success in other kinds of knowledge work. Managers should use this “coin of the realm” to motivate employees in their virtual organization.

Governing Virtual Organizations

Managing open source appears to be an impossible task because there are at least 750,000 developers, all of whom signed up on their own volition and can stop volunteering at any time. Yet, note Markus et al., many open source projects work well because they employ three governance principles: managed membership, rules and institutions, and social pressures.

Managed Membership

Open source work has a well-defined leadership, with the originator often maintaining a lead role in development and distribution. Or a lead team might rule, dividing the work, refereeing coordination across teams, and so on. Leaders are rarely elected. Although anyone can be involved in searching for bugs and fixes (in most open source work), project authority only comes from being given it by, say, the project’s core team based on the quality of one’s work on the project. In some cases, even working on a project may require being voted in. Thus, membership is limited, making it manageable.

Rules and Institutions

One rule is the open source license—how the software can be used. The license may, for instance, permit any form of commercial use or not allow commercial versions at all. Other rules relate to how members and leaders are chosen or how voting and discussions are conducted. All communications are generally done over the Internet and occur in phases for a specific length of time. For instance, there can be a request-for-discussion phase, a call-for-votes phase, and a results phase, note Markus et al. Each phase has its own rules. Most voting is democratic, but some is not.

Social Pressures

To have teeth, rules need means to enforce compliance and resolve disputes. To bring continual noncompliers into line, open source groups generally use social pressures. For example, a group may flame someone, which means sending the disobeyer angry e-mail. Or members may spam the person, that is, overwhelm the person with e-mail. Or members may simply shun the person by not responding to that person’s e-mail.

Generally, after such treatment, the disobeyer learns the rules of the community and falls into line. Such pressures can even be turned on leaders who act inappropriately.

Conflicts that end badly can cause volunteers to simply leave an open source group because it kills their motivation to contribute. Generally, open source groups use escalated sanctions to resolve conflict and bring noncompliers into line. They also monitor work, which represents another type of social pressure.

These social pressures work because reputation is so important, and because the work is so visible to everyone. Also underlying all the governance mechanisms are the shared values of the culture, which place emphasis on self-control (to maintain one's reputation) and social control (monitoring each other's behavior). IT is a key enabler for all these governing mechanisms, permitting the distributed software development, coordination among the participants, and groupwide enforcement of the rules via the various social controls.

Markus, Manville, and Agres recommend that managers in virtual organizations consider adopting these practices from the open source movement because intrinsic motivation and self-management are as important in virtual organizations as they are in open source. Furthermore, managers should consider rewarding collective results (as happens when an open source product gains commercial success) along with individual benefits. They should also foster development of reputation through the assignment of project lead roles and other mechanisms.

However, adopting the tenets of open source to managing in a virtual organization needs to take into account that a strong shared culture is a precondition for the governance mechanisms to work. A virtual organization without such a culture may not have the same results. Furthermore, Markus et al. question whether the mechanisms for governing programmers performing challenging work can apply equally well to employees performing routine activities. In short, self-governance is at the heart of managing virtual organizations. Without self-governance and strong reinforcing conditions, such social governance mechanisms might not work.

CONCLUSION

IT-based tools for supporting collaboration have been around for at least 30 years, becoming increasingly sophisticated over that time: The interaction between IT and the users is getting more flexible and more user-friendly. Modeling tools are more advanced. And data availability has become unprecedented. New IT platforms also make it more conducive to use technology to support collaboration. It is worth repeating the emerging role of wireless computing that brings data and processing power to the users, whenever and wherever they need them.

As reviewed in this chapter, some technologies are meant to support people attending a planning meeting. These tools permit more discussion, more evenly spread participation, more high-level company-wide discussion, and involvement by more people than a traditional planning meeting would allow. Other tools allow real-time collaboration among distributed team members who not only need to hear each other's voices, but also need to simultaneously see their hand-drawn changes to an engineering drawing in real time. Still other collaboration tools help team members located around the globe "converse," not in real time, but at different times of the day.

Supporting IT-Enabled Collaboration

Technologies to support collaboration can be deployed to enhance the effectiveness of workflow management, negotiation, and crisis management. For each type of application, there is a different set of design considerations regarding data requirements, modeling, and communication support.

In all cases, the use of IT-based collaboration tools changes the collaboration process, who can participate, how they participate, and even the kinds of work they do. Collaboration is at the heart of the business world. No single organization can hope to be successful going it alone. The business world is moving too fast to stay abreast on all fronts at once. Partnering with others has become the standard style of work. For this reason, this area of IT-based collaboration support is likely to grow and mature quickly in the years ahead.

QUESTIONS AND EXERCISES

Review Questions

1. According to Drucker, why are team-based organizations like hospitals or orchestras?
2. Explain five characteristics of groups.
3. Name several types of groups and briefly describe each.
4. Explain the three ways Communities of Practice can be nurtured.
5. What are the characteristics of the open source movement?
6. Describe the four cells of the time/place matrix. Give an example of a technology used in each.
7. What are some of the ways IT can help improve meetings?
8. What benefits did Burr-Brown get from its use of a group decision room?
9. List some of the ways Group Support Systems (GSSs) can improve the traditional presentation-discussion session? What are some potential disadvantages?
10. What were the four success factors for the SLICE team at Boeing-Rocketdyne?
11. What sorts of motivators should managers of virtual organizations adapt from the open source movement, according to Markus et al.?
12. What sorts of governance practices might managers of virtual organizations find useful, according to Markus et al.?

Discussion Questions

1. Support for communication and coordination is quite different from support for group decision making. The technologies also should be different. Do you agree or disagree? Explain your reasoning.
2. The lessons from the open source movement cannot be applied to virtual teams because the open source developers are truly volunteers and they have passion for their work. The same is not true of virtual teams getting paid to work. Do you agree or disagree? Explain your reasoning.
3. Network armies hold valuable lessons for the way some organizations should think about reorganizing themselves. Do you agree or disagree? If you agree, describe some organizations you are familiar with and what they could learn from

network armies. If you disagree, describe several organizations you are familiar with and why they have nothing to learn from network armies.

Exercises

1. Find an article that describes an IT-based collaborative tool. What is its major purpose? What technology is used?
2. Conduct a survey of products available in the marketplace for supporting collaboration. What kinds of support do the systems provide? How do they compare with the systems described in this chapter?
3. Visit a local company that is using technology to support group work. Map its activities onto the time/place matrix. What infrastructures has the company developed?

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SUPPORTING KNOWLEDGE WORK

INTRODUCTION

Companies Want to Manage Knowledge

A MODEL FOR MANAGING KNOWLEDGE

Building Human Capital

Case Example: Buckman Laboratories

Case Example: BP

Building Structural Capital

Case Example: A Pharmaceutical Company

Case Example: Skandia Future Centers

Case Example: A U.S. Energy Company

Building Customer Capital

Case Example: A North American Bank

The Cultural Side of Knowledge Management

Case Example: Partners HealthCare System

INTELLECTUAL CAPITAL ISSUES

Value Issues

Usage Issues

Sharing Issues

Social and Ecological Issues

WIKIS

A Simple Open Source for Online Knowledge Repository

Wikis for Business Use

THE VAST ARENA OF COMPUTER ETHICS

A Little History

What Is Computer Ethics?

Information Privacy

Intellectual Property Rights

Legal Jurisdiction

Online Contracting

Case Example: Clickwrap Agreements

CONCLUSION

QUESTIONS AND EXERCISES

REFERENCES

INTRODUCTION

In this chapter, we deal with two of the most important and most talked about, yet still evolving, topics that relate to supporting knowledge work. One is the subject of managing knowledge. That means not only encouraging people to share knowledge personally, but also putting their knowledge in a form that others can easily access. Because knowledge can come from inside as well as outside the firm, the final sections on knowledge management deal with customer knowledge and researchers' knowledge and how to embed this outside knowledge in a real-time system. Under this topic are the intellectual capital issues of valuing intellectual property, usage, and sharing knowledge.

The second topic is the vast arena of computer ethics, which deals with such areas as information privacy, intellectual property rights, and other legal and ethical issues relating to information and knowledge. Many laws and regulations written before the computer age and the Internet explosion are being applied to today's software, databases that house personally identifiable information, and networks that connect different cultures. The entire realm of intellectual capital challenges the applicability of these laws and norms.

There are three dimensions of knowledge work: technology, organization, and environment.

Companies Want to Manage Knowledge

One of the enduring subjects in the IT field since the mid-1990s has been knowledge management. Top corporate executives realize that their greatest corporate assets walk out the door every evening, taking with them another crucial asset, knowledge. Attempts to capture knowledge in computer systems continue. But for some experts and researchers in the field, knowledge is not something that can be captured in a machine; it only exists inside a person's head. Information can be captured in computers; knowledge cannot. Many feel that the term "knowledge management" creates the wrong impression. The term "management" often brings forth the "we can control it" mind-set. Knowledge cannot be controlled or engineered, so the mechanical metaphor is wrong. It can only be leveraged through processes and culture. The biological or ecological metaphor is much better. The more people are connected, and the more they exchange ideas, the more their knowledge spreads and can thus be leveraged. This view, of course, is still being debated, and raises the question, "If we cannot disembody knowledge, how do we better manage the knowledge within people to leverage this asset?"

Tony Brewer,^{1a} a researcher at Gartner, researched this topic and notes that as we move from a service economy to a knowledge economy, companies move toward managing their intellectual capital in a more formal and deliberate way. In essence, knowledge exists in two states, tacit and explicit. Tacit knowledge exists within a person's mind and is private and unique to each person. Explicit knowledge has been articulated, codified, and made public. Western management practices have concentrated on managing explicit knowledge; but cultivating and leveraging tacit knowledge is just as important. Effective knowledge management requires transferring knowledge between these two states.

Supporting Knowledge Work

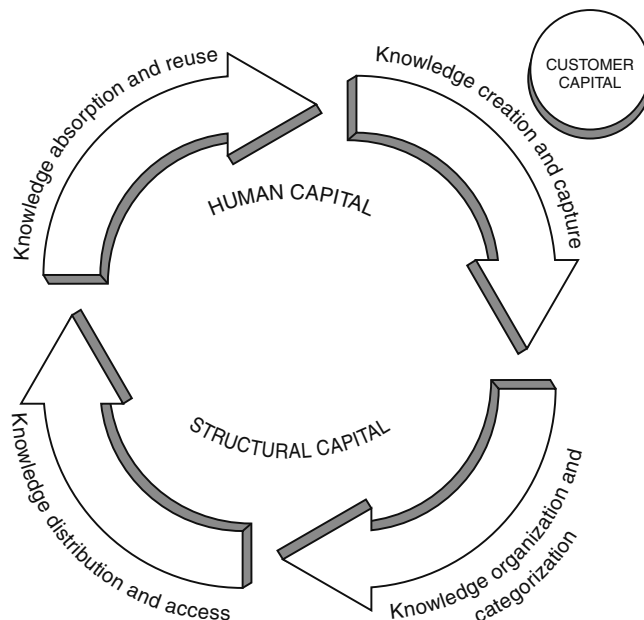
How is that done? Well, says Brewer, because knowledge is not a physical asset, it is not effectively described in terms of manufacturing analogies, such as storing it in inventory. Rather, it needs to be thought of in ecological terms, such as nurturing it, cultivating it, and harvesting it. Furthermore, ways to transfer knowledge back and forth between its tacit and explicit states are crucial and are generally a result of encouraging the free flow of ideas and information, something that organizational norms, departmental boundaries, and national differences can inhibit.

The process of transferring tacit knowledge to others is a key part of managing knowledge. To emphasize this idea, some companies have stopped talking about knowledge management and use only the term “knowledge sharing.” In this regard, IT is seen as one enabler, but not the main one. The key to knowledge sharing seems to be getting people together face-to-face to explain how they do things. Once people sit down and talk about what they do and why, barriers fall, knowledge flows, and sharing increases. Unfortunately, people are not given the time or the space these days for this kind of interaction; free time for sharing is not seen as important.

A MODEL FOR MANAGING KNOWLEDGE

Due to the increasing emphasis on knowledge, some now call it intellectual capital to distinguish it from the other kinds of capital that firms possess. Giga Information Group,² a research firm, has published a model for managing intellectual capital. As shown in Figure 1, the model is circular and has four stages, which

FIGURE 1 A Knowledge Management Framework



Source: Reprinted with permission from *Best Practices in Knowledge Management*, Giga Information Group, 1997, www.gigaweb.com.

Supporting Knowledge Work

represent what people generally do with knowledge. First, they create it or capture it from a source. Next, they organize it and put it into categories for easy retrieval. Then they distribute it (push) or access it (pull). Finally, they absorb another's knowledge for their own use or to create more new knowledge. Thus, the cycle begins again.

The four stages create three types of capital: human, structural, and customer.

- **Human capital.** This form of intellectual capital consists of knowledge, skills, and innovativeness of employees as well as company values, culture, and philosophy. It is created during the knowledge-creation-capture and knowledge-absorption-reuse stages because these two stages focus on getting people together to share knowledge. They deal with the people aspects of knowledge management. Their main question is, "How do we get people to have more knowledge in their heads?"
- **Structural capital.** This is the capabilities embedded in hardware, software, databases, organizational structure, patents, and trademarks that support employees as well as relationships with customers. Structural capital is formed in the knowledge-organization-categorization and knowledge-distribution-access stages because these stages focus on moving knowledge from people's heads to a tangible company asset. These stages deal with the technology issues surrounding knowledge management and sharing. Their main question is, "How do we get knowledge out of people's heads and into a computer, a process, a document, or another organizational asset?"
- **Customer capital.** This form of intellectual capital is the strength of a company's franchise with its customers and is concerned with its relationships and networks of associates. Furthermore, when customers are familiar with a company's products or services, the company can call that familiarity customer capital. This form of capital may be either human (relationships with the company) or structural (products used from the company).

Based on a series of case studies, Giga discovered that the human capital stages and the structural capital stages require different mind-sets. Hence, companies have had to use different approaches to grow each one; and the techniques for one do not work for the other. The companies that focused on human capital used touchy-feely, people-centric approaches. In some cases, no technology was used at all. The companies that focused on structural capital took a typical IS approach: using technology to solve a problem. Little talk addressed individuals, communities, and work practices; talk mainly centered on yellow pages of experts, knowledge bases, and such. However, to succeed in leveraging intellectual capital, companies need to do both.

Now we turn to specifics of what companies have done to build human capital, structural capital, and customer capital.

Building Human Capital

The emphasis in building human capital, notes Giga, is to answer the question, "How do we get people to have more knowledge in their heads?" Giga sees four ways: create it, capture it, absorb it, and reuse it.

Knowledge Creation and Capture

This phase deals with generating knowledge, either by nurturing employees to create it or by acquiring it from outside. Hence, it deals with both human capital and customer capital. As noted earlier, the Giga cases that emphasized this phase of managing knowledge have used high-touch approaches, such as creating a sharing culture, urging people to meet either in person or electronically, and encouraging innovation.

As another example of what a company can do to promote knowledge sharing globally, consider the approach that Buckman Laboratories has taken. This description is based on Brewer's^{1a} work.

CASE EXAMPLE

BUCKMAN LABORATORIES

www.buckman.com

Buckman Laboratories, an industrial chemical company based in Memphis, Tennessee, has some 1,300 employees across 70 countries around the world. The concept of sharing knowledge and best practices has been around in Buckman for more than 15 years. In fact, the company's code of ethics reinforces the sharing culture. The company believes that successfully transferring knowledge depends 90 percent on having the right culture and 10 percent on technology.

To bring the knowledge of all Buckman's employees to bear on a customer problem anywhere in the world—whether in Europe, South Africa, Australia/New Zealand, or Japan—Buckman established a knowledge transfer system called K'Netix, the Buckman Knowledge Network. The goal of K'Netix was to get people who had not met each other, but belonged to the same business, to communicate with each other and develop trust in each other: trust that one person was interested in the other's success, trust that what one person received from others was valid and sincere, and enough trust in the culture to help someone else.

Ten years ago, sharing was accomplished mainly by people traveling all over the world to see each other, with lots of face-to-face conversations and meetings. Today, such meetings still occur, but the technology helps people stay in touch between these meetings, making communications more continuous.

When employees need information or help, they ask via forums, which are Buckman-only online forums over the Internet. In all, seven forums in TechForum are organized by industry and are open to all employees.

One particularly influential conversation, which set the tone for company-wide sharing, took place over TechForum and concerned Buckman's global sales awards. A large cash award was split among the top three salespeople worldwide; the top 20 got plaques. It was based on a formula that took many factors into account. The salespeople, however, were unhappy with the formula. When this discussion appeared on the companywide forum, then-CEO Bob Buckman jumped into the fray and decided that the entire company should iron out the problems in

(Case Continued)

front of all employees. Hundreds of messages were recorded, and the entire award structure was restructured online in front of everyone. It was a rare opportunity to allow everyone to share in an important, yet sensitive, company subject. Moreover, top management did not dictate the results. This conversation reinforced the sharing culture.

The conversations are the basis for transferring knowledge around the company. So the important ones are captured. Volunteer experts identify conversations that contain valuable information and, more importantly, valuable streams of reasoning. This information is then edited to remove extraneous material, given keywords, and stored in the forum library. In essence, Buckman is capturing the artifacts of its virtual teams in action. In so doing, it is creating a self-building

knowledge base, which can be used for what-if analyses and can be mined to create new knowledge.

The prime benefit is timely, high-quality responses to customer needs. For example, a new employee in Brazil was scheduled to visit a customer who had a particular problem. The salesperson posted both the problem and a suggested solution in a forum and sought advice from anyone with more experience. A response came quickly: "I've faced this problem and your pH is too high; it will cause odors and ruin the paper. Bring the pH down by two points. That won't hurt the process, and it will clear up the problem." As a result, this new employee, who had only modest experience, was able to present a proposal with the experience of a 25-year veteran, and make the sale. ■

Knowledge Absorption and Reuse

This phase of building human capital addresses the notion of getting knowledge into people's heads where it can be enhanced and reused. Irrespective of whether people believe that knowledge only exists in minds or can exist in computers, the Giga cases that emphasized this phase of managing knowledge used high-touch approaches. They too focused on nurturing interactions among people, recognizing the knowledge brokers who exist in companies, and supporting communities of practice.

Recognizing knowledge brokers: "The Rudy problem." Simply discovering who has what knowledge is a step in the right direction to fostering knowledge sharing. Yet, when possessing knowledge is not rewarded by management, neither is sharing, as the following story illustrates.

At a knowledge management conference, Dr. Patricia Seemann,³ who headed up a knowledge management project at a pharmaceutical company, told the story of Serge and Rudy (fictitious names but real people). Serge, she said, was a "real" manager. He had a three-window office, a big desk, and a title. If you asked him what he did the past year, he would say, "I registered 600 products in 30 countries." Rudy, on the other hand, is a headache, his manager says, because he does not work. He just stands around and talks all day. Whenever you see him, he is talking to someone. When you ask him what he did the past year, he says, "I sort of helped out."

Supporting Knowledge Work

The company downsized, and guess who got laid off? Rudy. And then what happened? His department fell apart because there was no one to help, to provide guidance. When they fired Rudy, they fired their organizational memory, said Seemann. He was a crucial, yet unrecognized asset, because he was willing to share his knowledge.

While at this company, Seemann and her team created a yellow pages guide of company knowledge brokers. Guess who was in the book and who was not? Rudy, of course, was in the book. Serge was not, and neither was top management. How can companies fix what she calls “the Rudy problem”? One way is to create a technical career track and promote knowledge brokers. Giving Rudy a title would have made an enormous difference, Seemann said, because it would have sent a signal that knowledge sharing was recognized in the company. Companies cannot appoint knowledge brokers. They just emerge. And when they do emerge, they need support.

One approach to fostering knowledge sharing: T-shaped managers. If not understanding Rudy’s role in the organization is how not to foster knowledge sharing, what is a way to nurture it? Morton Hansen, of Harvard Business School and Bolko von Oetinger, of Boston Consulting Group⁴ propose what they call T-shaped managers. These are executives who have both a vertical role (such as running a business unit) and a horizontal role (such as sharing knowledge with their peers in other business units).

The goal of this structure is to circumvent the limitations of knowledge management systems: They can only house explicit knowledge (not implicit know-how); they cannot foster collaboration by just making documents available, and their directories of experts can get out of date quickly. T-shaped management is especially important in organizations with autonomous business units because it helps counterbalance their tendency to compete with each other and hoard expertise.

Whereas the value of T-managers’ vertical work is measured by traditional bottom-line financial performance, the value of their horizontal work is measured in five ways, note Hansen and von Oetinger:

1. Increased company efficiency from transferring best practices among business units
2. Better decisions by soliciting peer advice
3. Increased revenue by sharing expertise, again, among peers who are experts in areas in question
4. Development of new business ventures by cross-pollinating ideas
5. Moving strategically through well-coordinated efforts among peers

However, success in these five areas does not just happen. Knowledge sharing requires clear incentives. The company needs reward sharing. Furthermore, sharing needs to go both ways—give and take. Benchmarking across business units can encourage underperformers to ask for help. Success also requires formalizing cross-unit interactions. It does not mean creating bureaucracy, but rather creating peer-level collegial support (and confrontation). It also means picking and choosing which cross-unit requests to fulfill based on expected business results and how much someone can really contribute.

BP is exemplary in its use of the T-manager concept, state Hansen and von Oetinger. The insight Hansen and von Oetinger learned from studying BP is that mechanisms must be put in place to both foster and guide managers’ knowledge-sharing activities; otherwise, they start to take up too much time and produce few results.

CASE EXAMPLE

BP

www.bp.com

BP is in the energy business. It merged with Amoco in 1998, with ARCO in 2000, and Castrol and Veba Aral in Germany in 2002; it now has 100,000 employees in 110 countries. BP's approach to T-shaped management began in the early 1990s in BPX, its oil and gas exploration division. To cut layers and increase accountability, John Browne, then head of BPX and now head of BP, divided the division into 50 autonomous business units. Unfortunately, each business unit head focused only on his or her unit, not on BPX.

To get the business unit heads working together, Browne instituted peer groups in 1993, each with about 12 business unit leaders in similar businesses. No bosses were allowed in these peer groups, so the discussions would be candid and not consist of political posturing. Sharing did increase, but it was not until 1994, when these groups were made responsible for allocating capital within their group and for setting their performance levels, that their sharing started to truly impact BPX's performance. The peer group members finally saw the financial value of sharing expertise. When Browne became CEO in 1995, he instituted peer groups BP-wide.

BP has also created cross-unit networks around areas of shared interest. However, BP found, unfortunately, that these several hundred networks cost a lot of time and money (with people flying all over the globe) without resulting in

better results. Thus, the number and use have been limited.

BP has also instituted the practice of identifying a limited number of "human portals" who connect people, so that everyone is not trying to network with everyone else. Typically these people are not the top executives, note Hansen and von Oetinger, and typically they have been at BP a long time and in many jobs and locations.

IT plays a role in these various knowledge-sharing activities. An electronic yellow pages identifies experts, and multimedia e-mail and desktop video conferencing permit easier virtual team meetings, report Hansen and von Oetinger.

Since the mergers, BP has reorganized its business units into new peer groups that are more strategically focused. As Hansen and von Oetinger note, the evolution continues.

One T-Shaped Manager's Experiences

One BP T-shaped executive, who heads BP's gas business unit in Egypt, illustrates this new mode of operation. Formerly, whenever his business unit needed help, he would call headquarters. Now, he looks to his peers in other gas units.

His job essentially has two roles, one vertical and one horizontal. He is CEO of the business unit, so he is responsible for its profit-and-loss statement, capital

(Case Continued)

investment decisions, and such. He is also expected to participate in cross-unit activities, which take up some 20 percent of his time. These activities can undermine his vertical role, so he and the seven gas-production peers in the Mediterranean and Atlantic regions in his peer group limit their meetings to business purposes. Knowledge sharing is not enough of a reason to meet. Instead, they meet to decide how to allocate capital among themselves and how to meet production targets set by their division's executive committee.

In his knowledge-sharing role, in addition to collaborating, he also connects people, acting in some ways like a "human portal," suggesting who might help solve a problem, for example. He also gives advice to peer business units when asked and when he feels he can contribute. He was personally involved in 3 out of 20 of his business unit's "peer assists" one year, report Hansen and

von Oetinger. In addition, he also requests peer assists, receiving 10 assists one year from BP business units around the world.

Due to all BP's networking, people know where expertise lies, so they go directly to the expertise rather than through headquarters. And because sharing is rewarded, bosses know who is sharing (and requesting assistance) and who is not. In its knowledge-sharing efforts, BP has aimed to change management activities, not corporate structure, to gain the benefits of knowledge sharing while preserving the autonomy of its business units so that they can more quickly and effectively serve their local markets. As John Browne stepped down in 2007 as the Group Chief Executive, he claimed that the success of his tenure was the improvement of BP's ability to learn from mistakes and to create a knowledge-driven and sustainable institution. ■

Building Structural Capital

The Rudy story also fits with this second subject, building structural capital, because that is what Seemann and her team aimed to do in creating the online yellow pages of knowledge brokers. Her goal was to increase their value. Those yellow pages are a form of structural capital. As noted earlier, companies that emphasize building structural capital generally use high-tech approaches.

Knowledge Organization and Categorization

This phase is often handled by creating best practices knowledge bases or metadata indexes for documents. A few have even tried to measure intellectual capital. Following are two examples, one that focused on improving a knowledge-support process and one that looked into valuing intellectual capital.

CASE EXAMPLE

A PHARMACEUTICAL COMPANY

A project at a major pharmaceutical company was aimed at improving the process of developing new drugs and getting them approved by the U.S. Food and Drug Administration (FDA), a process that takes 5 to 10 years, costs \$250 million, and can yield revenues of \$1 million a day per drug once it reaches the market.

This project, described at the Knowledge Imperative Conference,³ revolved around creating a “knowledge infrastructure,” one that manages information, enables understanding, and supports learning. The crux of the matter was to understand the customer’s needs. In this case, the FDA is the primary customer; however, insurance companies, doctors, and consumers are also customers. The company sells all of them knowledge about disease, treatment, and how a drug will work in particular scenarios. When employees understand the type of knowledge they need to create for these customers and their role in its creation, they will identify better ways to work.

The project began by studying and codifying 60,000 pages of documents filed with the FDA to discern how the teams developing drugs and filing their results were sharing knowledge. These regulatory files explain to the FDA what the company knows about a drug, how it learned those things, and what conclusions it has reached.

The knowledge-infrastructure project team found the files lacking. Each file should have four parts: purpose, content, logic, and context. Only one of the files had a statement of purpose, which stated

the problem to be solved. A file without a statement of purpose shows that the author does not know the reason for the document. Many files had contradictions, which told the team that the authors had not talked to each other. For instance, they disagreed on whether the drug should be taken once or twice a day.

To rectify the situation, the study team created a generic knowledge tree of the questions the FDA asks when deciding whether to approve a drug. The top of the tree has their three main questions: Is it safe? Does it work? Does it have sufficient quality? The tree lays out the supporting questions for these three main questions, in layers, which shows the teams which questions they need to answer to the FDA’s satisfaction. It also shows people why others need specific information, thus giving them a context (beyond trust) for sharing.

In a pilot project, the knowledge-infrastructure team used a different process with one team: writing as a tool for thinking. They got the team to write up their 10-year drug study before they did it, so that the team members were clear about the data they needed to gather and present to the FDA. Furthermore, they wrote the report template publicly as a team. To create the template, they wrote critical points that had to be in the report on Post-It notes. Next, they prioritized the points on huge sheets of paper on the meeting-room wall. Then they designed studies to prove the points that had to be proven. In creating this virtual prototype of the

(Case Continued)

knowledge to be presented to the FDA, publicly, on the wall, they could physically see what knowledge was needed. They created a common mental model of the results. It was a powerful technique.

They have seen tangible progress in filling in the report sections on content, logic, context, and purpose. In another case, where an existing drug was to be

registered for use with a new disease, the team had not made much progress in two years' time. After they were shown the knowledge tree over a two-day period, they were able to submit the file to the FDA in three months (they had previously estimated 18 months), and the FDA approved it in 18 months (the team had estimated three years). ■

Skandia Future Centers^{1b} provides an example of delving into the world of valuing knowledge. Few firms have ventured into this realm, but because Skandia deals in knowledge and wants to experiment with the future, this is one area it has explored.

CASE EXAMPLE

SKANDIA FUTURE CENTERS

www.skandia.com

The charter for Skandia Future Centers is organizational prototyping. One project, the knowledge exchange, has addressed the question of putting a value on intangibles, such as knowledge.

Today, some 70 percent of investments in the United States are for intangibles; in Sweden it is 90 percent. However, no common mechanism for establishing their value or trading that value is yet available. A knowledge exchange increases the accessibility of hidden knowledge and will act as a multiplier for wealth creators, both people and organizations.

Skandia's knowledge exchange began as a network for exchanging knowledge using software akin to Lotus Notes. Over time, it has evolved into a Web-based

trading arena where people can buy and sell knowledge assets. It is now based on Nonet, a Lotus Notes-like product from Metaphor, a Spanish company.

It has two test sites called ICuniverse.com (IC stands for intellectual capital) and Futurizing.com. On ICuniverse.com, for example, before responding to an e-mail message, the recipient and the sender first agree on a price to be paid to the responder, perhaps via an auction. Thus, people are paid for the knowledge they provide. Ideas and writings can be housed on ICuniverse.com and resold, which gives high yield to currently unvalued intellectual assets.

The two sites run on an infrastructure (IQport) owned by NatWest in

(Case Continued)

the United Kingdom and were built over several years' time. IQport includes software and a financial clearing mechanism so that information that is generally thrown away can be wrapped into a package and given a price tag. The sites are linked to two accounts at NatWest; one is in financial currency (traditional money), the other is in digital currency, which can be used to purchase other knowledge. Skandia is testing this concept because it could become a new global currency. It is part of the new digital economy.

The knowledge-exchange project has been self-organizing from the start. The center simply provides the arena for "knowledge entrepreneurs" or "knowledge nomads"—people who go from arena to arena working on their latest ideas. Thus, the center supports a nontraditional working model.

To illustrate its migration, the project began with IT people from the United Kingdom who were then joined by IT people from Sweden and the United States. Later, students and the professor from Venezuela who developed Nonet for oil companies was the mainstay. The students collaborated with the professor at the center and with Metaphor, the Spanish company that bought Nonet. Today, the knowledge-exchange team has people from Sweden and Denmark.

The question that Skandia Future Centers is now asking itself is: How can we reward knowledge nomads? They do not want a career; they want a journey and freedom. Their lifestyle does not fit into traditional organizational models, yet working with them helps speed up accounting and organizational remodeling because they act like bees, moving among research centers pollinating companies with ideas. ■

Knowledge Distribution and Access

This phase emphasizes both pushing knowledge out to users (distribution) and accommodating users who pull information to themselves (access). The Giga cases that emphasized this phase also used high-tech approaches. They focused on implementing networks and networking tools to access human and structural capital. Intranets and groupware were important IT-based tools. To illustrate one enterprise's approach, we turn to a U.S. energy company discussed in the Giga report.²

CASE EXAMPLE

A U.S. ENERGY COMPANY

In this highly autonomous energy company, the 15 business units each focused on their own performance. To

instill sharing in this culture, these units would have to see the benefits themselves. In addition, many of the employees

(Case Continued)

were concerned they would not get credit for their good ideas. To overcome both issues, management decided to focus on promulgating best practices across the business units. A best practice was defined as a practice, know-how, or experience that had proven effective or valuable in one organization and might be applicable to another, notes Giga.

With management encouragement, a number of programs to collect best practices arose. For example, groups in the refining division documented best practices using Lotus Notes.¹³ They documented “hard” practices (such as distilling techniques) and “soft” practices (such as training) and recorded metrics, where possible. The division estimated it saved \$130 million a year utilizing each other’s best practices, notes Giga. Similar programs appeared in other divisions.

Yet, these efforts were disparate, so an enterprising manager within IS gathered all the statistics together and presented them to top management to demonstrate how the company could be nurtured to become a learning company. With top management support, an important booklet was created to align the various divisions. It explained the company’s mission, vision, values, total quality management (TQM), and environmental policies. It became the guide for sharing best practices.

In fact, the TQM principles of focusing on processes, measuring processes, and continuously improving them, which the company’s employees understood and used, played an important role in espousing knowledge distribution and reuse.

One example was in its capital projects management process. This process is used to manage some \$4 billion worth of projects a year. In benchmarking this

process, management discovered it had some gaps. Therefore, the process was redesigned, and management of capital projects improved. Seeing the benefits of this process orientation, the corporate office funded other cross-business-unit initiatives that fostered sharing.

However, there was still no central responsibility for knowledge distribution and reuse, and such centralization would not fit the culture well. To solve this problem, certain people were designated “technical knowledge experts” because they knew about best practices across the company. Their job was to disseminate tacit knowledge. To do that, they looked for technical ways to turn tacit knowledge into explicit knowledge. Lotus Notes, as noted earlier, was commonly used to house best practices. It links best practice databases across the 15 operating companies. Employees are encouraged to use Notes to describe best practices, search for a mentor on a subject they need to know about, and find best practices. Notes has also been used to support processes. For example, it is used to coordinate the around-the-clock work of 100 employees in the refining company. In creating this workflow system, the employees reengineered the work so coordination worked more smoothly.

The company has also created online discussion databases, some 50 of them, to encourage sharing and reduce travel. Some of the networks have attracted hundreds of employees, leading to a more networked culture. In turn, some of these networks have led to face-to-face get-togethers, which have further spurred sharing on common topics, such as how to reduce energy costs, improve quality, and hone public relations in different cultures.

(Case Continued)

In short, this company has spurred best practice sharing wherever it makes sense, mainly guided by the interests of the employees. The results have not only been cost savings, but also a change in employee

perception, based on the results of employee satisfaction surveys. Employees responded that there was increased emphasis on processes and more sharing of best practices across the company. ■

Building Customer Capital

As noted earlier, customer capital is the strength of a company's franchise with its customers, the percentage of customer "mindshare" in its industry. Brand recognition is part of customer capital. Familiarity with one's products is another. One of the most fascinating case studies in the Giga knowledge management report,² all of which are anonymous, is the one about the vice president who derived the notion of customer capital. Here is that story, based on that report.

CASE EXAMPLE

A NORTH AMERICAN BANK

After the U.S. savings and loan debacle and the devaluation of real estate in the 1980s, the vice president of organizational learning and leadership development at a North American bank asked, "Why have banks become so exposed to risk in their lending practices?" The answer he arrived at was, "Because they do not understand the new information age and its underpinning collateral." At the time, and still today, banks lent money against hard assets, such as a shopping mall. However, the value of such assets can dissipate almost overnight, making them risky collateral. "Perhaps there is less risk in lending against soft assets, such as a group's knowledge of a programming language

or a patented process," he reasoned. Knowledge in a person's head does not disappear overnight. However, the vice president had no way of valuing such intangibles. He continued to work on the problem of knowledge valuation. Over time, his thinking changed the way the bank evaluated new hires and reshaped some of its operations.

To begin his quest on how to value knowledge, or intellectual capital, he drew on the ideas of human capital and structural capital, and then added his own: customer capital.

Human capital was the know-how to meet customer needs; he asked bank managers to measure it by assessing how fast their teams learned. To increase

(Case Continued)

human capital, he shifted emphasis at the bank from training (pushing instruction to people) to learning (getting people to pull the instruction they needed to them), because he believed the crux of increasing human capital was increasing the pace at which an organization learns. He believed people learned when they “owned” their learning and took responsibility for applying it to improve their performance. He developed a list of skills needed to serve customers and gave employees numerous ways to learn these skills, from reading specific books to choosing a mentor.

Structural capital was the organizational capabilities needed by the marketplace. The vice president measured structural capital by uncovering the percentage of bank revenue that came from new services and similar metrics. He believed that although it takes human capital to build structural capital, the better the bank’s structural capital, the higher its human capital; one feeds the other. Thus, he generated structural capital from human capital by creating a competitive intelligence “library” about the industry that the bank considers a valuable “intellectual capital repository.” Rather than being a library of documents,

however, it was a map that showed the kinds of knowledge the bank held and where it existed, whether in an employee’s head or a database.

Customer capital was the intellectual assets in the minds of customers related to the bank. The vice president’s team measured three aspects: depth of knowledge about the bank in a customer organization, breadth of knowledge by a customer, and loyalty to the bank. To strengthen these aspects, the vice president believed the bank needed to assist its customers’ employees in learning. Some of that learning pertained to learning more about the bank, which required making the bank’s values and strategies congruent with those of its customers. The vice president therefore helped senior bank officials determine customer needs; establish a common language for communicating with customers; develop a sense of purpose for the relationship; and, most importantly, make learning within the customer organization an important part of the bank’s services. He believes that assisting customers will increase his bank’s customer capital: depth, breadth, and loyalty. Thus, his knowledge management efforts focused outwardly as well as inwardly. ■

To recap, Figure 2 shows the key activities in each of the four stages, the form of capital each supports, the skills required of people, and the tools and techniques that are proving valuable for that stage.

The Cultural Side of Knowledge Management

Success in managing knowledge comes as much from changing organizational behavior as it does from implementing new technology, notes Cyril Brooks.⁵ His company, Grapevine, offers a product for managing information and knowledge. He notes that besides the platitude of “create a culture that rewards sharing,” few people recommend specifics on how to reduce the cultural roadblocks that can hinder knowledge management projects. He describes some cultural barriers, which he calls “red flags.”

Supporting Knowledge Work

<i>Phase</i>	<i>Emphasis</i>	<i>Skills/People</i>	<i>Tools/Techniques</i>
Creation and Capture Generate new knowledge Make tacit knowledge explicit Hire people with the right knowledge Create culture of sharing Encourage innovation Incentives for sharing	Human capital Customer capital	Knowledge harvesters Knowledge owners Mentoring/coaching Partner with universities Teamwork Business intelligence Top management	Easy-to-use capture tools E-mail Face-to-face meetings Knowledge tree Write-to-think Feedback
Organization and Categorization Package knowledge Add context to information Create categories of knowledge Create knowledge vocabulary Create metadata tags for documents Measure intellectual capital	Structural capital	Academics Knowledge editors Librarians Knowledge architects Authors Subject matter experts IS	Frameworks Cull knowledge from sources Best practices databases Knowledge bases Knowledge thesaurus Knowledge indexes Measurement tools
Distribution and Access Create links to knowledge Create networks of people Create electronic push and pull distribution mechanisms Knowledge sharing	Structural capital	Publishers Top management IS	HTML Groupware, Lotus Notes Networks, intranets Navigation aids Search tools
Absorption and Reuse Stimulate interaction among people The learning organization Informal networks	Human capital	Group facilitators Organizational developers Matchmakers Knowledge brokers	Team processes Electronic bulletin boards Communities of practice Yellow pages

FIGURE 2 Knowledge Management Stages

Source: Reprinted with permission from *Best Practices in Knowledge Management*, Giga Information Group, 1997, www.gigaweb.com.

Watch Out for Cultural Red Flags

Cultural barriers can shut down knowledge management efforts because knowledge management is really about cooperation and sharing. To reach these lofty goals, efforts need to turn the tacit knowledge in people's heads into explicit knowledge in a process,

Supporting Knowledge Work

product, or other organizational artifact. Thus, knowledge management work must tap people's motivations to share and cooperate. Without the motivation, knowledge databases, for example, are not updated or errors are ignored. Or people avoid contributing to a knowledge-sharing network for fear they will give away their best ideas and lose their "competitive advantage" against their peers in the company. Such red flags are not obvious; they are often subtle, yet harmful, says Brooks.

Here are a few of his behavioral red flags that can derail a knowledge management effort:

- Being seen as a whistle-blower or messenger of bad news. Few people want to betray their boss, so they avoid presenting early warnings or disagreeing with internal documents. In organizations where "messengers get shot," sharing good news is fine, but sharing bad news is not, which defeats the full value of sharing.
- Losing one's place as a knowledge gatekeeper. Although knowledge brokers are important in organizations, their self-value comes from their controlling the knowledge they house and sharing it only with whom and when they choose. They may see a knowledge management system that encourages the free flow of ideas as decreasing their value, and therefore fight it.
- Knowledge sharing really does take time. Because sharing takes time, experts may hide so that they are not bothered by requests from others. Others may not participate in, say, presenting their ideas, which may benefit the organization as a whole but has no personal reward, so they think.

These reactions are human; therefore, knowledge management efforts often need to build "cultural workarounds" so that these kinds of reactions do not block the work. Brooks offers some suggestions. For example, to reduce concerns about being a messenger, the system might allow only limited dissemination of some ideas or give people the ability to rank feedback comments based on their significance. To counter concerns about losing personal advantage, contributions could require authorship or comments might always be linked to the original items. To reduce time consumption, the reward structure could reward contributions based on their value.

In addition to cultural red flags, management red flags are also a concern. Three management red flags are:

1. Saying the project is not cost-justifiable because the benefits are intangible
2. Concern that too much participation will reduce employee productivity
3. Concern that creating the taxonomy of knowledge categories will be just too expensive to undertake

Reducing these concerns is an important aspect of knowledge management. Some examples for mitigating these management roadblocks, says Brooks, include illustrating the value of serendipity that has occurred due to sharing, as illustrated in vendor case studies; ensuring that the new system promotes feedback to contributors, which can increase productivity; and drawing on vendor expertise to create knowledge taxonomies rather than start from scratch.

As Brooks points out, organizational culture is an important aspect of knowledge management efforts and a key determinant of success.

Design the System to Match What the Users Value

Thomas Stewart,⁶ a well-known writer in the knowledge management field, agrees and makes the important point that knowledge needs to be managed within the context where value is created. In short, the system needs to be designed to fit the people who will use it and gain value from it. He notes that many official knowledge management efforts have come to naught because they did not create the place where people first look for knowledge. On the other hand, a number of grassroots, unofficial efforts have succeeded.

Stewart gives the example of three consultants who created an informal, unofficial Notes-based e-mail list in their company to have a place to collaborate online. Anyone could join the list; to date, it has attracted over 500 company employees. It has actually become the premier knowledge-sharing mechanism in the company even though it is difficult to search and generates a lot of messages, which fill up e-mail boxes. It works for four reasons:

1. It is demand driven. Some 80 percent of the traffic is members asking each other, “Does anyone know anything about. . . ?”
2. It roots out tacit knowledge. People contribute what they know, which might not be recorded anywhere in the company.
3. It is right in front of the members in their e-mail boxes every day.
4. It is full of intriguing and strongly held opinions, which the members find most interesting.

The system is like a conversation rather than a library; thus, it is about learning rather than teaching. That is a major difference. It was designed to manage knowledge in the context where value is created. Given the high number of failed knowledge management projects, Stewart suggests answering the following three questions before launching off:

1. Which group will use this knowledge space? Once determined, make them responsible for the content.
2. What kind of knowledge does the group need? Once known, that knowledge needs to be managed within that group’s context because that is where the value arises. A knowledge management system or resource should only deal with a single group that creates value in the same way.
3. What is the company culture; is it composed of reusers or originators? The difference matters. A repository of things promotes a reuse culture; an online chat room helps originators, but not vice versa.

Beware of creating a system that supports the wrong culture. There is really no such thing as a generic knowledge management system. Each one needs to fit a knowledge-sharing group. Answering these questions will help uncover the structure and content of a knowledge management resource that will add value and actually be used.

As an example of a knowledge management project that has worked and has followed many of the tenets espoused by Stewart, consider the work at Partners HealthCare System in Boston. Notice how it takes into account the health care culture.

CASE EXAMPLE

PARTNERS HEALTHCARE SYSTEM

www.partners.org

Not too long ago, Tom Davenport of Accenture's Institute for Strategic Change and John Glaser, CIO of Partners HealthCare System in Boston,⁷ described how Partners HealthCare System is delivering just-in-time knowledge.

The problem the physicians at Partners HealthCare hospitals and physician groups face is the deluge of new knowledge they need to know but cannot possibly keep up with on their own. The solution has been to present physicians with the new knowledge they need when they need it through the information technology they already use in their work. In essence, this approach makes knowledge management part of their job, not a separate activity, and it can deliver knowledge just when a patient really needs it.

The work at Partners HealthCare began on a small, doable scale: using the doctors' online order entry system to notify doctors of drug interactions when they enter a prescription order. The system checks the patient's medical record, looks for allergic reactions to the drug (or a similar drug), and alerts the physician. The doctor can inquire about the reaction, and, if it was mild, override the computer's recommendation to switch to another medication.

The system can also tell the doctor about a newer, more effective drug or inform him or her of another drug the patient is taking that can lead to a bad interaction. Or, if the doctor is ordering a

test, the system can describe a newer, more effective test for the noted symptom. Or the system can warn the doctor that the prescribed medication could worsen a patient's disease.

This integrated system is built on knowledge bases (databases of knowledge about the patient, drugs, tests, medical research, and such) and a logic engine (which, as its name implies, performs the logical interconnections between the various kinds of knowledge in the knowledge bases).

The system also has an event-detection mechanism, which alerts a physician when it learns of an event that can endanger the health of a patient. For example, when the patient's health indicators deviate from the norm while the patient is in the hospital, the doctor or a nurse is notified via pager. This capability brings knowledge management into real time, note Davenport and Glaser.

However, this system could not be bought. It had to be built by Partners HealthCare. It was a large investment, but it was made because too many patients at Partners were experiencing drug interactions. Management had to fix that problem. One of the steps it took was to form committees of top clinicians to identify the knowledge that needed to be in the knowledge bases and keep it up to date. The drug therapy committee makes the medication recommendations, whereas the radiology committee develops the logic to guide radiology testing.

(Case Continued)

Participation in each committee is seen as prestigious, which is crucial to the success of the system, so that busy physicians give time to the committee work.

Another step Partners took was to only address the most critical processes. Furthermore, the system is simply seen as a recommendation system. It does not make final decisions. Those are left up to the physicians. The combined human-computer system seems to be working. Some 380 orders (out of 13,000 a day) are changed due to a computer suggestion.

Some one-third to one-half of orders with drug interactions are cancelled, and some 72 percent of treatments are changed when the event-detection system sounds an alert. Partner's strong measurement culture helps it gather such statistics and see the benefits of the system.

In summary, embedding knowledge in the systems and work processes that professionals use is an effective way to achieve just-in-time knowledge management and dramatically improve an organization's performance. ■

INTELLECTUAL CAPITAL ISSUES

Data, information, content, and intellectual capital all raise some thorny issues. These issues have prompted legislation in some countries, but not all, which causes even more problems in today's intertwined, global society. Their resolution is important for global e-commerce, and such resolution could be a long way off. We begin by looking at information value, usage, and sharing issues. Then we move on to the large, but rarely discussed, subject of computer ethics.

If information is to be viewed as an asset, as many companies now do, it must be treated differently from the traditional assets of labor and capital, notes Thomas Davenport.⁸ For one thing, information is not divisible. Nor is it scarce. In addition, ownership cannot be clearly defined. We discuss here four categories of issues in managing information:

1. Value issues
2. Usage issues
3. Sharing issues
4. Social and ecological issues

Value Issues

Information's value depends on the recipient and the context. In fact, most people cannot put a value on a piece of information until they have seen it. However, people do, indeed, place values on information. Look at all the information services that people buy. Information marketplaces exist, both inside and outside of companies. The only practical way to establish the value of information is to establish a price for it and see whether anyone buys it. Pricing possibilities include charging for the information itself rather than for the technology or the provider, charging by the document rather than

Supporting Knowledge Work

a smaller unit, charging by length or time or number of users, or charging by value rather than cost.

A number of tools are being used within companies to increase the value of information.

- **Information maps.** These maps can be text-based charts or even diagrammatic maps that point to the location of information, whether in written material, experts' minds, and so forth. IBM, for example, created a guide to market information so that managers can find out where to get quick answers to their ad hoc questions. The result has been less money spent on duplicate information and increased understanding of the kinds of questions people typically ask.
- **Information guides.** Guides are people who know where desired information can be found. Librarians have traditionally played this role. Hallmark Cards, for instance, created a job guide in its business units to help employees find computer-based information on available jobs. These guides have substantially reduced the time needed to find information.
- **Business documents.** Business documents are yet another tool for sharing information. They provide organization and context. One fruitful way to embark on information management is to uncover what documents an organization needs. This process can be easier, and more useful, than defining common terms. One brokerage firm discovered that its brokers all used the same documents, over and over. Some 90 percent of these documents could be put on one CD-ROM, kept on local servers, and updated monthly, greatly facilitating information use.
- **Groupware.** Groupware is a tool for getting greater value out of less structured information. It allows people to share information across distances in a more structured manner than e-mail. Lotus Notes is such a product. Groupware can ease discussions and aid distribution of information, but its success depends upon the culture. For one, better access to information increases (not decreases) people's appetite for even more information. However, employees using sophisticated groupware products need to learn how the technology can be used to improve work habits and profits, neither of which flows naturally from the technology.

To create value, the databases need to be managed, even pruned and restructured. Knowledgeable people are needed to manage the information resource and its use. This need is true for intranets and Web sites as well.

Usage Issues

Information management is a management issue because it deals with how people use information, not how they use machines, says Davenport. Three points illustrate the importance and difficulty of managing information use.

One, information's complexity needs to be preserved. Information should not be simplified to be made to fit into a computer, because doing so truncates sharing and conversations. Information does not conform to common definitions. It is messy. It naturally has different perspectives, which are important and need to be preserved. A certain amount of tension between the desire for one common global meaning and numerous familiar local meanings is inevitable. Companies that want to settle on common corporate terms must do so with line people, not technical people, because line

people will use the end results. The IS organization can facilitate these discussions, but the businesspeople should determine the meanings.

Two, people do not easily share information, even though its value grows as it is shared. Culture often blocks sharing, especially in highly competitive organizational cultures.

Three, technology does not change culture. Just building an information system does not mean that people will use it. It is a false assumption that too many IS people make. To change the information culture of a company requires changing basic behaviors, values, attitudes, and management expectations.

Sharing Issues

If information sharing is the goal, a number of contentious challenges must first be resolved. Davenport explains that a sharing culture must be in place or the existing disincentives will thwart use of a sharing system.

Technical solutions do not address the sharing issue. For example, much talk has touted information architectures, where the definitions of stable types of corporate data, such as customers, products, and business transactions, can be specified ahead of time and used consistently across the firm. This approach may work for data, but it is problematic for information, because information architectures generally fail to take into account how people use the information. Managers get two-thirds of their information from conversations, one-third from documents, and almost none directly from computer systems. Therefore, a common computer-based information architecture is not likely to solve the information-management problem.

An issue in sharing is: Who determines who has legitimate need for the information? The “owning” department? Top management? And who identifies the owner? The process of developing the principles for managing information—how it is defined and distributed—is actually more important than the resulting principles because the touchy subject of information sharing is brought out into the open during the process. In short, working out information issues requires addressing entrenched attitudes about organizational control. That is where consensus needs to be built: in discussions, not through edicts.

Is sharing good? asks Davenport. Not in all cases. Forcing employees to share information with those above them can lead to intrusive management. Some executive support systems limit “drill down” for just this reason. Managers must think about these types of issues in information management.

Unlimited information sharing does not work. Limits are necessary. On the one hand, the sharing of corporate performance figures is beneficial, especially when corporate performance is poor, because it usually increases morale; uninformed employees usually guess the worst. On the other hand, the sharing of rumors (noninformation) generally demoralizes people. Separating information from noninformation is an information-management issue. Allowing employees to send messages to large distribution lists exacerbates the information-management problem. Managements have awakened to the fact that they need to address this issue. Vendors have developed filters and agents for e-mail systems. Such responses can help resolve corporate information-management issues, but only when the correct underlying policies are put in place.

Even hiring practices play a role in information management. If promotions are based on circulation and publication of new ideas, a sharing environment exists. If these activities are not rewarded, sharing may be anathema to the culture.

Supporting Knowledge Work

In all, getting value out of information requires more than technology. Information is inherently hard to control. It is ever expanding and unpredictable. Only when executives view information in this light will they manage it for most effective use.

Social and Ecological Issues

It is worth repeating here that the leading theme of this chapter is how to use knowledge management to sustain individual and business performance. This is achieved through technology-supported learning, unlearning, and adaptation. Despite the advances of more intelligent systems, and the willingness of large corporations to invest billions of dollars in these technologies, it is also important to recognize the limitations of technologies. Data mining and other data-driven analytics have shown useful results, but they could also lead to inconsequential or dumb results. Human users of knowledge management technologies should remain as the key part of knowledge quality assurance, or at least, as educated knowledge consumers. Today's "intelligent" systems are certainly smarter than their predecessors. But it would be a stretch to argue that IT can store and distribute human intelligence and experience. The ability to deliver the right information to the right person at the right time in a dynamic, context-dependent concept still requires human intelligence.

An organization can be viewed as a knowledge ecology with evolving interactions between knowledge workers capable of learning and adapting to changing situations. Therefore, nurturing and protecting intellectual capital continue to be central concerns for knowledge-based organizations.

The social and ecological issue here is at least twofold. First, as knowledge, defined in its broadest sense, is widely fragmented across networks of servers, the power that can be derived from this knowledge is shifted to a large number of independent stakeholders. It is difficult to predict how these people work together or against each other in the creation and use of intellectual capital. Furthermore, with the ease of access to massively distributed knowledge, how do organizations bond human talents together to create and sustain a shared vision or common sense of purpose?

WIKIS

A Simple Open Source for Online Knowledge Repository

In 1994, Howard G. Cunningham started the development of a piece of software known as the WikiWikiWeb or simply WikiWiki, or simply Wiki for the Portland Pattern Repository. The idea was to build an electronic forum allowing computer programmers to exchange ideas about software development. The technology was based on Apple's hypercard concept developed in the 1980s to cross-link texts and documents. One of Cunningham's concerns was to design a platform that users can quickly log in and edit the text. Wiki in Hawaiian language means "fast." This very first Wiki now hosts tens of thousands of pages. When knowledge is not intended to be shared, a desktop-based Personal Wiki can be used to organize content.

The Wiki engine is a simple collaborative software installed on a Web server or more that allows Web pages to be created and edited using a Web browser. As information is entered in the text by users (affectionately called wikizens), the system stores information in a database-management system, or a content management system. To date, there

exists a rather extensive list of Wikis systems using net-centric and open source technologies with Java, JavaScript, PHP, Perl, VPScript, Python, and others.

The concept was quickly adopted by many communities, and turned the Wiki concept into a platform for online communities to build collective knowledge. Wikis are growing in number. They serve as knowledge repositories, with the Wikipedia as one of the success stories of collective and global knowledge creation. Today, many large organizations are creating their own context-specific Wikis for internal knowledge management.

The knowledge creation is based on trust and a strong code of ethics to give all participants the motivation to engage the building of the Wikis, with no malicious intent. Users can freely add or delete content, but here are roll-back procedures to revert to previous versions which are available Wikis as histories. In many Wikis, contributors are requested to register so that Wikis administrator can hold trace contact them or hold them accountable.

From a knowledge-management perspective, the creation of Wiki pages by the community of practice illustrates well the concept of conversational knowledge management. In distributed or virtual environments, individuals use a common Internet platform to create knowledge. Unlike other forms of information exchange or conversational knowledge such as e-mail, instant messaging, discussion forums, or decision support technologies, Wikis has the potential for organization to facilitate group work—such as writing an annual report or a business plan—without the need for meeting face-to-face. Wikis allow some off-line conversation. However, they excel in collaboration.

Wikis for Business Use

Wiki technology has evolved to meet business needs. Commercial Wiki software has features that require different levels of authorization for people to access, add, or modify existing contents. For example, the HR department posts some policies on a corporate Wiki and does not allow anyone to alter the document. New Wikis also have better versioning features, allowing the users to organize information.

Generally speaking, thanks to the low cost of acquisition and use, a Wiki would be a good technology for a business that needs to establish an intranet quickly with a reasonable level of functionality, security, and durability. Another reason for installing a Wiki is to allow corporate documents to be stored and accessible through the Internet, and let employees self-manage these documents with a minimum of effort, while avoiding redundancy. Many businesses have successfully used Wikis for project management and to manage and organize meeting agenda and minutes.

Like any business application, a business-oriented Wiki requires adequate computing resources and proper project management. The system that hosts a Wiki should have security and data-management tools. The organization should also appoint a staff member to be responsible for maintaining the Wiki.

As we discuss the issue of computer ethics in the next session, it is fitting to address a possible downside of knowledge creation using Wikis. As documented in the literature about group pathologies, the information, views, and opinions stored in the Wikis might de facto—for the better or worse—the collective wisdom. In many instances, and by its very nature, a Wiki's knowledge repository is built in an anarchic manner. The issue here is that this wisdom might be incomplete and biased, and Wiki users should be aware of how knowledge is being created, and the context of how knowledge is being built and rebuilt. The *Economist*, in its April 2006⁹ issue, raised the possibility of

vandalism in Wikis. Despite the code of ethics mentioned earlier and the effort of Wikis' administrators to enforce some quality control, there is a risk of people telling lies. The *Economist* reports the incident of a person telling lies on wikipedia.org. For 132 days, the lies went unnoticed and remained on the site, until some volunteers did detective work to trace the creator of vandalism.

Nevertheless, Wiki technologies have proved to be a flexible tool for collaboration. The issue here for CIO or top management leadership is to view Wiki technology as another enabler for knowledge acquisition and dissemination.

THE VAST ARENA OF COMPUTER ETHICS

To conclude, we need to address an issue that is coming more to the fore: computer ethics. We can only touch on this vast subject, but this brief discussion will give a flavor of the issues involved. New technologies pose ethical issues when they open up new possibilities for human action—individual action as well as collective action—points out Deborah Johnson¹⁰ of Georgia Institute of Technology, in her book *Computer Ethics*. Nuclear power, the atom bomb, genetic engineering, and other technologies raise ethical questions, as do computers; hence, the realm of computer ethics.

A Little History

In the first era of computing, when companies and governments used mainframes to collect personal information and store it in huge databases, the perceived threat was invasion of personal privacy. In the United States, that concern led to a major privacy study in 1976. At the time, no formal rules limited access to personal data in computers.

The second era of computing, mini- and micro-computers, turned attention to the democratizing aspects of computers and software and the ethical issues of property rights. Should software be owned? What sorts of intellectual property laws were needed to protect software owners? Such questions raised the ire of people who did not like the idea of property rights in software, those who believed software should be free. Issues of property rights also raised liability issues: Who is responsible for errors in code?

The third and latest era, the Internet, has brought “an endless set of ethical issues,” notes Johnson, because it can be used in so many aspects of life. Thus, all the concerns of the past have resurfaced: privacy, the democratizing nature of the Internet, property rights on Web sites, the concept of free speech (is information on the Internet a form of speech or expression?), and now even global property rights.

What Is Computer Ethics?

In 1985, James Moor wrote the seminal piece “What Is Computer Ethics?”¹¹ Moor stated that new technologies raise ethical issues because they create policy vacuums. The ethical issues are these vacuums. The role of computer ethics is to fill the vacuums. Thus, areas of ethical concern include privacy, property rights, liabilities, free speech, and professional ethics. This notion implies that the technology appears first and the ethics follow. It might be better for IT to follow ethics, says Johnson, but that rarely happens in any technology. Two possible examples are freeware and the privacy-enhancing technology of anonymous remailers.

Supporting Knowledge Work

New technologies bring benefits and problems, which raise the ethical issues of how to shape a technology's use for good and minimize its use for harm. We need to make moral choices about how we are going to use IT, personally, organizationally, nationally, and even globally. The central task of computer ethics is to determine what our personal and social policies should be, states Moor.

Johnson provides a whole host of examples of IT ethical issues. Here are abbreviated samplings of a few of her examples to show the breadth of this subject.

- John buys a software package to help him invest in penny stocks. At a party, he mentions the software to Mary and she asks to borrow it. She likes it, so she copies it and then returns the original software to John. What did Mary do wrong, if anything? Why is it wrong? (Intellectual property rights)
- Inga has a small business and collects customer data from her customers directly and from their purchases. She wants to use data-mining tools on these data to uncover patterns and correlations among her customers. The customers gave her the data to make a purchase; she wants to use those data for another purpose, even though individuals will not be uniquely identified in this use. Would she be doing anything wrong? (Privacy)
- Carl is a systems designer who is designing a system to monitor radar signals and launch missiles in response to those signals. He has become concerned that the system has not been made secure, for one thing, and that it cannot adequately distinguish between a missile and a small airplane, for another. His manager dismisses his concerns. What should he do? (Professional ethics)
- Grundner sent a message on an unmoderated listserv that contained the phrase "wives . . . and other informationally challenged individuals." Mabel sent him a private message reprimanding him for his sexist language. Grundner thought Mabel's message was sent to the entire listserv, so he broadcast a message that stated that online communications transcend barriers as long as "professional victim-mongers" do not "screw it up." Many members of the listserv felt Grundner's response was a personal attack on Mabel, and said so. Others sent messages on gender issues. Insults spread around the listserv. What's wrong with this? (Flaming)
- Kimiko is a successful pension fund manager who uses an expert system to help her make investment decisions. Her experience tells her the market is going to turn down, so she wants to sell stock. However, the expert system recommends buying stock, even when Kimiko double-checks the economic indicator data she has entered. She does not understand the reasoning in the expert system, so she cannot check its logic. For all she knows, it could be malfunctioning. What should she do, buy or sell? (Accountability)
- Milo is an independent journalist and an expert on South American politics. He subscribes to an Internet-based service that sends him articles and news on areas of interest to him. Upon returning from a trip, he discovers a posting that says he is involved in illegal drug dealing and his articles protect drug cohorts. Milo is enraged by the lie. He wants to sue for defamation of character, but the bulletin board owner will not give him the address of the message poster, who used a pseudonym. So he sues the bulletin board owner instead. Are bulletin board owners liable for the contents posted on their board? (Accountability)

Supporting Knowledge Work

To address such issues, says Johnson, some people look to traditional moral norms and apply them to the new situations. They extend property law (copyrights, patent, and trade secret laws) to software. Similarly, certain kinds of spoken and written communications have traditionally been considered impolite or confidential. The same should hold for computer-mediated communications, some contend.

However, to apply past norms, we must first define, say, the Internet or software, which is difficult to do when both are still evolving. Is the Internet a highway? A shopping mall? A fantasy world? Each would have different laws, contends Johnson, which is one reason why computer ethics is so difficult. She questions whether we should be treating new opportunities like old situations. Although it is true that new uses of, say, computers, touch familiar ethical notions, we need to ask whether they pose new ethical issues. That is the main purview of computer ethics. IT creates a new species of traditional moral issues, with new variations and new twists, says Johnson.

So the question becomes, should we fill the vacuums with laws or something else? The answer should not begin or end with laws. Rather, we need a shared sense of what is good and just. We need personal and institutional policies and social mores.

The ethical questions surround what people do to one another. Therefore, they involve such concepts as harm, responsibility, privacy, and property. In essence, says Johnson, IT creates a new instrumentation for human action, making new actions possible. As such, it can change the character of actions. For example, launching a computer virus on the Internet can wreak havoc for thousands, even tens of thousands of people and institutions. We need to account for this change in ethics, she contends.

Some actions are unethical only because they are illegal. Others are unethical whether or not they are legal. Much of the unethical behavior on the Internet is not controversial or complicated. It is just criminal behavior in a new medium. It is doing bad things in new ways. Computer ethics can thus be thought of as a new species of general moral issues that may not fit familiar categories. It has a global scope, which makes it unusual, and the actions have reproducibility in that they can be easily shared.

With this brief introduction to the realm of computer ethics, we now look at four areas that raise ethical and legal questions.

1. Information privacy
2. Intellectual property rights
3. Legal jurisdiction
4. Online contracting

Information Privacy

Privacy includes freedom from intrusion, the right to be left alone, the right to control information about oneself, and freedom from surveillance. It is a major issue in today's world because of the widespread availability of personal data and the ease of tracking a person's activities on the Internet.

The United States and many other countries have enacted laws to control certain types of personal information, such as medical, credit, and other financial information. These laws carry over to the online business environment. As companies have built large databases on their online customers, the value of these data makes selling them an attractive business option. That is one reason the United States now has a privacy

Supporting Knowledge Work

law that requires companies to publish a description of how they treat the personally identifiable information they handle.

Internet technologies, cookies in particular, make tracking the browsing activities of individuals possible. Consumer concerns about this perceived invasion of privacy now require companies in some countries to post and adhere to privacy statements on their Web sites.

Some companies use third-party cookies (i.e., cookies set by a firm other than the owner of the site being visited) to do online profiling. It is also known as profile-based advertising, and it is a technique that marketers use to collect information about the online behavior of Internet users and to facilitate targeted advertising. Profile-based advertising could easily be considered a form of online surveillance. What is worse, some third-party cookies are often placed on Web browsers' computers without their knowledge when banner advertisements appear. It is not necessary to click on the banner ad to generate a cookie.

Companies with cookies on their Web sites obviously want information about their customers to make better decisions about the types of products and services they should develop, says Johnson. On the other side of the coin is people's desire for privacy; their fear of who has information about them; and their mistrust of large, faceless organizations and governments.

Another technology that has privacy advocates concerned is RFID. They contend that these radio-frequency sensors on products will allow industry, governments, and thieves to monitor personal belongings after they have been purchased. As CNET's News.com reports, Debra Bowen, a California state senator, held a hearing on RFID technology and privacy to study what sorts of regulation might be needed to protect consumer privacy.¹² One example of privacy invasion mentioned at the hearing was, "How would you like it if you discovered that your clothes were reporting on your whereabouts?" Others presented other potential invasions of privacy from RFID tags on individual consumer items.

Still others suggested protection possibilities. One was to create a set of "fair use" guidelines for industry. One guideline might be that companies must label products that have RFID tags. Another might be to let consumers disable the sensors. A third could be to allow consumers to request and see the information collected about them from the sensors. Another suggestion was to require legal guidelines to be in place before deploying RFID.

Bowen has already introduced bills to regulate the use of other technologies that might invade privacy, including face recognition, data collected by cable and television companies on consumers' viewing habits, and shopper loyalty cards issued by supermarkets and other chains. Bowen is not alone in her concerns. Britain also is delving into RFID privacy issues.

However, the argument for personal information privacy has not "won the day," says Johnson. The following has not proven to be a strong argument: "We control relationships by controlling the information we give to another party. When we lose control of our information, we lose control over how others perceive and treat us. The loss reduces our ability to establish and influence relationships." The reason that this argument is not strong is because when people must make a choice between a social good (such as police protection) and loss of control of information, they give up control.

Supporting Knowledge Work

A much stronger argument for the right to privacy can be made if privacy is seen as a social good, rather than as an individual good. This argument goes as follows, notes Johnson: “Democracy is the freedom to exercise one’s autonomy. If the consequences are too negative, few people will take the risk, and democracy will diminish. For example, people act differently when they know they are being watched. Thus, privacy is a social good in its own right. The less privacy, the more difficult it is to make social change. How information is gathered, exchanged, and used affects us all, not just those who have something to hide.”

Johnson recommends five ways to increase information privacy protection:

- 1. At the national level.** Treat privacy as a social good that lies at the heart of democracy, giving its protection more weight. Deal with privacy policy nationwide rather than on an industry-by-industry basis, as it has been in the past. Citizens need protection from private institutions just as much as public ones, so include both public and private information gathering, with an eye toward global exchange. Treat personal information as part of the infrastructure of our society. It is better to manage this information outside the marketplace.
- 2. Computer professionals.** Point out privacy matters to clients when they build databases that contain personal information.
- 3. Technology.** Use privacy protection technologies, such as Web anonymity and tools for detecting the privacy level of a Web site.
- 4. Institutions.** Adopt internal policies that protect privacy, such as restricting who can see personal information.
- 5. Individuals.** Take personal actions to increase the privacy of information about you.

Intellectual Property Rights

The protection of intellectual property is critical in an Internet-based world because many products and services contain intellectual property, copies of such items are easy to make, and the copy is as good as the original. Examples of online activities in which intellectual property rights are critical include electronic publishing, software distribution, virtual art galleries, music distribution over the Internet, and online education.

Following are four types of legal protection of intellectual property: copyrights, patents, trademarks, and trade secrets.

Copyrights

Copyright law aims to protect an author’s or artist’s expression once it is in a tangible form. The work must be expressive rather than functional; a copyright protects the expression, not the idea. For example, a cartoon duck is an idea and cannot be copyrighted, but Donald Duck and Daffy Duck are expressions of that idea and are copyrighted. Registering a copyright is not a requirement; putting the expression into tangible form is sufficient. A copyright is valid for the life of the author plus 75 years.

Just about all original content on a Web site can be copyrighted by the creator of the site, from buttons to video, from text to a site layout. If a company hires someone to develop a site, by default the copyright belongs to the developer, not the company. The developer can then demand royalties from the company if it uses the Web site; therefore, it behooves companies to clearly define the ownership of the copyright in the contract.

Supporting Knowledge Work

The Internet raises many nontrivial issues for copyright law, which was developed for physical media. Placing copyrighted material, such as a photograph, on a Web site without permission of the copyright holder is a clear violation of the law. Less obvious is whether having a link to someone else's copyrighted material, say, a photograph, is a violation of copyright law. In this case, the answer is probably yes. However, if one includes a link to the homepage of the site rather than a direct link to the content, then probably no violation has occurred. Internet copyright issues are now being worked out in courts and legislatures.

Patents

Patent law aims to protect inventions—things or processes for producing things, where “things” are anything under the sun made by man but not abstract ideas or natural laws, according to U.S. copyright law. Valid for 20 years, patent protection is quite strong. In the United States, patents are granted by the U.S. Patent and Trademark Office after stringent thresholds on inventiveness have been met.

The United States recognizes patents for business processes. Although software, in general, cannot be patented—it must be copyrighted—certain business practices implemented in software can be patented. In the e-business area, Amazon.com has received a patent for “one-click purchasing.” The company has enforced its patent rights against its main competitor, Barnes and Noble. Barnes and Noble cannot use one-click purchasing on its Web site. British Telecom has claimed to have invented the hyperlink. To obtain the patent, the company will have to show that no prior use of hyperlinks occurred before its use. Any prior use would invalidate the patent.

Trademarks

Trademarks protect names, symbols, and other icons used to identify a company or product. Trademarks can be registered with the U.S. Patent and Trademark Office. A trademark is valid indefinitely, as long as it is used and does not become a generic name for the goods or services. The aim of trademark law is to prevent confusion among consumers in a market with similar identifying names or symbols. The standard for trademark infringement is whether the marks are confusingly similar.

The biggest area of trademark conflicts in e-business has to do with domain name registration. For a while, cybersquatters were registering domain names that clearly referred to known companies, realizing those companies would eventually want the domain name and would be willing to pay for it. Although this tactic worked for a while, anti-cybersquatting laws were passed and the practice is now illegal. To avoid potential problems, firms should obtain and register a trademark for its domain name. Note that most online services that register domain names do not check for trademark infringements. Firms are advised to do a search for possible trademark infringements before using a domain name, to avoid future litigation.

Trade Secrets

Trade secrets, as the name implies, protect company secrets, which can cover a wide range of processes, formulas, and techniques. A trade secret is not registered and is valid indefinitely, as long as it remains a secret. Although laws protect against the theft of trade secrets, it is not illegal to discover a trade secret through reverse engineering. Trade secrets are the area of intellectual property rights least applicable to e-business.

Legal Jurisdiction

Laws are written for particular jurisdictions with clear geographic boundaries, so how do those laws apply in cyberspace, which has no geographic boundaries? Take, for example, the case of trademark rights, which are limited to geographic areas. In the physical world, a sign over “Lee’s Computer Services” in Singapore would not have a significant impact on “Lee’s Computer Services” in Honolulu—neither in customers nor competition. However, in cyberspace the Web sites of the two companies would clearly overlap and, if the companies were to take advantage of the global reach of the Internet, competitive overlap could be an issue. The companies have little legal recourse for resolving their identical trademarks.

Gambling provides another example. Do Hawaiian laws against gambling apply to a Nevada company with a gambling site on its Web server located in Las Vegas? The Attorney General of Minnesota has asserted the right to regulate gambling that occurs on a foreign Web page that is accessed and “brought into” his state by a local resident.

Similar cases have involved sites dealing with pornography and securities trading. Alabama successfully prosecuted a California couple for bringing pornography into Alabama; their server was in California. Note that U.S. pornography laws are based on “community standards”; Los Angeles, California, standards are clearly different from those of Mobile, Alabama. The state of New Jersey is attempting to regulate securities trading over the Internet if anyone in the state has access to it, and many states are trying to revise their tax codes to gain revenues from e-commerce.

At best, this trend is disturbing. At worst, it could greatly disrupt e-business. Faced with the inability to control the flow of electrons across physical boundaries, some authorities strive to impose their boundaries on cyberspace. When technological mechanisms, such as filters, fail, the authorities assert the right to regulate online trade if their local citizens may be affected. In essence, under this approach, all Internet-based commerce would be subject simultaneously to the laws of all territorial governments. Imagine a Hawaiian company setting up a Web site for retailing over the Internet needing to consider the laws of Hawaii, California, New York, and the other 47 states, plus Singapore, Peru, Syria, and any other place you might name. This situation would clearly cripple e-business.

The concepts of “distinct physical location” and “place where an activity occurred” fall apart in cyberspace; no clear answer is available to the question: Where did this event take place? Of relevance are the locations of the business’s offices, warehouses, and servers containing the Web sites. Some of the uncertainty can be resolved by placing online contracts on the site specifying the legal jurisdiction that will be used for disputes. Users who agree to the contract designate so by clicking a button that says “I agree.” In most cases, the contract will hold.

In the United States, states have adopted the Uniform Commercial Code (UCC), a wide-ranging codification of significant areas of U.S. commercial laws. The National Conference of Commissioners of Uniform State Law and the American Law Institute, who sponsor the UCC, are working to adapt the UCC to cyberspace.

Internationally, the United Nations Commission on International Trade Law has developed a model law that supports the commercial use of international contracts in e-commerce. This model law establishes rules and norms that validate and recognize contracts formed through electronic means, sets standards governing electronic contract performance, defines what constitutes a valid electronic writing and original

Supporting Knowledge Work

document, provides for the acceptability of electronic signatures for legal and commercial purposes, and supports the admission of computer evidence in courts and arbitration proceedings.

Online Contracting

A contract is a voluntary exchange between two parties. Contract law looks for evidence that the parties have mutually assented to the terms of a particular set of obligations before it will impose those obligations on them. Before the law will recognize the existence of a binding contract, there must be

- A definite offer by one party, called the offeror
- A timely acceptance by the offeree
- Some consideration must pass between the offeree and the offeror

A widespread misconception holds that contracts must be in writing and signed before they are enforceable in court. The general rule is that offerees can show their acceptance of a contract offer by any means that are “reasonable under the circumstances.” Reasonable acceptance includes oral agreements. Some exceptions do apply, however. For example, sales of real property require signed writings and, in the United States under the UCC, any contract for the sale of goods for a price greater than \$500 requires a signed agreement.

In e-business, evidence of acceptance of a contract can be a simple click on a button saying “I accept” or “I agree.” The case becomes more complex when the transaction involves payment greater than \$500. The relevant questions are: Is our purely electronic communication “in writing” and have we “signed” the agreement? The answers are as yet unresolved. No cases have been presented regarding whether a file that exists in a computer’s memory is “written” for purposes of contract law. Most commentators think the answer is probably “yes,” but the final answer will have to wait until courts have reviewed the issue more closely.

In June 2000, President Clinton signed the Electronic Signatures in Global and National Commerce Act (E-Sign). Basically, E-Sign grants electronic signatures and documents equivalent legal status with traditional handwritten signatures. It is technology-neutral so that the parties entering into electronic contracts can choose the system they want to use to validate an online agreement. Many browsers contain minimal authentication features, and companies are developing pen-based and other types of technologies to facilitate online contracting. In addition, a number of companies already provide digital signature products using public key encryption methods.

The full impact of E-Sign may not be as revolutionary as some would hope. The act specifies that no one is obligated to use or accept electronic records or signatures—all parties must consent to using the method. The act does not apply to a wide range of situations, such as the creation and execution of wills, adoptions, divorces, any notice of cancellation or termination of utility services, or foreclosure or eviction under a credit agreement. In addition, the marketplace has to sort out some serious problems with varying electronic signature standards. For example, a number of companies issue digital certificates, but none of them can operate with the others. It would require parties interested in adopting electronic signatures for their business to provide several technologies or risk losing access to some customers.

CASE EXAMPLE

CLICKWRAP AGREEMENTS

www.cli.org

On its Web site, the Cyberspace Law Institute¹³ offers an interesting case. You subscribe to an electronic newsletter on a Web site with the following text:

You may obtain a 1-year subscription to our newsletter XYZ News for the special low price of \$5.00 for each monthly issue, simply by filling in your name and e-mail address on the form below and then clicking the SUBSCRIBE button. By subscribing, you agree to the terms and conditions set forth in our Subscriber's Contract; to read the Subscriber's Contract, click on CONTRACT TERMS below.

Suppose you fill in your name and e-mail address and click SUBSCRIBE but, like most folks, you don't actually take the time to look at, let alone read, the Subscriber's Contract. Do you have a contract with XYZ?

Absolutely. You received an offer (to deliver the weekly newsletter to you); you took a specific action that the offeror

deems to constitute acceptance of the offer (clicking on the SUBSCRIBE button); and you agreed to pay consideration for the contract (the offeror will deliver the newsletter to you for \$5.00 per issue).

This clickwrap contract is an example of what the law calls a contract of adhesion—a contract that you did not really bargain over in any way, but which was presented as more of a take-it-or-leave-it offer. Generally speaking, adhesion contracts are legally enforceable.

The use of the term “clickwrap contract” is an extension to the shrinkwrap licenses used in purchased software. Mass-marketed software comes with the terms of the contract—the license agreement—packaged under clear wrapping, with the notice that by opening the package you are agreeing to the terms of that license. Clickwrap is the same idea: by clicking here, you similarly agree to the contract's terms. ■

CONCLUSION

In organizations, knowledge management is the process of identifying, acquiring, creating, representing, and disseminating knowledge for situation awareness and assessment, learning, and reuse. In Part IV of this text, we have surveyed a number of technologies such as expert systems, knowledge repositories, group systems with case bases, and the likes. To properly support knowledge work, companies need to understand the life cycle of knowledge because each phase of the cycle is best supported by specific approaches. Two of the four phases discussed in this chapter are better supported using

Supporting Knowledge Work

high-touch approaches, and two are better supported using high-tech approaches. There have been many undisclosed knowledge management failures, so it behooves executives to understand where IT fits in the overall knowledge management and knowledge-sharing arena.

Likewise, it behooves management to understand the vast arena of computer ethics. IT adds new twists and, often, greater ramifications to long-standing ethical issues. New laws should not be the only recourse to address these ethical quandaries. Enterprises need to discuss these issues, make their own judgments, and make them clearly known to their stakeholders.

Companies in some countries are now required to state their privacy policies with respect to the personally identifiable information they handle. Many companies have also decided whether or not e-mail is company or private property and made their stance known to employees. It would be wise for CIOs to bring up other ethical issues and see that company policies are set, promulgated, and enforced, so that knowledge and other forms of intellectual property are properly used for good, not harm.

Many countries have also put into place stringent regulations with regard to intellectual property protection and consumer's privacy. It is thus a legal obligation for businesses to comply with regulations. However, for a forward-looking organization, the search for competitive knowledge assets and the need to cultivate a culture of knowledge sharing should be on the top agenda, not just a mere legal compliance.

QUESTIONS AND EXERCISES

Review Questions

1. What is tacit knowledge? What is explicit knowledge?
2. What are the four phases of Giga's knowledge management model?
3. How do human capital, structural capital, and customer capital differ?
4. How has Buckman Laboratories encouraged knowledge creation and capture worldwide?
5. What is "the Rudy problem" and how did Seemann attempt to deal with it?
6. What are the two roles of the BP T-shaped manager in Egypt?
7. What did the pharmaceutical company do to create a knowledge infrastructure?
8. What approach did the energy company take to encourage knowledge sharing among its 15 business units?
9. Give three cultural roadblocks to knowledge management projects, as noted by Brooks.
10. What three questions does Stewart recommend be asked before launching a knowledge management project?
11. According to Davenport, what are four management issues in managing information? Briefly describe each.
12. According to Moor, what is the role of computer ethics?
13. Give some examples of IT ethical issues.
14. How does Johnson recommend increasing information privacy protection?
15. What are the four methods of legal protection of intellectual property?

Discussion Questions

1. Should IS take the lead in the development of knowledge management and sharing? Why or why not?
2. Knowledge management is a misnomer because knowledge only exists in people's heads. Thus, knowledge management is really just people management. Do you agree or disagree? Discuss.
3. An ethical question regarding e-mail is whether the contents belong to the sender or the corporation. What is your opinion? Explain your reasoning.
4. How do you think the flaming example in the "Computer Ethics" section should have been handled by the listserv operator? By the listserv members?

Exercises

1. Find an article about a successful or failed knowledge management project. Why did it fail or succeed; that is, what were the "critical failure factors" or the "critical success factors"?
2. Visit a local organization that is developing a knowledge management system. Who is leading the development efforts? What benefits are being realized? What are their plans for the future?
3. Describe one or two computer ethics dilemmas either you or someone you know has faced. How was each handled? How could each have been handled better?
4. Describe your company's or school's policy on protecting information privacy. How easy was it to find this policy? Do you think it is being followed? If not, give examples of how it is being circumvented.

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Glossary

- 3G Mobile Communications** Third-generation wireless communication systems with high transmission capacity up to 2 Mb/s/sec) allowing fast Internet browsing, video conferencing, and a host of new applications on mobile appliances.
- 3G Teams** Teams of three generations (25+, 35+, 45+) that work together.
- Action Labs** An approach to planning where frontline employees identify and interactively refine local-level strategies by having to get them funded at action lab meetings with top management.
- Advanced Technology Group** A group within the IS department that is responsible for spotting and evaluating new technologies, often by conducting a pilot project.
- Agent** An electronic entity that performs tasks, either on its own or at the request of a person or a computer.
- Aggregation** Combining formerly separate pieces of infrastructure, providing companies with an e-business infrastructure on very short notice.
- Analog Technology** Signals sent as sine waves rather than ones and zeros (as in digital technology).
- Applets** Small, single-function applications, often written in Java, that are pulled from the Internet when needed.
- Application Program Interface (API)** An interface created for a software product that, like a standard, allows programmers to write to, link to, and utilize that software's interface in their applications.
- Application Service Provider (ASP)** A company that rents out software over the Internet.
- Architecture** A blueprint that shows how a system, house, vehicle, or product will look and how the parts interrelate.
- Artificial Intelligence (AI)** A group of technologies that attempts to mimic our senses and emulate certain aspects of human behavior, such as reasoning and communicating.
- Authentication** Assuring that the digital signature of the user is valid; biometric authentication is becoming increasingly popular.
- Authorization** Assuring that the correct user is accessing a network, application, or stored files or documents.
- BASIC (Beginners' All-Purpose Symbolic Instruction Code)** An early programming language that makes micro-computers popular as an instructional device. Microsoft successfully prolonged BASIC with its Windows-based Visual BASIC.
- Backbone Systems** Mainline corporate transaction processing systems.
- Back-end Systems** Computer systems that handle an enterprise's operational processing, as opposed to front-end systems that interact with users.
- Back-end Tools** Tools, such as code generators, in computer-aided software engineering suites that automatically generate source code.
- Best-of-Breed Outsourcing** Outsourcing specific functions, each to the most appropriate provider, rather than outsourcing all functions to one provider who may not be the best for all the functions.
- Blade Server** A server chassis that houses multiple thin, modular electronic circuit boards known as server blades designed to deliver high processing power with little physical space, little cabling, and less power consumption; a blade server is dedicated to a single application.
- Blogs** Self-published journals posted electronically on the Web.

Glossary

- Bricks-and-Clicks** Companies with a dual physical and Internet presence, becoming a hybrid of brick-and-mortar firms and dot-coms.
- Broadband** In telecommunications, refers to a wide band of frequencies to transmit information concurrently on many frequencies.
- Bull-Whip Effect** Where a small change by a customer results in a huge change upstream. For instance, a customer order triggers a company to generate an order to its supplier, who, in turn, generates its own larger order to its suppliers, and so on; moving upstream through the supply chain increases greater variance from the original order. If the customer then cancels the order, that cancellation ripples through the supply chain.
- Business Continuity** Involves not only disaster recovery (recovering data and programs from back-up and instituting communication links, for example) but also having back-up work procedures and office space for displaced employees to work with telephone lines and computers so that the business can continue operating.
- Business Process Outsourcing (BPO)** Outsourcing all or most of a reengineered process that has a large IT component.
- Business Process Redesign/Reengineering (BPR)** Significantly restructuring the operational business processes in a firm.
- Business Intelligence** An umbrella term used to describe a broad set of applications and technologies for gathering, storing, integrating, and analyzing data to help decision makers make decisions; typical applications include query and reporting, online analytical process (OLAP), Decision Support Systems (DSSs), and data mining.
- Business Visionary** One of the CIO's roles where the CIO will need to believe, and then convince others, that the Internet will lead to new business models. This makes the CIO's role a main driver of strategy.
- Case-Based Reasoning (CBR)** Expert systems that draw inferences by comparing a current problem (or case) to hundreds or thousands of similar past cases. CBR is best used when the situation involves too many nuances and variations to be generalized into rules.
- CDMA (Code Division Multiple Access)** A popular communication/network protocol that allows fast and parallel data transmission. CDMA has a number of variations; in particular, DS-CDMA (Direct Sequence CDMA) is an emerging technology for wireless communications systems that includes error-correction and error-detection, smart antenna management, and power control algorithms.
- Champion** A person inside or outside IS who has a vision and gets it implemented by obtaining the funding, pushing the project over hurdles, putting his or her reputation on the line, and taking on the risk of the project.
- Change Management** The process of assisting people to make major changes in their work and working environment.
- Chaos Theory** As applied to business, a theory that states that "order is free" when groups and organizations are allowed to be self-organizing because, as in scientific chaos theory, randomness (chaos) works within boundaries, which are called strange attractors. As a result, there is order in chaos.
- Circuit Switching** When a virtual (temporary) circuit is created between caller and receiver and that circuit is theirs alone to use; no other parties can share it during the duration of their telephone call. Most appropriate for voice calls.
- Cleansed Data** Data processed to make them usable for decision support; referred to in conjunction with data warehouses. Opposite is dirty data (data from different databases that do not match, have different names, use different time frames etc.).
- Cleartext** Nonencrypted versions of passwords and messages.
- Clickwrap** Contract A contract not really bargained over in any way, but presented as a take-it-or-leave-it offer. Generally speaking, these contracts are legally enforceable. The use of the term "clickwrap contract" is an extension to the "shrinkwrap licenses" used in purchased software.
- Client-Server** Splitting the computing workload between the "client," which is a computer used by the user and can sit on the desktop or be carried around, and the "server," which houses the sharable resources.
- Closed Network** A network that is offered by one supplier and to which only the products of that supplier can be attached.

Glossary

- Collaborative Outsourcing** Where one service provider becomes the prime contractor for numerous facets of an operation, but some of the work is provided by other external service providers (ESPs).
- Communities of Practice (CoPs)** Networks of people who work together in an unofficial way to get work accomplished using unofficial procedures that may be outside the company's formal corporate culture.
- Competitive Local Exchange Carriers (CLECs)** Telecom carriers that compete with incumbent local exchange carriers (ILECS) and provide new kinds of connection options to businesses and homes, such as cable modems, optical fiber, wireless, and satellite.
- Connectivity** Allowing users to communicate up, down, across, and out of an organization via a network.
- Content** Refers to information presented electronically in a variety of media: charts, text, voice, sound, graphics, animation, photographs, diagrams, and video.
- Cookie** A file in a Web user's computer that identifies the user to Web sites.
- Cooperative Processing** Computer systems that cooperate with each other to perform a task. The systems may span internal business functions or even span enterprises.
- Copyright** A law that aims to protect an expression in a tangible form; a copyright protects the expression, not the idea.
- Corporate Memory** The knowledge or information accumulated by a business, which is often stored in its software, databases, patents, and business processes.
- Corporate Portal** An intranet where employees, customers, and suppliers gain access to a company's information, applications, and processes. This approach moves the software from being decentralized (on PCs) to being centralized (on a server).
- Countermeasures** Mechanisms used by people and enterprises to protect themselves from security breaches, such as stealing data or machines, destroying files, redirecting traffic, shutting down Web sites, and unleashing computer viruses.
- Critical Success Factors (CSF)** The few key areas of an executive's job where things must go right in order for the organization to flourish.
- Customer Capital** The strength of a company's franchise with its customers and its relationships and networks of associates. This form of capital may be either human (relationships with the company) or structural (products used from the company).
- Customer Relationship Management (CRM)** Computer systems used to know much more about customers (and perhaps noncustomers). They are used to manage a firm's relationships with its customers; hence the name.
- Cyberspace** A "space" on the Internet where people "exist" in a virtual world.
- Cybersquatting** The act of registering domain names that clearly referred to known companies, anticipating that those companies would eventually want the domain name and would be willing to pay for it.
- Cycle Time** The amount of time it takes to accomplish a complete cycle, such as the time from getting an idea to turning it into a product or service.
- Data** Electronic information that is comprised of facts (devoid of meaning or context).
- Data Dictionary** The main tool by which data administrators control a company's standard data definitions, to make sure that corporate policy is being followed.
- Data Integrity** Data that maintain their integrity because they cannot be modified in transit or in storage.
- Data Mart** A subset of a data warehouse created for a specific set of users, such as the marketing department.
- Data Mining** Having computers explore huge repositories of data to uncover unknown patterns, trends, or anomalies.
- Data Model** A generalized, user-defined view of how data represent the real world. Data modeling is the analysis of data objects that are used in a business applications and the identification of the relationships among these data.
- Data Warehouse** A huge repository of historical data used to answer queries and uncover trends; contains a snapshot of data at a point in time as opposed to operational databases that are updated with every new transaction.
- Database** Repository of data stored in a particular manner, such as a hierarchy or tables.
- DDM Paradigm** A part of the architecture of a DSS: the dialog (D) between the user and the

Glossary

- system, the data (D) that support the system, and the models (M) that provide the analysis capabilities.
- Decision Support Systems (DSSs)** Computer applications used to support decision making.
- Demand-Pull** In this business model, companies offer customers the components of a service or product, and the customers create their own personalized versions, creating the demand that pulls the specific product or service they want through the supply chain; opposite is supply-push.
- Denial-of-Service Attack** Attack on a Web site from many coordinated computers that floods the site with so many empty messages that the site is overwhelmed and crashes and is therefore unable to process legitimate queries.
- Digital Subscriber Line (DSL)** A telephone subscription service that provides speed up to 1.2 Mbps (106 bits per second) over copper wire, as compared to modems' speed of 56 Kbps.
- Disruptive Technology** A new, low-cost, often simpler invention that displaces an existing product or service, and eventually transforms the entire market or industry.
- Distributed System** A computer system that has components physically distributed around a company or among companies.
- Document** A unit of recorded information structured for human consumption. This definition accommodates "documents" dating back to cuneiform inscriptions on clay tablets—what has changed are the ways information is represented and the ways documents are processed.
- Dot-coms** Businesses based primarily or exclusively on the Web, and hence merging IS and business. The dot-com crash refers to the stock market slump in 2000–2002 of many of these start-up companies. They failed to live up to expectations, the value of their stock fell to zero, and the companies folded. Internet-only dot-com competitors have now become more reality based, and the integration of the Internet into how companies work has proceeded.
- Dribbling Data** Obtaining data for a new application from data in an existing application.
- Dumb Terminals** Desktop machines without local processing or storage capabilities.
- Eavesdropping** Intercepting messages on a computer network.
- E-Business Outsourcing** Outsourcing e-commerce and e-business aspects of one's company, such as Web-site hosting, application hosting, telecom management, and so forth.
- E-Commerce** Buying and selling electronically, as in handling commerce transactions.
- Ecosystem** A web of relationships surrounding one or a few companies.
- Edge Server** Distributed databases on the edge of the Internet (close to a set of users), holding a copy of an organization's Web site.
- E-Enablement** Integrating use of the Internet into how companies work; building e-enabled relationships with consumers and other enterprises, not simply performing transactions electronically.
- Electronic Channel** An electronic link used to create, distribute, and present information and knowledge as part of a product or service or as an ancillary good.
- Electronic Data Interchange (EDI)** Business transactions, such as orders, that cross company boundaries via a network using carefully defined protocols and data formats.
- Electronic Tender** An electronic communication capability in a product or service that allows that product or service to be tended; that is, cared for, attended to, or kept track of by a remote computer.
- Electronic Vaulting** An off-site data storage facility used by organizations for backing up data against loss in case of a disaster.
- Encapsulation** Combining data and procedures in an object.
- Encryption** Coding and decoding documents for security.
- End-User Computing** Encompasses software development techniques that embrace the users in the design (Human Computer Interface, user-driven modeling.)
- End Users** Refers to a group of people who ultimately uses the systems; also known as target or expected users
- Enterprise Nervous System** The technical means to a real-time enterprise; a network that connects people, applications, and devices.
- Enterprise Resource Planning Systems (ERPs)** Systems that aim to provide companies with a

Glossary

- single source of data about their operations. The systems have financial, manufacturing, HR, and other modules.
- E-Procurement** Buying items via the Web using company-tailored electronic catalogs of items for which the company has negotiated prices with the seller; e-procurement generally uses a third-party marketplace to handle the coordination between buyer and seller.
- E-tailing** Retailing over the Web.
- Ethernet** A network protocol used in many local area networks that broadcasts messages across the network and rebroadcasts if a collision of messages occurs.
- Exchanges** Business-to-business electronic marketplaces where many buyers purchase goods from many sellers. These are generally organized by industry or by specialties within an industry.
- Executive Dashboard** A type of executive information system that allows executives access to a company's data warehouse (via a display screen that resembles a car dashboard), allowing real-time analysis of how well a division, region, or other part of the business is progressing on meeting its forecasts.
- Executive Information System (EIS)** A computer system specially built for executives to assist them in making decisions.
- Expert Systems** An automated type of analysis or problem-solving model that deals with a problem the way an "expert" does. The process involves consulting a base of knowledge or expertise to reason out an answer based on the characteristics of the problem. A popular form of reasoning is to use "If... then" rules.
- Explicit Knowledge** Knowledge that has been articulated, codified, and made public.
- Extended Enterprise** All of one's own organization plus those organizations with which one interacts, such as suppliers, buyers, and government agencies; interconnected single-organization networks that are not limited by industry and provide a type of electronic information consortium.
- External Document-Based Information** Electronic information that is available outside an organization and is text based, rather than numeric.
- External Operational Measures** Measures of computer operational performance that users can see, such as system and network uptime (or downtime), response time, turnaround time, and program failures. These directly relate to customer satisfaction.
- External Record-Based Information** Electronic information that is available outside an organization and is numeric, rather than text based.
- External Service Provider (ESP)** A company that provides services to a firm, often acting as an outsourcer. There are numerous types of ESPs, such as those that provide Web-site hosting, backup and recovery, and application hosting.
- Extract File** A file extracted from a company's transaction database and placed in a decision support database or a data warehouse where it can be queried by end users.
- Extranet** A private network that uses Internet protocols and the public telecommunications system to securely share part of a business's information or operations with suppliers, vendors, partners, customers, or other businesses. An extranet is created by extending the company's intranet to users outside the company.
- E-zines** Web pages owned by frustrated writers who publish their own electronic magazines.
- Federated Databases** A way of organizing databases where each retains its autonomy, where its data are defined independently of the other databases, and where its database-management system takes care of itself while retaining rules for others to access its data.
- Feeding the Web** Promoting the platform on which a firm bases its offerings because the firm's prosperity is linked to the platform's prosperity.
- Fiber Optics/Optics** Glass fiber that transmits voice or data signals via light pulses.
- Filtering** Using a software program (a filter) to automatically route messages or documents according to their content.
- Firewall** Software on Internet servers (or entire servers) that keeps the public from accessing the company's intranet.
- Fourth-Generation Language (4GLs)** A computer programming language used by end users, as opposed to COBOL (a third-generation language), or Assembler (a second-generation language), or programming via plug boards (first-generation programming).

Glossary

- Freeware** Software given away for free, generally via the Internet but also on CD-ROMs.
- Front-end Intelligence** An interface for interacting with the user, most useful when it is decentralized, flexible, personalized, and sensitive to context.
- Front-end Tools** Tools in a computer-aided software engineering suite that are used by analysts and designers to create the design of a computer system.
- Gateway** A data network connection that connects unlike networks.
- Globalizing** Striking a balance between global and local needs.
- Groupware** Electronic tools that support teams of collaborators.
- Hacking/Cracking** The unauthorized access to a host computer. This access may be a direct intrusion or via a computer virus or Trojan horse.
- Heuristics** Rules that draw upon experience, common sense, ways of doing business, and even rules and regulations.
- Homepage** A person's or organization's base page on the World Wide Web.
- Hubs** One of three types of computers that route traffic, these forward packets of data from one machine to another. When a number of computers share a hub, data sent from one goes to all the others.
- Human Capital** Knowledge, skills, and innovativeness of employees as well as company values, culture, and philosophy.
- Hypertext** A style of presenting text in computer systems or networks where the reader can click on a highlighted word and jump to a related thought or site.
- Hypertext Markup Language (HTML)** The language multimedia Web pages are formatted in that uses the same technique to link graphical items on the World Wide Web.
- Incumbent Local Exchange Carriers (ILECs)** Formerly called Regional Bell Operating Companies (RBOCs), telecom companies spun off from AT&T in 1984.
- Inference Engine** A portion of an expert system's software that contains the reasoning methods used to search the knowledge base and solve the problem.
- Information** Data in context, which means the data have been given an explicit meaning in a specific context.
- Information Age** Though defined a multitude of ways, this text refers to the information age as when the number of U.S. information workers surpassed the number of U.S. workers in all other sectors combined (information workers exceeded 50 percent of the U.S. workforce).
- Information Architecture** A blueprint of definitions of corporate data—such as customers, products, and business transactions—that is used consistently across the firm's applications.
- Information Repository** The heart of a computer-aided software engineering (CASE) system that stores and organizes all information needed to create, modify, and develop a software system.
- Information Resources** The intangible information assets of a firm, including data, information, knowledge, processes, patents, and so on.
- Infrastructure** The implementation of an architecture, including in hardware, software, databases, electronic links, and data centers as well as the standards that ensure the components work together, the skills for managing the operation, and even some of the electronic processes themselves.
- Insourcing** Moving responsibility for specific services to a group within the company rather than to an external service provider. Commonly the insourcer is the shared services group.
- Institutional DSS** A decision support system built by DSS professionals using a DSS language that is intended to be used for the long term to support the organization's operations rather than to support an individual or small group for a short time.
- Intellectual Capital** A preferred term for knowledge, to distinguish it from the other kinds of capital that firms possess.
- Inter-Exchange Carriers (IXCs)** Long-distance telecom carriers.
- Internal Document-Based Information** Information that is available in-house and is text based, such as internal reports, memos, and so forth.
- Internal Operational Measures** Metrics of the performance of a firm's IT operations that are of interest to its computer operations staff, such as computer usage as a percentage of capacity, availability of mainline systems, disk storage utilized, job queue length, number of jobs run, number of jobs rerun due to

Glossary

- problems, age of applications, and number of unresolved problems.
- Internal Record-Based Information** Information that is available in-house and is alphanumeric rather than textual.
- Internet Service Providers (ISPs)** Companies that offer Internet connectivity to homes and businesses; many bundle services such as e-mail, Web hosting, etc.
- Interoperate** Different products working together, driven by the open systems movement.
- Inter-organizational Systems (IOS)** Systems that require at least two parties with different objectives to collaborate on the development and operation of a joint computer-based system.
- Intranet** An internal company network that takes advantage of the Internet's infrastructure, telecommunications protocols, and browsers.
- IT Alignment or Business-IT Alignment** An effort to establish a correspondence between the organization's business mission and objectives to the IT architecture and infrastructure.
- IT Governance** The assignment of decision rights and the accountability framework to encourage desirable behavior in the use of IT. Governance differs from management in that governance is about deciding who makes decisions, while management is about making decisions once decision rights have been assigned.
- Keiretsu** Japanese term referring to the associations of independent and interdependent businesses working in concert.
- Knowledge** Information with direction or intent derived from strategies or objectives.
- Knowledge-Based Economy** An economy relies primarily on the production of values driven by the creation of knowledge.
- Knowledge Brokers** A way to promote knowledge sharing by giving titles to employees who excel at knowledge sharing.
- Knowledge Infrastructure** A support system that manages information, enables understanding, and supports learning.
- Knowledge Management** A set of methods and tools that can be used to discover, create, integrate, store, represent, and distribute knowledge for achieving a particular objective.
- Knowledgeware** Advanced groupware information technology that helps people and organizations share knowledge.
- Learning Organization** Ability of an organization to remain flexible, aspiring, adaptive, creative, and productive in a fast-changing environment.
- Legacy Systems** Mainframe computer applications that handle the day-to-day transactions of the company in a centralized, rather than distributed, manner. Alternatively, any system that does not use current technology.
- Line Executive** A business executive who manages a profit-oriented business unit, such as manufacturing, rather than a supporting staff unit, such as finance.
- Linkage Analysis Planning** A planning approach that studies the links between an organization and its suppliers and customers.
- Local Area Network (LAN)** A network that traverses a floor of a building, a work group, or a department (as opposed to a wide area network that crosses countries).
- Local Exchange Carrier (LEC)** Telecom companies that only handle local, not long distance, telephone calls.
- Loosely/Tightly Coupled Groups** Loosely coupled groups are where the activity of each member is relatively independent of the other members (such as salespeople who have their own sales territories). Tightly coupled groups are where the work of each member is tied closely to the work of the other members.
- Mainframe** A huge, very fast computer capable of handling all the computing for a large organization.
- Marketspace** A nonphysical marketplace where information substitutes for physical products and physical location.
- M-Commerce or Mobile Commerce** Conducting commerce via small wireless devices, such as buying an item from a vending machine using a cell phone or personal digital assistant (PDA).
- Mead's Law** Says that N transistors on a sliver of silicon yield N^2 performance and value.
- Metadata** Information about a data entity, such as its definition, how it was calculated, its source, when it is updated, who is responsible for it, and so forth.
- Middleware** Software that eases connection between clients and servers in a client-server system.

- Mid-Tier Servers** A network topology that has several tiers of servers, such as local work group servers, departmental servers, and an enterprise server (the corporate main-frame).
- Moore's Law** Computer processing power will double every 18 months. This law, stated by Gordon Moore, a founder of Intel, has proven true since 1959.
- Multidimensional Database (MDDDBMS)** Uses the concept of a data cube to represent multiple dimensions of data to users.
- Multimedia** The combination of text, graphics, sound, data, animation, and perhaps video in a message, a document, or at a Web site.
- Network Army** A set of individuals and communities aligned by a cause. They have moral and intellectual influencers as opposed to formal leadership, and are only as permanent as their common agenda. Their communications are open, in forums that anyone can join.
- Network Effect** When the value of a product or service offered on a platform (such as a gaming platform or an operating system) increases as the number of users increases, thereby creating a "virtuous" circle of upward spiraling product value and customers. The opposite is a downward spiraling "vicious" circle where a product continually loses its value and its customers.
- Neural Networks** A way to store knowledge and a type of decision-making system organized like the human brain, containing synapses and nodes that fire signals between each other. Neural networks are more intelligent than the other forms of knowledge representation discussed here because they can learn.
- Nonrepudiation** Not allowing a party in an electronic transaction to repudiate, which means claiming that the transaction never took place; nonrepudiation is an important cornerstone of electronic security.
- Object** In object-oriented programming, functions are packaged with data so that the two can be reused. These reusable components are called "classes," whereas at run time, each class can produce instances called "objects." Objects hold all the code and data in an object-oriented system.
- Object-Oriented Programming** A style of programming that encapsulates data and the operations that work on that data within an object, thus increasing the reusability of the code (as an object) and reducing the propagation of errors among objects.
- Object-to-Object Communication** The potential for objects such as smart tags to talk to one another.
- OLAP (Online Analytical Processing)** Computer applications that allow users to extract and view data from different points of view in real time.
- Open Network or Open System** Though the term "open" keeps expanding, this text refers to open networks/systems as those based on national or international standards so that the products of many manufacturers work with each other.
- Open Source** Software where the complete source code is distributed with any and all distributions, and where anyone can modify and redistribute the code.
- Open/Closed Groups** Open groups are where almost anyone can join. Closed groups are where membership is restricted. A "gray scale" between open and closed indicates the degree of difficulty to gain membership.
- Outsourcing** Contracting with another firm to perform work that had previously been performed in-house, generally requiring a multi-year contract and generally for "noncore" work.
- Packet Switching** Messages divided into packets, each with an address header, and each is sent separately—each packet may take a different path through the network.
- Partnering** Allying with another organization that has different core competencies, often on a strategic alliance basis, for mutual benefit.
- Patent** A law that aims to protect inventions (things or processes for producing things) but not abstract ideas or natural laws.
- Peer-to-Peer (P2P)** Computing distributing a task over a wide number of computers (peers) connected to the Internet.
- Personal Area Network (PAN)** A network that allows computers in a "personal area" to communicate wirelessly, much like Wi-Fi.
- Personal Digital Assistants (PDAs)** Handheld computers that sometimes allow wireless

Glossary

- connection to the Internet and contain personal productivity tools (such as calendaring, address book, to-do lists, and games).
- Personalization** Coordinating disparate pieces of intelligence to form personalized offerings.
- Phishing** A type of fraudulent e-mail or instant messaging designed to trick someone into giving out confidential information.
- Planning** Developing a view of the future that guides decision making today.
- Platform** A major trend in inter-organizational systems that provides the infrastructure for the operation of a business ecosystem, a region, or an industry. Examples are American Airlines' SABRE computer reservation system, or the video game industry's PlayStation, Nintendo, and Xbox platforms.
- Privacy** Includes the freedom from intrusion, the right to be left alone, the right to control information about oneself, and freedom from surveillance.
- Private Programs** Computer programs created and used by only one person.
- Process Owner** A person in an organization responsible for an end-to-end process such as the ordering process or a research and development process.
- Process-Centered Organization** A company whose perspective has shifted from tasks to processes; an approach to designing an organization where the business processes are the driving structures.
- Proprietary Software** Software sold only in its compiled state, undecipherable by humans, and whose code is not allowed to be changed except by the developer.
- Prototype** A computer program that is used to test a new computing concept or application idea, such as distributed Java applets, for learning and experimentation purposes.
- Public Key Encryption** A methodology for encrypting and decrypting text to ensure identity of the parties. A message sender uses the assigned private key to encrypt the message and the recipient uses the sender's public key (known to anyone) to decrypt it, thus validating the sender's identity. The process also works in reverse; sending a message encrypted using a person's public key that can only be decrypted and read by that person using their private key.
- Quality Assurance (QA)** A systematic process to ensure that all activities of a project are carried out with quality.
- Quality of Service** Refers to the ability of a network to provide a range of assured levels of performance.
- Quick Hit DSS** A system that is quite limited in scope, is developed and put into use quickly, and helps a manager come to a decision. The term "ad hoc" has also been used to distinguish from institutional DSS, although some quick hit systems become regularly used.
- Radio Frequency Identification (RFID)** A short distance automatic identification method, commonly used for inventory tracking and management.
- Rationalized Data** Using the same data name for all uses of the same data.
- Real-Time Enterprise** Where organizations can know how they are doing at the moment, rather than have to wait days, weeks, or months for analyzable data.
- Reengineering** Not to be confused with the term "business process reengineering," this term, "system or application reengineering," is much narrower and refers to rebuilding software for a new platform or new programming language.
- Regional Bell Operating Company** A regional telephone company formed by the 1984 deregulation of AT&T. Formerly, these companies were part of AT&T.
- Relational Databases** Databases that store data in a set of formally designed tables in such a way that allow data be accessed or reassembled in many different ways, using a query language known as Structured Query Language (SQL).
- Relationship Tech** New peer-to-peer relationships that are forming—between customer and firm, between customer and customer—which question past ways of working (such as recommender systems).
- Repudiation** Refusing a computer-based transaction, such as when one party reneges on an agreement after the fact, the other party may be left paying for the transaction processing unless it is repudiated.
- Routers** One of three types of computers that route network traffic, these use a routing table to pass along a packet to the next appropriate router on a network, directing packets via the

- most efficient route and relaying packets around a failed network component. Routers also link network segments that use different protocols, and can connect to wide area networks (WANs).
- Rules-Based Systems** A common way to store knowledge in an expert system knowledge base, where rules are obtained from experts drawing on their own expertise. Rules generally present this knowledge in the form of if-then statements, and are appropriate when knowledge can be generalized into such specific statements.
- Rummler-Brache Approach** An approach for deciding how to reengineer an organization using “swim lane diagrams” to plot, trace, and assess an organization’s processes and their interactions; the idea is to enhance communications and collaboration across departments and teams.
- Scan-Based Trading (SBT)** An arrangement between a retail store and product supplier whereby the scan data from point-of-sale checkout systems for products sold determines the amount the retailer pays the supplier.
- Scenario** A way to manage planning assumptions by creating a speculation of what the future might be like by drawing on trends, events, environmental factors, and the relationships among them.
- Scope Creep** Users asking for additional functions in applications as development proceeded.
- Secure Sockets Layer (SSL)** A protocol for providing security over the Internet.
- Security Accountability** Ability to trace to the cause of the security breach and deploy appropriate actions to include nonrepudiation, deterrence, fault isolation, intrusion detection and prevention, and after-action recovery and legal action.
- Security Assurance** Security goals are adequately met.
- Security Confidentiality** Security goal that seeks to protect from intentional or accidental attempts to perform unauthorized data reads during processing, transport, and storage.
- Security Integrity** Security goal that seeks to ensure data integrity (i.e., data are not altered in an unauthorized manner) or system integrity (i.e., the system functions as designed in an unimpaired manner and protected from unauthorized manipulation).
- Self-Managed Work Groups** Groups or teams that handle most supervisory tasks on their own, without a supervisor.
- Self-Organizing Systems** Entities, such as ecosystems, organisms, or organizations, that deal with their environment by responding to each stimulus in an appropriate manner, rather than in a predetermined manner, so they self-organize when needed.
- Sense-and-Respond Strategy Making** An approach to strategy making that endorses keeping in close contact with the business world, continually sensing for important changes, and then responding quickly to changes by conducting experiments that test different possible futures—as opposed to betting on one strategy for the future.
- Service-Oriented Architecture (SOA)** A generic software architecture aiming to achieve loose coupling among interacting and autonomous software agents.
- Shared Services** A department or division formed by consolidating and centralizing services formerly operated by business units. These services can include legal, travel, finance, IT, food service, fleet management, accounting, telecom, and others. It is a form of insourcing; business units draw on the expertise in shared services when needed.
- Short Message Service** An “always on” telecom service for communicating quickly and wirelessly using a small, handheld device; the messages are typed using a shorthand, code words, abbreviations, or short phrases.
- Smart Tags** Communicating objects with a small chip that contains information and a radio frequency identification device (RFID). They can carry far more information than bar codes because they carry the history of an item.
- Sniffing** The interception and reading of electronic messages as they travel over the communication networks. Usually for attempting to unveil passwords to gain access to a system.
- Social Network** A self-organized social structure made of nodes or actors (e.g., people, organizations, communities) and tied by one or more well-identified social needs (e.g., values, visions, friendships, trade).
- Software Agent** A self-contained, autonomous, and typically interactive program that acts with some (limited) intelligence. For example,

Glossary

a software agent could be created to deal with real-time auctioning.

Simple Object Access Protocol (SOAP) A simple XML-based protocol to let application exchange information across different computer platforms, operating systems, or programming languages.

Spaghetti Code The way code in many legacy systems appears to a programmer because it has been patched so many times that the logic of the application weaves in and out like a plate of spaghetti, making it difficult to understand and maintain.

Spam A technique that sends unsolicited messages, typically of promotional nature, to large e-mailing lists. To fight spam, dedicated software attempts to quarantine suspicious e-mails (through content analysis techniques).

Spiral Diagram A way of viewing the application development process as a spiral, as opposed to a waterfall, allowing many iterations or versions.

Spoofing Masquerading as another party, such as a storefront, to collect thousands (or millions) of credit card numbers and other information from naive consumers.

Stages of Growth The four stages that many organizations go through in the introduction and assimilation of new technologies. These are early successes (leading to increased interest and experimentation), contagion (the learning period for the field), control (integration of systems is attempted but proves difficult), and integration (use of the particular new technology is mature). An organization can be in several stages simultaneously for different technologies.

Status Access System A system for monitoring what is going on in the company and in the outside world.

Straight-Through Processing A system where transaction data are entered just once in a process or a supply chain.

Strategic Having a significant, long-term impact on the growth rate, industry, and revenue of an organization.

Strategic Alliances Systematic, long-term, and formal cooperation between two or more partners to pursue a set of agreed goals to gain competitive advantage.

Strategy Stating the direction in which you want to go and how you intend to get there.

Structural Capital The capabilities embedded in hardware, software, databases, organizational structure, patents, and trademarks that support employees as well as relationships with customers.

Structured Query Language (SQL) A database language for making queries of a database that has become the standard.

Supply-Chain Management Systems Systems that integrate supply chains that compete against one another on their ability to reduce costs and time across their entire chains. Development of these inter-organizational systems requires teams from the different organizations to work together.

Supply-Push In this business model, companies are organized to build a supply of products or services and then “push” them out to end customers, on store shelves, in catalogs, and such; the opposite is demand-pull.

Support Systems Systems that can help knowledge workers perform knowledge-based work.

Switches One of three types of computers that route traffic, these forward packets to the port of the intended computer, using the addressing information in each packet’s header.

System Development The process of building a system, originally by writing code to create an application and then linking together applications to form a system; a newer process is system integration.

System Development Life Cycle (SDLC) Overall step-by-step process of developing an information system from identification of business information needs to maintenance.

System Integration The current process of building systems by piecing together hardware components, software packages, database engines, and network products from numerous vendors into a single, cohesive system.

Systemwide Rules An operating discipline for distributed systems that is enforced at all times and governs security, communication between nodes, data accessibility, program and file transfers, and common operating procedures.

Tacit Knowledge Knowledge “known” but not easily explained to others.

Tech Clubs Cross-organizational groups that meet informally, but are supported and sanctioned by top management.

Glossary

- Technology Camel** A way to distinguish levels of comfort with any technology using five clusters, which, when graphed on a chart, look a lot like a two-humped camel.
- Telecommunications** The sending of information in any form from one place to another, electronically.
- The Long Tail** A statistical distribution characterized by a high-frequency population followed by a low-frequency population; the latter can make up the majority of the distribution area. In business, Anderson refers to the long tail as a market phenomenon by which many small, highly specialized businesses can survive the big businesses.
- Thin Clients** Network computers that are used much like telephones; they have no hard disk or house applications, but rather just a browser, memory, keyboard, and a modem.
- Third-Generation Language** A programming language used by a professional programmer, such as COBOL.
- Timebox** A methodology for building a system in which the developers promise to deliver specific portions of the system within a specific time frame (a timebox); the intent is to better control project delivery schedules.
- Total Quality Management (TQM)** A management technique that focuses on managing the quality of a service or product, often through statistical quality control techniques, in order to achieve higher customer satisfaction and reduce costs as well.
- Trademarks** A law to protect names, symbols, and other icons used to identify a company or product.
- Transitional Outsourcing** The outsourcing of legacy systems for maintenance so that the in-house staff can focus on developing replacement client-server systems.
- Trojan Virus** A computer program that appears to perform a legitimate task, but in fact is a hidden virus or a malware.
- T-Shaped Managers** Executives who have both a vertical role (such as running a business unit) and a horizontal role (such as sharing knowledge with their peers in other business units).
- Value Assessment Framework** A systematic way to separate potential benefits of IT investments by organizational levels.
- Value Chain** A technique for describing a chain of business processes from product/service conception through cessation of the product/service, where each of the processes adds some kind of value.
- Value Network** Technology-supported partnerships that allow internal and external specialized units to collaborate on a project, and collectively contribute to the value of the project.
- Virtual Circuit** A temporary circuit created between caller and receiver where that circuit is theirs alone to use; no other parties can share it during the duration of their telephone call.
- Virtualization** In computer application, a single physical resource (e.g., a server, an operating system, and a storage device) appears to the users to function as multiple virtual resources; vice versa, multiple distributed physical resources can be set up to serve as a single resource.
- Vision** A statement of how someone wants the future to be or believes it will be; it is used to set direction for an organization.
- Visual Programming** A technique for programming, such as creating a graphical user interface, by pointing and clicking on generic items—menus, dialog boxes, radio buttons, and other components of graphical displays—and then arranging them to create a screen.
- Waterfall Approach** A way to view the system development process as a series of steps that, when diagrammed, appear as a waterfall.
- Waves of Innovation** Primozić, Primozić, and Leben's presentation on how IT is used by industries and by enterprises, one view of the evolution of IT, and the escalating benefits it provides firms. They identify five waves of innovation, with time on the horizontal axis and benefit on the vertical access.
- Web 2.0** An ongoing transition of the World Wide Web from a collection of independent Web sites to an interconnected computing platform with constantly new (even beta-version) services such as search engines, blogs, Wikis, and Web Services to meet individual users.
- Web Cast** Broadcast of a live event over the World Wide Web.
- Web Services** This second-generation Internet-based system environment gives software modules URLs (Internet addresses) so they can be called upon to perform their function as a service via the Internet.

Glossary

- Web Site** A personal or organizational site on the World Wide Web. In just a few years, company Web sites have become standard business practice in most companies, large and small.
- Web Surfing (Surfing the Web)** Slang term for continuously following hyperlinks hidden behind highlighted words on Web pages that, when clicked, jump to another Web page.
- Wi-Fi** The 802.11 family of wireless Ethernet standards. For instance, 802.11b transmits up to 11 Mbps per second and behaves a lot like its wired cousin 10BaseT. Other members of this standard family exist and new ones are being developed.
- Wide Area Network (WAN)** A geographical, high-speed, high-bandwidth telecommunications network.
- Wiki** A collection of Web pages created collaboratively by its community users; anyone can freely contribute or modify content in the Wiki using a simplified markup language. Many organizations use Wikis as a means of communication and knowledge management for their employees.
- Worknets** Informal groups of people whose collective knowledge is used to accomplish a specific task.
- Workspace** The virtual workplace, which includes the Internet.
- Zero Latency** Reacting quickly to new information (with no wait time).
- ARPANET** Advanced Research Projects Agency Network
- ASP** Application Service Provider or Active Server Page
- AT&T** American Telephone and Telegraph
- ATM** Asynchronous Transfer Mode or Automated Teller Machine
- B2B** Business to Business
- B2C** Business to Consumer
- BCG** Boston Consulting Group
- BLISS** Banking and Loan Insurance Software System
- BMW** Bavarian Motor Works
- BPO** Business Process Outsourcing
- BPR** Business Process Redesign/Reengineering
- C/C++** Programming Languages Used with UNIX
- CAD/CAM** Computer-Aided Design/Computer-Aided Manufacturing
- CAPS** Center for Advanced Purchasing Studies
- CAS** Credit Authorization System
- CASE** Computer-Aided Software Engineering
- CBR** Case-Based Reasoning
- CC** Computer Center
- CCITT** Consultative Committee for International Telegraphy and Telephony
- CDMA** Code Division Multiple Access
- CDPD** Cellular Digital Packet Data
- CD-ROM** Compact Disc—Read-Only Memory
- CEO** Chief Executive Officer
- CFO** Chief Financial Officer
- CIO** Chief Information Officer
- CIR** Corporate Information Resources
- CIRANO** Center for Interuniversity Research and Analysis on Organizations
- CIS** Corporate Information Services
- CISR** Center for Information Systems Research
- CLEC** Competitive Local Exchange Carrier
- CMA** Cash Management Account
- COBOL** Common Business Oriented Language
- COE** Common Operating Environment
- COM** Computer Output Microfilm or Component Object Model
- COO** Chief Operations Officer
- CRAMM** United Kingdom Central Computer and Telecommunication Agency Risk Analysis and Management Method
- CRM** Customer Relationship Management
- CSC** Computer Sciences Corporation
- CSF** Critical Success Factor
- CTO** Chief Technology Officer

ACRONYMS AND ABBREVIATIONS

- 1G/2G/3G/4G** First, Second, Third, and Fourth Generation (of wireless systems)
- 3i** Investors in Industry
- 4GLs** Fourth-Generation Languages
- ACM** Association for Computing Machinery
- AI** Artificial Intelligence
- AIS** Association for Information Systems
- AM** Amplitude Modulation
- AmEx** American Express
- AMS/3** Third-Generation Automatic Order Matching and Execution System
- ANSI** American National Standards Institute
- AOL** America Online
- AOP** Advanced Optimization Planning
- API** Application Program Interface

Glossary

CU Credit Unions	GPRS General Packed Radio System
CXO A Group of “Chiefs” (CEO, CFO, CIO, COO, etc.)	GPS Global Positioning Satellite
DARPA Defense Advanced Research Projects Agency	GSM Global System for Mobile Communication
DASD Direct Access Data Storage	GSS Group Support System
DB Digital Business	GTE General Telephone Company
DB2 Database 2 (an IBM product)	HEC Hautes Etudes Commerciales
DBMS Database Management System	HICSS Hawaii International Conference on System Sciences
DDM Dialog, Data, and Modeling	HKEx Hong Kong Exchanges and Clearing
DES Data Encryption Standard	HP Hewlett-Packard
DGMS Dialog Generation and Management System	HR Human Resources
DNS Distributed Name Service	HTML Hypertext Markup Language
DOS Disk Operating System	HTTP Hypertext Transfer Protocol
DP Data Processing	IBM International Business Machines Corporation
DPI Dots Per Inch	IC Intellectual Capital
DSA Decision Support Application	ICT Information and Communication Technologies
DSL Digital Subscriber Line	ID Identification
DSS Decision Support System	IDE Integrated Development Environment
DVD Digital Video Disc	IDS Integrated Data Store or Intrusion Detection System
EAI Enterprise Application Integration	IEA Information Engineering Associates
EDI Electronic Data Interchange	IFTF Institute for the Future
EDM Electronic Document Management	IIML Indian Institute of Management, Lucknow
EDP Electronic Data Processing	ILEC Incumbent Local Exchange Carrier
EDS Electronic Data System	IM Information Management or Instant Messaging
EIS Executive Information System or Enterprise Information Solutions	INR Indian Rupes
EJB Enterprise Java Bean	IOS Inter-Organizational System
E-mail Electronic Mail	IP Internet Protocol
EMR Electro Magnetic Radiation	IPng Internet Protocol Next Generation
EPRI Electric Power Research Institute	IR Information Resources
ERD Enterprise Reference Data	IS Information Systems
ERP Enterprise Resource Planning	ISDN Integrated Services Digital Network
ES Enterprise System	ISM Information Security Management
ESOP Employee Stock Ownership Plan	ISO International Standards Organization
ESP External Service Provider	ISP Internet Service Provider
ESS Executive Support System	ISS Internet Security System
EUC End User Computing	IT Information Technology
EVP Executive Vice President	IXC Inter-exchange Carrier
E-zines Electronic magazines	J2EE Java 2 Enterprise Edition
FAQ Frequently Asked Question	JAD Joint Application Design
Fax Facsimile	JDS Job Diagnostic Survey
FBI Federal Bureau of Investigations	JIT Just-In-Time
FDA U.S. Food and Drug Administration	Kbps Kilobytes per second
FDDI Fiber Distributed Data Interface	KM Knowledge Management
FT Financial Times	LAN Local Area Network
FTC Federal Trade Commission	LEC Local Exchange Carrier
FTP File Transfer Protocol	LLC Limited Liability Company
GDSS Group Decision Support System	LN Local Network
GOTOS Go-to’s, in computer programming code	

Glossary

LTl Less-Than-Truckload	POTS Plain Old Telephone Service
Mac Apple's Macintosh Computer	PPSR Personal Property Securities Register Service
MAN Metropolitan Area Network	PRA Passenger Revenue Accounting
MBMS Model Base Management System	PRAC Plymouth Rock Assurance Corporation
Mbps Megabytes per second	PROFS Professional Office System
MGM Metro-Goldwyn-Mayer	PSTN Public Switched Telephone Network
MIPS Millions of Instructions Per Second	PTT Postal, Telephone, and Telegraph Authority
MIS Management Information Systems	PwC PricewaterhouseCoopers
MIT Massachusetts Institute of Technology	QoS Quality of Service
MOM Message-Oriented Middleware	R&D Research and Development
MU Multiple-User system	RAD Rapid Application Development
MVS Multiple Virtual System	RBOC Regional Bell Operating Company
NASA National Aeronautics and Space Administration	RCA Radio Corporation of America
NBC National Broadcasting Corporation	RF Radio Frequency
NC Network Computer	RFID Radio Frequency Identification
Net, The The Internet	RIPP Rapid Iterative Production Prototyping
NetBIOS Network BIOS, a proprietary network transfer protocol	RN Remote Network
NFL National Football League	ROI Return On Investment
NIC Network Interface Card	RPC Remote Procedure Call
NOC Network Operations Centers	RSA Encryption method named for developers Rivest, Shamir, & Adleman
NSS Negotiation Support Systems	RU Remote Utility
NT Network Technology	SAP Systeme Anwendung Produkte (System Application Product)
NTT Nippon Telephone and Telegraph	SAP R/3 SAP Release 3; the client-server version
NYNEX A New York-Based Telecom Company	SBT Scan-Based Trading
OEM Original Equipment Manufacturer	SCM Supply-Chain Management
OLAP Online Analytical Processing	SDLC System Development Life Cycle
OLTP Online Transaction Processing	SEC U.S. Securities and Exchange Commission
OM Owens & Minor	SEI Software Engineering Institute at Carnegie Mellon University
OO Object-Oriented	SET Secure Electronic Transactions
OPEC Organization of Petroleum Exporting Countries	SLBG Sara Lee Bakery Group
OR/MS Operations Research/Management Science	SLICE Simple Low Cost Innovative Engine
ORB Object Request Broker	SMS Short Message Service
OSI Open System Interconnection	SNA System Network Architecture
OSS Open Source Software	SOA Service-Oriented Architecture
OX Operations Expediter System	SOAP Simple Object Access Protocol
PAN Personal Area Network	SOHO Small Office/Home Office
PARC Xerox's Palo Alto Research Center	SQL Structured Query Language
PBX Private Branch Exchange	SRM Supply Relationship Management
PC Personal Computer	SSL Secure Sockets Layer
PCS Personal Communication Service	SSP Security Service Providers
PDA Personal Digital Assistant	STS Socio-Technical System
PDF Portable Document Format (proprietary file format in Adobe)	SU Single-User systems
PIN Personal Identification Number	SUMURU Single User, Multiple User, Remote Utility
PL/1 Programming Language/1	TCO Total Cost of Ownership
PLL Phase Lock Loops	TCP/IP Transmission Control Protocol/Internet Protocol
PODD Point of Delivery Device	

Glossary

TDL	Teleport Denver, Ltd.	VAN	Value Added Network
TDMA	Time Division Multiple Access	VoIP	Voice-over Internet Protocol
TQM	Total Quality Management	VPN	Virtual Private Network
TV	Television	VSAT	Very Small Aperture Terminal
TVA	Tennessee Valley Authority	WAN	Wide Area Network
UCC	Uniform Commercial Code	WAP	Wireless Application Protocol
UCLA	University of California at Los Angeles	Web	World Wide Web
UDDI	Universal Discovery, Description, and Integration	Wi-Fi	Wireless Fidelity
UHF	Ultra High Fidelity	WiNS	Wire Nova Scotia
UMT	United Management Technologies	WISP	Wireless Internet Service Providers
UNIX	“Unics” Operating System; an attempt at a pun	WS	Web Services
UPS	United Parcel Service	WSDL	Web Services Definition Language
URL	Uniform Resource Locator	XML	Extensible Markup Language
		XP	Extreme Programming
		Y2K	Year 2000

Index

Page references followed by "f" indicate illustrated figures or photographs; followed by "i" indicates a table.

A

abbreviations, 488, 491
 Absenteeism, 12
 Abstract, 139, 433, 472, 486
 Abstraction, 266
 Abuse, 103, 342, 353
 access control, 344, 349
 access control list, 349
 Account executive, 39
 Accountability, 8-9, 68, 233, 327, 450, 468, 485, 488
 Accountants, 283, 292-293
 Accounting, 4-5, 68, 72, 123, 148, 202-203, 243, 276, 454, 488, 493
 finance and, 276
 future of, 5
 accounts payable, 28, 67-68, 203, 244, 366, 409
 Accounts receivable, 67, 209, 279
 accuracy, 9, 17, 53, 68, 291
 of information, 17, 53, 68
 Achievement, 284, 308
 Acquisitions, 85
 Acrobat, 97
 acronyms, 491
 Action plans, 420
 activity-based costing, 203, 208
 Adaptation, 224, 434, 465
 addresses, 64, 119, 123, 135, 140, 144, 162, 170-172, 207, 211, 220, 327, 372, 448, 490
 adjustments, 79
 Administrative procedures, 201
 Administrators, 187-188, 196, 201, 249, 323, 344, 347, 359, 467, 481
 Advances, 2, 6, 11, 14, 110, 114, 291, 374, 465
 Advantages, 49, 60-61, 94, 97, 107, 116, 159, 166, 190, 228, 276-277, 401, 422
 Advertising, 63, 65, 322, 332, 390, 470
 corporate, 332
 e-mail, 63
 online, 63, 332, 470
 product, 332
 types of, 470
 Advertising agencies, 65
 Affect, 6, 41, 50, 71, 106, 109, 117, 190, 200, 236, 254, 272-273, 317, 391, 400, 421, 431
 Africa, 7, 89
 After-sales service, 58
 Age, 5, 8-9, 13, 33, 50, 159, 203, 234, 375-376, 410, 435, 441, 444, 456, 484-485
 Agencies, 65, 93, 105, 111, 157, 236, 243, 350, 433-434, 436, 483
 agenda, 85, 412-413, 417-418, 420, 466, 476, 486
 for meetings, 418
 Agent, 97, 117, 140, 291-292, 307, 365-366, 369, 388-389, 402-403, 432, 441, 479, 488-489
 Agents, 93, 111, 140, 186, 290-292, 307, 388-389, 432, 464, 488
 report, 292
 special, 290
 agreement, 39, 66, 248, 254, 256, 426, 429-430, 432, 474-475, 487
 Agreements, 67, 85, 142, 211, 248-250, 256, 287, 443, 474-475
 AIDS, 458
 Aircraft, 54, 382, 396
 business, 54, 382, 396
 AIS, 491
 operations, 491
 purchasing, 491
 technology, 491
 Alabama, 473
 American Management Association, 45
 American National Standards Institute, 491

anecdotes, 413
 Anger, 431
 Animation, 17, 194, 212, 273, 383, 481, 486
 announcements, 85
 company, 85
 Anomalies, 374, 402, 481
 anticipate, 375
 appearance, 214, 279, 324
 Application, 3, 15-16, 20, 27-29, 33, 35-36, 38-39, 53, 55, 80-81, 85, 104, 119, 123, 125-128, 131-136, 145-146, 166, 172, 184, 195-197, 199-202, 204, 210, 215, 217, 234, 239, 251, 255-256, 258, 264-266, 268-269, 271-273, 276, 279, 285-286, 288-289, 291-292, 294-296, 300, 319, 321-322, 326-328, 337-338, 342, 344-345, 348-349, 353, 361, 374, 377, 381-383, 388, 396-398, 430, 440-441, 466, 479, 482-483, 487, 489-494
 Application program interface, 479, 491
 Applications, 4-5, 15-18, 20, 25-29, 34-36, 39, 45, 48, 51, 53, 55, 70, 72, 74-75, 79-80, 85, 90, 113, 117, 119, 122, 125-129, 131-133, 135, 138, 142-148, 150, 159, 163-164, 169, 172, 174, 180, 195-196, 198-202, 204, 212-215, 228, 234-235, 237-238, 240, 242, 246, 251, 265-267, 270, 273, 276, 278-279, 284-288, 291-295, 318-319, 321-322, 326-328, 330, 336, 338, 342-344, 349-350, 352, 357, 361, 363, 368, 381-382, 384-385, 388, 390-391, 398, 418, 427, 431, 479-482, 484-486, 488-490
 Arbitration, 474
 archive, 75, 153, 167, 220, 404
 arguments, 48, 74, 363, 382
 ARM, 110-111
 Art, 9, 108, 114, 139, 180, 266, 294-295, 333, 471
 Asia, 7, 99, 159, 166, 169, 244, 253, 281, 328, 408, 425, 433
 Assets, 3, 33, 38, 83, 100, 104, 136, 150, 194, 206, 222, 233, 244, 246, 260, 280, 321, 332, 335-336, 339, 341, 354-355, 444, 453, 456-457, 462, 476, 484
 current, 150, 206, 222, 335
 fixed, 244, 246
 intangible, 335-336, 339, 484
 return on assets, 332
 attachments, 342, 347
 attention, 15, 48, 61, 72, 79, 92, 130, 143-144, 151, 184, 204, 211, 227, 235, 238, 251, 270, 277, 303, 311, 314, 344, 347, 373, 380, 388, 401, 415, 418, 422, 429, 433, 467
 Attitudes, 275, 311, 464
 Attorneys, 241
 Attribute, 50, 182, 185, 198, 204, 249
 attributes, 21, 40, 51, 53, 115, 117, 152-153, 162, 190, 198, 204, 316, 321, 400, 402
 AU, 244-245, 441
 audience, 186, 238, 422-424
 global, 238
 primary, 424
 auditing, 202, 352
 Audits, 353, 360, 362
 Australia, 244, 300-301, 447
 Austria, 89
 authentication, 133, 138, 173, 282, 347-348, 351, 434, 474, 479
 Authority, 11, 68, 89, 169, 193, 205, 217, 228, 283-284, 335-336, 343, 354, 408, 438, 493-494
 authorization, 55, 118, 134, 169, 202, 250, 341, 344, 386-387, 466, 479, 491
 availability, 14, 37, 51, 71, 103, 107, 111, 174, 201, 234, 268, 274, 341, 439, 469, 484
 backup, 268
 Available, 5, 7, 14, 18, 30, 41, 49, 61, 70-71, 74-75, 79, 81, 100, 104, 108, 111, 113, 118, 139, 153-154, 164, 178, 185, 191-192, 222, 229,

233-236, 241, 246, 252, 265, 271, 279, 287, 293, 296, 302, 306, 328, 338-339, 341, 344, 346, 349, 351-352, 358, 362, 368, 372, 381, 390, 404, 406, 417-418, 422, 438, 441, 449, 453, 463, 466, 473, 478, 483-485
 avoidance, 313
 Awareness, 62, 353, 362, 368-369, 431, 435, 475
B
 back orders, 71
 backup, 30, 122, 195, 202, 257, 268, 356-359, 363, 483
 bad news, 78, 141, 459
 Balance sheet, 67
 Banks, 65, 216, 244, 260, 345-346, 361, 456
 Bargaining, 93-95, 254, 293-294, 296, 431
 Bargaining power, 93-95
 Barrier to entry, 95
 batch processing, 14, 116
 Behavior, 46, 206, 245, 305, 312, 366, 374-375, 382, 388-389, 433, 439, 457, 469-470, 479, 485
 Benchmarking, 449, 455
 Benefits, 9, 49, 51, 66-67, 69, 72, 74, 97, 113, 130-131, 145-146, 149, 152-153, 190, 199, 203, 206, 213, 218, 224, 232, 248, 253, 255, 260, 273, 277, 288, 298-299, 301-304, 306, 311, 318, 327-328, 330-334, 336-338, 361, 373, 400, 412, 418, 422-423, 437, 439-440, 451, 454-455, 459, 462, 468, 477, 490
 extended, 131, 288, 304
 service, 9, 66, 69, 74, 97, 131, 145-146, 149, 153, 190, 248, 255, 288, 299, 318, 328, 331-332, 334, 337, 468, 490
 Best practices, 3, 37, 49, 233, 260, 266, 410-411, 445, 447, 449, 451, 455-456, 458, 477
 Bicycles, 62
 Bid, 63-64, 99, 185, 242, 250, 332
 billing, 59, 65, 116, 136, 160, 189, 199, 206, 248, 287, 309, 322, 393, 441
 Binder, 214-215
 blogging, 226, 229
 blogs, 45, 159, 193, 225-227, 304, 338, 479, 490
 business, 45, 193, 225-227, 304, 338, 490
 company, 193, 225-227, 338, 479, 490
 board of directors, 38
 Boards of directors, 80
 Body language, 408
 Bonds, 239
 bookmarking, 52
 bots, 93, 186-187, 353
 Bounded rationality, 366
 brainstorming, 102, 419-421
 Brand, 51, 160, 182, 288, 372, 456
 managing, 160, 182
 Brand loyalty, 182
 Branding, 62
 Brands, 2, 17, 102, 182, 223
 defined, 17
 national, 182
 store, 17
 Brazil, 89, 448
 Breakdown, 232, 302
 Bridges, 344
 Britain, 470
 Broker, 145, 279, 282, 284, 287, 293, 493
 Brokers, 111, 282-284, 287, 448-449, 451, 458-459, 463, 485
 Budget, 25, 36, 44, 78, 189, 232-233, 276, 284, 300-301, 306, 313-314, 316, 326, 331-332, 367, 379, 426
 defined, 78, 300, 379, 426
 Budgeting, 26, 148, 152, 373, 406, 412
 capital, 406
 Bulgaria, 64
 Bundling, 415
 Bureaucracies, 437
 Business analysis, 353

Business card, 64
 Business cards, 183
 Business cycle, 326
 Business cycles, 8
 Business environment, 1, 6-7, 12, 40, 44, 78, 86-87, 109, 277, 286, 292, 303, 326, 469
 countries and, 277
 business intelligence, 3, 72, 194, 210, 236, 365-366, 368, 398, 458, 480
 Business model, 7, 9, 45, 47, 49, 69-70, 82, 102, 137, 141, 255, 277, 482, 489
 Business operations, 4
 Business plan, 27-28, 80-81, 331, 466
 objectives, 28, 81
 Business planning, 80, 112, 149
 business plans, 8, 25, 113, 149
 Business process, 28, 33, 38, 66, 78, 82, 143, 149, 212, 216, 243, 255, 261, 265, 304, 306, 308, 314, 321, 361-362, 423, 480, 487, 491
 Business process outsourcing, 243, 255, 261, 480, 491
 business process reengineering, 28, 78, 82, 149, 216, 265, 321, 423, 487
 business processes, 2, 9, 16, 28-29, 32, 34, 44, 51, 66, 72-73, 83, 118, 125, 137, 144, 149-150, 202, 211-212, 216, 233, 243, 246, 275-277, 279, 281, 293, 321, 336, 399, 430, 472, 480-481, 487, 490
 definition, 118, 212, 430
 transaction, 28, 216, 233, 430, 481, 487
 transaction processing, 487
 Business review, 41, 48, 75, 93-94, 114, 153, 225, 229, 262, 295-296, 338, 403-404, 406, 441, 477
 Business risk, 311, 337
 Business rules, 11, 220, 270, 394, 430
 Business services, 145-146, 232, 246, 326
 Business strategy, 35, 43, 81, 138, 149-150, 203, 294, 314, 331, 406
 Business to consumer, 491
 Business Week, 75, 174, 192, 338, 403
 Buttons, 273, 325, 471, 490
 Buyers, 7, 9-10, 70, 93-95, 97, 104-105, 133, 137, 182, 199, 221, 240, 257-258, 293, 325, 389, 483
 Culture, 221, 389
 Product, 7, 9-10, 70, 94-95, 97, 199, 240, 389
 Role, 9, 325
 buzzwords, 392

C

Call centers, 96, 251, 260
 Canada, 55, 168
 Cancellation, 390, 392, 474, 480
 Capabilities, 11, 18, 50, 60, 81, 99-100, 104, 116, 121, 123, 125, 147, 154, 177, 185-187, 199, 224, 226, 238, 242, 252, 274, 284, 286, 319, 331, 333, 368-369, 388, 435, 446, 457, 477, 482, 489
 Capacity, 2, 20, 33, 37, 49, 126, 128, 149, 158, 169, 174, 181, 226, 234, 255, 309, 366, 433, 479, 484
 Capacity management, 37
 Capital, 8, 12-13, 17, 50, 87, 102, 104, 107-108, 111, 132, 137, 143, 160, 227, 236, 239, 302, 328-329, 335-336, 339, 406, 410, 438, 443-448, 450-451, 453-458, 462, 465, 476, 481, 484, 489, 492
 customer, 102, 137, 143, 160, 329, 443-448, 456-458, 476, 481
 definition of, 302
 fixed, 87
 growth, 87, 111, 132, 489
 human, 13, 236, 339, 443, 445-448, 450-451, 454, 456-458, 462, 465, 476, 481, 484, 492
 intellectual, 8, 12-13, 17, 87, 111, 227, 443-446, 451, 453, 456-458, 462, 465, 476, 484, 492
 requirements, 17
 structural, 443, 445-446, 451, 454, 456-458, 476, 481, 489
 working, 12-13, 137, 160, 302, 406, 438, 450, 454, 462
 Capital assets, 104
 capitalization, 132
 Career, 121, 236-237, 258, 449, 454
 Career development, 258
 Career opportunities, 121
 Case Studies, 446, 456, 459

employees, 446, 456
 Case study, 24-25, 131, 178, 225, 229, 239, 305, 338-339
 Cash flow, 239, 302-303, 366
 Cash management, 44, 276, 491
 Catalogs, 9, 72, 205, 483, 489
 CDC, 4
 Cell phones, 21, 86, 116, 163, 165, 174, 178, 180-181, 184-185, 259
 Centralization, 30-31, 33, 36, 121, 455
 Chain of command, 12, 408
 Chains of command, 11
 champions, 314
 Change agents, 111, 307
 change control, 257
 change management, 38, 81, 218, 235, 247, 298, 300, 307-308, 310-311, 451, 480
 Channel, 47, 85, 93, 95, 106-108, 166, 182, 221, 482
 Channels, 46-47, 94, 104-106, 113, 314, 411, 414, 422
 Service, 47, 106
 Character, 32, 125, 468-469
 Development, 32
 Checkout, 67, 488
 Checkpoint, 352
 Chief executive officer, 491
 Chief financial officer, 491
 CFO, 491
 Chief information officer, 22, 491
 Chief operating officer, 34
 Children, 185, 187, 197
 Chile, 89
 China, 18, 252, 254
 Chinese, 7, 71, 169
 Civil liberties, 413
 Claims, 146, 180, 251, 414
 Clearing, 264, 281, 295, 454, 492
 Climate, 92, 411, 421
 clothing, 86
 Clusters, 10, 17, 60, 147, 201, 206, 259, 374, 376, 394, 490
 Coaching, 458
 Code of ethics, 447, 466-467
 coding, 266, 268, 270, 273, 320, 482
 Cognition, 405, 433, 436, 441
 collaboration, 31, 53, 102, 113, 131, 151, 167-168, 185, 199, 225-226, 233, 259, 369, 405-442, 449, 466-467, 488
 defined, 151, 369, 426-427, 430, 438
 dynamic, 151
 Collapse, 109
 Collateral, 456
 Collections, 413
 Collision, 169, 483
 Columns, 139, 141, 152, 198, 204
 commenting, 421
 Commercial success, 439
 Commitment, 63, 84, 102, 152, 307, 315, 356, 380, 418, 430, 437
 committees, 247, 408-409, 461
 Communication, 11-12, 14, 18, 22, 25, 48, 60, 62, 75, 85, 102, 107, 117-118, 128, 135-136, 138, 150-151, 153, 157-158, 163-164, 172, 174, 178, 184-187, 189-190, 212-213, 225, 253-254, 258, 300-301, 308, 310, 318, 327-328, 330, 333, 335, 341, 344, 350, 356-359, 388, 396, 401, 413, 415-416, 422, 425, 427, 430, 432, 434-435, 440, 474, 479-480, 482, 486, 488-489, 491-493
 barriers to, 48, 190
 communities of practice, 405, 410-411, 440-441, 448, 458, 481
 Companies, 2, 7-10, 12-16, 18, 25, 29, 33, 41, 43-45, 47-48, 50-52, 54, 56-59, 61-66, 69, 71-74, 77, 79-82, 84, 92-100, 110-113, 117, 119, 125, 127, 130, 132, 134-136, 141, 144, 146, 148-149, 151-152, 157, 165, 167, 169-170, 175-176, 178, 180-181, 186, 189-190, 195, 200, 202-204, 206-207, 213, 219-221, 223, 225, 227-228, 232, 235-243, 246-249, 251-252, 255-260, 265, 271-272, 276-277, 279, 285-286, 288, 292-295, 299, 307-308, 317-319, 322, 324, 328-333, 335-337, 343, 345-348, 350, 352-353, 356-359, 362, 368, 374, 378, 390-392, 396-397, 406, 409, 411-412, 425, 432, 443-446, 448-449, 451-452, 454-455, 462-463, 467, 469-476, 479-482, 484-485, 487, 489, 491
 Company culture, 85, 253, 389, 460
 company policy, 103

Company stock, 373
 Company strategy, 94
 compatibility, 123
 Compensation, 13, 239, 255, 412
 Compete, 6, 56, 58, 61, 64, 85, 93, 95-96, 98, 100, 178, 208, 225, 279, 281, 308, 411, 449, 481, 489
 Competition, 32, 72, 94, 96, 105, 111, 146, 150, 159-160, 175, 208, 229, 239, 251-252, 280, 295, 333, 375, 378, 397, 411, 425, 427-429, 473
 Competitive advantage, 3, 44, 49-50, 74-75, 94, 97-99, 106, 108, 207, 209, 229, 264, 280, 328, 361, 459, 489
 positioning, 44
 Competitive environment, 72
 Competitive intelligence, 457
 Competitive strategy, 92
 Competitiveness, 19, 22, 49-50, 56, 190, 258, 361, 368
 Competitors, 4, 7, 10, 44, 46, 48, 56-57, 61, 63, 65, 70-71, 82, 93-96, 99, 101, 103, 105-107, 160, 175, 181, 185, 188, 190, 211, 225, 227, 239, 243, 251, 280, 326, 332, 343, 361, 367, 376, 396, 399, 411, 415, 482
 identifying, 105
 complaints, 383
 customer, 383
 Compliance, 35, 227, 242, 353, 362, 411, 438, 476
 Component Object Model, 286, 491
 compromise, 401, 433
 computer operators, 235
 computer programmers, 465
 Computer-aided design, 491
 Concurrency, 198
 Concurrency control, 198
 Conditions, 6, 166, 181, 200, 276, 320, 367-368, 372, 374, 385, 395, 430-431, 439, 475
 Confidence, 9, 184, 250, 292, 310, 335
 confidentiality, 173, 227, 341, 488
 Configuration, 36, 38, 116, 123, 132, 141, 164, 197, 270, 344
 manufacturing, 123
 Conflict, 247, 343, 431-432, 435, 439
 Conflict resolution, 247, 432
 connotation, 2
 Consideration, 96, 150, 317, 418, 474-475
 Consignment, 67
 Consistency, 195, 225, 270
 Consolidation, 160, 391
 Consortium, 111, 483
 Constraints, 61, 139, 195, 199, 201, 233, 369
 creating, 61, 195
 Construction, 159, 176, 267, 269, 301
 Consumer behavior, 374
 Consumer goods, 232
 Consumer preferences, 374
 Consumer products, 252, 277
 Consumer trends, 92
 Consumerism, 46
 Consumers, 2, 7, 10, 13-14, 20-21, 41, 46, 70, 73, 98, 137, 175, 180, 182, 186, 210, 259, 281, 291, 325, 389, 452, 465, 470, 472, 482, 489
 lifestyles, 2
 Consumption, 7, 100, 212, 345, 374, 459, 479, 482
 consumer, 7, 374
 Contacts, 22, 63, 317, 345
 Content, 2-3, 11, 17-18, 51, 53-54, 106, 110, 145, 166, 168, 187, 193-195, 205, 211, 219-225, 228-229, 236, 238, 255, 259, 304, 324-325, 338, 352, 424, 452-453, 460, 462, 465-466, 471-472, 481, 483, 489, 491
 e-commerce, 3, 220-221, 223-224, 324-325, 462
 Continuity, 34, 37, 260, 340, 356, 364, 379, 432, 480
 Continuous improvement, 80, 381
 Contract, 12, 15, 189, 210, 241, 244, 247-250, 253-255, 261, 294, 363, 471, 473-475, 478, 480, 486
 Contract law, 474, 478
 Contract of adhesion, 475
 Contracts, 45, 63, 110, 208, 211, 240-244, 248, 254-257, 278, 473-475, 480
 Control, 8, 15, 25, 27-28, 34, 41, 51, 53, 89-91, 105-106, 110-111, 120, 125, 134-135, 151, 160, 170-173, 186, 195-196, 198-203, 211, 216, 218, 220, 222, 225, 228, 238-240, 248, 250-251, 257, 259-260, 268, 275, 277, 283, 294, 300, 305, 307, 319, 328, 344-345, 349, 358, 369, 373, 384, 388, 396, 406-407, 419,

- 436, 438-439, 444, 464-465, 467, 469-470, 473, 480-481, 487, 489-490, 493
- Control process, 218
- Controllers, 357
- Controlling, 41, 121, 162, 300, 325, 430, 459, 470
- Conventions, 201, 320
- Convergence, 18, 21, 156, 159, 166-169, 180, 190, 341, 403
- Conversation, 33, 39, 87, 129, 167, 212, 428, 447-448, 460, 466
- conversations, 35-36, 39, 87, 158, 211, 256, 352, 422, 447-448, 463-464
- conversion, 128, 194, 214-215, 218, 288-290, 304, 316-317
- cookies, 470
- Cooperation, 5, 71, 150, 192, 278, 345, 361, 388, 426, 431, 458, 489
- Coordination, 26, 34, 54, 65, 69, 110, 121, 126, 130, 242-243, 249, 280, 312-315, 417, 425, 427-428, 430, 433-436, 438-440, 455, 483
 - manufacturing, 315, 430, 483
 - systems, 26, 34, 54, 65, 110, 121, 126, 130, 242, 280, 313, 427, 430, 433, 435, 440, 483
- Copyright, 1, 42, 77, 115, 133, 156, 193, 231, 264, 298, 340, 365, 405, 443, 471-472, 479, 481
- Copyrights, 469, 471
- Core competencies, 486
- Core competency, 340, 361, 363
- Core products, 85
- Corporate culture, 115, 120-121, 481
- Corporate mergers, 160
- Corporate strategies, 87
- Corporate strategy, 81, 85, 112, 151
- Corporate web sites, 358
- corporation, 1, 24-25, 30, 33-34, 36-38, 115-116, 141, 153, 203, 214, 229, 242-243, 280, 333, 338, 365, 367, 378, 383, 407, 411, 419, 477, 491-493
 - professional, 493
- Corporations, 7, 9, 14, 16, 133, 162, 185, 379, 465
 - corrections, 311
- Corrective action, 384
- Costs, 5, 7, 29-30, 37-38, 45, 47-49, 51, 65-68, 70-71, 90, 94-97, 100, 111, 120, 129-130, 132, 134, 149-151, 159-160, 169, 178, 182, 189-190, 206, 209-210, 212-214, 217, 233-234, 236-237, 239-241, 243-244, 246, 249, 251-252, 256, 258, 265, 270, 273, 275-276, 279, 288, 291, 299, 302-303, 306, 318, 326, 331-332, 355, 358, 375, 384, 389, 395, 397, 418, 432, 452, 455, 489-490
 - conversion, 214, 288
 - distribution, 151, 182, 210, 213, 279, 455, 490
 - labor costs, 7, 67, 251-252
 - product and, 210, 249
 - product lines, 100
 - sales and, 326, 332
- Countries, 6-7, 9, 18, 24, 54, 61, 89, 92, 133, 144, 159-160, 170, 178, 189, 224, 236-238, 242, 244, 251-255, 277, 284, 300, 308, 322, 362, 447-448, 450, 462, 469-470, 476, 485, 493
- Country culture, 254
- courtesy, 30, 34, 322, 417
- Creating value, 98
- Creativity, 3, 267, 337
 - developing, 3, 267, 337
- credibility, 22, 101, 242, 312, 415
 - establishing, 415
- Credit, 103, 115, 120, 134, 136, 144-146, 154, 240, 280, 288-289, 335, 339, 340, 342, 345-347, 350, 360, 366, 384, 386-387, 438, 455, 469, 474, 489, 491-492
- Credit cards, 345-346
- Credit unions, 492
- Crisis management, 225, 433, 435, 440-441
- criticism, 257
- CRM, 60-61, 72, 85, 151, 203, 276, 311, 329, 365, 390, 392-393, 403, 481, 491
- CRM software, 393
- CRM systems, 60-61, 311
- Cultural barriers, 457-458, 477
- Cultural differences, 130, 253, 261
- Cultural training, 253
- Culture, 2, 13-14, 25, 40, 46, 55, 78, 80, 85, 115, 120-121, 208, 221, 228, 233-234, 237, 253-254, 264, 277, 309, 314, 362-363, 389-390, 396, 399-400, 414, 437-439, 444, 446-448, 454-455, 457-460, 462-464, 476, 481, 484
 - change and, 80, 314
 - country culture, 254
 - definition of, 78
 - national, 277, 363
 - organizational culture, 459
- Currency, 7, 114, 194, 219, 221, 229, 288-290, 454
 - case study, 229
 - exchange of, 288
 - small firms, 7
- Currency conversion, 194, 288-290
- Curves, 56-57, 91
 - supply, 56
- Customer capital, 443, 445-447, 456-458, 476, 481
- Customer management, 202
- Customer needs, 65, 95, 448, 456-457
- Customer relationship management, 72, 203, 481, 491
 - CRM, 72, 203, 481, 491
- Customer satisfaction, 31, 101, 234, 332, 334, 376-377, 430, 483, 490
- Customer service, 21, 47, 61, 146, 208, 243, 251-252, 256, 259, 291, 299, 332, 334, 377, 387
 - Partnering, 243
- customer support, 246, 260
- Customer value, 394
- Customers, 9-10, 13, 15-22, 24, 27-29, 31-32, 37, 39, 42, 44-48, 50, 53-54, 57-66, 69-74, 82-83, 85, 89, 94-95, 98, 100, 102, 107-108, 110, 119, 125, 130, 134, 146, 149-151, 154, 163, 165-166, 170, 182, 188-189, 206-210, 213-214, 217, 220-221, 224, 226-227, 234, 238, 243, 258-259, 278, 280-281, 285, 288, 291-292, 299, 309-310, 324, 326, 331-334, 341, 351, 359, 361, 367, 374-377, 382, 390-392, 394, 397, 406, 409, 446, 452, 456-457, 464, 468-470, 473-474, 481-486, 489
 - as partners, 66
 - business-to-business, 42, 64, 134, 483
- Customs, 59
- D**
- Damage, 184, 304, 343
- Damages, 353
- data, 1-2, 4-5, 10, 14-18, 21-22, 25-30, 35, 40, 44, 48, 53-54, 58, 61, 66-68, 72, 80, 90-92, 99, 103, 110-111, 114, 116-119, 121-123, 125-130, 132-136, 138-143, 145, 148, 150-152, 157-160, 163-164, 166-167, 169, 172-175, 177, 179-180, 183-184, 187-189, 193-207, 209-212, 214-218, 221, 224-225, 227-229, 233, 235-238, 241-243, 245-248, 254-255, 257, 259, 265-266, 268-274, 276, 278-279, 282, 284, 286, 290, 292-293, 299, 304, 306, 309, 311, 317-319, 321-327, 329-331, 333, 335, 340-344, 346, 348-349, 351-353, 355-361, 364, 365-383, 385, 388-403, 406, 424-425, 432, 434-435, 439-441, 452, 462, 464-470, 480-489, 491-492
 - Data administration, 17, 200-202, 228, 322-323
 - data conversion, 317
 - data dictionary, 17, 201-202, 268, 270, 481
 - data flow, 217
 - data input, 268
 - Data mart, 54, 207, 306, 393-394, 481
 - Data mining, 17, 199, 243, 259, 365-367, 369-370, 374-377, 389, 398, 403, 465, 480-481
 - data model, 141, 207, 304, 323, 481
 - data modeling, 270, 481
 - data processing, 2, 4, 21, 25, 91, 150, 432, 492
 - Data sheet, 224
 - data storage, 121, 130, 195, 278, 357-359, 482, 492
 - Data type, 200
 - Data warehouse, 103, 129, 202, 206-207, 209-210, 228, 236, 324, 481, 483
 - DBMS, 202, 236
 - Database, 4, 12, 15, 17, 20, 26, 31, 52, 58, 67-68, 72, 117-119, 123-124, 126-128, 145, 186, 193, 195-202, 204, 216, 218, 222, 228-229, 234, 236, 249, 266, 268-269, 272, 274, 276, 285-286, 291-292, 316, 321-324, 329, 367, 369-371, 375-376, 416, 418, 457, 465, 481, 483, 486, 489, 492
 - characteristics of, 483
 - development of, 4, 15, 20, 26, 228, 266, 292, 465, 489
 - examples of, 199, 324, 370
 - purpose of, 145, 369-370
 - systems, 4, 12, 15, 17, 20, 26, 31, 52, 67-68, 72, 117-119, 123, 126-128, 145, 193, 195, 197-202, 216, 218, 222, 228-229, 234, 236, 266, 268-269, 272, 274, 276, 285-286, 291-292, 316, 321-322, 324, 329, 369-370, 375, 416, 418, 465, 481, 483, 486, 489, 492
 - uses, 17, 52, 58, 67-68, 72, 117, 127-128, 145, 197, 200, 202, 216, 218, 291, 321, 323, 329, 370, 416, 483, 486
 - Database administration, 26, 200-201, 323
 - database administrator, 195, 202
 - Database applications, 199
 - data mining, 199
 - Database design, 323
 - Database management system, 4, 229, 266, 370, 492
 - managing, 229
 - security, 266, 370, 492
 - Database systems, 198, 202, 229
 - personal, 229
 - Database technology, 195, 198
 - databases, 3, 9, 17, 51, 54, 116-119, 125-126, 128-129, 145, 151, 162, 187, 193-194, 198-202, 204-206, 211, 218, 236, 266, 274, 292, 321-323, 352, 375, 391-392, 411, 434-435, 444, 446, 455, 458-459, 461, 463, 467, 469, 471, 480-484, 487, 489
 - commercial, 236, 435
 - electronic, 51, 116-118, 151, 162, 194, 204, 211, 218, 434, 458, 471, 481-484
 - dates, 234, 316, 334
 - Deadlines, 220, 265, 313, 315-316, 331
 - Death, 78, 384
 - Debt, 33, 239
 - Decentralization, 25, 31, 38, 115, 120
 - Decision makers, 366, 368-369, 433, 480
 - Decision making, 40, 78, 216, 236, 317, 365-404, 415-416, 431, 436, 440, 482, 487
 - Decision support system, 371, 434, 484, 492
 - Decision-making, 10, 120, 224, 313, 335-336, 366, 368, 372, 384, 388-389, 399, 416, 486
 - group, 368, 416, 486
 - in organizations, 120, 366
 - Decision-making process, 10, 313, 366, 372
 - Decoding, 482
 - decryption, 350
 - defamation, 468
 - Delegation, 259
 - Deliverables, 302
 - Demand, 8-11, 15, 37, 46, 49, 61, 69-71, 73-74, 81, 94, 96-97, 99-100, 134, 136-137, 145, 159, 174, 188, 203, 246, 293, 296, 341, 368-369, 382, 400, 460, 471, 482, 489
 - change in, 96, 145, 400
 - Demand chain, 9, 69-70
 - Demand curve, 46
 - individual, 46
 - demand reports, 369
 - Democracy, 471
 - Demographics, 86, 105, 182, 186, 259, 394
 - Denmark, 454
 - Department of Commerce, 150
 - Department of Defense, 162, 395, 426
 - Department of Justice, 345, 360
 - Deregulation, 97, 160, 487
 - design, 25, 31, 33, 36, 50, 52-53, 91, 99, 132, 141, 145, 150, 162, 166, 188, 202, 212, 220-221, 223, 227, 229, 239, 259, 267-270, 272-273, 305, 321-323, 327, 330-331, 359, 362, 369-370, 409, 411, 426, 428, 432, 440-441, 460, 465, 482, 484, 491-492
 - elements of, 188
 - principles of, 229
 - Determinant, 319, 459
 - Devaluation, 456
 - Developed countries, 236, 252
 - Developing countries, 18, 159
 - Developing nations, 6
 - diagrams, 194, 218, 270, 323, 409, 481, 488
 - types of, 194
 - Differentiation, 49-51, 95
 - product, 95
 - digital assets, 100
 - digital certificate, 348, 350-351
 - Digital divide, 18
 - digital signature, 350-351, 474, 479
 - Directories, 3, 136, 298, 322-323, 449
 - Dirty data, 480
 - Discipline, 12, 30, 118, 199, 221, 235, 251, 257, 267, 270, 294, 316-317, 369, 489
 - Discount stores, 120

Discounts, 28, 189, 210
 Disease, 184, 384, 396, 452-453, 461
 Distance, 18, 20, 28, 150, 165, 176-177, 188-189, 356-357, 376, 408, 416-417, 435, 484-485, 487
 cultural, 435
 distractions, 422
 Distributed database, 118, 126, 128, 276
 Distribution, 56-60, 93, 102, 106, 108, 116, 151, 182, 202-203, 210, 213, 221, 277-279, 422, 429, 438, 446, 454-455, 458, 463-464, 471, 490
 marketing and, 93
 Distribution center, 59-60
 Distribution centers, 57
 Distribution channel, 108, 182
 Distribution channels, 106
 Distributors, 61, 65, 69-70, 166, 208, 210, 414
 Diversity, 82, 132
 Division of labor, 12
 Documentation, 37, 53, 59, 107, 203, 217-218, 220, 235, 267, 285, 316-318, 417, 432
 documents, 17, 39, 52, 165, 185, 194, 201, 204, 211-213, 215-218, 220, 222, 226-229, 287, 343-345, 379, 412, 420, 449, 451-452, 457-459, 463-466, 474, 479, 482-483
 distribution of, 463
 multimedia, 211
 Dollar, 54, 128, 175, 194, 334, 336, 353
 exchange rates, 194
 Dollars, 13, 30, 35, 174, 203, 222, 252, 290, 343, 345, 375, 386, 418, 465
 Domain name, 246, 472, 481
 Downsizing, 13
 Downstream, 58, 60, 69, 304
 downward communication, 310
 drawings, 63, 139, 217-218
 Drill down, 103, 378, 399, 464
 Drugs, 10, 452, 461
 Due diligence, 37
 Duty, 375
 Dynamics, 254

E

Early adopters, 167
 Earnings, 330, 377
 Eastern Europe, 159, 166
 E-business, 2, 5, 7, 44, 48, 61, 77, 82, 100-102, 113, 117, 125, 147, 154, 208, 210-211, 237, 246, 261, 265, 286-287, 296, 330, 337, 351, 354, 359, 472-474, 482
 defined, 265, 482
 e-commerce, 48, 246, 330, 473, 482
 E-commerce, 3-4, 32, 48, 79, 90, 150, 220-221, 223-224, 235, 246, 260, 266, 291, 324-326, 328, 330, 345-346, 364, 393-394, 432, 462, 473, 482
 benefits of, 224, 260, 462
 security and, 90, 364
 Economic growth, 14, 174, 244
 Economics, 33, 38, 46, 51, 113, 251, 267, 378, 432
 Economies of scale, 100, 149, 242
 Economy, 1-41, 46, 48, 72, 86, 92, 96-97, 100, 115, 133, 150, 157, 173-174, 195, 229, 232, 236, 239, 258, 401, 403, 444, 454, 485
 of managers, 38
 team, 11, 23, 31, 35, 37, 258, 454
 Education, 1, 6, 34, 42, 77, 115, 156, 193, 231, 236, 253, 264, 298, 335, 340, 355, 365, 368, 405, 421, 434, 438, 443, 471, 479
 Efficiency, 4, 14-15, 19, 21-22, 29, 61, 71, 95, 151, 169, 197, 208, 220-221, 234, 260, 282, 294, 299, 331-332, 368, 382, 418, 420, 430, 449
 Egypt, 450, 476
 Electronic Commerce, 7, 150
 Electronic data, 21, 28, 359, 482, 492
 Electronic data interchange, 28, 482, 492
 EDI, 28, 482, 492
 Electronic equipment, 69
 Electronic mail, 11, 124, 162, 492
 electronic media, 217
 Electronic meeting, 367, 416
 email, 29
 E-mail, 4-5, 9, 13, 18, 35, 48, 53, 59, 61, 63, 70, 72, 93, 107, 117, 119, 126, 151, 158, 162, 164, 167, 172-173, 180, 182-185, 188, 190, 194, 205, 225, 246, 342, 345-347, 351, 353-358, 367, 381, 407, 411, 414-418, 421, 425, 427, 438, 450, 453, 458, 460, 463-464, 466, 475-477, 485, 487, 492

advertising, 63
 EMC, 346
 emphasis, 3, 27-28, 43-44, 79, 219-220, 425, 427, 439, 445-446, 456-458
 Employee productivity, 459
 Employee stock ownership plan, 373, 492
 Employee training, 53, 336
 Employees, 4-5, 9-11, 13, 16-17, 19-22, 24, 29, 32, 43, 45, 51-53, 55, 58, 67, 69, 71, 73-74, 83, 85-86, 88, 99-100, 103-104, 106-107, 112, 130, 132-133, 141, 144, 150, 163-165, 181, 185, 189, 192, 197, 209, 218-219, 223, 225-228, 236-237, 241, 243, 245, 251, 253, 255-258, 278, 288, 308-315, 324, 329, 334, 336, 342-343, 348, 351-352, 355-356, 358, 362-363, 369, 377, 381, 389, 392, 397, 399, 411, 416, 419, 431, 437-439, 446-448, 450, 452, 454-457, 460, 463-464, 466, 476, 479-481, 484-485, 489, 491
 loyalty, 377, 457
 outsourcing and, 255, 336
 Employment, 75, 227, 254
 full, 227
 Empowerment, 10
 encryption, 133, 178, 183, 284, 343, 348-351, 474, 482, 487, 492-493
 decryption, 350
 definition, 482
 digital certificate, 348, 350-351
 digital signature, 350-351, 474
 nonrepudiation, 348
 privacy and, 348
 private key, 349-350, 487
 public key, 284, 349-351, 474, 487
 public key infrastructure, 349
 end-user computing, 20, 25-28, 40, 43, 127, 482
 England, 132-133, 308, 425
 English, 220, 224, 252, 413
 Enhancement, 36, 232, 292, 321-322
 Enterprise resource planning, 5, 15, 193, 202-203, 482, 492
 Enterprise resource planning (ERP) systems, 15, 203
 enterprise resource planning systems, 482
 Entities, 83, 85, 105, 151, 185, 195, 198, 204, 270, 321, 411, 488
 Entity concept, 204
 Entrepreneur, 62
 Entrepreneurs, 454
 Environment, 1-3, 6-7, 9, 12-14, 17, 19, 29, 39-40, 44, 61, 72, 78, 80, 82, 86-87, 92, 95, 105, 109, 129, 134, 136, 152, 157, 188, 218, 234, 244, 266, 270, 274-275, 277-278, 283-287, 291-293, 303-304, 307-311, 324, 326, 344, 352, 378, 381, 387, 400-401, 432, 444, 464, 469, 480, 485, 488, 490-492
 natural, 304
 Environmental factors, 488
 Environmental scanning, 205
 E-procurement, 244, 293, 483
 Equity, 239, 332, 431
 Equity capital, 239
 Error correction, 173
 ETC, 4, 140, 167, 186, 194, 197, 203, 222, 232, 284, 306, 311, 341, 352, 362, 374, 381-382, 388, 397-398, 480, 485, 492
 Ethical issues, 444, 467-469, 476
 Ethics, 9, 443-444, 447, 462, 466-469, 476-478
 Code of ethics, 447, 466-467
 Company policies, 476
 Internet, 9, 444, 447, 466-469
 Laws, 444, 467, 469, 476
 EU, 254
 Europe, 7, 59-60, 99, 157, 159, 166, 169, 178, 299, 318, 328, 373, 425, 447
 European Union, 254
 EU, 254
 European Union (EU), 254
 Evaluation, 353, 361, 369, 374, 434
 evidence, 151, 228, 239, 302, 409, 424, 474
 supporting, 409, 424, 474
 Exchange, 7, 66, 71, 87, 103, 117, 123, 151, 159-160, 172, 185, 194, 201, 211, 226, 282, 284, 288, 290-291, 401, 409, 432-434, 438, 444, 453-454, 465-466, 471, 474, 481, 484-485, 489, 491-493
 Exchange rate, 7
 fixed, 7
 Exchange rates, 103, 194
 U.S. dollar and, 194

Exchanges, 7, 71, 95, 209, 264, 281, 283, 288, 295, 357, 483, 492
 Exclusions, 302
 Exclusive agreements, 250
 executive dashboard, 101, 381, 403, 483
 Expansion, 2, 215, 240
 expect, 39, 53, 61-62, 71, 97, 150, 159, 220, 256, 273, 417, 430
 Expectations, 15, 36, 73, 187, 218, 233, 241, 250, 274, 276, 302, 334, 369, 464, 482
 Expenditures, 143, 276, 330, 332
 defined, 143
 Expenses, 35, 103, 149, 189-190, 279, 302, 355
 Experience, 13, 28, 31, 42, 56-58, 63, 67, 73, 88-89, 130, 147, 202, 251, 255, 280, 285, 291, 311-312, 326, 337-338, 376, 378, 384-385, 387, 392, 401, 410, 412, 425-426, 431, 433, 448, 455, 465, 468, 484
 Experience curve, 42, 56-58, 73
 expertise, 13, 27, 61, 103, 132, 238, 241-243, 246, 259, 274, 288, 317, 319, 383, 385, 387-388, 399, 409-411, 449-451, 459, 483, 488
 Explicit knowledge, 13, 194, 444, 449, 455, 458, 476, 483
 Explosion, 46, 444
 Exporting, 493
 OPEC, 493
 External costs, 302
 External environment, 381
 Externalities, 133
 network, 133
 Extranet, 32, 70, 72, 163, 165-166, 209, 243, 351, 483
 Extranets, 102, 165, 348

F

Facilitators, 458
 Failure, 102, 238, 260, 279, 283, 304-305, 312, 318, 331, 379, 398, 426, 477
 Fair price, 64
 fairness, 431
 Family, 64, 325, 330, 371, 384-385, 389, 419, 491
 FAST, 41, 47, 59, 61, 78, 85, 120, 146, 148, 157, 162, 164, 166, 173-175, 183, 194, 197, 216, 238, 246, 261, 272, 279, 292, 295, 327, 329, 331, 334, 344, 358, 374, 377, 396, 401, 404, 440, 456, 465, 479-480, 485
 fault tolerance, 117
 Fax machines, 29
 Feature, 52, 118, 136, 168, 209, 306, 370, 381, 394, 432
 Federal government, 33
 Federal Trade Commission, 360, 492
 feedback, 53, 58, 63, 89, 220-221, 249, 269, 309-310, 406, 422-424, 458-459
 giving, 58
 Fields, 107, 117, 196, 199, 206-207, 300
 Filtering, 3, 46, 138, 348, 393-394, 402, 418, 434, 483
 Finance, 31, 39, 68, 72, 101, 121, 123, 202, 209, 239, 242, 276, 278, 326, 352, 408-409, 485, 488
 accounting and, 202
 Financial analysis, 205
 Financial institutions, 345
 Financial management, 37, 85
 Financial markets, 56
 Financial plan, 302
 Financial services, 86, 144, 146, 232, 257, 283, 357, 382
 Financial statement, 366
 Financial systems, 29
 Financial Times, 492
 Finland, 178, 213-214
 Fire, 116, 160, 356-357, 359, 364, 384, 486
 firewall, 52, 110, 124, 164, 349, 354, 483
 Firm performance, 336
 Firms, 6-7, 9, 11, 16, 44-46, 48-50, 53, 57, 61-62, 71, 73, 82, 93-94, 96-97, 99, 105, 107, 111, 134, 149, 170, 232, 236, 239, 243, 252-254, 256, 258-259, 272, 282-283, 318-319, 333, 335-336, 350-351, 359, 361, 382, 392, 445, 453, 472, 480, 484, 490
 case study, 239
 organizational processes, 259, 333
 value chain, 44, 46, 71, 94, 97, 99, 490
 First-mover advantage, 280
 Fiscal policy, 283
 Five forces model, 97
 Fixed costs, 95-96, 240-241, 299
 Flexibility, 8, 112, 148-149, 153, 159, 203, 248, 273-274, 278, 281-282, 294, 315, 328, 410

Flood, 283, 356
 following up, 329
 fonts, 370
 Food, 7, 64-65, 67, 69, 120, 184, 223, 280, 308, 372, 381, 452, 488, 492
 production, 381
 Food and Drug Administration, 452, 492
 Forecasting, 203, 208, 369, 371, 398
 sales, 208, 371
 Forecasts, 103, 248, 372, 377, 483
 formality, 250
 Forrester Research, 239
 Forward engineering, 321-322
 Foundations, 5, 249, 264, 266, 275, 442
 Fragmentation, 189
 France, 89, 406
 fraud, 340, 342, 345-346, 353, 360-361, 386-387
 employee, 346
 fraud hotline, 360
 Free goods, 375
 Freedom, 395, 454, 469, 471, 487
 Freezing, 308
 Frequency, 177-179, 184, 210, 280, 395, 470, 487-488, 490, 493
 FTC, 360, 492
 Fund, 80, 284, 341, 468

G
 Gambling, 345, 375-377, 473
 contract, 473
 slot machines, 375, 377
 Game theory, 432
 Gatekeeper, 459
 Gender, 376, 468
 General contractors, 111
 General Ledger, 31, 203
 Geography, 305
 Georgia, 307, 379, 467
 Germany, 86, 166, 177, 412, 450
 Gifts, 10, 181
 Global economy, 1-41, 150
 Global Positioning System, 58
 GPS, 58
 Global sourcing, 252
 Global teams, 408
 Globalization, 2, 7, 45, 79, 97, 224, 281, 410
 markets, 7, 224, 281
 goal conflict, 431
 Goals, 6, 12, 14-15, 20-23, 35, 40, 50, 77, 79-80, 88, 92, 105, 114, 120, 180, 201, 214, 219, 228, 234, 243, 247, 249, 258, 278, 294, 304, 306, 312, 315, 331, 334, 381, 399, 418, 425-426, 431-433, 458, 488-489
 definition of, 201
 Gold, 332, 339, 377
 Goods, 2, 7, 28, 46, 57-60, 62, 65, 67-68, 73, 95, 102, 106, 111, 157, 232, 239, 244, 292-293, 301, 374-375, 472, 474, 483
 complement, 46
 free, 375
 private, 67, 106, 483
 public, 2, 157, 474, 483
 substitute, 95
 Government, 9, 33, 37, 105-109, 157, 162, 175, 217, 318, 342, 350, 361, 378, 436, 483
 Government agencies, 105, 157, 350, 483
 Government policies, 107
 Government regulation, 9
 Government regulations, 105, 217, 378
 GPS, 58, 150, 159-160, 180, 434, 492
 GPS navigation, 150, 159, 180
 Grants, 474
 Grapevine, 457
 Graphical user interface, 490
 Groundswell, 18
 Group, 25-28, 33, 42, 67-69, 75, 79, 81, 86, 88-89, 107, 109, 128, 131, 143-144, 151, 164, 170, 174, 181-182, 192, 193, 204, 207-208, 213-214, 223, 225, 227-229, 231, 241-250, 252, 259, 261, 271-272, 283, 287, 295-296, 298, 305-308, 318, 322-323, 326-329, 334, 337, 364, 367-368, 373-374, 382, 391, 407-410, 412, 415-423, 426, 430, 432, 434-435, 438-441, 445, 450-451, 456, 458, 460, 466, 475, 477, 479, 482, 484-486, 491-493
 behavior in, 485
 Group membership, 408
 groups, 2, 10, 12-13, 25-27, 29, 71, 127, 130, 141,

160, 162, 164, 188, 207-208, 210, 212-214, 216, 223, 243, 248-249, 307, 317, 328, 371, 374, 399, 405, 407-411, 415-416, 419-421, 424-425, 438-440, 450, 455, 461, 480, 485-486, 488-489, 491
 development of, 26-27, 439, 489
 groupware, 11, 13, 87, 111, 407, 416-417, 425, 454, 458, 463, 484-485
 Growth capital, 132
 Growth rate, 43, 78, 489
 Guidelines, 26, 138, 225-226, 228-229, 316, 470
H
 hacking, 236, 313, 348, 484
 Harvesting, 27, 445
 Health care, 58, 208, 211, 232, 255, 361, 383, 434, 460
 help desk, 299
 helping others, 437
 Heuristics, 268, 366, 484
 Hierarchy, 12, 115, 121-123, 197, 258, 407-410, 435, 481
 Hiring practices, 464
 Home country, 254
 Hong Kong, 166, 264, 281-284, 295, 492
 Hospitals, 116, 148, 175, 208-210, 299, 406, 440, 461
 investments, 148, 299
 Household appliances, 290
 HTML, 51, 74-75, 153, 162, 192, 223, 229, 296, 360, 363, 404, 458, 478, 484, 492
 HTTP, 51, 135, 172, 244, 247, 287, 363, 492
 Human capital, 236, 443, 445-448, 456-458, 476, 484
 Human resource management, 98
 Human resources, 13, 31, 202-203, 254-255, 301, 492
 humor, 186
 hyperlinks, 162, 472, 491
 Hypertext Markup Language, 51, 484, 492
 hypothesis, 83

I
 Ice, 187
 Idea generation, 418
 identity theft, 360
 Ill, 75, 153, 288, 296, 299, 338, 384
 illustration, 105, 393
 Image, 21, 124, 216, 225, 353
 Immigration, 236, 254
 global, 254
 Implementation, 16, 30-33, 48, 81-82, 116, 118-119, 143-144, 152, 196, 217-218, 261, 276-278, 294, 306-308, 310-311, 314-316, 318, 321, 323, 338, 362, 484
 implementation plan, 81
 Impression, 444
 Inbound logistics, 97-98
 Inc., 1, 42, 77, 102, 115, 156, 191, 193, 231, 255, 261, 264, 295, 298, 338-339, 340, 346, 364, 365, 372, 394, 405, 443, 479
 Incentives, 10, 102, 245, 335, 366, 377, 389, 449, 458
 Income, 63, 69, 88, 214, 245
 market, 88, 214, 245
 personal, 63, 214
 Indexes, 201, 205, 372, 451, 458
 India, 18, 239, 242, 245, 251-253, 255-258, 260
 global sourcing, 252
 offshoring, 251-253, 257-258, 260
 Indonesia, 166
 Industrial Revolution, 156-157
 Industrialization, 258
 Industry, 4-8, 10, 15-16, 18, 31-32, 37-38, 42-43, 45, 53, 56-58, 68-70, 72-73, 78-79, 82, 84, 92-97, 102, 104, 107-109, 114, 132-133, 137, 144, 148, 157, 159-160, 162, 169, 173, 175, 178, 185, 188-189, 192, 210-211, 221, 225, 232, 241, 251, 255, 258, 261, 279-280, 283-284, 286-287, 293-294, 308, 310, 316-318, 332, 334, 336, 342, 351, 377, 381-382, 397, 426, 447, 456-457, 470-471, 482-483, 487, 489, 491
 Industry structure, 97
 Inefficiencies, 32, 217
 Information, 1-41, 42-75, 77-114, 115, 117-118, 120, 125-126, 128, 130-133, 139, 141, 143-147, 150, 152-154, 156-158, 164-166, 170-172, 178, 181, 184-185, 187-189, 192, 193-229, 231-232, 236, 238, 244-245, 250, 258-259, 264, 270-271, 274-277, 280, 282, 284, 287, 292, 295, 298, 301, 305-310, 322, 324-326,

329-335, 338-339, 340-364, 365-404, 405-407, 409, 411, 413, 415, 417-418, 424-425, 427-436, 441, 443-445, 447-448, 452, 454, 456-458, 461-467, 469-471, 476-477, 479-485, 487-493
 Information access, 3, 367, 432
 information and communication, 12, 107, 432, 492
 information architecture, 464, 484
 Information economy, 97, 258
 Information gathering, 418, 471
 Information management, 17, 126, 150, 153, 203, 205, 208, 229, 277, 295, 308, 425, 427-429, 434, 441, 463-464, 477, 492
 information needs, 90, 92, 103, 236, 369, 372, 379, 489
 information overload, 378, 400, 433, 435
 Information processing, 17, 22, 29, 120, 200, 370, 435
 information rights management, 222
 information security, 34, 245, 340-364, 492
 access control list, 349
 exploit, 353
 firewall, 349, 354
 Internet Protocol, 492
 passwords, 342-344, 346-347, 352
 patch, 345
 software design, 362
 TCP/IP, 350
 vulnerabilities, 360-361
 Information system, 16, 26, 31, 103-104, 139, 141, 189, 295, 332, 339, 367, 381, 397-399, 464, 483, 489, 492
 Information systems, 1-41, 42-43, 61, 65, 77-114, 115, 120, 143, 156, 193, 205, 229, 231, 264, 275-276, 298, 322, 330-332, 335, 339, 340, 344, 365-366, 369, 377, 390, 396, 398, 404, 405, 407, 441, 443, 479, 491-493
 Information technology, 2, 5-6, 16, 18-19, 25, 32, 37, 42-75, 91, 112, 114, 147, 154, 330, 338-339, 461, 485, 492
 Infrastructure, 2-3, 20, 22-23, 27-29, 34-38, 40, 48-51, 71, 77, 79-81, 89-90, 98, 110-111, 115-117, 130, 133-134, 138, 142, 145-154, 157-160, 166-168, 202-203, 208, 211, 227, 233, 237, 239, 241-242, 246, 256, 278-279, 284, 293, 295, 298-299, 309, 326-328, 330, 349, 362, 369, 405, 411-413, 434-435, 452-453, 471, 476-477, 479, 484-485, 487
 investment in, 27, 35, 330
 Initiative, 50, 55, 209, 395
 Innovation, 14, 40, 44, 50-51, 56, 79, 84-85, 87, 96, 150-151, 156-157, 159-160, 175, 190, 236, 298-299, 447, 458, 490
 importance of, 150, 160
 Innovations, 45, 49-50, 71, 83, 168, 175, 410, 427-429, 441
 defined, 427
 Innovators, 211
 Insourcing, 3, 231, 233, 259-260, 484, 488
 Installations, 54
 instant messaging, 4-5, 11, 45, 133, 159, 167, 180, 184, 225, 341, 353, 357, 416, 466, 487, 492
 Insults, 468
 Insurance, 12, 86, 100, 146, 193, 199, 213-216, 228, 232, 313, 357, 359, 361, 381, 432, 452, 491
 applications, 146, 199, 213-215, 228, 357, 361, 381
 risk and, 313
 types of, 193, 199, 214, 228
 Intangible assets, 335-336, 339
 Intangibles, 17, 453, 456
 Integrated Development Environment, 492
 Integration, 3, 16, 21, 29, 32, 35, 44, 66, 72, 90-91, 125, 131, 135, 142, 144-145, 151, 153-154, 235, 240, 251, 253, 264-265, 274-279, 283, 286-288, 290, 292, 294, 301, 326-327, 330, 368, 370, 403, 416, 430, 434, 482, 489, 492, 494
 Integrity, 29, 127, 173, 195, 199-201, 229, 341, 347-348, 370, 481, 488
 Intellectual capital, 8, 12-13, 17, 87, 111, 227, 443-446, 451, 453, 456-458, 462, 465, 484, 492
 Intellectual property, 254, 260, 426, 443-444, 467-469, 471-472, 476
 defined, 254, 426
 e-commerce, 260
 royalties, 471
 Intellectual property rights, 443-444, 468-469, 471-472
 intelligence, 3-4, 72, 87, 89, 138, 194, 210, 236, 295, 321, 323, 365-366, 368, 382, 398, 432-434,

457-458, 465, 479-480, 484, 487-488, 491
 emotional, 432
 Intelligent agents, 93
 Interest, 10-11, 17-18, 70, 83, 87, 90, 200, 204, 234, 275, 284, 353, 380, 415, 450, 468, 484, 489
 credit, 489
 Intermediaries, 94-95, 293
 channel, 95
 Internal rate of return, 353
 IRR, 353
 International business, 492
 environment, 492
 International trade, 473
 Internet, 2, 5, 7-9, 11, 13-14, 16, 18, 29-30, 32, 41, 42-53, 57-58, 60-62, 65, 67-68, 72-75, 77, 79-86, 89-96, 98, 100, 103-104, 111-112, 114, 115, 117-119, 122-125, 130-137, 148, 150-151, 156-160, 162-163, 165-167, 169-170, 172-173, 175-176, 178, 180-182, 184, 186-192, 194, 200, 204-205, 208-209, 211, 213, 227, 235-238, 246, 264-265, 282, 284-287, 294-295, 299, 328, 330, 337, 340-343, 345-350, 354, 361, 363-364, 390, 396, 407-409, 413-414, 416, 424, 426-427, 432, 438, 444, 447, 466-473, 479-488, 490-494
 defined, 13, 16, 29, 118, 151, 160, 194, 265, 294, 348, 361, 426-427, 438, 481-484
 e-procurement, 483
 privacy concerns, 61
 search engines, 8, 45-46, 52-53, 85, 345, 490
 Internet Protocol, 18, 45, 51, 123, 135, 492-494
 Internet telephony, 167, 236
 Interpersonal skills, 275
 Interviews, 317, 423
 Intranet, 16, 29, 32, 42, 44, 51-53, 55, 72, 74, 101, 163-166, 185, 202, 220, 235, 348, 351, 416, 418, 466, 481, 483, 485
 Intranets, 44, 51, 55, 72-73, 165, 204, 211, 220, 348, 357, 409, 418, 454, 458, 463
 Inventions, 157, 159, 472, 486
 Inventories, 11, 209
 Inventory, 4-5, 11, 18, 31, 54, 56, 58-59, 66-67, 70, 92, 106, 126, 130, 137, 142, 176-177, 187, 202-203, 205, 208-209, 214, 271-272, 274, 276, 291, 325, 335, 338, 355, 366, 372, 381, 396, 398, 435, 445, 487
 management of, 203
 Inventory management, 4, 18, 381, 396
 Investment, 8-9, 27, 33, 35, 39-40, 49, 57, 65, 133, 146, 149, 159, 190, 233, 284, 330, 332-334, 336, 353, 361, 376, 406, 451, 461, 468, 493
 government, 9, 33, 361
 net, 353, 493
 private, 468, 493
 Investment banks, 65
 Investment decisions, 39, 451, 468
 Investments, 34-40, 49, 51, 80, 144, 146, 148-150, 153, 189, 233, 237, 241, 243, 298-299, 330-331, 333, 335-337, 453, 490
 Investors, 9, 132, 281-284, 298, 335-337, 491
 Invoices, 69
 Ireland, 242, 251
 IRR, 353
 ISO, 170, 172, 492

J

Japan, 178, 180, 184, 259, 318, 325, 447
 Japanese yen, 194
 Jargon, 16, 144, 160, 317, 382
 Java Database Connectivity, 292
 using, 292
 Java platform, 291
 Java virtual machine, 286
 Job description, 202, 236
 Job performance, 20
 Job satisfaction, 333
 Jobs, 2, 5, 9, 21, 39, 63, 111-112, 142, 201-202, 234, 251-252, 258-259, 264, 291, 314, 336, 341, 409, 411, 450, 463, 484
 levels, 5, 450
 measuring, 336
 movement of, 9
 service, 9, 21, 39, 63, 111, 142, 251-252, 258-259, 264, 291, 484
 journals, 479
 entity, 479

K

Keiretsu, 9, 485
 Kiosks, 382
 Knowledge, 3, 6, 8, 12-13, 17, 21-23, 29, 40-41, 46, 63, 83, 86-87, 106-108, 111-112, 114, 136, 138, 143, 147, 151, 157, 194, 202, 208-209, 227-229, 257-258, 300-301, 308-309, 318, 337-338, 362, 374, 382-385, 387-389, 394, 402, 406-407, 410-413, 422, 427-428, 434, 437-438, 443-478, 481-486, 488-492
 sharing, 3, 13, 151, 410, 427-428, 443-452, 454-460, 462-464, 476-477, 485, 490
 specialized, 136, 406, 490
 Knowledge management, 3, 17, 136, 151, 194, 362, 410, 427, 443-446, 448-449, 456-462, 465-466, 475-477, 485, 491-492
 knowledge management systems, 449
 Knowledge workers, 406, 437, 465, 489
 Defined, 465
 Korea, 180

L

Labor, 6-7, 12, 45, 67, 217-218, 236, 239, 251-252, 271, 299, 384, 406, 433, 437, 462
 Labor costs, 7, 67, 251-252
 labor force, 239, 251
 Labor market, 236, 239
 Lags, 392
 Language, 4, 51, 84, 107-108, 119, 131, 135-136, 147-148, 166, 172, 186, 198, 220-221, 224, 241, 253-254, 265-266, 268-269, 285-288, 290, 319, 370-371, 382, 389, 406, 408, 413, 428, 432, 434, 456-457, 465, 468, 479, 483-484, 487, 489-494
 charismatic, 266
 online, 51, 107, 131, 166, 186, 221, 266, 269, 285-286, 288, 290, 319, 370, 382, 406, 465, 468, 491, 493
 style, 370, 408, 484
 language differences, 285
 Latin America, 159, 166
 Lawsuits, 403
 Layoffs, 239
 layout, 199, 223, 471
 Leader, 33, 50, 89, 102, 182, 223, 255, 266, 272, 277, 301, 308, 312, 327, 334, 408, 413, 416, 419
 Leadership, 4, 20, 22-23, 31, 36, 71, 83, 86, 248-249, 258, 311-315, 379, 413, 438, 456, 467, 486
 Learning, 14, 31, 56, 89-91, 103, 255, 258, 304, 373, 381, 400, 410, 422-424, 441, 452, 455-458, 460, 465, 475, 485, 487, 489
 Learning curve, 56, 91
 Learning organization, 485
 Leasing, 328
 Ledger, 31, 203
 legal aspects, 426
 of intellectual property, 426
 Legal issues, 254, 340
 taxation, 254
 Legal jurisdiction, 443, 469, 473
 Legal systems, 61
 Legislation, 111, 462
 letters, 170-171, 205, 211, 214-215, 332, 360, 367
 application, 215
 formats for, 215
 international, 170
 Leverage, 10, 12-13, 22-23, 27, 30-32, 36, 95, 107-108, 144, 239, 243-244, 248, 264, 273, 280, 295, 399, 429, 444
 Liabilities, 321, 467
 Liability, 22, 467, 492
 business, 492
 Licensees, 175, 324
 Licenses, 175, 182, 241, 246, 324, 475, 480
 Licensing, 85, 175, 274
 Licensing agreements, 85
 Lifestyle, 454
 Limited liability company, 492
 Living standards, 252
 Loading, 58, 208, 310, 389
 Loans, 136
 Lobbying, 175
 Local data, 351
 Local government, 436
 Localization, 221, 224
 Locals, 376-377
 Logistics, 31, 56, 58, 72, 97-98, 166, 232, 243, 295,

310, 397-398, 434

importance of, 72
 information management, 295, 434
 transportation, 58, 97, 232, 434
 Logos, 64, 324
 Long tail, 46, 75, 490
 Loss, 68, 130, 208, 250, 258, 313, 376, 387, 422, 433, 435-436, 450, 470, 482
 assessment, 313, 435
 chance of, 433
 control, 250, 436, 470
 direct, 208, 376
 expected, 130, 376, 422, 433, 435, 482
 forecasting, 208
 frequency, 470
 indirect, 130
 known, 130, 470, 482
 prevention, 433
 severity, 433

M

Magazines, 483, 492
 Malaysia, 89, 397
 malware, 490
 Management, 1-41, 42, 44-45, 49-50, 53, 55-59, 64, 69, 72-75, 77-79, 81-83, 85, 87, 89-92, 94, 98, 100, 102-105, 107-111, 114, 115, 119-121, 125-126, 128, 130, 136, 141-143, 147, 149-153, 156, 166, 188-191, 193-200, 202-206, 208-209, 211-214, 216-226, 228-229, 231, 233-240, 242-245, 247-249, 251, 253, 255-258, 260-261, 264, 266-268, 270-272, 275-280, 282, 291, 293-295, 298-339, 340-341, 344, 349, 351-352, 355-356, 362-363, 365-366, 368-370, 372-373, 380-382, 387, 393, 396-397, 399-403, 405-408, 410-411, 419, 425-430, 432-435, 437, 439-442, 443-446, 448-451, 455-467, 475-477, 479-482, 485, 487-494
 activities of, 4, 21, 487
 functions of, 15, 190, 268, 294, 313, 344
 Management information system, 189, 295, 381
 Management issues, 229, 298-339, 476
 operations, 299, 311, 331
 Managers, 4-5, 14-15, 21-22, 38-39, 53, 68, 78, 92, 99, 106, 150-151, 157, 160, 195, 210, 212, 214, 222, 229, 234, 237, 248, 250, 257, 261, 277, 300-302, 309-310, 315, 317-318, 326, 338, 341, 348, 352, 367-368, 372, 377, 381, 389, 400, 402, 406, 417-418, 426, 437-440, 449, 456, 463-464, 477, 490
 skills required of, 234
 Manufacturers, 15, 57-58, 61, 64-65, 67, 69-71, 162, 170, 178, 208, 210, 252, 291, 385, 419, 486
 Manufacturing, 16, 31, 33, 35, 57, 59, 72, 102, 104, 120, 123, 125, 150, 176, 195, 202-203, 232, 251-252, 258, 276, 315, 318, 352, 385, 387, 397, 406, 411, 426, 430, 445, 483, 485, 491
 Manufacturing firms, 258
 Manufacturing operations, 176
 Margin, 239, 243, 291, 305-306
 Margins, 61-62, 103, 240-241, 243, 400
 Market capitalization, 132
 Market changes, 277
 Market demand, 382
 Market entry, 180
 Market position, 82, 278, 284
 strategic, 82
 Market power, 97
 Market research, 10
 Market share, 13, 44, 57, 79, 88, 96, 166, 210, 324, 330, 333-335, 400
 Market value, 335-336
 Marketing, 14, 17, 54, 72, 93, 97-98, 102, 108, 120, 166, 181-182, 205-206, 209, 214, 219, 239, 246, 278, 326, 331-332, 343, 367, 372, 376-377, 381, 481
 defined, 17, 108, 372, 481
 global, 14, 17, 54, 97, 102, 108, 166, 239, 278, 326
 ideas, 17, 102, 377
 metrics, 332, 377
 of value, 98
 people, 14, 17, 54, 102, 108, 120, 166, 181-182, 214, 239, 331, 343, 377, 481
 place, 54, 97, 108, 166, 209, 331
 price elasticity, 97
 Marketing management, 372
 defined, 372
 Marketing strategies, 72

- Marketing strategy, 376
 - Marketplace, 6-8, 13, 64, 70, 85-87, 89-90, 95, 98-100, 136, 149, 167, 183, 253, 256, 325, 331, 425, 441, 457, 471, 474, 483, 485
 - Markets, 7-8, 46, 50, 56, 82, 88, 93, 102, 106, 134, 159, 166, 200, 223-224, 226, 244, 251, 281-282, 284, 293, 296, 322, 333, 372, 389, 451
 - Markup, 51, 131, 135, 484, 491-492, 494
 - Markups, 218
 - masquerading, 347, 489
 - Mass customization, 9, 42, 46
 - Massachusetts, 92, 493
 - master file, 54, 118
 - Materials management, 203, 278
 - Matrix structure, 412
 - M-commerce, 485
 - meaning, 7, 28, 48, 194, 203, 206, 221, 270, 378, 383, 410, 441, 463, 481, 484
 - understanding of, 463
 - Measurement, 234, 330, 334-335, 413, 458, 462
 - measurements, 35, 248
 - mechanics, 29
 - Media, 17, 50, 133, 157, 159, 166-168, 194, 217, 222, 225, 227, 238, 283, 342, 432, 435, 472, 481
 - Mediation, 233
 - Medical care, 216
 - medium, 53-54, 79, 101, 163, 167, 179, 226, 238, 333, 469
 - written, 469
 - meetings, 11, 79, 104, 211, 251, 275, 317, 378, 399-400, 416-421, 426, 432, 440, 447, 450-451, 458, 479
 - conducting, 479
 - formal, 426
 - minutes of, 418
 - online, 104, 211, 275, 426, 447, 451
 - purpose of, 432
 - types of, 399, 440
 - virtual, 104, 426, 440, 450
 - Memory, 14, 71, 79, 130, 174, 266, 344, 433-434, 449, 474, 481, 490-491
 - memos, 205, 211, 484
 - Merchant, 150, 324, 350
 - Mergers, 7, 160, 450
 - horizontal, 450
 - vertical, 450
 - message, 63, 134, 145, 164, 167, 170, 172-173, 185, 273, 278-279, 288, 290-291, 327, 345, 348-351, 355, 367, 378, 390, 453, 468, 486-488, 493
 - delivery of, 290
 - ethical, 468
 - marketing, 278, 367
 - negative, 279
 - organization of, 493
 - positive, 278
 - producing, 486
 - purpose of, 145
 - sales, 134, 173, 185, 278, 367, 378
 - timing of, 288
 - Metadata, 52, 128, 204, 206-207, 228, 287, 368, 451, 458, 485
 - metaphors, 428
 - Metrics, 50, 101, 249, 332, 361, 377, 399, 401, 455, 457, 484
 - Microeconomics, 96
 - Microsoft SQL Server, 198
 - concurrency control, 198
 - Middle East, 7
 - Middle managers, 78, 309, 406
 - MIS, 2, 4, 19, 21, 108, 114, 154, 189, 204, 229, 258, 262, 312-313, 338, 398, 404, 493
 - Mission statement, 334
 - mobile phones, 16, 73, 282, 284
 - Modernization, 338
 - Money, 8, 37, 47, 51, 67-68, 70, 134, 183, 208-210, 215, 235, 241-245, 249-250, 272, 280, 288, 302, 306, 329, 332, 345, 354-356, 375-376, 386, 396, 402, 412-413, 437-438, 450, 454, 456, 463
 - commodity, 243, 245
 - demand for, 8
 - Monopolies, 97
 - value of, 97
 - Mortgage, 22
 - Motivation, 141, 175, 239, 259, 300, 380, 432, 439, 459, 466
 - Motivators, 437, 440
 - multimedia, 2-3, 21, 70, 159, 162, 164, 180, 198, 211, 221, 274, 367-368, 370, 434, 450, 484, 486
 - Multinational corporations, 7
 - Music, 46, 62, 93, 133-134, 158-159, 169, 180, 198, 325, 471
 - Music piracy, 133
 - Mutual funds, 69
- N**
- NASDAQ, 389
 - National security, 349, 435
 - Nations, 2, 6, 24, 199, 473
 - navigation, 58, 150, 159, 180, 223, 370, 427, 458
 - Negotiation, 293, 296, 405, 431-433, 440-441, 493
 - Defined, 293
 - Planning, 433
 - Process, 431-433, 440
 - Questions, 405, 440
 - Net income, 88
 - Net present value, 353
 - NPV, 353
 - Netherlands, 59-60
 - Network structure, 181
 - Networking, 4-5, 16, 18, 27, 86, 102, 111, 123, 128-129, 142, 150, 169, 173, 246, 350, 451, 454
 - Neural network, 384-385
 - neural networks, 369, 375, 382, 384-385, 486
 - New entrants, 93
 - New products, 8, 90, 150-151, 277-278
 - New York Stock Exchange, 401
 - New Zealand, 244, 447
 - news releases, 185
 - nonrepudiation, 347-348, 486, 488
 - Norms, 253-254, 431, 444-445, 469, 473
 - North America, 67, 159, 277, 318, 328, 358
 - Norway, 89
 - NPV, 353
- O**
- Objectives, 2, 20-21, 28, 35, 40, 81, 92, 130, 139-140, 149, 194, 244, 248, 250, 301-303, 316, 334, 363, 366, 369, 379, 381, 399, 420-421, 425-426, 485
 - objectivity, 421
 - Object-oriented programming, 199, 295, 486
 - Obligation, 437, 476
 - Obsolescence, 213, 367
 - Occurrence, 348, 436
 - OECD, 6, 159, 192
 - Organization for Economic Cooperation and Development, 192
 - OEM, 237-238, 261, 493
 - Offer, 2, 9, 40, 46, 50, 53, 100, 102, 107, 111, 119, 121, 134-135, 149, 152, 159-160, 163, 165, 169, 178, 182, 209, 221, 240-241, 243, 259, 276, 282, 284-285, 291, 303, 324, 328, 336, 343, 345, 358-359, 393, 474-475, 480, 482, 485
 - Offset, 62, 212-213
 - Offshoring, 45, 97, 231, 236, 246, 251-254, 257-261
 - Oil, 77, 87-88, 113, 234, 385, 388, 450, 454
 - Olympics, 408
 - OnLine Analytical Processing, 369, 486, 493
 - cube, 486
 - server, 486, 493
 - Online auctions, 95, 345
 - Online databases, 435
 - Online marketing, 182
 - OPEC, 493
 - Organization of Petroleum Exporting Countries, 493
 - Open systems, 15, 49, 51, 118-119, 265, 285-286, 485
 - Operating ratio, 334
 - operation and maintenance, 267
 - Operational excellence, 100-103, 208
 - Operational planning, 112
 - Operations, 4, 9, 11, 22, 25-28, 30, 32-34, 44, 66, 68, 72, 82, 87, 92, 97-99, 101, 105, 108, 110, 115, 120, 138, 142, 152, 169, 176-177, 185, 198, 206, 219, 222-223, 231-262, 273, 277-278, 287, 299, 311, 331, 346, 352-353, 357, 359, 369, 381-382, 389-391, 399-400, 403, 432, 435-436, 441, 456, 483-484, 486, 491, 493
 - operations and maintenance, 138
 - Operations management, 233, 249
 - Opportunities, 49-50, 88, 100, 105, 120-121, 151, 188, 225, 227, 229, 233, 301-303, 330, 343, 346, 396, 422, 428, 469
 - e-commerce, 330, 346
 - Optic technology, 174
 - Oracle, 4, 54, 198, 202, 222, 236, 276, 278, 305, 374
 - Order processing, 61, 125, 276, 430
 - Organization, 1-2, 5-6, 15, 19, 23, 25, 29-30, 33, 35-41, 53, 55, 72, 78, 82, 86, 91-92, 97-98, 105-107, 109, 113-114, 118, 121, 125, 130, 137, 141-143, 150-151, 153, 157, 170, 188-190, 192, 195-197, 200-202, 205, 212, 216-217, 221-223, 225, 228, 233-236, 240, 242-243, 247, 257, 260, 264, 266, 276-278, 293-294, 300, 306-310, 313-314, 316, 318, 332, 336, 340-341, 343-344, 352-354, 356, 361-363, 368-370, 380-381, 389, 391, 397, 401, 405-409, 411, 413, 431-432, 434-442, 444, 446, 449, 451, 455, 457-459, 462-466, 476-477, 481-490, 492-493
 - definition of, 78, 118, 201, 369
 - future of, 5, 109, 293
 - Organization for Economic Cooperation and Development, 192
 - OECD, 192
 - Organization of Petroleum Exporting Countries, 493
 - Organization structure, 30
 - Organizational behavior, 366, 457
 - Organizational culture, 459
 - Organizational objectives, 20
 - Organizational processes, 112, 157, 212, 216, 259, 333
 - Organizational structure, 25, 29, 33, 35, 41, 203, 219, 229, 236, 246-247, 277, 406, 411, 446, 489
 - defined, 29, 35
 - Organizations, 1-6, 9, 11-13, 18-19, 22-24, 35, 37, 41, 64, 69, 72, 75, 78-80, 85, 89-90, 104-106, 108-112, 118, 120, 125, 138, 144, 150-152, 157, 188, 193-194, 197, 201-202, 204, 208, 212, 216, 225-227, 233-234, 238, 240-241, 251-252, 265-266, 275-276, 278-279, 283, 292-293, 295, 311, 313, 318, 340, 342, 344, 351, 353-354, 356-359, 361, 366, 380, 390, 405-407, 409-410, 426, 430, 435-441, 449, 453, 459, 465-466, 470, 475, 480, 482-483, 485, 487-489, 491
 - Orientation, 16, 37, 253, 455
 - future, 37
 - Original equipment manufacturer, 237, 493
 - OEM, 237, 493
 - Outbound logistics, 97-98
 - outlines, 33
 - Output, 22, 116, 121, 199, 211, 214-216, 219-220, 252, 317, 320-321, 323, 370, 491
 - potential, 317, 323
 - Outsourcing, 3, 9, 12, 87, 96-98, 136, 138, 149, 166, 168, 189, 211, 231, 233, 237-253, 255-256, 258-262, 299, 319, 336, 346, 479-482, 486, 490-491
 - overhead, 100-101, 158, 249, 321
 - Ownership, 35, 133-134, 246, 372-373, 407, 411, 462, 471, 492-493
- P**
- PACE, 6, 138, 162, 173, 246, 259, 310, 457
 - Packaging, 222-223, 273
 - Paradigm shift, 18, 29, 388
 - paragraphs, 254
 - participative management, 313, 315
 - Partnering, 96, 243, 274-275, 440, 486
 - Defined, 243
 - Partnership, 4, 8, 29, 80, 191, 231-262, 426, 429
 - Partnership agreement, 426, 429
 - passwords, 342-344, 346-347, 352, 480, 488
 - Patent, 469, 472, 486
 - Patent and Trademark Office, 472
 - Patents, 166, 446, 471-472, 481, 484, 489
 - payroll, 4-5, 22, 35, 103, 116, 195, 240-241, 255, 366
 - payroll check, 240
 - Perceived value, 424, 433
 - Percentage of sales, 182
 - Perception, 8, 314-315, 405, 421, 431, 433, 441, 456
 - Performance, 2, 5, 14, 19-21, 23, 38, 50, 54, 114, 120, 127, 130, 146, 150, 159, 166, 173, 189-190, 207, 229, 234, 241, 245, 249, 265, 279, 283, 296, 304, 312, 315, 331-334, 336, 352, 362, 368, 377-378, 380, 389, 398-401, 406, 420, 430, 433, 449-450, 454, 457, 462, 464-465, 473, 483-485, 487
 - firm performance, 336

Performance measures, 331, 333
 performance metrics, 50
 Perils, 340, 342, 346-347
 Permits, 135-136, 168-169, 220, 282, 354
 Personal communication, 153, 164, 493
 Personal property, 493
 Personality, 186
 Peru, 473
 Philippines, 251, 260
 Phishing, 353, 487
 photographs, 17, 194, 199, 212, 481
 PHP, 466
 PILOTS, 10, 396
 Piracy, 133
 Place, 3, 6, 13, 24, 27, 32-33, 38-40, 45-46, 52-54, 62, 70, 73, 83, 86, 89, 91, 97, 99, 101, 108, 113, 117, 125-126, 128, 133, 145, 148, 157, 166, 173, 176-177, 189, 209-210, 221, 224, 226-227, 234-235, 237, 241, 259-261, 283-284, 295, 309, 311, 313, 324, 328, 331, 346-347, 352, 354-355, 360, 363, 374, 395, 405, 407, 416-418, 421, 425-429, 437, 439-441, 447, 449, 459-460, 462, 464, 470, 473, 476, 486, 490
 planning and scheduling, 31
 planning stage, 418
 Plans, 8, 22, 25-26, 77, 79, 88, 92, 111-113, 121, 128, 139, 149, 189-190, 218, 248-249, 281, 283, 288, 326-327, 354-356, 358, 364, 378, 380, 408, 420-421, 477
 approaches to, 356
 business, 8, 25, 77, 79, 88, 92, 111-113, 121, 149, 189-190, 248-249, 281, 283, 288, 326-327, 354, 356, 358, 364, 380, 421, 477
 reasons for, 380
 Point-of-sale systems, 17
 Poland, 251
 Policies, 10, 35, 51, 53, 100, 103, 107-108, 188, 199, 214, 224-225, 235-236, 248, 251, 268, 352, 362-363, 386-387, 399, 408, 431, 434, 455, 464, 466, 468-469, 471, 476
 policy statements, 211, 215
 politeness, 423
 Political parties, 413
 Politics, 102, 225, 468
 Population, 259, 490
 Portability, 119, 286
 Portfolio, 4, 35, 40, 79, 87, 90, 100, 102, 104, 146, 188-189, 231, 233, 338
 Model, 35, 40, 90, 102
 Positioning, 44, 58, 225, 492
 Power, 4-5, 8, 14-15, 40-41, 42, 49, 53-55, 66, 74, 77, 87, 93-95, 97, 104-107, 113, 116, 130, 150, 173-174, 181, 184, 203, 217, 225, 246, 286, 312, 316, 332, 345, 362, 364, 366, 374, 379, 381, 410, 413, 438-439, 465, 467, 479-480, 486, 492
 PowerPoint, 5, 164, 167, 423
 preaching, 138
 Premium, 188, 214, 335
 Present value, 353
 presentation software, 125, 274
 presentations, 164, 405, 421-424
 electronic, 422-424
 online, 422-424
 Press release, 64, 220
 press releases, 220
 Price, 7-8, 10, 13, 46, 54, 59, 61-62, 64, 66-67, 71, 96-97, 111, 134, 174, 185, 209-210, 222, 248, 272, 308, 335-336, 353, 382, 389, 395, 425, 453-454, 462, 474-475
 defined, 13, 174, 462
 price changes, 54, 66
 price elasticity, 97
 Price changes, 54, 66
 Price elasticity, 97
 Prices, 32, 45-46, 49, 61-62, 68-70, 93-94, 162, 176, 222, 284, 336, 372, 396-397, 415, 483
 auction, 93
 custom, 70
 flexible, 372
 maximum, 68
 retail, 68, 372
 Pricing, 54, 62, 66, 97, 160, 175, 203, 247-248, 256, 289-290, 294, 335, 396, 462
 dynamic, 54
 elements of, 160
 horizontal, 203
 objectives, 248
 payment, 290
 strategy, 97, 203, 294
 value, 66, 97, 160, 248, 335, 462
 Pricing strategies, 97
 Primary activities, 97-98
 Primary data, 357
 Primary research, 424
 Principal, 6, 20-21, 379
 Principles, 12-13, 20, 40, 91, 106, 195-196, 199, 229, 233, 260, 265, 293, 316, 366, 370, 438, 455, 464
 privacy, 9, 17, 61, 70, 74, 90, 111, 134, 138, 191, 236, 254, 256-257, 268, 286, 347-348, 360, 364, 395, 401, 410, 441, 443-444, 467-471, 476-478, 487
 invasion of, 467, 470
 of information, 17, 61, 70, 74, 111, 236, 443, 470-471
 Privacy policy, 471
 Private exchanges, 71
 private key, 349-350, 487
 Probability, 108, 380, 433
 problem solving, 21, 216, 268, 368, 415
 Process technology, 212
 Procurement, 7, 98, 189, 202-204, 243-245, 276, 293, 301, 483
 Product development, 166
 Product line, 94, 103
 Product or service, 9, 57, 60, 69, 74, 95, 97-98, 106, 331-332, 481-482, 486
 Product planning, 202
 Product quality, 259, 397
 Production, 4, 6, 13, 21, 45, 70, 85, 96, 99, 128, 151, 174, 177, 195, 212, 214, 221, 234, 251, 269, 271-273, 276, 283-284, 306, 311, 323, 334, 366, 370, 377, 381, 383, 386, 396, 400, 430, 451, 485, 493
 centralized, 214, 485
 national, 493
 Production costs, 45
 Productivity, 12, 15, 19, 39, 72, 101, 130, 150, 188, 212, 229, 233, 241, 252, 265-267, 286, 331, 459, 477, 487
 labor, 12, 252
 Products, 3, 7-10, 14-17, 19-21, 24-26, 28-29, 31, 45-47, 51-54, 58-62, 67, 69-70, 72-73, 82, 85, 88, 90, 93-100, 104, 106-107, 110-111, 113, 118-119, 139, 141, 150-151, 162, 165-167, 170, 181, 186-187, 200, 205, 208-210, 214, 221-225, 233, 240, 246-247, 251-252, 274-279, 282, 309, 319, 321, 324, 326, 331-332, 343, 349, 352, 361-363, 375, 382, 386, 389, 391, 393, 395, 407, 436, 441, 446, 448, 456, 463-464, 470-471, 474, 480-481, 484-486, 488-489
 attributes of, 51
 branding, 62
 consumer products, 252, 277
 defined, 15-17, 19, 21, 29, 69, 118, 141, 151, 361-362, 464, 481, 484
 development of, 15, 20, 26, 73, 104, 170, 246, 279, 489
 levels of, 19, 170
 packaging, 222-223
 Professionals, 19-20, 22, 78, 123, 133, 157, 212, 295, 300, 304, 354, 371, 379, 418, 462, 471, 484
 Profit, 46, 61-62, 208-209, 239, 243, 306, 376, 450, 485
 Profits, 106, 245, 277, 376, 463
 Programmer, 196-197, 215, 223, 243, 268, 286, 337, 489-490
 progress reports, 418
 Project management, 4, 15, 44, 55, 78, 151-152, 233, 258, 266-267, 270-271, 282, 298-301, 303, 311-316, 318, 336-339, 430, 434, 466
 Project plan, 301-303, 317
 Project scope, 312, 373
 projection, 372, 419
 Promotion, 182, 332, 367
 Property, 134, 199, 254, 260, 335, 426, 433, 443-444, 467-469, 471-472, 474, 476, 493
 risks, 254
 Property rights, 443-444, 467-469, 471-472
 proposals, 338
 Prosperity, 483
 Protection, 16, 35, 61, 184, 344, 352, 355, 435, 470-472, 476
 Prototype, 269, 272, 278, 452, 487
 Prototypes, 99, 269, 272
 prototyping, 15, 55, 264, 266, 268-269, 271, 274-275, 294-295, 305, 374, 453, 493
 application, 15, 55, 264, 266, 268-269, 271, 294-295, 374, 493
 definition, 266
 developing, 264, 266, 268-269, 271, 274-275, 294-295
 Psychology, 432
 Public health, 434
 public key, 173, 284, 349-351, 474, 487
 public key infrastructure, 349
 Public opinion, 332
 Public relations, 455
 defined, 455
 Publicity, 353
 Purchasing, 28-29, 31, 68, 73, 131, 182, 203, 208, 210, 240, 248, 278-279, 288, 409, 472, 491
 purpose, 5-6, 15, 40, 51, 103, 105, 145, 227, 247, 269, 310, 360, 369-370, 374, 380-381, 386, 419, 424, 432, 441, 452-453, 457, 465, 468, 479
 general, 5, 370, 380-381
 specific, 145, 360, 369, 374, 380-381, 419, 452, 457, 479
 statement of, 452
Q
 Quality, 8, 12, 14, 37, 42, 50, 53, 56, 68, 83, 93, 96-97, 99, 120, 158, 163, 167, 178, 188, 202-203, 206-207, 212, 216, 219-221, 224, 233-234, 236, 249-250, 252, 255-257, 259, 265, 287, 295, 301, 331-332, 366-368, 370, 383, 386, 397-399, 414, 424, 426, 433, 435-436, 438, 452, 455, 465, 467, 477, 487, 490, 493-494
 quality control, 203, 467, 490
 Quality management, 14, 216, 455, 490, 494
 query, 4, 58, 119, 198, 210, 268, 292, 324, 369, 389, 398, 480, 487, 489, 493
 Questionnaires, 334
 Quiet period, 226
R
 Race, 174
 Radiation, 179, 184, 492
 radio frequency identification, 280, 395, 487-488, 493
 RFID, 280, 395, 487-488, 493
 Railroads, 48
 Rate of return, 353
 internal, 353
 Rates, 103, 180, 194, 208, 217, 424
 Rating, 63, 240, 377
 Raw materials, 69, 383
 Reach, 5, 7, 11, 56, 58, 73, 88, 97, 106, 162, 164, 166, 189, 220, 238, 282, 335, 361, 383, 388-389, 406, 413, 415, 421, 431, 458, 473
 Readiness, 401, 405, 435
 Real estate, 242, 456
 Real value, 412
 Receivables, 203, 335
 Recession, 377
 recommendations, 26, 111, 142, 250, 302, 310, 360, 402, 420, 461
 Reconciliation, 169
 Records, 69, 96, 122, 195, 197, 204-205, 211, 218, 232, 255, 268, 321-322, 343, 345, 352, 359, 384, 474
 Records management, 204-205, 211
 Recruiting, 223, 255, 389
 redundancy, 118, 190, 354, 357, 359, 466
 Reform, 302
 Regulation, 9, 108, 470, 478
 state, 470
 Regulations, 9, 17, 102, 105, 109, 166, 217, 226-227, 283, 362-363, 378, 385, 444, 476, 484
 global, 9, 17, 102, 105, 109, 166, 484
 Relational database, 4, 202, 218, 229, 272
 relational databases, 119, 198, 487
 attributes, 198
 designing, 119, 487
 tuple, 198
 Relational model, 197-198
 terminology, 197
 Relationship marketing, 14
 Relationships, 2-3, 8, 12, 17, 39-40, 42, 63, 65-68, 73-74, 86, 90, 99-100, 104-107, 110-111, 113, 143, 182-183, 196-198, 207, 209-210, 231, 240, 243, 247-248, 250, 254-257, 260-261, 270, 299, 331, 367, 370, 372, 374,

- 382, 409, 411, 430, 446, 470, 481-482, 487-489
 - preferences, 2, 374
 - Religion, 415
 - Reorganization, 25-27, 39
 - Replication, 128
 - Reporting system, 243, 380
 - functions, 243
 - reports, 10, 19, 44, 88, 103, 107, 138, 166, 180, 189, 194, 205-206, 209-212, 216, 235, 238, 240, 243, 245-246, 250, 252-253, 272, 292, 311, 341-342, 357, 367, 369, 372, 374-375, 406, 418, 430, 467, 470, 484
 - components of, 272, 367
 - distributing, 107, 212, 235
 - online, 10, 103, 107, 166, 209, 211, 235, 238, 292, 342, 357, 369, 406, 470
 - organizing, 211
 - producing, 19, 406
 - types of, 138, 194, 205, 252, 341-342, 369, 374, 430, 470, 484
 - Representations, 139-140, 270
 - research, 5, 10-11, 25-26, 30, 35, 62, 73, 77, 81, 83-85, 89, 92, 106-108, 126-127, 150, 153-154, 162, 184, 198, 229, 239, 243, 246, 258, 261, 295, 308, 311, 335, 337, 364, 366, 369-370, 382, 410, 423-426, 431-432, 437, 441, 445, 454, 461, 477, 487, 491-493
 - planning, 5, 25-26, 77, 81, 83-85, 89, 92, 106-108, 369, 382, 487, 491-492
 - primary, 424
 - purpose of, 5, 369-370, 432
 - Research and development, 35, 487, 493
 - cost of, 35, 493
 - Resources, 3, 6, 13, 17, 19, 22-23, 25, 27-28, 30-31, 34-37, 51, 53, 65, 73, 83, 87, 106, 119-120, 133-134, 150, 152, 180, 189, 193-229, 232-233, 252, 254-255, 258-260, 265, 267-268, 301-302, 313, 318, 321, 340, 356, 358, 360-361, 363, 401, 412, 433, 435-436, 466, 480, 484, 490-492
 - enterprise resource planning (ERP), 193, 202-203
 - response time, 66, 207, 233-234, 483
 - Responsibility, 3, 12, 23, 28, 77-79, 119-120, 193, 204-205, 209, 211, 237, 259, 261, 271, 336, 343, 408, 411, 455, 457, 469, 484
 - Restricted, 169, 324, 344, 407, 486
 - Restrictions, 344
 - Retail stores, 175, 279
 - Retailers, 17, 58, 61, 64-65, 67-70, 199, 281, 291, 325, 395
 - Retailing, 7, 88, 182, 199, 232, 473, 483
 - Retention, 332-333
 - Retirement, 255
 - Return on assets, 332
 - Return on equity, 332
 - Return on investment, 35, 330, 333-334, 353, 493
 - Revenue, 43, 63, 78, 96, 158, 207, 209, 214, 330-332, 334, 337, 376-377, 379, 391, 398, 449, 457, 489, 493
 - marginal, 398
 - Revenues, 54, 73, 103, 217, 276, 291, 376-377, 397, 413, 415, 452, 473
 - Reverse auctions, 36
 - Reverse engineering, 321-322, 472
 - revision, 218, 270
 - Reward sharing, 449
 - Rewards, 12, 89, 375-377, 402, 457
 - RFID, 18, 72, 187, 280, 395-396, 403-404, 470, 478, 487-488, 493
 - RFID technology, 280, 395, 470
 - RFP, 338
 - Risk, 49, 66, 100-102, 136, 159, 241, 274, 283, 298, 300-301, 303, 306, 311-315, 318, 325, 327, 337-338, 344, 356, 358, 362-363, 387, 456, 467, 471, 474, 480, 491
 - asset, 318
 - business, 49, 66, 100-102, 136, 283, 300-301, 303, 306, 311-315, 318, 327, 337-338, 356, 358, 362-363, 387, 474, 480, 491
 - commercial, 474
 - enterprise, 136, 325, 327, 363
 - financial, 102, 159, 241, 283, 491
 - fire, 356
 - market, 159, 283, 337
 - operational, 100-102, 306, 358, 480
 - personal, 344, 356, 467, 471, 491
 - property, 467, 471, 474
 - strategic, 49, 66, 100-102, 301, 314, 325
 - Risk management, 298, 300, 311-312, 387
 - decision making, 387
 - techniques, 300
 - Risk transfer, 313
 - Risks, 9, 36, 49-50, 66, 72, 130, 240, 245, 254, 301-303, 308, 310-311, 313-315, 332, 338, 341, 353, 362, 384
 - Rivalry, 93-95
 - Role, 3, 9, 23, 28, 32-33, 38-39, 44, 58, 82, 96, 98, 100, 130, 132, 138-140, 156, 160, 188, 191, 200-201, 211, 248, 250, 261, 275, 309, 320, 324-325, 344, 362, 366, 369, 378, 411, 418, 438-439, 449-452, 455, 463-464, 467, 476, 480, 490
 - interpersonal, 275
 - routers, 158, 164, 167, 190, 234, 487-488
 - Royalties, 471
 - Rumors, 464
 - Rwanda, 435
- S**
- sabotage, 313, 342, 353
 - Salaries, 6, 232, 418
 - Salary, 6, 384-385
 - Sales, 7, 10-11, 21-22, 35, 47, 54-55, 58, 67, 71-73, 75, 95, 97-99, 103, 119, 134, 141, 150, 165-166, 173, 182, 185, 208-210, 219, 223-225, 243, 277-278, 298, 305-306, 322, 325-326, 329-330, 332, 337, 366-368, 371-372, 374, 377-378, 381-383, 391, 394, 401, 407, 409, 419, 447, 474, 485
 - Sales and marketing, 166, 326
 - Sales data, 367, 374
 - Sales force, 54, 166, 305-306, 329, 368, 391
 - training, 306, 329, 368
 - Sales presentation, 409
 - Sales promotion, 367
 - Salesforce.com, 329, 339
 - Salespeople, 54-55, 164, 176, 182, 274, 323, 329, 367, 407, 447, 485
 - Inside, 54
 - Outside, 54, 164, 447
 - Samples, 166
 - Sampling, 80
 - Sanctions, 439
 - SAP, 4, 31-33, 35-36, 142-143, 177, 202, 255, 276, 278, 315-316, 328, 493
 - Sarbanes-Oxley Act, 9, 17, 353
 - Saving, 58, 244, 332, 418, 477
 - Scandinavia, 184
 - Scanning, 177, 205, 325
 - Scarcity, 50
 - scheduled reports, 369
 - Schema, 201
 - Scientific management, 366
 - scope, 33, 100, 139-140, 143, 205, 249, 251, 267, 272, 299, 301-302, 306-307, 311-315, 317, 340, 344, 373, 469, 487-488
 - SEA, 185
 - Search engines, 8, 45-46, 52-53, 85, 345, 490
 - Second Life, 151
 - Securities, 226-227, 281-283, 473, 493
 - Securities and Exchange Commission, 493
 - Security, 6, 16-18, 29, 31, 34-35, 38, 53-54, 68, 73, 85, 90, 110, 118, 130, 132, 134, 136, 138, 164, 169, 173, 183, 189, 193, 200-202, 210, 223, 226, 236, 245, 256, 260, 266, 268, 279, 284, 286-287, 326, 340-364, 370, 389, 392, 434-435, 466, 481-482, 486, 488-489, 492-493
 - of e-commerce, 260
 - security management, 38, 340-341, 344, 352, 362-363, 492
 - Segmentation, 51
 - Selection, 13, 59, 78-79, 120, 125, 183, 222, 268, 317, 369, 375
 - Self-interest, 83
 - Self-reliance, 436
 - Sellers, 7, 62, 95, 133, 240, 345, 389, 483
 - sentences, 254
 - September 11, 2001, 109, 185
 - Service provider, 53, 60, 85, 156, 169, 176, 236, 243, 287, 479, 481, 483-484, 491-492
 - Services, 2, 6-10, 12, 15-16, 21, 25-27, 29-31, 33-34, 37-39, 46, 52-54, 58, 60-62, 69, 73, 80-82, 85-87, 89-91, 93-96, 100-102, 104, 106-107, 110-111, 115, 117, 129, 134-137, 142-153, 156, 158-160, 162, 165-166, 169-170, 172, 180-182, 184, 186, 188-191, 195, 199, 204-205, 207, 225, 232-233, 235, 237, 239-244, 246-252, 255, 257-262, 264-265, 271, 279, 282-288, 290-296, 301, 324-327, 329, 331, 334-335, 337, 340, 344, 348, 352, 354-359, 361-363, 365, 367, 373, 382, 402, 407, 409, 415, 432, 446, 457, 462, 470-474, 483-485, 488-492, 494
 - attributes of, 115, 117, 152, 402
 - branding, 62
 - defined, 15-16, 21, 29, 39, 69, 142-143, 151-152, 160, 241, 243, 250, 265, 288, 293-294, 327, 348, 361-362, 462, 483-484
 - differentiation, 95
 - levels of, 149, 170, 283, 334, 490
 - quality management, 490, 494
 - Servlet, 291
 - Shared values, 439
 - Shareholder, 239, 335, 339
 - Shareholders, 150, 226, 239
 - shipping, 42, 47, 56-59, 65, 157, 167, 203, 210, 291, 309, 432
 - Ships, 59, 65, 185, 390
 - Shortage, 236
 - Shrinkage, 68
 - SIMPLE, 1, 12-13, 19-20, 39, 53, 113, 130, 135, 151, 201, 234, 245, 269, 286, 290, 300, 316-317, 344, 346, 372, 374-375, 379, 384, 425, 443, 465, 474, 489, 493
 - Simple Object Access Protocol, 135, 290, 489, 493
 - Singapore, 396, 473
 - Six Sigma, 426
 - Size, 21, 33, 46, 87, 166, 194, 208, 210, 214-215, 236, 242, 276, 300, 309, 329, 333, 335-336, 344, 349, 389, 393, 396, 431
 - Skills, 6, 37, 50, 73, 103, 109, 116, 147, 151, 234, 236, 247, 256-258, 275, 299-301, 307, 311, 319, 335-336, 388, 446, 457-458, 484
 - Slang, 491
 - slides, 419, 423
 - Sloan School of Management, 92, 335
 - Small business, 468
 - Smoke, 157, 180
 - SOAP, 135, 289-291, 489, 493
 - Social activities, 186, 195
 - Social needs, 488
 - Social network, 185, 488
 - Social networking, 4
 - social networks, 186, 225
 - business, 225
 - private, 186, 225
 - Social Security, 342, 359-360
 - Social Security Administration, 360
 - SSA, 360
 - Societies, 109
 - Society, 8, 111, 115, 146, 153, 208, 229, 295, 413, 425, 427-429, 437, 441, 462, 471
 - summary, 462
 - software, 1, 3-5, 14-16, 18, 22-23, 25-26, 29, 31-32, 34-35, 37, 40, 45-46, 51, 53-54, 70-72, 84-85, 87, 111, 116, 119-120, 123, 125-130, 132-136, 140, 143-145, 151, 162, 170, 185-186, 188-189, 198, 201-203, 215, 217, 220-223, 225-226, 232-235, 239, 241, 246, 249, 252, 257, 262, 264-271, 274-276, 278-279, 282, 286-287, 292, 294-296, 299, 304-305, 311, 317, 319-321, 324-325, 328-329, 336-337, 344-349, 351, 354-355, 358, 361-362, 364, 367-371, 373-374, 377, 379, 381-383, 388, 391, 393-394, 407, 414-415, 419-420, 423, 430, 432-433, 437-439, 444, 446, 453-454, 465-469, 471-472, 475, 479-491, 493
 - auditing, 202
 - business process reengineering, 265, 321, 423, 487
 - computer-aided design, 491
 - computer-aided software engineering, 264, 270, 294, 479, 484, 491
 - custom, 70, 271, 279, 299
 - end-user computing, 25-26, 40, 127, 482
 - evaluation of, 361, 369, 374
 - help desk, 299
 - malicious, 233, 345, 347, 466
 - outsourcing, 3, 87, 136, 189, 233, 239, 241, 246, 249, 252, 262, 299, 319, 336, 346, 479-482, 486, 490-491
 - prototyping, 15, 264, 266, 268-269, 271, 274-275, 294-295, 305, 374, 453, 493
 - purchasing, 29, 31, 203, 278-279, 472, 491

tracking, 14, 324, 469, 487
Sourcing, 241, 243-244, 246-248, 250-252, 256, 261, 364
South Africa, 89
South America, 166
South Korea, 180
Spam, 342, 438, 489
Specialization, 13, 20, 96
Specific performance, 50
Speculation, 488
speeches, 137
spoofing, 344, 347, 350, 489
Spot transactions, 110
spreadsheets, 43, 126, 198, 292-293, 406
spyware, 342, 348-349
SQL, 4, 119, 198-199, 222, 274, 343, 487, 489, 493
 queries, 198-199, 489
 view, 198, 274, 487
SSA, 360, 393
Stakeholders, 104, 160, 188, 302, 465, 476
Standardization, 33, 36, 90, 142, 328, 434
Statement of work, 254, 256
statistics, 225, 384, 455, 462
Status, 50, 54, 59, 88, 177, 183, 205, 211, 224, 274, 284, 292, 307, 311, 380, 390, 418, 430, 474, 489
Status quo, 88, 307
Steam, 369
steering committee, 26, 33, 35, 38, 78, 143, 317
Stock, 28, 32, 44, 68-71, 130, 137, 219, 281, 283-284, 293, 335-336, 353, 366, 373, 389, 401, 468, 482, 492
Stock exchanges, 281
Stock markets, 281
Stockholders, 106
Storefront, 489
Stories, 8, 54, 60, 108, 153, 229, 378, 413, 466
Strategic alliance, 12, 150, 261, 486
Strategic alliances, 5, 12, 151, 489
Strategic issues, 244, 248
strategic objectives, 130
Strategic planning, 78, 80, 97, 108, 112, 378, 419, 421
Strategic plans, 420
Strategies, 1, 8, 12-13, 37, 71-72, 82-83, 85, 87-89, 94, 97, 101, 103, 109, 113-114, 140, 150, 162, 194, 248, 258, 260, 276, 278, 309, 318-319, 326, 338, 363, 389, 403, 410, 457, 479, 485
 competitive, 8, 12, 71-72, 94, 97, 113-114, 150, 162, 457
 corporate, 8, 13, 72, 85, 87-88, 101, 140, 150, 162, 194, 276, 318, 479
 functional, 103
Strategy, 13, 27-28, 35, 37, 40-41, 43, 46-47, 71, 75, 77-90, 92-94, 97, 100-102, 104, 109, 112-114, 119, 129, 138, 140, 149-151, 153-154, 157, 203, 208, 219, 238, 244-245, 259, 278, 294-296, 314, 324, 329, 331, 337, 341, 361, 363, 376-377, 404, 406, 420, 429, 477, 480, 488-489
 combination, 13, 47, 112, 295
 defined, 13, 35, 78, 151, 294, 361
 focus, 27-28, 35, 40, 43, 78, 86, 89-90, 101, 150, 203, 219, 238, 244-245, 259, 278, 294-295, 406, 429
 global, 13, 27-28, 35, 37, 40-41, 87, 97, 102, 109, 138, 150-151, 157, 238, 244-245, 278, 294, 314
 pull, 13, 71, 314, 489
 push, 13, 71, 238, 245, 489
Stress, 68, 88, 236, 239, 366, 433
Structural capital, 443, 445-446, 451, 454, 456-458, 476, 489
Structured problem, 366
structured programming, 15, 270
Students, 236, 360, 454
Subsidiaries, 260
Substitute products or services, 93
Success, 23, 46, 49, 52, 57, 60, 77, 82, 87, 89-90, 92, 96, 100-101, 106, 113-114, 153, 184, 220, 233, 235, 248, 253, 259-260, 278, 296, 299, 303, 306, 309-312, 314-316, 318, 327, 331-333, 336, 338, 374, 380, 386, 397, 426, 438-440, 447, 449, 451, 457, 459, 462-463, 466, 477, 481, 491
Supermarkets, 64-65, 470
Supply, 4-5, 9-10, 39, 42, 45, 56, 58-60, 64, 69-71, 73, 75, 81, 95-96, 100, 103-105, 137, 145, 150, 174, 177, 203, 208-211, 216, 229, 232-233,

236, 245, 251, 265, 275, 277-279, 293, 323, 325, 368, 379, 390, 392, 398, 400, 404, 427-428, 434-435, 441, 480, 482, 489, 493
 currency, 229
 of money, 208
Supply and demand, 70, 96, 174
Supply chain, 4, 9, 42, 58-60, 69-70, 75, 96, 103-104, 177, 245, 277-278, 392, 427-428, 441, 480, 482, 489
 defined, 69, 427, 482
Supply chains, 105, 232, 265, 275, 279, 325, 390, 392, 398, 404, 489
 logistics, 232, 398
Support, 4-6, 9, 11, 13, 15-16, 21-23, 26, 28-31, 33-34, 37, 39, 50-51, 55, 57, 65, 73, 79-82, 88, 97-98, 104, 112, 115, 120, 127, 132, 138, 143-144, 146, 149, 151, 157, 163, 169, 180, 185, 195, 200, 202, 208-209, 212-213, 216, 222, 232, 234-236, 242, 246-248, 260, 274-275, 278, 287, 293-294, 299, 306-307, 310-311, 318, 326, 328-332, 336, 338, 358, 363, 365-366, 368-369, 371-374, 379-380, 389, 394, 402-403, 405-413, 415-418, 421-422, 425, 429-432, 434-436, 438-441, 446, 449, 451, 455, 464, 466, 475, 480, 482-485, 489, 492-493
support activities, 97-98
Supporting industries, 236
surveys, 248-249, 307, 377, 456
Sustainability, 245
Sweden, 86-87, 178, 215, 453-454
Switzerland, 144
system, 1, 3-4, 10, 12, 16, 18-20, 22-23, 25-26, 28-29, 31-32, 45-46, 51, 54-60, 64, 66-68, 72, 74, 77, 79, 84-85, 89, 95, 99, 101, 103-104, 107-108, 116-126, 129-134, 136-141, 143, 145-146, 152-153, 157, 163-164, 168-169, 177-178, 180, 185, 187, 189-191, 198-204, 207-210, 215-225, 229, 234-235, 237-238, 243-244, 246, 255, 257-258, 264-287, 290-295, 298-339, 341-344, 347, 349, 351-355, 359, 362, 367, 369-371, 373-374, 378-388, 390-395, 397-400, 402-403, 413-414, 416, 418-420, 422-423, 427, 430, 432, 434-436, 443-444, 447, 455, 459-462, 464-466, 468, 474, 477, 479, 482-494
System definition, 272
System design, 132, 267-268, 359
systems analysts, 19, 26
systems development, 22, 232, 266, 286
 introduction, 232
 planning, 22, 232

T

Tables, 10, 86, 198, 201, 423, 432, 481, 487
 naming, 201
Tacit knowledge, 12-13, 194, 444-445, 455, 458, 460, 476, 489
Tactical plans, 248
Tapes, 235
Target market, 94
task forces, 409
Taxation, 148, 254
 European Union, 254
Taxes, 256
taxonomy, 459
TCP/IP, 51-52, 119, 135, 163, 172-173, 350, 493
Team structure, 429
teams, 11, 22, 35, 38-39, 52-53, 86, 88-89, 99, 101, 113, 120, 142, 163, 202-203, 206-207, 225, 233, 242, 247, 253, 258, 269, 274, 279, 282, 300, 308-309, 316-317, 327, 335-336, 360, 399, 402, 405-409, 413, 417, 425-430, 434, 437-438, 440-441, 448, 452, 456, 479, 484, 488-489
 effective, 39, 52-53, 120, 202, 233, 247, 269, 274, 279, 282
 evolution of, 86, 113
 types of, 113, 120, 203, 336, 399, 405, 408, 430, 440, 484, 489
Teamwork, 120, 149, 458
Technical competence, 379
Technical services, 25, 27, 30, 33-34
Technical standards, 29
Technological advances, 6
Technological environment, 80
Technology, 1-2, 5-6, 8, 11, 13-14, 16, 18-23, 25-29, 32-33, 36-37, 40, 42-75, 78-81, 84-86, 90-92, 94, 96, 98, 101-102, 104-105,

107-108, 111-112, 114, 128, 131-132, 134, 138-140, 142, 144-145, 147, 151, 154, 156, 158, 166-169, 173-181, 184, 187-188, 190-192, 195, 198, 203, 205, 209, 211-212, 216, 226, 228, 232-233, 235-236, 241, 244-245, 249, 252, 259, 266, 274-275, 280, 285, 287, 290, 292, 300, 306, 315, 318, 324, 326, 330, 333, 335, 338-339, 340, 343-344, 351-352, 355, 362-363, 379, 382, 388-391, 393-396, 401, 405-406, 410, 412, 414, 416, 423, 425-427, 429-430, 432-433, 435, 439-441, 444, 446-447, 457, 461-468, 470-471, 474, 479-480, 482, 485, 489-493
 advances in, 2, 11, 14, 114
 culture and, 55, 447
 information technology, 2, 5-6, 16, 18-19, 25, 32, 37, 42-75, 91, 112, 114, 147, 154, 330, 338-339, 461, 485, 492
 strategic use of, 43, 64-65, 73, 92
Technology management, 91, 114, 203
Teens, 180
Telecommunications, 2, 6, 8, 15, 18, 21, 23, 25-27, 30, 34, 45, 48, 71, 96-97, 142, 148, 152, 156-192, 199, 234, 242, 247-248, 252, 256, 259-260, 271-272, 299, 356-359, 382, 480, 483, 485, 490-491
 infrastructure, 2, 23, 27, 34, 48, 71, 142, 148, 152, 157-160, 166-168, 242, 256, 299, 485
Telecommuting, 132, 346
teleconferences, 428-429
Teleconferencing, 434
Telemarketers, 377
telephone, 5, 18, 27-28, 30, 48, 128, 157-158, 163-165, 167-169, 174, 178, 185, 191, 199, 236, 249, 271, 322, 346, 351, 354, 357, 359-360, 387, 407, 435, 480, 482, 485, 487, 490-493
templates, 222-223, 427
Tenure, 137, 314, 378, 451
Termination, 474
Terminology, 128, 197, 223
Territory, 65, 87, 402
Terrorism, 6, 260
Text messaging, 185
Thailand, 397
The Economist, 9, 392, 395, 466-467, 477
Theft, 68, 100, 342-343, 345, 353, 360-361, 396, 472
 employee, 343
 identity, 360
Think globally, act locally, 7
Threats, 11, 93, 105, 260, 340-344, 352-353, 355, 361-364
three-step process, 311
Three-tier architecture, 222
throughput, 19
Time dimension, 408
Time management, 365, 401
Time zones, 11
Timing, 249, 288, 301, 303, 316, 400
tone, 248, 447
Total cost, 35-36, 132, 213, 493
 computing, 132
Total costs, 129, 331
Total quality management, 14, 216, 455, 490, 494
 TQM, 455, 490, 494
Total quality management (TQM), 455, 490
Trade, 37, 45, 60, 73, 97, 150-151, 233-234, 281, 352, 358, 360, 378, 469, 471-473, 488, 492
 globalization and, 97
Trade associations, 37
Trade secrets, 471-472
Trademark, 472-473
Trademarks, 223, 227, 446, 471-473, 489-490
Trade-offs, 233, 352
Traffic flow, 388
Training, 6, 12, 37, 41, 48, 51, 53, 72, 104, 203, 218, 234, 236, 240, 253, 257, 266, 293, 306, 308, 310, 329, 336, 353, 362, 368, 385, 406, 433-434, 455, 457
 for teams, 53
Training programs, 72
transaction processing, 15, 19, 126, 193, 205, 221, 479, 487, 493
Transactions, 3, 19, 21-22, 28, 51, 106, 110, 146, 190, 205, 210, 216, 221, 240, 243, 279, 287, 293, 345-346, 386, 394, 464, 482, 484-485, 493
Transfers, 103, 117, 235, 489
transitions, 38
Translation, 19, 147, 166, 220, 224, 276, 324, 434

- language, 147, 166, 220, 224, 434
- translation software, 276, 324
- Translations, 67, 127
- Transmission Control Protocol, 51, 135, 173, 493
 - TCP, 51, 135, 173, 493
- Transparency, 8-9, 70-71, 432-433
- Transportation, 58-59, 97, 136, 157, 213, 232, 291, 434-435
 - costs, 97, 213, 291
 - networks, 58, 97, 157, 232
- treasurer, 373
- Treasury Department, 103
- trend analysis, 103, 369
- Trends, 1, 3-7, 14-16, 18, 40, 87, 92, 102, 108-109, 138, 159, 206, 216, 243, 279, 329, 375, 381, 394, 481, 488
- Trojan horse, 341, 347, 484
- Trucks, 57, 65, 67, 99, 291, 309
- Trust, 62-63, 71, 184, 200, 225, 227, 243, 248, 250, 371, 403, 415, 434, 447, 452, 466
- tuple, 198
- Turnover, 389

U

- Uniform Commercial Code, 473, 494
- Unions, 245, 492
- United Kingdom, 133, 454, 491
- United Nations, 473
- United Nations Commission on International Trade Law, 473
- United States, 5, 9-10, 17, 47-48, 67, 86, 99, 107, 141, 157, 159, 169, 174-175, 177-178, 181, 186, 208, 214, 217, 224, 236, 239, 252-254, 257-259, 278, 284, 290, 360, 368, 373, 375, 377, 412-413, 453-454, 467, 469, 472-474
 - copyright law, 472
- Universities, 107-108, 458
- Upstream, 69, 392, 480
- Upward feedback, 310
- U.S., 5-7, 30, 33, 45, 48, 65, 150, 162, 166, 171, 175, 185, 194, 232, 236, 239, 248, 251-254, 256-258, 281, 284, 308, 325, 329, 341, 343, 345, 360, 395-396, 417, 425, 443, 452, 454, 456, 472-473, 484, 492-493
- U.S., 5-7, 30, 33, 45, 48, 65, 150, 162, 166, 171, 175, 185, 194, 232, 236, 239, 248, 251, 253-254, 256-258, 281, 284, 308, 325, 329, 341, 343, 345, 360, 395-396, 417, 425, 443, 452, 454, 456, 472-473, 484, 492-493
- U.S. Air Force, 396
- U.S. Census Bureau, 150
- U.S. dollar, 194
- U.S. economy, 232, 239
- U.S. Food and Drug Administration, 452, 492
 - FDA, 452, 492
- U.S. law, 254
- U.S. Patent and Trademark Office, 472
- U.S. Securities and Exchange Commission, 493
- Utilities, 49, 53, 97, 107, 116, 136, 217, 332
- Utility, 35, 49-50, 107-108, 114, 136, 149-150, 153, 177, 232, 246, 332, 474, 493
- Utility companies, 149, 332

V

- Validity, 390
- Value, 7, 10, 13, 17, 21-22, 27, 32, 35-36, 38-39, 42-44, 46, 48-50, 61, 63, 66-71, 73-74, 77, 79, 87, 90, 94-102, 104-105, 111, 113-114, 138, 149-150, 160, 173, 182, 208, 210, 212-213, 216, 224-226, 228, 239, 245, 248, 250, 252, 258-259, 280, 293, 298, 318, 325, 327-328, 330-337, 339, 353, 355, 372, 376-377, 394, 401, 410-413, 424, 431, 433, 443, 449-451, 453, 456, 459-460, 462-465, 469, 482, 485-486, 490, 494
 - building, 27, 42, 44, 48, 71, 79, 95, 104, 114, 138, 208, 252, 327, 412, 443, 451, 456, 464, 482, 485, 490
 - defined, 13, 17, 21-22, 35, 39, 69, 160, 250, 293, 327, 372, 462, 464-465, 482
 - market value, 335-336
 - marketing and, 97-98
- Value added, 105, 494
- Value chain, 42, 44, 46, 69-71, 74, 77, 90, 94, 97-100, 113-114, 208, 210, 245, 490
- Value chains, 73, 98, 111
 - Internet and, 73, 111
- Value creation, 87, 150, 248

- value of information, 330, 462-463
- Value proposition, 46
- Value-added, 68, 105, 182, 239, 293, 401
 - Product, 68
 - Relationships, 68, 105, 182
- Value-added networks, 105
- Vandalism, 467
- Variable costs, 96, 240-241, 246
- Variables, 139
- Variance, 392, 399, 480
- Venezuela, 454
- Venture capital, 132, 438
- video clips, 8, 158, 185, 432
- Video conferences, 425
- Video conferencing, 101, 107, 167, 408, 411, 416, 450, 479
- Video sharing, 341
- Videoconferencing, 55, 417
- videos, 7, 46, 55, 222
 - digital, 7, 222
 - online, 46, 55
- Vietnam, 252
- virtual meetings, 426
- Virtual offices, 133
- Virtual organization, 142, 151, 438-439, 442
- virtual organizations, 405, 437-440
- virtual private network, 494
 - VPN, 494
- Virtual team, 425, 450
- virtual teams, 425, 428, 437, 440, 448
- Virtual worlds, 185-186, 409
- virtualization, 490
- virus, 16, 342, 349, 353-354, 469, 484, 490
- virus protection, 16
- Vision, 3, 29-31, 33, 55, 79, 86, 107, 199, 277, 455, 465, 480, 490
- visualization, 222, 369, 398, 431, 434
- Visualize, 160, 375, 432
- voice mail, 11, 142, 188, 417-418
- Voice-over Internet protocol, 494
- VoIP, 18, 45, 96, 157-158, 167-168, 236, 341-342, 352, 434, 494
- Volume, 21-22, 65, 107, 189, 194, 198, 210, 212, 242, 291, 305-306, 367, 382, 435
- Volumes, 16, 28, 66, 146, 210, 221, 282
- vulnerabilities, 49, 360-361, 396

W

- walk-throughs, 199
- Wall Street Journal, 41, 44, 85
- War, 162, 173, 354
- Warehousing, 10, 17, 206-207, 209-210, 236, 369-370, 374
- Warranty, 326, 328
- Water, 54, 410
- Weaknesses, 348
- Wealth, 100, 453
- Weather conditions, 374, 395
- Web, 5, 7-10, 15-18, 20-21, 35-36, 41, 42, 46-48, 51-55, 58-64, 66, 70, 75, 80, 82, 85, 87, 91, 93, 95-96, 98, 101, 103, 111, 115, 117-118, 125-127, 131-132, 134-138, 142-144, 146-147, 151-153, 157-158, 162-164, 166, 172, 180-184, 186, 190-191, 194-195, 199, 204-205, 207, 209, 211, 219-223, 225-229, 232-233, 237-238, 244, 246, 258-260, 264-265, 285-296, 303-304, 316, 324-326, 328-329, 331, 336-338, 342, 344-347, 350, 353-355, 358, 360, 363, 365, 367, 369-370, 392-394, 402, 415, 432, 453, 463, 465, 467, 470-473, 475, 479, 481-486, 490-491, 494
- Web 2.0, 490
- Web portal, 42, 53, 85, 151, 292
- Web site, 9, 16, 41, 47, 58-60, 62-64, 66, 70, 75, 95-96, 118, 125, 127, 131, 134, 162, 164, 166, 172, 181-183, 186, 190-191, 220-223, 225-229, 232, 237, 246, 259, 303-304, 324, 328, 337-338, 342, 345, 347, 353, 355, 360, 363, 365, 392-394, 471-473, 475, 482, 486, 491
 - design, 162, 166, 220-221, 223, 227, 229, 259, 482, 491
 - domain name, 246, 472
 - global reach of, 473
 - privacy, 9, 70, 134, 191, 347, 360, 471
 - security, 16, 118, 134, 164, 183, 223, 226, 342, 345, 347, 353, 355, 360, 363, 392, 482, 486
- Web sites, 48, 51, 53, 60-61, 63, 93, 96, 98, 126, 135,

- 137, 147, 162-163, 166, 184, 190, 195, 204, 220-221, 223, 225-226, 238, 246, 260, 295, 325, 328, 346, 354-355, 358, 463, 467, 470, 473, 481, 490-491
- webcasts, 185, 237-238
- weblogs, 225-226, 229
- Widgets, 163
- Wiki, 465-467, 477, 491
- wikis, 45, 443, 465-467, 490-491
 - benefits of, 490
- wireless access, 168-169
- Wireless communications, 8, 174, 186-187, 480
- wireless networks, 21, 60, 157, 159, 186, 299
- Women, 186, 275
- Won, 63, 166, 186, 208, 211, 259, 304, 306, 448, 470
- word processing, 29, 126, 151, 205
- Work, 1-7, 9-15, 17-19, 21-23, 26, 28, 31-32, 35-36, 39-40, 44-45, 53, 58, 62-65, 68, 71, 75, 79-80, 85-89, 92, 95, 99, 101, 111-112, 116-117, 119-120, 125, 127, 130, 132-135, 140-144, 151-152, 157, 162, 164, 168, 170, 173, 177, 187-189, 195, 198-199, 202-203, 207, 209, 215, 217-218, 220-221, 225, 234, 236, 239-240, 242-243, 245, 248, 250-252, 254-257, 260, 265, 269, 273-275, 279, 282, 290, 299-303, 307, 309, 311-312, 315-319, 323, 325-326, 328-331, 334, 336-337, 341, 343, 350, 353-356, 358, 362, 366, 371, 374, 379-382, 387-388, 395, 400-401, 403, 406-411, 413, 415-418, 422, 425-426, 428-430, 435, 438-442, 443-478, 479-482, 484-486, 488-489
- Workers, 5-6, 11-12, 21-23, 41, 218, 236, 251, 344, 406, 411, 435, 437, 465, 484, 489
- workforce, 6, 15, 87, 252, 313, 405, 437, 484
- Working capital, 137, 302
- workplace, 13, 226, 343, 491
- World, 2-9, 12-13, 15-16, 24, 33, 35, 46, 52, 54, 61, 69, 71, 73, 77-78, 80, 83, 85-86, 88, 95, 97-98, 100, 102, 105-106, 108-109, 116-119, 123, 128, 131, 134-135, 138-139, 151, 157-160, 162-164, 166, 170, 173-174, 181, 183, 186, 189-190, 192, 194-195, 197-199, 206, 211, 215, 220, 222, 224, 229, 238-239, 244, 247, 253, 255, 259, 261, 265, 269, 273-274, 278, 281, 284, 327, 330, 334, 341, 348, 350, 354, 358, 362, 364, 368, 374, 380, 382-383, 386, 388-390, 395, 409-410, 413-415, 430, 440-441, 447, 451, 453, 469, 471, 473, 481, 484, 488-491, 494
- World economy, 46, 86, 173
- World Trade Organization, 97
 - WTO, 97
- World Trade Organization (WTO), 97
- World War, 173
 - First, 173
 - Second, 173
- World Wide Web, 5, 7, 117, 157-158, 162, 194, 220, 484, 490-491, 494
- worm, 347
- WTO, 97
- WWW, 24, 41, 47, 54, 59, 62, 65, 67, 69, 74-75, 84, 86, 88, 102, 106, 131-132, 137, 141, 144, 153-154, 165, 168, 177, 181, 186, 191-192, 208, 213, 217, 222, 226, 229, 237, 250, 255, 261, 271, 273, 277, 280-281, 287-288, 290, 296, 303-304, 308, 314, 322, 324-325, 329, 338-339, 342, 353, 359-361, 364, 372, 375, 378, 381, 386, 391, 393-394, 397, 404, 411, 417, 419, 423, 425, 445, 447, 450, 453, 458, 461, 475, 477

X

- XML, 131, 134-135, 197, 199, 221, 228, 286-291, 324-326, 489, 494
 - benefits of, 131, 288
 - development of, 228, 489
 - industry standards, 286

Y

- Yen, 194
- YouTube, 8, 46, 159

