

Information Systems for Business and Beyond (2019)

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Information systems, their use in business, and the larger impact they are having on our world.

DAVID BOURGEOIS

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This book was initially developed in 2014 by Dr. David Bourgeois as part of the Open Textbook Challenge funded by the Saylor Foundation. This 2019 edition is an update to that textbook.

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Information Systems for Business and Beyond

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Book Contributors

Information Systems for Business and Beyond was originally developed in 2014 by David T. Bourgeois Ph.D.

Updates for the 2019 edition were graciously contributed by:

- James L. Smith Ph.D. (all chapters)
- Shouhong Wong, Ph.D. (chapters 4 and 8)
- Joseph Mortati, MBA (chapter 10)

Changes from Previous Edition

Information Systems for Business and Beyond was written by Dr. David Bourgeois and originally published in 2014 as part of the Open Textbook Challenge at the Saylor Foundation. Since then, it has been accessed thousands of times and used in many courses worldwide. This 2019 update to the textbook brings it up to date and adds many new topics. True to its open textbook roots, many of the updates have come from the community of instructors and practitioners who are passionate about information systems. See the page Book Contributors to see the primary contributors to this edition. A majority of the changes listed below were made by Dr. James Smith, who did a revision to this text in 2018.

Here is a summary of the changes made:

Overall

- New and updated images, especially those related to statistics, in order to bring them up to date.
- References brought up to date.
- Added labs for every chapter.
- Added an index.
- Editing for consistency.

Chapter 1: What is an information system?

- Added video: Blum's fibre optic TED Talk

Chapter 2: Hardware

- Removed text which discussed increasing dependency on tablets and decreasing use of desktops
- Clarification of bit vs. byte, binary vs. digital. Added tables to Understanding Binary sidebar
- Added Huang's Law on graphics processor units
- Modified text regarding Moore's Law to state that his law is no longer able to be maintained

Chapter 3: Software

- Added information about Ubuntu Linux
- Added Eclipse IDE
- Added information about Tableau
- Supply Chain Management: added an emphasis on use of Information Systems up and down supply chain by Walmart to gain competitive advantage

Chapter 4: Data and Databases

- Database schemas redesigned
- Data types added
- SQL examples include output
- NoSQL described
- Data Dictionary re-ordered to column name
- New section on “Why database technology?”
- Differentiation of data, information, and knowledge
- Section on Data models
- Changed illustrative example of database tables and relationships.
- Updated section on Business Intelligence to focus on the rise of analytics and data science. Includes a new “What is Data Science?” sidebar.

Chapter 5: Networking and Communication

- History of ARPANET initial four nodes, etc.
- Metcalfe’s Law

Chapter 6: Information Systems Security

- Added information on blockchain and Bitcoin.

Chapter 8: Business Processes

- Introduce tools (DFD, BPMN, UML) of business process modeling
- Introduce examples of DFD.

Chapter 10: Information Systems Development

- Java sample code
- Mismanaging Change side bar
- Added section on mobile development.
- Added sidebar on risks of end-user computing

Chapter 11: Globalization and the Digital Divide

- World 3.0 written by economist Pankaj Ghemawat; also his TED talk video

Chapter 12: The Ethical and Legal Implications of Information Systems

- Facebook and Cambridge Analytics data privacy
- General Data Protection Regulation section

Chapter 13: Trends in Information Systems

- Waze mapping app
- Drone video
- Drone blood delivery in Kenya video
- Added sidebar on Mary Meeker and her Internet Trends report

How you can help

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1. Let us know you are using this textbook.
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Introduction

Welcome to *Information Systems for Business and Beyond*. In this book, you will be introduced to the concept of information systems, their use in business, and how information systems can be used to gain competitive advantage.

Audience

This book is written as an introductory text, meant for those with little or no experience with computers or information systems. While sometimes the descriptions can get a bit technical, every effort has been made to convey the information essential to understanding a topic while not getting overly focused in detailed terminology.

Chapter Outline

The text is organized around thirteen chapters divided into three major parts, as follows:

- **Part 1: What Is an Information System?**
 - *Chapter 1: What Is an Information System?* – This chapter provides an overview of information systems, including the history of how information systems got to where it is today.
 - *Chapter 2: Hardware* – This is a discussion of information systems hardware and how it works. You will look at different computer parts and learn how they interact.
 - *Chapter 3: Software* – Without software, hardware is useless. This chapter covers software and the role it plays in an organization.
 - *Chapter 4: Data and Databases* – This chapter explores how organizations use information systems to turn data into information that can then be used for competitive advantage. Special attention is paid to the role of databases.
 - *Chapter 5: Networking and Communication* – Today's computers are expected to also be communication devices. This chapter reviews the history of networking, how the Internet works, and the use of networks in organizations today.
 - *Chapter 6: Information Systems Security* – This chapter discusses the information security triad of confidentiality, integrity, and availability. Different security technologies are reviewed, and the chapter concludes with a primer on personal information security.

- **Part 2: Information Systems for Strategic Advantage**
 - *Chapter 7: Does IT Matter?* – This chapter examines the impact that information systems have on an organization. Can IT give a company a competitive advantage? This chapter discusses the seminal works by Brynjolfsson, Carr, and Porter as they relate to IT and competitive advantage.
 - *Chapter 8: Business Processes* – Business processes are the essence of what a business does, and information systems play an important role in making them work. This chapter will discuss business process management, business process reengineering, and ERP systems.

- *Chapter 9: The People in Information Systems* – This chapter will provide an overview of the different types of people involved in information systems. This includes people who create information systems, those who operate and administer information systems, those who manage information systems, and those who use information systems.
 - *Chapter 10: Information Systems Development* – How are information systems created? This chapter will review the concept of programming, look at different methods of software development, review website and mobile application development, discuss end-user computing, and look at the “build vs. buy” decision that many companies face.
- **Part 3: Information Systems beyond the Organization**
 - *Chapter 11: Globalization and the Digital Divide* – The rapid rise of the Internet has made it easier than ever to do business worldwide. This chapter will look at the impact that the Internet is having on the globalization of business and the issues that firms must face because of it. It will also cover the concept of the digital divide and some of the steps being taken to alleviate it.
 - *Chapter 12: The Ethical and Legal Implications of Information Systems* – The rapid changes in information and communication technology in the past few decades have brought a broad array of new capabilities and powers to governments, organizations, and individuals alike. This chapter will discuss the effects that these new capabilities have had and the legal and regulatory changes that have been put in place in response.
 - *Chapter 13: Future Trends in Information Systems* – This final chapter will present an overview of some of the new technologies that are on the horizon. From wearable technology to 3-D printing, this chapter will provide a look forward to what the next few years will bring.

For the Student

Each chapter in this text begins with a list of the relevant learning objectives and ends with a chapter summary. Following the summary is a list of study questions that highlight key topics in the chapter. In order to get the best learning experience, you would be wise to begin by reading both the learning objectives and the summary and then reviewing the questions at the end of the chapter.

For the Instructor

Instructors: if you have adopted this book for your course, would you be so kind as to let us know in the instructor survey?

Learning objectives can be found at the beginning of each chapter. Of course, all chapters are recommended for use in an introductory information systems course. However, for courses on a shorter calendar or courses using additional textbooks, a review of the learning objectives will help determine which chapters can be omitted.

At the end of each chapter, there is a set of study questions and exercises (except for chapter 1, which only offers study questions). The study questions can be assigned to help focus students’ reading on the learning objectives. The exercises are meant to be a more in-depth, experiential way for students to learn chapter topics. It is recommended that you review any exercise before assigning it, adding any detail needed (such as length, due date) to complete the assignment. Some chapters also includes lab assignments.

As an open textbook, support for supplemental materials relies on the generosity of those who have created them and

wish to share them. Supplemental materials, including slides and quizzes, are located on the home page for this book. If you wish to contribute materials that you have created, please fill out the instructor survey and communicate that fact.

PART I

PART I: WHAT IS AN INFORMATION SYSTEM?

I. Chapter 1: What Is an Information System?

Learning Objectives

Upon successful completion of this chapter, you will be able to:

- define what an information system is by identifying its major components;
- describe the basic history of information systems; and
- describe the basic argument behind the article “Does IT Matter?” by Nicholas Carr.

Introduction

Welcome to the world of information systems, a world that seems to change almost daily. Over the past few decades information systems have progressed to being virtually everywhere, even to the point where you may not realize its existence in many of your daily activities. Stop and consider how you interface with various components in information systems every day through different electronic devices. Smartphones, laptop, and personal computers connect us constantly to a variety of systems including messaging, banking, online retailing, and academic resources, just to name a few examples. Information systems are at the center of virtually every organization, providing users with almost unlimited resources.

Have you ever considered why businesses invest in technology? Some purchase computer hardware and software because everyone else has computers. Some even invest in the same hardware and software as their business friends even though different technology might be more appropriate for them. Finally, some businesses do sufficient research before deciding what best fits their needs. As you read through this book be sure to evaluate the contents of each chapter based on how you might someday apply what you have learned to strengthen the position of the business you work for, or maybe even your own business. Wise decisions can result in stability and growth for your future enterprise.

Information systems surround you almost every day. Wi-fi networks on your university campus, database search services in the learning resource center, and printers in computer labs are good examples. Every time you go shopping you are interacting with an information system that manages inventory and sales. Even driving to school or work results in an interaction with the transportation information system, impacting traffic lights, cameras, etc. Vending machines connect and communicate using the Internet of Things (IoT). Your car’s computer system does more than just control the engine – acceleration, shifting, and braking data is always recorded. And, of course, everyone’s smartphone is constantly connecting to available networks via Wi-fi, recording your location and other data.

Can you think of some words to describe an information system? Words such as “computers,” “networks,” or “databases” might pop into your mind. The study of information systems encompasses a broad array of devices, software, and data systems. Defining an information system provides you with a solid start to this course and the content you are about to encounter.

Defining Information Systems

Many programs in business require students to take a course in *information systems*. Various authors have attempted to define the term in different ways. Read the following definitions, then see if you can detect some variances.

- “An information system (IS) can be defined technically as a set of interrelated components that collect, process, store, and distribute information to support decision making and control in an organization.”¹
- “Information systems are combinations of hardware, software, and telecommunications networks that people build and use to collect, create, and distribute useful data, typically in organizational settings.”²
- “Information systems are interrelated components working together to collect, process, store, and disseminate information to support decision making, coordination, control, analysis, and visualization in an organization.”³

As you can see these definitions focus on two different ways of describing information systems: the *components* that make up an information system and the *role* those components play in an organization. Each of these need to be examined.

The Components of Information Systems

Information systems can be viewed as having five major components: hardware, software, data, people, and processes. The first three are *technology*. These are probably what you thought of when defining information systems. The last two components, people and processes, separate the idea of information systems from more technical fields, such as computer science. In order to fully understand information systems, you will need to understand how all of these components work together to bring value to an organization.

Technology

Technology can be thought of as the application of scientific knowledge for practical purposes. From the invention of the wheel to the harnessing of electricity for artificial lighting, technology has become ubiquitous in daily life, to the degree that it is assumed to always be available for use regardless of location. As discussed before, the first three components of information systems – hardware, software, and data – all fall under the category of technology. Each of these will be addressed in an individual chapter. At this point a simple introduction should help you in your understanding.

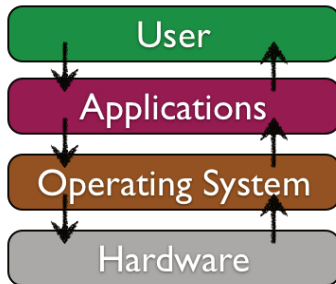
Hardware

Hardware is the tangible, physical portion of an information system – the part you can touch. Computers, keyboards,

1. [1]
2. [2]
3. [3]

disk drives, and flash drives are all examples of information systems hardware. How these hardware components function and work together will be covered in Chapter 2.

Software



Software comprises the set of instructions that tell the hardware what to do. Software is not tangible – it cannot be touched. Programmers create software by typing a series of instructions telling the hardware what to do. Two main categories of software are: Operating Systems and Application software. Operating Systems software provides the interface between the hardware and the Application software. Examples of operating systems for a personal computer include Microsoft Windows and Ubuntu Linux. The mobile phone operating system market is dominated by Google Android and Apple iOS. Application software allows the user to perform tasks such as creating documents, recording data in a spreadsheet, or messaging a friend. Software will be explored more thoroughly in Chapter 3.

Data

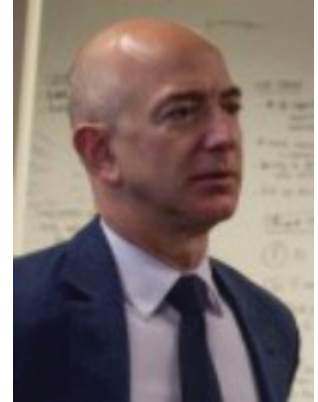
The third technology component is data. You can think of data as a collection of facts. For example, your address (street, city state, postal code), your phone number, and your social networking account are all pieces of data. Like software, data is also intangible, unable to be seen in its native state. Pieces of unrelated data are not very useful. But aggregated, indexed, and organized together into a database, data can become a powerful tool for businesses. Organizations collect all kinds of data and use it to make decisions which can then be analyzed as to their effectiveness. The analysis of data is then used to improve the organization's performance. Chapter 4 will focus on data and databases, and how it is used in organizations.

Networking Communication

Besides the technology components (hardware, software, and data) which have long been considered the core technology of information systems, it has been suggested that one other component should be added: communication. An information system can exist without the ability to communicate – the first personal computers were stand-alone machines that did not access the Internet. However, in today's hyper-connected world, it is an extremely rare computer that does not connect to another device or to a network. Technically, the networking communication component is made up of hardware and software, but it is such a core feature of today's information systems that it has become its own category. Networking will be covered in Chapter 5.

People

When thinking about information systems, it is easy to focus on the technology components and forget to look beyond these tools to fully understand their integration into an organization. A focus on the people involved in information systems is the next step. From the front-line user support staff, to systems analysts, to developers, all the way up to the chief information officer (CIO), the people involved with information systems are an essential element. The people component will be covered in Chapter 9.



Jeff Bezos, Amazon CEO

Process

The last component of information systems is process. A process is a series of steps undertaken to achieve a desired outcome or goal. Information systems are becoming more integrated with organizational processes, bringing greater productivity and better control to those processes. But simply automating activities using technology is not enough – businesses looking to utilize information systems must do more. The ultimate goal is to improve processes both internally and externally, enhancing interfaces with suppliers and customers. Technology buzzwords such as “business process re-engineering,” “business process management,” and “enterprise resource planning” all have to do with the continued improvement of these business procedures and the integration of technology with them. Businesses hoping to gain a competitive advantage over their competitors are highly focused on this component of information systems. The process element in information systems will be discussed in Chapter 8.

The Role of Information Systems

You should now understand that information systems have a number of vital components, some tangible, others intangible, and still others of a personnel nature. These components collect, store, organize, and distribute data throughout the organization. You may have even realized that one of the roles of information systems is to take data and turn it into information, and then transform that information into organizational knowledge. As technology has developed, this role has evolved into the backbone of the organization, making information systems integral to virtually every business. The integration of information systems into organizations has progressed over the decades.

The Mainframe Era

From the late 1950s through the 1960s, computers were seen as a way to more efficiently do calculations. These first business computers were room-sized monsters, with several machines linked together. The primary work was to organize and store large volumes of information that were tedious to manage by hand. Only large businesses, universities, and government agencies could afford them, and they took a crew of specialized personnel and dedicated facilities to provide information to organizations.

Time-sharing allowed dozens or even hundreds of users to simultaneously access mainframe computers from locations in the same building or miles away. Typical functions included scientific calculations and accounting, all under the broader umbrella of “data processing.”



Registered trademark of International Business Machines

In the late 1960s, Manufacturing Resources Planning (MRP) systems were introduced. This software, running on a mainframe computer, gave companies the ability to manage the manufacturing process, making it more efficient. From tracking inventory to creating bills of materials to scheduling production, the MRP systems gave more businesses a reason to integrate computing into their processes. IBM became the dominant mainframe company. Continued improvement in software and the availability of cheaper hardware eventually

brought mainframe computers (and their little sibling, the minicomputer) into most large businesses.

Today you probably think of Silicon Valley in northern California as the center of computing and technology. But in the days of the mainframe's dominance corporations in the cities of Minneapolis and St. Paul produced most computers. The advent of the personal computer resulted in the “center of technology” eventually moving to Silicon Valley.

The PC Revolution

In 1975, the first microcomputer was announced on the cover of *Popular Mechanics*: the Altair 8800. Its immediate popularity sparked the imagination of entrepreneurs everywhere, and there were soon dozens of companies manufacturing these “personal computers.” Though at first just a niche product for computer hobbyists, improvements in usability and the availability of practical software led to growing sales. The most prominent of these early personal computer makers was a little company known as Apple Computer, headed by Steve Jobs and Steve Wozniak, with the hugely successful “Apple II.” Not wanting to be left out of the revolution, in 1981 IBM teamed with Microsoft, then just a startup company, for their operating system software and hurriedly released their own version of the personal computer simply called the “PC.” Small businesses finally had affordable computing that could provide them with needed information systems. Popularity of the IBM PC gave legitimacy to the microcomputer and it was named *Time* magazine's “Man of the Year” for 1982.



IBM 704 Mainframe (Copyright: Lawrence Livermore National Laboratory)

Because of the IBM PC's open architecture, it was easy for other companies to copy, or "clone" it. During the 1980s, many new computer companies sprang up, offering less expensive versions of the PC. This drove prices down and spurred innovation. Microsoft developed the Windows operating system, with version 3.1 in 1992 becoming the first commercially successful release. Typical uses for the PC during this period included word processing, spreadsheets, and databases. These early PCs were standalone machines, not connected to a network.



IBM PC

Client-Server

In the mid-1980s, businesses began to see the need to connect their computers as a way to collaborate and share resources. Known as "client-server," this networking architecture allowed users to log in to the Local Area Network (LAN) from their PC (the "client") by connecting to a central computer called a "server." The server would lookup permissions for each user to determine who had access to various resources such as printers and files. Software companies began developing applications that allowed multiple users to access the same data at the same time. This evolved into software applications for communicating, with the first popular use of electronic mail appearing at this time.



Registered Trademark of SAP

This networking and data sharing all stayed mainly within the confines of each business. Sharing of electronic data between companies was a very specialized function. Computers were now seen as tools to collaborate internally within an organization. These networks of computers were becoming so powerful that they were replacing many of the functions previously performed by the larger mainframe computers at a fraction of the cost. It was during this era that the first Enterprise Resource Planning (ERP) systems were developed

and run on the client-server architecture. An ERP system is an application with a centralized database that can be used to run a company's entire business. With separate modules for accounting, finance, inventory, human resources, and many more, ERP systems, with Germany's SAP leading the way, represented the state of the art in information systems integration. ERP systems will be discussed in Chapter 9.

The Internet, World Wide Web and E-Commerce

The first long distance transmission between two computers occurred on October 29, 1969 when developers under the direction of Dr. Leonard Kleinrock sent the word “login” from the campus of UCLA to Stanford Research Institute in Menlo Park, California, a distance of over 350 miles. The United States Department of Defense created and funded ARPA Net (Advanced Research Projects Administration), an experimental network which eventually became known as the Internet. ARPA Net began with just four nodes or sites, a very humble start for today’s Internet. Initially, the Internet was confined to use by universities, government agencies, and researchers. Users were required to type commands (today we refer to this as “command line”) in order to communicate and transfer files. The first e-mail messages on the Internet were sent in the early 1970s as a few very large companies expanded from local networks to the Internet. The computer was now evolving from a purely computational device into the world of digital communications.



ARPANet, 1969

In 1989, Tim Berners-Lee developed a simpler way for researchers to share information over the Internet, a concept he called the *World Wide Web*.⁴ This invention became the catalyst for the growth of the Internet as a way for businesses to share information about themselves. As web browsers and Internet connections became the norm, companies rushed to grab domain names and create websites.



Registered trademark of Amazon.com, Inc.

In 1991 the National Science Foundation, which governed how the Internet was used, lifted restrictions on its commercial use. Corporations soon realized the huge potential of a digital marketplace on the Internet and in 1994 both eBay and Amazon were founded. A mad rush of investment in Internet-based businesses led to the dot-com boom through the late 1990s,

and then the dot-com bust in 2000. The bust occurred as investors, tired of seeing hundreds of companies reporting losses, abandoned their investments. An important outcome for businesses was that thousands of miles of Internet connections, in the form of fiber optic cable, were laid around the world during that time. The world became truly “wired” heading into the new millenium, ushering in the era of globalization, which will be discussed in Chapter 11. This TED Talk video focuses on connecting Africa to the Internet through *undersea fibre optic cable*.

The digital world also became a more dangerous place as virtually all companies connected to the Internet. Computer viruses and worms, once slowly propagated through the sharing of computer disks, could now grow with tremendous speed via the Internet. Software and operating systems written for a standalone world found it very difficult to defend against these sorts of threats. A whole new industry of computer and Internet security arose. Information security will be discussed in Chapter 6.

Web 2.0

As the world recovered from the dot-com bust, the use of technology in business continued to evolve at a frantic pace. Websites became interactive. Instead of just visiting a site to find out about a business and then purchase its

4. [4]

products, customers wanted to be able to customize their experience and interact online with the business. This new type of interactive website, where you did not have to know how to create a web page or do any programming in order to put information online, became known as Web 2.0. This new stage of the Web was exemplified by blogging, social networking, and interactive comments being available on many websites. The new Web 2.0 world, in which online interaction became expected, had a major impact on many businesses and even whole industries. Many bookstores found themselves relegated to a niche status. Video rental chains and travel agencies simply began going out of business as they were replaced by online technologies. The newspaper industry saw a huge drop in circulation with some cities such as New Orleans no longer able to support a daily newspaper.

Disintermediation is the process of technology replacing a middleman in a transaction. Web 2.0 allowed users to get information and news online, reducing dependence of physical books and newspapers.

As the world became more connected, new questions arose. Should access to the Internet be considered a right? Is it legal to copy a song that had been downloaded from the Internet? Can information entered into a website be kept private? What information is acceptable to collect from children? Technology moved so fast that policymakers did not have enough time to enact appropriate laws. Ethical issues surrounding information systems will be covered in Chapter 12.

The Post-PC World, Sort of

Ray Ozzie, a technology visionary at Microsoft, stated in 2012 that computing was moving into a phase he called the post-PC world.⁵ Now six years later that prediction has not stood up very well to reality. As you will read in Chapter 13, PC sales have dropped slightly in recent years while there has been a precipitous decline in tablet sales. Smartphone sales have accelerated, due largely to their mobility and ease of operation. Just as the mainframe before it, the PC will continue to play a key role in business, but its role will be somewhat diminished as people emphasize mobility as a central feature of technology. Cloud computing provides users with mobile access to data and applications, making the PC more of a part of the communications channel rather than a repository of programs and information. Innovation in the development of technology and communications will continue to move businesses forward.

Eras of Business Computing

Era	Hardware	Operating System	Applications
Mainframe (1970s)	Terminals connected to mainframe computer	Time-sharing (TSO) on Multiple Virtual Storage (MVS)	Custom-written MRP software
PC (mid-1980s)	IBM PC or compatible. Sometimes connected to mainframe computer via network interface card.	MS-DOS	WordPerfect, Lotus 1-2-3
Client-Server (late 80s to early 90s)	IBM PC “clone” on a Novell Network.	Windows for Workgroups	Microsoft Word, Microsoft Excel
World Wide Web (mid-90s to early 2000s)	IBM PC “clone” connected to company intranet.	Windows XP	Microsoft Office, Internet Explorer
Web 2.0 (mid-2000s – present)	Laptop connected to company Wi-Fi.	Windows 10	Microsoft Office
Post-PC (today and beyond)	Smartphones	Android, iOS	Mobile-friendly websites, mobile apps

Can Information Systems Bring Competitive Advantage?

It has always been the assumption that the implementation of information systems will bring a business competitive advantage. If installing one computer to manage inventory can make a company more efficient, then it can be expected that installing several computers can improve business processes and efficiency.

In 2003, Nicholas Carr wrote an article in the *Harvard Business Review* that questioned this assumption. Entitled “I.T. Doesn’t Matter.” Carr was concerned that information technology had become just a commodity. Instead of viewing technology as an investment that will make a company stand out, Carr said technology would become as common as electricity – something to be managed to reduce costs, ensure that it is always running, and be as risk-free as possible.

The article was both hailed and scorned. Can I.T. bring a competitive advantage to an organization? It sure did for Walmart (see sidebar). Technology and competitive advantage will be discussed in Chapter 7.

Sidebar: Walmart Uses Information Systems to Become the World’s Leading Retailer



Registered Trademark of Walmart, Inc.

Walmart is the world’s largest retailer, earn 8.1 billion for the fiscal year that ended on January 31, 2018. Walmart currently serves over 260 million customers every week worldwide through its 11,700 stores in 28 countries.⁶In 2018 Fortune magazine for the sixth straight year ranked Walmart the number one company for

6. [6]

annual revenue as they again exceeded \$500 billion in annual sales. The next closest company, Exxon, had less than half of Walmart's total revenue.⁷ Walmart's rise to prominence is due in large part to making information systems a high priority, especially in their Supply Chain Management (SCM) system known as Retail Link.ing \$14.3 billion on sales of \$30

This system, unique when initially implemented in the mid-1980s, allowed Walmart's suppliers to directly access the inventory levels and sales information of their products at any of Walmart's more than eleven thousand stores. Using Retail Link, suppliers can analyze how well their products are selling at one or more Walmart stores with a range of reporting options. Further, Walmart requires the suppliers to use Retail Link to manage their own inventory levels. If a supplier feels that their products are selling out too quickly, they can use Retail Link to petition Walmart to raise the inventory levels for their products. This has essentially allowed Walmart to "hire" thousands of product managers, all of whom have a vested interest in the products they are managing. This revolutionary approach to managing inventory has allowed Walmart to continue to drive prices down and respond to market forces quickly.

Today Walmart continues to innovate with information technology. Using its tremendous market presence, any technology that Walmart requires its suppliers to implement immediately becomes a business standard. For example, in 1983 Walmart became the first large retailer to require suppliers to use Uniform Product Code (UPC) labels on all products. Clearly, Walmart has learned how to use I.T. to gain a competitive advantage.

Summary

In this chapter you have been introduced to the concept of information systems. Several definitions focused on the main components: technology, people, and process. You saw how the business use of information systems has evolved over the years, from the use of large mainframe computers for number crunching, through the introduction of the PC and networks, all the way to the era of mobile computing. During each of these phases, new innovations in software and technology allowed businesses to integrate technology more deeply into their organizations.

Virtually every company uses information systems which leads to the question: Does information systems bring a competitive advantage? In the final analysis the goal of this book is to help you understand the importance of information systems in making an organization more competitive. Your challenge is to understand the key components of an information system and how it can be used to bring a competitive advantage to every organization you will serve in your career.

Study Questions

1. What are the five major components that make up an information system?
2. List the three examples of information system hardware?
3. Microsoft Windows is an example of which component of information systems?
4. What is application software?
5. What roles do people play in information systems?
6. What is the definition of a process?
7. What was invented first, the personal computer or the Internet?

7. [7]

8. In what year were restrictions on commercial use of the Internet first lifted?
9. What is Carr's main argument about information technology?

Exercises

1. Suppose that you had to explain to a friend the concept of an information system. How would you define it? Write a one-paragraph description *in your own words* that you feel would best describe an information system to your friends or family.
2. Of the five primary components of an information system (hardware, software, data, people, process), which do you think is the most important to the success of a business organization? Write a one-paragraph answer to this question that includes an example from your personal experience to support your answer.
3. Everyone interacts with various information systems every day: at the grocery store, at work, at school, even in our cars. Make a list of the different information systems you interact with daily. Can you identify the technologies, people, and processes involved in making these systems work.
4. Do you agree that we are in a post-PC stage in the evolution of information systems? Do some original research and cite it as you make your prediction about what business computing will look like in the next generation.
5. The Walmart sidebar introduced you to how information systems was used to make them the world's leading retailer. Walmart has continued to innovate and is still looked to as a leader in the use of technology. Do some original research and write a one-page report detailing a new technology that Walmart has recently implemented or is pioneering.

Labs

1. Examine your PC. Using a four column table format identify and record the following information: 1st column: Program name, 2nd column: software manufacturer, 3rd column: software version, 4th column: software type (editor/word processor, spreadsheet, database, etc.).
2. Examine your mobile phone. Create another four column table similar to the one in Lab #1. This time identify the apps, then record the requested information.
3. In this chapter you read about the evolution of computing from mainframe computers to PCs and on to smartphones. Create a four column table and record the following information about your own electronic devices: 1st column – Type: PC or smartphone, 2nd column – Operating system including version, 3rd column – Storage capacity, 4th column – Storage available.

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2. Chapter 2: Hardware

Learning Objectives

Upon successful completion of this chapter, you will be able to:

- describe information systems hardware;
- identify the primary components of a computer and the functions they perform; and
- explain the effect of the commoditization of the personal computer.

Introduction

As you learned in the first chapter, an information system is made up of five components: hardware, software, data, people, and process. The physical parts of computing devices – those that you can actually touch – are referred to as hardware. In this chapter, you will take a look at this component of information systems, learn a little bit about how it works, and discuss some of the current trends surrounding it.

As stated above, computer hardware encompasses digital devices that you can physically touch. This includes devices such as the following:

- desktop computers
- laptop computers
- mobile phones
- tablet computers
- e-readers
- storage devices, such as flash drives
- input devices, such as keyboards, mice, and scanners
- output devices such as printers and speakers.

Besides these more traditional computer hardware devices, many items that were once not considered digital devices are now becoming computerized themselves. Digital technologies are being integrated into many everyday objects so the days of a device being labeled categorically as computer hardware may be ending. Examples of these types of digital devices include automobiles, refrigerators, and even beverage dispensers. In this chapter, you will also explore digital devices, beginning with defining what is meant by the term itself.

Digital Devices

A digital device processes electronic signals into discrete values, of which there can be two or more. In comparison analog signals are continuous and can be represented by a smooth wave pattern. You might think of digital (discrete) as being the opposite of analog.

Many electronic devices process signals into two discrete values, typically known as binary. These values are represented as either a one (“on”) or a zero (“off”). It is commonly accepted to refer to the *on* state as representing the presence of an electronic signal. It then follows that the *off* state is represented by the absence of an electronic signal. Note: Technically, the voltages in a system are evaluated with high voltages converted into a one or on state and low voltages converted into a zero or off state.

Each one or zero is referred to as a *bit* (a blending of the two words “binary” and “digit”). A group of eight bits is known as a *byte*. The first personal computers could process 8 bits of data at once. The number of bits that can be processed by a computer’s processor at one time is known as *word size*. Today’s PCs can process 64 bits of data at a time which is where the term *64-bit processor* comes from. You are most likely using a computer with a 64-bit processor.

Sidebar: Understanding Binary

The numbering system you first learned was Base 10 also known as Decimal. In Base 10 each column in the number represents a power of 10 with the exponent increasing in each column as you move to the left, as shown in the table:

Thousands	Hundreds	Tens	Units
10^3	10^2	10^1	10^0

The rightmost column represents units or the values zero through nine. The next column from the left represents tens or the values teens, twenties, thirties, etc, followed by the hundreds column (one hundred, two hundred, etc.), then the thousands column (one thousand, two thousand) etc. Expanding the table above, you can write the number 3456 as follows:

Thousands	Hundreds	Tens	Units
10^3	10^2	10^1	10^0
3	4	5	6
3000	400	50	6

Computers use the Base 2 numbering system. Similar to Base 10, each column has a Base of 2 and has an increasing exponent value moving to the left as shown in the table below:

Two cubed	Two squared	Two	Units
2^3	2^2	2^1	2^0

The rightmost column represents 2^0 or units (1). The next column from the left represents 2^1 twos or (2). The third

column represents 2^2 or (4) and the fourth column represents 2^3 or (8). Expanding the table above, you can see how the decimal number 15 is converted to 1111 in binary as follows:

Two cubed	Two squared	Two	Units
2^3	2^2	2^1	2^0
1	1	1	1
8	4	2	1

$$8 + 4 + 2 + 1 = 15$$

Understanding binary is important because it helps us understand how computers store and transmit data. A “bit” is the lowest level of data storage, stored as either a one or a zero. If a computer wants to communicate the number 15, it would need to send 1111 in binary (as shown above). This is four bits of data since four digits are needed. A “byte” is 8 bits. If a computer wanted to transmit the number 15 in a byte, it would send 00001111. The highest number that can be sent in a byte is 255, which is 11111111, which is equal to $2^7+2^6+2^5+2^4+2^3+2^2+2^1+2^0$.

As the capacities of digital devices grew, new terms were developed to identify the capacities of processors, memory, and disk storage space. Prefixes were applied to the word *byte* to represent different orders of magnitude. Since these are digital specifications, the prefixes were originally meant to represent multiples of 1024 (which is 2^{10}), but have more recently been rounded for the sake of simplicity to mean multiples of 1000, as shown in the table below:

Prefix	Represents	Example
kilo	one thousand	kilobyte=one thousand bytes
mega	one million	megabyte = one million bytes
giga	one billion	gigabyte = one billion bytes
tera	one trillion	terabyte = one trillion bytes
peta	one quadrillion	petabyte = one quadrillion bytes
exa	one quintillion	exabyte = one quintillion bytes
zetta	one sextillion	zettabyte = one sextillion bytes
yotta	one septillion	yottabyte = one septillion bytes

Tour of a PC

All personal computers consist of the same basic components: a Central Processing Unit (CPU), memory, circuit board, storage, and input/output devices. Almost every digital device uses the same set of components, so examining the

personal computer will give you insight into the structure of a variety of digital devices. Here's a "tour" of a personal computer.

Processing Data: The CPU

The core of a computer is the Central Processing Unit, or CPU. It can be thought of as the "brains" of the device. The CPU carries out the commands sent to it by the software and returns results to be acted upon.



Intel Core i7 CPU

The earliest CPUs were large circuit boards with limited functionality. Today, a CPU can perform a large variety of functions. There are two primary manufacturers of CPUs for personal computers: Intel and Advanced Micro Devices (AMD).

The speed ("clock time") of a CPU is measured in hertz. A hertz is defined as one cycle per second. A kilohertz (abbreviated kHz) is one thousand cycles per second, a megahertz (mHz) is one million cycles per second, and a gigahertz (gHz) is one billion cycles per second. The CPU's processing power is increasing at an amazing rate (see the sidebar about Moore's Law).

Besides a faster clock time, today's CPU chips contain multiple processors. These chips, known as dual-core (two processors) or quad-core (four processors), increase the processing power of a computer by providing the capability of multiple CPUs all sharing the processing load. Intel's Core i7 processors contain 6 cores and their Core i9 processors contain 16 cores. This video shows how a CPU works.

Sidebar: Moore's Law and Huang's Law

As you know computers get faster every year. Many times we are not sure if we want to buy today's model because next week it won't be the most advanced any more. Gordon Moore, one of the founders of Intel, recognized this phenomenon in 1965, noting that microprocessor transistor counts had been doubling every year.¹ His insight eventually evolved into Moore's Law:

The number of integrated circuits on a chip doubles every two years.

Moore's Law has been generalized into the concept that computing power will double every two years for the same price point. Another way of looking at this is to think that the price for the same computing power will be cut in half every two years. Moore's Law has held true for over forty years (see figure below).

The limits of Moore's Law are now being reached and circuits cannot be reduced further. However, Huang's Law regarding Graphics Processors Units (GPUs) may extend well into the future. Nvidia's CEO Jensen Huang spoke at the GPU Technology Conference in March 2018 announcing that the speed of GPUs are increasing faster than Moore's Law. Nvidia's GPUs are 25 times faster than five years ago. He admitted that the advancement is because of advances in architecture, memory technology, algorithms, and interconnects.²

1. [1]

2. [2]

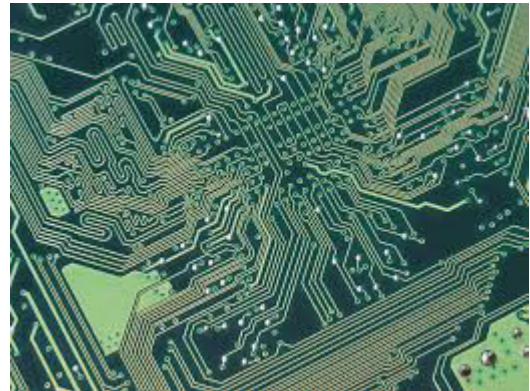
Motherboard

The motherboard is the main circuit board on the computer. The CPU, memory, and storage components, among other things, all connect into the motherboard. Motherboards come in different shapes and sizes, depending upon how compact or expandable the computer is designed to be. Most modern motherboards have many integrated components, such as network interface card, video, and sound processing, which previously required separate components.

The motherboard provides much of the bus of the computer (the term *bus* refers to the electrical connections between different computer components). The bus is an important factor in determining the computer's speed – the combination of how fast the bus can transfer data and the number of data bits that can be moved at one time determine the speed. The traces shown in the image are on the underside of the motherboard and provide connections between motherboard components.

Picture of motherboard

Motherboard



Motherboard bus traces

Random-Access Memory

When a computer boots, it begins to load information from storage into its working memory. This working memory, called Random-Access Memory (RAM), can transfer data much faster than the hard disk. Any program that you are running on the computer is loaded into RAM for processing. In order for a computer to work effectively, some minimal amount of RAM must be installed. In most cases, adding more RAM will allow the computer to run faster. Another characteristic of RAM is that it is “volatile.” This means that it can store data as long as it is receiving power. When the computer is turned off, any data stored in RAM is lost.

RAM is generally installed in a personal computer through the use of a Double Data Rate (DDR) memory module. The type of DDR accepted into a computer is dependent upon the motherboard. There have been basically four generations of DDR: DDR1, DDR2, DDR3, and DDR4. Each generation runs faster than the previous with DDR4 capable of speeds twice as fast as DDR3 while consuming less voltage.

DDR4 Memory

DDR4 Memory

Hard Disk



Hard disk interior

While the RAM is used as working memory, the computer also needs a place to store data for the longer term. Most of today's personal computers use a hard disk for long-term data storage. A hard disk is considered non-volatile storage because when the computer is turned off the data remains in storage on the disk, ready for when the computer is turned on. Drives with a capacity less than 1 Terabyte usually have just one platter. Notice the single platter in the image. The read/write arm must be positioned over the appropriate track before accessing or writing data."

Solid State Drives

Solid State Drives (SSD) are becoming more popular in personal computers. The SSD performs the same function as a hard disk, namely long-term storage. Instead of spinning disks, the SSD uses flash memory that incorporates EEPROM (Electrically Erasable Programmable Read Only Memory) chips, which is much faster.

Solid-state drives are currently a bit more expensive than hard disks. However, the use of flash memory instead of disks makes them much lighter and faster than hard disks. SSDs are primarily utilized in portable computers, making them lighter, more durable, and more efficient. Some computers combine the two storage technologies, using the SSD for the most accessed data (such as the operating system) while using the hard disk for data that is accessed less frequently. SSDs are considered more reliable since there are no moving parts.



Solid State Drive interior

Removable Media



USB Drive

Removable storage has changed greatly over the four decades of PCs. Floppy disks have been replaced by CD-ROM drives, then they were replaced by USB (Universal Serial Bus) drives. USB drives are now standard on all PCs with capacities approaching 512 gigabytes. Speeds have also increased from 480 Megabits in USB 2.0 to 10 Gigabits in USB 3.1. USB devices also use EEPROM technology.

3

Network Connection

When personal computers were first stand-alone units when first developed, which meant that data was brought into the computer or removed from the computer via removable media. Beginning in the mid-1980s, however, organizations began to see the value in connecting computers together via a digital network. Because of this personal computers needed the ability to connect to these networks. Initially, this was done by adding an expansion card to the computer that enabled the network connection. These cards were known as *Network Interface Cards* (NIC). By the mid-1990s an Ethernet network port was built into the motherboard on most personal computers. As wireless technologies began to dominate in the early 2000s, many personal computers also began including wireless networking capabilities. Digital communication technologies will be discussed further in Chapter 5.

Input and Output

In order for a personal computer to be useful, it must have channels for receiving input from the user and channels for delivering output to the user. These input and output devices connect to the computer via various connection ports, which generally are part of the motherboard and are accessible outside the computer case. In early personal computers, specific ports were designed for each type of output device. The configuration of these ports has evolved over the years, becoming more and more standardized over time. Today, almost all devices plug into a computer through the use of a USB port. This port type, first introduced in 1996, has increased in its capabilities, both in its data transfer rate and power supplied.



USB port on a computer

Bluetooth

Besides USB, some input and output devices connect to the computer via a wireless-technology standard called Bluetooth which was invented in 1994. Bluetooth exchanges data over short distances of 10 meters up to 100 meters using radio waves. Two devices communicating with Bluetooth must both have a Bluetooth communication chip installed. Bluetooth devices include pairing your phone to your car, computer keyboards, speakers, headsets, and home security, to name just a few.

Input Devices

All personal computers need components that allow the user to input data. Early computers simply used a keyboard for entering data or select an item from a menu to run a program. With the advent operating systems offering the graphical user interface, the mouse became a standard component of a computer. These two components are still the primary input devices to a personal computer, though variations of each have been introduced with varying levels of success over the years. For example, many new devices now use a touch screen as the primary way of data entry.

Other input devices include scanners which allow users to input documents into a computer either as images or as text. Microphones can be used to record audio or give voice commands. Webcams and other types of video cameras can be used to record video or participate in a video chat session.

Output Devices

Output devices are essential as well. The most obvious output device is a display or monitor, visually representing the state of the computer. In some cases, a personal computer can support multiple displays or be connected to larger-format displays such as a projector or large-screen television. Other output devices include speakers for audio output and printers for hardcopy output.

Sidebar: Which Hardware Components Contribute to the Speed of Your Computer

The speed of a computer is determined by many elements, some related to hardware and some related to software. In hardware, speed is improved by giving the electrons shorter distances to travel in completing a circuit. Since the first CPU was created in the early 1970s, engineers have constantly worked to figure out how to shrink these circuits and put more and more circuits onto the same chip – these are known as *integrated circuits*. And this work has paid off – the speed of computing devices has been continuously improving.

Multi-core processors, or CPUs, have contributed to faster speeds. Intel engineers have also improved CPU speeds by using QuickPath Interconnect, a technique which minimizes the processor's need to communicate directly with RAM or the hard drive. Instead, the CPU contains a cache of frequently used data for a particular program. An algorithm evaluates a program's data usage and determines which data should be temporarily stored in the cache.

The hardware components that contribute to the speed of a personal computer are the CPU, the motherboard, RAM, and the hard disk. In most cases, these items can be replaced with newer, faster components. The table below shows how each of these contributes to the speed of a computer. Besides upgrading hardware, there are many changes that can be made to the software of a computer to make it faster.

Component	Speed measured by	Units	Description
CPU	Clock speed	GHz (billions of cycles)	Hertz indicates the time it takes to complete a cycle.
Motherboard	Bus speed	MHz	The speed at which data can move across the bus.
RAM	Data transfer rate	Mb/s (millions of bytes per second)	The time it takes for data to be transferred from memory to system measured in Megabytes.
Hard Disk	Access time	ms (millisecond)	The time it takes for the drive to locate the data to be accessed.
	Data transfer rate	MBit/s	The time it takes for data to be transferred from disk to system.

Other Computing Devices

A personal computer is designed to be a general-purpose device, able to solve many different types of problems. As the technologies of the personal computer have become more commonplace, many of the components have been integrated into other devices that previously were purely mechanical. The definition or description of what defines a computer has changed. Portability has been an important feature for most users. Here is an overview of some trends in personal computing.

Portable Computers



MacBook Air

Portable computing today includes laptops, notebooks and netbooks, many weighing less than 4 pounds and providing longer battery life. The MacBook Air is a good example of this: it weighs less than three pounds and is only 0.68 inches thick!

Netbooks (short for Network Books) are extremely light because they do not have a hard drive, depending instead on the Internet “cloud” for data and application storage. Netbooks depend on a Wi-Fi connection and can run Web browsers as well as a word processor.

Smartphones

While cell phones were introduced in the 1970s, smartphones have only been around for the past 20 years. As cell phones evolved they gained a broader array of features and programs. Today’s smartphones provide the user with telephone, email, location, and calendar services, to name a few. They function as a highly mobile computer, able to connect to the Internet through either cell technology or Wi-Fi. Smartphones have revolutionized computing, bringing the one feature PCs and laptops could not deliver, namely mobility. Consider the following data regarding mobile computing⁴:

1. There are **3.7 billion global mobile Internet users** as at January 2018.
2. Mobile devices influenced sales to the tune of over \$1.4 trillion in 2016.
3. Mobile commerce revenue in the U.S. is projected to be \$459.38 billion in 2018, and it is estimated to be \$693.36 billion by 2019.
4. By the end of 2018, over \$1 trillion – or 75 percent – of ecommerce sales in China will be done via mobile devices.
5. The average order value for online orders placed on Smartphones in the first quarter of 2018 is \$84.55 while the average order value for orders placed on Tablets is \$94.91.
6. Of the 2.79 billion active social media users in the world, 2.55 billion actively use their mobile devices for social media-related activities.
7. 90 percent of the time spent on mobile devices is spent in apps.
8. Mobile traffic is responsible for 52.2 percent of Internet traffic in 2018 – compared to 50.3 percent from 2017.
9. While the total percentage of mobile traffic is more than desktop, engagement is higher on desktop. 55.9 percent

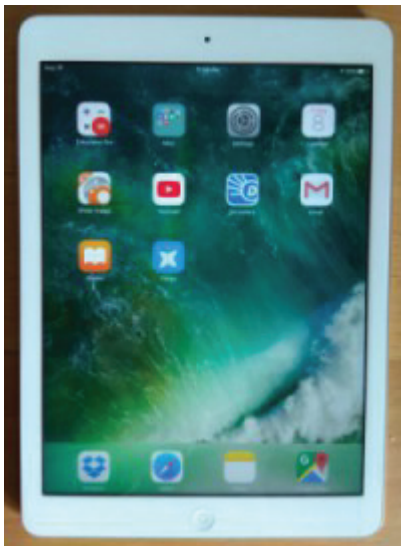
4. [4]

of time spent on sites is by desktop users and 40.1 percent of time spent on sites is by mobile users.

10. By 2020, mobile commerce will account for 45 percent of all e-commerce activities – compared to 20.6 percent in 2016.

The Apple iPhone was introduced in January 2007 and went on the market in June of that same year. Its ease of use and intuitive interface made it an immediate success and solidified the future of smartphones. The first Android phone was released in 2008 with functionality similar to the iPhone.

Tablet Computers



iPad Air

A tablet computer uses a touch screen as its primary input and is small enough and light enough to be easily transported. They generally have no keyboard and are self-contained inside a rectangular case. Apple set the standard for tablet computing with the introduction of the iPad in 2010 using iOS, the operating system of the iPhone. After the success of the iPad, computer manufacturers began to develop new tablets that utilized operating systems that were designed for mobile devices, such as Android.

Global market share for tablets has changed since the early days of Apple's dominance. Today the iPad has about 25% of the global market while Amazon Fire has 15% and Samsung Galaxy has 14%.⁵ However, the popularity of tablets has declined sharply in recent years.

Integrated Computing and Internet of Things (IoT)

Along with advances in computers themselves, computing technology is being integrated into many everyday products. From automobiles to refrigerators to airplanes, computing technology is enhancing what these devices can do and is adding capabilities into our every day lives thanks in part to IoT.

Internet of Things and the Cloud

The Internet of Things (IoT) is a network of billions of devices, each with their own unique network address, around the world with embedded electronics allowing them to connect to the Internet for the purpose of collecting and sharing data, all without the involvement of human beings.⁶

Objects ranging from a simple light bulb to a fitness band such as FitBit to a driverless truck are all part of IoT thanks to the processors inside them. A smartphone app can control and/or communicate with each of these devices as well as others such as electric garage door openers (for those who can't recall if the door has been closed), kitchen appliances ("Buy milk after work today."), thermostats such as Nest, home security, audio speakers, and the feeding of pets.

Here are three of the latest ways that computing technologies are being integrated into everyday products through IoT:

5. [5]

6. [6]

- How IoT Works
- The Smart House
- The Self-Driving Car

The Commoditization of the Personal Computer

Over the past forty years, as the personal computer has gone from technical marvel to part of everyday life, it has also become a commodity. There is very little differentiation between computer models and manufacturers, and the primary factor that controls their sale is their price. Hundreds of manufacturers all over the world now create parts for personal computers which are purchased and assembled. As commodities, there are essentially little or no differences between computers made by these different companies. Profit margins for personal computers are minimal, leading hardware developers to find the lowest-cost manufacturing methods.

There is one brand of computer for which this is not the case – Apple. Because Apple does not make computers that run on the same open standards as other manufacturers, they can design and manufacture a unique product that no one can easily copy. By creating what many consider to be a superior product, Apple can charge more for their computers than other manufacturers. Just as with the iPad and iPhone, Apple has chosen a strategy of differentiation, an attempt to avoid commoditization.

Summary

Information systems hardware consists of the components of digital technology that you can touch. This chapter covered the components that make up a personal computer, with the understanding that the configuration of a personal computer is very similar to that of any type of digital computing device. A personal computer is made up of many components, most importantly the CPU, motherboard, RAM, hard disk, removable media, and input/output devices. Variations on the personal computer, such as the smartphone, were also examined. Finally, commoditization of the personal computer was addressed.

Study Questions

1. Write your own description of what the term *information systems hardware* means.
2. What has led to the shift toward mobility in computing?
3. What is the impact of Moore's Law on the various hardware components described in this chapter?
4. Write a one page summary of one of the items linked to in the "Integrated Computing" section.
5. Explain why the personal computer is now considered a commodity.
6. The CPU can also be thought of as the _____ of the computer.
7. List the units of measure for data storage in increasing order from smallest to largest, kilobyte to yottabyte.
8. What is the bus of a computer?
9. Name two differences between RAM and a hard disk.
10. What are the advantages of solid-state drives over hard disks?

Exercises

1. If you could build your own personal computer, what components would you purchase? Put together a list of the components you would use to create it, including a computer case, motherboard, CPU, hard disk, RAM, and DVD drive. How can you be sure they are all compatible with each other? How much would it cost? How does this compare to a similar computer purchased from a vendor such as Dell or HP?
2. Re-read the section on IoT, then find at least two scholarly articles about IoT. Prepare a minimum of three slides that address issues related to IoT. Be sure to give attribution to your sources.
3. What is the current status of solid-state drives vs. hard disks? Research online and compare prices, capacities, speed, and durability. Again, be sure to give attribution to your sources.

Labs

1. Review the sidebar on the binary number system. Represent the following decimal numbers in binary: 16, 100. Represent the following binary numbers in decimal: 1011, 100100. Write the decimal number 254 in an 8-bit byte.
2. Re-read the section on IoT, then look around your building (dorm, apartment, or house) and make a list of possible instances of IoTs. Be sure to list their location and likely function.

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3. Chapter 3: Software

Learning Objectives

Upon successful completion of this chapter, you will be able to:

- define the term *software*;
- identify and describe the two primary categories of software;
- describe the role ERP software plays in an organization;
- describe cloud computing and its advantages and disadvantages for use in an organization; and
- define the term *open-source* and identify its primary characteristics.

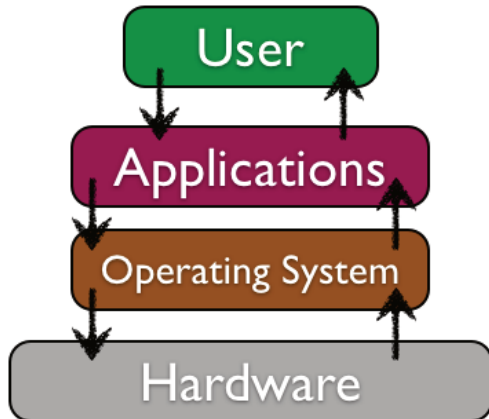
Introduction

The second component of an information system is software, the set of instructions that tells the hardware what to do. Software is created by developers through the process of programming (covered in more detail in Chapter 10). Without software, the hardware would not be functional.

Types of Software

Software can be broadly divided into two categories: operating systems and application software. *Operating systems* manage the hardware and create the interface between the hardware and the user. *Application software* performs specific tasks such as word processing, accounting, database management, video games, or browsing the web.

Operating Systems



An operating system is first loaded into the computer by the boot program, then it manages all of the programs in the computer, including both programs native to the operating system such as file and memory management and application software. Operating systems provide you with these key functions:

1. managing the hardware resources of the computer;
2. providing the user-interface components;
3. providing a platform for software developers to write applications.

All computing devices require an operating system. The most popular operating systems for personal computers are: Microsoft Windows, Apple's Mac OS, and various versions of Linux. Smartphones and tablets run operating systems as well, such as iOS (Apple), Android (Google), Windows Mobile (Microsoft), and Blackberry.

Microsoft provided the first operating system for the IBM-PC, released in 1981. Their initial venture into a Graphical User Interface (GUI) operating system, known as Windows, occurred in 1985. Today's Windows 10 supports the 64-bit Intel CPU. Recall that "64-bit" indicates the size of data that can be moved within the computer.

Apple introduced the Macintosh computer 1984 with the first commercially successful GUI. Apple's operating system for the Macintosh is known as "Mac OS" and also uses an Intel CPU supporting 64-bit processing. Mac OS versions have been named after mountains such as El Capitan, Sierra, and High Sierra. Multitasking, virtual memory, and voice input have become standard features of both operating systems.

The Linux operating system is open source, meaning individual developers are allowed to make modifications to the programming code. Linux is a version of the Unix operating. Unix runs on large and expensive minicomputers. Linux developer Linus Torvalds, a professor in Finland and the creator of Linux, wanted to find a way to make Unix run on less expensive personal computers. Linux has many variations and now powers a large percentage of web servers in the world.



Linux Ubuntu desktop

Sidebar: Why Is Microsoft Software So Dominant in the Business World?

If you've worked in business, you may have noticed that almost all computers in business run a version of Microsoft Windows. However, in classrooms from elementary to college, there is almost a balance between Macs and PCs. Why has this not extended into the business world?

As discussed in Chapter 1, many businesses used IBM mainframe computers back in the 1960s and 1970s. When businesses migrated to the microcomputer (personal computer) market, they elected to stay with IBM and chose the PC. Companies took the safe route, invested in the Microsoft operating system and in Microsoft software/applications.

Microsoft soon found itself with the dominant personal computer operating system for businesses. As the networked PC began to replace the mainframe computer, Microsoft developed a network operating system along with a complete suite of programs focused on business users. Today Microsoft Office in its various forms controls 85% of the market.¹

Application Software

The second major category of software is application software. Application software is utilized directly today to accomplish a specific goal such as word processing, calculations on a spreadsheet, or surfing the Internet using your favorite browser.

The “Killer” App

When a new type of digital device is invented, there are generally a small group of technology enthusiasts who will purchase it just for the joy of figuring out how it works. A “killer” application is one that becomes so essential that large numbers of people will buy a device just to run that application. For the personal computer, the killer application was the spreadsheet.

The first spreadsheet was created by an MBA student at Harvard University who tired of making repeated calculations to determine the optimal result on a problem and decided to create a tool that allowed the user to easily change values and recalculate formulas. The result was the spreadsheet. Today's dominant spreadsheet is Microsoft Excel which still retains the basic functionality of the first spreadsheet.

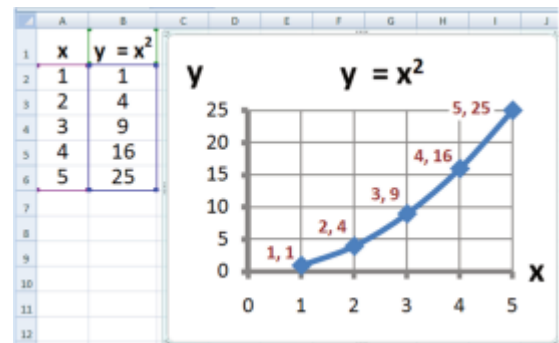


Image of Microsoft Excel

1. [1]

Productivity Software

Along with the spreadsheet, several other software applications have become standard tools for the workplace. Known as productivity software, these programs allow office employees to complete their daily work efficiently. Many times these applications come packaged together, such as in Microsoft's Office suite. Here is a list of some of these applications and their basic functions:

- **Word processing** Users can create and edit documents using this class of software. Functions include the ability to type and edit text, format fonts and paragraphs, as well as add, move, and delete text throughout the document. Tables and images can be inserted. Documents can be saved in a variety of electronic file formats with Microsoft Word's DOCX being the most popular. Documents can also be converted to other formats such as Adobe's PDF (Portable Document Format) or a .TXT file.
- **Spreadsheet** This class of software provides a way to do numeric calculations and analysis, displaying the result in charts and graphs. The working area is divided into rows and columns, where users can enter numbers, text, or formulas. It is the formulas that make a spreadsheet powerful, allowing the user to develop complex calculations that can change based on the numbers entered. The most popular spreadsheet package is Microsoft Excel, which saves its files in the XLSX format.
- **Presentation** Users can create slideshow presentations using this class of software. The slides can be projected, printed, or distributed to interested parties. Text, images, audio, and visual can all be added to the slides. Microsoft's PowerPoint is the most popular software right now, saving its files in PPTX format.
- Some office suites include other types of software. For example, Microsoft Office includes Outlook, its e-mail package, and OneNote, an information-gathering collaboration tool. The professional version of Office also includes Microsoft Access, a database package. (Databases are covered more in Chapter 4.)

Microsoft popularized the idea of the office-software productivity bundle with their release of the Microsoft Office Suite. This package continues to dominate the market and most businesses expect employees to know how to use this software. However, many competitors to Microsoft Office do exist and are compatible with the file formats used by Microsoft (see table below). Microsoft also offers a cloud-based version of their office suite named Microsoft Office 365. Similar to Google Drive, this suite allows users to edit and share documents online utilizing cloud-computing technology.

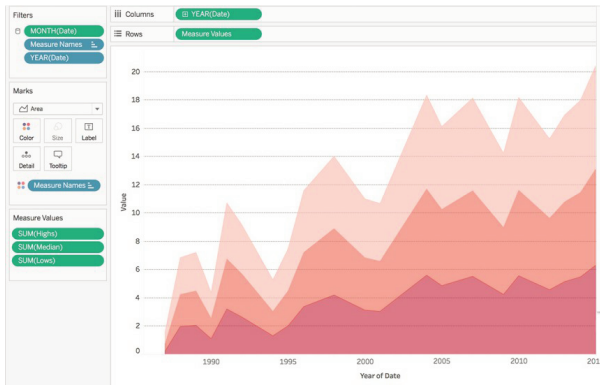
Category:	Word Processing	Spreadsheet	Presentation	Other
Suite:				
Microsoft Office	Word	Excel	PowerPoint	Outlook (email), Access (database), OneNote (information gathering)
Apple iWork	Pages	Numbers	Keynote	Integrates with iTunes, iCloud, and other Apple software
OpenOffice	Writer	Calc	Impress	Base (database), Draw (drawing), Math (equations)
Google Drive	Document	Spreadsheet	Presentation	Gmail (email), Forms (online form data collection), Draw (drawing)

Utility Software and Programming Software

Utility software includes programs that allow you to fix or modify your computer in some way. Examples include anti-malware software and programs that totally remove software you no longer want installed. These types of software packages were created to fill shortcomings in operating systems. Many times a subsequent release of an operating system will include these utility functions as part of the operating system itself.

Programming software's purpose is to produce software. Most of these programs provide developers with an environment in which they can write the code, test it, and convert/compile it into the format that can then be run on a computer. This software is typically identified as the *Integrated Development Environment (IDE)* and is provided free from the corporation that developed the programming language that will be used to write the code.

Sidebar: “PowerPointed” to Death



Screen shot of Tableau (click to enlarge)

As presentation software has gained acceptance as the primary method to formally present information to a group or class, the art of giving an engaging presentation is becoming rare. Many presenters now just read the bullet points in the presentation and immediately bore those in attendance, who can already read it for themselves. The real problem is not with PowerPoint as much as it is with the person creating and presenting. Author and chief evangelist Guy Kawasaki has developed the 10/20/30 rule for PowerPoint users. Just remember: 10 slides, 20 minutes, 30 point font.”² If you are determined to improve your PowerPoint skills, read *Presentation Zen* by Garr Reynolds.

New digital presentation technologies are being developed that go beyond Powerpoint. For example, Prezi uses a single canvas for the presentation, allowing presenters to place text, images, and other media on the canvas, and then navigate between these objects as they present. Tools such as Tableau allow users to analyze data in depth and create engaging interactive visualizations.

Sidebar: I Own This Software, Right? Well...

When you purchase software and install it on your computer, are you the owner of that software? Technically, you are not! When you install software, you are actually just being given a license to use it. When you first install a package, you are asked to agree to the terms of service or the license agreement. In that agreement, you will find that your rights to use the software are limited. For example, in the terms of the Microsoft Office software license, you will find the following statement: “This software is licensed, not sold. This agreement only gives you some rights to use the features included in the software edition you licensed.”

For the most part, these restrictions are what you would expect. You cannot make illegal copies of the software and you may not use it to do anything illegal. However, there are other, more unexpected terms in these software agreements. For example, many software agreements ask you to agree to a limit on liability. Again, from Microsoft: “Limitation on and exclusion of damages. You can recover from Microsoft and its suppliers only direct damages up to the amount you paid for the software. You cannot recover any other damages, including consequential, lost profits, special, indirect or incidental damages.” This means if a problem with the software causes harm to your business, you cannot hold Microsoft or the supplier responsible for damages.

Applications for the Enterprise

As the personal computer proliferated inside organizations, control over the information generated by the organization began splintering. For instance, the customer service department creates a customer database to keep track of calls and problem reports, and the sales department also creates a database to keep track of customer information. Which one should be used as the master list of customers? Or perhaps someone in sales might create a spreadsheet to calculate sales revenue, while someone in finance creates a different revenue document that meets the needs of their department, but calculates revenue differently. The two spreadsheets will report different revenue totals. Which one is correct? And who is managing all of this information?

Enterprise Resource Planning



In the 1990s the need to bring an organization's information back under centralized control became more apparent. The Enterprise Resource Planning (ERP) system (sometimes just called enterprise software) was developed to bring together an entire organization within one program. ERP software utilizes a central database that is implemented throughout the entire organization. Here are some key points about ERP.

- **A software application.** ERP is an application that is used by many of an organization's employees.
- **Utilizes a central database.** All users of the ERP edit and save their information from the same data source. For example, this means there is only one customer table in the database, there is only one sales (revenue) table in the database, etc.
- **Implemented organization-wide.** ERP systems include functionality that covers all of the essential components of a business. An organization can purchase modules for its ERP system that match specific needs such as order entry, manufacturing, or planning.

ERP systems were originally marketed to large corporations. However, as more and more large companies began installing them, ERP vendors began targeting mid-sized and even smaller businesses. Some of the more well-known ERP systems include those from SAP, Oracle, and Microsoft.

In order to effectively implement an ERP system in an organization, the organization must be ready to make a full commitment. All aspects of the organization are affected as old systems are replaced by the ERP system. In general, implementing an ERP system can take two to three years and cost several million dollars.

So why implement an ERP system? If done properly, an ERP system can bring an organization a good return on their investment. By consolidating information systems across the enterprise and using the software to enforce best practices, most organizations see an overall improvement after implementing an ERP. Business processes as a form of competitive advantage will be covered in Chapter 9.

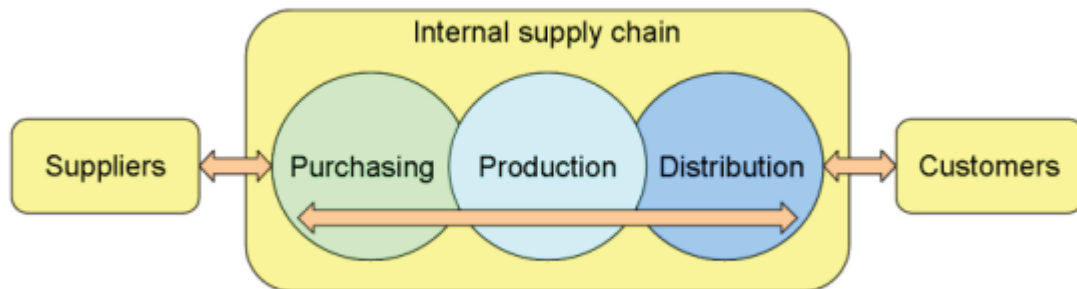
Customer Relationship Management

A Customer Relationship Management (CRM) system manages an organization's customers. In today's environment, it is important to develop relationships with your customers, and the use of a well-designed CRM can allow a business to personalize its relationship with each of its customers. Some ERP software systems include CRM modules. An example of a well-known CRM package is Salesforce.

Supply Chain Management

Supply Chain

Many organizations must deal with the complex task of managing their supply chains. At its simplest, a supply chain is the linkage between an organization's suppliers, its manufacturing facilities, and the distributors of its products. Each link in the chain has a multiplying effect on the complexity of the process. For example, if there are two suppliers, one manufacturing facility, and two distributors, then the number of links to manage = $4 (2 \times 1 \times 2)$. However, if two more suppliers are added, plus another manufacturing facility, and two more distributors, then the number of links to manage = $32 (4 \times 2 \times 4)$. Also, notice in the above illustration that all arrows have two heads, indicating that information flows in both directions. Suppliers are part of a business's supply chain. They provide information such as price, size, quantity, etc. to the business. In turn, the business provides information such as quantity on hand at every store to the supplier. The key to successful supply chain management is the information system.



A Supply Chain Management (SCM) system handles the interconnection between these links as well as the inventory of the products in their various stages of development. As discussed previously much of Walmart's success has come from its ability to identify and control the supply chain for its products. Walmart invested heavily in their information system so they could communicate with their suppliers and manage the thousands of products they sell.

Walmart realized in the 1980s that the key to their success was information systems. Specifically, they needed to manage their complex supply chain with its thousands of suppliers, thousands of retail outlets, and millions of customers. Their success came from being able to integrate information systems to every entity (suppliers, warehouses, retail stores) through the sharing of sales and inventory data. Take a moment to study the diagram above...look for the double-headed arrow. Notice that data flows down the supply chain from suppliers to retail stores. But it also flows up the supply chain, back to the suppliers so they can be up to date regarding production and shipping.

Mobile Applications

Just as with the personal computer, mobile devices such as smartphones and electronic tablets also have operating systems and application software. These mobile devices are in many ways just smaller versions of personal computers. A mobile app is a software application designed to run specifically on a mobile device.

As shown in Chapter 2, smartphones are becoming a dominant form of computing, with more smartphones being sold than personal computers. A greater discussion of PC and smartphone sales appears in Chapter 13, along with statistics regarding the decline in tablet sales. Businesses have adjusted to this trend by increasing their investment in the development of apps for mobile devices. The number of mobile apps in the Apple App Store has increased from zero in 2008 to over 2 million in 2017.³

Building a mobile app will be covered in Chapter 10.

Cloud Computing

Historically, for software to run on a computer an individual copy of the software had to be installed on the computer. The concept of “cloud” computing changes this.

Cloud Computing

The “cloud” refers to applications, services, and data storage located on the Internet. Cloud service providers rely on giant server farms and massive storage devices that are connected via the Internet. Cloud computing allows users to access software and data storage services on the Internet.

You probably already use cloud computing in some form. For example, if you access your e-mail via your web browser, you are using a form of cloud computing if you are using Google Drive’s applications. While these are free versions of cloud computing, there is big business in providing applications and data storage over the web. Cloud computing is not limited to web applications. It can also be used for services such as audio or video streaming.

Advantages of Cloud Computing

- No software to install or upgrades to maintain.
- Available from any computer that has access to the Internet.
- Can scale to a large number of users easily.
- New applications can be up and running very quickly.
- Services can be leased for a limited time on an as-needed basis.
- Your information is not lost if your hard disk crashes or your laptop is lost or stolen.
- You are not limited by the available memory or disk space on your computer.

Disadvantages of Cloud Computing

- Your information is stored on someone else's computer.
- You must have Internet access to use it.
- You are relying on a third-party to provide these services.

Cloud computing has the ability to really impact how organizations manage technology. For example, why is an IT department needed to purchase, configure, and manage personal computers and software when all that is really needed is an Internet connection?

Using a Private Cloud

Many organizations are understandably nervous about giving up control of their data and some of their applications by using cloud computing. But they also see the value in reducing the need for installing software and adding disk storage to local computers. A solution to this problem lies in the concept of a *private cloud*. While there are various models of a private cloud, the basic idea is for the cloud service provider to section off web server space for a specific organization. The organization has full control over that server space while still gaining some of the benefits of cloud computing.

Virtualization

Virtualization is the process of using software to simulate a computer or some other device. For example, using virtualization a single physical computer can perform the functions of several virtual computers, usually referred to as Virtual Machines (VMs). Organizations implement virtual machines in an effort to reduce the number of physical servers needed to provide the necessary services to users. This reduction in the number of physical servers also reduces the demand for electricity to run and cool the physical servers. For more detail on how virtualization works, see this informational page from VMWare.

Software Creation

```
1 // class declaration
2 public class ProgrammingExample {
3
4     // method declaration
5     public void sayHello() {
6
7         // method output
8         System.out.println("Hello World!");
9     }
10 }
```

Example program "Hello World" written in Java

Modern software applications are written using a programming language such as Java, Visual C, C++, Python, etc. A programming language consists of a set of commands and syntax that can be organized logically to execute specific functions. Using this language a programmer writes a program (known as source code) that can then be compiled into machine-readable form, the ones and zeroes necessary to be executed by the CPU. Languages such as HTML and Javascript are used to develop web pages.

Open-Source Software

When the personal computer was first released, computer enthusiasts banded together to build applications and solve problems. These computer enthusiasts were motivated to share any programs they built and solutions to problems they found. This collaboration enabled them to more quickly innovate and fix problems.

As software began to become a business, however, this idea of sharing everything fell out of favor with many developers. When a program takes hundreds of hours to develop, it is understandable that the programmers do not want to just give it away. This led to a new business model of restrictive software licensing which required payment for software, a model that is still dominant today. This model is sometimes referred to as *closed source*, as the source code is not made available to others.

There are many, however, who feel that software should not be restricted. Just as with those early hobbyists in the 1970s, they feel that innovation and progress can be made much more rapidly if they share what has been learned. In the 1990s, with Internet access connecting more people together, the open-source movement gained steam.



Open Office Suite

Open-source software makes the source code available for anyone to copy and use. For most people having access to the source code of a program does little good since it is challenging to modify existing programming code. However, open-source software is also available in a compiled format that can be downloaded and installed. The open-source movement has led to the development of some of the most used software in the world such as the Firefox browser, the Linux operating system, and the Apache web server.

Many businesses are wary of open-source software precisely because the code is available for anyone to see. They feel that this increases the risk of an attack. Others counter that this openness actually decreases the risk because the code is exposed to thousands of programmers who can incorporate code changes to quickly patch vulnerabilities.

There are thousands of open-source applications available for download. For example, you can get the productivity suite from Open Office. One good place to search for open-source software is sourceforge.net, where thousands of programs are available for free download.

Summary

Software gives the instructions that tell the hardware what to do. There are two basic categories of software: operating systems and applications. Operating systems interface with the computer hardware and make system resources available. Application software allows users to accomplish specific tasks such as word processing, presentations, or databases. This group is also referred to as productivity software. An ERP system stores all data in a centralized database

that is made accessible to all programs and departments across the organization. Cloud computing provides access to software and databases from the Internet via a web browser. Developers use various programming languages to develop software.

Study Questions

1. Develop your own definition of software being certain to explain the key terms.
2. What are the primary functions of an operating system?
3. Which of the following are operating systems and which are applications: Microsoft Excel, Google Chrome, iTunes, Windows, Android, Angry Birds.
4. What is your favorite software application? What tasks does it help you accomplish?
5. How would you categorize the software that runs on mobile devices? Break down these apps into at least three basic categories and give an example of each.
6. What does an ERP system do?
7. What is open-source software? How does it differ from closed-source software? Give an example of each.
8. What does a software license grant to the purchaser of the software?

Exercises

1. Find a case study online about the implementation of an ERP system. Was it successful? How long did it take? Does the case study tell you how much money the organization spent?
2. If you were running a small business with limited funds for information technology, would you consider using cloud computing? Find some web-based resources that support your decision.
3. Go to sourceforge.net and review their most downloaded software applications. Report on the variety of applications you find. Then pick one that interests you and report back on what it does, the kind of technical support offered, and the user reviews.
4. Review this article on the security risks of open-source software. Write a short analysis giving your opinion on the different risks discussed.
5. List three examples of programming languages? What features in each language makes it useful to developers?

Lab

1. Download Apache Open Office and create a document. Note: If your computer does not have Java Runtime Environment (JRE) 32-bit (x86) installed, you will need to download it first from this site. Open Office runs only in 32-bit (x86) mode. Here is a link to the Getting Started documentation for Open Office. How does it compare to Microsoft Office? Does the fact that you got it for free make it feel less valuable?
-

1. Statista. (2017). Microsoft – Statistics & Facts. Retrieved from <https://www.statista.com/topics/823/microsoft/>
2. Kawasaki, G. (n.d.). The 10/20/30 Rules for PowerPoint. Retrieved from https://guykawasaki.com/the_102030_rule/.
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4. Chapter 4: Data and Databases

Learning Objectives

Upon successful completion of this chapter, you will be able to:

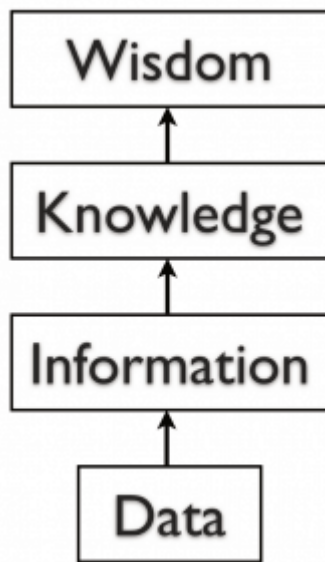
- Describe the differences between data, information, and knowledge;
- Describe why database technology must be used for data resource management;
- Define the term *database* and identify the steps to creating one;
- Describe the role of a database management system;
- Describe the characteristics of a data warehouse; and
- Define data mining and describe its role in an organization.

Introduction

You have already been introduced to the first two components of information systems: hardware and software. However, those two components by themselves do not make a computer useful. Imagine if you turned on a computer, started the word processor, but could not save a document. Imagine if you opened a music player but there was no music to play. Imagine opening a web browser but there were no web pages. Without data, hardware and software are not very useful! Data is the third component of an information system.

Data, Information, and Knowledge

There have been many definitions and theories about data, information, and knowledge. The three terms are often used interchangeably, although they are distinct in nature. We define and illustrate the three terms from the perspective of information systems.



Data are the raw facts, and may be devoid of context or intent. For example, a sales order of computers is a piece of data. Data can be quantitative or qualitative. Quantitative data is numeric, the result of a measurement, count, or some other mathematical calculation. Qualitative data is descriptive. “Ruby Red,” the color of a 2013 Ford Focus, is an example of qualitative data. A number can be qualitative too: if I tell you my favorite number is 5, that is qualitative data because it is descriptive, not the result of a measurement or mathematical calculation.

Information is processed data that possess context, relevance, and purpose. For example, monthly sales calculated from the collected daily sales data for the past year are information. Information typically involves the manipulation of raw data to obtain an indication of magnitude, trends, in patterns in the data for a purpose.

Knowledge in a certain area is human beliefs or perceptions about relationships among facts or concepts relevant to that area. For example, the conceived relationship between the quality of goods and the sales is knowledge. Knowledge can be viewed as information that facilitates action.

Once we have put our data into context, aggregated and analyzed it, we can use it to make decisions for our organization. We can say that this consumption of information produces knowledge. This knowledge can be used to make decisions, set policies, and even spark innovation.

Explicit knowledge typically refers to knowledge that can be expressed into words or numbers. In contrast, *tacit knowledge* includes insights and intuitions, and is difficult to transfer to another person by means of simple communications.

Evidently, when information or explicit knowledge is captured and stored in computer, it would become data if the context or intent is devoid.

The final step up the information ladder is the step from knowledge (knowing a lot about a topic) to *wisdom*. We can say that someone has wisdom when they can combine their knowledge and experience to produce a deeper understanding of a topic. It often takes many years to develop wisdom on a particular topic, and requires patience.

Big Data

Almost all software programs require data to do anything useful. For example, if you are editing a document in a word processor such as Microsoft Word, the document you are working on is the data. The word-processing software can manipulate the data: create a new document, duplicate a document, or modify a document. Some other examples of data are: an MP3 music file, a video file, a spreadsheet, a web page, a social media post, and an e-book.

Recently, *big data* has been capturing the attention of all types of organizations. The term refers to such massively

large data sets that conventional data processing technologies do not have sufficient power to analyze them. For example, Walmart must process millions customer transactions every hour across the world. Storing and analyzing that much data is beyond the power of traditional data management tools. Understanding and developing the best tools and techniques to manage and analyze these large data sets are a problem that governments and businesses alike are trying to solve.

Databases

The goal of many information systems is to transform data into information in order to generate knowledge that can be used for decision making. In order to do this, the system must be able to take data, allow the user to put the data into context, and provide tools for aggregation and analysis. A database is designed for just such a purpose.

Why Databases?

Data is a valuable resource in the organization. However, many people do not know much about database technology, but use non-database tools, such as Excel spreadsheet or Word document, to store and manipulate business data, or use poorly designed databases for business processes. As a result, the data are redundant, inconsistent, inaccurate, and corrupted. For a small data set, the use of non-database tools such as spreadsheet may not cause serious problem. However, for a large organization, corrupted data could lead to serious errors and destructive consequences. The common defects in data resources management are explained as follows.

(1) No control of redundant data

People often keep redundant data for convenience. Redundant data could make the data set inconsistent. We use an illustrative example to explain why redundant data are harmful. Suppose the registrar’s office has two separate files that store student data: one is the registered student roster which records all students who have registered and paid the tuition, and the other is student grade roster which records all students who have received grades.

Student Roster			
Student ID	Student Name	Student Major	Student Email
1234	John Smith	Marketing	jsmith@university.edu
2345	Robert Jackson	MIS	rjackson@university.edu
3456	Anne Sun	Accounting	asun@university.edu
4567	Mary Brown	Finance	mbrown@university.edu

Grade Roster				
Student ID	Student Name	Student Major	Course	Grade
1234	John Smith	Marketing	MKT211	A
2345	Robert Jackson	MIS	MIS315	B
3456	Anne Sun	Accounting	ACT211	A
4567	Mary Brown	Finance	ACT211	A
9991	Alex Wilson	Marketing	MKT211	B
4567	Mary Brown	Finance	FIN311	B

As you can see from the two spreadsheets, this data management system has problems. The fact that “Student 4567 is Mary Brown, and her major is Finance” is stored more than once. Such occurrences are called data redundancy. Redundant data often make data access convenient, but can be harmful. For example, if Mary Brown changes her name or her major, then all her names and major stored in the system must be changed altogether. For small data systems, such a problem looks trivial. However, when the data system is huge, making changes to all redundant data is difficult if not impossible. As a result of data redundancy, the entire data set can be corrupted.

(2) Violation of data integrity

Data integrity means consistency among the stored data. We use the above illustrative example to explain the concept of data integrity and how data integrity can be violated if the data system is flawed. You can find that Alex Wilson

received a grade in MKT211; however, you can't find Alex Wilson in the student roster. That is, the two rosters are not consistent. Suppose we have a data integrity control to enforce the rules, say, "no student can receive a grade unless she/he has registered and paid tuition", then such a violation of data integrity can never happen.

(3) Relying on human memory to store and to search needed data

The third common mistake in data resource management is the over use of human memory for data search. A human can remember what data are stored and where the data are stored, but can also make mistakes. If a piece of data is stored in an un-remembered place, it has actually been lost. As a result of relying on human memory to store and to search needed data, the entire data set eventually becomes disorganized.

To avoid the above common flaws in data resource management, database technology must be applied. A database is an organized collection of related data. It is an *organized* collection, because in a database, all data is described and associated with other data. For the purposes of this text, we will only consider computerized databases.

Though not good for replacing databases, spreadsheets can be ideal tools for analyzing the data stored in a database. A spreadsheet package can be connected to a specific table or query in a database and used to create charts or perform analysis on that data.

Data Models and Relational Databases

Databases can be organized in many different ways by using different models. The data model of a database is the logical structure of data items and their relationships. There have been several data models. Since the 1980s, the relational data model has been popularized. Currently, relational database systems are commonly used in business organizations with few exceptions. A relational data model is easy to understand and use.

In a relational database, data is organized into tables (or *relations*). Each table has a set of *fields* which define the structure of the data stored in the table. A record is one instance of a set of fields in a table. To visualize this, think of the *records* as the *rows* (or *tuple*) of the table and the fields as the columns of the table.

In the example below, we have a table of student data, with each row representing a student *record*, and each column representing one field of the student record. A special field or a combination of fields that determines the unique record is called *primary key* (or *key*). A key is usually the unique identification number of the records.

**Fields
(Columns)**

Primary key

Records (Rows)	StudentID	StudentName	StudentMajor	StudentEmail
	1234	Jonh Smith	Marketing	jsmith@university.edu
	2345	Robert Jackson	MIS	rjackson@university.edu
	3456	Anne Sun	Accounting	asun@university.edu
	4567	Mary Brown	Finance	mbrown@university.edu

Rows and columns in a table

Designing a Database

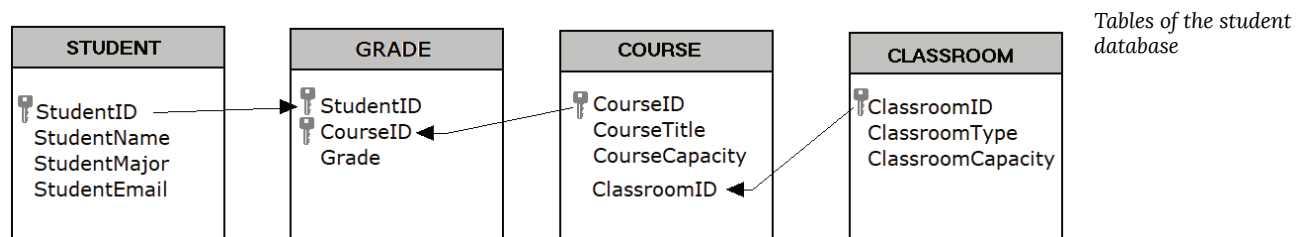
Suppose a university wants to create a School Database to track data. After interviewing several people, the design team learns that the goal of implementing the system is to give better insight into students' performance and academic resources. From this, the team decides that the system must keep track of the students, their grades, courses, and classrooms. Using this information, the design team determines that the following tables need to be created:

- STUDENT: student name, major, and e-mail.
- COURSE: course title, enrollment capacity.
- GRADE: this table will correlate STUDENT with COURSE, allowing us to have any given student to enroll multiple courses and to receive a grade for each course.
- CLASSROOM: classroom location, classroom type, and classroom capacity

Now that the design team has determined which tables to create, they need to define the specific data items that each table will hold. This requires identifying the fields that will be in each table. For example, course title would be one of the fields in the COURSE table. Finally, since this will be a relational database, every table should have a field in common with at least one other table (in other words, they should have relationships with each other).

A primary key must be selected for each table in a relational database. This key is a unique identifier for each record in the table. For example, in the STUDENT table, it might be possible to use the student name as a way to identify a student. However, it is more than likely that some students share the same name. A student's e-mail address might be a good choice for a primary key, since e-mail addresses are unique. However, a primary key cannot change, so this would mean that if students changed their e-mail address we would have to remove them from the database and then re-insert them – not an attractive proposition. Our solution is to use student ID as the primary key of the STUDENT table. We will also do this for the COURSE table and the CLASSROOM table. This solution is quite common and is the reason you have so many IDs! The primary key of table can be just one field, but can also be a combination of two or more fields. For example, the combination of StudentID and CourseID the GRADE table can be the primary key of the GRADE table, which means that a grade is received by a particular student for a specific course.

The next step of design of database is to identify and make the relationships between the tables so that you can pull the data together in meaningful ways. A relationship between two tables is implemented by using a *foreign key*. A foreign key is a field in one table that connects to the primary key data in the original table. For example, ClassroomID in the COURSE table is the foreign key that connects to the primary key ClassroomID in the CLASSROOM table. With this design, not only do we have a way to organize all of the data we need and have successfully related all the table together to meet the requirements, but have also prevented invalid data from being entered into the database. You can see the final database design in the figure below:



Normalization

When designing a database, one important concept to understand is *normalization*. In simple terms, to normalize a database means to design it in a way that: 1) reduces data redundancy; and 2) ensure data integrity.

In the School Database design, the design team worked to achieve these objectives. For example, to track grades, a simple (and wrong) solution might have been to create a Student field in the COURSE table and then just list the names of all of the students there. However, this design would mean that if a student takes two or more courses, then his or her data would have to be entered twice or more times. This means the data are redundant. Instead, the designers solved this problem by introducing the GRADE table.

In this design, when a student registers into the school system before taking a course, we first must add the student to the STUDENT table, where their ID, name, major, and e-mail address are entered. Now we will add a new entry to denote that the student takes a specific course. This is accomplished by adding a record with the StudentID and the CourseID in the GRADE table. If this student takes a second course, we do not have to duplicate the entry of the student's name, major, and e-mail; instead, we only need to make another entry in the GRADE table of the second course's ID and the student's ID.

The design of the School database also makes it simple to change the design without major modifications to the existing structure. For example, if the design team were asked to add functionality to the system to track instructors who teach the courses, we could easily accomplish this by adding a PROFESSOR table (similar to the STUDENT table) and then adding a new field to the COURSE table to hold the professors' ID.

Data Types

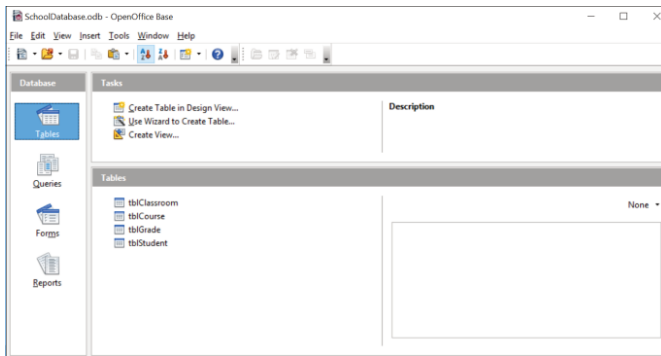
When defining the fields in a database table, we must give each field a data type. For example, the field StudentName is text string, while EnrollmentCapacity is number. Most modern databases allow for several different data types to be stored. Some of the more common data types are listed here:

- Text: for storing non-numeric data that is brief, generally under 256 characters. The database designer can identify the maximum length of the text.
- Number: for storing numbers. There are usually a few different number types that can be selected, depending on how large the largest number will be.
- Boolean: a data type with only two possible values, such as 0 or 1, "true" or "false", "yes" or "no".
- Date/Time: a special form of the number data type that can be interpreted as a number or a time.
- Currency: a special form of the number data type that formats all values with a currency indicator and two decimal places.
- Paragraph Text: this data type allows for text longer than 256 characters.
- Object: this data type allows for the storage of data that cannot be entered via keyboard, such as an image or a music file.

There are two important reasons that we must properly define the data type of a field. First, a data type tells the database what functions can be performed with the data. For example, if we wish to perform mathematical functions with one of the fields, we must be sure to tell the database that the field is a number data type. For example, we can subtract the course capacity from the classroom capacity to find out the number of extra seats available.

The second important reason to define data type is so that the proper amount of storage space is allocated for our data. For example, if the StudentName field is defined as a Text(50) data type, this means 50 characters are allocated for each name we want to store. If a student's name is longer than 50 characters, the database will truncate it.

Database Management Systems



Open Office Database Management System

To the computer, a database looks like one or more files. In order for the data in the database to be stored, read, changed, added, or removed, a software program must access it. Many software applications have this ability: iTunes can read its database to give you a listing of its songs (and play the songs); your mobile-phone software can interact with your list of contacts. But what about applications to create or manage a database? What software can you use to create a database, change a database's structure, or simply do analysis? That is the purpose of a category of software applications called database management systems (DBMS).

DBMS packages generally provide an interface to view and change the design of the database, create queries, and develop reports. Most of these packages are designed to work with a specific type of database, but generally are compatible with a wide range of databases.

A database that can only be used by a single user at a time is not going to meet the needs of most organizations. As computers have become networked and are now joined worldwide via the Internet, a class of database has emerged that can be accessed by two, ten, or even a million people. These databases are sometimes installed on a single computer to be accessed by a group of people at a single location. Other times, they are installed over several servers worldwide, meant to be accessed by millions. In enterprises the relational DBMS are built and supported by companies such as Oracle, Microsoft SQL Server, and IBM Db2. The open-source MySQL is also an enterprise database.

Microsoft Access and Open Office Base are examples of personal database-management systems. These systems are primarily used to develop and analyze single-user databases. These databases are not meant to be shared across a network or the Internet, but are instead installed on a particular device and work with a single user at a time. Apache OpenOffice.org Base (see screen shot) can be used to create, modify, and analyze databases in open-database (ODB) format. Microsoft's Access DBMS is used to work with databases in its own Microsoft Access Database format. Both Access and Base have the ability to read and write to other database formats as well.

Structured Query Language

Once you have a database designed and loaded with data, how will you do something useful with it? The primary way to work with a relational database is to use Structured Query Language, SQL (pronounced "sequel," or simply stated as S-Q-L). Almost all applications that work with databases (such as database management systems, discussed below) make use of SQL as a way to analyze and manipulate relational data. As its name implies, SQL is a language that can be used to work with a relational database. From a

simple request for data to a complex update operation, SQL is a mainstay of programmers and database administrators. To give you a taste of what SQL might look like, here are a couple of examples using our School database:

The following query will retrieve the major of student John Smith from the STUDENT table:

```
SELECT StudentMajor
FROM STUDENT
WHERE StudentName = 'John Smith';
```

The following query will list the total number of students in the STUDENT table:

```
SELECT COUNT (*)
```


FROM STUDENT;

SQL can be embedded in many computer languages that are used to develop platform-independent web-based applications. An in-depth description of how SQL works is beyond the scope of this introductory text, but these examples should give you an idea of the power of using SQL to manipulate relational databases. Many DBMS, such as Microsoft Access, allow you to use QBE (*Query-by-Example*), a graphical query tool, to retrieve data through visualized commands. QBE generates SQL for you, and is easy to use. In comparison with SQL, QBE has limited functionalities and is unable to work without the DBMS environment.

Other Types of Databases

The relational database model is the most used database model today. However, many other database models exist that provide different strengths than the relational model. The hierarchical database model, popular in the 1960s and 1970s, connected data together in a hierarchy, allowing for a parent/child relationship between data. The document-centric model allowed for a more unstructured data storage by placing data into “documents” that could then be manipulated.

Perhaps the most interesting new development is the concept of NoSQL (from the phrase “not only SQL”). NoSQL arose from the need to solve the problem of large-scale databases spread over several servers or even across the world. For a relational database to work properly, it is important that only one person be able to manipulate a piece of data at a time, a concept known as record-locking. But with today’s large-scale databases (think Google and Amazon), this is just not possible. A NoSQL database can work with data in a looser way, allowing for a more unstructured environment, communicating changes to the data over time to all the servers that are part of the database.

As stated earlier, the relational database model does not scale well. The term *scale* here refers to a database getting larger and larger, being distributed on a larger number of computers connected via a network. Some companies are looking to provide large-scale database solutions by moving away from the relational model to other, more flexible models. For example, Google now offers the App Engine Datastore, which is based on NoSQL. Developers can use the App Engine Datastore to develop applications that access data from anywhere in the world. Amazon.com offers several database services for enterprise use, including Amazon RDS, which is a relational database service, and Amazon DynamoDB, a NoSQL enterprise solution.

Sidebar: What Is Metadata?

The term *metadata* can be understood as “data about data.” Examples of metadata of database are:

- number of records
- data type of field
- size of field
- description of field
- default value of field
- rules of use.

When a database is being designed, a “*data dictionary*” is created to hold the metadata, defining the fields and structure of the database.

Finding Value in Data: Business Intelligence

With the rise of Big Data and a myriad of new tools and techniques at their disposal, businesses are learning how to use information to their advantage. The term *business intelligence* is used to describe the process that organizations use to take data they are collecting and analyze it in the hopes of obtaining a competitive advantage. Besides using their own data, stored in data warehouses (see below), firms often purchase information from data brokers to get a big-picture understanding of their industries and the economy. The results of these analyses can drive organizational strategies and provide competitive advantage.

Data Visualization

Data visualization is the graphical representation of information and data. These graphical representations (such as charts, graphs, and maps) can quickly summarize data in a way that is more intuitive and can lead to new insights and understandings. Just as a picture of a landscape can convey much more than a paragraph of text attempting to describe it, graphical representation of data can quickly make meaning of large amounts of data. Many times, visualizing data is the first step towards a deeper analysis and understanding of the data collected by an organization. Examples of data visualization software include Tableau and Google Data Studio.

Data Warehouses

As organizations have begun to utilize databases as the centerpiece of their operations, the need to fully understand and leverage the data they are collecting has become more and more apparent. However, directly analyzing the data that is needed for day-to-day operations is not a good idea; we do not want to tax the operations of the company more than we need to. Further, organizations also want to analyze data in a historical sense: How does the data we have today compare with the same set of data this time last month, or last year? From these needs arose the concept of the data warehouse.

The concept of the data warehouse is simple: extract data from one or more of the organization's databases and load it into the data warehouse (which is itself another database) for storage and analysis. However, the execution of this concept is not that simple. A data warehouse should be designed so that it meets the following criteria:

- It uses non-operational data. This means that the data warehouse is using a copy of data from the active databases that the company uses in its day-to-day operations, so the data warehouse must pull data from the existing databases on a regular, scheduled basis.
- The data is time-variant. This means that whenever data is loaded into the data warehouse, it receives a time stamp, which allows for comparisons between different time periods.
- The data is standardized. Because the data in a data warehouse usually comes from several different sources, it is possible that the data does not use the same definitions or units. For example, each database uses its own format for dates (e.g., mm/dd/yy, or dd/mm/yy, or yy/mm/dd, etc.). In order for the data warehouse to match up dates, a standard date format would have to be agreed upon and all data loaded into the data warehouse would have to be converted to use this standard format. This process is called extraction-transformation-load (ETL).

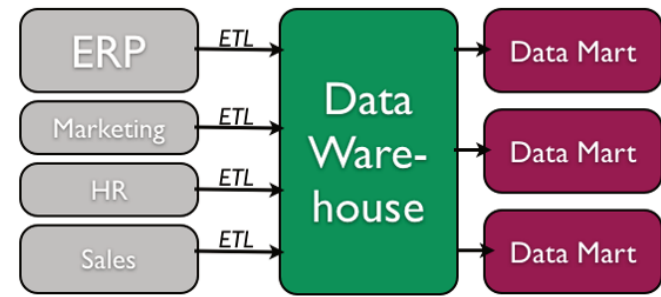
There are two primary schools of thought when designing a data warehouse: bottom-up and top-down. The bottom-up approach starts by creating small data warehouses, called data marts, to solve specific business problems. As these data marts are created, they can be combined into a larger data warehouse. The top-down approach suggests that we should

start by creating an enterprise-wide data warehouse and then, as specific business needs are identified, create smaller data marts from the data warehouse.

Benefits of Data Warehouses

Organizations find data warehouses quite beneficial for a number of reasons:

- The process of developing a data warehouse forces an organization to better understand the data that it is currently collecting and, equally important, what data is not being collected.
- A data warehouse provides a centralized view of all data being collected across the enterprise and provides a means for determining data that is inconsistent.
- Once all data is identified as consistent, an organization can generate “one version of the truth”. This is important when the company wants to report consistent statistics about itself, such as revenue or number of employees.
- By having a data warehouse, snapshots of data can be taken over time. This creates a historical record of data, which allows for an analysis of trends.
- A data warehouse provides tools to combine data, which can provide new information and analysis.



Data Warehouse Process (top-down)

Data Mining and Machine Learning

Data mining is the process of analyzing data to find previously unknown and interesting trends, patterns, and associations in order to make decisions. Generally, data mining is accomplished through automated means against extremely large data sets, such as a data warehouse. Some examples of data mining include:

- An analysis of sales from a large grocery chain might determine that milk is purchased more frequently the day after it rains in cities with a population of less than 50,000.
- A bank may find that loan applicants whose bank accounts show particular deposit and withdrawal patterns are not good credit risks.
- A baseball team may find that collegiate baseball players with specific statistics in hitting, pitching, and fielding make for more successful major league players.

One data mining method that an organization can use to do these analyses is called *machine learning*. Machine learning is used to analyze data and build models without being explicitly programmed to do so. Two primary branches of machine learning exist: supervised learning and unsupervised learning.

Supervised learning occurs when an organization has data about past activity that has occurred and wants to replicate it. For example, if they want to create a new marketing campaign for a particular product line, they may look at data from past marketing campaigns to see which of their consumers responded most favorably. Once the analysis is done, a machine learning model is created that can be used to identify these new customers. It is called “supervised” learning because we are directing (supervising) the analysis towards a result (in our example: consumers who respond favorably). Supervised learning techniques include analyses such as decision trees, neural networks, classifiers, and logistic regression.

Unsupervised learning occurs when an organization has data and wants to understand the relationship(s) between

different data points. For example, if a retailer wants to understand purchasing patterns of its customers, an unsupervised learning model can be developed to find out which products are most often purchased together or how to group their customers by purchase history. Is it called “unsupervised” learning because no specific outcome is expected. Unsupervised learning techniques include clustering and association rules.

Privacy Concerns

The increasing power of data mining has caused concerns for many, especially in the area of privacy. In today’s digital world, it is becoming easier than ever to take data from disparate sources and combine them to do new forms of analysis. In fact, a whole industry has sprung up around this technology: data brokers. These firms combine publicly accessible data with information obtained from the government and other sources to create vast warehouses of data about people and companies that they can then sell. This subject will be covered in much more detail in chapter 12 – the chapter on the ethical concerns of information systems.

Sidebar: What is data science? What is data analytics?

The term “data science” is a popular term meant to describe the analysis of large data sets to find new knowledge. For the past several years, it has been considered one of the best career fields to get into due to its explosive growth and high salaries. While a data scientist does many different things, their focus is generally on analyzing large data sets using various programming methods and software tools to create new knowledge for their organization. Data scientists are skilled in machine learning and data visualization techniques. The field of data science is constantly changing, and data scientists are on the cutting edge of work in areas such as artificial intelligence and neural networks.

Knowledge Management

We end the chapter with a discussion on the concept of knowledge management (KM). All companies accumulate knowledge over the course of their existence. Some of this knowledge is written down or saved, but not in an organized fashion. Much of this knowledge is not written down; instead, it is stored inside the heads of its employees. Knowledge management is the process of creating, formalizing the capture, indexing, storing, and sharing of the company’s knowledge in order to benefit from the experiences and insights that the company has captured during its existence.

Summary

In this chapter, we learned about the role that data and databases play in the context of information systems. Data is made up of facts of the world. If you process data in a particular context, then you have information. Knowledge is gained when information is consumed and used for decision making. A database is an organized collection of related

data. Relational databases are the most widely used type of database, where data is structured into tables and all tables must be related to each other through unique identifiers. A database management system (DBMS) is a software application that is used to create and manage databases, and can take the form of a personal DBMS, used by one person, or an enterprise DBMS that can be used by multiple users. A data warehouse is a special form of database that takes data from other databases in an enterprise and organizes it for analysis. Data mining is the process of looking for patterns and relationships in large data sets. Many businesses use databases, data warehouses, and data-mining techniques in order to produce business intelligence and gain a competitive advantage.

Study Questions

1. What is the difference between data, information, and knowledge?
2. Explain in your own words how the data component relates to the hardware and software components of information systems.
3. What is the difference between quantitative data and qualitative data? In what situations could the number 42 be considered qualitative data?
4. What are the characteristics of a relational database?
5. When would using a personal DBMS make sense?
6. What is the difference between a spreadsheet and a database? List three differences between them.
7. Describe what the term *normalization* means.
8. Why is it important to define the data type of a field when designing a relational database?
9. Name a database you interact with frequently. What would some of the field names be?
10. What is metadata?
11. Name three advantages of using a data warehouse.
12. What is data mining?
13. In your own words, explain the difference between supervised learning and unsupervised learning. Give an example of each (not from the book).

Exercises

1. Review the design of the School database earlier in this chapter. Reviewing the lists of data types given, what data types would you assign to each of the fields in each of the tables. What lengths would you assign to the text fields?
2. Download Apache OpenOffice.org and use the database tool to open the “Student Clubs.odt” file available here. Take some time to learn how to modify the database structure and then see if you can add the required items to support the tracking of faculty advisors, as described at the end of the Normalization section in the chapter. Here is a link to the Getting Started documentation.
3. Using Microsoft Access, download the database file of comprehensive baseball statistics from the website SeanLahman.com. (If you don’t have Microsoft Access, you can download an abridged version of the file here that is compatible with Apache Open Office). Review the structure of the tables included in the database. Come up with three different data-mining experiments you would like to try, and explain which fields in which tables would have to be analyzed.
4. Do some original research and find two examples of data mining. Summarize each example and then write about what the two examples have in common.
5. Conduct some independent research on the process of business intelligence. Using at least two scholarly or

- practitioner sources, write a two-page paper giving examples of how business intelligence is being used.
6. Conduct some independent research on the latest technologies being used for knowledge management. Using at least two scholarly or practitioner sources, write a two-page paper giving examples of software applications or new technologies being used in this field.

5. Chapter 5: Networking and Communication

Learning Objectives

Upon successful completion of this chapter, you will be able to:

- understand the history and development of networking technologies;
- define the key terms associated with networking technologies;
- understand the importance of broadband technologies; and
- describe organizational networking.

Introduction

In the early days of computing, computers were seen as devices for making calculations, storing data, and automating business processes. However, as the devices evolved, it became apparent that many of the functions of telecommunications could be integrated into the computer. During the 1980s, many organizations began combining their once-separate telecommunications and information systems departments into an Information Technology (IT) department. This ability for computers to communicate with one another and to facilitate communication between individuals and groups has had a major impact on the growth of computing over the past several decades.

Computer networking began in the 1960s with the birth of the Internet. However, while the Internet and web were evolving, corporate networking was also taking shape in the form of local area networks and client-server computing. The Internet went commercial in 1994 as technologies began to pervade all areas of the organization. Today it would be unthinkable to have a computer that did not include communications capabilities. This chapter reviews the different technologies that have been put in place to enable this communications revolution.

A Brief History of the Internet

In the Beginning: ARPANET

The story of the Internet, and networking in general, can be traced back to the late 1950s. The United States was in the depths of the Cold War with the USSR as each nation closely watched the other to determine which would gain a military or intelligence advantage. In 1957, the Soviets surprised the U.S. with the launch of Sputnik, propelling us into the space age. In response to Sputnik, the U.S. Government created the Advanced Research Projects Agency (ARPA), whose initial

role was to ensure that the U.S. was not surprised again. It was from ARPA, now called DARPA ((Defense Advanced Research Projects Agency), that the Internet first sprang.

ARPA was the center of computing research in the 1960s, but there was just one problem. Many of the computers could not communicate with each other. In 1968 ARPA sent out a request for proposals for a communication technology that would allow different computers located around the country to be integrated together into one network. Twelve companies responded to the request, and a company named Bolt, Beranek, and Newman (BBN) won the contract. They immediately began work and were able to complete the job just one year later.



ARPA Net 1969

Professor Len Kleinrock of UCLA along with a group of graduate students were the first to successfully send a transmission over the ARPANET. The event occurred on October 29, 1969 when they attempted to send the word “login” from their computer at UCLA to the Stanford Research Institute. You can read their actual notes. The first four nodes were at UCLA, University of California, Stanford, and the University of Utah.

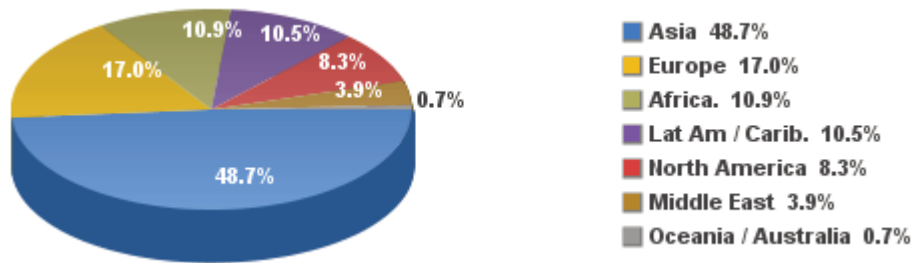
The Internet and the World Wide Web

Over the next decade, the ARPANET grew and gained popularity. During this time, other networks also came into existence. Different organizations were connected to different networks. This led to a problem. The networks could not communicate with each other. Each network used its own proprietary language, or protocol (see sidebar for the definition of *protocol*) to send information back and forth. This problem was solved by the invention of Transmission Control Protocol/Internet Protocol (TCP/IP). TCP/IP was designed to allow networks running on different protocols to have an intermediary protocol that would allow them to communicate. So as long as your network supported TCP/IP, you could communicate with all of the other networks running TCP/IP. TCP/IP quickly became the standard protocol and allowed networks to communicate with each other. It is from this breakthrough that we first got the term *Internet*, which simply means “an interconnected network of networks.”

Sidebar: An Internet Vocabulary Lesson

Network communication is full of some very technical concepts based on simple principles. Learn the following terms and you'll be able to hold your own in a conversation about the Internet.

- **Packet** The fundamental unit of data transmitted over the Internet. When a host (PC, workstation, server, printer, etc.) intends to send a message to another host (for example, your PC sends a request to YouTube to open a video), it breaks the message down into smaller pieces, called packets. Each packet has the sender's address, the destination address, a sequence number, and a piece of the overall message to be sent. Different packets in a single message can take a variety of routes to the destination and they can arrive at different times. For this reason the sequence number is used to reassemble the packets in the proper order at the destination.
 - **Switch** A network device that connects multiple hosts together and forwards packets based on their destination within the local network which is commonly known as a Local Area Network (LAN).
 - **Router** A device that receives and analyzes packets and then routes them towards their destination. In some cases a router will send a packet to another router. In other cases it will send it directly to its destination. Routers are used to connect one network to another network.
 - **IP Address** Every device on the Internet (personal computer, a tablet, a smartphone, etc.) is assigned a unique identifying number called an IP (Internet Protocol) address. Originally, the IPv4 (version 4) standard was used. It had a format of four numbers with values ranging from 0 and 255 separated by a period. For example, the domain Dell.com has the IPv4 address 107.23.196.166. The IPv4 standard has a limit of 4,294,967,296 possible addresses. As the use of the Internet has grown, the number of IP addresses needed has increased to the point where the use of IPv4 addresses will be exhausted. This has led to the new IPv6 standard. The IPv6 standard is formatted as eight groups of four hexadecimal digits, such as 2001:0db8:85a3:0042:1000:8a2e:0370:7334. The IPv6 standard has a limit of 3.4×10^{38} possible addresses. For example, the domain LinkedIn.com has an IPv6 address of: [2620:109:c002::6cae:a0a]. You probably noticed that the address has only five groups of numbers. That's because IPv6 allows the use of two semi-colons (::) to indicate groups that are all zeroes and do not need to be displayed. For more detail about the IPv6 standard, see this Wikipedia article.
 - **Domain name** If you had to try to remember the IP address of every web site you wanted to access, the Internet would not be nearly as easy to use. A domain name is a human-friendly name, convenient for remembering a website. These names generally consist of a descriptive word followed by a dot (period) and the Top-Level Domain (TLD). For example, Wikipedia's domain name is wikipedia.org. *Wikipedia* describes the organization and *.org* is the TLD. Other well-known TLDs include *.com*, *.net*, and *.gov*. For a list and description of top level domain names, see this Wikipedia article.
 - **DNS** DNS stands for "domain name server or system." DNS acts as the directory of websites on the Internet. When a request to access a host with a domain name is given, a DNS server is queried. It returns the IP address of the host requested, allowing for proper routing.
 - **Packet-switching** When a message's packets are sent on the Internet, routers try to find the optimal route for each packet. This can result in packets being sent on different routes to their destination. After the packets arrive they are re-assembled into the original message for the recipient. For more details on packet-switching, see this interactive web page.
 - **Protocol** A protocol is the set of rules that govern how communications take place on a network. For example, File Transfer Protocol (FTP) are the communication rules for transferring files from one host to another. TCP/IP, discussed earlier, is known as a protocol suite since it contains numerous protocols.
-



Internet Users Worldwide, December 2017.

(Public Domain. Courtesy of the Miniwatts Marketing Group)

The 1980s witnessed a significant growth in Internet usage. Internet access came primarily from government, academic, and research organizations. Much to the surprise of the engineers, the early popularity of the Internet was driven by the use of electronic mail (see the next sidebar).

Initially, Internet use meant having to type commands, even including IP addresses, in order to access a web server. That all changed in 1990 when Tim Berners-Lee introduced his World Wide Web project which provided an easy way to navigate the Internet through the use of *hypertext*. The World Wide Web gained even more steam in 1993 with the release of the Mosaic browser which allowed graphics and text to be combined as a way to present information and navigate the Internet.

The Dot-Com Bubble

In the 1980s and early 1990s, the Internet was being managed by the National Science Foundation (NSF). The NSF had restricted commercial ventures on the Internet, which meant that no one could buy or sell anything online. In 1991, the NSF transferred its role to three other organizations, thus getting the US government out of direct control over the Internet and essentially opening up commerce online.

This new commercialization of the Internet led to what is now known as the dot-com bubble. A frenzy of investment in new dot-com companies took place in the late 1990s with new tech companies issuing Initial Public Offerings (IPO) and heating up the stock market. This investment bubble was driven by the fact that investors knew that online commerce would change everything. Unfortunately, many of these new companies had poor business models and anemic financial statements showing little or no profit. In 2000 and 2001, the bubble burst and many of these new companies went out of business. Some companies survived, including Amazon (started in 1994) and eBay (1995). After the dot-com bubble burst, a new reality became clear. In order to succeed online, e-business companies would need to develop business models appropriate for the online environment.

Web 2.0

In the first few years of the World Wide Web, creating and hosting a website required a specific set of knowledge. A person had to know how to set up a web server, get a domain name, create web pages in HTML, and troubleshoot various technical issues.

Starting in the early 2000s, major changes came about in how the Internet was being used. These changes have come to be known as *Web 2.0*. Here are some key characteristics in Web 2.0.

- Universal access to Apps
- Value is found in content, not display software

- Data can be easily shared
 - Distribution is bottom up, not top down
 - Employees and customers can use access and use tools on their own
 - Informal networking is encouraged since more contributors results in better content
 - Social tools encourage people to share information
- 1

Social networking, the last item in the list, has led to major changes in society. Prior to Web 2.0 major news outlets investigated and reported important news stories of the day. But in today's world individuals are able to easily share their own views on various events. Apps such as Facebook, Twitter, Youtube, and personal blogs allow people to express their own viewpoint.

Sidebar: E-mail Is the “Killer” App for the Internet

As discussed in chapter 3, a “killer app” is a use of a device that becomes so essential that large numbers of people will buy the device just to run that application. The killer app for the personal computer was the spreadsheet, enabling users to enter data, write formulas, and easily make “what if” decisions. With the introduction of the Internet came another killer app – E-mail.

The Internet was originally designed as a way for the Department of Defense to manage projects. However, the invention of electronic mail drove demand for the Internet. While this wasn't what developers had in mind, it turned out that people connecting with people was the killer app for the Internet. As we look back today, we can see this being repeated again and again with new technologies that enable people to connect with each other.

Sidebar: The Internet and the World Wide Web Are Not the Same Thing

Many times the terms “Internet” and “World Wide Web,” or even just “the web,” are used interchangeably. But really, they are *not* the same thing.

The *Internet* is an interconnected network of networks. Services such as email, voice and video, file transfer, and the World Wide Web all run across the Internet. The *World Wide Web* is simply one part of the Internet. It is made up of web servers that have HTML pages that are being viewed on devices with web browsers.

The Growth of High Speed Internet

In the early days of the Internet, most access was accomplished via a modem over an analog telephone line. A modem

1. [1]

was connected to the incoming phone line when then connected to a computer. Speeds were measured in bits-per-second (bps), with speeds growing from 1200 bps to 56,000 bps over the years. Connection to the Internet via modems is called *dial-up* access. As the web became more interactive, dial-up hindered usage when users wanted to transfer more and more data. As a point of reference, downloading a typical 3.5 MB song would take 24 minutes at 1200 bps and 2 minutes at 28,800 bps.

High speed Internet speeds, by definition, are a minimum of 256,000 bps, though most connections today are much faster, measured in millions of bits per second (megabits or Mbps) or even billions (gigabits). For the home user, a high speed connection is usually accomplished via the cable television lines or phone lines using a Digital Subscriber Line (DSL). Both cable and DSL have similar prices and speeds, though price and speed can vary in local communities. According to the website Recode, the average home broadband speed ranges from 12 Mbps and 125 Mbps.² Telecommunications companies provide T1 and T3 lines for greater bandwidth and reliability.

High speed access, also known as broadband, is important because it impacts how the Internet is used. Communities with high speed Internet have found residences and businesses increase usage of digital resources. Access to high speed Internet is now considered a basic human right by the United Nations, as declared in their 2011 statement:

“Broadband technologies are fundamentally transforming the way we live,” the Broadband Commission for Digital Development, set up in 2017 by the UN Educational Scientific and Cultural Organization (UNESCO) and the UN International Telecommunications Union (ITU), said in issuing “The Broadband Challenge” at a leadership summit in Geneva.

“It is vital that no one be excluded from the new global knowledge societies we are building. We believe that communication is not just a human need – it is a right.”³

Wireless Networking

Thanks to wireless technology, access to the Internet is virtually everywhere, especially through a smartphone.

Wi-Fi

Wi-Fi takes an Internet signal and converts it into radio waves. These radio waves can be picked up within a radius of approximately 65 feet by devices with a wireless adapter. Several Wi-Fi specifications have been developed over the years, starting with 802.11b in 1999, followed by the 802.11g specification in 2003 and 802.11n in 2009. Each new specification improved the speed and range of Wi-Fi, allowing for more uses. One of the primary places where Wi-Fi is being used is in the home. Home users access Wi-Fi via in-home routers provided by the telecommunications firm that services the residence.

Mobile Network

As the cellphone has evolved into the smartphone, the desire for Internet access on these devices has led to data networks being included as part of the mobile phone network. While Internet connections were technically available

2. [2]

3. [3]

earlier, it was really with the release of the 3G networks in 2001 (2002 in the US) that smartphones and other cellular devices could access data from the Internet. This new capability drove the market for new and more powerful smartphones, such as the iPhone, introduced in 2007. In 2011, wireless carriers began offering 4G data speeds, giving the cellular networks the same speeds that customers were accustomed to getting via their home connection.

Beginning in 2019, some part of the world began seeing the implementation of 5G communication networks. Speeds associated with 5G will be greater than 1 GB/second, providing connection speeds to handle just about any type of application. Some have speculated that the 5G implementation will lead households to eliminate the purchase of wired Internet connections for their homes, just using 5G wireless connections instead.

3G, 4G, and 5G Comparison

	3G	4G	5G
Deployed	2004-2005	2006-2010	By 2020
Bandwidth	2 mbps	200 mbps	> 1 gbps,
Service	Integrated high-quality audio, video and data	Dynamic information access, variable devices	Dynamic information access, variable devices with all capabilities

(James Dean, Raconteur, December 7, 2014)

4

Sidebar: Why Doesn't My Cellphone Work When I Travel Abroad?

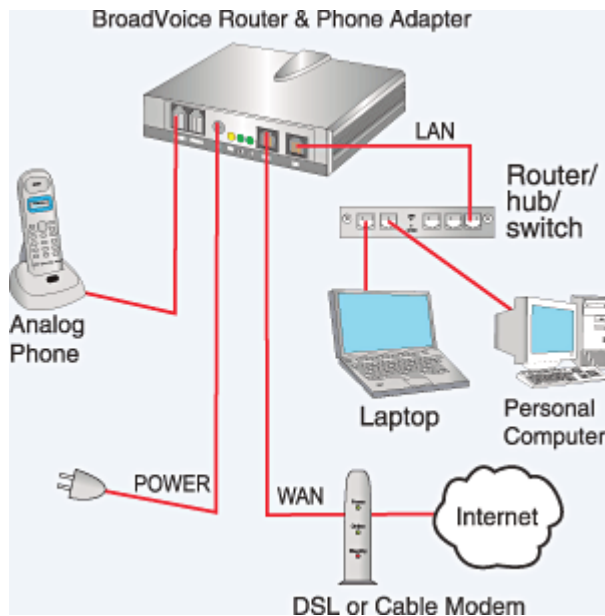
As mobile phone technologies have evolved, providers in different countries have chosen different communication standards for their mobile phone networks. There are two competing standards in the US: GSM (used by AT&T and T-Mobile) and CDMA (used by the other major carriers). Each standard has its pros and cons, but the bottom line is that phones using one standard cannot easily switch to the other. This is not a big deal in the US because mobile networks exist to support both standards. But when traveling to other countries, you will find that most of them use GSM networks. The one exception is Japan which has standardized on CDMA. It is possible for a mobile phone using one type of network to switch to the other type of network by changing out the SIM card, which controls your access to the mobile network. However, this will not work in all cases. If you are traveling abroad, it is always best to consult with your mobile provider to determine the best way to access a mobile network.

Bluetooth



While Bluetooth is not generally used to connect a device to the Internet, it is an important wireless technology that has enabled many functionalities that are used every day. When created in 1994 by Ericsson, it was intended to replace wired connections between devices. Today, it is the standard method for wirelessly connecting nearby devices. Bluetooth has a range of approximately 300 feet and consumes very little power, making it an excellent choice for a variety of purposes. Some applications of Bluetooth include: connecting a printer to a personal computer, connecting a mobile phone and headset, connecting a wireless keyboard and mouse to a computer, or connecting your mobile phone to your car, resulting in hands free operation of your phone.

VoIP

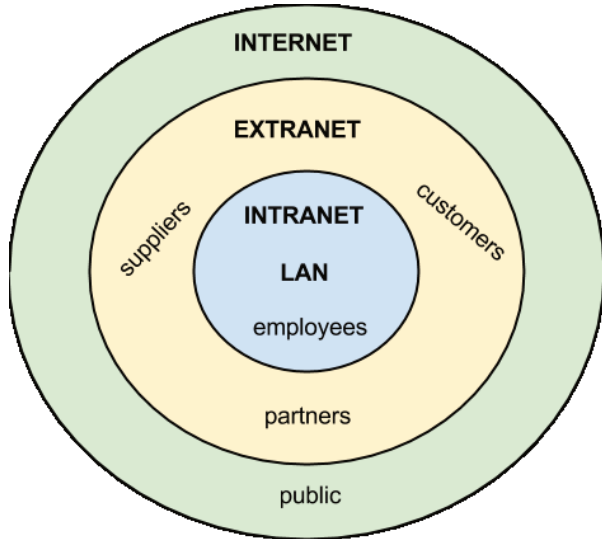


Typical VoIP communication

Voice over IP (VoIP) allows analog signals to be converted to digital signals, then transmitted on a network. By using existing technologies and software, voice communication over the Internet is now available to anyone with a browser (think Skype, WebEx, Google Hangouts). Beyond this, many companies are now offering VoIP-based telephone service for business and home use.

Organizational Networking

LAN and WAN



Scope of business networks

While the Internet was evolving and creating a way for organizations to connect to each other and the world, another revolution was taking place inside organizations. The proliferation of personal computers led to the need to share resources such as printers, scanners, and data. Organizations solved this problem through the creation of local area networks (LANs), which allowed computers to connect to each other and to peripherals.

A LAN is a local network, usually operating in the same building or on the same campus. A Wide Area Network (WAN) provides connectivity over a wider area such as an organization's locations in different cities or states.

Client-Server

Client-server computing provides stand-alone devices such as personal computers, printers, and file servers to work together. The personal computer originally was used as a stand-alone computing device. A program was installed on the computer and then used to do word processing or calculations. With the advent of networking and local area networks, computers could work together to solve problems. Higher-end computers were installed as servers, and users on the local network could run applications and share information among departments and organizations.

Intranet

An intranet, as the name implies, provides web-based resources for the users within an organization. These web pages are not accessible to those outside the company. The pages typically contain information useful to employees such as policies and procedures. In an academic setting the intranet provides an interface to learning resources for students.

Extranet

Sometimes an organization wants to be able to collaborate with its customers or suppliers while at the same time maintaining the security of being inside its own network. In cases like this a company may want to create an *extranet*, which is a part of a company's network that can be made available securely to those outside of the company. Extranets can be used to allow customers to log in and place orders, or for suppliers to check their customers' inventory levels.

Sometimes an organization will need to allow someone who is not located physically within its internal network to gain secure access to the intranet. This access can be provided by a virtual private network (VPN). VPNs will be discussed further in Chapter 6 which focuses on Information Security).

Sidebar: Microsoft's SharePoint Powers the Intranet

As organizations begin to see the power of collaboration between their employees, they often look for solutions that will allow them to leverage their intranet to enable more collaboration. Since most companies use Microsoft products for much of their computing, some are using Microsoft's SharePoint to support employee collaboration.

SharePoint provides a communication and collaboration platform that integrates seamlessly with Microsoft's Office suite of applications. Using SharePoint, employees can share a document and edit it together, avoiding the need to email the document for others to review. Projects and documents can be managed collaboratively across the organization. Corporate documents are indexed and made available for search.

Cloud Computing

Cloud computing was covered in Chapter 3. The universal availability of the Internet combined with increases in processing power and data-storage capacity have made cloud computing a viable option for many companies. Using cloud computing, companies or individuals can contract to store data on storage devices somewhere on the Internet. Applications can be "rented" as needed, giving a company the ability to quickly deploy new applications. The I.T. department benefits from not having to maintain software that is provided on the cloud.

Sidebar: Metcalfe's Law

Just as Moore's Law describes how computing power is increasing over time, Metcalfe's Law describes the power of networking. Metcalfe's Law states that the value of a telecommunications network is proportional to the square of the number of connected users of the system, or N^2 . If a network has 10 nodes, the inherent value is 100, or 10^2 .

Metcalfe's Law is attributed to Robert Metcalfe, the co-inventor of Ethernet. It attempts to address the added value provided by each node on the network. Think about it this way: If none of your friends were on Instagram, would you

spend much time there? If no one else at your school or place of work had e-mail, would it be very useful to you? Metcalfe's Law tries to quantify this value.

Summary

The networking revolution has completely changed how personal computers are used. Today, no one would imagine using a computer that was not connected to one or more networks. The development of the Internet and World Wide Web, combined with wireless access, has made information available at our fingertips. The Web 2.0 revolution has made everyone potential authors of web content. As networking technology has matured, the use of Internet technologies has become a standard for every type of organization. The use of intranets and extranets has allowed organizations to deploy functionality to employees and business partners alike, increasing efficiencies and improving communications. Cloud computing has truly made information available everywhere.

Study Questions

1. What were the first four locations hooked up to the Internet (ARPANET)?
2. What does the term *packet* mean?
3. Which came first, the Internet or the World Wide Web?
4. What was revolutionary about Web 2.0?
5. What was the so-called killer app for the Internet?
6. What does the term VoIP mean?
7. What is a LAN?
8. What is the difference between an intranet and an extranet?
9. What is Metcalfe's Law?

Exercises

1. What is the difference between the Internet and the World Wide Web? Create at least three statements that identify the differences between the two.
2. Who are the broadband providers in your area? What are the prices and speeds offered?
3. Pretend you are planning a trip to three foreign countries in the next month. Consult your wireless carrier to determine if your mobile phone would work properly in those countries. What would the costs be? What alternatives do you have if it would not work?

Labs

1. Check the speed of your Internet connection by going to the following web site: speedtest.net
What is your download and upload speed?
 2. What is the IP address of your computer? How did you find it? Hint for Windows: Go to the start icon and click Run. Then open the Command Line Interface by typing: **cmd** Then type: **ipconfig** What is your IPv4 address? What is your IPv6 address?
 3. When you enter an address in your web browser, a Domain Name Server (DNS) is used to lookup the IP address of the site you are seeking. To locate the DNS server your computer is using, type: **nslookup** Write down the name and address of your DNS server. Use the *nslookup* command to find the address for a favorite web site. For example, to find the IP address of espn type: **nslookup espn** Write down your website's name and address. Note: it is on the line following the name of the web site you entered.
 4. You can use the *tracert* (trace route) command to display the path from your computer to the web site's IP address you used in the previous lab. For example, **tracert 199.181.132.250** Be patient as *tracert* contacts each router in the path to your website's server. A "Request timed out" message indicates the tracing is taking too long, probably due to a lack of bandwidth. You can stop the trace by pressing Ctrl + C
 5. The *ping* command allows you check connectivity between the local host (your computer) and another host. If you are unable to connect to another host, the ping command can be used to incrementally test your connectivity. The IP address 127.0.0.1 is known as your home address (local host). Begin your test by going to your command line interface (command promkpt) and pinging your local host: **ping 127.0.0.1** You should get a series of "Reply from 127.0.0.1" messages Next, ping the IP address you used in lab #3. Sometimes a failed ping is not the result of a lack of connectivity. Network administrators of some IP addresses/hosts do not want their site pinged so they block all ICMP packets. That's the protocol used for pinging.
- The whois.domaintools.com site provides you with information about a web site. For example, to find information about google.com open your web browser and type: **whoisdomaintools.com** Then in the Lookup window, type: **google.com** Find information about a favorite site of yours. Record the following: administrator name, phone number, when the site was created, and the site's name servers (the names begin with "ns").
 - Network statistics can be displayed using the *netstat* command. In the command line window (see lab #2 for instructions on how to get to the command line), type: **netstat -e** How many bytes were sent and how many were received? Execute the command again and record your results. You should see an increase in both received and sent bytes. To see a complete list of options/switches for the netstat command, type: **netstat ?**

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1. Wolcott, M. (2017). What is Web 2.0? *MoneyWatch*. Retrieved from <https://www.cbsnews.com/news/what-is-web-20/> ↓
 2. Molla, R. (2017). These are the fastest and slowest Internet speeds". *Recode*. Retrieved from <https://www.recode.net/2017/6/9/15768598/states-fastest-slowest-internet-speeds> ↓
 3. *International Telecommunications Union*. (2018, January 23). UN Broadband Commission sets goal broadband targets to bring online the world's 3.8 billion not connected to the Internet. Retrieved from <https://www.itu.int/en/mediacentre/Pages/2018-PR01.aspx> ↓
 4. "Dean, J. (2014). 4G vs 5G Mobile Technology. *Raconteur* Retrieved from <https://www.raconteur.net/technology/4g-vs-5g-mobile-technology>.

6. Chapter 6: Information Systems Security

Learning Objectives

Upon successful completion of this chapter, you will be able to:

- identify the information security triad;
- identify and understand the high-level concepts surrounding information security tools; and
- secure yourself digitally.

Introduction

As computers and other digital devices have become essential to business and commerce, they have also increasingly become a target for attacks. In order for a company or an individual to use a computing device with confidence, they must first be assured that the device is not compromised in any way and that all communications will be secure. This chapter reviews the fundamental concepts of information systems security and discusses some of the measures that can be taken to mitigate security threats. The chapter begins with an overview focusing on how organizations can stay secure. Several different measures that a company can take to improve security will be discussed. Finally, you will review a list of security precautions that individuals can take in order to secure their personal computing environment.

The Information Security Triad: Confidentiality, Integrity, Availability (CIA)

Confidentiality

Protecting information means you want to be able to restrict access to those who are allowed to see it. This is sometimes referred to as NTK, Need to Know. Everyone else should be disallowed from learning anything about its contents. This is the essence of confidentiality. For example, federal law requires that universities restrict access to private student information. Access to grade records should be limited to those who have authorized access.



Integrity

Integrity is the assurance that the information being accessed has not been altered and truly represents what is intended. Just as a person with integrity means what he or she says and can be trusted to consistently represent the truth, information integrity means information truly represents its intended meaning. Information can lose its integrity through malicious intent, such as when someone who is not authorized makes a change to intentionally misrepresent something. An example of this would be when a hacker is hired to go into the university's system and change a student's grade.

The security triad

Integrity can also be lost unintentionally, such as when a computer power surge corrupts a file or someone authorized to make a change accidentally deletes a file or enters incorrect information.

Availability

Information availability is the third part of the CIA triad. *Availability* means information can be accessed and modified by anyone authorized to do so in an appropriate timeframe. Depending on the type of information, *appropriate timeframe* can mean different things. For example, a stock trader needs information to be available immediately, while a sales person may be happy to get sales numbers for the day in a report the next morning. Online retailers require their servers to be available twenty-four hours a day, seven days a week. Other companies may not suffer if their web servers are down for a few minutes once in a while.

Tools for Information Security

In order to ensure the confidentiality, integrity, and availability of information, organizations can choose from a variety of tools. Each of these tools can be utilized as part of an overall information-security policy.

Authentication

The most common way to identify someone is through their physical appearance, but how do we identify someone sitting behind a computer screen or at the ATM? Tools for authentication are used to ensure that the person accessing the information is, indeed, who they present themselves to be.

Authentication can be accomplished by identifying someone through one or more of three factors:

1. Something they know,
2. Something they have, or
3. Something they are.

For example, the most common form of authentication today is the user ID and password. In this case, the authentication is done by confirming something that the user knows (their ID and password). But this form of authentication is easy to compromise (see sidebar) and stronger forms of authentication are sometimes needed. Identifying someone only by something they have, such as a key or a card, can also be problematic. When that identifying token is lost or stolen, the identity can be easily stolen. The final factor, something you are, is much harder to compromise. This factor identifies a user through the use of a physical characteristic, such as a retinal scan, fingerprint, or facial geometry. Identifying someone through their physical characteristics is called *biometrics*.



RSA SecurID token

A more secure way to authenticate a user is through *multi-factor authentication*. By combining two or more of the factors listed above, it becomes much more difficult for someone to misrepresent themselves. An example of this would be the use of an RSA SecurID token. The RSA device is something you have, and it generates a new access code every sixty seconds. To log in to an information resource using the RSA device, you combine something you know, such as a four-digit PIN, with the code generated by the device. The only way to properly authenticate is by both knowing the code *and* having the RSA device.

Access Control

Once a user has been authenticated, the next step is to ensure that they can only access the information resources that are appropriate. This is done through the use of access control. Access control determines which users are authorized to read, modify, add, and/or delete information. Several different access control models exist. Two of the more common are: the Access Control List (ACL) and Role-Based Access Control (RBAC).

An information security employee can produce an ACL which identifies a list of users who have the capability to take specific actions with an information resource such as data files. Specific permissions are assigned to each user such as *read*, *write*, *delete*, or *add*. Only users with those permissions are allowed to perform those functions.

ACLs are simple to understand and maintain, but there are several drawbacks. The primary drawback is that each information resource is managed separately, so if a security administrator wanted to add or remove a user to a large set of information resources, it would be quite difficult. And as the number of users and resources increase, ACLs become

harder to maintain. This has led to an improved method of access control, called *role-based access control*, or RBAC. With RBAC, instead of giving specific users access rights to an information resource, users are assigned to roles and then those roles are assigned the access. This allows the administrators to manage users and roles separately, simplifying administration and, by extension, improving security.

The following image shows an ACL with permissions granted to individual users. RBAC allows permissions to be assigned to roles, as shown in the middle grid, and then in the third grid each user is assigned a role. Although not modeled in the image, each user can have multiple roles such as Reader and Editor.

Access Control List

User	Read	Write	Add	Delete
jsmith	x			
rlee	x			
knguyen	x	x	x	x
mroberts	x	x		
manderson	x	x		



Role-Based Access Control

Role	Read	Write	Add	Delete
Reader	x			
Editor	x	x		
Administratc	x	x	x	x

Role Assignments

User	Role
jsmith	Reader
rlee	Reader
knguyen	Admin
mroberts	Editor
manderson	Editor

Comparison of ACL and RBAC

Sidebar: Password Security

So why is using just a simple user ID and password not considered a secure method of authentication? It turns out that this single-factor authentication is extremely easy to compromise. Good password policies must be put in place in order to ensure that passwords cannot be compromised. Below are some of the more common policies that organizations should use.

- **Require complex passwords.** One reason passwords are compromised is that they can be easily guessed. A recent study found that the top three passwords people used were *password*, *123456* and *12345678*.^[1] A password should not be simple, or a word that can be found in a dictionary. Hackers first attempt to crack a password by testing every term in the dictionary. Instead, a good password policy should require the use of a minimum of eight characters, at least one upper-case letter, one special character, and one digit.
- **Change passwords regularly.** It is essential that users change their passwords on a regular basis. Also, passwords may not be reused. Users should change their passwords every sixty to ninety days, ensuring that any passwords that might have been stolen or guessed will not be able to be used against the company.
- **Train employees not to give away passwords.** One of the primary methods used to steal passwords is to simply figure them out by asking the users for their password. *Pretexting* occurs when an attacker calls a helpdesk or security administrator and pretends to be a particular authorized user having trouble logging in. Then, by providing some personal information about the authorized user, the attacker convinces the security person to reset the password and tell him what it is. Another way that employees may be tricked into giving away passwords is through e-mail phishing. *Phishing* occurs when a user receives an e-mail that looks as if it is from a trusted source, such as their bank or employer. In the e-mail the user is asked to click a link and log in to a website that mimics the genuine website, then enter their ID and password. The userID and password are then captured by the attacker.

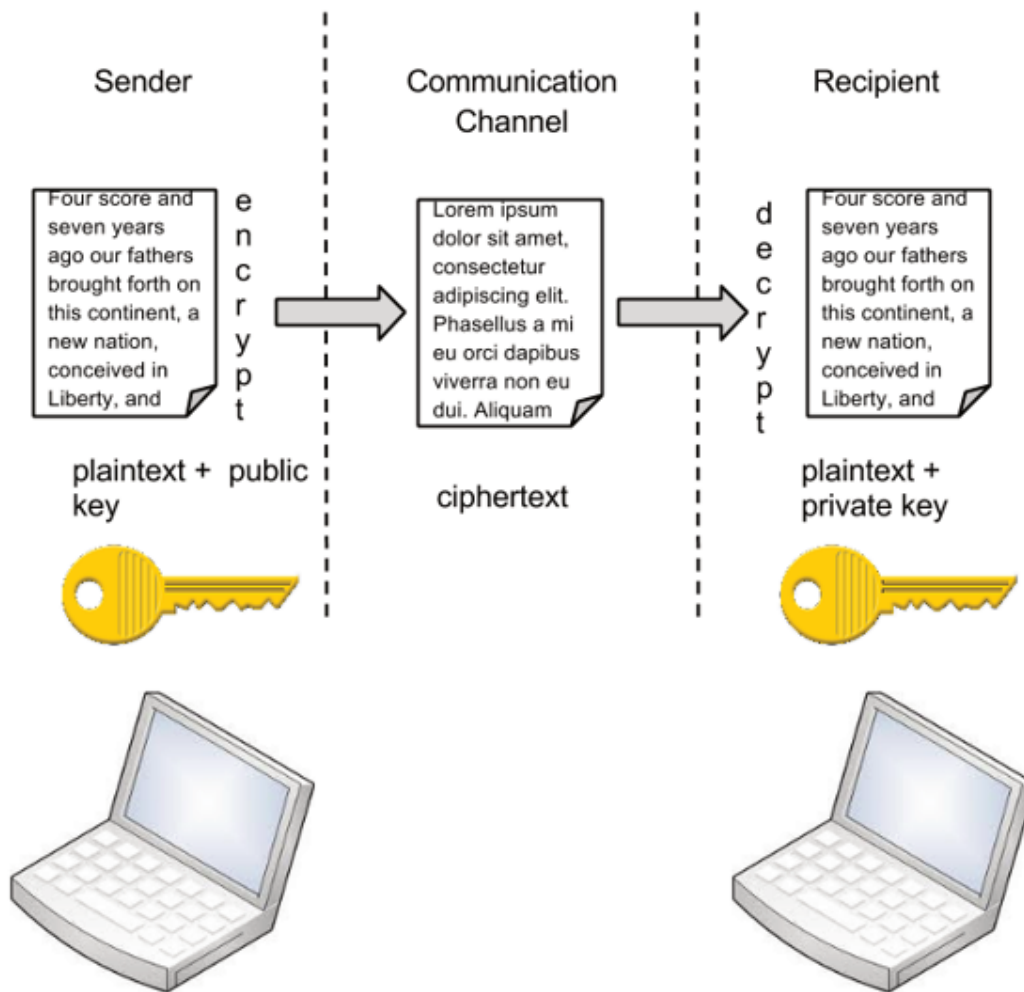
Encryption

Many times an organization needs to transmit information over the Internet or transfer it on external media such as a flash drive. In these cases, even with proper authentication and access control, it is possible for an unauthorized person to gain access to the data. Encryption is a process of encoding data upon its transmission or storage so that only authorized individuals can read it. This encoding is accomplished by software which encodes the plain text that needs to be transmitted (encryption). Then the recipient receives the cipher text and decodes it (decryption). In order for this to work, the sender and receiver need to agree on the method of encoding so that both parties have the same message. Known as *symmetric key encryption*, both parties share the encryption key, enabling them to encode and decode each other's messages.

An alternative to symmetric key encryption is *public key encryption*. In public key encryption, two keys are used: a public key and a private key. To send an encrypted message, you obtain the public key, encode the message, and send it. The recipient then uses their private key to decode it. The public key can be given to anyone who wishes to send the recipient a message. Each user simply needs one private key and one public key in order to secure messages. The private key is necessary in order to decrypt a message sent with the public key.

Notice in the image how the sender on the left creates a plaintext message which is then encrypted with a public key. The ciphered text is transmitted through the communication channel and the recipient uses their private key to decrypt the message and then read the plain text.

Public Key Encryption Example



Sidebar: Blockchain and Bitcoin

Blockchain

Introduced in 2008 as part of a proposal for Bitcoin, Blockchain is a peer-to-peer network which provides an open, distributed record of transactions between two parties. A “peer-to-peer” network is one where there is no server between the two nodes trying to communicate. Essentially, this means that each node acts as a server and a client.

Supporters see blockchain as a tool to simplify all types of transactions: payments, contracts, etc. Motivation comes from the desire to remove the middleman (lawyer, banker, broker) from transactions, making them more efficient and readily available across the Internet. Blockchain is already being used to track products through supply chains.

Blockchain is considered a *foundational* technology, potentially creating new foundations in economics and social systems. There are numerous concerns about Blockchain and its adoption. Consider the following:

- **Speed of adoption.** Initially there is a great deal of enthusiasm by a small group. However, adoption on a larger scale can take a great number of years even decades for a worldwide acceptance of a new method of doing business.
- **Governance.** The banking sector, both in individual countries (U. S. Federal Reserve System) and the world at large (the International Monetary Fund), controls financial transactions. One purpose of these organizations is an attempt to avoid banking and financial systems collapse. Blockchain will result in the governance of financial transactions shifting away from these government-controlled institutions.
- **Smart contracts.** The smart contract will re-shape how businesses interact. It is possible for blockchain to automatically send payment to a vendor the instant the product is delivered to the customer. Such “self-executing” contracts are already taking place in banking and venture capital funding.¹

Many are forecasting some universal form of payment or value transfer for business transactions. Blockchain and Bitcoin are being used to transform banking in various locations around the world. The following Bitcoin section includes a look at a new banking venture in Tanzania, East Africa.

Bitcoin



Bitcoin logo

Bitcoin is a world wide payment system using cryptocurrency. It functions without a central bank, operating as a peer-to-peer network with transactions happening directly between vendors and buyers. Records for transactions are recorded in the blockchain. Bitcoin technology was released in 2009. The University of Cambridge estimated there were 2.9 and 5.8 million unique users of bitcoin in 2017.² This web site provides more information about bitcoin.

A major bitcoin project is underway in Tanzania. Business transactions in this East African country are fraught with many challenges such as counterfeit currency and a 28% transaction fee on individuals who do not have a bank account. Seventy percent of the country’s population fall into this category. Benjamin Fernandes, a Tanzanian and 2017 graduate of Stanford Graduate School of Business, is co-founder of NALA, a Tanzanian firm working to bring cryptocurrency to a

1. [9]

2. [10]

country where 96% of the population have access to mobile devices. NALA's goal is to provide low cost transactions to all of the country's citizens through cryptocurrency.³ You can read more of this cryptocurrency venture here.

Backups

Another essential tool for information security is a comprehensive backup plan for the entire organization. Not only should the data on the corporate servers be backed up, but individual computers used throughout the organization should also be backed up. A good backup plan should consist of several components.

- **Full understanding of the organization's information resources.** What information does the organization actually have? Where is it stored? Some data may be stored on the organization's servers, other data on users' hard drives, some in the cloud, and some on third-party sites. An organization should make a full inventory of all of the information that needs to be backed up and determine the best way to back it up.
- **Regular backups of all data.** The frequency of backups should be based on how important the data is to the company, combined with the ability of the company to replace any data that is lost. Critical data should be backed up daily, while less critical data could be backed up weekly. Most large organizations today use data redundancy so their records are always backed up.
- **Offsite storage of backup data sets.** If all backup data is being stored in the same facility as the original copies of the data, then a single event such as an earthquake, fire, or tornado would destroy both the original data and the backup. It is essential the backup plan includes storing the data in an offsite location.
- **Test of data restoration.** Backups should be tested on a regular basis by having test data deleted then restored from backup. This will ensure that the process is working and will give the organization confidence in the backup plan.

Besides these considerations, organizations should also examine their operations to determine what effect downtime would have on their business. If their information technology were to be unavailable for any sustained period of time, how would it impact the business?

Additional concepts related to backup include the following:

- **Uninterruptible Power Supply (UPS).** A UPS provides battery backup to critical components of the system, allowing them to stay online longer and/or allowing the IT staff to shut them down using proper procedures in order to prevent data loss that might occur from a power failure.
- **Alternate, or "hot" sites.** Some organizations choose to have an alternate site where an exact replica of their critical data is always kept up to date. When the primary site goes down, the alternate site is immediately brought online so that little or no downtime is experienced.

As information has become a strategic asset, a whole industry has sprung up around the technologies necessary for implementing a proper backup strategy. A company can contract with a service provider to back up all of their data or they can purchase large amounts of online storage space and do it themselves. Technologies such as Storage Area Networks (SAN) and archival systems are now used by most large businesses for data backup.

3. [11]

Firewalls

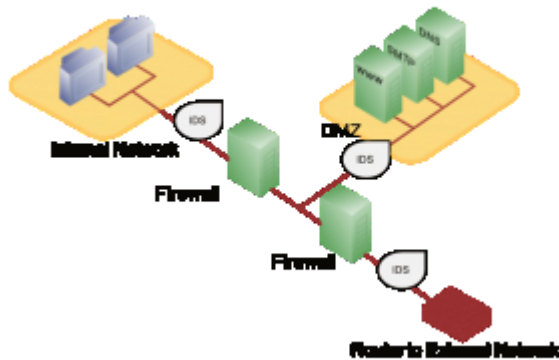


Diagram of a network configuration with firewalls, a router, and a DMZ.

Firewalls are another method that an organization can use for increasing security on its network. A firewall can exist as hardware or software, or both. A hardware firewall is a device that is connected to the network and filters the packets based on a set of rules. One example of these rules would be preventing packets entering the local network that come from unauthorized users. A software firewall runs on the operating system and intercepts packets as they arrive to a computer.

A firewall protects all company servers and computers by stopping packets from outside the organization's network that do not meet a strict set of criteria. A firewall may also be configured to restrict the flow of packets leaving the organization. This may be done to eliminate the possibility of employees watching YouTube videos or using Facebook from a company computer.

A demilitarized zone (DMZ) implements multiple firewalls as part of network security configuration, creating one or more

sections of their network that are partially secured. The DMZ typically contains resources that need broader access but still need to be secured.

Intrusion Detection Systems

Intrusion Detection Systems (IDS) can be placed on the network for security purposes. An IDS does not add any additional security. Instead, it provides the capability to identify if the network is being attacked. An IDS can be configured to watch for specific types of activities and then alert security personnel if that activity occurs. An IDS also can log various types of traffic on the network for analysis later. It is an essential part of any good security system.

Sidebar: Virtual Private Networks

Using firewalls and other security technologies, organizations can effectively protect many of their information resources by making them invisible to the outside world. But what if an employee working from home requires access to some of these resources? What if a consultant is hired who needs to do work on the internal corporate network from a remote location? In these cases, a *Virtual Private Network (VPN)* is needed.

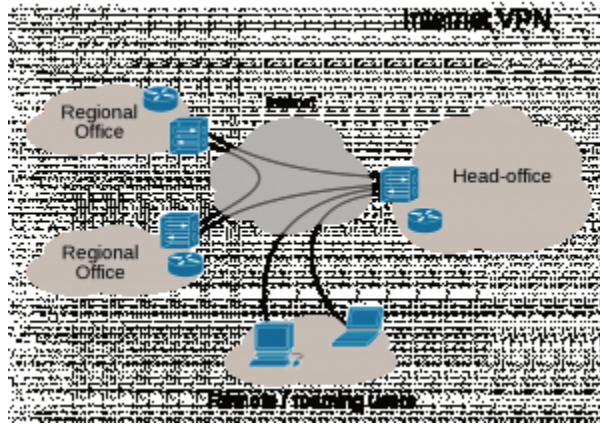


Diagram of VPN (click to enlarge). Attribution to Ludovic.ferre.

A VPN allows a user who is outside of a corporate network to take a detour around the firewall and access the internal network from the outside. Through a combination of software and security measures, a VPN provides off-site access to the organization's network while ensuring overall security.

The Internet cloud is essentially an insecure channel through which people communicate to various web sites/servers. Implementing a VPN results in a secure pathway, usually referred to as a tunnel, through the insecure cloud, virtually guaranteeing secure access to the organization's resources. The diagram represents security by way of the functionality of a VPN as it "tunnels" through the insecure Internet Cloud. Notice that the remote user is given access to the organization's intranet, as if the user was physically located within the intranet.

Physical Security

An organization can implement the best authentication scheme in the world, develop superior access control, and install firewalls and intrusion detection, but its security cannot be complete without implementation of physical security. Physical security is the protection of the actual hardware and networking components that store and transmit information resources. To implement physical security, an organization must identify all of the vulnerable resources and take measures to ensure that these resources cannot be physically tampered with or stolen. These measures include the following.

- **Locked doors.** It may seem obvious, but all the security in the world is useless if an intruder can simply walk in and physically remove a computing device. High value information assets should be secured in a location with limited access.
- **Physical intrusion detection.** High value information assets should be monitored through the use of security cameras and other means to detect unauthorized access to the physical locations where they exist.
- **Secured equipment.** Devices should be locked down to prevent them from being stolen. One employee's hard drive could contain all of your customer information, so it is essential that it be secured.
- **Environmental monitoring.** An organization's servers and other high value equipment should always be kept in a room that is monitored for temperature, humidity, and airflow. The risk of a server failure rises when these factors

exceed acceptable ranges.

- **Employee training.** One of the most common ways thieves steal corporate information is the theft of employee laptops while employees are traveling. Employees should be trained to secure their equipment whenever they are away from the office.

Security Policies

Besides the technical controls listed above, organizations also need to implement security policies as a form of administrative control. In fact, these policies should really be a starting point in developing an overall security plan. A good information security policy lays out the guidelines for employee use of the information resources of the company and provides the company recourse in the event that an employee violates a policy.

According to the SANS Institute, a good policy is “a formal, brief, and high-level statement or plan that embraces an organization’s general beliefs, goals, objectives, and acceptable procedures for a specified subject area.” Policies require compliance. Failure to comply with a policy will result in disciplinary action. A policy does not list the specific technical details, instead it focuses on the desired results. A security policy should be based on the guiding principles of confidentiality, integrity, and availability.⁴

Web use is a familiar example of a security policy. A web use policy lays out the responsibilities of company employees as they use company resources to access the Internet. A good example of a web use policy is included in Harvard University’s “Computer Rules and Responsibilities” policy, which can be found here.

A security policy should also address any governmental or industry regulations that apply to the organization. For example, if the organization is a university, it must be aware of the Family Educational Rights and Privacy Act (FERPA), which restricts access to student information. Health care organizations are obligated to follow several regulations, such as the Health Insurance Portability and Accountability Act (HIPAA).

A good resource for learning more about security policies is the SANS Institute’s Information Security Policy Page.

Sidebar: Mobile Security

As the use of mobile devices such as laptops and smartphones proliferates, organizations must be ready to address the unique security concerns that the use of these devices bring. One of the first questions an organization must consider is whether to allow mobile devices in the workplace at all. Many employees already have these devices, so the question becomes: Should we allow employees to bring their own devices and use them as part of their employment activities? Or should we provide the devices to our employees? Creating a BYOD (“Bring Your Own Device”) policy allows employees to integrate themselves more fully into their job and can bring higher employee satisfaction and productivity. In many cases, it may be virtually impossible to prevent employees from having their own smartphones or laptops in the workplace. If the organization provides the devices to its employees, it gains more control over use of the devices, but it also increases the burden of having to administrate distribution and use.

Mobile devices can pose many unique security challenges to an organization. Probably one of the biggest concerns is theft of intellectual property. For an employee with malicious intent, it would be a very simple process to connect a

4. [2]

mobile device either to a computer via the USB port, or wirelessly to the corporate network, and download confidential data. It would also be easy to secretly take a high-quality picture using a built-in camera.

When an employee does have permission to access and save company data on his or her device, a different security threat emerges. Namely, that device now becomes a target for thieves. Theft of mobile devices (in this case, including laptops) is one of the primary methods that data thieves use.

So what can be done to secure mobile devices? Begin with a good policy regarding their use. According to a 2013 SANS study, organizations should consider developing a mobile device policy that addresses the following issues: use of the camera, use of voice recording, application purchases, encryption at rest, Wi-Fi autoconnect settings, Bluetooth settings, VPN use, password settings, lost or stolen device reporting, and backup.⁵

Besides policies, there are several different tools that an organization can use to mitigate some of these risks. For example, if a device is stolen or lost, geolocation software can help the organization find it. In some cases, it may even make sense to install remote data removal software, which will remove data from a device if it becomes a security risk.

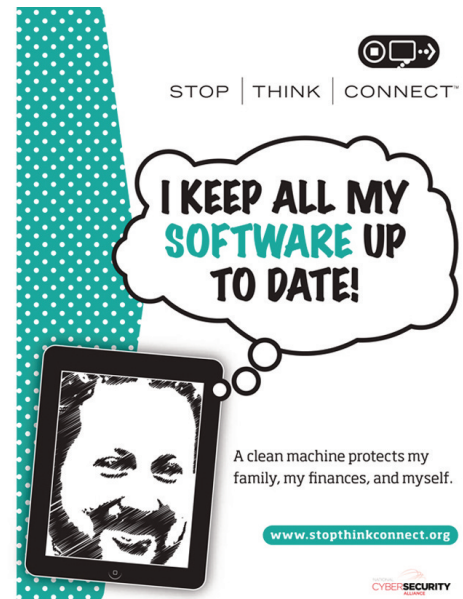
Usability

When looking to secure information resources, organizations must balance the need for security with users' needs to effectively access and use these resources. If a system's security measures make it difficult to use, then users will find ways around the security, which may make the system more vulnerable than it would have been without the security measures. Consider password policies. If the organization requires an extremely long password with several special characters, an employee may resort to writing it down and putting it in a drawer since it will be impossible to memorize.

Personal Information Security

As a final topic for this chapter, consider what measures each of us, as individual users, can take to secure our computing technologies. There is no way to have 100% security, but there are several simple steps each individual can take to be more secure.

- **Keep your software up to date.** Whenever a software vendor determines that a security flaw has been found in their software, an update will be released so you can download the patch to fix the problem. You should turn on automatic updating on your computer to automate this process.
- **Install antivirus software and keep it up to date.** There are many good antivirus software packages on the market today, including some that are free.
- **Be smart about your connections.** You should be aware of your surroundings. When connecting to a Wi-Fi network in a public place, be aware that you could be at risk of being spied on by others sharing that network. It is advisable not to access your financial or personal data while attached to a Wi-Fi hotspot. You should also be aware that connecting USB flash drives to your device could also put you at risk. Do not attach an unfamiliar flash drive to your device unless you can scan it first with your security software.
- **Backup your data.** Just as organizations need to backup their data, individuals need to so as well. The same rules apply. Namely, do it regularly and keep a copy of it in another location. One simple solution for this is to set up an account with an online backup service to automate your backups.
- **Secure your accounts with two-factor authentication.** Most e-mail and social media providers now have a two-factor authentication option. When you log in to your account from an unfamiliar computer for the first time, it sends you a text message with a code that you must enter to confirm that you are really you. This means that no one else can log in to your accounts without knowing your password *and* having your mobile phone with them.
- **Make your passwords long, strong, and unique.** Your personal passwords should follow the same rules that are recommended for organizations. Your passwords should be long (at least 12 random characters) and contain at least two of the following: uppercase and lowercase letters, digits, and special characters. Passwords should not include words that could be tied to your personal information, such as the name of your pet. You also should use different passwords for different accounts, so that if someone steals your password for one account, they still are locked out of your other accounts.
- **Be suspicious of strange links and attachments.** When you receive an e-mail, tweet, or Facebook post, be suspicious of any links or attachments included there. Do not click on the link directly if you are at all suspicious. Instead, if you want to access the website, find it yourself with your browser and navigate to it directly. The I Love You virus was distributed via email in May 2000 and contained an attachment which when opened copied itself into numerous folders on the user's computer and modified the operating system settings. An estimated 50,000 computers were affected, all of which could have been avoided if users had followed the warning to not open the attachment.



Stop.Think.Connect. poster (click to enlarge)

You can find more about these steps and many other ways to be secure with your computing by going to Stop. Think. Connect. This website is part of a campaign by the STOP. THINK. CONNECT. Messaging Convention in partnership with the U.S. government, including the White House.

Summary

As computing and networking resources have become more an integral part of business, they have also become a target of criminals. Organizations must be vigilant with the way they protect their resources. The same holds true for individuals. As digital devices become more intertwined in everyone's life, it becomes crucial for each person to understand how to protect themselves.

Study Questions

1. Briefly define each of the three members of the information security triad.
2. What does the term *authentication* mean?
3. What is multi-factor authentication?
4. What is role-based access control?
5. What is the purpose of encryption?
6. What are two good examples of a complex password?
7. What is pretexting?
8. What are the components of a good backup plan?
9. What is a firewall?
10. What does the term *physical security* mean?

Exercises

1. Describe one method of multi-factor authentication that you have experienced and discuss the pros and cons of using multi-factor authentication.
2. What are some of the latest advances in encryption technologies? Conduct some independent research on encryption using scholarly or practitioner resources, then write a two- to three-page paper that describes at least two new advances in encryption technology.
3. Find favorable and unfavorable articles about both blockchain and bitcoin. Report your findings, then state your own opinion about these technologies
4. What is the password policy at your place of employment or study? Do you have to change passwords every so often? What are the minimum requirements for a password?
5. When was the last time you backed up your data? What method did you use? In one to two pages, describe a method for backing up your data. Ask your instructor if you can get extra credit for backing up your data.
6. Find the information security policy at your place of employment or study. Is it a good policy? Does it meet the standards outlined in the chapter?
7. How diligent are you in keeping your own information secure? Review the steps listed in the chapter and comment on your security status.

Labs

1. **The Caesar Cipher.** One of the oldest methods of encryption was used by Julius Caesar and involved simply shifting text a specified number of positions in the alphabet. The number of shifted positions is known as the key. So a key = 3 would encrypt ZOO to CRR. Decrypt the following message which has a key = 3: FRPSXWHU
2. **The Vigenere Cipher.** This cipher was used as recently as the Civil War by the Confederate forces. The key is slightly more complex than the Caesar Cipher. Vigenere used the number of letters after 'A' for his key. For example, if the key = COD, the first letter in the cypher is shifted 2 characters (because "C" is 2 letters after the letter 'A'), the second letter is shifted 14 letters (O being 14 letters after 'A'), and the third letter is shifted 3 letters (D being 3 letters after 'A'). Then the pattern is repeated for subsequent letters. Decrypt the following message which has a key = COD: YSPGSWCHGCKQ
3. **Frequency and Pattern Analysis.** If you've ever watched Wheel of Fortune you know that contestants look for patterns and frequencies in trying to solve a puzzle. Your job in this lab is to analyze letter frequency and letter patterns to determine the plaintext message which in this case is a single word. The key is a simple substitution where the same letter in plaintext always results in the same letter in the cyphertext. The most frequently used letters in the English language are: E, A, O, I, T, S, N. Pattern analysis includes knowing words that have double letters such as "school." Other patterns include "ing" at the end of a word, "qu" and "th" as a pairs of letters. Cyphertext = CAGGJW what is the key and the plaintext?

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PART II

PART II: INFORMATION SYSTEMS FOR
STRATEGIC ADVANTAGE

7. Chapter 7: Does IT Matter?

Learning Objectives

Upon successful completion of this chapter, you will be able to:

- define the productivity paradox and explain the current thinking on this topic;
- evaluate Carr's argument in "Does IT Matter?";
- describe the components of competitive advantage; and
- describe information systems that can provide businesses with competitive advantage.

Introduction

For over fifty years, computing technology has been a part of business. Organizations have spent trillions of dollars on information technologies. But has all this investment in IT made a difference? Have there been increases in productivity? Are companies that invest in IT more competitive? This chapter looks at the value IT can bring to an organization and attempts to answer these questions. Two important works in the past two decades have attempted to address this issue.

The Productivity Paradox

In 1991, Erik Brynjolfsson wrote an article, published in the *Communications of the ACM*, entitled "The Productivity Paradox of Information Technology: Review and Assessment." After reviewing studies about the impact of IT investment on productivity, Brynjolfsson concluded that the addition of information technology to business had not improved productivity at all. He called this the "productivity paradox." While he did not draw any specific conclusions from his work,¹ he did provide the following analysis.

Although it is too early to conclude that IT's productivity contribution has been subpar, a paradox remains in our inability to unequivocally document any contribution after so much effort. The various explanations that have been proposed can be grouped into four categories:

- 1) **Mismeasurement** of outputs and inputs
- 2) **Lags** due to learning and adjustment

1. [1]

- 3) **Redistribution** and dissipation of profits
- 4) **Mismanagement** of information and technology

In 1998, Brynjolfsson and Lorin Hitt published a follow-up paper entitled “Beyond the Productivity Paradox”^[2] In this paper, the authors utilized new data that had been collected and found that IT did, indeed, provide a positive result for businesses. Further, they found that sometimes the true advantages in using technology were not directly relatable to higher productivity, but to “softer” measures, such as the impact on organizational structure. They also found that the impact of information technology can vary widely between companies.

IT Doesn't Matter

Just as a consensus was forming about the value of IT, the Internet stock market bubble burst. Two years later in 2003, Harvard professor Nicholas Carr wrote his article “IT Doesn't Matter” in the *Harvard Business Review*. In this article Carr asserted that as information technology had become ubiquitous, it has also become less of a differentiator, much like a commodity. Products that have the same features and are virtually indistinguishable are considered to be commodities. Price and availability typically become the only discriminators when selecting a source for a commodity. In Carr's view all information technology was the same, delivering the same value regardless of price or supplier. Carr suggested that since IT is essentially a commodity, it should be managed like one. Just select the one with the lowest cost this is most easily accessible. He went on to say IT management should see themselves as a utility within the company and work to keep costs down. For Carr IT's goal is to provide the best service with minimal downtime. Carr saw no competitive advantage to be gained through information technology.

As you can imagine, this article caused quite an uproar, especially from IT companies. Many articles were written in defense of IT while others supported Carr. In 2004 Carr released a book based on the article entitled *Does IT Matter?* A year later he was interviewed by CNET on the topic “IT still doesn't matter.” Click here to watch the video of Carr being interviewed about his book on CNET.

Probably the best thing to come out of the article and subsequent book were discussions on the place of IT in a business strategy, and exactly what role IT could play in competitive advantage. That is the question to be addressed in this chapter.

Competitive Advantage

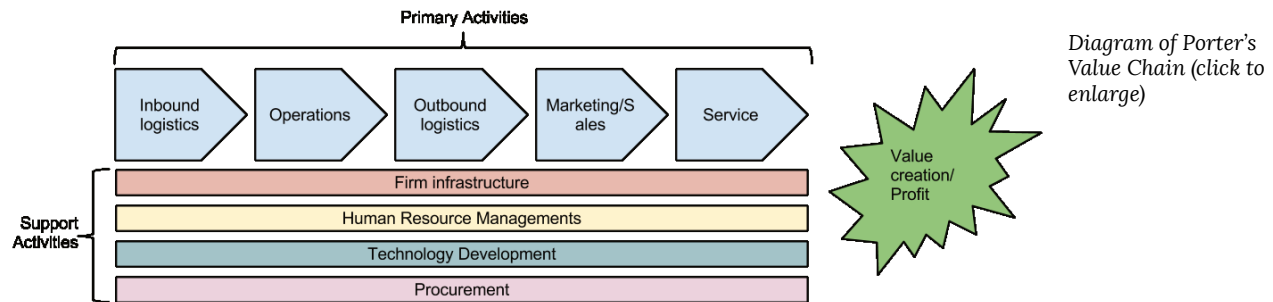
What does it mean when a company has a competitive advantage? What are the factors that play into it? Michael Porter in his book *Competitive Advantage: Creating and Sustaining Superior Performance*. writes that a company is said to have a competitive advantage over its rivals when it is able to sustain profits that exceed the average for the industry. According to Porter, there are two primary methods for obtaining competitive advantage: cost advantage and differentiation advantage.² So the question for I.T. becomes: *How can information technology be a factor in one or both of these methods?*

The following sections address this question by using two of Porter's analysis tools: the value chain and the five forces model. Porter's analysis in his 2001 article “Strategy and the Internet,” which examines the impact of the Internet on

2. [3]

business strategy and competitive advantage, will be used to shed further light on the role of information technology in gaining competitive advantage.³

The Value Chain



In his book *Competitive Advantage: Creating and Sustaining Performance* Porter describes exactly how a company can create value and therefore profit. Value is built through the value chain: a series of activities undertaken by the company to produce a product or service. Each step in the value chain contributes to the overall value of a product or service. While the value chain may not be a perfect model for every type of company, it does provide a way to analyze just how a company is producing value. The value chain is made up of two sets of activities: primary activities and support activities. An explanation of these activities and a discussion of how information technology can play a role in creating value by contributing to cost advantage or differentiation advantage appears next.

Primary activities are the functions that directly impact the creation of a product or service. The goal of a primary activity is to add value that is greater than the cost of that activity. The primary activities are:

- **Inbound logistics.** These are the processes that bring in raw materials and other needed inputs. Information technology can be used to make these processes more efficient, such as with supply-chain management systems which allow the suppliers to manage their own inventory.
- **Operations.** Any part of a business that converts the raw materials into a final product or service is a part of operations. From manufacturing to business process management (covered in Chapter 8), information technology can be used to provide more efficient processes and increase innovation through flows of information.
- **Outbound logistics.** These are the functions required to get the product out to the customer. As with inbound logistics, IT can be used here to improve processes, such as allowing for real-time inventory checks. IT can also be a delivery mechanism itself.
- **Sales/Marketing.** The functions that will entice buyers to purchase the products are part of sales and marketing. Information technology is used in almost all aspects of this activity. From online advertising to online surveys, IT can be used to innovate product design and reach customers as never before. The company website can be a sales channel itself.
- **Service.** Service activity involves the functions a business performs after the product has been purchased to maintain and enhance the product's value. Service can be enhanced via technology as well, including support services through websites and knowledge bases.

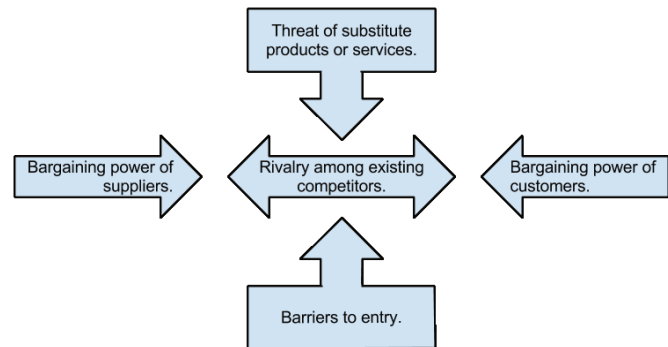
The support activities are the functions in an organization that support all of the primary activities. Support activities can be considered indirect costs to the organization. The support activities are:

- **Firm infrastructure.** An organization's infrastructure includes finance, accounting, ERP systems (covered in Chapter 9) and quality control. All of these depend on information technology and represent functions where I.T. can have a positive impact.
- **Human Resource Management** Human Resource Management (HRM) consists of recruiting, hiring, and other services needed to attract and retain employees. Using the Internet, HR departments can increase their reach when looking for candidates. I.T. also allows employees to use technology for a more flexible work environment.
- **Technology development.** Technology development provides innovation that supports primary activities. These advances are integrated across the firm to add value in a variety of departments. Information technology is the primary generator of value in this support activity.
- **Procurement.** Procurement focuses on the acquisition of raw materials used in the creation of products. Business-to-business e-commerce can be used to improve the acquisition of materials.

This analysis of the value chain provides some insight into how information technology can lead to competitive advantage. Another important concept from Porter is the "Five Forces Model."

Porter's Five Forces

Porter developed the Five Forces model as a framework for industry analysis. This model can be used to help understand the degree of competition in an industry and analyze its strengths and weaknesses. The model consists of five elements, each of which plays a role in determining the average profitability of an industry. In 2001 Porter wrote an article entitled "Strategy and the Internet," in which he takes this model and looks at how the Internet impacts the profitability of an industry. Below is a quick summary of each of the Five Forces and the impact of the Internet.



Porter's Five Forces (click to enlarge)

- **Threat of substitute products or services.** The first force challenges the user to consider the likelihood of another produce or service replacing the product or service you offer. The more types of products or services there are that can meet a particular need, the less profitability there will be in an industry. In the communications industry, the smartphone has largely replaced the pager. In some construction projects, metal studs have replaced wooden studs for framing. The Internet has made people more aware of substitute products, driving down industry profits in those industries in which substitution occurs. Please notice that substitution refers to a product being replaced by a similar product for the purpose of accomplishing the same task. It does not mean dissimilar products or services such as flying to a destination rather than traveling by rail.
- **Bargaining power of suppliers.** A supplier's bargaining power is strong when there are few suppliers from which your company can obtain a needed product or service. Conversely, when there are many suppliers their bargaining power is lower since your company would have many sources from which to source a product. When your company has several suppliers to choose from, you can negotiate a lower price. When a sole supplier exists, then your company is at the mercy of the supplier. For example, if only one company makes the controller chip for a car engine, that company can control the price, at least to some extent. The Internet has given companies access to

more suppliers, driving down prices.

- **Bargaining power of customers.** A customer's bargaining power is strong when your company along with your competitors is attempting to provide the same product to this customer. In this instance the customer has many sources from which to source a product so they can approach your company and seek a price reduction. If there are few suppliers in your industry, then the customer's bargaining power is considered low.
- **Barriers to entry.** The easier it is to enter an industry, the more challenging it will be to make a profit in that industry. Imagine you are considering starting a lawn mowing business. The entry barrier is very low since all you need is a law mower. No special skills or licenses are required. However, this means your neighbor next door may decide to start mowing lawns also, resulting in increased competition. In contrast a highly technical industry such as manufacturing of medical devices has numerous barriers to entry. You would need to find numerous suppliers for various components, hire a variety of highly skilled engineers, and work closely with the Food and Drug Administration to secure approval for the sale of your products. In this example the barriers to entry are very high so you should expect few competitors.
- **Rivalry among existing competitors:** Rivalry among existing competitors helps you evaluate your entry into the market. When rivalry is fierce, each competitor is attempting to gain additional market share from the others. This can result in aggressive pricing, increasing customer support, or other factors which might lure a customer away from a competitor. Markets in which rivalry is low may be easier to enter and become profitable sooner because all of the competitors are accepting of each other's presence.

Porter's five forces are used to analyze an industry to determine the average profitability of a company within that industry. Adding in Porter's analysis of the Internet to his Five Forces results in the realization that technology has lowered overall profitability.⁴

Using Information Systems for Competitive Advantage

Having learned about Porter's Five Forces and their impact on a firm's ability to generate a competitive advantage, it is time to look at some examples of competitive advantage. A strategic information system is designed specifically to implement an organizational strategy meant to provide a competitive advantage. These types of information systems began popping up in the 1980s, as noted in a paper by Charles Wiseman entitled "Creating Competitive Weapons From Information Systems."⁵

A strategic information system attempts to do one or more of the following:

- Deliver a product or a service at a lower cost;
- Deliver a product or service that is differentiated;
- Help an organization focus on a specific market segment;
- Enable innovation.

Here are some examples of information systems that fall into this category.

4. [5]

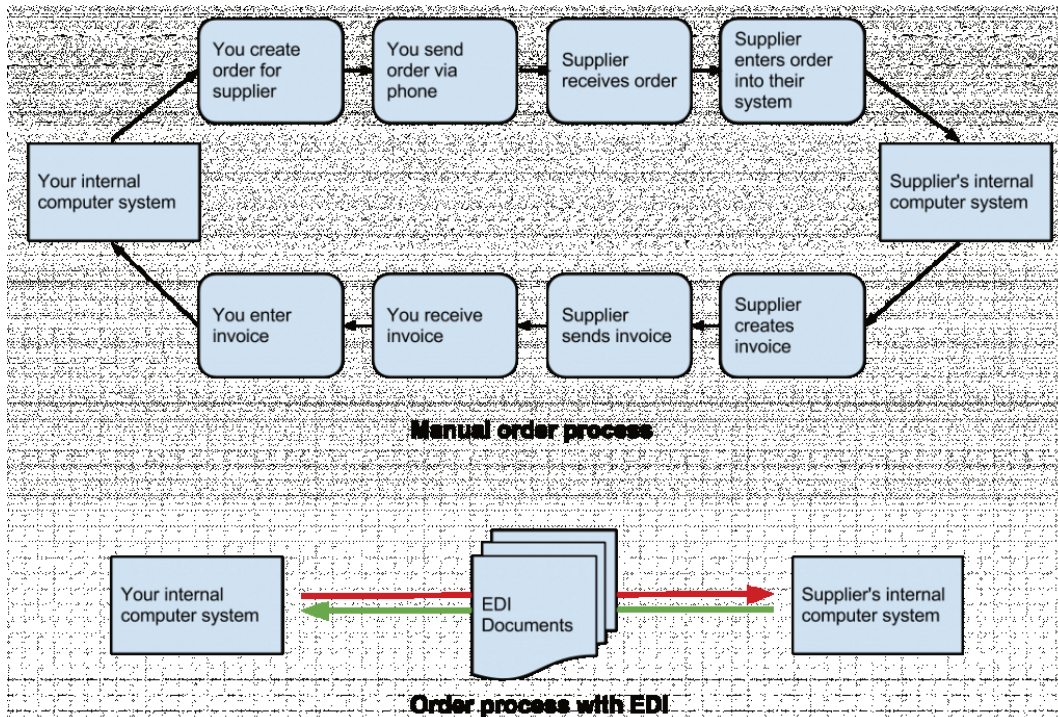
5. [6]

Business Process Management Systems

In their book, *IT Doesn't Matter – Business Processes Do*, Howard Smith and Peter Fingar argue that it is the integration of information systems with business processes that leads to competitive advantage. The authors state that Carr's article is dangerous because it gave CEOs and IT managers approval to start cutting their technology budgets, putting their companies in peril. True competitive advantage can be found with information systems that support business processes. Chapter 8 focuses on the use of business processes for competitive advantage.

Electronic Data Interchange

Electronic Data Interchange (EDI) provides a competitive advantage through integrating the supply chain electronically. EDI can be thought of as the *computer-to-computer exchange of business documents in a standard electronic format between business partners*. By integrating suppliers and distributors via EDI, a company can vastly reduce the resources required to manage the relevant information. Instead of manually ordering supplies, the company can simply place an order via the computer and the products are ordered.



Comparison of process with and without EDI (click to enlarge)

Collaborative Systems

As organizations began to implement networking technologies, information systems emerged that allowed employees to begin collaborating in different ways. These systems allowed users to brainstorm ideas together without the necessity of physical, face-to-face meetings. Tools such as video conferencing with Skype or WebEx, collaboration and document sharing with Microsoft SharePoint, and project management with SAP's Project System make collaboration possible in a variety of endeavors.

Broadly speaking, any software that allows multiple users to interact on a document or topic could be considered collaborative. Electronic mail, a shared Word document, and social networks fall into this broad definition. However, many software tools have been created that are designed specifically for collaborative purposes. These tools offer a broad spectrum of collaborative functions. Here is just a short list of some collaborative tools available for businesses today:

- Google Drive. Google Drive offers a suite of office applications (such as a word processor, spreadsheet, drawing, presentation) that can be shared between individuals. Multiple users can edit the documents at the same time and the threaded comments option is available.
- Microsoft SharePoint. SharePoint integrates with Microsoft Office and allows for collaboration using tools most office workers are familiar with. SharePoint was covered in greater detail in chapter 5.
- Cisco WebEx. WebEx combines video and audio communications and allows participants to interact with each other's computer desktops. WebEx also provides a shared whiteboard and the capability for text-based chat to be going on during the sessions, along with many other features. Mobile editions of WebEx allow for full participation using smartphones and tablets.
- GitHub. Programmers/developers use GitHub for web-based team development of computer software.

Decision Support Systems

A decision support system (DSS) helps an organization make a specific decision or set of decisions. DSSs can exist at different levels of decision-making within the organization, from the CEO to first level managers. These systems are designed to take inputs regarding a known (or partially-known) decision making process and provide the information necessary to make a decision. DSSs generally assist a management level person in the decision-making process, though some can be designed to automate decision-making.

An organization has a wide variety of decisions to make, ranging from highly structured decisions to unstructured decisions. A structured decision is usually one that is made quite often, and one in which the decision is based directly on the inputs. With structured decisions, once you know the necessary information you also know the decision that needs to be made. For example, inventory reorder levels can be structured decisions. Once your inventory of widgets gets below a specific threshold, automatically reorder ten more. Structured decisions are good candidates for automation, but decision-support systems are generally not built for them.

An unstructured decision involves a lot of unknowns. Many times unstructured decisions are made for the first time. An information system can support these types of decisions by providing the decision makers with information gathering tools and collaborative capabilities. An example of an unstructured decision might be dealing with a labor issue or setting policy for the implementation of a new technology.

Decision support systems work best when the decision makers are having to make semi-structured decisions. A semi-structured decision is one in which most of the factors needed for making the decision are known but human experience and other outside factors may still impact the decision. A good example of an semi-structured decision would be diagnosing a medical condition (see sidebar).

As with collaborative systems, DSSs can come in many different formats. A nicely designed spreadsheet that allows for input of specific variables and then calculates required outputs could be considered a DSS. Another DSS might be one that assists in determining which products a company should develop. Input into the system could include market research on the product, competitor information, and product development costs. The system would then analyze these inputs based on the specific rules and concepts programmed into it. The system would report its results with recommendations and/or key indicators to be used in making a decision. A DSS can be looked at as a tool for

competitive advantage because it can give an organization a mechanism to make wise decisions about products and innovations.

Sidebar: Isabel – A Health Care DSS

Isabel screen shot
Isabel screen shot

A discussed in the text, DSSs are best applied to semi-structured decisions, in which most of the needed inputs are known but human experience and environmental factors also

play a role. A good example for today is Isabel, a health care DSS. The creators of Isabel explain how it works:

Isabel uses the information routinely captured during your workup, whether free text or structured data, and instantaneously provides a diagnosis checklist for review. The checklist contains a list of possible diagnoses with critical “Don’t Miss Diagnoses” flagged. When integrated into your Electronic Medical Records (EMR) system, Isabel can provide “one click” seamless diagnosis support with no additional data entry.⁶

Investing in IT for Competitive Advantage

In 2008, Brynjolfsson and McAfee published a study in the *Harvard Business Review* on the role of IT in competitive advantage, entitled “Investing in the IT That Makes a Competitive Difference.” Their study confirmed that IT *can* play a role in competitive advantage if deployed wisely. In their study, they drew three conclusions⁷:

- First, the data show that IT has sharpened differences among companies instead of reducing them. This reflects the fact that while companies have always varied widely in their ability to select, adopt, and exploit innovations, technology has accelerated and amplified these differences.
- Second, good management matters. Highly qualified vendors, consultants, and IT departments might be necessary for the successful implementation of enterprise technologies themselves, but the real value comes from the process innovations that can now be delivered on those platforms. Fostering the right innovations and propagating them widely are both executive responsibilities – ones that can’t be delegated.
- Finally, the competitive shakeup brought on by IT is not nearly complete, even in the IT-intensive US economy. You can expect to see these altered competitive dynamics in other countries, as well, as their IT investments grow.

Information systems can be used for competitive advantage, but they must be used strategically. Organizations must understand how they want to differentiate themselves and then use all the elements of information systems (hardware, software, data, people, and process) to accomplish that differentiation.

6. [7]

7. [8]

Summary

Information systems are integrated into all components of business today, but can they bring competitive advantage? Over the years, there have been many answers to this question. Early research could not draw any connections between IT and profitability, but later studies have shown that the impact can be positive. IT is not a panacea. Just purchasing and installing the latest technology will not by itself make a company more successful. Instead, the combination of the right technologies and good management will give a company the best chance for a positive result.

Study Questions

1. What is the productivity paradox?
2. Summarize Carr's argument in "Does IT Matter?"
3. How is the 2008 study by Brynjolfsson and McAfee different from previous studies? How is it the same?
4. What does it mean for a business to have a competitive advantage?
5. What are the primary activities and support activities of the value chain?
6. What has been the overall impact of the Internet on industry profitability? Who has been the true winner?
7. How does EDI work?
8. Give an example of a semi-structured decision and explain what inputs would be necessary to provide assistance in making the decision.
9. What does a collaborative information system do?
10. How can IT play a role in competitive advantage, according to the 2008 article by Brynjolfsson and McAfee?

Exercises

1. Analyze Carr's position in regards to PC vs. Mac, Open Office vs. Microsoft Office, and Microsoft Powerpoint vs. Tableau.
2. Do some independent research on Nicholas Carr (the author of "IT Doesn't Matter") and explain his current position on the ability of IT to provide competitive advantage.
3. Review the WebEx website. What features of WebEx would contribute to good collaboration? Compare WebEx with other collaboration tools such as Skype or Google Hangouts?

Lab

1. Think of a semi-structured decision that you make in your daily life and build your own DSS using a spreadsheet that would help you make that decision.
-

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8. McAfee, A. and Brynjolfsson, E. (2008, July–August). Investing in the IT That Makes a Competitive Difference. *Harvard Business Review*. ↵

8. Chapter 8: Business Processes

Learning Objectives

Upon successful completion of this chapter, you will be able to:

- define the term *business process*;
- understand the tools of documentation of business processes;
- identify the different systems needed to support business processes in an organization;
- explain the value of an enterprise resource planning (ERP) system;
- explain how business process management and business process reengineering work; and
- understand how information technology combined with business processes can bring an organization competitive advantage.

Introduction

The fourth component of information systems is *process*. But what is a process and how does it tie into information systems? And in what ways do processes have a role in business? This chapter looks to answer those questions and also describe how business processes can be used for strategic advantage.

What Is a Business Process?

We have all heard the term process before, but what exactly does it mean? A process is a series of tasks that are completed in order to accomplish a goal. A business process, therefore, is a process that is focused on achieving a goal for a business. Processes are something that businesses go through every day in order to accomplish their mission. The better their processes, the more effective the business. Some businesses see their processes as a strategy for achieving competitive advantage. A process that achieves its goal in a unique way can set a company apart. A process that eliminates costs can allow a company to lower its prices (or retain more profit). If you have worked in a business setting, you have participated in a business process. Anything from a simple process for making a sandwich at Subway to building a space shuttle utilizes one or more business processes. In the context of information systems, a business process is a set of business activities performed by human actors and/or the information system to accomplish a specific outcome.

Documenting a Process

Every day each of us will perform many processes without even thinking about them such as getting ready for work, using an ATM, texting a friend, etc. As processes grow more complex, documenting becomes necessary. It is essential for businesses to do this because it allows them to ensure control over how activities are undertaken in their organization. It also allows for standardization. For example, McDonald's has the same process for building a Big Mac in all of its restaurants.

The simplest way to document a process is to just create a list. The list shows each step in the process. Each step can be checked off upon completion. A simple process such as how to create an account on gmail might look like this:

1. Go to gmail.com.
2. Click "Create account."
3. Enter your contact information in the "Create your Google Account" form.
4. Choose your username and password.
5. Agree to User Agreement and Privacy Policy by clicking on "Submit."

For processes that are not so straightforward, documenting all of the steps as a checklist may not be sufficient. For example, here is the process for determining if an article for a term needs to be added to Wikipedia:

1. Search Wikipedia to determine if the term already exists.
2. If the term is found, then an article is already written, so you must think of another term. Go to step 1.
3. If the term is not found, then look to see if there is a related term.
4. If there is a related term, then create a redirect.
5. If there is not a related term, then create a new article.

This procedure is relatively simple. In fact it has the same number of steps as the previous example, but because it has some decision points, it is more difficult to track as a simple list. In these cases it may make more sense to use a diagram to document the process.

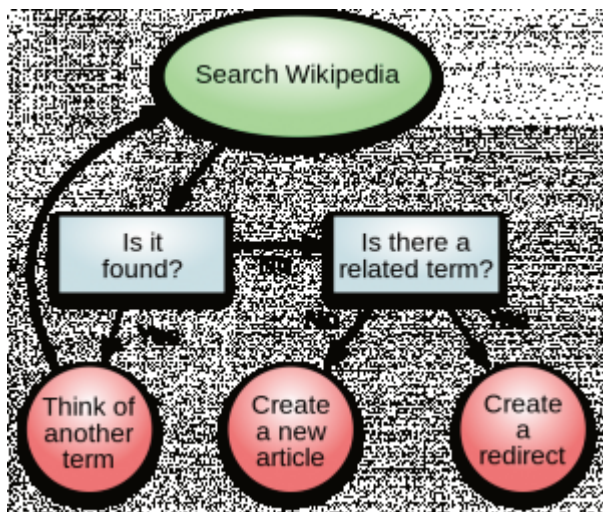


Diagram of an example business process (click to enlarge)

Business Process Modeling Notation

A diagramming tool for documentation of business process is a formalized visual language that provides systems analysts with the ability to describe the business processes unambiguously, to visualize the business processes for systematic understanding, and to communicate the business process for business process management. Natural languages (e.g., English) are incapable to explain complex business processes. Diagrams have been used as tools for business process modeling in the information systems field. There have been many types of

business process diagramming tools, and each of them has its own style and syntax to serve its particular purpose. The most commonly used business process diagramming tools are Business Process Modeling Notation (BPMN), Data Flow Diagram (DFD), and the Unified Modeling Language (UML).

BPMN is an extension of the traditional flowchart method by adding more diagramming elements for descriptions of

business process. The objective of BPMN is to support business process documentation by providing intuitive notations for business rules. The flowchart style diagrams in BPMN can provide detailed specifications business processes from start to end. However, BPMN is short of the ability of system decomposition for large information systems.

DFD has served as a foundation of many other tools of documentation of business process. The central concept of DFD is a top-down approach to understanding a system. The top-down approach is consistent with the system concept that views a system in a holistic manner and concerns an understanding of a system by examining the components and their interactions within the system. More importantly, while describing a business process by using DFD, the data stores used in the process and generated data flows in the process are also defined. We will provide an example of DFD in the Sidebar section of this chapter to illustrate the integration of data and business tasks in documenting a business process.

The Unified Modeling Language (UML) is a general-purpose modeling tool in the field of software engineering for constructing all types of computerized systems. UML includes a set of various types of diagrams with different subjects of modeling and diversified graphics styles. The diversified diagrams in UML can provide detailed specifications for software engineering in many perspectives for construction of information systems, but could be too complicated for documenting business processes from the perspective of business process management.

Managing Business Process Documentation

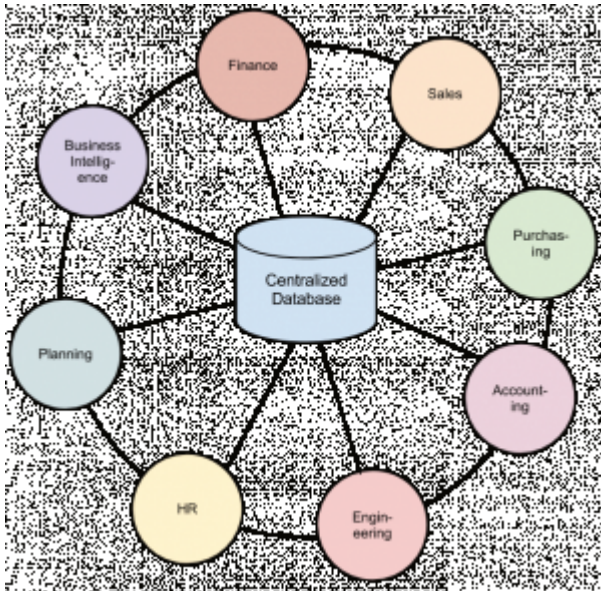
As organizations begin to document their processes, it becomes an administrative responsibility to keep track of them. As processes change and improve, it is important to know which processes are the most recent. It is also important to manage the process so that it can be easily updated. The requirement to manage process documentation has been one of the driving forces behind the creation of the *document management system*. A document management system stores and tracks documents and supports the following functions.

- **Versions and timestamps.** The document management system will keep multiple versions of documents. The most recent version of a document is easy to identify and will be considered the default.
- **Approvals and workflows.** When a process needs to be changed, the system will manage both access to the documents for editing and the routing of the document for approval.
- **Communication.** When a process changes, those who implement the process need to be made aware of the changes. The document management system will notify the appropriate people when a change to a document has been approved.

Of course, document management systems are not only used for managing business process documentation. Many other types of documents are managed in these systems, such as legal documents or design documents.

ERP Systems

An Enterprise Resource Planning (ERP) system is software with a centralized database that can be used to run an entire company. Here are some of the main components of an ERP system.



An ERP System (click to enlarge)

Computer program. The system is a computer program, which means that it has been developed with specific logic and rules behind it. It is customized and installed to work specifically for an individual organization.

Centralized database. All data in an ERP system is stored in a single, central database. Centralization is key to the success of an ERP. Data entered in one part of the company can be immediately available to other parts of the company.

Used to run an entire company. An ERP can be used to manage an entire organization's operations. Companies can purchase modules for an ERP that represent different functions within the organization such as finance, manufacturing, and sales. Some companies choose to purchase many modules, others choose a subset of the modules.

An ERP system not only centralizes an organization's data, but the processes it enforces are the processes the organization has adopted.

When an ERP vendor designs a module, it has to implement the rules for the associated business processes. Best practices can be built into the ERP – a major selling point for ERP. In other words, when an organization implements an ERP, it also gets improved best practices as part of the deal.

For many organizations the implementation of an ERP system is an excellent opportunity to improve their business practices and upgrade their software at the same time. But for others an ERP brings a challenge. Is the process embedded in the ERP really better than the process they are currently utilizing? And if they implement this ERP and it happens to be the same one that all of their competitors have, will they simply become more like them, making it much more difficult to differentiate themselves? A large organization may have one version of the ERP, then acquire a subsidiary which has a more recent version. Imagine the challenge of requiring the subsidiary to change back to the earlier version.

One of the criticisms of ERP systems has been that they commoditize business processes, driving all businesses to use the same processes and thereby lose their uniqueness. The good news is that ERP systems also have the capability to be configured with custom processes. For organizations that want to continue using their own processes or even design new ones, ERP systems offer customization so the ERP is unique to the organization.



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There is a drawback to customizing an ERP system. Namely, organizations have to maintain the changes themselves. Whenever an update to the ERP system comes out, any organization that has created a custom process will be required to add that change to their new ERP version. This requires someone to maintain a listing of these changes as well as re-testing the system every time an upgrade is made. Organizations will have to wrestle with this decision. When should they go ahead and accept the best-practice processes built into the ERP system and when should they spend the resources to develop their own processes?

Some of the best-known ERP vendors are SAP, Microsoft, and Oracle.

Business Process Management

Organizations that are serious about improving their business processes will also create structures to manage those processes. Business process management (BPM) can be thought of as an intentional effort to plan, document, implement, and distribute an organization's business processes with the support of information technology.

BPM is more than just automating some simple steps. While automation can make a business more efficient, it cannot be used to provide a competitive advantage. BPM, on the other hand, can be an integral part of creating that advantage.

Not all of an organization's processes should be managed this way. An organization should look for processes that are essential to the functioning of the business and those that may be used to bring a competitive advantage. The best processes to look at are those that include employees from multiple departments, those that require decision-making that cannot be easily automated, and processes that change based on circumstances. Here is an example.

Suppose a large clothing retailer is looking to gain a competitive advantage through superior customer service. A task force is created to develop a state-of-the-art returns policy that allows customers to return any article of clothing, no questions asked. The organization also decides that, in order to protect the competitive advantage that this returns policy will bring, they will develop their own customization to their ERP system to implement this returns policy. In preparation for the rollout of the system, all customer service employees are trained, showing how to use the new system and specifically how to process returns. Once the updated returns process is implemented, the organization will be able to measure several key indicators about returns that will allow them to adjust the policy as needed. For example, if it is determined that many women are returning their high-end dresses after wearing them once, they could implement a change to the process that limits the return period to 14 days from the original purchase date. As changes to the returns policy are made, the changes are rolled out via internal communications and updates to the returns processing on the system are made.

If done properly, business process management will provide several key benefits to an organization, which can be used to contribute to competitive advantage. These benefits include:

- **Empowering employees.** When a business process is designed correctly and supported with information technology, employees will be able to implement it on their own authority. In the returns policy example, an employee would be able to accept returns made before fourteen days or use the system to make determinations on what returns would be allowed after fourteen days.
- **Built-in reporting.** By building measurement into the programming, the organization can stay current on key metrics regarding their processes. In this example, these can be used to improve the returns process and also, ideally, to reduce returns.
- **Enforcing best practices.** As an organization implements processes supported by information systems, it can work to implement the best practices for that class of business process. In this example, the organization may want to require that all customers returning a product without a receipt show a legal ID. This requirement can be built into the system so that the return will not be processed unless a valid ID number is entered.
- **Enforcing consistency.** By creating a process and enforcing it with information technology, it is possible to create consistency across the entire organization. In this example, all stores in the retail chain can enforce the same returns policy. If the returns policy changes, the change can be instantly enforced across the entire chain.

Business Process Re-engineering

As organizations look to manage their processes to gain a competitive advantage, it is also important to understand that

existing ways of doing things may not be the most effective or efficient. A process developed in the 1950s is not going to be better just because it is now supported by technology.

In 1990 Michael Hammer published an article in the *Harvard Business Review* entitled “Reengineering Work: Don’t Automate, Obliterate.” This article suggested that simply automating a bad process does not make it better. Instead, companies should “blow up” their existing processes and develop new processes that take advantage of the new technologies and concepts. He states in the introduction to the article:

Many of our job designs, work flows, control mechanisms, and organizational structures came of age in a different competitive environment and before the advent of the computer. They are geared towards greater efficiency and control. Yet the watchwords of the new decade are innovation and speed, service, and quality.

It is time to stop paving the cow paths. Instead of embedding outdated processes in silicon and software, we should obliterate them and start over. We should “re-engineer” our businesses: use the power of modern information technology to radically redesign our business processes in order to achieve dramatic improvements in their performance.¹

Business Process Re-engineering (BPR) is not just taking an existing process and automating it. BPR is fully understanding the goals of a process and then dramatically redesigning it from the ground up to achieve dramatic improvements in productivity and quality. But this is easier said than done. Most people think in terms of how to do small, local improvements to a process. Complete redesign requires thinking on a larger scale. Hammer provides some guidelines for how to go about doing business process re-engineering:

- **Organize around outcomes, not tasks.** This simply means design the process so that, if possible, one person performs all the steps. Instead of passing the task on to numerous people, one person does the entire process, resulting in greater speed and customer responsiveness.
- **Have those who use the outcomes of the process perform the process.** With the use of information technology many simple tasks are now automated so the person who needs the outcome should be empowered to perform it. Hammer provides the following example. Instead of having every department in the company use a purchasing department to order supplies, have the supplies ordered directly by those who need the supplies using an information system.
- **Merge information processing work into the real work that produces the information.** When one part of the company creates information, such as sales information or payment information, it should be processed by that same department. There is no need for one part of the company to process information created in another part of the company.
- **Treat geographically dispersed resources as though they were centralized.** With the communications technologies available today, it becomes easier than ever to focus on physical location. A multinational organization does not need separate support departments (such as IT, purchasing, etc.) for each location anymore.
- **Link parallel activities instead of integrating their results.** Departments that work in parallel should be sharing data and communicating with each other during a process instead of waiting until each group is done and then comparing notes. The outdated concept of only linking outcomes results in re-work, increased costs, and delays.
- **Put the decision points where the work is performed, and build controls into the process.** The people who do the work should have decision making authority and the process itself should have built-in controls using information technology. Today’s workforce is more educated and knowledgeable than in the past so providing workers with information technology can result in the employees controlling their processes.
- **Capture information at the source.** Requiring information to be entered more than once causes delays and errors. With information technology, an organization can capture it once and then make it available whenever needed.

1. [1]

These principles may seem like common sense today, but in 1990 they took the business world by storm. Hammer gives example after example of how organizations improved their business processes by many orders of magnitude without adding any new employees, simply by changing how they did things (see sidebar).

Unfortunately, business process re-engineering got a bad name in many organizations. This was because it was used as an excuse for cost cutting that really had nothing to do with BPR. For example, many companies simply used it as a reason for laying off part of their workforce. However, today many of the principles of BPR have been integrated into businesses and are considered part of good business-process management.

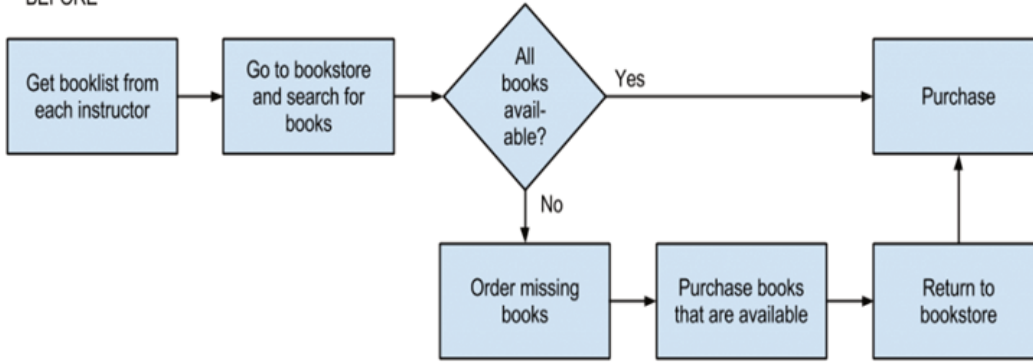
Sidebar: Reengineering the College Bookstore

The process of purchasing the correct textbooks in a timely manner for college classes has always been problematic. Now with online bookstores competing directly with the college bookstore for students' purchases, the college bookstore is under pressure to justify its existence.

But college bookstores have one big advantage over their competitors, namely they have access to students' data. Once a student has registered for classes, the bookstore knows exactly what books that student will need for the upcoming term. To leverage this advantage and take advantage of new technologies, the bookstore wants to implement a new process that will make purchasing books through the bookstore advantageous to students. Though they may not be able to compete on price, they can provide other advantages such as reducing the time it takes to find the books and the ability to guarantee that the book is the correct one for the class. In order to do this, the bookstore will need to undertake a process redesign.

The goal of the process redesign is simple. Capture a higher percentage of students as customers of the bookstore. After diagramming the existing process and meeting with student focus groups, the bookstore comes up with a new process. In the new process the bookstore utilizes information technology to reduce the amount of work the students need to do in order to get their books. In this new process the bookstore sends the students an e-mail with a list of all the books required for their upcoming classes. By clicking a link in this e-mail the students can log into the bookstore, confirm their books, and complete the purchase. The bookstore will then deliver the books to the students. And there is an additional benefit to the faculty: Professors are no longer asked to delay start of semester assignments while students wait for books to arrive in the mail. Instead, students can be expected to promptly complete their assignments and the course proceeds on schedule.

BEFORE

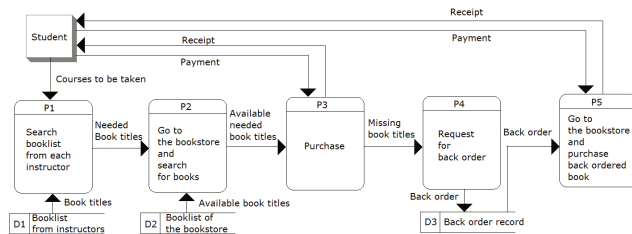


REDESIGNED



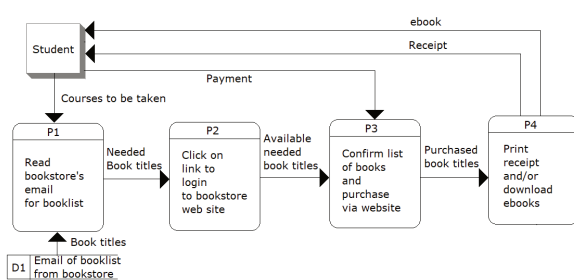
Here are the changes to this process shown as data flow diagrams:

BEFORE



College bookstore data flow diagram (original) (Click to enlarge)

REDESIGNED



College bookstore data flow diagram (redesigned) (Click to enlarge)

Sidebar: ISO Certification

Many organizations now claim that they are using best practices when it comes to business processes. In order to set themselves apart and prove to their customers, and potential customers, that they are indeed doing this, these organizations are seeking out an ISO 9000 certification. ISO is an acronym for International Standards Organization (website here). This body defines quality standards that organizations can implement to show that they are, indeed, managing business processes in an effective way. The ISO 9000 certification is focused on quality management.

In order to receive ISO certification, an organization must be audited and found to meet specific criteria. In its most simple form, the auditors perform the following review.

- Tell me what you do (*describe the business process*).
- Show me where it says that (*reference the process documentation*).
- Prove that this is what happened (*exhibit evidence in documented records*).

Over the years, this certification has evolved and many branches of the certification now exist. ISO certification is one way to separate an organization from others. You can find out more about the ISO 9000 standard here.

Summary

The advent of information technologies has had a huge impact on how organizations design, implement, and support business processes. From document management systems to ERP systems, information systems are tied into organizational processes. Using business process management, organizations can empower employees and leverage their processes for competitive advantage. Using business process reengineering, organizations can vastly improve their effectiveness and the quality of their products and services. Integrating information technology with business processes is one way that information systems can bring an organization lasting competitive advantage.

Study Questions

1. What does the term *business process* mean?
2. What are three examples of business process from a job you have had or an organization you have observed?
3. What is the value in documenting a business process?
4. What is an ERP system? How does an ERP system enforce best practices for an organization?
5. What is one of the criticisms of ERP systems?
6. What is business process re-engineering? How is it different from incrementally improving a process?
7. Why did BPR get a bad name?
8. List the guidelines for redesigning a business process.
9. What is business process management? What role does it play in allowing a company to differentiate itself?
10. What does ISO certification signify?

Exercises

1. Think of a business process that you have had to perform in the past. How would you document this process? Would a diagram make more sense than a checklist? Document the process both as a checklist and as a diagram.
2. Review the return policies at your favorite retailer, then answer this question. What information systems do you think would need to be in place to support their return policy?
3. If you were implementing an ERP system, in which cases would you be more inclined to modify the ERP to match your business processes? What are the drawbacks of doing this?
4. Which ERP is the best? Do some original research and compare three leading ERP systems to each other. Write a two- to three-page paper that compares their features.

Labs

1. Visit a fast food restaurant of your choice. Observe the processes used in taking an order, filling the order, and receiving payment. Create a flowchart showing the steps used. Then create a second flowchart indicating where you would recommend improvements to the processes.
2. Virginia Mason Medical Center, located in Seattle, Washington, needed to radically change some of their business processes. Download the case study. Then read the case study and respond to the following items.
 1. Number of campuses
 2. Number of employees
 3. Number of physicians
 4. Nature of the issue at Virginia Mason
 5. "You cannot improve a process until..."
 6. Discuss staff walking distance and inventory levels
 7. How were patient spaces redesigned?
 8. What happened to walking distance after this redesign?
 9. Inventory was reduced by what percent?
 10. Total cost savings =

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1. Hammer, M. (1990). Reengineering work: don't automate, obliterate. *Harvard Business Review* 68.4, 104-112. ↵

9. Chapter 9: The People in Information Systems

Learning Objectives

Upon successful completion of this chapter, you will be able to:

- describe each of the different roles that people play in the design, development, and use of information systems;
- understand the different career paths available to those who work with information systems;
- explain the importance of where the information-systems function is placed in an organization; and
- describe the different types of users of information systems.

Introduction

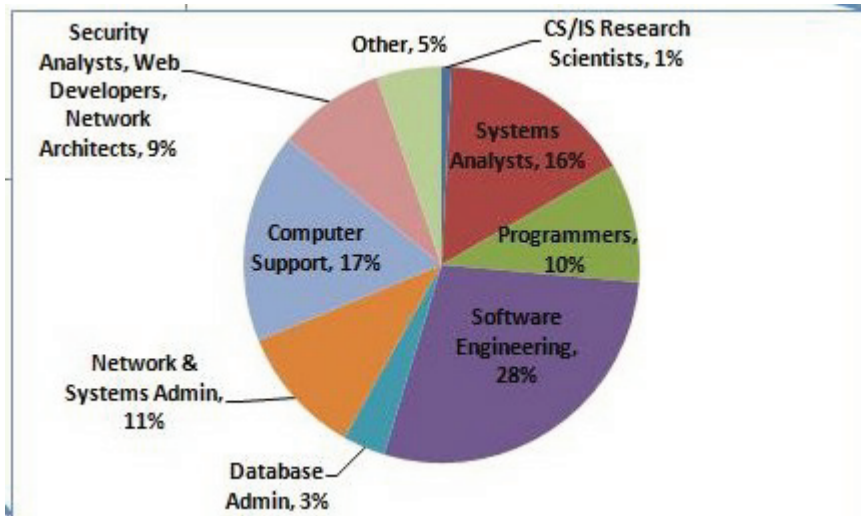
The opening chapters of this text focused on the technology behind information systems, namely hardware, software, data, and networking. The last chapter covered business processes and the key role they can play in the success of a business. This chapter discusses people, the last component of an information system.

People are involved in information systems in just about every way. People imagine information systems, people develop information systems, people support information systems, and, perhaps most importantly, people use information systems.

The Creators of Information Systems

The first group of people to be considered play a role in designing, developing, and building information systems. These people are generally technical and have a background in programming, analysis, information security, or database design. Just about everyone who works in the creation of information systems has a minimum of a bachelor's degree in computer science or information systems, though that is not necessarily a requirement. The process of creating information systems will be covered in more detail in Chapter 10.

The following chart shows the U. S. Bureau of Labor Statistics projections for computing career employment in 2020.



Systems Analyst

The systems analyst straddles the divide between identifying business needs and imagining a new or redesigned system to fulfill those needs. This individual works with a team or department seeking to identify business requirements and analyze the specific details of an existing system or a system that needs to be built. Generally, the analyst is required to have a good understanding of the business itself, the purpose of the business, the business processes involved, and the ability to document them well. The analyst identifies the different stakeholders in the system and works to involve the appropriate individuals in the analysis process.

Prior to analyzing the problem or the system of concern, the analyst needs to a) clearly identify the problem, b) gain approval for the project, c) identify the stakeholders, and d) develop a plan to monitor the project. The analysis phase of the project can be broken down into five steps.

1. Seek out and identify the details
2. Specify requirements
3. Decide which requirements are most important
4. Create a dialog showing how the user interacts with the existing system
5. Ask users to critique the list of requirements that have been developed

The analysis phase involves both the systems analyst and the users. It is important to realize the role the users take in the analysis of the system. Users can have significant insights into how well the current system functions as well as suggest improvements.

Once the requirements are determined, the analyst begins the process of translating these requirements into an information systems design. It is important to understand which different technological solutions will work and provide several alternatives to the client, based on the company's budgetary constraints, technology constraints, and culture. Once the solution is selected, the analyst will create a detailed document describing the new system. This new document will require that the analyst understand how to speak in the technical language of systems developers.

The design phase results in the components of the new system being identified, including how they relate to one another. The designer needs to communicate clearly with software developers as well database administrators by using terminology that is consistent with both of these specialties. The design phase of the project can be broken down into six steps.

1. Design the hardware environment
2. Design the software
3. Design how the new system will interface with the users
4. Design hardware interfaces
5. Design database tables
6. Design system security

A systems analyst generally is not the one who does the actual development of the information system. The design document created by the systems analyst provides the detail needed to create the system and is handed off to a developer to actually write the software and to the database administrator to build the database and tables that will be in the database.

Sometimes the system may be assembled from off-the-shelf components by a person called a systems integrator. This is a specific type of systems analyst that understands how to get different software packages to work with each other.

To become a systems analyst, you should have a background both in the business analysis and in systems design. Many analysts first work as developers and have business experience before becoming system analysts. It is vital for analysts to clearly understand the purpose of the business of interest, realizing that all businesses are unique.

Programmer/Developer

Programmers spend their time writing computer code in a programming language. In the case of systems development, programmers generally attempt to fulfill the design specifications given to them by a systems analyst/designer. Many different styles of software development exist. A programmer may work alone for long stretches of time or work as part of a team with other developers. A programmer needs to be able to understand complex processes and also the intricacies of one or more programming languages.

Computer Engineer

Computer engineers design the computing devices that are used every day. There are many types of computer engineers who work on a variety of different types of devices and systems. Some of the more prominent computer engineering jobs are as follows:

- **Hardware engineer.** A hardware engineer designs hardware and test components such as microprocessors, memory devices, routers, and networks. Many times, a hardware engineer is at the cutting edge of computing technology, creating something brand new. Other times, the hardware engineer's job is to re-engineer an existing component to work faster or use less power. Many times a hardware engineer's job is to write code to create a program that will be implemented directly on a computer chip.
- **Software engineer.** Software engineers tend to focus on a specific area of software such as operating systems, networks, applications, or databases. Software engineers use three primary skill areas: computer science, engineering, and mathematics.
- **Systems engineer.** A systems engineer takes the components designed by other engineers and makes them all work together, focusing on the integration of hardware and software. For example, to build a computer the mother board, processor, memory, and hard disk all have to work together. A systems engineer has experience with many different types of hardware and software and knows how to integrate them to create new functionality.
- **Network engineer.** A network engineer understands the networking requirements of an organization and then

designs a communications system to meet those needs, using the networking hardware and software, sometimes referred to as a network operating system. Network engineers design both local area networks as well as wide area networks.

There are many different types of computer engineers, and often the job descriptions overlap. While many may call themselves engineers based on a company job title, there is also a professional designation of “professional engineer” which has specific requirements. In the United States each state has its own set of requirements for the use of this title, as do different countries around the world. Most often, it involves a professional licensing exam.

Information Systems Operations and Administration

Another group of information systems professionals are involved in the day-to-day operations and administration of IT. These people must keep the systems running and up-to-date so that the rest of the organization can make the most effective use of these resources.

Computer Operator

A computer operator is the person who oversees the mainframe computers and data centers in organizations. Some of their duties include keeping the operating systems up to date, ensuring available memory and disk storage, providing for redundancy (think electricity, connectivity to the Internet, and database backups), and overseeing the physical environment of the computer. Since mainframe computers increasingly have been replaced with servers, storage management systems, and other platforms, computer operators’ jobs have grown broader and include working with these specialized systems.

Database Administrator

A Database Administrator (DBA) is the person who designs and manages the databases for an organization. This person creates and maintains databases that are used as part of applications or the data warehouse. The DBA also consults with systems analysts and programmers on projects that require access to or the creation of databases.

Help Desk/Support Analyst

Most mid-size to large organizations have their own information technology help desk. The help desk is the first line of support for computer users in the company. Computer users who are having problems or need information can contact the help desk for assistance. Many times a help desk worker is a junior level employee who is able to answer basic issues that users need assistance with. Help desk analysts work with senior level support analysts or have a computer knowledgebase at their disposal to help them investigate the problem at hand. The help desk is a great place to break into working in IT because it exposes you to all of the different technologies within the company. A successful help desk analyst should have good communications skills and a sincere interest in helping users.

Trainer

A computer trainer conducts classes to teach people specific computer skills. For example, if a new ERP system is being installed in an organization, one part of the implementation process is to teach all of the users how to use the new system. A trainer may work for a software company and be contracted to come in to conduct classes when needed; a trainer may work for a company that offers regular training sessions. Or a trainer may be employed full time for an organization to handle all of their computer instruction needs. To be successful as a trainer you need to be able to communicate technical concepts clearly and demonstrate patience with learners.

Managing Information Systems

The management of information-systems functions is critical to the success of information systems within the organization. Here are some of the jobs associated with the management of information systems.

CIO

The Chief Information Officer (CIO) is the head of the information-systems function. This person aligns the plans and operations of the information systems with the strategic goals of the organization. Tasks include budgeting, strategic planning, and personnel decisions for the information systems function. The CIO must also be the face of the IT department within the organization. This involves working with senior leaders in all parts of the organization to ensure good communication, planning, and budgeting.

Interestingly, the CIO position does not necessarily require a lot of technical expertise. While helpful, it is more important for this person to have good management skills and understand the business. Many organizations do not have someone with the title of CIO. Instead, the head of the information systems function is called the Vice President of Information Systems or Director of Information Systems.

Functional Manager

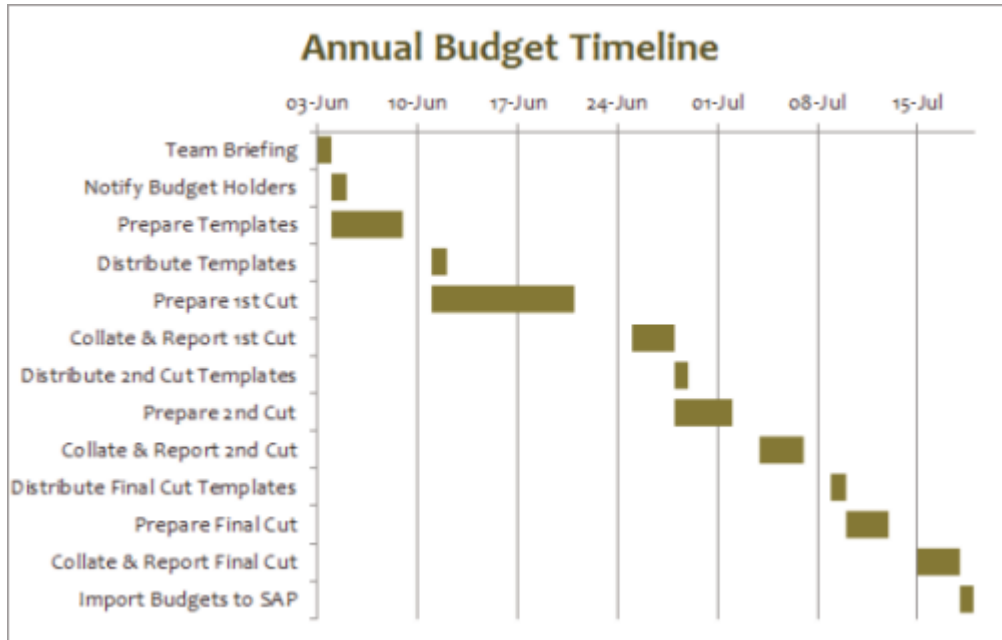
As an information systems organization becomes larger, many of the different functions are grouped together and led by a manager. These functional managers report to the CIO and manage the employees specific to their function. For example, in a large organization there are a group of systems analysts who report to a manager of the systems analysis function. For more insight into how this might look, see the discussion later in the chapter of how information systems are organized.

ERP Management

Organizations using an ERP require one or more individuals to manage these systems. ERP managers make sure that

the ERP system is completely up to date, work to implement any changes to the ERP that are needed, and consult with various user departments on needed reports or data extracts.

Project Managers



Gantt Chart for managing projects

Information systems projects are notorious for going over budget and being delivered late. In many cases a failed IT project can spell doom for a company. A project manager is responsible for keeping projects on time and on budget. This person works with the stakeholders of the project to keep the team organized and communicates the status of the project to management. Gantt charts, shown above, are used to graphically illustrate a project's schedule, tasks, and resources.

A project manager does not have authority over the project team. Instead, the project manager coordinates schedules and resources in order to maximize the project outcomes. This leader must be a good communicator and an extremely organized person. A project manager should also have good people skills. Many organizations require each of their project managers to become certified as a Project Management Professional (PMP).

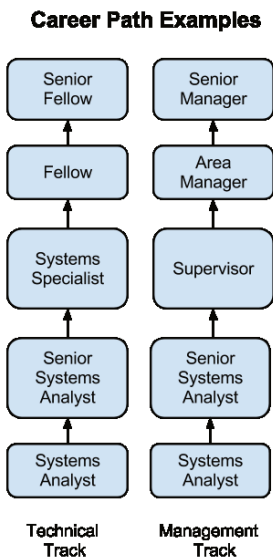
Information Security Officer

An information security officer is in charge of setting information security policies for an organization and then overseeing the implementation of those policies. This person may have one or more people reporting to them as part of the information security team. As information has become a critical asset, this position has become highly valued. The information security officer must ensure that the organization's information remains secure from both internal and external threats.

Emerging Roles

As technology evolves many new roles are becoming more common as other roles diminish. For example, as we enter the age of “big data,” we are seeing the need for more data analysts and business intelligence specialists. Many companies are now hiring social media experts and mobile technology specialists. The increased use of cloud computing and Virtual Machine (VM) technologies also is increasing demand for expertise in those areas.

Career Paths in Information Systems



Career Paths in Information Systems
(click to enlarge)

These job descriptions do not represent all possible jobs within an information systems organization. Larger organizations will have more specialized roles, while smaller organizations may combine some of these roles. Many of these roles may exist outside of a traditional information-systems organization, as we will discuss below.

Working with information systems can be a rewarding career choice. Whether you want to be involved in very technical jobs (programmer, database administrator), or you want to be involved in working with people (systems analyst, trainer, project manager), there are many different career paths available.

Many times those in technical jobs who want career advancement find themselves in a dilemma. A person can continue doing technical work, where sometimes their advancement options are limited, or become a manager of other employees and put themselves on a management career track. In many cases those proficient in technical skills are not gifted with managerial skills. Some organizations, especially those that highly value their technically skilled employees, create a technical track that exists in parallel to the management track so that they can retain employees who are contributing to the organization with their technical skills.

Sidebar: Are Certifications Worth Pursuing?

As technology becomes more important to businesses, hiring employees with technical skills is becoming critical. But how can an organization ensure that the person they are hiring has the necessary skills? Many organizations are including technical certifications as a prerequisite for getting hired.

Cisco Certified Internetwork Expert.

Certifications are designations given by a certifying body that someone has a specific level of knowledge in a specific technology. This certifying body is often the vendor of the product itself, though independent certifying organizations, such as CompTIA, also exist. Many of these organizations offer certification tracks, allowing a beginning certificate as a prerequisite to getting more advanced certificates. To get a certificate, you generally attend one or more training classes and then take one or more certification exams. Passing the exams with a certain score will qualify you for a certificate. In most cases, these classes and certificates are not free. In fact a highly technical certification can cost thousands dollars. Some examples of the certifications in highest demand include Microsoft (software certifications), Cisco (networking), and SANS (security).



CISCO certification badge

For many working in IT, determining whether to pursue one or more of these certifications is an important question. For many jobs, such as those involving networking or security, a certificate will be required by the employer as a way to determine which potential employees have a basic level of skill. For those who are already in an IT career, a more advanced certificate may lead to a promotion. For those wondering about the importance of certification, the best solution is to talk to potential employers and those already working in the field to determine the best choice.

Organizing the Information Systems Function

In the early years of computing, the information-systems function (generally called “data processing”) was placed in the finance or accounting department of the organization. As computing became more important, a separate information-systems function was formed, but it still was generally placed under the Chief Financial Officer and considered to be an administrative function of the company. By the 1980s and 1990s, when companies began networking internally and then connecting to the Internet, the information systems function was combined with the telecommunications functions and designated as the Information Technology (IT) department. As the role of information technology continued to increase, its place in the organization became more important. In many organizations today, the head of IT (the CIO) reports directly to the CEO.

Where in the Organization Should IS Be?

Before the advent of the personal computer, the information systems function was centralized within organizations in order to maximize control over computing resources. When the PC began proliferating, many departments within organizations saw it as a chance to gain some computing resources for themselves. Some departments created an internal information systems group, complete with systems analysts, programmers, and even database administrators. These departmental IS groups were dedicated to the information needs of their own departments, providing quicker turnaround and higher levels of service than a centralized IT department. However, having several IS groups within an organization led to a lot of inefficiencies. There were now several people performing the same jobs in different departments. This decentralization also led to company data being stored in several places all over the company.

In some organizations a matrix reporting structure developed in which IT personnel were placed within a department and reported to both the department management and the functional management within IS. The advantages of dedicated IS personnel for each department must be weighed against the need for more control over the strategic information resources of the company.

For many companies, these questions are resolved by the implementation of the ERP system (see discussion of ERP in Chapter 8). Because an ERP system consolidates most corporate data back into a single database, the implementation of an ERP system requires organizations to find “silos” of data so that they can integrate them back into the corporate system. The ERP allows organizations to regain control of their information and influences organizational decisions throughout the company.

Outsourcing

Frequently an organization needs a specific skill for a limited period of time. Instead of training existing employees or hiring new staff, it may make more sense to outsource the job. Outsourcing can be used in many different situations within the information systems function, such as the design and creation of a new website or the upgrade of an ERP system. Some organizations see outsourcing as a cost-cutting move, contracting out a whole group or department.

New Models of Organizations

The integration of information technology has influenced the structure of organizations. The increased ability to communicate and share information has led to a “flattening” of the organizational structure due to the removal of one or more layers of management.

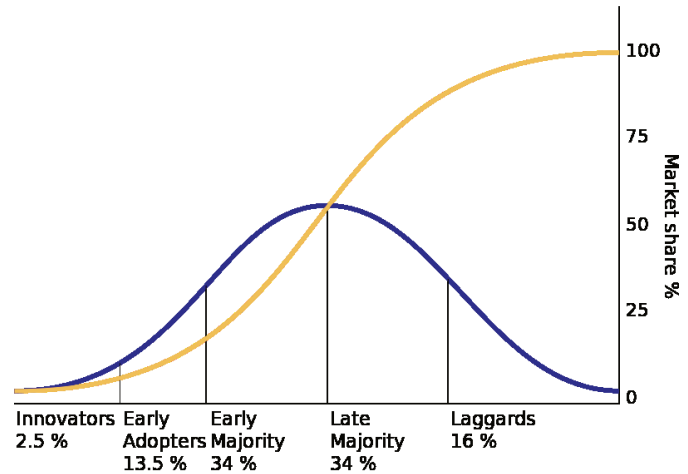
The network-based organizational structure is another changed enabled by information systems. In a network-based organizational structure, groups of employees can work somewhat independently to accomplish a project. People with the right skills are brought together for a project and then released to work on other projects when that project is over. These groups are somewhat informal and allow for all members of the group to maximize their effectiveness.

Information Systems Users – Types of Users

Besides the people who work to create, administer, and manage information systems, there is one more extremely important group of people, namely, the users of information systems. This group represents a very large percentage of an organization’s employees. If the user is not able to successfully learn and use an information system, the system is doomed to failure.

Technology adoption user types

One tool that can be used to understand how users will adopt a new technology comes from a 1962 study by Everett Rogers. In his book, *Diffusion of Innovation*,^[1] Rogers studied how farmers adopted new technologies and noticed that the adoption rate started slowly and then dramatically increased once adoption hit a certain point. He identified five specific types of technology adopters:



Diffusion of Innovation (click to enlarge)

- Innovators.** Innovators are the first individuals to adopt a new technology. Innovators are willing to take risks, are the youngest in age, have the highest social class, have great financial liquidity, are very social, and have the closest contact with scientific sources and interaction with other innovators. Risk tolerance is high so there is a willingness to adopt technologies that may ultimately fail. Financial resources help absorb these failures (Rogers, 1962, p. 282).
- Early adopters.** The early adopters are those who adopt innovation soon after a technology has been introduced and proven. These individuals have the highest degree of opinion leadership among the other adopter categories, which means that these adopters can influence the opinions of the largest majority. Characteristics include being younger in age, having a higher social status, possessing more financial liquidity, having advanced education, and being more socially aware than later adopters. These adopters are more discrete in adoption choices than innovators, and realize judicious choice of adoption will help them maintain a central communication position (Rogers, 1962, p. 283).
- Early majority.** Individuals in this category adopt an innovation after a varying degree of time. This time of adoption is significantly longer than the innovators and early adopters. This group tends to be slower in the adoption process, has above average social status, has contact with early adopters, and seldom holds positions of opinion leadership in a system (Rogers, 1962, p. 283).
- Late majority.** The late majority will adopt an innovation after the average member of the society. These individuals approach an innovation with a high degree of skepticism, have below average social status, very little financial liquidity, are in contact with others in the late majority and the early majority, and show very little opinion leadership.
- Laggards.** Individuals in this category are the last to adopt an innovation. Unlike those in the previous categories, individuals in this category show no opinion leadership. These individuals typically have an aversion to change agents and tend to be advanced in age. Laggards typically tend to be focused on “traditions,” are likely to have the lowest social status and the lowest financial liquidity, be oldest of all other adopters, and be in contact with only family and close friends.^[2]

These five types of users can be translated into information technology adopters as well, and provide additional insight into how to implement new information systems within the organization. For example, when rolling out a new system, IT may want to identify the innovators and early adopters within the organization and work with them first, then leverage their adoption to drive the rest of the implementation to the other users.

Summary

In this chapter we have reviewed the many different categories of individuals who make up the people component of

information systems. The world of information technology is changing so fast that new roles are being created all the time and roles that existed for decades are being phased out. This chapter this chapter should have given you a good idea and appreciation for the importance of the people component of information systems.

Study Questions

1. Describe the role of a systems analyst.
2. What are some of the different roles for a computer engineer?
3. What are the duties of a computer operator?
4. What does the CIO do?
5. Describe the job of a project manager.
6. Explain the point of having two different career paths in information systems.
7. What are the advantages and disadvantages of centralizing the IT function?
8. What impact has information technology had on the way companies are organized?
9. What are the five types of information-systems users?
10. Why would an organization outsource?

Exercises

1. Which IT job would you like to have? Do some original research and write a two-page paper describing the duties of the job you are interested in.
2. Spend a few minutes on Dice or Monster to find IT jobs in your area. What IT jobs are currently available? Write up a two-page paper describing three jobs, their starting salary (if listed), and the skills and education needed for the job.
3. How is the IT function organized in your school or place of employment? Create an organization chart showing how the IT organization fits into your overall organization. Comment on how centralized or decentralized the IT function is.
4. What type of IT user are you? Take a look at the five types of technology adopters and then write a one-page summary of where you think you fit in this model.

Lab

1. Define each job in the list, then ask 10 friends to identify which jobs they have heard about or know something about. Tabulate your results.
2. Chief marketing technologist
3. Developer evangelist
4. Ethical hacker
5. Business intelligence analyst
6. Digital marketing manager

7. Growth hacker
 8. UX designer
 9. Cloud architect
 10. Data detective
 11. Master of edge computing
 12. Digital prophet
 13. NOC specialist
 14. SEO/SEM specialist
-

1. Rogers, E. M. (1962). *Diffusion of innovations*. New York: Free Press. ↵
2. Rogers, E. M. (1962). *Diffusion of innovations*. New York: Free Press. ↵

10. Chapter 10: Information Systems Development

Learning Objectives

Upon successful completion of this chapter, you will be able to:

- Explain the overall process of developing new software;
- Explain the differences between software development methodologies;
- Understand the different types of programming languages used to develop software;
- Understand some of the issues surrounding the development of websites and mobile applications; and
- Identify the four primary implementation policies.

Introduction

When someone has an idea for a new function to be performed by a computer, how does that idea become reality? If a company wants to implement a new business process and needs new hardware or software to support it, how do they go about making it happen? This chapter covers the different methods of taking those ideas and bringing them to reality, a process known as information systems development.

Programming

Software is created via programming, as discussed in Chapter 2. Programming is the process of creating a set of logical instructions for a digital device to follow using a programming language. The process of programming is sometimes called “coding” because the developer takes the design and encodes it into a programming language which then runs on the computer.

The process of developing good software is usually not as simple as sitting down and writing some code. Sometimes a programmer can quickly write a short program to solve a need, but in most instances the creation of software is a resource-intensive process that involves several different groups of people in an organization. In order to do this effectively, the groups agree to follow a specific software development methodology. The following sections review several different methodologies for software development, as summarized in the table below and more fully described in the following sections.

Characteristic	Methodology			
	SDLC	RAD	Agile	Lean
Overall Flow	Structured	Structured	Incremental	Minimalist
Analysis	Methodical	Methodical	Iterative	Iterative
Design	Methodical	Interactive	Iterative	Iterative
Development	Sequential	Interactive	Iterative	Iterative
Testing	Follows Development	Combined with Development	Combined with Development	Combined with Development

Systems Development Life Cycle

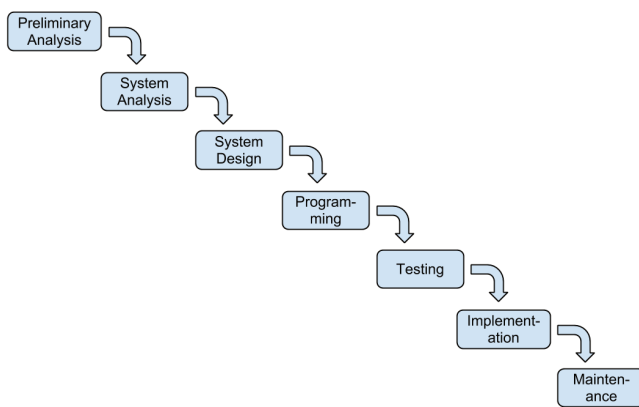
The Systems Development Life Cycle (SDLC) was first developed in the 1960s to manage the large software projects associated with corporate systems running on mainframes. This approach to software development is very structured and risk averse, designed to manage large projects that include multiple programmers and systems that have a large impact on the organization. It requires a clear, upfront understanding of what the software is supposed to do and is not amenable to design changes. This approach is roughly similar to an assembly line process, where it is clear to all stakeholders what the end product should do and that major changes are difficult and costly to implement.

Various definitions of the SDLC methodology exist, but most contain the following phases.

1. *Preliminary Analysis.* A request for a replacement or new system is first reviewed. The review includes questions such as: What is the problem-to-be-solved? Is creating a solution possible? What alternatives exist? What is currently being done about it? Is this project a good fit for our organization? After addressing these questions, a feasibility study is launched. The feasibility study includes an analysis of the technical feasibility, the economic feasibility or affordability, and the legal feasibility. This step is important in determining if the project should be initiated and may be done by someone with a title of Requirements Analyst or Business Analyst
2. *System Analysis.* In this phase one or more system analysts work with different stakeholder groups to determine the specific requirements for the new system. No programming is done in this step. Instead, procedures are documented, key players/users are interviewed, and data requirements are developed in order to get an overall impression of exactly what the system is supposed to do. The result of this phase is a system requirements document and may be done by someone with a title of Systems Analyst
3. *System Design.* In this phase, a designer takes the system requirements document created in the previous phase and develops the specific technical details required for the system. It is in this phase that the business requirements are translated into specific technical requirements. The design for the user interface, database, data inputs and outputs, and reporting are developed here. The result of this phase is a system design document. This document will have everything a programmer needs to actually create the system and may be done by someone with a title of Systems Analyst, Developer, or Systems Architect, based on the scale of the project.
4. *Programming.* The code finally gets written in the programming phase. Using the system design document as a guide, programmers develop the software. The result of this phase is an initial working program that meets the requirements specified in the system analysis phase and the design developed in the system design phase. These tasks are done by persons with titles such as Developer, Software Engineer, Programmer, or Coder.
5. *Testing.* In the testing phase the software program developed in the programming phase is put through a series of structured tests. The first is a unit test, which evaluates individual parts of the code for errors or bugs. This is

followed by a system test in which the different components of the system are tested to ensure that they work together properly. Finally, the user acceptance test allows those that will be using the software to test the system to ensure that it meets their standards. Any bugs, errors, or problems found during testing are resolved and then the software is tested again. These tasks are done by persons with titles such as Tester, Testing Analyst, or Quality Assurance.

6. **Implementation.** Once the new system is developed and tested, it has to be implemented in the organization. This phase includes training the users, providing documentation, and data conversion from the previous system to the new system. Implementation can take many forms, depending on the type of system, the number and type of users, and how urgent it is that the system become operational. These different forms of implementation are covered later in the chapter.
7. **Maintenance.** This final phase takes place once the implementation phase is complete. In the maintenance phase the system has a structured support process in place. Reported bugs are fixed and requests for new features are evaluated and implemented. Also, system updates and backups of the software are made for each new version of the program. Since maintenance is normally an Operating Expense (OPEX) while much of development is a Capital Expense (CAPEX), funds normally come out of different budgets or cost centers.



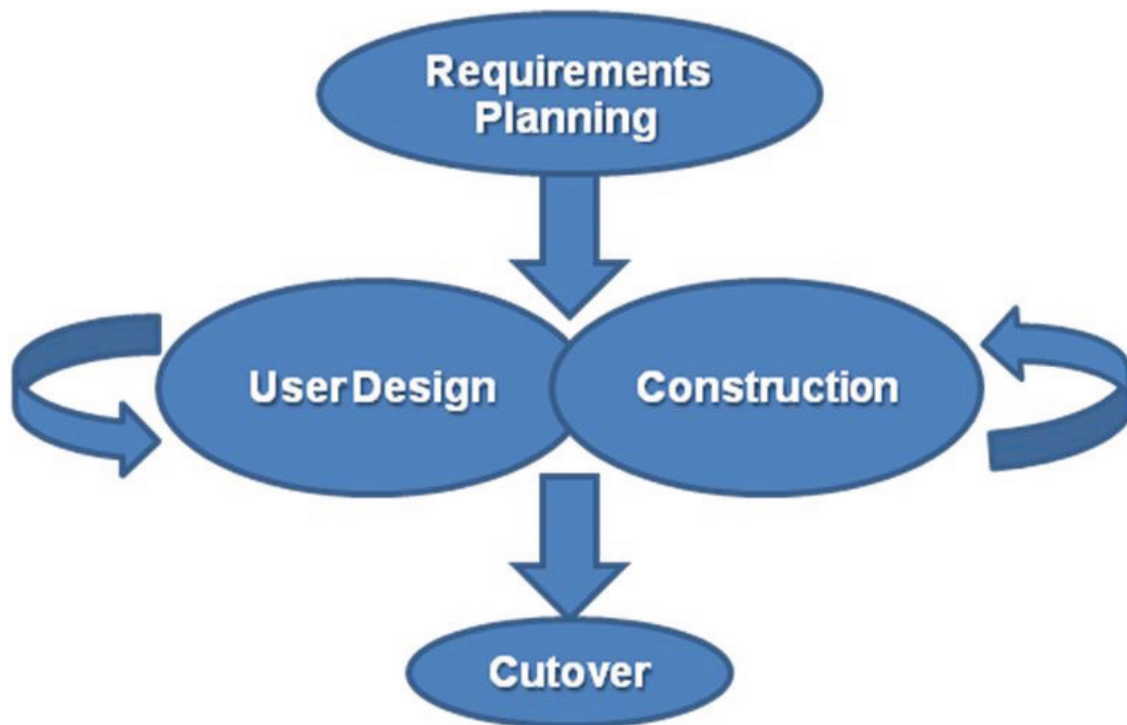
The SDLC method (click to enlarge)

The SDLC methodology is sometimes referred to as the waterfall methodology to represent how each step is a separate part of the process. Only when one step is completed can another step begin. After each step an organization must decide when to move to the next step. This methodology has been criticized for being quite rigid, allowing movement in only one direction, namely, forward in the cycle. For example, changes to the requirements are not allowed once the process has begun. No software is available until after the programming phase.

Again, SDLC was developed for large, structured projects. Projects using SDLC can sometimes take months or years to complete. Because of its inflexibility and the

availability of new programming techniques and tools, many other software development methodologies have been developed. Many of these retain some of the underlying concepts of SDLC, but are not as rigid.

Rapid Application Development



RAD Methodology (click to enlarge)

Rapid Application Development (RAD) focuses on quickly building a working model of the software, getting feedback from users, and then using that feedback to update the working model. After several iterations of development, a final version is developed and implemented.

The RAD methodology consists of four phases.

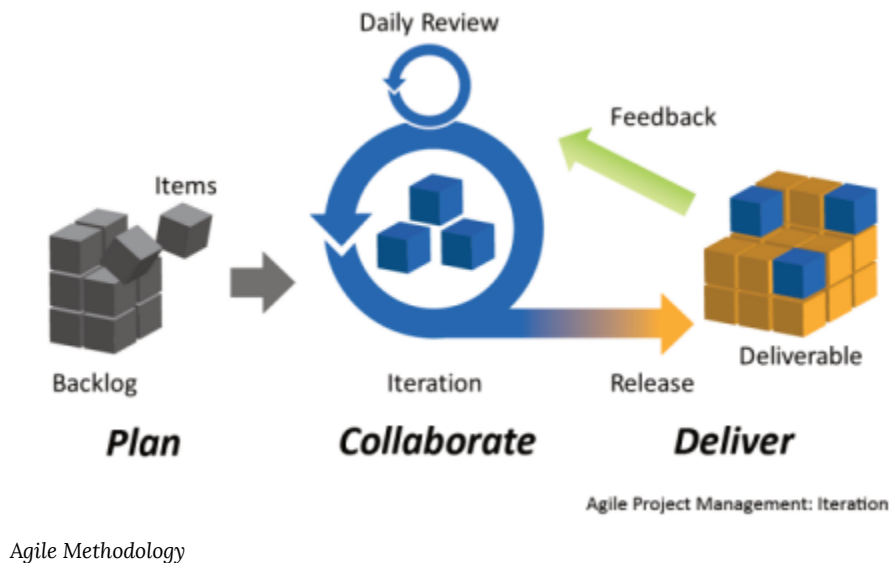
1. *Requirements Planning*. This phase is similar to the preliminary analysis, system analysis, and design phases of the SDLC. In this phase the overall requirements for the system are defined, a team is identified, and feasibility is determined.
2. *User Design*. In the user design phase representatives of the users work with the system analysts, designers, and programmers to interactively create the design of the system. Sometimes a Joint Application Development (JAD) session is used to facilitate working with all of these various stakeholders. A JAD session brings all of the stakeholders for a structured discussion about the design of the system. Application developers also participate and observe, trying to understand the essence of the requirements.
3. *Construction*. In the construction phase the application developers, working with the users, build the next version of the system through an interactive process. Changes can be made as developers work on the program. This step is executed in parallel with the User Design step in an iterative fashion, making modifications until an acceptable version of the product is developed.
4. *Cutover*. Cutover involves switching from the old system to the new software. Timing of the cutover phase is crucial and is usually done when there is low activity. For example, IT systems in higher education undergo many changes and upgrades during the summer or between fall semester and spring semester. Approaches to the migration from the old to the new system vary between organizations. Some prefer to simply start the new software and terminate use of the old software. Others choose to use an incremental cutover, bringing one part

online at a time. A cutover to a new accounting system may be done one module at a time such as general ledger first, then payroll, followed by accounts receivable, etc. until all modules have been implemented. A third approach is to run both the old and new systems in parallel, comparing results daily to confirm the new system is accurate and dependable. A more thorough discussion of implementation strategies appears near the end of this chapter.

As you can see, the RAD methodology is much more compressed than SDLC. Many of the SDLC steps are combined and the focus is on user participation and iteration. This methodology is much better suited for smaller projects than SDLC and has the added advantage of giving users the ability to provide feedback throughout the process. SDLC requires more documentation and attention to detail and is well suited to large, resource-intensive projects. RAD makes more sense for smaller projects that are less resource intensive and need to be developed quickly.

Agile Methodologies

Agile methodologies are a group of methodologies that utilize incremental changes with a focus on quality and attention to detail. Each increment is released in a specified period of time (called a time box), creating a regular release schedule with very specific objectives. While considered a separate methodology from RAD, the two methodologies share some of the same principles such as iterative development, user interaction, and flexibility to change. The agile methodologies are based on the “Agile Manifesto,” first released in 2001.



Agile and Iterative Development

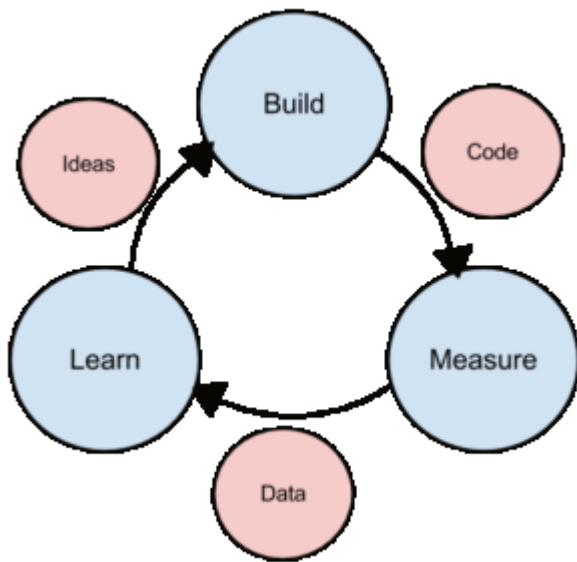
The diagram above emphasizes iterations in the center of agile development. You should notice how the building blocks of the developing system move from left to right, a block at a time, not the entire project. Blocks that are not acceptable are returned through feedback and the developers make the needed modifications. Finally, notice the Daily Review at the top of the diagram. Agile Development means constant evaluation by both developers and customers (notice the term “Collaboration”) of each day’s work.

The characteristics of agile methodology include:

- Small cross-functional teams that include development team members and users;
- Daily status meetings to discuss the current state of the project;
- Short time-frame increments (from days to one or two weeks) for each change to be completed; and
- Working project at the end of each iteration which demonstrates progress to the stakeholders.

The goal of agile methodologies is to provide the flexibility of an iterative approach while ensuring a quality product.

Lean Methodology

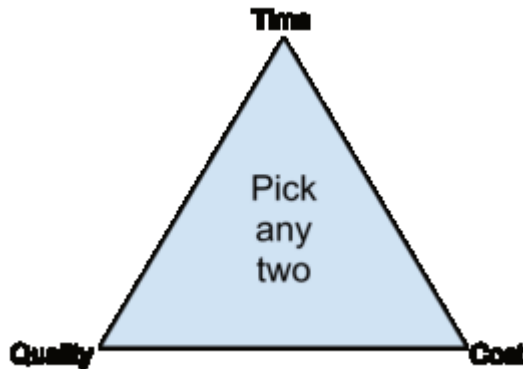


Lean Methodology (click to enlarge)

One last methodology to discuss is a relatively new concept taken from the business bestseller *The Lean Startup* by Eric Reis. Lean focuses on taking an initial idea and developing a Minimum Viable Product (MVP). The MVP is a working software application with just enough functionality to demonstrate the idea behind the project. Once the MVP is developed, the development team gives it to potential users for review. Feedback on the MVP is generated in two forms. First, direct observation and discussion with the users and second, usage statistics gathered from the software itself. Using these two forms of feedback, the team determines whether they should continue in the same direction or rethink the core idea behind the project, change the functions, and create a new MVP. This change in strategy is called a pivot. Several iterations of the MVP are developed, with new functions added each time based on the feedback, until a final product is completed.

The biggest difference between the iterative and non-iterative methodologies is that the full set of requirements for the system are not known when the project is launched. As each iteration of the project is released, the statistics and feedback gathered are used to determine the requirements. The lean methodology works best in an entrepreneurial environment where a company is interested in determining if their idea for a program is worth developing.

Sidebar: The Quality Triangle



The quality triangle (click to enlarge)

When developing software or any sort of product or service, there exists a tension between the developers and the different stakeholder groups such as management, users, and investors. This tension relates to how quickly the software can be developed (time), how much money will be spent (cost), and how well it will be built (quality). The quality triangle is a simple concept. It states that for any product or service being developed, you can only address two of the following: time, cost, and quality.

So why can only two of the three factors in the triangle be considered? Because each of these three components are in competition with each other! If you are willing and able to spend a lot of money, then a project can be completed quickly with high quality results because you can provide more

resources towards its development. If a project's completion date is not a priority, then it can be completed at a lower cost with higher quality results using a smaller team with fewer resources. Of course, these are just generalizations, and different projects may not fit this model perfectly. But overall, this model is designed to help you understand the trade-offs that must be made when you are developing new products and services.

There are other, fundamental reasons why low-cost, high-quality projects done quickly are so difficult to achieve.

1. The human mind is analog and the machines the software run on are digital. These are completely different natures that depend upon context and nuance versus being a 1 or a 0. Things that seem obvious to the human mind are not so obvious when forced into a 1 or 0 binary choice.
2. Human beings leave their imprints on the applications or systems they design. This is best summed up by Conway's Law (1968) – "Organizations that design information systems are constrained to do so in a way that mirrors their internal communication processes." Organizations with poor communication processes will find it very difficult to communicate requirements and priorities, especially for projects at the enterprise level (i.e., that affect the whole organization).

Programming Languages

As noted earlier, developers create programs using one of several programming languages. A programming language is an artificial language that provides a way for a developer to create programming code to communicate logic in a format that can be executed by the computer hardware. Over the past few decades, many different types of programming languages have evolved to meet a variety of needs. One way to characterize programming languages is by their "generation."

Generations of Programming Languages

Early languages were specific to the type of hardware that had to be programmed. Each type of computer hardware had a different low level programming language. In those early languages very specific instructions had to be entered line by line – a tedious process.

First generation languages were called *machine code* because programming was done in the format the machine/computer could read. So programming was done by directly setting actual ones and zeroes (the bits) in the program using binary code. Here is an example program that adds 1234 and 4321 using machine language:

```
10111001 00000000
11010010 10100001
00000100 00000000
10001001 00000000
00001110 10001011
00000000 00011110
00000000 00011110
00000000 00000010
10111001 00000000
11100001 00000011
00010000 11000011
10001001 10100011
00001110 00000100
00000010 00000000
```

Assembly language is the **second generation** language and uses English-like phrases rather than machine-code instructions, making it easier to program. An assembly language program must be run through an assembler, which converts it into machine code. Here is a sample program that adds 1234 and 4321 using assembly language.

```
MOV CX,1234
MOV DS:[0],CX
MOV CX,4321
MOV AX,DS:[0]
MOV BX,DS:[2]
ADD AX,BX
MOV DS:[4],AX
```

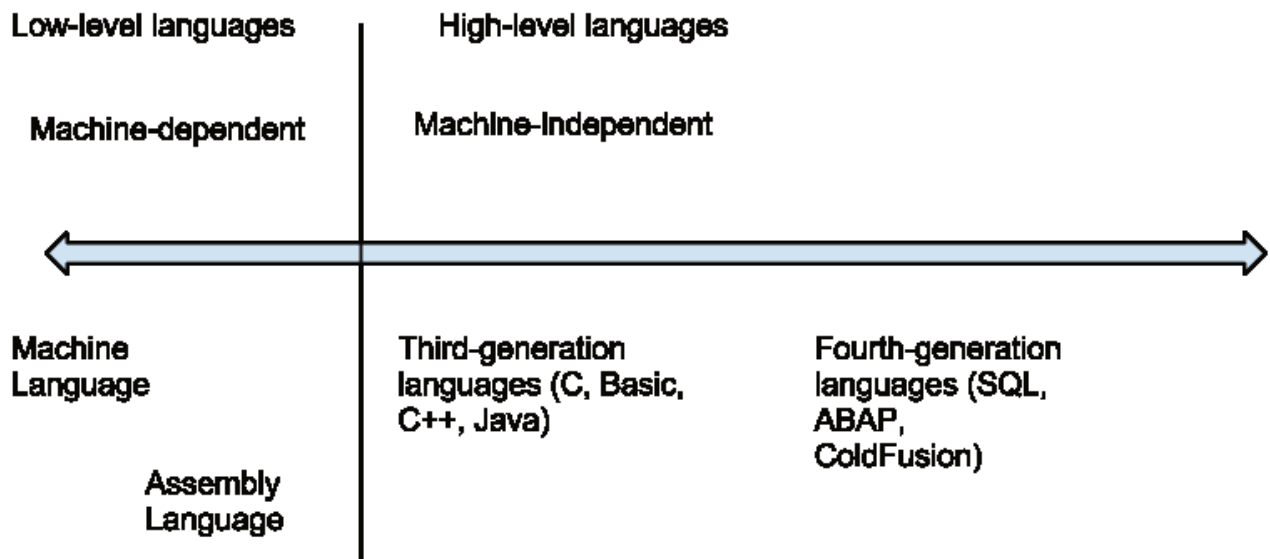
Third-generation languages are not specific to the type of hardware on which they run and are similar to spoken languages. Most third generation languages must be compiled. The developer writes the program in a form known generically as *source code*, then the compiler converts the source code into machine code, producing an executable file. Well-known third generation languages include BASIC, C, Python, and Java. Here is an example using BASIC:

```
A=1234
B=4321
C=A+B
END
```

Fourth generation languages are a class of programming tools that enable fast application development using intuitive interfaces and environments. Many times a fourth generation language has a very specific purpose, such as database interaction or report-writing. These tools can be used by those with very little formal training in programming and

allow for the quick development of applications and/or functionality. Examples of fourth-generation languages include: Clipper, FOCUS, SQL, and SPSS.

Why would anyone want to program in a lower level language when they require so much more work? The answer is similar to why some prefer to drive manual transmission vehicles instead of automatic transmission, namely, control and efficiency. Lower level languages, such as assembly language, are much more efficient and execute much more quickly. The developer has finer control over the hardware as well. Sometimes a combination of higher and lower level languages is mixed together to get the best of both worlds. The programmer can create the overall structure and interface using a higher level language but use lower level languages for the parts of the program that are used many times, require more precision, or need greater speed.



The programming language spectrum (click to enlarge).

Compiled vs. Interpreted

Besides identifying a programming language based on its generation, we can also classify it through the distinction of whether it is compiled or interpreted. A computer language is written in a human-readable form. In a compiled language the program code is translated into a machine-readable form called an *executable* that can be run on the hardware. Some well-known compiled languages include C, C++, and COBOL.

Interpreted languages require a runtime program to be installed in order to execute. Each time the user wants to run the software the runtime program must interpret the program code line by line, then run it. Interpreted languages are generally easier to work with but also are slower and require more system resources. Examples of popular interpreted languages include BASIC, PHP, PERL, and Python. The web languages of HTML and JavaScript are also considered interpreted because they require a browser in order to run.

The Java programming language is an interesting exception to this classification, as it is actually a hybrid of the two. A program written in Java is partially compiled to create a program that can be understood by the Java Virtual Machine (JVM). Each type of operating system has its own JVM which must be installed before any program can be executed. The JVM approach allows a single Java program to run on many different types of operating systems.

Procedural vs. Object-Oriented

A *procedural programming language* is designed to allow a programmer to define a specific starting point for the program and then execute sequentially. All early programming languages worked this way. As user interfaces became more interactive and graphical, it made sense for programming languages to evolve to allow the user to have greater control over the flow of the program. An *object-oriented programming language* is designed so that the programmer defines “objects” that can take certain actions based on input from the user. In other words, a procedural program focuses on the sequence of activities to be performed while an object oriented program focuses on the different items being manipulated.

Object: EMPLOYEE
EMPLOYEEID
FIRSTNAME
LASTNAME
BIRTHDATE
HIREDATE
ADDEMPLOYEE() EDITEMPLOYEE()

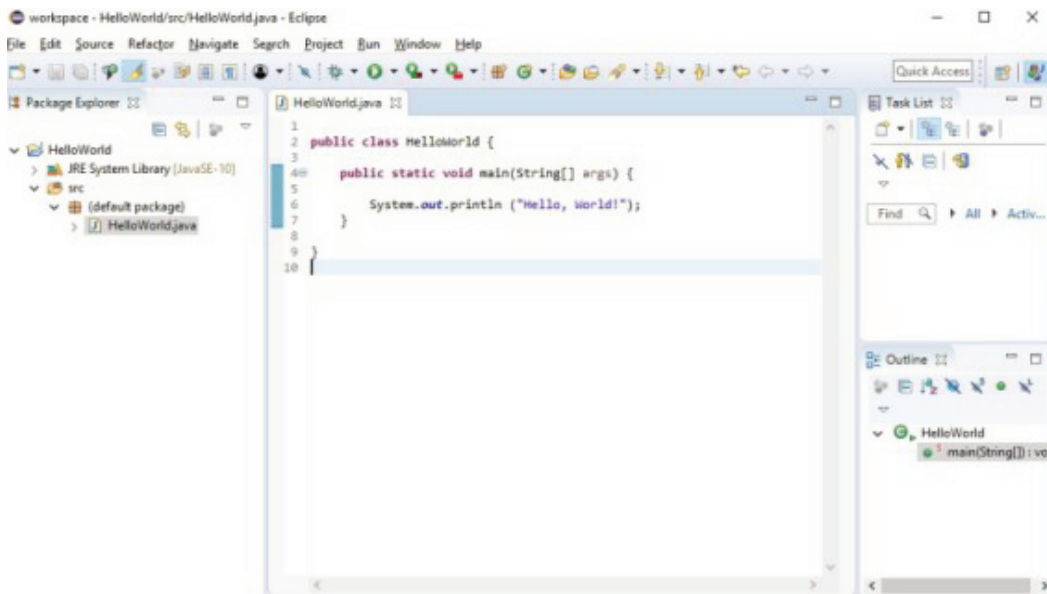
Employee object

Consider a human resources system where an “EMPLOYEE” object would be needed. If the program needed to retrieve or set data regarding an employee, it would first create an employee object in the program and then set or retrieve the values needed. Every object has properties, which are descriptive fields associated with the object. Also known as a Schema, it is the logical view of the object (i.e., each row of properties represents a column in the actual table, which is known as the physical view). The employee object has the properties “EMPLOYEEID”, “FIRSTNAME”, “LASTNAME”, “BIRTHDATE” and “HIREDATE”. An object also has methods which can take actions related to the object. There are two methods in the example. The first is “ADDEMPLOYEE()”, which will create another employee record. The second is “EDITEMPLOYEE()” which will modify an employee’s data.

Programming Tools

To write a program, you need little more than a text editor and a good idea. However, to be productive you must be able to check the syntax of the code, and, in some cases, compile the code. To be more efficient at programming, additional tools, such as an Integrated Development Environment (IDE) or computer-aided software-engineering (CASE) tools can be used.

Integrated Development Environment



Screen shot of Oracle Eclipse

For most programming languages an Integrated Development Environment (IDE) can be used to develop the program. An IDE provides a variety of tools for the programmer, and usually includes:

- **Editor.** An editor is used for writing the program. Commands are automatically color coded by the IDE to identify command types. For example, a programming comment might appear in green and a programming statement might appear in black.
- **Help system.** A help system gives detailed documentation regarding the programming language.
- **Compiler/Interpreter.** The compiler/interpreter converts the programmer's source code into machine language so it can be executed/run on the computer.
- **Debugging tool.** Debugging assists the developer in locating errors and finding solutions.
- **Check-in/check-out mechanism.** This tool allows teams of programmers to work simultaneously on a program without overwriting another programmer's code.

Examples of IDEs include Microsoft's Visual Studio and Oracle's Eclipse. Visual Studio is the IDE for all of Microsoft's programming languages, including Visual Basic, Visual C++, and Visual C#. Eclipse can be used for Java, C, C++, Perl, Python, R, and many other languages.

CASE Tools

While an IDE provides several tools to assist the programmer in writing the program, the code still must be written. Computer-Aided Software Engineering (CASE) tools allow a designer to develop software with little or no programming. Instead, the CASE tool writes the code for the designer. CASE tools come in many varieties. Their goal is to generate quality code based on input created by the designer.

Sidebar: Building a Website

In the early days of the World Wide Web, the creation of a website required knowing how to use HyperText Markup Language (HTML). Today most websites are built with a variety of tools, but the final product that is transmitted to a browser is still HTML. At its simplest HTML is a text language that allows you to define the different components of a web page. These definitions are handled through the use of HTML tags with text between the tags or brackets. For example, an HTML tag can tell the browser to show a word in italics, to link to another web page, or to insert an image. The HTML code below selects two different types of headings (h1 and h2) with text below each heading. Some of the text has been italicized. The output as it would appear in a browser is shown after the HTML code.

```
<h1>This is a first-level heading</h1>
Here is some text. <em>Here is some emphasized text.</em>
<h2>Here is a second-level heading</h2>
Here is some more text.
```

HTML code

This is a first-level heading HTML output

Here is some text. *Here is some emphasized text.*

Here is a second-level heading

Here is some more text.

While HTML is used to define the components of a web page, *Cascading Style Sheets* (CSS) are used to define the styles of the components on a page. The use of CSS allows the style of a website to be set and stay consistent throughout. For example, a designer who wanted all first-level headings (h1) to be blue and centered could set the “h1” style to match. The following example shows how this might look.

```
<style>
h1
{
color:blue;
text-align:center;
}
</style>
<h1>This is a first-level heading</h1>
Here is some text. <em>Here is some emphasized text.</em>
<h2>Here is a second-level heading</h2>
Here is some more text.
```

HTML code with CSS added

This is a first-level heading HTML with CSS output

Here is some text. *Here is some emphasized text.*

This is a second-level heading

Here is some more text.

The combination of HTML and CSS can be used to create a wide variety of formats and designs and has been widely adopted by the web design community. The standards for HTML are set by a governing body called the World Wide Web Consortium. The current version of HTML 5 includes new standards for video, audio, and drawing.

When developers create a website, they do not write it out manually in a text editor. Instead, they use web design tools that generate the HTML and CSS for them. Tools such as Adobe Dreamweaver allow the designer to create a web page that includes images and interactive elements without writing a single line of code. However, professional web designers still need to learn HTML and CSS in order to have full control over the web pages they are developing.

Sidebar: Building a Mobile App

In many ways building an application for a mobile device is exactly the same as building an application for a traditional computer. Understanding the requirements for the application, designing the interface, and working with users are all steps that still need to be carried out.

Mobile Apps

So what's different about building an application for a mobile device? There are five primary differences:

1. **Breakthroughs in component technologies.** Mobile devices require multiple components that are not only smaller but more energy-efficient than those in full-size computers (laptops or desktops). For example, low-power CPUs combined with longer-life batteries, touchscreens, and Wi-Fi enable very efficient computing on a phone, which needs to do much less actual processing than their full-size counterparts.
2. **Sensors have unlocked the notion of context.** The combination of sensors like GPS, gyroscopes, and cameras enables devices to be aware of things like time, location, velocity, direction, altitude, attitude, and temperature. Location in particular provides a host of benefits.
3. **Simple, purpose-built, task-oriented apps are easy to use.** Mobile apps are much narrower in scope than enterprise software and therefore easier to use. Likewise, they need to be intuitive and not require any training.
4. **Immediate access to data extends the value proposition.** In addition to the app providing a simpler interface on the front end, cloud-based data services provide access to data in near real-time, from virtually anywhere (e.g.,

banking, travel, driving directions, and investing). Having access to the cloud is needed to keep mobile device size and power use down.

5. **App stores have simplified acquisition.** Developing, acquiring, and managing apps has been revolutionized by app stores such as Apple’s App Store and Google Play. Standardized development processes and app requirements allow developers outside Apple and Google to create new apps with a built-in distribution channel. Average low app prices (including many of which that are free) has fueled demand.

In sum, the differences between building a mobile app and other types of software development look like this:

Component Technologies	Sensors	Apps	Cloud	Stores
Low-power CPU Batteries Touchscreens Wi-Fi	Unlock notion of context: <ul style="list-style-type: none"> • Time • Location • Velocity • Direction • Altitude • Temperature 	Simple Purpose-built	External processing Data Access	Simpler to build Easy to buy

Mobile app differences

Building a mobile app for both iOS and Android operating systems is known as cross platform development. There are a number of third-party toolkits available for creating your app. Many will convert existing code such as HTML5, JavaScript, Ruby, C++, etc. However, if your app requires sophisticated programming, a cross platform developer kit may not meet your needs.

Responsive Web Design (RWD) focuses on making web pages render well on every device: desktop, laptop, tablet, smartphone. Through the concept of fluid layout RWD automatically adjusts the content to the device on which it is being viewed. You can find out more about responsive design here.

Build vs. Buy

When an organization decides that a new program needs to be developed, they must determine if it makes more sense to build it themselves or to purchase it from an outside company. This is the “build vs. buy” decision.

There are many advantages to purchasing software from an outside company. First, it is generally less expensive to purchase software than to build it. Second, when software is purchased, it is available much more quickly than if the package is built in-house. Software can take months or years to build. A purchased package can be up and running within a few days. Third, a purchased package has already been tested and many of the bugs have already been worked out. It is the role of a systems integrator to make various purchased systems and the existing systems at the organization work together.

There are also disadvantages to purchasing software. First, the same software you are using can be used by your competitors. If a company is trying to differentiate itself based on a business process incorporated into purchased software, it will have a hard time doing so if its competitors use the same software. Another disadvantage to purchasing software is the process of customization. If you purchase software from a vendor and then customize it, you will have to manage those customizations every time the vendor provides an upgrade. This can become an administrative headache, to say the least.

Even if an organization determines to buy software, it still makes sense to go through the same analysis as if it was going to be developed. This is an important decision that could have a long-term strategic impact on the organization.

Web Services

Chapter 3 discussed how the move to cloud computing has allowed software to be viewed as a service. One option, known as *web services*, allows companies to license functions provided by other companies instead of writing the code themselves. Web services can greatly simplify the addition of functionality to a website.

Suppose a company wishes to provide a map showing the location of someone who has called their support line. By utilizing Google Maps API web services, the company can build a Google Map directly into their application. Or a shoe company could make it easier for its retailers to sell shoes online by providing a shoe sizing web service that the retailers could embed right into their website.

Web services can blur the lines between “build vs. buy.” Companies can choose to build an application themselves but then purchase functionality from vendors to supplement their system.

End-User Computing (EUC)

In many organizations application development is not limited to the programmers and analysts in the information technology department. Especially in larger organizations, other departments develop their own department-specific applications. The people who build these applications are not necessarily trained in programming or application development, but they tend to be adept with computers. A person who is skilled in a particular program, such as a spreadsheet or database package, may be called upon to build smaller applications for use by their own department. This phenomenon is referred to as *end-user development*, or *end-user computing*.

End-user computing can have many advantages for an organization. First, it brings the development of applications closer to those who will use them. Because IT departments are sometimes backlogged, it also provides a means to have software created more quickly. Many organizations encourage end-user computing to reduce the strain on the IT department.

End-user computing does have its disadvantages as well. If departments within an organization are developing their own applications, the organization may end up with several applications that perform similar functions, which is inefficient, since it is a duplication of effort. Sometimes these different versions of the same application end up providing different results, bringing confusion when departments interact. End-user applications are often developed by someone with little or no formal training in programming. In these cases, the software developed can have problems that then have to be resolved by the IT department.

End-user computing can be beneficial to an organization provided it is managed. The IT department should set guidelines and provide tools for the departments who want to create their own solutions. Communication between departments can go a long way towards successful use of end-user computing.

Sidebar: Risks of EUC's as “Shadow IT”

The Federal Home Loan Mortgage Company, better known as Freddie Mac, was fined over \$100 million in 2003 in part for understating its earnings. This triggered a large-scale project to restate its financials, which involved automating financial reporting to comply with the Sarbanes-Oxley Act of 2002. Part of the restatement project found that EUCs (such as spreadsheets and databases on individual laptops) were feeding into the General Ledger. While EUCs were not the cause of Freddie Mac's problems (they were a symptom of insufficient oversight) to have such poor IT governance in such a large company was a serious issue. It turns these EUCs were done in part to streamline the time it took to make changes to their business processes (a common complaint of IT departments in large corporations is that it takes too long to get things done). As such, these EUCs served as a form of “shadow IT” that had not been through a normal rigorous testing process.

Implementation Methodologies

Once a new system is developed or purchased, the organization must determine the best method for implementation. Convincing a group of people to learn and use a new system can be a very difficult process. Asking employees to use new software as well as follow a new business process can have far reaching effects within the organization.

There are several different methodologies an organization can adopt to implement a new system. Four of the most popular are listed below.

- **Direct cutover.** In the direct cutover implementation methodology, the organization selects a particular date to terminate the use of the old system. On that date users begin using the new system and the old system is unavailable. Direct cutover has the advantage of being very fast and the least expensive implementation method. However, this method has the most risk. If the new system has an operational problem or if the users are not properly prepared, it could prove disastrous for the organization.
- **Pilot implementation.** In this methodology a subset of the organization known as a pilot group starts using the new system before the rest of the organization. This has a smaller impact on the company and allows the support team to focus on a smaller group of individuals. Also, problems with the new software can be contained within the group and then resolved.
- **Parallel operation.** Parallel operations allow both the old and new systems to be used simultaneously for a limited period of time. This method is the least risky because the old system is still being used while the new system is essentially being tested. However, this is by far the most expensive methodology since work is duplicated and support is needed for both systems in full.
- **Phased implementation.** Phased implementation provides for different functions of the new application to be gradually implemented with the corresponding functions being turned off in the old system. This approach is more conservative as it allows an organization to slowly move from one system to another.

Your choice of an implementation methodology depends on the complexity of both the old and new systems. It also depends on the degree of risk you are willing to take.

Change Management

As new systems are brought online and old systems are phased out, it becomes important to manage the way change is implemented in the organization. Change should never be introduced in a vacuum. The organization should be sure to communicate proposed changes before they happen and plan to minimize the impact of the change that will occur after implementation. Change management is a critical component of IT oversight.

Sidebar: Mismanaging Change

Target Corporation, which operates more than 1,500 discount stores throughout the United States, opened 133 similar stores in Canada between 2013 and 2015. The company decided to implement a new Enterprise Resources Planning (ERP) system that would integrate data from vendors, customers, and do currency calculations (US Dollars and Canadian Dollars). This implementation was coincident with Target Canada's aggressive expansion plan and stiff competition from Wal-Mart. A two-year timeline – aggressive by any standard for an implementation of this size – did not account for data errors from multiple sources that resulted in erroneous inventory counts and financial calculations. Their supply chain became chaotic and stores were plagued by not having sufficient stock of common items, which prevented the key advantage of “one-stop shopping” for customers. In early 2015, Target Canada announced it was closing all 133 stores. In sum, “This implementation broke nearly all of the cardinal sins of ERP projects. Target set unrealistic goals, didn't leave time for testing, and neglected to train employees properly.”¹

Maintenance

After a new system has been introduced, it enters the maintenance phase. The system is in production and is being used by the organization. While the system is no longer actively being developed, changes need to be made when bugs are found or new features are requested. During the maintenance phase, IT management must ensure that the system continues to stay aligned with business priorities and continues to run well.

Summary

Software development is about so much more than programming. It is fundamentally about solving business problems. Developing new software applications requires several steps, from the formal SDLC process to more informal processes such as agile programming or lean methodologies. Programming languages have evolved from very low-level machine-

1. Taken from ACC Software Solutions. "THE MANY FACES OF FAILED ERP IMPLEMENTATIONS (AND HOW TO AVOID THEM)" <https://4acc.com/article/failed-erp-implementations/>

specific languages to higher-level languages that allow a programmer to write software for a wide variety of machines. Most programmers work with software development tools that provide them with integrated components to make the software development process more efficient. For some organizations, building their own software does not make the most sense. Instead, they choose to purchase software built by a third party to save development costs and speed implementation. In end-user computing, software development happens outside the information technology department. When implementing new software applications, there are several different types of implementation methodologies that must be considered.

Study Questions

1. What are the steps in the SDLC methodology?
2. What is RAD software development?
3. What makes the lean methodology unique?
4. What are three differences between second-generation and third-generation languages?
5. Why would an organization consider building its own software application if it is cheaper to buy one?
6. What is responsive design?
7. What is the relationship between HTML and CSS in website design?
8. What is the difference between the pilot implementation methodology and the parallel implementation methodology?
9. What is change management?
10. What are the four different implementation methodologies?

Exercises

1. Which software-development methodology would be best if an organization needed to develop a software tool for a small group of users in the marketing department? Why? Which implementation methodology should they use? Why?
2. Doing your own research, find three programming languages and categorize them in these areas: generation, compiled vs. interpreted, procedural vs. object-oriented.
3. Some argue that HTML is not a programming language. Doing your own research, find three arguments for why it is not a programming language and three arguments for why it is.
4. Read more about responsive design using the link given in the text. Provide the links to three websites that use responsive design and explain how they demonstrate responsive-design behavior.

Labs

1. Here's a Python program for you to analyze. The code below deals with a person's weight and height. See if you can guess what will be printed and then try running the code in a Python interpreter such as https://www.onlinegdb.com/online_python_interpreter.

```

measurements = (8, 20)
print("Original measurements:")

for measurement in measurements:
    print(measurement)

measurements = (170, 72)
print("\nModified measurements:")

for measurement in measurements:
    print(measurement)

```

2. Here's a broken Java program for you to analyze. The code below deals with calculating tuition, multiplying the tuition rate and the number of credits taken. The number of credits is entered by the user of the program. The code below is broken and gives the incorrect answer. Review the problem below and determine what it would output if the user entered "6" for the number of credits. How would you fix the program so that it would give the correct output?

```

package calcTuition;

//import Scanner
import java.util.Scanner;

public class CalcTuition
{

public static void main(String[] args)
{

//Declare variables
int credits;
final double TUITION_RATE = 100;
double tuitionTotal;

//Get user input
Scanner inputDevice = new Scanner(System.in);
System.out.println("Enter the number of credits: ");
credits = inputDevice.nextInt();

//Calculate tuition
tuitionTotal = credits + TUITION_RATE;

//Display tuition total
System.out.println("You total tuition is: " + tuitionTotal);

}
}

```


PART III

PART III: INFORMATION SYSTEMS BEYOND THE
ORGANIZATION

II. Chapter II: Globalization and the Digital Divide

Learning Objectives

Upon successful completion of this chapter, you will be able to:

- explain the concept of globalization;
- describe the role of information technology in globalization;
- identify the issues experienced by firms as they face a global economy; and
- define the digital divide and explain Nielsen's three stages of the digital divide.

Introduction

The Internet has wired the world. Today it is just as simple to communicate with someone on the other side of the world as it is to talk to someone next door. But keep in mind that many businesses attempted to outsource different needs in technology, only to discover that near-sourcing (outsourcing to countries to which your country is physically connected) had greater advantage. This chapter looks at the implications of globalization and the impact it is having on the world.

What Is Globalization?

Globalization refers to the integration of goods, services, and culture among the nations of the world. Globalization is not necessarily a new phenomenon. In many ways globalization has existed since the days of European colonization. Further advances in telecommunication and transportation technologies accelerated globalization. The advent of the the worldwide Internet has made all nations virtual next door neighbors.

The Internet is truly a worldwide phenomenon. As of December 2017 the Internet was being used by over 4.1 billion people world wide.¹ From its initial beginnings in the United States in the 1970s to the development of the World Wide Web in the 1990s to the social networks and e-commerce of today, the Internet has continued to increase the integration between countries, making globalization a fact of life for citizens all over the world.

1. [1]

WORLD INTERNET USAGE AND POPULATION STATISTICS JUNE, 2019 - Updated						
World Regions	Population (2019 Est.)	Population % of World	Internet Users 30 June 2019	Penetration Rate (% Pop.)	Growth 2000-2019	Internet World %
Africa	1,320,038,716	17.1 %	525,148,631	39.8 %	11,533 %	11.9 %
Asia	4,241,972,790	55.0 %	2,200,658,148	51.9 %	1,825 %	49.8 %
Europe	829,173,007	10.7 %	719,413,014	86.8 %	585 %	16.3 %
Latin America / Caribbean	658,345,826	8.5 %	447,495,130	68.0 %	2,377 %	10.1 %
Middle East	258,356,867	3.3 %	173,576,793	67.2 %	5,184 %	3.9 %
North America	366,496,802	4.7 %	327,568,628	89.4 %	203 %	7.4 %
Oceania / Australia	41,839,201	0.5 %	28,634,278	68.4 %	276 %	0.6 %
WORLD TOTAL	7,716,223,209	100.0 %	4,422,494,622	57.3 %	1,125 %	100.0 %

Internet Statistics by
Continent. Source:
<https://www.internetworldstats.com/stats.htm>.
(Click to enlarge)

The Network Society

In 1996 social-sciences researcher Manuel Castells published *The Rise of the Network Society*, in which he identified new ways economic activity was being organized around the networks that the new telecommunication technologies had provided. This new, global economic activity was different from the past, because “it is an economy with the capacity to work as a unit in real time on a planetary scale.”² Having a world connected via the Internet has some massive implications.

The World Is Flat

Thomas Friedman's 2005 book *The World Is Flat* uses anecdotal evidence to present the impact the personal computer, the Internet, and communication software have had on business, specifically the impact on globalization. Three eras of globalization are defined at the beginning of the book.³:

- “Globalization 1.0” occurred from 1492 until about 1800. In this era globalization was centered around countries. It was about how much horsepower, wind power, and steam power a country had and how creatively it was deployed. The world shrank from size “large” to size “medium.”
- “Globalization 2.0” occurred from about 1800 until 2000, interrupted only by the two World Wars. In this era, the dynamic force driving change was multinational companies. The world shrank from size “medium” to size “small.”
- “Globalization 3.0” is our current era, beginning in the year 2000. The convergence of the personal computer, fiber-optic Internet connections, and software has created a “flat-world platform” that allows small groups and even individuals to go global. The world has shrunk from size “small” to size “tiny.”

According to Friedman, this third era of globalization was brought about, in many respects, by information technology. Some of the specific technologies include:

- **Graphical user interface for the personal computer popularized in the late 1980s.** Before the graphical user interface, using a computer was relatively difficult, requiring users to type commands rather than click a mouse.

2. [2]

3. [3]

By making the personal computer something that anyone could use, the computer became a tool of virtually every person, not just those intrigued by technology. Friedman says the personal computer made people more productive and, as the Internet evolved, made it simpler to communicate information worldwide.

- **Build-out of the Internet infrastructure during the dot-com boom during the late-1990s.** During the late 1990s, telecommunications companies laid thousands of miles of fiber optic cable all over the world, turning network communications into a commodity. At the same time, the Internet protocols, such as SMTP (e-mail), HTML (web pages), and TCP/IP (network communications) became standards that were available for free and used by everyone through their email programs and web browsers.
- **Introduction of software to automate and integrate business processes.** As the Internet continued to grow and become the dominant form of communication, it became essential to build on the standards developed earlier so that the websites and applications running on the Internet would work well together. Friedman calls this “workflow software,” by which he means software that allows people to work together more easily, and allows different software and databases to integrate with each other more easily. Examples include payment processing systems and shipping calculators.

These three technologies came together in the late 1990s to create a “platform for global collaboration.” Once these technologies were in place, they continued to evolve. Friedman also points out a couple more technologies that have contributed to the flat-world platform, namely the open source movement discussed in Chapter 10 and the advent of mobile technologies.

Economist Pankaj Ghemawat authored the book *World 3.0* in 2011 in an attempt to provide a more moderate and research-based analysis of globalization. While Friedman talked with individuals and produced an anecdotally-based book, Ghemawat’s approach was to research economic data, then draw conclusions about globalization. His research found the following:

- Mailed letters that cross international borders = 1%
- Telephone calling minutes that are international = 2%
- Internet traffic that is routed across international borders = 18%
- National, as opposed to international, TV news sources = 95%
- First generation immigrants as portion of world’s population = 3%
- People who at sometime in their lives will cross an international border = 10%
- Global exports as portion of the value of all goods produced in the world = 20%

4

According to Ghemawat, while the Internet has had an impact on the world’s economy, it may well be that domestic economies can be expected to continue to be the main focus in most countries. You can watch Ghemawat’s Ted Talk here. Current and future trends will be discussed in Chapter 13.

The Global Firm

The new era of globalization allows virtually any business to become international. By accessing this new platform of technologies, Castells’s vision of working as a unit in real time on a planetary scale can be a reality. Some of the advantages include:

- **Ability to locate expertise and labor around the world.** Instead of drawing employees from their local area, organizations can now hire people from the global labor pool. This also allows organizations to pay a lower labor cost for the same work based on the prevailing wage in different countries.
- **Ability to operate 24 hours a day.** With employees in different time zones all around the world, an organization can literally operate around the clock, handing off work on projects from one part of the world to another as the normal business day ends in one region and begins in another. A few years ago three people decided to open a web hosting company. They strategically relocated to three places in the world which were eight hours apart, giving their business 24 hour coverage while allowing each to work during the normal business day. Operating expenses were minimized and the business provided 24/7 support to customers world wide.
- **Larger market for their products.** Once a product is being sold online, it is available for purchase from a worldwide customer base. Even if a company's products do not appeal beyond its own country's borders, being online has made the product more visible to consumers within that country.

In order to fully take advantage of these new capabilities, companies need to understand that there are also challenges in dealing with employees and customers from different cultures. Some of these challenges include:

- **Infrastructure differences.** Each country has its own infrastructure with varying levels of quality and bandwidth. A business cannot expect every country it deals with to have the same Internet speeds. See the sidebar titled "How Does My Internet Speed Compare?"
- **Labor laws and regulations.** Different countries (even different states in the United States) have different laws and regulations. A company that wants to hire employees from other countries must understand the different regulations and concerns.
- **Legal restrictions.** Many countries have restrictions on what can be sold or how a product can be advertised. It is important for a business to understand what is allowed. For example, in Germany, it is illegal to sell anything Nazi related.
- **Language, customs, and preferences.** Every country has its own unique culture which a business must consider when trying to market a product there. Additionally, different countries have different preferences. For example, in many parts of Europe people prefer to eat their french fries with mayonnaise instead of ketchup. In South Africa a hamburger comes delivered to your table with gravy on top.
- **International shipping.** Shipping products between countries in a timely manner can be challenging. Inconsistent address formats, dishonest customs agents, and prohibitive shipping costs are all factors that must be considered when trying to deliver products internationally.

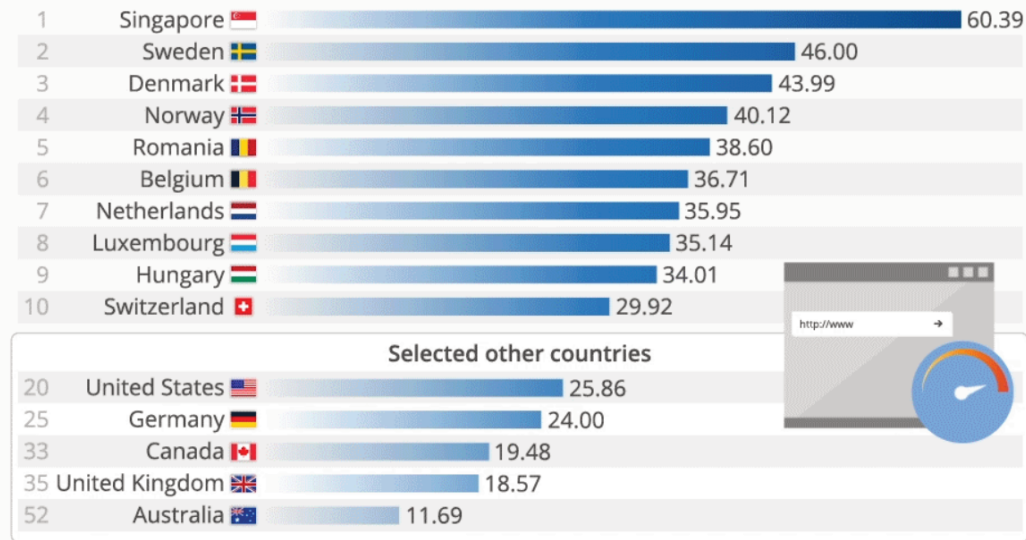
Because of these challenges, many businesses choose not to expand globally, either for labor or for customers. Whether a business has its own website or relies on a third-party, such as Amazon or eBay, the question of whether or not to globalize must be carefully considered.

Sidebar: How Does My Internet Speed Compare?

How does your Internet speed compare with others in the world? The following chart shows how Internet speeds compare in different countries. You can find the full list of countries by going to [this article](#) . You can also compare the evolution of Internet speeds among countries by using [this tool](#) .

The Countries with the Fastest Internet

Mean download speed in Megabits per second* (in Mbps)



* Download speed test data collected by M-Lab from June 2017 to May 2018.
Source: cable.co.uk

statista

Comparison of top world Internet speeds in 2019.
Source:
<https://www.statista.com/chart/7246/the-countries-with-the-fastest-internet/> (Click to enlarge)

So how does your own Internet speed compare? There are many online tools you can use to determine the speed at which you are connected. One of the most trusted sites is speedtest.net, where you can test both your download and upload speeds.

The Digital Divide

As the Internet continues to make inroads across the world, it is also creating a separation between those who have access to this global network and those who do not. This separation is called the “digital divide” and is of great concern. An article in *Crossroads* puts it this way:

Adopted by the ACM Council in 1992, the ACM Code of Ethics and Professional Conduct focuses on issues involving the Digital Divide that could prevent certain categories of people – those from low-income households, senior citizens, single-parent children, the undereducated, minorities, and residents of rural areas – from receiving adequate access to the wide variety of resources offered by computer technology. This Code of Ethics positions the use of computers as a fundamental ethical consideration: “In a fair society, all individuals would have equal opportunity to participate in, or benefit from, the use of computer resources regardless of race, sex, religion, age, disability, national origin, or other similar factors.” This article summarizes the digital divide in its various forms, and analyzes reasons for the growing inequality in people’s access to Internet services. It

also describes how society can bridge the digital divide: the serious social gap between information “haves” and “have-nots.”⁵

The digital divide can occur between countries, regions, or even neighborhoods. In many US cities, there are pockets with little or no Internet access, while just a few miles away high-speed broadband is common.

Solutions to the digital divide have had mixed success over the years. Many times just providing Internet access and/or computing devices is not enough to bring true Internet access to a country, region, or neighborhood.

A New Understanding of the Digital Divide

In 2006, web-usability consultant Jakob Nielsen wrote an article that got to the heart of our understanding of this problem. In his article he breaks the digital divide up into three stages: the economic divide, the usability divide, and the empowerment divide⁶.

- **Economic divide.** This is what many call the digital divide. The economic divide is the idea that some people can afford to have a computer and Internet access while others cannot. Because of Moore’s Law (see Chapter 2), the price of hardware has continued to drop and, at this point, we can now access digital technologies, such as smartphones, for very little. Nielsen asserts that for all intents and purposes, the economic divide is a moot point and we should not focus our resources on solving it.
- **Usability divide.** Usability is concerned with the fact that “technology remains so complicated that many people couldn’t use a computer even if they got one for free.” And even for those who can use a computer, accessing all the benefits of having one is beyond their understanding. Included in this group are those with low literacy and seniors. According to Nielsen, we know how to help these users, but we are not doing it because there is little profit in doing so.
- **Empowerment divide.** Empowerment is the most difficult to solve. It is concerned with how we use technology to empower ourselves. Very few users truly understand the power that digital technologies can give them. In his article, Nielsen explains that his and others’ research has shown that very few users contribute content to the Internet, use advanced search, or can even distinguish paid search ads from organic search results. Many people will limit what they can do online by accepting the basic, default settings of their computer and not work to understand how they can truly be empowered.

Understanding the digital divide using these three stages provides a more nuanced view of how we can work to alleviate it. More work needs to be done to address the second and third stages of the digital divide for a more holistic solution.

Refining the Digital Divide

The Miniwatts Marketing Group, host of Internet World Stats, has sought in 2018 to further clarify the meaning of *digital divide* by acknowledging that the divide is more than just who does or does not have access to the Internet. In addition to Nielsen’s economic, usability, and empowerment divides, this group sees the following concerns.

5. [5]

6. [6]

- **Social mobility.** Lack of computer education works to the disadvantage of children with lower socioeconomic status.
- **Democracy.** Greater use of the Internet can lead to healthier democracies especially in participation in elections.
- **Economic growth.** Greater use of the Internet in developing countries could provide a shortcut to economic advancement. Using the latest technology could give companies in these countries a competitive advantage.

The focus on the continuing digital divide has led the European Union to create an initiative known as The European 2020 Strategy. Five major areas are being targeted: a) research and development, b) climate/energy, c) education, d) social inclusion, and e) poverty reduction.⁷

Sidebar: Using Gaming to Bridge the Digital Divide

Paul Kim, the Assistant Dean and Chief Technology Officer of the Stanford Graduate School of Education, designed a project to address the digital divide for children in developing countries.⁸ In their project the researchers wanted to learn if children can adopt and teach themselves mobile learning technology, without help from teachers or other adults, and the processes and factors involved in this phenomenon. The researchers developed a mobile device called TeacherMate, which contained a game designed to help children learn math. The unique part of this research was that the researchers interacted directly with the children. They did not channel the mobile devices through the teachers or the schools. There was another important factor to consider. In order to understand the context of the children's educational environment, the researchers began the project by working with parents and local nonprofits six months before their visit. While the results of this research are too detailed to go into here, it can be said that the researchers found that children can, indeed, adopt and teach themselves mobile learning technologies.

What makes this research so interesting when thinking about the digital divide is that the researchers found that, in order to be effective, they had to customize their technology and tailor their implementation to the specific group they were trying to reach. One of their conclusions stated the following:

Considering the rapid advancement of technology today, mobile learning options for future projects will only increase. Consequently, researchers must continue to investigate their impact. We believe there is a specific need for more in-depth studies on ICT [Information and Communication Technology] design variations to meet different challenges of different localities.

To read more about Dr. Kim's project, locate the paper referenced here.

Summary

Information technology has driven change on a global scale. Technology has given us the ability to integrate with people all over the world using digital tools. These tools have allowed businesses to broaden their labor pools, their

7. [7]

8. [8]

markets, and even their operating hours. But they have also brought many new complications for businesses, which now must understand regulations, preferences, and cultures from many different nations. This new globalization has also exacerbated the digital divide. Nielsen has suggested that the digital divide consists of three stages (economic, usability, and empowerment), of which the economic stage is virtually solved.

Study Questions

1. What does the term *globalization* mean?
2. How does Friedman define the three eras of globalization?
3. Which technologies have had the biggest effect on globalization?
4. What are some of the advantages brought about by globalization?
5. What are the challenges of globalization?
6. What perspective does Ghemawat provide regarding globalization in his book *World 3.0*?
7. What does the term *digital divide* mean?
8. What are Jakob Nielsen's three stages of the digital divide?
9. What was one of the key points of *The Rise of the Network Society*?
10. Which country has the highest average Internet speed? How does your country compare?

Exercises

1. Compare the concept of Friedman's "Globalization 3.0" with Nielsen empowerment stage of the digital divide.
2. Do some original research to determine some of the regulations that a US company may have to consider before doing business in one of the following countries: China, Germany, Saudi Arabia, Turkey.
3. Give one example of the digital divide and describe what you would do to address it.
4. How did the research conducted by Paul Kim address the three levels of the digital divide?

Lab

1. Go to speedtest.net to determine your Internet speed. Compare your speed at home to the Internet speed at two other locations, such as your school, place of employment, or local coffee shop. Write a one-page summary that compares these locations.

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12. Chapter 12: The Ethical and Legal Implications of Information Systems

Learning Objectives

Upon successful completion of this chapter, you will be able to:

- describe what the term *information systems ethics* means;
- explain what a code of ethics is and describe the advantages and disadvantages;
- define the term *intellectual property* and explain the protections provided by copyright, patent, and trademark; and
- describe the challenges that information technology brings to individual privacy.

Introduction

Information systems have had an impact far beyond the world of business. New technologies create new situations that have never had to be confronted before. One issue is how to handle the new capabilities that these devices provide to users. What new laws are going to be needed for protection from misuse of new technologies. This chapter begins with a discussion of the impact of information systems has on user behavior or ethics. This will be followed with the new legal structures being put in place with a focus on intellectual property and privacy.

Information Systems Ethics

The term *ethics* means “a set of moral principles” or “the principles of conduct governing an individual or a group.”¹ Since the dawn of civilization, the study of ethics and their impact has fascinated mankind. But what do ethics have to do with information systems?

The introduction of new technology can have a profound effect on human behavior. New technologies give us capabilities that we did not have before, which in turn create environments and situations that have not been specifically addressed in an ethical context. Those who master new technologies gain new power while those who cannot or do not master them may lose power. In 1913 Henry Ford implemented the first moving assembly line to create his Model T cars.

1. [1]

While this was a great step forward technologically and economically, the assembly line reduced the value of human beings in the production process. The development of the atomic bomb concentrated unimaginable power in the hands of one government, who then had to wrestle with the decision to use it. Today's digital technologies have created new categories of ethical dilemmas.

For example, the ability to anonymously make perfect copies of digital music has tempted many music fans to download copyrighted music for their own use without making payment to the music's owner. Many of those who would never have walked into a music store and stolen a CD find themselves with dozens of illegally downloaded albums.

Digital technologies have given us the ability to aggregate information from multiple sources to create profiles of people. What would have taken weeks of work in the past can now be done in seconds, allowing private organizations and governments to know more about individuals than at any time in history. This information has value, but also chips away at the privacy of consumers and citizens.

Sidebar: Data Privacy, Facebook, and Cambridge Analytica



Facebook logo

In early 2018 Facebook acknowledged a data breach affecting 87 million users. The app “thisisyourdigitallife”, created by Global Science Research, informed users that they could participate in a psychological research study. About 270,000 people decided to participate in the research, but the app failed to tell users that the data of all of their friends on Facebook would be automatically captured as well. All of this data theft took place prior to 2014, but it did not become public until four years later.

In 2015 Facebook learned about Global Science Research's collection of data on millions of friends of the users in the research. Global Science Research agreed to delete the data, but it had already been sold to Cambridge Analytica who used it in the 2016 presidential primary campaign. The ensuing firestorm resulted in Mark Zuckerberg, CEO of Facebook, testifying before the U.S. Congress in 2018 on what happened and what Facebook would do in the future to protect users' data. Congress is working on legislation to protect user data in the future, a prime example of technology advancing faster than the laws needed to protect users. More information about this case of data privacy can be found at Facebook and Cambridge Analytica.²

Code of Ethics

A code of ethics is one method for navigating new ethical waters. A code of ethics outlines a set of acceptable behaviors for a professional or social group. Generally, it is agreed to by all members of the group. The document details different actions that are considered appropriate and inappropriate.

A good example of a code of ethics is the *Code of Ethics and Professional Conduct* of the Association for Computing Machinery,³ an organization of computing professionals that includes academics, researchers, and practitioners. Here is a quote from the preamble:

2. [2]

3. [3]

Commitment to ethical professional conduct is expected of every member (voting members, associate members, and student members) of the Association for Computing Machinery (ACM).

This Code, consisting of 24 imperatives formulated as statements of personal responsibility, identifies the elements of such a commitment. It contains many, but not all, issues professionals are likely to face. Section 1 outlines fundamental ethical considerations, while Section 2 addresses additional, more specific considerations of professional conduct. Statements in Section 3 pertain more specifically to individuals who have a leadership role, whether in the workplace or in a volunteer capacity such as with organizations like ACM. Principles involving compliance with this Code are given in Section 4.

In the ACM's code you will find many straightforward ethical instructions such as the admonition to be honest and trustworthy. But because this is also an organization of professionals that focuses on computing, there are more specific admonitions that relate directly to information technology:

- No one should enter or use another's computer system, software, or data files without permission. One must always have appropriate approval before using system resources, including communication ports, file space, other system peripherals, and computer time.
- Designing or implementing systems that deliberately or inadvertently demean individuals or groups is ethically unacceptable.
- Organizational leaders are responsible for ensuring that computer systems enhance, not degrade, the quality of working life. When implementing a computer system, organizations must consider the personal and professional development, physical safety, and human dignity of all workers. Appropriate human-computer ergonomic standards should be considered in system design and in the workplace.

One of the major advantages of creating a code of ethics is that it clarifies the acceptable standards of behavior for a professional group. The varied backgrounds and experiences of the members of a group lead to a variety of ideas regarding what is acceptable behavior. While the guidelines may seem obvious, having these items detailed provides clarity and consistency. Explicitly stating standards communicates the common guidelines to everyone in a clear manner.

A code of ethics can also have some drawbacks. First, a code of ethics does not have legal authority. Breaking a code of ethics is not a crime in itself. What happens if someone violates one of the guidelines? Many codes of ethics include a section that describes how such situations will be handled. In many cases repeated violations of the code result in expulsion from the group.

In the case of ACM: "Adherence of professionals to a code of ethics is largely a voluntary matter. However, if a member does not follow this code by engaging in gross misconduct, membership in ACM may be terminated." Expulsion from ACM may not have much of an impact on many individuals since membership in ACM is usually not a requirement for employment. However, expulsion from other organizations, such as a state bar organization or medical board, could carry a huge impact.

Another possible disadvantage of a code of ethics is that there is always a chance that important issues will arise that are not specifically addressed in the code. Technology is quickly changing and a code of ethics might not be updated often enough to keep up with all of the changes. A good code of ethics, however, is written in a broad enough fashion that it can address the ethical issues of potential changes to technology while the organization behind the code makes revisions.

Finally, a code of ethics could also be a disadvantage in that it may not entirely reflect the ethics or morals of every member of the group. Organizations with a diverse membership may have internal conflicts as to what is acceptable behavior. For example, there may be a difference of opinion on the consumption of alcoholic beverages at company events. In such cases the organization must make a choice about the importance of addressing a specific behavior in the code.

Sidebar: Acceptable Use Policies

Many organizations that provide technology services to a group of constituents or the public require agreement to an Acceptable Use Policy (AUP) before those services can be accessed. Similar to a code of ethics, this policy outlines what is allowed and what is not allowed while someone is using the organization's services. An everyday example of this is the terms of service that must be agreed to before using the public Wi-Fi at Starbucks, McDonald's, or even a university. Here is an example of an acceptable use policy from Virginia Tech.

Just as with a code of ethics, these acceptable use policies specify what is allowed and what is not allowed. Again, while some of the items listed are obvious to most, others are not so obvious:

- “Borrowing” someone else’s login ID and password is prohibited.
- Using the provided access for commercial purposes, such as hosting your own business website, is not allowed.
- Sending out unsolicited email to a large group of people is prohibited.

As with codes of ethics, violations of these policies have various consequences. In most cases, such as with Wi-Fi, violating the acceptable use policy will mean that you will lose your access to the resource. While losing access to Wi-Fi at Starbucks may not have a lasting impact, a university student getting banned from the university's Wi-Fi (or possibly all network resources) could have a large impact.

Intellectual Property

One of the domains that has been deeply impacted by digital technologies is intellectual property. Digital technologies have driven a rise in new intellectual property claims and made it much more difficult to defend intellectual property.

Intellectual property is defined as “property (as an idea, invention, or process) that derives from the work of the mind or intellect.”⁴ This could include creations such as song lyrics, a computer program, a new type of toaster, or even a sculpture.

Practically speaking, it is very difficult to protect an idea. Instead, intellectual property laws are written to protect the tangible results of an idea. In other words, just coming up with a song in your head is not protected, but if you write it down it can be protected.

Protection of intellectual property is important because it gives people an incentive to be creative. Innovators with great ideas will be more likely to pursue those ideas if they have a clear understanding of how they will benefit. In the US Constitution, Article 8, Section 8, the authors saw fit to recognize the importance of protecting creative works:

Congress shall have the power . . . To promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries.

An important point to note here is the “limited time” qualification. While protecting intellectual property is important because of the incentives it provides, it is also necessary to limit the amount of benefit that can be received and allow the results of ideas to become part of the public domain.

4. [4]

Outside of the US, intellectual property protections vary. You can find out more about a specific country's intellectual property laws by visiting the World Intellectual Property Organization.

The following sections address three of the best known intellectual property protections: copyright, patent, and trademark.

Copyright

Copyright is the protection given to songs, computer programs, books, and other creative works. Any work that has an "author" can be copyrighted. Under the terms of copyright, the author of a work controls what can be done with the work, including:

- Who can make copies of the work.
- Who can make derivative works from the original work.
- Who can perform the work publicly.
- Who can display the work publicly.
- Who can distribute the work.

Many times a work is not owned by an individual but is instead owned by a publisher with whom the original author has an agreement. In return for the rights to the work, the publisher will market and distribute the work and then pay the original author a portion of the proceeds.

Copyright protection lasts for the life of the original author plus seventy years. In the case of a copyrighted work owned by a publisher or another third party, the protection lasts for ninety-five years from the original creation date. For works created before 1978, the protections vary slightly. You can see the full details on copyright protections by reviewing the Copyright Basics document available at the US Copyright Office's website.

Obtaining Copyright Protection

In the United States a copyright is obtained by the simple act of creating the original work. In other words, when an author writes down a song, makes a film, or develops a computer program, the author has the copyright. However, for a work that will be used commercially, it is advisable to register for a copyright with the US Copyright Office. A registered copyright is needed in order to bring legal action against someone who has used a work without permission.

First Sale Doctrine

If an artist creates a painting and sells it to a collector who then, for whatever reason, proceeds to destroy it, does the original artist have any recourse? What if the collector, instead of destroying it, begins making copies of it and sells them? Is this allowed? The first sale doctrine is a part of copyright law that addresses this, as shown below⁵:

The first sale doctrine, codified at 17 U.S.C. § 109, provides that an individual who knowingly purchases a copy

5. [5]

of a copyrighted work from the copyright holder receives the right to sell, display or otherwise dispose of *that particular copy*, notwithstanding the interests of the copyright owner.

Therefore, in our examples the copyright owner has no recourse if the collector destroys the artwork. But the collector does not have the right to make copies of the artwork.

Fair Use

Another important provision within copyright law is that of fair use. Fair use is a limitation on copyright law that allows for the use of protected works without prior authorization in specific cases. For example, if a teacher wanted to discuss a current event in class, copies of the copyrighted new story could be handed out in class without first getting permission. Fair use is also what allows a student to quote a small portion of a copyrighted work in a research paper.

Unfortunately, the specific guidelines for what is considered fair use and what constitutes copyright violation are not well defined. Fair use is a well-known and respected concept and will only be challenged when copyright holders feel that the integrity or market value of their work is being threatened. The following four factors are considered when determining if something constitutes fair use:⁶

1. The purpose and character of the use, including whether such use is of commercial nature or is for nonprofit educational purposes;
2. The nature of the copyrighted work;
3. The amount and substantiality of the portion used in relation to the copyrighted work as a whole;
4. The effect of the use upon the potential market for, or value of, the copyrighted work.

If you are ever considering using a copyrighted work as part of something you are creating, you may be able to do so under fair use. However, it is always best to check with the copyright owner to be sure you are staying within your rights and not infringing upon theirs.

Sidebar: The History of Copyright Law

As noted above, current copyright law grants copyright protection for seventy years after the author's death, or ninety-five years from the date of creation for a work created for hire. But it was not always this way.

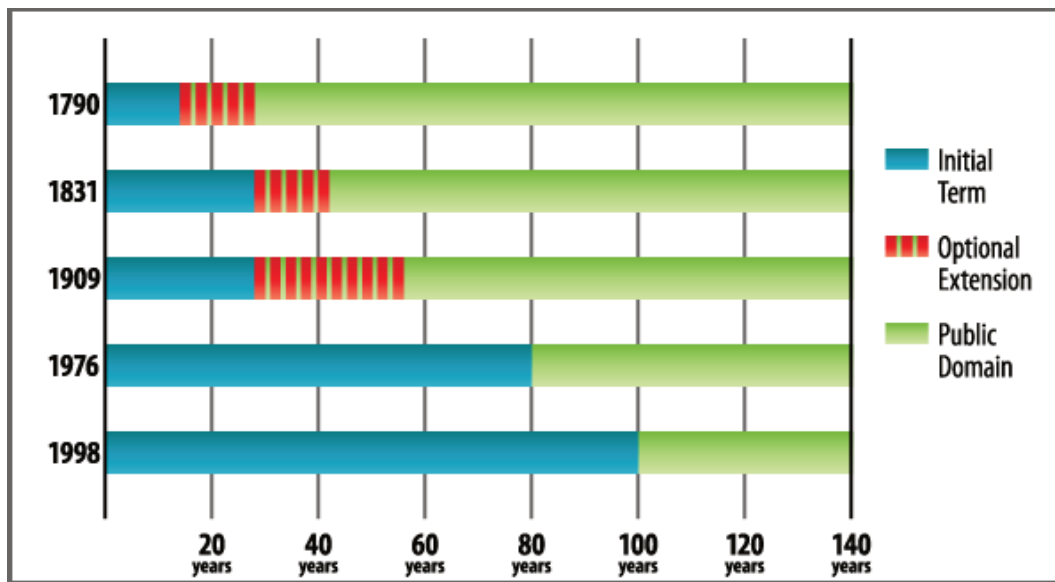
The first US copyright law, which only protected books, maps, and charts, provided protection for only 14 years with a renewable term of 14 years. Over time copyright law was revised to grant protections to other forms of creative expression, such as photography and motion pictures. Congress also saw fit to extend the length of the protections, as shown in the following chart. Today, copyright has become big business with many businesses relying on the income from copyright protected works for their income.

Many now think that the protections last too long. The Sonny Bono Copyright Term Extension Act has been nicknamed the "Mickey Mouse Protection Act," as it was enacted just in time to protect the copyright on the Walt Disney

6. [6]

Company's Mickey Mouse character. Because of this term extension, many works from the 1920s and 1930s that would have been available now in the public domain are still restricted.

Evolution of copyright



The Digital Millennium Copyright Act

As digital technologies have changed what it means to create, copy, and distribute media, a policy vacuum has been created. In 1998, the US Congress passed the Digital Millennium Copyright Act (DMCA), which extended copyright law to take into consideration digital technologies. Two of the best-known provisions from the DMCA are the anti-circumvention provision and the “safe harbor” provision.


- The anti-circumvention provision makes it illegal to create technology to circumvent technology that has been put in place to protect a copyrighted work. This provision includes not just the creation of the technology but also the publishing of information that describes how to do it. While this provision does allow for some exceptions, it has become quite controversial and has led to a movement to have it modified.
- The “safe harbor” provision limits the liability of online service providers when someone using their services commits copyright infringement. This is the provision that allows YouTube, for example, not to be held liable when someone posts a clip from a copyrighted movie. The provision does require the online service provider to take action when they are notified of the violation (a “takedown” notice). For an example of how takedown works, here’s how YouTube handles these requests: [YouTube Copyright Infringement Notification](#).

Many think that the DMCA goes too far and ends up limiting our freedom of speech. The Electronic Frontier Foundation (EFF) is at the forefront of this battle. In discussing the anti-circumvention provision, the EFF states:

Yet the DMCA has become a serious threat that jeopardizes fair use, impedes competition and innovation, chills free expression and scientific research, and interferes with computer intrusion laws. If you circumvent DRM [digital rights management] locks for non-infringing fair uses or create the tools to do so you might be on the receiving end of a lawsuit.

Sidebar: Creative Commons

Chapter 2 introduced the topic of open-source software. Open-source software has few or no copyright restrictions. The creators of the software publish their code and make their software available for others to use and distribute for free. This is great for software, but what about other forms of copyrighted works? If an artist or writer wants to make their works available, how can they go about doing so while still protecting the integrity of their work? Creative Commons is the solution to this problem.

Creative Commons is a nonprofit organization that provides legal tools for artists and authors. The tools offered make it simple to license artistic or literary work for others to use or distribute in a manner consistent with the author's intentions. Creative Commons licenses are indicated with the symbol . It is important to note that Creative Commons and public domain are not the same. When something is in the public domain, it has absolutely no restrictions on its use or distribution. Works whose copyrights have expired are in the public domain.

By using a Creative Commons license, authors can control the use of their work while still making it widely accessible. By attaching a Creative Commons license to their work, a legally binding license is created. Here are some examples of these licenses:

- **CC-BY.** This is the least restrictive license. It lets others distribute and build upon the work, even commercially, as long as they give the author credit for the original work.
- **CC-BY-SA.** This license restricts the distribution of the work via the “share-alike” clause. This means that others can freely distribute and build upon the work, but they must give credit to the original author *and* they must share using the same Creative Commons license.
- **CC-BY-NC.** This license is the same as CC-BY but adds the restriction that no one can make money with this work. NC stands for “non-commercial.”
- **CC-BY-NC-ND.** This license is the same as CC-BY-NC but also adds the ND restriction, which means that no derivative works may be made from the original.

These are a few of the more common licenses that can be created using the tools that Creative Commons makes available. For a full listing of the licenses and to learn much more about Creative Commons, visit their web site.

Patent

Patents are another important form of intellectual property protection. A patent creates protection for someone who invents a new product or process. The definition of invention is quite broad and covers many different fields. Here are some examples of items receiving patents:

- circuit designs in semiconductors;
- prescription drug formulas;
- firearms;
- locks;
- plumbing;
- engines;

- coating processes; and
- business processes.

Once a patent is granted it provides the inventor with protection from others infringing on his or her patent. A patent holder has the right to “exclude others from making, using, offering for sale, or selling the invention throughout the United States or importing the invention into the United States for a limited time in exchange for public disclosure of the invention when the patent is granted.”⁷

As with copyright, patent protection lasts for a limited period of time before the invention or process enters the public domain. In the US, a patent lasts twenty years. This is why generic drugs are available to replace brand-name drugs after twenty years.

Obtaining Patent Protection

Unlike copyright, a patent is not automatically granted when someone has an interesting idea and writes it down. In most countries a patent application must be submitted to a government patent office. A patent will only be granted if the invention or process being submitted meets certain conditions.

- **Must be original.** The invention being submitted must not have been submitted before.
- **Must be non-obvious.** You cannot patent something that anyone could think of. For example, you could not put a pencil on a chair and try to get a patent for a pencil-holding chair.
- **Must be useful.** The invention being submitted must serve some purpose or have some use that would be desired.

The job of the patent office is to review patent applications to ensure that the item being submitted meets these requirements. This is not an easy job. In 2017 the US Patent Office granted 318,849 patents, an increase of 5.2% over 2016.⁸ The current backlog for a patent approval is 15.6 months. Information Technology firms have apply for a significant number of patents each year. Here are the top five I.T. firms in terms of patent applications filed since 2009. The percents indicate the percent of total I.T. patents filed since 2009. Notice that over half of patent filings come from just these five corporations.

- International Business Machines (IBM) 21.6%
- Microsoft Corporation 14.2%
- AT & T, Inc. 7.1%
- Alphabet (Google), Inc. 5.0%
- Sony Corporation 4.7%

You might have noticed that Apple is not in the top five listing. Microsoft holds the lead in Artificial Intelligence (AI) patents.

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Sidebar: What Is a Patent Troll?

The advent of digital technologies has led to a large increase in patent filings and therefore a large number of patents being granted. Once a patent is granted, it is up to the owner of the patent to enforce it. If someone is found to be using the invention without permission, the patent holder has the right to sue to force that person to stop and to collect damages.

The rise in patents has led to a new form of profiteering called patent trolling. A *patent troll* is a person or organization who gains the rights to a patent but does not actually make the invention that the patent protects. Instead, the patent troll searches for those who are illegally using the invention in some way and sues them. In many cases the infringement being alleged is questionable at best. For example, companies have been sued for using Wi-Fi or for scanning documents, technologies that have been on the market for many years.

Recently, the U.S. government has begun taking action against patent trolls. Several pieces of legislation are working their way through the U.S. Congress that will, if enacted, limit the ability of patent trolls to threaten innovation. You can learn a lot more about patent trolls by listening to a detailed investigation conducted by the radio program *This American Life*, by clicking this link.

Trademark



Apple logo

A trademark is a word, phrase, logo, shape or sound that identifies a source of goods or services. For example, the Nike “Swoosh,” the Facebook “f,” and Apple’s apple (with a bite taken out of it) are all trademarked. The concept behind trademarks is to protect the consumer. Imagine going to the local shopping center to purchase a specific item from a specific store and finding that there are several stores all with the same name!

Two types of trademarks exist – a common law trademark and a registered trademark. As with copyright, an organization will automatically receive a trademark if a word, phrase, or logo is being used in the normal course of business (subject to some restrictions, discussed below). A common law trademark is designated by placing “TM” next to the trademark. A registered trademark is one that has been examined, approved, and registered with the trademark office, such as the Patent and Trademark Office in the US. A registered trademark has the circle-R (®) placed next to the trademark.

While most any word, phrase, logo, shape, or sound can be trademarked, there are a few limitations. A trademark will not hold up legally if it meets one or more of the following conditions:

- The trademark is likely to cause confusion with a mark in a registration or prior application.
- The trademark is merely descriptive for the goods/services. For example, trying to register the trademark “blue” for a blue product you are selling will not pass muster.
- The trademark is a geographic term.
- The trademark is a surname. You will not be allowed to trademark “Smith’s Bookstore.”
- The trademark is ornamental as applied to the goods. For example, a repeating flower pattern that is a design on a plate cannot be trademarked.

As long as an organization uses its trademark and defends it against infringement, the protection afforded by it does not expire. Because of this, many organizations defend their trademark against other companies whose branding even only slightly copies their trademark. For example, Chick-fil-A has trademarked the phrase “Eat Mor Chikin” and

has vigorously defended it against a small business using the slogan “Eat More Kale.” Coca-Cola has trademarked the contour shape of its bottle and will bring legal action against any company using a bottle design similar to theirs. Examples of trademarks that have been diluted and have now lost their protection in the US include: “aspirin” (originally trademarked by Bayer), “escalator” (originally trademarked by Otis), and “yo-yo” (originally trademarked by Duncan).

Information Systems and Intellectual Property

The rise of information systems has resulted in rethinking how to deal with intellectual property. From the increase in patent applications swamping the government’s patent office to the new laws that must be put in place to enforce copyright protection, digital technologies have impacted our behavior.

Privacy

The term *privacy* has many definitions, but for purposes here, privacy will mean the ability to control information about oneself. The ability to maintain our privacy has eroded substantially in the past decades, due to information systems.

Personally Identifiable Information

Information about a person that can be used to uniquely establish that person’s identity is called personally identifiable information, or PII. This is a broad category that includes information such as:

- Name;
- Social Security Number;
- Date of birth;
- Place of birth;
- Mother’s maiden name;
- Biometric records (fingerprint, face, etc.);
- Medical records;
- Educational records;
- Financial information; and
- Employment information.

Organizations that collect PII are responsible to protect it. The Department of Commerce recommends that “organizations minimize the use, collection, and retention of PII to what is strictly necessary to accomplish their business purpose and mission.” They go on to state that “the likelihood of harm caused by a breach involving PII is greatly reduced if an organization minimizes the amount of PII it uses, collects, and stores.”¹⁰ Organizations that do not

10. [10]

protect PII can face penalties, lawsuits, and loss of business. In the US, most states now have laws in place requiring organizations that have had security breaches related to PII to notify potential victims, as does the European Union.

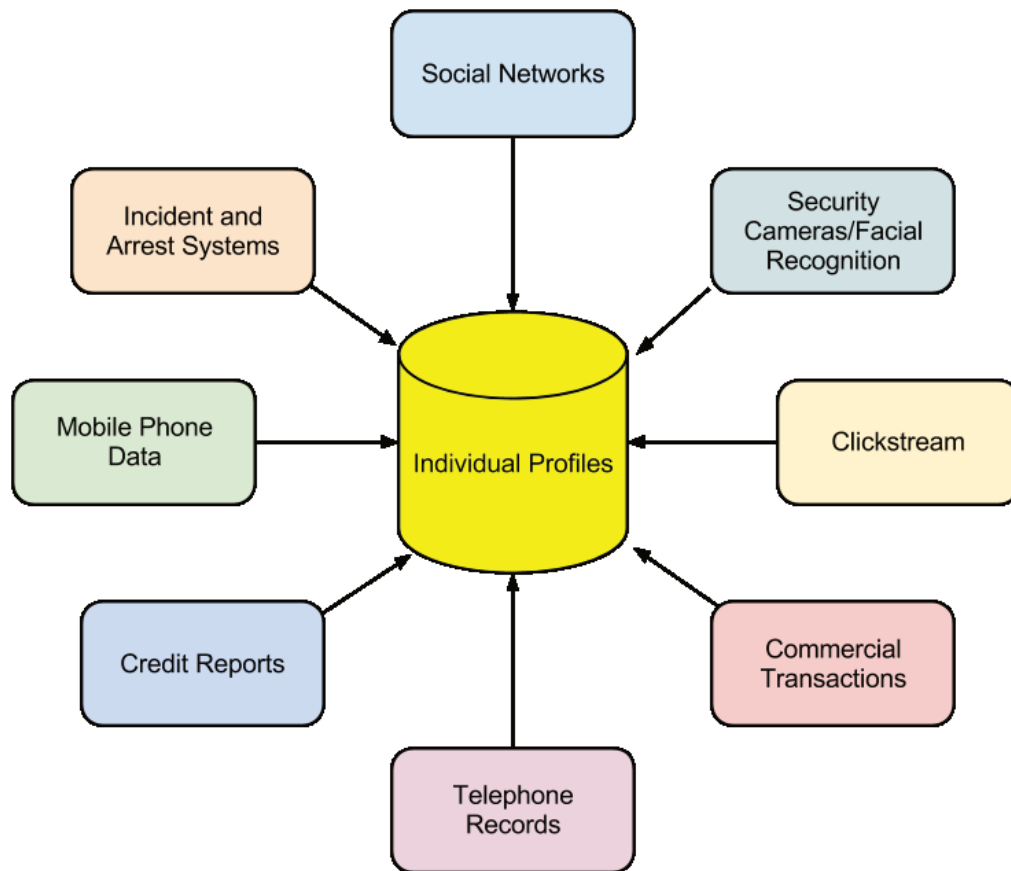
Just because companies are required to protect your information does not mean they are restricted from sharing it. In the US, companies can share your information without your explicit consent (see the following sidebar), though not all do so. Companies that collect PII are urged by the FTC to create a privacy policy and post it on their website. The State of California requires a privacy policy for any website that does business with a resident of the state (see <http://www.privacy.ca.gov/lawenforcement/laws.htm>).

While the privacy laws in the US seek to balance consumer protection with promoting commerce, privacy in the European Union is considered a fundamental right that outweighs the interests of commerce. This has led to much stricter privacy protection in the EU, but also makes commerce more difficult between the US and the EU.

Non-Obvious Relationship Awareness

Digital technologies have given people many new capabilities that simplify and expedite the collection of personal information. Every time a person comes into contact with digital technologies, information about that person is being made available. From location to web-surfing habits, your criminal record to your credit report, you are constantly being monitored. This information can then be aggregated to create profiles of each person. While much of the information collected was available in the past, collecting it and combining it took time and effort. Today, detailed information about a person is available for purchase from different companies. Even information not categorized as PII can be aggregated in such a way that an individual can be identified.

This process of collecting large quantities of a variety of information and then combining it to create profiles of individuals is known as *Non-Obvious Relationship Awareness*, or NORA. First commercialized by big casinos looking to find cheaters, NORA is used by both government agencies and private organizations, and it is big business.



Non-obvious relationship awareness (NORA)

In some settings NORA can bring many benefits such as in law enforcement. By being able to identify potential criminals more quickly, crimes can be solved sooner or even prevented before they happen. But these advantages come at a price, namely, our privacy.

Restrictions on Data Collecting

In the United State the government has strict guidelines on how much information can be collected about its citizens. Certain classes of information have been restricted by laws over time and the advent of digital tools has made these restrictions more important than ever.

Children's Online Privacy Protection Act

Websites that collect information from children under the age of thirteen are required to comply with the Children's Online Privacy Protection Act (COPPA), which is enforced by the Federal Trade Commission (FTC). To comply with COPPA, organizations must make a good-faith effort to determine the age of those accessing their websites and, if users are under thirteen years old, must obtain parental consent before collecting any information.

Family Educational Rights and Privacy Act

The Family Educational Rights and Privacy Act (FERPA) is a US law that protects the privacy of student education records. In brief, this law specifies that parents have a right to their child's educational information until the child reaches either the age of eighteen or begins attending school beyond the high school level. At that point control of the information is given to the child. While this law is not specifically about the digital collection of information on the Internet, the educational institutions that are collecting student information are at a higher risk for disclosing it improperly because of digital technologies.

Health Insurance Portability and Accountability Act

The Health Insurance Portability and Accountability Act of 1996 (HIPAA) singles out records related to health care as a special class of personally identifiable information. This law gives patients specific rights to control their medical records, requires health care providers and others who maintain this information to get specific permission in order to share it, and imposes penalties on the institutions that breach this trust. Since much of this information is now shared via electronic medical records, the protection of those systems becomes paramount.

General Data Protection Regulation



GDPR Logo

The European Union, in an effort to help people take control over their personal data, passed the General Data Protection Regulation (GDPR) in May 2016. While this protection applies to the countries in the EU, it is having an impact of U.S. companies using the Internet as well. The regulation went into effect May 25, 2018.

EU and non-EU countries have different approaches to protecting the data of individuals. The focus in the U.S. has been on protecting data privacy so that it does not impact commercial interests.

In the EU the individual's data privacy rights supercede those of business. Under GDPR data cannot be transferred to countries that do not have adequate data protection for individuals. Currently, those countries include, but are not limited to, the United States, Korea, and Japan. While the GDPR applies to countries in the EU, it is having an impact around the world as businesses in other countries seek to comply with this regulation. IEEE Spectrum. Retrieved from <https://spectrum.ieee.org/telecom/internet/your-guide-to-the-gdpr>.¹¹

One week prior to the effective date of May 25, 2018, only 60% of companies surveyed reported they would be ready by the deadline. Information Management. Retrieved from <https://www.information-management.com/opinion/playing-catch-up-with-the-general-data-protection-regulation>.¹²

Clearly, the message of GDPR has gone out around the world. It is likely that greater data protection regulations will forthcoming from the U.S. Congress as well.

11. [11]

12. [12]

Sidebar: Do Not Track

When it comes to getting permission to share personal information, the US and the EU have different approaches. In the US, the “opt-out” model is prevalent. In this model the default agreement states that you have agreed to share your information with the organization and must explicitly tell them that you do not want your information shared. There are no laws prohibiting the sharing of your data, beyond some specific categories of data such as medical records. In the European Union the “opt-in” model is required to be the default. In this case you must give your explicit permission before an organization can share your information.

To combat this sharing of information, the Do Not Track initiative was created. As its creators explain¹³:

Do Not Track is a technology and policy proposal that enables users to opt out of tracking by websites they do not visit, including analytics services, advertising networks, and social platforms. At present few of these third parties offer a reliable tracking opt out and tools for blocking them are neither user-friendly nor comprehensive. Much like the popular Do Not Call registry, Do Not Track provides users with a single, simple, persistent choice to opt out of third-party web tracking.

Summary

The rapid changes in information technology in the past few decades have brought a broad array of new capabilities and powers to governments, organizations, and individuals alike. These new capabilities have required thoughtful analysis and the creation of new norms, regulations, and laws. This chapter has covered the areas of intellectual property and privacy regarding how these domains have been affected by new information systems capabilities and how the regulatory environment has been changed to address them.

Study Questions

1. What does the term *information systems ethics* mean?
2. What is a code of ethics? What is one advantage and one disadvantage of a code of ethics?
3. What does the term *intellectual property* mean? Give an example.
4. What protections are provided by a copyright? How do you obtain one?
5. What is fair use?
6. What protections are provided by a patent? How do you obtain one?
7. What does a trademark protect? How do you obtain one?
8. What does the term *personally identifiable information* mean?
9. What protections are provided by HIPAA, COPPA, and FERPA?
10. How would you explain the concept of NORA?
11. What is GDPR and what was the motivation behind this regulation?

13. [13]

Exercises

1. Provide one example of how information technology has created an ethical dilemma that would not have existed before the advent of I.T.
2. Find an example of a code of ethics or acceptable use policy related to information technology and highlight five points that you think are important.
3. Do some original research on the effort to combat patent trolls. Write a two-page paper that discusses this legislation.
4. Give an example of how NORA could be used to identify an individual.
5. How are intellectual property protections different across the world? Pick two countries and do some original research, then compare the patent and copyright protections offered in those countries to those in the US. Write a two- to three-page paper describing the differences.
6. Knowing that GDPR had a deadline of May 25, 2018, provide an update on the status of compliance by firms in non-European countries.

Labs

1. Contact someone who has created a mobile device app, composed music, written a book, or created some other type of intellectual property. Ask them about the amount of effort required to produce their work and how they feel about being able to protect that work. Write a one or two page paper on your findings.
2. Research the intellectual property portion of the End User License Agreement (EULA) on a favorite computer program of yours. Explain what the EULA is saying about protection of this work.

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1. Merriam-Webster Dictionary. (n.d.). Ethics. Retrieved from <http://www.merriam-webster.com/dictionary/ethics> ↵
 2. Grigonis, H. (2018, April 5). Nine Things to Know About Facebook and Cambridge Analytica. *Digital Trends*. Retrieved from <https://www.digitaltrends.com/social-media/what-facebook-users-should-know-about-cambridge-analytica-and-privacy/>
 3. Association for Computing Machinery (1992, October 16) ACM Code of Ethics and Professional Conduct. ↵
 4. Merriam-Webster Dictionary. (n.d.). Intellectual Property. Retrieved from <http://www.merriam-webster.com/dictionary/intellectual%20property> ↵
 5. United States Department of Justice. (n.d.). Copyright Infringement – First Sale Doctrine. Retrieved from http://www.justice.gov/usao/eousa/foia_reading_room/usam/title9/crm01854.htm ↵
 6. United States Copyright Office. (n.d.). Fair Use Index. Retrieved from <http://www.copyright.gov/fls/fl102.html> ↵
 7. United States Patent and Trademark Office (n.d.). What Is A Patent? Retrieved from <http://www.uspto.gov/patents/> ↵
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 9. Bachmann, S. (2016, December 22). America's Big 5 Tech companies increase patent filings, Microsoft holds lead in AI technologies. *IP Watchdog*. Retrieved from <http://www.ipwatchdog.com/2016/12/22/big-tech-companies-increase-patent/id=76019/> ↵
 10. McAllister, E., Grance, T., and Scarfone, K. (2010, April). Guide to Protecting the Confidentiality of Personally Identifiable Information (PII). *National Institute of Standards and Technology*. Retrieved from <http://csrc.nist.gov/>

publications/nistpubs/800-122/sp800-122.pdf↵

11. Sanz, R. M. G. (2018, April 30). Your Guide to the GDPR. *IEEE Spectrum*. Retrieved from <https://spectrum.ieee.org/telecom/internet/your-guide-to-the-gdpr>↵
12. Zafrin, W. (2018, May 25). Playing Catch-up with the General Data Protection Regulation. *Information Management*. Retrieved from <https://www.information-management.com/opinion/playing-catch-up-with-the-general-data-protection-regulation>↵
13. *Electronic Frontier Foundation*. (n.d.). Do Not Track. Retrieved from <http://donottrack.us/>↵

13. Chapter 13: Trends in Information Systems

Learning Objectives

Upon successful completion of this chapter, you will be able to:

- describe current trends in information systems.
- know how to think about the impacts of changes in technology on society and culture.

Introduction

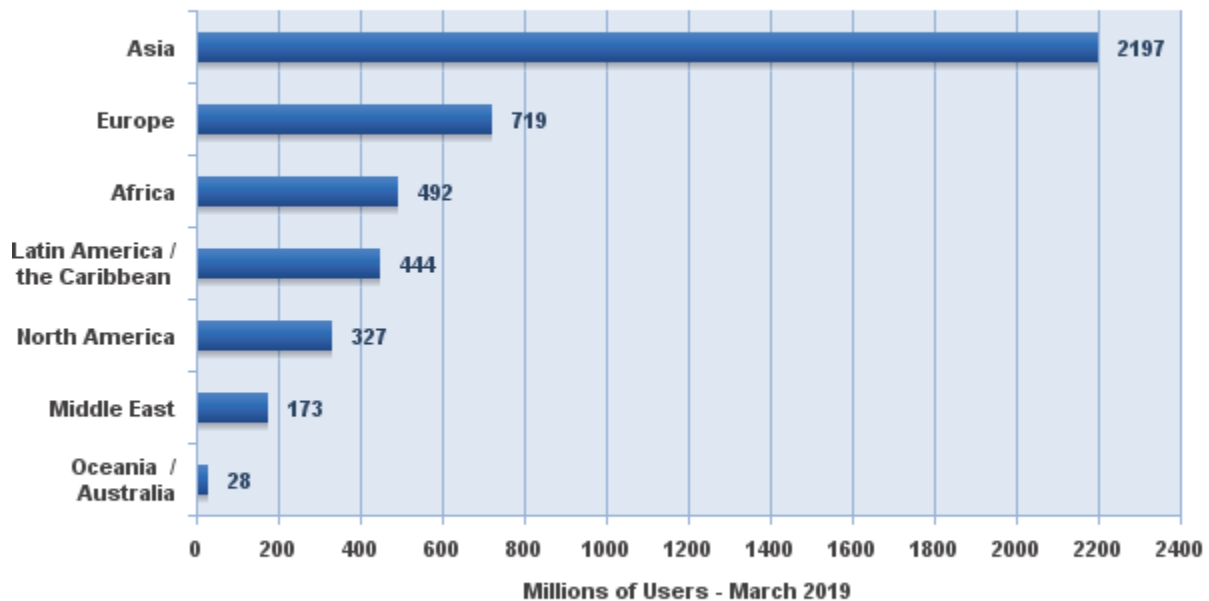
Information systems have evolved at a rapid pace ever since their introduction in the 1950s. Today devices you can hold in one hand are more powerful than the computers used to land a man on the moon in 1969. The Internet has made the entire world accessible to you, allowing you to communicate and collaborate like never before. This chapter examines current trends and looks ahead to what is coming next. As you read about technology trends in this chapter, think how you might gain competitive advantage in a future career through implementation of some of these devices.

Global

The first trend to note is the continuing expansion of globalization. The use of the Internet is growing all over the world, and with it the use of digital devices. Penetration rates, the percent of the population using the Internet, remains high in the developed world, but other continents are gaining.¹

1. Internet World Stats

Internet Users in the World by Geographic Regions - March, 2019 - Updated



Source: Internet World Stats - www.internetworldstats.com/stats.htm

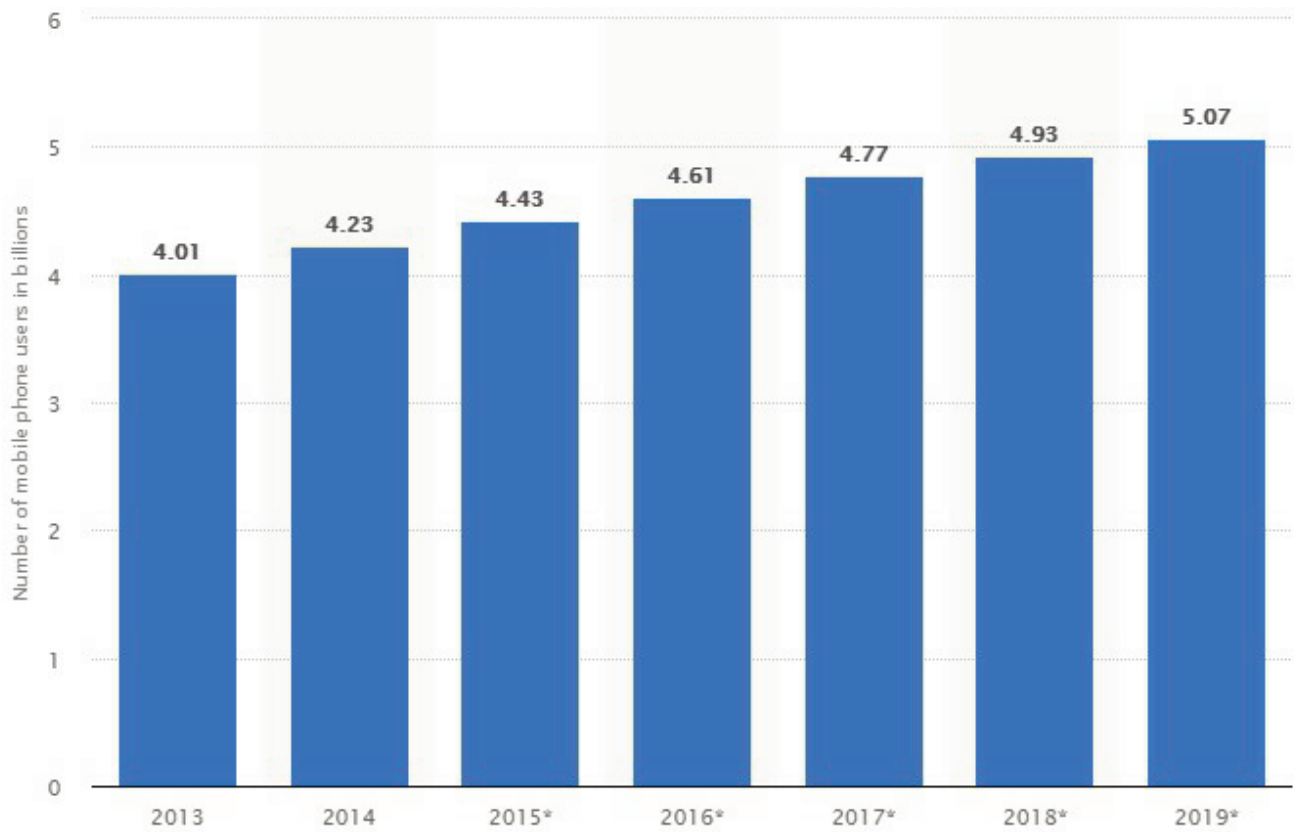
Basis: 4,383,810,342 Internet users estimated in March 31, 2019

Copyright © 2019, Miniwatts Marketing Group

Internet Users by Continent (Source: Internet World Stats)

In addition to worldwide growth in Internet penetration, the number of mobile phones in use continues to increase. At the end of 2017 the world population of people over the age 10 years (those old enough to possibly have their own mobile phone) was about 5.7 billion with an estimated 4.77 billion mobile phone users. This equates to over 80% of people in the world having a mobile phone.²

2. Statistica Forecast of Mobile Phone Users Worldwide



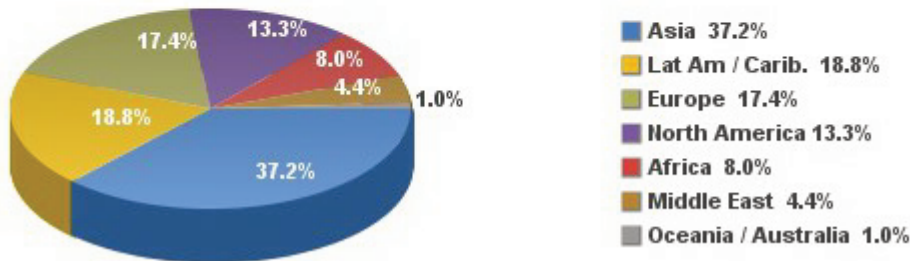
World wide mobile phone users (Source: Statista)

Social

Social media growth is another trend that continues at a firm growth rate. As of April 2018 there were about 2.18 billion Facebook users, a 14% increase from April 2017.³

Facebook Usage and Facebook Growth Statistics By World Geographic Regions

Facebook Subscribers in the World by Regions - June 2017



Facebook users world wide in June 2017 (Source: Internet World Stats)

In 2018, of the 2.2 billion users who regularly use Facebook, only half them spoke English and only 10% were from the US.⁴

Besides Facebook, other social media sites are also seeing tremendous growth. Over 83% of YouTube's users are outside the US, with the UK, India, Germany, Canada, France, South Korea, and Russia leading the way.⁵ Pinterest gets over 57% of its users from outside the US, with over 9% residing in India.⁶ Twitter now has over 330 million active users.⁷ Social media sites not based in the US are also growing. China's WeChat multipurpose messaging and social media app is the fifth most-visited site in the world.⁸

Personal

Ever since the advent of Web 2.0 and e-commerce, users of information systems have expected to be able to modify their experiences to meet their personal tastes. From custom backgrounds on computer desktops to unique ringtones on mobile phones, makers of digital devices provide the ability to personalize how we use them. More recently, companies such as Netflix have begun assisting their users with personalizations by viewing suggestions. In the future, we will begin seeing devices perfectly matched to our personal preferences, based upon information collected about us.

4. <https://blog.hootsuite.com/facebook-statistics>

5. Omnicore Agency Facebook Statistics

6. Omnicore Agency Pinterest Statistics

7. Omnicore Agency Twitter Statistics

8. Statista

Sidebar: Mary Meeker and Internet Trends



Mary Meeker making her Internet Trends presentation

Chapters such as this are difficult to maintain because the future is a moving target. The same goes for businesses looking to figure out where to develop new products and make investments. Enter Mary Meeker, up until 2018 a partner at the notable venture capital firm Kleiner Perkins Caufield & Byers and now forming her own investment group, Bond Capital. For the past several years, Ms. Meeker has presented the “Internet Trends” report at the Code Conference every May. The presentation consists of rapid-fire summaries of data that provides insights into all of the latest trends in digital technologies and their impact on economies, culture, and investing. For those wanting to keep up with technology, there is no better way than to unpack her annual presentation by

watching a video of the presentation and reviewing the associated slide deck.

Here are the last few years of videos of her presentation: [2019](#) [2018](#) [2017](#)

You can view her slide decks from previous years by going to the [Bond Capital archive](#).

Mobile

Perhaps the most impactful trend in digital technologies in the last decade has been the advent of mobile technologies. Beginning with the simple cellphone in the 1990s and evolving into the smartphones of today, the growth of mobile has been overwhelming. Here are some key indicators of this trend:

- **Mobile vs. Desktop.** Minutes spent each day on a mobile device are 2.5 times the number of minutes spent on a desktop computer.
- **Daytime vs. Evening.** Desktop use dominates in the daytime hours, but mobile devices are dominant in the evening, with peak usage around 8:00 pm.
- **Device usage.** Smartphones are used more than any other technology. Laptops are in second place, followed by tablets holding a slight edge over desktops.⁹
- **Smartphone sales decline.** According to Gartner Group, world wide smartphone sales declined in the fourth quarter of 2017 by 4.7% compared with the fourth quarter of 2016. This is the first decline in global smartphone sales since Gartner began tracking mobile phone sales in 2004.¹⁰
- **The rise and fall of tablets.** In 2012 the iPad sold more than three times as many units in its first twelve months as the iPhone did in its first twelve months. However, tablet sales dropped 20% from the fourth quarter 2015 to fourth quarter 2016.¹¹

9. Smart Insights

10. Gartner.com

The decline in tablet sales continued into 2017 when first quarter sales dropped 8.5% to their lowest total since the third quarter of 2012, the year they were introduced.¹² In comparison, PC sales dropped only 1.7% in 2017 compared with tablet sales being down 10%.¹³

As discussed in chapter 5, the advent of 5G connection technologies will accelerate an “always-connected” state for a majority of people around the world.

Wearable

The average smartphone user looks at his or her smartphone 150 times a day for functions such as messaging (23 times), phone calls (22), listening to music (13), and social media (9). Many of these functions would be much better served if the technology was worn on, or even physically integrated into, our bodies. This technology is known as a “wearable.”

Wearables have been around for a long time, with technologies such as hearing aids and, later, bluetooth earpieces. Now the product lines have expanded to include the Smartwatch, body cameras, sports watch, and various fitness monitors. The following table from the Gartner Group reports both historical and predicted sales.

Wearable Devices Worldwide (millions of units)

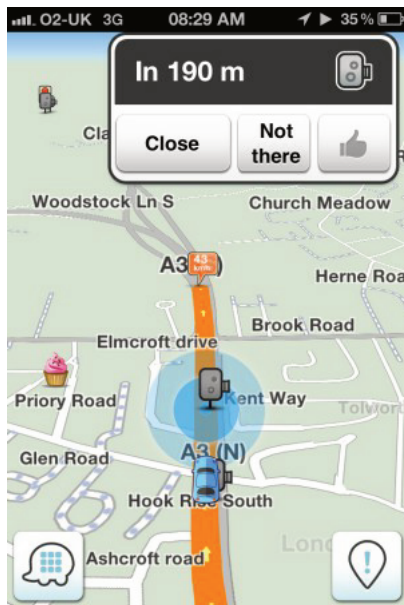
Device	2016	2017	2018	2021
Smartwatch	34.80	41.50	48.20	80.96
Head-mounted display	16.09	22.01	28.28	67.17
Body-worn camera	0.17	1.05	1.59	5.62
Bluetooth headset	128.50	150.00	168.00	206.00
Wristband	34.97	44.10	48.84	63.86
Sports watch	21.23	21.43	21.65	22.31
Other fitness monitor	55.46	55.7	56.23	58.73
Total	265.88	310.37	347.53	504.65

Wearable Devices Actual and Forecast (Source: Gartner Group, August 2017)

Notice the strong growth predicted by 2021. Total wearable devices are projected to increase by about 45% from 2018 to 2021.

11. Techcrunch
12. Business Insider
13. Telegraph

Collaborative



Waze Screen Shot (Click to enlarge)

As more people use smartphones and wearables, it will be simpler than ever to share data with each other for mutual benefit. Some of this sharing can be done passively, such as reporting your location in order to update traffic statistics. Other data can be reported actively, such as adding your rating of a restaurant to a review site.

The smartphone app Waze is a community-based tool that keeps track of the route you are traveling and how fast you are making your way to your destination. In return for providing your data, you can benefit from the data being sent from all of the other users of the app. Waze directs you around traffic and accidents based upon real-time reports from other users.

Yelp! allows consumers to post ratings and reviews of local businesses into a database, and then it provides that data back to consumers via its website or mobile phone app. By compiling ratings of restaurants, shopping centers, and services, and then allowing consumers to search through its directory, Yelp! has become a huge source of business for many companies. Unlike data collected passively however, Yelp! relies on its users to take the time to provide honest ratings and reviews.

Printable

One of the most amazing innovations to be developed recently is the 3-D printer. A 3-D printer allows you to print virtually any 3-D object based on a model of that object designed on a computer. 3-D printers work by creating layer upon layer of the model using malleable materials, such as different types of glass, metals, or even wax.

3-D printing is quite useful for prototyping the designs of products to determine their feasibility and marketability. 3-D printing has also been used to create working prosthetic legs and an ear that can hear beyond the range of normal hearing. The US military now uses 3-D printed parts on aircraft such as the F-18.¹⁴

Here are more amazing productions from 3D printers.

- **Buildings.** Researchers at MIT in 2017 unveiled a 3D printing robot that can construct a building. It has a large arm and small arm. The large arm moves around the perimeter of the building while the small arm sprays a variety of materials including concrete and insulation. Total time to construct a dome-shaped building is just 14 hours.
- **Musical Instruments.** Flutes, fiddles, and acoustic guitars are being produced with 3D printing using both metal and plastic. You can click here for an example of making a violin.
- **Medical Models.** Medical models are being used to help doctors train in the areas of orthopedics, transplant surgery, and oncology. Using a 3D printed brain model similar to the one shown here, surgeons were able to save a patient from a cerebral aneurysm.
- **Clothing.** How would you like clothes that fit perfectly? Special software is used to measure a person, then 3D printing produces the clothing to the exact measurements. The result is well-fitting clothes that consume less raw materials. Initially the challenge was to find materials that would not break. You can read more about 3D printing

14. The Economist. (2013, September 13). 3-D Printing Scales Up.

of clothes and shoes.

15

3-D printing is one of many technologies embraced by the “maker” movement. Chris Anderson, editor of *Wired* magazine, puts it this way¹⁶:

In a nutshell, the term “Maker” refers to a new category of builders who are using open-source methods and the latest technology to bring manufacturing out of its traditional factory context, and into the realm of the personal desktop computer. Until recently, the ability to manufacture was reserved for those who owned factories. What’s happened over the last five years is that we’ve brought the Web’s democratizing power to manufacturing. Today, you can manufacture with the push of a button.

Findable

decorative

The “Internet of Things” (IoT) refers to devices that have been embedded into a variety of objects including appliances, lamps, vehicles, lightbulbs, toys, thermostats, jet engines, etc. and then connecting them via Wi-Fi, BlueTooth, or LTE to the Internet. Principally three factors have come together to give us IoT: inexpensive processors, wireless connectivity, and a new standard for addresses on the Internet known as IPv6. The result is these small, embedded objects (things) are capable of sending and receiving data. Lights can be turned on or off remotely. Thermostats can be reset with anyone being present. And, perhaps on the downside, how you drive your car can be monitored and evaluated by your insurance company.

Processors have become both smaller and cheaper in recent years, leading to their being embedded in more devices. Consider technological advancements in your vehicles. Your car can now collect data about how fast you drive, where you go, radio stations you listen to, and your driving performance such as acceleration and braking. Insurance companies are offering discounts for the right to monitor your driving behavior. On the positive side, imagine the benefit of being informed instantly of anticipated traffic delays each time you adjust your route to work in the morning.

Think of IoT as devices that you wouldn’t normally consider being connected to the Internet. And, the connection is independent of human intervention. So a PC is not an IoT, but a fitness band could be. One keyword for IoT would be “independent”, not relying directly or constantly on human action.

Another keyword would be “interconnected”, in the sense that IoTs are connected to other IoTs and data collection points or data servers. This interconnectedness or uploading of data is virtually automatic.

“Ubiquitous” is also a good descriptor of IoTs. And so is “embeddedness.” It is reasonable to expect that devices through IoTs are reporting data about conditions and events that are not foremost in our thinking, at least not on a continuous basis. Today there are IoTs for monitoring traffic, air quality, soil moisture, bridge conditions, consumer electronics, autonomous vehicles, and the list seemingly never stops. The question that might come to mind is “How many IoTs are there today?”

The Gartner Group released a study in January 2017 which attempted to identify where IoTs exist. They reported that

15. Bosavage, J. (2017, September 5). Unbelievable Creations from 3-D Printers.

16. Anderson, C. (2012). *Makers: The New Industrial Revolution..* Crown Business.

over half of all IoTs are installed in devices used by consumers. They also noted that growth in IoTs increased by over 30% from 2016 to the projected levels for 2017.¹⁷

Benefits from IoTs are virtually everywhere. Here is a quick list.

- **Optimization of Processes.** IoTs in manufacturing monitor a variety of conditions that impact production including temperature, humidity, barometric pressure – all factors which require adjustment in application of manufacturing formulas.
- **Component Monitoring.** IoTs are added to components in the manufacturing process, then monitored to see how each component is performing.
- **Home Security Systems.** IoTs make the challenge of monitoring activity inside and outside your home are now easier.
- **Smart Thermostats.** Remote control of home thermostats through the use of IoTs allows the homeowner to be more efficient in consumption of utilities.
- **Residential Lighting.** IoTs provide remote control of lighting, both interior and exterior, and at any time of day.¹⁸

Security issues need to be acknowledged and resolved, preferably before IoTs in the form of remote lighting, thermostats, and security systems are installed in a residence. Here are some security concerns that need monitoring.

- **Eavesdropping.** Smart speaker systems in residences have been hacked, allowing others to eavesdrop on conversations within the home.
- **Internet-connected Smart Watches.** These devices are sometimes used to monitor the location of children in the family. Unfortunately, hackers have been able to break in and again, eavesdrop as well as learn where children are located.
- **Lax Use by Owners.** Devices such as smart thermometers, security systems, etc. come with a default password. Many owners fail to change the password, thereby allowing easy access by a hacker.

Autonomous

Another trend that is emerging is an extension of the Internet of Things: autonomous robots and vehicles. By combining software, sensors, and location technologies, devices that can operate themselves to perform specific functions are being developed. These take the form of creations such as medical nanotechnology robots (nanobots), self-driving cars, or unmanned aerial vehicles (UAVs).

A nanobot is a robot whose components are on the scale of about a nanometer, which is one-billionth of a meter. While still an emerging field, it is showing promise for applications in the medical field. For example, a set of nanobots could be introduced into the human body to combat cancer or a specific disease.

In March of 2012, Google introduced the world to their driverless car by releasing a video on YouTube showing a blind man driving the car around the San Francisco area. The car combines several technologies, including a laser radar system, worth about \$150,000. While the car is not available commercially yet, three US states (Nevada, Florida, and California) have already passed legislation making driverless cars legal.

17. Ranger, S. (2018, January 19). What is the IoT? Everything You Wanted to Know about The Internet of Things Right Now. ZDNet.
18. Ranger, S. (2018, January 19). What is the IoT? Everything You Wanted to Know about The Internet of Things Right Now. ZDNet.

A UAV, often referred to as a “drone,” is a small airplane or helicopter that can fly without a pilot. Instead of a pilot, they are either run autonomously by computers in the vehicle or operated by a person using a remote control. While most drones today are used for military or civil applications, there is a growing market for personal drones. For around \$300, a consumer can purchase a drone for personal use.

Secure

As digital technologies drive relentlessly forward, so does the demand for increased security. One of the most important innovations in security is the use of encryption, which we covered in chapter 6.

Summary

As the world of information technology moves forward, we will be constantly challenged by new capabilities and innovations that will both amaze and disgust us. As we learned in chapter 12, many times the new capabilities and powers that come with these new technologies will test us and require a new way of thinking about the world. Businesses and individuals alike need to be aware of these coming changes and prepare for them.

Study Questions

1. Which countries are the biggest users of the Internet? Social media? Mobile?
2. Which country had the largest Internet growth (in %) in the last five years?
3. How will most people connect to the Internet in the future?
4. What are two different applications of wearable technologies?
5. What are two different applications of collaborative technologies?
6. What capabilities do printable technologies have?
7. How will advances in wireless technologies and sensors make objects “findable”?
8. What is enhanced situational awareness?
9. What is a nanobot?
10. What is a UAV?

Exercises

1. If you were going to start a new technology business, which of the emerging trends do you think would be the biggest opportunity? Do some original research to estimate the market size.
2. What privacy concerns could be raised by collaborative technologies such as Waze?
3. Do some research about the first handgun printed using a 3-D printer and report on some of the concerns raised.
4. Write up an example of how IoT might provide a business with a competitive advantage.
5. How do you think wearable technologies could improve overall healthcare?

6. What potential problems do you see with a rise in the number of autonomous cars? Do some independent research and write a two-page paper that describes where autonomous cars are legal and what problems may occur.
7. Seek out the latest presentation by Mary Meeker on “Internet Trends” (if you cannot find it, the video from 2018 is available at Mary Meeker). Write a one-page paper describing what the top three trends are, in your opinion.
8. Select a business enterprise of interest to you, one that you may pursue following graduation. Select one or more of the technologies listed in this chapter, then write a one or two page paper about how you might use that technology to gain a competitive advantage.

Index

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