

## Information Systems for Business

In this course, you will be introduced to the concept of information systems, their use in business, and the larger impact they are having on our world.

### Introduction

If you are reading this, you are most likely taking a course in information systems, but do you even know what the course is going to cover? When you tell your friends or your family that you are taking a course in information systems, can you explain what it is about? For the past several years, I have taught an Introduction to Information Systems course. The first day of class I ask my students to tell me what they think an information system is. I generally get answers such as computers, databases, Excel. These are good answers, but definitely incomplete ones. The study of information systems goes far beyond understanding some technologies. Let's begin our study by defining information systems.

### Defining Information Systems

Almost all programs in business require students to take a course in something called *information systems*. But what exactly does that term mean? Let's take a look at some of the more popular definitions, first from Wikipedia and then from a couple of textbooks:

*Information system (IS) is the study of complementary networks of hardware and software that people and organizations use to collect, filter, process, create, and distribute data. (Wikipedia)*

*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. (Information Systems Today - Managing in the Digital World, fourth edition. Prentice-Hall, 2010)*

*Information systems are interrelated components working together to collect, process, store, and disseminate information to support decision making, coordination, control, analysis, and virtualization in an organization. (Management Information Systems, twelfth edition, Prentice-Hall, 2012.)*

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* that those components play in an organization. Let's take a look at each of these.

### **The Components of Information Systems**

There are some specific components related to Information Systems.

#### 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 is a part of our lives in so many ways that we tend to take it for granted. 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 get its own chapter and a much lengthier discussion, but we will take a moment here to introduce them so we can get a full understanding of what an information system is.

## Hardware

Information systems hardware is the part of an information system you can touch – the physical components of the technology. Computers, keyboards, disk drives, iPads, and flash drives are all examples of information systems hardware. We will spend some time going over these components and how they all work together in next lesson.

## Software

Software is a set of instructions that tells the hardware what to do. Software is not tangible – it cannot be touched. When programmers create software programs, what they are really doing is simply typing out lists of instructions that tell the hardware what to do. There are several categories of software, with the two main categories being operating-system software, which makes the hardware usable, and application software, which does something useful. Examples of operating systems include Microsoft Windows on a personal computer and Google's Android on a mobile phone. Examples of application software are Microsoft Excel and Angry Birds. Software will be explored more thoroughly in next lesson.

## Database

The third component is data. You can think of data as a collection of facts. For example, your street address, the city you live in, and your phone number are all pieces of data. Like software, data is also intangible. By themselves, pieces of data are not really very useful. But aggregated, indexed, and organized together into a database, data can become a powerful tool for businesses. In fact, all of the definitions presented at the beginning of this chapter focused on how information systems manage data. Organizations collect all kinds of data and use it to make decisions. These decisions can then be analyzed as to their effectiveness and the organization can be improved. Chapter 4 will focus on data and databases, and their uses in organizations.

## Communication

Besides the components of 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. We will be covering communication in next.

## People

When thinking about information systems, it is easy to get focused on the technology components and forget that we must look beyond these tools to fully understand how they integrate into an organization. A focus on the people involved in information systems is the next step. From the front-line help-desk workers, to systems analysts, to programmers, all the way up to the chief information officer (CIO), the people involved with information systems are an essential element that must not be overlooked.

## 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 and more integrated with organizational processes, bringing more productivity and better control to those processes. But simply automating activities

using technology is not enough – businesses looking to effectively utilize information systems do more. Using technology to manage and improve processes, both within a company and externally with suppliers and customers, is the ultimate goal. Technology buzzwords such as “*business process reengineering,*” “*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 an advantage over their competitors are highly focused on this component of information systems.

## **The Role of Information Systems**

Now we need to turn our attention to the role that information systems play in an organization. So far we have looked at what the components of an information system are, but what do these components actually do for an organization? From our definitions above, we see that these components collect, store, organize, and distribute data throughout the organization. In fact, we might say that one of the roles of information systems is to take data and turn it into information, and then transform that into organizational knowledge. As technology has developed, this role has evolved into the backbone of the organization.

### 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 refrigerator-sized machines linked together. The primary work of these devices 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 specialized facilities to maintain. These devices served dozens to hundreds of users at a time through a process called time-sharing. Typical functions included scientific calculations and accounting, under the broader umbrella of “data processing.”

In the late 1960s, the 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 (and later the MRP II systems) gave more businesses a reason to want to integrate computing into their processes. IBM became the dominant mainframe company. Nicknamed “Big Blue” the company became synonymous with business computing. Continued improvement in software and the availability of cheaper hardware eventually brought mainframe computers (and their little sibling, the minicomputer) into most large businesses.

### 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 quickly dozens of companies making 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 (teaming with a little company called Microsoft for their operating-system software) hurriedly released their own version of the personal computer, simply called the PC.

Businesses, who had used IBM mainframes for years to run their businesses, finally had the permission they needed to bring personal computers into their companies, and the IBM PC took off. The IBM PC was named Time magazine Man of the Year for 1982.

Because of the IBM PCs 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 its Windows operating system and made the PC even easier to use. Common uses for the PC during this period included word processing, spreadsheets, and databases. These early PCs were not connected to any sort of network; for the most part they stood alone as islands of innovation within the larger organization.

### Client-Server

In the mid-1980s, businesses began to see the need to connect their computers together as a way to collaborate and share resources. This networking architecture was referred to as client-server because users would log in to the local area network (LAN) from their PC (the client) by connecting to a powerful computer called a server, which would then grant them rights to different resources on the network (such as shared file areas and a printer). 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 real popular use of electronic mail appearing at this time.

This networking and data sharing all stayed within the confines of each business, for the most part. While there was sharing of electronic data between companies, this was a very specialized function. Computers were now seen as tools to collaborate internally, within an organization. In fact, 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 a software 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, many more, ERP systems, with Germany's SAP leading the way, represented the state of the art in information systems integration.

### The World Wide Web and E-Commerce

First invented in 1969, the Internet was confined to use by universities, government agencies, and researchers for many years. Its rather arcane commands and user applications made it unsuitable for mainstream use in business. One exception to this was the ability to expand electronic mail outside the confines of a single organization. While the first e-mail messages on the Internet were sent in the early 1970s, companies who wanted to expand their LAN-based e-mail started hooking up to the Internet in the 1980s. Companies began connecting their internal networks to the Internet in order to allow communication between their employees and employees at other companies. It was with these early Internet connections that the computer truly began to evolve from a computational device to a communications device.

In 1989, Tim Berners-Lee developed a simpler way for researchers to share information over the network at CERN laboratories, a concept he called the World Wide Web. This invention became the launching point of 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. In 1991, the National Science Foundation, which governed how the Internet was used, lifted restrictions on its commercial use. The year 1994 saw the establishment of both eBay and Amazon.com, two true pioneers in the use of the new digital marketplace. 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. While much can be learned from the speculation and crazy economic theories espoused during that bubble, one important outcome for businesses was that thousands of miles of Internet connections were laid around the world during that time.

As it became more expected for companies to be connected to the Internet, the digital world also became a more dangerous place. Computer viruses and worms, once slowly propagated through the sharing of computer disks, could now grow with tremendous speed via the Internet. Software written for a disconnected world found it very difficult to defend against these sorts of threats. A whole new industry of computer and Internet security arose.

### 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 purchase its products, customers wanted to be able to customize their experience and interact 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. Web 2.0 is exemplified by blogging, social networking, and interactive comments being available on many websites. This new web-2.0 world, in which online interaction became expected, had a big impact on many businesses and even whole industries. Some industries, such as bookstores, found themselves relegated to a niche status.

Others, such as video rental chains and travel agencies, simply began going out of business as they were replaced by online technologies. This process of technology replacing a middleman in a transaction is called disintermediation.

As the world became more connected, new questions arose. Should access to the Internet be considered a right? Can I copy a song that I downloaded from the Internet? How can I keep information that I have put on a website private? What information is acceptable to collect from children? Technology moved so fast that policymakers did not have enough time to enact appropriate laws, making for a Wild West-type atmosphere.

### The Post-PC World

After thirty years as the primary computing device used in most businesses, sales of the PC are now beginning to decline as sales of tablets and smartphones are taking off. Just as the mainframe before it, the PC will continue to play a key role in business, but will no longer be the primary way that people interact and do business. The limited storage and processing power of these devices is being offset by a move to cloud computing, which allows for storage, sharing, and backup of information on a massive scale. This will require new rounds of thinking and innovation on the part of businesses as technology continues to advance.

Era	Hardware	Operating System	Applications
Mainframe (1970s)	Terminals connected to mainframe computer.	Time-sharing (TSO) on MVS	Custom-written MRP software
PC (mid-1980s)	IBM PC or compatible. Sometimes connected to mainframe computer via expansion 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 to present)	Laptop connected to company Wi-Fi.	Windows 7	Microsoft Office, Firefox
Post-PC (today and beyond)	Apple iPad	iOS	Mobile-friendly websites, mobile apps

## Hardware

The physical parts of computing devices – those that you can actually touch – are referred to as hardware. In this chapter, we 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 now 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 soft drink dispensers.

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 traverse to complete 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. And this work has paid off – the speed of computing devices has been continuously improving ever since.

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. In the case of RAM, simply adding more RAM can also speed up the computer. The table below shows how each of these contributes to the speed of a computer.

Component	Speed measured by	Units	Description
CPU	Clock speed	GHz	The time it takes to complete a circuit.
Motherboard	Bus speed	mHz	How much data can move across the bus simultaneously.
RAM	Data transfer rate	MB/s	The time it takes for data to be transferred from memory to system.
Hard Disk	Access time	ms	The time it takes before the disk can transfer data.
	Data transfer rate	MBit/s	The time it takes for data to be transferred from disk to system.

### Portable Computers

In 1983, Compaq Computer Corporation developed the first commercially successful portable personal computer. By today's standards, the Compaq PC was not very portable: weighing in at 28 pounds, this computer was portable only in the most literal sense – it could be carried around. But this was no laptop; the computer was designed like a suitcase, to be lugged around and laid on its side to be used. Besides portability, the Compaq was successful because it was fully compatible with the software being run by the IBM PC, which was the standard for business.

In the years that followed, portable computing continued to improve, giving us laptop and notebook computers. The “luggable” computer has given way to a much lighter clamshell computer that weighs from 4 to 6 pounds and runs on batteries. In fact, the most recent advances in technology give us a new class of laptop that is quickly becoming the standard: these laptops are extremely light and portable and use less power than their larger counterparts. The MacBook Air is a good example of this: it weighs less than three pounds and is only 0.68 inches thick.

## Smartphones

The first modern-day mobile phone was invented in 1973. Resembling a brick and weighing in at two pounds, it was priced out of reach for most consumers at nearly four thousand dollars. Since then, mobile phones have become smaller and less expensive; today mobile phones are a modern convenience available to all levels of society. As mobile phones evolved, they became more like small computers. These smartphones have many of the same characteristics as a personal computer, such as an operating system and memory. The first smartphone was the IBM Simon, introduced in 1994.

In January of 2007, Apple introduced the iPhone. Its ease of use and intuitive interface made it an immediate success and solidified the future of smartphones. Running on an operating system called iOS, the iPhone was really a small computer with a touch-screen interface. In 2008, the first Android phone was released, with similar functionality.

## Tablet Computers

A tablet computer is one that uses a touch screen as its primary input and is small enough and light enough to be carried around easily. They generally have no keyboard and are self-contained inside a rectangular case. The first tablet computers appeared in the early 2000s and used an attached pen as a writing device for input. These tablets ranged in size from small personal digital assistants (PDAs), which were handheld, to full-sized, 14-inch devices. Most early tablets used a version of an existing computer operating system, such as Windows or Linux.

These early tablet devices were, for the most part, commercial failures. In January, 2010, Apple introduced the iPad, which ushered in a new era of tablet computing. Instead of a pen, the iPad used the finger as the primary input device. Instead of using the operating system of their desktop and laptop computers, Apple chose to use iOS, the operating system of the iPhone. Because the iPad had a user interface that was the same as the iPhone, consumers felt comfortable and sales took off. The iPad has set the standard for tablet computing. 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.

## The Rise of Mobile Computing

Mobile computing is having a huge impact on the business world today. The use of smart phones and tablet computers is rising at double-digit rates each year. The Gartner Group, in a report issued in April, 2013, estimates that over 1.7 million mobile phones will ship in the US in 2013 as compared to just over 340,000 personal computers. Over half of these mobile phones are smartphones.<sup>2</sup> Almost 200,000 tablet computers are predicted to ship in 2013. According to the report, PC shipments will continue to decline as phone and tablet shipments continue to increase.

## Integrated Computing

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 that would have been considered science fiction just a few years ago. Here are two of the latest ways that computing technologies are being integrated into everyday products:

- The Smart House
- The Self-Driving Car

Over the past thirty years, as the personal computer has gone from technical marvel to part of our everyday lives, it has also become a commodity. The PC has become a commodity in the sense that there is very little differentiation between computers, and the primary factor that controls their sale is their price. Hundreds of manufacturers all over the world now create parts for personal computers. Dozens of companies buy these parts and assemble the computers. As commodities, there are essentially no differences between computers made by these different companies. Profit margins for personal computers are razor-thin, leading hardware developers to find the lowest-cost manufacturing.

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 make 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, which, at least at this time, seems to be paying off.

## **Software**

The second component of an information system is software. Simply put: Software is the set of instructions that tell the hardware what to do. Software is created through the process of programming. 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* is the category of programs that do something useful for the user.

### Operating Systems

The operating system provides several essential functions, including:

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 run an operating system. For personal computers, the most popular operating systems are Microsoft's Windows, Apple's OS X, and different versions of Linux. Smart phones and tablets run operating systems as well, such as Apple's iOS, Google's Android, Microsoft's Windows Mobile, and Blackberry.

Early personal-computer operating systems were simple by today's standards; they did not provide multitasking and required the user to type commands to initiate an action. The amount of memory that early operating systems could handle was limited as well, making large programs impractical to run. The most popular of the early operating systems was IBM's Disk Operating System, or DOS, which was actually developed for them by Microsoft.

In 1984, Apple introduced the Macintosh computer, featuring an operating system with a graphical user interface. Though not the first graphical operating system, it was the first one to find commercial success. In 1985, Microsoft released the first version of Windows. This version of Windows was not an operating system, but instead was an application that ran on top of the DOS operating system, providing a graphical environment. It was quite limited and had little commercial success. It was not until the 1990 release of Windows 3.0 that Microsoft found success with a graphical user interface. Because of the hold of IBM and IBM-compatible

personal computers on business, it was not until Windows 3.0 was released that business users began using a graphical user interface, ushering us into the graphical-computing era. Since 1990, both Apple and Microsoft have released many new versions of their operating systems, with each release adding the ability to process more data at once and access more memory. Features such as multitasking, virtual memory, and voice input have become standard features of both operating systems.

A third personal-computer operating system family that is gaining in popularity is Linux (pronounced “linn-ex”). Linux is a version of the Unix operating system that runs on the personal computer. Unix is an operating system used primarily by scientists and engineers on larger minicomputers. These are very expensive computers, and software developer Linus Torvalds wanted to find a way to make Unix run on less expensive personal computers. Linux was the result. Linux has many variations and now powers a large percentage of web servers in the world. It is also an example of *open-source software*.

Ever since its introduction in 1984, users of the Apple Macintosh have been quite biased about their preference for the Macintosh operating system (now called OS X) over Microsoft’s.

When Microsoft introduced Windows, Apple sued Microsoft, claiming that they copied the “look and feel” of the Macintosh operating system. In the end, Microsoft successfully defended themselves. Over the past few years, Microsoft and Apple have traded barbs with each other, each claiming to have a better operating system and software. While Microsoft has always had the larger market share (see sidebar), Apple has been the favorite of artists, musicians, and the technology elite. Apple also provides a lot of computers to elementary schools, thus gaining a following among the younger generation.

### Application Software

The second major category of software is application software. Application software is, essentially, software that allows the user to accomplish some goal or purpose. For example, if you have to write a paper, you might use the application-software program Microsoft Word. If you want to listen to music, you might use iTunes. To surf the web, you might use Internet Explorer or Firefox. Even a computer game could be considered application software.

Two subcategories of application software worth mentioning are utility software and programming software. Utility software includes software that allows you to fix or modify your computer in some way. Examples include antivirus software and disk defragmentation software. These types of software packages were invented 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 is software whose purpose is to make more software. Most of these programs provide programmers with an environment in which they can write the code, test it, and convert it into the format that can then be run on a computer.

### **Applications for the Enterprise**

As the personal computer proliferated inside organizations, control over the information generated by the organization began splintering. Say 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? As another example, someone in sales might create a spreadsheet to calculate sales revenue, while someone in finance creates a different one that meets the needs of their department.

However, it is likely that the two spreadsheets will come up with different totals for revenue. Which one is correct? And who is managing all of this information?

There are some specific applications related to business organizations such as Enterprise Resource Planning, Customer Relationship Management and Supply Chain Management.

In the 1990s, the need to bring the 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 in one software application. Simply put, an ERP system is a software application utilizing a central database that is implemented throughout the entire organization.

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 several million dollars. In most cases, the cost of the software is not the most expensive part of the implementation: it is the cost of the consultants.

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.

A customer relationship management (CRM) system is a software application designed to manage 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 Sales force.

A supply chain management (SCM) system manages the interconnection between supply chain links, as well as the inventory of the products in their various stages of development. A full definition of a supply chain management system is provided by the Association for Operations Management: The design, planning, execution, control, and monitoring of supply chain activities with the objective of creating net value, building a competitive infrastructure, leveraging worldwide logistics, synchronizing supply with demand, and measuring performance globally.

### **Mobile Applications**

Just as with the personal computer, mobile devices such as tablet computers and smart phones also have operating systems and application software. In fact, these mobile devices are in many ways just smaller versions of personal computers. A mobile app is a software application programmed to run specifically on a mobile device.

These days, most mobile devices run on one of two operating systems: Android or iOS. Android is an open-source operating system purchased and supported by Google; iOS is Apple's mobile operating system. In the fourth quarter of 2012, Android was installed on 70.1% of all mobile phones shipped, followed by 21.0% for iOS. Other mobile operating systems of note are Blackberry (3.2%) and Windows (2.6%).

As organizations consider making their digital presence compatible with mobile devices, they will have to decide whether to build a mobile app. A mobile app is an expensive proposition, and it will only run on one type of mobile device at a time. For example, if an organization creates an iPhone app, those with Android phones cannot run the application. Each app takes several thousand dollars to create, so this is not a trivial decision for many companies. One option many companies have is to create a website that is mobile-friendly. A mobile website works on all mobile devices and costs about the same as creating an app.

## **Cloud Computing**

Historically, for software to run on a computer, an individual copy of the software had to be installed on the computer, either from a disk or, more recently, after being downloaded from the Internet. The concept of “cloud” computing change this, however.

To understand cloud computing, we first have to understand what the cloud is. “The cloud” refers to applications, services, and data storage on the Internet. These service providers rely on giant server farms and massive storage devices that are connected via Internet protocols. Cloud computing is the use of these services by individuals and organizations.

You probably already use cloud computing in some forms. For example, if you access your e-mail via your web browser, you are using a form of cloud computing. If you use Google Drive’s applications, you are using cloud computing. While these are free versions of cloud computing, there is big business in providing applications and data storage over the web. Sales force is a good example of cloud computing – their entire suite of CRM applications are offered via the cloud. Cloud computing is not limited to web applications: it can also be used for services such as phone 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 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 – how safe is it?
- You must have Internet access to use it. If you do not have access, you’re out of luck.
- You are relying on a third-party to provide these services.

## **Software Creation**

Modern software applications are written using a programming language. A programming language consists of a set of commands and syntax that can be organized logically to execute specific functions. This language generally consists of a set of readable words combined with symbols. Using this language, a programmer writes a program (called the source code) that can then be compiled into machine-readable form, the ones and zeroes necessary to be executed by the CPU. Examples of well-known programming languages today include Java, PHP, and various flavors of C (Visual C, C++, C#). Languages such as HTML and Javascript are used to develop web pages. Most of the time, programming is done inside a programming environment; when you

purchase a copy of Visual Studio from Microsoft, it provides you with an editor, compiler, and help for many of Microsoft's programming languages.

Software programming was originally an individual process, with each programmer working on an entire program, or several programmers each working on a portion of a larger program.

However, newer methods of software development include a more collaborative approach, with teams of programmers working on code together.

### Open-Source Software

When the personal computer was first released, it did not serve any practical need. Early computers were difficult to program and required great attention to detail. However, many personal-computer enthusiasts immediately banded together to build applications and solve problems. These computer enthusiasts were happy 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, at least with some. When a software program takes hundreds of man-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 we share what we learn. In the 1990s, with Internet access connecting more and more people together, the open source movement gained steam.

Open-source software is software that makes the source code available for anyone to copy and use. For most of us, having access to the source code of a program does us little good, as we are not programmers and won't be able to do much with it. The good news is that open-source software is also available in a compiled format that we can simply download and install. The open-source movement has led to the development of some of the most-used software in the world, including the Firefox browser, the Linux operating system, and the Apache web server. Many also think open-source software is superior to closed source software. Because the source code is freely available, many programmers have contributed to open source software projects, adding features and fixing bugs.

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 many arguments on both sides of the aisle for the benefits of the two models. Some benefits of the open-source model are:

- The software is available for free.
- The software source-code is available; it can be examined and reviewed before it is installed.
- The large community of programmers who work on open-source projects leads to quick bug fixing and feature additions.

Some benefits of the closed-source model are:

- By providing financial incentive for software development, some of the brightest minds have chosen software development as a career.
- Technical support from the company that developed the software.

Today there are thousands of open-source software applications available for download. You can get free Open Source Software from our Partner Website [www.files2pc.com](http://www.files2pc.com).

## Data and Databases

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

**Data** are the raw bits and pieces of information with no context. 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, not the result of a measurement or mathematical calculation.

By itself, data is not that useful. To be useful, it needs to be given context. By adding the context to data, we called that **Information**. 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.

### Examples of 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, and an e-book. In some cases, such as with an e-book, you may only have the ability to read the data.

### 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, put the data into context, and provide tools for aggregation and analysis. A database is designed for just such a purpose.

A **database** is an organized collection of related information. It is an *organized* collection, because in a database, all data is described and associated with other data. All information in a database should be *related* as well; separate databases should be created to manage unrelated information. For example, a database that contains information about students should not also hold information about company stock prices. Databases are not always digital a filing cabinet, for instance, might be considered a form of database. For the purposes of this text, we will only consider digital databases.

## Relational Databases

Databases can be organized in many different ways, and thus take many forms. The most popular form of database today is the relational database. Popular examples of relational databases are Microsoft Access, MySQL, and Oracle. A relational database is one in which data is organized into one or more tables. Each table has a set of fields, which define the nature 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 of the table and the fields as the columns of the table.

In the example below, a table of student information, with each row representing a student and each column representing one piece of information about the student.

		Fields (Columns)			
		First Name	Last Name	Major	Birthdate
Records (Rows)		Ann Marie	Cortez	Political Science/Pre-Law	02/01/1993
		Evan	Nguyen	Business	3/12/1994
		Michelle	Smith	Computer Science	5/10/1992

### Rows and columns in a table

In a relational database, all the tables are related by one or more fields, so that it is possible to connect all the tables in the database through the field(s) they have in common. For each table, one of the fields is identified as a primary key. This key is the unique identifier for each record in the table. To help you understand these terms further, let's walk through the process of designing a database.

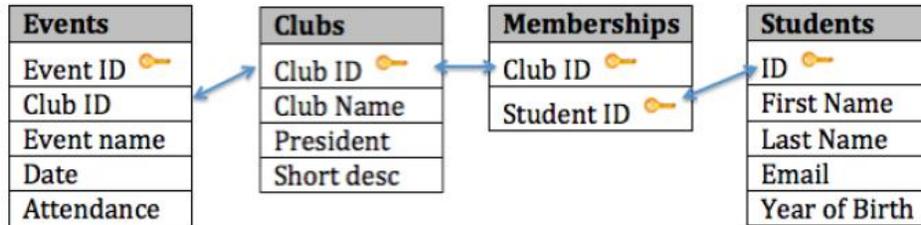
### Designing a Database

Suppose a university wants to create an information system to track participation in student clubs. After interviewing several people, the design team learns that the goal of implementing the system is to give better insight into how the university funds clubs. This will be accomplished by tracking how many members each club has and how active the clubs are. From this, the team decides that the system must keep track of the clubs, their members, and their events. Using this information, the design team determines that the following tables need to be created:

- Clubs: this will track the club name, the club president, and a short description of the club.
- Students: student name, e-mail, and year of birth.
- Memberships: this table will correlate students with clubs, allowing us to have any given student join multiple clubs.
- Events: this table will track when the clubs meet and how many students showed up.

Now that the design team has determined which tables to create, they need to define the specific information that each table will hold. This requires identifying the fields that will be in each table. For example, Club Name would be one of the fields in the Clubs table. First Name and Last Name would be fields in the Students 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 a relationship with each other).

In order to properly create this relationship, a primary key must be selected for each table. This key is a unique identifier for each record in the table. For example, in the Students table, it might be possible to use students' last name as a way to uniquely identify them. However, it is more than likely that some students will share a last name (like Rodriguez, Smith, or Lee), so a different field should be selected. 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 create a value for each student a user ID that will act as a primary key.



With this design, not only do we have a way to organize all of the information we need to meet the requirements, but we have also successfully related all the tables together. Here's what the database tables might look like with some sample data. Note that the Memberships table has the sole purpose of allowing us to relate multiple students to multiple clubs.

Club ID	Club name	President	Short desc
1	Cheese Club	14	To talk about our love of cheese.
2	Chess Club	1	To learn how to become better chess players.
3	Archery Club	6	To compete in archery tournaments.

Table: Clubs

Club ID	Student ID
1	1
1	2
1	14
2	1
2	3
2	5
2	6
3	1
3	6
3	12
3	14
3	15

Table: Memberships

ID	First Name	Last Name	Email	Year of Birth
1	Peter	Lee	plee@university.edu	1992
2	Jonathan	Edwards	jedwards@university.edu	1994
3	Marilyn	Johnson	mjohnson@university.edu	1993
6	Joe	Kim	jkim@university.edu	1992
12	Haley	Martinez	hmartinez@university.edu	1993
14	John	Mfume	jmfume@university.edu	1991
15	David	Letty	dletty@university.edu	1995

Table: Students

Club ID	Event name	Date	Attendance
1	Cheese promo	1/10/2013	6
2	MLK Tournament	1/21/2013	17
3	January meeting	1/22/2013	12
2	January meeting	1/28/2013	10

Table: Events

## 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 duplication of data between tables*
- 2) *Gives the table as much flexibility as possible.*

In the Student Clubs database design, the design team worked to achieve these objectives. For example, to track memberships, a simple solution might have been to create a Members field in the Clubs table and then just list the names of all of the members there. However, this design would mean that if a student joined two clubs, then his or her information would have to be entered a second time. Instead, the designers solved this problem by using two tables: Students and Memberships.

In this design, when a student joins their first club, we first must add the student to the Students table, where their first name, last name, e-mail address, and birth year are entered. This addition to the Students table will generate a student ID. Now we will add a new entry to denote that the student is a member of a specific club. This is accomplished by adding a record with the student ID and the club ID in the Memberships table. If this student joins a second club, we do not have to duplicate the entry of the student's name, e-mail, and birth year; instead, we only need to make another entry in the Memberships table of the second club's ID and the student's ID.

The design of the Student Clubs 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 faculty advisors to the clubs, we could easily accomplish this by adding a Faculty Advisors table (similar to the Students table) and then adding a new field to the Clubs table to hold the Faculty Advisor ID.

## Data Types

When defining the fields in a database table, we must give each field a data type. For example, the field Birth Year is a year, so it will be a number, while First Name will be text. 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.
- **Yes/No:** a special form of the number data type that is (usually) one byte long, with a 0 for "No" or "False" and a 1 for "Yes" or "True".
- **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. So if

we have, say, a field storing birth year, we can subtract the number stored in that field from the current year to get age. 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 First Name field is defined as a text (50) data type, this means fifty characters are allocated for each first name we want to store. However, even if the first name is only five characters long, fifty characters (bytes) will be allocated. While this may not seem like a big deal, if our table ends up holding 50,000 names, we are allocating  $50 * 50,000 = 2,500,000$  bytes for storage of these values. It may be prudent to reduce the size of the field so we do not waste storage space.

## 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. 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 Student Clubs database.

- The following query will retrieve a list of the first and last names of the club presidents:

```
SELECT "First Name", "Last Name" FROM "Students" WHERE "Students.ID"
```

- The following query will create a list of the number of students in each club, listing the club name and then the number of members:

```
SELECT "Clubs.Club Name", COUNT("Memberships.Student ID") FROM "Clubs"
```

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 data. Many database packages, such as Microsoft Access, allow you to visually create the query you want to construct and then generate the SQL query for you.

## 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.

## Database Management Systems

To the computer, a database looks like one or more files. In order for the data in the database to be 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.

For example, 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.

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.

### Enterprise 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. These relational enterprise database packages are built and supported by companies such as Oracle, Microsoft, and IBM.

The open-source MySQL is also an enterprise 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 Data store, which is based on NoSQL. Developers can use the App Engine Data store 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.

### **Data Warehouse**

#### Big Data

A new buzzword that has been capturing the attention of businesses lately is **big data**. The term refers to such massively large data sets that conventional database tools do not have the processing power to analyze them. For example, Walmart must process over one million customer transactions every hour. Storing and analyzing that much data is beyond the power of traditional database-management tools. Understanding the best tools and

techniques to manage and analyze these large data sets is a problem that governments and businesses alike are trying to solve.

### Metadata

The term *metadata* can be understood as “data about data.” For example, when looking at one of the values of Year of Birth in the Students table, the data itself may be “1992”. The metadata about that value would be the field name Year of Birth, the time it was last updated, and the data type (integer).

Another example of metadata could be for an MP3 music file, like the one shown in the image below; information such as the length of the song, the artist, the album, the file size, and even the album cover art, are classified as metadata. When a database is being designed, a “data dictionary” is created to hold the metadata, defining the fields and structure of the database.

### Data Warehouse

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.

### 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 Mining

Data mining is the process of analyzing data to find previously unknown 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.

In some cases, a data-mining project is begun with a hypothetical result in mind. For example, a grocery chain may already have some idea that buying patterns change after it rains and want to get a deeper understanding of exactly what is happening. In other cases, there are no presuppositions and a data-mining program is run against large data sets in order to find patterns and associations.

## 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.

## Business Intelligence and Business Analytics

With tools such as data warehousing and data mining 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 data from their internal databases, firms often purchase information from data brokers to get a big-picture understanding of their industries. **Business analytics** is the term used to describe the use of internal company data to improve business processes and practices.

## 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 formalizing the capture, indexing, and storing of the company's knowledge in order to benefit from the experiences and insights that the company has captured during its existence.

## Networking and Communication

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, or IT, department. This ability for computers to communicate with one another and, maybe more importantly, to facilitate communication between individuals and groups, has been an important factor in the growth of computing over the past several decades.

Computer networking really began in the 1960s with the birth of the Internet, as we'll see below. 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. In the 1990s, when the Internet came of age, Internet technologies began to pervade all areas of the organization. Now, with the Internet a global phenomenon, it would be unthinkable to have a computer that did not include communications capabilities.

### Internet and World Wide Web

The Internet is a global system of interconnected computer networks. That interchange data by packet switching using the standardized Internet Protocol Suite. It is actually a physical network and also known as network of networks. The Internet is a giant network spread throughout the world by connecting millions of computers. Therefore the standards of the Internet Infrastructure based upon worldwide standards. This enables the world-wide connectivity and generality to use the Internet.

The Internet Originated from the older concept of ARPAnet (Advance Research Project Agency Network) in 1970s. ARPAnet used for military purposes by USA department of defense during the 2<sup>nd</sup> world war. It's a protected network used for effectively against enemy parties during those days. After the war that system re-established used by scientists and engineers to share their experiment details, and after sometime it used within Universities, and after while it popular among whole community.

World Wide Web (WWW) is a service provided by the Internet that allows users to view information on remote computers. World Wide Web is the most powerful application on the Internet. It defines the Software part of the Internet. All the Websites and other software resources are falls in to this W3 category.

In 1990 Tim Berners-Lee and at team at the CERN developed this World Wide Web.

### **Networking Communication Technology**

Networking communication is full of some very technical concepts based on some simple principles. Learn the terms below and you'll be able to get a clear idea about the Internet.

- **Packet:** The fundamental unit of data transmitted over the Internet. When a device intends to send a message to another device (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.
- **Packet-switching:** When a packet is sent from one device out over the Internet, it does not follow a straight path to its destination. Instead, it is passed from one router to another across the Internet until it is reaches its destination. In fact, sometimes two packets from the same message will take different routes.

Sometimes, packets will arrive at their destination out of order. When this happens, the receiving device restores them to their proper order.

- **Hub:** A simple network device that connects other devices to the network and sends packets to all the devices connected to it.
- **Bridge:** A network device that connects two networks together and only allows packets through that are needed.
- **Switch:** A network device that connects multiple devices together and filters packets based on their destination within the connected devices.
- **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.
- **IP Address:** Every device that communicates on the Internet, whether it be a personal computer, a tablet, a smart phone, or anything else, is assigned a unique identifying number called an IP (Internet Protocol) address. Historically, the IP-address standard used has been IPv4 (version 4), which has the format of four numbers between 0 and 255 separated by a period. For example, the domain Saylor.org has the IP address of 107.23.196.166. The IPv4 standard has a limit of 4,294,967,296 possible addresses. As the use of the Internet has proliferated, the number of IP addresses needed has grown to the point where the use of IPv4 addresses will be exhausted. This has led to the new IPv6 standard, which is currently being phased in. 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  $3.4 \times 10^{38}$  possible addresses.
- **Domain name:** If you had to try to remember the IP address of every web server you wanted to access, the Internet would not be nearly as easy to use. A domain name is a human-friendly name for a device on the Internet. These names generally consist of a descriptive text followed by the top-level domain (TLD). For example, Wikipedia's domain name is wikipedia.org; *Wikipedia* describes the organization and *.org* is the top-level domain. In this case, the *.org* TLD is designed for nonprofit organizations. Other well-known TLDs include *.com*, *.net*, and *.gov*.
- **DNS:** DNS stands for "domain name system," which acts as the directory on the Internet. When a request to access a device with a domain name is given, a DNS server is queried. It returns the IP address of the device requested, allowing for proper routing.
- **Protocol:** In computer networking, a protocol is the set of rules that allow two (or more) devices to exchange information back and forth across the network.

Using the Internet in these early days was not easy. In order to access information on another server, you had to know how to type in the commands necessary to access it, as well as know the name of that device. 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 linked text (hypertext). The World Wide Web gained even more steam with the release of the Mosaic browser in 1993, which allowed graphics and text to be combined together as a way to present information and navigate the Internet. The Mosaic browser took off in popularity and was soon superseded by Netscape Navigator, the first commercial web browser, in 1994. The Internet and the World Wide Web were now poised for growth.

## People in Information Systems

In the opening chapters of this text, we focused on the technology behind information systems: hardware, software, data, and networking. In the last chapter, we discussed business processes and the key role they can play in the success of a business. In this chapter, we will be discussing the last component of an information system: people.

People are involved in information systems in just about every way you can think of: 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 we are going to look at play a role in designing, developing, and building information systems. These people are generally very technical and have a background in programming and mathematics. 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.

#### *Systems Analyst*

The role of the systems analyst is to straddle the divide between identifying business needs and imagining a new or redesigned computer-based system to fulfill those needs. This individual will work with a person, team, or department with business requirements and identify the specific details of a system that needs to be built.

#### *Programmer*

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. Many different styles of programming exist: a programmer may work alone for long stretches of time or may work in a team with other programmers. A programmer needs to be able to understand complex processes and also the intricacies of one or more programming languages. Generally, a programmer is very proficient in mathematics, as mathematical concepts underlie most programming code.

#### *Computer Engineer*

Computer engineers design the computing devices that we use 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 engineering jobs are as follows:

- **Hardware engineer.** A hardware engineer designs hardware components, such as microprocessors. 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 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 do not actually design devices; instead, they create new programming languages and operating systems, working at the lowest levels of the hardware to develop new kinds of software to run on the hardware.
- **Systems engineer.** A systems engineer takes the components designed by other engineers and makes them all work together. 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's job is to understand the networking requirements of an organization and then design a communications system to meet those needs, using the networking hardware and software available.

### ***Computer Operator***

A computer operator is the person who keeps the large computers running. This person's job is to oversee 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, 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 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 does not necessarily know how to answer all of the questions that come his or her way. In these cases, 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 people and communications skills, as well as at least junior-level IT skills.

### ***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 well and also have a lot of patience.

## **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 CIO, or chief information officer, 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. This includes tasks

such as 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 and planning.

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 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 is a group of systems analysts who report to a manager of the systems-analysis function.

### ***ERP Management***

Organizations using an ERP require one or more individuals to manage these systems. These people 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***

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. 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. A project manager must be a good communicator and an extremely organized person. A project manager should also have good people skills.

### ***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 fade. 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 technologies also is breeding demand for expertise in those areas.

## The Ethical and Legal Implications of Information Systems

Information systems have had an impact far beyond the world of business. New technologies create new situations that we have never dealt with before. How do we handle the new capabilities that these devices empower us with? What new laws are going to be needed to protect us from ourselves? This chapter will kick off with a discussion of the impact of information systems on how we behave (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* is defined as “a set of moral principles” or “the principles of conduct governing an individual or a group.”<sup>1</sup> 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?

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.

### Code of Ethics

One method for navigating new ethical waters is a code of ethics. A code of ethics is a document that 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.

- ✓ 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.

### 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.

- ✓ “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.

### Intellectual Property

One of the domains that have been deeply impacted by digital technologies is the domain of 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.”<sup>3</sup> 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.

## **Best-known intellectual property protections**

### **1. 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.

### **2. Patent**

Another important form of intellectual property protection is the patent. 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.

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:

- It must be original. The invention being submitted must not have been submitted before.
- It 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.
- It must be useful. The invention being submitted must serve some purpose or have some use that would be desired.

### 3. Trademark

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 has the circle-R (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:

1. The trademark is likely to cause confusion with a mark in a registration or prior application.
2. 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.
3. The trademark is a geographic term.
4. The trademark is a surname. You will not be allowed to trademark “Smith’s Bookstore.”
5. 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.

### 4. Privacy

The term *privacy* has many definitions, but for our purposes, privacy will mean the ability to control information about oneself. Our 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 identify 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
- Employment information.

## Future Trends in Information Systems

Information systems have evolved at a rapid pace ever since their introduction in the 1950s. Today, devices that we can hold in one hand are more powerful than the computers used to land a man on the moon. The Internet has made the entire world accessible to us, allowing us to communicate and collaborate with each other like never before. In this chapter, we will examine current trends and look ahead to what is coming next.

- ✓ **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.
- ✓ **Social** - Social media growth is another trend that continues. Facebook now has over one billion users. Besides Facebook, other social media sites are also seeing tremendous growth.
- ✓ **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.
- ✓ **Mobile** - Perhaps the most impactful trend in digital technologies in the last decade has been the advent of mobile technologies. Beginning with the simple cell phone in the 1990s and evolving into the smart phones and tablets of today, the growth of mobile has been overwhelming.
- ✓ **Wearable** - Many of computing & mobile 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."
- ✓ **Collaborative** - As more of us 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 our location in order to update traffic statistics. Other data can be reported actively, such as adding our rating of a restaurant to a review site.
- ✓ **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.
- ✓ **Autonomous** - A final 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).