Розглянуто ключові поняття, пов'язані з сучасним розвитком інформаційних систем та комп'ютерних технологій. Наведено основні елементи структури сучасних комп'ютерів та периферійних пристроїв. Проаналізовано структуру та особливості сучасного програмного забезпечення. Наведено класифікацію сучасних операційних систем. Розраховано на підготовку кваліфікованих користувачів, які знають будову комп'ютера й основні принципи його роботи.

Рекомендовано для студентів напрямів підготовки «Туризм», «Бізнес-адміністрування», «Менеджмент інноваційної діяльності».

Key aspects, connected with the modern development of information computer systems and technologies are considered. Basic elements of modern computers and peripherals are given. The structure and peculiarities of modern software are analyzed. The classification of modern operation systems is given. It is meant for preparation of qualified users, who know the structure and main principles of computers' work.

It is recommended for students of preparatory direction "Tourism", "Business Administration", "Innovations management".

Preface

This summary of lectures has been prepared for the use by students interested in information systems and technologies. While we have tried to present our advice as clearly and as fully as it is possible within a short form, this handbook is not a substitute for direct contact with the faculty.

What is information systems and technologies? First of all it is not about programming. It is more concentrated on how computers function and how they run different programs. That's why **the object** of this handbook is represented by the study of basic principles that govern operation of modern personal computers. Within this concept a special attention is given to the analysis of computer architecture, computer periphery and basic computer software. Each part of computer hardware is disclosed in detail and in close interconnection with other parts. Basic MS Office package applications are considered and given a detailed explanation. **The purpose** of this handbook is to make students of economic specialities become aware of information systems and technologies basic principles and concepts and as a result get the following **professional competencies**:

to know basic trends in information systems development in the context of the economy of a new type;

to know what parts a personal computer consists of and what the purpose of each part is;

to know what kinds of computer peripherals can be connected to a personal computer and what their purpose and architecture is;

to be aware of existing types of computer software and the role and purpose of each type of software.

The summary of lectures covers the first part of the "Information systems and technologies" discipline called "Computer science". The course is taught to the first-year students of economic specialities. Structurally the summary of lectures is divided into six separate sections which together cover the lecture material for first-year students of the "Tourism", "Business Administration" and "Innovations management" specialities.

The handbook is constructed to make it easy for readers to find and learn the basic points of the theoretic material. This is achieved through the use of visual accents for most important parts of the material and also thanks to a considerable number of original illustrations. Most relaxing pictures, used to make the study of the discipline a real fun, are taken from the caricatures created by a renowned caricaturist Herluf Bidstrup.

Section 1. Theoretic basics of information systems and technologies as a field of scientific research. Computer hardware and its structure

Theme 1. Introduction to information systems and technologies and its connection to computer science


Information systems and technologies. Computer science. Connection of computer science to other disciplines

- IS&T and computer science
- Computer science branches
- Neighbouring disciplines

Information. Basic forms of information. Information age

- The concept of information
- Forms of information
- Information Age

Information technologies
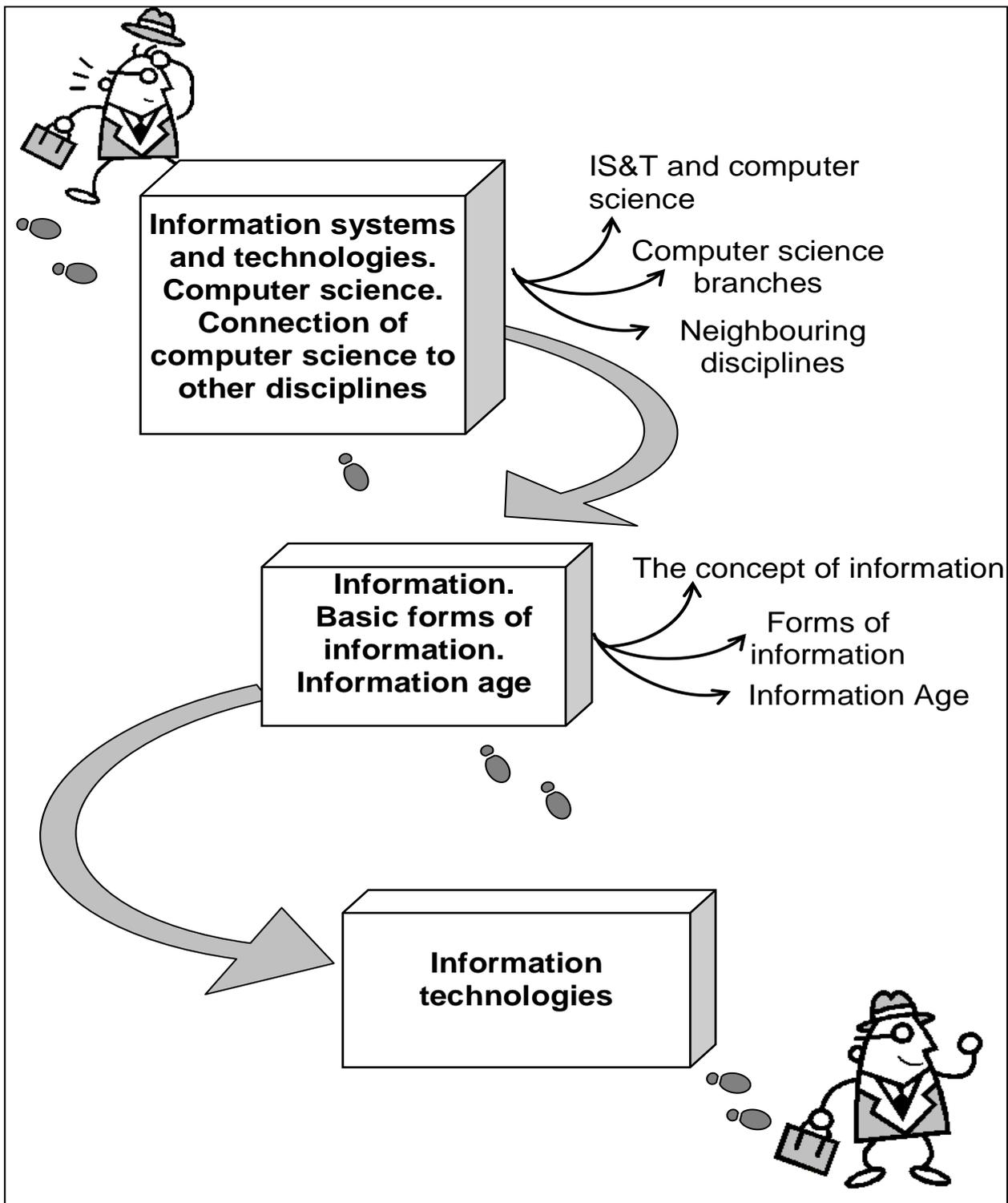
Fig. 1.1. **System elements of the theme**

■ Introduction

The purpose of this theme is to give a basic idea of the role of information in computer science and in human activity in general. The theme covers questions such as the place of information in facilitating processes connected with information tendencies such as coming of the Information age, increasing role of information work etc. Special attention is given to interdisciplinary relations of information technologies and computer science.

Clue notions of the theme include: information; information work; information age; stages of economic development; information system; information technology; branches of computer science; forms of information.

This theme covers the following **topics**: Connection of information systems and technologies to computer science. What is information? What are the forms of information? Which stages did the humankind pass during its economic development? What are the main branches of computer science? How is computer science connected with other disciplines? What is information technology and how does it affect the development of computer science?

As a result of the study of the material represented in this theme students will acquire the following **competencies**:

they would know the notion and concept of information;

they would learn the nature of computer science and its interdisciplinary connections;

they would become aware of what information technologies are and how they influence the development of modern society and computer science in particular.

1.1. Information systems and technologies. Computer science. Connection of computer science to other disciplines

★ **Information systems and technologies** (IS&T) is an academic/professional discipline concerned with the strategic, managerial and operational activities involved in the gathering, processing, storing, distributing and use of information, and its associated technologies, in society and organizations.

The term "information systems and technologies" is also used to describe an organizational function that applies information systems and

technologies knowledge in industry, government agencies and not-for-profit organizations.

Information systems are implemented within an organization for the purpose of improving the effectiveness and efficiency of that organization. Capabilities of the information system and characteristics of the organization, its work systems, its people, and its development and implementation methodologies together determine the extent to which that purpose is achieved.

As an area of study, IS&T includes the multidisciplinary business field and the interdisciplinary computer science field that is evolving toward a new scientific discipline. IS&T course is a broader field that includes computer science course as its main constituent part. At this point we would consider IS&T and computer science to be coinciding notions.

★ *Computer Science* *is study of the theory, experimentation, and engineering that forms the basis for the design and use of computers — devices that automatically process information.*

Computer science traces its roots to the work done by English mathematician **Charles Babbage**, who first proposed a programmable mechanical calculator in 1837 (fig. 2).


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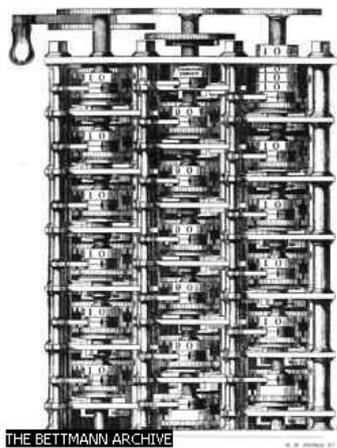
Fig. 1.2. **Charles Babbage's difference engine [14]**

Until the advent of electronic digital computers in the 1940s, computer science was not generally distinguished as being separate from mathematics and engineering. Since then it has sprouted numerous branches of research that are unique to the discipline.

The general public sometimes confuses computer science with vocational areas that deal with computers (such as information technology),

or think that it relates to their own experience of computers, which typically involves activities such as gaming, web-browsing, and word-processing.

However, the focus of computer science is more on understanding the **properties of the programs** used to implement software such as games and web-browsers, and using that understanding to create new programs or improve existing ones.

The early foundations of what would become computer science predate the invention of the modern digital computer. Machines for calculating fixed numerical tasks, such as the abacus, have existed since antiquity. Wilhelm Schickard built the first mechanical calculator in 1623. Charles Babbage designed a difference engine in Victorian times helped by Ada Lovelace. Around 1900, punch-card machines were introduced. However, all of these machines were constrained to perform a single task, or at best some subset of all possible tasks.

During the 1940s, as newer and more powerful computing machines were developed, the term *computer* came to refer to the machines rather than their human predecessors. As it became clear that computers could be used for more than just mathematical calculations, the field of computer science broadened to study computation in general. Computer science began to be established as a distinct academic discipline in the 1960s, with the creation of the first computer science departments and degree programs. Since practical computers became available, many applications of computing have become distinct areas of study in their own right.

Although many initially believed it impossible that computers themselves could actually be a scientific field of study, in the late fifties it gradually became accepted among the greater academic population.

It is the now well-known IBM brand that formed part of the computer science revolution during this time. IBM (short for International Business Machines) released the IBM 704 and later the IBM 709 computers, which were widely used during the exploration period of such devices. "Still, working with the IBM [computer] was frustrating...if you had misplaced as much as one letter in one instruction, the program would crash, and you would have to start the whole process over again". During the late 1950s, the computer science discipline was very much in its developmental stages, and such issues were commonplace.

Time has seen significant improvements in the usability and effectiveness of computer science technology. Modern society has seen a

significant shift from computers being used solely by experts or professionals to a more widespread user base.

Computer science can be divided into four main fields (fig. 1.3): software development, computer architecture (hardware), human-computer interfacing (the design of the most efficient ways for humans to use computers), and artificial intelligence (the attempt to make computers behave intelligently).

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┌─────────────────────────────────┐
│   Information systems and       │
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        │  Human-computer          │
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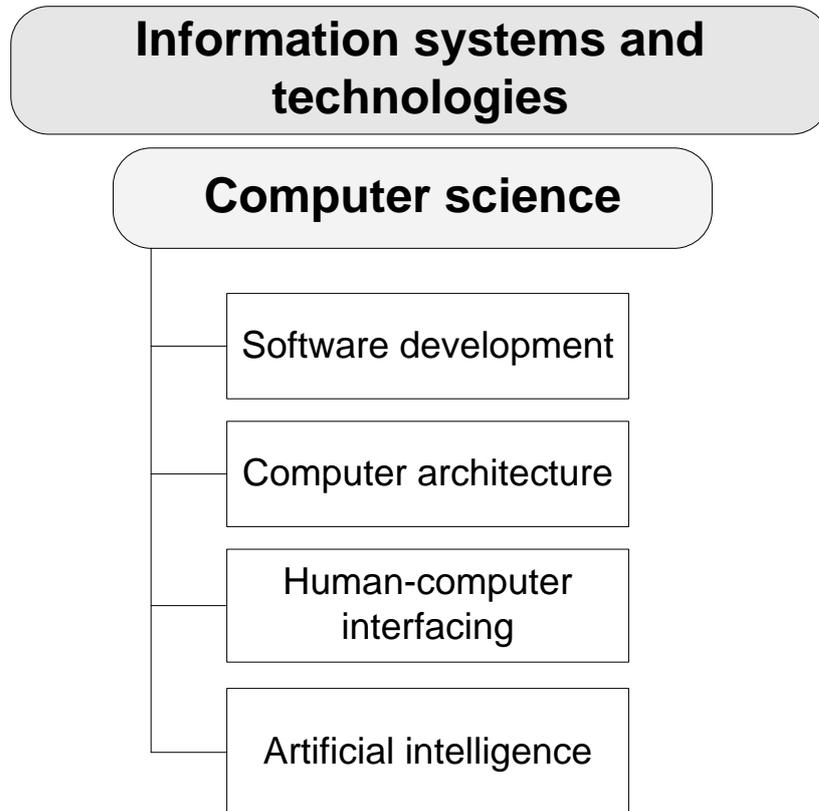
Fig. 1.3. **The structure of computer science**

Software development is concerned with creating computer programs that perform efficiently. Computer architecture is concerned with developing optimal hardware for specific computational needs. The areas of artificial intelligence (AI) and human-computer interfacing often involve the development of both software and hardware to solve specific problems.

Software Development. In developing computer software, computer scientists and engineers study various areas and techniques of software design, such as the best types of programming languages and algorithms to use in specific programs, how to efficiently store and retrieve information, and the computational limits of certain software-computer combinations.

Algorithms and data structures are the building blocks of computer programs and software applications.

★ An **algorithm** is a precise step-by-step procedure for solving a problem within a finite time and using a finite amount of memory.
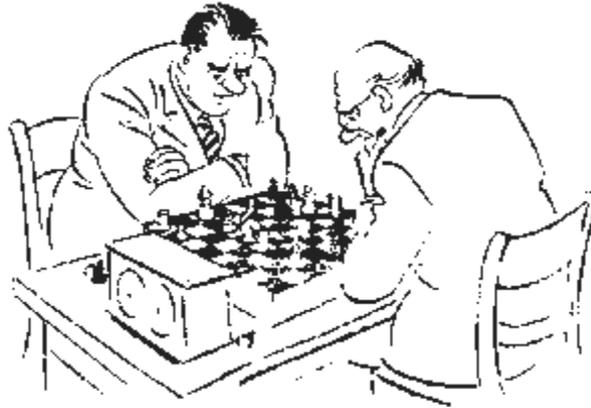
An algorithm is a precise step-by-step procedure

Software engineers use programming languages to communicate algorithms to a computer. Natural languages such as English are ambiguous, meaning that their grammatical structure and vocabulary can be interpreted in multiple ways, so they are not suited for programming. Instead, simple and unambiguous artificial languages are used.

Computer Architecture. Computer architecture is the design and analysis of new computer systems. Computer architects study ways of improving computers by increasing their speed, storage capacity, and reliability, and by reducing their cost and power consumption. The optimization of computer architecture to specific tasks often yields higher performance, lower cost, or both.

Artificial Intelligence. Artificial intelligence (AI) research seeks to enable computers and machines to imitate human intelligence and sensory processing ability, and models human behavior with computers to improve our understanding of intelligence. The many branches of AI research include machine learning, inference, cognition, knowledge representation, problem solving, case-based reasoning, natural language understanding, speech recognition, computer vision, and artificial neural networks.

Human-Computer Interfacing. Human-computer interfaces provide the means for people to use computers. An example of a human-computer interface is the keyboard, which lets humans enter commands into a computer and enter text into a specific application.

Connection of computer science to other disciplines.

Because computer science grew out of mathematics and electrical engineering, it retains many close connections to those disciplines.

Theoretical computer science draws many of its approaches from mathematics and logic. Research in numerical computation overlaps with mathematics research in numerical analysis. Computer architects work closely with the electrical engineers who design the circuits of a computer.

Beyond these historical connections, there are strong ties between AI research and psychology, neurophysiology, and linguistics. Human-computer interface research also has connections with psychology. Roboticists work with both mechanical engineers and physiologists in designing new robots.

Computer science also has **indirect relationships** with virtually **all disciplines that use computers**. Applications developed in other fields often involve collaboration with computer scientists, who contribute their knowledge of algorithms, data structures, software engineering, and existing technology. In return, the computer scientists have the opportunity to observe novel applications of computers, from which they gain a deeper insight into their use. These relationships make computer science a highly interdisciplinary field of study.

Computer science is connected with virtually all disciplines

Some universities teach computer science as a theoretical study of computation and algorithmic reasoning. These programs often feature the theory of computation, analysis of algorithms, formal methods, concurrency theory, databases, computer graphics and systems analysis, among others. They typically also teach computer programming, but treat it as a vessel for the support of other fields of computer science rather than a central focus of high-level study.

Other colleges and universities, as well as secondary schools and vocational programs that teach computer science, emphasize the practice of advanced programming rather than the theory of algorithms and computation

in their computer science curricula. Such curricula tend to focus on those skills that are important to workers entering the software industry. The practical aspects of computer programming are often referred to as software engineering. However, there is a lot of disagreement over the meaning of the term, and whether or not it is the same thing as programming.

## 1.2. Information. Basic forms of information. Information age

Information always has been extremely important. Throughout history some information has had value beyond measure.

The lack of information often cost huge amounts of money and, sometimes, many lives.

★ *Information as a concept has a diversity of meanings, from everyday usage to technical settings. Generally speaking, the concept of information is closely related to notions of constraint, communication, control, data, form, instruction, knowledge, meaning, mental stimulus, pattern, perception, representation.*

Information is:
1) knowledge acquired through experience or study;
2) knowledge of specific and timely events or situations; news;
3) the act of informing or the condition of being informed (fig. 1.4).
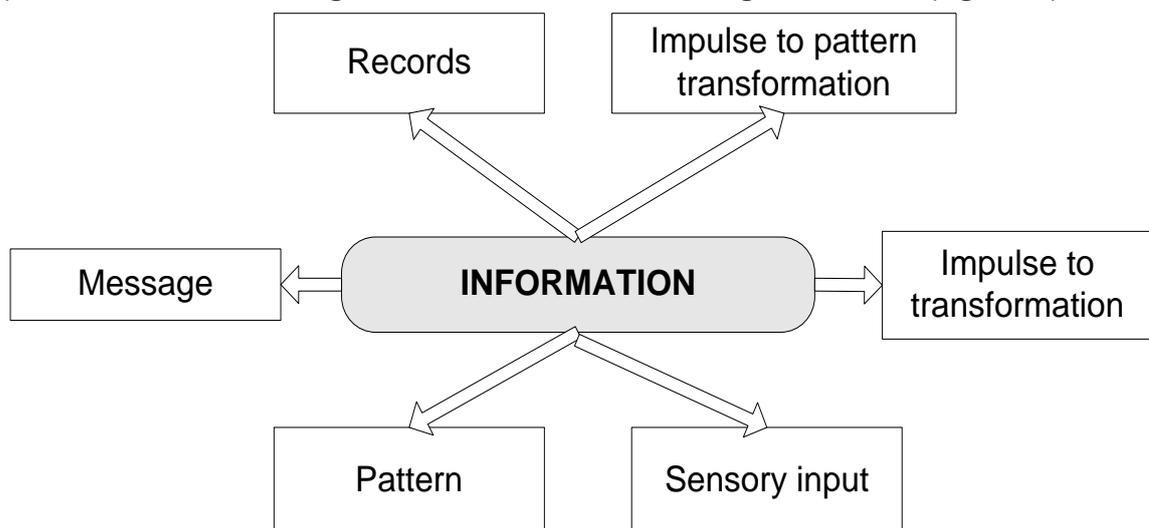
Fig. 1.4. **Forms of information**

There exist several basic forms of information.

1. Information as a message.

Information is the state of a system of interest. Message is the information materialized.

11

Information is always about something. Viewed in this manner, information does not have to be accurate; it may be a truth or a lie, or just the sound of a falling tree.

This model assumes there is a definite sender and at least one receiver. Many refinements of the model assume the existence of a common language understood by the sender and at least one of the receivers.

2. Information as a pattern.

Information is any represented pattern. This assumes a separation between an object and its representation. Consider the following example: economic statistics represent an economy.

But if information can be defined merely as a pattern, does that mean that neither utility nor meaning are necessary components of information? Arguably a distinction must be made between raw unprocessed data and information which possesses utility, value or some quantum of meaning. On this view, information may indeed be characterized as a pattern; but this is a necessary condition, not a sufficient one. The gap between data and information is only closed by a behavioral bridge whereby some value, utility or meaning is added to transform mere data or pattern into information.

3. Information as sensory input.

Often information is viewed as a type of input to an organism or designed device. Inputs are of two kinds. Some inputs are important to the function of the organism (for example, food) or device (energy) by themselves. Other inputs (information) are important only because they are associated with causal inputs and can be used to predict the occurrence of a causal input at a later time. For example, light is often a causal input to plants but provides information to animals.

4. Information as an influence which leads to a transformation.

5. Information is any type of pattern that influences the formation or transformation of other patterns.

6. Information as records.

Records are a specialized form of information. Essentially, records are information produced consciously or as by-products of business activities or transactions and retained because of their value. For example, in the previous sense, there is no need for a conscious mind to perceive, much less appreciate, the pattern. Consider, for example, DNA. The sequence of nucleotides is a pattern that influences the formation and development of an organism without any need for a conscious mind.

Information itself is useless unless it is used in some process that brings some economic effect or value. So, information must work in order to be information, not just data. Information is a very important participant in information work. As Bill Gates stated, "information work is thinking work. When thinking and working together are significantly assisted by computer technology, you have a digital nervous system. It consists of the advanced digital processes that knowledge workers use to make better decisions – to think, act, react, and adapt".

The notion of information is closely connected with the notion of Information age. Information age is considered the last and most progressive stage of human development.

Thus the following **stages of economic development** can be marked out:

1. Pre-industrial stage – farming, mining and mineral extraction.
2. Industrial stage – producing of goods.
3. Post-industrial stage – producing of services.
4. Information stage (Information Age) – producing, processing, exchange and consumption of information (see metaphor on fig. 1.5).
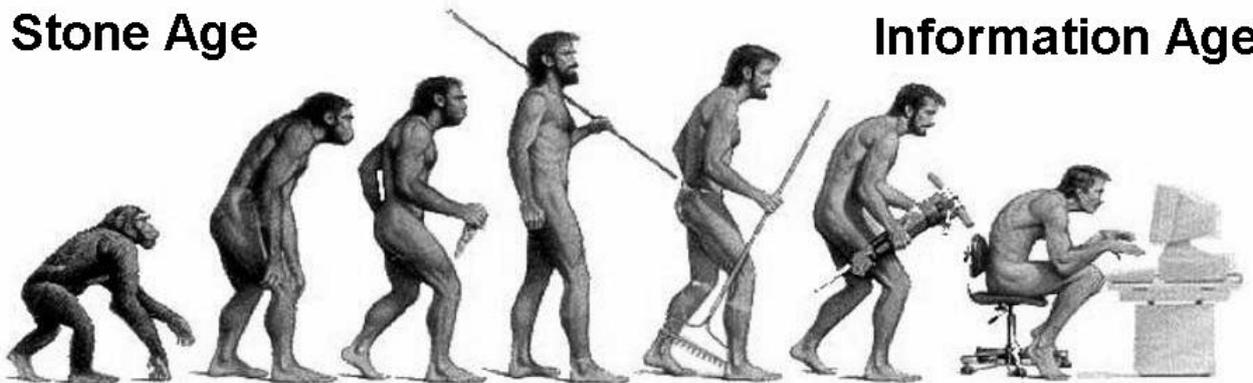
Fig. 1.5. **Information Age metaphor [17]**

★ *Information Age is a term that has been used to refer to the present era. The name alludes to the global economy's shift in focus away from the production of physical goods (as exemplified by the industrial age) and towards the manipulation of information.*

Most researchers connect quick coming of the information age with fast development of **Internet technologies**. The Internet was originally conceived as a distributed, fail-proof network that could connect computers together and be resistant to any one point of failure; the Internet can't be totally destroyed

in one event, and if large areas are disabled, the information is easily re-routed. It was with the invention of the World Wide Web in 1989 that the Internet really became a global network. Today the Internet has become the ultimate place to accelerate the flow of relevant information and the fastest growing form of media.

The Information Age means something different to everyone. In 1956 in the United States, researchers noticed that the number of people holding **"white collar" jobs** had just exceeded the number of people holding **"blue collar" jobs**. These researchers realized that this was an important change, as it was clear that the Industrial Age was coming to an end. As the Industrial Age ended, the newer times adopted the title of "the Information Age". Of course, at that time relatively few jobs had much to do with computers and computer-related technology. What was occurring was a steady trend away from people holding Industrial Age manufacturing jobs. An increasing number of people held jobs as clerks in stores, office workers, teachers, nurses, etc. The Western world was shifting into a service economy.

Eventually, Information and Communication Technology — computers, computerized machinery, fiber optics, communication satellites, Internet, and other ICT tools — became a significant part of the economy. Microcomputers were developed, and many business and industries were greatly changed by ICT. Nicholas Negroponte captured the essence of these changes in his 1995 book, Being Digital. At the time, he was the head of the Massachusetts Institute of Technology's Media Lab. His book discusses similarities and differences between products made of atoms and products made of bits. In essence, one can very cheaply and quickly make a copy of a product made of bits, and ship it across the country or around the world both quickly and at very low cost. Nowadays, many people tend to think of the Information Age in terms of cell phones, digital music, high definition television, digital cameras, email on the Internet, the Web, computer games, and other relatively new products and services that have come into widespread use. The pace of change brought on by such technology has been very rapid.

1.3. Information technologies

★ *Information technology (IT) is the study, design, development, implementation, support or management of computer-based information systems, particularly software applications and computer hardware.*

IT deals with the use of electronic computers and computer software to convert, store, protect, process, transmit, and securely retrieve information.

The term Information Technology (IT) was coined by Jim Domsic of Michigan in November 1981. Domsic created the term to modernize the outdated phrase "data processing". Domsic at the time worked as a computer manager for an automotive related industry.

Today, the term "information technology" has ballooned to encompass many aspects of computing and technology, and the term has become very recognizable. The information technology umbrella can be quite large, covering many fields. IT professionals perform a variety of duties that range from installing applications to designing complex computer networks and information databases. A few of the duties that IT professionals perform may include data management, networking, engineering computer hardware, database and software design, as well as the management and administration of entire systems.

When computer and communication technologies are combined, the result is information technology, or "infotech". Information Technology (IT) is a general term that describes any technology that helps to produce, manipulate, store, communicate, and/or disseminate information. When speaking of Information Technology (IT) as a whole, it should be noted that the use of computers and information are associated.

■ Questions

1. What is computer science and which branches does it include?

2. How do information technologies affect the development of Information age tendencies?

3. What is information work and what is the difference between this kind of work and other kinds of human activities?

4. What are the basic stages of economic development?

5. What is information technology and what areas does it cover?

Theme 2. Computer architecture
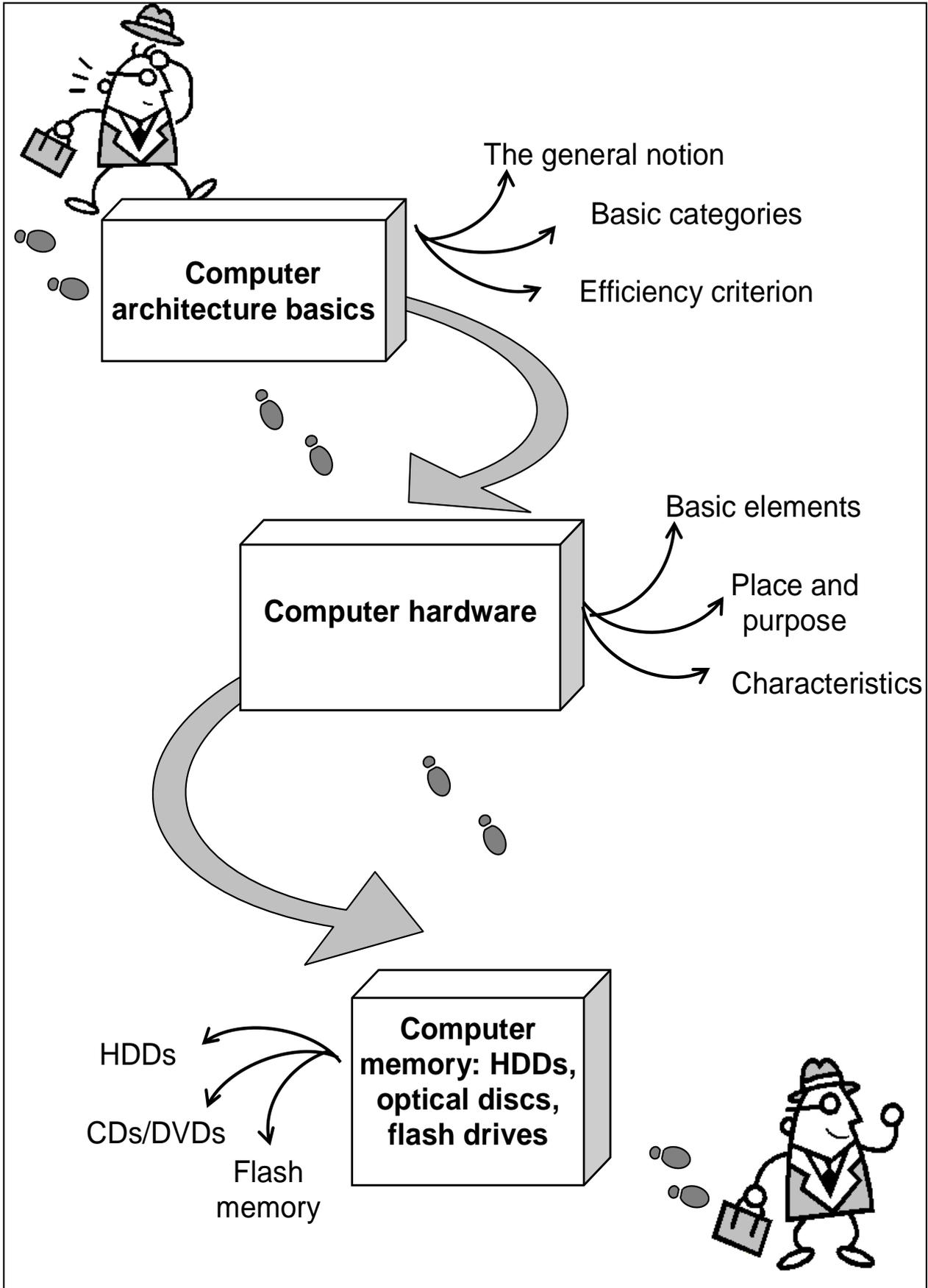
Fig. 2.1. **System elements of the theme**

■ Introduction

The purpose of this theme is to give a clear understanding of the structure of computer architecture as a field of scientific research. A thorough consideration is given to the analysis of factors that determine the efficiency of computer architecture operation. A close attention is given to the study of the constituent parts of computer hardware.

Clue notions of the theme include: computer architecture; computer hardware; latency; throughput; clock speed; on-board devices; peripheral devices; computer memory.

This theme covers the following **topics**: What is computer architecture? What are the categories that are included in the general structure of computer architecture? What are the main criteria for assessing computer architecture efficiency? What devices are included in computer hardware?

As a result of the study of the material represented in this theme students will acquire the following **competencies**:

they would know the notion and structure of computer architecture;

they would learn retrospective peculiarities in the development process of computer architecture;

they would become aware of the basic components hat form computer hardware and understand the place and interconnection of each part inside the computer chassis.

2.1. Computer architecture basics

★ *Computer architecture is the conceptual design and fundamental operational structure of a computer system. It is a blueprint and functional description of requirements (especially speeds and interconnections) and design implementations for the various parts of a computer — focusing largely on the way by which the central processing unit (CPU) performs internally and accesses addresses in memory.*

The term also covers the design of system software, such as the operating system (the program that controls the computer), as well as referring to the combination of hardware and basic software that links the machines on a computer network. **Computer architecture** refers to an entire structure and to the details needed to make it functional.

Thus, computer architecture covers computer systems,

microprocessors, circuits, and system programs. Typically the term does not refer to application programs, such as spreadsheets or word processing, which are required to perform a task but not to make the system run.

Computer architecture may also be defined as the science and art of selecting and interconnecting hardware components to create computers that meet functional, performance and cost goals.

Computer architecture comprises at least **three main subcategories** (fig. 2.2):
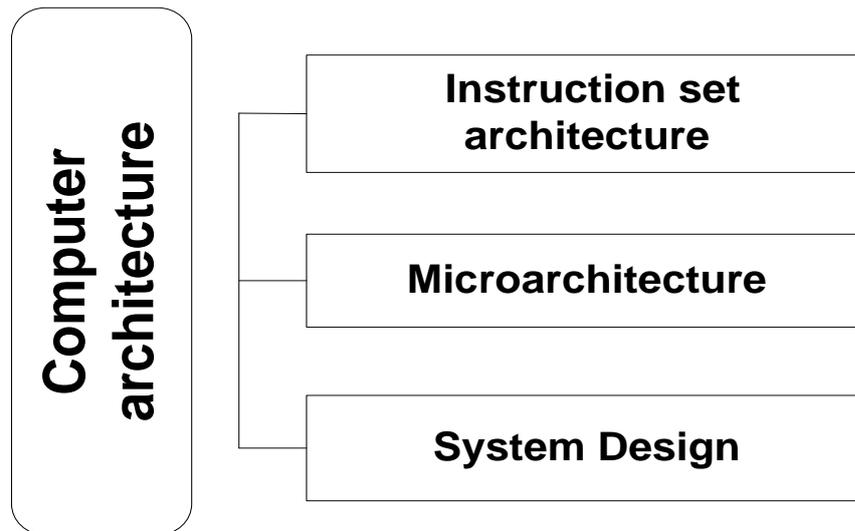
Fig. 2.2. **The structure of computer architecture**

Instruction set architecture, or ISA, is the abstract image of a computing system that is seen by a machine language (or assembly language) programmer, including the instruction set, memory address modes, processor registers, and address and data formats.

Microarchitecture, also known as Computer organization is a lower level, more concrete and detailed, description of the system that involves how the constituent parts of the system are interconnected and how they interoperate in order to implement the ISA. The size of a computer's cache for instance, is an organizational issue that generally has nothing to do with the ISA.

System Design which includes all of the other hardware components within a computing system such as:

1) system interconnects such as computer buses and switches;
2) memory controllers and hierarchies;
3) CPU off-load mechanisms such as direct memory access;
4) issues like multi-processing.

Once both ISA and microarchitecture have been specified, the actual device needs to be designed into **hardware**. This design process is called **implementation**. Implementation is usually not considered architectural definition, but rather hardware design engineering.

Implementation can be further broken down into three (not fully distinct) pieces:

Logic Implementation – design of blocks defined in the microarchitecture at (primarily) the register-transfer and gate levels.

Circuit Implementation – transistor-level design of basic elements (gates, multiplexers, latches etc) as well as of some larger blocks (ALUs, caches etc) that may be implemented at this level, or even (partly) at the physical level, for performance reasons.

Physical Implementation – physical circuits are drawn out, the different circuit components are placed in a chip floor-plan or on a board and the wires connecting them are routed.

The exact form of a computer system depends on the constraints and goals for which it was optimized. Computer architectures usually trade off standards, cost, memory capacity, latency and throughput. Sometimes other considerations, such as features, size, weight, reliability, expandability and power consumption are factors as well.

The most common scheme carefully chooses the bottleneck that most reduces the computer's speed. Ideally, the cost is allocated proportionally to assure that the data rate is nearly the same for all parts of the computer, with the most costly part being the slowest. This is how skillful commercial integrators optimize personal computers.

Main criteria for computer architecture efficiency.

1. Performance.

Computer performance is often described in terms of **clock speed** (usually in MHz or GHz). This refers to the cycles per second of the main clock of the CPU. However, this metric is somewhat misleading, as a machine with a higher clock rate may not necessarily have higher performance. As a result manufacturers have moved away from clock speed as a measure of performance.

Computer performance can also be measured with the amount of cache a processor has. If the speed, MHz or GHz, were to be a car then the cache is like a traffic light. No matter how fast the car goes, it still will be stopped by a red traffic light. The higher the speed, and the greater the cache, the faster

a processor runs. Modern CPUs can execute multiple instructions per clock cycle, which dramatically speeds up a program. Other factors influence speed, such as the mix of functional units, bus speeds, available memory, and the type and order of instructions in the programs being run.

There are two main types of speed, latency and throughput.

★ **Latency** *is the time between the start of a process and its completion.*

★ **Throughput** *is the amount of work done per unit time.*

COMPUTER ARCHITECTURE
EFFICIENCY

LATENCY   THROUGHPUT
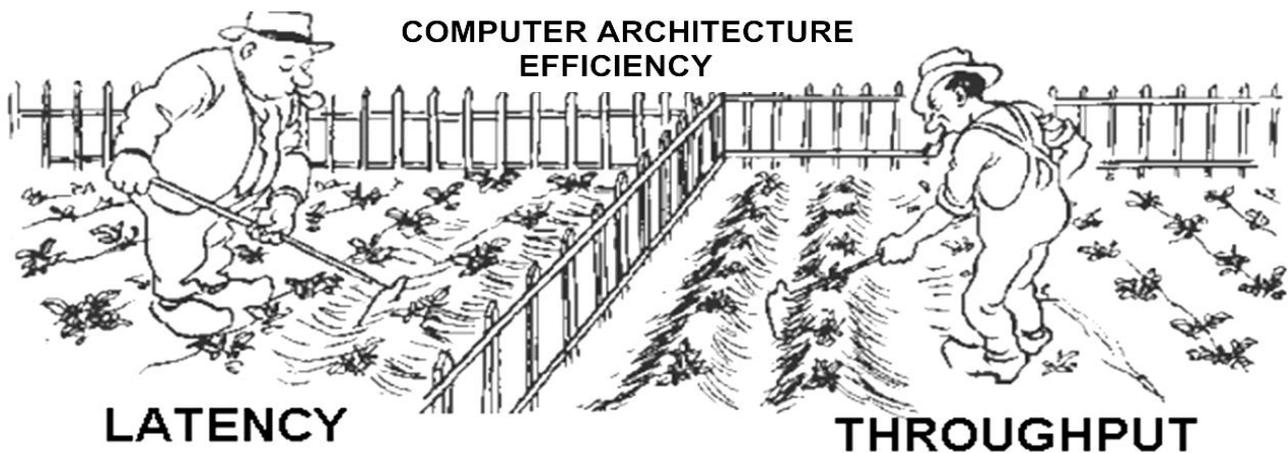
Computer performance development is believed to submit to Moore's Law. In 1965 semiconductor pioneer Gordon Moore predicted that the number of transistors contained on a computer chip would double every year. This is now known as Moore's Law, and it has proven to be somewhat accurate. The number of transistors and the computational speed of microprocessors currently doubles approximately every 18 months. Components continue to shrink in size and are becoming faster, cheaper, and more versatile.

2. Power consumption

Power consumption is another design criterion that factors in the design of modern computers. Power efficiency can often be traded for performance or cost benefits. With the increasing power density of modern circuits as the number of transistors per chip scales, power efficiency has increased in importance.

| More transistors | ➡ | More powerful CPUs and circuits | ➡ | Increased POWER CONSUMPTION |
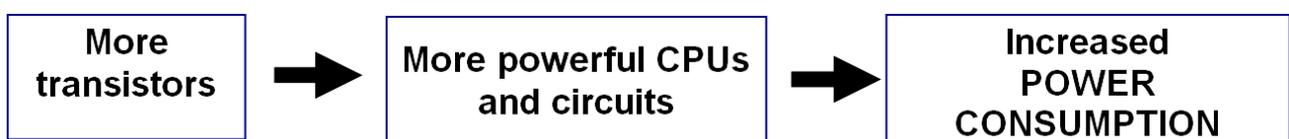
Recent processor designs such as the Intel Core 2 put more emphasis on increasing power efficiency. Also, in the world of embedded computing, power efficiency has long been and remains the primary design goal next to performance.
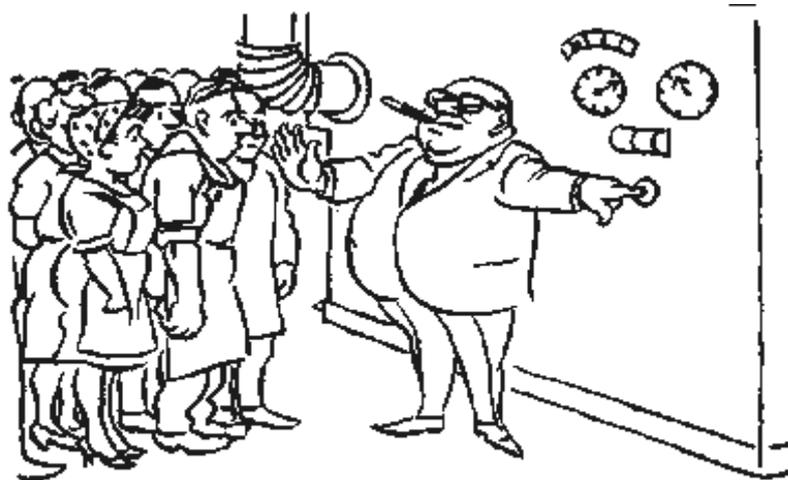
powerful hardware leads to encreased
power consumption

The term **"architecture"** in computer literature can be traced to the work of Lyle R. Johnson and Frederick P. Brooks, Jr., members in 1959 of the Machine Organization department in IBM's main research center.

Johnson had occasion to write a proprietary research communication about Stretch, an IBM-developed supercomputer for Los Alamos Scientific Laboratory; in attempting to characterize his chosen level of detail for discussing the luxuriously embellished computer, he noted that his description of formats, instruction types, hardware parameters, and speed enhancements aimed at the level of "system architecture" – a term that seemed more useful than "machine organization."

Subsequently Brooks, one of the Stretch designers, started Chapter 2 of a book (Planning a Computer System: Project Stretch, ed. W. Buchholz, 1962) by writing, "Computer architecture, like other architecture, is the art of determining the needs of the user of a structure and then designing to meet those needs as effectively as possible within economic and technological constraints." Brooks went on to play a major role in the development of the IBM System/360 line of computers, where "architecture" gained currency as a noun with the definition "what the user needs to know." Later the computer world would employ the term in many less-explicit ways.

The first mention of the term **architecture** in the referred computer literature is in a 1964 article describing the IBM System/360. The article defines architecture as the set of "attributes of a system as seen by the

programmer, i.e., the conceptual structure and functional behavior, as distinct from the organization of the data flow and controls, the logical design, and the physical implementation." In the definition, the programmer perspective of the computer's functional behavior is key. The conceptual structure part of an architecture description makes the functional behavior comprehensible, and extrapolatable to a range of use cases. Only later on did 'internals' such as "the way by which the CPU performs internally and accesses addresses in memory," mentioned above, slip into the definition of computer architecture.

2.2. Computer hardware

Once both ISA (instruction set architecture) and microarchitecture has been specified, the actual device needs to be designed into **hardware**. A personal computer is made up of computer hardware, multiple physical components onto which can be loaded into a multitude of software that perform the functions of the computer.

★ **Computer hardware** *is the equipment involved in the function of a computer. Computer hardware consists of the components that can be physically handled.*

The function of these components is typically divided into three main categories: input, output, and storage. Though a PC comes in many different form factors, a typical personal computer consists of a **case or chassis** in a tower shape (desktop) and the following parts (fig. 2.3):
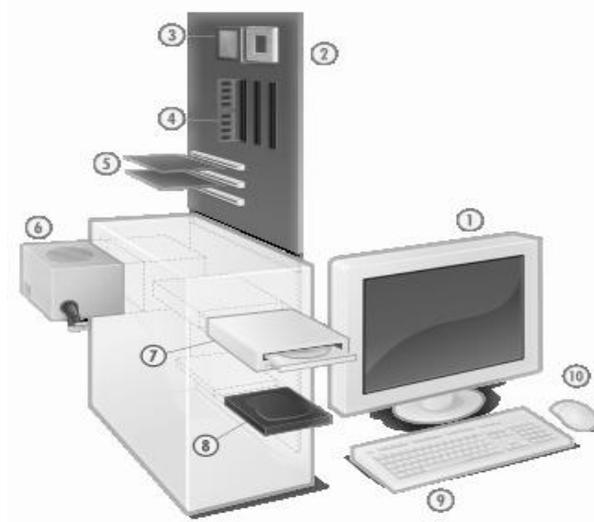
1. Monitor. 2. Motherboard. 3. CPU. 4. RAM Memory. 5. Expansion card. 6. Power Supply. 7. CD-rom. 8. Hard Disk. 9. Keyboard. 10. Mouse
Fig. 2.3. **Hardware of a personal computer [10]**

Typical PC hardware consists of the following elements (fig. 2.4):
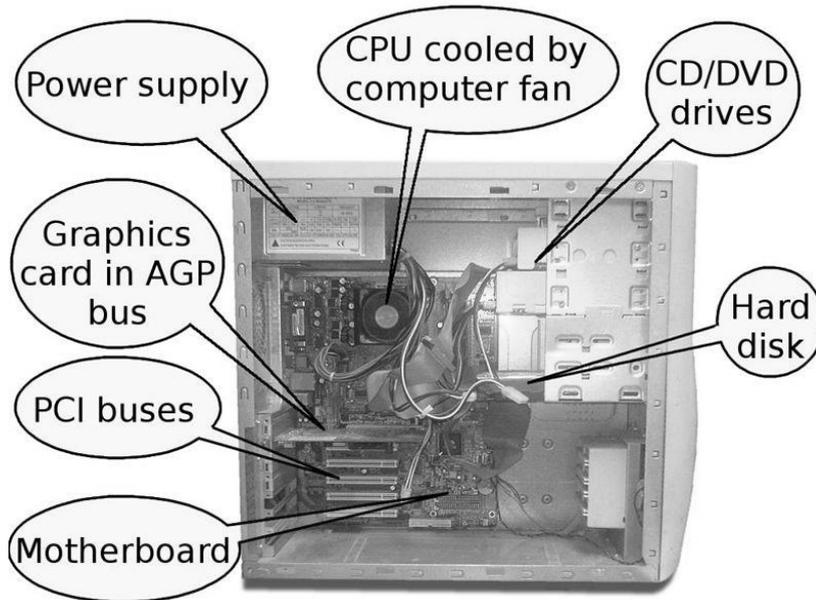
Fig. 2.4. **Typical PC hardware elements**

Motherboard – the motherboard is sometimes alternatively known as the mainboard, system board, or, on Apple computers, the logic board. It is also sometimes casually shortened to mobo. It is the "body" or mainframe of the computer, through which all other components interface (fig. 2.5).
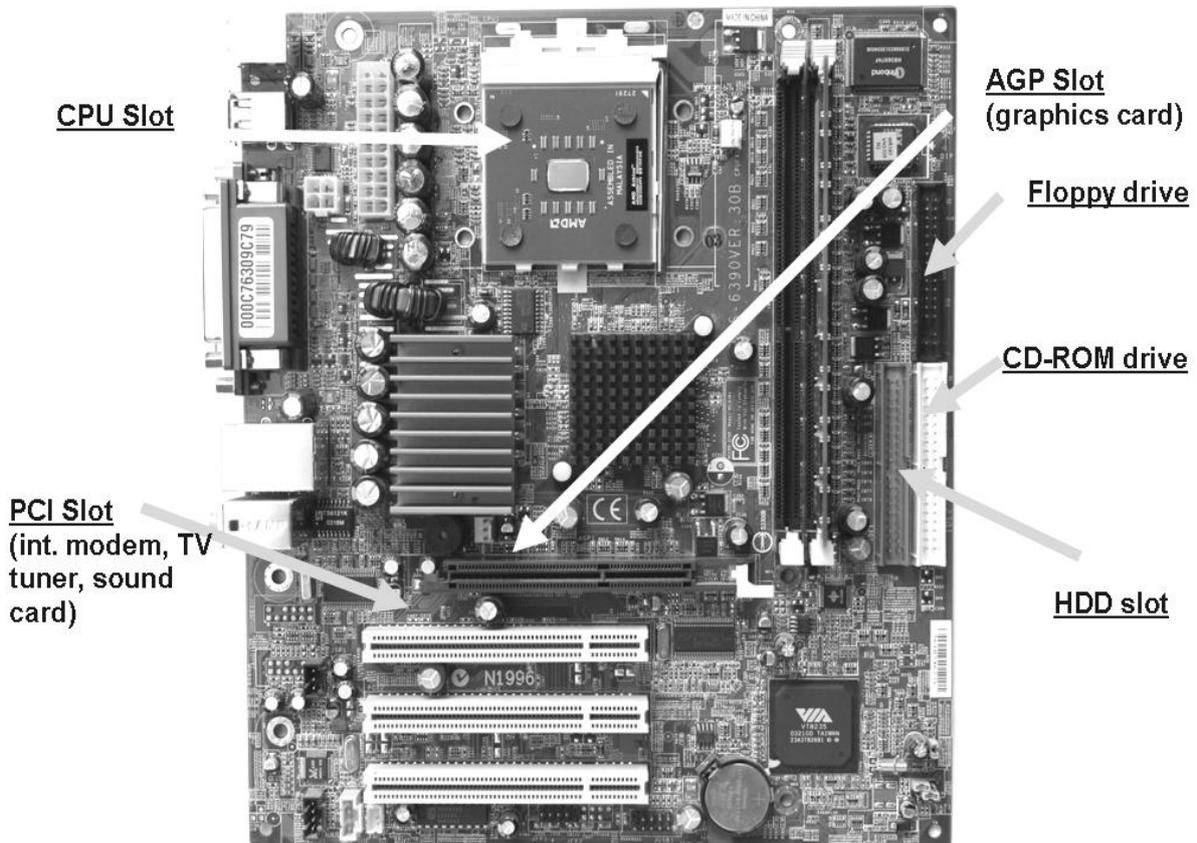
Fig. 2.5. **Computer motherboard**

Central processing unit (CPU) – performs most of the calculations which enable a computer to function, sometimes referred to as the "backbone or brain" of the computer.

Computer fan – is used to lower the temperature of the computer. A fan is almost always attached to the CPU, and the computer case will generally have several fans to maintain a constant airflow. Liquid cooling can also be used to cool a computer, though it focuses more on individual parts rather than the overall temperature inside the chassis.

Random Access Memory (RAM) – is a form of computer data storage. Today it takes the form of integrated circuits that allows the stored data to be accessed in any order (i.e., at random). The word random thus refers to the fact that any piece of data can be returned in a constant time, regardless of its physical location and whether or not it is related to the previous piece of data. It is the physical memory of the computer in the form of DRAM memory modules. RAM is a fast-access memory that is cleared when the computer is powered-down. RAM attaches directly to the motherboard, and is used to store programs that are currently running.

Internal storage (HDD – hard disk drive) – hardware that keeps data inside the computer for later use and remains persistent even when the computer has no power.

Video display controller – produces the output for the visual display unit. This will either be built into the motherboard or attached in its own separate slot (PCI or AGP), in the form of a graphics card. Graphics card is an expansion card whose function is to generate and output images to a display. Some video cards offer added functions, such as video capture, TV tuner adapter, MPEG-2 and MPEG-4 decoding, FireWire, light pen, TV output, or the ability to connect multiple monitors.

Power supply – is the component that supplies power to a computer. It usually includes a case control, and (usually) a cooling fan. Most common types of power supplies are AT and ATX (Advanced Technology Extended). On newer ATX power supplies, the switch goes to the motherboard, allowing other hardware or software to turn the system on or off.

Buses – in computer architecture, a bus is a subsystem that transfers data between computer components inside a computer or between computers. Unlike a point-to-point connection, a bus can logically connect several peripherals over the same set of wires. Each bus defines its set of connectors to physically plug devices, cards or cables together.

Early computer buses were literally parallel electrical buses with multiple connections, but the term is now used for any physical arrangement that provides the same logical functionality as a parallel electrical bus. Modern computer buses can use both parallel and bit-serial connections, and can be wired in either a multidrop (electrical parallel) or daisy chain topology, or connected by switched hubs, as in the case of USB. PC buses fall into two groups (fig. 2.5):
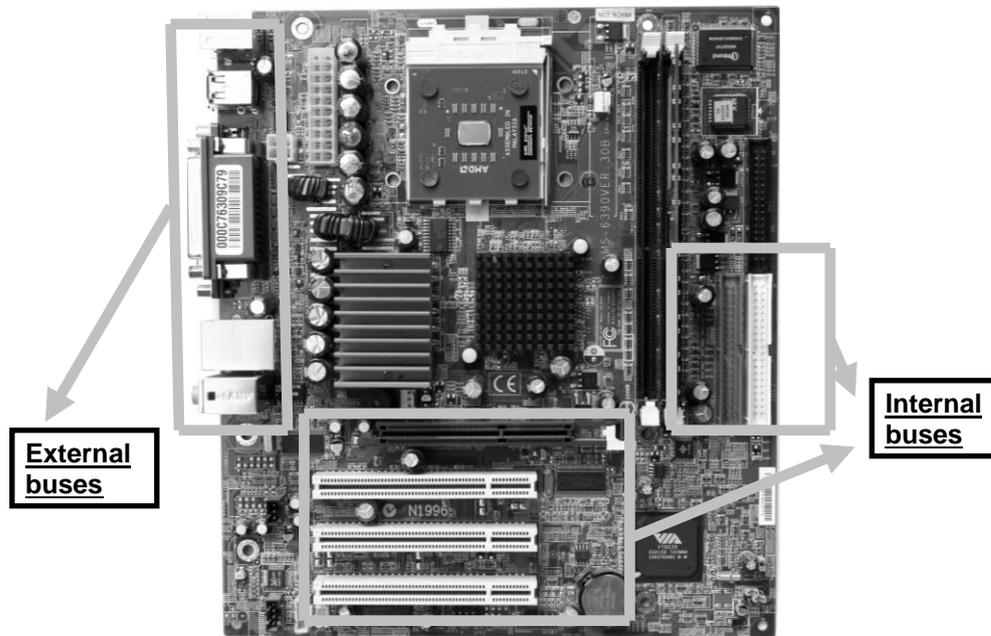
Fig. 2.6. **Position of computer buses on the motherboard**

Internal Buses – Connections to various internal components. For example, PCI, PCI-E, USB, AGP, IDE etc.

External Buses – used to connect to external peripherals, such as printers and input devices. These ports may also be based upon expansion cards, attached to the internal buses.

Sound card – enables the computer to output sound to audio devices, as well as accept input from a microphone. Most modern computers have sound cards built-in to the motherboard, though it is common for a user to install a separate sound card as an upgrade.

Removable media devices include:

CD, CD-ROM Drive, DVD (digital versatile disc), DVD-ROM Drive, Blu-ray CD, HD DVD CD – optical storages, which store information in deformities on the surface of a circular discs and read this information by illuminating the surface with a laser diode and observing the reflection. Optical disc storages are non-volatile. The deformities may be permanent (read only media),

formed once (write once media) or reversible (recordable or read/write media).

Floppy disk – an outdated storage device consisting of a thin disk of a flexible magnetic storage medium.

USB flash drive – a flash memory data storage device integrated with a USB interface, typically small, lightweight, removable, and rewritable.

Tape drive – a device that reads and writes data on a magnetic tape, used for long term storage.

Other peripherals. In addition, hardware devices can include external components of a computer system. The following are either standard or very common. Peripheral devices include various input and output devices, usually external to the computer system.

Input devices:

Text input devices.

Keyboard – a device to input text and characters by depressing buttons (referred to as keys), similar to a typewriter. The most common English-language key layout is the QWERTY layout. The QWERTY design is based on a layout created by Christopher Latham Sholes in 1873 for the Sholes and Glidden typewriter and sold to Remington in the same year, when it first appeared in typewriters (fig. 2.7).
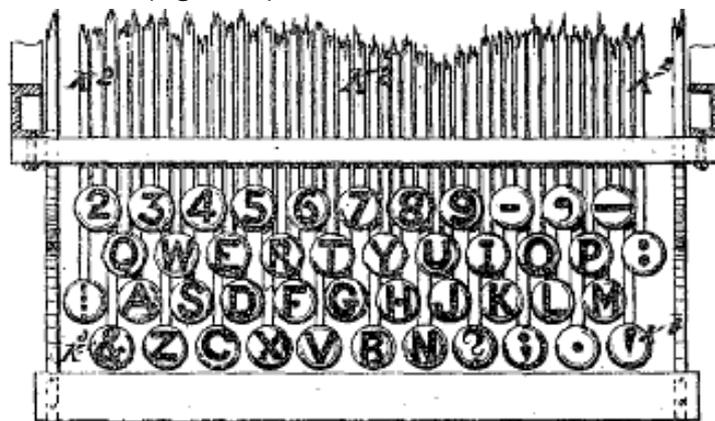
Fig. 2.7. **Typewriter and PC QWERTY layouts [11]**

Pointing devices.

Mouse – a pointing device that detects two dimensional motion relative to its supporting surface.

Trackball – a pointing device consisting of an exposed protruding ball housed in a socket that detects rotation about two axes (fig. 2.8).

Fig. 2.8. **A trackball**   Fig. 2.9. **A gamepad**

Gaming devices.

Joystick – a general control device that consists of a handheld stick that pivots around one end, to detect angles in two or three dimensions.

Gamepad – a general handheld game controller that relies on the digits (especially thumbs) to provide input (fig. 2.9).

Game controller – a specific type of controller specialized for certain gaming purposes.

Image, Video input devices.

Image scanner – a device that provides input by analyzing images, printed text, handwriting, or an object.

Webcam – a low resolution video camera used to provide visual input that can be easily transferred over the internet.

Audio input devices.

Microphone – an acoustic sensor that provides input by converting sound into electrical signals.

Output devices:

Image, Video output devices.

Printer – a peripheral which produces a hard copy (that is a permanent human-readable text and/or graphics) of documents stored in electronic form, usually on physical print media such as paper or transparencies

Monitor – a piece of electrical equipment which displays images generated from the video output of devices such as a PC graphics card, without producing a permanent record.

Audio output devices.

Speakers – are external sound producing devices, commonly equipped with a low-power internal amplifier. The standard audio connection is a 3.5mm (1/8 inch) stereo jack plug often colour-coded lime green (following the PC 99 standard) for computer sound cards.

Headset – a pair of small loudspeakers, or less commonly a single speaker, with a way of holding them close to a user's ears and a means of connecting them to a signal source such as an audio amplifier, radio or CD player. They are also known as earphones, earbuds, stereophones, headsets or, informally cans.

2.3. Computer memory: HDDs, optical discs, flash drives

There are two types of memory which are at a disposal of a personal computer: random access memory (RAM) and permanent memory (hard disc drives). Random access memory was given a close attention in the previous section, so now we'll focus on PC's permanent memory that is represented by hard disc drives (HDD).

★ *A hard disk drive (HDD), commonly referred to as a hard drive, hard disk, or fixed disk drive, is a non-volatile storage device which stores digitally encoded data on rapidly rotating platters with magnetic surfaces.*

Strictly speaking, "drive" refers to a device distinct from its medium, such as a tape drive and its tape, or a floppy disk drive and its floppy disk. Early HDDs had removable media; however, an HDD today is typically a sealed unit (except for a filtered vent hole to equalize air pressure) with fixed media.

HDDs record data by **magnetizing ferromagnetic material** directionally, to represent either a 0 or a 1 binary digit. They read the data back by detecting the magnetization of the material. A typical HDD design consists of a spindle which holds one or more flat circular disks called platters, onto which the data are recorded (fig. 2.10). The platters are made from a non-magnetic material, usually aluminum alloy or glass, and are coated with a thin layer of magnetic material. Older disks used iron oxide as the magnetic material, but current disks use a cobalt-based alloy.
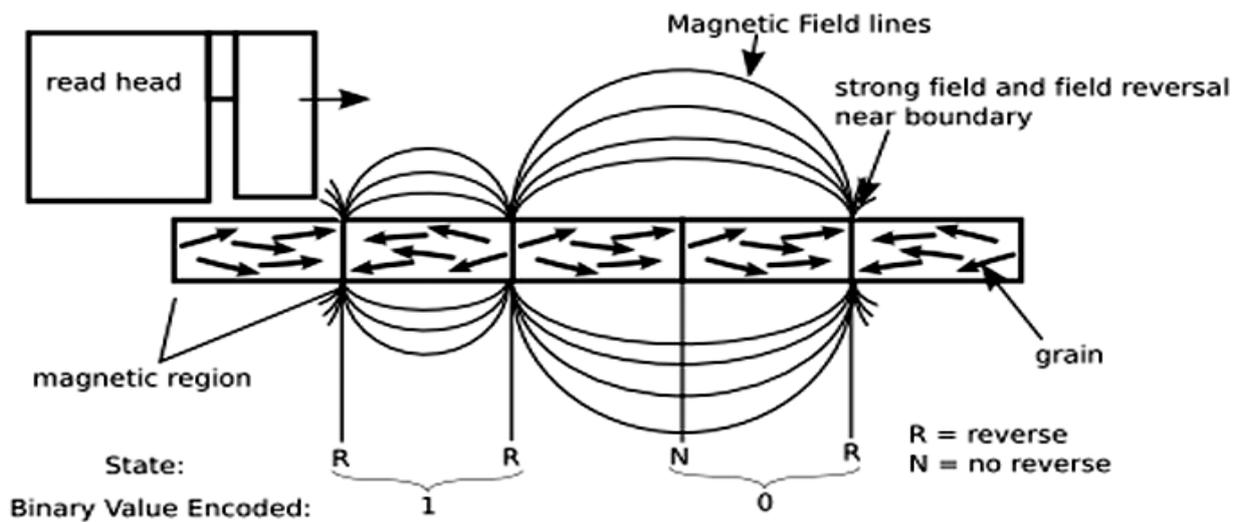
Fig. 2.10. **The structure of HDD surface [15]**

Initially the regions were oriented horizontally, but beginning about 2005, the orientation was changed to perpendicular (2.11).
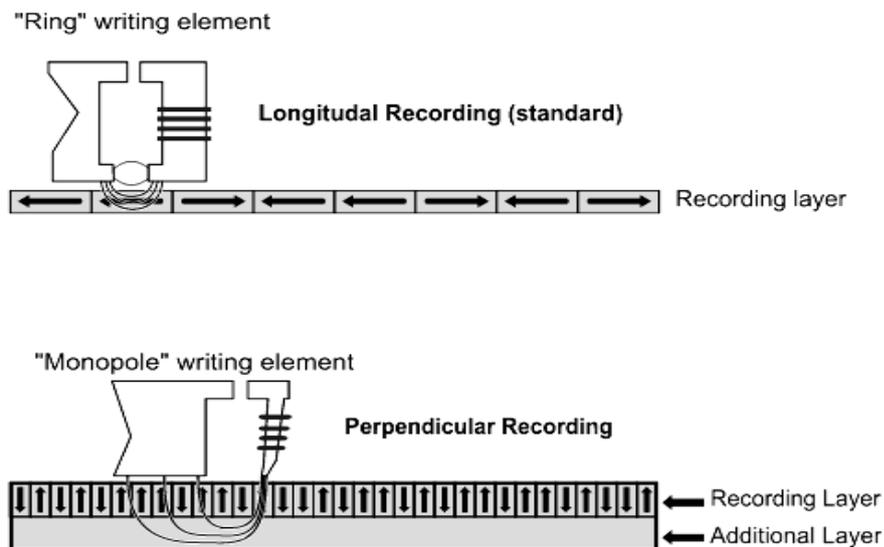
Fig. 2.11. **The direction of recording layers [15]**

The platters are spun at very high speeds. Information is written to a platter as it rotates past devices called read-and-write heads that operate very close (tens of nanometers in new drives) over the magnetic surface. The read-and-write head is used to detect and modify the magnetization of the material immediately under it. There is one head for each magnetic platter surface on the spindle, mounted on a common arm. An actuator arm (or access arm) moves the heads on an arc (roughly radially) across the platters as they spin, allowing each head to access almost the entire surface of the platter as it spins. The arm is moved using a voice coil actuator or (in older designs) a stepper motor.

HD heads are kept from contacting the platter surface by the air that is extremely close to the platter; that air moves at, or close to, the platter speed. The record and playback head are mounted on a block called a slider, and the surface next to the platter is shaped to keep it just barely out of contact. It's a type of air bearing (fig. 2.12).
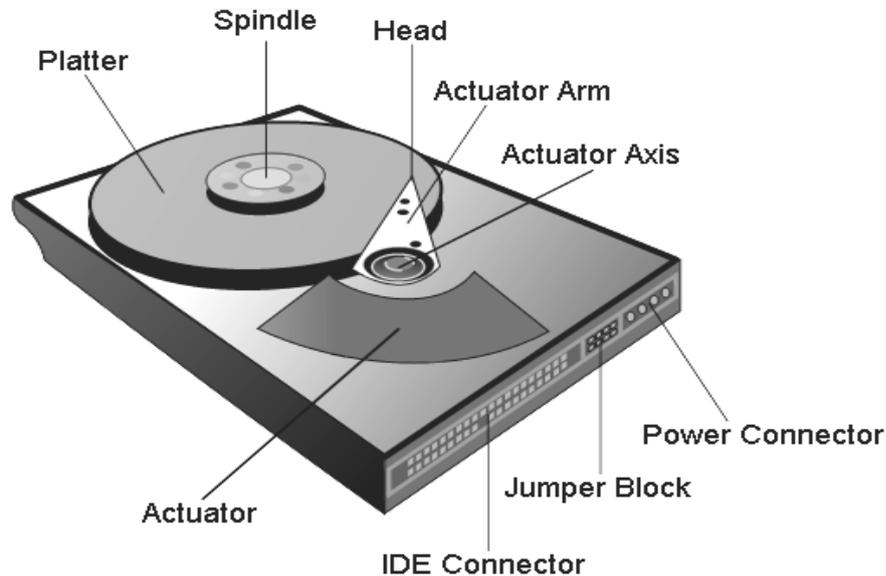
Fig. 2.12. **Computer hard drive's structural parts [15]**

The magnetic surface of each platter is conceptually divided into many small sub-micrometre-sized magnetic regions, each of which is used to encode a single binary unit of information. In today's HDDs, each of these magnetic regions is composed of a few hundred magnetic grains. Each magnetic region forms a magnetic dipole which generates a highly localized magnetic field nearby. The write head magnetizes a region by generating a strong local magnetic field.

⋆ ***Flash memory*** *is a non-volatile computer storage chip that can be electrically erased and reprogrammed.*

Since flash memory is non-volatile, no power is needed to maintain the information stored in the chip. It is primarily used in memory cards, USB flash drives, MP3 players and solid-state drives for general storage and transfer of data between computers and other digital products.

Flash memory was invented by Dr. Fujio Masuoka while working for Toshiba circa 1980. Dr. Masuoka presented the invention at the IEEE 1984 International Electron Devices Meeting (IEDM) held in San Francisco, California. According to Toshiba, the name "flash" was suggested by Dr. Ma-

suoka's colleague, Mr. Shoji Ariizumi, because the erasure process of the memory contents reminded him of the flash of a camera.

First flash memory devices worked only with large block sizes. *That meant that in order to erase a piece of data the whole data had to be erased.* Modern flash memory is erasable and rewritable in small blocks, typically bytes.

Singaporean Trek Technology and IBM began selling the first USB flash drives commercially in 2000. The model under the brand name "ThumbDrive", and "DiskOnKey" became available on December 15, 2000, and had a storage capacity of 8 MB, more than five times the capacity of the then-common floppy disks (fig. 2.13).

IBM DiskOnKey

Fig. 2.13. **First USB flash drive [18]**

Storage capacities in 2011 can be as large as 512 GB with steady improvements in size and price per capacity expected. Some allow 1 million write or erase cycles and have a 10-year data retention cycle.

Most commercially available flash products are guaranteed to withstand around 100,000 program-erase (P/E) cycles, before the wear begins to deteriorate the integrity of the storage. Flash drives can be defragmented, but this brings little advantage as there is no mechanical head that moves from fragment to fragment. *Defragmenting shortens the life of the drive by making many unnecessary writes.* There also exist viruses that "kill" or shorten the operation period of a flash drive by making a lot of unnecessary read-write operations. Flash memory stores information in an array of memory cells made from floating-gate transistors. In traditional devices, each cell stores only one bit of information (fig.2.14).
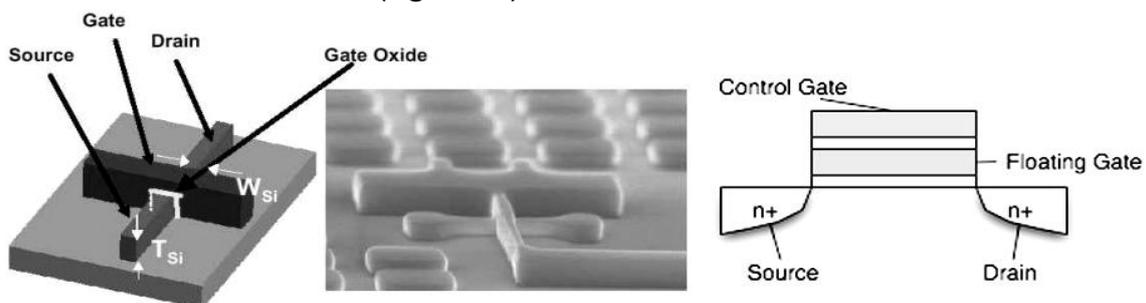
Fig. 2.14. **Flash memory structure**

A flash cell can be programmed, or set to a binary "0" value, by the following procedure:

an elevated on-voltage (typically >5 V) is applied to the CG;

the channel is now turned on, so electrons can flow from the source to the drain;

the source-drain current is sufficiently high to cause some high energy electrons to jump through the insulating layer onto the FG, via a process called hot-electron injection (fig. 2.15).
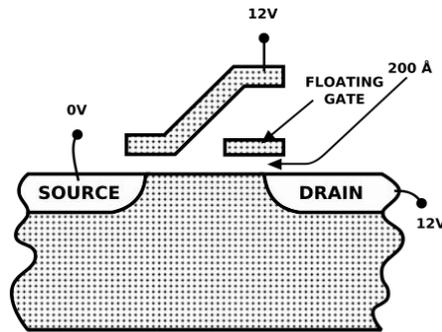
Fig. 2.15. **Flash memory operation principles**

In order to "erase" a flash cell a large voltage *of the opposite polarity* is applied between the CG and source, pulling the electrons off the FG.

There are typically four parts to a flash drive:

USB connector – provides a physical interface to the host computer;

USB mass storage controller – implements the USB host controller. The controller contains a small microcontroller with a small amount of on-chip ROM and RAM;

flash memory chip – stores data;

crystal oscillator – produces the device's main 12 MHz clock signal and controls the device's data output through a phase-locked loop (fig. 2.16).

1	USB connector
2	USB mass storage controller
3	Test points
4	Flash memory chip
5	Crystal oscillator
6	LED
7	Write-protect switch (Optional)
8	Space for second flash memory chip
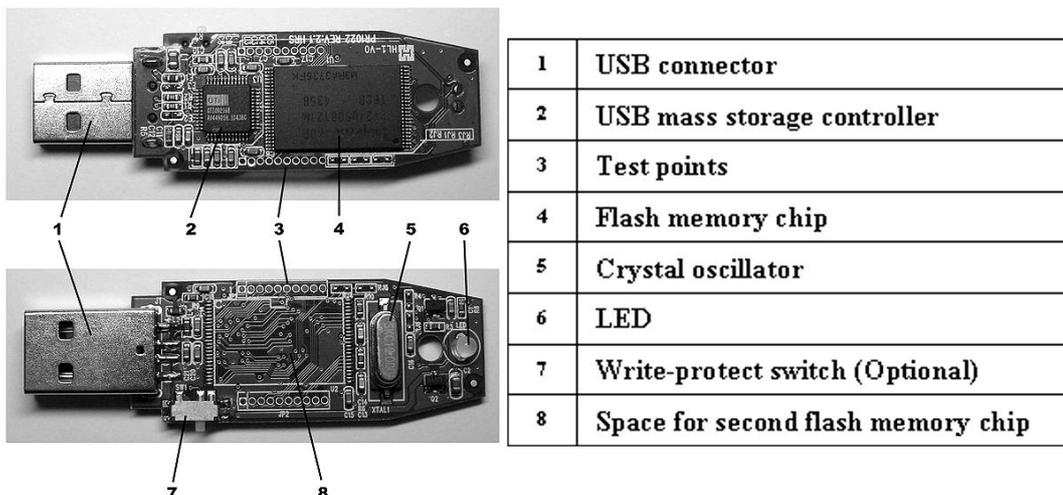
Fig. 2.16. **Typical parts of a flash drive**

⭐ **Optical read only memory** is represented by compact optical discs (also known as a CDs or DVDs) that are used to store digital data.

It was originally developed to store sound recordings exclusively, but later it also allowed the preservation of other types of data. Standard CDs have a diameter of 120 mm and can hold up to 80 minutes of uncompressed audio (700 MB of data for common CDs or 4.7 Gb for DVDs).

Sony first publicly demonstrated an optical digital audio disc in September 1976. The first test CD was presented at a conference in Hannover, Germany, by the Polydor Pressing Operations plant in 1982. The disc contained a recording of Richard Strauss's Eine Alpensinfonie (in English language, An Alpine Symphony).

The size and length of the first CD had to be enough to hold the 9th Symphony of Beethoven – the favorite composition of the head of Sony Corporation. Later it became a standard.

CD data are stored as a series of tiny indentations known as **"pits"**, encoded in a spiral track molded into the top of the polycarbonate layer. The areas between pits are known as **"lands".** Each pit is approximately 100 nm deep by 500 nm wide, and varies from 850 nm to 3.5 nm in length. The distance between the tracks, the **pitch**, is 1.6 nm (fig. 2.17).
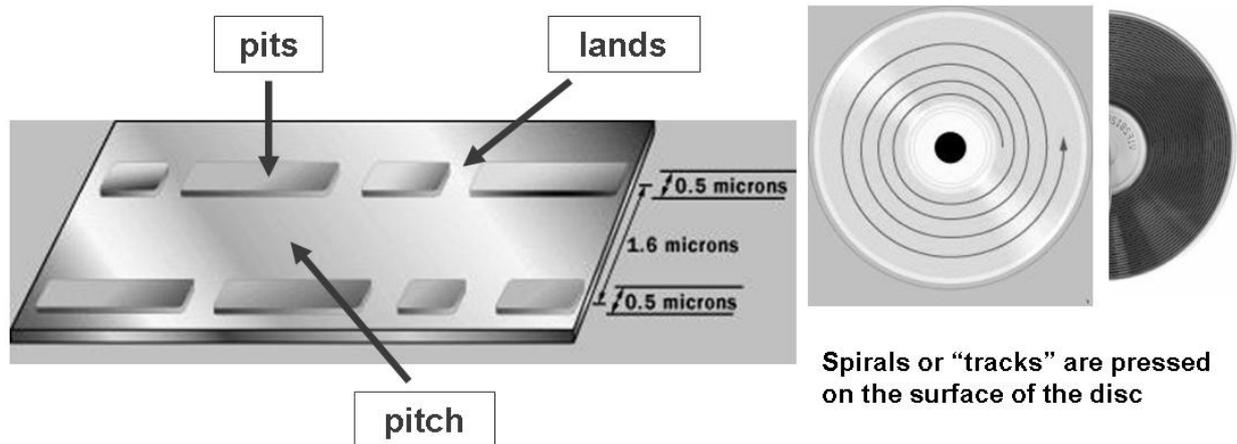
Fig. 2.17. **Optical disc structure**

A typical CD consists of a set of layers (fig.2.18):

A. A polycarbonate disc layer has the data encoded by using bumps.

B. A shiny layer reflects the laser.

C. A layer of lacquer helps keep the shiny layer shiny.

D. Artwork is screen printed on the top of the disc.

E. A laser beam reads the CD and is reflected back to a sensor, which converts it into electronic data

A CD under electronic microscope
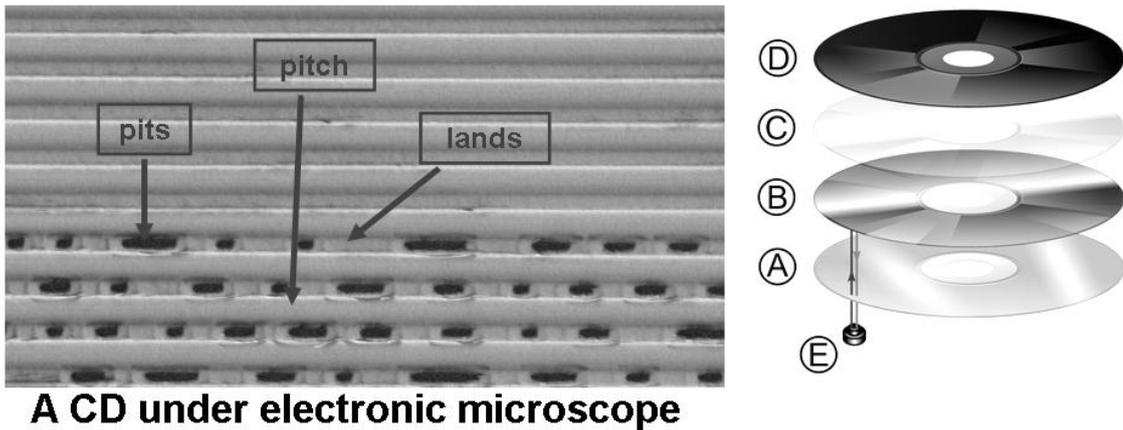
Fig. 2.18. **Optical disc layers [16]**

Optical discs can be recorded in **Disc At Once**, **Track At Once**, **Session at Once** (i.e. multiple burning sessions for one disc), or packet writing modes. Many disc manufacturers extend a recordable disc to leave a small margin of extra groove at the outer edge. This lead-out was originally intended to provide tolerance for the read head of an audio CD player should it overseek, by providing a padding of up to 90 seconds of silent digital audio. It can be used to "overburn" a disc.

⭐ **Overburning** is the process of recording data past the normal size limit of a compact disc.

An optical disc is designed to support one of three recording types: read-only (e.g.: CD and CD-ROM), recordable (write-once, e.g. CD-R), or re-recordable (rewritable, e.g. CD-RW). Write-once optical discs commonly have an organic dye recording layer between the substrate and the reflective layer. Rewritable discs typically contain an alloy recording layer composed of a phase change material that can restore its original state.

■ **Questions**

1. What is computer hardware? What elements does it include?
2. How does magnetic memory work?
3. What is the operational principle of flash memory devices?
4. What are the basic elements of a compact disc?
5. What is overburning?

Theme 3. Computer periphery: basic devices overview

The notion of a peripheral

Computer accessories

Types of peripherals

Peripheral devices: short overview

Image scanners. Architecture and basic types of scanners

Flatbed scanners

Drum scanners

Hand scanners

Dot-matrix technology

Jet technology

Printers. Architecture and basic types of printers

Laser technology
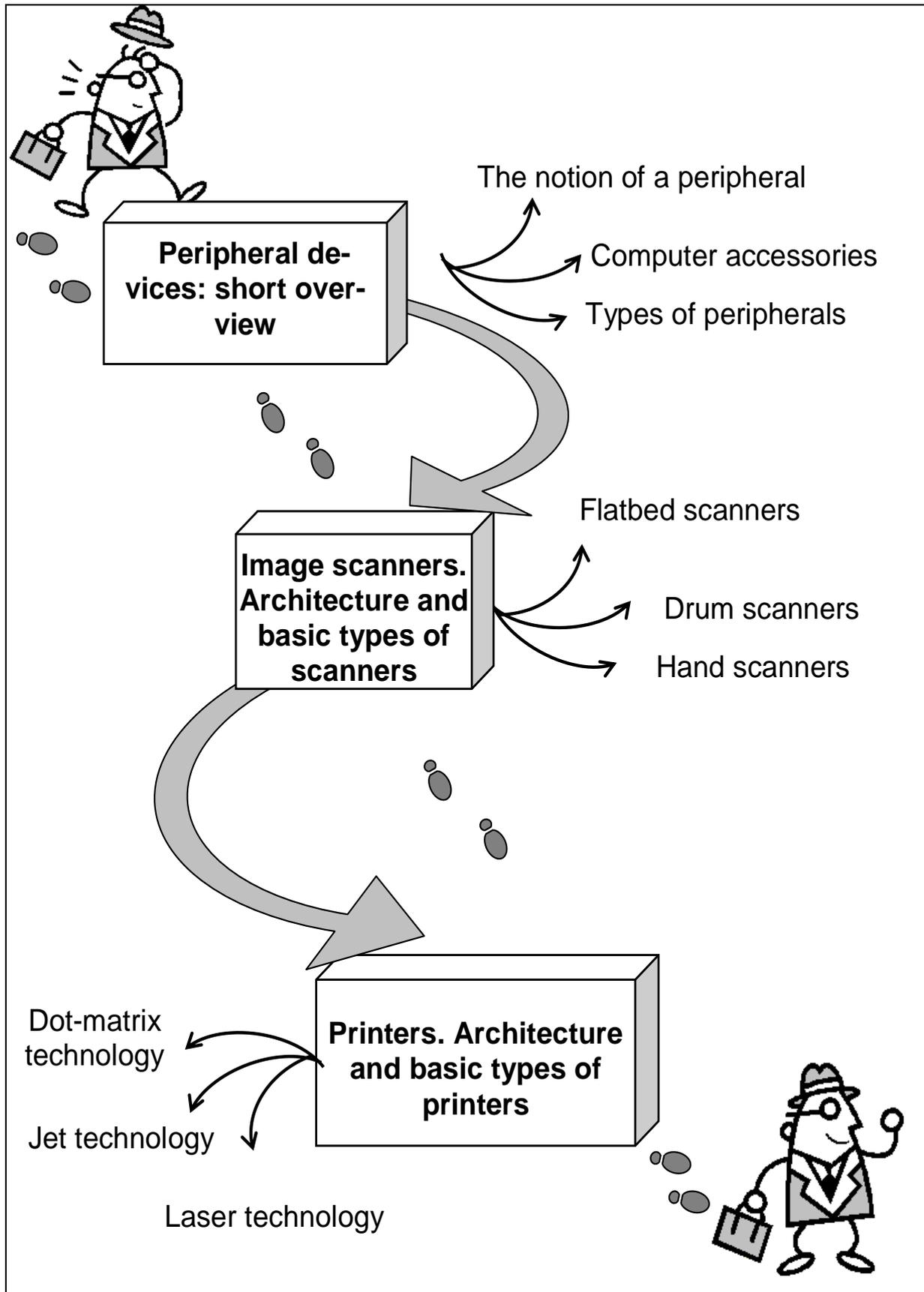
Fig. 3.1. **System elements of the lecture**

■ Introduction

The purpose of this theme lies in a close study of the basic peripheral devices that can be connected (directly or indirectly) to a personal computer. Although most common peripheral devices are named, a special attention is given to a thorough consideration of two types of computer peripherals that are commonly used by most users: scanners and printers. All types of scanners and printers are analyzed including architecture features and common areas of use.

Clue notions of the theme include: computer periphery; scanner; printer; dot-matrix technology; laser technology; dye-sublimation technology; drum scanners; flatbed scanners; hand scanners; films; inks and dyes.

This theme covers the following **topics**: What is computer periphery? What devices can be named computer peripherals? What is a scanner, for what purposes can it be used? What is a printer, for what purposes can it be used? What are the most widespread types of printers and scanners?

As a result of the study of the material represented in this theme students will acquire the following **competencies**:

they would know the basic devices that form computer architecture environment;

they would learn the types of scanners most widely used for office work, their architectural features and ways of implementation;

they would become aware of the principles that govern the work of most types of printers most widely used for office work and industrial tasks.

3.1. Peripheral devices: short overview

Generally, a periphery is a boundary or outer part of any space or body. In computer science, a peripheral is a device added to a host computer in order to expand its abilities.

★ *So, **a peripheral** is a device attached to a host computer behind the chipset whose primary functionality is dependent upon the host, and can therefore be considered as expanding the host's capabilities, while not forming part of the system's core architecture.*

Some of the more common peripheral devices are printers, scanners, disk drives, tape drives, microphones, speakers, and cameras. Peripheral devices can also include other computers on a network system. A device can

also refer to a non-physical item, such as a pseudo terminal, a RAM drive, or a virtual network adapter (fig. 4.2).
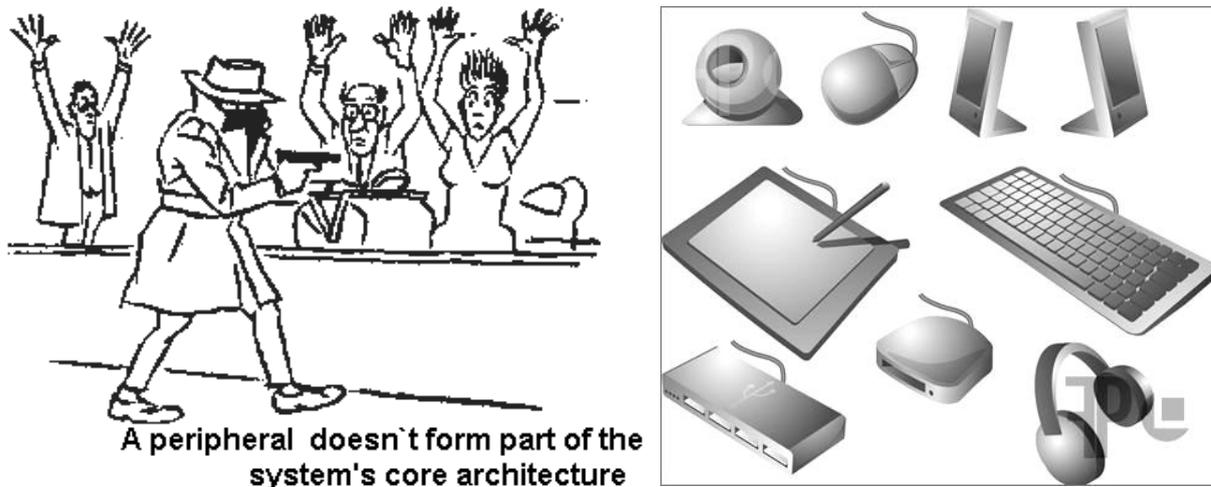
Fig. 3.2. **Computer periphery**

The term is different from **computer accessories**: computer peripheral has a narrow meaning that refers only to the input-output devices of a computer, whereas, computer accessories has a broader meaning, that refers to all the parts that support a computer which include motherboards, sensors, chips, including all the input and output devices.

Some people consider internal devices such as video capture cards, disk drives, TV-tuners, tape drives etc. also peripheral devices because they have external appendages.

3.2. Image scanners. Architecture and basic types of scanners

★ *A **scanner** is a device that optically scans images, printed text, handwriting, or an object, and converts it to a digital image.*

Common examples found in offices are variations of the desktop (or flatbed) scanner where the document is placed on a glass window for scanning. Hand-held scanners, where the device is moved by hand, have evolved from text scanning "wands" to 3D scanners used for industrial design, reverse engineering, test and measurement, orthotics, gaming and other applications. Mechanically driven scanners that move the document are typically used for large-format documents, where a flatbed design would be impractical.

Another category of scanner is digital camera scanners, which are based on the concept of reprographic cameras. Due to increasing resolution

and new features such as anti-shake, digital cameras have become an attractive alternative to regular scanners.

There are three most widespread types of scanners:

> drum scanners;
>
> flatbed scanners;
>
> hand scanners;

Drum scanners capture image information with photomultiplier tubes (PMT), rather than the charge-coupled device (CCD) arrays found in flatbed scanners and inexpensive film scanners. Reflective and transmissive originals are mounted on an acrylic cylinder, the scanner drum, which rotates at high speed while it passes the object being scanned in front of precision optics that deliver image information to the PMTs. Most modern color drum scanners use 3 matched PMTs, which read red, blue, and green light respectively. Light from the original artwork is split into separate red, blue, and green beams in the optical bench of the scanner.

The drum scanner gets its name from the clear acrylic cylinder, the drum, on which the original artwork is mounted for scanning. One of the unique features of drum scanners is the ability to control sample area and aperture size independently. The sample size is the area that the scanner encoder reads to create an individual pixel. The aperture is the actual opening that allows light into the optical bench of the scanner. The ability to control aperture and sample size separately is particularly useful for smoothing film grain when scanning black-and-white and color negative originals (fig. 4.4).

Fig. 3.3. **A typical drum scanner**

Only a few companies continue to manufacture drum scanners. However, drum scanners continue to be used in high-end applications, such as museum-quality archiving of photographs and print production of high-quality books and magazine advertisements.

A **flatbed scanner** is usually composed of a glass pane (or platen), under which there is a bright light (often xenon or cold cathode fluorescent) which illuminates the pane, and a moving optical array in CCD scanning. CCD type scanners typically contain three rows (arrays) of sensors with red, green, and blue filters. CIS scanning consists of a moving set of red, green and blue LEDs strobed for illumination and a connected monochromatic photodiode array for light collection (fig. 3.4).
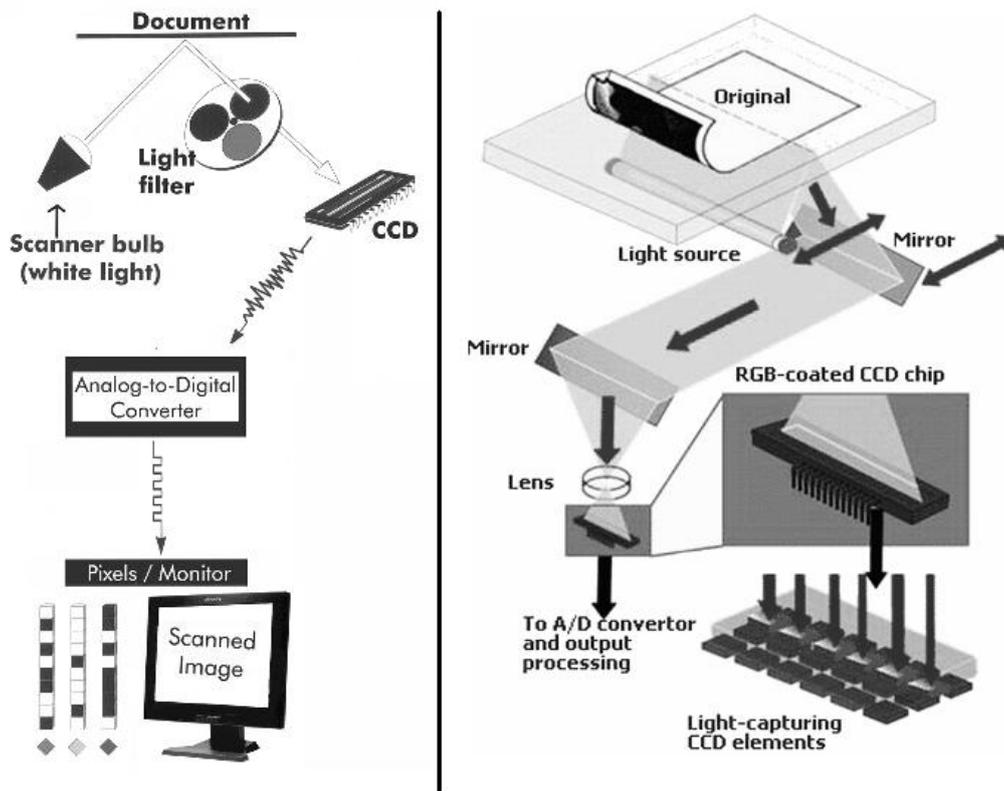
Fig.3.4. **Flatbed scanners: operation principles [12]**

Images to be scanned are placed face down on the glass, an opaque cover is lowered over it to exclude ambient light, and the sensor array and light source move across the pane, reading the entire area. An image is therefore visible to the detector only because of the light it reflects. Transparent images do not work in this way, and require special accessories that illuminate them from the upper side. Many scanners offer this as an option.

Basic scanner characteristics include three components (fig. 3.5).

Color depth is the number of bits used to represent the color of a single pixel in a bitmapped image. Color depth varies depending on the scanning array characteristics, but is usually at least 24 bits. High quality models have 48 bits or more color depth.
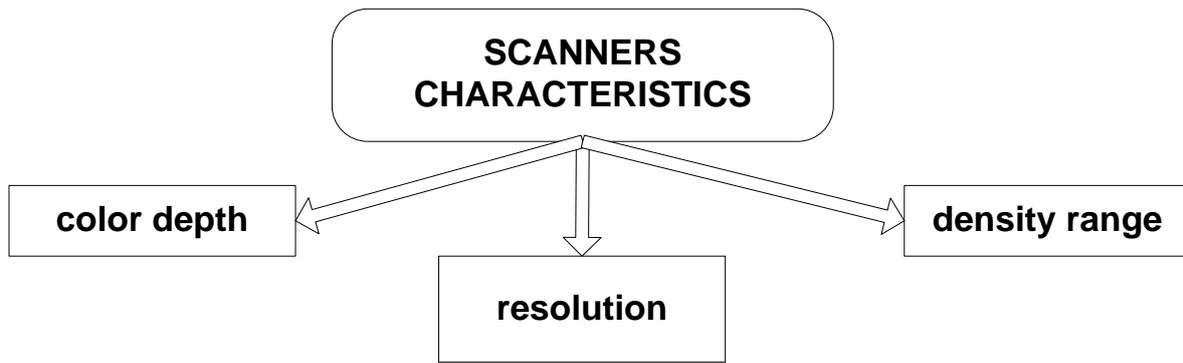
Fig. 3.5. **A typical scanner's characteristics**

Resolution is the number of pixels (dots) per unit of measurement (such as inch or centimeter). The size of the file created increases with the square of the resolution; doubling the resolution quadruples the file size. A resolution must be chosen that is within the capabilities of the equipment, preserves sufficient detail, and does not produce a file of excessive size.

Density range means the ability of a scanner to reproduce shadow details and brightness details in one scan. A high density range means that the scanner is able to reproduce shadow details and brightness details in one scan.

3.3. Printers. Dot-matrix, laser and dye-sublimation printers

★ *In computing, **a printer** is a peripheral which produces a hard copy (permanent human-readable text and/or graphics) of documents stored in electronic form, usually on physical print media such as paper or transparencies.*

Many printers are primarily used as local peripherals, and are attached by a **printer cable** or, in most newer printers, a USB cable to a computer which serves as a document source. Some printers, commonly known as network printers, have built-in network interfaces (typically wireless or Ethernet), and can serve as a hardcopy device for any user on the network. Individual printers are often designed to support both local and network connected users at the same time.

In addition, a few modern printers can directly interface to electronic media such as memory sticks or memory cards, or to image capture devices such as digital cameras, scanners; some printers are combined with scanners and/or fax machines in a single unit, and can function as photocopiers. Printers that include non-printing features are sometimes called Multifunction

Printers (MFP), Multi-Function Devices, or All-In-One printers. Most MFPs include printing, scanning, and copying among their features.

Printers are designed for low-volume, short-turnaround print jobs requiring virtually no setup time to achieve a hard copy of a given document. However, printers are generally slow devices (30 pages per minute is considered fast; and many inexpensive consumer printers are far slower than that), and the cost per page is actually relatively high. The world's first computer printer was a 19th century mechanically driven apparatus invented by Charles Babbage for his Difference Engine.

Now there exist a wide range of printers. Printers can be categorized in any of several ways (fig. 3.6).
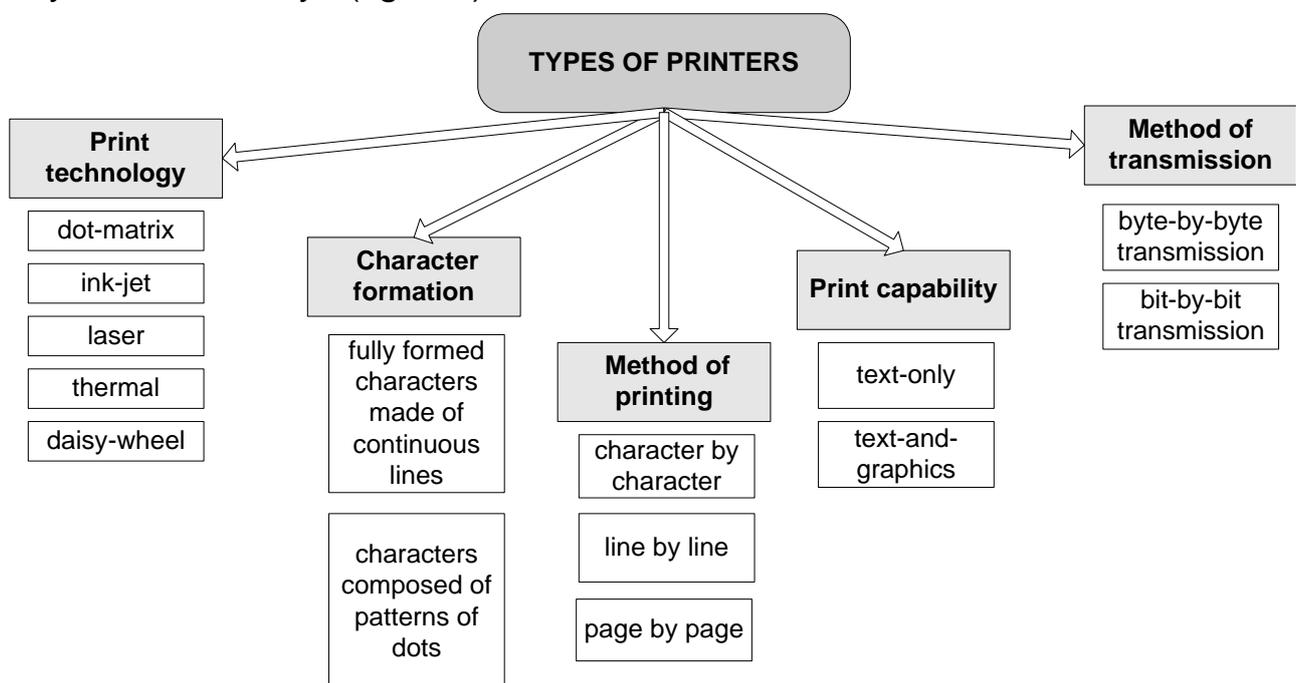
Fig. 3.6. **A typical scanner's characteristics**

★ *A dot matrix printer or impact matrix printer is a type of computer printer with a print head that runs back and forth, or in an up and down motion, on the page and prints by impact, striking an ink-soaked cloth ribbon against the paper, much like a typewriter.*

Unlike a typewriter letters are drawn out of a dot matrix, and thus, varied fonts and arbitrary graphics can be produced. Because the printing involves mechanical pressure, these printers can create carbon copies and carbonless copies.

Each dot is produced by a tiny metal rod, also called a "wire" or "pin", which is driven forward by the power of a tiny electromagnet or solenoid,

either directly or through small levers (pawls) (fig. 3.7). Facing the ribbon and the paper is a small guide plate (often made of an artificial jewel such as sapphire or ruby) pierced with holes to serve as guides for the pins.
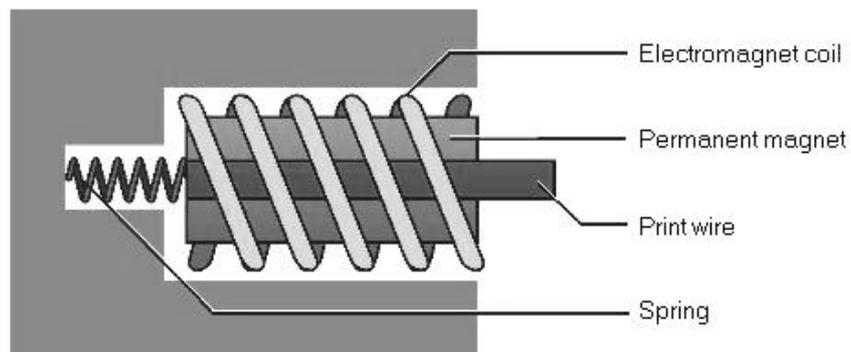
Fig. 3.7. **Dot-matrix pin structure**

The moving portion of the printer is called the print head, and when running the printer as a generic text device generally prints one line of text at a time. Most dot matrix printers have a single vertical line of dot-making equipment on their print heads; others have a few interleaved rows in order to improve dot density (fig. 3.8).
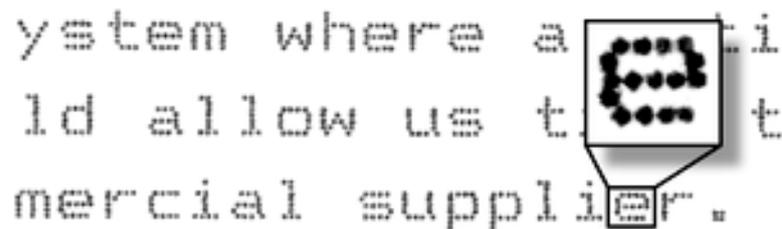
Fig. 3.8. **Typical output from a dot matrix printer [13]**

These machines can be highly durable. When they do wear out, it is generally due to ink invading the guide plate of the print head, causing grit to adhere to it; this grit slowly causes the channels in the guide plate to wear from circles into ovals or slots, providing less and less accurate guidance to the printing wires. Eventually, even with tungsten blocks and titanium pawls, the printing becomes too unclear to read.

In the 1970s and 1980s, dot matrix impact printers were generally considered the best combination of expense and versatility, and until the 1990s they were by far the most common form of printer used with personal computers. In the 1990-s the desktop impact printer was gradually replaced by the inkjet printer. The main use of dot-matrix printers now is in areas of intensive transaction-processing systems that churn out quite a lot of printing. Many companies who might have started off with dot-matrix printers are not so easily convinced to go for printers based on other technologies. Dot matrix

printers are the dominant type of printer in small firms and offices. They are still used to fulfill mass printing tasks that don't require high quality printing. Dot matrix impact technology remains in use in devices such as cash registers, ATM, and many other point-of-sales terminals.

★ *A laser printer is a common type of computer printer that rapidly produces high quality text and graphics on plain paper.*

As with digital photocopiers and multifunction printers (MFPs), laser printers employ a **xerographic printing process** but differ from analog photocopiers in that the image is produced by the direct scanning of a laser beam across the printer's photoreceptor.

A laser beam projects an image of the page to be printed onto an electrically charged rotating drum coated with selenium. Photoconductivity removes charge from the areas exposed to light. Dry ink (toner) particles are then electrostatically picked up by the drum's charged areas. The drum then prints the image onto paper by direct contact and heat, which fuses the ink to the paper (fig. 3.9).
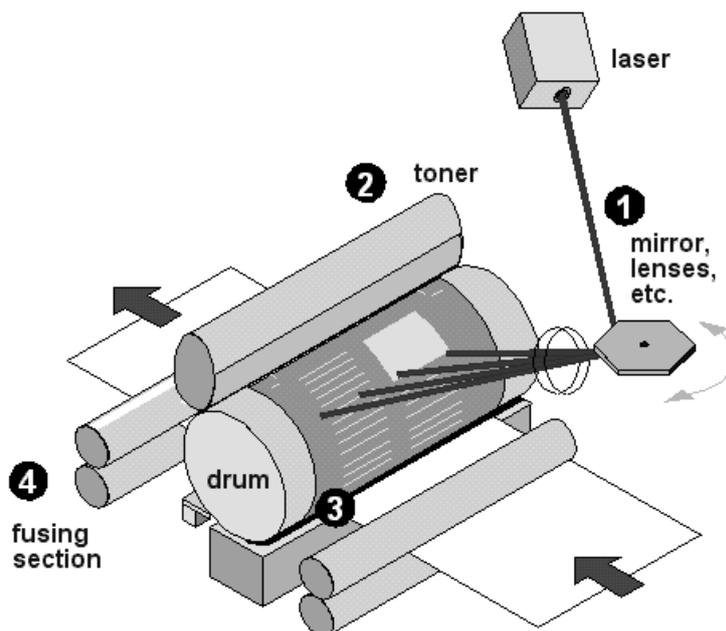
Fig. 3.9. **Laser printer operation**

The laser printer was invented at Xerox in 1969 by researcher Gary Starkweather, who had an improved printer working by 1971 and incorporated into a fully functional networked printer system by about a year later. The prototype was built by modifying an existing xerographic copier. Starkweather disabled the imaging system and created a spinning drum with

8 mirrored sides, with a laser focused on the drum. Light from the laser would bounce off the spinning drum, sweeping across the page as it traveled through the copier. The hardware was completed in just a week or two, but the computer interface and software took almost 3 months to complete.

The first commercial implementation of a laser printer was the IBM model 3800 in 1976, used for high-volume printing of documents such as invoices and mailing labels. It is often cited as "taking up a whole room," implying that it was a primitive version of the later familiar device used with a personal computer. The first laser printer designed for use with an individual computer was released with the Xerox Star 8010 in 1981. Although it was innovative, the Star was an expensive ($17,000) system that was purchased by only a relatively small number of businesses and institutions. After personal computers became more widespread, the first laser printer intended for a mass market was the HP LaserJet 8ppm, released in 1984, using a Canon engine controlled by HP software. The HP LaserJet printer was quickly followed by laser printers from Brother Industries, IBM, and others.

There are typically seven steps involved in the laser printing process (refer to fig. 3.9):

1. Raster image processing.
2. Charging.
3. Exposing.
4. Developing.
5. Transferring.
6. Fusing.
7. Cleaning.

★ **Inkjet printers** *operate by propelling variably-sized droplets of liquid or molten material (ink) onto almost any sized page.*

They are the most common type of computer printer for the general consumer due to their low cost, high quality of output, capability of printing in vivid color, and ease of use. There are three main technologies in use in contemporary inkjet printers: thermal; piezoelectric; continuous;

Thermal inkjets. Most consumer inkjet printers use print cartridges with a series of tiny electrically heated chambers. To produce an image, the printer runs a pulse of current through the heating elements causing a steam explosion in the chamber to form a bubble, which propels a droplet of ink onto the paper. The ink's surface tension as well as the condensation and thus contraction of the vapor bubble, pulls a further charge of ink into the chamber through a narrow channel attached to an ink reservoir. The principle was discovered by Canon engineer Ichiro Endo in August 1977.

Piezoelectric inkjets. Most commercial and industrial ink jet printers use a piezoelectric material in an ink-filled chamber behind each nozzle instead of a heating element. When a voltage is applied, the piezoelectric material changes shape or size, which generates a pressure pulse in the fluid forcing a droplet of ink from the nozzle. This is essentially the same mechanism as the thermal inkjet but generates the pressure pulse using a different physical principle. Piezoelectric (also called Piezo) ink jet allows a wider variety of inks than thermal or continuous ink jet but the print heads are more expensive.

Continuous inkjets. The continuous ink jet method is used commercially for marking and coding of products and packages. The idea was first patented in 1867, by Lord Kelvin and the first commercial devices (medical strip chart recorders) were introduced in 1951 by Siemens. In continuous ink jet technology, a high-pressure pump directs liquid ink from a reservoir through a gunbody and a microscopic nozzle, creating a continuous stream of ink droplets. Continuous ink jet is one of the oldest ink jet technologies in use and is fairly mature. Mostly it is used for printing mass low-quality graphics for industrial needs.

Special types of printers: heat printers (dye-sublimation printers)

⊠ *A dye-sublimation printer (or dye-sub printer) is a computer printer which employs a printing process that uses heat to transfer dye to a medium such as a plastic card, printer paper, poster paper, or fabric.*

Most consumer and professional dye-sublimation printers are designed and used for producing high-quality photographic prints.

It uses **CMYO** (cyan (blue), magenta (red), yellow, overcoating) color transfer technology instead of CMYK (cyan, magenta, yellow, key (black)) used by color inkjet and laser printers. The overcoating is thin laminate which protects the print from discoloration from UV light and the air while also rendering the print water-resistant.

⊠ *Sublimation is when a substance transitions between the solid and gas states without going through a liquid stage.*

In a dye-sublimation printer the printing dye is heated up until it turns into a gas, at which point it diffuses onto the printing media and solidifies.

The dye is stored on a cellophane ribbon. The ribbon is made up of three colored panels (cyan, magenta, and yellow) and one clear panel which

holds the lamination material for the overcoating. Each colored panel is the size of the media that is being printed on. So the printer can print on the media only of a certain size.

During the printing cycle, the printer rollers move the media and one of the colored panels together under a thermal printing head. Tiny heating elements on the head change temperature rapidly, laying different amounts of dye depending on the amount of heat applied (fig. 3.10).
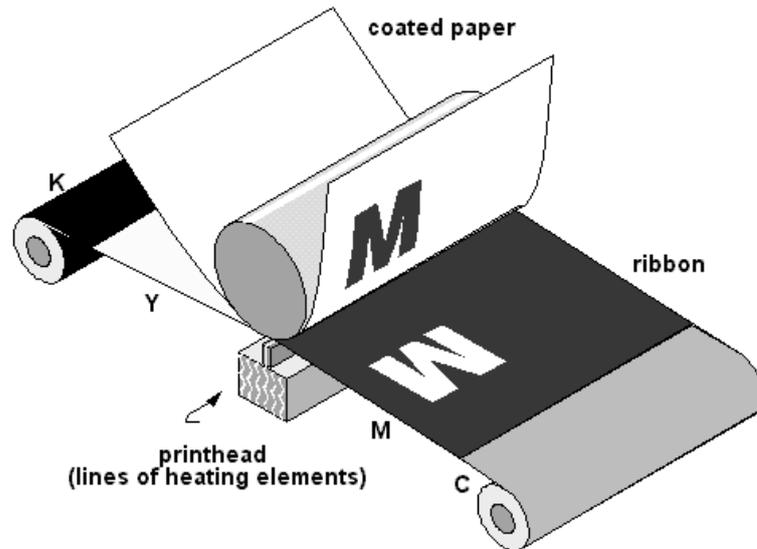
Fig. 3.10. **Dye-sublimation printer work scheme**

After the printer finishes covering the media in one color, it winds the ribbon on to the next color panel and partially ejects the media from the printer to prepare for the next cycle. The entire process is repeated four times in total: the first three lay the colors onto the media to form a complete image, while the last one lays the laminate over top. This layer protects the dye from resublimating when handled or exposed to warm conditions.

■ **Questions**

1. What is computer periphery? What computer peripherals do you know?
2. What is a scanner? Name basic types of scanners.
3. What is the scheme of scanner operation?
4. What is a printer? What types of media can be used for printing?
5. What are the classification criterion for computer printers?
6. Name basic types of printers.
7. What are the areas of use of dye-sublimation printers?

Section 2. Computer software. MS Windows operating system
Theme 4. Computer software: structure and principles of organization

Overview: software relationship to computer hardware

Sofware vs Hardware

Software role in PC operation

Software history

Types of computer software

System software

Application software

Programming software

Software copyright protection

Copyright

Patent

License
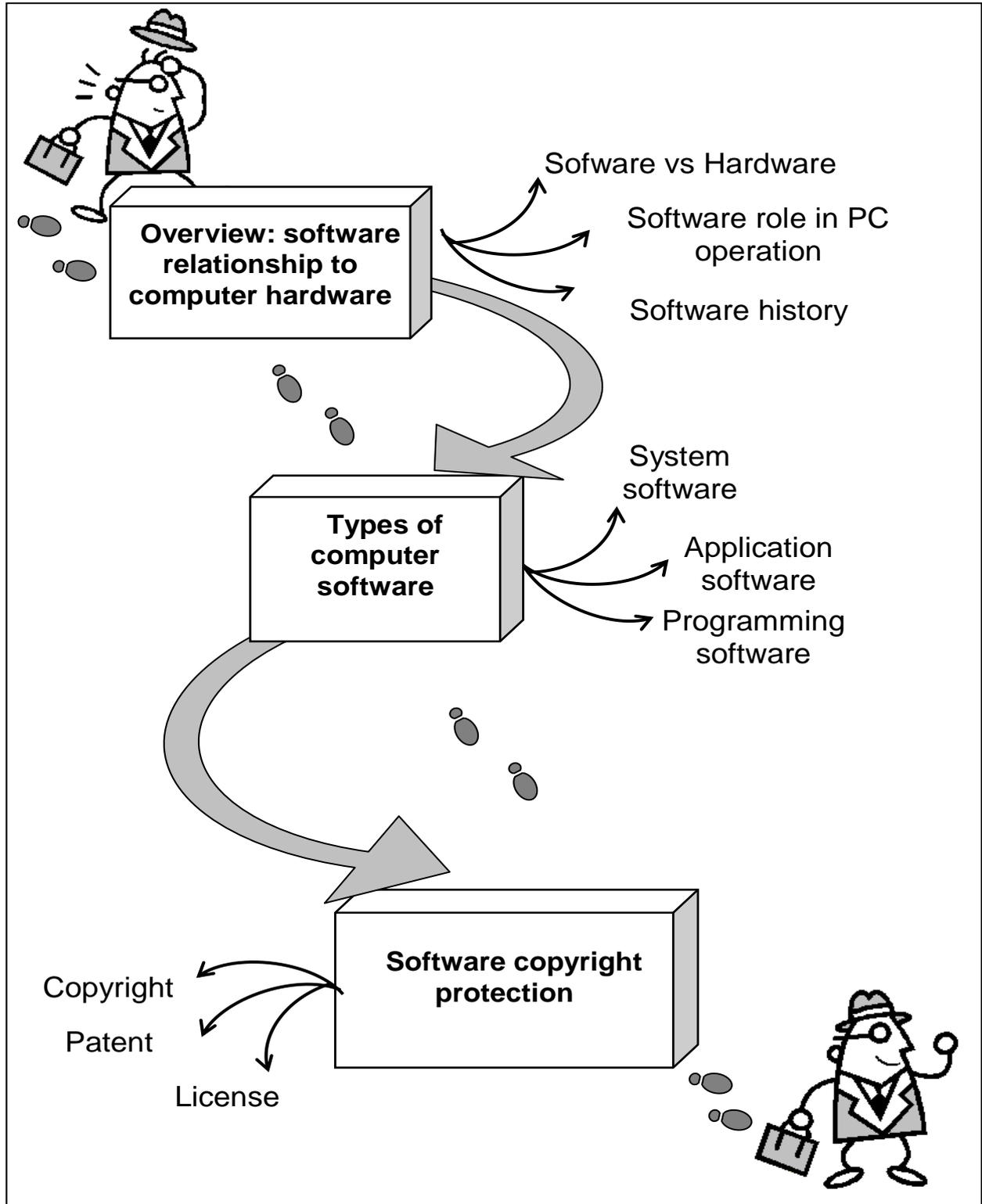
Fig. 4.1. **System elements of the theme**

■ Introduction

The purpose of this theme lies in a close study of the peculiar features of computer software. The nature of computer software is analyzed and questions connected with software copyright protection are given a special consideration. A thorough analysis covers different types of computer software and their use by particular groups of users.

Clue notions of the theme include: computer software; copyright; patent law; trademark law; shrink-wrap licenses; system software; programming software; application software.

This theme covers the following **topics**: What is computer software? What ways of protecting computer software do exist? What are the basic types of computer software? What is the role of the system software in sustaining computer operation? What are the basic types of computer application software?

As a result of the study of the material represented in this theme students will acquire the following **competencies**:

they would know the difference between computer software and hardware;

they would learn the basic types of computer software;

they would become aware of the types of software used for solving of tasks arising as a result of economic activities of individuals and enterprises.

4.1. Overview: software relationship to computer hardware

⭐ *Software is an ordered sequence of instructions for changing the state of the computer hardware in a particular sequence.*

Computer software is often regarded as anything but hardware, meaning that the "hard" are the parts that are tangible while the "soft" part is the intangible objects inside the computer. Besides users often presume that "hardware" is the part of a computer which does most of the job.

Software encompasses an extremely wide array of products and technologies developed using different techniques like programming languages, scripting languages, microcode etc. The types of software include web pages developed by technologies like HTML, PHP, Perl, JSP, ASP.NET, XML, and desktop applications like OpenOffice, Microsoft Word developed by technologies like C, C++, Java,or C#.
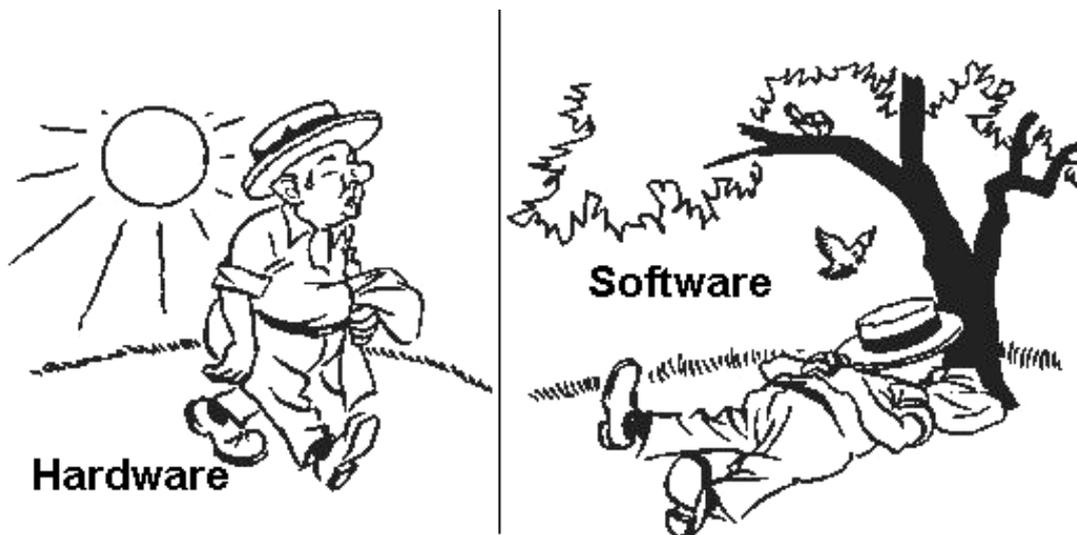
Software usually runs on underlying **software operating systems** such as Microsoft Windows, Linux or MacOS. Software also includes video games and the logic systems of modern consumer devices such as automobiles, televisions, and toasters.

Computer software is so called to distinguish it from computer hardware, which encompasses the physical interconnections and devices required to store and execute (or run) the software. At the lowest level, software consists of a machine language specific to an individual processor. A machine language consists of groups of binary values signifying processor instructions that change the state of the computer from its preceding state.

It is usually written in high-level programming languages that are easier and more efficient for humans to use (closer to natural language) than machine language. High-level languages are compiled or interpreted into machine language object code. Software may also be written in an assembly language, essentially, a mnemonic representation of a machine language using a natural language alphabet. Assembly language must be assembled into object code via an assembler.

The term **"software"** was first used in this sense by John W. Tukey in 1958. In computer science and software engineering, computer software is all computer programs. The theory that is the basis for most modern software was first proposed by Alan Turing in his 1935 essay "Computable numbers with an application to the Entscheidungsproblem".

So, to sum it up, computer software is represented by a set of instructions that cause a computer to perform one or more tasks. The set of instructions is often called a program or, if the set is particularly large and complex, a system. Computers cannot do any useful work without instructions

from software; thus a combination of software and hardware (the computer) is necessary to do any computerized work. A program must tell the computer each of a set of minuscule tasks to perform, in a framework of logic, such that the computer knows exactly what to do and when to do it.

Software "tells" Hardware what to do

Programs are usually written in programming languages, especially designed to facilitate the creation of software.

In the 1950s, programming languages were numerical languages easily understood by computer hardware; often, programmers said they were writing such programs in machine language. The programmable aspects of computer hardware have not changed much since the 1950s. Computers still have numerical operations, and numerical addresses by which data may be accessed. However, programmers now use high-level languages, which look much more like English than a string of numbers or operation codes.

Until the personal computer revolution began in the 1980s, software was written mainly for business, government, and the military, which employed large mainframe computers as hardware. With the introduction of personal computers, which have rapidly increased in power and performance, software has emerged as an important commercial product that can be marketed to individuals and small business as well as big business and the government.

4.2. Types of computer software

Practical computer systems divide software systems into three major classes: system software, programming software and application software, although the distinction is arbitrary, and often blurred (fig. 4.2).
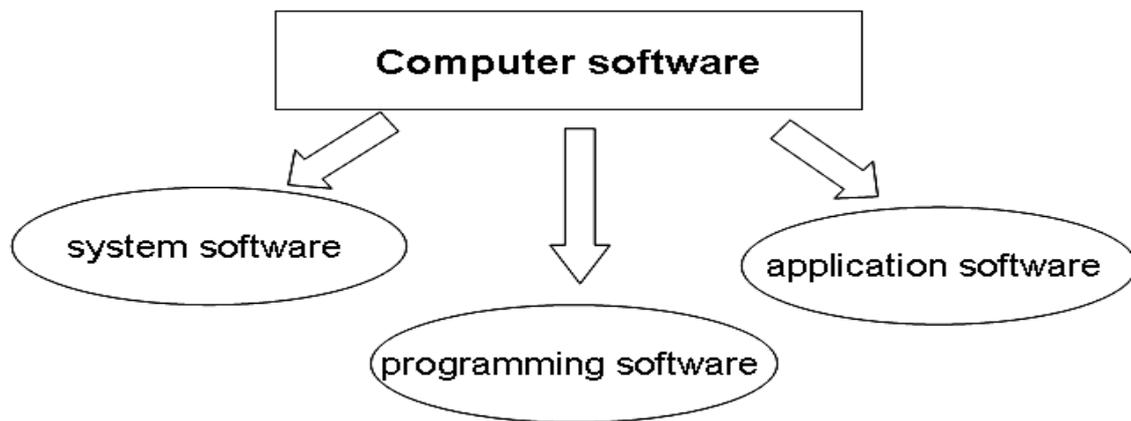
Fig. 4.2. **Classes of computer software**

Computer software has to be "loaded" into the computer's storage (such as a hard drive, memory, or RAM). Once the software is loaded, the computer is able to execute the software. Computers operate by executing the computer program. This involves passing instructions from the application software, through the system software, to the hardware which ultimately receives the instruction as machine code. Each instruction causes the computer to carry out an operation – moving data, carrying out a computation, or altering the control flow of instructions.

System software helps run the computer hardware and computer system. It includes a combination of the following:

device drivers (a computer program allowing higher-level computer programs to interact with a hardware device);

operating systems (an interface between hardware and user);

utilities (computer software designed to help manage and tune the computer hardware, operating system or application software by performing a single task or a small range of tasks);

windowing systems (a component of a graphical user interface which supports the implementation of window managers, and provides basic support for graphics hardware, pointing devices such as mice, and keyboards).

The purpose of systems software is to **unburden the applications programmer** from the often complex details of the particular computer being used, including such accessories as communications devices, printers, device readers, displays and keyboards, and also to partition the computer's resources such as memory and processor time in a safe and stable manner. Examples are Windows, Linux and Mac.
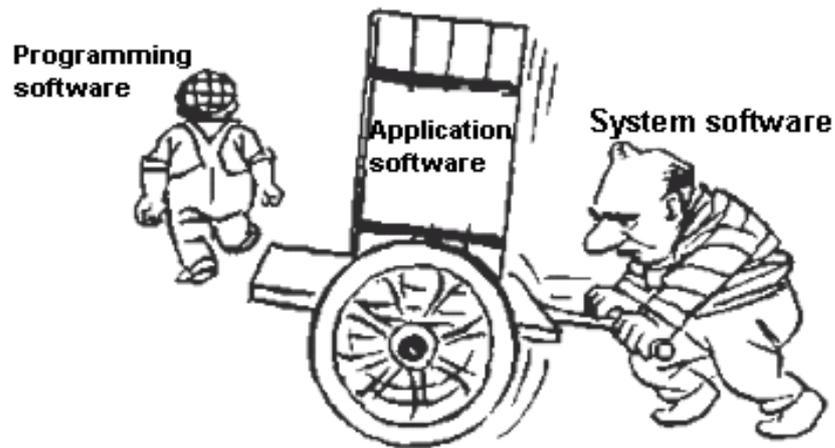
Programming software usually provides tools to assist a programmer in writing computer programs, and software using different programming languages in a more convenient way. The tools include:

compilers;

debuggers;

interpreters;

linkers;

text editors.

An Integrated development environment is a single application that attempts to manage all these functions.

After a piece of software is created using programming software, it becomes either system software or application software.

Application software allows end users to accomplish one or more specific (not directly computer development related) tasks, such as writing letters, computing formulas, playing games, or carrying out desktop publishing tasks. Typical applications fall into one of the following groups.

1. Writing tasks previously done on typewriters with considerable effort can now be easily completed with **word-processing software**. Writing tasks such as keying in reports, letters, and tables, as well as merging documents, can be performed easily. Documents can be easily edited and formatted. Revisions can be made by deleting (cutting), inserting, moving (cutting and pasting), and copying data. Documents can be stored (saved) and opened again for revisions and/or printing. Many styles and sizes of fonts are available to make the document attractive.

2. **Spreadsheet software** permits performance of an almost endless variety of quantitative tasks such as budgeting, keeping track of inventory, preparing financial reports, or manipulating numbers in any fashion, such as

averaging each of ten departmental monthly sales over a six-month period. A spreadsheet contains cells, the intersection of rows and columns. Each cell contains a value keyed in by the user. Cells also contain formulas with many capabilities, such as adding, multiplying, dividing, subtracting, averaging, or even counting. An outstanding feature is a spreadsheet's ability to recalculate automatically. If one were preparing a budget, for example, and wanted to change a variable such as an increase in salary or a change in amount of car payments, the formulas would automatically recalculate the affected items and the totals.

3. **Database software** contains a list of information items that are similar in format and/or nature. An example is a phone book that lists a name, address, and phone number for each entry. Once stored in a database, information can be retrieved in several ways, using reports and queries. For example, all the names listed for a given area code could be printed out and used for a commercial mailing to that area.

4. **Desktop publishing software** permits the user to prepare documents by using both word-processing devices and graphics. Desktop publishing software uses word-processing software, with all its ease of entering and revising data, and supplements it with sophisticated visual features that stem from graphics software. For example, one can enhance a printed message with virtually any kind of illustration, such as drawings, paintings, and photographs.

5. **Presentation software** is used to organize a slide show presentation for an audience. Text, graphics, sound, and movies can easily be included in the presentation. An added feature is that the slide show may be enhanced by inclusion of handouts with two to six slides printed on a page. The page may be organized to provide space for notes to be written in by the audience as the presentation ensues. An example of this is Power Point. Preparation of the software is simplified by the use of 'wizards' that walk the user through the creation of the presentation.

6. **Office suite software** puts together complete programs of software. A typical suite package might include word processing, spreadsheet, databases, and presentation software. Depending on the jobs that need to be done, the suite provides the tools to make professional-looking documents.

Each piece of software works independently as well as with other parts of the suite. Items on the menu bar – such as File, Insert, and Format – work

similarly on all the programs in a suite. Thus, familiarity with one program makes it easy to work with the other programs.

4.3. Software copyright protection

Software is, under the law, intellectual property and therefore entitled to protection from persons who seek to exploit it illegally. Software can be protected through the use of trade secrets, copyright, patents, and trademarks.

Once software is developed and is ready to be sold, it can be copyrighted. **Copyright** protects the expression of an idea, not the idea itself. For example, a person could not copyright the idea of a computer database management system but could copyright the structure and content of a database software program that expresses the idea of a database system.

Patent law supplies another avenue of protection for software companies. A patent protects the idea itself. It is often an unattractive option, however, because it takes a significant amount of time and money to obtain a patent.

Trademark law protects the name of the software, not the software itself. Protecting a name from being used by others can be more valuable than other forms of protection.

When software is leased or sold, the purchaser usually must agree to accept a software license. When a business negotiates with a software company, it will sign a license agreement that details how the software is to be used and limits its distribution. A **software license** is an effective tool in preventing piracy. When consumers buy software from a software company or through a third-party business, they find in the packaging a software license. The license is typically on the sealed envelope that contains the software media, which itself is sealed in plastic wrapping. These **"shrink-wrap licenses"** describe contractual conditions regarding the purchaser's use of the software.

Opening of the "shrink-wrap" constitutes acceptance
of all of the terms of the license agreement

The opening of the shrink-wrap, according to the license, constitutes acceptance of all of the terms contained in the license agreement. The purchaser is informed that the software is licensed and not sold to the purchaser.

By retaining title to the software, the computer software company seeks to impose conditions upon the purchaser, or licensee, that are not otherwise permissible under the copyright law. The principal terms of the shrink-wrap license include prohibiting the unauthorized copying and renting of the software, prohibiting reverse engineering and modifications of the software, limiting the use of the software to one computer, disclaiming warranties, and limiting liabilities.

Software developers have legitimate concerns about software piracy. Counterfeiting is an international problem that results in the sale of millions of dollars of pirated software. The Software Publisher's Association (SPA) and the Business Software Alliance (BSA) are major organizations that combat software piracy. The SPA is the leading international trade association for the personal computer software industry. Both SPA and BSA have collected millions of dollars worldwide from companies that have used pirated software. Most companies using pirated software are reported by former employees.

■ Questions

1. What is computer software? What is the difference between computer software and hardware?

2. What ways of protecting computer software do exist?

3. What are the basic types of computer software?

4. What is the role of the system software in sustaining computer operation?

5. What are the basic types of computer application software?

6. Name the basic types of computer application software.

7. What is the difference between different types of computer software (system, programming and application)?

Theme 5. MS Windows operating system

Introduction to computer operating systems

Operating system

Installed applications

Resource usage

WINDOWS OS: general characteristic

Windows OS history

Win OS topology

New OS versions

Modern versions of MS Windows OS: XP, Vista, Seven

Interface

File organization

Built-in apps

MS Windows OS concept: user interface, file system, built-in tools and applications
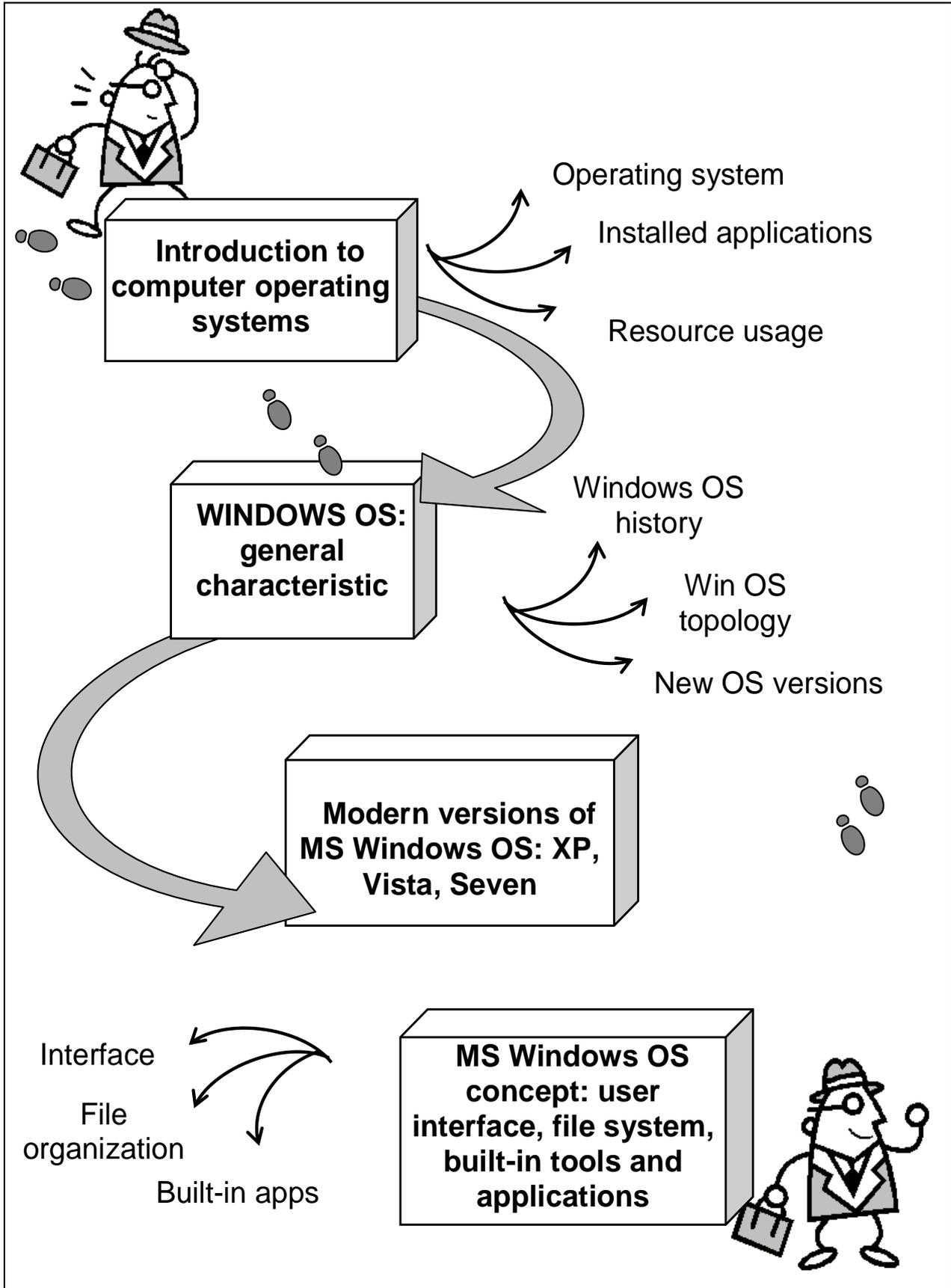
Fig. 5.1. **System elements of the theme**

■ Introduction

The purpose of this theme lies in a close study of the peculiar features of computer operating systems. The nature of computer operating systems is analyzed and questions connected with operating systems at work are given a special consideration. A thorough analysis covers different types of MS Windows computer operating systems and their use by different groups of users.

Clue notions of the theme include: computer operating system; security; operation modes; Windows; built-in applications, personalization.

This theme covers the following **topics**: What is a computer operating system? What work is done by computer operating systems? How do computer operating systems control computer operation? What are the basic types of MS Windows computer operating systems?

As a result of the study of the material represented in this theme students will acquire the following **competencies**:

they would know the difference between operating systems and other types of computer software;

they would learn the basic principles that guide computer operating systems` work;

they would become aware of the features of the most known computer operating systems.

5.1. Introduction to computer operating systems

⋆ *An Operating System (OS) is an interface between hardware and user which is responsible for the management and coordination of activities and the sharing of the resources of the computer that acts as a host for computing applications run on the machine.*

As a host, one of the purposes of an operating system is to handle the details of the operation of the hardware. This relieves application programs from having to manage these details and makes it easier to write applications.

Almost all computers (including handheld computers, desktop computers, supercomputers, video game consoles) as well as some robots, domestic appliances (dishwashers, washing machines), and portable media players use an operating system of some type (fig. 5.2).
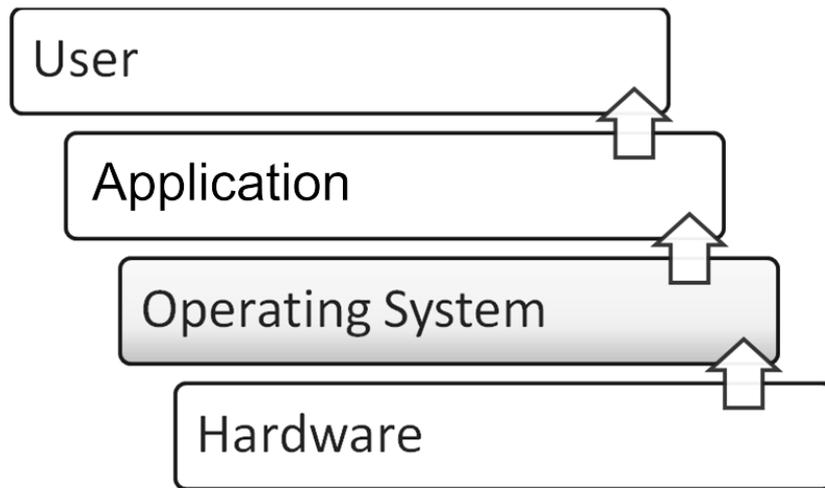
Fig. 5.2. **The place of the operating system in the process of user-computer interaction**

Operating systems offer a number of services to application programs and users. Applications access these services through application programming interfaces (APIs) or system calls. By invoking these interfaces, the application can request a service from the operating system, pass parameters, and receive the results of the operation.
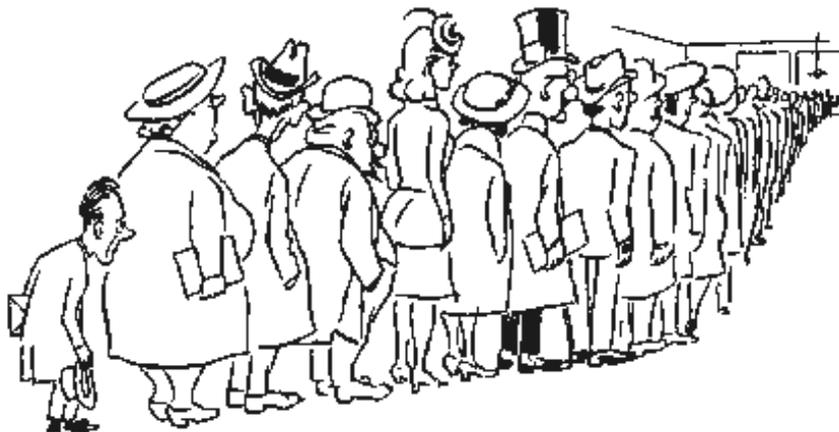
Users may also interact with the operating system with some kind of software user interface (SUI) like typing commands by using command line interface (CLI) or using a graphical user interface (GUI, commonly pronounced "gooey"). For hand-held and desktop computers, the user interface is generally considered part of the operating system.

Common contemporary operating systems include BSD, Darwin (Mac OS X), Linux, SunOS (Solaris/OpenSolaris), and Windows NT (XP/Vista/7). While servers generally run Unix or some Unix-like operating system, embedded system markets are split amongst several operating systems,

although the Microsoft Windows line of operating systems has almost 90% of the client PC market.

Modern operating systems provide the capability of running multiple application programs simultaneously, which is referred to as multiprogramming. Each program running is represented by a process in the operating system. The operating system provides an execution environment for each process by sharing the hardware resources so that each application does not need to be aware of the execution of other processes. The central processing unit (CPU) of the computer can be used by only one program at a time. The operating system can share the CPU among the processes by using a technique known as time slicing. In this manner, the processes take turns using the CPU. Single-user desktop personal computers (PCs) may simplify this further by granting the CPU to whichever application the user has currently selected and allowing the user to switch between applications at will.

Operating system controls all programs installed on a computer

The main memory of a computer (referred to as random access memory, or RAM) is a finite resource. The operating system is responsible for sharing the memory among the currently running processes. When a user initiates an application, the operating system decides where to place it in memory and may allocate additional memory to the application if it requests it. The operating system may use capabilities in the hardware to prevent one application from overwriting the memory of another. This provides security and prevents applications from interfering with one another.

The details of device management are left to the operating system. The operating system provides a set of APIs to the applications for accessing input/output (I/O) devices in a consistent and relatively simple manner regardless of the specifics of the underlying hardware. The operating system itself will generally use a software component called a device driver to control an I/O device. This allows the operating system to be upgraded to support

new devices as they become available. In addition to a device driver for the network I/O device, the operating system includes software known as a network protocol and makes various network utilities available to the user.

Operating systems provide security by preventing unauthorized access to the computer's resources. Many operating systems also prevent users of a computer from accidentally or intentionally interfering with each other. The security policies that an operating system enforces range from none in the case of a video game console, to simple password protection for hand-held and desktop computers, to very elaborate schemes for use in high-security environments.

5.2. WINDOWS OS: general characteristic

Microsoft Windows is a series of software operating systems and graphical user interfaces produced by Microsoft. Microsoft first introduced an operating environment named Windows in November 1985 as an add-on to MS-DOS in response to the growing interest in graphical user interfaces (GUIs).

Microsoft Windows came to dominate the world's personal computer market, overtaking Mac OS, which had been introduced previously. As of July 2010, Windows had approximately 90% of the market share of the client operating systems for usage on the Internet. The most recent client version of Windows is Windows Vista; the most recent server version is Windows Server 2008. Vista's successor, Windows 7 is currently at release to manufacturing (see fig. 6.3).

As of June 2010, Microsoft Windows holds a large amount of the worldwide desktop market share. In recent years, Microsoft has spent significant marketing and research & development money to demonstrate that Windows is capable of running any enterprise application, which has resulted in consistent price/performance records and significant acceptance in the enterprise market.

On October 2001, Microsoft released Windows XP, a popular version built on the Windows NT kernel that also retained the consumer-oriented usability of Windows 95 and its upcoming successors (see Windows topology on fig. 5.3). This version was widely praised in computer magazines. It shipped in two distinct editions, "Home" and "Professional", the former lacking many of the superior security and networking features of the Professional

edition. Additionally, the first "Media Center" edition was released in 2002, with an emphasis on support for DVD and TV functionality including program recording and a remote control. Mainstream support for Windows XP ended on April 14, 2009. Extended support will continue until April 8, 2014.
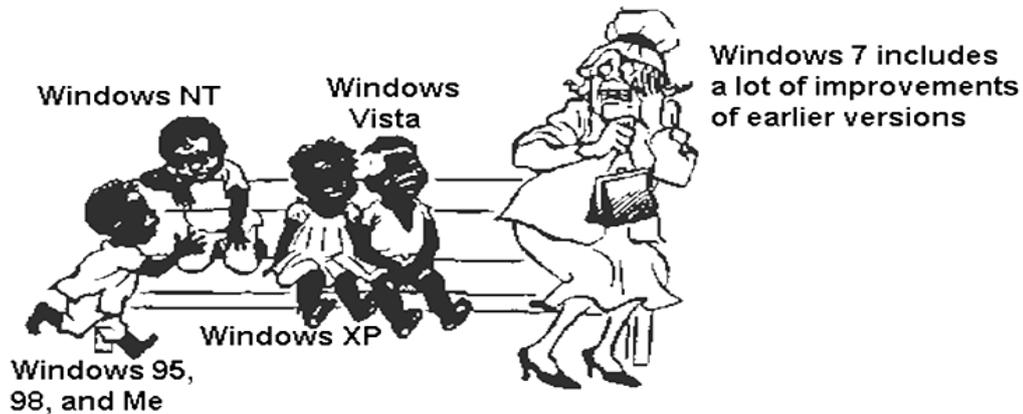
Fig. 5.3. **OS Windows family**

On January 30, 2007, Microsoft released Windows Vista. It contains a number of new features, from a redesigned shell and user interface to significant technical changes, with a particular focus on security features. It is available in a number of different editions, and has been subject to some criticism.

On October 22, 2009, Microsoft released Windows 7. Unlike its predecessor, Windows Vista, which introduced a large number of new features, Windows 7 was intended to be a more focused, incremental upgrade to the Windows line, with the goal of being compatible with applications and hardware which Windows Vista was not at the time. Windows 7 has multi-touch support, a redesigned Windows shell with a new taskbar, referred to as the Superbar, a home networking system called HomeGroup, and performance improvements.

Windows 8, the successor to Windows 7, is currently in development. Microsoft has posted a blog in Dutch on October 22, 2010 hinted that Windows 8 will be released after 2 years.

5.3. Modern versions of MS Windows OS: XP, Vista, Seven

A bit less than three years ago, Windows Vista was officially launched after a long delay. The operating system brought a raft of long-overdue new features to the Windows platform to make it truly fit for hardware of the 21st century. In came a new graphics stack and sound stack, as well as significant security, networking, and storage changes.

The changes were all well and good — the graphics work in particular was essential to allow Windows to offer functionality equivalent to that found in Mac OS X for many years — but they came at a high cost. To take advantage of all the new features required the use of all-new Windows Vista hardware drivers. As for its impact on users, Vista also brought with it higher hardware demands that caused many to recoil in horror. This wasn't a new phenomenon, of course; Windows XP and Windows 2000 before it both had the same effect. So big, so bloated, so slow — these are traditional criticisms leveled at any new Windows release, and Vista was no exception. In truth, Vista's hardware requirements were not egregious; the problem was that in comparison to XP's ancient, five-year-old requirements, Vista's requirements represented a big step up, especially in the area of video hardware.

So when Windows Vista became publicly available in early 2007, the reception was rather lukewarm. Third-party hardware and software support was spotty, backwards compatibility was reduced, and system demands were markedly higher. This led to a computing public that clamored for the continued availability of Windows XP, and many businesses (chipmaker Intel among them) swore off the new version of Windows in favor of its ancient predecessor.

The thing that XP had on its side was time. XP should have been replaced by Windows Longhorn in 2004 or 2005, but the cancellation of the Longhorn project and subsequent wait for Vista meant that everyone — users, software developers, hardware vendors — treated Windows XP as the main (or even only) version of Windows, with the result that everything worked with XP. The early woes were forgotten, and XP, old and clunky as it was, became the version of Windows that everyone loved and adored (or at least, tolerated).

Although Windows Vista may have caused vendors and users alike some amount of pain, it was all for a good reason. Vista was progress, and it paved the way for Windows 7. To take advantage of modern video cards, Windows needed a new graphics stack; to withstand the increasing malware onslaught, Windows needed to tighten security and make running as a regular user more comfortable. These changes were not made lightly; the break with the past was necessary to put the operating system on the same footing as its competition and to address long-standing, legitimate criticisms of the platform. Microsoft was never going to revert to a more XP-like operating system, no matter how desperately some cling to the old OS.

The Start menu wasn't the only positive change in Vista. Vista moved the bulk of video drivers into user mode, which means that they can crash and be restarted more or less seamlessly. In a similar vein, upgrading video drivers without rebooting is now a reality. Moving from video to sound, Vista's new sound stack lets users set audio volume on a per-application basis, which is another good feature. In the end, Vista brought a lot of good stuff. It was a major overhaul of the platform, and in retrospect, it's not entirely surprising that the transition was somewhat imperfect. Third parties could, and should, have done better, but they have at least caught up now.

Windows 7 can take advantage of the two and a half years of progress that hardware and software vendors have made in supporting Vista. It can exploit the fact that Moore's Law means even cheap netbooks have got the horsepower to run the new OS. Vista's life was always going to be hard; any major update to a platform as diverse and widely used as Windows is always going to be met with resistance. But Vista has done its job; XP is no longer the target platform for developers, and vendors are producing hardware and software that works with the stricter security and modernized graphics and audio subsystems.

Windows 7 has an important job to do. First, it must consolidate the architectural changes that made Vista so painful, and to provide small refinements to the platform and smooth off rough edges. And second, it has to be a version of Windows that people want to run, and it needs to be this right out the gate.

5.4. MS Windows OS concept: user interface, file system, built-in tools and applications

Windows 7 has been around for some time now and since its release on July 22, 2009 more and more users are working with it. So we'll use it as an example in order to characterize Windows OS of today.

One of the first things you'll notice when you boot into the Windows 7 desktop for the first time is how pristine things are by default. There's only a single icon on the desktop, Recycle Bin. The taskbar includes only three buttons by default – Internet Explorer, Windows Media Player, and Windows Explorer – and the notification area has just three, Action Center, Networking, and Volume. Those that like to populate the desktop with shortcuts are still free to do so, of course. You can also add a selection of Desktop Gadgets to the desktop, if you're so inclined. In Vista, these gadgets were part of an extraneous bit of UI called the Sidebar, and it

was enabled by default. This time around, the Sidebar is gone but the gadgets remain. Indeed, the stock collection of gadgets is largely unchanged from that which was offered with Vista, an odd shortcoming (fig. 5.4).

Fig. 5.4. **Windows gadgets list**

The familiar right-click desktop menu has been simplified since Vista, with the screen resolution and other personalization options separated for quicker access. The Personalization control panel has been significantly overhauled with support for new Aero Themes which combine wallpaper (or, optionally, constantly rotating sets of wallpaper), an Aero window color, a sound scheme, and a screensaver into a single, savable, and shareable entity. Windows 7 ships with a number of very high quality themes, and you can download more online from a variety of places or make your own (fig. 5.5).

Fig. 5.5. **Personalization window**

Windows Flip – what most people think of as "ALT + TAB" since that's how you access it – has been updated to provide full-screen previews of the currently

selected window only. So as you scroll through the list of open windows, all windows but the currently-selected one will be hidden (fig. 5.6).

Fig. 5.6. **Windows Flip picks up a nice windows preview capability**

In Windows 7, the taskbar has been significantly elevated from its previous pedestrian use as a way to track open windows. Now, it takes on double duty, managing both running and non-running applications (and open and unopened windows). So in Windows 7, Microsoft has combined the Quick Launch toolbar right into the taskbar (fig. 5.7). The Windows 7 taskbar is bigger by default than previous versions, with bigger, easier-to-see and read buttons.

Fig. 5.7. **The new Windows 7 taskbar combines shortcuts for non-running applications with buttons for running applications.**

Regardless of the view style you use, the new taskbar does provide some other interesting new capabilities. If you mouse over the button for an open window or running application, the taskbar displays a handy pop-up thumbnail of the underlying window. The taskbar buttons and previews are all live. So if you minimize, say, Windows Media Player while it's playing a video and then mouse over the application's taskbar button, you'll see the video playing in the thumbnail that appears (fig. 5.8).

Fig. 5.8. **Taskbar thumbnails are live**

Though the Start Menu has lost some of its mojo to the new taskbar in Windows 7, one long-time bit of Start Menu functionality is being made more broadly available in this system courtesy of a new feature called Jump Lists. Whereas the global Start Menu was a central jumping off point for all applications and documents, however, Jump Lists are like mini, application- and control panel-specific Start Menus.They appear, attached to applications (and control panel) shortcuts, in both the Start Menu and on the new taskbar. And like the Start Menu itself, Jump Lists are highly customizable, by both application developers and users.

Jump Lists exhibit two types of behaviors: those that are automatic and those that are customized. By default, application Jump Lists will display a list of the most-recently-used documents that are associated with that application. In the Start Menu, those lists appear like so, expanding out into the right-hand side of the Start Menu (fig. 5.9).
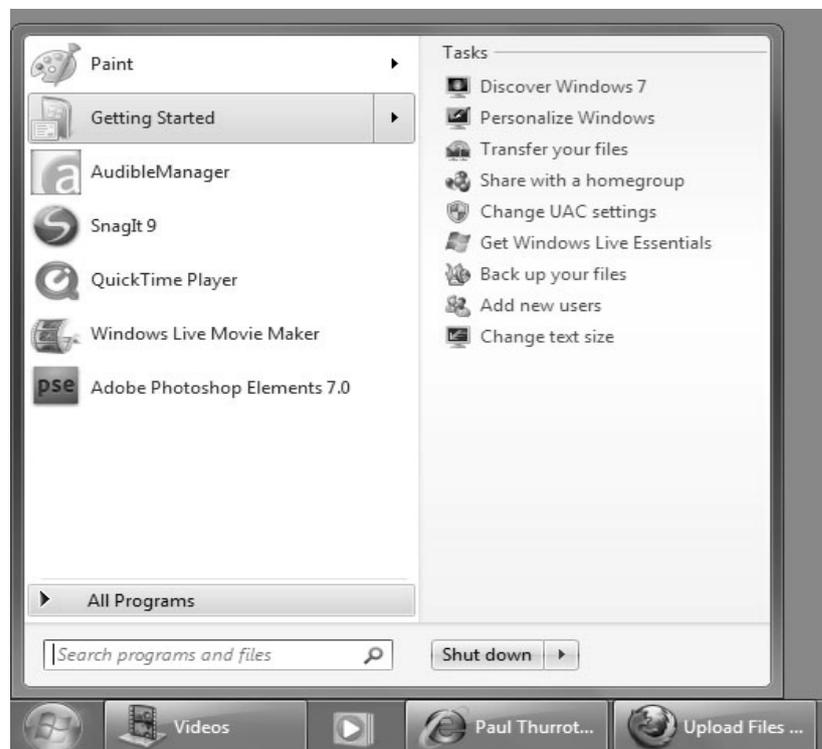
Fig. 5.9. **A Jump List in the Start Menu.**

At first, you won't see much in an application's Jump List: Just the name of the application (which can be clicked to launch a new instance of that application, or window) and a Close window option.

If you have pinned the shortcut to the Start Menu or taskbar and enable the Jump List from that location, you'll also see an option related to unpinning it. Document-based applications will auto-populate their Jump Lists with links to the 10 most-recently-used documents.

In previous Windows versions, there were special shell folders like My

Documents and My Music that mapped to specific locations in the shell hierarchy. In Windows 7, these locations still exist, but instead, Microsoft provides four virtual folders, or Libraries – Documents, Music, Photos, and Videos – which aggregate content from a variety of shell locations and provide the basis for Windows 7's document and media sharing capabilities (fig. 5.10).
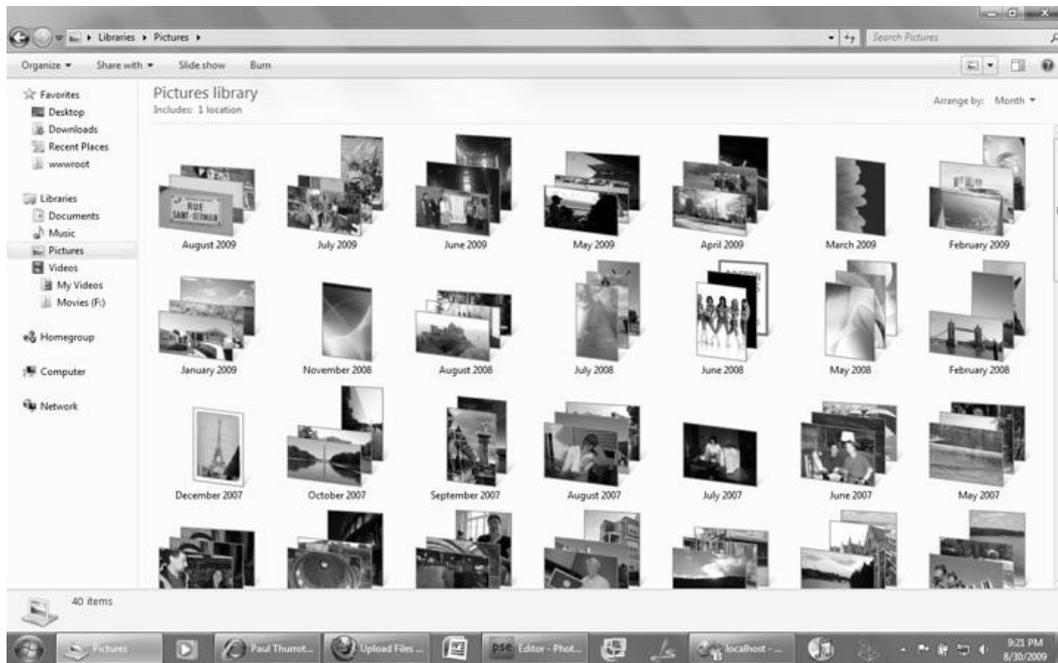
Fig. 5.10. **Some unique arrangement views are available only in Library windows**

Applications that are bundled with Windows 7 OS

Microsoft bundles a number of applications and utilities in Windows OS, and several are worth longer discussions. Two applications, Paint and WordPad, have been updated fairly dramatically, both for the first time in years. The most obvious change to both, of course, is the addition of the second-generation ribbon user interface called Scenic Ribbon. This toolbar-like construct exposes features that were previously hidden and you're probably at least passingly familiar with the first generation ribbon that debuted in Office 2007 (fig. 5.11).
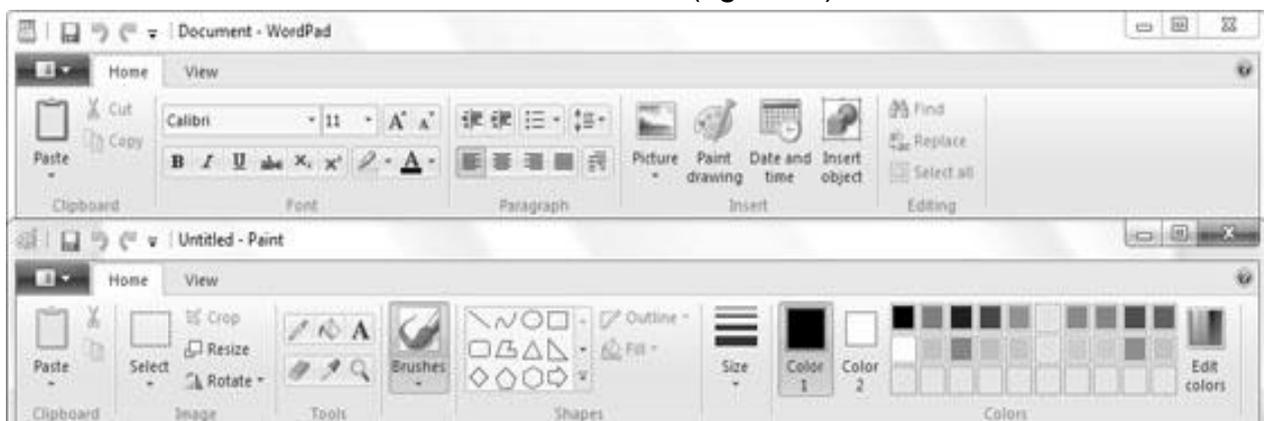
Fig. 5.11. **The Scenic Ribbon appears in Paint and WordPad**

Paint, in particular, has gotten a surprisingly thorough makeover in Windows 7. There are many new capabilities, including numerous brushes and shapes, easy transparent selections, and more.

WordPad picks up the ribbon too, but the changes there are less dramatic. It does support the new Open XML (*.docx) and Open Document (*.odf) document formats, however, so this app is a great tool for those with older Office versions who need to read newer documents.

On the utility front, there are some interesting changes and additions. The age-old Calculator utility has been dramatically updated for Windows 7, and spots numerous modes and built-in functions and worksheets (fig. 5.12).
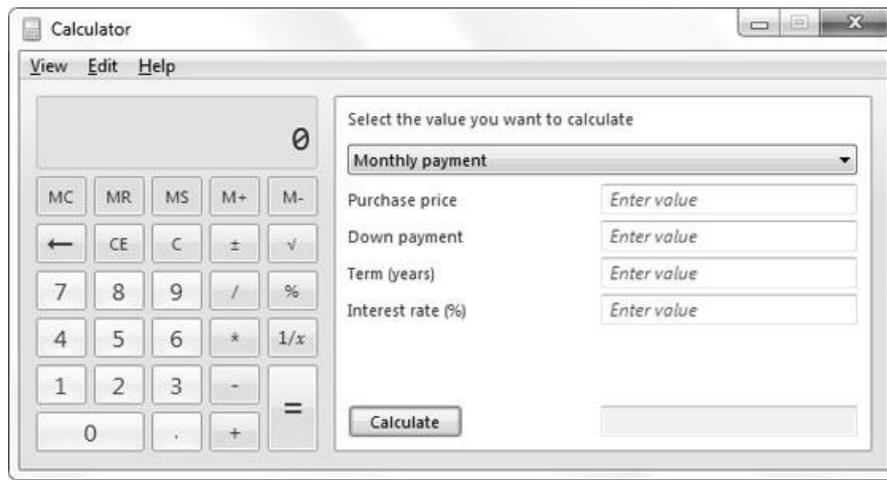
Fig. 5.12. **Calculator picks up a bunch of new functionality, including this handy mortgage calculator**

Windows 7 also includes a Sticky Notes application instead of the Notes gadget that graced Windows Vista. This one runs like a normal application and so provides a taskbar button along with an associated (if not hugely useful) Jump List (fig. 5.13).
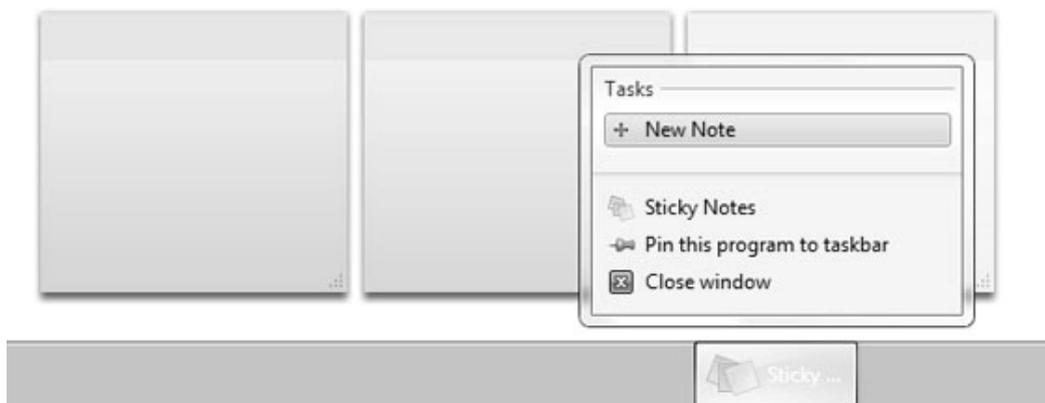
Fig. 5.13. **Sticky Notes**

XPS Viewer staggers in from Windows Vista – does anyone ever actually use this thing? – along with the Snipping Tool screen capture utility that debuted in

Windows XP Tablet PC Edition and is now available in all mainstream Windows 7 versions. (Don't worry, the PRTSCN screen capture methods still work too.) For you old-timers, Windows Fax and Scan soldiers along in Windows 7, as does the Windows Journal application, which also debuted first on tablet PCs.

Enterprise features. Windows 7 comes with a range of new features to improve manageability and security, and enterprise deployment of Windows 7 builds on the new features introduced with Vista.

AppLocker. Software Restriction Policies are an effective and widely used mechanism for locking down Windows installations and permitting only specific applications to run.

AppLocker, a new SRP-like technology, improves this situation. AppLocker allows policies to be set in a more flexible way. For example, a policy might say "Allow the program Acrobat Reader, as long as its publisher (verified by digital signature) is Adobe and the version is at least 9." Such a rule would allow deployment of bugfixes without any need to create new rules.

BitLocker To Go. It has become a popular pastime amongst government employees to load as much sensitive data as possible onto a laptop and then deposit that laptop in a public place so that someone can find it. This hobby has likely spread to the private sector too, although it attracts less attention there. Windows Vista's BitLocker feature enabled encryption of whole partitions, requiring a PIN or suitable USB key to decrypt them.

However, the data-losers are an inventive bunch, and many of them have noticed that you can use removable media to lose data quite effectively, too. One solution has been to block the use of removable media entirely, but this is often a rather heavy-handed approach. Windows 7 provides an alternative; it supports the use of BitLocker on removable media, "BitLocker To Go." This supports USB flash drives, external hard disks, memory cards, and anything else that's NTFS, FAT, FAT32, or exFAT-formatted. The use of BitLocker To Go can further be mandated, to ensure that all removable media are secure. Unencrypted disks can still be read, but any attempts to write are blocked until secured.

The Problem Steps Recorder should be a boon for helpdesks everywhere. This simple tool lets you make a recording of the steps required to reproduce a problem. The recording includes screenshots, system information, and optional annotations as necessary, and should do a good job of taking the guesswork out of supporting end-user problems.

PowerShell 2.0 is installed as standard, which should in principle make it easier to write and use complex login scripts. PowerShell scripts can also be

invoked remotely, allowing an administrator on a single PC to perform standard management actions on a set of PCs at once, or take specific action on a single remote machine.

Offline Files, one of the things that has seen some refinements. Policies can now be applied to prevent, for example, MP3s from being synced. The offline file store can also now be used as a cache.

Normally with Offline Files a PC with a network connection will still depend on the fileserver for all access to the file. If access to the fileserver is slow for whatever reason then so is access to the file.

By enabling Transparent Caching through GPOs (it's not enabled by default), the client machine will use the local cache in preference to the network. To ensure the file is kept up-to-date the network still needs to be queried, but unless the file has been changed, no data will be transferred, making an excellent feature even better. By now you can probably guess which OS is required on the server for this capability.

The new enterprise features are all pretty compelling. But there is a common refrain to many of them; they need Windows Server 2008 R2 to work. Most of the network-related features, including the improved deployment capabilities, won't work until the server infrastructure is updated in tandem.

■ Questions

1. What is a computer operating system?

2. What is the difference between operating systems and other types of computer software?

3. What work is done by computer operating systems?

4. How do computer operating systems control computer operation?

5. What are the basic types of MS Windows computer operating systems?

6. Can a personal computer run any operating system without reconfiguring its hardware?

Section 3. Text processing engines. MS Office Word
Theme 6. Introduction to MS Office Word essentials

Microsoft Office Word workspace

Working with documents: editing a document, formatting text and paragraphs

Working with tables: create, modify the table structure and format a table. The use of special characters and equations

Bulleted and numbered lists. Page margins and orientations. Spelling and grammar checking
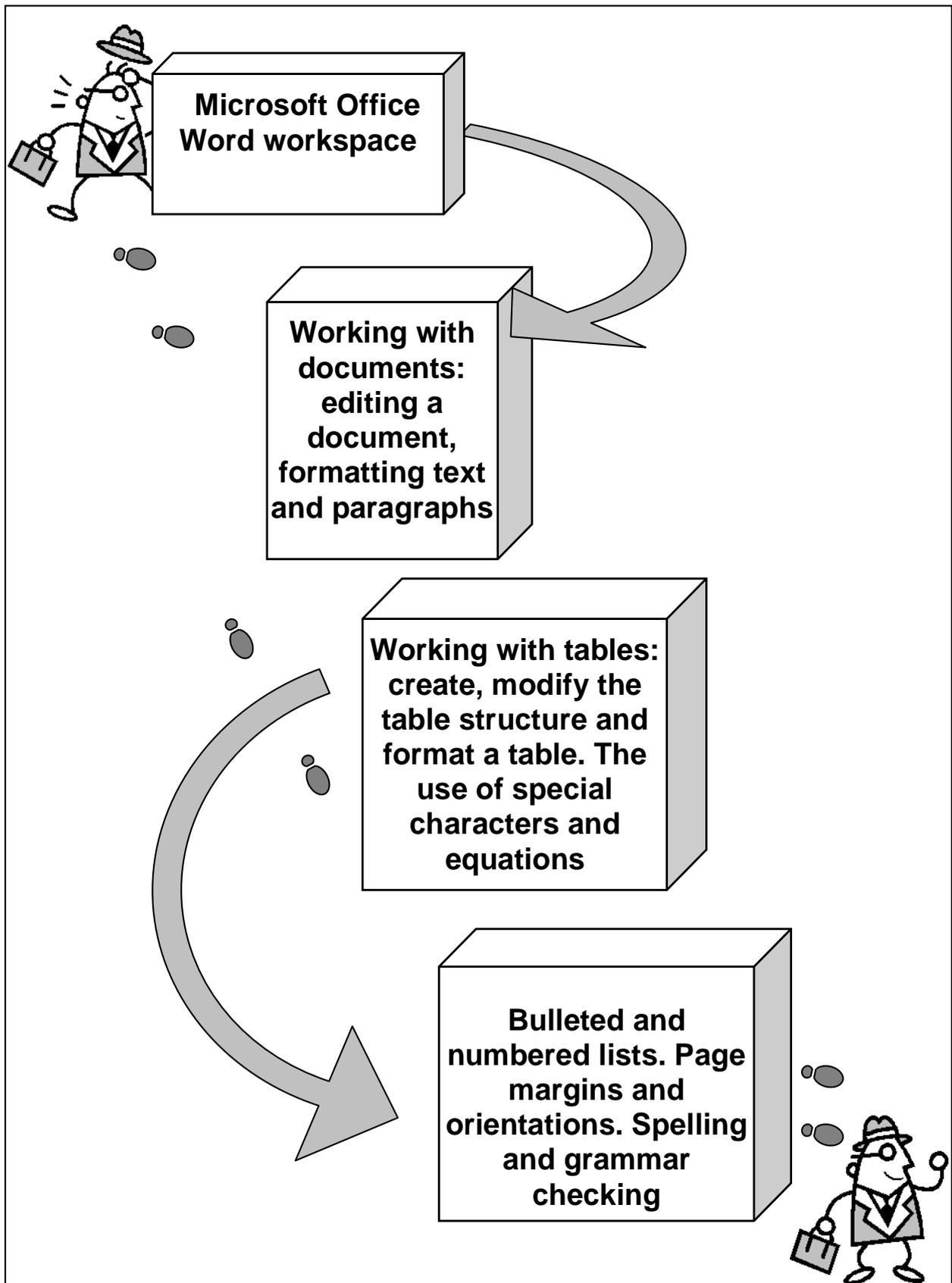
Fig. 6.1. **System elements of the theme**

◼ Introduction

The purpose of this theme is connected with the study of main features of MS Office Word text processing engine. The program's interface is considered in detail and basic operations concerned with the creation and modification of text documents are given a special attention.

Clue notions of the theme include: office button; ribbon; pop-up menus; text formatting; tables; lists; fonts, paragraphs.

This theme covers the following **topics**: What is text document? How to create and save a document? What are the basic text formatting operations? How to work with tables, lists and special objects?

As a result of the study of the material represented in this theme students will acquire the following **competencies**:

they would learn how to create, modify and save text documents;

they would master main text formatting techniques;

they would learn the basic operations with tables and special objects;

they would become aware of the text proofing options available in MS Office Word.

6.1. Microsoft Office Word workspace

⭐ *Microsoft Word is a non-free word processor designed by Microsoft. It was first released in 1983 under the name Multi-Tool Word for Xenix systems. Subsequent versions were later written for several other platforms including IBM PCs running DOS (1983), the Apple Macintosh (1984), the AT&T Unix PC (1985), Atari ST (1986), SCO UNIX, OS/2, and Microsoft Windows (1989). It is a component of the Microsoft Office system; it is also sold as a standalone product and included in Microsoft Works Suite. The current versions are Microsoft Word 2010 for Windows and 2011 for Mac.*

When you launch MS Word, the workspace appears and your screen looks similar to the one shown below (fig. 6.2).

When you begin to explore MS Word you will notice a new look to the menu bar. There are three features that you should remember as you work within Word: the Microsoft Office Button, the Quick Access Toolbar, and the Ribbon. These three features contain many of the functions that were in the menu of previous versions of Word.
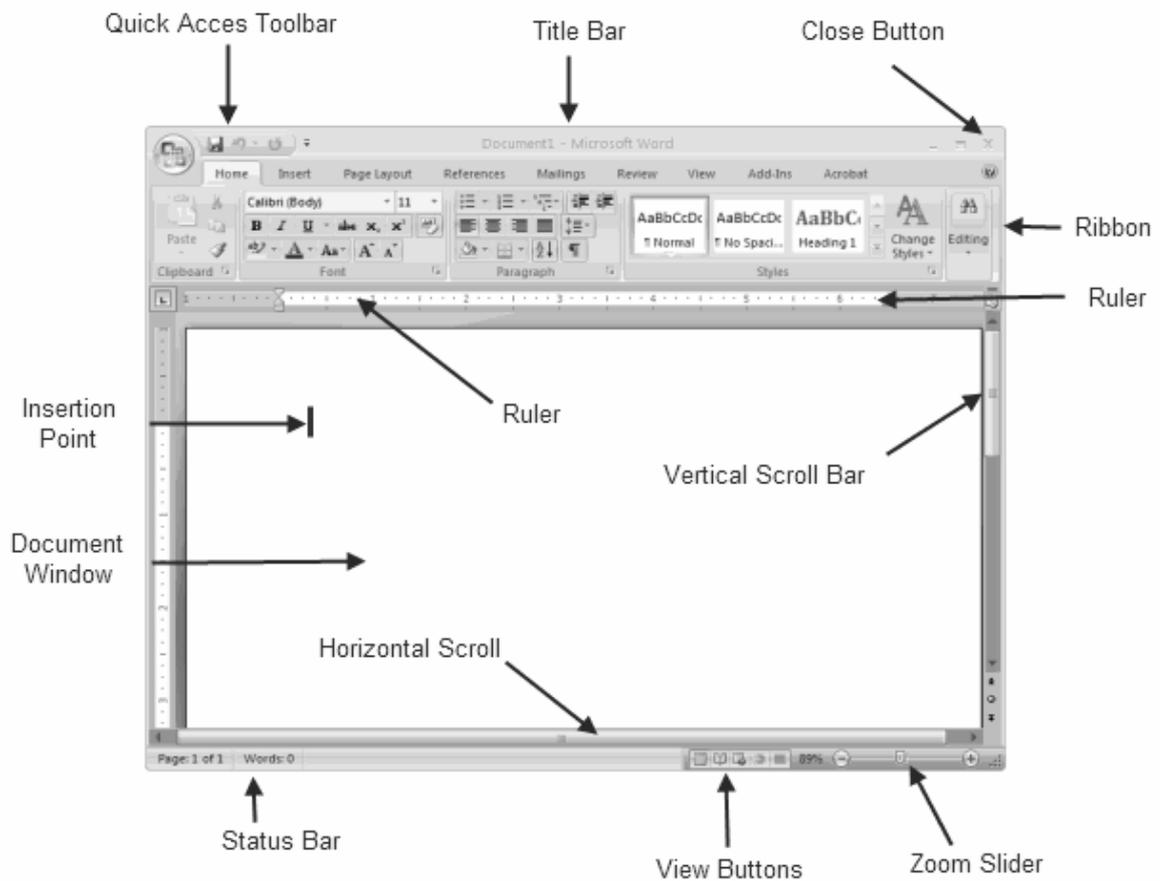
Fig. 6.2. **MS Office Word interface**

The Microsoft Office button performs many of the functions that were located in the File menu of older versions of Word. This button allows you to create a new document, open an existing document, save or save as, print, send (through email or fax), publish or close (fig. 3).
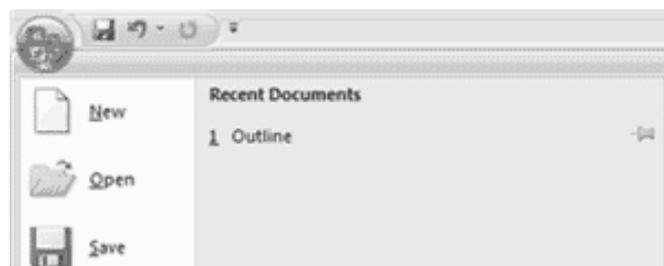
Fig. 6.3. **MS Office Button**

The Ribbon is the panel at the top portion of the document. It has seven tabs: Home, Insert, Page Layout, References, Mailings, Review, and View that contain many new and existing features of Word. Each tab is divided into groups. The groups are logical collections of features designed to perform functions that you will utilize in developing or editing your Word document.
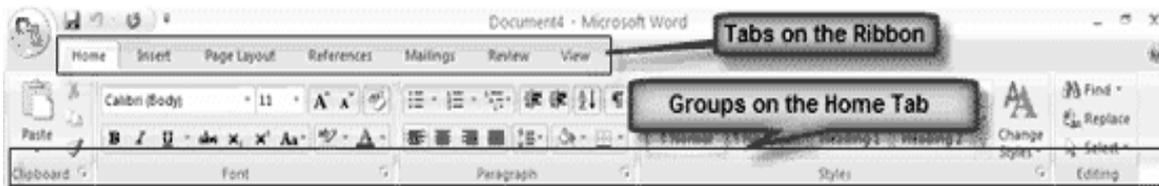
Fig. 6.4. **MS Office Word ribbon area**

Each of the tabs contains the following tools:

Home: Clipboard, Fonts, Paragraph, Styles, and Editing.

Insert: Pages, Tables, Illustrations, Links, Header & Footer, Text, and Symbols

Page Layout: Themes, Page Setup, Page Background, Paragraph, Arrange

References: Table of Contents, Footnote, Citation & Bibliography, Captions, Index, and Table of Authorities

Mailings: Create, Start Mail Merge, Write & Insert Fields, Preview Results, Finish

Review: Proofing, Comments, Tracking, Changes, Compare, Protect

View: Document Views, Show/Hide, Zoom, Window, Macros

The quick access toolbar is a customizable toolbar that contains commands that you may want to use. You can place the quick access toolbar above or below the ribbon. To change the location of the quick access toolbar, click on the arrow at the end of the toolbar and click on Show Below the Ribbon (fig 5).
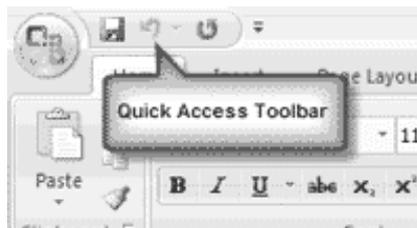
Fig. 6.5. Quick Access toolbar

You can also add items to the quick access toolbar. Right click on any item in the Office Button or the Ribbon and click on Add to Quick Access Toolbar and a shortcut will be added to the Quick Access Toolbar.

6.2. Working with documents: editing a document, formatting text and paragraphs

There are several ways to create new documents, open existing documents, and save documents in Word:

Click the Microsoft Office Button and Click New or Press CTRL+N. You will notice that when you click on the Microsoft Office Button and Click New, you have many choices about the types of documents you can create. If you wish to start from a blank document, click Blank. If you wish to start from a template you can browse through your choices on the left, see the choices on center screen, and preview the selection on the right screen.

Opening an Existing Document. Click the Microsoft Office Button and Click Open, or Press CTRL+O on the keyboard, or if you have recently used the document you can click the Microsoft Office Button and click the name of the document in the Recent Documents section of the window Insert picture of recent docs

Saving a Document. Click the Microsoft Office Button and Click Save or Save As (remember, if you're sending the document to someone who does not have newer Office, you will need to click the Office Button, click Save As, and Click Word 97-2003 Document), or Press CTRL+S on the keyboard, or Click the File icon on the Quick Access Toolbar:
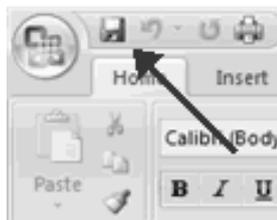
Renaming Documents. To rename a Word document while using the program:

Click the Office Button and find the file you want to rename. Right-click the document name with the mouse and select Rename from the shortcut menu. Type the new name for the file and press the ENTER key.

Working on Multiple Documents. Several documents can be opened simultaneously if you are typing or editing multiple documents at once. All open documents will be listed in the View Tab of the Ribbon when you click on Switch Windows. The current document has a checkmark beside the file name. Select another open document to view it (fig. 6).
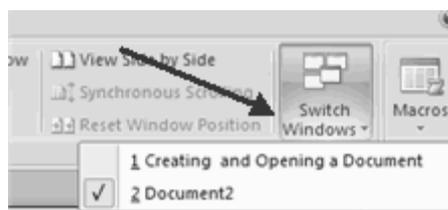
Fig. 6.6. **Window switch option**

There are many ways to view a document in Word.

Print Layout: This is a view of the document as it would appear when printed. It includes all tables, text, graphics, and images.

Full Screen Reading: This is a full length view of a document. Good for viewing two pages at a time.

Web Layout: This is a view of the document as it would appear in a web browser.

Outline: This is an outline form of the document in the form of bullets.

Draft: This view does not display pictures or layouts, just text.

To enter text, just start typing it. The text will appear where the blinking cursor is located. Move the cursor by using the arrow buttons on the keyboard or positioning the mouse and clicking the left button. The keyboard shortcuts listed below are also helpful when moving through the text of a document (table 1).

Table 6.1

Keyboard shortcuts

Move Action	Keystroke
Beginning of the line	**HOME**
End of the line	**END**
Top of the document	**CTRL+HOME**
End of the document	**CTRL+END**

To change any attributes of text it must be highlighted first. Select the text by dragging the mouse over the desired text while keeping the left mouse button depressed, or hold down the SHIFT key on the keyboard while using the arrow buttons to highlight the text. The following table contains shortcuts for selecting a portion of the text (table 2).

Table 6.2

Text selecting shortcuts

Selection	Technique
Whole word	double-click within the word
Whole paragraph	triple-click within the paragraph
Several words or lines	drag the mouse over the words, or hold down **SHIFT** while using the arrow keys
Entire document	choose **Editing	Select	Select All** from the Ribbon, or press **CTRL+A**

Deselect the text by clicking anywhere outside of the selection on the page or press an arrow key on the keyboard.

Text can be inserted in a document at any point using any of the following methods:

Type Text: Put your cursor where you want to add the text and begin typing.

Copy and Paste Text: Highlight the text you wish to copy and right click and click Copy, put your cursor where you want the text in the document and right click and click Paste.

Cut and Paste Text: Highlight the text you wish to copy and right click and click Cut, put your cursor where you want the text in the document and right click and click Paste.

Drag Text: Highlight the text you wish to move, click on it and drag it to the place where you want the text in the document.

To find a particular word or phrase in a document:

Click Find on the Editing Group on the Ribbon

To find and replace a word or phrase in the document, click Replace on the Editing Group of the Ribbon (fig. 6.7).
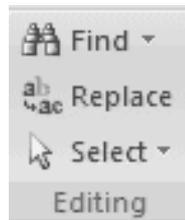
Fig. 6.7. **Text Editing group**

Work with text styles.

⭐ *A **style** is a format enhancing tool that includes font typefaces, font size, effects (bold, italics, underline, etc.), colors and more.*

You will notice that on the Home Tab of the Ribbon, that you have several areas that will control the style of your document: Font, Paragraph, and Styles (fig. 6.8).
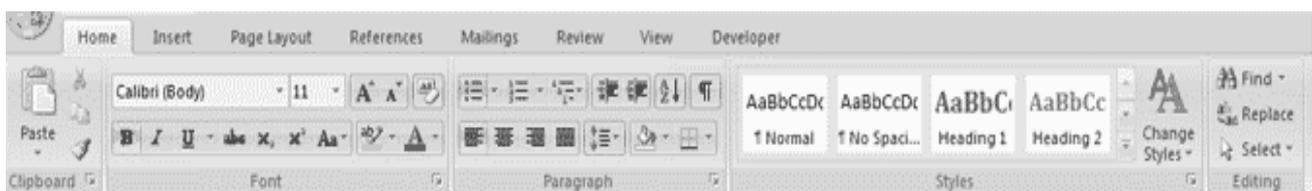
Fig. 6.8. **Text Style area of the Ribbon**

To change the font typeface click the arrow next to the font name and choose a font. Remember that you can preview how the new font will look by highlighting the text, and hovering over the new font typeface.

To change the font size click the arrow next to the font size and choose the appropriate size, or click the increase or decrease font size buttons (see fig. 6.9).

Fig. 6.9. **Font group**

It is also possible to change font styles and effects. Font styles are predefined formatting options that are used to emphasize text. They include: Bold, Italic, and Underline. To add these to text select the text and click the Font Styles included on the Font Group of the Ribbon, or Select the text and right click to display the font tools (fig. 6.9)

To change the text color select the text and click the Colors button included on the Font Group of the Ribbon (fig. 9), or Highlight the text and right click and choose the colors tool.

If you have already formatted text the way you want it and would like another portion of the document to have the same formatting, you can copy the formatting. To copy the formatting, do the following:

select the text with the formatting you want to copy;

copy the format of the text selected by clicking the Format Painter button on the Clipboard Group of the Home Tab;

apply the copied format by selecting the text and clicking on it (fig. 6.10).
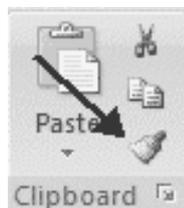
Fig. 6.10. **Formatting copy tool**

Formatting of paragraphs. Formatting paragraphs allows you to change the look of the overall document. You can access many of the tools of paragraph formatting by clicking the Page Layout Tab of the Ribbon or the Paragraph Group on the Home Tab of the Ribbon (fig. 6.11).

Fig. 6.11. **Paragraph group of the Ribbon**

The paragraph alignment allows you to set how you want text to appear. To change the alignment click the Home Tab and choose the appropriate button for alignment on the Paragraph Group (fig. 6.11).

Indenting paragraphs allows you set text within a paragraph at different margins. There are several options for indenting.

First Line: Controls the left boundary for the first line of a paragraph.

Hanging: Controls the left boundary of every line in a paragraph except the first one.

Left: Controls the left boundary for every line in a paragraph.

Right: Controls the right boundary for every line in a paragraph.

To indent paragraphs, you can do the following click the Indent buttons to control the indent (fig. 6.11).

You can change the space between lines and paragraphs by doing the following:

select the paragraph or paragraphs you wish to change;

on the Home Tab, Click the Paragraph Dialog Box;

click the Indents and Spacing Tab;

in the Spacing section, adjust your spacing accordingly (fig. 6.12).

Fig. 6.12. **Paragraph dialog box**

6.3. Working with tables: create, modify the table structure and format a table. The use of special characters and equations

Tables are used to display data in a table format. To create a table:

place the cursor on the page where you want the new table;

click the Insert Tab of the Ribbon;

click the Tables Button on the Tables Group.

You can create a table one of four ways: highlight the number of row and columns; click Insert Table and enter the number of rows and columns; click the Draw Table, create your table by clicking and entering the rows and columns; click Quick Tables and choose a table (fig. 6.13).
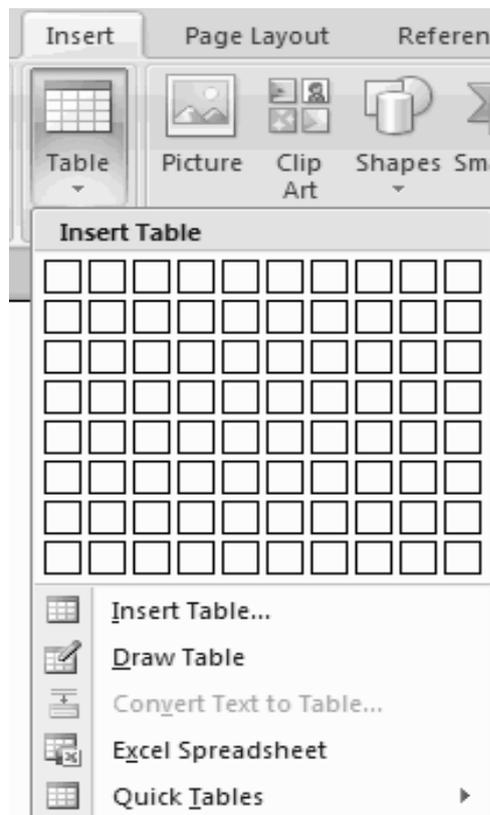
Fig. 6.13. **Table creation options**

To modify the structure of a table click the table and notice that you have two new tabs on the Ribbon: Design and Layout. These pertain to the table design and layout (fig. 6.14).
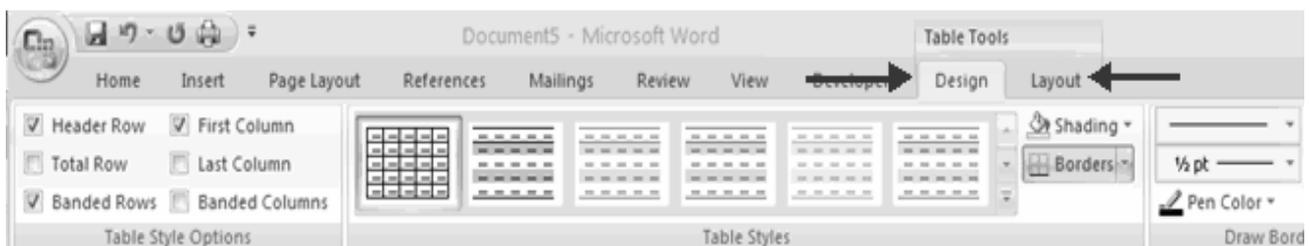
Fig. 6.14. **Table styles option**

To format a table, click the table and then click the Layout Tab on the Ribbon. This Layout tab allows you to:

view Gridlines and Properties (from the Table Group);

insert Rows and Columns (from the Rows & Columns Group);

delete the Table, Rows and/or Columns (from the Rows & Columns Group);

merge or Split Cells (from the Merge Group);

increase and Decrease cell size (Cell Size Group);

align text within the cells and change text directions (Alignment Group) (fig. 6.15).
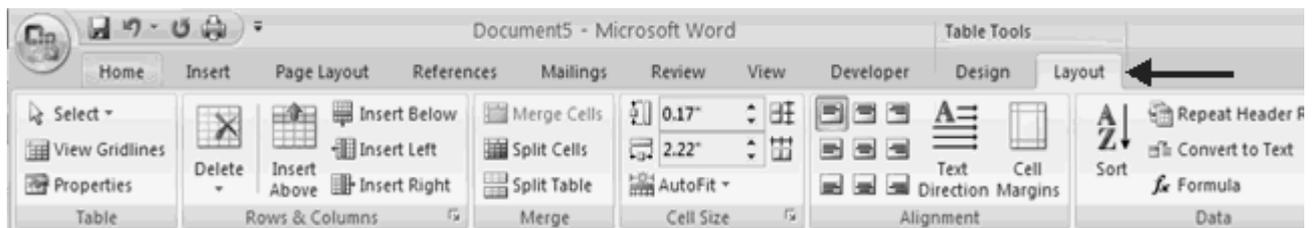
Fig. 6.15. **Table tools part of the Ribbon**

MS Word allows you to insert special characters, symbols, pictures, illustrations, and watermarks. Special characters are punctuation, spacing, or typographical characters that are not generally available on the standard keyboard. To insert symbols and special characters:

place your cursor in the document where you want the symbol;

click the Insert Tab on the Ribbon;

click the Symbol button on the Symbols Group;

choose the appropriate symbol (fig. 6.16).

Fig. 6.16. **Special character insert tab on the Ribbon**

MS Word also allows you to insert mathematical equations. To access the mathematical equations tool:

place your cursor in the document where you want the symbol

click the Insert Tab on the Ribbon

click the Equation Button on the Symbols Group

choose the appropriate equation and structure or click Insert New Equation (fig. 6.17)
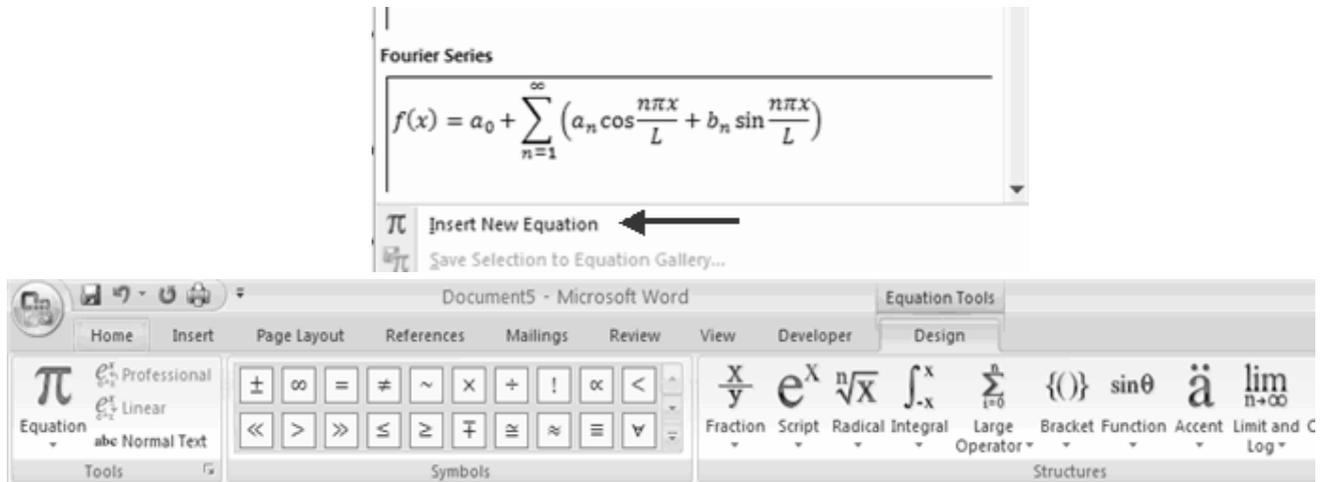
Fig. 6.17. **Equation tools on the Symbols group**

To edit the equation click the equation and the Design Tab will be available in the Ribbon

6.4. Bulleted and numbered lists. Page margins and orientations. Spelling and grammar checking

Lists allow you to format and organize text with numbers, bullets, or in an outline. Bulleted lists have bullet points, numbered lists have numbers, and outline lists combine numbers and letters depending on the organization of the list.

To add a list to existing text select the text you wish to make a list and from the Paragraph Group on the Home Tab, Click the Bulleted or Numbered Lists button (fig. 6.18).
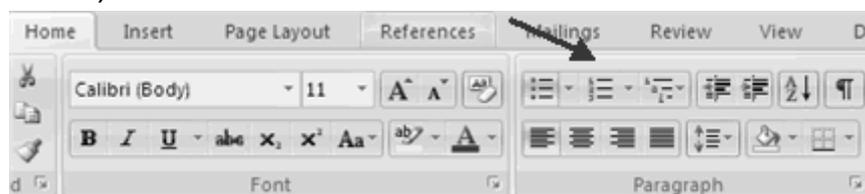
Fig. 6.18. **Bulleted or Numbered Lists button**

A nested list is list with several levels of indented text. To create a nested list:

create your list following the directions above;

click the Increase or Decrease Indent button:
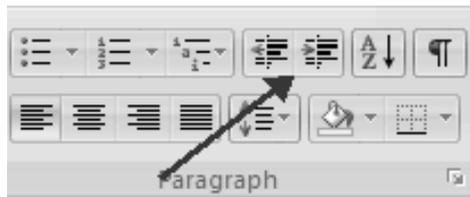
The bullet image and numbering format can be changed by using the Bullets or Numbering dialog box. Select the entire list to change all the bullets or numbers, or place the cursor on one line within the list to change a single bullet, right click an then click the arrow next to the bulleted or numbered list and choose a bullet or numbering style (fig. 6.19).
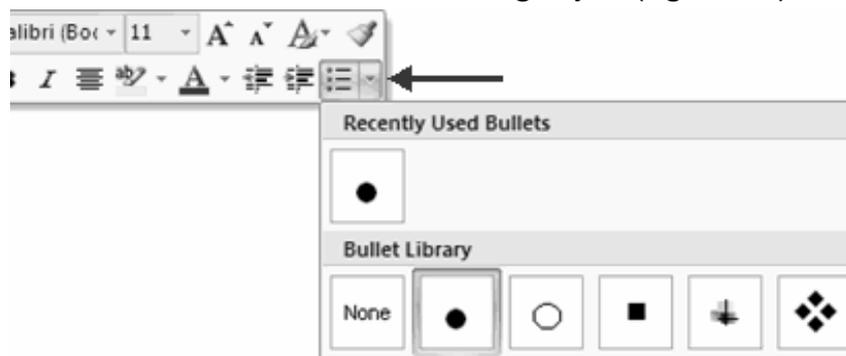
Fig. 6.19. **Custom bullets option**

In some cases it may become necessary to change the page margins of the document. The page margins can be modified through the following steps:

click the Page Layout Tab on the Ribbon;

on the Page Setup Group, Click Margins;

click a Default Margin, or click Custom Margins and complete the dialog box (fig. 6.20).
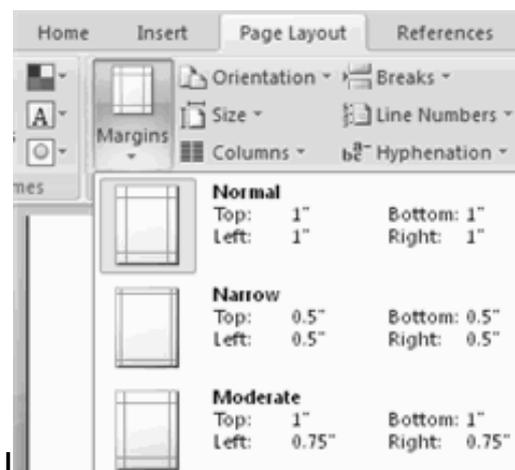
Fig. 6.20. **Change margins group**

To change the Orientation, Size of the Page, or Columns:

click the Page Layout Tab on the Ribbon;

on the Page Setup Group, Click the Orientation, Size, or Columns drop down menus;

click the appropriate choice;

It is also possible to customize page borders. To apply a page border or color click the Page Layout Tab on the Ribbon and on the Page Background Group, click the Page Colors or Page Borders drop down menus (fig. 6.21)
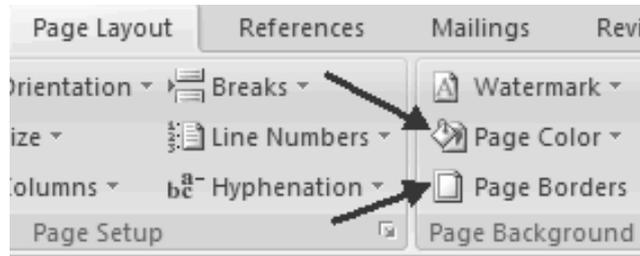
Fig. 6.21. **Page Borders option**

★ *Headers* and *footers* are special areas of the page that can contain some additional information.

To insert Header and Footer information such as page numbers, date, or title, first, decide if you want the information in the header (at the top of the page) or in the Footer (at the bottom of the page), then:

click the Insert Tab on the Ribbon;

click Header or Footer;

choose a style (fig. 6.22).
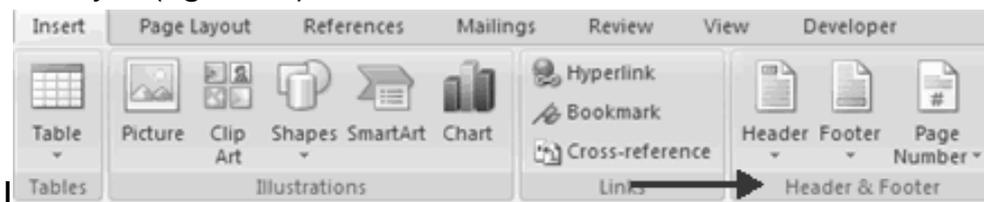
Fig. 6.22. **The Header/Footer Design tab of the Ribbon**

Choose the information that you would like to have in the header or footer (date, time, page numbers, etc.) or type in the information you would like to have in the header or footer.

Proofreading a Document. In MS Word there are many features to help you proofread your document. These include: Spelling and Grammar, Thesaurus, AutoCorrect, Default Dictionary, and Word Count. To check the spelling and grammar of a document:

place the cursor at the beginning of the document or the beginning of the section that you want to check;

click the Review Tab on the Ribbon;

click Spelling & Grammar on the Proofing Group (fig. 6.23).
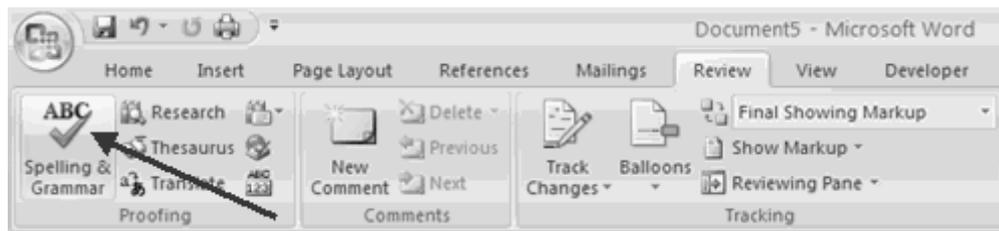
Fig. 6.23. **Spelling & Grammar group**

Any errors will display a dialog box that allows you to choose a more appropriate spelling or phrasing:

If you wish to check the spelling of an individual word, you can right click any word that has been underlined by Word and choose a substitution.

■ Questions

1. What are the main elements of the MS Word interface?

2. What is the reason to save documents in a different format so that they could be usable by earlier versions of MS Word?

3. What is a text style?

4. What types of lists are available in MS Word?

5. How many ways are there in MS Word to create a table?

6. What are Headers and Footers for?

7. What is the reason to use text proofing options in MS Word?

Section 4. Spreadsheet processing engines basics. MS Office Excel

Theme 7. Introduction to MS Office Excel essentials
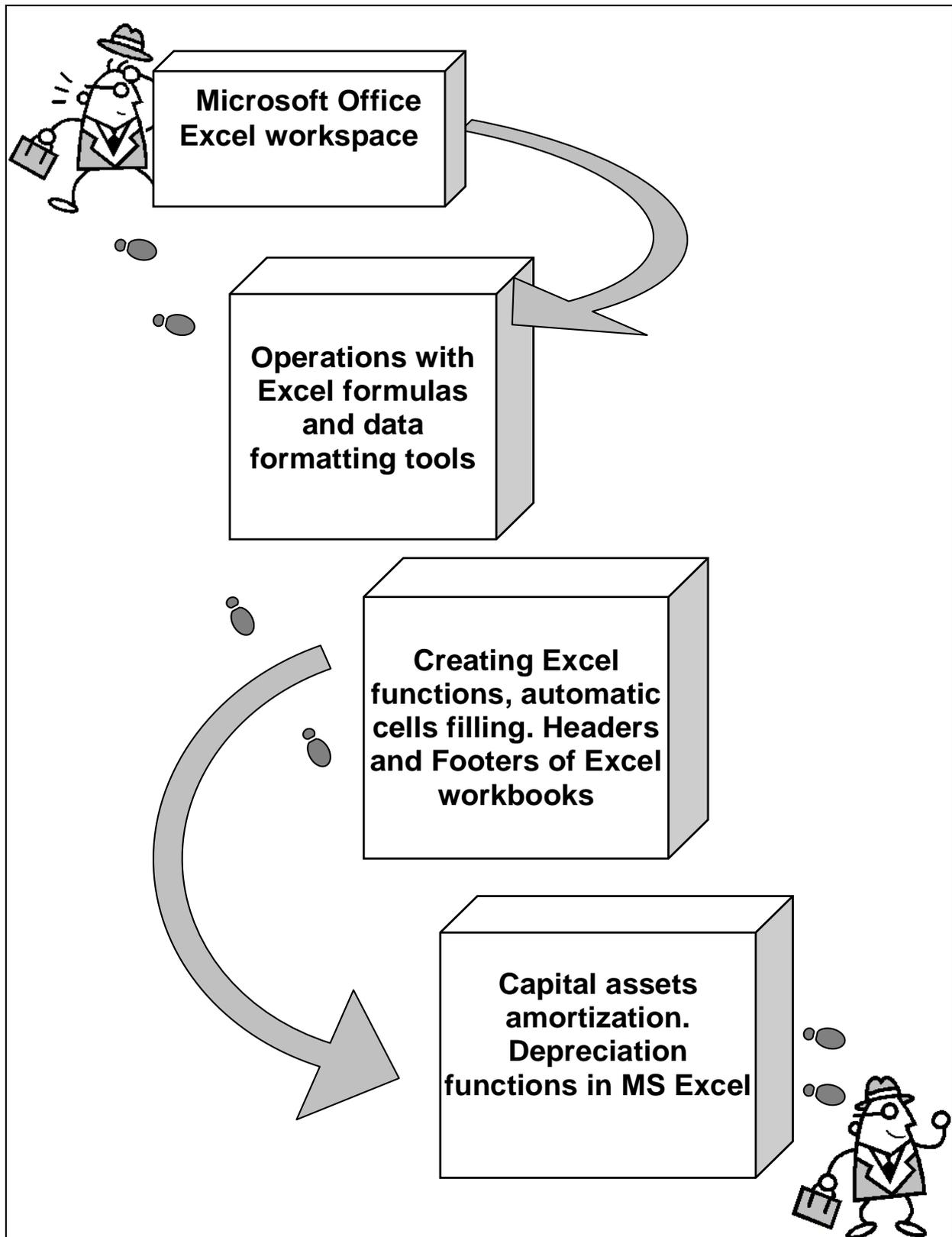
Fig. 7.1. **System elements of the theme**

▉ Introduction

The purpose of this theme is concerned with the study of main features of MS Office Excel spreadsheet processing engine.

The program's interface is considered in detail and basic operations concerned with the creation and modification of spreadsheet documents are given a special attention.

Clue notions of the theme include: office button; ribbon; pop-up menus; tables formatting; cells; lists; fonts, formulas; functions; printing.

This theme covers the following **topics:** Introduction to MS Excel electronic tables organizer. Program's interface customizing and basic options study. Entering and erasing data. Basic operations with numbers. Use of functions. Cells addressing. Manipulations with cells, columns and rows. Basic operations with the simplest formulas and functions. Study of different ways of automatic cells filling. Headers and Footers of the document. Page adjusting and printing.

As a result of the study of the material represented in this theme students will acquire the following **competencies**:

they would get acquainted with the program's interface features;

they would learn how to input and edit data and move across the worksheet;

they would learn how to perform basic operations with numbers;

they would become aware of the use of basic functions and simple formulas;

they would learn how to fill parts of Header and Footer areas;

they would practice different ways of adjusting page options before printing.

7.1. Microsoft Office Excel workspace

★ ***Microsoft Excel*** *is an electronic spreadsheet. It can be used to organize various data into rows and columns. It can also be used to perform mathematical calculations and manage databases.*

After you start Microsoft Excel the Microsoft Excel window appears and the screen looks similar to the one shown below (fig. 7.2).
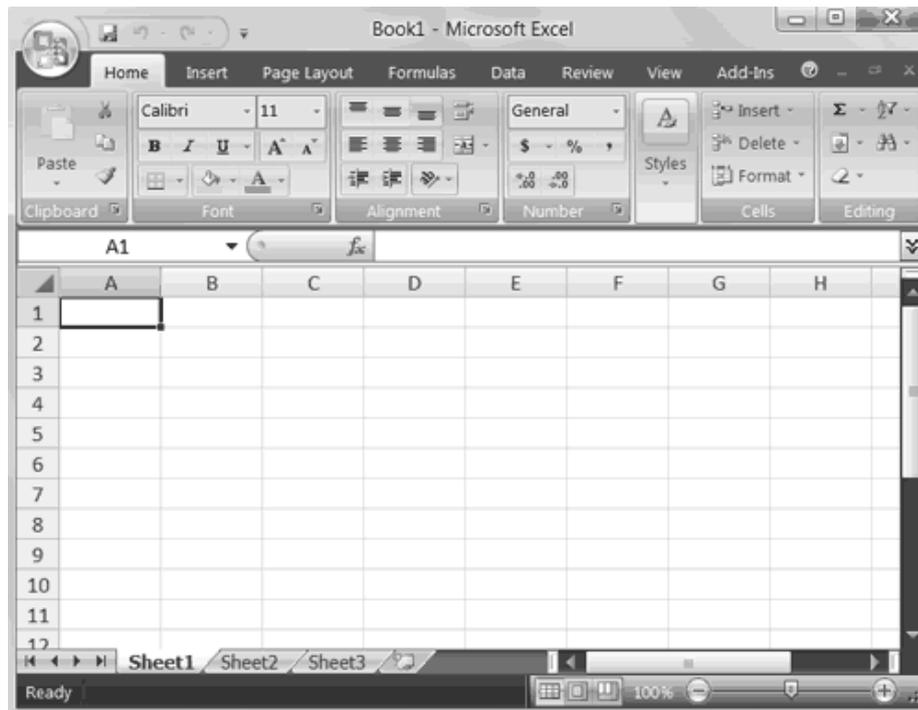
Fig. 7.2. **Microsoft Excel window**

Your screen will probably not look exactly like the screen shown. In MS Excel, how a window displays depends on the size of your window, the size of your monitor, and the resolution to which your monitor is set.

In the upper-left corner of the Excel window is the **Microsoft Office button** . When you click the button, a menu appears. You can use the menu to create a new file, open an existing file, save a file, and perform many other tasks.

Next to the Microsoft Office button is the **Quick Access** toolbar. The Quick Access toolbar gives you access to commands you frequently use. By default, Save, Undo, and Redo appear on the Quick Access toolbar. You can use Save to save your file, Undo to roll back an action you have taken, and Redo to reapply an action you have rolled back.

Next to the Quick Access toolbar is the **Title bar**. On the Title bar, Microsoft Excel displays the name of the workbook you are currently using. At the top of the Excel window, you should see "Microsoft Excel - Book1" or a similar name.

You use commands to tell Microsoft Excel what to do. In Microsoft Excel, you use the Ribbon to issue commands. The Ribbon is located near the top of the Excel window, below the Quick Access toolbar. At the top of the Ribbon are several tabs; clicking a tab displays several related command groups. Within each group are related command buttons (fig. 7.3).
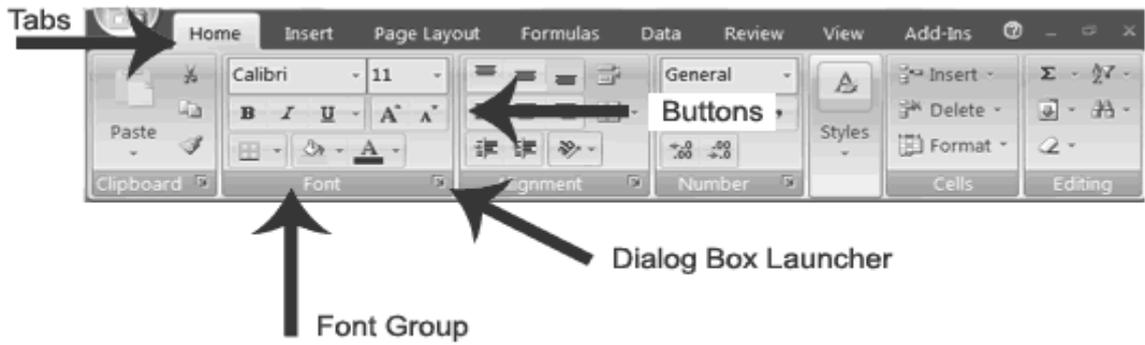
Fig. 7.3. **The Ribbon areas**

You click buttons to issue commands or to access menus and dialog boxes. You may also find a dialog box launcher in the bottom-right corner of a group. When you click the dialog box launcher, a dialog box makes additional commands available.

Microsoft Excel consists of worksheets. Each worksheet contains columns and rows. The columns are lettered A to Z and then continuing with AA, AB, AC and so on; the rows are numbered 1 to 1,048,576. The number of columns and rows you can have in a worksheet is limited by your computer memory and your system resources.

The combination of a column coordinate and a row coordinate make up a **cell address**. For example, the cell located in the upper-left corner of the worksheet is cell A1, meaning column A, row 1. Cell E10 is located under column E on row 10. You enter your data into the cells on the worksheet (fig. 7.4).
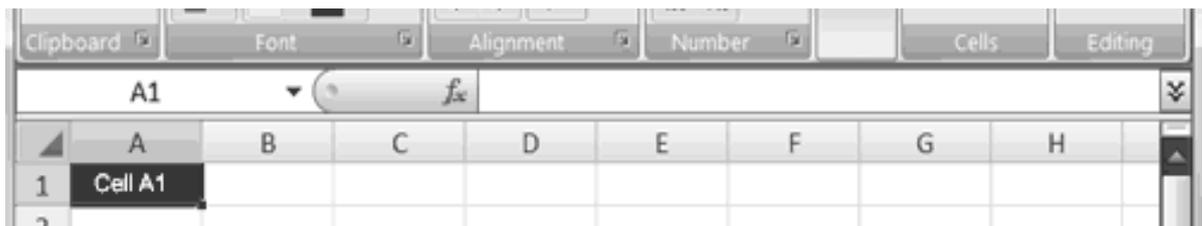
Fig. 7.4. **Cell address area**

The **Formula Bar** is used to show the formula or other contents of a cell (fig. 7.5).

Fig. 7.5. **Formula Bar**

If the Formula bar is turned on, the cell address of the cell you are in displays in the **Name box** which is located on the left side of the Formula bar. **Cell entries** display on the right side of the Formula bar.

The **Status bar** appears at the very bottom of the Excel window and

provides such information as the sum, average, minimum, and maximum value of selected numbers (fig. 7.6). You can change what displays on the Status bar by right-clicking on the Status bar and selecting the options you want from the Customize Status Bar menu. You click a menu item to select it. You click it again to deselect it. A check mark next to an item means the item is selected.
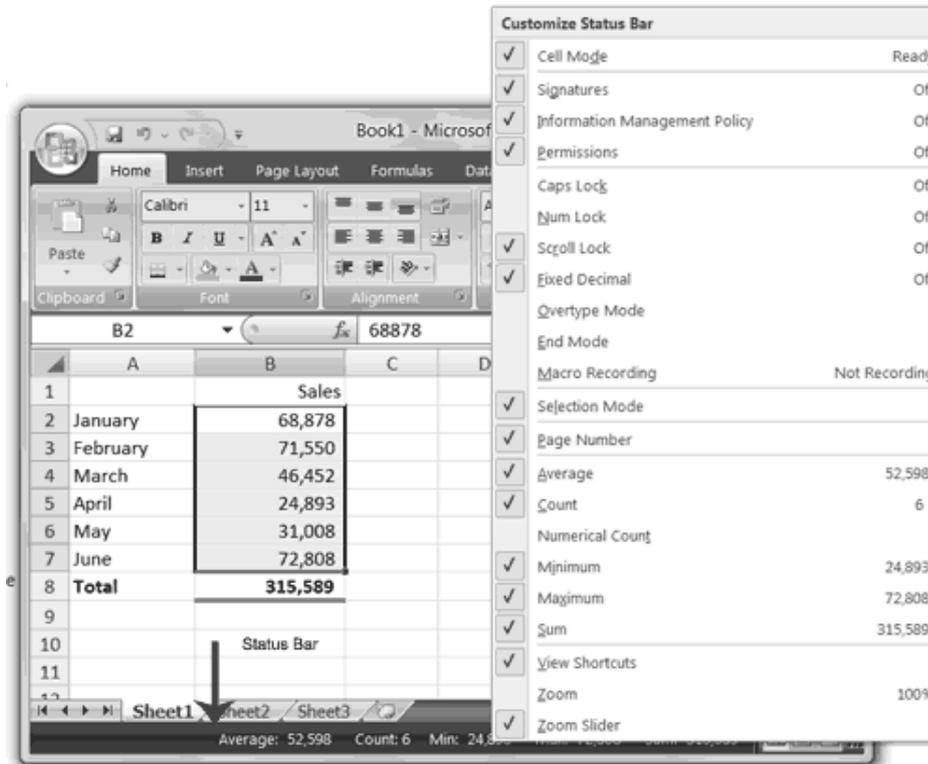
Fig. 7.6. **MS Excel Status bar**

By using the arrow keys, you can move around your worksheet. You can use the down arrow key to move downward one cell at a time. You can use the up arrow key to move upward one cell at a time. You can use the **Tab key** to move across the page to the right, one cell at a time. You can hold down the Shift key and then press the Tab key to move to the left, one cell at a time. You can use the right and left arrow keys to move right or left one cell at a time. The Page Up and Page Down keys move up and down one page at a time. If you hold down the Ctrl key and then press the Home key, you move to the beginning of the worksheet.

7.2. Operations with Excel formulas and data formatting tools

★ *A major **strength** of Excel is that you can perform mathematical calculations and format your data.*

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In Microsoft Excel, you can enter not only text, but also numbers and mathematical formulas into cells. Whether you enter a number or a formula, you can reference the cell when you perform mathematical calculations such as addition, subtraction, multiplication, or division. When entering a mathematical formula, precede the formula with an **equal** (=) sign. Use the following to indicate the type of calculation you wish to perform:

+ Addition

- Subtraction

* Multiplication

/ Division

^ Exponential

You can use the AutoSum button Σ on the Home tab to automatically add a column or row of numbers. When you press the AutoSum button Σ, Excel selects the numbers it thinks you want to add. If you then click the check mark on the Formula bar or press the Enter key, Excel adds the numbers. If Excel's guess as to which numbers you want to add is wrong, you can select the cells you want.

When you type text into a cell, by default your entry aligns with the left side of the cell. When you type numbers into a cell, by default your entry aligns with the right side of the cell. You can change the cell alignment. You can center, left-align, or right-align any cell entry. Look at cells A1 to D1. Note that they are aligned with the left side of the cell (fig. 7.7).

	A	B	C	D
1	Add	Subtract	Multiply	Divide
2	2	8	4	12

Fig. 7.7. **Default cell alignment**

In Excel, you can copy data from one area of a worksheet and place the data you copied anywhere in the same or another worksheet. In other words, after you type information into a worksheet, if you want to place the same information somewhere else, you do not have to retype the information. You simply copy it and then paste it in the new location.

You can use Excel's Cut feature to remove information from a worksheet. Then you can use the Paste feature to place the information you cut anywhere in the same or another worksheet. In other words, you can move information from one place in a worksheet to another place in the same or different worksheet by using the **Cut** and **Paste** features.

Microsoft Excel records cell addresses in formulas in three different ways, called **absolute, relative, and mixed**. The way a formula is recorded is important when you copy it. With **relative** cell addressing, when you copy a formula from one area of the worksheet to another, Excel records the position of the cell relative to the cell that originally contained the formula.

With **absolute** cell addressing, when you copy a formula from one area of the worksheet to another, Excel references the same cells, no matter where you copy the formula. You can use **mixed** cell addressing to keep the row constant while the column changes, or vice versa. The following exercises demonstrate.

You can insert and delete columns and rows. When you delete a column, you delete everything in the column from the top of the worksheet to the bottom of the worksheet. When you delete a row, you delete the entire row from left to right. Inserting a column or row inserts a completely new column or row.

You can use borders to make entries in your Excel worksheet **stand out**. You can choose from several types of borders. When you press the down arrow next to the **Border button** , a menu appears. By making the proper selection from the menu, you can place a border on the top, bottom, left, or right side of the selected cells; on all sides; or around the outside border. Accountants usually place a single underline above a final number and a double underline below.

A **font** is a set of characters represented in a single typeface. Each character within a font is created by using the same basic style. Excel provides many different fonts from which you can choose. The size of a font is measured in points. There are 72 points to an inch. The number of points assigned to a font is based on the distance from the top to the bottom of its longest character. You can change the Font, Font Size, and Font Color of the data you enter into Excel.

In Microsoft Excel, each **workbook** is made up of several or more **worksheets**. Each worksheet has a tab. By default, a workbook has three sheets and they are named sequentially, starting with Sheet1. The name of the worksheet appears on the tab. Before moving to the next topic, move to a new worksheet.

7.3. Creating Excel functions, automatic cells filling. Headers and Footers of Excel workbooks

By using functions, you can quickly and easily make many useful calculations, such as finding an average, the highest number, the lowest number, and a count of the number of items in a list. Microsoft Excel has many functions that you can use.

To use functions, you need to understand reference operators. Reference operators refer to a cell or a group of cells. There are two types of reference operators: **range** and **union**.

A *range reference* refers to all the cells between and including the reference. A range reference consists of two cell addresses separated by a colon. The reference A1:A3 includes cells A1, A2, and A3. The reference A1:C3 includes cells A1, A2, A3, B1, B2, B3, C1, C2, and C3.

A *union reference* includes two or more references. A union reference consists of two or more numbers, range referneces, or cell addresses separated by a comma. The reference A7,B8:B10,C9,10 refers to cells A7, B8 to B10, C9 and the number 10.

Functions are prewritten formulas. Functions differ from regular formulas in that you supply the value but not the operators, such as +, -, *, /. For example, you can use the SUM function to add. When using a function, remember the following:

use an equal sign to begin a formula;

specify the function name;

supply all the operators that are needed to build up the function and make it work (e.g. if you look for the highest number, be sure to supply the range of cells, under which to perform the check).

To fulfill the third demand correctly, enclose arguments within parentheses. Arguments are values on which you want to perform the calculation. For example, arguments specify the numbers or cells you want to add. Use a comma to separate arguments.

Here is an example of a function: =SUM(2,13,A1,B2:C7)

In this function:

the equal sign begins the function;

SUM is the name of the function;

2, 13, A1, and B2:C7 are the arguments;

parentheses enclose the arguments;

commas separate the arguments.

After you type the first letter of a function name, the AutoComplete list appears. You can double-click on an item in the AutoComplete list to complete your entry quickly. Excel will complete the function name and enter the first parenthesis.

The **SUM** function adds argument values (fig. 7.8).

Fig. 7.8. **The SUM function**

You can use the AVERAGE function to calculate the average of a series of numbers (fig. 7.9).

Fig. 7.9. **The AVERAGE function**

You can use the **MIN** function to find the lowest number in a series of numbers. You can use the **MAX** function to find the highest number in a series of numbers.

You can use Microsoft Excel to fill cells automatically with a series. For example, you can have Excel automatically fill your worksheet with days of the week, months of the year, years, or other types of series.

Before doing this exercise first you need to create sample lists which later would be used to accomplish automatic filling.

For this go to Office button→Excel options→Popular→Edit custom lists. In the opening window create two sets of lists: full and abbreviated names of weekdays (fig. 7.10)
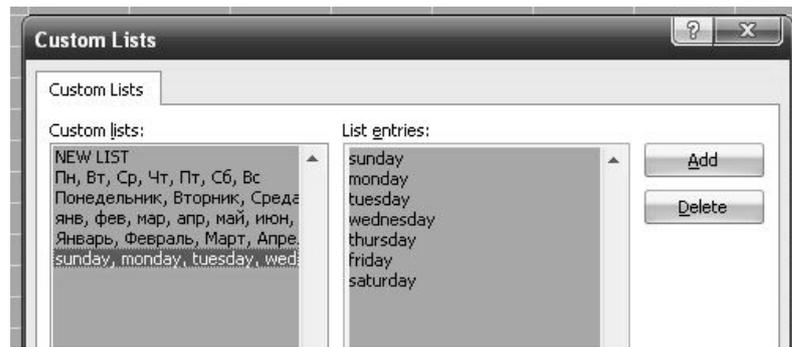
Fig. 7.10. **Sample lists creation tool**

After doing all these operations with auto filling it is possible to try other ways of automatic "predefined" filling of cells with numbers using options in Home tab – Editing – Fill. Pay special attention at ways of filling using Filling – Series. Look at results depending on different ways you use Series options (fig. 7.11).

Fig. 7.11. **Series fill option**

You can use the **Header & Footer** button on the Insert tab to create headers and footers. A header is text that appears at the top of every page of your printed worksheet. A footer is text that appears at the bottom of every page of your printed worksheet. When you click the Header & Footer button, the Design context tab appears and Excel changes to Page Layout view. A context tab is a tab that only appears when you need it. Page Layout view structures your worksheet so that you can easily change the format of your document. You usually work in Normal view.

You can type in your header or footer or you can use predefined headers and footers. To find predefined headers and footers, click the Header or Footer button or use the Header & Footer Elements group's buttons. When you choose a header or footer by clicking the Header or Footer button, Excel

centers your choice. The table shown here describes each of the Header & Footer Elements group button options (table 7.1).

Table 7.1

Header & Footer Elements

Button	Purpose
Page Number	Inserts the page number
Number of Pages	Inserts the number of pages in the document
Current Time	Inserts the current time
File Path	Inserts the path to the document
File Name	Inserts the file name
Sheet Name	Inserts the name of the worksheet
Picture	Enables you to insert a picture

Both the header and footer areas are divided into three sections: left, right, and center. When you choose a Header or Footer from the Header & Footer Elements group, where you place your information determines whether it appears on the left, right, or center of the printed page. You use the Go To Header and Go To Footer buttons on the Design tab to move between the header and footer areas of your worksheet.

7.4. Workbook print options: page orientation, margins, print order

There are many print options that are supported by Excel. You set print options on the Page Layout tab. Among other things, you can set your margins, set your page orientation, and select your paper size.

Margins define the amount of white space that appears on the top, bottom, left, and right edges of your document. The Margin option on the Page Layout tab provides several standard margin sizes from which you can choose.

There are two page orientations: **portrait** and **landscape**. Paper, such as paper sized 8 1/2 by 11, is longer on one edge than it is on the other. If you print in Portrait, the shortest edge of the paper becomes the top of the page.

Portrait is the default option. If you print in Landscape, the longest edge of the paper becomes the top of the page:

Portrait

Landscape

Paper comes in a variety of sizes. Most business correspondence uses 8 1/2 by 11 paper, which is the default page size in Excel. If you are not using 8 1/2 by 11 paper, you can use the Size option on the Page Layout tab to change the Size setting.

In order to set the page layout:

choose the Page Layout tab;

click Margins in the Page Setup group. A menu appears;

click Wide. Word sets your margins to the Wide settings (fig. 7.12).
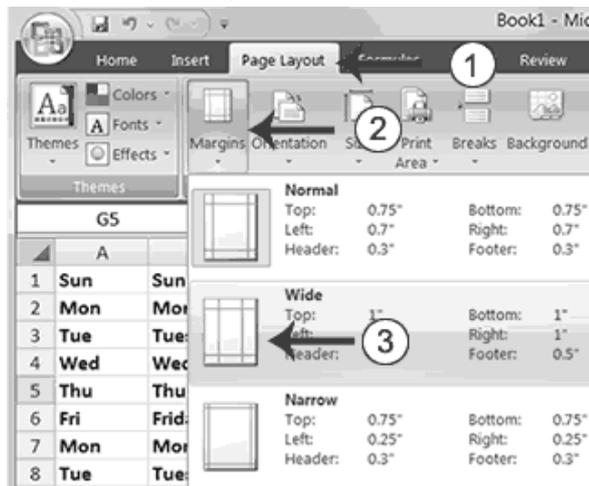
Fig. 7.12. **Page layout**

In order to set the page orientation (fig. 7.13):

choose the Page Layout tab;

click Orientation in the Page Setup group. A menu appears;
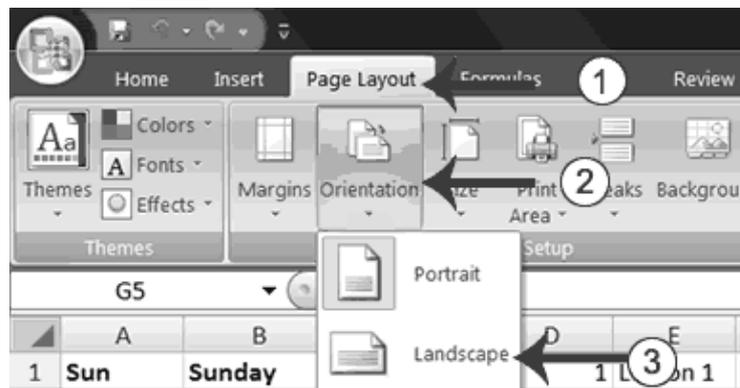
Fig 7.13. **Page orientation**

click Landscape. Excel sets your page orientation to landscape.

In order to set the paper size:

choose the Page Layout tab;

click Size in the Page Setup group. A menu appears;

click the paper size you are using. Excel sets your page size (fig. 7.14).
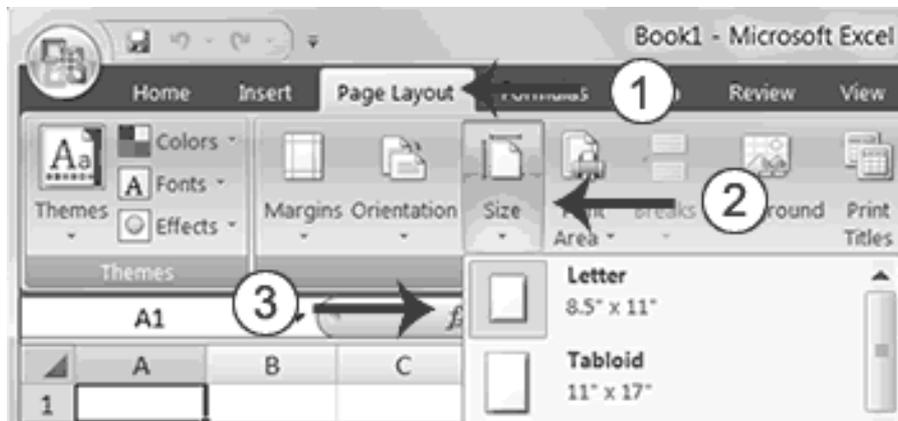
Fig. 7.14. **Paper size**

The simplest way to print is to click the Office button, highlight Print on the menu that appears, and then click Quick Print in the **Preview and Print the Document** pane.

Dotted lines appear on your screen, and your document prints. The dotted lines indicate the right, left, top, and bottom edges of your printed pages.

You can also use the Print Preview option to print. When using Print Preview, you can see onscreen how your printed document will look when you print it.

If you click the Page Setup button while in Print Preview mode, you can set page settings such as centering your data on the page.

If your document is several pages long, you can use the Next Page and Previous Page buttons to move forward and backward through your document.

If you check the Show Margins check box, you will see margin lines on your document. You click the Print button when you are ready to print. The Print dialog box appears (fig. 7.15).

Print dialog box contains a set of options that allow to adjust the parameters that would be further used by the printing device to produce a hard copy of the document.
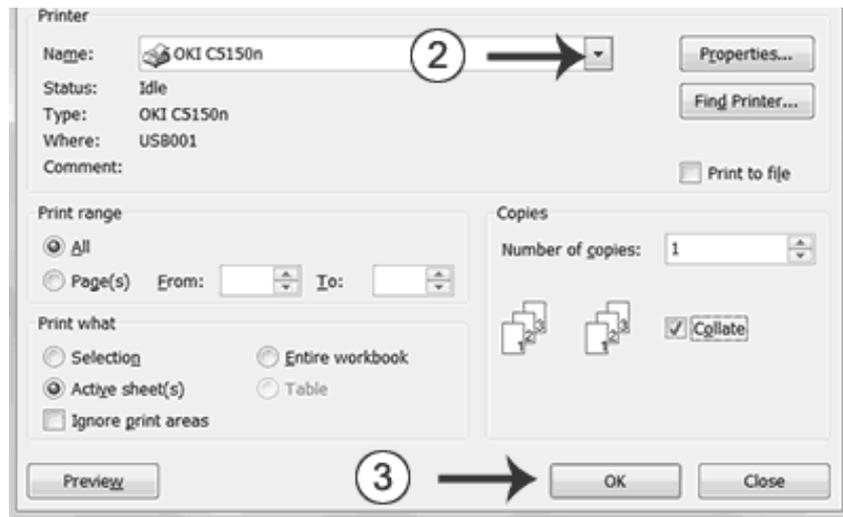
Fig. 7.15. **Print dialog box**

You can choose to print the entire worksheet or specific pages. If you want to print specific pages, enter the page numbers in the From and To fields. You can enter the number of copies you want to print in the Number of Copies field:

click the Print button. The Print dialog box appears;

click the down arrow next to the name field and select the printer to which you want to print;

click OK. Excel sends your worksheet to the printer.

■ Questions

1. What are the main elements of the MS Excel interface?

2. What is the principle of data organization in MS Excel?

3. What is a workbook? What is the difference between a workbook and a worksheet?

4. What methods are available in MS Excel to automatically filling cells?

5. Is there any difference between a formula and a function?

6. What are Headers and Footers used for?

7. What are the main print options in MS Excel?

Theme 8. Use of formulas and logical functions in MS Excel. Error trapping and formula auditing

MS Excel data types. Error value indicators

Error values

Basic data types

Reasons for errors

Logical functions and error-trapping formulas

AND, OR and IF logical functions

TRUE/FALSE logical functions

Error-trapping techniques

Formula auditing. Tracing precedents and dependents methods

Audit of formulas

Precedents

Dependents
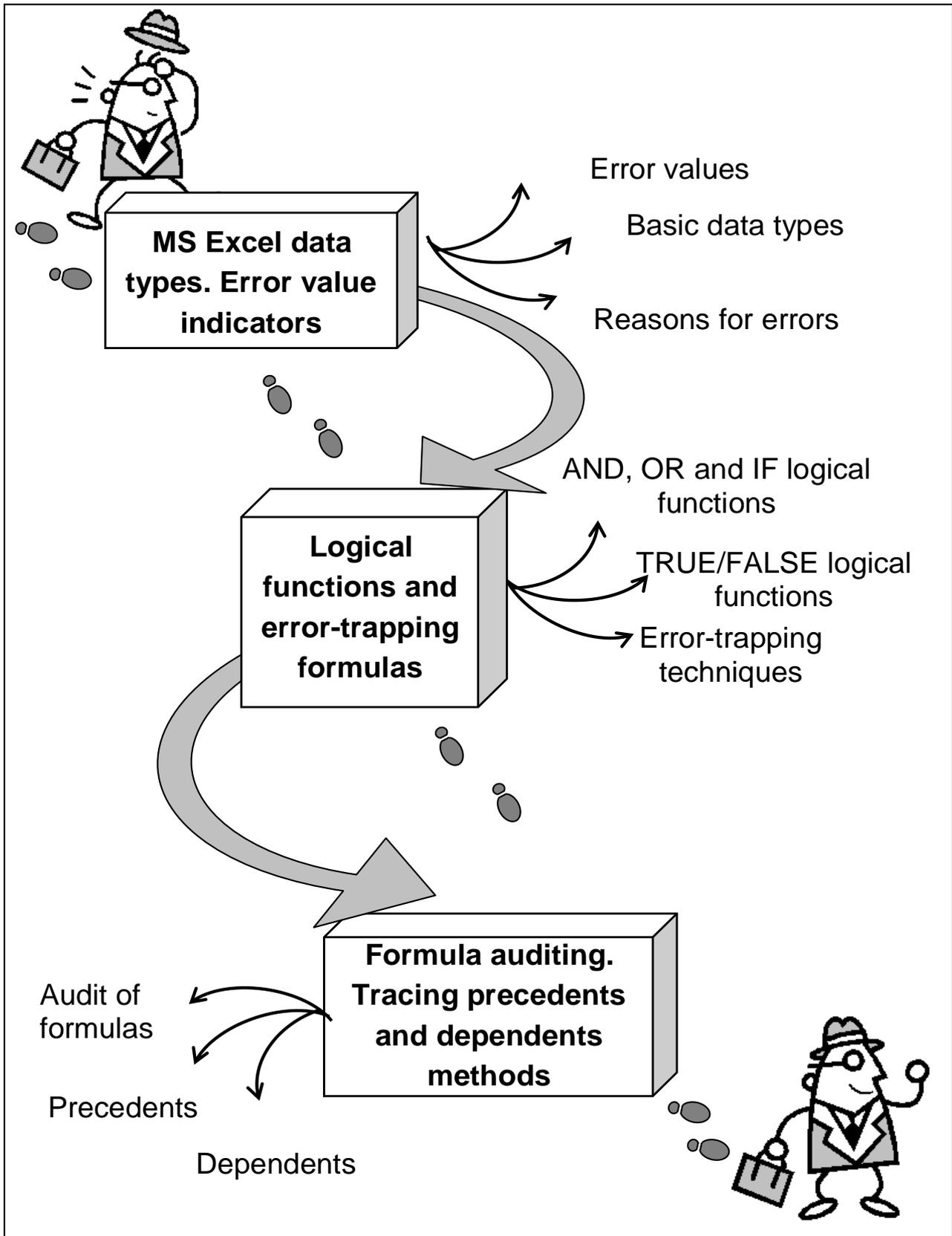
Fig. 8.1. **System elements of the theme**

◼ Introduction

The purpose of this theme lies in a close study of main logical functions available in MS Office Excel spreadsheet processor. Basic types of data that MS Excel works with are analyzed in detail and error messages that appear in case of a misuse of data types in formulas are considered. Major formula auditing tools are used to trace precedent and dependent cells in a sequence of related calculations.

Clue notions of the theme include: error values; conditions; logical functions; error-trapping; formula auditing; precedents; dependents.

This theme covers the following **topics:** Study of data types. Basic operations with logical functions. Study of different ways of errors check. Formulas audit and dependences detection.

As a result of the study of the material presented in this theme students will acquire the following **competencies**:

they would master basic data types used in MS Excel;

they would understand formula error values;

they would learn main logical functions;

they would study the use of IF formulas that can trap errors;

they would master formula auditing tools.

8.1. MS Excel data types. Error value indicators

Excel normally processes data strictly depending on its **type**. The type of data, that each cell contains, has to be manually specified by the user in order for Excel to work correctly with it. The type of data stored in a cell is specified through a **Format Cell** dialog box (fig. 8.2).
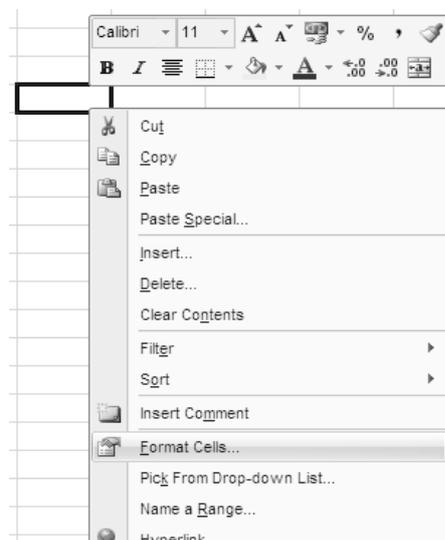
Fig. 8.2. **Format cell dialog box**

In the Number category of the Format Cell dialog box the user has to specify the type of data contained in a cell by choosing between the available data categories (fig. 8.3).
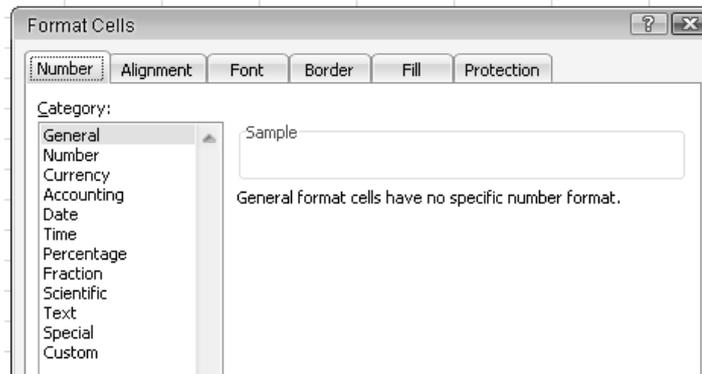
Fig. 8.3. **Basic data categories**

General – is used for cells that have no specific number format;

Number – is used for general display of numbers.

Currency – is used for general monetary values.

Accounting – formats line up the currency symbols and decimal points in a column

Date – displays date and time serial numbers as date values. Date formats that begin with an asterisk (*) respond to changes in regional date and time settings that are specified for the operating system. Formats without an asterisk are not affected by operating system settings.

Time – displays date and time serial numbers as date values. Time formats that begin with an asterisk (*) respond to changes in regional date and time settings that are specified for the operating system. Formats without an asterisk are not affected by operating system settings.

Percentage – multiplies the cell value by 100 and displays the result with a percent symbol.

Text – it makes cells treated as text even when a number is in the cell. The cell is displayed exactly as entered.

Special – is useful for tracking list and database values

It is extremely important to correctly specify the type of data stored in a cell otherwise it may become the main source of errors.

★ *If you build a legitimate formula, Excel either computes the answer and displays it in the current cell in the worksheet or, if unable to successfully calculate the answer, the program displays one of the following error values in the cell.*

#NULL! appears when your formula specifies an intersection of two ranges that do not, in fact, intersect.

#DIV/0! appears when your formula attempts to divide by zero.

#VALUE! appears when your formula contains some sort of improper argument type or operand (such as a text entry when the operator requires a value).

#REF! appears when your formula contains an improper cell reference.

#NAME? appears when your formula contains a text reference that Excel doesn't recognize (such as a reference to a range name that no longer exists in the workbook)

#NUM! appears when your formula contains invalid numeric values (such as a text entry where a number is required)

#N/A appears when your formula refers to a value that is not available to it

The biggest problem with errors in formulas — besides how ugly such values as #REF! and #DIV/0! are — is that they spread like wildfire through the workbook to other cells containing formulas that refer to their error-laden cells.

If you're dealing with a large worksheet in a really big workbook, you may not be able to tell which cell actually contains the formula that's causing all the hubbub. And if you can't apprehend the cell that is the cause of all this unpleasantness, you really have no way of restoring law and order to your workbook.

If a formula in your worksheet contains a reference to a cell that returns an error value, that formula returns that error value as well. This can cause error values to appear throughout the worksheet, thus making it very difficult for you to discover which cell contains the formula that caused the original error value so that you can fix the problem.

8.2. Logical functions and error-trapping formulas

Excel uses the following seven logical functions, which appear on the Logical command button's drop-down menu on the Formulas tab of the Ribbon (Alt+ML). All the logical functions (except IFERROR) return either the logical TRUE or logical FALSE to their cells when their functions are evaluated. Here are the names of the functions along with their argument syntax:

AND(logical1,logical2,...) — tests whether the logical arguments are TRUE or FALSE. If they are all TRUE, the AND function returns TRUE to the cell. If any are FALSE, the AND function returns FALSE;

FALSE() — takes no argument and simply enters logical FALSE in its cell;

IF(logical_test,value_if_true,value_if_false) — tests whether the logical_test expression is TRUE or FALSE. If TRUE, the IF function uses *the value_if_true* argument and returns it to the cell. If FALSE, the IF function uses *the value_if_false* argument and returns it to the cell;

IFERROR(value,value_if_error) — tests whether the value expression is an error. IFERROR returns *value_if_error* if the expression is an error, or value of the expression if it is not an error;

NOT(logical) — tests whether the logical argument is TRUE or FALSE. If TRUE, the NOT function returns FALSE to the cell. IF FALSE, the NOT function returns TRUE to the cell;

OR(logical1,logical2,...) — tests whether the logical arguments are TRUE or FALSE. If any are TRUE, the OR function returns TRUE. If all are FALSE, the OR function returns FALSE;

TRUE() — takes no argument and simply enters logical TRUE in its cell.

The *logical_test* and *logical* arguments that you specify for these logical functions usually employ the comparison operators (=, <, >, <=, >=, or <>), which themselves return logical TRUE or logical FALSE values. For example, suppose that you enter the following formula in your worksheet:

=AND(B5=D10,C15>=5 00)

In this formula, Excel first evaluates the first logical argument to determine whether the contents in cell B5 and D10 are equal to each other. If they are, the first comparison returns TRUE. If they are not equal to each other, this comparison returns FALSE. The program then evaluates the second logical argument to determine whether the content of cell C15 is greater than or equal to 500. If it is, the second comparison returns TRUE. If it is not greater than or equal to 500, this comparison returns FALSE.

After evaluating the comparisons in the two logical arguments, the AND function compares the results: If logical argument 1 and logical argument 2 are both found to be TRUE, then the AND function returns logical TRUE to the cell. If, however, either argument is found to be FALSE, then the AND function returns false to the cell.

When you use the IF function, you specify what's called a *logical-test* argument whose outcome determines whether the *value_true* or *value_false* argument is evaluated and returned to the cell. The logical-test argument normally uses comparison operators, which return either the logical TRUE or logical FALSE value. When the argument returns TRUE, the entry or expression in the value_true argument is used and returned to the cell. When the argument returns FALSE, the entry or expression in the value_ false argument is used.

Consider the following formula that uses the IF function to determine whether to charge tax on an item (fig. 8.4): =IF(E5="Yes", D5+D5*7.5%, D5)

If cell E5 (the first cell in the column where you indicate whether the item being sold is taxable or not) contains "Yes," the IF function uses the value_true argument that tells Excel to add the extended price entered in cell D5, multiply it by a tax rate of 7.5%, and then add the computed tax to the extended price. If, however, cell D5 is blank or contains anything other than the text "Yes," then the IF function uses the value_false argument, which tells Excel to just return the extended price to cell D5 without adding any tax to it.

	A	B	C	D	E	F
1						
2						
3						
4		Item ID	Item name	Price	Taxability	Payment
5		2724245	Cigarettes	3,50	Yes	6,125

Cell F5 formula: =IF(E5="Yes";D5+D5*0,75;D5)

Fig. 8.4. **Use of the IF function to check a condition and perform a calculation**

As you can see, the value_true and value_false arguments of the IF function can contain constants or expressions whose results are returned to the cell that holds the IF formula.

Error-Trapping Formulas. Sometimes, you know ahead of time that certain error values are unavoidable in a worksheet as long as it's missing certain data. The most common error value that gets you into this kind of trouble is the #DIV/0! error value. Suppose, for example, that you're creating a new sales workbook from your sales template, and one of the rows in this template contains formulas that calculate the percentage that each monthly total is of the quarterly total. To work correctly, the formulas must divide the

value in the cell that contains the monthly total by the value in the cell that contains the quarterly total. When you start a new sales workbook from its template, the cells that contain the formulas for determining the quarterly totals contain zeros, and these zeros put #DIV/0! errors in the cells with formulas that calculate the monthly/quarterly percentages.

These particular #DIV/0! error values in the new workbook don't really represent mistakes as such because they automatically disappear as soon as you enter some of the monthly sales for each quarter (so that the calculated quarterly totals are no longer (0).

To see how you can use the IF function in a formula that sometimes gives you a #DIV/0! error, consider the sample worksheet shown in Figure 8.5. This figure shows a blank Production Schedule worksheet for storing the 2008 production figures arranged by month and part number. Because you haven't yet had a chance to input any data into this table, the SUM formulas in the last row and column contain 0 values. Because cell K7 with the grand total currently also contains 0, all the percent-of-total formulas in the cell range B9:J9 contain #DIV/0! error values.

The first percent-of-total formula in cell B9 contains the following:
=B7/$K$7
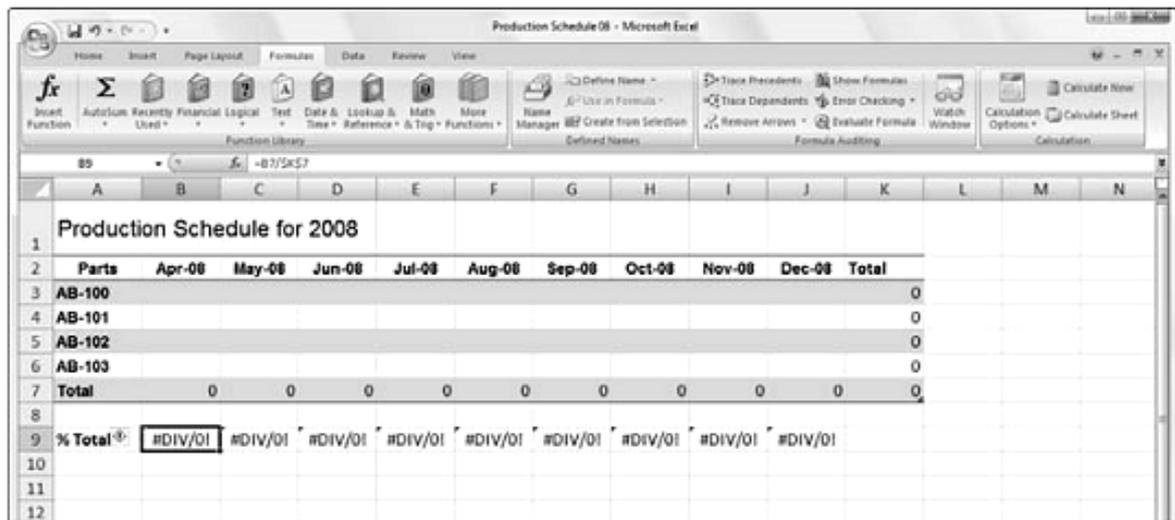
Fig. 8.5. **Blank 2008 Production Schedule spreadsheet that's full of #DIV/0! errors.**

Because cell K7 with the grand total contains 0, the formula returns the #DIV/0! error value. Now, you'll see how to set a trap for the error in the logical_test argument inside an IF function. After the logical_test argument, you enter the value_true argument (which is 0 in this example) and the

value_false argument (which is the B7/$K$7). With the addition of the IF function, the final formula looks like this:

=IF($K$7=0,0,B7/$K$7)

This formula then inputs 0 into cell B9, as shown in Figure 8.6, when the formula actually returns the #DIV/0! error value (because cell K7 is still empty or has a 0 in it), and returns the percentage of total production when the formula doesn't return the #DIV/0! error value (because cell K7 with the total production divisor is no longer empty or contains any other value besides (0). Next, all you have to do is copy this error-trapping formula in cell B9 over to J9 to remove all the #DIV/0! errors from this worksheet.

		Function Library					Defined Names				Formula Auditing			Calculation	
B9			*fx*	=IF($K$7=0,0,B7/$K$7)												
	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Production Schedule for 2008													
2	Parts	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep-08	Oct-08	Nov-08	Dec-08	Total			
3	AB-100										0			
4	AB-101										0			
5	AB-102										0			
6	AB-103										0			
7	Total	0	0	0	0	0	0	0	0	0	0			
8														
9	% Total	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%				
10														
11														
12														

Fig. 8.6. **2008 Production Schedule spreadsheet after trapping all the #DIV/0! errors.**

The error-trapping formula created with the IF function in cell B9 works fine as long as you know that the grand total in cell K7 will contain either 0 or some other numerical value. It does not, however, trap any of the various error values, such as #REF! and #NAME?, nor does it account for the special #NA (Not Available) value. If, for some reason, one of the formulas feeding into the SUM formula in K7 returns one of these beauties, they will suddenly cascade throughout all the cells with the percent-of-total formulas (cell range B9:J9).

To trap all error values in the grand total cell K7 and prevent them from spreading to the percent-to-total formulas, you need to add the **ISERROR** function to the basic IF formula. The ISERROR function returns the logical value TRUE if the cell specified as its argument contains any type of error value, including the special #N/A value (if you use ISERR instead of ISERROR, it checks for all types of error values except for #N/A).

To add the ISERROR function, place it in the IF function as the logical_test argument. If, indeed, K7 does contain an error value or the #N/A

value at the time the IF function is evaluated, you specify 0 as the value_true argument so that Excel inputs 0 in cell B9 rather than error value or #N/A. For the value_false argument, you specify the original IF function that inputs 0 if the cell K7 contains 0; otherwise, it performs the division that computes what percentage the January production figure is of the total production.

This amended formula with the ISERROR and two IF functions in cell B9 looks like this:

=IF(ISERROR($K$7),0,IF($K$7=0,0,B7/$K$7))

As soon as you copy this original formula to the cell range C9:J9, you've protected all the cells with the percent-of-total formulas from displaying and spreading any of those ugly error values.

Some people prefer to remove the display of zero values from any template that contains error-trapping formulas so that no one interprets the zeros as the correct value for the formula. To remove the display of zeros from a worksheet, deselect the Show a Zero in Cells That Have Zero Values check box in the Display Options for this Worksheet section of the Advanced tab of the Excel Options dialog box (Office Button I Excel Options or Alt+FI). By this action, the cells with error-trapping formulas remain blank until you give them the data that they need to return the correct answers.

8.3. Formula auditing. Tracing precedents and dependents methods

If you don't happen to trap those pesky error values before they get out into the spreadsheet, then you end up having to track down the original cell that caused all the commotion and set it right. Fortunately, Excel offers some very effective formula-auditing tools for tracking down the cell that's causing your error woes by tracing the relationships between the formulas in the cells of your worksheet. By tracing the relationships, you can test formulas to see which cells, called direct precedents in spreadsheet jargon, directly feed the formulas and which cells, called dependents (nondeductible, of course), depend on the results of the formulas. Excel even offers a way to visually backtrack the potential sources of an error value in the formula of a particular cell.

The formula-auditing tools are found in the command buttons located in the **Formula Auditing group** on the **Formulas tab** of the Ribbon. These command buttons include the following:

Trace Precedents. When you click this button, Excel draws arrows to the cells (the so-called direct precedents) that are referred to in the formula inside the selected cell. When you click this button again, Excel adds "tracer" arrows that show the cells (the so-called indirect precedents) that are referred to in the formulas in the direct precedents.

Trace Dependents. When you click this button, Excel draws arrows from the selected cell to the cells (the so-called direct dependents) that use, or depend on, the results of the formula in the selected cell. When you click this button again, Excel adds tracer arrows identifying the cells (the so-called indirect dependents) that refer to formulas found in the direct dependents.

Remove Arrows. Clicking this button removes all the arrows drawn, no matter what button or pull-down command you used to put them there — click the drop-down button attached to this button to display a drop-down menu with three options: Remove Arrows to remove all arrows (just like clicking the Remove Arrows command button); Remove Precedent Arrows to get rid of the arrows that were drawn when you clicked the Trace Precedents button; and Remove Dependent Arrows to get rid of the arrows that were drawn when you clicked the Trace Dependents button.

Show Formulas. To display all formulas in their cells in the worksheet instead of their calculated values (just like pressing Ctrl+V).

Error Checking. When you click this button or click the Error Checking option on its drop-down menu, Excel displays the Error Checking dialog box, which describes the nature of the error in the current cell, gives you help on it, and enables you to trace its precedents. Click the Trace Error option on this button's drop-down menu to attempt to locate the cell that contains the original formula that has an error.

Evaluate Formula. Clicking this button opens the Evaluate Formula dialog box, where you can have Excel evaluate each part of the formula in the current cell. The Evaluate Formula feature can be quite useful in formulas that nest many functions within them.

If these cells are on the same worksheet, Excel draws solid red or blue arrows extending from each of the precedent cells to the active cell and from the active cell to the dependent cells. If the cells are not located locally on the same worksheet (they may be on another sheet in the same workbook or even on a sheet in a different workbook), Excel draws a black dotted arrow. This arrow comes from or goes to an icon picturing a miniature worksheet

that sits to one side, with the direction of the arrowheads indicating whether the cells on the other sheet feed the active formula or are fed by it.

You can click the **Trace Precedents** command button on the **Formulas tab** of the Ribbon or press Alt+MP to trace all the generations of cells that contribute to the formula in the selected cell (kind of tracing all the ancestors in your family tree).

Figures 8.7 and 8.8 illustrate how you can use the **Trace Precedents** command button or its hot key equivalent to quickly locate the cells that contribute, directly and indirectly, to the simple addition formula in cell B9.
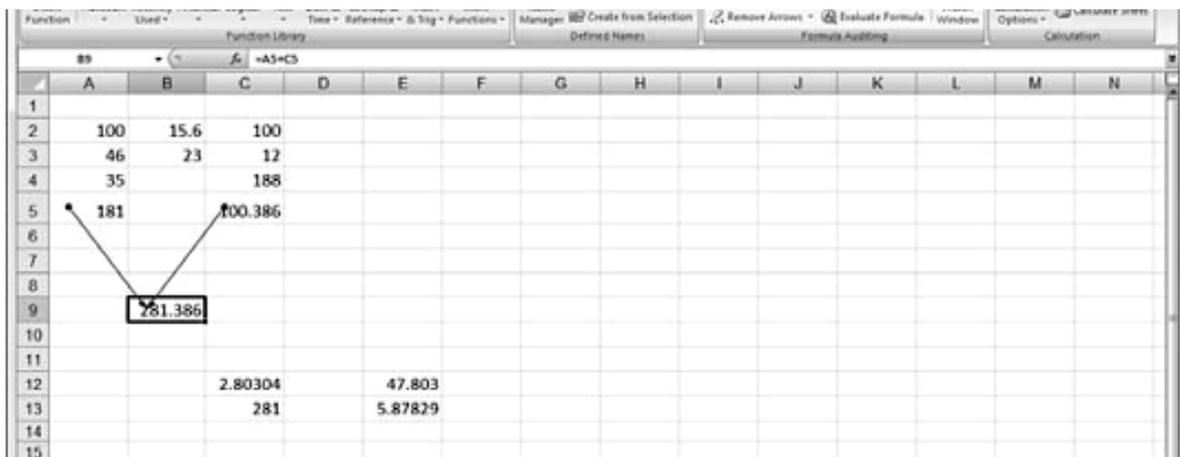
Fig. 8.7. **Trace Precedents command button clicked one time**

Figure 7 shows the worksheet after the Trace Precedents command button was clicked the first time.

As you can see, Excel draws trace arrows from cells A5 and C5 to indicate that they are the direct precedents of the addition formula in cell B9. In Figure 7/8, you see what happened when this command button was clicked a second time to display the indirect precedents of this formula (think of them as being a generation earlier in the family tree).

The new tracer arrows show that cells A2, A3, and A4 are the direct precedents of the formula in cell A5 — indicated by a border around the three cells. (Remember that cell A5 is the first direct precedent of the formula in cell B9.)

Likewise, cells B2 and B3 as well as cell C4 are the direct precedents of the formula in cell C5. (Cell C5 is the second direct precedent of the formula in cell B9.)

Each time you click the Trace Precedents command button, Excel displays another (earlier) set of precedents (until no more generations exist).
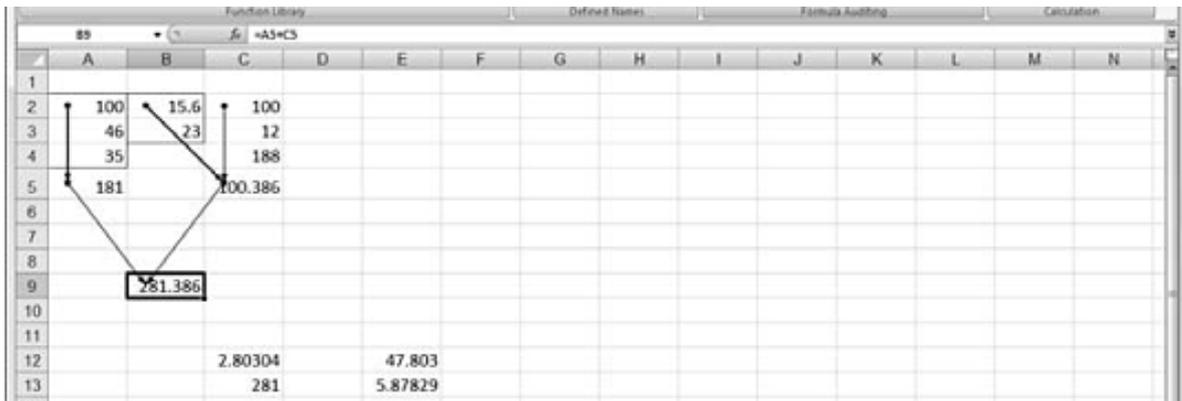
Fig. 8.8. **Trace Precedents command button clicked two times**

If you are in a hurry (as most of us are most of the time), you can speed up the process and display both the direct and indirect precedents in one operation by double-clicking the Trace Precedents command button. To clear the worksheet of tracer arrows, click the Remove Arrows command button on the Formulas tab.

Figure 8.9 shows what happened after the Trace Precedents command button was clicked (after clicking it twice before, as shown in Figures 7 and 8).

Clicking the command button reveals both the indirect precedents for cell C5. The formulas in cells C2 and C3 are the direct precedents of the formula in cell C5. The direct precedent of the formula in cell C2 (and, consequently, the indirect precedent of the one in cell C5) is not located on this worksheet. This fact is indicated by the dotted tracer arrow coming from that cute miniature worksheet icon sitting on top of cell A3.
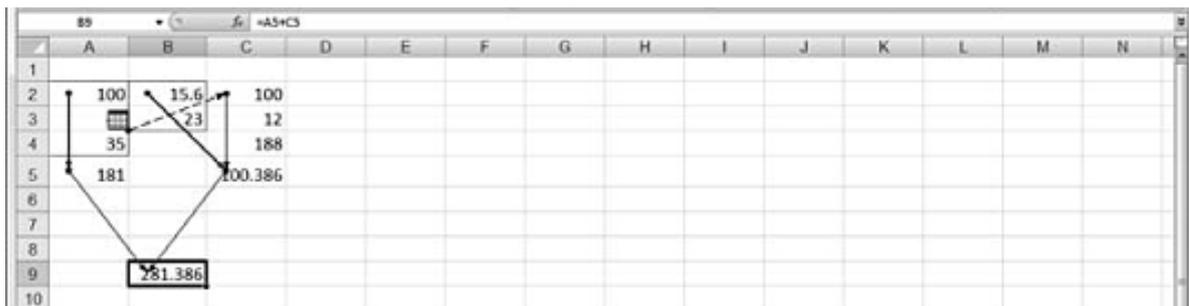
Fig. 8.9. **Precedent located on another worksheet**

To find out exactly which workbook, worksheet, and cell(s) hold the direct precedents of cell C2, double-click somewhere on the dotted arrow. Double-clicking the dotted tracer arrow opens the Go To dialog box, which shows a list of all the precedents (including the workbook, worksheet, and cell references). To go to a precedent on another worksheet, double-click the reference in the Go To list box, or select it and click OK. (If the worksheet is in

another workbook, this workbook file must already be open before you can go to it.) (fig. 8.10).
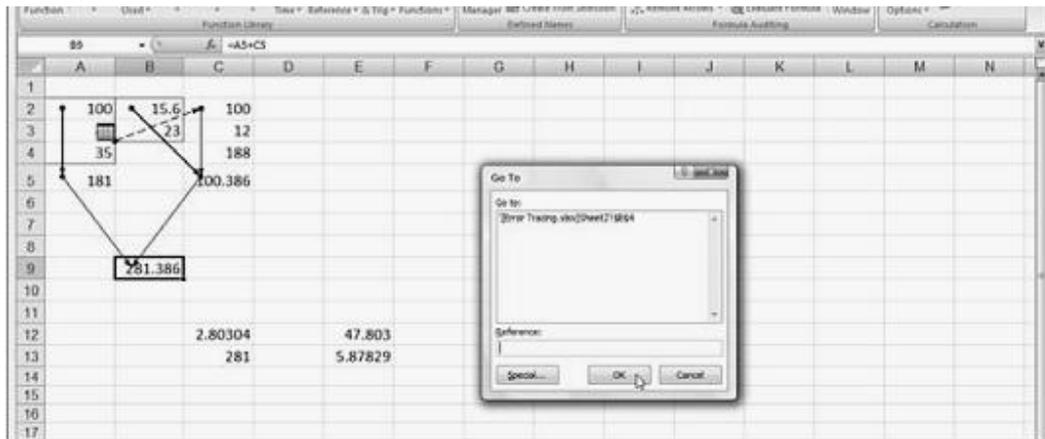
Fig. 8.10. **The Go To option**

The Go To dialog box, shown in Figure 10, displays the following direct precedent of cell C2, which is cell B4 on Sheet2 of the same workbook:

'[Error Tracer.xls]Sheet2'!$B$4

To jump directly to this cell, double-click the cell reference in the Go To dialog box. You can also select precedent cells that are on the same worksheet as the active cell by double-clicking somewhere on the cell's tracer arrow. Excel selects the precedent cell without bothering to open up the Go To dialog box.

You can use the **Special** button in the Go To dialog box (refer to Figure 10) to select all the direct or indirect precedents or the direct or indirect dependents that are on the same sheet as the formula in the selected cell. After opening the Go To dialog box (Ctrl+G or F5) and clicking the Special button, you simply click the Precedents or Dependents option button and then choose between the Direct Only or All Levels option button before you click OK.

You can also click the **Trace Dependents** command button in the **Formula Auditing** group of the Formulas tab on the Ribbon or press Alt+MD to trace all the generations of cells that either directly or indirectly utilize the formula in the selected cell (kind of like tracing the genealogy of all your progeny). Tracing dependents with the Trace Dependents command button is much like tracing precedents with the Trace Precedents command button. Each time you click this button, Excel draws another set of arrows that show a generation of dependents further removed. To display both the direct and indirect dependents of a cell in one fell swoop, double-click the Trace Dependents command button (fig. 8.11).
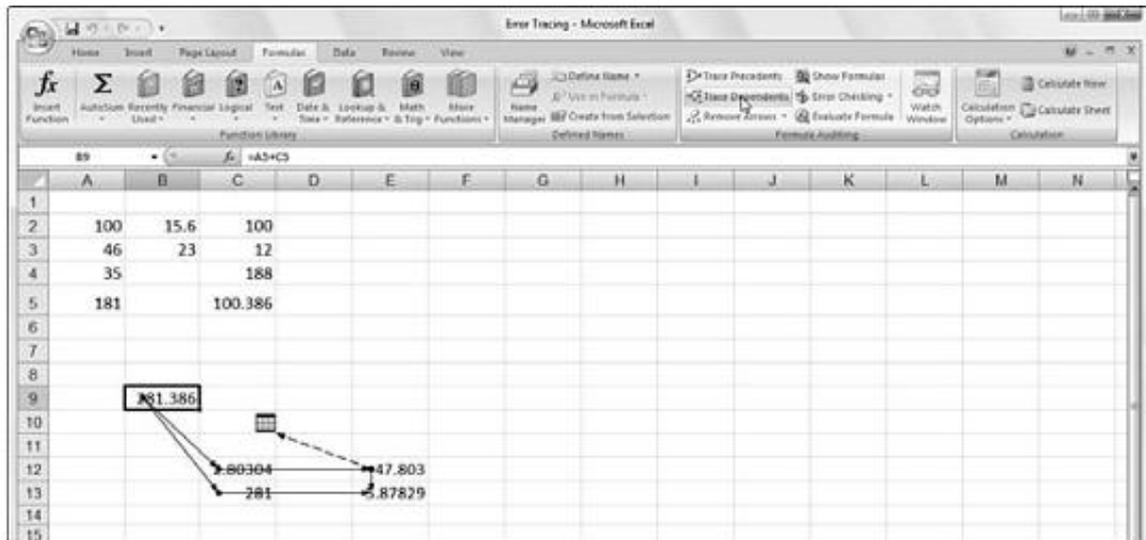
Fig. 8.11. **Trace Dependents command**

Figure 8.11 shows what happened after cell B9 was selected and then double-clicked the Trace Dependents command button on the Formulas tab of the Ribbon to display both the direct and indirect dependents and then was clicked a third time to display the dependents on another worksheet.

As this figure shows, Excel first draws tracer arrows from cell B9 to cells C12 and C13, indicating that C12 and C13 are the direct dependents of cell B9. Then, it draws tracer arrows from cells C12 and C13 to E12 and E13, respectively, the direct dependents of C12 and C13 and the indirect dependents of B9. Finally, it draws a tracer arrow from cell E12 to another sheet in the workbook (indicated by the dotted tracer arrow pointing to the worksheet icon).

■ **Questions**

1. What are the main data types used by MS Excel?

2. What are the general reasons for errors in the process of calculations?

3. What are the common error messages?

4. For what purpose are logical functions used?

5. What logical functions can check several conditions?

6. What is the purpose of performing formula auditing operations?

7. What is the difference between tracing precedents and dependents methods?

Theme 9. Use of date and time functions in MS Excel. Financial formulas and depreciation of assets
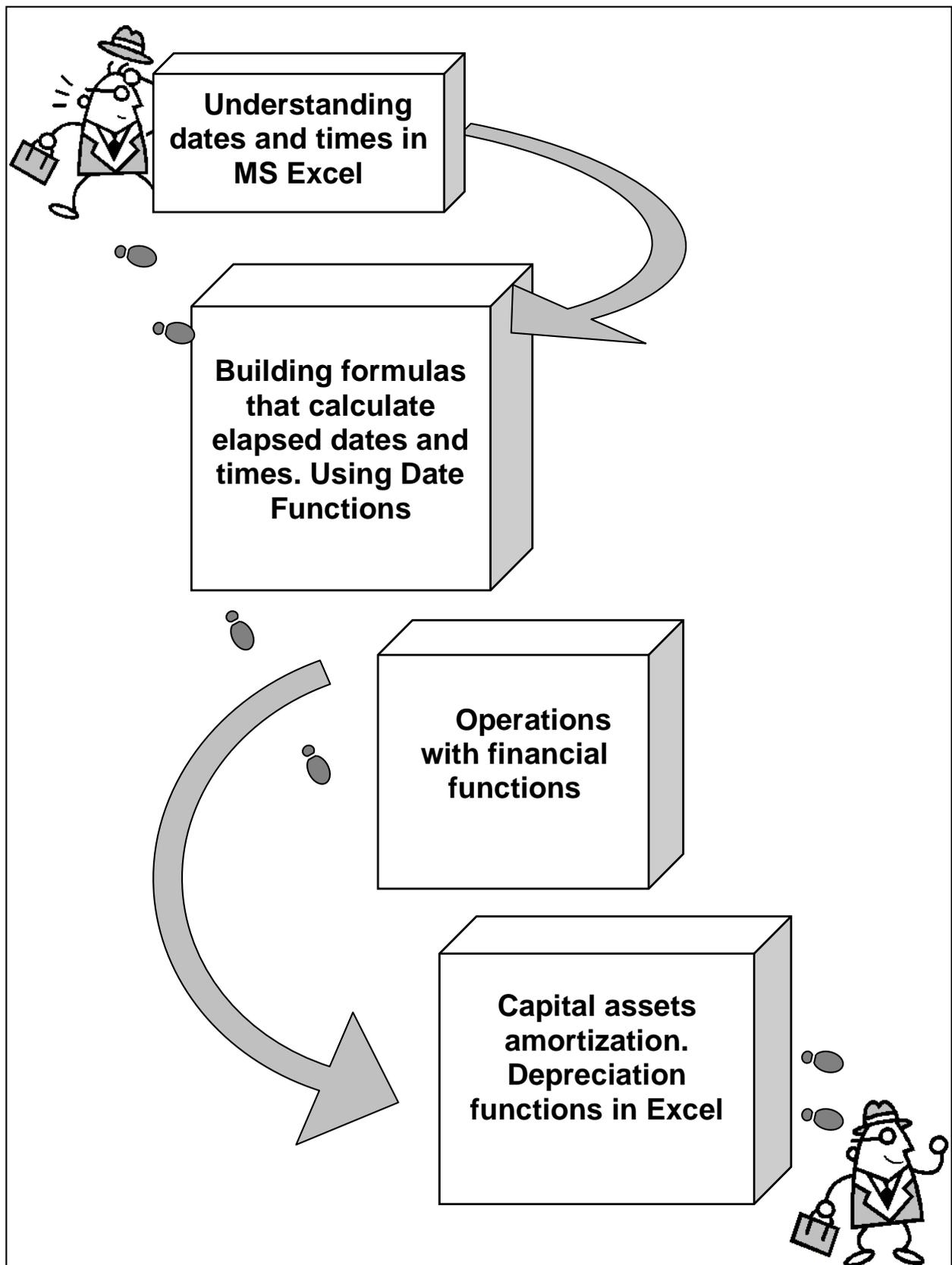
Fig. 9.1. **System elements of the theme**

▉ Introduction

The purpose of this theme lies in a close study of date and time functions available in MS Office Excel and functions that are used to track financial assets. Basic operations with date and time values are given a thorough consideration both with the calculation of the value of financial assets. Capital assets depreciation methods are analyzed together with the MS Excel functions used to support the overall process.

Clue notions of the theme include: date and time values; future value; present value; incoming cash-flows; outgoing cash-flows; net present value; payments; depreciation methods.

This theme covers the following **topics:** Basic operations with date and time functions. Study of formulas that calculate elapsed dates and times. Basic operations with financial functions. Study of formulas that calculate investment and depreciation of assets.

As a result of the study of the material presented in this theme students will acquire the following **competencies**:

they would understand dates and times in Excel;

they would learn how to use date and time functions;

they would learn how Excel rounds up values;

they would master basic investment functions;

they would study basic depreciation functions.

9.1. Understanding dates and times in MS Excel

Excel doesn't treat the dates and times that you enter in the cells of your worksheet as simple text entries. Any entry with a format that resembles one of the date and time number formats utilized by Excel is automatically converted, behind the scenes, into a serial number.

In the case of dates, this **serial number** represents the **number** of days that have elapsed since the beginning of the twentieth century so that January 1, 1900, is serial number 1; January 2, 1900, is serial number 2; and so forth.

In the case of times, this **serial number** is a **fraction** that represents the number of hours, minutes, and seconds that have elapsed since midnight, which is serial number 0.00000000, so that 12:00:00 p.m. (noon) is serial number 0.50000000; 11:00:00 p.m. is 0.95833333; and so forth.

As long as you format a numeric entry so that it conforms to a recognized date or time format, Excel enters it as a date or time serial

number. Only when you enter a formatted date or time as a text entry (by prefacing it with an apostrophe) or import dates and times as text entries into a worksheet do you have to worry about converting them into date and time serial numbers, which enables you to build spreadsheet formulas that perform calculations on them.

9.2. Building formulas that calculate elapsed dates and times. Using Date Functions

Most of the date formulas that you build are designed to calculate the number of days or years that have elapsed between two dates. To do this, you build a simple formula that subtracts the later date from the earlier date. For example, if you input the date 4/25/75 in cell B11 and 6/3/04 in cell C11 and you want to calculate the number of days that have elapsed between April 25, 1975, and June 3, 2004, in cell D11, you would enter the following subtraction formula in that cell: =C11-B11

Excel then inputs the number of days between these dates in cell D5. The only problem is that the program will also apply the **Date format** used by these two dates so that the result in cell D5 appears as the date: 2/8/1929.

To display this result as a whole number, as you'd expect, you still have to format the result with another number format. If, for example, you apply the General number format to the cell D5 (you can do this quickly by pressing Ctrl+Shift+` or Ctrl+~), the calculated result in this cell becomes the much more sensible number of days: 10632.

If you want the result between two dates expressed in the number of years rather than the number of days, divide the result of your subtraction by the number of days in a year. In this example, you can enter the formula =D11/365 in cell Ell to return the result 29.12877, which you can then round off to 29 by clicking the **Decrease Decimal** button in the **Number group** on the **Home tab** of the **Ribbon** or by pressing Alt+H9 until only 29 remains displayed in the cell.

Some spreadsheets require that formulas calculate the amount of elapsed time between a **starting** and **ending** time. To build a formula that calculates how much time has elapsed between two different times of the day, subtract the ending time of day from the starting time of day. For example, suppose that you enter a person's starting time in cell B14 and ending time in CI4. In cell D14, you would enter the following subtraction formula: =C14-B14.

Excel then returns the difference in cell D14 as a decimal value representing what fraction that difference represents of an entire day (that is, a 24-hour period). If, for example, cell B14 contains a starting time of 9:15 a.m. and cell C14 contains an ending time of 3:45 p.m., Excel returns the following decimal value to cell D14: 6:30   AM.

To convert this time of day into its equivalent decimal number, you convert the time format automatically given to it to the General format (Ctrl+Shift+` or Ctrl+~), which displays the following result in cell D14: 0.270833.

To convert this decimal number representing the fraction of an entire day into the number of hours that have elapsed, you simply multiply this result by 24 as in =D14*24, which gives you a result of 6.5 hours when you apply the General format (Ctrl+Shift+` or Ctrl+~) to it.

Using Date Functions. Excel contains a number of built-in date functions that you can use in your spreadsheets.

The easiest date function has to be TODAY. This function takes no arguments and is always entered as follows: =TODAY()

When you enter the TODAY function in a cell by clicking it on the **Date & Time** command button's drop-down list on the Ribbon's **Formulas** tab or by typing it, Excel returns the current date by using the following Date format: 7/23/2008

Keep in mind that the date inserted into a cell with the TODAY function is not static. Whenever you open a worksheet that contains this function, Excel recalculates the function and updates its contents to the current date. This means that you don't usually use TODAY to input the current date when you're doing it for historical purposes (an invoice, for example) and never want it to change.

The DATE function on the **Date & Time** command button's drop-down menu returns a date serial number for the date specified by the year, month, and day argument. This function uses the following syntax: DATE (year, month, day) (fig. 9.2).

This function comes in handy when you have a worksheet that contains the different parts of the date in separate columns, similar to the one shown in Figure 1. You can use it to combine the three columns of date information into a single date cell that you can use in sorting and filtering.

The DATEVALUE function on the Date & Time button's drop-down menu returns the date serial number for a date that's been entered into the

spreadsheet as text so that you can use it in date calculations. This function takes a single argument: DATEVALUE (date_text).
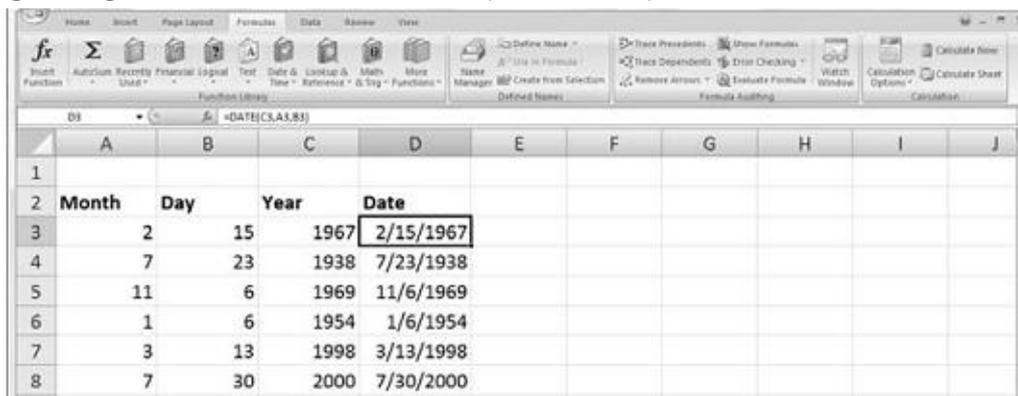
Fig. 9.2. **Using the DATE function to combine separate date information into a single entry**

The DAY, WEEKDAY and MONTH date functions on the **Date & Time** command button's drop-down menu all return just parts of the date serial number that you specify as their argument:

DAY(serial_number or date) to return the day of the month in the date (as a number between 1 and 31);

WEEKDAY(serial_number or date,[return_type]) to return the day of the week (as a number between 1 and 7 or 0 and 6). The optional return_type argument is a number between 1 and 3; 1 (or no return_type argument) specifies the first type where 1 equals Sunday and 7 equals Saturday; 2 specifies the second type where 1 equals Monday and 7 equals Sunday; and 3 specifies the third type where 0 equals Monday and 6 equals Sunday;

MONTH(serial_number or date to return the number of the month in the date serial number (from 1 to 12).

For example, if you enter the following DAY function in a cell as follows: DAY(DATE (08,4,15)) or just DAY(E4), where E4 contains date, Excel returns the value 15 to that cell. If, instead, you use the WEEKDAY function as follows: WEEKDAY(DATE(08,4,15)), Excel returns the value 4, which represents Wednesday (using the first return_type where Sunday is 1 and Saturday is 7) because the optional return_type argument isn't specified. If you use the MONTH function on this date as in the following: MONTH(DATE (08 ,4, 15), Excel returns 4 to the cell. Don't use these functions on dates entered as text entries. Always use the DATE/VALUE function to convert these text dates and then use the DAY, WEEKDAY, MONTH functions on the serial numbers returned by the DATE/VALUE function to ensure accurate results.

9.3. Operations with financial functions

The key to using any of Excel's financial functions is to understand the terminology used by their arguments. Many of the most common financial functions, such as PV (Present Value), NPV (Net Present Value), FV (Future Value), and PMT (Payment), take similar arguments:

PV (present value of an investment) is the present value that is the principal amount of the annuity;

FV (future value of an investment) is the future value that represents the principal plus interest on the annuity;

PMT (payment for a loan) is the payment made each period in the annuity. Normally, the payment is set over the life of the annuity and includes principal plus interest without any other fees;

RATE is the interest rate per period. Normally, the rate is expressed as an annual percentage;

NPER (number of periods for an investment) is the total number of payment periods in the life of the annuity. You calculate this number by taking the Term (the amount of time that interest is paid) and multiplying it by the Period (the point in time when interest is paid or earned) so that a loan with a three-year term with 12 monthly interest payments has 3 x 12, or 36 payment periods.

When using financial functions, keep in mind that the **fv, pv**, and **pmt** arguments can be positive or negative, depending on whether you're receiving the money (as in the case of an investment) or paying out the money (as in the case of a loan). Also keep in mind that you have to express the rate argument in the same units as the **nper** argument, so that if you make monthly payments on a loan and you express the **nper** as the total number of monthly payments, as in 360 (30 x 12) for a 30-year mortgage, you need to express the annual interest rate in monthly terms as well. For example, if you pay an annual interest rate of 7.5 percent on the loan, you express the rate argument as 0.075/12 so that it is monthly as well.

The NPV, PV and FV functions

⊠ *Net present value is an economic standard method for evaluating competing long-term projects. It is defined as the total present value (PV) of a time series of cash flows. It is a standard method for using the time value of money to appraise long-term projects.*

Each cash inflow/outflow is discounted back to its present value (PV). Then they are summed. Therefore NPV is the sum of all terms (9.1):

$$\frac{R_t}{(1+i)^t}$$ (9.1), where

t - the time of the cash flow;

i - the discount rate (the rate of return that could be earned on an investment in the financial markets with similar risk;

R_t - the net cash flow (the amount of cash, inflow minus outflow) at time t (for educational purposes, R_0 is commonly placed to the left of the sum to emphasize its role as (minus the) investment).

⭐ *The discount rate is the rate used to discount future cash flows to their present values is a key variable of this process.*

A widespread approach to choosing the discount rate factor is to decide the rate which the capital needed for the project could return if invested in an alternative venture. If, for example, the capital required for Project A can earn five percent elsewhere, use this discount rate in the NPV calculation to allow a direct comparison to be made between Project A and the alternative.

NPV is an indicator of how much value an investment or project adds to the firm. With a particular project, if Ct is a positive value, the project is in the status of discounted cash inflow in the time of t. If Ct is a negative value, the project is in the status of discounted cash outflow in the time of t. Appropriately risked projects with a positive NPV could be accepted.

In financial theory, if there is a choice between two mutually exclusive alternatives, the one yielding the higher NPV should be selected. The following sums up the NPVs in various situations (table 9.1).

Table 9.1

NPV value ranges

If...	It means...	Then...
NPV > 0	the investment would add value to the firm	the project may be accepted
NPV < 0	the investment would subtract value from the firm	the project should be rejected
NPV = 0	the investment would neither gain nor lose value for the firm	Decision should be based on other criteria, e.g. strategic positioning or other factors.

Example. A corporation must decide whether to introduce a new product line. The new product will have startup costs, operational costs, and incoming cash flows over six years. This project will have an immediate (t=0) cash outflow of $100,000 (which might include machinery, and employee training costs). Other cash outflows for years 1 – 6 are expected to be $5,000 per year. Cash inflows are expected to be $30,000 each for years 1 – 6. All cash flows are after-tax, and there are no cash flows expected after year 6. The required rate of return is 10%. The present value (PV) can be calculated for each year:

Year	Cashflow	Present Value
T=0	$\dfrac{-100,000}{(1+0.10)^0}$	-$100,000
T=1	$\dfrac{30,000-5,000}{(1+0.10)^1}$	$22,727
T=2	$\dfrac{30,000-5,000}{(1+0.10)^2}$	$20,661
T=3	$\dfrac{30,000-5,000}{(1+0.10)^3}$	$18,783
T=4	$\dfrac{30,000-5,000}{(1+0.10)^4}$	$17,075
T=5	$\dfrac{30,000-5,000}{(1+0.10)^5}$	$15,523
T=6	$\dfrac{30,000-5,000}{(1+0.10)^6}$	$14,112

The sum of all these present values is the net present value, which equals $8,881.52. Since the NPV is greater than zero, it would be better to invest in the project than to do nothing, and the corporation should invest in this project if there is no alternative with a higher NPV.

The PV (Present Value), NPV (Net Present Value), and FV (Future Value) functions all found on the **Financial button's** drop-down menu on the **Ribbon's Formulas tab** (Alt+MI) enable you to determine the profitability of an investment.

The PV, or **Present Value**, function returns the present value of an investment, which is the total amount that a series of future payments is

worth presently. The syntax of the PV function is as follows: =PV(rate,nper,pmt,[fv],[type])

The **fv** and **type** arguments are optional arguments in the function (indicated by the square brackets). The fv argument is the future value or cash balance that you want to have after making your last payment. If you omit the fv argument, Excel assumes a future value of zero (0). The type argument indicates whether the payment is made at the beginning or end of the period: Enter 0 (or omit the type argument) when the payment is made at the end of the period and use 1 when it is made at the beginning of the period.

Figure 9.3 contains several examples using the PV function. All three PV functions use the same annual percentage rate of 7.25 percent and term of 10 years. Because payments are made monthly, each function converts these annual figures into monthly ones.

For example, in the PV function in cell E3, the annual interest rate in cell A3 is converted into a monthly rate by dividing by 12 (A3/12) and the annual term in cell B3 is converted into equivalent monthly periods by multiplying by 12 (B3 x 12).

Fig. 9.3. **Using the PV function to calculate the present value of various investments**

Note that although the PV functions in cells E3 and E5 use the rate, nper, and pmt ($218.46) arguments, their results are slightly different. This is caused by the difference in the type argument in the two functions: the PV function in cell E3 assumes that each payment is made at the end of the period (the type argument is 0 whenever it is omitted), while the PV function in cell E5 assumes that each payment is made at the beginning of the period (indicated by a type argument of 1).When the payment is made at the beginning of the period, the present value of this investment is $0.49 higher than when the payment is made at the end of the period, reflecting the interest accrued during the last period.

The third example in cell E7 (shown in fig. 9.3) uses the PV function with an **fv** argument instead of the **pmt** argument. In this example, the PV function states that you would have to make monthly payments of $3,883.06 for a 10-year period to realize a cash balance of $8,000, assuming that the investment returned a constant annual interest rate of 71/4 percent. Note that when you use the PV function with the fv argument instead of the pmt argument, you must still indicate the position of the pmt argument in the function with a comma (thus the two commas in a row in the function) so that Excel doesn't mistake your fv argument for the pmt argument.

The NPV function calculates the net present value based on a series of cash flows. The syntax of this function is: =NPV(rate,valuel,[value2],[...]), where value 1, value 2, and so on are between 1 and 13 value arguments representing a series of payments (negative values) and income (positive values), each of which is equally spaced in time and occurs at the end of the period. The NPV investment begins one period before the period of the value 1 cash flow and ends with the last cash flow in the argument list. If your first cash flow occurs at the beginning of the period, you must add it to the result of the NPV function rather than include it as one of the arguments.

Figure 9.4 illustrates the use of the NPV function to evaluate the attractiveness of a five-year investment that requires an initial investment of $30,000 (the value in cell G3). The first year, you expect a loss of $22,000 (cell B3); the second year, a profit of $15,000 (cell C3); the third year, a profit of $25,000 (cell D3); the fourth year, a profit of $32,000 (cell E3); and the fifth year, a profit of $38,000 (cell F3). Note that these cell references are used as the value arguments of the NPV function.

Fig. 9.4. **Using the NPV function to calculate the net present value of an investment.**

Unlike when using the PV function, the NPV function doesn't require an even stream of cash flows. The rate argument in the function is set at 8 percent. In this example, this represents the discount rate of the investment; that is, the interest rate that you may expect to get during the five-year period if you put your money into some other type of investment, such as a high-

yield money-market account. This NPV function in cell A3 returns a net present value of $31,718.63, indicating that you can expect to realize about $1,719 more from investing your $30,000 in this investment than you would from investing the money in a money-market account at an interest rate of 8 percent.

The **FV, Future value,** function calculates the future value of an investment. The syntax of this function is: =FV(rate,nper,pmt, [pv] , [type]).

The rate, nper, pmt, and type arguments are the same as those used by the PV function. The pv argument is the present value or lump-sum amount for which you want to calculate the future value. As with the fv and type arguments in the PV function, both the pv and type arguments are optional in the FV function. If you omit these arguments, Excel assumes their values to be zero (0) in the function.

You can use the FV function to calculate the future value of an investment, such as an IRA (Individual Retirement Account). For example, suppose that you establish an IRA at age 43 and will retire 22 years hence at age 65 and that you plan to make annual payments into the IRA at the beginning of each year. If you assume a rate of return of 8.5 percent a year, you would enter the following FV function in your worksheet: =FV(8.5%,22,-1000, ,1).

Excel then indicates that you can expect a future value of $64,053.66 for your IRA when you retire at age 65. If you had established the IRA a year prior and the account already has a present value of $1,085, you would amend the FV function as follows: =FV(8.5%,22,-1000,-1085,1).

In this case, Excel indicates that you can expect a future value of $70,583.22 for your IRA at retirement.

The PMT function. The PMT function calculates the periodic payment for an annuity, assuming a stream of **equal** payments and a constant rate of interest. It's situated on the Financial button's drop-down menu on the Formulas tab of the Ribbon. The PMT function uses the following syntax: =PMT(rate,nper,pv,[fv],[type]).

As with the other common financial functions, **rate** is the interest rate per period, **nper** is the number of periods, **pv** is the present value or the amount the future payments are worth presently, **fv** is the future value or cash balance that you want after the last payment is made.

Excel assumes a future value of **zero** when you omit this optional argument as you would when calculating loan payments, and **type** is the

value 0 for payments made at the end of the period or the value 1 for payments made at the beginning of the period (if you omit the optional type argument, Excel assumes that the payment is made at the end of the period).

The PMT function is often used to calculate the payment for mortgage loans that have a fixed rate of interest. Figure 9.5 shows you a sample worksheet that contains a table using the PMT function to calculate loan payments for a range of interest rates (from 5 percent to 6.75 percent) and principals ($350,000 to $359,000).

Fig. 9.5. **Loan Payments table using the PMT function to calculate various loan payments.**

The table uses the initial principal that you enter in cell B2, copies it to cell A7, and then increases it by $1,000 in the range A8:A16. The table uses the initial interest rate that you enter in cell B3, copies to cell B6, and then increases this initial rate by 1/4 of a percent in the range C6:G6. The term in years in cell B4 is a constant factor that is used in the entire loan payment table.

9.4. Capital assets amortization. Depreciation functions in Excel

⭐ *In economics and accounting, **depreciation** is seen as the change in the market value of capital over a given period of time.It is calculated as the market price of the capital at the beginning of the period minus its market price at the end of the period. The similar concept for intangible assets is called **amortization.***

*For natural resources like minerals and oil the similar concept is called **depletion**.*

Excel lets you choose from four different **Depreciation functions**, each of which uses a slightly different method for depreciating an asset over time. These built-in Depreciation functions found on the Financial button's dropdown menu on the Formulas tab of the Ribbon include the following:

SLN (cost,salvage,life) to calculate straight-line depreciation. This function returns the straight-line depreciation of an asset for one period. It's the simplest and most often used technique, in which the company estimates the "salvage value" of the asset after the length of time over which it is depreciated, and assumes the drop in the asset's value is spread **evenly in equal**, **yearly** increments over that amount of time. The salvage value is an estimate of the value of the asset at the time it will be sold or disposed of;

SYD (cost, salvage, life, per) to calculate sum-of-years' digits depreciation of an asset for a specified period. It`s an accelerated schedule that adds up the digits for the remaining years of the useful life. An asset with three years of remaining useful life would add up 3 + 2 + 1 =6. The depreciation schedule is then 3/6th for the first year, 2/6th for the second and 1/6th for the 3rd year, assuming no remaining value;

DB (cost,salvage,life,period,[month]) to calculate declining balance depreciation. This function returns the depreciation of an asset for a specified period using the fixed-declining balance method;

DDB (cost,salvage,life,period,[factor]) to calculate double-declining balance depreciation. This function returns the depreciation of an asset for a specified period using the double-declining balance method or some other method you specify.

As you can see, with the exception of the optional month argument in the **DB** function and the optional factor argument in the **DDB** function, all the Depreciation functions require the cost, salvage, and life arguments, and all but the **SLN** function require a period argument as well:

Cost is the initial cost of the asset that you're depreciating;

Salvage is the value of the asset at the end of the depreciation (also known as the salvage value of the asset);

Life is the number of periods over which the asset is depreciating (also known as the useful life of the asset);

Per or Period is the period over which the asset is being depreciated. The units that you use in the period argument must be the same as those used in the life argument of the Depreciation function so that if you express

the life argument in years, you must also express the period argument in years.

Note that the DB function accepts an optional month argument. This argument is the number of months that the asset is in use in the first year. If you omit the month argument from your DB function, Excel assumes the number of months of service to be 12.

When using the DDB function to calculate the double-declining balance method of depreciation, you can add an optional factor argument. This argument is the rate at which the balance declines in the depreciation schedule. If you omit this optional factor argument, Excel assumes the rate to be 2 (thus, the name double-declining balance).

Figure 6 contains a Depreciation table that uses all four depreciation methods to calculate the depreciation of office furniture originally costing $50,000 to be depreciated over a 10-year period, assuming a salvage value of $1,000 at the end of this depreciation period.

The Formula bar shown in Figure 9.6 shows the SLN formula that is entered into cell B9: =B8-SLN($B$3,$B$5,$B$4).

Year	Straight Line	SYD	Declining Balance	Double-declining Balance
0	$ 50,000	$ 50,000	$ 50,000	$ 50,000
1	$ 45,100	$ 41,091	$ 33,800	$ 40,000
2	$ 40,200	$ 33,073	$ 22,849	$ 32,000
3	$ 35,300	$ 25,945	$ 15,446	$ 25,600
4	$ 30,400	$ 19,709	$ 10,441	$ 20,480
5	$ 25,500	$ 14,364	$ 7,058	$ 16,384
6	$ 20,600	$ 9,909	$ 4,771	$ 13,107
7	$ 15,700	$ 6,345	$ 3,225	$ 10,486
8	$ 10,800	$ 3,673	$ 2,180	$ 8,389
9	$ 5,900	$ 1,891	$ 1,474	$ 6,711
10	$ 1,000	$ 1,000	$ 996	$ 5,369

Fig. 9.6. **Depreciation Table showing 10-year depreciation of an asset using various methods.**

This formula subtracts the amount of straight-line depreciation to be taken in the first year of service from the original cost of $50,000 (this value is brought forward from cell B3 by the formula =B3). After creating this original formula in cell B9, then the Fill handle was used to copy it down to cell B18, which contains the final salvage value of the asset in the 10th year of service.

Cell C9 contains a similar formula for calculating the sum-of-years-digits depreciation for the office furniture. This cell contains the following formula: =C8-SYD($B$3,$B$5,$B$4,$A9).

This formula subtracts the amount of sum-of-years-digits depreciation to be taken at the end of the first year from the original cost of $50,000 in cell C8 (also brought forward from cell B3 by the formula =B3).

After creating this original formula in cell C9, again Fill handle was used the to copy it down to cell C18, which also contains the final salvage value of the asset in the 10th year of service.

The same basic procedure was used to create the formulas using the **DB** and **DDB** depreciation methods in the cell ranges D8:D18 and E8:E18, respectively.

Note that, like the SYD function, both of these depreciation functions require the use of a period argument, which is supplied by the list of years in the cell range A9:A18.

Note also, that the values in cell B4, which supplies the life argument to the SYD, DB, and DDB functions, matches the year units used in this cell range.

■ Questions

1. How does MS Excel interpret date and time values?
2. What are main date functions?
3. Which date function is responsible for filling-in the current date?
4. For what purpose PV and FV functions are used?
5. What economic method is supported by NPV function?
6. What is depreciation of assets? What functions are used to calculate depreciation?
7. What is the difference between straight-line depreciation method and other depreciation methods?

Theme 10. Use of MS Excel as a database management software. Data look-up and retrieval methods

Databases

Characteristics

Requirements

Using Microsoft Excel as a database

Basic Lookup functions: VLOOKUP and HLOOKUP

One-way look-up

Vertical look-up

Horizontal look-up

Performing a two-way lookup in MS Excel

Two-way look-up

INDEX function

MATCH function

Sorting and filtering of information in MS Excel databases
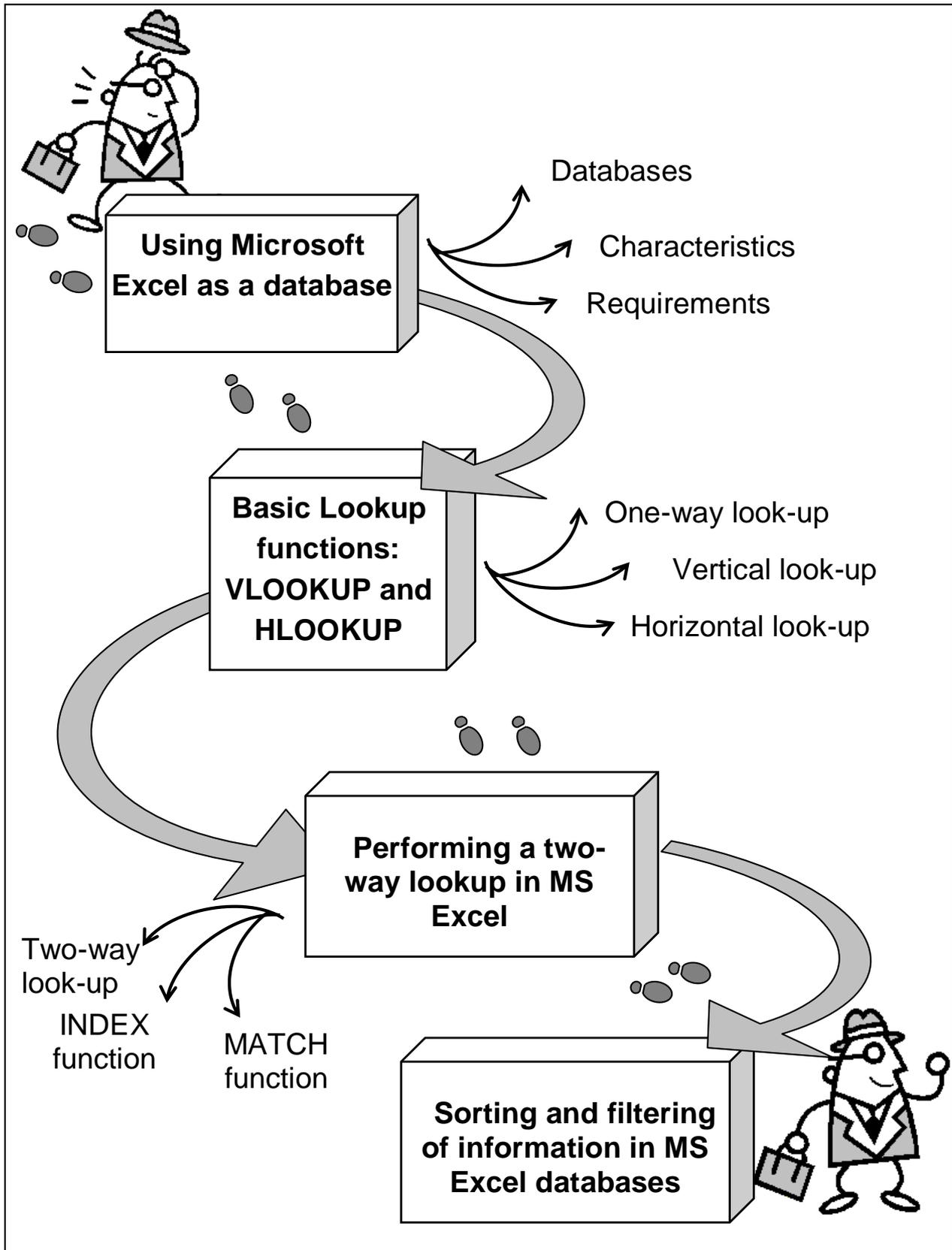
Fig. 10.1. **System elements of the theme**

■ Introduction

The purpose of this theme lies in a close study of main features of MS Office Excel as a database management software. Basic operations on data look-up and retrieval are considered together with the functions that support these processes. Data filtering and sorting procedures are given a thorough consideration both from the conceptual and technological points of view.

Clue notions of the theme include: database; data entries; vertical look-up; horizontal look-up; two-way look-up; sorting; filtering.

This theme covers the following **topics:** Study of database basics. Basic operations with look-up and retrieval of information. Study of two-way look-up cases. Operations concerned with sorting and filtering of information.

As a result of the study of the material presented in this theme students will acquire the following **competencies**:

they would learn basic characteristics of databases in MS Excel;

they would study requirements for database creation and use;

they would learn main look-up functions in MS Excel;

they would study the use of sorting and filtering tools in MS Excel.

10.1. Using Microsoft Excel as a database

MS Excel is a spreadsheet program. It is in fact the application of choice for the majority of businesses globally. Excel has therefore been primarily used for developing departmental budgets, expense reports and a host of other accounting or financial deliverables. What some users of MS Excel do not know is that the software possesses excellent database tools built right into it.

Though MS Excel isn't a specialized database software, still many people use MS Excel as a database. Excel can be a convenient way to store information as a database as long as the information is not too cumbersome to be contained in a spreadsheet format. Because Microsoft Office comes with Excel, using Excel as a database is less expensive than purchasing additional software to house a database.

⭐ *A database consists of an organized collection of data for one or more uses, typically in digital form.*

One way of classifying databases involves the type of their contents, for example: bibliographic, document-text, statistical. Digital databases are managed using database management systems, which store database

contents, allowing data creation and maintenance, and search and other access.

In order to take full advantage of MS Excel's database features it is important to structure you data properly. For professional looking databases spreadsheets always use consistent formatting, e.g., using the same formats for the column labels and row containers. Here some recommendations on how to set up an excel spreadsheet as a database:

identify the data you want to include in the database. Before you can set up a spreadsheet as a database, you need to know what information you will be tracking;

use Row 1 as headings for each item that you plan to track. For example, if you plan to use Excel as a database for contact information, you would include name, address, cell number and other headings across Row 1;

format Row 1. Change the formatting of Row 1 to separate the headings from the data in your database. To do this, click the number one next to Row 1, which highlights the entire row. Add your formatting, such as bold, center and a gray background;

freeze the heading row. Use the freeze pane feature so that your headings will always appear at the top of the database. For that click on the number two next to Row 2 to highlight the first row under the headings. Click the View tab. Click Freeze Panes and then Freeze Top Row;

type in the data. Use one row for each database entry, keying in the information to match the heading information;

sort the data in the database. After you enter the information into the database, you can view the data in a variety of ways.

Most common operations on data in excel databases are look-up, sorting and filtering of information.

10.2. Basic Lookup functions: VLOOKUP and HLOOKUP

In some cases it may become necessary to look for and retrieve some data entries from a database. MS Excel has built-in look-up functions to perform this task.

The lookup functions are located on the **Lookup & Reference** command button's drop-down list (Alt+MO) on the **Ribbon's Formulas tab**. Excel makes it easy to perform table lookups that either return information about entries in the table or actually return related data to other data lists in the spreadsheet. By using Lookup tables to input information into a data list,

you not only reduce the amount of data input that you have to do, but also eliminate the possibility of data entry errors. Using Lookup tables also makes it a snap to update your data lists: All you have to do is make the edits to the entries in the original Lookup table or schedule to have all their data entries in the list updated as well.

The most popular of the lookup functions are HLOOKUP (for Horizontal Lookup) and VLOOKUP (for Vertical Lookup) functions. These functions are located in the Lookup & Reference category in the Insert Function dialog box. They are part of a powerful group of functions that can return values by looking them up in data tables.

The **VLOOKUP** function searches vertically (top to bottom) the leftmost column of a Lookup table until the program locates a value that matches or exceeds the one you are looking up. The **HLOOKUP** function searches horizontally (left to right) the topmost row of a Lookup table until it locates a value that matches or exceeds the one that you're looking up.

The **VLOOKUP** function uses the following syntax: =VLOOKUP(lookup_value, table_array, col_index_num, [range_lookup])

The **HLOOKUP** function follows the nearly identical syntax: =HLOOKUP(lookup_value, table_array, row_index_num, [range_lookup])

In both functions, the *lookup_value* argument is the value that you want to look up in the Lookup table, table_array is the cell range or name of the Lookup table that contains both the value to look up and the related value to return.

The *col_index_num* argument in the VLOOKUP function is the number of the column whose values are compared to the *lookup_value* argument in a vertical table. The *row_index_num* argument in the HLOOKUP function is the number of the row whose values are compared to the *lookup_value* in a horizontal table.

When entering the *col_index_num* or *row_index_num* arguments in the VLOOKUP and HLOOKUP functions, you must enter a value greater than zero that does not exceed the total number of columns or rows in the Lookup table.

The optional ***range_lookup*** argument in both the VLOOKUP and the HLOOKUP functions is the logical **TRUE** or **FALSE** that specifies whether you want Excel to find an exact or approximate match for the *lookup_value* in the table_array. When you specify TRUE or omit the *range_lookup* argument

in the VLOOKUP or HLOOKUP function, Excel finds an approximate match. When you specify FALSE as the *range_lookup* argument, Excel finds only exact matches.

Finding approximate matches is appropriate only when you're looking up numeric entries (rather than text) in the first column or row of the vertical or horizontal Lookup table. When Excel doesn't find an exact match in this Lookup column or row, it locates the next highest value that doesn't exceed the *lookup_value* argument and then returns the value in the column or row designated by the *col_ndex_num* or *row_index_num* arguments.

When using the VLOOKUP and HLOOKUP functions, the text or numeric entries in the Lookup column or row (that is, the leftmost column of a vertical Lookup table or the top row of a horizontal Lookup table) must be unique.

Figure 10.2 shows an example of using the VLOOKUP function to return either a 15% or 20% tip from a tip table, depending on the pretax total of the check.

Fig. 10.2. **Using the VLOOKUP function to return the amount of the tip to add from a Lookup table**

Cell F5 contains the VLOOKUP function:

=VLOOKUP(Pretax_Total, Tip_Table, IF(Tip_Percentage=0.15,2,3)).

This formula returns the amount of the tip based on the tip percentage in cell F3 and the pretax amount of the check in cell F4.

To use this tip table, enter the percentage of the tip (15% or 20%) in cell F1 (named Tip_Percentage) and the amount of the check before tax in cell F2 (named Pretax_Total). Excel then looks up the value that you enter in the

Pretax_Total cell in the first column of the Lookup table, which includes the cell range A2:C31 and is named Tip_Table.

Excel then moves down the values in the first column of Tip_Table until it finds a match, whereupon the program uses the *col_index_num* argument in the VLOOKUP function to determine which tip amount from that row of the table to return **to cell** F3. If Excel finds that the value entered in the Pretax_Total cell ($16.50 in this example) doesn't exactly match one of the values in the first column of Tip_Table, the program continues to search down the comparison range until it encounters the first value that exceeds the pretax total (17.00 in cell A19 in this example). Excel then moves back up to the previous row in the table and returns the value in the column that matches the *col_index_num* argument of the VLOOKUP function (this is because the optional *range_lookup* argument has been omitted from the function).

Note that the tip table example in Figure 2 uses an IF function to determine the *col_index_num* argument for the VLOOKUP function in cell F3. The IF function determines the column number to be used in the tip table by matching the percentage entered in Tip_Percentage (cell F1) with 0.15. If they match, the function returns 2 as the *col_index_num* argument and the VLOOKUP function returns a value from the second column (the 15% column B) in the Tip_Table range. Otherwise, the IF function returns 3 as the *col_index_num* argument and the VLOOKUP function returns a value from the third column (the 20% column C) in the Tip_Table range.

Figure 10.3 shows an example that uses the HLOOKUP function to look up the price of each bakery item stored in a separate price Lookup table and then to return that price to the Price/Doz column of the Daily Sales list. Cell F3 contains the original formula with the HLOOKUP function that is then copied down column F: =HLOOKUP(item,prices,2,FALSE)

In this HLOOKUP function, the range name Item that's given to the Item column in the range C3:C27 is defined as the *lookup_value* argument and the cell range name Prices that's given to the cell range J1:M2 is the *table_array* argument. The *row_index_num* argument is 2 because you want Excel to return the prices in the second row of the Prices Lookup table, and the optional *range_lookup* argument is FALSE because the item name in the Daily Sales list must match exactly the item name in the Prices Lookup table.

By having the HLOOKUP function use the Prices Lookup table to input the price per dozen for each bakery goods item in the Daily Sales list, you make it a very simple matter to update any of the sales in the list.
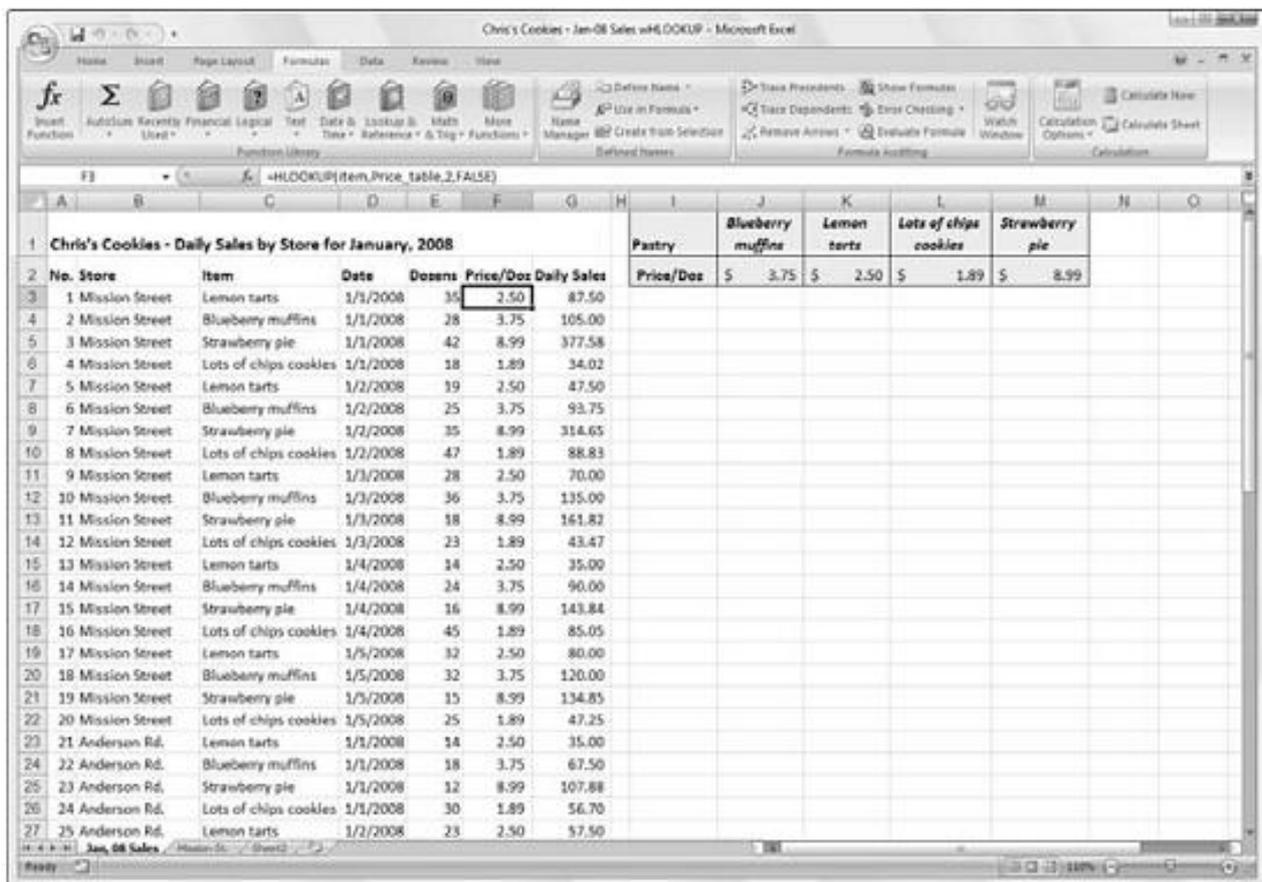
Fig. 10.3. **Using the HLOOKUP function to return the price of a bakery item from a Lookup table**

All you have to do is change its Price/Doz cost in the Prices Lookup table, and the HLOOKUP function immediately updates the new price in the Daily Sales list wherever the item is sold.

10.3. Performing a two-way lookup: MATCH and INDEX functions

In both the VLOOKUP and HLOOKUP examples, Excel only compares a **single value** in the data list to a **single value** in the **vertical or horizontal Lookup table**. Sometimes, however, you may have a table in which you need to perform a two-way lookup, whereby a piece of data is retrieved from the Lookup table based on looking up a value *in the top row* (with the table's column headings) and a value in **the first column** (with the table's row headings).

Figure 10.4 illustrates a situation in which you would use two values, the production date and the part number, to look up the expected production. In the 2008 Production Schedule table, the production dates for each part form the column headings in the first row of the table, and the part numbers form the row headings in its first column of the table.

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Fig. 10.4. **Doing a two-way lookup in the Production Schedule table.**

To look up the number of parts to be produced for a particular month, you need to the use a bit complicated technology that consists of two functions: the MATCH function and the INDEX function. The MATCH function returns the **relative position** of a particular value in a cell range or array. The syntax of the MATCH function is as follows: =MATCH(lookup_value, lookup_array, [match_type]).

The *lookup_value* argument is the value whose **position** you want returned when a match is found, and the *lookup_array* is the cell range or array containing the values that you want to match. The optional match *Type* argument is the number 1, 0, or -1, which specifies how Excel matches the value specified by the *lookup_value* argument in the range specified by the *lookup_array* argument. There are several rules about using of the *match_type*:

use *match_type* 1 to find the largest value that is less than or equal to the lookup_value;

use *matc_type* 0 to find the first value that is exactly equal to the lookup value;

use *match_type* -1 to find the smallest value that is greater than or equal to the lookup value.

In addition to looking up the **position** of the production date and part number in the column and row headings in the Production Schedule table, we need to use an INDEX function, which uses the relative **row and column number** position to **return** the number to be produced from the table itself. The INDEX function follows two different syntax forms: array and reference. You use the array form when you want a value returned from the table (as

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you do in this example), and you use the reference form when you want a reference returned from the table. The syntax of the array form of the INDEX function is as follows: =INDEX(array,[row_num],[col_num])

The syntax of the reference form of the INDEX function is as follows: =INDEX(reference,[row_num],[col_num],[area_num])

The array argument of the array form of the INDEX function is a **range of cells** or array constant that you want Excel to use in the lookup. If this range or constant contains only one row or column, the corresponding *row_num* or *col_num* arguments are optional. If the range or array constant has more than one row or more than one column, and you have to **specify** both the *row_num* and the *col_num* arguments. Excel then returns the value in the array argument that is located at the **intersection** of the row_num argument and the col_num argument.

So, for the INDEX function to find the lookup value we need to know (or find out) the row and column numbers of this lookup value in the lookup table. This job in our case would be done by the MATCH function.

For the MATCH and INDEX functions in the example shown in Figure 4 assigned the following range names to the following cell ranges:

Table_data to the cell range A2:J6 with the production data plus <u>column and row headings;</u>

Part_list to the cell range A2:A6 with the <u>row headings</u> in the first column of the table;

Date_list to the cell range A2:J2 with the <u>column headings</u> in the first row of the table;

Part_lookup to cell B10 that contains the name of the part to look up in the table;

Date_lookup to cell BI1 that contains the name of the production date to look up in the table.

As Figure 4shows, cell B12 contains a rather long and - at first glance - complex formula using the range names outlined previously and combining the INDEX and MATCH functions:

=INDEX(table_data,MATCH(part_lookup,part_list),MATCH(date_ lookup,date_list))

So you can better understand how this formula works, we'll break the formula down into its three major components: the first MATCH function that returns the *row_num* argument for the INDEX function, the second MATCH

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function that returns the *col_num* argument for the INDEX function, and the INDEX function itself that uses the values returned by the two MATCH functions to return the number of parts produced.

The first MATCH function that returns the row_num argument for the INDEX function is: =MATCH(part_lookup,part_list)

This MATCH function uses the value input into cell B10 (named part_lookup) and looks up its position in the cell range A2:A6 (named part_list). It then returns this row number to the INDEX function as its row_num argument. In the case of the example shown in Figure 1 where part AB-102 is entered in the part_lookup cell in B10, Excel returns 4 as the row_num argument to the INDEX function.

The second MATCH function that returns the col_num argument for the INDEX function is: =MATCH(date_lookup,date_list)

This second MATCH function uses the value input into cell Bll (named date_lookup) and looks up its position in the cell range A2:J2 (named dat_list). It then returns this column number to the INDEX function as its col_num argument. In the case of the example shown in Figure 1 where June 1, 2008 (formatted as Jun-08), is entered in the date_lookup cell in Bll, Excel returns 4 as the col_num argument to the INDEX function.

This means that for all its supposed complexity, the INDEX function shown on the Formula bar in Figure 1 contains the equivalent of the following formula:

= INDEX(table_data,4, 4), where 4 and 4 are supplied by the MATCH function.

Excel then returns 306 as the planned production value for part AB-102 in June, 2008.

10.4. Sorting and filtering of information in MS Excel databases

Sorting and Filtering allow you to manipulate data in a worksheet based on given set of criteria.

★ *Sorting is any process of arranging items in some sequence and/or in different sets. The main purpose of sorting information is to optimize its usefulness for specific tasks.*

To execute a basic descending or ascending sort based on one column:
highlight the cells that will be sorted;
click the **Sort & Filter** button on the **Home** tab;

click the **Sort Ascending** (A-Z) button or **Sort Descending** (Z-A) button (fig. 10.5).
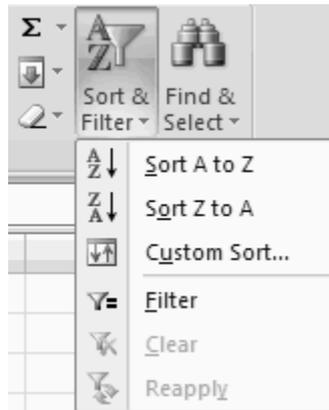
Fig. 10.5. **Basic sorts**

To sort on the basis of more than one column:

click the **Sort & Filter** button on the **Home** tab;

choose which column you want to sort by first;

click **Add Level** and Choose the next column you want to sort and Click **OK** (fig. 10.6).

Fig. 10.6. **Custom sorts**

⋆ *Filtering is a process of data structuring (typically a list) in some order to produce a new data structure containing exactly those elements of the original data structure according to a certain criteria.*

Filtering allows you to display only data that meet certain criteria. To filter:

click the column or columns that contain the data you wish to filter;

on the **Home** tab, click on **Sort & Filter and** Click **Filter** button;

click the **Arrow** at the bottom of the first cell and Click the **Text Filter**; click the **Words** you wish to Filter (fig. 10.7).
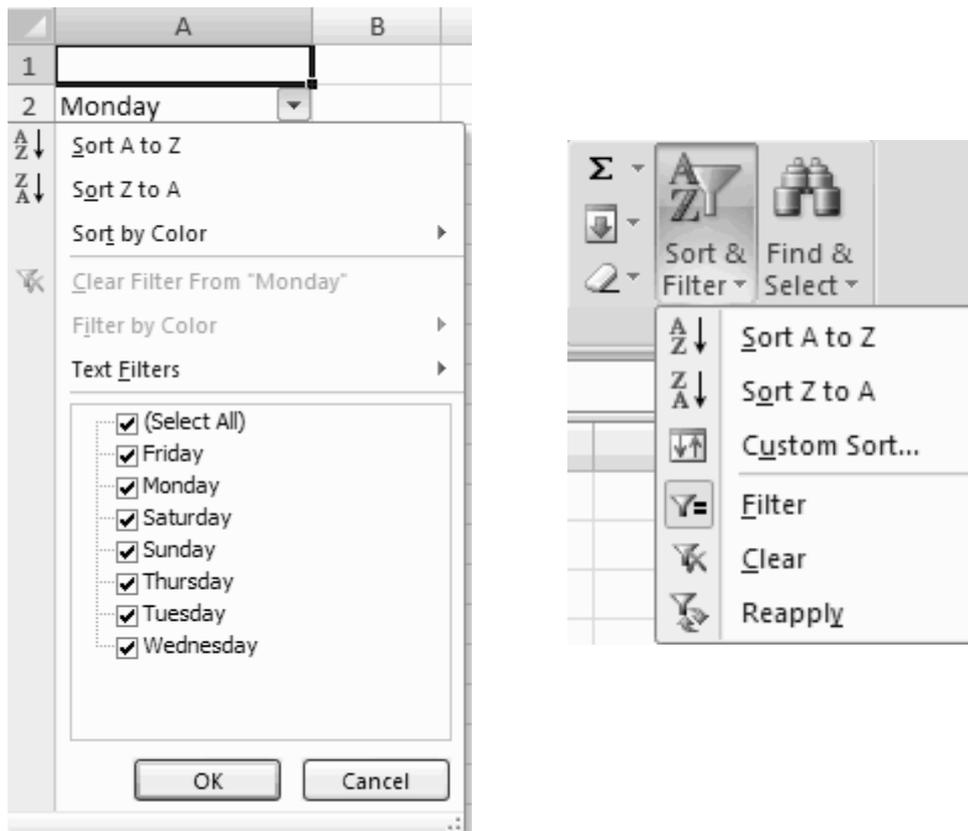
Fig 10.7. **Filtering of data**

To clear the filter click the **Sort & Filter** button and after that lick **Clear** (fig. 10.7).

■ Questions

1. What are the main requirements for MS Excel database?
2. What is the principle of performing one-way look-up?
3. What is the difference between one-way and two-way look-ups?
4. What is the purpose of filtering information in a database?
5. What sorting options are available in MS Excel?

Theme 11. Use of graphics in MS Excel: creation, editing and formatting of diagrams

Types of charts

Charts' elements

Charts basics: graphic objects` main elements and their purpose

Charts' attributes

Creating charts in MS Office Excel

Styles

Layouts

Design
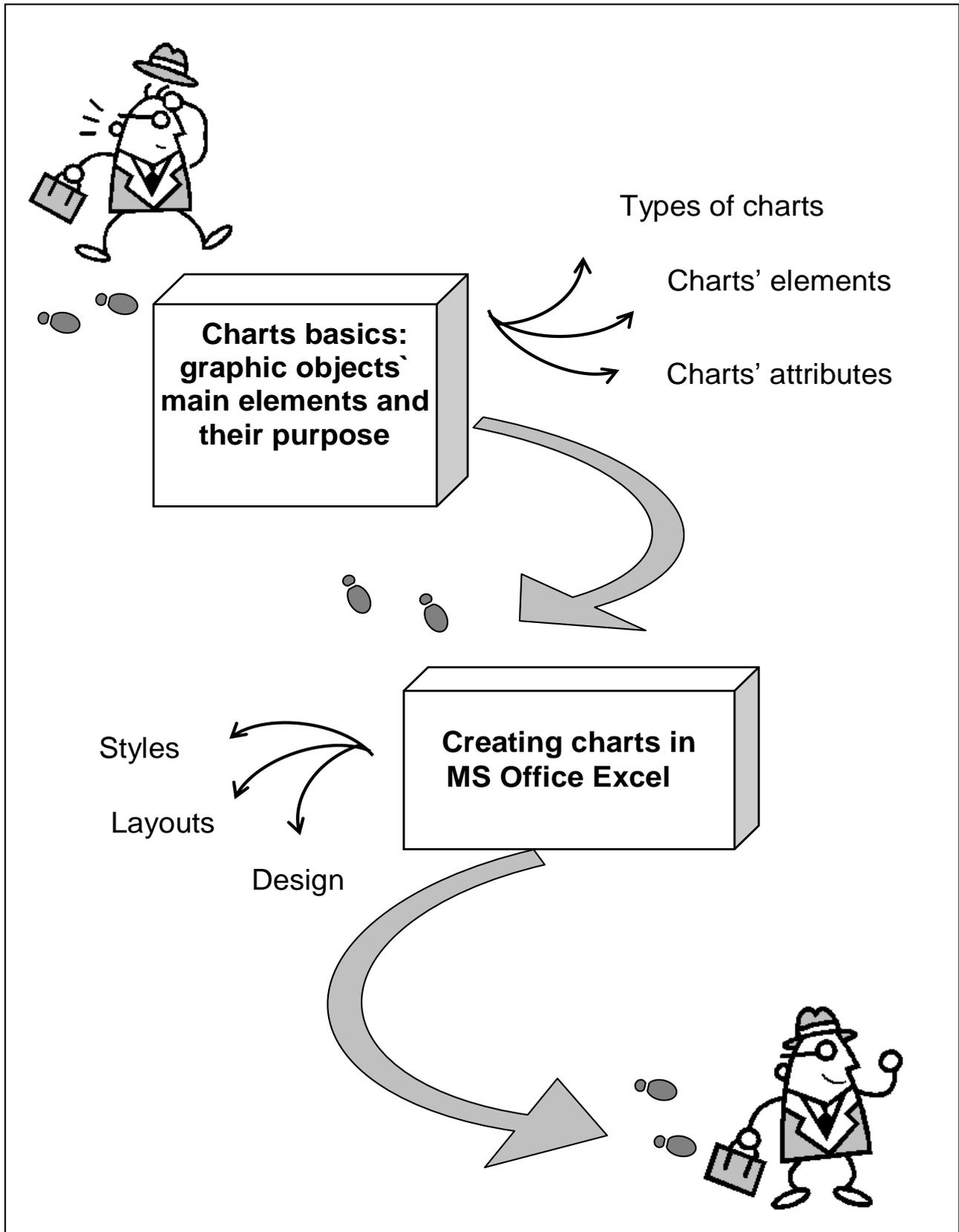
Fig. 11.1. **System elements of the theme**

■ Introduction

The purpose of this theme lies in a close study of charts and their use in MS Office Excel. Charts` element and attributes are analyzed and ways of diagrams creation, editing and formatting are given a thorough consideration.

Clue notions of the theme include: charts; axis; headings; labels; layouts; styles; design; grid of lines.

This theme covers the following **topics:** Basic operations with charts: creation, formatting and editing. Study of different chart types. Charts' basic elements: heading, grid, axis, legend. Moving of chart objects.

As a result of the study of the material presented in this theme students will acquire the following **competencies**:

they would learn how to use basic chart types;

they would master basic methods of charts creation;

they would learn how to format and edit charts;

they would practice different ways of data representation using different types of charts.

11.1. Charts basics: graphic objects' main elements and their purpose

⋆ *A chart is a visual representation of data, in which the data are represented by symbols such as bars in a bar chart or lines in a line chart. A chart can represent tabular numeric data, functions or some kinds of qualitative structures.*

Charts are often used to ease understanding of large quantities of data and the relationships between parts of the data. Charts can usually be read more quickly than the raw data that they are produced from. They are used in a wide variety of fields, and can be created by hand (often on graph paper) or by computer using a charting application.

Certain types of charts are more useful for presenting a given data set than others. For example, data that present percentages in different groups (such as "satisfied, not satisfied, unsure") are often displayed in a pie chart, but may be more easily understood when presented in a horizontal bar chart. On the other hand, data that represents numbers that change over a period of time (such as "annual revenue from 1990 to 2000") might be best shown as a line chart.

A chart can take a large variety of forms, however there are common features that provide the chart with its ability to extract meaning from data.

Typically a chart is graphical, containing very little text, since humans are generally able to infer meaning from pictures quicker than from text. One of the more important uses of text in a graph is in the title. **A graph's title** usually appears above the main graphic and provides a succinct (brief) description of what the data in the graph refers to.

Dimensions in the data are often displayed on **axes**. If a horizontal and a vertical axis are used, they are usually referred to as the **x-axis** and **y-axis** respectively. Each axis will have a scale, denoted by periodic graduations and usually accompanied by numerical or categorical indications. Each axis will typically also have a label displayed outside or beside it, briefly describing the dimension represented. If the scale is numerical, the label will often be suffixed with the unit of that scale in parentheses. For example, "Distance travelled (m)" is a typical x-axis label and would mean that the distance travelled in metres is related to the horizontal position of the data.

Within the graph a **grid of lines** may appear to aid in the visual alignment of data. The grid can be enhanced by visually emphasising the lines at regular or significant graduations. The emphasized lines are then called major grid lines and the rest of the grid lines are minor grid lines.

The data of a chart can appear in all manner of formats, with or without individual labels. It may appear as dots or shapes, connected or unconnected, and in any combination of colors and patterns. Inferences or points of interest can be overlayed directly on the graph to further aid information extraction.

When the data appearing in a chart contains multiple variables, the chart may include a **legend**. A legend contains a list of the variables appearing in the chart and an example of their appearance. This information allows the data from each variable to be identified in the chart.

11.2. Creating charts in MS Excel

In Microsoft Excel, you can represent numbers in a chart. Charts allow you to present information contained in the worksheet in a graphic format. On the **Insert tab**, you can choose from a variety of chart types, including column, line, pie, bar, area, and scatter. The basic procedure for creating a chart is the same no matter what type of chart you choose. As you change

your data, your chart will automatically update.To view the charts available click the Insert Tab on the Ribbon.

You select a chart type by choosing an option from the Insert tab's **Chart group**. After you choose a chart type, such as column, line, or bar, you choose a chart **sub-type**. For example, after you choose Column Chart, you can choose to have your chart represented as a two-dimensional chart, a three-dimensional chart, a cylinder chart, a cone chart, or a pyramid chart. There are further sub-types within each of these categories. As you roll your mouse pointer over each option, Excel supplies a brief description of each chart sub-type. To create a chart:

select the **cells** that contain the data you want to use in the chart;

click the **Insert** tab on the Ribbon;

click the type of **Chart** you want to create (fig. 11.2).
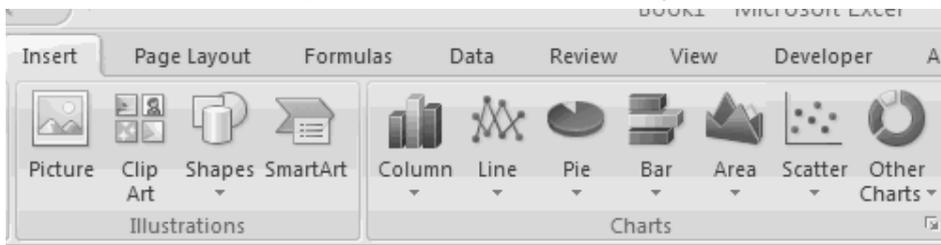
Fig. 11.2. **Insert chart option**

Once you have created a chart you can do several things to modify the chart. To move the chart click the **Chart** and **Drag** it another location on the same worksheet, or click the **Move Chart** button on the **Design** tab and choose the desired location (either a new sheet or a current sheet in the workbook). To change the data included in the chart click the **Chart,** then click the **Select Data** button on the **Design** tab (fig. 11.3).
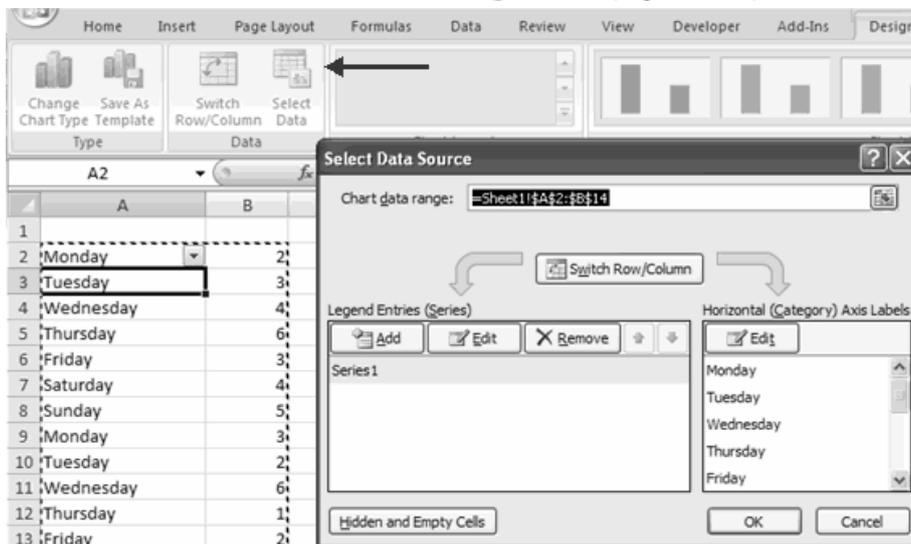
Fig. 11.3. **Data source dialog box**

To reverse which data are displayed in the rows and columns click the **Chart** and then click the **Switch Row/Column** button on the **Design** tab (fig. 11.4).
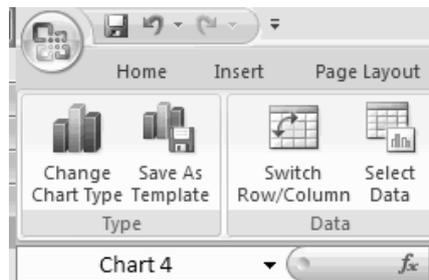
Fig. 11.4. **Switch Row/Column option**

To modify the labels and titles:

click the **Chart;**

on the **Layout** tab, click the **Chart Title** or the **Data Labels** button;

change the **Title** and click **Enter** (fig. 11.5).
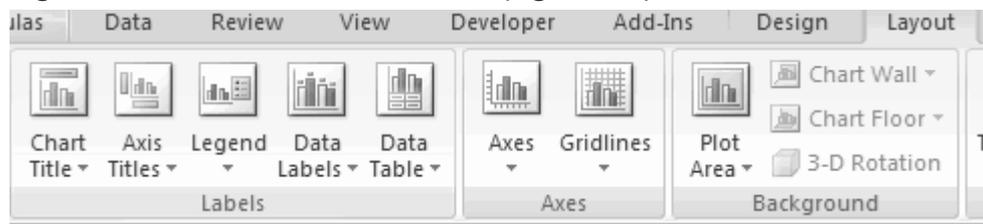
Fig. 11.5. **Labels change group**

The Chart Tools appear on the Ribbon when you click on the chart. The tools are located on three tabs: Design, Layout, and Format. Within the **Design** tab you can control the chart type, layout, styles, and location (fig. 11.6). The tabs become available when you create a new chart or when you click on a chart. You can use these tabs to customize your chart.
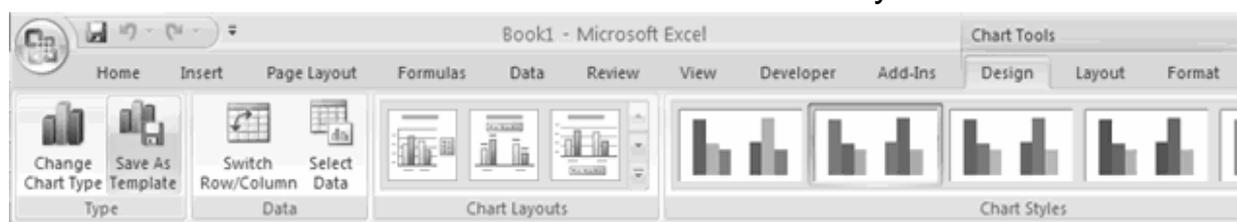
Fig. 11.6. **Chart Tools group**

You can determine what your chart displays by choosing a layout. For example, the layout you choose determines whether your chart displays a title, where the title displays, whether your chart has a legend, where the legend displays, whether the chart has axis labels and so on. Excel provides several layouts from which you can choose. Within the **Layout** tab you can control inserting pictures, shapes and text boxes, labels, axes, background,

and analysis. Within the **Format** tab you can modify shape styles, word styles and size of the chart (fig. 11.7).
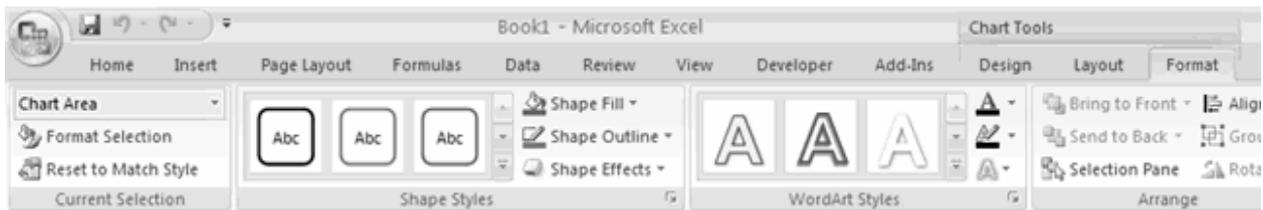
Fig. 11.7. **Format Chart options**

A **style** is a set of formatting options. You can use a style to change the color and format of your chart. Excel has several predefined styles that you can use. They are numbered from left to right, starting with 1, which is located in the upper-left corner.

When you click a chart, **handles** appear on the right and left sides, the top and bottom, and the corners of the chart. You can drag the handles on the top and bottom of the chart to increase or decrease the height of the chart. You can drag the handles on the left and right sides to increase or decrease the width of the chart. You can drag the handles on the corners to increase or decrease the size of the chart proportionally. You can change the position of a chart by clicking on an unused area of the chart and dragging.

It is possible to copy a chart to MS Word. In order to do it you should select the chart; click Copy on the Home tab; then go to the Word document where you want the chart to be located; click Paste on the Home tab.

■ **Questions**

1. What is a chart and for what purposes is it used?
2. What are the main elements of a chart?
3. Is it possible to remove a grid of lines from a chart?
4. What formatting tools are available in MS Excel to change the looks of a chart?
5. Is it possible to use charts created in MS Excel in other MS Office applications?

Section 5. Database management systems. MS Office Access
Theme 12. Getting familiar with Microsoft Access database manager
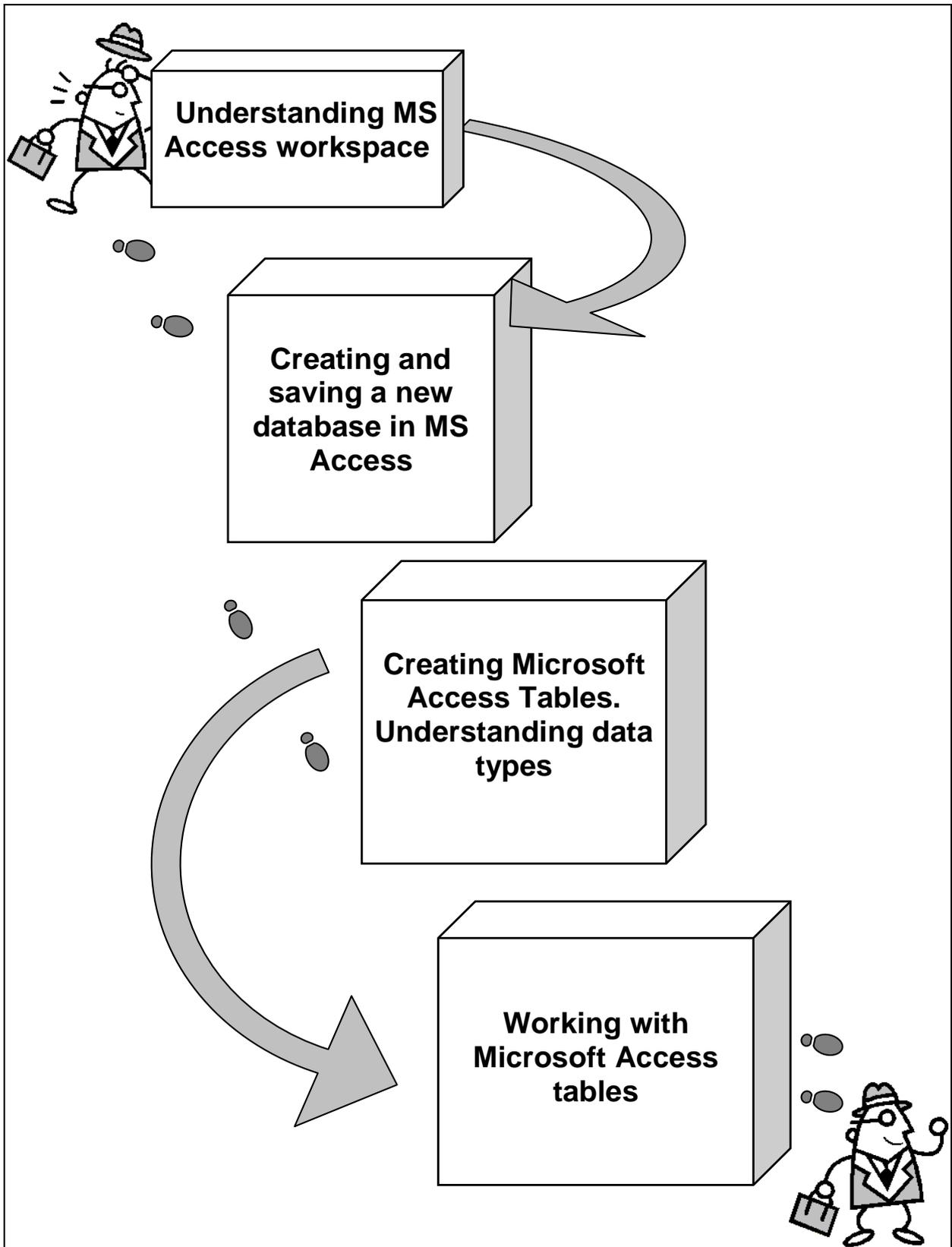
Fig. 12.1. **System elements of the theme**

■ Introduction

The purpose of this theme is concerned with the study of main features of MS Office Access database management system. The program's interface is considered in detail and basic operations concerned with the creation and modification of tables are given a special attention. Data types are analyzed and data entry techniques are considered.

Clue notions of the theme include: database; tables; fields; primary key; data types; names; records, draft mode; work mode.

This theme covers the following **topics:** Introduction to MS Access database management system. Program's interface customizing and basic options study. Creating tables. Entering and erasing data. Basic operations with data entries. Tables adjusting and fitting.

As a result of the study of the material represented in this theme students will acquire the following **competencies**:

they would get acquainted with the program's interface features;

they would learn how to input and edit data and move across the database;

they would learn how to perform basic operations with data entries;

they would become aware of the use of basic data types;

they would learn how to format and edit tables.

12.1. Understanding MS Access workspace

Microsoft Access is a database software package.

⭐ A ***database*** is an organized collection of records.

Telephone and address books are examples of paper databases. With MS Access, it is possible create a computerized database. For example, you can use Access to organize the students who attend a school, the courses they take, and the instructors who teach them. After you create an Access database, you can search it, manipulate it, and extract information from it.

You use windows to interact with Access. After you start MS Access your screen will look similar to the one shown on Figure 12.1.

From this initial screen, the user can create a new database (either blank or with some tables created with the database wizard), or open up an existing database. In general, the first time one begins a project, a new, blank database should be created. After that point, use the *Open existing database* option to re-open the database created previously. If you have

previously created a database, and then create it again using the same name, you will overwrite any work you have done.

Fig. 12.1. **MS Access start screen**

Northwind is a sample database you can download from the Microsoft website. We will use the Northwind database to introduce MS Access windows.

An Access database consists of the following objects: tables, queries, forms, reports, macros, and modules. The Navigation pane displays the objects in a database (fig. 12.2).

Fig. 12.2. **MS Access navigation pane**

In order to manipulate the Navigation pane you can lick the double right-arrows ⟫ to open or close it. In this example, the objects are organized by type, which is not the default setting. You may want to organize the objects

in your database by type also. You can use the down-arrow on the top of the Navigation pane to change the manner in which objects are organized (fig. 12.3).
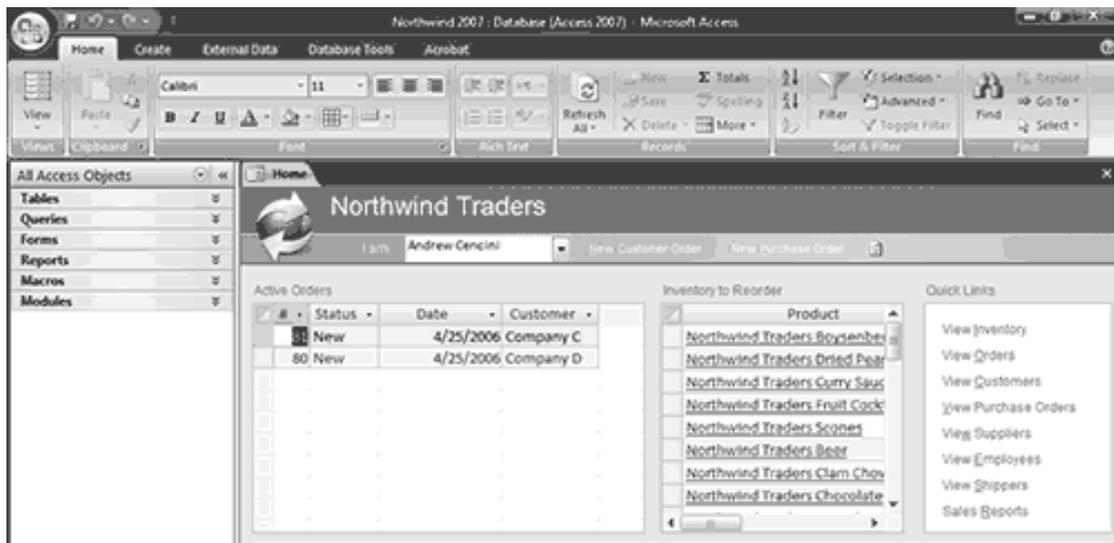
Fig. 12.3. **The Access window with the Northwind database open**

In the upper-left corner of the Access window is the Microsoft Office button. When you click the button, a menu appears. You can use the menu to create a new file, open an existing file, save a file, and perform many other tasks. Next to the Microsoft Office button is the Quick Access toolbar. The Quick Access toolbar provides you with access to commands you frequently use. By default, Save, Undo, and Redo appear on the Quick Access toolbar. You use Save to save an object, Undo to roll back an action you have taken, and Redo to reapply an action you have rolled back. The Title bar is located at the top in the center of the Access window. The Title bar displays the name of the database on which you are currently working.

You use commands to tell Access what to do. The Ribbon is used to issue commands. The Ribbon is located near the top of the Access window, below the Quick Access toolbar. At the top of the Ribbon are several tabs; clicking a tab displays related command groups. Within each group are related command buttons. You click buttons to issue commands or to access menus and dialog boxes. You may also find a dialog box launcher ⊡ in the bottom-right corner of a group. When you click the dialog box launcher ⊡, a dialog box makes additional commands available.

The Navigation pane stores the objects in your database: tables, queries, forms, reports, macros, and modules. Objects always display with an icon to the right. The icon tells you the object type: ⊞ table, ⊡ query, ⊟ form, ⊟ report, ⊿ macro, and ⁂ module (fig. 12.4).

Fig. 12.4. **MS Access objects**

Tables. In Access, data is stored in tables. A table is a set of columns and rows, with each column referred to as a field. Each value in a field represents a single type of data. Each row of a table is referred to as a record.

Queries. You use queries to retrieve specific data from your database and to answer questions about your data. For example, you can use a query to find the names of the employees in your database who live in a particular state.

Forms. Forms give you the ability to choose the format and arrangement of fields. You can use a form to enter, edit, and display data.

Reports. Reports organize or summarize your data so you can print it or view it onscreen. You often use reports when you want to analyze your data or present your data to others.

Macros. Macros give you the ability to automate tasks. You can use a macro to add functionality to a form, report, or control.

Modules. Like macros, modules give you the ability to automate tasks and add functionality to a form, report, or control. Macros are created by choosing from a list of macro actions, whereas modules are written in Visual Basic for Application.

You double-click an object to open the object. You right-click an object to view a menu of options. You can use the menu to do such things as open objects, rename objects, and delete objects.

Objects that are open appear on tabs. Right-click a tab to view a menu of options you can perform, such as save the object, close the object, or change the view (fig. 12.5).

A view is a way of looking at an object. For example, in Access, data is stored in tables. Two of the possible ways you can view a table are Datasheet view and Design view.

You can see the data contained in a table in Datasheet view.
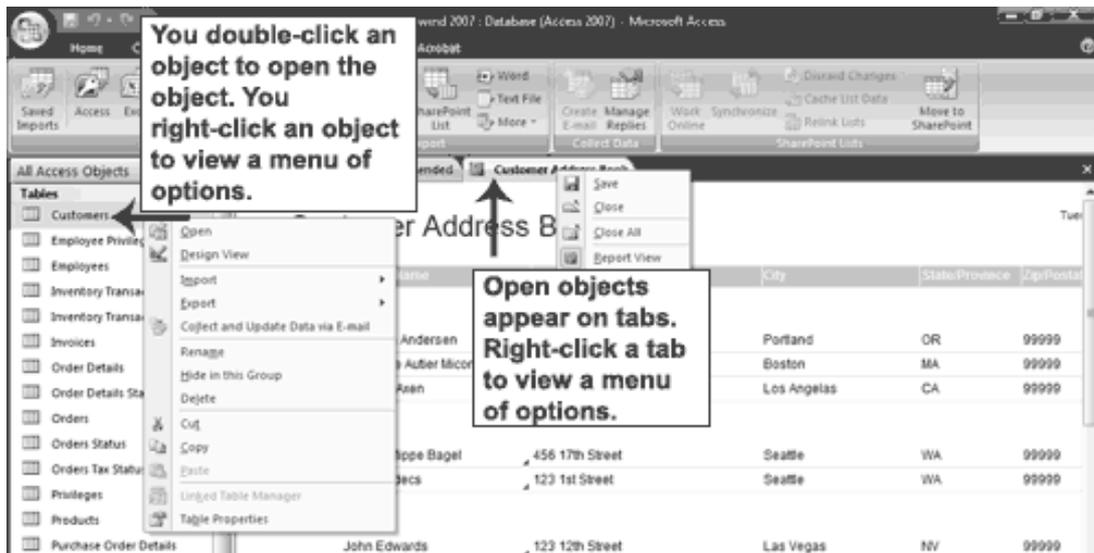
Fig. 12.5. **Manipulation with objects in MS Access**

You can see the design of a table in Design view. When you open an object, buttons ▦⊞⌂✉ appear in the lower-right corner of the Access window. You can use the View button on the Home tab to change views, or you can click the proper button in the lower-right corner of the window.

12.2. Creating and saving a new database in MS Access

When you start Access, the Getting Started With Microsoft Office Access screen appears (refer to fig. 1). You can use this screen to create a database. Within a database, you can do such things as enter data, create reports, and retrieve data. You can create a blank database or you can use one of the templates provided by Microsoft. When you use a template, Access creates forms you can use to enter data, reports you can use to retrieve data, and more. You can modify the forms, reports, and other objects to suit your needs. This tutorial will teach you how.

The following templates are included with Access: Assets, Contacts, Events, Faculty, Issues, Marketing Projects, Projects, Sales Pipeline, Students, and Tasks. Other templates are available online. Each template creates a database related to the title. For example, the Faculty template creates a faculty database that includes tables, queries, forms, and reports related to faculty. In Access, you use tables to store data, queries to retrieve data, forms to enter data, and reports to display data.

To use a template to create a database you should:

start Access. The Getting Started With Microsoft Office Access screen appears;

click Local Templates. Icons representing local templates appear in the center of the window;

click the icon for the template you want to use;

click the Browse button. The File New Database window appears;

locate the folder in which you want to store your database and Click OK. Then click Create. Access creates and opens your database (fig. 12.6).
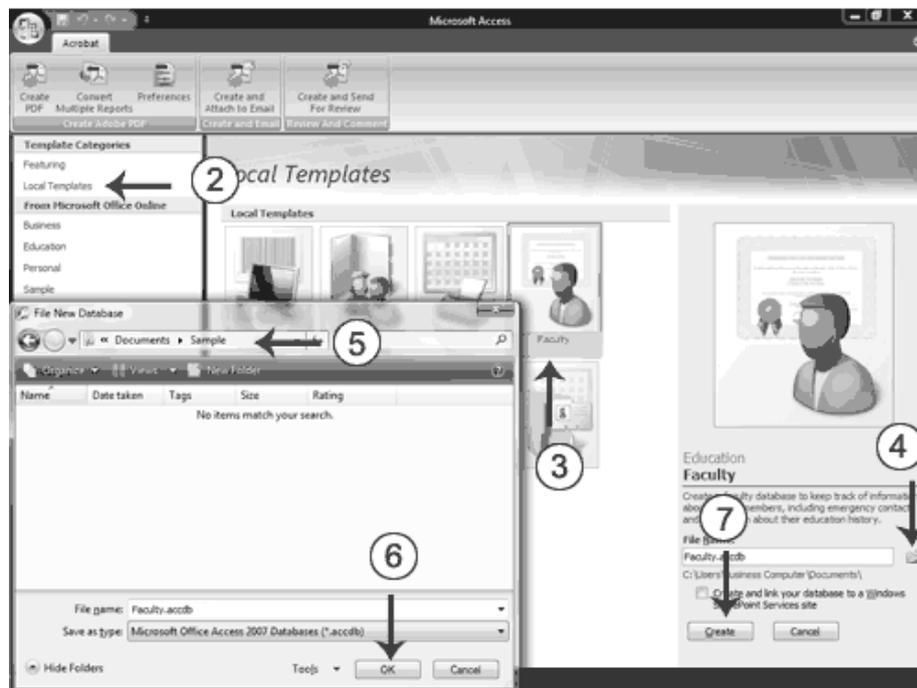
Fig. 12.6. **Creating a database from a template**

A blank database is a database with nothing in it. You must create all the tables, forms, reports, queries, and so on. If you cannot find a template that suits your needs, create a blank database. After you create the database, Access opens to a datasheet and makes available the tools you need to create objects. Creating tables is the first step in building a database.

In Access, data is stored in tables. A datasheet displays the information stored in a table in columns and rows. The columns are called fields and the rows are called records. You can use a datasheet to create a table, enter data, retrieve data, and perform other tasks.

12.3. Creating Microsoft Access Tables. Understanding data types

Tables are the foundation of an Access database. Access stores data in tables. A table is a set of columns and rows. Each column is called a field. Within a table, each field must be given a name and no two fields can have the same name. Each value in a field represents a single category of data. For example, a table might have three fields: Last Name, First Name, and

Phone Number. The table consists of three columns: one for last name, one for first name, and one for phone number. In every row of the table, the Last Name field contains the last name, the First Name field contains the first name, and the Phone Number field contains the phone number. Each row in a table is called a record (fig. 12.7).
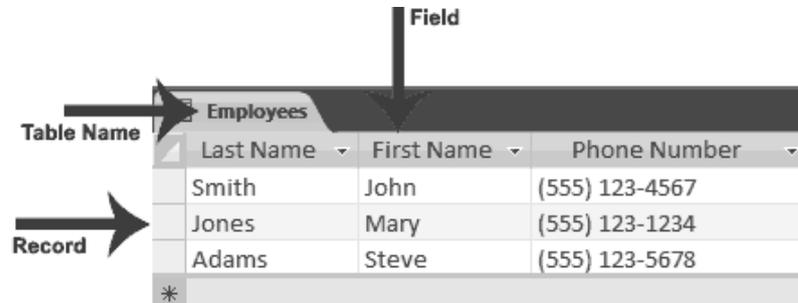
Fig. 12.7. **MS Access table**

All of the data in a table should refer to the same subject. For example, all of the data in the Employees table should refer to employees, all of the data in the Students table should refer to students, and all of the data in the Courses table should refer to courses.

You can view an Access database as a collection of related tables. For example, in a database that contains tables for Employees, Students, and Courses, the Employees table lists the employees, the Students table lists students, and the Courses table lists the courses students can take.

After MS Access creates a blank database, it opens in Datasheet view and makes available the tools you need to create a table. Datasheet view displays a table as a set of columns and rows. When you view a blank database for the first time in Datasheet view, you see a column named ID. This column is by default the primary key field.

A *primary key* is a field or combination of fields that uniquely identify each record in a table. No two records in a table should have the same values in every field. For example, the following should not occur in a table (table 12.1).

Table 12.1

Table with duplicate data

Last Name	First Name	City
Smith	John	Jonestown
Smith	John	Jonestown

In the real world, it is possible to have two people from the same city with the same first and last name. In cases like this, you can use the ID field

as the primary key field and use it to make each record unique. The ID field has a data type of AutoNumber; as a result, Access automatically creates a unique number for each record in the database. The resulting table will look like the one shown here (table 12.2).

Table 12.2

Modified table with duplicate data and a unique key

ID	Last Name	First Name	City
1	Smith	John	Jonestown
2	Smith	John	Jonestown

The primary key is a unique identifier for a record. The primary key cannot be the same for two records. This field can never be blank. A composite key is a primary key that is comprised of two or more fields. It can also be called a compound or concatenated key. A foreign key is a field or combination of fields that are related to the primary key of another table (fig. 12.8).
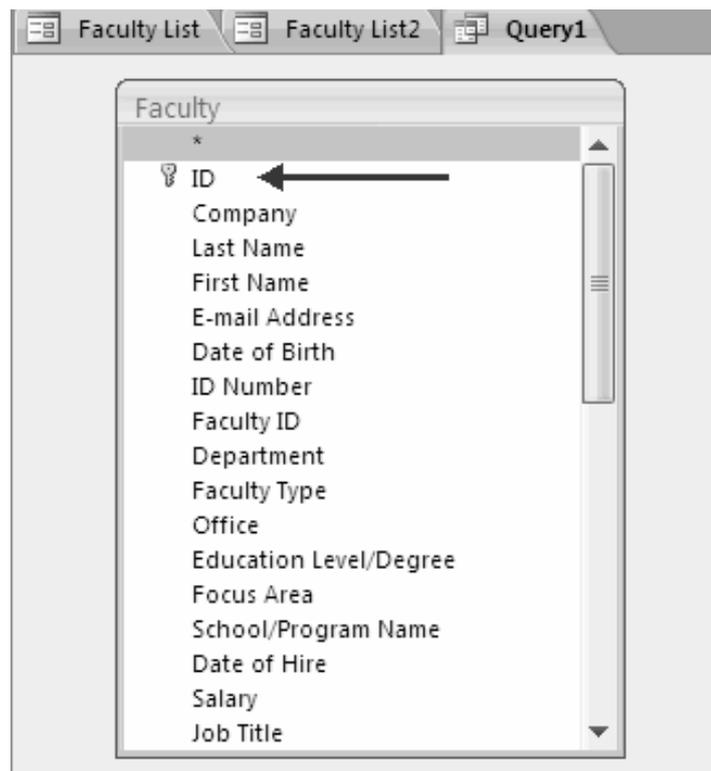
12.8. **Primary key indicator**

Access provides several methods for creating a table. One method is to use the Rename option with the Add New Field column label to give each column the field name you want it to have and then to type or paste your data into the table. Field names can include letters, numbers, and spaces and can be up to 64 characters long. When choosing a field name, try to keep it short.

When you save your table for the first time, Access gives you the opportunity to name your table. Each table name must be unique; hence, two tables in the same database cannot have the same name. The table name should describe the data in the table; can consist of letters, numbers, and spaces; and can be up to 64 characters long. When choosing a table name, try to keep it short.

You can save a table by clicking the Save button on the Quick Access toolbar or by right-clicking the Tables tab and then choosing Save from the menu that appears (fig. 12.9).
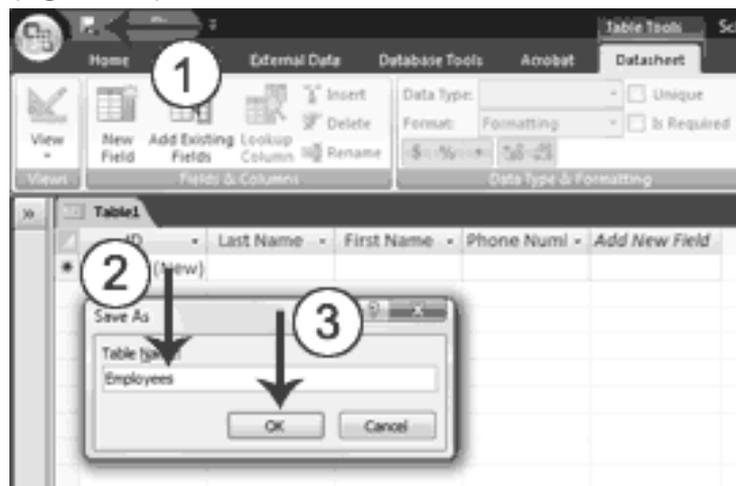
Fig. 12.9. **Save table option**

In Access, you use data types to specify the type of data each field can capture (table 12.3). A field with a data type of text can store alphabetic characters and numbers. Generally speaking, you cannot perform mathematical calculations by using a text field. For example, you can use a text field to store a street address. Unless you do some manipulation, you cannot use the numbers in the street address in mathematical calculations. You will not be able to sum or average the numbers in an address field, which is fine, because you probably do not want to. Alternatively, you can assign a Test Score field a data type of Number. You can enter numbers into the field and then average, sum, or perform other calculations with the numbers. However, you cannot enter an alphabetic character in a number field.

After you create the fields for a table, you can enter data by typing in each field. As you type, Access assigns a data type to each field based on your entry. You may want to change the data type Access assigned to a field, or you may want to explicitly assign a data type to each field. You can do so by choosing the Datasheet tab and then selecting the proper option in the Data Type field in the Data Type & Formatting group.

Table 12.3

MS Access data types

Data type	Use	Notes
Text	Alphanumeric data. Use for text and for numbers that are not used in mathematical calculations. Use for names, addresses, and other relatively short pieces of text. Can store up to 255 characters.	
Memo	Long text. Use for long pieces of text, such as notes and long descriptions. Can store up to 64,000 characters.	
Number	Numeric data. Use for numbers you want to use in mathematical calculations.	If you are working with currency, use the currency type.
Date/Time	Use for dates and times.	
Currency	Use for currency.	Prevents rounding during calculation.
AutoNumber	Unique sequential numbers or random numbers automatically inserted when you create a record. Use to create a primary key.	
Yes/No	Logical data. Use when only one of two values is valid. Yes/No, True/False, etc.	
Hyperlink	Use to store hyperlinks.	
Attachment	Use to store attachments.	
OLE Object	Use to attach an OLE object such as a Word document, Excel spreadsheet, or PowerPoint presentation.	

Some data types allow you to select the formatting you want. By formatting, you determine how data in a field displays. For example, if you choose a data type of number and a format of Euro, any number you enter will appear with a Euro sign in front.

To explicitly assign a data type or format to a field:

click the field label for the field to which you want to assign a data type;

activate the Datasheet tab and click the down-arrow next to the Data Type field and then choose a data type;

click the down-arrow next to the Format field and then choose a format.

Access assigns a data type and format to the field you selected (fig. 12.10).
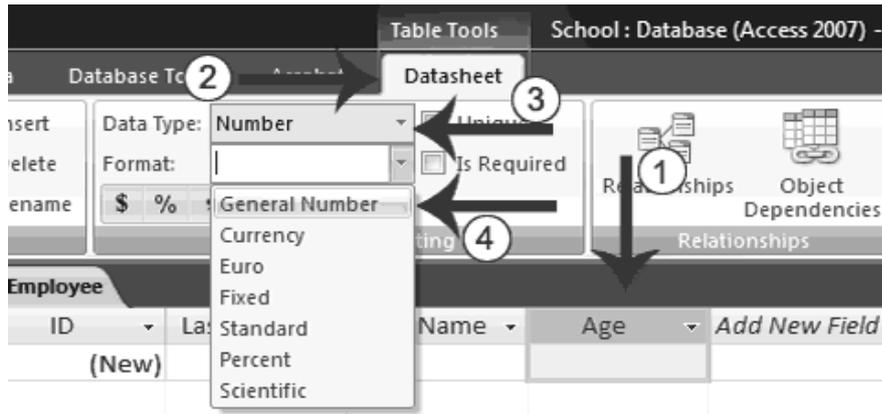
Fig. 12.10. Data type assignment in MS Access

Access provides several ways to view the objects in your database. You can use Design view to create or modify an Access table. You can use the View button on the Home tab or the Table Design button on the Create tab to change to Design view. Using Design view is the preferred method for creating a table because it provides you with the most options and enables you to precisely define your table.

12.4. Working with Microsoft Access tables

After you create an Access table, you can modify it, enter data into it manually or import data from somewhere else, such as Excel. Data can be added, deleted or modified in tables using a simple spreadsheet-like display. To bring up this view of a single table's data, highlight the name of the table and then double-click on the name of the table. In this view of the Customer table, shown in the Figure 12.11 below, the fields (columns) appear across the top of the window and the rows or records appear below. This view is similar to how a spreadsheet would be designed.
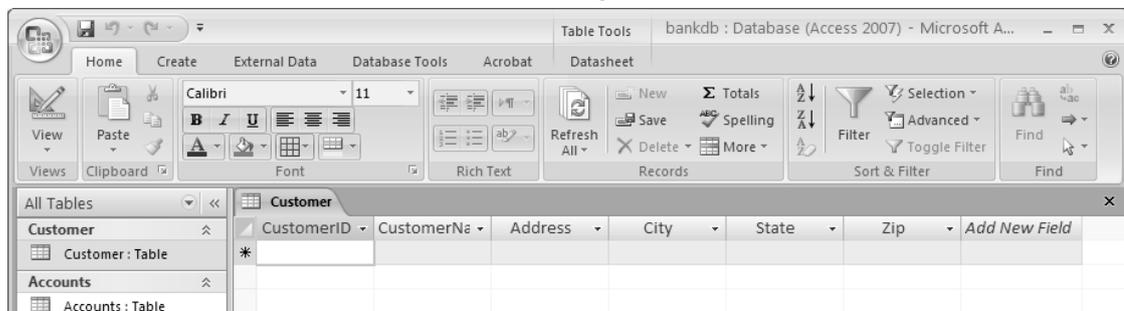
Fig. 12.11. **Data entry option**

To add an attachment to an attachment field double-click in the attachment field (fig. 12.12). The Attachments dialog box appears. After that click Add. The Choose File dialog box appears.
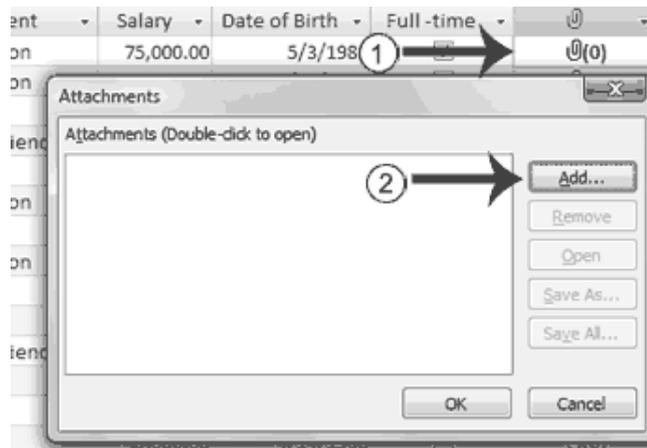
Fig. 12.12. **Attachment options**

To enter data into a date field you can manually type the date or select the date from the calendar that appears to the left of the field when you click in the field (fig. 12.13). You click the calendar to open it. Use the left-arrow at the top of the calendar to move to the previous month; use the right-arrow at the top of the calendar to move to the next month. When you reach the proper month, click the proper date.
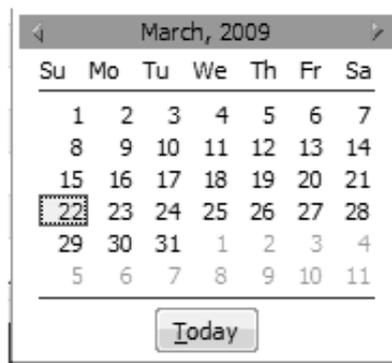
Fig. 12.13. **Date input option**

After you create a table, you may need to modify it. You can delete columns, insert columns, or move columns. The Delete option permanently deletes columns and all the data contained in them. You cannot undo a column delete.

MS Access provides several methods for moving around a table. On the Home tab, there is a Go To button. When you click it, a menu of options appears. You can use the menu to go to the first, last, previous, or next record in your table.

You can click the New option to add a new record. You can also use special keys and the navigation bar in Access to move around a table. The navigation bar appears at the bottom of the table (fig. 12.14).

Fig. 12.14. **The Go To button to move around a table**

Before you can perform an operation on a column or row, you must select it. To select a column, click the column head. To select several columns, click a column head and then drag. To select a row, click the blank area to the left of the row. To select several rows, click the blank area to the left of a row and then drag. To select the entire table, click the Select All button ▨ in the upper-left corner of the table.

If all of the information in a column or row does not display, you may want to make the column or row larger. If you want to fit more information on the screen, you may want to make a column or row smaller.

In either case, you can click and drag to increase or decrease column width or row height.

■ Questions

1. What is a database?
2. What does a database consist of?
3. What data types are used by MS Access?
4. What is a primary key? What other types of keys can be used in MS Access?
5. Why can't entries in a key field be duplicated?
6. What is the initial container of data in MS Access?

Theme 13. Sorting, filtering, and creating relationships between MS Access tables
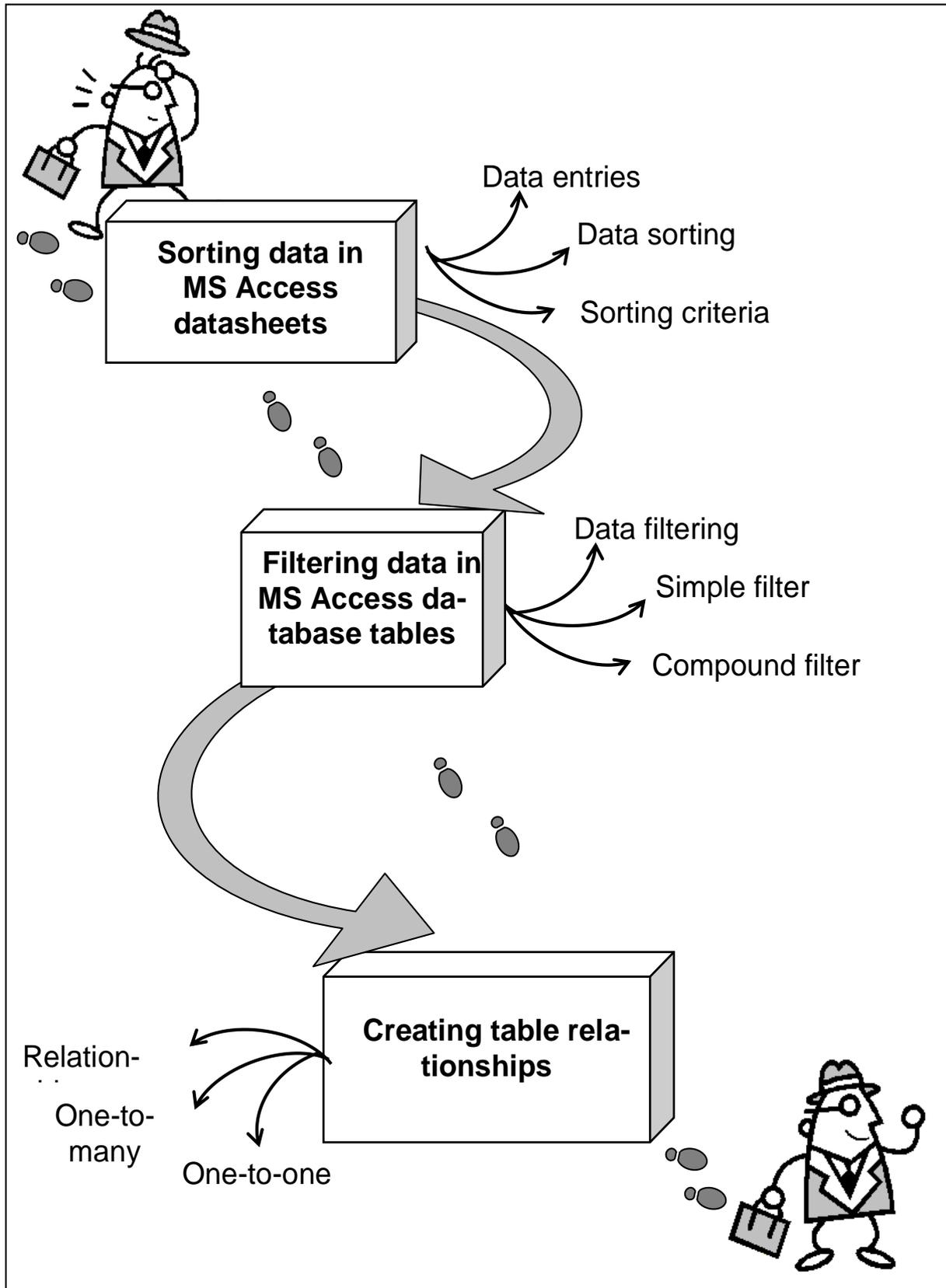
Fig. 13.1. **System elements of the theme**

■ Introduction

The purpose of this theme lies in a close study of the peculiar features connected with data sorting and filtering in MS Access tables. The nature of Access filters is analyzed and questions connected with entries sorting are given a special consideration. A thorough analysis covers establishing of different types of relationships between tables in MS Access databases.

Clue notions of the theme include: sorting; filtering; simple filter; compound filter; relationships; one-to-one relationship; one-to-many relationship.

This theme covers the following **topics**: What is data sorting? What ways of filtering data exist? What are the basic types of data filters? What is the role of relationships in ensuring database integrity? What are the basic types of relationships between tables in a database?

As a result of the study of the material represented in this theme students will acquire the following **competencies**:

they would know the difference between sorting and filtering data in a database;

they would learn the basic types of filters;

they would become aware of the types of relationships that can exist between tables in a database.

13.1. Sorting data in MS Access datasheets

You can sort Access data so you can view records in the order you want to view them, and you can filter data so you only see the records you want to see. By sorting, you can put a column of information in alphabetical, numerical, or date order. You can sort in ascending order (alphabetical from A to Z, lowest number to highest number, earliest date to latest date) or descending order (alphabetical from Z to A, highest number to lowest number, latest date to earliest date). You can also sort within a sort. For example, you can sort by state and then sort within each state by city. When sorting within a sort, perform the innermost sort first. For example, if you are sorting by state and then city, sort the city first and then sort by state.

You can sort records in a datasheet by a single column or by two adjacent columns. To sort records by a single column you should select the field you wish to sort and then click the **Sort Ascending** or **Sort Descending** button (fig. 13.1).
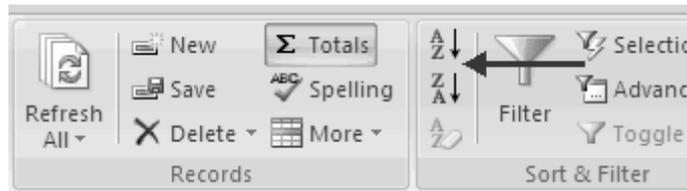
Fig. 13.1. **Data sort option**

It is also possible to sort data in two columns at the same time if they are adjacent to each other. For this one has to select the desired columns for sorting by holding the shift key and clicking on the columns. Then it is necessary to click the **Sort Ascending** or **Sort Descending** button (fig. 13.2)

Fig. 13.2. **Two columns sort**

To clear the sort just click the **Clear Sort** button .

13.2. Filtering data in MS Access database tables

You can apply a filter to see only the records you want to see. For example, perhaps your database contains students from the states of DE, NJ, and PA and you only want to see the students from DE. You can filter your data so only DE students display.

Each time you apply a filter to a column, it replaces any previous filter you applied to that column. For example, if you apply a filter so you only see students in DE, and later you apply a filter so you only see students in NJ, Access clears the DE filter and then applies the NJ filter.

You can apply filters to multiple columns in the same table. For example, by applying a filter first to the State field and then to the Last Name field, you can see all of the students in the state of DE whose last names are Adams.

To apply a filter:

click the column label for the column you want to filter and activate the Home tab;

click the Filter button. A menu appears;

uncheck the items you do not want to appear, making sure only the items you want are checked and click OK.

Access filters your data and displays the word Filtered at the bottom of the window (fig. 13.3).

Fig. 13.3. **Filtering data by "state"**

To remove a filter click Clear All Filters. Access clears all the filters you have applied.

In addition to simply searching for a specific value, you can apply several specialized filters. For example, you can find all of the records that do not equal the value you specify or you can find all of the records that fall between two dates. The following are lists of specialized filters (table 13.1).

Table 13.1

MS Access data filters

Filter	Comment
1	2
Text Filters	
Equals	Finds every record in the table where the field's value equals the value you enter
Does Not Equal	Finds every record in the table where the field's value does not equal the value you enter
Begins With	Finds every record in the table where the field's value begins with the value you enter
Does Not Begin With	Finds every record in the table where the field's value does not begin with the value you enter
Contains	Finds every record in the table where the field's value contains the value you enter
Does Not Contain	Finds every record in the table where the field's value does not contain the value you enter
Ends With	Finds every record in the table where the field's value ends with the value you enter

Table 13.1 (the ending)

1	2
Does Not End With	Finds every record in the table where the field's value does not end with the value you enter
Number Filters	
Equals	Finds every record in the table where the field's value equals the value you enter
Does Not Equal	Finds every record in the table where the field's value does not equal the value you enter
Less Than	Finds every record in the table where the field's value is less than the value you enter
Greater Than	Finds every record in the table where the field's value is greater than the value you enter
Between	Finds every record in the table where the field's value is between the values you enter
Date Filters	
Equals	Finds every record in the table where the field's value equals the date you enter
Does Not Equal	Finds every record in the table where the field's value does not equal the date you enter
Before	Finds every record in the table where the field's value is before the date you enter
Greater Than	Finds every record in the table where the field's value is greater than (comes after) the date you enter
Between	Finds every record in the table where the field's date is between the dates you enter
All Dates in a Period	Finds every record in the table where the field's date is in the period you enter

13.3. Creating table relationships

Table relationships are the associations of data between tables. By defining table relationships, you can pull records from related tables based on matching fields. In Access, you store data in multiple tables and then use relationships to join the tables. After you have created relationships, you can use data from all of the related tables in a query, form, or report (fig. 13.4).

A *primary key* is a field or combination of fields that uniquely identify each record in a table. A *foreign key* is a value in one table that must match the primary key in another table. You use primary keys and foreign keys to join tables together – in other words, you use primary keys and foreign keys to create relationships.
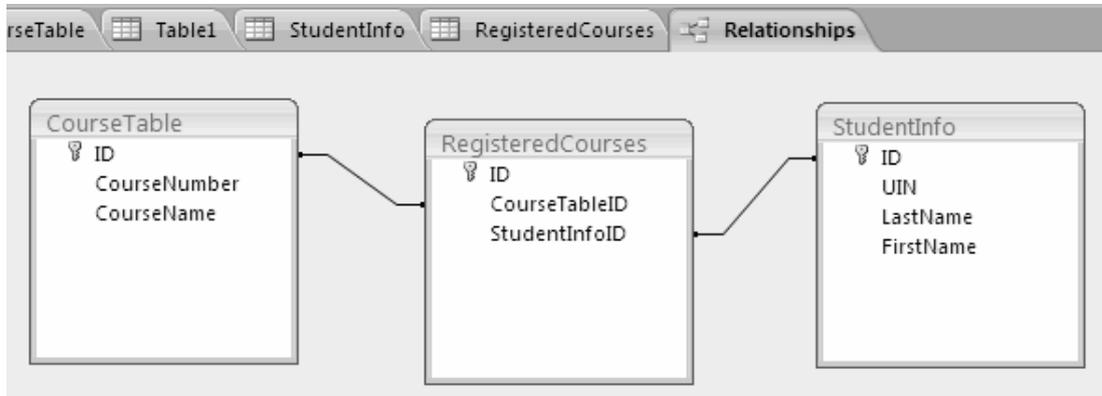
Fig. 13.4. **Table relationships**

There are two valid types of relationships: one-to-one and one-to-many. In a *one-to-one relationship*, for every occurrence of a value in table A, there can only be one matching occurrence of that value in table B, and for every occurrence of a value in table B, there can only be one matching occurrence of that value in table A. A one-to-one relationship is between two tables where the primary key in one table and the foreign key in another table are the same. For each record in the first table, there is a single matching record in the second table (fig. 13.5).
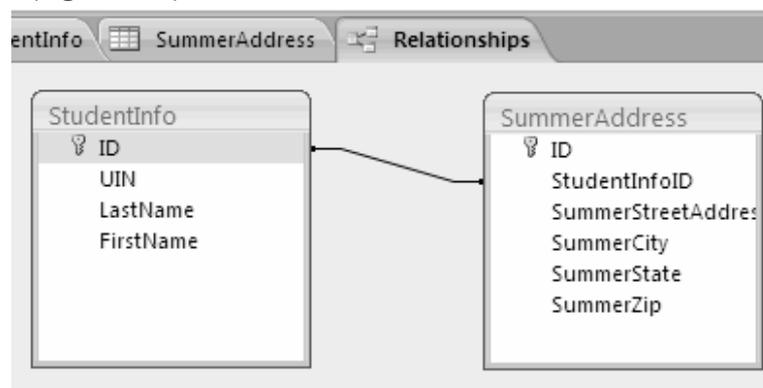
Fig. 13.5. **One-to-one relationship**

One-to-one relationships are rare because if there is a one-to-one relationship, the data is usually stored in a single table. However, a one-to-one relationship can occur when you want to store the information in a separate table for security reasons, when tables have a large number of fields, or for other reasons.

In a *one-to-many relationship*, for every occurrence of a value in table A, there can be zero or more matching occurrences in table B, and for every one occurrence in table B, there can only be one matching occurrence in table A. A one-to-many relationship occurs between two tables where the primary key in one table can be duplicated many times in another table (fig. 13.6)
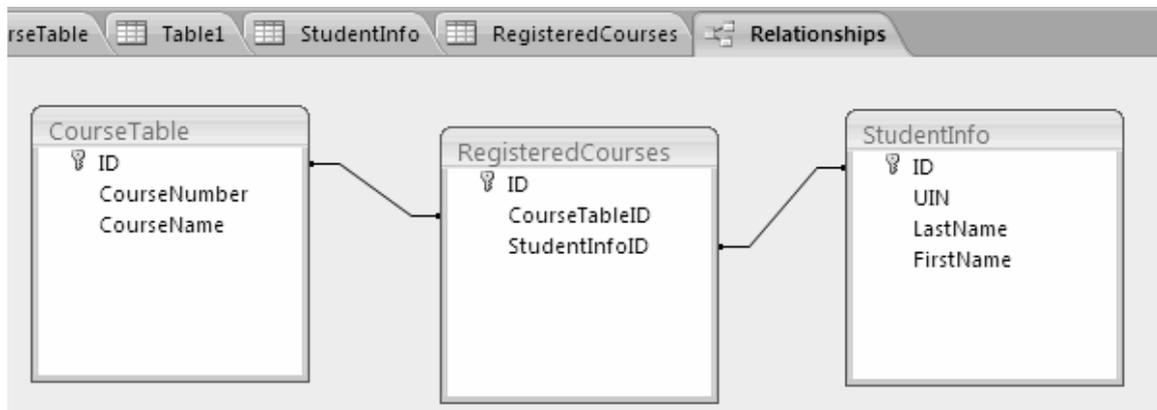
Fig. 13.6. **One-to-many relationship**

When tables have a one-to-many relationship, the table with the one value is called the *primary table* and the table with the many values is called the *related table*. *Referential integrity* ensures that the validity of the relationship between two tables remains intact. It prohibits changes to the primary table that would invalidate an entry in the related table. For example, a school has students. Each student can make several payments, but each payment can only be from one student. The Students table is the primary table and the Payments table is the related table (table 13.2, 13.3).

Table 13.2

List of students

Students		
Student ID	Last Name	First Name
Primary Key		
1	John	Smith
2	Mark	Adams
3	Valerie	Kilm

If you delete Student ID 1 from the Students table, Student ID 1 is no longer valid in the Payments table. Referential integrity prevents you from deleting Student ID 1 from the Students table.

Also, if the only valid Student IDs are 1, 2, and 3, referential integrity prevents you from entering a value of 4 in the Student ID field in the Payments table.

A foreign key without a primary key reference is called an orphan. Referential integrity prevents you from creating orphans.

Payment records

Payments			
Payment ID	Student ID	Amount Due	Amount Paid
Primary key	Foreign key		
1	1	500	500
2	2	700	300
3	3	500	250
4	2	400	300
5	3	250	250

To create relationships first close all tables and forms. For that right-click on the tab of any Object. A menu appears. Click Close All.). After that activate the Database Tools tab (fig. 13.7).
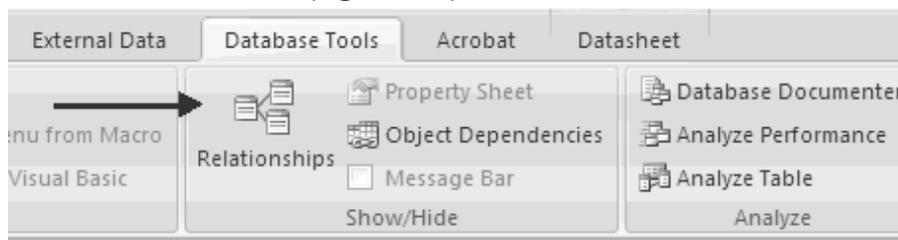
Fig. 13.7. **Database Tools group**

Click the Relationships button in the Show/Hide group. The Relationships window appears. If anything appears in the relationships window, click the Clear Layout button in the Tools group. If you are prompted, click Yes. After that click the Show Table button in the Relationships group. The Show Table dialog box appears (fig. 13.8).
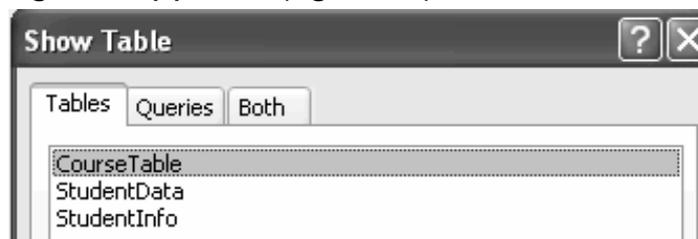
Fig. 13.8. **Show Table dialog box**

Activate the Tables tab if your relationships will be based on tables, activate the Queries tab if your relationships will be based on queries, or activate the Both tab if your relationships will be based on both. Then double-click each table or query you want to use to build a relationship. The tables

appear in the Relationships window. Click the Close button to close the Show Table dialog box.

Drag the Primary table's primary key over the related table's foreign key. After you drag the primary key to the related table's box, the cursor changes to an arrow. Make sure the arrow points to the foreign key. The Edit Relationships Dialog box appears (fig. 13.9).
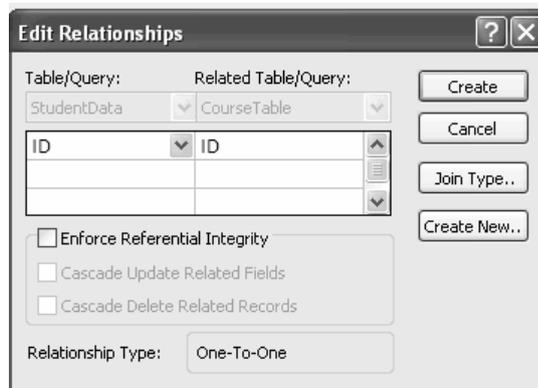
Fig. 13.9. **Edit Relationships dialog box**

After that click the Enforce Referential Integrity checkbox and choose Create. Access creates a one-to-many relationship between the tables (fig.13.10)
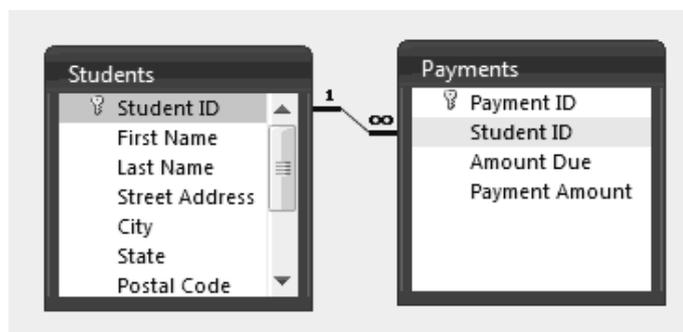
Fig. 13.10. **A new relationship created**

When all the operations are finished click the Save button on the Quick Access toolbar to save the relationship.

■ **Questions**

1. What is a relationship? What types of relationships can exist between tables in a database?

2. What are the basic types of filters?

3. What is the difference between sorting and filtering data in a database?

Theme 14. The technology of creating, editing and using queries, forms and reports in MS Access

Creating Microsoft Access queries
- Data queries
- Multitabling
- Quering criteria

Creating and using Microsoft Access forms
- Data forms
- Fields and expressions
- Compound forms

Generating MS Access reports
- Reports
- Simple reports
- Complex reports
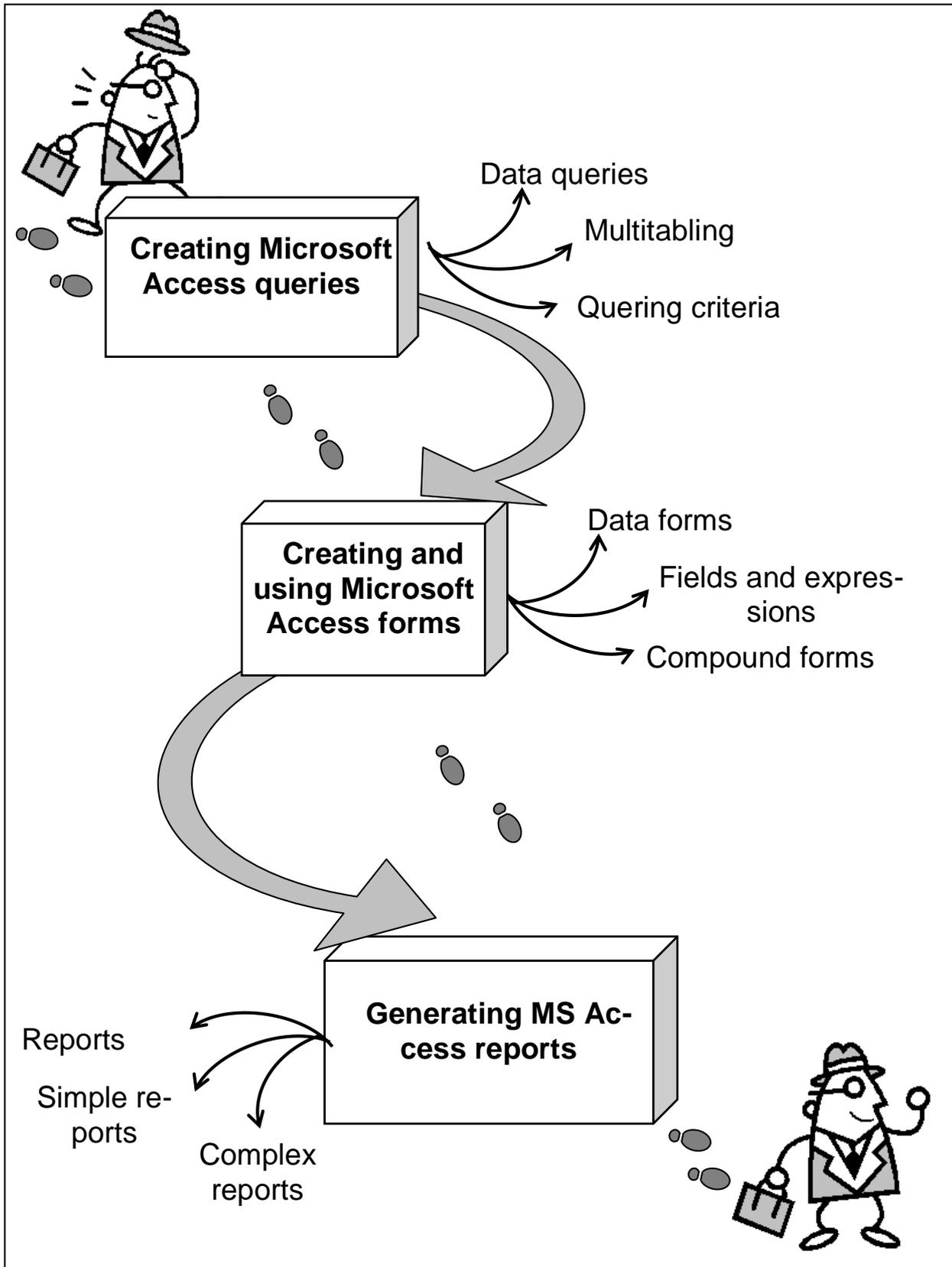
Fig. 14.1. **System elements of the theme**

■ Introduction

The purpose of this theme lies in a close study of the main features connected with creating, editing and using queries, forms and reports in MS Access. The nature of Access queries is analyzed and questions connected with forms creation and use are given a thorough consideration. A detailed analysis covers specific aspects of the work with MS Access reports.

Clue notions of the theme include: queries; forms; reports filtering; sorting; calculated fields; query criteria; reports printing.

This theme covers the following **topics**: What is database querying? What are ways of querying data in MA Access? What are the basic types of forms? What is the role of calculated fields? What are the basic reports creation options?

As a result of the study of the material represented in this theme students will acquire the following **competencies**:

they would know the difference between queries and reports in a database;

they would learn how to create, edit and use queries, forms and reports;

they would become aware of the types and purpose of forms in MS Access databases.

14.1. Creating Microsoft Access queries

⊡ A **query** allows you to select and filter data from multiple tables.

Queries can be saved and utilized as often as you need them. You can use a query to view a subset of your data or to answer questions about your data. For example, if you want to view a list of student names and email addresses, but you do not want to see addresses and other data, you can create a query that displays the student's first name, last name, and email address only. Alternatively, if you want to know which students live in DE, you can restrict your list to those students.

A query can be based on tables or on other queries. To create a query, you open the tables or queries on which you are going to base your query in Query Design view, and then use the options in Design view to create your query. You then click the Run button to display the results. You can save queries for later use.

To open tables or queries in Query Design view Activate the Create tab→Click the Query Design button in the Other group. The Show Table

dialog box appears→Activate the Tables tab if you want to base your query on tables, activate the Queries tab if you want base your query on queries or activate the Both tab if you want to base your query on both tables and queries→Click to choose the table or query on which you want to base your query→Click Add. The table appears in the window. After that click to choose the next table or query on which you want to base your query. Continue clicking tables or queries until you have all the tables and queries you plan to use→Click Close. Access changes to Query Design view (fig. 14.1).
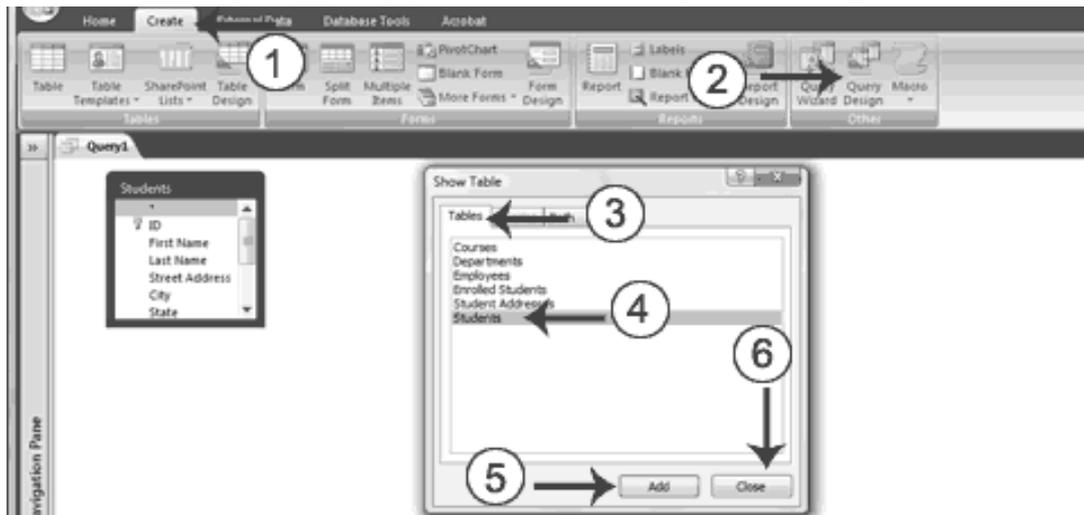
Fig. 14.1. **Queries view**

In Query Design view, each table has an option that allows you to display all of the fields and all of the records in a table. This option appears on the field line on the drop-down menu as the table name followed by a period and an asterisk (*tablename.**).

After you run a query, you can easily change back to Query Design view and make modifications to your query or create a new query. You can also click the Design button 📝 in the lower-right corner of the Access window to change to Design view.

You can use an Access query to retrieve a single column of data. Instead of choosing the *tablename.** option on the Field line in Query Design view, choose the name of the field you want to retrieve. You can use an Access query also to retrieve multiple columns of data.

On the Field line in Query Design view, choose the field name of each field you want to retrieve in the order you want to retrieve them. For that open a table or query in Query Design view. Then choose the field names you want to retrieve in the order you want to retrieve them and click the Run button. Access retrieves the columns you chose (fig. 14.2).
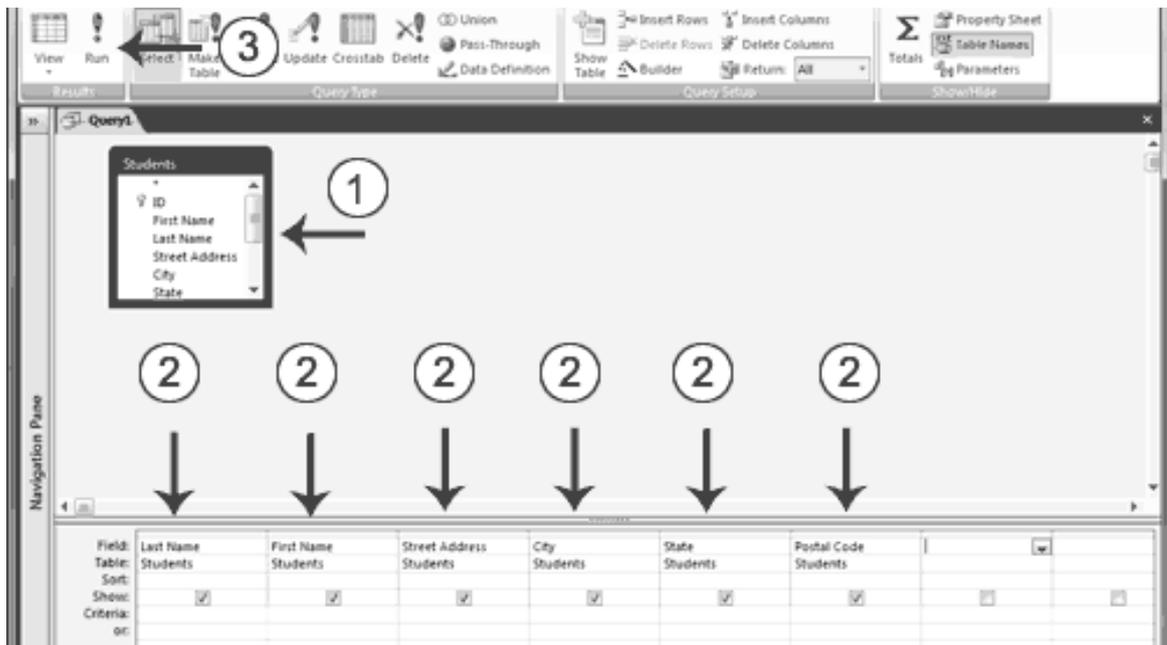
Fig. 14.2. **One and multiple columns use in a query**

When creating a query, you can sort the rows you retrieve in ascending or descending order by choosing the option you want on the Sort row in Query Design view.

You can also create sorts within a sort. For example, you can sort by state and then within a state, you can sort by last name and then by first name. You specify the sort in the order you want the sort to occur. If you want to sort by state and then by last name within a state and then by first name within last name, you enter the sort in the following order: city, last name, first name. Your sort order may not agree with the order in which you want to display fields. In such a case, you can use fields that do not display to enter your sort order. To prevent a field from displaying, deselect the Show box on the Show row.

To sort multiple columns open a table or query in Query Design view. Then choose the field names you want to retrieve in the order you want to retrieve them. Then choose the field names you want to sort by in the order you want to sort. After that under the fields you want to sort by, choose Ascending or Descending and deselect the Show button for the columns you do not want to display. Click the Run button. Access retrieves the columns you chose and displays the rows in the order you specified (fig. 14.3).

In the examples so far, you have been retrieving all of the records (rows) in your table. You can, however, specify which records you wish to retrieve. For example, you can retrieve only those students who live in DE,

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only the student whose student number is 5, or only those students whose birth date is 2/16/88.
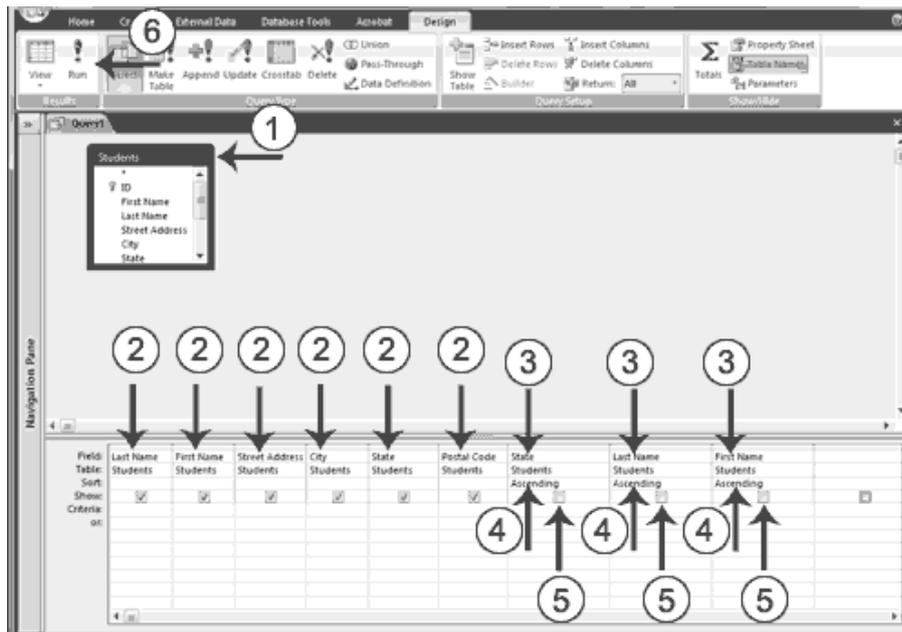
Fig. 14.3. **Sort multiple columns in a query**

You use logical operators such as = (equal), <> (not equal), > (greater than), or < (less than) to restrict the records you retrieve. For example, if you only want to display students who live in DE, enter **= "DE"** in the State column on the Criteria line. Access will only retrieve records where the value in the State column is equal to DE. Selection criteria are not case-sensitive, so Access will retrieve records where the entry is DE, de, De, or dE (table 14.1)

Table 14.1

Querying criteria

"Value"	Will only display items that are that exact value (replace the word value with what you want to search by)
=	Is equal to
<	Less than
<=	Less than or equal to
>	Greater than
>=	Greater than or equal to
<>	Not equal to
Between X And Y	Within a range (replace X & Y with values)
Is Null	Null values
And	True only if both conditions exist
Or	True if either condition exists
Not	True if the single instance is not true

You can apply multiple criteria to the same table. If you place two criteria on the same line, Access will only retrieve records where both criteria are met.

For example, if you want all records where the State is equal to "DE" *and* the Last Name is equal to Smith, you would set the State field to = "DE" and the Last Name field to = "Smith" and you would place both criteria on the same line.

If you place one set of criteria on the Criteria line and the second set of criteria on the Or line, Access will retrieve records if either criteria are met. For example, you want all records where the State is equal to "DE" *or* the Last Name is equal to Smith.

You would set the State field to = "DE" and the Last Name field to = "Smith" and you would place one set of criteria on the Criteria line and the other set of criteria on the Or line. Access will bring back all records where the state equals DE *and* all records where the Last Name is equal to Smith no matter what the State is.

You can add additional *and* and *or* statements by using the lines below the Or line. For And clauses, place the criteria on the same line; for Or clauses, place the criteria on separate lines.

If you want to view data from two or more tables or queries, you can create a query that pulls the data from multiple tables or queries. The tables and queries from which you pull your data should have a relationship (refer to fig. 14.4).
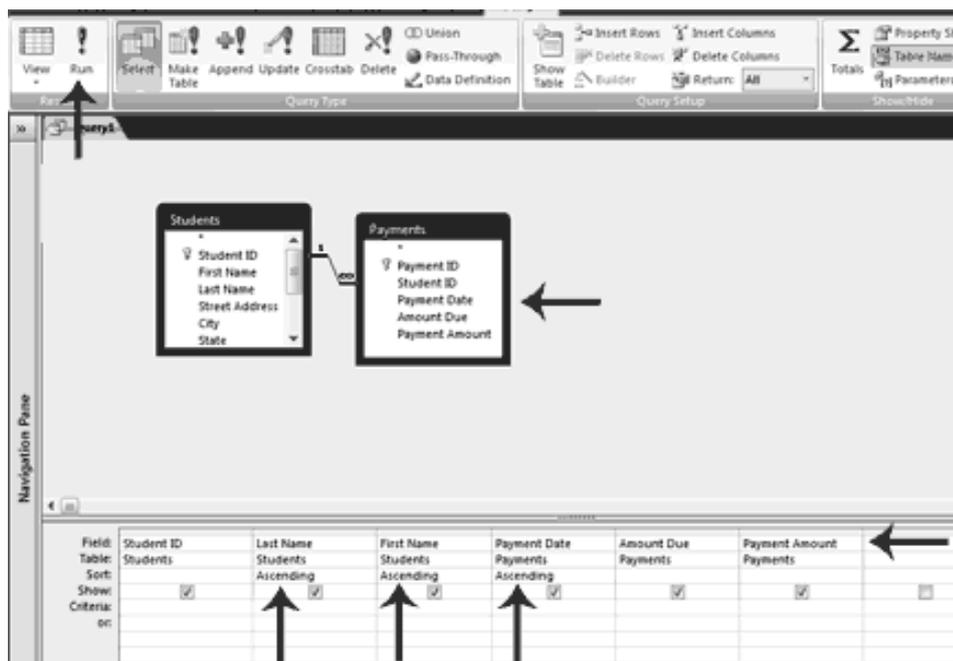
Fig. 14.4. **Multiple table query**

It is also possible to use calculated fields In MS Access queries. A calculated field is a field that gets its information from the calculations performed on other fields.

You can build calculated fields in the Query screen by using the addition (+), subtraction (-), multiplication (*) and division (/) operators. Expression is a combination of functions, field names, numbers, text, and the operators listed above (fig. 14.5).
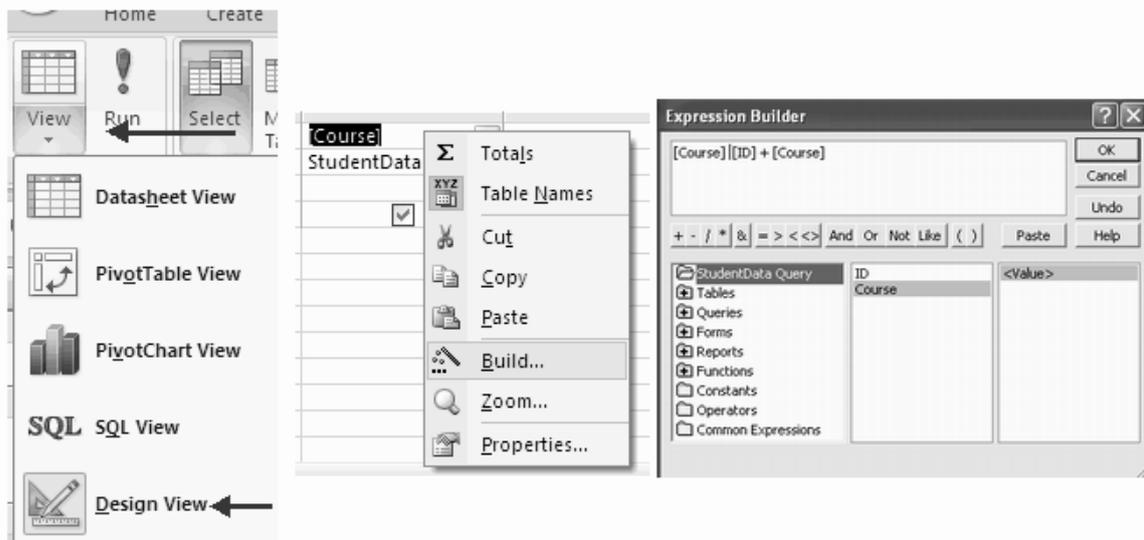
Fig. 14.5. **Build expressions option**

After you create a query, you can save it. You can rerun a saved query at any time. If you change the data on which the saved query is based, you will see the changes when you rerun the query.

Once created, a query can be modified. Simply open the query in Query Design view and make the changes. You can add columns, change the sort order, change the criteria, and make other changes.

14.2. Creating and using Microsoft Access forms

Data entry forms are the primary means of entering data into tables in the database. Access forms are much like paper forms: you can use them to enter, edit, or display data. They are based on tables. When using a form, you can choose the format, the arrangement, and which fields you want to display.

Access can automatically create several types of forms. For example, when you click the Form button on the Create tab, Access places all fields in the selected table on a form. If the table has a one-to-many relationship with one other table or query, Access creates a stacked form (the records are

displayed in a column) for the primary table and a datasheet for the related table. If there are several tables with a one-to-many relationship, Access does not create the datasheet.

To create a form open the Navigation pane→Click the table or query on which you want to base your form→Activate the Create tab→Click Form in the Forms group. Access creates a form (fig. 14.6).
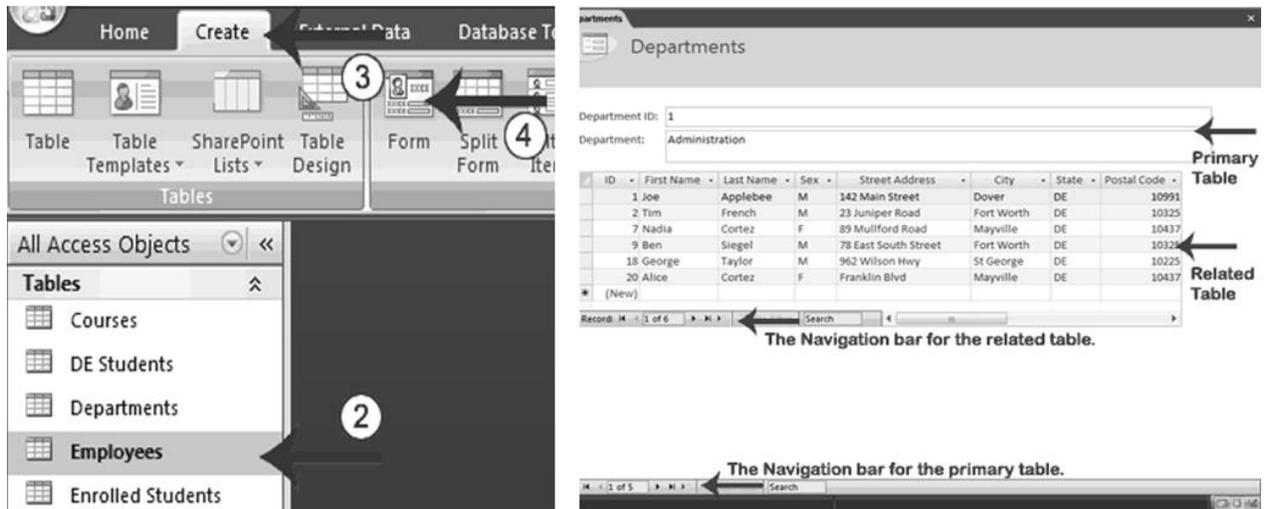
Fig. 14.6. **One-view forms creation technology**

A split form is a form in which the same data is displayed in two views simultaneously. One part of the form displays in Form view (stacked fields), while the other part displays in Datasheet view. The two views are synchronized, so as you select a field in one view, it is automatically selected in the other view. You can add, change, or delete the data in either view. Using a split form gives you the benefits of two types of forms in a single form. For example, you can use the datasheet portion to locate records and the form portion to edit records (fig. 14.7).
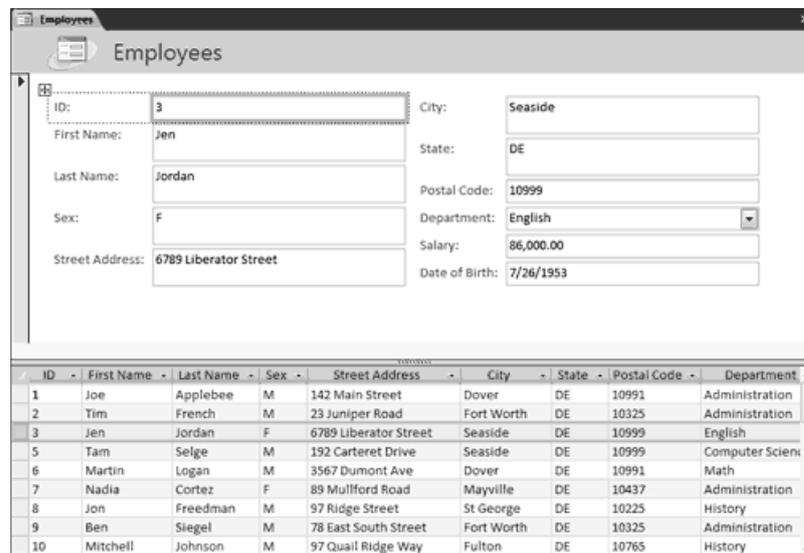
Fig. 14.7. **A typical MS Access split form**

You can use the Multiple Items button on the Forms tab to create a form that displays multiple records, one record per row. To create a multiple items form open the Navigation pane. Then click the table or query on which you want to base your form. Activate the Create tab and click Multiple Items in the Forms group. Access creates a multiple items form (fig. 14.8).
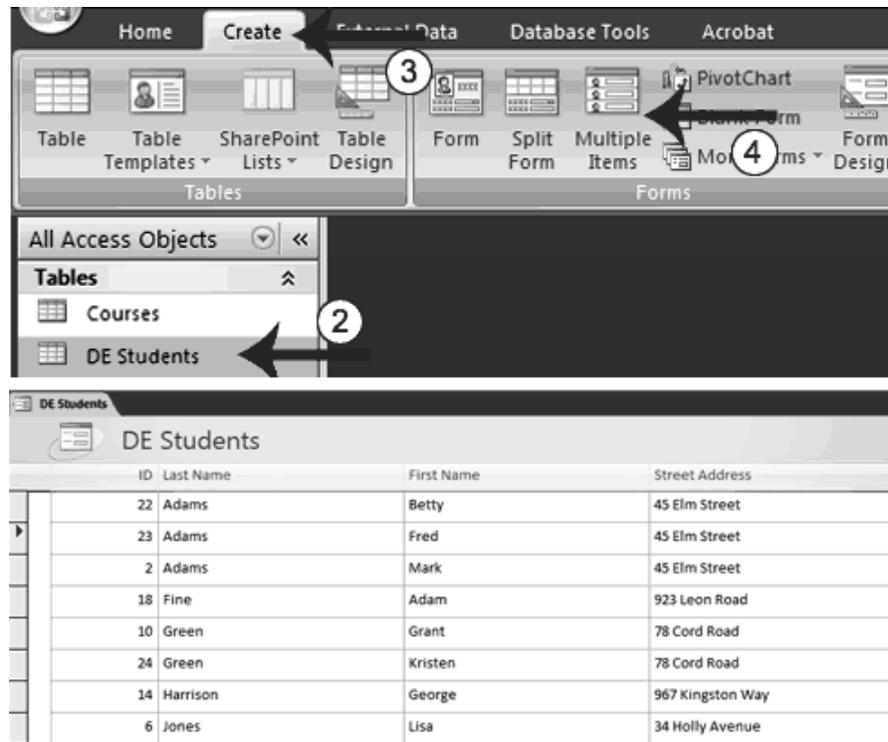
Fig. 14.8. **MS Access multiple items form**

There are three ways to view forms in Access (table 14.2).

Table 14.2

MS Access form views

View	Comment
Design View	Allows you to design a form that includes a header, a footer, and details in the form. You can also add images and control which fields appear on the form
Form View	This is a dynamic page which allows the user to enter and edit data or navigate through data in a field
Layout View	This view allows you to design the form from one of the given layouts

To save a form:

click the Save button on the Quick Access toolbar. Access saves the form unless you are saving for the first time. If you are saving for the first time, the Save As dialog box appears;

type the name you want to give the form and click OK. Access saves the form. You can now access the form by using the Navigation pane.

14.3. Generating MS Access reports

★ **Reports** organize and summarize data for viewing online or for printing a hard copy.

A detail report displays all of the selected records. You can include summary data such as totals, counts, and percentages in a detail report. A summary report does not list the selected records but instead summarizes the data and presents totals, counts, percentages, or other summary data only. Access has several report generation tools that you can use to create both detail and summary reports quickly.

The Report button creates a simple report that lists the records in the selected table or query in a columnar format (fig. 14.9).
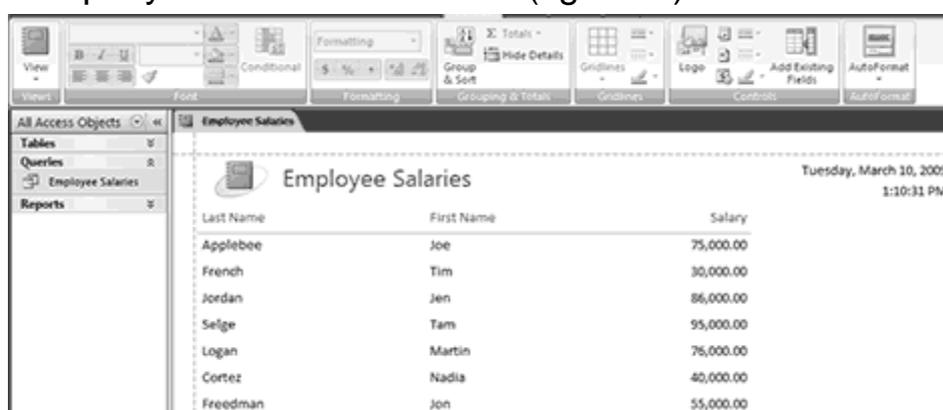
Fig. 14.9. **A simple MS Access report**

Access reports created simply by using the Report button have several sections. They are detailed in Table 14.3 and Figure 14.10.

Table 14.3

Sections of a Report

Section	Comment
Report Header	Appears at the top of the first page and displays the report title
Page Header	Appears at the top of every page and displays the headings (field labels) for each column
Page Footer	Appears at the bottom of every page and displays the page number and total number of pages
Detail Section	Appears between the page header and page footer and displays the records from the table or query
Report Footer	This section is optional. Appears on the last page of the report and displays summary information such as grand totals

Fig. 14.10. **Sections of a Report**

You can also use the Report Wizard to create a report. The Report Wizard provides you with more flexibility than you get by using the Report button. You can choose the tables and fields, group the data, sort the data, summarize the data, choose a layout and orientation, apply a style, and title your report.

When using the Report Wizard, you can group data. Grouping puts all of the values in a field into a group based on the field's value. For example, if your data is grouped by the Department field and the records in the Department field have values such as Administration, Computer Science, and English. Access will group all of the data for the Administration department together, all of the data for the Computer Science department together, and all of the data for the English department together (fig. 14.11).
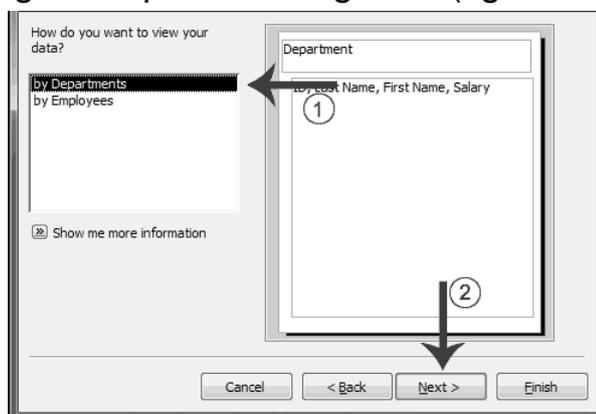
Fig. 14.11. **Grouping data using the Report Wizard**

By using the Report Wizard, you can create up to four levels of sort. Access sorts the first level, and then sorts the second level within that sort, and so on. If you have grouped your data, you can summarize it by displaying the sum, average, and minimum or maximum value for each numeric field. You can choose to have your report display just the summary data or each detail line and the summary data.

There is also an option that allows you to display the percent the sum of each group is of the grand total. All of the fields in your report may not fit on a single page. You can have Access automatically adjust the size of the font so that every field fits (fig. 14.12).
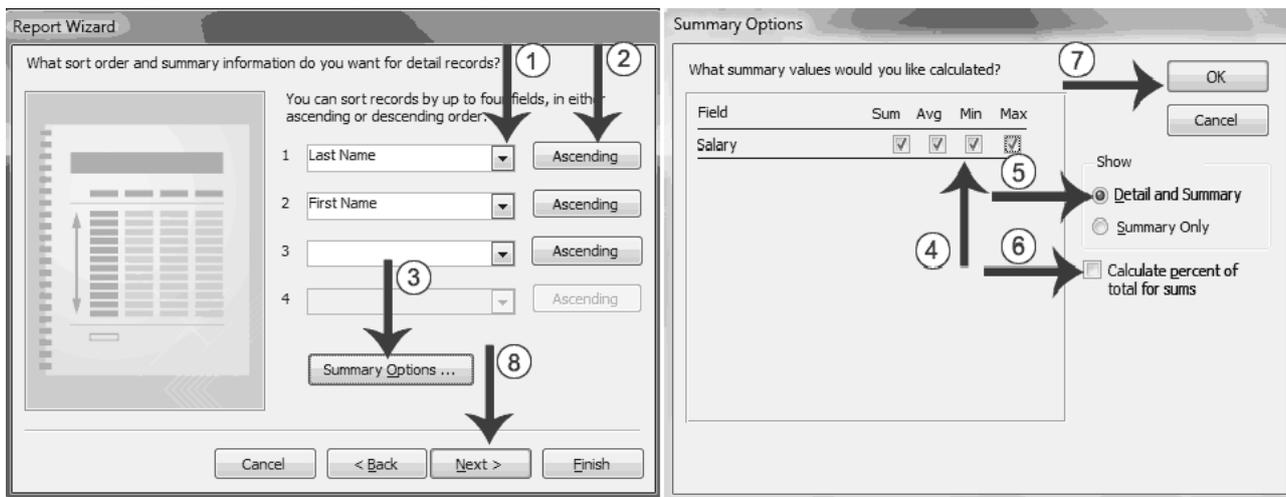
Fig. 14.12. **Sorting data using the Report Wizard**

You can choose the layout and orientation of your report. The layout determines where each field appears on the page. Access provides three options to choose from: Stepped, Block, and Outline. When you choose an option, the left side of the window displays a graphic of the layout.

Orientation determines whether Access creates the report in portrait or landscape. Most paper, such as paper sized 8 1/2 by 11, is longer on one edge than it is on the other. If you print in Portrait, the shortest edge of the paper becomes the top of the page. Portrait is the default option. If you print Landscape, the longest edge of the paper becomes the top of the page.

⭐ A **style** is a set of formats consisting of such things as background colors, fonts, font colors, and font sizes.

Access supplies predesigned styles that format titles, labels, and more. When you choose a style, the left side of the window displays a preview.

After you create a report, you can modify it. You can add groups or sorts, add fields, change labels, and perform many other tasks (fig. 14.13).
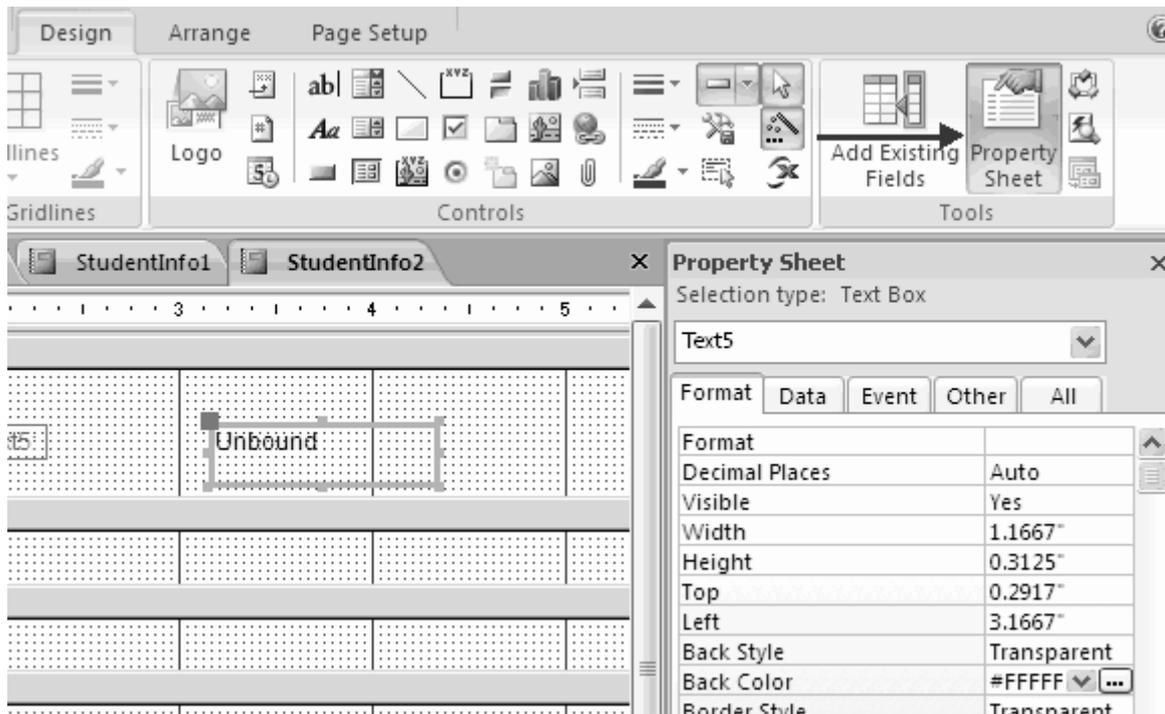
Fig. 14.13. **Adding fields to MS Access reports**

You can view a report in Report view, Layout view, Design view, and Print Preview. You can modify a report in Layout view or Design view. In Layout view, you can see your data, and the report you see closely resembles how your report will look when you print it. You can make most, but not all, changes to your report in Layout view. Design view displays the structure of your report. In this view you cannot see the underlying data, but you can perform some tasks in Design view that you cannot perform in Layout view.

Often, the people who use Access data only see a printed report. In Print Preview, you can see exactly how your report will look when printed, you can make changes to it, and you can print it. To print, click the Print button in the Print group. The Print dialog box opens and you can select your print options.

■ **Questions**

1. What is a database form? What types of forms can be created in a MS Access database?

2. What is a query? For what purpose is it used?

3. What is the difference between queries and reports in a database? What is the purpose of each?

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Section 6. Presentations creation technology using MS Office PowerPoint
Theme 15. Introduction to MS Office PowerPoint essentials
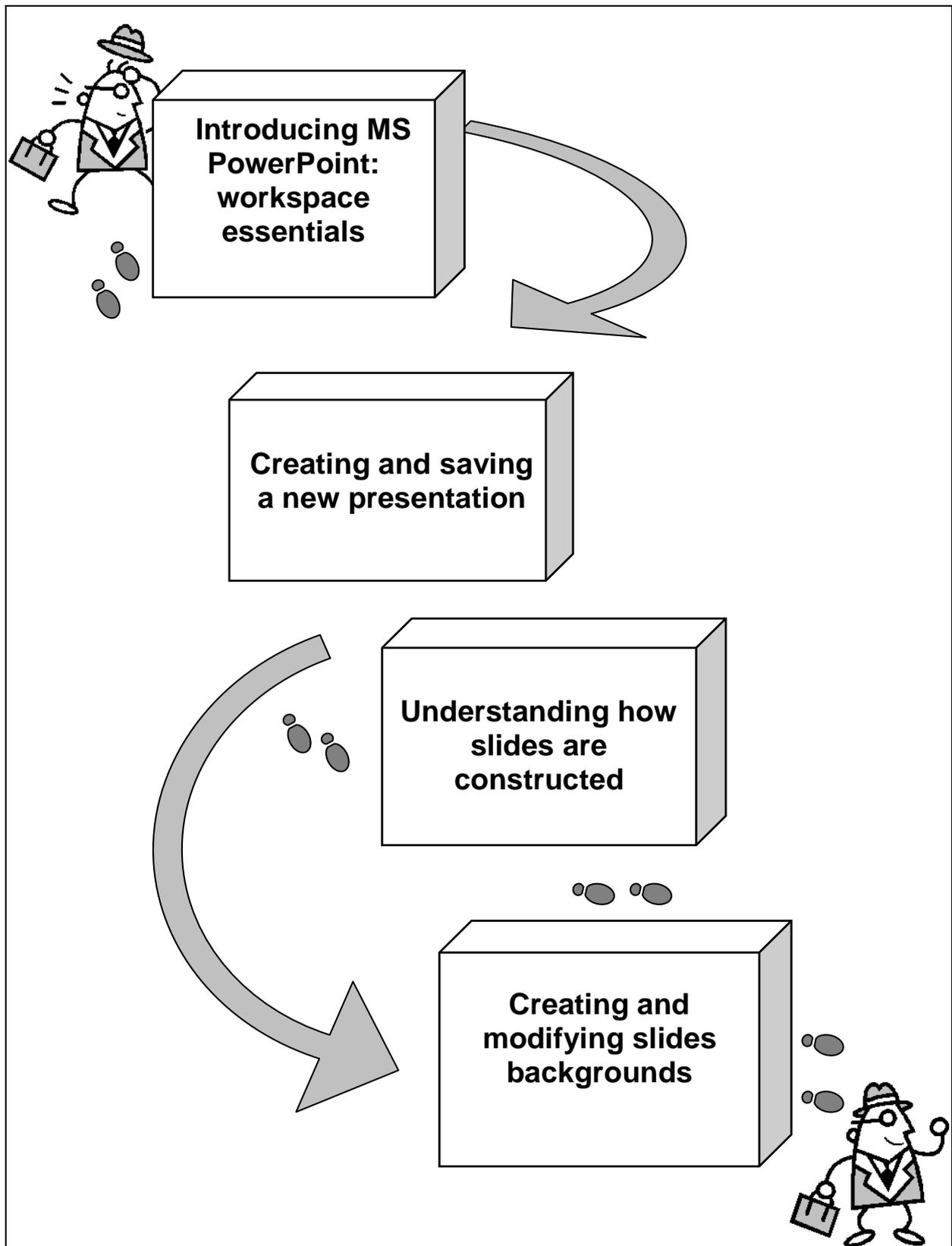
Fig. 15.1. **System elements of the theme**

▉ Introduction

The purpose of this theme is concerned with the study of main features of MS Office PowerPoint presentations creation software. The program's interface is considered in detail and basic operations concerned with the creation and modification of presentation documents are given a special attention.

Clue notions of the theme include: office button; ribbon; pop-up menus; slides formatting; headings; backgrounds; layouts, themes; templates; file formats.

This theme covers the following **topics:** Introduction to the Power Point environment. The Power Point interface and its basic elements. Power Point files and basic operations with Power Point presentations. Moving around slides and presentations. Introduction to the technology of inserting and manipulating slides in a presentation. Inserting slides from different sources. Changing the size and orientation of presentation slides. Showing of hidden slides during the presentation. Introduction to the technology of creating and modifying slides backgrounds in MS Power Point presentations.

As a result of the study of the material represented in this theme students will acquire the following **competencies**:

they would get acquainted with the program's interface features;

they would master the technology of creating slides manually and using templates;

they would learn how to save presentations in different formats, including availability for previous versions of Microsoft Office;

they would master basic navigational operations in the Power Point environment;

they would master the technology creating new slides and using existing slides from other presentations and MS Word documents;

they would learn different ways of organizing and changing the background for MS Power Point slides.

15.1. Introducing MS PowerPoint: workspace essentials

Microsoft PowerPoint, usually called just PowerPoint, is a proprietary presentation program developed by Microsoft. It is part of the Microsoft Office suite, and runs on Microsoft Windows and Apple's Mac OS X operating system. To make PowerPoint do your bidding, you need to know a little jargon.

> ★ *Presentation – all the slides, from start to finish, that you show your audience. Sometimes presentations are called "slide shows." Presentations are saved in presentation files (.pptx files).*

Slides are the images you create with PowerPoint. During a presentation, slides appear on-screen one after the other.

Handouts are printed pages that you may give to the audience after a presentation. A handout shows the slides in the presentation. Handouts are also known by the somewhat derogatory term "leave-behinds."

PowerPoint isn't just a speaker's aid, but a means of communicating something to an audience — an idea, a business plan, a marketing strategy. PowerPoint offers numerous ways to communicate with an audience above and beyond what can be said in words. For that PowerPoint uses colors, photographs and other images, tables, charts, diagrams, shapes and text-box shapes, sounds and videos.

Most presentations are made to be delivered in person by a speaker, but you can deliver presentations from afar by choosing special commands. These kinds of presentations can run in your absence:

self-running presentation – a presentation that runs on its own and can be exhibited at a trade show or other public place;

user-run presentation – a presentation that others can run. Special buttons permit individuals to go from slide to slide;

a handout is a printed copy of a presentation;

a CD (DVD) is a packaged CD copy of a presentation that others can show on their computers. People who don't have PowerPoint can view presentations after they are packed for a CD;

a Web page is a version of a presentation formatted for display on the Internet or an intranet.

Here is a short explanation of some basic elements of the Power Point interface (fig. 15.2).

Title bar is the stripe along the top of the screen. It lists your presentation's name. **Window buttons** are for shrinking, enlarging, and closing the PowerPoint window. **Office button** is the round button you can click to open a menu with commands for creating, opening and saving PowerPoint presentations, as well as doing other file-management tasks. **Quick Access toolbar** is a toolbar with three buttons – Save, Undo, and Repeat. You see this toolbar wherever you go in PowerPoint.
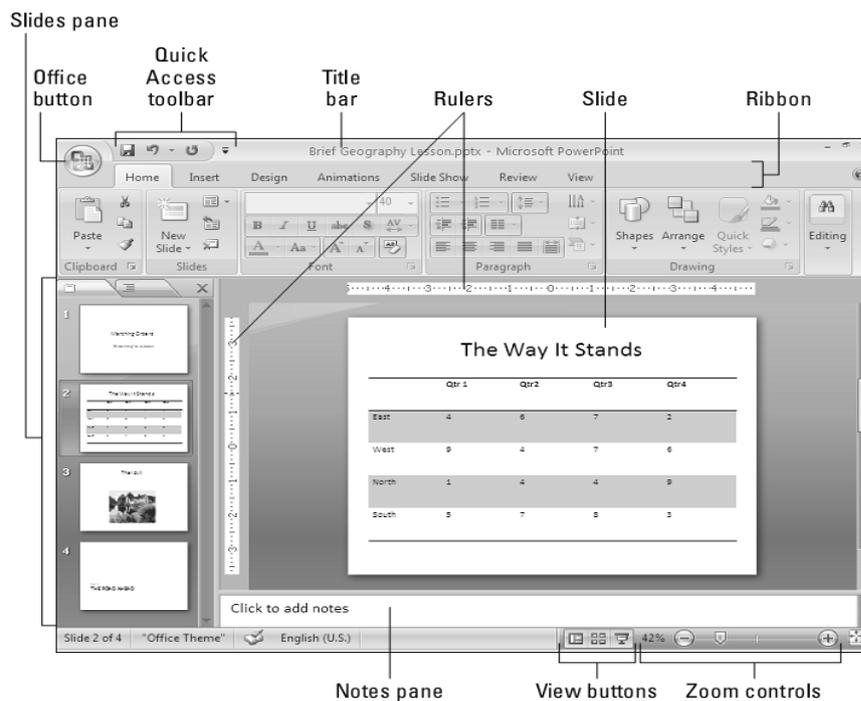
Fig. 15.2. **The different parts of the PowerPoint screen**

Ribbon is the place where the tabs are located. Click a tab – Home, Insert, Design, Animations, Slide Show, Review, or View – to start a task. **Slides pane** is the place on the left side of the screen where you can see the slides or the text on the slides in your presentation. Scroll in the Slides pane to move backward and forward in a presentation. **Slide window** is where a slide (in Normal view) or slides (in Slide Sorter view) are displayed. Scroll to move backward or forward in your presentation. **Notes pane** is where you type notes (in Normal view) that you can refer to when giving your presentation. The audience can't see these notes — they are for you and you alone. **Status ban** tells you information about your presentation. **View buttons** are the buttons you can click to switch to (from left to right) Normal, Slide Sorter, and Slide Show view. **Zoom controls** are used to enlarge or shrink the slide (in Normal view) or slides (in Slide Sorter view).

Across the top of the screen is the **Ribbon**, an assortment of different tabs; click a tab to undertake a task. For example, click the **Home** tab to add a slide to a presentation and format the text on slides; click the **Insert** tab to insert a table or picture, among other things, on a slide. Figure 15.3 shows what you see when you click the Home, Insert, and Design tab on the Ribbon. Each tab offers a different set of buttons and galleries.

To make the Ribbon disappear and get more room to view slides, right-click the Ribbon and choose **Minimize the Ribbon** on the shortcut menu. To see the Ribbon again, right-click a tab name or the Quick Access toolbar and

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deselect Minimize the Ribbon on the shortcut menu. While the Ribbon is mini-mized, you can click a tab name to display a tab.
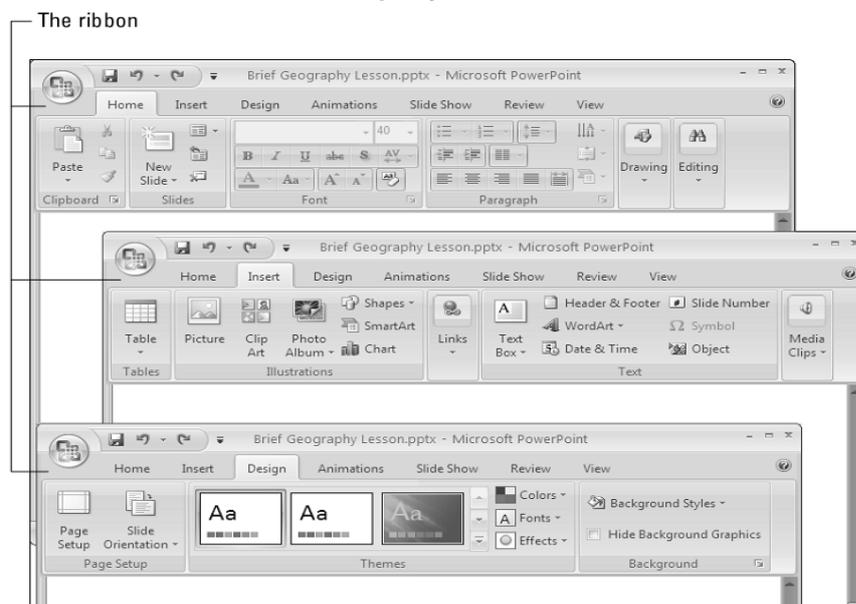
Fig. 15.3. **The commands are different on each tab on the Ribbon**

A **Mini toolbar** is a ghost-like menu that appears on-screen to help you do a task, as shown in Figure 15.4. Move the pointer onto a Mini toolbar, and it ceases being ghost-like. You can choose an option from a drop-down list or click a button on the Mini toolbar to complete a task.

Fig. 15.4. **Move the pointer over a Mini toolbar to make it come alive**

Depending on the task at hand, some views are better than others. Figure 5 demonstrates different ways of viewing a presentation. PowerPoint offers two places to change the view.

View buttons on the Status bar: click a View button – Normal, Slide Sorter, or Slide Show – on the Status bar to change views, as shown in Figure 15.5.

View tab: click the View tab and then click a button on the Presentation Views group to change views, as shown in Figure 5.

Outline Switch to **Normal view** and select the **Outline tab** in the Slides pane when you're entering or reading text. You can find the Outline tab at the top of the Slides pane. The words appear in outline form. Normal/ Outline view is ideal for focusing on the words in a presentation.

Slides Switch to **Normal view** and select the **Slides tab** in the Slides pane when you want to examine a slide. In this view, thumbnail slides appear in the Slides pane, and you can see your slide in all its glory in the middle of the screen. Scroll to and select a slide to make it appear on-screen. You can use the scrollbar in the Slides pane to find a particular slide.
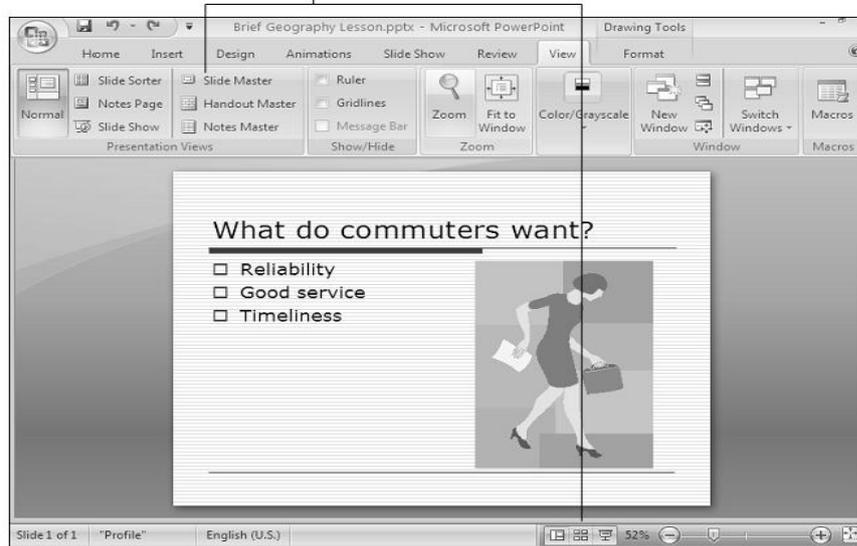
Fig. 15.5. **Techniques for changing views**

In **Slide Sorter view**, you see thumbnails of all the slides in the presentation. From here, moving slides around is easy, and seeing many slides simultaneously gives you a sense of whether the different slides are consistent with one another and how the whole presentation is holding up. The slides are numbered so that you can see where they appear in a presentation.

In **Slide Show view**, you see a single slide. Not only that, but the slide fills the entire screen. This is what your presentation will look like when you show it to an audience. You can see what a slide really looks like at this size. To advance from slide to slide, click the screen. To quit Slide Show view, press the Esc key or right-click and choose End Show on the shortcut menu.

In **Notes Page view**, you see notes you have written to aid in your presentation, if you've written any. You can write notes in this view as well as on the Notes pane in the Normal view. PowerPoint gives you one page per slide (although you can change that). To get from page to page, drag the scrollbar.

Sometimes color on slides, not to mention animations and graphics, is a distraction. To strip down slides to their bare essence, change to Grayscale or Pure Black and White view. These views don't actually change the color on slides — they change the slides' appearance only on your computer monitor. Pure Black and White is especially useful for focusing on text.

Also on the View tab are the Master views — Slide Master, Handout Master, and Notes Master. To switch to these views, visit the View tab and click the appropriate button. These sophisticated views are for handling master styles, the formatting commands that pertain to all the slides in a presentation (Slide Master view), the printed handouts you can give to audience members (Handout Master view), and the notes you write to yourself about giving a presentation (Notes Master view).

15.2. Creating and saving a new presentation

When you start PowerPoint, the program creates a new, blank presentation. You can make this bare-bones presentation the starting point for constructing your presentation, or you can get a more sophisticated, fully realized layout and design by starting with a template.

★ *A **template** is a starter file for creating a presentation. Each presentation is founded on a template.*

Each presentation inherits its colors, designs, fonts, and slide layouts from the template on which it was founded (the blank presentation gets its design from a simple, bare-bones template). When you decide between creating a presentation from the blank presentation or a template, you're really deciding what your presentation will look like.

Figure 15.6 shows a slide created from the blank presentation (left) and a slide created from a template (right). When you create a presentation with a template, all design decisions are made for you. You get ready-made background colors, fonts, and slide layouts.

Templates are designed by artists and they look very good. Some templates come with *boilerplate text* – already written material that you can recycle into your presentation. However, presentations made from templates are harder to modify. Sometimes the design gets in the way. A loud or intricate background may overwhelm the diagram or chart you want to put on a slide.

For example, the clip-art image on the blank-presentation slide in Figure 6 would look out of place on the template slide because the image and the template background are incompatible.
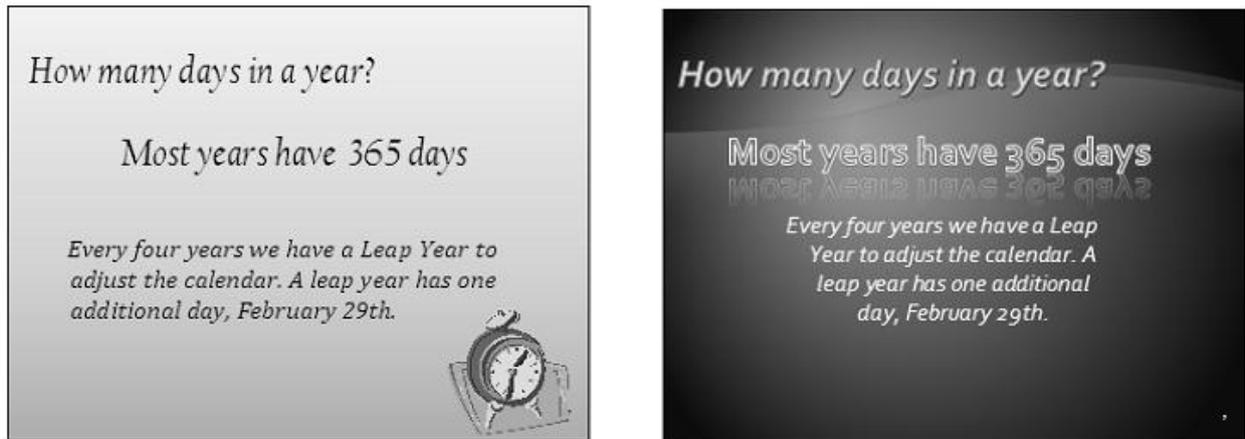
Fig. 15.6. **A slide made from the blank presentation (left) and a template (right).**

Starting from the blank presentation means doing the design work on your own, although, as it was mentioned earlier, designing presentations isn't as hard as most people think because you can choose ready-made themes and background styles for a blank presentation. Sometimes simpler is better. By starting from a blank presentation, you aren't locked into someone else's design choices, and you have more creative opportunities.

PowerPoint shows you a blank presentation each time you open the program. You can save this presentation and start to work or, if you're working on another presentation already and you want to create a new, blank presentation, you can follow these steps to create it:

1. Click the Office button.

2. Choose New on the drop-down list.

You see the New Presentation dialog box, shown in Figure 15.7.

3. Double-click Blank Presentation.

A new presentation appears. You can also create a new blank presentation by pressing Ctrl+N. Try visiting the Design tab and choosing a theme or background style to get a taste of all the things you can do to redesign a presentation.

The New Presentation dialog box (refer to Figure 15.7) offers many opportunities for finding a suitable template. To open this dialog box, click the Office button and choose New on the drop-down list. As you employ the following techniques to find a template, remember that you can click the Back

or Forward button in the dialog box to retreat and advance during your search.
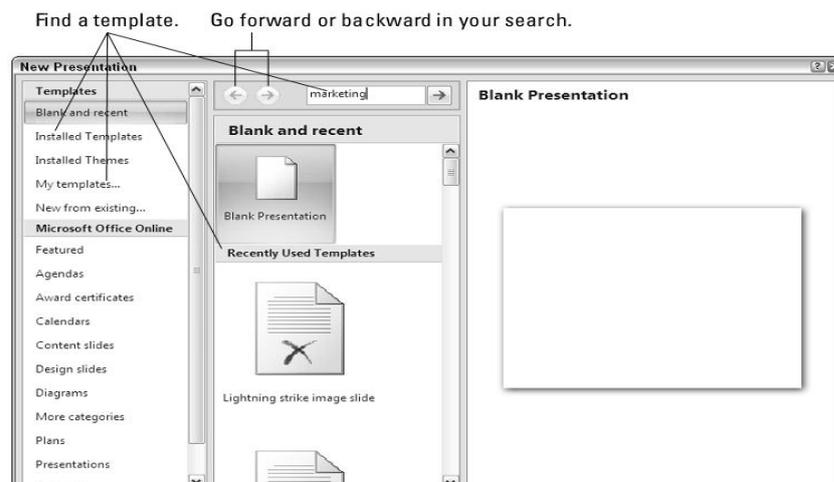
Fig. 15.7. **The New Presentation dialog box is the starting point for creating a new presentation**

Soon after you create a new presentation, be sure to save it. And save your presentation from time to time as you work on it as well. Until you save your work, it rests in the computer's electronic memory (RAM), a precarious location. To save a presentation, do one of the following:

click the Save button 🖫;

press Ctrl+S;

click the Office button and choose Save on the drop-down list.

Not everyone is a proud owner of new versions of Microsoft Office PowerPoint. Before you pass along a document to a co-worker who has an earlier version of PowerPoint, be sure to save a presentation so that PowerPoint 97, 2000, 2002, or 2003 can open it.

15.3. Understanding how slides are constructed

Before you insert a slide, PowerPoint asks you a very important question, "What kind of slide do you want?" You can choose among several different slide layouts, the preformatted slide designs that help you enter text, graphics, and other things. Some layouts have text placeholder frames for entering titles and text. Some layouts come with icons that you can click to insert a table, diagram, clip-art image, picture, Excel worksheet, or video.

To make a wise choice about inserting slides, it helps to know how slide layouts are constructed. Figure 15.8 shows one of the simplest layouts, **Title** and **Content**, in three incarnations:

the **Title and Content** layout as it appears on the New Slide drop-down list (left). As you will find out shortly, you create a slide by choosing a layout from the New Slide drop-down list;

the slide as it looked right after it was selected, before any text was entered (middle);

the finished product, after a bulleted list was entered (right).

The **Title and Content** slide layout comprises two placeholder frames, one for entering a title and one for entering either a bulleted list or "content" of some kind – table, chart, diagram, picture, clip-art image, or video. Most slide layouts come with text placeholder frames to make the task of entering text on a slide easier.

Fig. 15.8. **A slide layout (left), the bare-bones slide (middle), and the finished slide (right)**

When you create a slide, select the layout that best approximates the slide you have in mind for your presentation. As you get better with PowerPoint, you'll discover that slide layouts are actually kind of limiting. You'll find yourself tweaking the layouts to remove some of the frames and change the size of frames. For now, remember that slides are constructed from **frames** and that frames are designed to help you lay out text and graphics. Remember that **frames** help you enter text and other content.

After you create a presentation, your next step is to start inserting the slides. PowerPoint has done its best to make this little task as easy as possible. You can insert slides one at a time, duplicate a slide you have already made, steal slides from another presentation, or nab content from a Microsoft Word document.

Creating a duplicate slide can save you the trouble of doing layout work. All you have to do is re-create a slide and then go into the duplicate and change its title, text, or other particulars. PowerPoint offers no fewer than three different ways to clone slides.

Stealing is wrong, of course, except when stealing slides from other PowerPoint presentations. One way to steal slides is to open the other presentation, copy slides to the Clipboard, and paste the slides into your presentation (see the previous section in this lesson). You can also take advantage of PowerPoint commands designed especially for recycling slides (fig. 15.9).

Headings in a Microsoft Word document are similar to titles in a Microsoft PowerPoint slide. As do titles, headings introduce a new topic. They tell you what is to follow.
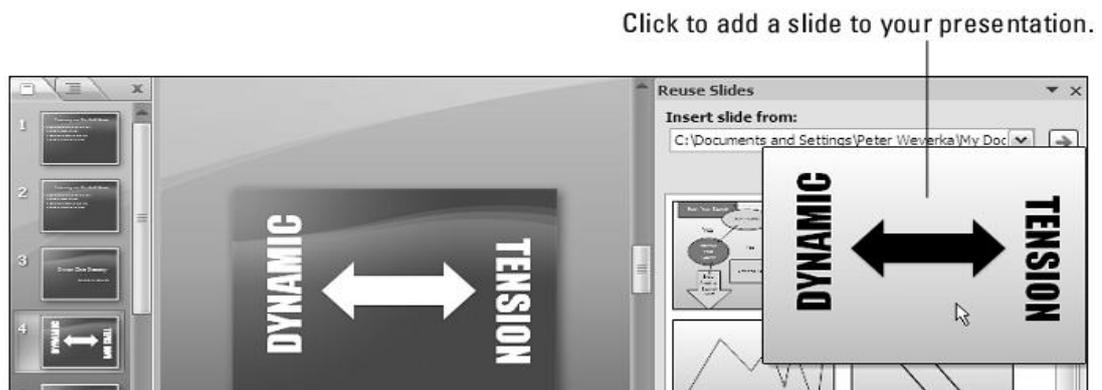
Fig. 15.9. **Examine and select slides in the Reuse Slides task pane**

A heading announces the subject of the text to follow in the same way that a slide title announces what the subject of a slide is. If you have the wherewithal to do it, you can create slides from the headings in a Word document. First-level headings – that is, headings assigned the "Heading 1" style in Word – become slide titles in your presentation. Second-level headings become top-level bullet points on slides; third-level headings become second-level bullet points on slides; and so on. Figure 15.10 shows what the headings from a Word document look like after they land in a PowerPoint presentation.
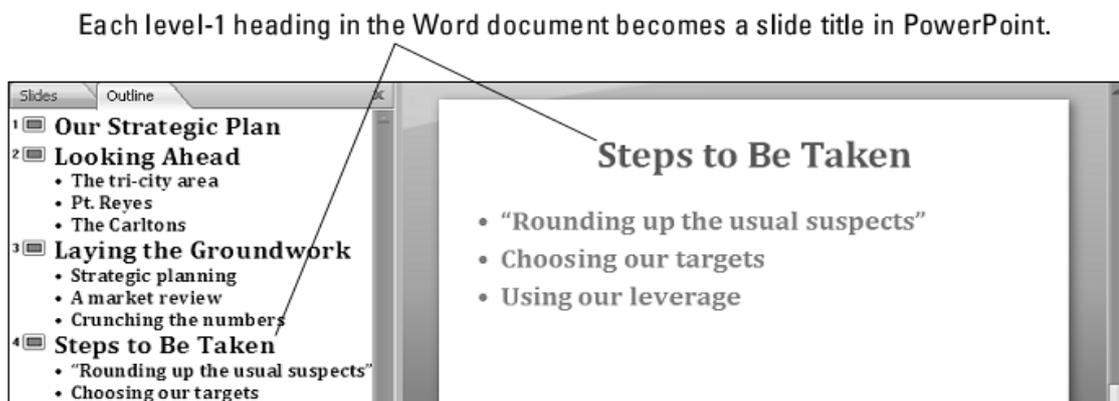
Fig. 15.10. **Headings from a Word document imported into a PowerPoint presentation**.

PowerPoint creates one new slide for each first-level heading in your Word document. The new slides are given the Title and Content slide layout. Each first-level heading from the Word document appears in a slide title. Depending on how many first-level headings are in the Word document, you get a certain number of new slides.

The first thing to know about changing the size of the slides in a presentation is **don't do it**! Unless you have a **very good reason** for that. PowerPoint presentations are designed to fill a computer monitor screen. If your slides aren't doing that, you may have inherited an old PowerPoint presentation with slides that need resizing. In that case, follow these steps to choose a new size for the slides in your presentation:

click the **Design tab**;

click the **Page Setup button**.

The Page Setup dialog box opens, as shown in Figure 15.11.
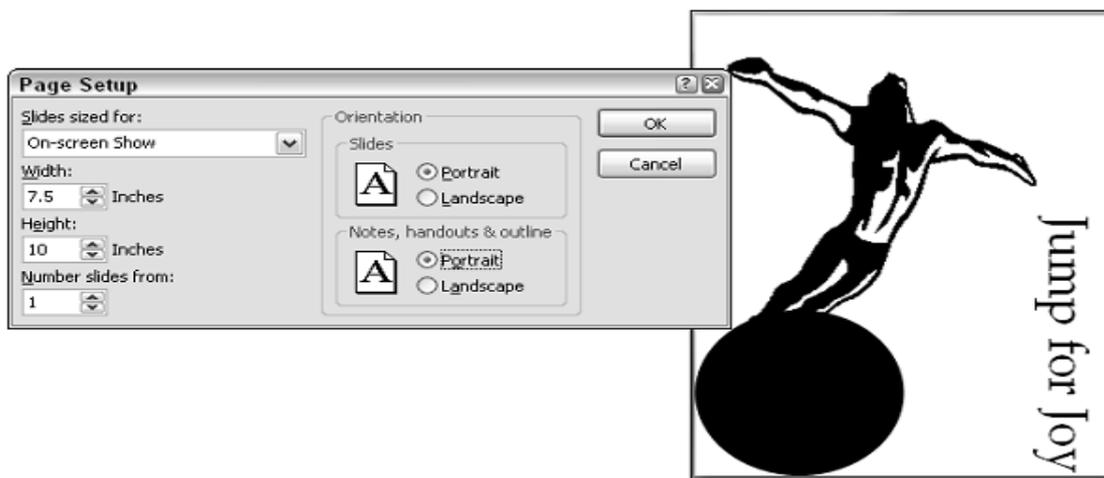
Fig. 11. **The Page Setup dialog box (left) and a portrait-style slide (right).**

Sometimes there appears a necessity to hide a slide when you want to keep it on hand "just in case" during a presentation. Hidden slides don't appear in slide shows unless there is a shortcut to them in some other slides.

The best place to put hidden slides is the end of a presentation where you know you can find them. Follow these steps to hide slides:

select the slide or slides;

on the Slide Show tab, click the **Hide Slide** button.

You can also right-click and choose Hide Slide. Hidden slides' numbers are boxed in the Slides pane and Slide Sorter window. To "unhide" a slide, select the slide and click the Hide Slide button again or right-click it in the Slides pane or Slide Sorter window and choose Hide Slide on the menu.

Hidden slides **don't appear** during the course of a presentation, but suppose that the need arises to show one. Before showing a hidden slide, take careful note of which slide you're viewing now. You'll have to return to this slide after viewing the hidden slide (fig. 15.12).
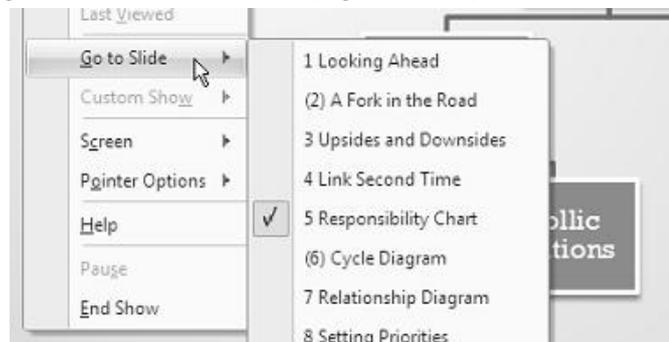
Fig. 15.12. **Going to a hidden slide.**

15.4. Creating and modifying slides backgrounds

From the audience's point of view, this part is very important. What your presentation looks like – which theme and background style you select for the slides in your presentation, what is the formatting style of the text – sets the tone.

Besides using a pre-installed theme another option for creating slide backgrounds is to do it on manually. For a background, you can have a solid color, a transparent color, a gradient blend of two colors, a picture, or a clip-art image. How to create these kinds of slide backgrounds on your own is the subject of this lesson.

To create a background style of your own, start on the **Design tab** and click the **Background Styles** button. Then, on the drop-down list, select Format Background. You see the **Format Background** dialog box. From there, you can get to work on creating a customized background on your own.

Using a solid or transparent color as the background of slides gives your presentation a straightforward, honest look. Because all the slides are the same color or transparent color, the audience can focus better on the presentation itself rather than the razzle-dazzle.

Gradient refers to how and where two colors grade, or blend, into one another on a slide. As well as the standard linear gradient direction, you can opt for a radial, rectangular, or path gradient direction, as shown in fig. 15.13.

Gradient backgrounds look terribly elegant. Using a gradient is an excellent way to create an original background that looks different from all the other presenters' slide backgrounds.
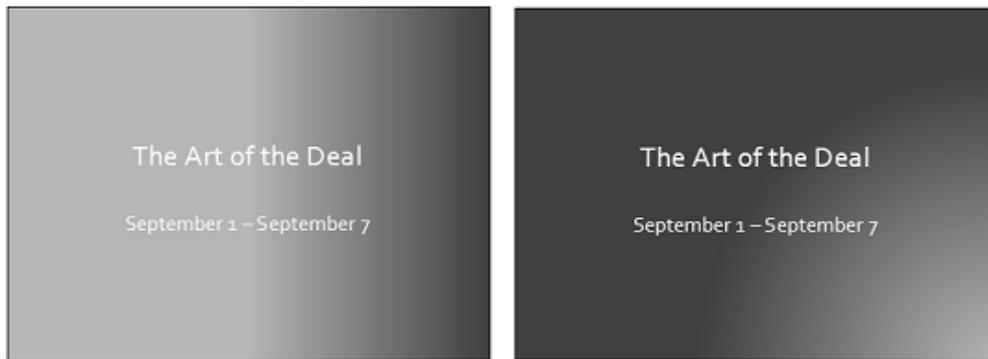
Fig. 15.13. **The Gradient Type options**

To create a gradient background for slides, start on the **Design tab**, click the **Background Styles** button, and choose **Format Background** on the dropdown list. Then, in the Format Background dialog box, click the **Gradient Fill** option button. You get a different set of options in the **Format Background** dialog box.

Before you experiment with gradients, try opening the **Preset Colors** dropdown list to see whether one of the preset options does the job for you.

Drag the **Format Background** dialog box to the left side of the screen so that you can see your slide better, and follow these steps to create the gradient blend of the different colors:

select **Stop 1** on the Gradient Stops drop-down list; then click the Color button and select a color; then click the Add button;

select **Stop 2** on the Gradient Stops drop-down list, select a color for it as well, and click the Add button.

Now you've selected the two gradient colors. You can select more colors if you wish. Your next task is to tell PowerPoint where to blend the colors.

Clip-art images and graphics do fine for slide backgrounds. They look especially good on title slides. Figure 15.14 shows examples of clip-art images as backgrounds.
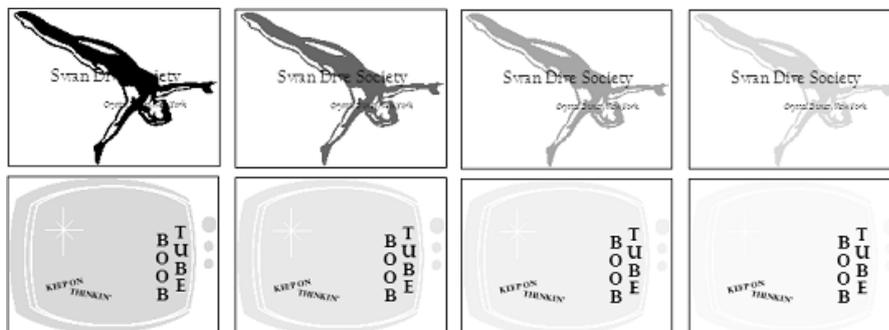
Fig. 15.14. **For backgrounds, clip art usually has to be at least somewhat transparent**

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PowerPoint comes with numerous clip-art images. You are invited to place one in the background of your slides by following these steps: on the **Design tab**, click the **Background Styles** button to open the drop-down list; choose the **Format Background** command at the bottom of the menu; click the **Picture** or Texture Fill option button and find a clip-art image you can use in the background of your slides.

Another option for slide backgrounds is to use a texture (fig. 15.15).
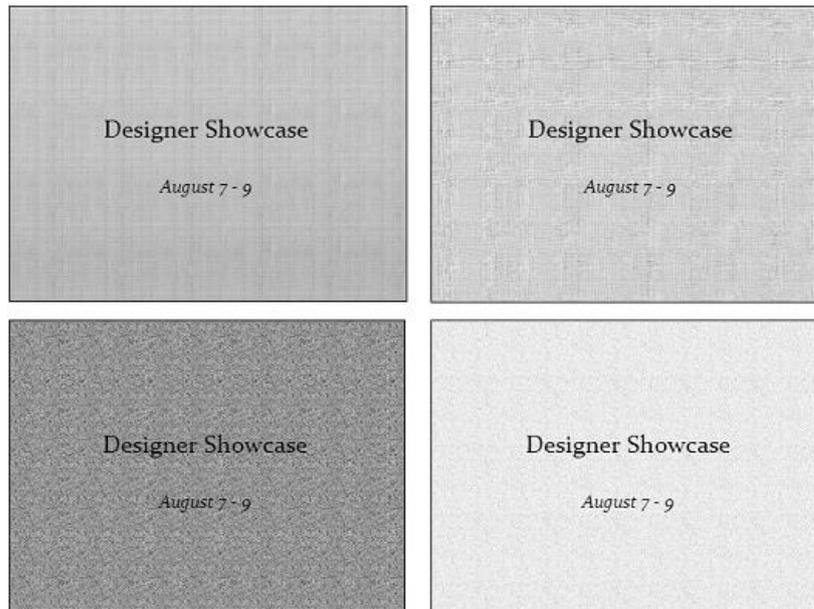
Fig. 15.15. **Different textures (clockwise from upper-left): Papyrus, Canvas, Newsprint, and Cork.**

As shown in Figure 15.15, a texture gives the impression that the slide is displayed on a material such as cloth or stone. A texture can make for a very elegant slide background.

■ **Questions**

1. What is a presentation and for what purposes is it used?

2. What are the main elements of a presentation?

3. Is it possible to hide slides in a presentation?

4. What formatting tools are available in MS PowerPoint to change the looks of slides?

5. Is it possible to use text created in MS Word in MS PowerPoint slides?

6. What types of slide backgrounds are available in MS PowerPoint?

Theme 16. Adding and formatting information content to MS PowerPoint slides: text, tables, diagrams and graphics
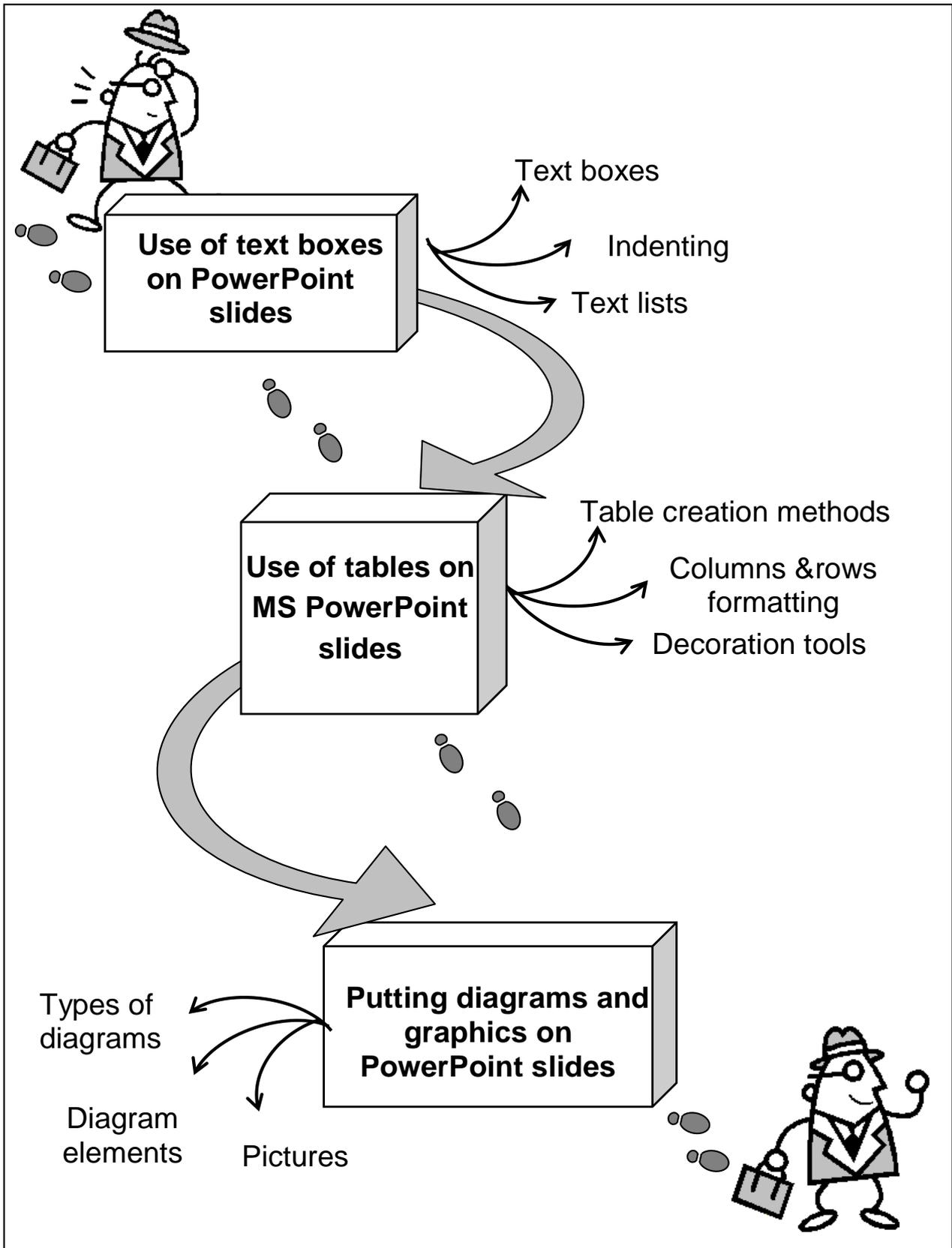
Fig. 16.1. **System elements of the theme**

■ Introduction

The purpose of this theme lies in a close study of main operations connected with adding and formatting of information content to MS PowerPoint slides. Work with text blocks, tables, diagrams and picture objects are considered supplied with detailed step-by-step instructions.

Clue notions of the theme include: text boxes; tables; diagrams; pictures; compression; shapes; bitmapped and vector graphics.

This theme covers the following **topics:** How to create text boxes and how to place text with precision on slides. Tables creation and editing technology. Analysis of how PowerPoint diagrams are constructed from SmartArt graphics and how to create a thematic diagram

As a result of the study of the material presented in this theme students will acquire the following **competencies**:

they would learn different ways of formatting text on MS Power Point slides;

they would master different ways of formatting tables;

they would study different ways of formatting diagrams and images on MS Power Point slides.

16.1. Use of text boxes on PowerPoint slides

Text boxes give an opportunity to exercise personal creativity. They add another element to slides. Use them to position text wherever you want, annotate a chart or equation, or place an announcement on a slide. You can even create a vertical text box in which the text reads from top to bottom instead of left to right, or turn a text box into a circle, arrow, or other shape. Figure 16.2 shows examples of text boxes.
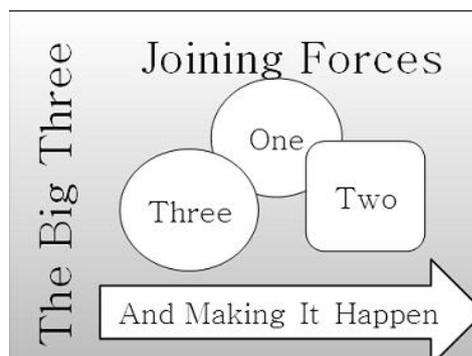
Fig. 16.2 . **Examples of text boxes**

In order to create a text box Open the drop-down list on the **Text Box button** and choose **Horizontal** or **Vertical**, as shown in Figure 16.3.
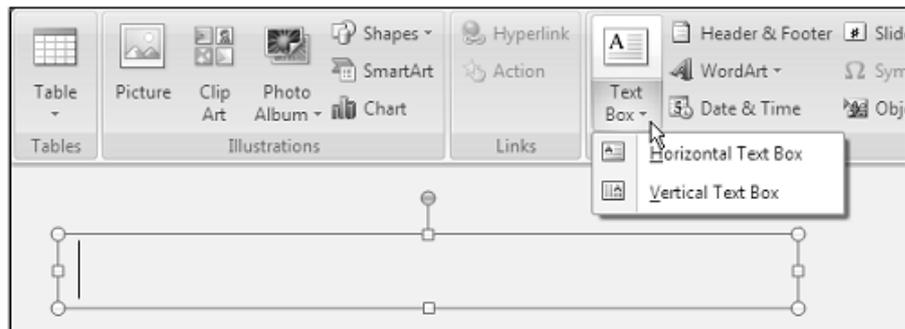
Fig. 16.3. **Drawing, moving, and resizing a text box**

To remove a text box, select it by clicking its perimeter; then, press the Delete key. Deleting a text box deletes all the text inside it as well.

Besides creating a vertical text box by opening the drop-down list on the **Text Box** button (see the previous section), you can turn a text box on its side, as shown in Figure 16.3. Use one of these techniques:

drag the **rotation handle**: click and drag the green rotation handle (refer to Figure 4);

choose a **Rotate** or **Flip** command: on the (**Drawing Tools**) **Format tab**, click the **Rotate** button and choose a **Rotate** or **Flip** command on the drop-down list (depending on the size of your screen, you may have to click the **Arrange** button first);

open the **Size** and **Position** dialog box: On the (Drawing Tools) Format tab, click the **Size group button** (you may have to click the Size button first). You see the **Size and Position** dialog box. On the Size tab, enter a measurement in the Rotation box. Use the Size and Position dialog box to rotate several text boxes or other objects by the same degree (fig. 16.4).

Fig. 16.4. **You can turn text boxes on their ears**

Rather than use the conventional rectangle as a text box, use can a shape. PowerPoint offers no fewer than 140 different shapes, including arrows, circles, stars, and banners. Any of these shapes can do double-duty as a text box. Figure 16.5 shows examples of shapes as text boxes. Create a

text box with rounded corners, or to really call attention to text, use a heart or arrow as a text box.
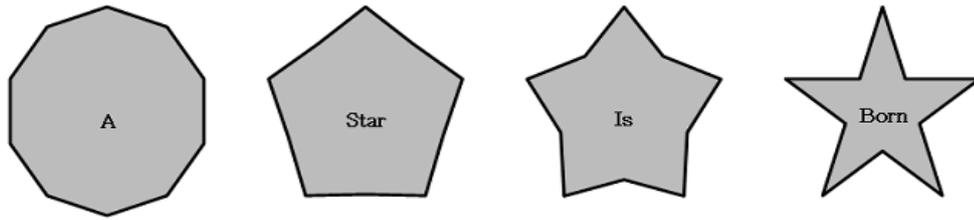
Fig. 16.5. **Using shapes as textboxes**

You probably have to resize the shape to make the text fit snugly inside it. If your text-box shape appears not to have changed shapes, click the Shape Fill button and choose a color for your shape.

Figure 16.6 demonstrates ways to change the direction of text in a text box or text frame. Normally, text is horizontal and reads from left to right, but you can turn it on its ear or stack it. In stacked text, the letters appear one below the next. Stacked text can be appealing when you stack a single word.
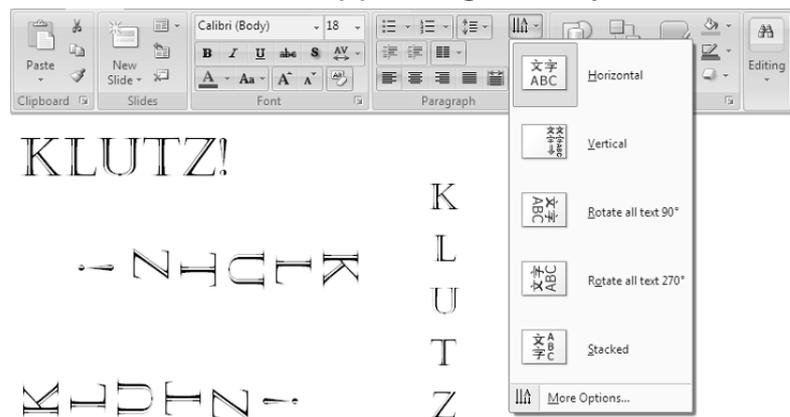
Fig. 16.6. **Ways to change the direction of text**

Follow these steps to change the direction of text in a text box or text frame:

select the text box or text frames and go to the **Home tab**;

click the **Text Direction** button and select a **Text Direction** option on the drop-down list, as shown in Figure 6.

Choose the **Horizontal** option to read text the normal way. Often you have to change the shape of a text box to make the text fit inside it after you choose a Text Direction command.

You can also change the direction of text by way of the Format Shape dialog box. Right-click the text box, choose Format Shape (or choose More Options on the Text Direction drop-down list), and click the **Text Box** category in the **Format Shape** dialog box. Then open the **Text Direction**

drop-down list and choose an option. Another way to change the direction of text is to rotate the text box or text frame holding the text.

As shown in Figure 16.7, how text is aligned in text frames and text boxes is governed by two sets of commands, the Align commands and the Align Text commands. **Align commands –** <u>Align Left, Center, Align Right, and Justify</u> – control horizontal (left-to-right) alignments. **Align Text commands –** <u>Top, Middle, and Bottom</u> – control vertical (up-and-down) alignments.

By choosing combinations of **Align** and **Align Text** commands, you can land text where you want it in a text frame or text box. Just wrestle with the two commands until you land your text where you want it to be in the text frame or box.
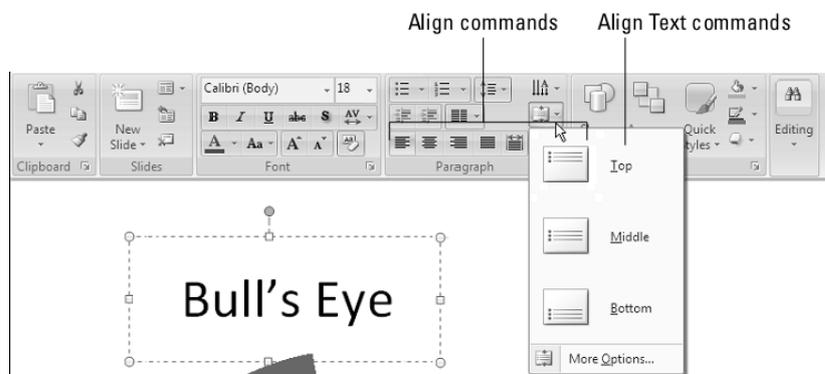
Fig. 16.7. **Align Text and an Align commands to position text in text frames and boxes**

Indenting text means to put a dent in a text frame or text box. Actually, indenting means to move text inward from the left or right side of a text frame or text box.

On the printed page, how text is indented tells one something about the text. For example, when you see text indented from the left and right side, you can be pretty sure you're looking at a long, block quotation. Because slides present text in small doses and the text usually fits on one line, text indentation doesn't matter as much on slides as it does on the printed page. Still, indenting text in different ways can give a slide presentation variety and make it a little livelier. Here are the different ways to indent text.

Left indent: text is indented from the left side of the text box or frame.

Right indent: text is indented from the right side. Used along with left indents for block quotations, announcements in the text, and other occasions when text needs to stand out.

First-line indent: the first line of each paragraph is indented. Helps readers mark the start of a new paragraph.

Hanging indent: the second and subsequent lines are indented, not the first line. Used in bulleted lists and numbered lists. In a hanging indent, the bullet character or number on the first line is flush with the left side of the text box or frame, and the other lines in the paragraph are indented. A hanging indent is sometimes called an outdent.

PowerPoint offers two means of indenting indent text. To indent text from the left and right sides of a text box or text frame, choose between two options.

Paragraph dialog box. On the Home tab, click the Paragraph group button to open the Paragraph dialog box and enter indentation settings, as shown in Figure 16.8.
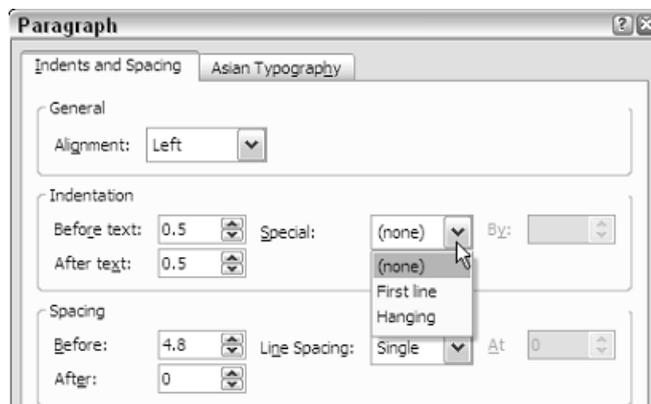
Fig. 16.8. **Paragraph dialog box**

Indent Markers on the Ruler. Drag markers on the ruler to indent a paragraph, as shown in Figure 16.9. To display the ruler, click the View tab and then click the Ruler check box (you may have to click the Show/Hide button first, depending on the size of your screen).
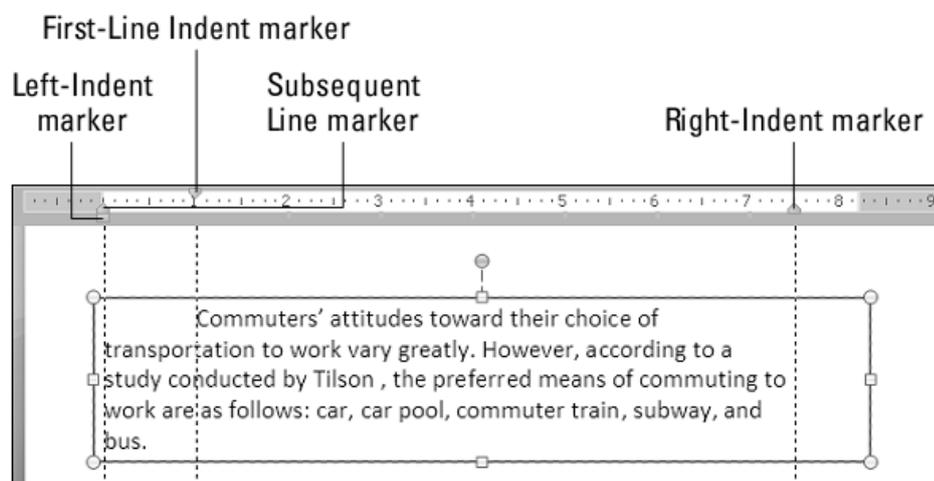
Fig. 16.9. **Changing indents with ruler markers**

In typesetting terms, a **bullet** is a black, filled-in circle or other character that **marks** an item on a list.

As Figure 16.10 shows, bulleted lists are useful when you want to present the reader with **alternatives** or **present a list** in which the items are not ranked in any order. Use a numbered list to rank items in a list or present step-by-step instructions, as shown in Figure 16.10.

Populous Cities	Most Populous Cities
• Delhi	1. Mumbai
• Karachi	2. Karachi
• Moscow	3. Delhi
• Mumbai	4. Shanghai
• São Paulo	5. Moscow
• Shanghai	6. Seoul
• Seoul	7. São Paulo

Fig. 16.10. **Items aren't ranked in a bulleted list (left); use a numbered list to show rankor chronology**

Many slide layouts include text frames that are already formatted for bulleted lists. All you have to do in these text frames is "click to add text" and keep pressing the **Enter key** as you enter items for your bulleted list. Each time you press **Enter**, PowerPoint adds another bullet to the list.

As Figure 16.11 demonstrates, the black filled-in circle isn't the only character you can use to mark items in a bulleted list. You can also opt for what PowerPoint calls "pictures" or symbols from the Symbol dialog box. While you're at it, you can change bullets colors and size.
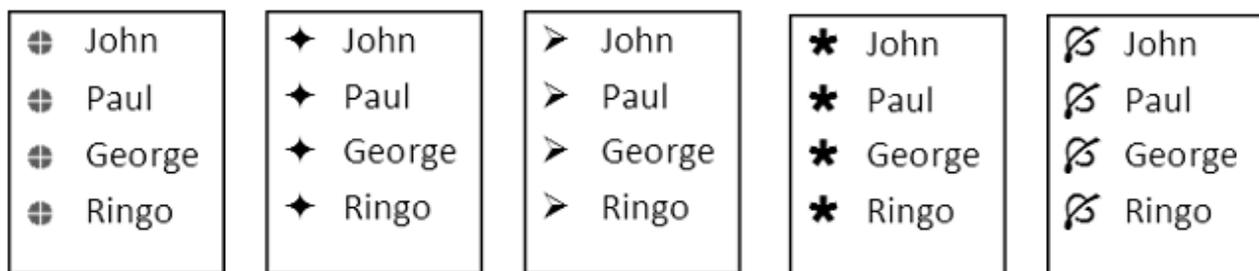
Fig. 16.11. **Examples of characters that can be used for bulleted lists**

To use pictures or unusual symbols for bullets, start by selecting your bulleted list (if you've already entered the list items), clicking the Home tab, and opening the drop-down list on the Bullets button. Click the Bullets and Numbering option at the bottom of the drop-down list.

Also it is possible to set the amount of space between lines of text and between different paragraphs. Changing the amount of space between lines is simply a matter of clicking the **Line Spacing button** or choosing options in

the **Paragraph dialog box**. To change spacing start either by clicking in a single paragraph or selecting part of several paragraphs whose line spacing you want to change. Then click the Home tab and change line spacing with the **Line Spacing button** or **Paragraph dialog box.**

16.2. Use of tables on MS PowerPoint slides

The best way to present a bunch of data at one time is to do it in a table. Viewers can compare and contrast the data. A PowerPoint slide isn't the place for an exhaustive table like the kind found in reference books. Researchers can't come back to a PowerPoint table to look up information as they can in a book table. Still, provided that the row labels and column headings are descriptive, a PowerPoint table is a great way to plead your case or defend your position.

As with much else in "ComputerLand", tables have their own jargon. Figure 16.12 describes table jargon. You need to catch up on these terms to construct the perfect table.

Row labels   Header row

	Qtr 1	Qtr 2	Qtr 3	Qtr 4
East	4	8	5	6
West	3	4	4	9
North	3	8	9	6
South	8	7	7	9

Borders   Gridlines   Cells

Fig. 16.12. **Parts of a table**

PowerPoint offers no fewer than four ways to create the cells and rows for a table. Create your table with one of these techniques.

Dragging on the Table menu. On the Insert tab, click the Table button, point on the drop-down to the number of columns and rows you want, as shown in Figure 16.13, and let go of the mouse button.

Clicking the Table icon. Click the Table icon in a content placeholder frame. You see the Insert Table dialog box, shown in Figure 16.13. Enter the number of columns and rows you want for your table and click OK.

Using the Insert Table dialog box. On the Insert tab, click the Table

button and choose Insert Table on the drop-down list. The Insert Table dialog box shown in Figure 16.13 appears. Enter the number of columns and rows you want and click OK.

Point to how many columns and rows you want. . .   or enter how many you want.
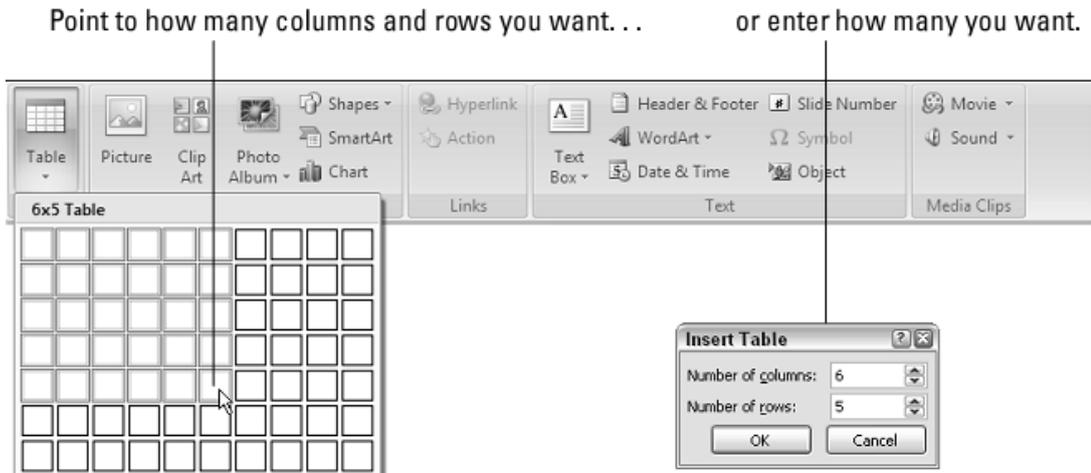
Fig. 16.13. **Declare how many columns and rows you want for the table**

Drawing a table. On the Insert tab, click the Table button and choose Draw Table on the drop-down list. The pointer changes into a pencil. Use the pencil to draw the table borders, the rows, and the columns.

It is possible to merge and split cells to make tables a little more elegant than run-of-the-mill tables. Merge cells to break down the barriers between cells and join them into one cell; split cells to divide a single cell into several cells (or several cells into several more cells).

In the table shown in Figure 16.14, the cells in rows 2, 4, and 6 have been merged, and a baseball player's name is in each merged cell. Where rows 2, 4, and 6 should have nine cells, they have only one.

1994	1995	1996	1997	1998	1999	2000	2001	2002
Mark McGwire's Home Runs								
53	51	52	58	70	65	32	20	—
Sammy Sosa's Home Runs								
11	38	37	48	64	63	50	64	49
Barry Bonds' Home Runs								
37	33	42	40	37	34	49	73	46

Fig. 16.14. **Merge cells to create larger cells**

The fastest way to adjust the width of columns, the height of rows, and the size of a table itself is to "eyeball it" and drag the mouse: **column or row** or a **table** as shown in Figure 16.15.

Because resizing columns and rows can be problematic, PowerPoint also offers these handy buttons on the Layout tab for adjusting the width and height of rows and columns.

Distribute Rows: click this button to make all rows in the table the same height. Select rows before clicking the button to make only the rows you selected the same height.

Distribute Columns: click this button to make all columns the same width. Select columns before giving this command to make only the columns you selected the same width.
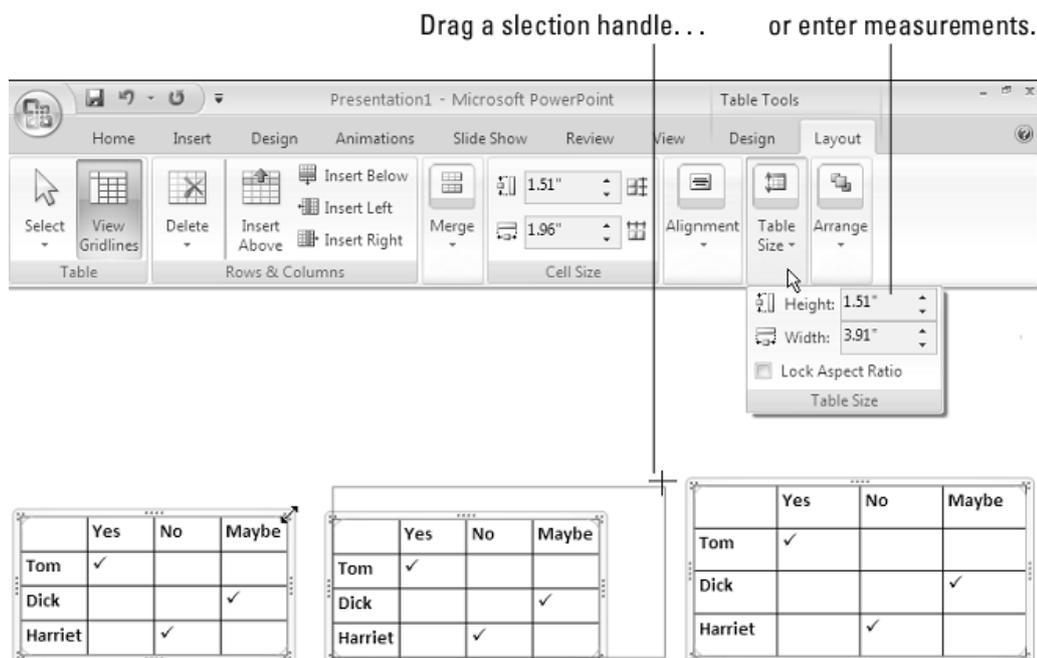
Fig. 16.15. **The two ways to change a table's size**

The trick to inserting and deleting columns and rows is to correctly select part of the table first. You can insert more than one column or row at a time by first selecting more than one column or row To insert two columns, select two columns and choose an Insert command; to insert three rows, select three rows and choose an Insert command.

It is possible to slap color on the columns and rows of your table, draw borders around columns and rows, and choose a look for borders. Figure 16.16 shows the drop-down lists on the (Table Tools) Design tab that pertain to table decoration.

In a top-heavy table in which the header row cells – the cells in the first row – contain text and the cells below contain numbers, consider changing the direction of the text in the header row to make the table easier to read.
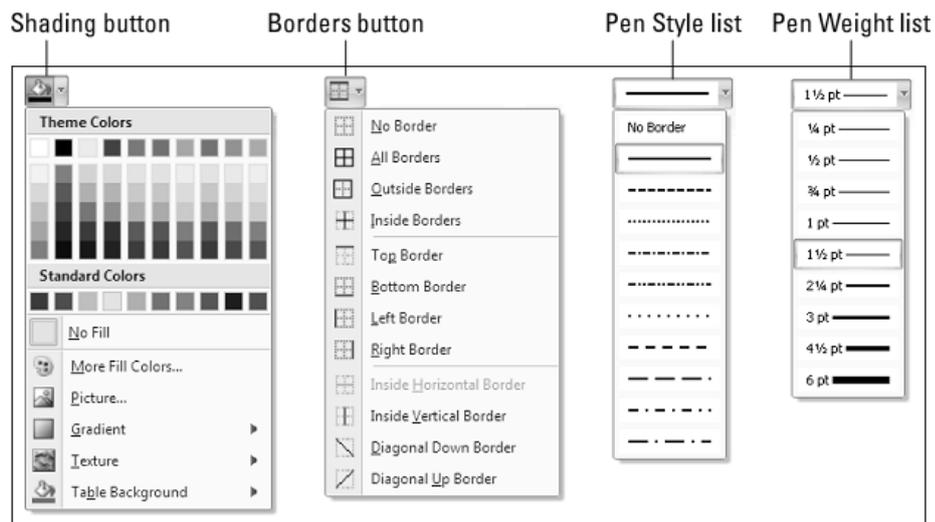
Fig. 16.16. **Tools on the (Table Tools) Design tab for decorating tables**

Changing text direction in the header row is also a good way to squeeze more columns onto a table. Consider how wide the table shown in Figure 16.17 would be if the words in the first row were displayed horizontally.

Fig. 16.17. **Change the direction of text to squeeze more columns on a table**

Draw diagonal lines across table cells to cancel out those cells or otherwise make cells look different. In Figure 16.18, diagonal lines are drawn on cells to show that information that would otherwise be in the cells is either not available or is not relevant.

	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.	Sun.
McKeef	8:00			3:00		8:00	2:15
Arnez	9:00	6:00	2:30	12:00	8:15		4:00
Danes	9:30		2:00	7:30		3:30	7:30
Minor		12:00	4:15	5:15	2:00		

Fig. 16.18. **Diagonal lines mark off cells as different**

16.3. Putting diagrams and graphics on PowerPoint slides

Along with tables, diagrams are the best way to present ideas to an audience. Diagrams clearly show, for example, employees' relationships with one another, product cycles, workflow processes, and spheres of influence. A

diagram is an excellent marriage of images and words. Diagrams allow an audience to literally visualize a concept, idea, or relationship (fig. 16.19).

Diagram Type	Use
List	For describing blocks of related information, as well as sequential steps in a task, process, or workflow.
Process	For describing how a concept or physical process changes over time or is modified.
Cycle	For illustrating a circular progression without a beginning or end, or a relationship in which the components are in balance.
Hierarchy	For describing hierarchical relationships between people, departments, and other entities, as well as portraying branch-like relationships in which one decision or action leads to another.
Relationship	For describing the relationship between different components (but not hierarchical relationships).
Matrix	For showing the relationship between quadrants.
Pyramid	For showing proportional or hierarchical relationships.

Fig. 16.19. **Types of diagrams in MS PowerPoint**

In PowerPoint, diagrams are made from SmartArt graphics. These diagram graphics are "interactive" in the sense that you can move, alter, and write text on them. In other words, you can use them to construct diagrams of different types (refer to fig. 16.19).

The first step in creating a diagram is to select a layout in the dialog box shown in Figure 16.20.
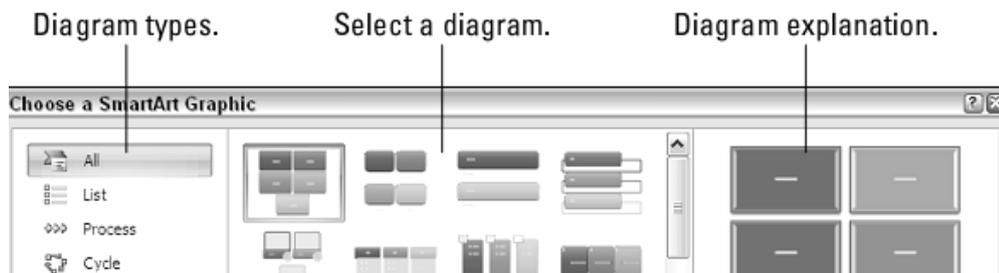
Fig. 16.20. **To create a diagram, start by selecting a diagram in this dialog box**

After selecting a generic diagram in the Choose a SmartArt Graphic dialog box and click OK, the next step is to make the diagram your own by completing these tasks:

change the diagram's size and position: change the size and position of a diagram to make it fit squarely on your slide;

add shapes to (or remove shapes from) the diagram: adding a shape involves declaring where to add the shape, promoting or demoting the shape

with respect to other shapes, and declaring how the new shape connects to another shape;

enter the text: enter text on each shape, or component, of the diagram.

If you have the skill and the wherewithal, you can create a diagram from scratch by piecing together shapes, arrows, and connectors on the Insert tab. The diagram in Figure 16.21, for example, was made not from SmartArt graphics but from shapes, arrows, and connectors.
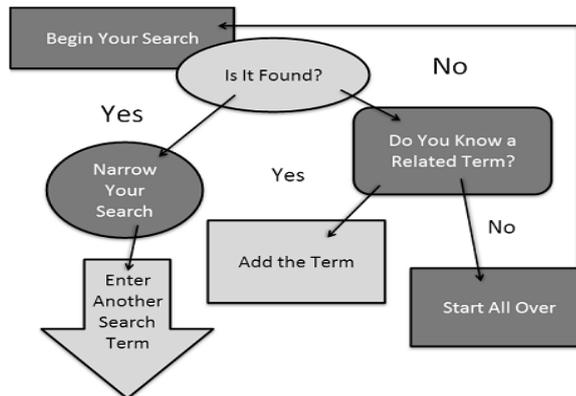
Fig. 16.21. **A homegrown diagram made without SmartArt graphics**

Making a diagram from scratch has some advantages. You can draw the connectors any which way. Lines can cross the diagram chaotically. You can include text boxes as well as shapes etc.

Using graphics (pictures and photos) on Power Point slides

A picture, so they say, is worth a thousand words. What is certain is that visuals help people remember things. A carefully chosen image in a presentation may help audience members remember or understand what your presentation is about. The image reinforces in their minds the ideas that you are trying to put across.

All graphic images fall into either the bitmap or vector category. A **bitmap graphic** is composed of thousands upon thousands of tiny dots called pixels that, taken together, form an image (the term "pixel" comes from "picture element"). A **vector graphic** is drawn with the aid of computer instructions that describe the shape and dimension of each line, curve, circle, and so on.

Resolution refers to how many pixels comprise a bitmap image. The higher the resolution, the clearer the image. Resolution is measured in dots per inch (dpi), sometimes called pixels per inch (ppi). Images with more dots (or pixels) per inch are clearer and display more fineness of detail. When you scan an image, your scanner permits you to choose a dots-per-inch setting.

High-resolution images look better but require more disk space than low-resolution images.

Compression refers to a mathematical algorithm by which bitmap graphic files can be made smaller. In effect, compression enables your computer to store a bitmap graphic with less disk space. Some bitmap graphic types can't be compressed; other bitmap graphic types are compressed using either lossless or lossy compression.

Color depth refers to the number of colors that can be displayed in a graphic file. The larger the color depth, the larger the number of colors that can be displayed, the richer the graphic looks, and the larger its file size is. Color depth is measured in bits. To get technical on you, color depth is measured in the number of bits that are needed to describe each pixel's color in the image.

Follow these steps to insert a graphic on a slide:

click the **Insert tab** and open the **Insert Picture** dialog box;

select a file in the **Insert Picture** dialog box and click the **Insert** button.

Figure 16.22 shows a graphic that has been made over several times with the Brightness and Contrast commands. Select a graphic, go to the (Picture Tools) Format tab, and experiment with the Brightness and Contrast commands to alter a graphic's look. You'll find the Brightness and Contrast commands in the Adjust group.

Fig. 16.22. **Experiments with the Brightness and Contrast commands**

In MS PowerPoint it is possible to crop-off part of a graphic. Cropping means to cut off part of a graphic. You can cut strips from the side, top, or bottom to do the job. In Figure 16.23, the cropping tool was used to cut off all but the head of a figure to turn a portrait into a head shot.

A good thing about PowerPoint is that it allows to compress graphics to save disk space. By compressing graphics, you reduce their file size and consequently the file size of your presentation.
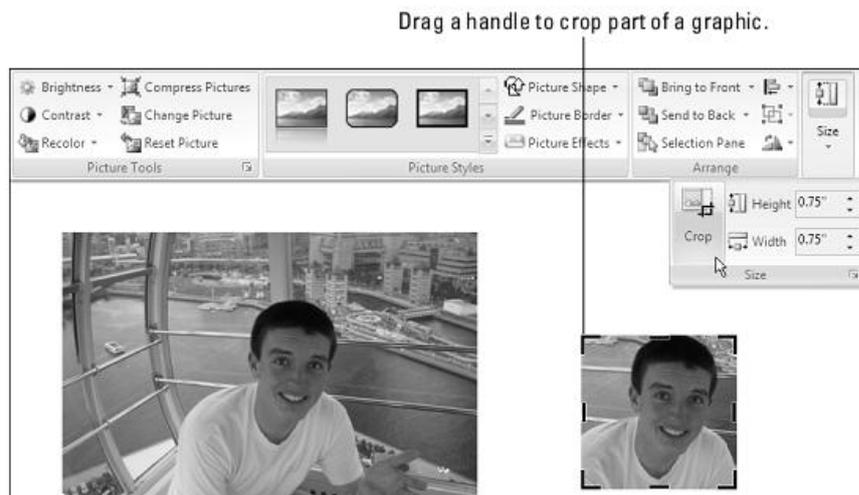
Fig. 16.23. **You can cut off parts of a graphic with the Crop tool**

Not all graphics can be compressed, and some types of graphics lose their integrity when they are compressed. You can't resize lossy-compressed graphics without their looking odd. Compress graphics to make presentations load faster and make e-mail messages with PowerPoint attachments travel faster over the Internet (fig. 16.24).

Fig. 16.24. **Compressing graphics**

Compressing a graphic file reduces its points per inch (ppi) setting. The **Compress Pictures** command compresses the graphics in a presentation. You see the Compress Pictures dialog box shown on the left side of the Figure 16.24.

■ **Questions**

1. What is a text box and for what purposes is it used?
2. What are the main elements of a diagram?
3. Is it possible to create a diagram from random shapes?
4. What table formatting tools are available in MS Excel?
5. What is the difference between bitmapped and vector graphics?
6. What is the reason to compress graphics in a presentation?
7. What types of diagrams are present in MS PowerPoint?

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