

COMPUTERS TODAY!



EVERETT E. MURDOCK

CONTENTS

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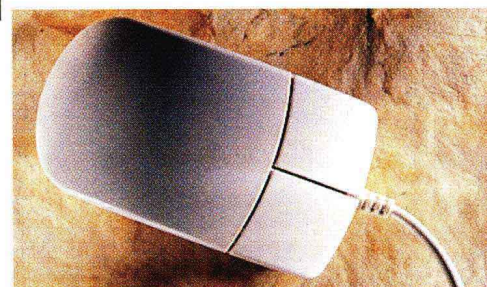
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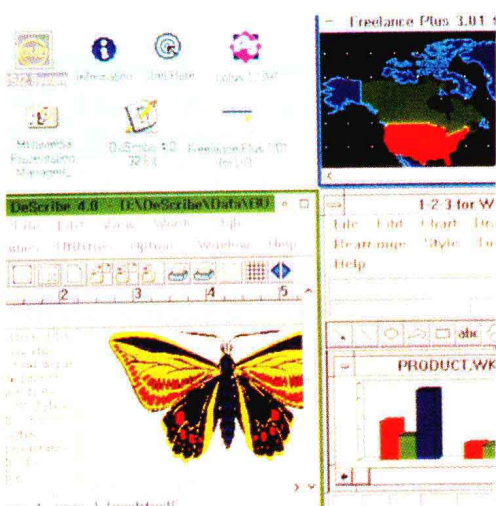
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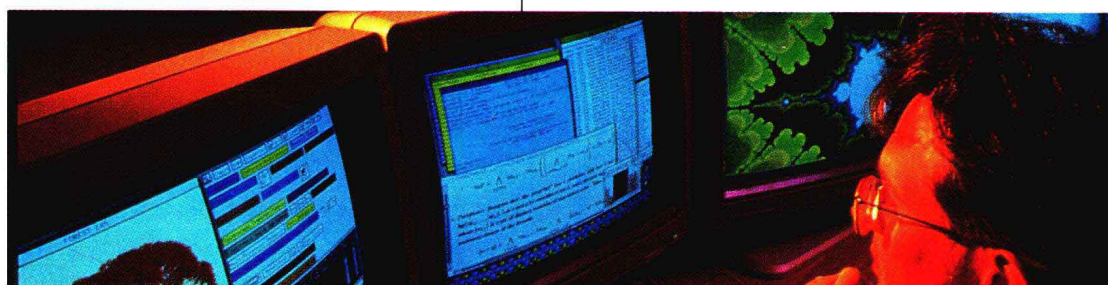
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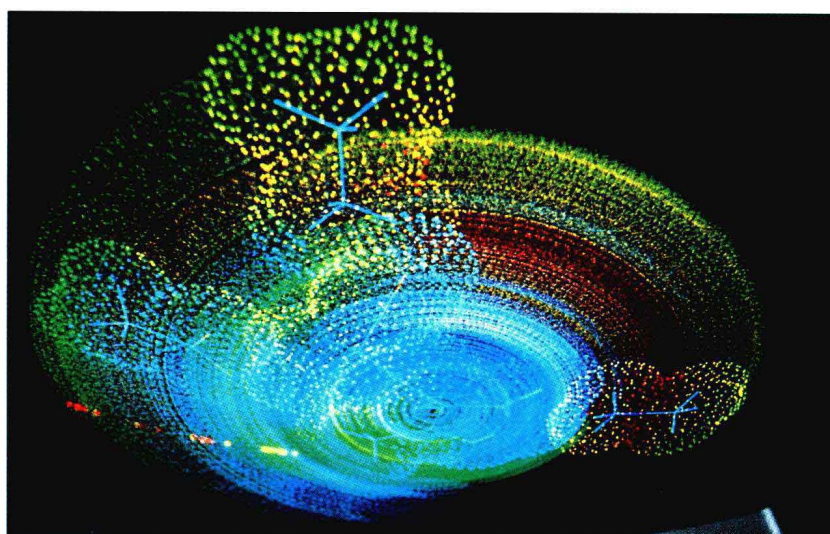
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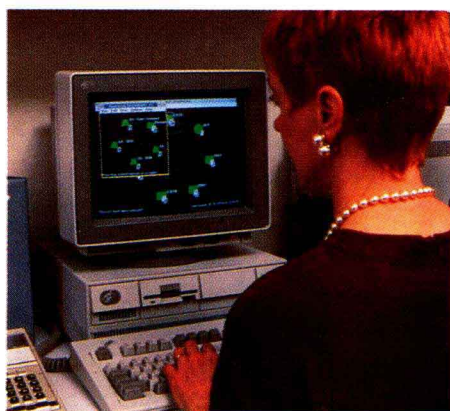
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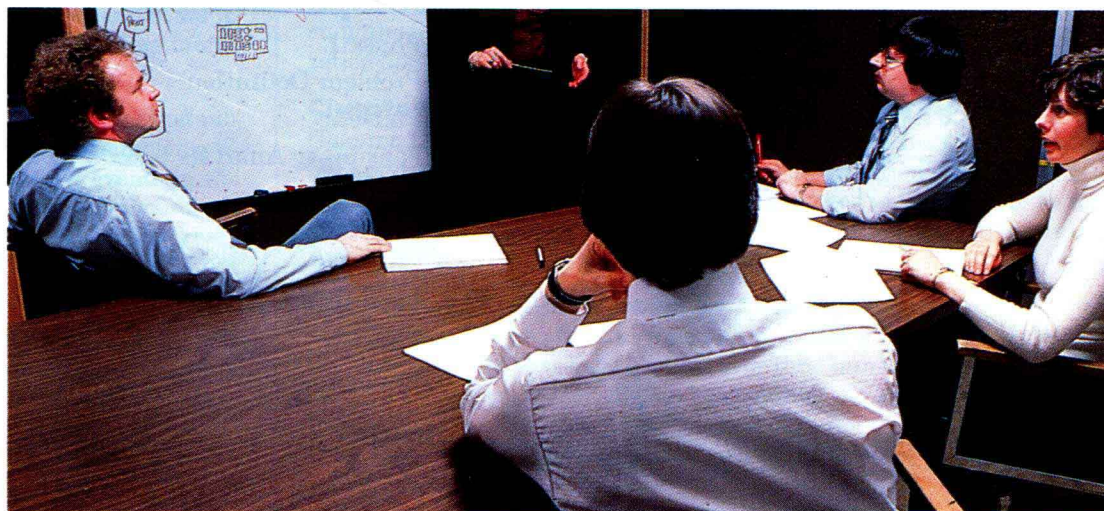
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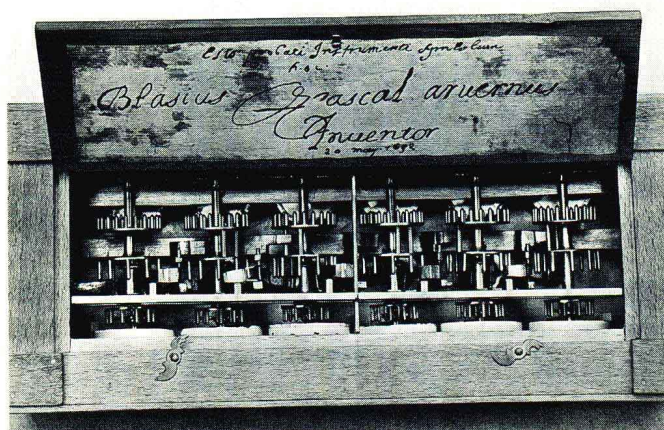
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PREFACE

I Hate To Tell You, But...

This book is old news. In fact, all books about computers are old news by the time they hit the street. Sorry to drop the bomb, but between the time you picked this book up at the bookstore and opened the cover, someone, somewhere, developed a computing device that's better, faster, and cheaper. The ever-changing nature of the computer industry is one reason computing is such an exciting and challenging field of study.

It's been a relatively short time since the early days of computing, when a computer filled an entire room. In that short time, computers have grown smaller, faster, and easier to use. Today, you can carry your small, fast, fairly cheap computer in your backpack.

This book starts at the beginning. It presents introductory information about computers in a comprehensive, straightforward manner. It describes how computers were first developed, how they evolved, and how they influence our lives today.

Is This Really a Textbook?

Not all computer textbooks are the same. Some try to intimidate readers, using long complicated words and offering complex and detailed descriptions of strange devices and mysterious electronic processes. We believe you will find this book to be different. *Computers Today* is an attempt to provide information about basic computing concepts and, at the same time, give you a down-to-earth understanding of what a computer is, and how you can use it to your best advantage.

This is not your average textbook—as you can tell by its magazine-like look and feel. The goal of this book's unique format is to make the material easy to read and easy to understand. We describe it as “user-friendly,” (by the way, that was your first introduction to computer jargon!); you should be aware, however, that the rigor of the material in this textbook has not been compromised. Despite its easy-to-use format, this book contains complete information about every aspect of computers, how they have evolved, and how they are used today. The book presents, in detail, information about computers, computing devices, and computer software, as well as such hot emerging topics as networking, multimedia, and virtual reality.

Remember what we said about every computer book being instantly out of date? To help overcome that situation, this book is supplemented with attention-grabbing news articles about emerging events in the computer world. These articles come from today's most popular magazines and journals—there's something to catch the interest of any reader, from computer phobics to computer experts.

You'll also find plenty of study aids in each chapter: key terms and concepts, chapter objectives, and study questions as well as a chapter summary, review questions, and a comprehensive list of terms covered in the chapter (complete definitions of all terms are provided in a glossary at the end of the book).

Chapter-by-Chapter, We'll Discover

Chapter 1: Introduction to Today's Computers

Chapter 1 will give you an overview of the kinds of computers we use today and will help you understand the evolution of technologies that have brought us to where we are today. You will also learn some of the basic issues, definitions, and concepts related to computers and their use.

Chapter 2: Computer Hardware

Chapter 2 introduces you to the different types of computers and the variety of computer devices that are in use today. You will learn about the inner workings of the computer and how a computer system and its devices are used to input, store, and output information.

Chapter 3: Computer Software

Chapter 3 presents information about the types of computer programs that are used with today's computers. You will learn not only about user applications, but also about the other two types of software: computer operating systems and programming languages.

Chapter 4: Computers and Society

Chapter 4 focuses your attention on the way computers are used throughout society. It points out how computers are being utilized in almost every aspect of our lives.

Chapter 5: Word Processing and Desktop Publishing

Chapter 5 introduces you to the basic concepts related to the design and function of today's word processing and desktop publishing programs. You will learn about the main features and capabilities made available by these types of programs.

Chapter 6: Electronic Spreadsheets

Chapter 6 will help you understand the basic concepts related to the design and use of today's electronic spreadsheet programs. You will learn about the many features that make this type of program a powerful tool for analyzing numerical data.

Chapter 7: Computer Graphics and Multimedia

Chapter 7 introduces you to the wide variety of computer programs that are currently available for creating images of all kinds. You will learn about the basic features of each type of application and you will gain insight into how these programs are being used by professionals in all walks of life.

Chapter 8: Managing Computer Data

Chapter 8 presents you with information about the design and function of computer programs that are used for the management of data. You will learn about the different types of computerized data-management systems and how data are stored and retrieved when using each type of system.

Chapter 9: Data Communications and Networks

Chapter 9 introduces you to the world of data communications and computer networks. You will learn about the special software and hardware required to establish communication links between users at varying distances and locations.

Chapter 10: Computers in Business

Chapter 10 explores the powerful influence that computers and computer software have had in the business community. It will help you understand the fundamental changes that have occurred at every level of organization and how the role and function of every employee has been affected.

Chapter 11: Systems Analysis and Design

Chapter 11 introduces you to the complex processes involved in designing and maintaining an efficient computer information system. You will learn about the role of the various people involved in this process as well as the different methods they might use for designing and implementing such a system.

Chapter 12: The History of Computing

Chapter 12 takes you back in time and introduces you to the technological developments that have evolved over time into the complex computer systems we use today. By understanding the connections between these early developments in the history of computers, you can gain insight into the processes of technological evolution that continue today.

What's In It for the Instructor?

The instructor's manual is designed to provide a variety of resources to augment the text. In the instructor's manual, the author provides background on the organization and methodology of the text. He provides detailed information about the book's approach to teaching and learning and how its methods evolved from his own teaching experience.

Special materials, such as overhead transparencies, are included to make it easier to lecture on material covered in the text. The author also provides a wide variety of quiz, exam, and study questions for each chapter. This bank of test questions (available on computer diskette) can be used as a whole or they can be adapted by the instructor to the particular needs of any type of computer class.

Finally, the author contributes his ideas on the types of computer lab assignments that will give students the kind of hands-on experience that leads to practical knowledge of the facts and concepts presented in the text.

INTRODUCTION TO TODAY'S COMPUTERS

This chapter presents a brief history of computers and introduces the various types of hardware and software that comprise today's computer systems. In this chapter, you will learn about the following topics:

- Defining the computer
- How computers are used
- The evolution of computers
- Next-generation computers
- Computer hardware components
- Types of computer software

TERMS & CONCEPTS

As you go through this chapter, watch for the following key terms and concepts:

A **computer** is an electronic device used to process information.

With the advent of the computer we began the move from a period of industrialization to the **information age**.

Today, computers can be **found in all aspects of society** including education, communication, science and medicine, and business.

Communications systems have been significantly enhanced with the advent of **facsimile devices (FAX)** and **electronic mail (e-mail)** technologies.

An **operating system** is used to manage many of the day-to-day operations of a computer.

The **first generation** of computers, known as **mainframe** computers, were very large machines based on vacuum-tube technology. They were developed in response to needs generated during World War II.

The **transistor** was an important invention associated with the **second generation** of computers.

The **third generation** of computers utilized integrated circuit technology.

The **high-level programming languages** developed during the **third generation** of computers were easier to use than previous languages and resulted in many new programs being written.

The downsizing of computers that occurred in the **fourth generation** eventually resulted in the **personal computer** or **PC**, which is based on a small processor known as a **microprocessor**.

The **next generation** of computing may involve applications of **artificial intelligence** and **expert systems**.

The term **large-scale integration (LSI)** and very large-scale integration (VLSI) are used to describe the move towards the miniaturization of computers.

A computer along with its related devices is known as a **computer system**. The physical components are known as **hardware**.

Input devices are used to get information into the computer and **output devices** are used to get information out of the computer in a form useable by humans.

Today, computers are designed around a single processing chip known as the **central processing unit (CPU)**. It can be thought of as the "brains" of the computer.

The CPU acts on instructions that are retrieved from an internal storage system

known as **main memory** or **random-access memory (RAM)**.

The term **secondary storage** refers to permanent storage systems such as floppy disks, fixed disks, magnetic tape, and optical disks.

Computer systems can utilize several types of input devices including, a keyboard, a mouse, and a variety of digitizing devices.

The **display monitor** and the **printer** are the most common types of output devices.

Printers can be classified as impact printers and nonimpact printers.

Computer programs and **software** are two terms used to refer to the set of instructions used to control the computer.

The term **software interface** refers to the way a program presents information to the user.

Systems software is comprised of a set of programs used to operate the computer itself.

Applications or **productivity software** is used to perform specific tasks such as writing letters, calculating costs, or maintaining records.

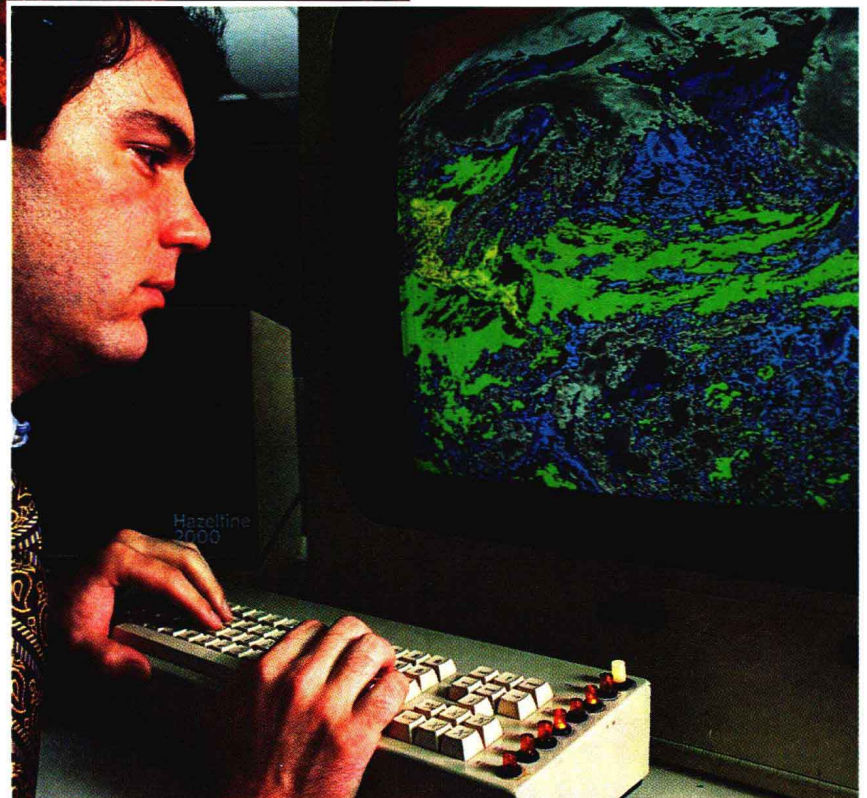
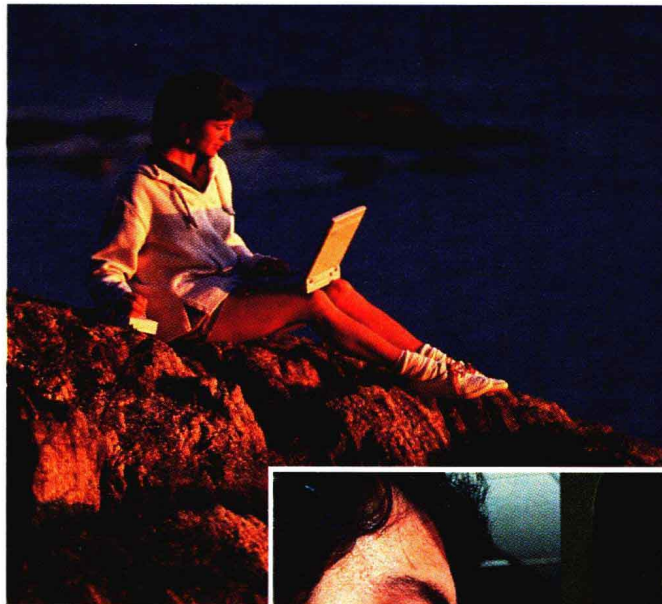
Programming software is used by professional **computer programmers** to create computer programs. There are four types—machine languages, assembly languages, high-level languages, and nonprocedural fourth-generation languages (4GLs).

New programming methods include **natural language** approaches and **object-oriented programming (OOP)**, which is based on a concept of "objects" that combine data and procedures. ■

OBJECTIVES

When you have completed this chapter:

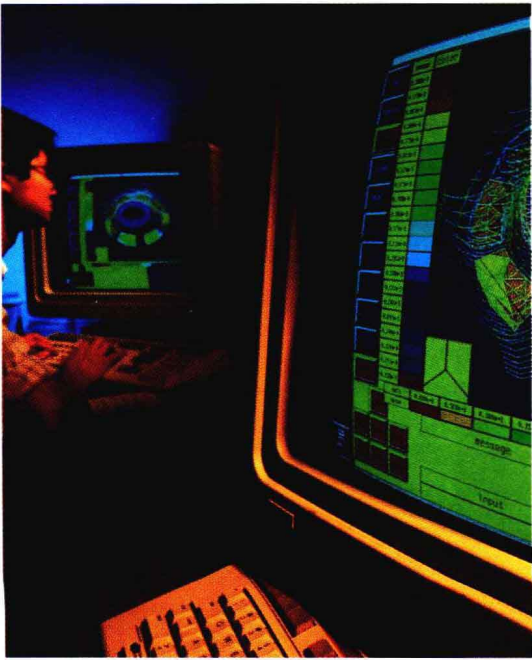
- You will be able to define the word computer.
- You will be able to describe the various elements that make up a computer system, including hardware and software components.
- You will be able to describe the differences between main memory (RAM) and secondary storage.
- You will be able to categorize peripheral devices as either input or output devices.
- You will be able to describe the three different types of computer software.
- You will be able to state the differences between the four basic types of computer programming languages.



QUESTIONS

As you read this chapter, look for answers to the following questions:

- 1** What is a computer?
- 2** How are today's computers being used in education, communications, science, medicine, and business?
- 3** What technological advances are identified with each generation of computers?
- 4** What is a programming language and how is it different from an operating system or an applications program?
- 5** What contribution did the integrated circuit make to the development of computers?
- 6** How will new technologies such as artificial intelligence and expert systems affect the use of computers in the future?
- 7** What is the function of a computer's central processing unit (CPU)?
- 8** Why is a computer's main memory system called random-access memory (RAM) and how does it differ from secondary storage systems?
- 9** What does the term "interface" refer to?



In a remarkably short time, the computer, a relatively new invention, has changed our world. During the first half of the twentieth century, economic growth in the world's industrial societies was fueled by large-scale manufacturing processes that converted natural resources into metals-based products. During the same period, the industrialized countries developed factories and assembly lines to build automobiles, tractors, ships, and locomotives. The countries that were best able to adapt their societies to produce these products became the "industrialized" societies, and they dominated the world's economy.

Today, in the second half of the century, a new invention, the computer, is leading to a shift in the world's power

structure. Economic growth is now being fueled by the processing of information, the storage and delivery of facts and knowledge. We have moved into the **information age**. While industrialized societies still build products like automobiles and tractors, the computer has become an indispensable element in their design, manufacture, and distribution. Today, more than half of the business and economic activity in the United States involves the computer. Much of the country's design work, its management of money and banking, and its manufacture, marketing, and distribution of products is now computerized. And as the national and international markets become ever more competitive, the computer's role will grow steadily.

DEFINING THE COMPUTER

But what exactly is this new invention, this computer, that is changing the world? A common, somewhat simplified definition is that the **computer** is an electronic device that can be used to *process* information. As we might expect from this definition, the fact that the computer is electronic means that it will be fast: it can operate at electronic speed.

But what do we mean when we say the computer can *process* information? The answer to that question is not so simple. When computers were first used, they were used exclusively for calculating numbers. During that period, information *processing* was defined as calculating numbers. But today, computers are not only used for calculations, but also for creating and manipulating text and pictures. They are used to design bridges

and spacecraft, to record a company's sales and to keep track of customers, to create a school newspaper or to estimate the cost of a new school. If computers can do all these things, then it appears that we must define information processing in terms of what the *current* crop of computers can do, and that definition is constantly expanding.

TODAY'S COMPUTERS

Computers today are far more than the number crunchers that they started out to be. Today, computers are used to store and manage information in the form of words, numbers, sounds, and pictures.

In the past, the role of information in the world's businesses was limited by the people's capability to manage it. Information and knowledge in all its forms passed through many hands and, at each stage, a human had to make a judgement about its purpose and its

routing. Often, information had to be converted into another form by handwriting it, typing it, or by communicating it verbally. This created the potential for errors and it drastically slowed the flow of information. This slow flow of information dictated the pace of many of society's tasks.

With the invention of the computer, a few people began to see the potential for faster management of this information flow. Even though computers were at first used mainly for mathematical calculation, it wasn't long before businesses

began to understand how their ability to speed the handling of information could be used as a competitive advantage over other companies that had not yet computerized. Soon businesses were racing to convert information into forms that could be managed by computers.

Today, much of the world's information has been computerized and the race has changed to finding new ways to use it. The world's businesses, libraries, governments, and educational institutions now need people who are willing to learn new ways to process information. The

end of the twentieth century will mark a new beginning both for computer professionals and for computer users. It will be the period in which we all come to terms

with the computer. During this period, computers will find a role in nearly every aspect of our lives. We will all become everyday computer users. We now realize

that although computers will affect everyone's life, we won't have to change the way we do things because computer professionals are finding ways to adapt the computer to our needs, instead of the other way around. In fact, as computers take on additional roles in our lives, we may not even realize that we are using a computer. Soon computers, in one form or another, will have a role to play as we use automobiles or public transportation to get to work, as we buy products and services, as we teach, as we learn, as we are entertained, and as we carry out our jobs at every level in every occupation.

The end of the **TWENTIETH CENTURY...**
will be the period
in which we all come to terms
with the **COMPUTER.**

COMPUTERS IN OUR LIVES

In the past, many might have questioned the need to know about computers. Computers were complex, mysterious devices that were managed by computer professionals in computer centers that were hidden away in specially designed, climate-controlled rooms. But today, we use computers and computerized devices every day. And while there is still a tremendous need for computer programmers and other com-

puter professionals in our society, there is an even greater need for knowledgeable computer users. From word processing to medical imaging, today's computers give us new capabilities and new ways to accomplish our daily tasks. Today's users need to know what computers and computer programs are capable of and how to take advantage of those capabilities.

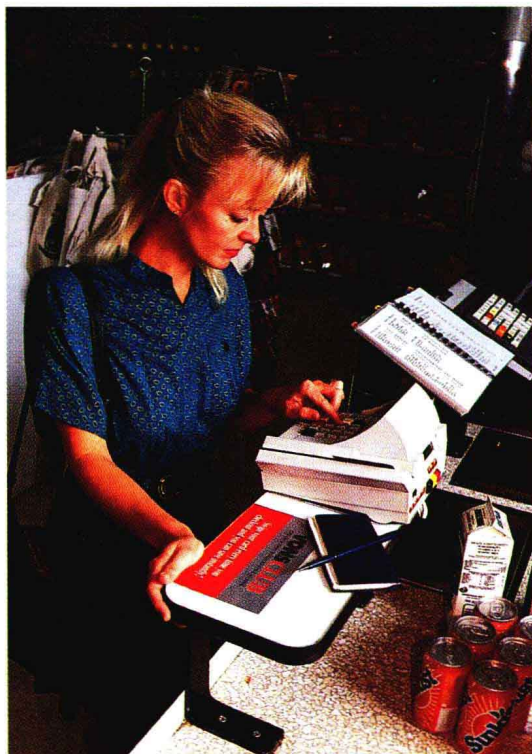
But before they can play a part in our lives, computers must be demystified. Today, computer users are learning that computers are no longer the incredibly complex and expensive room-sized monsters of the past. Today's "personal" computers fit nicely on our desktops. Today, computers can be carried in a briefcase or even in a pocket and new, easier-to-use

...**COMPUTERS** make us
more **PRODUCTIVE.**

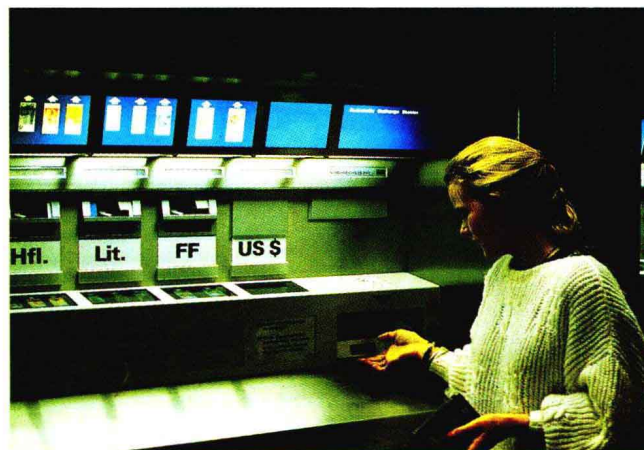
With each passing day, the computer becomes more involved in our daily lives, and for many it has meant a change in how we do our jobs. Over the last two decades, computers have become a familiar aspect of our society. As we carry out our daily tasks, we now confront computers everywhere—in our banking transactions, to detect problems with our automobiles, to program our VCRs and our microwave ovens, even to check the prices of our groceries at the supermarket.

In many of today's jobs, computers make us more productive. In education, they can help us learn faster and broaden our views of the world. In a myriad of everyday activities they can help us get things done better and faster.

computer programs make them easier to use. In a few short years, the computer has changed the way we work, the way we learn, and the way we communicate.



Using electronic funds transfer, this shopper can pay for her groceries without cash or checks.



This automatic teller machine dispenses currency from four different countries.

In this campus computer lab, students can complete assignments using word-processing, spreadsheet, and many other types of software.



These children are learning to use computers in the first grade.



This large-screen monitor makes it possible for all students to see at once.

Using a sophisticated database, this researcher can pull together information quickly and easily.



This doctor can access patient records from a computer terminal.

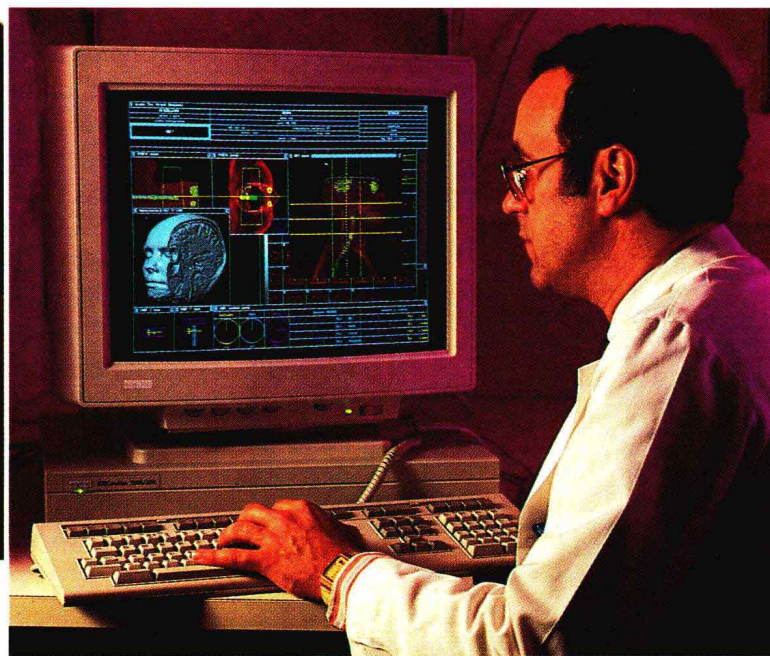
Education

In education, personal computers have given teachers new ways to individualize instruction. New types of computerized learning programs can combine text, graphics, and even on-screen digitized video to give students more realistic, motivational lessons. Programs that provide practice and feedback about basic concepts have now been supplemented with tutorials and simulations that present students with information about real-world situations.

Today, elementary and secondary schools as well as colleges and universities provide a variety of courses about using computers. Many high schools and colleges are now requiring *all* students to take at least one course on using computers and some states now require all teachers to be knowledgeable about computers and computer programs before they can acquire teaching credentials.

Science and Medicine

Researchers in science and medicine have used computers since they were invented, but today new, more powerful computers and more sophisticated computer programs have made them indispensable to scientists. Scientific instrumentation for research and analysis has now become thoroughly computerized. And medical diagnostic technologies and computer-based medical imaging represent one of the fastest-growing areas in the computer field.



Using imaging software, this lab technician can render realistic human figures.

Communication

Computer-based communications systems have significantly enhanced our ability to communicate with each other. In the last few decades, computer-based technologies led to a redesign of our telephone systems, and new technologies have created new ways to convey information. **FAX** machines and computers that can communicate with FAX machines now quickly send copies of documents across the country or across the world.

Even our traditional methods of sending mail have changed because of the computer. Computers are now used to prepare memos, letters, and business information. New programs can create much more attractive documents that include graphics and varieties of text styles and sizes.

In addition, many computer users now send mail electronically. **Electronic mail (e-mail)** systems are computer-based systems that provide individual computer users with an "address" to which computer messages can be sent. Once sent by the computer, the e-mail message will arrive almost instantaneously at its destination, where it will be stored until the addressee uses a computer to access it. Individuals can also send and receive e-mail through subscriber services. E-mail systems are one of the fastest-growing uses of computers. Today, they are becoming common in business and in education.

Business

Over the last few decades, almost every business, whether large or small, has "computerized." And every aspect of business—from sales to product delivery—now involves the use of a computer. In marketing, the computer is used to maintain information about customers and accounts. In manufacturing, the computer is used to keep track of raw materials, production, and inventory. Computers are now so common in business that they are used to track a company's products from their design to their delivery. And most large businesses now have a special department to manage the computers and the flow of computerized business information. In today's competitive business environments, decisions about which types of computers and computer programs to use are often closely related to the overall success of the company.



This computer room in a large corporation, serves as the "control center" for all computer use.

This computer operator generates reports for use by management staff.



Using a PC, this sales manager has immediate access to product information and sales figures.

Homes

Our private homes represent one of the last places in our society to be significantly changed by the computer. While government offices, schools, hospitals, and businesses have found advantageous applications for computers, many homes have not. Some have predicted that the next great surge in new computer applications will be for our homes. They say we will soon be ordering our groceries, our auto service, our cable TV programs, or our Sunday papers simply by choosing an option from a menu of choices on the computer's screen.

Today, there are already computerized security systems in many homes. Some home builders have installed systems in houses that use a computer to control the lights, the heat, and even

the electric appliances. In some homes, these computerized systems can be controlled by calling the house from any phone and typing in number sequences using the phone's numbered dialing buttons.

Now, many computer experts believe that the computer will finally find its way into our homes as part of a unified information and entertainment system. If the technologies of television, computers, and electronic games come together, they will provide a new form of *interactive* video entertainment. This may take the form of continually available television broadcasts that can be stored inside your computerized entertainment center, letting you determine what you want to see when you want to see it.

THE EVOLUTION OF COMPUTERS

As important as computers are to today's businesses, hospitals, and educational institutions, they haven't been in general use very long. In the late 1800s, a variety of mechanical devices were designed to carry out numerical calculations. But the catalyst for the first real computers came during World War II when governments that were involved in the large-scale movement of men and materials needed better and faster calculating systems. The earliest computers were designed to facilitate weapons management, code breaking, and wartime recordkeeping.

Many of the earliest computers were designed and built at universities. In the late 1930s, Howard Aiken at Harvard University was working with a \$500,000 grant from IBM to develop an automatic calculating machine. The machine, which came to be known as the Mark 1, was completed in 1944. It used electrically powered mechanical counters to store the results of arithmetic calculations. It contained 500 miles of wire, had 3 million electrical connections, and required about 6 seconds to carry out each multiplication task.

At about the same time, similar efforts were underway at Iowa State University, where a computing device that incorporated an advanced design was built by John Atanasoff and Clifford Berry. Although the device was not designed for large-scale processing, it was the first to be based on vacuum-tube technology and was therefore the first fully electronic computing device. Completed in 1942, it became known as Atanasoff-Berry Computer, or the ABC computer.

At the University of Pennsylvania, J. Presper Eckert and John W. Mauchley were working on a much larger device. With the support of the U.S. Army, they designed a completely electronic device that could be used for a variety of calculating tasks. They called it the Electronic Numerical Integrator and Calculator, or ENIAC. Unveiled in 1944, it is now considered to be the first large-scale, general-purpose electronic computer. Although it was very slow and very limited in capability as compared to today's computers, it represented a remarkable advance-

ment in computing power for the time. The ENIAC contained 19,000 vacuum tubes and 5 million soldered electrical connections. It could perform up to 5000 additions per second, but it consumed so much power it is said that it often caused the lights to dim in the Philadelphia neighborhood in which it was housed.

None of the early computers could be *programmed* the way our modern computers can be. Although they could be used for a number of different calculating tasks, a program change required time-consuming rewiring of many circuits. In the mid-1940s, John von Neumann joined Eckert and Mauchley. His ideas for designing a programmable computer were to form the basis for the types of *stored-program* computers we still use today. These stored programs are now known as **software** (in contrast to the computer's physical devices, known as **hardware**).

The computer is often described as having gone through four distinct generations. Each of these generations is based on the type of technology used during the period.

The First Generation (1951-1958)

The first generation of electronic computers was based on vacuum-tube technology. The UNIVAC 1 (shown in Figure 1-1), which was designed by the Eckert, Mauchley, and John von Neumann team, is often considered to be the first computer of this generation.

Although the computers of this first generation were much faster and more flexible than the electromechanical devices that preceded them, they were very large. His contained many parts that were prone to failure. The computers of this generation were the first to become known as **mainframe** computers and they generally used punched tape or punched cards (shown in Figure 1-2) as the primary input medium.

Not only were these punched cards used to program and feed data into the computers of this generation, they were sometimes used to output information

Figure 1-1 The UNIVAC 1. The First of the First-Generation Computers

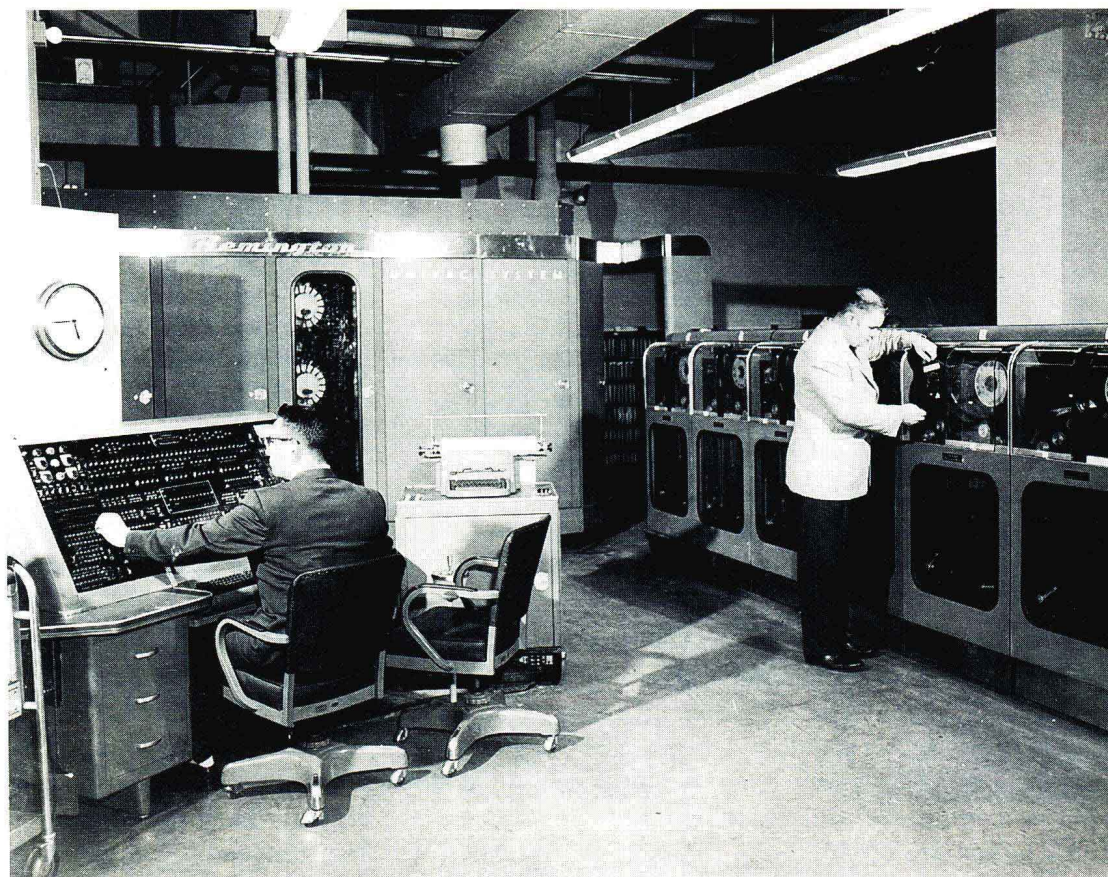
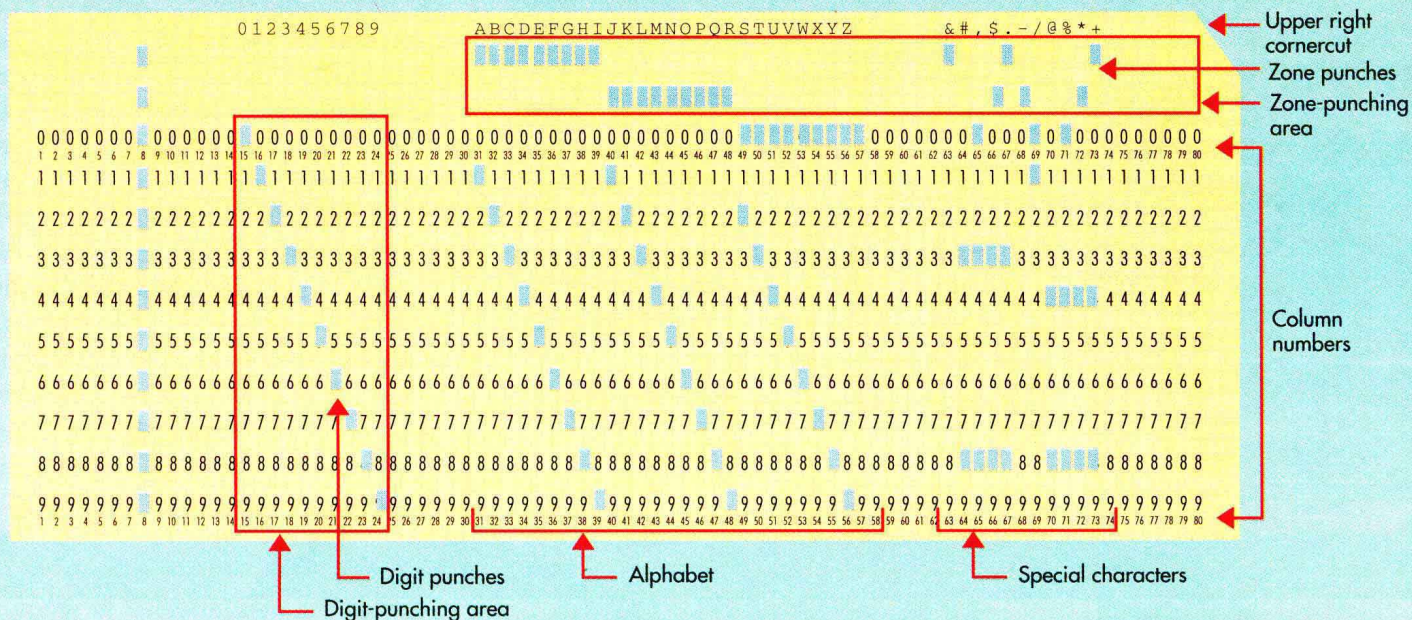


Figure 1-2
Computer-Punched Card



in such forms as payroll checks. Many employees of large corporations during this period got used to paper payroll checks with little square holes in them. These checks were famous for their printed warnings not to “fold, spindle, or mutilate” them (because they would have to be read by the bank’s cardreader later).

Computers of the first generation were used initially for computational purposes, mainly by governmental agencies such as the U.S. census bureau, but they soon found a broader use in business. The commercial role of computers started with their use in basic business transactions related to customer billing, internal accounting, inventory tracking, and payroll calculations. Since computers could be used to replace many of the employees who were maintaining these records, it was easier to justify their cost. By the late 1950s, many of America’s larger companies were considering the purchase of a computer and a new generation of computers was evolving to meet the demand.

The Second Generation (1959-1964)

Near the end of the 1950s, a new invention, the **transistor**, began to be used to replace the thousands of vacuum tubes used in electronic computers. This is generally considered to be the beginning of



Figure 1-3 Second-Generation Computer

the second generation of computers (represented in Figure 1-3).

Although the use of transistors in computers did not change the way the computer was used, transistors were smaller, faster, and required less power than the vacuum tubes that had been used in the first-generation computers. And transistors were not the only improvements of this period. Magnetic core memories began to appear and computers became more modular in design. In addition, **programming languages**, the sets of special instructional statements that were used to program these computers, became easier to use and this brought more people into contact with computers. As a result, a new occupation, computer programmer, came into being. As these computer programmers became more proficient, they began to design new computer programs for use in business and education, known as **applications**. The

applications of the period were generally used to automate tasks that previously had been carried out by specially trained employees. Examples include the computerization of airline reservation systems and banking transactions.

Important changes in the way data was stored and retrieved also evolved during this period. Data storage based on magnetic tape began to compete with the punched cards used in the first generation.

The Third Generation (1965-1970)

By the beginning of the 1960s, many large and mid-sized businesses were considering the purchase of a computer. These businesses were more interested in the computer’s data storage and processing capabilities than in its calculating capabilities. The



Figure 1-4 Third-Generation Computer

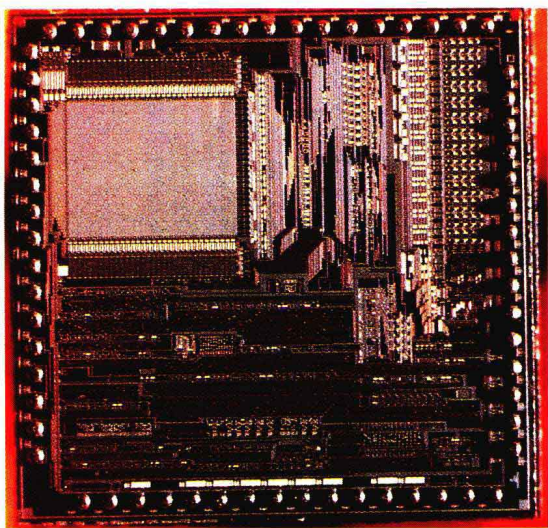


Figure 1-5 Integrated Circuit

ability of the computer to efficiently store and retrieve information about employees, products, and customers made the large costs seem more worthwhile. During this period, there was a growing need for faster, smaller computers and new, more specialized computer devices. There was also a need for more specialized computer programs to meet the special demands of business. The very few computer companies in existence at the time responded with new computer systems. For example, the International Business Machines (IBM) Corporation introduced a new "family" of computers, the IBM System/360 (shown in

Figure 1-4), that soon became America's most widely used computer system.

The IBM 360 and 370 families included several different versions of the same computer. Each model provided different data-processing capabilities and each was specialized for a different scale of business use. Business-oriented programs were written for these computers that could be used on any of the computers in the family: a company could buy one of the less costly computers in the family and later upgrade to a more powerful computer and still continue to use the same programs. Other computer companies soon followed

ROCK 'N' ROM

BY PETER BERKOW

It's been more than a decade since music videos entered the home. Nobody paid much attention to early MTV except for a handful of cutting-edge artists and consumers, who insisted on seeing and hearing their favorite stars. Today performers spend nearly as much time preening for the cameras in slick million-dollar videos as they do cutting records in the studios.

In the '90s, techno-literate rock-music buyers, who range from 15 to 55 in age, are demanding more interaction with their idols. Suddenly electronic publishers and music moguls are teaming up to deliver the goods. Would you like to remix your favorite music video? Go ahead. Do you want to go backstage and chat with the band? No problem.

Many new CDs incorporate cut-up music videos with fresh interviews and interactive components. Some discs, such as Time Warner Interactive's musical chronicle of the rise and fall of San Francisco's Haight-Ashbury district (tel: 818-955-9999), lean toward a documentary style. Still others offer a combination of original music, video, and gaming. For rock wannabes, there is a growing number of karaoke and music-composition CDs, such as *Dr. T's Rock, Rap 'N Roll* (tel: 800-282-1366) that let you play singer or producer.

Until recently, record companies have been hesitant to jump into the multimedia milieu, content with their slice of the \$10 billion music pie. Although popular grunge groups and gangsta rappers may soon go virtual, older rockers such as David Bowie, Peter Gabriel, and Todd Rundgren have displayed the most interest in new technologies.

"These artists have a history of innovation," explains *Rolling Stone* music editor Anthony DeCurtis. "It makes sense that they would break this ground."

THE I IS FOR INTERACTIVE ■

Composer Todd Rundgren isn't modest about his contribution to pop culture. "I invented interactive music," he proudly states.

Rundgren, an adept hacker as well as a musician, was the first to marry music to interactive computers. His 1993 CD-I release, *No World Order* (\$24.98; tel: 800-845-7301) features compositions that were written with listener participation in mind. A Mac version will be out soon.

"I used to record hard-to-digest musical structures," explains Rundgren, who has produced such artists as Meatloaf, Grand Funk Railroad, and Hall & Oates. But success began to wear thin, Rundgren says, and he felt a need to compose songs that "would allow the audience to explore and experience my music in unforeseen ways."

Moods, tempos, and mixes on *No World Order* can be altered at the whim of the user. Even a "linear version" of the music, released on audio CD, contains several unusual variations of the same songs. Rundgren is so involved with the process that he has changed his stage name to TR-I—the "I" stands for interactive.

Moreover, Rundgren has replaced his touring band with a PowerBook, which allows him to create an infinite number of on-the-spot variations of *No World Order*.

While long on musical innovation, *No World Order* lacks an interactive story line and provocative graphic images that make CD-ROM so compelling. Those elements, however, are thoroughly explored by Peter Gabriel and David Bowie in their new releases.

ARE YOU EXPERIENCED? ■

Peter Gabriel, a visually oriented showman since his days in Genesis, has long maintained he's more interested in creating experiences than in recording songs. His Mac-compatible *Xplora 1* CD-ROM lets him realize that vision.

Gabriel was introduced to CD-ROM possibilities by Steve Nelson, a San Francisco software developer who had worked closely with Apple Advanced Technology to create a series of educational and informational CD-ROM projects. With personal funds, Nelson started his own company, Brilliant Media, and used Gabriel's music to create a rock-'n'-ROM prototype.

"I had been working with Apple from the beginning," Nelson recalls, "and thought these guys were missing the boat [with popular music.]"

Gabriel fell in love with Nelson's CD-ROM prototype and embarked on an interactive project with Nelson, Michael Coulson (who became artistic director and co-producer), and more than 40 other artists, designers, and software developers. As much a video-game experience as a music project, *Xplora* invites you to interact with Gabriel and his multicultural musical experiences.

Gabriel has planned a dozen more CD-ROM projects, including a follow-up to *Xplora 1*.

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suit with their own versions of the computer “family” concept.

The computers of this generation used **integrated circuits** instead of transistors. These integrated circuit systems incorporated thousands of circuits etched into tiny “chips” made of silicon (shown in Figure 1-5).

During this period, the new integrated circuit designs began to result in smaller and faster computers that soon became known as **minicomputers**. These minicomputers were downsized versions of the larger mainframes that had been used prior to this period. They were of the same basic design as the mainframes, but the computer was less likely to be housed in a special computer center: minicomputers could be put to more specialized use in a number of different locations.

A number of new methods for operating the computer and maintaining computerized information were introduced during this period. For the first time, special programs were created to manage the day-to-day operations of the computer. Earlier computers required the intervention of a computer operator to manage many of the operational tasks required of computers. These new programs were known as **operating systems**, and they automated many of the tasks that had formerly been done by humans.

Also, **high-level programming languages** evolved to meet the demands of business during this period. These new languages were easier to use and they were more specialized for the management of business-oriented records. This meant that a greater variety of business employees could learn to modify the company's computer programs or design new ones for special tasks. This resulted in a broader variety of computer programs and once again created an increased demand for computers worldwide.

The Fourth Generation (1971 to Today)

The 1970s saw the beginning of a significant period of evolution of computer design and programming techniques. Throughout the 1970s, the downsizing of mainframe and minicomputers continued. And, by the late 1970s, most businesses had redesigned their data-acquisition and data-processing techniques in order to maximize the role of computers. But



Figure 1-6 A Microprocessor (the IBM PowerPC 604) and IBM, Compaq, and Macintosh Microcomputers

something else was also happening during that period: an entirely new concept of “personal” computing was slowly growing outside of business circles. Hobbyists and some fledgling electronics companies were beginning to create computing devices that used small, limited processors, termed **microprocessors**.

These microprocessors were being built into small computers (shown in Figure 1-6) that were intended to serve the special processing needs of individuals. Nicknamed **personal computers**, or **PCs**, the value of these little computers was not at first recognized by businesses and government agencies. The concept of a “personal” computer that could be placed on the desktop and used exclusively by one user was so radically different from the concepts related to shared use of large computers that most saw them as hopelessly underpowered “toys.”

But the value of having your own personal microcomputer was soon recog-

nized. The personal computer required the user to be more knowledgeable about the computer's operating system, but a PC was found to be more of a personal servant than the big host computers that had to serve many different needs for many different users. Small business owners saw the PC as a way to computerize without the huge expense of the larger computers. Educators saw the value of a small computer that could be used to meet the individualized needs of classroom teachers and school administrators.

By the beginning of the 1980s, some of the personal computer makers were developing into full-fledged computer companies. Companies like Apple Computer, which had been started by young computer enthusiasts in a garage, were fast becoming well-known names in the computer industry. With the PC's rapid growth in acceptance and popularity, some of the manufacturers of the largest computers scrambled to develop