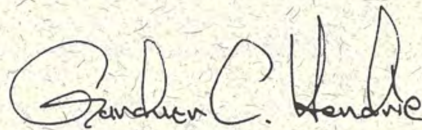
The Computer Museum

Annual Report 1991

Inside this year's *Annual,* you will find a guide to *People and Computers: Milestones of a Revolution.* The June opening of this definitive historical exhibition capped another year in which The Computer Museum successfully advanced its educational mission. Funded in part by a major grant from The National Endowment for the Humanities, the exhibit uses the Museum's unique collection to help the public better understand the evolution of computers over the last 50 years and the changes they have made in our daily lives.

***People and Computers* and the Museum's many other national and local programs were propelled by the enthusiastic support of many individuals, corporations, and state and federal agencies. On behalf of the Museum's Board of Directors, I gratefully acknowledge all of you who helped make fiscal year 1991 such a resounding success.**



Gardner C. Hendrie
Chairman of the Board of Directors

THE COMPUTER MUSEUM, INC.
BALANCE SHEET / JUNE 30, 1991

	Operating Fund	Capital Fund	Plant Fund	Totals 1991
ASSETS				
Current assets:				
• Cash and equivalents	$120,568			$120,568
• Receivables and other assets	113,981	$148		114,129
• Store inventory	72,764			72,764
• Interfund receivable		207,798		207,798
Total current assets	307,313	207,946		515,259
• Net property and equipment		11,328	$2,277,160	2,288,488
Total assets	$307,313	$219,274	$2,277,160	$2,803,747
LIABILITIES AND FUND BALANCES				
Current liabilities:				
• Accounts payable and other current liabilities	97,078	121,927		219,005
• Interfund payable	207,798			207,798
Total current liabilities	304,876	121,927		426,803
Fund balances:				
• Unrestricted	2,437	12,675	2,277,160	2,292,272
• Restricted		84,672		84,672
Total fund balances	2,437	97,347	2,277,160	2,376,944
Total liabilities and fund balances	$307,313	$219,274	$2,277,160	$2,803,747

STATEMENT OF ACTIVITY for the year ended June 30, 1991

	Operating Fund	Capital Fund	Plant Fund	Totals
Support and revenue:				
• Unrestricted gifts	$496,004	$87,938		$583,942
• Restricted gifts	129,643	1,065,056		1,194,699
• Memberships	256,859			256,859
• Admissions	524,090			524,090
• Store/Functions	466,368			466,368
• Investment gain	43	4,140		4,183
• Other	1,814	13,314		15,128
Total	1,874,821	1,170,448		3,045,269
Expenses:				
• Exhibits and education	453,166	134,134		587,300
• Marketing and membership	320,608			320,608
• Depreciation			$458,246	458,246
• Supporting Services:				
Management and general	251,509	67,069		318,578
Fund-raising	192,971	185,445		378,416
Bldg opns. & mortgage debt	286,200	147,377		433,577
• Store/Functions	347,656			347,656
Total	1,852,110	534,025	458,246	2,844,381
Excess/(deficiency) of support and revenue over expenses	22,711	636,423	(458,246)	200,888
Fund balance, beginning of year	(213,274)	651,683	1,737,647	2,176,056
Add/(deduct) transfers				
• Plant		(997,759)	997,759	
• Unrestricted	193,000	(193,000)		
Fund Balance, end of year	$2,437	$97,347	$2,277,160	$2,376,944

Museum Staff

Finance and Administration
Oliver Strimpel, *Executive Director*
Brian McLaughlin
Geraldine Rogers

Development and Public Relations
Janice Del Sesto, *Director*
Elizabeth Armbruster
Gail Jennes
Kate Jose
Julie Oates
Susan Pekock
Janet Walsh
Peter Yamasaki

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Nancy Boland
James Boyd
Troy Fryatt
Giselle Gonzalez
Gerald Knight
Robert Krikorian
Chris McElroy
Mary-Catherine McElroy
Tom Mosher
Wanda Mourant
Marko Pankovich
Karl Schoonover
Noah Southall
Earl Yavner
Tony Walker
Marilyn Weiss

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Greg Welch, *Director*
Wayne Cookson
Mary Beth Dorus
Don Greene
David Greschler
Dan Griscom
Lauren O'Neal
Stephen Snow

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Åsa Chibas

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Martha Ballard
Daniel Burke
Brian Lee
Christina O'Sullivan
Christa Santos
Noah Southall

Collections
Gwen Bell, *Director*
Brian Wallace

From The Executive Director

The past fiscal year has been far and away the most successful in the Museum's history. It began with the opening of *The Walk-Through Computer*™, a two-story-high working model of a desktop computer. The bold nature of this project captured the imagination of the media. Since its inception, features have appeared in print, on TV, and radio in over 65 countries, generating an estimated 350 million media impressions to date. People poured into the Museum, boosting the number of visitors by 44% over the previous year. The Computer Museum became known around the world as the place with the giant computer.

Visitors' positive reactions so far are a testament to the wisdom of our advisors and the immense dedication and ingenuity of Museum staff, brilliantly led by Greg Welch.

During the past year, the Museum developed the major exhibit *People & Computers: Milestones of a Revolution,* addressing the question "How did computers evolve?" This was the second phase of our exhibit development plan designed to produce exhibitions that answer questions including "How do computers work?" (realized by *The Walk-Through Computer*) and "What can computers do?" The latter theme, currently realized by the existing *Smart Machines* and *The Computer and the Image* galleries, will be dramatically expanded with *Tools & Toys: The Amazing Personal Computer*, exploring the myriad uses of personal computers. Originally known as *The Computer Discovery Center, Tools & Toys* is a joint project with The Boston Computer Society. It will open to the public on June 13, 1992.

This year's *Annual* contains a booklet based on *People and Computers*. The exhibit was designed to make the history of technology accessible to visitors from very diverse backgrounds. Visitors' positive reactions so far are a testament to the wisdom of our advisors and the immense dedication and ingenuity of Museum staff, brilliantly led by Greg Welch. The exhibition opened 5,000 square feet (a 20% expansion) of Museum exhibit space—on time and on budget, itself a major accomplishment, occurring with just a year of lead time. With the opening of *People & Computers,* several of the collection's "crown jewels" have gone on public view for the first time. The exhibition also helped spur on the Museum's active collecting, resulting, for example, in the acquisition of a much sought-after IBM System/360.

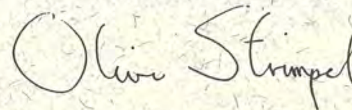
After a national search for a Director of Exhibits, it became apparent that the Museum's own experience in building exhibits about computers was unique. Greg Welch's experience at the Museum, culminating in his leadership of the *People & Computers* project, also includes the development of *Computers in Your Pocket,* the Museum's first traveling exhibit, which toured nationwide under the auspices of the Smithsonian Institution Traveling Exhibition Service. Greg also developed a broad international perspective during a year-long Harvard fellowship to study the museums of Europe. His background, coupled with his enormous energy and enthusiasm, made him the best qualified to lead our original, fast-paced development program, and in January I appointed him as Director of Exhibits.

The Museum made major strides in extending its reach beyond its walls this year. Exhibit Kits, copies of our interactive exhibits, were installed in three other museums. The St. Louis Science Center installed the entire first series of nine Kits. Over 6,000 copies of our first educational video *How Computers Work: A Journey Into The Walk-Through Computer* have been sold. Further materials, such as educator kits that meet the needs of teachers, are in the works. In all our activities, we pay special attention to reaching underserved communities.

During the last week of April, many Museum staff and friends descended on Silicon Valley for the Third Computer Bowl. The Valley's enormous enthusiasm, support, and appreciation of our mission were extremely encouraging, enabling us to make this Bowl our most successful fundraising event to date.

The success of both the exhibits and outreach activities resulted in the growth of the Museum's base of support. Our operating budget grew 27% to $1.9 million and remained balanced. In addition, nearly a million dollars was raised for the exhibit development program.

On behalf of the staff and our many visitors, I thank the numerous individuals, corporations, and foundations who have contributed to the Museum, enabling us to deliver quality education to all who benefit from our programs. As always, we eagerly seek new friends to join us in the adventure of growing this one-of-a-kind international institution.



Dr. Oliver Strimpel
Executive Director

Computers
Apple Computer, Inc.
Macintosh 512, 1985
Used to produce desktop-published school paper; on display in *People and Computers* exhibit
Gift of Granada High School, X1074.91

Datavue Corporation
Spark, 1985
Laptop computer, peripherals
Gift of Steven B. Leeland, X1090.90

Digital Equipment Corporation
PDP-8e, 1971
Used to control brain tissue testing equipment at West Haven Veterans' Administration Medical Center; on display in *People and Computers* exhibit
Gift of Dr. Truett Allison, X1075.91

Digital Equipment Corporation
PDP-8a, 1975
Embedded in lighting controller for Broadway show *A Chorus Line*; on display in *People and Computers* exhibit
Gift of Gordon Pearlman, X1060.91

ElectroData Division of Burroughs Corporation
Datatron Model 205, 1954
First general-purpose computer sold by Burroughs Corporation
Gift of Southeastern Massachusetts University, X1055.91

Institute für Informatik, Switzerland, and Brigham Young University
Lilith personal computer, 1980
Graphical user interface computer tailored to programming language Modula-2
Gift of Tektronix Corporation, X1051.91

Intel Corporation
iPSC, 1985
128 processor parallel computer; marked "First Production System"
Gift of Robert Brams, X1076.91

International Business Machines Corporation
IBM System/360 Model 30, 1965
First line of compatible computers, peripherals, programs; on display in insurance company setting in *People and Computers* exhibit
Gift of Frost and Sullivan, X1059.91

IXO Corporation
IXO Telecomputer, 1978
Briefcase-size modular computer, display, modem, printer
Gift of Brian Randell, X1088.90

Sun Microsystems, Inc.
Sun 1, 1982
First Sun graphics workstation
Gift of Sun Microsystems, Inc., X1073.91

Televideo Systems, Inc.
TS 802, 1981
Personal computer with CP/M operating system
Gift of Don Wolman, X1089.90

Analogue Computer
Northrop Aircraft, Inc.
MADDIDA magnetic drum differential analyzer, 1947
Engineering prototype for airborne navigational calculator
Gift of Los Angeles County Museum of Natural History, X1050.91

Sub-assemblies and components
International Business Machines Corporation
IBM 1720 SMS mercury-wetted switches, 1959
Standard Modular System components developed for process-control computer system
Gift of Howard L. Funk, X1069.91

MasPar Computer Corporation
MP-1 components: array control unit, processor board, 1990
Parallel computer scalable from 1,024 to 16384 processors
Gift of MasPar Computer, X1062.91

MIT Instrumentation Laboratory, C. S. Draper Laboratories, Raytheon Company
Apollo Guidance Computer Block 1 components, 1962
3 logic prototypes and 1 finished logic module from first production phase of first integrated circuit digital computer
Gift of Eldon Hall, X1067.91

MIT Instrumentation Laboratory, C. S. Draper Laboratories, Raytheon Company
Apollo Guidance Computer Block 2 components, 1962
1 sense amplifier prototype and 2 logic prototypes from second production phase of first integrated circuit digital computer
Gift of Eldon Hall, X1068.91

Sun Microsystems, Inc.
Sun 2 cpu and other boards, 1983
Networked graphics workstation
Gift of Sun Microsystems, Inc., X1053.91

Sun Microsystems, Inc.
Sun 3 cpu board, 1986
Single-board workstation
Gift of Sun Microsystems, Inc., X1054.91

Trilogy Corporation
Prototype and production logic components, 1984
First wafer-scale integration
Gift of Gene Amdahl, X1086.91

Union of Soviet Socialist Republics
Minsk 32 logic module, 1973
A copy of the Digital Equipment Corporation PDP-8, the Minsk 32 was particularly known for its reliability
Gift of U.S.S.R. State Academy of Finance, X1084.91

United Technologies Mostek
Mostek chip die, wafer, chips, 1976
Domestically-produced Dynamic Random Access Memory (DRAM) integrated circuits
Anonymous Gift, X1087.91

Transducers
Digital Equipment Corporation
PDP-7 console, 1967
One of a line of 12-bit computers; on display in *People and Computers* exhibit
Gift of Digital Equipment Corporation, X1072.91

Recognition Equipment, Inc.
Electronic eye, 1968
Light-sensing device consisting of array of discrete components
Gift of Reid Dennis, X1056.91

Recognition Equipment, Inc.
96 element Photodiode Array, 1970
Integrated circuit light-sensing device
Gift of Reid Dennis, X1057.91

Recognition Equipment, Inc.
512 Element LSI Scanned Array, 1972
High resolution integrated circuit light-sensing device
Gift of Reid Dennis, X1058.91

Tektronix Corporation
Type 543A oscilloscope and stand
Computer test equipment; on display in *People and Computers* exhibit
Gift of Michael Callahan, X1061.91

Versatron Corporation
Foot Mouse, 1990
Anonymous gift, X1081.91

Memory
Union of Soviet Socialist Republics
Ural 11-B core memory plane, 1969
The Central Statistical Department of the Supreme Soviet used Ural 11-B computers from 1969 to 1977
Gift of U.S.S.R. State Academy of Finance, X1083.91

Digital Calculators
Dennert & Pape KG
Aristo M 36 Pocket calculator, 1974
Gift of Hermann Zapf, X1070.91

Wang Laboratories, Inc.
Model 360 Scientific calculator, 1967
Four interlinked calculators with shared logic and storage registers
Gift of Dan Freitas, X1052.91

Slide Rules
The Binary Slide Rule, 1940
Gift of Herbert and Louise Spirer, X1066.91

Cabric Limited
Cylindrical slide rule, 1910
Gift of Herbert and Louise Spirer, X1063.91

Dennert & Pape
Hohenrechenscheiber cylindrical slide rule
Gift of Herbert and Louise Spirer, X1064.91

George W. Richardson
Richardson's Direct Reading Slide Rule, 1912
Gift of Herbert and Louise Spirer, X1065.91

Ephemera
Remington Rand UNIVAC
UNIVAC Solid State 80 scale model, 1960
Gift of the Family of Dr. Donald G. McBrien, X1080.91

Other
Dr. Donald G. McBrien
Core memory learning aid
Memory addressing learning aid
Binary adder learning aid
Professor McBrien fabricated these learning aids to communicate principles of computing to students in his classes on computing, the first offered at Boston University
Gift of the Family of Dr. Donald G. McBrien, X1077.91 to X1079.91

Richard O. Spencer
Stylist's rendering of the Johnniac computer, 1950
Rand Corporation engineers designed the Johnniac's case and framework to Institute of Advanced Studies guidelines and this drawing.
Gift of Raymond Clewett, X1082.91

TAB Corporation
Punched card carrying case, 1970
Donated by Dr. J. Paul Hartman, X1085.91

Weston Electrical Instrument Corporation
Model 270 tube tester, 1949
Used on UNIVAC 1 computer in Boston
Gift of Joseph C. Macura, X1071.91

Donors to the Document, Film and Video, Photograph, and Library Collections
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Barrie Sosinski
Herbert and Louise Spirer
Sun Microsystems, Inc.
University of Texas at Austin
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Rod Wilmot
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PEOPLE *and* COMPUTERS

Milestones of a Revolution

A Permanent Exhibit at

The Computer Museum

Major Underwriter

The National Endowment for the Humanities

Principal Sponsors

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International Business Machines Corporation

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Douglas Ross

Jean E. Sammet

Photograph: Doug Baker

This 18-screen Video Archway dramatizes 50 years of computer history in 90 seconds, and forms the entrance to the exhibit.

Milestone 1
Mechanizing Names and Numbers
The 1930s

Milestone 2
The Electronic Computer is Born
The 1940s

Milestone 3
A Big Machine for Big Business
The Early 1950s

Milestone 4
Marching Orders for a Corps of Computers
The Late 1950s

Milestone 5
Big Business Buys the Computer
The 1960s

Milestone 6
Unleashing the Computer
The Early 1970s

Milestone 7
A Small World Still Has Big Problems
The Late 1970s

Milestone 8
Computing Power for People
The 1980s

Milestone 9
We Are All Programmers
The 1990s

The past fifty years have witnessed immense technological change. Foremost among those changes has been the explosive growth in computer technology that has been called the Computer Revolution. This booklet is a companion to the exhibition *People and Computers: Milestones of a Revolution.* Through a series of nine milestones this exhibition portrays important eras in computer history. The milestones explore the historical forces that shaped major advances in computing technology. They also investigate the effect these advances have had on our world.

When computers were invented in the 1940s, their impact was revolutionary, offering a thousand-fold improvement over hand-operated, mechanical calculators. Since that time, computers have incorporated new inventions such as integrated circuits, microprocessors, and new computer languages. Today's desktop computers are a thousand times faster than the first million-dollar mainframes that launched the Computer Age.

Each of the nine milestones depicted in this booklet typifies a new way of using and thinking about computers. Together, they create an outline of the course of the Computer Revolution, from punched paper cards through personal computers. This booklet combines photographs of the exhibition itself with vintage photographs depicting the historical context of the various milestones in the Computer Revolution.

The changes in computer technology were not linear and direct, but had false starts, dead ends, and led to unexpected applications. While each new development offered advantages, it also created and compounded problems. For example, the ability to organize data on every person electronically helped the operation of governments and corporations, but threatened the privacy of individuals. Computers created new jobs, but they also made others unnecessary.

The Computer Revolution is not over. When you finish this booklet, we hope you will ask yourself: "What have computers meant to me and my family? And how will they affect my future?"

Milestone 1

MECHANIZING NAMES AND NUMBERS

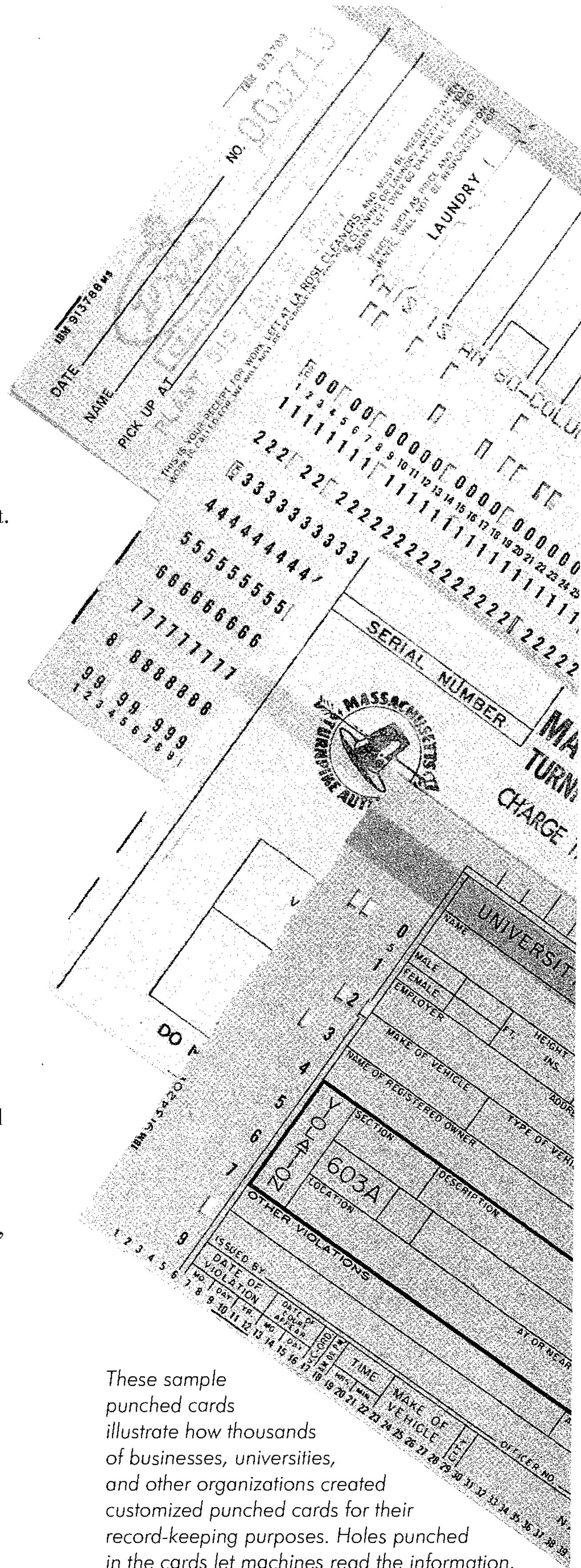
Governments keep records on their citizens. Before the advent of machinery for processing information, this painstaking work was done by hand. The invention of punched card equipment in 1890 changed all this. Bureaucracies came to depend on these machines which processed information using gears, switches, and paper cards. Punched card data processors were ancestors of the computers we use now.

Census clerks took over seven years to tabulate and interpret the results of the 1880 Census. By the time the statistics were ready, over 10 million new immigrants had entered the United States, making the results virtually worthless. A faster process had to be found to compile the results of the next census. A Census Bureau employee named Herman Hollerith invented a better way to get the job done. He devised mechanical machinery to read a pattern of holes punched in paper cards. Each hole represented information, such as a person's country of birth, age or sex. Using this system, Census Bureau workers tabulated information on 64 million people in six weeks, at a savings of over $5 million.

In 1896, Hollerith established the Tabulating Machine Company to sell his invention to government agencies, both in the U.S. and abroad, and to railroads and other business. This launched the punched card office machine industry. By the 1930s, police departments, schools, and many other government agencies and businesses depended on these machines for record-keeping and accounting. Herman Hollerith's original company became part of IBM. By the end of the 1930s, many companies, such as Remington Rand in the U.S., Powers-Samas in England, and Bull in France, were producing data processing equipment.

During the Great Depression many people faced financial hardship. One of the programs created in response to this crisis in the U.S. was the Social Security Act of 1935 to ensure pensions for millions of citizens. To administer this program, the federal government turned to punched card equipment.

Starting in 1937, the U.S. Social Security Administration used IBM punched card machines to keep records on over 27 million people. The key was punched paper cards that stored records of each individual's contributions to the system. Clerks used special typing machines to punch a person's Social Security number, name, and employer onto paper cards. Mechanical machines were then used to process this information: some sorted cards, some added numbers, and others printed out reports for policy makers to study. Day after day, hundreds of clerks carried thousands of cards from one machine to the next. These machines were essential for the timely distribution of over 30,000 Social Security pension checks a month.



These sample punched cards illustrate how thousands of businesses, universities, and other organizations created customized punched cards for their record-keeping purposes. Holes punched in the cards let machines read the information. A particular pattern of holes in a column of the card corresponded to a given letter of the alphabet or digit.

Courtesy of the Dorothea Lange Collection, The City of Oakland, The Oakland Museum

Times were hard in the 1930s. Millions of people lost their jobs, homes, and hope. To get the United States back on its feet, the Congress and President Franklin D. Roosevelt set up new federal agencies that required more detailed data about human needs to deliver expanded human services.

The Electronic Computer is Born

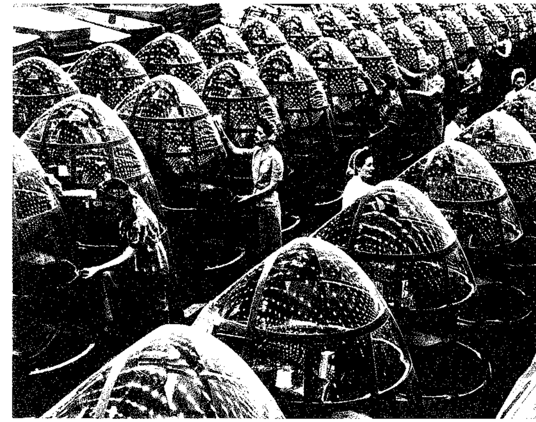
Before World War II, solving complex mathematical problems took a long time and required the coordination of dozens of people working with mechanical calculators. These workers were often called "computers." With the War, the British and U.S. governments funded major efforts to develop automatic calculating machines. By and large, the British focused on tools for cracking coded messages, and the U.S., on tools to achieve accuracy in firing from ships and in the field. The modern electronic computer sprang from these efforts.

One such effort was Project Whirlwind at the Massachusetts Institute of Technology (MIT). Like many other early experimental computers in the U.S., Whirlwind was built with government support—close to $4.5 million over the course of the project. Started during World War II by the U.S. Navy, Whirlwind continued to receive military support after the War and led to many important advances in computer technology.

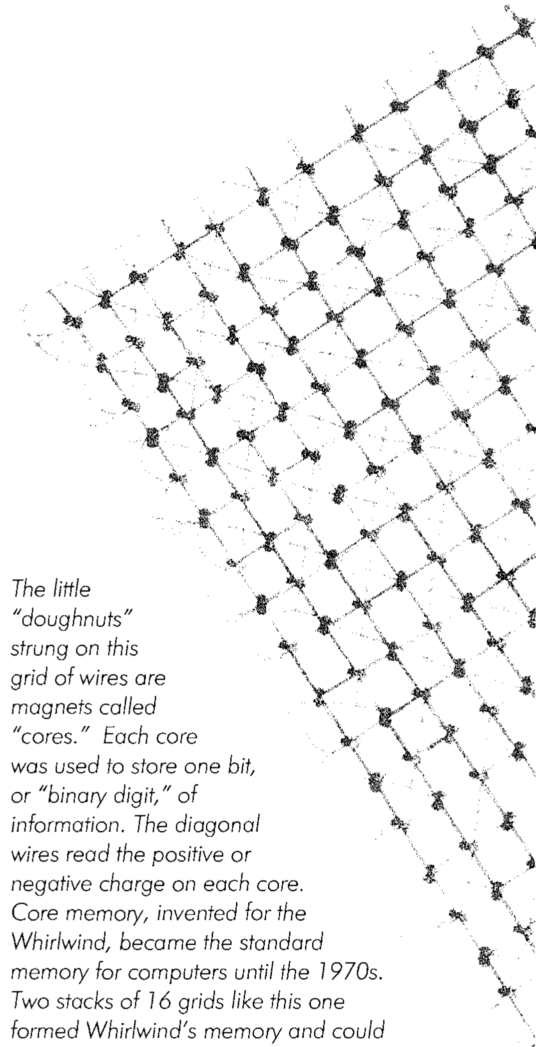
Jay W. Forrester led the team at MIT that developed the Whirlwind computer. The original goal had been to build a machine for training Navy pilots during World War II. Simulating the response of an airplane meant executing complex calculations as rapidly as the pilot moved the controls. At the time, it proved difficult to build a computer which was that fast.

The Whirlwind's circuitry depended on over 12,500 vacuum tubes. Since vacuum tubes burned out, Forrester and his team worked to increase their reliability, designing the computer so that the vacuum tubes could be periodically checked and those in imminent danger of failure could be easily removed and replaced. In search of ever greater speed, the engineers constantly refined their designs. The development of faster, more reliable circuits and memory enabled Whirlwind to meet its original goals for speed, but by then the War was over, and the purpose of the project had changed.

After the War, the Air Force took over support of the project, and Whirlwind became a prototype for an air defense computer system that tracked every plane flying over North America. The Whirlwind also became a resource for academic research. The machine was never idle; when it was not doing work for the Air Force project, MIT professors took the opportunity to assign it calculations that would otherwise have taken hundreds of hours to solve by hand. Using the computer, they tackled such problems as designing optical lenses, controlling machinery, and studying economics, to name just a few.



World War II forced nations to build planes, tanks, ships, and guns in greater variety and number than ever before. Around the world, money and minds focused intently on developing new technologies. These efforts produced many important inventions: jet engines, rockets, radar, the atom bomb, and the computer.



The little "doughnuts" strung on this grid of wires are magnets called "cores." Each core was used to store one bit, or "binary digit," of information. The diagonal wires read the positive or negative charge on each core. Core memory, invented for the Whirlwind, became the standard memory for computers until the 1970s. Two stacks of 16 grids like this one formed Whirlwind's memory and could hold 32,768 bits of information—or 4K bytes.

Courtesy of The Computer Museum

Courtesy of The Computer Museum

Joe Thompson, one of Whirlwind's full-time operators, was hired right out of high school. He is shown preparing instructions for the computer on a "Flexowriter." The racks of switches and lights along the wall of the control room allowed the operator to check that Whirlwind's circuitry was running correctly. The Whirlwind control room and computer occupied 3,100 square feet, the size of a ten-room house.

A Big Machine for Big Business

In the years following World War II, factories pressed into service during the War returned to commercial use. Similarly, the computers that were developed for military use were adapted for peacetime activities in government, business and education. By the end of the 1950s, thousands of computers were in use by business and government alike.

The first machines to make the jump from government and scientific applications to practical uses in business were the UNIVAC I (short for UNIVersal Automatic Computer) in the U.S. and the LEO I (short for the Lyons Electronic Office) in England.

UNIVAC sprang directly from ENIAC, a pioneering computer developed for the U. S. Army during the War by John W. Mauchly and J. Presper Eckert, Jr. While most people still saw the computer as a tool for science and engineering, Eckert and Mauchly recognized its potential for business data processing. Inspired by their vision, they founded a company to produce the UNIVAC I, a computer specifically designed to meet the needs of business. Early customers for the million-dollar UNIVACs included General Electric, Metropolitan Life, and the U.S. Census Bureau.

G.E. purchased their UNIVAC in 1952 when they consolidated all their major appliance manufacturing into a single factory in Louisville, Kentucky. Post-war demand had increased sales of stoves, refrigerators, and washing machines. Meeting this demand meant keeping track of all the wire, plastic, steel, springs, and other materials that went into the appliances and paying a growing workforce. In addition to the $1 million price tag, G.E. had to provide specially climate controlled conditions and a large team of technicians and consultants to install the machine and keep it running. G.E. also retained the services of Arthur Anderson, a large accounting firm, to assist them in getting the UNIVAC up and running for the first time.

Since this was one of the first commercial applications of a computer, no off-the-shelf software, operating systems or databases were available. Only after months of work, did the team of G.E. and Arthur Anderson experts succeed in completing programs that instructed UNIVAC I to perform its giant task: keeping track of the millions of parts in the factory's inventory and calculating paychecks for the plant's 12,000 employees, with their own tax deductions, Social Security payments, wages, overtime, and health benefits.

In England, LEO I was patterned after the Cambridge University EDSAC, one of the world's first stored program computers. In this case, the Lyons Tea Company faced the daunting task of supplying hundreds of tea shops with tea, biscuits, and cakes according to ever changing demand. To assist them in processing thousands of orders every day, Lyons decided to build their own computer. After the first machine was installed and working successfully, Lyons went into the business of manufacturing computers to meet the growing need of other businesses for data processing systems.

By the mid-1950s, managers around the world saw the computer as a symbol of a thriving, modern enterprise—the latest tool for scientific business administration. Orders for computers soared to the thousands. The UNIVAC I and LEO I had broken open the market for business computers.

Using computers in business was part of a larger trend: automation. Machines that seemed to think and work tirelessly were viewed with great expectation and trepidation. Some people claimed this technology would free humans from boring, repetitive labor; others feared it would put people out of work.

Courtesy of The Computer Museum

This is a typical UNIVAC I installation of the 1950s. Here you see the computer's console and tape drives.

After World War II, economies boomed. People bought cars, refrigerators, and washing machines in unprecedented numbers. Factories churned out more and more products. To keep up with demand and to gain competitive advantages, a handful of large companies began to see the emerging computer as a tool for managing their vast operations.

Marching Orders for a Corps of Computers

Toward the end of the 1950s, government and business invested in more and more computers produced by a growing number of companies. Each manufacturer's machines were unique and only followed their own instruction code. No common languages like BASIC or PASCAL existed. Customers complained that it took too long to get their expensive machines into operation, and no common basis existed for training the growing population of programmers. The difficulty of programming was a major obstacle to the growth of computer use.

In May 1959, at a meeting in the Pentagon, representatives from ten computer manufacturers, seven government agencies, and 11 large users formed a committee to figure out a single way to program business problems.

After six months of work and debate, members of this committee issued a report describing a language for programming business problems. They called it COBOL (short for COmmon Business-Oriented Language). COBOL offered several advantages over programming a problem in the obtuse code of individual computers: it used symbols and words familiar to business people to express instructions, and with only minor modifications, a program written in COBOL could be run on any computer that used the language.

The key to COBOL and other early programming languages was a special program called a *compiler*. A compiler program took the COBOL commands written by the programmer and automatically translated them into the series of minute instructions which that particular computer actually executed. This made writing a program in COBOL much quicker and easier than having to write out the instructions the computer executed. It also permitted the same program to run on different machines.

COBOL was not the only important programming language to emerge during this period. Others included: FORTRAN (short for FORmula TRANslator and used for scientific problems), APT (Automatically Programmed Tools for controlling machinery), and LISP, the language that virtually launched the field of artificial intelligence. Programming languages allowed the development of curricula for training programmers and other users. This meant people could be trained in the use of one language and work on many different machines.

Certain languages, such as FORTRAN, enjoyed wide use and became "de facto" industry standards. In contrast, COBOL, and later ADA, a subsequent language, became standard languages by decree. The Defense Department required that all its administrative computers have COBOL compilers. But these standards were not universal; by the 1970s, hundreds of different programming languages were in use.

COBOL allowed different computers to "speak" the same language.

Courtesy of the Associated Press

In 1961, an East German soldier escapes to the West as the Berlin wall goes up.

Courtesy of the John F. Kennedy Library

President John F. Kennedy gives his 1961 inaugural address in Washington, DC.

Big Business Buys The Computer

By the mid-1960s, computer data processing had become a crucial part of business. Designed to satisfy both business and scientific users, computers came in a range of sizes and prices, starting at $50,000. But most were large "mainframe" computers that processed customers' orders, issued bills, kept personnel records, and performed many other functions central to commercial enterprise. The IBM System/360 was typical of computers during this period.

The IBM System/360 was actually a family of computers that came in various sizes, all of which could use the same tape drives, printers, and other "peripherals." As their business grew, customers could simply expand their computer system. Switching to a more powerful computer no longer meant writing new programs. This "modular" approach to building computers was one reason the System/360 sold so well.

The Travelers Insurance Companies exemplified how large corporations came to rely on computers. At its central data processing center in Hartford, Connecticut, The Travelers recorded and managed the more than 1.5 million insurance policies written by its agents nationwide, and processed over 16,000 claims every day from around the country. Enormous computer tape "libraries," or "data banks," stored information about the company's customers. As The Travelers computerized more and more insurance policies, it added more computing power and memory to handle the additional information.

The Travelers used its computer primarily for electronic record keeping on a vast scale. For example, in a single day the computer might be fed 3,000 claims for fire damage to private homes. The computer's central processing unit would then hunt down the policy record for each customer whose house had caught fire, verify that the damage was covered by the policy, record the claim, and print a check to pay for repairs.

In the 1960s, computers could generally run only one program at a time, and were shared by dozens of users. Most people who used computers for problem-solving never actually saw or touched the machine. Full-time operators ran the programs. Users had to wait until the computer could run their job. If there were errors, they had to correct them and then start again at the end of the line.

This method of operation was called "batch processing." For example, a programmer working on a new customer database would write a program, have it punched on cards, and then hand it over to the computer operator. The operator would run the job when its turn came and hand the results back to the programmer who had submitted it. This often took hours, sometimes days. If there were a problem, or "bug," in their code, programmers had to find and correct it by hand and then start over at the end of the line of jobs waiting to be processed by the computer.

The large mainframe computers of the 1960s required specially made computer rooms that were heavily air conditioned and had extra space in the floors, ceilings, and walls for cables and wiring. Clattering and whirring equipment filled these rooms with a constant din. Access to computer centers was generally restricted to operators and service people, who exercised strict control over the use of the machines.

New technologies raised new dilemmas. During the 1960s, governments and big corporations began to build huge stockpiles of information using computers. Enormous databases kept medical records, bank account records, criminal records, driver's license records, income tax records, etc. Almost every United States citizen was affected. Some people began to joke about computers, blaming them for making mistakes on their bills. Others began to be concerned about the potential threat computers posed to their privacy. A 1965 proposal to create a nationwide, unified government database met with strenuous opposition.

Courtesy of the Bettmann Archive

The Beatles appear on Ed Sullivan's television show in 1964.

Courtesy of Digital Equipment Corporation

This is a computer's "library." The reels of tape magnetically stored volumes of information in a form the computer could read.

Mainframe computers required their own special facilities. Here, a technician installs cabling for a new tape drive.

Milestone 6

Unleashing The Computer

Smaller, cheaper, more efficient components resulted in smaller cheaper computers that didn't need their own special environmental controls. Relying at first on transistors and then on more compact integrated circuits, *minicomputers* spread to many new and smaller-scale uses. From the first manned mission to the moon to operating rooms and theaters, the minicomputer went where no computer had gone before.

In 1965, Digital Equipment Corporation announced the PDP-8, one of the most popular minicomputers. This new breed of computer opened up a new universe of applications. These computers were small enough that they could be used where mainframes could never fit (including inside other pieces of equipment) and inexpensive enough that customers who could never have afforded a full-scale mainframe could buy a computer of their own.

The Surgeon and the Computer

In the early 1970s, medical researchers and surgeons at the Yale Medical School and the West Haven VA Medical Center in Connecticut began experimenting with a PDP-8e to assist in neurosurgery. Before using the PDP-8, brain surgeons had to keep patients awake during surgery and manually prod the brain to identify the cerebral cortex. Damaging the cortex could leave the patient paralyzed. By hooking the patient up to the PDP-8, the researchers could stimulate nerves in the patient's body and electronically map the cortex while the patient slept. This method was not only faster, but also much less gruelling on both patient and surgeon.

A Chorus Line

At the Shubert Theater in New York City, the Broadway show *A Chorus Line* played to sold-out audiences for years. Most of the audiences didn't know there was a electronic stagehand on the job to help things run smoothly.

"Sam" was the nickname given to the LS-8 light controller by its operators. A lighting designer programmed Sam to remember and execute all the lighting effects for the show. Sam could flash lights faster and more precisely than any technician could by hand. That was key to running *A Chorus Line*—Sam had to keep pace with 17 whirling dancers. It would have taken eight lighting technicians to put on the show Sam and its single operator did. But computerized lighting had one drawback. If a dancer tripped or missed a cue in the middle of a special effect, Sam kept right on going.

Electronics Diversified, Inc., built the LS-8 light controller around a PDP-8a computer. The PDP-8a served as Sam's "brain" and memory. From 1975 to 1987, Sam controlled the lights for every show of *A Chorus Line* at the Shubert Theater.

Embedding a minicomputer inside another piece of equipment, be it an assembly line robot, automatic potato picker, or lighting controller, became a typical way of using computers.

The dancers in A Chorus Line *were not the only ones who had to make some quick changes backstage. The PDP-8a embedded inside the lighting board console stored thousands of pre-programmed lighting cues. With the touch of a button, the lighting technician could trigger a whole effect involving hundreds of lights.*

The rack of equipment to the left of the operating table contains a PDP-8e minicomputer.

The biggest scientific project of modern times, the race to put a human being on the moon, contributed to the smallest, most efficient tool in history: the integrated circuit. With it came smaller computers.

Milestone 7

A Small World Still Has Big Problems

As scientists pierced the frontiers of knowledge, the problems they struggled with became ever more complex. To assist them in their research, scientists sought ever faster, more powerful computers. The fastest computers of their day came to be known as "super-computers."

When introduced in 1976, the CRAY-1 computer was by far the fastest in the world, performing 166 million operations per second. Such calculating power helped change the way scientists used computers for research. With the CRAY-1, scientists could construct and study complex mathematical models of objects or events too dangerous, inaccessible, or big to experiment with directly.

Meteorologists at the European Centre for Medium-Range Weather Forecasts (ECMWF) in Reading, England, used the CRAY-1 super-computer to predict the world's weather for extended ten-day forecasts. The mathematical calculations used to chart weather patterns and track major storm systems were performed by the CRAY-1 computer.

To make its weather predictions, the ECMWF built a computer center the size of a small factory and filled it with an array of computer equipment. The CRAY-1 supercomputer was its heart. "Talking" to a person would only slow down the CRAY-1, so other computers were used to feed it data and instructions rapidly.

Forecasting the weather was exactly the type of enormous arithmetic problem that demanded the use of supercomputers like the CRAY-1. The ECMWF fed the computer the temperature, humidity, baro-metric pressure, wind speed, and wind direction from satellites, 9,000 weather stations, 750 weather balloons, and numerous ships and planes around the world (80 million bits of information total). From these readings, the CRAY-1 calculated the estimated conditions for every point on a grid covering the globe's atmosphere. (With points spaced 200 km apart and 15 layers deep, there were 273,630 points in all.) Then, applying the physical laws describing the behavior of gases and fluids, the computer figured out how the weather conditions at each point of the grid would affect the points surrounding it 15 minutes later. The CRAY-1 system repeated this last step 960 times, and 500 billion calculations later the meteorologists had an approximate view of the weather around the world for the next ten days. Of course, as with all such predictions, the accuracy of the forecast was limited by the simplifying approximations made by the programmers.

It's not hard to understand why this global weather model required a very fast and large computer. Neither a minicomputer nor a data-processing mainframe could have handled all the data and calculations fast enough. The CRAY-1 computer produced the forecast in just five hours.

Supercomputers were not cheap (the CRAY-1 computer system cost $8,000,000 in 1976), but some jobs, both then and now, could not be done without them. For example, defense laboratories use supercomputers to simulate new weapons under design. Environmental scientists use them to study different scenarios to explain global warming. Aircraft companies use supercomputers to test the design of airplanes before they start construction. Oil companies use them to map the Earth's interior. The weather forecast still comes to you thanks to supercomputers like the current CRAY, NEC and Fujitsu machines.

From a room in Reading, England, a meteorologist at the European Centre for Medium-Range Weather Forecasts studies the prediction of the world's weather for the next ten days. The charts on the wall show the European forecast for June 11-21, 1979. The mathematical calculations used to produce these charts were performed by a CRAY-1 computer.

Courtesy of the Jimmy Carter Library

Egyptian President Sadat, U.S. President Carter and Israeli President Begin sign the Camp David Peace Accord in 1978.

The speed of the CRAY-1 is partly attributable to the tightly packed circuits arranged in a semi-circle to minimize the distance between the computer's parts. The CRAY-1 is so fast that if the electricity had to travel too far, the computer would have to wait for it. The "seat" houses the equipment that supplies power to the rack of circuitry above it. A pump circulates Freon (the liquid used in air conditioners) through the cast aluminum racks to keep the computer cool.

Computing Power For People

During the 1980s, technology expanded the possibilities of personal choice. With automatic teller machines (ATMs) people could do their banking whenever they chose. VCRs let people watch movies and television shows on their own schedule. The inexpensive personal computer allowed people to use computers more freely for work, play, and self-expression.

In 1971, the invention of the *micro-processor* set the stage for the personal computer. By 1974, enthusiasts designed and built their own "home-brew" computers based on this inexpensive "computer-on-a-chip," and small companies began to sell do-it-yourself computer kits for hobbyists. In growing numbers, these *micro-computer* owners swapped programs and ideas, pioneering the use of computers by individuals.

By the late 1970s, the Apple II, TRS-80, and Commodore PET were sold as complete units in retail stores. Then, in August 1981, IBM introduced its Personal Computer. Two-and-a-half years later, in December 1984, Apple Computer responded with its Macintosh. More than any other personal computers, these two transformed the way people and organizations thought about and used computers. Low-cost systems, sold with word processors and spreadsheets, expanded the use of computers to individuals and within large organizations. By the late 1980s, resources that had been concentrated in central computing facilities during the 1950s and 1960s started to migrate to desk tops.

Ready-made, shrink-wrapped, load-and-run software programs enabled practically anyone to use these personal computers without any knowledge of programming or electronics. The software that helped make the IBM PC a success was *Lotus 1-2-3*—a *spreadsheet* program.

Businesses of all sizes bought the PC and *1-2-3* for analyzing complex charts of financial information. This combination of hardware and software helped make the personal computer a part of everyday business life.

In 1981, the IBM Personal Computer (PC) sold only 20,000 machines. In 1983, sales had grown to more than 500,000, prompting over 150 companies to try to market imitations. Compaq was the first of many "clones" with the ability to run the same software. Within a few years a whole industry of PC *clones*, *peripherals*, and software arose, all built around the basic design of the IBM PC.

One reason for this was a program made by a company called Microsoft. MS-DOS (for Microsoft Disk Operating System) administered the IBM PC's operations. Any computer that used MS-DOS could run any software written for the PC. And conversely, any program written to run with MS-DOS would work with any *PC-compatible* computer, or "clone." In this way, MS-DOS contributed to explosive growth in the personal computer market. By 1990, Microsoft had sold over 12 million copies of MS-DOS, two million more than the best selling record album of the year.

The Macintosh, with its own non-DOS operating system, offered an alternative form of computing more focused on graphics. Users could easily make text LARGER, smaller, *italicized*, or **bold** and see the result right on the screen. They could also easily create pictures, charts, and other graphics. Rather than taking their print jobs to a printer or typesetter, Macintosh users—from individuals and advertisers to schools and corporations—could produce fancy documents themselves on their own computers. Using these machines to design newsletters, catalogs, magazines, and brochures became known as *desktop publishing*.

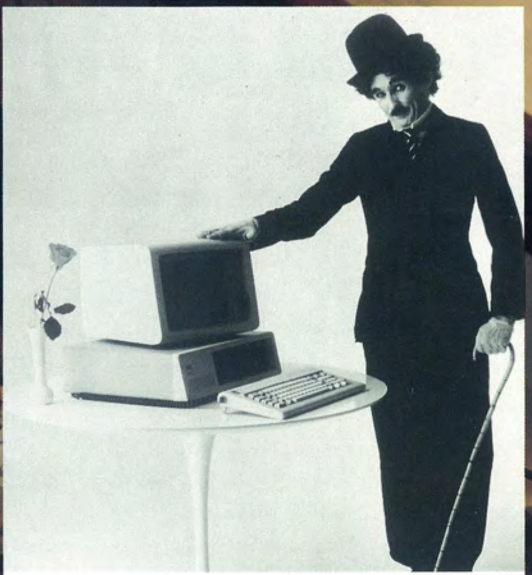
One of the Macintosh's most appealing features was that it was easy to use. Rather than having to memorize and type out commands, as with most PCs, Macintosh users simply pointed to an icon, or small representative picture, of the command they wanted and clicked the computer's *mouse*. This meant new users and young children could quickly get down to useful work and play, without spending a long time learning the ropes. In this way, the Macintosh helped popularize styles of computing known as a "GUI" (Graphic User Interface) and "WYSIWYG" (What You See Is What You Get).

Photograph: David Bohl

The horses are on the track. . . they're at the gate. . . And they're off!

At over 5,000 ticket windows across Hong Kong, fans scramble to bet on their favorite horses before the race begins at Happy Valley Racetrack. The ticket windows report their sales to central offices where personal computers, running Lotus 1-2-3 *spreadsheet software, create reports for the managers. The computers rapidly compile statistics showing how the volume of bets placed compares to the previous year, how many betting tickets are sold per ticket window, and the size of the average bet. Such information is critical to keeping tabs on the operation of Happy Valley and planning for the future.*

Read all about it! "Nifty Tips for a Great Homecoming Date!" "Teenagers From Around the World!"
Starting in 1985, students at Granada High School in Livermore, California, used an Apple Macintosh computer and a program called PageMaker to publish their school newspaper, The Wall. *To help pay for the computer and the software, the students also used their system to design publications for county agencies.*



This print advertisement for the IBM PC was introduced in 1981.

Milestone 9

WE ARE ALL PROGRAMMERS

By the late 1980s, computer processors and memories were found in many, many devices—for example, CD players, telephones, thermostats, microwave ovens, cameras, and answering machines. People who programmed their VCRs were actually programming microcomputers embedded inside the VCRs. The computer itself was becoming smaller—lap-top and palm-top computers had more capability than the 20 pound IBM PC of ten years before. All these machines depended on ever more powerful, less expensive microprocessors. In 1990, world production of microprocessors totaled 1.5 *billion* (10 times the number of people born that year).

Today, many consumers in the developed world own and use several computers—in their cars, VCRs, telephones, calculators, watches, and electronic games—not to mention their personal computers. While this proliferation of computers has yet to occur in the developing world, the inexpensive, easily programmed, and durable microprocessor has greater potential for use by people around the globe than any of its predecessors.

Today, computers surround us, easing some age-old human problems and making others worse. They have begun to affect every person on earth in ways we can only begin to understand. Still greater changes lie ahead. Today's youth will be the first to grow up with computers. What will this mean for them and their world?

Courtesy of the Associated Press

Crowds celebrate the destruction of the Berlin Wall in 1989.

Computers surround us. Many of today's consumer electronics products rely on embedded microprocessors.

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EASA-PHONE
KX-T2634 Silver
Integrated Telephone System
with Answering System
Panasonic
EASA-PHONE
AUTO-LOGIC
KX-T2634 Silver
Voice Menu/Time Day Stamp
Auto-Answer Speakerphone
PRISM
PRISM

You are the Future

Inexpensive microprocessors have made computers more widely available and the opportunities for their use more diverse than ever. It is up to us to decide what we do with these ever-evolving tools. Are they:

- Games to while away boredom or to foster learning?
- Tools to maintain the status quo or to encourage new outbursts of creativity and entrepreneurship?
- Devices to invade people's privacy or to aid democratic change and the flow of information?
- Machines to replace people's jobs or to create new opportunities?

These are a few of the choices and challenges of the continuing Computer Revolution.

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