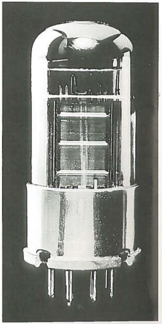
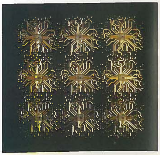
Innovation in IBM Computer Technology





1890

IBM, although not yet known under this name, opens subsidiaries in:

1910 Germany
1920 France
1927 Switzerland
1928 Austria
1928 Sweden
1929 Italy
1933 Yugoslavia
1933 Czechoslovakia (Service bureau)
1933 Denmark (Service bureau)
1934 Poland
1935 Norway
1935 Hungary (Service bureau)
1936 Belgium
1936 Bulgaria
1936 Finland
1938

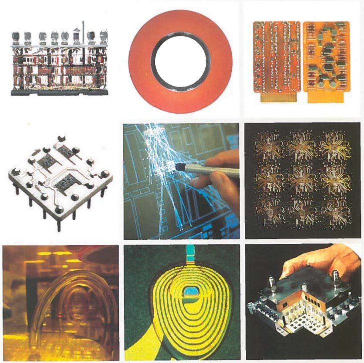
Innovation in IBM Computer Technology

Computers today can process information and solve problems thousands of times faster than could the early electronic systems of the Forties and Fifties — at a small fraction of the cost.

In four decades, the industry has progressed from electromechanical punched card machines and vacuum tube calculators to powerful electronic computers that measure speeds in billionths of a second. This is the result of technical innovation by many people and organizations across the industry — by IBM and other computer producers, universities, customers and individual inventors. IBM has contributed many significant machines, devices, software and manufacturing developments — technology that reflects the company's 10,000 patents and leadership in overall computer research and development. Highlights of that technology are presented on the following pages, which cover the major eras in the evolution of computer circuitry and trace parallel developments in programming and peripheral equipment.

The goal in IBM laboratories and plants has been not only to invent but also to apply engineering and manufacturing skills to convert inventiveness into a useful form — new products and systems that are easy to use, are cost-effective, can be produced economically and will perform reliably.

As a result of such innovation by IBM and others in the industry, computers are being put to use at a growing rate across the spectrum of human activity — from science, business and health, to government, education and the arts — in all parts of the world.



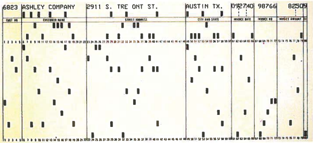
Wires, Wheels and L

The Beginning of Modern Information Pr

1890-1946

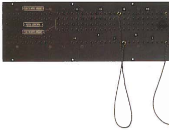
Electromechanical machines to punch, tabulate and sort cards at high speed were the heart of information processing in the US and abroad throughout the Second World War.

Originally developed by Herman Hollerith for the 1890 US Census, punched card machines ware later put to use by government, railroads and insurance companies. Progressively faster machines came into use throughout business, science and government. However, even the fas-



Information is stored in cards by holes punched in columns on the card. Numbers are represented by single holes; letters of the alphabet by two holes. The machine 'reads' the holes electrically as the card is moved across sensors.

Production of punched card machines grew rapidly in the 1920s and 1930s. This IBM card sorter was used widely until the late 1940s. Many punched card installations continued in operation until replaced by electronic machines in the 1960s.



Wired control panels, or 'plugboards', directed the operation of punched card equipment. The operator rearranged the plugs by hand to make the machine do different jobs.

Punched cards themselves were the basic means of storing information and were often organized in 'tub files'. This file was typical of the punched card era.

This 3 1/4-inch-long printing cylinder is from the first machine to manufacture punched cards commercially at high speed — the Carroll Press developed by IBM in 1924. The fast rotary press helped meet the industry's need for billions of punched cards annually.

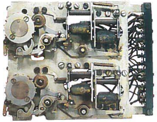
Portugal
1938 Turkey
1940 Netherlands

1940

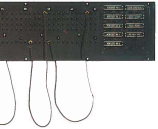
evers

ocessing

test punched card machines were bypassed by technological change, as vacuum tubes began to replace the electromechanical wheels and levers in the late 1940s.



Electromagnets that controlled counting wheels, together with switching relays, performed the arithmetic function in punched card machines used into the 1960s.



The first operating machine that could execute long computations automatically was the Automatic Sequence Controlled Calculator (Harvard Mark I). A project conceived by Harvard University's Dr. Howard Aiken, the Mark I was built by IBM engineers in Endicott, N.Y., where it is shown before shipment to Harvard in 1944. It was the industry's largest electromechanical calculator.

1941 Essonnes plant inaugurated
1941 Spanish subsidiary established
1947 French IBM HQ opens at Place Vendôme
1948 Italian IBM has 63 dp equipment users
1949 IBM Belgium produces one million cards a day
1949 IBM Germany moves from Berlin to Boeblingen
1950 First IBM WTC 100 % Club meetings held in Berne, Stockholm, London
1950 Danish subsidiary established

Vacuum Tubes

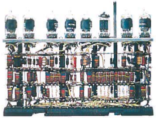
Thousands of Times Faster

1946-1958

The electronic computer was born of the vacuum tube. Developed for the radio industry, the vacuum tube permitted machines to calculate several thousand times faster than did earlier electromechanical relays.

Among the first calculators and computers to use vacuum tubes, built in the years 1946 to 1952, were ENIAC at the University of Pennsylvania, the IBM 603 and 604, the IBM SSEC, EDSAC at Cambridge University, UNIVAC I of Eckert and Mauchly, the Institute for Advanced Study computer and the IBM 701. Some of these incorporated a new 'stored program' concept that greatly expanded the machine's ability to do complex work at high speed and helped bring the modern computer into being.

The earliest computers were designed for scientific problems. However, vacuum tube computers moved rapidly into commercial work in the 1950s —in billing, payroll, accounts receivable, inventory control and many other applications.



This is a vacuum tube rack from the IBM 701 computer. First deliveries of the 701 in 1952 signaled IBM's commitment to the new electronic machines — a significant technical and business risk at the time. Principally a scientific computer, the 701 had electrostatic storage tube memory, magnetic tape and drum units, and many electronic circuit refinements. Nineteen 701s were shipped, mostly for government and research work.

The IBM Naval Ordnance Research Calculator (NORC) — the most powerful existing computer when completed in 1954 — could perform this calculation in 31 millionths of a second (including placement of the decimal point).

```
                        2368.912941062
NORC                    867124.0510296
      --------------------------------
                      1421347764637 2
                     2132021646955 8
                     473782588212 4
                   23689129410 62
                 11844564705310
                9475651764248
               4737825882124
              2368912941062
            1658239058743 4
           1421347764637 2
          1895130352849 6
      --------------------------------
          20541413859901255052174352
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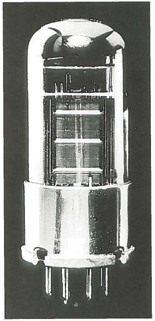
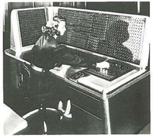


The vacuum tube in early computers was used basically to switch electrical signals to perform operations such as adding, multiplying, storing and comparing.

The computer industry's first 'replaceable unit' was this assemblage of electronic parts in the IBM 604 calculator in 1948. Service engineers could simply plug in a replacement.

The largest of all vacuum tube machines was SAGE, a computer used as part of the US air defense system. Twenty-seven were built by IBM during the 1950s in a program directed by the Massachussetts Institute of Technology's Lincoln Laboratory. SAGE was the first large computer network to provide man-machine interaction in 'real time' — as events were occurring.



The first operating computer to combine electronic computation with stored instructions was the IBM Selective Sequence Electronic Calculator (SSEC), completed in 1948. It had more than 12,000 vacuum tubes and 21,000 electromechanical relays.

The widely used programming language FORTRAN was developed originally by IBM and made available to users in 1957. FORTRAN enables engineers and scientists using a computer to state a problem in familiar symbols, close to the language of mathematics.

Typical mathematical formula:

$D=B^2-4AC$

Equivalent FORTRAN statement:

```
D=B**2-4*A*C
```

1950

1951 IBM UK starts marketing IBM products and services
1952 Quarter Century Club established in Germany
1952 New plant opens in Amsterdam
1953 New plant opens in Greenock, Scotland
1955 IBM Institute of Data Processing and Computing opens in Paris
1956 IBM Research Laboratory, Adliswil, Switzerland, inaugurated
1956 IBM Ireland organized to market data processing equipment
1957 UK Atomic Authority instals first IBM 704 in British Isles
1958 European and US programming specialists meet in Zurich and agree to a unified programming language, ALGOL
1958 The IBM 7070 transistorized computing system is annou
1958 German e
developm
IB

Magnetic Storage

Better Ways to File and Retrieve Information

1952-1964

In the 1950s, new ways to store more information were in demand. Early electrostatic storage, using cathode ray tubes, was fast, but could be expensive and troublesome. Punched cards were low-cost, but slow. Computer tape could be a problem because of delays when data was recorded at scattered points on a reel. The answer for high-speed main memory within the computer turned out to be the tiny magnetic core, originated by several inventors and organizations. The answer for large-volume storage was the magnetic disk, which enabled users to retrieve any piece of information directly, in less than a second. This
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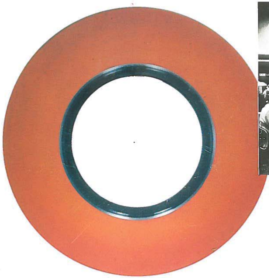
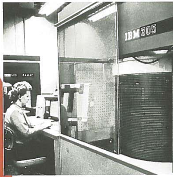
needed fast access to fi

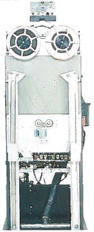
In this same period,
were also found to p
computer and to impr
munications ability.





Data processing took a new direction in 1957 with initial delivery of the IBM 305 RAMAC, the first computer disk storage system. Such machines became the industry's basic storage medium for on-line transaction processing. In less than a second, the RAMAC's 'random access' arm could retrieve data stored on any of 50 spinning disks.

Left: In 1962, IBM introduced the first storage units with removable disks. Each 'disk pack' on the IBM 1311 could hold more than two million characters of information. Users could easily switch files for different applications.



Right: This 1950 laboratory model proved out IBM's 'vacuum column' invention for controlling magnetic tape. The glass vacuum chamber provided leeway for the tape and prevented it from breaking when abruptly started or stopped. This technique was to be adopted throughout the industry.

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...M 3000 series

... was signifi-
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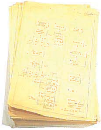
... better ways
...rogram the
...ove its com-

1960 IBM Germany opens new R&D laboratory in Boeblingen
1960 Swedish IBM is first in Europe to use teleprocessing
1960 IBM Nordic Laboratory starts in Solna, Sweden

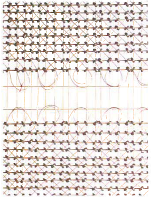
1960

1961 IBM 709 installed by CERN in Geneva
1961 Computer centers with IBM 7090-1401 open in Boeblingen, Paris and London
1961 Alitalia is first European airline with IBM 7070-1401 System
1961 Italy's National Committee for Nuclear Energy inaugurates IBM 704
1961 IBM laboratory starts in Vienna
1961 IBM Denmark establishes new HQ in Copenhagen
1962 University of Ghent instals IBM 1620 -first scientific computer in a Belgian university
1962 IBM laboratory in Switzerland announces new thin film memory, operating at 100 billionths of a second
1962 Max Planck Institute in Germany uses IBM 7090 for plasma physics research
1962 IBM Sweden opens new HQ in Stockholm
1963 La Gaude laboratory dedicated
1963 Rueschlikon laboratory dedicated
1964 IBM Teleprocessing System used at Olympic Games in Innsbruck, Austria
1964 Hursley, Essonnes, and Poughkeepsie connected by teleprocessing
1964 Gallic calendar code, discovered at Coligny in 1897, cracked with aid of IBM 1620
1964 Deutsches Kernforschungsze... (Nuclear Research Center) b... customer of IBM Ge...
1964 Hi... N...

This 16-inch-long drum spun at 12,500 revolutions per minute to provide the IBM 650 computer of the mid-1950s with 10,000 characters of main memory. Data was magnetically encoded on 40 tracks around the drum.

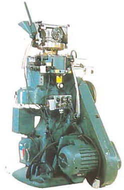


Copy of the 1,115-page patent application covering IBM's 1954 invention of the computer 'channel'. Operating under its own program, the channel synchronized the flow of data into and out of the computer while computation was in process, relieving the central processor of that task. The channel was later widely adopted in the industry.



Magnetic cores were the basic technology for computer main memory from the 1950s into the early 1970s. The tiny iron oxide cores could be magnetized clockwise or counterclockwise to represent bits of information. Data could be retrieved in millionths of a second.

Below: Magnetic cores originated with two inventors, A. Wang and F.W. Viehe, who independently began experimenting with cores for computer memory in the 1940s. Later development work was done by others, including the Massachussetts Institute of Technology, the Radio Corporation of America and IBM. In the 1950s and 1960s, cores were progressively miniaturized to produce higher-speed memories.



IBM adapted pill-making machinery to produce tens of billions of cores in the 1950s and 1960s. Shown here is a Colton Manufacturing Co. machine redesigned by IBM to compress ferrite powder into 32,000 cores an hour. Among many other automated techniques, IBM designed wire feeders to string thousands of cores in one operation.

The IBM 701 system in 1952 was one of the first computers to use magnetic tape for reading, writing and storing information. Recording at 100 characters per inch, this eight-inch-diameter reel was equivalent to 12,500 punched cards. The 701's tape units contained a new vacuum column and magnetic clutch tape drive system and were among the first to use plastic rather than metal tape.

Originated at Harvard University and further developed at IBM in the early 1960s, APL (A Programming Language) is an unusually concise language in which a problem can be solved with relatively few instructions. APL today is popular for engineering studies and systems design and is used by many business professionals

Transistors

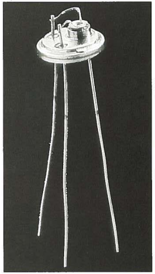
Smaller, Faster, More Reliable

1957-1964

The invention of the transistor at Bell Laboratories in 1947 foreshadowed the time, a decade later, when the device would give birth to a new 'generation' of computer technology. As a replacement for the vacuum tube, the tiny transistor shortened the time needed for electrical pulses to complete a circuit. It generated less heat, was much more reliable and lowered production costs.

Ways were found to incorporate the new transistor technology into computers and to automate the manufacture and testing of transistors by the millions. At the same time, computer companies intensified their development of new systems — both computing equipment and programming support — to meet the needs of many different users, large or small, in business, science and government.

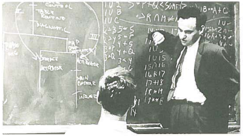
Right: Only 1/200th the size of an early vacuum tube and using less than 1/100th the power, the transistor came into general use in computer systems about 1960. The transistor's basic function in a computer is that of an electrical switch to perform logical operations.



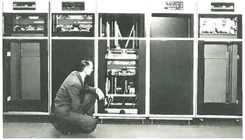
In 1959, the transistorized IBM 1401 brought computer use within the reach of smaller organizations for the first time. Much more powerful than vacuum tube machines of comparable size, the moderately priced 1401 was popular with banks, retail chains, manufacturers and other organizations. In six years, more than 10,000 were delivered.

Typical of what transistors meant to computing was the higher speed of the IBM 7080. The same programs written for payroll, billing and inventory on the older vacuum tube IBM 705 ran six to ten times faster on the transistorized 7080.

The 'chain' printer for computers was introduced with the IBM 1401 computer in 1959. Improving both speed and reliability, the new machine printed 600 lines a minute from a chain-loop of characters moving at 90 inches a second. The technology was later used widely in the industry.



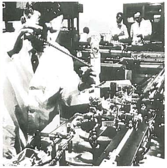
IBM programmers were early leaders in providing users with prewritten computer programs. Such systems sofware included instructions for sorting and merging data, controlling input and output, and generating reports. Users of the IBM 7090 computer in 1961, for example, could take advantage of more than one million such prewritten machine instructions.



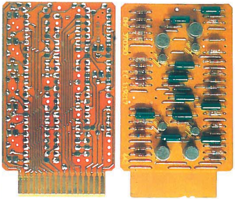
Tractor, an automatic computer tape storage system developed by IBM for the US National Security Agency, was designed to attach to an enhanced IBM Stretch computer. Delivered in 1962, Tractor could store the equivalent of 88 billion characters in 160 cartridges. Its read/write speed of 1.1 million characters per second was the fastest achieved for magnetic tape during the 1960s.

um
mes largest
ny
Council of Scientific Research in
id coordinates all Spanish scientific activities with IBM 7070

1964 Hursley builds first IBM System/360 Model 40
1964 IBM Italy opens new HQ in Milan
1964 Istanbul Technical Library instals first IBM 1620 in Turkey
1964 Portuguese IBM opens new HQ in Lisbon
1965 Microelectronics made in France used in every IBM System/360 made in Europe
1965 First IBM System/360-40, manufactured at Essonnes, is shipped to Franco-German Research Institute, St Louis, France
1965 Northern University Computing Center opens in Denmark with an IBM 7090
1965 Glasgow University instals first IBM 7044 in UK
1965 IBM France opens plant in Montpellier
1965 IBM equipment used by 98 commercial banks and 42 saving banks in Italy
1965 IBM Germany constructs plant near Mainz for IBM System/360
1966 The 1,000th IBM System/360-40 produced by Germany is shipped
1967 The 2,000th IBM System/360-40 produced at Montpellier is delivered
1967 An IBM System/360-H65 provides all facilities for London University
1968 IBM Netherlands has 3,514 employees
1968 IBM Ireland has 200 employees
1968 IBM Norway conducts first opinion survey
1968 5455 disk is developed at Hursley, IBM UK
1969 IBM Spain opens new HQ at Castillana-4, Madrid
1969 250,000th typewriter assembled in Amsterdam plant, IBM Netherlands
1970 Uithoorn lab. introduces 1270 Optical Reader Sorter



The first fully automatic production line for transistors was designed by IBM engineers in Poughkeepsie, N.Y., and placed in operation in 1960. Up to 1,800 individual transistors were produced and tested per hour.



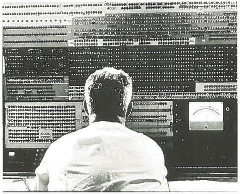
To form circuits, transistors were combined with capacitors, resistors and other electrical elements on circuit cards. On the reverse side, electrical paths were printed — to improve reliability and speed manufacturing. The circuit cards were then plugged into 'gates' and the cards interconnected by wires to form the logic and control elements of processors.

Through simulation techniques in the early 1960s, NASA's Saturn moon flight rocket was 'flown' thousands of times within the IBM 7090 computer before real flight. The fully transistorized 7090 could perform 229,000 calculations a second.

The Target

An IBM engineer's view of the company's computer development of the late 1950s:
The key wasn't only the transistor card, it was the whole circuit packaging system — the back panel, the gate, the industrial design, the memories, the power supplies. Everything had to be standardized to assure high, *predictable* reliability, at reasonable cost, machine after machine after machine."

The SABRE reservation system for airline passengers was the first large, high-speed commercial computer/communications network that operated in 'real time' — handling transactions at the time they occurred. It was developed by IBM for American Airlines over six years of joint research and became operational in 1962.



This is the maintenance console of IBM's Stretch, the industry's most powerful computer when first delivered in 1961. Stretch had 150,000 transistors and could perform 100 billion computations a day. Stretch pioneered in various advanced systems concepts, known in industry terminology as look-ahead, overlapping/pipelining of instructions, error-checking and correction, control-program operating systems and the eight-bit byte.

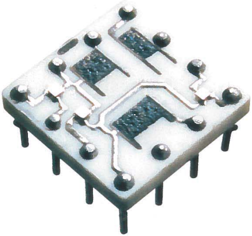
Solid Logic Technology

For System/360 — First Big 'Family' of Computers

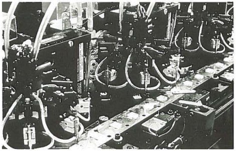
1964-1971

In 1964, IBM System/360 was introduced. Incorporating new Solid Logic Technology, System/360 replaced IBM's existing computer product lines. It was the first 'family' of computers — ranging from small to large — that were both upward and downward compatible, using the same programming instructions. In most cases, the input/output, storage and other equipment could be used interchangeably with any of the central processors.

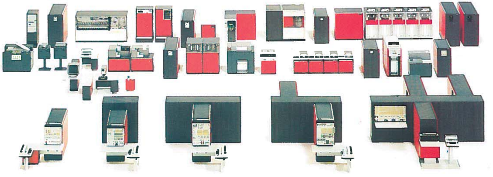
During the 1960s, computer storage grew in capacity and speed. Programming took on greater importance. Major focus was on software systems designed to make the most efficient and productive use of the computer.



The Solid Logic Technology (SLT), introduced by IBM in System/360, was the industry's first high-volume, automatic, microminiature production of semiconductor circuits. Mounted on half-inch-square ceramic modules (left), the SLT circuits were denser, faster and required less power than the previous generation of transistor technology.



SLT was fast and reliable, and because of IBM's automation of basic tools it could be mass-produced on the scale demanded by System/360. Statistically, the average time before failure of an SLT module was more than 33 million hours.

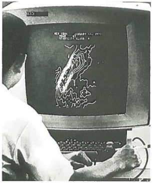


In the foreground of this scale model are the central processors of the first five computers announced as part of the IBM System/360 in 1964. To the rear are many of the input/output and storage attachments available at announcement time. Those units could be connected interchangeably with the different processors. Instructions written for one of the System/360 computers would work with any of the others.

1970 IBM in Switzerland changes name to IBM Switzerland
1970 IBM Sweden opens new plant in Jarfalla
1970 IBM Germany's fourth plant, in Hannover, opens

1970

1971 First woman in IBM Netherlands as QCC member
1971 IBM UK announces Hursley-developed and Havant-manufactured System/370 Model 135
1972 IBM Spain inaugurates Scientific center, Madrid
1972 IBM Israel establishes Scientific Center, Haifa
1972 IBM Germany opens new HQ in Stuttgart
1973 IBM Greece donates two 1401 Systems to University of Athens and Salonica
1973 IBM Selectric appears at world typewriting championship in Valencia, Spain
1973 Amsterdam plant instals first waste purifier in the Netherlands
1973 Data Center Services of IBM in Ankara starts operations
1973 IBM Switzerland opens new HQ in Zurich
1974 International Education Centre at La Hulpe, near Brussels, Belgium, is dedicated
1974 IBM Ireland donates a Blood Cell Separator to Our Lady's Hospital at Crumlin
1975 IBM Italy moves to new HQ at Segrate, near Milan
1976 IBM UK moves to new HQ at North Harbour, Portsmouth
1976 IBM Italy welcomes its 9,000th employee
1976 IBM Greece has 227 employees
1977 IBM Spain opens new plant in Valenc
1977 IBM Spain welcomes 3,000 employee
1977 Amsterdam holds 25th
19



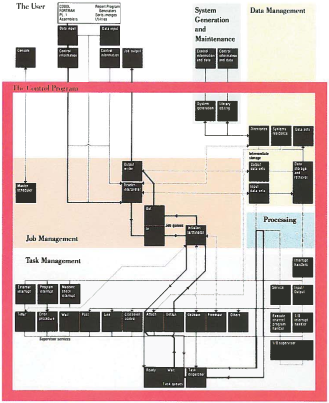
The IBM 2250, which was introduced with System/360 in 1964, was a machine displaying information in the form of charts, graphs and dynamic computer drawings. Primarily a design tool, the 2250 enabled designers to perfect their work on the screen through use of the keyboard and light pen. Among many applications, the 2250 produced maps of air pollution over big cities, as part of studies of smog control.

Hundreds of IBM programmers wrote more than three million instructions to produce Operating System/360.

Determining where hundreds of thousands of electrical connections must be made was one way existing IBM computers were used to automate the design and manufacture of System/360. Dozens of other new manufacturing techniques and machines were also developed.

Circuit card from the industry's first sizable, high-speed 'cache', or buffer, memory, introduced in the IBM System/360 Model 85 computer in 1968. The cache memory could make priority information available for processing in 80 billionths of a second — about 12 times faster than the main magnetic core memory.

Operating System/360



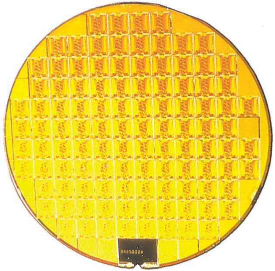
Operating System/360 was a set of programs that permitted the computer to process a continuous flow of different jobs without interruption. It automatically controlled the computing units, language translators, storage units, job control programs and data flow to provide greater 'throughput' — or productive work — for users of System/360.

Integrated Circuits

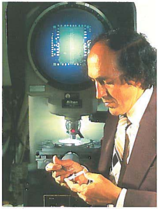
More Problem-Solving for Less

1970s

Full-scale use of monolithic, integrated circuit technology was introduced in the early 1970s. That technology compresses many circuits on to single, tiny silicon chips. The first computer with an entire main memory of monolithic technology was the IBM System/370 Model 145, delivered in 1971. Very dense, large-scale integration of both memory and logic technology brought major gains in speed, capacity and reliability. Also introduced in the 1970s were storage concepts and devices that greatly increased the amount of data that could be stored, as well as the ease of handling it. Users with complex applications could now work with millions or billions of characters of information. Programming was tailored ever closer to the needs of the user in health care, manufacturing, government, education and many other areas.

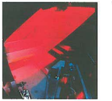


This 3 1/4-inch production wafer contains 109 silicon memory chips, each able to store 64,000 bits of information. In 1978, IBM was the first to mass-produce 64,000-bit chips for use in production line computers.

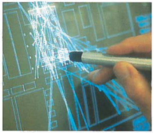


IBM's 1967 invention of the dynamic memory cell — using only one transistor per bit of information — permitted major increases in computer memory density. This technology was later adopted throughout the industry.

The industry's first flexible magnetic disk, or diskette, was introduced by IBM in 1971. Such 'floppy disks' greatly increased the convenience of data handling. They are now widely used as a basic storage medium for small systems.



The IBM 3800 laser-electrophotographic printer has a speed of 20,000 lines a minute in preparing bank statements, premium notices and other high-volume documents. Laser beam paths are altered millions of times a second and are reflected from an 18-sided mirror that spins at 12,000 revolutions per minute.



Through computer simulation of complex functions, an IBM engineering design system using graphic displays has speeded the circuit development of more than 100 IBM computer products.

, IBM Netherlands,
versary

BM Germany's Sindelfingen plant
celebrates 50th anniversary. Close by, at
Boeblingen, a new plant opens

1978 IBM South Africa announces first SA
typewriter keyboard

1978 IBM Israel moves to new HQ in Tel
Aviv

1978 IBM Belgium moves to new HQ in
Brussels

1978 IBM Switzerland has 2,415 employees

1978 IBM Sweden is 50 years old; new HQ
in Stockholm is inaugurated; 3,800
employees

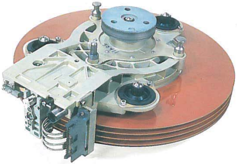
1979 IBM South Africa supports with 2.3
million Rands a video education project

1979 IBM Italy opens Program Product
Development Center and Scientific Center in
Rome

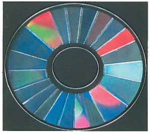
1980 IBM in Germany is 70 years old;
26,362 employees, 7,380 million DM revenue
(about one tenth of corporate revenue)

1980 IBM establishes
Scientific Center in
Kuwait

Built into IBM System/370 Model 145, delivered 1971, was the first computer main memory made entirely of monolithic, integrated circuit technology. The Model 145 initially offered up to 131 of the circuit cards shown in the open gate. That many cards held more than 262,000 characters of information, any of which could be retrieved in 200 billionths of a second.

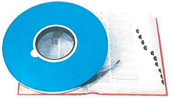


In 1973, the IBM 3340 disk unit introduced to the industry an advanced disk technology known as 'Winchester', after IBM's internal project name. The 3340 featured a smaller, lighter read/write head and a ski-like head design that enabled the head to ride closer to the disk surface — on an air film 18 millionths of an inch thick. The 3340 doubled the information density of IBM disks — to nearly 1.7 million bits per square inch.



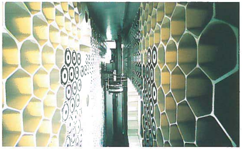
Above: The merchandise scanner in IBM's supermarket checkout station incorporates a spinning disk of 24 holographic films that function as glass prisms and lenses. A laser beam passing through the disk creates a complex light pattern that strikes the Universal Product Code stripes on merchandise held over the scanner. Light reflected from the stripes is converted by the scanner into electrical signals for computer processing.

Below: A high level of security in protecting computer data transmitted over communication lines is provided by an IBM-invented cryptographic algorithm for making a stream of characters unintelligible. Incorporated into the IBM 3845 encryption unit, the algorithm can accept more than 70 quadrillion possible keys, making unauthorized discovery extremely difficult. It has been adopted as a national standard by the US Government and the American National Standards Institute.



Above: The IBM System/370 of the early 1970s could read or write on magnetic tape at rates as fast as 1,250,000 characters a second. The contents of a 1,500-page dictionary could be read from the tape reel in about 13 seconds. The rate resulted from high reel speed and high data density on the tape.

By the early 1970s, more than six million computer instructions had been written by IBM programmers to help users of larger IBM computers operate their systems more economically and productively. Users of early computers in the 1950s had to write most such instructions themselves.



The 'honeycomb' cell structure of the IBM 3850 mass storage system, introduced in 1976, stores small cartridges containing reels of magnetic tape. Each reel can store 50 million characters of information. Up to 472 billion characters can be economically filed in one 3850 system for on-line computer use.

1980

1981 Greenock plant, IBM UK, receives
Scottish award for 30 years of industrial
achievement

1981 IBM Italy opens new plant in Santa
Palomba, near Rome

1982 Hursley, IBM UK, develops the 3278
'talking terminal' for blind operators

1982 IBM Norway has 1,028 employees

1983 IBM opens Scientific Center in Cairo,
Egypt

1983 IBM Portugal has 600 employees

1983 IBM Turkey has 180 employees

1983 EHQ moves to Tour Pascal

1983 European Traveling Technology
Exhibit is announced

1983 IBM has 105,443
countries; 15 m
9 research
9

Very High Densities

More Speed, Function, Capacity, Reliability

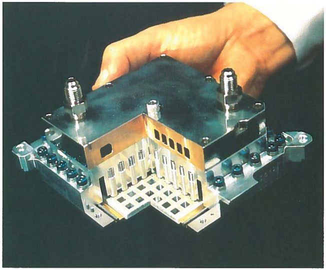
1980s

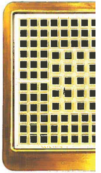
The industry's rapid rate of technological change is likely to continue in the 1980s, raising productivity for the computer user.

Silicon memory and logic circuits are being further miniaturized for better cost-performance over the full range of computers — from large systems to the smallest microprocessors in remote terminals.

Greater recording density in magnetic disks and tapes is increasing storage capacity and read/write speed. New communication, display and printing
are expanding the
usefulness.

Significant programm
ces are making the co
easier to use and more a
specific needs.

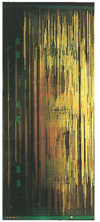




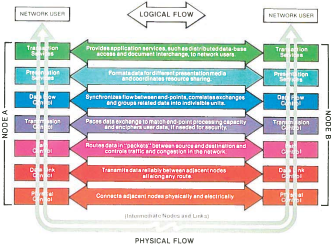
*Today, the information-pro
of electronic computers of t
held in one hand. The logic
in large IBM systems (cuta
part of the industry's dense
packaging. Up to 133 electr
mounted in each module (a
total of 45,000 logic circuit
other circuitry.*

Left: Magnified several hundred times, this copper coil is part of the 'thin film' recording head used in several IBM disk files. The IBM 3380 file uses the technology to read and write data at three million characters a second, the first commercial unit to achieve such a rate. (Light refraction from minutely separated film layers produces the iridescent color pattern).

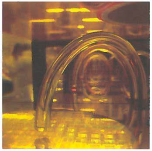
Right: This 24 x 28-inch copper plane is part of the densest computer circuit packaging yet reported. Used in large IBM computers, the plane is one of 20 layers in a printed circuit board that is one-fifth of an inch thick and contains nearly a mile of wire interconnections.



This is a representation of the overall design of IBM Systems Network Architecture (SNA) — an organized structure for operating many kinds of computer/communications networks. Since the mid-1970s, IBM programmers have spent a total of several thousand years in developing software to free users from the complexities of communicating through local, national or international computer networks.


NETWORK USER
LOGICAL FLOW
NETWORK USER
NODE A
NODE B
Transaction Services
Provides application services, such as distributed data-base access and document interchange, to network users.
Presentation Services
Formats data for different presentation media and coordinates resource sharing.
Data Flow Control
Synchronizes flow between end-points, correlates exchanges and groups related data into indivisible units.
Transmission Control
Paces data exchange to match end-point processing capacity and enciphers user data, if needed for security.
Path Control
Routes data in "packets" between source and destination and controls traffic and congestion in the network.
Data Link Control
Transmits data reliably between adjacent nodes all along any route.
Physical Control
Connects adjacent nodes physically and electrically.
(Intermediate Nodes and Links)
PHYSICAL FLOW

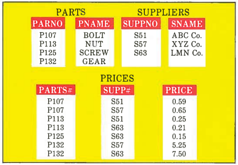
This IBM computer memory chip, just three-eighths of an inch thick, can store 288,000 bits of data — the highest information capacity fabricated on a circuit production line through 1983. (The chip's three-dimensional features are made visible by different color light rays, directed at low angles over its surface.)



IBM-designed production process for computer circuits moves silicon wafers automatically under computer control. Circular, flat 3 1/4-inch wafers of high-density chips (foreground) are moved by air jets from below when detected by glass optical sensor loops.

Today's large-scale computers, such as the IBM 3081 and the 3083 and 3084 systems, have the densest logic circuit packaging yet developed. Extended Architecture and other IBM control programs permit users to attach several thousand terminals, printers, and disk and tape units — arranged in different ways to meet specific needs. The IBM 3084, the industry's most advanced general-purpose system through 1983, links four powerful computers in parallel processing.

IBM programmers have written more than 20 million computer instructions in direct support of major NASA space flights and US defense space programs. The IBM Federal Systems Division has helped provide equipment and software for all US manned missions, including the Mercury, Gemini, Apollo, Skylab and Space Shuttle flights.



PARTS

PARNO	PNAME
P107	BOLT
P113	NUT
P125	SCREW
P132	GEAR

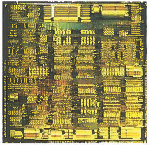
SUPPLIERS

SUPPNO	SNAME
S51	ABC Co.
S57	XYZ Co.
S63	LMN Co.

PRICES

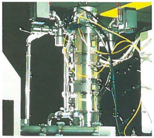
PARTS#	SUPP#	PRICE
P107	S51	0.59
P107	S57	0.65
P113	S51	0.25
P113	S63	0.21
P125	S63	0.15
P132	S57	5.25
P132	S63	7.50

The relational data base concept of filing, modifying and retrieving computer information was originated by IBM and has been implemented and tested by IBM researchers since 1970. Information in the computer is arranged in easy-to-interpret tables. The method minimizes the need for computer experience, since users can merely specify what they wish to do, without having to instruct the computer on how to do it.

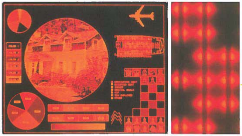


The densest high-speed computer logic chip reported in the industry through 1983 is incorporated into the IBM 8150 system processor. The quarter-inch square chip developed by IBM contains up to 4,400 bipolar logic circuits.

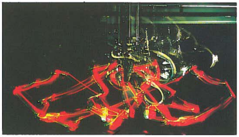
More than 50 computer-controlled systems designed by IBM are quality-testing thousands of different circuit parts on IBM production lines. In less than a minute, this device can test a silicon wafer that has more than 100 complex logic or memory chips containing thousands of transistors.



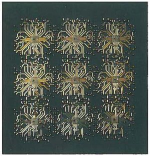
An IBM-designed, electron-beam machine can interconnect circuits on as many as 2,000 high-density computer chips per hour. This is the fastest plant production rate for the lithographic electron-beam process. A beam narrower than 1/10,000 of an inch traces intricate circuit patterns under computer control.



A gas-panel display screen technology introduced by IBM in 1983 produces flicker-free images from a grid of wires with three-quarters of a million intersections. Ionized neon-argon gas glows at selected intersection points to create high-resolution characters and illustrations. Techniques developed by IBM for very precise fabrication of the wire grid produce the high image quality.

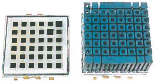


The IBM 7565, a high-precision, programmable robotic system, uses the most advanced commercially available robotic control language. The IBM-developed system has general-purpose applications in light manufacturing and assembly operations that place a premium on speed and accuracy.



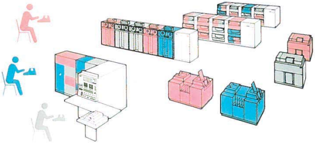
Wiring pattern of one of 23 ceramic layers in the two-inch-square logic module used in the IBM 4341 processor. Cost and space savings result from packaging 33 feet of wiring and more than 6,300 logic circuits into each small module.

Below: High-density circuit chips in the medium-scale IBM 4381 computer are mounted on 2 1/2-inch-square ceramic substrates and cooled with a heat sink that directs room-temperature air on to the center of each chip. Up to 22 such modules, each with as many as 36 logic and memory chips, are plugged into a single board to form the 4381's central processor.

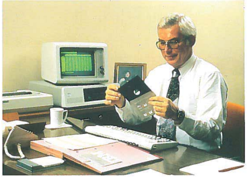


Highly magnified area of magnetic disk surface in the IBM 3380 shows elongated information bits recorded along five of the disk's 1,774 concentric tracks. One square inch of disk surface contains about 12 million bits.

Right: Virtual Machine architecture (VM) is a programming and systems design approach that enables multiple users at terminals to share a computer in a highly flexible manner — virtually as though each were using a separate version of the computer. Developed by IBM and others in the 1960s, Virtual Machine was made available on System/370 in 1972 and is now used in advanced forms on large IBM systems. A control program automatically shares the computer's processing time in split seconds among all users. The program also allocates the user's work among existing devices, reducing the need for equipment.



The Personal Computer



Personal computers with the processing power of medium-scale computers of the 1960s are winning wide acceptance in the home, in schools, and in science and industry. The low-cost systems of many producers are incorporating advanced technologies developed over the industry's decades of innovation. The effect on most areas of computing is profound. In addition to delivering millions of machines each year for personal and commercial applications, the industry is developing networks of personal computers that promise further large gains in problem-solving and productivity. Such 'intelligent' workstations can be operated as stand-alone computers, and users will also be able to communicate with many other linked workstations, as well as having access to large processors and data bases throughout the networks.

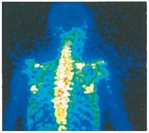
Benefits from Technology

Year by year, the demand for new computer technology continues to expand. Why? The answer lies in the world's need for greater productivity. Businesses wish to provide more complete and responsive services. Manufacturers seek lower costs, while improving quality and maintaining schedules. Hospitals strive for more efficient health care. Governments at every level search for ways to serve many needs, while staying within limited budgets. Farmers seek healthier crops and livestock, while making the best use of feeds and equipment. Individuals look for ways to manage personal finances better, improve family education and make home equipment more efficient.

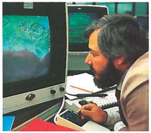
For these and many other requirements, computers can be an important part of the answer. They are broadly adaptable to each user's needs. They are available in low-cost models easy to set up and use... office systems with many features that simplify and speed paperwork... powerful computers for complex tasks... communications systems that let widely separated units of an organization function smoothly as parts of the whole. And the cost keeps going down.

As a result, computers are appearing everywhere — in the warehouse, at the sales counter, in the classroom, at the secretary's desk, in the fire station, the home, the bank and the town hall. And no limit is in sight to the ways computers can be used to help more people — wherever they live around the world.

More productive farm management



Aid in diagnosing illness



Studies of earth and sea resources

How new technology has lowered the cost of information processing

This chart shows the time and cost for large IBM computers to complete a fixed amount of data processing. The figures in each column are based on an identical mix of 1,700 typical data processing operations, involving millions of computer instructions. Included is a cross section of payroll, discount computation, file maintenance, table lookup and report preparations. Figures show costs of the period, not adjusted for inflation.

	1955	**1960**	**1965**	**1975**	**1983**
Cost	**$14.54**	**$2.48**	**47c**	**20c**	**7c**
Processing time	**375 sec.**	**47 sec.**	**29 sec.**	**4 sec.**	**1 sec.**
Technology	Vacuum tubes Magnetic cores Magnetic tape Magnetic drum	Transistors Channels Faster cores Faster tape	Solid Logic Technology Large, fast disk files New channels Larger, faster core memory Faster tape	Monolithic memory Monolithic logic Virtual Storage Virtual Machine Larger, faster disk files New channels Advanced tape	High-capacity memory chips Very dense logic packaging Extended Architecture Thin film head disk technology Magnetic cartridge mass storage
Programming	Stored program	Overlapped input/output Batch processing	Operating system Faster batch processing	Advanced operating systems Virtual Storage Virtual Machine Multiprogramming Batch, plus on-line processing	Full-function, advanced operating systems Multiprocessing Advanced networking products Extended Architecture Comprehensive data base facilities Interactive, user oriented functions