A Short History of the Computer

by

Jeremy Meyers

Note: Yes, a lot of this is from Groliers Encyclopaedia. Hey, I was young. I didn't know any better. Credit where credit is due. Also, this information is only current as of the early 1990's (1993, to be exact), and no I'm not planning to add more information anytime soon.

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In The Beginning...

The history of computers starts out about 2000 years ago, at the birth of the abacus, a wooden rack holding two horizontal wires with beads strung on them. When these beads are moved around, according to **programming** rules memorized by the user, all regular arithmetic problems can be done. Another important invention around the same time was the Astrolabe, used for navigation.

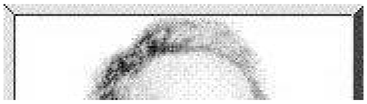
Blaise Pascal is usually credited for building the first **digital** computer in 1642. It added numbers entered with dials and was made to help his father, a tax collector. In 1671, Gottfried Wilhelm von Leibniz invented a computer that was built in 1694. It could add, and, after changing some things around, multiply. Leibniz invented a special **stepped gear mechanism** for introducing the addend digits, and this is still being used.

The prototypes made by Pascal and Leibniz were not used in many places, and considered weird until a little more than a century later, when Thomas of Colmar (A.K.A. Charles Xavier Thomas) created the first successful mechanical calculator that could add, subtract, multiply, and divide. A lot of improved desktop calculators by many inventors followed, so that by about 1890, the range of improvements included:

- Accumulation of partial results
- Storage and automatic reentry of past results (A memory function)
- Printing of the results

Each of these required manual installation. These improvements were mainly made for commercial users, and not for the needs of science.

Babbage



While Thomas of Colmar was developing the desktop calculator, a series of very interesting developments in computers was started in Cambridge, England, by

Charles Babbage (*left*, of which the computer store "Babbages" is named), a mathematics professor. In 1812, Babbage realized that many long calculations, especially those needed to make mathematical tables, were really a series of predictable actions that were constantly repeated. From this he suspected that it should be possible to do these automatically.

He began to design an automatic mechanical calculating machine, which he called a **difference engine**. By 1822, he had a working model to demonstrate with. With financial help from the British government, Babbage started fabrication of a difference engine in 1823. It was intended to be steam powered and fully automatic, including the printing of the resulting tables, and commanded by a fixed instruction program.

The difference engine, although having limited adaptability and applicability, was really a great advance. Babbage continued to work on it for the next 10 years, but in 1833 he lost interest because he thought he had a **better idea** -- the construction of what would now be called a general purpose, fully program-controlled, automatic mechanical digital computer. Babbage called this idea an **Analytical Engine**. The ideas of this design showed a lot of foresight, although this couldn't be appreciated until a full century later.

The plans for this engine required an identical decimal computer operating on numbers of 50 decimal digits (or words) and having a storage capacity (memory) of 1,000 such digits. The built-in operations were supposed to include everything that a modern general - purpose computer would need, even the all important **Conditional Control Transfer Capability** that would allow commands to be executed in any order, not just the order in which they were programmed.

The analytical engine was soon to use **punched cards** (similar to those used in a Jacquard loom), which would be read into the machine from several different **Reading Stations**. The machine was supposed to operate automatically, by steam power, and require only one person there.

Babbage's computers were never finished. Various reasons are used for his failure. Most used is the lack of precision machining techniques at the time. Another speculation is that Babbage was working on a solution of a problem that few people in 1840 really needed to solve. After Babbage, there was a temporary loss of interest in automatic digital computers.

Between 1850 and 1900 great advances were made in mathematical physics, and it came to be known that *most observable dynamic phenomena can be identified by differential equations* (which meant that most events occurring in nature can be measured or described in one equation or another), so that easy means for their calculation would be helpful.

Moreover, from a practical view, the availability of steam power caused manufacturing (boilers), transportation (steam engines and boats), and commerce to prosper and led to a period of a lot of engineering achievements. The designing of railroads, and the making of steamships, textile mills, and bridges required **differential calculus** to determine such things as:

- center of gravity
- center of buoyancy
- moment of inertia
- stress distributions

Even the assessment of the power output of a steam engine needed mathematical integration. A strong need thus developed for a machine that could rapidly perform many repetitive calculations.

Use of Punched Cards by Hollerith

A step towards automated computing was the development of punched cards, which were first successfully used with computers in 1890 by Herman Hollerith (*left*) and James Powers, who worked for the US. Census Bureau. They developed devices that could read the information that had been punched into the cards automatically, without human help. Because of this, reading errors were reduced dramatically, work flow increased, and, most importantly, stacks of punched cards could be used as easily accessible memory of almost unlimited size. Furthermore, different problems could be stored on different stacks of cards and accessed when needed.

These advantages were seen by commercial companies and soon led to the development of improved punch-card using computers created by International Business Machines (IBM), Remington (yes, the same people that make shavers), Burroughs, and other corporations. These computers used electromechanical devices in which electrical power provided mechanical motion -- like turning the wheels of an adding machine. Such systems included features to:

- feed in a specified number of cards automatically
- add, multiply, and sort
- feed out cards with punched results

As compared to today's machines, these computers were slow, usually processing 50 - 220 cards per minute, each card holding about 80 decimal numbers (characters). At the time, however, punched cards were a huge step forward. They provided a means of I/O, and memory storage on a huge scale. For more than 50 years after their first use, punched card machines did most of the world's first business computing, and a considerable amount of the computing work in science.

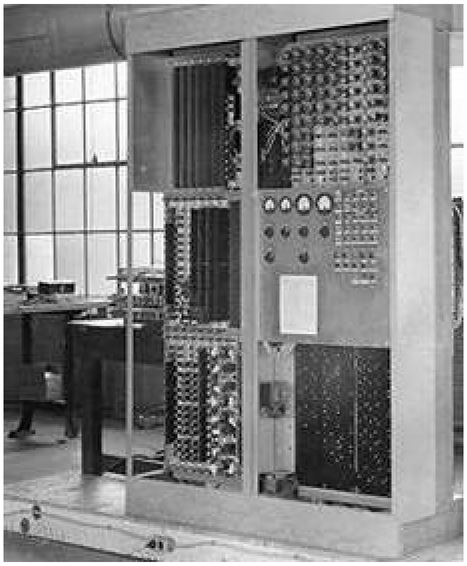
Electronic Digital Computers

The start of World War II produced a large need for computer capacity, especially for the military. New weapons were made for which **trajectory tables** and other essential data were needed. In 1942, John P. Eckert, John W. Mauchly (left), and their associates at the Moore school of Electrical Engineering of University of Pennsylvania decided to build a high - speed electronic computer to do the job. This machine became known as ENIAC (Electrical Numerical Integrator And Calculator)

The size of ENIAC's numerical "word" was 10 decimal digits, and it could multiply two of these numbers at a rate of 300 per second, by finding the value of each product from a multiplication table stored in its memory. ENIAC was therefore about 1,000 times faster then the previous generation of relay computers.

ENIAC used 18,000 vacuum tubes, about 1,800 square feet of floor space, and consumed about 180,000 watts of electrical power. It had punched card I/O, 1 multiplier, 1 divider/square rooter, and 20 adders using decimal ring **counters**, which served as adders and also as quick-access (.0002 seconds) read-write register storage. The executable instructions making up a program were embodied in the separate "units" of ENIAC, which were plugged together to form a "route" for the flow of information.

These connections had to be redone after each computation, together with presetting function tables and switches. This "wire your own" technique was inconvenient (for obvious reasons), and with only some latitude could ENIAC be considered programmable. It was, however, efficient in handling the particular programs for which it had been designed.



ENIAC is commonly accepted as the first successful high - speed electronic digital computer (EDC) and was used from 1946 to 1955. A controversy developed in 1971, however, over the patentability of ENIAC's basic digital concepts, the claim being made that another physicist, John V. Atanasoff (*left*) had already used basically the same ideas in a simpler vacuum - tube device he had built in the 1930's while at Iowa State College. In 1973 the courts found in favor of the company using the Atanasoff claim.

The Modern Stored Program EDC

Fascinated by the success of ENIAC, the mathematician John Von Neumann (*left*) undertook, in 1945, an abstract study of computation that showed that a computer should have a **very simple, fixed physical structure**, and yet be able to execute any kind of computation by means of a **proper programmed control** without the need for any change in the unit itself.

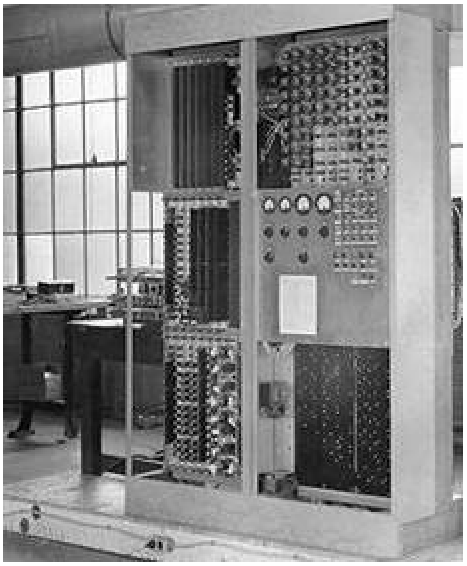
Von Neumann contributed a new awareness of how practical, yet fast computers should be organized and built. These ideas, usually referred to as the stored - program technique, became essential for future generations of high - speed digital computers and were universally adopted.

The Stored - Program technique involves many features of computer design and function besides the one that it is named after. In combination, these features make very - high - speed operation attainable. A glimpse may be provided by considering what 1,000 operations per second means. If each instruction in a job program were used once in consecutive order, no human programmer could generate enough instruction to keep the computer busy.

Arrangements must be made, therefore, for parts of the job program (called subroutines) to be used repeatedly in a manner that depends on the way the computation goes. Also, it would clearly be helpful if instructions could be changed if needed during a computation to make them behave differently. Von Neumann met these two needs by making a special type of machine instruction, called a **Conditional control transfer** - which allowed the program sequence to be stopped and started again at any point - and by storing all instruction programs together with data in the same memory unit, so that, when needed, instructions could be arithmetically changed in the same way as data.

As a result of these techniques, computing and programming became much faster, more flexible, and more efficient with work. Regularly used subroutines did not have to be reprogrammed for each new program, but could be kept in "libraries" and read into memory only when needed. Thus, much of a given program could be assembled from the subroutine library.

The all - purpose computer memory became the assembly place in which all parts of a long computation were kept, worked on piece by piece, and put together to form the final results. The computer control survived only as an "errand runner" for the overall process. As soon as the advantage of these techniques became clear, they became a standard practice.



The first generation of modern programmed electronic computers to take advantage of these improvements were built in 1947. This group included computers using Random - Access - Memory (RAM), which is a memory designed to give almost constant access to any particular piece of information. . These machines had punched - card or punched tape I/O devices and RAM’s of 1,000 - word capacity and access times of .5 Greek MU seconds (.5*10-6 seconds). Some of them could perform multiplications in 2 to 4 MU seconds. Physically, they were much smaller than ENIAC. Some were about the size of a grand piano and used **only 2,500** electron tubes, a lot less then required by the earlier ENIAC. The first - generation stored - program computers needed a lot of maintenance, reached probably about 70 to 80% reliability of operation (ROO) and were used for 8 to 12 years. They were usually programmed in ML, although by the mid 1950’s progress had been made in several aspects of advanced programming. This group of computers included EDVAC (above) and UNIVAC (below) the first commercially available computers.

computers.

Advances in the 1950's

Early in the 50's two important engineering discoveries changed the image of the electronic - computer field, from one of fast but unreliable hardware to an image of relatively high reliability and even more capability. These discoveries were the magnetic core memory and the **Transistor - Circuit Element**. These technical discoveries quickly found their way into new models of digital computers. RAM capacities increased from 8,000 to 64,000 words in commercially available machines by the 1960's, with access times of 2 to 3 MS (Milliseconds). These machines were very expensive to purchase or even to rent and were particularly expensive to operate because of the cost of expanding programming. Such computers were mostly found in large computer centers operated by industry, government, and private laboratories - staffed with many programmers and support personnel. This situation led to modes of operation enabling the sharing of the high potential available.

One such mode is batch processing, in which problems are prepared and then held ready for computation on a relatively cheap storage medium. Magnetic drums, magnetic - disk packs, or magnetic tapes were usually used. When the computer finishes with a problem, it "dumps" the whole problem (program and results) on one of these peripheral storage units and starts on a new problem.

Another mode for fast, powerful machines is called time-sharing. In time-sharing, the computer processes many jobs in such rapid succession that each job runs as if the other jobs did not exist, thus keeping each "customer" satisfied. Such operating modes need elaborate **executable** programs to attend to the administration of the various tasks.

Advances in the 1960's

In the 1960's, efforts to design and develop the fastest possible computer with the greatest capacity reached a turning point with the LARC machine, built for the Livermore Radiation Laboratories of the University of California by the Sperry - Rand Corporation, and the Stretch computer by IBM. The LARC had a base memory of 98,000 words and multiplied in 10 Greek MU seconds. Stretch was made with several degrees of memory having slower access for the ranks of greater capacity, the fastest access time being less then 1 Greek MU Second and the total capacity in the vicinity of 100,000,000 words.

During this period, the major computer manufacturers began to offer a range of capabilities and prices, as well as accessories such as:

- Consoles
- Card Feeders
- Page Printers
- Cathode - ray - tube displays
- Graphing devices

These were widely used in businesses for such things as:

- Accounting
- Payroll
- Inventory control
- Ordering Supplies
- Billing

CPU’s for these uses did not have to be very fast arithmetically and were usually used to access large amounts of records on file, keeping these up to date. By far, the most number of computer systems were sold for the more simple uses, such as hospitals (keeping track of patient records, medications, and treatments given). They were also used in libraries, such as the National Medical Library retrieval system, and in the Chemical Abstracts System, where computer records on file now cover nearly all known chemical compounds.

More Recent Advances

The trend during the 1970's was, to some extent, moving away from very powerful, single - purpose computers and toward a larger range of applications for cheaper computer systems. Most **continuous-process manufacturing**, such as petroleum refining and electrical-power distribution systems, now used computers of smaller capability for controlling and regulating their jobs.

In the 1960’s, the problems in programming applications were an obstacle to the independence of medium sized on-site computers, but gains in applications programming language technologies removed these obstacles. Applications languages were now available for controlling a great range of manufacturing processes, for using machine tools with computers, and for many other things. Moreover, a new revolution in computer hardware was under way, involving shrinking of computer-logic circuitry and of components by what are called **large-scale integration** (LSI) techniques. In the 1950s it was realized that "scaling down" the size of electronic digital computer circuits and parts would increase speed and efficiency and by that, improve performance, if they could only find a way to do this. About 1960 **photo printing** of conductive circuit boards to eliminate wiring became more developed. Then it became possible to build resistors and capacitors into the circuitry by the same process. In the 1970’s, **vacuum deposition of transistors** became the norm, and entire assemblies, with adders, shifting registers, and counters, became available on tiny "chips."

In the 1980's, **very large scale integration** (VLSI), in which hundreds of thousands of transistors were placed on a single chip, became more and more common. Many companies, some new to the computer field, introduced in the 1970s programmable **minicomputers** supplied with software packages. The "shrinking" trend continued with the introduction of personal computers (PC's), which are programmable machines small enough and inexpensive enough to be purchased and used by individuals.

Many companies, such as Apple Computer and Radio Shack, introduced very successful PC's in the 1970s, encouraged in part by a fad in computer (video) games. In the 1980s some friction occurred in the crowded PC field, with Apple and IBM keeping strong. In the manufacturing of semiconductor chips, the Intel and Motorola Corporations were very competitive into the 1980s, although Japanese firms were making strong economic advances, especially in the area of memory chips. By the late 1980s, some personal computers were run by microprocessors that, handling 32 bits of data at a time, could process about 4,000,000 instructions per second.

Microprocessors equipped with read-only memory (ROM), which stores constantly used, unchanging programs, now performed an increased number of process-control, testing, monitoring, and diagnosing functions, like automobile ignition systems, automobile-engine diagnosis, and production-line inspection duties.

Cray Research and Control Data Inc. dominated the field of supercomputers, or the most powerful computer systems, through the 1970s and 1980s. In the early 1980s, however, the Japanese government announced a gigantic plan to design and build a new generation of supercomputers. This new generation, the so-called "fifth" generation, is using new technologies in very large integration, along with new programming languages, and will be capable of amazing feats in the area of artificial intelligence, such as voice recognition.

Progress in the area of software has not matched the great advances in hardware. Software has become the major cost of many systems because programming productivity has not increased very quickly. New programming techniques, such as object-oriented programming, have been developed to help relieve this problem. Despite difficulties with software, however, the **cost per calculation** of computers is rapidly lessening, and their convenience and efficiency are expected to increase in the early future.

The computer field continues to experience huge growth. Computer networking, computer mail, and electronic publishing are just a few of the applications that have grown in recent years. Advances in technologies continue to produce cheaper and more powerful computers offering the promise that in the near future, computers or terminals will reside in most, if not all homes, offices, and schools.

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