

History of computing hardware assignment



History of computing hardware The history of computing hardware is the record of the constant drive to make computer hardware faster, cheaper, and store more data. Before the development of the general-purpose computer, most calculations were done by humans. Tools to help humans calculate were then called “calculating machines”, by proprietary names, or even as they are now, calculators.

It was those humans who used the machines who were then called computers; there are pictures of enormous rooms filled with desks at which computers (often young women) used their machines to jointly perform calculations, as for instance, aerodynamic ones required for in aircraft design. Calculators have continued to develop, but computers add the critical element of conditional response and larger memory, allowing automation of both numerical calculation and in general, automation of many symbol-manipulation tasks.

Computer technology has undergone profound changes every decade since the 1940s. Computing hardware has become a platform for uses other than mere computation, such as process automation, electronic communications, equipment control, entertainment, education, etc. Each field in turn has imposed its own requirements on the hardware, which has evolved in response to those requirements, such as the role of the touch screen to create a more intuitive and natural user interface .

Aside from written numerals, the first aids to computation were purely mechanical devices which required the operator to set up the initial values of an elementary arithmetic operation, then manipulate the device through

manual manipulations to obtain the result. A sophisticated (and comparatively recent) example is the slide rule in which numbers are represented as lengths on a logarithmic scale and computation is performed by setting a cursor and aligning sliding scales, thus adding those lengths.

Numbers could be represented in a continuous “ analog” form, for instance a voltage or some other physical property was set to be proportional to the number. Analog computers, like those designed and built by Vannevar Bush before WWII were of this type. Or, numbers could be represented in the form of digits, automatically manipulated by a mechanical mechanism. Although this last approach required more complex mechanisms in many cases, it made for greater precision of results. Both analog and digital mechanical techniques continued to be developed, producing many practical computing machines.

Electrical methods rapidly improved the speed and precision of calculating machines, at first by providing motive power for mechanical calculating devices, and later directly as the medium for representation of numbers. Numbers could be represented by voltages or currents and manipulated by linear electronic amplifiers. Or, numbers could be represented as discrete binary or decimal digits, and electrically controlled switches and combinational circuits could perform mathematical operations. The invention of electronic amplifiers made calculating machines much faster than their mechanical or electromechanical predecessors. vacuum tube (thermionic valve) amplifiers gave way to solid state transistors, and then rapidly to integrated circuits which continue to improve, placing millions of electrical switches (typically transistors) on a single elaborately manufactured piece of

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semi-conductor the size of a fingernail. By defeating the tyranny of numbers, integrated circuits made high-speed and low-cost digital computers a widespread commodity. This article covers major developments in the history of computing hardware, and attempts to put them in context.

For a detailed timeline of events, see the computing timeline article. The history of computing article treats methods intended for pen and paper, with or without the aid of tables. Since all computers rely on digital storage, and tend to be limited by the size and speed of memory, the history of computer data storage is tied to the development of computers. * | Earliest true hardware Devices have been used to aid computation for thousands of years, mostly using one-to-one correspondence with our fingers. The earliest counting device was probably a form of tally stick.

Later record keeping aids throughout the Fertile Crescent included calculi (clay spheres, cones, etc.) which represented counts of items, probably livestock or grains, sealed in containers. [1][2] Counting rods is one example. The abacus was early used for arithmetic tasks. What we now call the Roman abacus was used in Babylonia as early as 2400 BC. Since then, many other forms of reckoning boards or tables have been invented. In a medieval European counting house, a checkered cloth would be placed on a table, and markers moved around on it according to certain rules, as an aid to calculating sums of money.

Several analog computers were constructed in ancient and medieval times to perform astronomical calculations. These include the Antikythera mechanism and the astrolabe from ancient Greece (c. 150–100 BC), which are generally

regarded as the earliest known mechanical analog computers. [3] Other early versions of mechanical devices used to perform one or another type of calculations include the planisphere and other mechanical computing devices invented by Abu Rayhan al-Biruni (c. AD 1000); the equatorium and universal latitude-independent astrolabe by Abu Ishaq Ibrahim al-Zarqali (c. AD 1015); the astronomical analog computers of other medieval Muslim astronomers and engineers; and the astronomical clock tower of Su Song (c. AD 1090) during the Song Dynasty. The “ castle clock”, an astronomical clock invented by Al-Jazari in 1206, is thought to be the earliest programmable analog computer. [4] It displayed the zodiac, the solar and lunar orbits, a crescent moon-shaped pointer traveling across a gateway causing automatic doors to open every hour,[5][6] and five robotic musicians who play music when struck by levers operated by a camshaft attached to a water wheel.

The length of day and night could be re-programmed every day in order to account for the changing lengths of day and night throughout the year. [4] Suanpan (the number represented on this abacus is 6, 302, 715, 408) Scottish mathematician and physicist John Napier noted multiplication and division of numbers could be performed by addition and subtraction, respectively, of logarithms of those numbers. While producing the first logarithmic tables Napier needed to perform many multiplications, and it was at this point that he designed Napier’s bones, an abacus-like device used for multiplication and division. 7] Since real numbers can be represented as distances or intervals on a line, the slide rule was invented in the 1620s to allow multiplication and division operations to be carried out significantly

faster than was previously possible. [8] Slide rules were used by generations of engineers and other mathematically involved professional workers, until the invention of the pocket calculator. [9] Yazu Arithmometer. Patented in Japan in 1903. Note the lever for turning the gears of the calculator. Wilhelm Schickard, a German polymath, designed a calculating clock in 1623, unfortunately a fire destroyed it during its construction in 1624 and Schickard abandoned the project. Two sketches of it were discovered in 1957; too late to have any impact on the development of mechanical calculators[10]. In 1642, while still a teenager, Blaise Pascal started some pioneering work on calculating machines and after three years of effort and 50 prototypes[11] he invented the mechanical calculator[12][13]. He built twenty of these machines (called the Pascaline) in the following ten years[14].

Gottfried Wilhelm von Leibniz invented the Stepped Reckoner and his famous cylinders around 1672 while adding direct multiplication and division to the Pascaline. Leibniz once said “ It is unworthy of excellent men to lose hours like slaves in the labour of calculation which could safely be relegated to anyone else if machines were used. “[15] Around 1820, Charles Xavier Thomas created the first successful, mass-produced mechanical calculator, the Thomas Arithmometer, that could add, subtract, multiply, and divide. [16] It was mainly based on Leibniz’ work. Mechanical calculators, like the base-ten addiator, the comptometer, the Monroe, the Curta and the Addo-X remained in use until the 1970s. Leibniz also described the binary numeral system,[17] a central ingredient of all modern computers. However, up to the 1940s, many subsequent designs (including Charles Babbage’s machines

of the 1822 and even ENIAC of 1945) were based on the decimal system;[18] ENIAC's ring counters emulated the operation of the digit wheels of a mechanical adding machine.

In Japan, Ryoichi Yazu patented a mechanical calculator called the Yazu Arithmometer in 1903. It consisted of a single cylinder and 22 gears, and employed the mixed base-2 and base-5 number system familiar to users to the soroban (Japanese abacus). Carry and end of calculation were determined automatically. [19] More than 200 units were sold, mainly to government agencies such as the Ministry of War and agricultural experiment stations. [20][21]. punched card technology In 1801, Joseph-Marie Jacquard developed a loom in which the pattern being woven was controlled by punched cards.

The series of cards could be changed without changing the mechanical design of the loom. This was a landmark achievement in programmability. In 1833, Charles Babbage moved on from developing his difference engine (for navigational calculations) to a general purpose design, the Analytical Engine, which drew directly on Jacquard's punched cards for its program storage. [22] In 1835, Babbage described his analytical engine. It was a general-purpose programmable computer, employing punch cards for input and a steam engine for power, using the positions of gears and shafts to represent numbers.

His initial idea was to use punch-cards to control a machine that could calculate and print logarithmic tables with huge precision (a special purpose machine). Babbage's idea soon developed into a general-purpose

programmable computer. While his design was sound and the plans were probably correct, or at least debuggable, the project was slowed by various problems included disputes with the chief machinist building parts for it. Babbage was a difficult man to work with and argued with anyone. All the parts for his machine had to be made by hand.

Small errors in each item might sometimes sum to cause large discrepancies. In a machine with thousands of parts, which required these parts to be much better than the usual tolerances needed at the time, this was a major problem. The project dissolved in disputes with the artisan who built parts and ended with the decision of the British Government to cease funding. Ada Lovelace, Lord Byron's daughter, translated and added notes to the "Sketch of the Analytical Engine" by Federico Luigi, Conte Menabrea. his appears to be the first published description of programming. [23] IBM 407 tabulating machine, (1961) Punched card with the extended alphabet Leslie Comrie's articles on punched card methods and W. J. Eckert's publication of Punched Card Methods in Scientific Computation in 1940, described punch card techniques sufficiently advanced to solve some differential equations or perform multiplication and division using floating point representations, all on punched cards and unit record machines.

Those same machines had been used during WWII for cryptographic statistical processing. In the image of the tabulator (see left), note the patch panel, which is visible on the right side of the tabulator. A row of toggle switches is above the patch panel. The Thomas J. Watson Astronomical Computing Bureau, Columbia University performed astronomical calculations

representing the state of the art in computing. [28] Computer programming in the punch card era was centered in the “ computer center”.

Computer users, for example science and engineering students at universities, would submit their programming assignments to their local computer center in the form of a stack of punched cards, one card per program line. They then had to wait for the program to be read in, queued for processing, compiled, and executed. In due course, a printout of any results, marked with the submitter’s identification, would be placed in an output tray, typically in the computer center lobby. In many cases these results would be only a series of error messages, requiring yet another edit-punch-compile-run cycle. 29] Punched cards are still used and manufactured to this day, and their distinctive dimensions (and 80-column capacity) can still be recognized in forms, records, and programs around the world. They are the size of American paper currency in Hollerith’s time, a choice he made because there was already equipment available to handle bills. Desktop calculators The Curta calculator can also do multiplication and division By the 20th century, earlier mechanical calculators, cash registers, accounting machines, and so on were redesigned to use electric motors, with gear position as the representation for the state of a variable.

The word “ computer” was a job title assigned to people who used these calculators to perform mathematical calculations. By the 1920s Lewis Fry Richardson’s interest in weather prediction led him to propose human computers and numerical analysis to model the weather; to this day, the most powerful computers on Earth are needed to adequately model its weather using the Navier-Stokes equations Companies like Friden, Marchant <https://assignbuster.com/history-of-computing-hardware-assignment/>

Calculator and Monroe made desktop mechanical calculators from the 1930s that could add, subtract, multiply and divide.

During the Manhattan project, future Nobel laureate Richard Feynman was the supervisor of the roomful of human computers, many of them female mathematicians, who understood the use of differential equations which were being solved for the war effort. In 1948, the Curta was introduced. This was a small, portable, mechanical calculator that was about the size of a pepper grinder. Over time, during the 1950s and 1960s a variety of different brands of mechanical calculators appeared on the market. The first all-electronic desktop calculator was the British ANITA Mk. VII, which used a Nixie tube display and 177 subminiature thyratron tubes.

In June 1963, Friden introduced the four-function EC-130. It had an all-transistor design, 13-digit capacity on a 5-inch (130 mm) CRT, and introduced Reverse Polish notation (RPN) to the calculator market at a price of \$2200. The EC-132 model added square root and reciprocal functions. In 1965, Wang Laboratories produced the LOCI-2, a 10-digit transistorized desktop calculator that used a Nixie tube display and could compute logarithms. ENIAC performed ballistics trajectory calculations with 160 kW of power. The US-built ENIAC (Electronic Numerical Integrator and Computer) was the first electronic general-purpose computer.

It combined, for the first time, the high speed of electronics with the ability to be programmed for many complex problems. It could add or subtract 5000 times a second, a thousand times faster than any other machine. (Colossus couldn't add). It also had modules to multiply, divide, and square

root. High speed memory was limited to 20 words (about 80 bytes). Built under the direction of John Mauchly and J. Presper Eckert at the University of Pennsylvania, ENIAC's development and construction lasted from 1943 to full operation at the end of 1945.

The machine was huge, weighing 30 tons, and contained over 18,000 vacuum tubes. One of the major engineering feats was to minimize tube burnout, which was a common problem at that time. The machine was in almost constant use for the next ten years. ENIAC was unambiguously a Turing-complete device. It could compute any problem (that would fit in memory). A "program" on the ENIAC, however, was defined by the states of its patch cables and switches, a far cry from the stored program electronic machines that evolved from it. Once a program was written, it had to be mechanically set into the machine.

Six women did most of the programming of ENIAC. (Improvements completed in 1948 made it possible to execute stored programs set in function table memory, which made programming less a "one-off" effort, and more systematic). First-generation machines Design of the von Neumann architecture (1947) Even before the ENIAC was finished, Eckert and Mauchly recognized its limitations and started the design of a stored-program computer, EDVAC. John von Neumann was credited with a widely circulated report describing the EDVAC design in which both the programs and working data were stored in a single, unified store.

This basic design, denoted the von Neumann architecture, would serve as the foundation for the worldwide development of ENIAC's successors. [54] In

this generation of equipment, temporary or working storage was provided by acoustic delay lines, which used the propagation time of sound through a medium such as liquid mercury (or through a wire) to briefly store data. A series of acoustic pulses is sent along a tube; after a time, as the pulse reached the end of the tube, the circuitry detected whether the pulse represented a 1 or 0 and caused the oscillator to re-send the pulse.

Others used Williams tubes, which use the ability of a small cathode-ray tube (CRT) to store and retrieve data as charged areas on the phosphor screen.

By 1954, magnetic core memory[55] was rapidly displacing most other forms of temporary storage, and dominated the field through the mid-1970s.

EDVAC was the first stored-program computer designed; however it was not the first to run. Eckert and Mauchly left the project and its construction floundered. The first working von Neumann machine was the Manchester “Baby” or Small-Scale Experimental Machine, developed by Frederic C.

Williams and Tom Kilburn at the University of Manchester in 1948 as a test bed for the Williams tube;[56] it was followed in 1949 by the Manchester Mark 1 computer, a complete system, using Williams tube and magnetic drum memory, and introducing index registers. [57] The other contender for the title “first digital stored-program computer” had been EDSAC, designed and constructed at the University of Cambridge. Operational less than one year after the Manchester “Baby”, it was also capable of tackling real problems.

EDSAC was actually inspired by plans for EDVAC (Electronic Discrete Variable Automatic Computer), the successor to ENIAC; these plans were already in

place by the time ENIAC was successfully operational. Unlike ENIAC, which used parallel processing, EDVAC used a single processing unit. This design was simpler and was the first to be implemented in each succeeding wave of miniaturization, and increased reliability. Some view Manchester Mark 1 / EDSAC / EDVAC as the “Eves” from which nearly all current computers derive their architecture. Manchester University’s machine became the prototype for the

Ferranti Mark 1. The first Ferranti Mark 1 machine was delivered to the University in February, 1951 and at least nine others were sold between 1951 and 1957. The first universal programmable computer in the Soviet Union was created by a team of scientists under direction of Sergei Alekseyevich Lebedev from Kiev Institute of Electrotechnology, Soviet Union (now Ukraine). The computer MESM (????, Small Electronic Calculating Machine) became operational in 1950. It had about 6, 000 vacuum tubes and consumed 25 kW of power. It could perform approximately 3, 000 operations per second.

Another early machine was CSIRAC, an Australian design that ran its first test program in 1949. CSIRAC is the oldest computer still in existence and the first to have been used to play digital music. [58] Second generation: transistors A bipolar junction transistor The bipolar transistor was invented in 1947. From 1955 onwards transistors replaced vacuum tubes in computer designs,[72] giving rise to the “second generation” of computers. Initially the only devices available were germanium point-contact transistors, which although less reliable than the vacuum tubes they replaced had the advantage of consuming far less power. 73] The first transistorised computer

was built at the University of Manchester and was operational by 1953;[74] a second version was completed there in April 1955. The later machine used 200 transistors and 1, 300 solid-state diodes and had a power consumption of 150 watts. However, it still required valves to generate the clock waveforms at 125 kHz and to read and write on the magnetic drum memory, whereas the Harwell CADET operated without any valves by using a lower clock frequency, of 58 kHz when it became operational in February 1955. 75] Problems with the reliability of early batches of point contact and alloyed junction transistors meant that the machine's mean time between failures was about 90 minutes, but this improved once the more reliable bipolar junction transistors became available. [76] Compared to vacuum tubes, transistors have many advantages: they are smaller, and require less power than vacuum tubes, so give off less heat. Silicon junction transistors were much more reliable than vacuum tubes and had longer, indefinite, service life. Transistorized computers could contain tens of thousands of binary logic circuits in a relatively compact space. Transistors greatly reduced computers' size, initial cost, and operating cost. Typically, second-generation computers were composed of large numbers of printed circuit boards such as the IBM Standard Modular System[77] each carrying one to four logic gates or flip-flops. A second generation computer, the IBM 1401, captured about one third of the world market. IBM installed more than one hundred thousand 1401s between 1960 and 1964. This RAMAC DASD is being restored at the Computer History Museum Transistorized electronics improved not only the CPU (Central Processing Unit), but also the peripheral devices.

The IBM 350 RAMAC was introduced in 1956 and was the world's first disk drive. The second generation disk data storage units were able to store tens of millions of letters and digits. Next to the fixed disk storage units, connected to the CPU via high-speed data transmission, were removable disk data storage units. A removable disk stack can be easily exchanged with another stack in a few seconds. Even if the removable disks' capacity is smaller than fixed disks,' their interchangeability guarantees a nearly unlimited quantity of data close at hand.

Magnetic tape provided archival capability for this data, at a lower cost than disk. Many second generation CPUs delegated peripheral device communications to a secondary processor. For example, while the communication processor controlled card reading and punching, the main CPU executed calculations and binary branch instructions. One databus would bear data between the main CPU and core memory at the CPU's fetch-execute cycle rate, and other databusses would typically serve the peripheral devices.

On the PDP-1, the core memory's cycle time was 5 microseconds; consequently most arithmetic instructions took 10 microseconds (100, 000 operations per second) because most operations took at least two memory cycles; one for the instruction, one for the operand data fetch. During the second generation remote terminal units (often in the form of teletype machines like a Friden Flexowriter) saw greatly increased use. Telephone connections provided sufficient speed for early remote terminals and allowed hundreds of kilometers separation between remote-terminals and the computing center.

Eventually these stand-alone computer networks would be generalized into an interconnected network of networks—the Internet Third generation and beyond Intel 8742 eight-bit microcontroller IC The explosion in the use of computers began with “ third-generation” computers, making use of Jack St. Clair Kilby’s[79] and Robert Noyce’s[80] independent invention of the integrated circuit (or microchip), which later led to the invention of the microprocessor,[81] by Ted Hoff, Federico Faggin, and Stanley Mazor at Intel. [82] The integrated circuit in the image on the right, for example, an Intel 8742, is an 8-bit microcontroller that includes a CPU running at 12 MHz, 128 bytes of RAM, 2048 bytes of EPROM, and I/O in the same chip. During the 1960s there was considerable overlap between second and third generation technologies. [83] IBM implemented its IBM Solid Logic Technology modules in hybrid circuits for the IBM System/360 in 1964. As late as 1975, Sperry Univac continued the manufacture of second-generation machines such as the UNIVAC 494.

The Burroughs large systems such as the B5000 were stack machines, which allowed for simpler programming. These pushdown automatons were also implemented in minicomputers and microprocessors later, which influenced programming language design. Minicomputers served as low-cost computer centers for industry, business and universities. [84] It became possible to simulate analog circuits with the simulation program with integrated circuit emphasis, or SPICE (1971) on minicomputers, one of the programs for electronic design automation (EDA).

The microprocessor led to the development of the microcomputer, small, low-cost computers that could be owned by individuals and small businesses.

Microcomputers, the first of which appeared in the 1970s, became ubiquitous in the 1980s and beyond. Steve Wozniak, co-founder of Apple Computer, is sometimes erroneously credited with developing the first mass-market home computers. However, his first computer, the Apple I, came out some time after the MOS Technology KIM-1 and Altair 8800, and the first Apple computer with graphic and sound capabilities came out well after the Commodore PET.

Computing has evolved with microcomputer architectures, with features added from their larger brethren, now dominant in most market segments. Systems as complicated as computers require very high reliability. ENIAC remained on, in continuous operation from 1947 to 1955, for eight years before being shut down. Although a vacuum tube might fail, it would be replaced without bringing down the system. By the simple strategy of never shutting down ENIAC, the failures were dramatically reduced.

Hot-pluggable hard disks, like the hot-pluggable vacuum tubes of yesteryear, continue the tradition of repair during continuous operation. Semiconductor memories routinely have no errors when they operate, although operating systems like Unix have employed memory tests on start-up to detect failing hardware. Today, the requirement of reliable performance is made even more stringent when server farms are the delivery platform. [85] Google has managed this by using fault-tolerant software to recover from hardware failures, and is even working on the concept of replacing entire server farms on-the-fly, during a service event. [86][87] In the 21st century, multi-core CPUs became commercially available. [88] Content-addressable memory (CAM)[89] has become inexpensive enough to be used in networking,
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although no computer system has yet implemented hardware CAMs for use in programming languages. Currently, CAMs (or associative arrays) in software are programming-language-specific. Semiconductor memory cell arrays are very regular structures, and manufacturers prove their processes on them; this allows price reductions on memory products.

During the 1980s, CMOS logic gates developed into devices that could be made as fast as other circuit types; computer power consumption could therefore be decreased dramatically. Unlike the continuous current draw of a gate based on other logic types, a CMOS gate only draws significant current during the ‘transition’ between logic states, except for leakage. This has allowed computing to become a commodity which is now ubiquitous, embedded in many forms, from greeting cards and telephones to satellites. Computing hardware and its software have even become a metaphor for the operation of the universe. [90] Although DNA-based computing and quantum qubit computing are years or decades in the future, the infrastructure is being laid today, for example, with DNA origami on photolithography. [91] Fast digital circuits (including those based on Josephson junctions and rapid single flux quantum technology) are becoming more nearly realizable with the discovery of nanoscale superconductors. [92] Fiber-optic and photonic devices, which already have been used to transport data over long distances, are now entering the data center, side by side with CPU and semiconductor memory components.

This allows the separation of RAM from CPU by optical interconnects. [93] An indication of the rapidity of development of this field can be inferred by the history of the seminal article. [94] By the time that anyone had time to write <https://assignbuster.com/history-of-computing-hardware-assignment/>

anything down, it was obsolete. After 1945, others read John von Neumann's First Draft of a Report on the EDVAC, and immediately started implementing their own systems. To this day, the pace of development has continued, worldwide. [95][96]