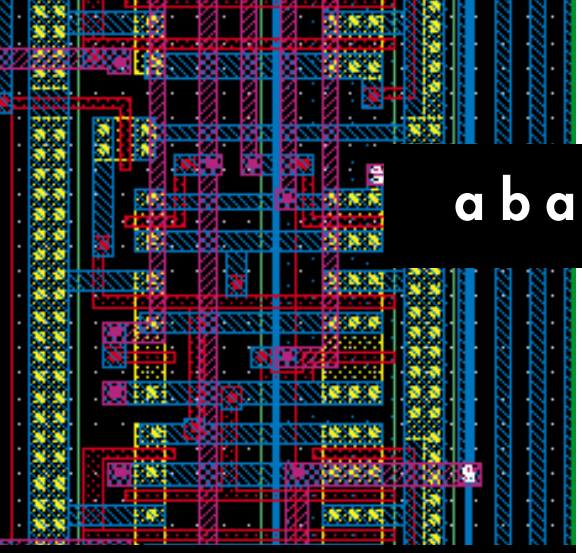
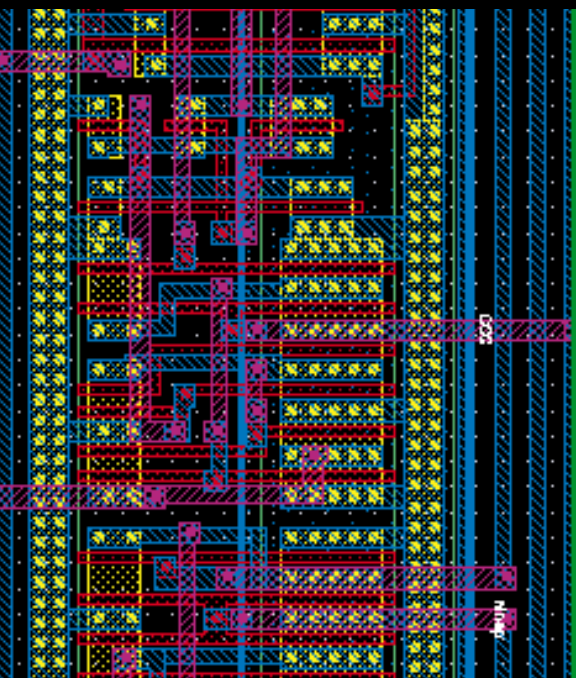


# abacus to eniac

## highlights in the history of computing

From ancient times, people have used digital devices as computational aids. Fingers and toes, the quintessential digital devices, gradually gave way to sticks and pebbles. Stone counters, used by the Greeks before 450 B.C., were an early form of abacus that the Romans adopted around 50 B.C. and which later developed into the medieval European counting board. Some of the highlights along the road that led to the ENIAC are listed here; the chronology is based on material in *Landmarks in Digital Computing: A Smithsonian Pictorial History* by Peggy A. Kidwell and Paul E. Ceruzzi (1994).



**1300** The abacus, using beads strung on wires and mounted in a frame, was in widespread use in China.

**1500** The quipu, a system of knotted strings, was in extensive use by Peruvian Incas.

**1614** John Napier described logarithms.

**1617** Napier described his calculating rods, or "bones," in a book published the year he died.

**1623** Wilhelm Schickard, in a letter to Johannes Kepler, gave the first known description of an automatic adding machine.

**1642** Blaise Pascal invented an adding machine; it is the oldest surviving example of a true adding machine where tens carry.

**1673** Gottfried Wilhelm Leibniz's calculator mechanized multiplication as well as addition.

**1803** Joseph Marie Jacquard began work on an automatic loom that used punched cards to control the manufacturing process.

**1822** Charles Babbage completed a model of the difference engine, a device that linked adding and subtracting mechanisms to one another to calculate the values of more complex mathematical functions.

**1834** Babbage turned from construction of the difference engine to a far more ambitious analytical engine: a machine that embodied in its design most of the features of a modern digital computer.

**1843** Ada Augusta, Countess of Lovelace, published a description of Babbage's analytical engine that incorporated many of the concepts of modern computer programming.

**1851** Victor Schilt exhibited a key-driven adding machine at the Crystal Palace Exposition in London.

**1853** The Scheutz difference engine, the world's first printing calculator, was completed.

**1854** George Boole published *Laws of Thought*, which led to what would be called Boolean algebra. His rules for manipulating logical expressions would be adopted by computer designers as the basis for the electronic circuits or "logic" of computers.

**1879** James and John Ritty patented a cash register.

**1884** John H. Patterson and his associates acquired the Ritty patents and established National Cash Register Company (NCR).

**1885** Dorr Felt constructed the "macaroni box" prototype for his key-driven adding machine.

**1890** Hollerith punched-card equipment was used in the U.S. census.

**1891** William S. Burroughs began commercial manufacture of his printing adding machine.

**1893** The Millionaire calculator, introduced in Switzerland, allowed direct multiplication by any digit and was used by government agencies and scientists, especially astronomers, well into the 20th century.

**1911** Charles Flint founded the Computing-Tabulating-Recording Company (C-T-R), which produced and sold electronic Hollerith tabulating equipment, time clocks, and other business machinery. James Powers began manufacturing a mechanical punched-card system that competed with Hollerith's. His machines eventually were made and sold by the Remington-Rand Corporation.

**1917-1918** At Aberdeen Proving Ground, in Maryland, mathematical techniques for computing and printing firing tables for new types of advanced ordnance used in WWI were developed.

**1918** Charles Kettering developed the Kettering Bug—an unmanned flying bomb guided by internal gyroscopes.

**1919** Early versions of the Enigma cipher machine were built in Europe.

**1924** Thomas Watson, President of C-T-R, changed the company's name to International Business Machines Corporation.

**1928** IBM adopted the 80-column punched card, the standard for the next 50 years.

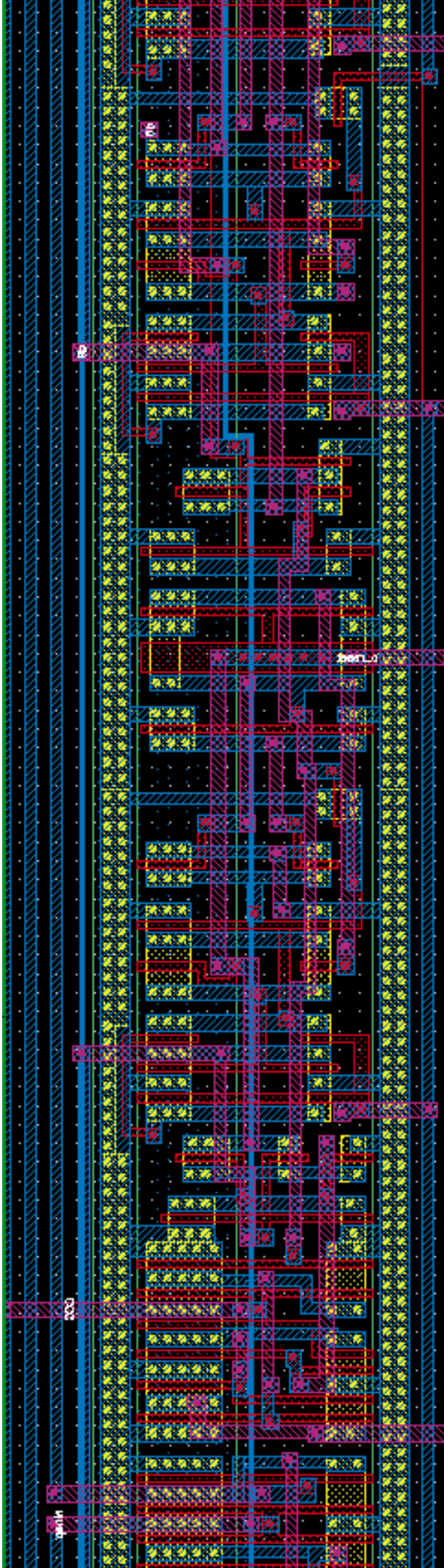
**1930** Vannevar Bush of MIT developed the differential analyzer, a large analog computer.

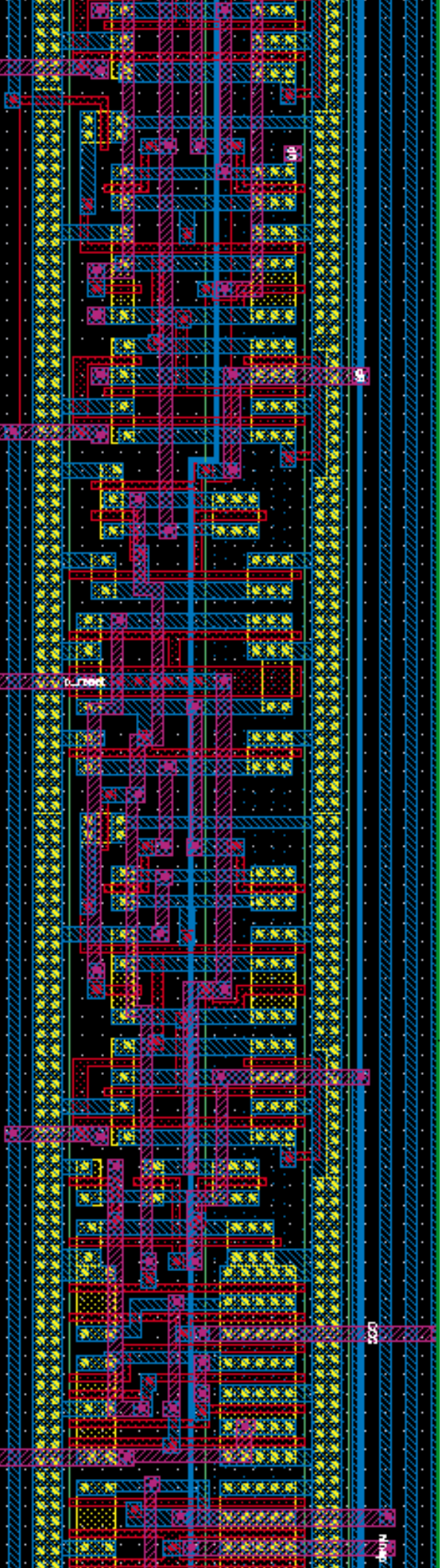
**1936** Alan Turing, a British mathematician, published "On Computable Numbers...," a description of a "machine" that could in principle solve any mathematical problem presented to it in symbolic form. His proof of the feasibility of building a "general purpose machine" provided the theoretical basis for modern computer software.

**1937** George Stibitz, a research mathematician at Bell Telephone Laboratories, built a binary adder out of a few light bulbs, batteries, and wire on his kitchen table. His Model K (for "kitchen") demonstrated the feasibility of mechanizing binary arithmetic.

**1938** Claude Shannon of MIT showed in theory what Stibitz had demonstrated with the *(continued on next page)*







Model K: that the two-valued algebra developed by George Boole could be implemented electrically by telephone relays. Konrad Zuse, a German mechanical engineer, began building a mechanical computer in his parents' Berlin apartment. Independently of Shannon, he developed a form of symbolic logic to assist in the design of the binary circuits.

**1939** The World's Fair in New York featured many exhibits showing the promise of technology. Among them were Electro, a robot man that exhibited simple intelligence. J.V. Atanasoff began work on an electronic computer at Iowa State University. George Stibitz and Samuel Williams of Bell Labs completed the Complex Number Computer (later known as the Bell Labs Model I), which used telephone relays and coded decimal numbers as groups of four binary digits each.

**1940** Stibitz demonstrated the Bell Labs Model I at Dartmouth College, with a terminal in New Hampshire and the Model I in New York. Twenty years later Dartmouth would become a center for time-sharing and remote use of computers.

**1941** Within a few days of America's entry into WWII, Konrad Zuse demonstrated a working, programmable calculator to German military authorities. His Z3 used surplus telephone relays and was programmed by holes punched into discarded 35mm movie film.

**1942** J. Presper Eckert and John W. Mauchly, of the University of Pennsylvania, proposed an electronic version of the Bush differential analyzer for the Army, which would operate digitally instead of by analog means. The proposal led to the creation of the ENIAC.

**1943** Electromechanical Bombes were built in Britan and the U.S. to decipher German messages encrypted by Enigma.

**1944** The first of several Colossus machines was completed in Britain, using vacuum tubes instead of relay circuits to decipher German messages. The ASCC, also known as the Harvard Mark I, was unveiled at Cruft Laboratory in Cambridge, Massachusetts.

**1945** The ENIAC was completed and tested at the Moore School of Electrical Engineering, University of Pennsylvania. Konrad Zuse completed the Z4, a large electromechanical programmable machine, shortly before VE-day (May 8). The "First Draft of a Report on the EDVAC," by John von Neumann, summarized discussions at the Moore School concerning the proposed successor to the ENIAC. Von Neumann's reputation as a world-class mathematician, as well as his description of the EDVAC in symbolic rather than engineering terms, helped win widespread acceptance of this design.

**1946** February 14: The public unveiling of the ENIAC took place in Philadelphia. Summer: A series of lectures on the "Theory and Techniques for Design of Electronic Digital Computers" was given at the Moore School. The course led to widespread adoption of the EDVAC-type design, including stored programs, for nearly all subsequent computer development.