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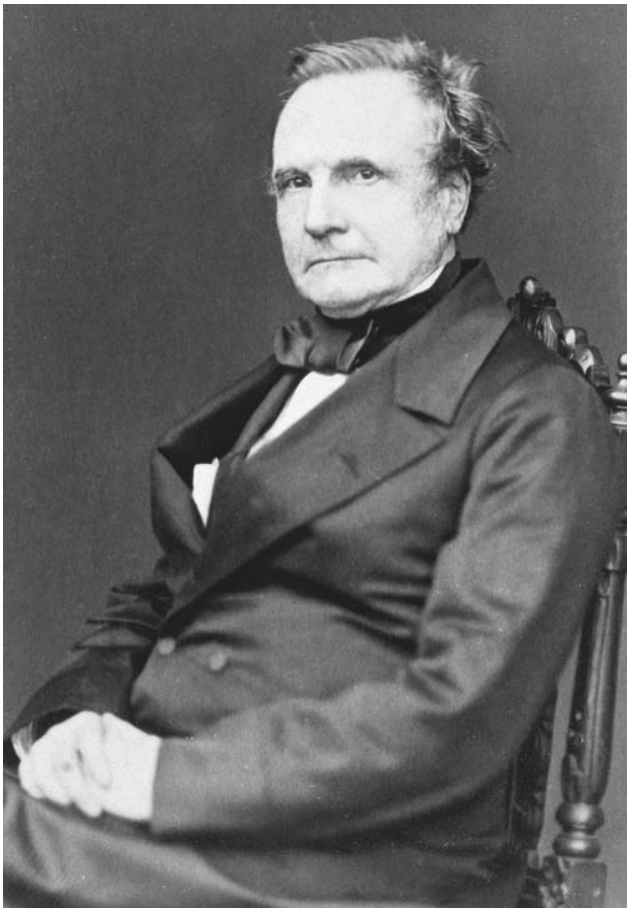
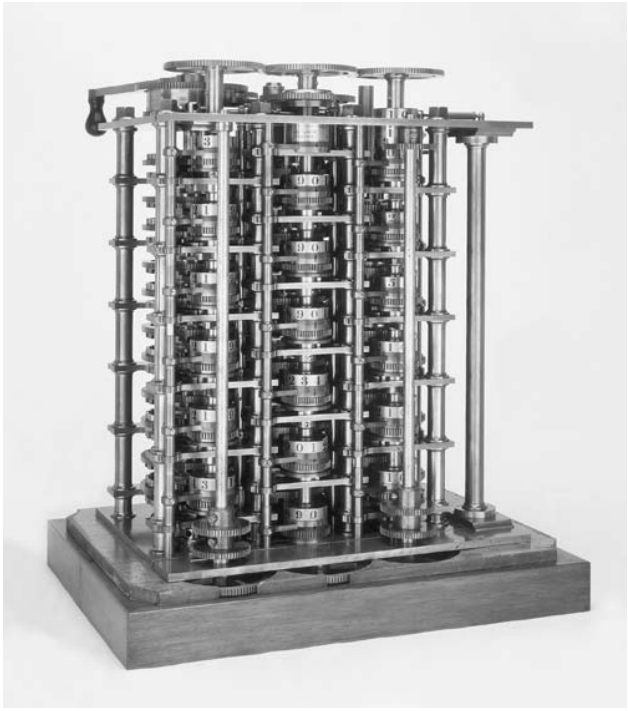
Babbage, Charles (1791–1871) British *Computation*
Born on December 26, 1791, in London, England, Charles Babbage is best remembered for his work on the design and manufacture of a mechanical calculator, the forerunner of a computer. After first constructing a "difference machine," Babbage devoted the remainder of his life to the construction of a superior "analytic engine" capable of performing all mathematical operations. His work toward this goal laid the foundations of computer design used today. Partly due to lack of funding, however, the machine was never completed.

Babbage entered Trinity College, Cambridge, in 1810. While a student, he and a fellow undergraduate coauthored *Differential and Integral Calculus,* an influential memoir on the history of calculus. After transferring to Peterhouse College, Babbage received his bachelor's degree in mathematics in 1814 to then begin a career in mathematical research. Babbage published a number of influential papers on the topic of functional equations and was honored with election to the ROYAL SOCIETY in 1816. In 1827 he became the Lucasian Professor of Mathematics at Cambridge.

Much of Babbage's theoretical work relied on consulting tables of logarithms and trigonometric functions. Aware of the inaccuracy of human calculation, Babbage became interested in the problem of using a mechanical device to perform complex computations. In 1819 he began work on a small "difference engine," which he completed three years later. He announced his invention to the scientific community in an 1822 paper, "Note on the Application of



Charles Babbage, an eminent mathematician of the 19th century, is best known for his design and manufacture of a mechanical computer. ***(Photo courtesy of the Science Museum, London/ Topham-HIP/The Image Works)***



Charles Babbage completed work on his "difference engine," the world's first sophisticated mechanical computer, in 1822. ***(Photo courtesy of the Science Museum, London/Topham-HIP/The Image Works)***

Machinery to the Computation of Astronomical and Mathematical Tables."

Although the machine was capable of performing relatively simple, but highly accurate, computations (using the method of FINITE DIFFERENCES to compute values of POLYNOMIAL functions), his invention was well received and was understood to be a first step toward a new era in computational capabilities. Babbage was awarded a gold medal from the Astronomical Society and was given a grant from the Chancellor of the Exchequer to construct a larger, more complex, difference engine.

In 1801 Joseph-Marie Jacquard invented a loom capable of weaving complex patterns by making use of a set of instructions set out on cards punched with holes. Two decades later Babbage decided to follow the same idea and design a steam-powered engine that would accept instructions and data from punched cards. With the assistance of Lord Byron's daughter, LADY AUGUSTA ADA LOVELACE, Babbage took to work on creating a sophisticated calculating device. In 1832 he published a book, *On the Economy of Machinery and Manufactures,* offering a theoretical discussion on the topic. This could be considered the first published work in the field of OPERATIONS RESEARCH.

Unfortunately, due to financial and technological difficulties, the machine was never completed. (The metalwork technology of the mid-1800s was not capable of the levels of precision Babbage's machine demanded.) The device in its unfinished state is preserved today in the Science Museum of London. Although he never realized his dream of building an operational, mechanical computer, his design concepts have since been proved correct. It is not an exaggeration to say that the modern computers constructed on Babbage's theoretical design have revolutionized almost all aspects of 20th-century life.

Babbage died in London, England, on October 18, 1871.

Babylonian mathematics The Babylonians of 2000 B.C.E. lived in Mesopotamia, the fertile plain between the Euphrates and Tigris Rivers in what is now Iraq. We are fortunate that the peoples of this region kept extensive records of their society—and their mathematics—on hardy sun-baked clay tablets. A large number of these tablets survive today. The Babylonians used a simple stylus to make marks in the clay and developed a form of writing based on cuneiform (wedge shaped) symbols.

The mathematical activity of the Babylonians seems to have been motivated, at first, by the practical everyday needs of running their society. Many problems described in early tablets are concerned with calculating the number of workers needed for building irrigation canals and the total expense of wages, for instance. But many problems described in later texts have no apparent practical application and clearly indicate an interest in pursuing mathematics for its own sake.

The Babylonians used only two symbols to represent numbers: the symbol 𒁹 to represent a unit and the symbol 𒌋 to represent a group of ten. A simple additive system was used to represent the numbers 1 through 59. For example, the cluster 𒌋𒌋𒌋𒁹𒁹 represents "32." A base-60 PLACE-VALUE SYSTEM was then used to represent numbers greater than 59. For instance, the number 40,992, which equals $11 \times 60^2 + 23 \times 60 + 12$, was written: 𒁹 𒌋𒌋𒁹𒁹𒁹 𒌋𒁹𒁹 . Spaces were inserted between clusters of symbols.