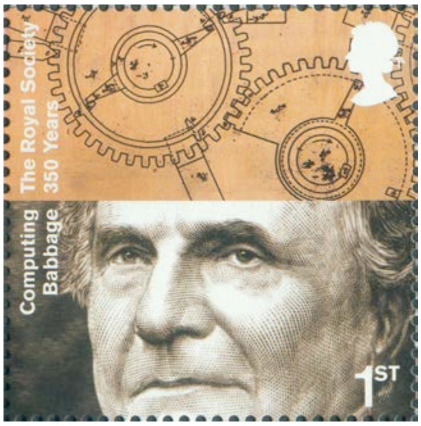
CHARLES BABBAGE (December 26, 1791 – October 18, 1871)

by HEINZ KLAUS STRICK, Germany



CHARLES BABBAGE grew up first in London; his frequent illnesses in childhood may have been caused by the unhealthy climate of the rapidly growing metropolis. His father, a wealthy banker, therefore decided that the boy should attend a small private school in Devonshire run by a clergyman.

The instruction to pay more attention to the health of the pupil than to his education was – as BABBAGE later writes – conscientiously followed by the clergyman.

Nevertheless, at the next school he attended, his teacher was able to awaken him to a special interest in mathematics. Thanks to the competence of a private teacher from Oxford University, he even reached such a level of knowledge that when he entered the prestigious *Trinity College* of Cambridge University, he realised that there was not much more to learn.

In Cambridge, the *NEWTONian Calculus* was still being taught, while on the continent the more convenient *LEIBNIZian notation* had long since established itself. With great financial effort he procured (despite NAPOLEON's continental blockade) the work of the Frenchman SYLVESTRE FRANÇOIS DE LACROIX *Sur le calcul différentiel et intégral*.

He was so enthusiastic about this textbook that he convinced fellow students to found an association, the *Analytical Society*, which set itself the task of translating this work into English. In the journal they founded (*Memoirs of the Analytical Society*) BABBAGE and his fellow student JOHN HERSCHEL (son of the famous astronomer WILLIAM HERSCHEL) published a remarkable article on the development of the methods of analysis and the controversy between NEWTON and LEIBNIZ. The translation of LACROIX's work and an book of exercises with examples appeared in 1816 and 1820.

Meanwhile BABBAGE left Cambridge with a bachelor's degree; he married and moved to London.

Already at the age of 24 he was elected to the *Royal Society*.

However, he did not feel comfortable there. He described the *Society* as a gathering of men who dined at the expense of the *Society* and who elected each other to offices or presented each other with awards at the "meetings".

Robert Boyle, Isaac Newton, Benjamin Franklin, Edward Jenner, Charles Babbage
Alfred Russel Wallace, Joseph Lister, Ernest Rutherford, Dorothy Hodgkin, Nicholas Shackleton

In 1820, Babbage was one of the founders of the *Royal Astronomical Society* and for many years he worked on its board.
(The British stamp from 1970 shows Sir William Herschel, the first President of the *Royal Astronomical Society*, Francis Baily, John Herschel and William Herschel's 40-ft telescope.)

In 1827 he took over the prestigious *Lucasian Chair* of Mathematics at Cambridge (his predecessors were Isaac Barrow, Isaac Newton and George Airy).

However, in the 12 years in which he held this office, he did not give a single lecture, because he was only occupied with one thought - namely, to develop a powerful calculating machine.

At that time, calculations in astronomy required logarithms with as many digits as possible, but during the various steps between the calculation of the logarithms by assistants and the setting of the plates in the printing press, numerous mistakes were made, which Babbage was extremely annoyed about.

So Babbage came up with the idea of having one machine do the calculations of the logarithms as well as the printing of the plates. In 1822 the *Royal Astronomical Society journal* published the article *Note on the application of machinery to the computation of astronomical and mathematical tables*, in which he presented his ideas.

He explained how it worked using the example of the calculation of the following elements of a sequence a_n with $a_n = n^2 + n + 41$:

For two adjacent terms you can calculate the difference Δ and then from the difference sequence repeat the process to get the difference sequence Δ_2. Compare the table below.

n	0	1	2	3	4	5	6	7
a_n	41	43	47	53	61	71	83	…
Δ	0	2	4	6	8	10	12	…
Δ_2	2	2	2	2	2	2	2	…

The machine starts the calculations with the start triples (2, 0, 41) to be entered and from these it calculates independently step by step the triples (2, 2, 43), (2, 4, 47), (2, 6, 53), and so on - just using addition.

His goal was to perform such calculations for arbitrary polynomials, because for arithmetic sequences of the *n*-th order, there is the proposition that their *n*-th difference sequence Δ_n is a constant sequence, and, since any function that can be differentiated as often as desired can be approximated by polynomials according to the Taylor *theorem*, logarithms and values of trigonometric functions can also be calculated in this way.

Referring to the situation in France, where large teams were working on the recalculation of logarithmic and trigonometric tables on behalf of the government, he argued that the machine he designed would cost much less and would not make any mistakes.

In 1823 he received a prize from the *Astronomical Society* for his idea and the *Royal Society* also asked the government to support the project financially.

After he was granted a start-up grant of £1,500, he began work on the construction of the *difference engine*. He was convinced that he would be able to demonstrate the machine, which was composed of gears, levers and axles, in three years.

However, the cost of producing the 4000 individual parts soon exceeded all his calculations, and the project made little progress, because BABBAGE constantly had new ideas and constantly changed his plans.

Then he was also hit by personal strokes of fate. In 1827 his father, his wife and two of his eight children died in quick succession; but Babbage did not give up. Once again, he convinced a government delegation to invest even more money in the project.

In 1830, government support was extended for the last time, as he was able to present a hand-crank operated protype that could be used to calculate value tables for quadratic functions.

In 1834 the project was finally declared to be finished with £17,000 from government funds and £6,000 from his inherited property.

BABBAGE had long been planning a far more comprehensive machine, the *analytical engine*. While the difference engine could only carry out additions, this forerunner of today's computer should be able to be used for calculations of all kinds:

The computer should have a *memory* (for input and output of data) and a *calculating engine*. All operations would be controlled by a *program* that can be read in by means of punched cards (as in the case of the automatic looms invented by JOSEPH-MARIE JACQUARD in 1801).

ADA LOVELACE, daughter of Lord BYRON, was one of the few people who believed in BABBAGE. She wrote a program for the *analytical engine* which could be used to calculate the BERNOULLI numbers.

In 1847 he tried once again to implement the concept of a simpler machine (*Difference Engine No. 2*), with which value tables of seventh-degree polynomials were to be calculated with 31-digit precision; but even these plans failed.

In addition to building a calculating machine, BABBAGE was also involved in many other areas, including making mortality tables and exposing life insurance fraud. He was the first to succeed in deciphering a document encrypted with the *Vigenère code*.

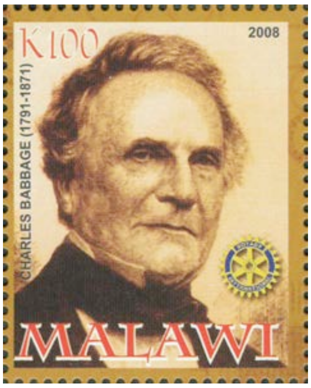
BABBAGE wrote *On the Economy of Machine and Manufacture*, in which he analysed the work processes in factories and concluded that a greater division of labour would reduce labour costs (the so called *Babbage principle*). KARL MARX quoted this analysis in *Das Kapital* as the expected development of the capitalist system.

BABBAGE created an *Association for the Advancement of Science* to prevent scientific fraud, founded the *Statistical Society of London*, and invented the ophthalmoscope, a cowcatcher for locomotives, the signal generator for lighthouses and much more.

But with some of his investigations he exposed himself to ridicule: he compiled statistics on the reasons why window panes in factory buildings are broken, demanded fines against street musicians (especially barrel organ players) who disrupted 25 percent of his working hours with their music and thus caused costly losses of time. (This eventually led to the *BABBAGE Law* to regulate street music). Twice he ran in vain for a seat in parliament.

In the end, BABBAGE died bitterly in his London home - this was partly due to the fact that, in the meantime, a Swedish engineer built a working calculating machine based on BABBAGE's plans.

This brought him international fame and even an order from the British government, while BABBAGE's merits seemed to have been forgotten.



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