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The First Microprocessor
The 4004

INTEL

In the summer of 1969, Busicom, a now defunct Japanese calculator manufacturer, approached Intel with a contract to design a set of chips for a family of high-performance programmable calculators. The Japanese wanted to develop a calculator that could be plugged into printers and electronic displays, as well as perform ordinary mathematical chores; they intended to make the machine programmable by providing specialized sets of ROMs that could be inserted in the machines. These ROMs would contain the instructions for the calculator's logic chips.

In Busicom's original design, the calculator required at least twelve memory and logic chips, each consisting of an unusually large number of leads. In the late 1960s, when Busicom approached Intel, the technology for making relatively intricate ICs had been around for only a couple of years. The ICs of the time were all hardwired - that is, they generally contained a fixed number of logic gates, which could perform only certain functions.

A young Intel engineer named Marcian E. (Ted) Hoff, Jr., was assigned to the Busicom project. Hoff thought that Busicom's design was too complicated at cumbersome to be cost-effective, so he came up with a novel alternative. "Instead of making their device act like a calculator with some programming abilities," he recalled, " I wanted to make it function as a general-purpose computer programmed to be a calculator."

To this end, Hoff and fellow engineers Frederico Faggin and Stan Mazor whittled the twelve chips down to four: a 256-byte ROM, a 32-bit RAM, a 10-bit shift register (a form of RAM), and a 4-bit microprocessor. The microprocessor was the key to Intel's trimmed-down design. Instead of distributing the arithmetic and logic functions of the calculator among several hardwired ICs, all guided by many ROMs, Hoff proposed placing all those functions on a single IC - a chip that could be programmed to carry out almost any function. Busicom bought the idea (which other companies, notably General Electric, were also exploring at the time), and the 4004, the first microprocessor to reach the market, was born.

With 2,300 MOS transistors, the 4004 can execute some 60,000 operations a second (an operation involves a single manipulation of two binary numbers) and address 1,280 half-bytes, or nibbles, of data and 4K bytes of programmed instructions. By today's standards, the 4004 was hopelessly primitive; microprocessors that can carry out millions of operations a second and address millions of bytes of memory are now commonplace. But the 4004 was a revolutionary development that changed the face of modern electronics, making it possible to include data processing ability in hundreds of devices for the first time.

The 4004 can add two 4-bit numbers in about eleven millionths of a second and can multiply only by repeated addition. The chip contains a 4-bit adder (for doing just that), an accumulator (for keeping track of subtotals), and sixteen registers (for temporarily storing results). The two larges registers are the rectangular grids on the far right. The black bars along the edges are wires. Actual size: 0.110 x 0.150 inches.

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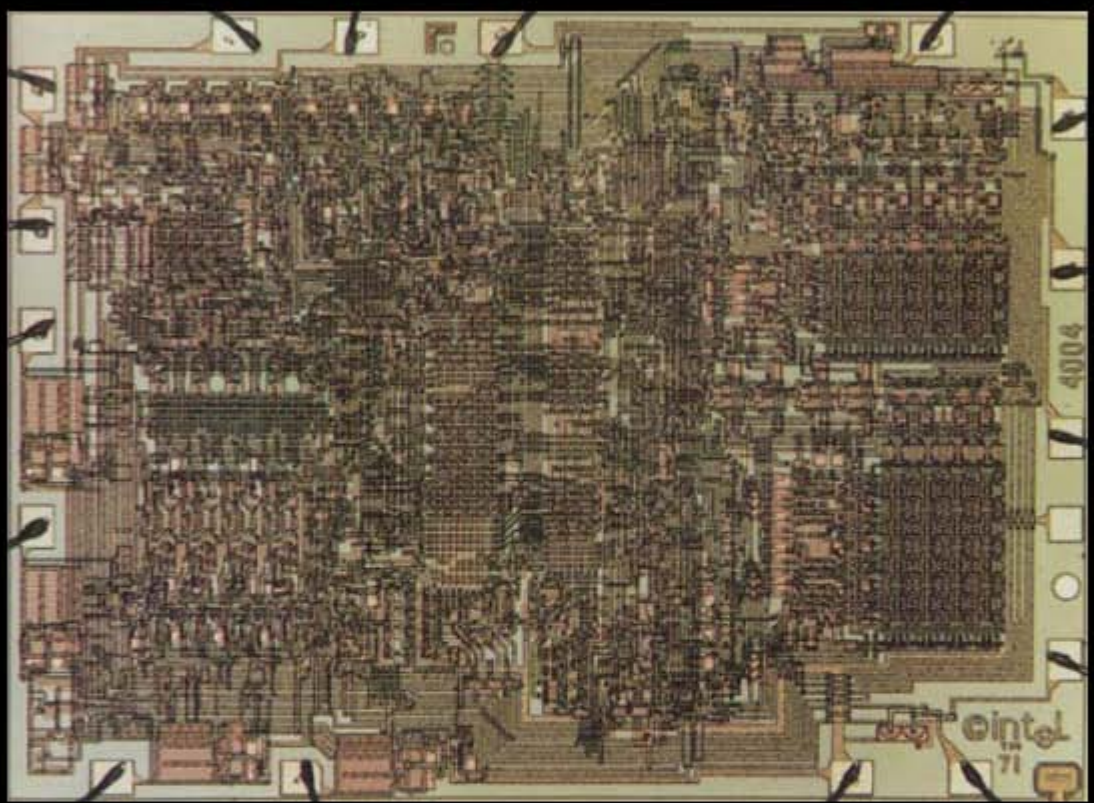

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