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By GEORGE JOHNSON

Dr. Claude Elwood Shannon, the American mathematician and computer scientist whose theories laid the groundwork for the electronic communications networks that now lace the earth, died on Saturday in Medford, Mass., after a long fight with Alzheimer's disease. He was 84.

Understanding, before almost anyone, the power that springs from encoding information in a simple language of 1's and 0's, Dr. Shannon as a young man wrote two papers that remain monuments in the fields of computer science and information theory.

"Shannon was the person who saw that the binary digit was the fundamental element in all of communication," said Dr. Robert G. Gallager, a professor of electrical engineering who worked with Dr. Shannon at the Massachusetts Institute of Technology. "That was really his discovery, and from it the whole communications revolution has sprung."

Dr. Shannon's later work on chess- playing machines and an electronic mouse that could run a maze helped create the field of artificial intelligence, the effort to make machines that think. And his ability to combine abstract thinking with a practical approach - he had a penchant for building machines - inspired a generation of computer scientists.

Dr. Marvin Minsky of M.I.T., who as a young theorist worked closely with Dr. Shannon, was struck by his enthusiasm and enterprise. "Whatever came up, he engaged it with joy, and he attacked it with some surprising resource - which might be some new kind of technical concept or a hammer and saw with some scraps of wood," Dr. Minsky said. "For him, the harder a problem might seem, the better the chance to find something new."

Born in Petoskey, Mich., on April 30, 1916, Claude Elwood Shannon got a bachelor's degree in mathematics and electrical engineering from the University of Michigan in 1936. He got both a master's degree in electrical engineering and his Ph.D. in mathematics from M.I.T. in 1940.

While at M.I.T., he worked with Dr. Vannevar Bush on one of the early calculating machines, the "differential analyzer," which used a precisely honed system of shafts, gears, wheels and disks to solve equations in calculus.

Though analog computers like this turned out to be little more than footnotes in the history of the computer, Dr. Shannon quickly made his mark with digital electronics, a considerably more influential idea.

In what has been described as one of the most important master's theses ever written, he showed how Boolean logic, in which problems can be solved by manipulating just two symbols, 1 and 0, could be carried out automatically with electrical switching circuits. The symbol 1 could be represented by a switch that was turned on; 0 would be a switch that was turned off.

The thesis, “A Symbolic Analysis of Relay and Switching Circuits,” was largely motivated by the telephone industry’s need to find a mathematical language to describe the behavior of the increasingly complex switching circuits that were replacing human operators. But the implications of the paper were far more broad, laying out a basic idea on which all modern computers are built.

George Boole, the 19th-century British mathematician who invented the two-symbol logic, grandiosely called his system “The Laws of Thought.” The idea was not lost on Dr. Shannon, who realized early on that, as he once put it, a computer is “a lot more than an adding machine.” The binary digits could be used to represent words, sounds, images - perhaps even ideas.

The year after graduating from M.I.T., Dr. Shannon took a job at AT&T Bell Laboratories in New Jersey, where he became known for keeping to himself by day and riding his unicycle down the halls at night.

“Many of us brought our lunches to work and played mathematical blackboard games,” said a former colleague, Dr. David Slepian. “Claude rarely came. He worked with his door closed, mostly. But if you went in, he would be very patient and help you along. He could grasp a problem in zero time. He really was quite a genius. He’s the only person I know whom I’d apply that word to.”

In 1948, Dr. Shannon published his masterpiece, “A Mathematical Theory of Communication,” giving birth to the science called information theory. The motivation again was practical: how to transmit messages while keeping them from becoming garbled by noise.

To analyze this problem properly, he realized, he had to come up with a precise definition of information, a dauntingly slippery concept. The information content of a message, he proposed, has nothing to do with its content but simply with the number of 1’s and 0’s that it takes to transmit it.

This was a jarring notion to a generation of engineers who were accustomed to thinking of communication in terms of sending electromagnetic waveforms down a wire. “Nobody had come close to this idea before,” Dr. Gallager said. “This was not something somebody else would have done for a very long time.”

The overarching lesson was that the nature of the message did not matter - it could be numbers, words, music, video. Ultimately it was all just 1’s and 0’s.

Today, when gigabytes of movie trailers, Napster files and e-mail messages course through the same wires as telephone calls, the idea seems almost elemental. But it has its roots in Dr. Shannon’s paper, which may contain the first published occurrence of the word “bit.”

Dr. Shannon also showed that if enough extra bits were added to a message, to help correct for errors, it could tunnel through the noisiest channel, arriving unscathed at the end. This insight has been developed over the decades into sophisticated error-correction codes that ensure the integrity of the data on which society interacts.

In later years, his ideas spread beyond the fields of communications engineering and computer science, taking root in cryptography, the mathematics of probability and even investment theory. In biology, it has become second nature to think of DNA replication and hormonal signaling in terms of information.

And more than one English graduate student has written papers trying to apply information theory to literature - the kind of phenomenon that later caused Dr. Shannon to complain of what he called a "bandwagon effect."

"Information theory has perhaps ballooned to an importance beyond its actual accomplishments," he lamented.

After he moved to M.I.T. in 1958, and beyond his retirement two decades later, he pursued a diversity of interests - a mathematical theory of juggling, an analog computer programmed to beat roulette, a system for playing the stock market using probability theory.

He is survived by his wife, Mary Elizabeth Moore Shannon; a son, Andrew Moore Shannon; a daughter, Margarita Shannon; a sister, Catherine S. Kay; and two granddaughters.

In the last years of his life, Alzheimer's disease began to set in. "Something inside him was getting lost," Dr. Minsky said. "Yet none of us miss him the way you'd expect - for the image of that great stream of ideas still persists in everyone his mind ever touched."