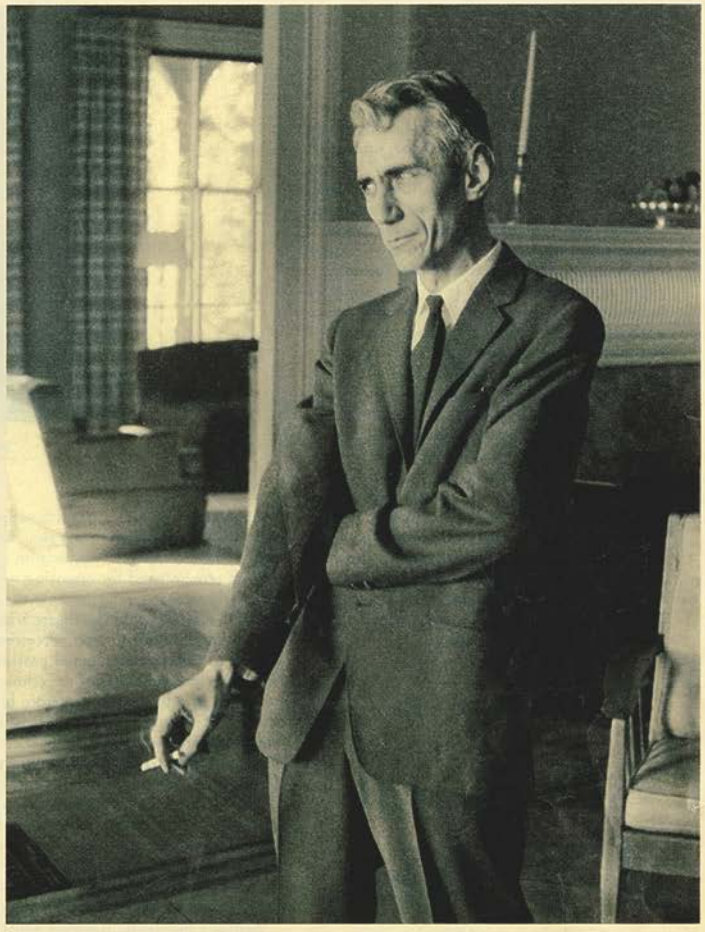
CLAUDE SHANNON, B. 1916

Bit Player

The mathematician invented the very essence of the Information Age.

By James Gleick



Above: Shannon, 1962. Right: Starr, mid-1970's. Far right: Hoyle, undated.

Halfway through the last century, information became a thing. It became a commodity, a force — a quantity to be measured and analyzed. It's what our world runs on. Information is the gold and the fuel. We measure it in bits. That's largely because of Claude Shannon.

Shannon is the father of information theory, an actual science devoted to messages and signals and communication and computing. The advent of information theory can be pretty well pinpointed: July 1948, the Bell System Technical Journal, his landmark paper titled simply "A Mathematical Theory of Communication." Before that, no such theory existed. Suddenly, there it was, almost full grown.

To treat information scientifically, engineers needed to answer the kinds of questions they were asking about matter and energy: how much? How fast? For fundamental particles, an irreducible unit of measure. Shannon proposed the word "bits" — as shorthand (suitably compressed) for "binary digits." A bit is a choice. On or off. Yes or no. One or zero. Shannon saw that these pairs are all the same. Information is fungible: smoke signals and semaphores, telegraph and television, all channels carrying bits.

Back then, the main technologies for sending and storing information were analog, not digital, so this was far from obvious. Phonograph records embodied sound waves in vinyl, and Shannon's telephone-company employers trafficked mostly in wavy signals, too. Yet some interesting communications channels were not continuous but discrete: the telegraph and teletype.

Mainly, though, Shannon was thinking of electrical circuits. The marriage of on-off to yes-no meant that circuits could carry out something akin to logic. They could not only transmit bits; they could manipulate them. Not coincidentally, in that same year Bell Labs was preparing to announce a new invention: the transistor. "It is almost certain," Scientific American declared bravely in 1952, "that 'bit' will become common parlance in the field of information, as 'horsepower' is in the motor field." Sure enough, bits led to bytes and, inexorably, to kilobytes, megabytes, gigabytes and terabytes.

All that still rests on the theoretical foundation laid by this playful mathematician and electrical engineer. Shannon was born in rural Michigan in 1916, the son of a language teacher and a probate judge. He was an early and enthusiastic tinkerer in the new American style. Thomas Edison was his hero. Once he built a crude telegraph using a half-mile of barbed wire between his house and a friend's.

Nor did he stop playing just because he grew up. At Bell Labs, and then as a professor at the Massachusetts Institute of Technology, he amused colleagues by building juggling machines, unicycles, chess-playing computers and robotic turtles. He left a body of work comprising more than a hundred technical papers along the lines of "Reliable Circuits Using Less Reliable Relays," as well as others, not quite so influential, like "Scientific Aspects of Juggling" and "The Fourth-Dimensional Twist, or a Modest Proposal in Aid of the American Driver in England." He was also the author of "A Rubric on Rubik Cubics," which can be sung to the tune of "Ta-ra-ra-boom-de-ay."

When modern theorists worry about compressing data, maximizing bandwidth and coping with noise, they use the tools Shannon provided. They also keep in mind a paradox he emphasized from the very beginning — one that is either lovely or perverse, depending on your point of view. Information, in its new scientific sense, is utterly divorced from meaning. Chaotic systems, and strings of random numbers, altogether meaningless, are dense with information.

The medium, it turns out, is not the message. Words, sounds, pictures or gibberish — it's still just bits. ■