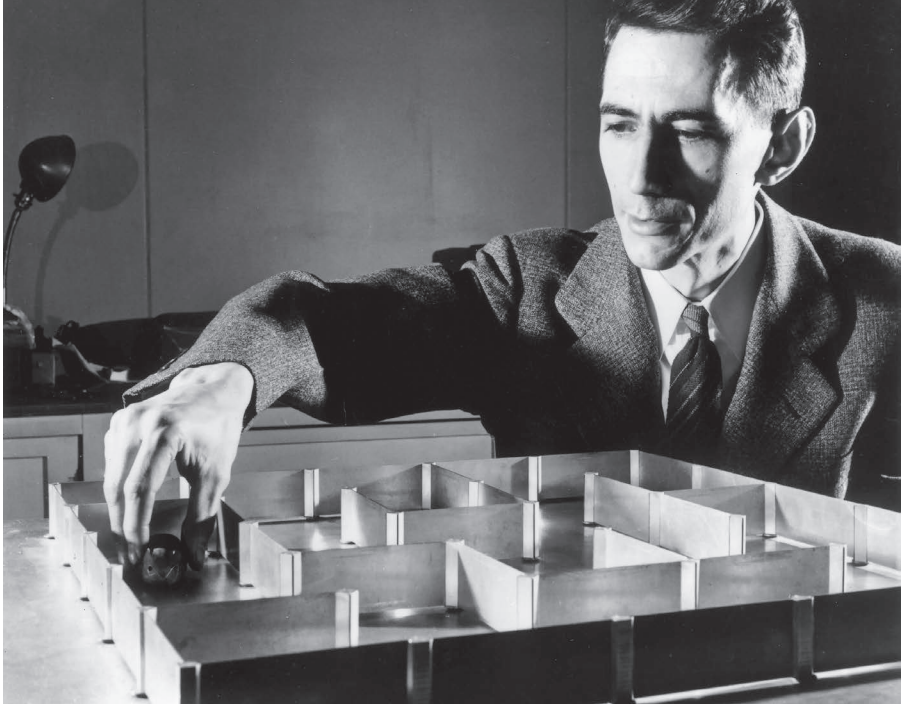


KEYSTONE/GETTY

Claude Shannon in 1952 with Theseus, his electromechanical mouse, which could navigate a maze.

INFORMATION TECHNOLOGY

A digital genius at play

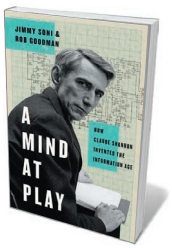
Vint Cerf savours a life of Claude Shannon, information-theory pioneer and wildly inventive tinkerer.

The US mathematician and electrical engineer Claude Shannon, whose life spanned the tumultuous, technologically explosive twentieth century, is often called the father of information theory. This is no exaggeration: Shannon crafted the idea that information can be quantified independently of its meaning and content. Working mainly in a world of analog technology, he laid the foundations of our digitized universe.

In *A Mind at Play*, journalist Jimmy Soni and political theorist Rob Goodman tell Shannon's story engagingly, from the perspective of a lay reader wrestling with the sophisticated ideas that Shannon explored with dedication and panache. The book is a boon for those eager to know more about his incredibly influential life — whimsical, independent and curiosity-driven.

Shannon was only 21 when, in 1937, he put forward a theory of digital circuit design in a momentous thesis — later published as a paper — for his master's degree at the Massachusetts Institute of Technology (MIT) in Cambridge. He laid out how Boolean logic (a type of algebra in which variables can take only one of two values, 'true' or 'false') could be mechanically realized using the relays of telephone-switching systems. This marked the dawn of digital computer design.

In 1948, Shannon published his even more influential mathematical theory of communication. His idea — that any signalling channel has a maximum capacity for delivering perfect information in the presence of noise — is a fundamental property of all communications today. In this paper, he introduced the quantified measure 'bits', short for binary digits, a name that he attributed to mathematician John Tukey. Shannon's brilliance also spilt over into inveterate tinkering and a lifelong fascination with mechanical devices.



A Mind at Play: How Claude Shannon Invented the Information Age
JIMMY SONI & ROB GOODMAN
Simon & Schuster: 2017.

Soni and Goodman have done their research. Their vivid portrayal of Shannon is well contextualized by the intellectual ferment that led to the eruption in the development of computing and communication during his lifetime. We meet Shannon's parents (his father a probate judge, his mother a language teacher and high-school principal), and follow his interactions with giants of the time. Among them were Albert Einstein, Vannevar Bush, John von Neumann, Alan Turing — and movers and shakers at MIT, Bell Labs in Murray Hill, New Jersey, and farther afield. Many of these encounters undoubtedly affected Shannon's thinking. In 1940, at the Institute for Advanced Study in Princeton, New Jersey, he met von Neumann, a seminal figure in computer design. His occasional meetings with Einstein and the logician Kurt Gödel also probably had a formative impact on his work.

The chapter on Shannon's time as a visiting professor at MIT was personally satisfying for me. A number of the scientists mentioned, many of them students of Shannon's, are acquaintances and colleagues: computer scientist Leonard Kleinrock; Irwin Jacobs, founder of mobile-technologies company Qualcomm; Lawrence Roberts, pioneer of Internet-forerunner ARPANET; and information theorist Thomas Kailath.

Soni and Goodman also show how Shannon helped to solve practical problems that plagued the US military and government during the Second World War, such as how to encrypt covert communication. It was during this period that Shannon came into contact with Turing, now famed for his code-breaking efforts at Bletchley Park, UK. Turing's work on computation and Shannon's on information theory are pillars of modern computer science.

As its name suggests, *A Mind at Play* also revels in the quirks that made Shannon such an endearing character. As a would-be inventor, he created many working models, including a flame-throwing trumpet. He crafted a series of idiosyncratic unicycles, trying to see how small they could be before they became impossible to ride. His Ultimate Machine was an unassuming box with an on–off switch; when it was turned on, a hand reached out, turned the switch off and disappeared back inside. There was a rocket-powered Frisbee and a computer using Roman numerals, THROBAC (Thrifty Roman-Numeral Backward-Looking Computer). In 1950, Shannon invented an electromechanical mouse, Theseus, that could learn to negotiate a maze and then replicate its path from anywhere inside. He enjoyed juggling tins of paint, loved jazz and played the clarinet.

What emerges is a portrait of an exceptional, free-spirited mind, nurtured by colleagues at MIT and Bell Labs such as Tukey and engineer John Pierce, as well as his second wife, Betty. Shannon was protected from some of the more mundane aspects of work, such as reporting progress, by colleagues and managers. They recognized his unique ability to wrestle insight from complexity, by peeling away details that obscured the kernel of problems and inviting creative solutions. *A Mind at Play* reveals the remarkable human behind some of the most important theoretical and practical contributions to the information age. ■

Vint Cerf *co-designed the TCP/IP protocols and the architecture of the Internet. He is chief Internet evangelist for Google.*
e-mail: vint@google.com