



*Robert W. Fernald*

## ROBERT M. FANO

1917–2016

Elected in 1973

*“Pioneering work in the development of the first interactive time-sharing computer system and contributions to communication theory.”*

BY DANIELA RUS

**R**OBERTO MARIO FANO, computing pioneer and professor emeritus at the Massachusetts Institute of Technology, died July 13, 2016, in Naples, Florida. He was 98. During his 75 years at MIT he played a critical role in establishing computer science as an academic discipline.

Bob was born November 11, 1917, to Gino and Rosetta Fano in Turin, capital of the Piedmont region of northern Italy. He grew up with the disciplines of math and science at close range: his father was a prominent mathematician and pioneer of finite geometry, and his brother Ugo and cousin Giulio Racah were both physicists.

He began his academic career at the School of Engineering in Turin before emigrating to America in 1939 in response to anti-Jewish legislation passed by Benito Mussolini. He earned his bachelor’s degree at MIT in 1941 and then worked on microwave circuits at the MIT Radiation Laboratory during World War II. After the war he cowrote chapters in one of the books in the famous “Rad Lab” series that was required reading for decades of electrical engineers. He then returned to school and received his doctorate at MIT in 1947; he wrote his thesis on broadband microwave filters under the supervision of Ernst Guillemin.

In 1947 he was hired as an assistant professor in what was then called MIT's Department of Electrical Engineering. He became a visionary leader in research, with three remarkable parallel careers in microwaves, information theory, and computer science, contributing fundamental work in each area.

As assistant professor Bob led the Radar Techniques Group at MIT's Lincoln Laboratory from 1950 to 1953. His early work touched on such diverse fields as network theory, electromagnetism, and information theory. He authored *Transmission of Information: A Statistical Theory of Communication* (MIT Press, 1961), often referred to as the bible of information theory, and he coauthored, with Richard B. Adler and Lan Jen Chu, the pivotal textbooks *Electromagnetic Energy Transmission and Radiation* (John Wiley & Sons, 1960) and *Electromagnetic Fields, Energy, and Forces* (MIT Press, 1968).

His pioneering research with Claude Shannon led to data compression techniques such as Huffman coding that are used in today's high-definition TVs and computer networks. He also developed Fano's inequality and the Fano sequential decoding algorithm, the most advanced sequential algorithm for convolutional codes.

In the early 1960s he started thinking more about how to make computing accessible to the general population. At the time, computers were large, inefficient, and expensive. Programmers entered commands on punch cards that could take days to execute for a single task. He had the vision of computation as a utility.

Bob realized that there was a great opportunity to develop computers that could work on multiple tasks for multiple users. Computer scientists such as MIT professors John McCarthy and Fernando "Corby" Corbato had developed time-sharing systems that allowed multiple people to program computer tasks at once. Bob began conversations with Corby and J.C.R. Licklider, who was then director of the Department of Defense Advanced Research Projects Agency (ARPA).

In the fall of 1962 Bob wrote an ARPA proposal for "Project MAC" (MAC stood for machine-aided cognition), an effort he would oversee to build on Corby's time-sharing work. Legend

has it that it took only one week to get approval for the project and its space requirements. The name Project MAC was selected because, in 1963, many academics didn't view computer science as an academic discipline. Bob opted to call the center a "project" instead of a "lab" so that he could collaborate with researchers across campus without pushback from the institute.

As founding director of Project MAC, Bob created a cross-disciplinary organization and vibrant research space that was later home to the development of Multics, one of the world's first operating systems and a direct influence on systems such as Unix, Linux, and OSX. Project MAC grew in size and scope to become MIT's largest interdepartmental research lab, the Computer Science and Artificial Intelligence Laboratory (CSAIL).

In 1962 Bob was appointed Ford Professor of Engineering, a title he retained until his retirement in 1984. And he was the first associate department head for computer science in the Electrical Engineering and Computer Science Department (1971–74).

In addition to his technical advances, Bob was a very passionate mentor and educator. In his computer science lectures he used to say that "computing is fundamentally about communication among people," a view that remains accurate 50 years later.

His 1972 paper "On the Social Role of Computer Communications" (*IEEE Proceedings* 87(12):2130–35) highlights some of the fundamental issues that persist about computing and democracy, and about the responsibility of computer scientists to address technology's societal implications. In the paper he stated his belief about the importance and impact of computing on society:

The computer and communication technologies will not, by themselves, solve our problems, but it is very unlikely that we will be able to solve them without substantial help from them.

He also outlined his concerns about how the growth of automation could lead to a rigid bureaucracy defined by

“widespread surveillance” and control over information. “This is most likely to occur unintentionally as a result of the actions of many well-meaning people attempting to solve the problems they face in the best way they know how at the time,” he wrote. “The opposite choice involves exploiting [the technologies] to augment the intellectual capabilities of people and to facilitate communication between them.”

In 1976 he received the Claude E. Shannon Award for his work in information theory, and in 1977 the IEEE James H. Mulligan Jr. Education Medal for his contributions to the teaching of electrical engineering. Among his other honors, he was a member of both the National Academy of Engineering and the National Academy of Sciences, and a fellow of the Institute of Electrical and Electronics Engineers and the American Academy of Arts and Sciences. The International Institute of Communications awarded him the City of Columbus, Ohio Prize (1969) and the Columbian Gold Medal (1986) of the city of Genoa, Italy.

Bob also had a deep connection to education in his community. He served on the board of trustees (1973–93) of Bentley College in Waltham, MA, and was named a member of its executive committee in 1991.

Bob was predeceased in 1998 by his wife of 49 years, Jacqueline (née Crandall). He is survived by daughters Paola Nisonger, Linda Ryan, and Carol Fano, and five grandchildren.

