NATIONAL ACADEMY OF SCIENCES

JOHN ROBINSON PIERCE
1910–2002

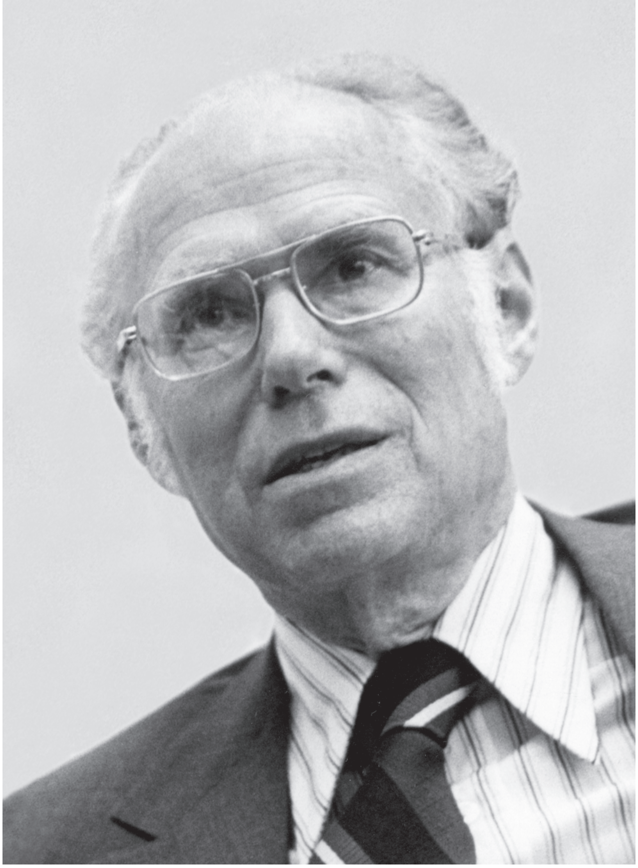
A Biographical Memoir by

EDWARD E. DAVID, JR., MAX V. MATHEWS,

AND A. MICHAEL NOLL

Biographical Memoirs, VOLUME 85

PUBLISHED 2004 BY
THE NATIONAL ACADEMIES PRESS
WASHINGTON, D.C.



J. R. Philip

JOHN ROBINSON PIERCE

March 27, 1910–April 2, 2002

BY EDWARD E. DAVID, JR., MAX V. MATHEWS, AND
A. MICHAEL NOLL

JOHN ROBINSON PIERCE is most renowned for being the father of communications satellites, namely, *Echo* and *Telstar*. He was also an active stimulator of innovative research in his division at Bell Labs from the mid-1950s to 1971. He was able to challenge and inspire many of the brightest researchers in communication science and technology, leading to a host of discoveries and innovations that created today's digital era. All who knew him were affected by his wit and quick, intelligent grasp of science and technology. He was a gifted author, not only of books that explained communication science and technology to nontechnicians but also of science fiction. His many keen comments are treasured memories of him that continue to inspire his many friends and colleagues. This wit led him to coin the term "transistor" for the device that his colleagues at Bell Labs had invented. We have all benefited from his innovativeness, intelligence, energy, and enthusiasm for communication science and technology.

John Robinson Pierce was born on March 27, 1910, in Des Moines, Iowa, an only child of John Starr Pierce and Harriet Ann Pierce. Although neither parent had gone beyond high school, they recognized their son's talents and worked to put him through the California Institute of Technology, where he earned his doctor of philosophy degree. Pierce spent most of his childhood in St. Paul, Minnesota. The family then moved in 1927 to Long Beach, California, where his parents worked in real estate sales, earning the money to pay for his education. They later moved to Pasadena so John could live at home to save money while attending Caltech and studying electrical engineering and physics.

During John's childhood, his father was frequently away from home for weeks at a time as a salesman. His mother had to cope with the mechanical problems of managing a household, which exposed John to all sorts of mechanical interests. "My mother encouraged me in all sorts of technical play," John said at one time, adding, "I was really my mother's child." Then, "As an only child with a certain amount of timidity, I led a somewhat sheltered life. I should have been learning more from other people and less from books." He clearly outgrew any timidity, eventually constructing and flying gliders until one of his acquaintances fell from such a machine and was killed. After that he ceased flying these homemade flyers. He quit because at the funeral of the friend, he thought about how many such funerals he had attended involving the glider community.

Reading excited him, at first science fiction and subsequently murder mysteries. The science fiction stories he wrote helped finance his education, and he would later state, "I wished that I could be a writer, but I thought it would be more practical to be an engineer." Even after he became one of the great research engineers at Bell Labs, he continued to enjoy writing, not only technical memoranda and books about communication but also science fiction under the pseudonym J. J. Coupling. He would later say, "I enjoy writing. . . . I also enjoy being known as the author." Clearly, writing was great fun for John. When he received the Marconi Award in 1979, he used the money to finance the writing of a book, *The Science of Musical Sound*.

Pierce was married three times. His first marriage, to Martha Peacock, the mother of his two children, John Jeremy Pierce and Elizabeth Anne Pierce, ended in a divorce in 1964 after 26 years. His second marriage, in 1964, was to Ellen Richter McKown, who died in 1986. Brenda Katharine Woodard, whom he married in 1987, survives him.

Upon graduation from the California Institute of Technology with a Ph.D. magna cum laude in 1936, John went to work at Bell Labs in its facility on West Street in New York City, where he performed research on vacuum tubes, particularly electron multiplier tubes and the reflex Klystron tube that was used in X-band radars during the Second World War. While at Bell Labs, John shared an apartment in New York City with Chuck Elmendorf (Charles Halsey Elmendorf III, later a vice-president of AT&T). They became fast friends over the next decades at Bell Labs and interchanged information and experiences.

In 1944 Pierce visited England, where he met Rudy Kompfner, inventor of the traveling-wave tube (TWT). Kompfner moved to Bell Labs in 1951, and they continued to perfect TWTs. While Kompfner saw the TWT chiefly as a low-noise amplifier, Pierce saw its application as a broadband amplifier. The Bell Labs' research organization and John moved from West Street to Murray Hill, New Jersey, in 1949, and John's work on TWTs continued until 1959.

As early as 1954 John had studied the practicality of using communications satellites to relay signals back and forth from Earth. In the summer of 1958 Pierce and Kompfner attended a summer study in Woods Hole, Massachusetts, sponsored by the Air Force. There they promoted the idea of a balloon satellite for communications, work that John would later say "had the most impact of anything I have ever done." A signal was to be sent to the satellite and bounced back to Earth. But Mervin Kelly, then president of Bell Labs, was not enthusiastic and refused to pursue it. His reasons involved the hostility of the U.S. Department of Justice and its aversion to the Bell System's "monopoly." Kelly retired in 1959, and his successor as president of Bell Labs, James Fisk, thought it was proper to proceed with the idea; *Echo* thus became reality. The *Echo* passive satellite was launched on August 12, 1960, and a message recorded by President Eisenhower was bounced off it. Pierce then went on to promote the idea for an active communications satellite, *Telstar*, which was to use transistors and a traveling-wave tube. However, the government then decreed that the Bell System, which was a regulated monopoly, should not work in satellite communications, just as Kelly had feared. (Kelly also foresaw the Justice Department's antitrust suit against the Bell System.) So *Telstar* was not deployed as a communications business. John would later state, "I took that hard . . . [but] I liked Bell Labs better than I liked satellites."

John, Claude E. Shannon, and Bernard M. Oliver described the idea of digital encoding of speech and other communication signals under the term "pulse code modulation" (PCM) and in 1948 published a paper entitled "The Philosophy of PCM" describing this technique in the *Proceedings of the Institute of Radio Engineers*. This paper and the ideas that led to and followed from it were the beginnings of today's digital era.

In 1952 John was made director of electronics research at Bell Labs, reporting to Harald Friis. John greatly admired Friis, who was very much his mentor at Bell Labs. Upon Friis's retirement, William O. Baker, then vice-president of research at Bell Labs, promoted John to executive director. Friis had formed a microwave laboratory in Holmdel, New Jersey, where the Bell System's highly successful long-distance microwave telephone transmission technology was developed. The microwave towers spaced about 30 miles apart throughout the entire country are still a visible reminder of this system. Kompfner took over the management of this laboratory, working under John.

John had a considerable affection for Bell Labs and a strong appreciation of the skills and talents represented there. The environment and mission of Bell Labs, which was to improve the performance of telecommunications across the world, profoundly influenced him. John always believed that any subject, no matter how complex, could be made understandable, and the creation of this clarity often required his skills and his ability to avoid becoming trapped in trivialities.

John spent over three decades of his professional life at Bell Labs. As executive director of communications research he reported directly to William O. Baker, the vice-president of research. John and Bill were a tremendous team, working together in a unique intellectual environment in which John could flourish, free from the bureaucratic intricacies that seem to grip so many organizations. Baker felt that Pierce's biggest contribution to Bell labs was "his ability to inspire and lead people." John retired from Bell Labs in 1971.

After retiring from Bell Labs, John joined the engineering faculty of Caltech, living in Pasadena in a stunning Japanese-style home with naturalistic pool and small waterfall. The layout was very graceful with *shoji* screens and sliding panels, but it lacked a private guestroom. John cured this deficiency by excavating a room under the house with his own hands. Nevertheless, after decades at Bell Labs, he found it hard to adapt to university life—raising research money and doing formal teaching, but he much enjoyed interacting with individual Caltech students.

He became emeritus at Caltech in 1980 and accepted the part-time post of chief technologist at the Jet Propulsion

Laboratory from 1980 to 1983, but his real interest in this last phase of his life turned to the technology of electronic and computer music. In 1983 he moved to Stanford as visiting professor of music associated with the Stanford Center for Computer Research in Music and Acoustics, CCRMA (pronounced "karma"). In 1987 Max Mathews joined him at CCRMA. They spent a wonderful decade working together until John's failing eyesight made computers inaccessible for him. In 2000 Parkinson's disease forced him to move to an assisted living facility.

John had a long-time interest in music. He studied the piano while a student at Caltech and later installed a pipe organ in his home near Bell Labs. John, Claude Shannon, and Shannon's wife, Betty, who was a pianist, carried out several ingenious experiments to estimate the information content of music. The results were interesting but not successful, and the essence of music continues to this day to elude quantification as information.

John and Mathews attended a piano concert in 1957, which included pieces by Schoenberg and Schnabel. They both felt that the Schoenberg was great and the Schnabel was horrible. During the concert, John said to Mathews, "Max, with the right program your equipment should be able to synthesize better music than this. Take some time and write a music program." This sojourn into computer music was possible because to facilitate research on speech coding, Mathews with Ed David and H. S. McDonald had recently developed equipment to put digitized sound into a computer and to recover processed sound from a stream of numbers generated by the computer. John's support and inspiration led Mathews to write a series of programs, "Music 1" through "Music 5," which started and set the course of present-day synthesized music. John, frustrated by his limitations as a pianist, took up the computer with great zest and composed about a dozen early pieces and exercises for the computer—more original compositions than anyone else.

AT&T administrators, when it came to their attention, were not enthusiastic about the public success of music programs. They asked for an explanation as to the appropriateness of the work in a telephone company laboratory. With the strong support of both John and Bill Baker, Mathews was able to show them how music synthesis grew directly out of vital speech compression research and how music synthesis techniques fed back useful technology to speech synthesis. Without the support and encouragement from John and Bill Baker, computer music would not have begun when, where, and how it did. Similar comments can be made about radio astronomy and the measurement of the 3° Kelvin background noise that supports the big bang theory of the beginning of the Universe. The measurement required Harold Friis's very-low-noise horn antenna at Holmdel, New Jersey.

During his decade at Stanford, John's interests focused on the perception of music. He created a new course in musical psychoacoustics He also invented a new musical scale based on a new chord, the 3:5:7 chord, which has many properties similar to the conventional major triad, the 4:5:6 chord. The 3:5:7 chord leads to a different harmony since its scale does not contain octave intervals (2:1).

In addition to his scientific contributions to music, Pierce was the most important patron of computer music. He attracted support for this field during its adolescence from 1970 through 1985. Without the funds he secured, computer music certainly would have progressed much more slowly and might not have survived.

John was a very social person. He was also very practical and efficient. He loved to write. Some of his books served multiple purposes. *Man's World of Sound*, written with David, is a good example. He and David had recently been given the task of managing speech research at Bell Labs, a domain new to both men. On a trip to attend a seminar on the subject in New York City they discussed their concerns. John said, "Ed, what do you know about speech and hearing?" David answered, "Very little." Pierce replied, "Then let's write a book about that." Ed concurred with enthusiasm. After the meeting, John called his editor; they went downtown and signed a book contract. The result was not only a fine book but a lifelong friendship.

Another example of an authorship, which served multiple purposes, was the rewrite of *Signals* with Noll. The original book, still useful for teaching, was out of print and needed revision. John also was glad to have a reason to work with Noll, a long-time friend whose work on computer graphics and arts John particularly admired. After agreeing to the collaboration, John, as he always did, crashed ahead as if to win a race with Noll to see who could write the quicker.

John was like an electron, a package of energy that seemed everywhere, yet was indefinable. His fast mind was quick to grasp concepts, and his energy was inexhaustible. He ran up and down stairs, always in a hurry. His speech seemed unable to catch up with the thoughts in his mind. He was very impatient, and would have little time for those who dallied or delayed the forward progress of science and technology. John always seemed restless, and this could make him seem forbidding in his dealings with people.

John certainly had strong views and a gift for summarizing these views in one-line statements. During a conference on the use of computers, including people from his division, much to John's disapproval, John dismissed the project saying, "What is not worth doing is not worth doing well." Another famous John one-liner was his dismissal of research into artificial intelligence, saying, “Artificial intelligence is mostly real stupidity.”

John was always very modest. He had little patience with Washington and its bureaucracies, and never created a lucrative consulting business around himself. Asked why he did not do so, he responded, “I didn’t promote myself.”

JOHN R. PIERCE IN HIS OWN WORDS

On technical journals

I will say this of our multitude of technical journals, they beat the hell out of ideas mathematically and erect an awful lot of mathematics about things. And whether they really find out anything, I don’t know. I will say that one of my criteria in life is that things have to be good enough. But after they’re good enough, they get a little boring.[1]

On music

I like striking and effective music. I think that one of the troubles with avant-garde is that they don’t know what else to do to be different.[1]

Electronically produced sounds should not be part of electronics; they should be a part of the evolution of musical sound, from drum, lyre, and Stradivarius to some of today’s entirely new sounds.[5]

On information theory

Make no mistake. Information theory is not nonsense just because so much nonsense has been written about it.[4]

On communications satellites

Communications satellites were more important than I could have realized.[1]

On Bell Labs and administration in general

Doing things right is awfully important. But that wasn't my part of Bell Laboratories. My part was finding either new ways to do or rather drastically different ways of doing them.[1]

[I]n the university, no one can tell a professor what to do, on the one hand. But in any deep sense, nobody cares what he's doing, either. . . . But in the Bell Laboratories . . . research department . . . people cared about everything.[1]

[T]he Bell Labs, where I worked for 35 years, was the best industrial research laboratory in the world, and perhaps the best laboratory in the world.[2]

When I was Executive Director, the person who appeared at my door or who called me had precedence over anything else.[1]

On his life and creativity

I've really had a lot of good fortune in my life. But you'll never have good fortune unless you believe you're fortunate.

I've never been a good experimenter. I did a lot of tinkering.[1]

I've described myself as a low-grade theoretician.[1]

Night thoughts or dreams seldom solve problems correctly or definitively, however great the inspiration may seem at the time.[2]

My view of getting something new done was always that you started small with somebody who had done something real. With good luck, that would grow.[3]

Some problems are so difficult that they can't be solved in a hundred years, unless someone thinks about them for five minutes.

On universities

It takes a great deal of a lot of things to operate successfully on a university campus. If you really want to be successful, you have to set up a stream of graduate students and government support.[1]

On the application of science

Valid science is never old or out of date. It is only speculation about science, the "application" of science to philosophy, and false analogies between science and other matters that become old almost as soon as they are new.[6]

Surely, it is wonderful if a new idea contributes to the solution of a broad range of problems. But, first of all, to be worthy to notice a new idea must have some solid and clearly demonstrated value, however narrow that value may be.[7]

On knowledge and the future

Knowledge is hard learned. But, without knowledge, we can do no more than fantasize, which is childishly easy. The knowledge that can take us beyond fantasy requires an exercise of the mind, an exercise that can be as invigorating as exercise of the body.[4]

Whatever we may say of the future, it is open to us. That is, if we are knowledgeable enough to act, and if we leave ourselves free to act.[4]

I do feel sure that the future will be different, and I hope that it will be better. All of my experience tells me that the way to make it so is to work hard on present problems, with an eye always open for the unexpected.[6]

John Pierce was an extraordinary person with many skills and an awesome intellect. He contributed to the productivity of the many people, institutions, and corporations that came into contact with him. Above all, John Pierce was a person of strict integrity. He knew the difference between speculation, wishful thinking, and factual evidence. Pretense was not his way. This attitude permeated his life, his contributions to science and engineering, and his personal relations. We will not often see his kind again.

HONORARY DOCTORATES

1961	D.Eng., Newark College of Engineering
	D.Sc., Northwestern University
1963	D.Sc., Yale University
	D.Sc., Polytechnic Institute of Brooklyn
1964	E.D., Carnegie Institute of Technology
1965	D.Sc., Columbia University
1970	D.Sc., University of Nevada
1974	LL.D., University of Pennsylvania
	D.Eng., University of Bologna (Italy)
1978	D.Sc., University of Southern California

HONORS

1955	Elected to membership in the National Academy of Sciences
1960	Stuart Ballantine Medal (Franklin Institute)
1962	Elected to membership in the American Academy of Arts and Sciences
1963	National Medal of Science
	Edison Medal (IEEE)
1965	Elected to membership in the National Academy of Engineering
1974	John Scott Award (Franklin Institute)
	Marconi Fellowship Award
1977	Founder's Award (National Academy of Engineering)
1985	Japan Prize
1987	Arthur C. Clarke Award
1995	Charles Stark Draper Prize
2003	National Inventors Hall of Fame (posthumous)