Philip McCord Morse

1903-1985

By Robert Herman

Philip McCord Morse, professor emeritus of physics at the Massachusetts Institute of Technology (MIT), founder and pioneer of modern operations research, physicist and renaissance scientist, community leader, and leader in professional societies, died on September 5, 1985, in Concord, Massachusetts. As Phil Morse wrote in his autobiography, *In at the Beginnings: A Physicist's Life,* 1977, "They told me I was born on August 6, 1903, at three in the morning; I don't remember. My seventy-year memory tape is a series of vividly recollected scenes, separated by blanks later filled in with conjecture and hearsay. The early scenes are disconnected flashes, glimpses of a now unfamiliar world, seen through a stranger's eyes. It takes effort to remember how different that world was, how many differences there are between the Midwest of 1910 and the East Coast of the 1970s."

Morse's distinguished career in science and technology is characterized by a remarkable breadth and diversity of interests. In physics, it ranged from acoustics and quantum mechanics to nuclear physics and methods of theoretical physics. In operations research, which he pioneered, his career encompassed military operations research, vehicular traffic, queues, and public systems. His fundamental contributions in these diverse areas, together with his service to the pro fessional community and society in general, created a most outstanding career.

His early development years were spent in Cleveland, Ohio. He was the son of a telephone engineer, the grandson of a civil engineer, and the great grandson of an architect and builder. His great grandfather worked for the federal government designing and building post offices and custom houses all over the country and was also elected to the Ohio legislature. While still in grade school, Morse read voraciously, was attracted to chemistry, and learned to play the violin. He indicated that while facts didn't interest him very much he was excited by patterns, such as the recurrent patterns in the Mendeleev table of the elements. During high school he decided to become a chemist. Interestingly, he never aspired to be a mathematician because, he said, mathematics had been treated as a tool rather than as a subject for intellectual exploration. Eric Bell's *Men of Mathematics* had not yet been written when Morse made that statement; he later speculated that if the book had already appeared he might have become enmeshed in the mysteries of prime numbers of Diophantine analysis and his entire life might have been different. As for his nonscholastic interests, when the radio craze hit Cleveland in the early twenties, Morse operated his own radio supply and repair shop.

After one year of undergraduate study, Morse took the year 1922-23 off to operate his radio business when family fortunes were at a low ebb. By the fall of 1923 when he returned to college as a sophomore, he was considerably more certain about what he wished to learn. Upon deciding to pursue the physics program, his father's only comment was, "That's fine, but what will you do for money?" It is interesting to read in Morse's recollections that he didn't share this concern for money and that he envisioned a career teaching college physics. He commented at the time that "Professors never got rich—but then they never seemed to starve."

Morse received his B.S. in 1926 from what was then the Case School of Applied Science. He pursued his graduate studies at Princeton University and received his Ph.D. in physics in 1929. It was during his undergraduate days that he became involved with the eminent American physicist Dayton C. Miller, who was one of the earliest experts in sound and musical acoustics, and whose large collection of flutes is now in the Library of Congress. It was during this period that Morse developed his lifelong interest in acoustics.

Physics and mathematics claimed much of his time as a graduate student at Princeton. Three courses didn't sound like much to him, but analytic dynamics, electron theory, and mathematical physics generated a great work load. Unlike the students of pure mathematics, Morse was interested in analysis and higher algebra as the language of physics. The late 1920s were exciting times thanks to the development of the new quantum mechanics; in 1930 Dirac prophesied accurately that quantum mechanics would explain all of chemistry and most of physics.

Aside from his course work and research on molecular physics with Ernst Stueckelberg, with whom he published several papers, Morse developed a solution for a force that was repulsive when two particles are close together, attractive when they are further apart, and under which they vanish at greater distances. He realized that he had stumbled upon a quantum mechanical representation of a vibrating diatomic molecule. To this day, the particular force field, expressed as a related potential field, is known as the Morse Potential.

Edward Condon, upon his return from Europe, where the new quantum theory had been developed, decided to write an English text on the subject. When the writing progressed too slowly, he invited Morse to collaborate. The idea appealed to Morse as an opportunity to learn the rapidly developing quantum mechanics not only by teaching it but by structuring a monograph on it. Thus, Morse coauthored one of the earliest texts on the new quantum theory.

Among his other notable associations, he assisted in the development of the theoretical understanding of the Davison-Germer experiment during a summer at the AT&T Bell Laboratories. His postdoctoral studies were conducted with Arnold Sommerfeld in Munich and included theoretical research in electron scattering under an international fellowship. Thanks to Morse's early renown, Karl T. Compton, then president of MIT, asked Morse to join the MIT physics faculty when he returned from his fellowship in Europe. As Morse recounts—"It was easy to say yes."

So Morse joined the MIT physics faculty in 1931 as assistant professor, rapidly rose to associate professor in 1934, and became a full professor in 1938. With his very broadly gauged interests, he participated in the development of the physics curriculum and accepted the position of graduate registration officer. His research continued in a diverse fashion; during this period he worked on electron scattering, nuclear binding forces, and even on the subject of stellar interiors in astrophysics. One of his important contributions to physics was the acoustics textbook *Vibrations and Sound* published in 1936. This work presented the application of scattering theory to sound waves. In fact it was also during this early period in Morse's life that he developed course notes that were later combined with those of Herman Feshbach to produce the famous two-volume work *Methods of Theoretical Physics,* published in 1953. The book is a basic source of methods of mathematical physics to this day.

With the advent of World War II, Philip Morse's renaissance talent entered a new phase in his technical life. By the time the United States entered the war, the catastrophic loss of allied ships to the German U-boats in the Atlantic Ocean was a major concern. It was imperative that the U.S. develop superior equipment that would locate and neutralize this threat. The British, who had been engaged in the struggle for two years, already had several operations research groups not only designing equipment but also studying and maximizing its effectiveness in actual war operations.

Early in 1942 the U.S. armed forces established an operations research group in the navy. Morse, who was considered a distinguished scientist and who had been the director of a project at the Underwater Sound Laboratory at Harvard University for the previous two years, was chosen by the National Defense Research Council to head the operations research effort.

Several months after the formation of the operations research group, the navy consolidated the antisubmarine operations under the Tenth Fleet, and the Antisubmarine Warfare Operations Research Group was transferred to Washington, D.C. Morse had a substantial fraction of the group out in the field working with the operational commands. He did an outstanding job both in coordinating the technical work and in his liaison with the operational leaders running the actual war operations. Those who worked with Morse during this period report that it was a continuous learning experience. As the war effort and operations research became more successful, the Antisubmarine Warfare Operations Research Group became the navy's Operations Research Group. This group took on submarine activity studies in the Pacific Theater of Operations. It then addressed naval air activities and ultimately became involved in all aspects of navy task force operations. The group became very well accepted and at the conclusion of the war Morse received the Presidential Medal for Merit, the nation's highest civilian award.

After the war Morse generated an orderly windup of the group's activities, part of which became the nucleus of the Operations Evaluation Group. He returned to research and teaching at MIT but continued to monitor this postwar transition. In 1946, he had been at MIT no longer than one year when he became the director of the Atomic Energy Commission's Brookhaven National Laboratory. The position occupied all of his time in organization and administration and left no time for personal scientific research. In 1948, with Brookhaven well established, Morse went to Washing ton to organize an operations research group for the Secretary of Defense and the Joint Chiefs of Staff. This resulted in the Weapons Systems Evaluation Group for which he served as deputy director and director of research until 1950. The group's civilian unit developed into the Institute for Defense Analyses in 1956; Morse served as a trustee.

In another area of interest, Morse was convinced of the great importance of computation and the rapidly growing power of the digital computer. This no doubt arose from his experience with calculations in acoustics and astrophysics in the late 1930s. The establishment of the MIT Computation Center was a result of his efforts to introduce computers to research and research to computers in the late 1940s and early 1950s. He became its first director and served in that position until 1967.

In 1952 Morse created an operations research activity at MIT with an interdepartmental committee and a small contract for fundamental research from the U.S. Army. In two years, the first doctoral student, John D. C. Little, was graduated, and in 1956 the Operations Research Center was formally established with Morse as director; he remained in this role until his official retirement in 1968. His high research activity in the field of operations research was continuous and included the following books: *Queues, Inventories and Maintenance,* 1958; *Library Effectiveness: A Systems Approach,* 1968; *Operations Research for Public Systems,* 1967, coeditor; and *Analysis of Public Systems,* 1972, coeditor.

The Operations Research Society of America (ORSA) was founded in 1952, and as might have been expected, Morse became its first president. Of the next eight presidents, half had worked for him in one capacity or another, mostly during World War II. About twenty years later, there came an echo of Morse's influence as two of his former students became presidents of the society. Morse received the Frederick W. Lanchester Prize of the Operations Research Society in 1968 for his library work and was the first recipient of that society's George E. Kimball Medal in 1974 for his contributions to the profession of operations research in general and to the Society in particular.

Professor Morse's worldwide promotion of operations research never ceased. He was involved in organizing the first International Operations Research Conference in 1957; the International Federation of Operations Research Societies originated at this conference. Interest in the operations research discipline overseas led to the 1959 North American Treaty Organization conference with Morse as chairman of the advisory panel. He was associated with many international operations research projects in which he always stressed that the discipline was applicable to a host of fundamental problems that were neither military nor industrial in nature. It is interesting to recall that most recently, in April 1985, at the age of 81, Morse chaired a session at ORSA's Boston meeting and spoke on the early use of computers in operations research, a topic that combined two of his major interests.

Morse's honors are legion. Among these, he was a member of the National Academy of Sciences; and a fellow of the American Academy of Arts and Sciences, the Acoustical Society of America, and the American Physical Society. He was elected to the National Academy of Engineering in 1985. He was also a member of Sigma Xi, Tau Beta Pi, and the Cosmos Club of Washington. He received the Silver Medal of the Operational Research Society of the United Kingdom, and the Gold Medal of the Acoustical Society of America. He was the president of the Acoustical Society of America (1950-1951) and of the American Physical Society (1971-1972). In addition, he was a member (1974-1977) and chairman (1975) of the Governing Board of the American Institute of Physics. From 1958 to 1960 he was chairman of the MIT faculty.

Philip Morse, one of the first wave of home-grown American scientists, made outstanding contributions to science and technology through his work in physics, computer science, and operations research. He influenced and guided many students and colleagues in the struggle to seek scientific truth. In his autobiography Morse gives great food for thought to many of us. He reflects that his successes would have been fewer had he not chosen, back in 1923, to become a physicist through training that forced him to look facts in the face, that made him want to measure them and work out their implications, whether these facts applied to atoms or automobiles.

The last comment of Morse's autobiography conveys much of his philosophy—"For those who like exploration, immersion in scientific research is not dehumanizing; in fact, it is a lot of fun. And, in the end, if one is willing to grasp the opportunities, it can enable one to contribute something to human welfare."