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PHILIP MCCORD MORSE

1903—1985

A Biographical Memoir by

HERMAN FESHBACH

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Biographical Memoir

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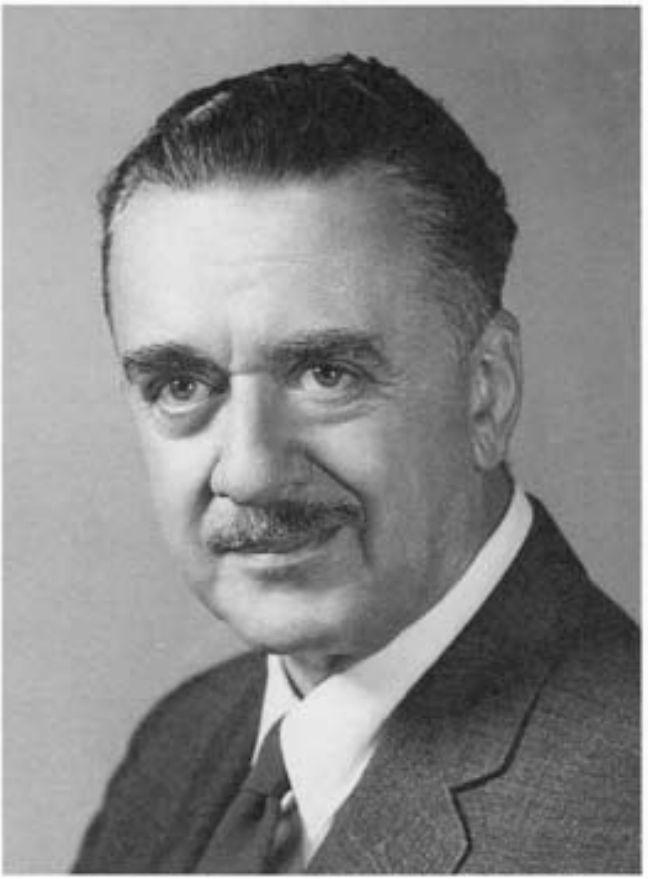

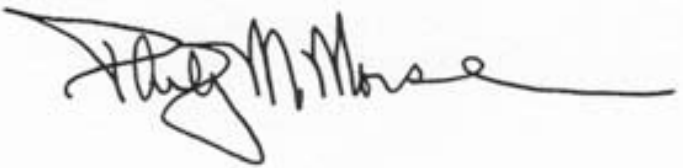

PHILIP MCCORD MORSE

August 6, 1903–September 5, 1985

BY HERMAN FESHBACH

DURING HIS LIFETIME, Philip McCord Morse was at times a researcher, educator, author, pioneer, a statesman of science, and an administrator. He filled all these roles with distinction in a career replete with accomplishments of importance not only for science for also for society. The high regard in which he was held is indicated by his election to the presidency of the American Physical Society, the Acoustical Society of America, and the Operations Research Society of America. He was awarded the U.S. Presidential Medal for Merit, recognition of his extraordinary service during World War II.

Philip M. Morse was born on August 6, 1903, at Shreveport, Louisiana. The family shortly afterward moved to Cleveland, Ohio, where Morse spent his youth, graduating from the Case School of Applied Science (now part of Case–Western Reserve University) in 1926. The family on both sides was from Ohio. His great-great-grandfather founded the town of Kirtland, east of Cleveland in the early nineteenth century. His mother was a reporter on the newspaper edited by her father in East Liverpool, Ohio. His father was a telephone engineer who worked in telephone-system construction. They married in 1901.

It surely was easier in 1921 but still it is most revealing.

Morse joined a young radio operator and his two friends in setting up a radio-supply store. He was eighteen. Later he contributed a weekly article to a Cleveland newspaper on items of interest to radio fans. It demonstrated a facet of his character, as symbolized by the title of his autobiography, *In at the Beginnings* (1977). Morse was able to initiate, to be first, to create new entities. There was an element of daring but also the ability to discern a need and to respond to that need. His volume with E. U. Condon was the first American book on quantum mechanics. He revolutionized the study of acoustics with his book *Vibration and Sound.* He initiated the study of operations research in the U.S. and then actively secured its use throughout the world. He founded and was the first president of the Operations Research Society. He was the first director of the Brookhaven National Laboratory. He was the first director of the MIT Computation Laboratory. He was the first chairman of the APS Panel on Public Affairs. He founded and was the first editor of the *Annals of Physics.*

The major figures in his career at Case were a mathematics-astronomy professor, Jason J. Nassau, and the well-known Dayton C. Miller. Morse's first paper published in 1927 was with Nassau. Morse served as Miller's assistant in the latter's attempt to improve upon the Michelson–Morley experiment and thus detect the ether drift. But of greater importance to Morse's career was the interest in acoustics which Miller generated.

Morse decided to go to Princeton for his graduate work. The department was then headed by K. T. Compton, whose main research was in electron discharge in gases, a forerunner of what is today called plasma physics. Morse joined in this research publishing four papers between 1927 and 1929. But the big excitement of the day was the discovery of quantum mechanics by Heisenberg and Schrödinger. Morse joined

with E. U. Condon to publish the first American text on this subject in 1929. His research then turned to the quantum mechanics of diatomic molecules, writing several papers on this subject with E. C. G. Stueckelberg from 1929 to 1941. It was during this period that he discovered the "Morse potential" for which solutions to the Schrödinger equation in a closed form could be obtained. He applied this result to a discussion of vibration of diatomic molecules.

He married Annabelle Hopkins in April 1929. They had two children, Conrad Philip and Annabella.

In 1930 Morse lectured on quantum mechanics at the famous University of Michigan summer school. He and Annabelle then departed for Munich and Cambridge as a Rockefeller International Fellow. It was during this period that he collaborated with Stueckelberg on collision processes and wrote a seminal paper on the scattering of slow electrons with W. P. Allis, a lifelong friend and colleague. In 1932 he wrote a fifty-seven-page article in the *Review of Modern Physics,* entitled "Quantum Mechanics of Collision Processes."

On his return to the United States in 1931, Morse joined the MIT Physics Department. K. T. Compton was the new president and John C. Slater was the new head of the department. It was Compton's goal to convert the department from a service department to one which would play an important role in both research and education in the world of physics. Among his colleagues were Julius Stratton, W. P. Allis, R. J. van de Graaf, Manual Sandoval y Vallarta, B. Warren, George Harrison, Francis Bitter, Robley D. Evans, and N. H. Frank. It was an exhilarating time as this group wrestled with the problems of creating a new and vital department. The two wonderful elementary texts by Frank and the *Introduction to Theoretical Physics* by Slater and Frank were among the products of this cooperative enterprise.

Research continued with publications on atomic wave function, and in 1935–37 publications on the neutron-proton scattering with J. B. Fisk and L. I. Schiff, which exploited once more the happy properties of the Morse potential. Except for his papers on the "Opacity of Gas Mixtures in Steller Interiors" published in 1940, and "Excitation of Molecular Rotation—Vibrations by Electron Impact" in 1953, these were his last papers in which quantum mechanics plays an important role.

As part of the renaissance of the MIT Physics Department, Morse taught two new courses. The one on acoustics lead to the publication of *Vibration and Sound* in 1936, and the publication in 1968 of *Theoretical Acoustics* with K. U. Ingard. In these books and in his research he treated the wave properties of acoustical systems, rooms, pipes, and internal combustion engines (the last with Charles Stark Draper) using the methods he had learned in his quantum mechanical studies. In 1944 he and Richard H. Bolt published a *Review of Modern Physics* article on "Sound Waves in Rooms." This article, together with one on "Acoustics Impedance and Sound Absorption" (1940 with Bolt and R. L. Brown), form the foundation of modern room acoustics. The principles developed in these papers are used today in the design, for example, of orchestral halls.

A second course initiated by Morse was entitled "Methods of Theoretical Physics." He worked up a set of notes which I revised and enlarged during the period Morse was away from MIT because of World War II. These notes, further enlarged, eventually became the two-volume book, *Methods of Theoretical Physics,* published in 1953. This book deals with the equations satisfied by the classical fields as well as the one-body Schrödinger equation. It had the unusual feature of stereoscopic illustrations drawn by Morse which permits three-dimensional views of coordinate systems, electric

and magnetic fields, etc. By this time well over 50,000 two-volume sets have been sold to which should be added the 25,000 translated into Russian and printed in the Soviet Union. Some thirty-seven years later it is still selling but it is time for a revision.

We are getting ahead of our story. Morse's participation in World War II had a decisive impact on his career. At the beginning he was director of the MIT Underwater Sound Project (1940–42), which had as its main goal the development of a noisemaker that could mimic the sound of a ship well enough to fool an acoustic mine. A very simple structure was eventually invented. It was later used effectively against the acoustic torpedo employed by the German submarines.

Morse's principal contribution to the war effort was as director of the U.S. Navy Operations Research Group (1942–46). Its task was the containment of the U-boat offensive which was destroying Atlantic and Mediterranean shipping at a catastrophic rate. Morse brought the physicist's approach to this problem. In this approach it is necessary to understand what the important variables are and to obtain quantitative relations among them by comparisons with field data. Both of these required, as Morse soon discovered, the active involvement of the civilian scientist in gathering and evaluating the necessary data. Moreover, new equipment could not be effectively used unless care was taken to fit the equipment to the capabilities of its generally non-technical users and to the circumstances under which it is to be used. Scientists in the field were absolutely essential to the development and use of new tactics, as well as of new equipment. It was a great step forward when Morse was able to convince the Navy of the necessity of scientifically sophisticated field observers. The anti-submarine campaign suc-

ceeded and, in recognition of that success, Morse was awarded the Presidential Medal for Merit in 1946.

A by-product of this wartime experience was the recognition of a new branch of applied science, operations research. Morse's postwar years were in large part devoted to research in this field as well as acting as a missionary to the world's industrial, military, and academic sectors on the usefulness of operations research. At MIT, he became director of the Operations Research Center and began giving out advanced degrees in the subject. He lectured on operations research in France, England, Japan, Greece, Norway, Taiwan, India, and Israel. He was secretary-general of the International Federation of Operations Research Societies. He advised the militaries of both the U.S. and NATO. He collaborated on projects of the non-military Organization for Economic Cooperation and Development (OECD). Industry and civilian governmental agencies were also patrons. And he wrote several books. One with George K. Kimball, entitled *Methods of Operations Research* (1951), summarized their wartime experience. *Queues, Inventories and Maintenance* (1958) is an example of the use of operations research in civilian situations. An interesting application was its use to improve the management of libraries, to which Morse contributed several articles as well as a book, *Library Effectiveness: A Systems Approach* (1968).

Morse's return to MIT after his war service lasted a very short while, for he soon accepted the position as the first director of the Brookhaven National Laboratory established by a consortium of leading eastern research universities. The laboratory was located at the World War I army camp at Yaphank. A laboratory had to be created from scratch. This involved not only the construction of scientific facilities, including a nuclear reactor, but a whole organization had to be created as well. A staff had to be recruited, physi-

cal facilities constructed, a library built up. And there were many decisions to be made on what research the new laboratory would conduct, and on the relationship of the laboratory to the members of the consortium and to the Atomic Energy Commission. Establishing good relations with the laboratory's neighbors was still another task for the director.

In 1948 Morse returned to MIT. There he served as chairman of the faculty (1958–60). Perhaps his most important contribution to MIT in the postwar period came from his recognition of the important role computational facilities would have for MIT's research and education. He became chairman of the MIT Committee on Machine Aids to Computation (1950–52) and then chairman of the succeeding Computation Committee (1953–67). He was instrumental in inducing IBM to donate its best computer of that time, the IBM 704, to MIT together with funds for a dozen fellowships in computer use for students. Later the 704 was replaced by still more powerful IBM computers, the 709, the 7090, and then the 7094. Eventually, the Computation Center developed a time sharing system.

One should also mention Morse's initiative which resulted in the publication of the extraordinarily useful volume published in 1964, *The Handbook of Mathematical Functions with Formulas, Graphs and Mathematical Talks.*

Morse retired from MIT in 1968. At a dinner held to mark that occasion he was presented with a book entitled *In Honor of Philip M. Morse,* containing articles on nuclear physics, acoustics, and operations research written by his friends and colleagues in an expression of their high regard for him, for his accomplishments, and for his friendship.

In touching on some of the highlights of his multi-faceted career I have said little about Morse, the man. Need-

less to say, he possessed extraordinary talent and energy. He was a quick study. Characteristically discerning problems, his response was to find a pragmatic solution. There was much talk but in short order a practical plan was developed and implemented. In spite of his many endeavors, he found time for mountain climbing, for the theater, and for reading. He read on the average of five books a week, mostly in the fields of history, archeology, and biography. He was especially concerned for the human condition, as evidenced by his chairmanship of the American Physical Society's Panel on Public Affairs. Under his leadership, the panel not only sponsored important studies at the intersection of physics and public policy but also devoted considerable effort in behalf of physicists oppressed by totalitarian regimes. In his autobiography he wrote, "A corporation should not have the right to deplete irreplaceable mineral resources or to damage irreversibly our environment. A city should not be allowed to foster segregation and pollution by its tax and zoning laws. A country should not have the right to reduce another country to poverty and starvation just to increase temporarily its own citizen's standard of living—or merely their dream of omnipotence." Morse in 1977 saw the future need for international planning, a development which is today apparent in scientific, economic, and environmental arenas.

He was an excellent scientist, a caring person, and a wonderful friend and colleague. He died on September 5, 1985, in Concord, Massachusetts.

HONORS AND DISTINCTIONS

1926	Bachelor of Science, Case Institute
1927	Master of Arts, Princeton University
1928	Porter Odgen Jacovus Fellow, Princeton University
1929	Ph.D., Princeton University
1929–30	Instructor of Physics, Princeton University
1930–31	Rockefeller International Fellow, Munich and Cambridge, England
1931–34	Assistant Professor of Physics, Massachusetts Institute of Technology
1934	Fellow of American Academy of Arts and Sciences
1934–39	Associate Professor of Physics, Massachusetts Institute of Technology
1939–69	Professor of Physics, Massachusetts Institute of Technology
1940	Doctor of Science (Honorary), Case Institute
1940–44	Chairman, NRC Committee on Sound Control
1940–42	Director, Navy—MIT Underwater Sound Project
1942–46	Director, U.S. Navy Operations Research Group
1945	Distinguished Service Award, U.S. Navy Bureau of Ordinances
1946	U.S. Presidential Medal for Merit
1946–48	Director, Brookhaven National Laboratory
1949–50	Deputy Director and Director of Research, Weapons Systems Evaluation Group
1950–65	Graduate Registration Officer, Department of Physics, MIT
1950	President, Acoustical Society of America
1952–69	Chairman, Operations Research Committee, MIT
1952–53	President, Operations Research Society of America
1953–67	Chairman, Computation Committee, MIT
1954–65	Chairman, NRC Committee on Revision of Mathematical Tables
1955	Elected to National Academy of Sciences
1955–69	Chairman, Committee of Institutional Representatives to the MIT Computation Center
1956–76	Editor, *Annals of Physics*, Academic Press, New York
1956–69	Director, Operations Research Center, MIT

1957–67	Director, Computation Center, MIT
1958–60	Chairman of the Faculty, MIT
1960–64	Chairman, NATO Advisory Panel on Operations Research
1961	Awarded Silver Medal of the Acoustical Society of America
1962–68	Chairman, OECD Advisory Panel on Operations Research
1965	Awarded Silver Medal of the United Kingdom Operational Research Society
1967–70	Chairman, Advisory Panel to Technical Analysis Division of the National Bureau of Standards
1969	Awarded Lanchester Prize, Operational Research Society of America
1972	President, American Physical Society
1973	Awarded Gold Medal of the Acoustical Society of America
1974–75	Chairman, Special Study for Strengthening the Capabilities of Less Developed Countries in Systems Analyses, National Academy of Sciences, Board of Science and Technology for International Relations
1974	Awarded Kimball Medal by the Operations Research Society of America
1975	Chairman, Governing Board, American Institute of Physics
1975–76	Chairman, Panel on Public Affairs, American Physical Society

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