



Jacob P. Den Hartog

Jacob Pieter Den Hartog

1901–1989

By Robert Cannon and Stephen Crandall

Jacob Pieter Den Hartog, internationally famous vibration consultant, author, and teacher, died March 17, 1989, after a long illness. He authored the best-known textbook on mechanical vibrations and was widely acclaimed for his skill in perceiving the mechanisms underlying unexpected vibration problems in machines and structures.

Yet above all, Professor Den Hartog was a consummate teacher. He would get you raptly engrossed in some inscrutable mechanical system, and envelop you in the sheer fun of imagining the ways in which it will move, and why—physically. It's called dynamics; and he taught each of its secrets with words that always created a vivid image of yet another particular mechanism whose intriguing behavior dramatized a generic concept. And you never forgot that image; and that's why that concept was now yours in whatever new guise you encountered it. Generations of students were enriched by this man of verve, of wit, of captivating physical insight, who was affectionately known as Jaappy (pronounced Yahppy, the Dutch diminutive of Jacob).

Den Hartog was born on July 23, 1901, in the Netherlands East Indies (now Indonesia), where he lived until the family returned to Holland in 1916. He did his undergraduate study at Delft Polytechnical Institute in Holland, graduating with a degree in electrical engineering in 1924. Because of poor economic conditions in Holland at that time, he emigrated immediately to the

United States. Through a series of fortunate accidents, he soon found himself in Pittsburgh working for Westinghouse as the assistant to a Russian émigré, Stephen P. Timoshenko, twenty years his senior and venerated world guru in applied mechanics. Timoshenko's selection process was to compose a written examination for the group of Westinghouse candidates to try their hand at. When he saw Den Hartog's solution set he pronounced, "Bring me this man!"

Timoshenko assigned the young Dutchman to a gamut of vibration problems in electric motors and generators, hydraulic power machinery, railroad electrification, steam turbines, and the like. And his repertoire of physical images began to take shape. The sequence, Dr. Den Hartog explained, was that "one day in freshman physics at Delft the professor slowly charged up two great spheres, one at each end of the lecture table, until suddenly a great bolt of electricity leaped between them. *At that instant* I became an electrical engineer; and it took Stephen Timoshenko three years in Pittsburgh to convert me back to mechanical." Later a son was named Stephen Den Hartog.

While at Westinghouse, Jacob Pieter studied mathematics at the University of Pittsburgh in the evenings, completing his Ph.D. in 1929 with a thesis on nonlinear vibrations.

In 1931 he spent a sabbatical year in Göttingen in the laboratory of Professor Prandtl. On his return in 1932 he joined the faculty of Harvard University and began his teaching career, lecturing on vibrations and assembling an extensive collection of vibration demonstration models. His lectures had such a reputation that professors from the nearby Massachusetts Institute of Technology (MIT) would take the trolley across town to sit in with the Harvard students. Here he published the first edition of his famous text *Mechanical Vibrations* in 1934. He had also published another dozen papers before the signs of impending war persuaded him that he could be more useful (and have more fun) by serving in the military than by remaining a civilian. He accepted a reserve commission in the U.S. Navy in 1939. From 1941 to 1944 he was on active full-time duty on ship vibration problems in the Bureau of Ships, working in the nation's navy yards and ships as well as in naval machinery

manufacturing plants all over the country. In 1945 he served in Europe on the Naval Technical Mission, Europe.

When the war was over, Captain Den Hartog returned with great energy and enthusiasm to a civilian life of consulting, and to a new—and rest-of-his-life—post as professor of mechanical engineering at MIT. He served also as department head from 1954 to 1958, but his first love was lecturing and tackling challenging consulting problems.

His consulting life was one of helping solve mysterious dynamic problems. Usually something was inexplicably vibrating in a system just built—a submarine's drive shaft, or an electric power transmission line, or a very tall chimney. The proprietor would put the project on "hold" and call Professor Den Hartog. He would come on the next overnight train and watch the phenomenon intently and ask questions. In his remarkable mind an image would develop of the simple essence of the phenomenon, of cause and effect. He would of course share his surgical insight in real time, in simple terms, and with a unique and endearing wit.

And then he would share it with his students; it would become part of the delightful set of case studies with which he wove the fabric of fundamental concepts. And finally, of course, they took their place in the body of his written contributions. There came a series of landmark papers in nonlinear vibrations of electrical machinery, of turbine blades, of tall stacks with von Kármán vortices, of piping systems, of the foundations for elevated structures, of great furnace walls and tubes, and on torsional vibration dampers and dynamic vibration absorbers. There came three new textbooks. And there came successively three new American editions of the venerable *Mechanical Vibrations*, which had also fifteen foreign editions in eleven languages. The style is so simple and direct as the reader is led skillfully (and impishly) to the essential heart of each problem.

Thus Den Hartog's precious legacy came in three parts: his wealth of new physical insights into mechanical vibrations, the highly readable way he committed them to prose, and the solid, endearing (and entertaining!) way in which he shared them with the generations of lucky students who got to study with him.

In the 1940s Professor Den Hartog's fame as lecturer spread rapidly; he was invited to lecture in most leading American universities and in approximately sixty foreign universities.

He spent four months in 1955 as a Fulbright visiting lecturer in Japan and was invited to give the Thomas Hawksley Lecture in London in 1957, the first American to be so honored.

Jaappy loved music, was a good amateur violinist, and a marvelous raconteur. He and his wife, Beppie, and sons, Maarten and Stephen, also loved to act as unofficial ambassadors to foreign students and scientists. They owned an island in the middle of Lake Winnepesaukee, which they used to entertain visitors. For many foreign scientists their most vivid memory of the United States is of being bundled into a car, driven up to New Hampshire, seated in a canoe, and paddled across the lake to spend an idyllic weekend on the island.

Jacob Den Hartog's talents were widely recognized, and he received many honors from his fellow engineers, from universities, and from prestigious academies. From the American Society of Mechanical Engineers (ASME), in addition to the Timoshenko Medal in 1972, he received the Charles Russ Richards Memorial Award, the Worcester Reed Warner Medal, and the American Society of Mechanical Engineers Medal. The American Society for Engineering Education awarded him the Lamme Award, and the Acoustical Society of America awarded him the Trent-Crede Award. He was an honorary member of ASME and the Japan Society of Mechanical Engineers, and a fellow of the British Institution of Mechanical Engineers. He was awarded honorary doctorates from Carnegie Institute of Technology, the University of Ghent, the Technical University of Delft, Salford University, and the University of Newcastle-Upon-Tyne. He was elected to both the U.S. National Academy of Sciences and the U.S. National Academy of Engineering, to the American Academy of Arts and Sciences, and to the Royal Dutch Academy of Arts and Sciences. At the end of his career, he received three major awards during his eightieth year: the James Watt International Medal from the British Institution of Mechanical Engineers, the Founders Award from the U.S. National Academy of Engineering, and the Order of the Rising Sun from the Emperor

of Japan. He is remembered also by MIT's J. P. Den Hartog Distinguished Educator award to recognize "excellence ... in the tradition of Den Hartog," and the ASME Design Engineering Division's Jacob P. Den Hartog Award for "sustained meritorious contributions to vibration engineering," of which he was first recipient.

Some of us remember best that he told us, "Spend your life teaching, and you'll have a lot of fun." For we did. And he was right.