Donald E. Hudson

DONALD E. HUDSON

1916–1999

Elected in 1973

"For the development of widely used instruments to record destructive earthquake ground shaking."

BY MIHAILO D. TRIFUNAC
SUBMITTED BY THE NAE HOME SECRETARY

DONALD ELLIS HUDSON, Don as he was known to his friends, died of heart failure on April 24, 1999, at the age of 83. By the time of his death he had built a distinguished career of teaching, research, and service, spanning a broad range of science and engineering and centered in earthquake engineering. His work extended from experimental mechanical engineering, geophysical engineering, vibration engineering, rocketry, and underwater ordnance design during World War II to the development of instrumentation and data processing in earthquake engineering.

Don was born on February 25, 1916, in Alma, Michigan. In 1924, to avoid hay fever, his family moved to Pasadena, California, where he attended Franklin Elementary School, Woodrow Wilson Junior High, and Pasadena City College and then switched to the California Institute of Technology (Caltech) in his junior year in 1936. He completed his B.S. degree in 1938, M.S. degree in 1939, and Ph.D. in 1942. He then began his distinguished 39-year-long career at Caltech. He was assistant professor of mechanical engineering (1943–1949), associate professor of mechanical engineering (1949–1955), professor of mechanical engineering (1955–1963), and professor of mechanical engineering and applied mechanics (1963–1981). He retired from Caltech with emeritus status in

1981. From 1981 to 1985, Don chaired the Department of Civil Engineering at the University of Southern California School of Engineering, where he held the Fred Champion Professorship in Civil Engineering. He retired from USC in 1985.

Hudson's first exposure to earthquake studies, which would later guide him in his pioneering work in earthquake engineering, dated back to his undergraduate and graduate studies at Caltech where he and some of his classmates, who eventually also became leaders in earthquake studies (Walter Munk, Ben Howell, Egor Popov), took classes and interacted with Guttenberg, Benioff, Richter, von Kármán, and Biot. While Don was a graduate student, von Kármán and Biot completed their book *Mathematical Methods in Engineering* (New York: McGraw-Hill, 1940), which included the basic theory of structural mechanics and dynamics. Thirty years later, in the mid-1960s, when I took Don's class in the dynamics of structures, the simplicity and elegance of the physical formulation of the von Kármán and Biot approach were still evident. Don's lectures were exceptionally well prepared, and his blackboard work was like a Dürer painting, photographically perfect to the minute detail.

Don's thesis adviser and mentor was Frederick C. Lindvall, who later chaired the Division of Engineering at Caltech (from 1945 to 1969). During the World War II projects at Caltech, Hudson worked for the jet-assisted takeoff group, which was headed by Lindvall. They developed methods for carrying rockets on an airplane and launching them. When the U.S. Navy needed to solve the stability problem of aircraft-launched torpedoes, Lindvall and his group set up the testing facilities, behind Morris Dam, above Azusa, and in China Lake, which eventually became the China Lake Naval Ordnance Test Station. The stability of the torpedoes was solved by adding a shroud ring over the tail of a torpedo—just in time to build several thousand torpedoes for the battle of Midway. During these projects, Don worked with many future leaders in engineering and applied sciences at Caltech (C. Anderson, C. H. Wilts, and R. B. Leighton).

In 1958–1959, Hudson spent six months in India, at the University of Roorkee, sponsored by the Technical Cooperation Mission of the U.S. State Department (subsequently the Agency for International Development). Roorkee, the oldest technical institute in Asia (formerly the Thomason College of Engineering), was founded by the British to train surveyors for the North India canal system. Today it is the Indian Institute of Technology, Roorkee. During a visit to Caltech in 1957, Professor A. N. Khosla, then vice chancellor and president of the University of Roorkee, was impressed with the dynamic measurement laboratory Hudson had set up at Caltech, and arranged with Caltech President Lee A. DuBridge for Don to take a leave of absence and go to Roorkee. Don's assignment was to organize a dynamics measurement laboratory there and to teach courses in dynamic measurements and structural mechanics. This stay in India marked the beginning of a long and fruitful cooperation between Roorkee and Caltech faculty and students and the beginning of earthquake engineering in India. Several times Don went back to India to evaluate their progress.

He was also a member of the steering committee and Caltech representative on the Kanpur committee, which coordinated establishment and organization of the American-sponsored I.I.T. campus at Kanpur. One of the people who came over to work with Don at Caltech was Jai Krishna. Later Krishna became vice chancellor of Roorkee and president of the International Association for Earthquake Engineering and founded the Indian Academy of Engineering in Delhi. Don Hudson was the first and for many years the only foreign member and until his death the only earthquake engineer from America to be elected a member of this highly selective academy. In 1978 during the world conference on earthquake engineering, Prime Minister Indira Gandhi held a tea party at her house and on behalf of her father thanked Don for his contributions and help with establishing the earthquake engineering program in India. Don always felt that this was a remarkable expression of appreciation and gratitude, and he proudly shared his memory of the event with friends.

Following the first steps at Caltech made by von Kármán and Biot in the early 1930s, the dynamic response of structures to earthquake shaking remained in the academic sphere of research for many years and did not gain widespread engineering acceptance until the early 1970s. There were two main reasons for this. First, computation of the response to earthquake ground motion, without digital computers, led to formidable numerical difficulties; second, there were only a few well-recorded accelerograms that could be used for that purpose. This started to change in the 1960s with the arrival of digital computers and the commercial availability of strong-motion accelerographs. By the late 1960s and early 1970s, however, the digitization of analog accelerograph records, organized by Hudson and his graduate students at Caltech, and the digital computation of ground motion and of the response spectra were developed completely. Then in 1971 with the occurrence of the earthquake in San Fernando, California, which was recorded by 241 accelerographs, the modern era of earthquake engineering was launched.

Don was among the first to recognize the significance of the availability of a comprehensive and accurate database for future developments of earthquake engineering. With T. Caughey, his former student and later a faculty colleague at Caltech, Don invested considerable effort to develop a special-purpose analog computer (Mark II) for computation of the response spectra from recorded strong-motion accelerograms, but the process was time consuming and the results were not accurate. In retrospect, it is clear and logical that in the mid-1960s Hudson decided to gather all important records of strong ground motion and to organize digitization, processing, and dissemination of digital strong-motion data, a *conditio sine qua non* for all subsequent developments in modern earthquake engineering. Von Kármán and Biot formulated the response spectrum method in earthquake engineering, but it was Don Hudson who made modern analyses possible by gathering and processing the data, thus providing a sound and realistic experimental basis for the theory.

Don was erudite; he read widely in history and literature; and he loved music, Oriental art, and philosophy. He had an impressive collection of classical music records and was always willing to share his rare books on Buddhism and Indian art. He loved chamber music and enjoyed travel and archeology in Europe, India, Japan, and South America. His travel was often combined with work for the United Nations, foreign universities, and international conferences.

A bachelor in the earlier part of his life, Don married Phyllis Henderson in 1972. They organized and supported many chamber music performances at Caltech and enjoyed traveling together.

Don's many achievements did not go without recognition. He was elected to the National Academy of Engineering in 1973 and to the Indian Academy of Engineering in 1987. He was president of the Seismological Society of America (1971–1972) and president of the International Association of Earthquake Engineering (1980–1984). In 1989 the American Society of Civil Engineers awarded him the Nathan M. Newmark Medal, and in 1992 the Earthquake Engineering Research Institute awarded him the Housner Medal.

Don was a patient, thoughtful, and generous gentleman. The respect and immense influence he commanded were the result of his reputation for fairness and his ability to lead through reason and unselfish motives, which were aimed for the benefit of others and for the common good. He had the ability to attract and to lead his students and coworkers with unassuming suggestions and by carefully listening to their views and ideas. His students continue to emulate and to propagate his methods and ideas on how to educate young people and new creative minds. Theodore von Kármán, one of Don's teachers, was cited for saying that "scientists study the world as it is, but engineers create the world that has never been." We will always remember Don as our teacher who helped create those engineers. He was a friend and communicator par excellence.