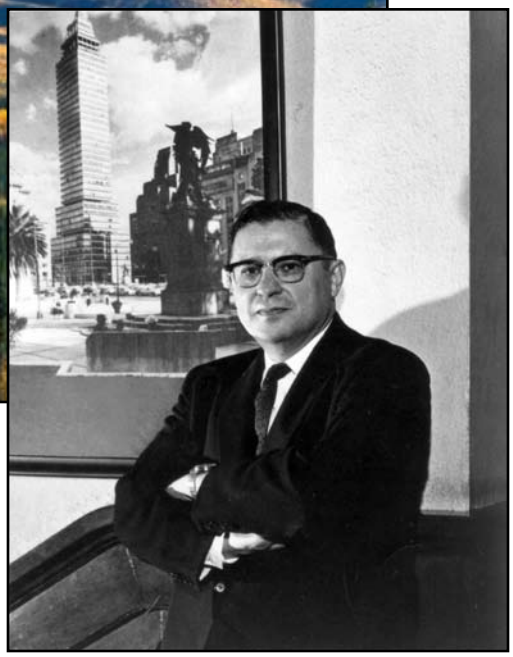
Nathan M. Newmark

Structural Dynamics Innovator Extraordinaire

By Richard G. Weingardt, P.E.

Trans-Alaska Pipeline in the fall. Courtesy of Alyeska Pipeline Service Company.



Nathan M. Newmark. Courtesy of Civil Engineering Department, University of Illinois.

As one of the most recognized and respected pioneers in the field of structural dynamics and seismic design for more than a half of a century, Nathan "Nate" Mortimore Newmark elevated the stature of the U.S. civil engineering profession in those disciplines to the top tier internationally. He developed countless innovative theories, analysis procedures and design criteria for seismic soil-structure interaction for building earthquake-resistive structures that remain in wide use today.

The Latino Americana Tower, Mexico City's tallest high-rise. It has withstood several large magnitude earthquakes with little or no structural damage. Courtesy of Civil Engineering Department, University of Illinois.

His cutting-edge methods continue to be applied to the analysis and design of a wide range of complex structures including high-rises, large dams, bridges and nuclear reactor facilities, both in the U.S. and abroad. Along with his theories for such construction are included the universal design criteria he developed for U.S. military protective projects and nuclear reactor facilities. Among his noted consulting projects were the Bay Area Rapid Transit System (BART) and the Trans-Alaska Oil Pipeline.

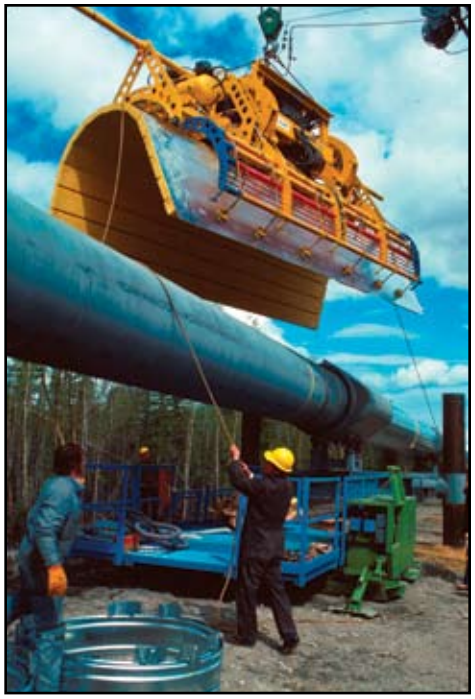
According to William Hall, a longtime colleague of Newmark at the University of Illinois at Urbana-Champaign (UIUC), "Professor Newmark developed simple yet powerful and widely used methods for analyzing complex structural components and assemblies under a variety of conditions of loading, and for calculating the stresses and deformations in soil beneath foundations. He contributed significantly to a better understanding of the behavior of structural materials under various environments including fatigue and brittle fracture. He added materially to knowledge of the behavior and design of highway bridge decks and floor slabs in buildings, and structures subjected to impact, periodic excitation, wave action, wind, blast and earthquakes."

For Newmark's "special contributions to the advancement of engineering knowledge of structures subjected to earthquake or blast, and for inspiration to others in improving man's environment," Newmark was honored with two prestigious national recognitions: first, the 1968 National Medal of Science presented by President Lyndon B. Johnson; then, the 1969 Washington Medal from the Western Society of Engineers and several other major U.S. engineering societies.

The importance and practicality of his work in structural dynamics and seismic analysis was showcased when one of his projects –the Latino Americana Tower, Mexico's City's tallest building at 600-plus feet, counting its 138-foot television antenna – withstood two large earthquakes unscathed, one in 1957, the other in 1985. It proved to be a case study in how properly designed high-rise buildings can successfully survive major seismic activity.

A year before the 1957 earthquake, Newmark (along with Mexico City consulting engineer Leonardo Zeevaert, one of his former students) had presented a seminal paper on the innovative design of the Tower at the World Conference on Earthquake Engineering at the University of California. In their presentation, they delineated the crux of their design, emphasizing the project's unusual characteristics. They said, "The building is nearly twice as tall as any other building in the city, and because of poor foundation soils, a light but rigid structure was designed to rest on a foundation comprised of a floating concrete box set upon piles."

So successful was Newmark's seismic analysis for the structure that *Engineering News-Record* (ENR), in reporting on the 1957 disaster, wrote, "The most encouraging news from earthquake-struck Mexico City is that the city's one true skyscraper, the 43-story



Construction of the Trans-Alaska Pipeline in the 1970s. Courtesy of Alyeska Pipeline Service Company.

Latino-Americana Tower, rode the shock waves undamaged, even to its window glass and partitions."

Nate was born on September 22, 1910, in Plainfield, New Jersey, to Abraham S. and Mollie (Nathanson) Newmark. After receiving his early education in North Carolina and New Jersey, Newmark graduated from Rutgers University with high special honors in civil engineering in 1930. He immediately enrolled in graduate school at UIUC. When he arrived there, its civil engineering department was blessed with a stellar staff that included three world-renowned icons in the structural engineering field – Wilbur Wilson, Harold Westergaard and Hardy Cross,

In Newmark's first encounter with Cross, the engineer-philosopher asked where each student had studied. When Newmark answered Rutgers, Cross looked down his nose at him and commented, "You've got a lot of things to unlearn." In time, the two developed a mutual admiration for each other – and a broad spectrum of interests. Their relationship was based on the interplay and exchange of ideas, not only in engineering but also in a wide range of subjects. They discussed politics, philosophy, art, and the classics with equal relish. Newmark once remarked that his part of the discussions "must have been audible for blocks because Cross was so deaf I had to yell just to be heard."

Newmark received his master's degree in engineering from UIUC in 1932, the same year he married Anne May Cohen. Over the years, they raised one son and two daughters, Richard, Linda and Susan.

Two years later, in 1934, Newmark received his PhD. He continued on at Illinois as a research assistant – the first of several positions he would hold at UIUC. He was appointed research professor of civil engineering in 1943 and became head of the Department of Civil Engineering in 1956.

From 1947 to 1957, he chaired the Digital Computer Laboratory at the University where he participated in developing one of the country's first large-scale digital computers (ILLIAC II). This triumph marked the beginning of applying computer science to engineering and establishing an entire new department at the University – its Digital Computer Department – which spawned numerous spin-offs and expansion into supercomputing nationwide.

His lifelong tenure at the institution resulted in many rewarding recognitions for himself and his alma mater. Hall stated, "Newmark carried his university [UIUC] with him wherever he went, even into professional practice. Engineers, young and old, who came into contact with this man, sensed an intense intellectual and educational challenge. His penetrating insight, his keen engineering judgment, and his genuine interest in people have been a constant source of inspiration to all who have had the privilege of working with him."

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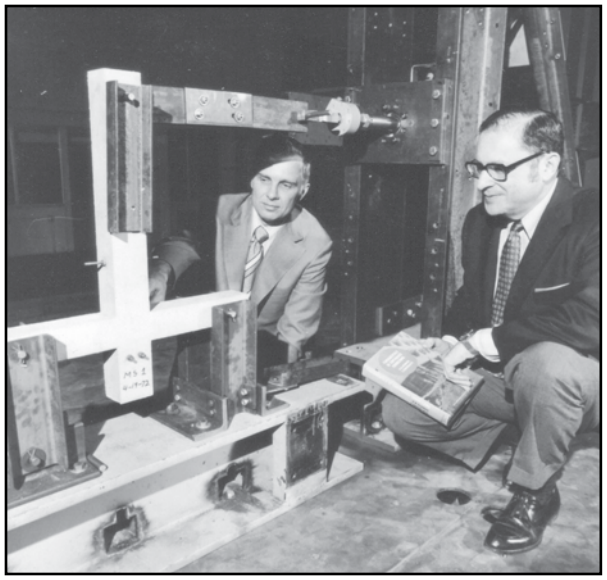


Newmark (right) with his protégé and frequent collaborator William Hall examining a reinforced concrete beam-column specimen being tested for flexure and shear. Courtesy of Civil Engineering Department, University of Illinois.

When geotechnical engineer Ralph Peck – Karl Terzaghi's protégé – began teaching at Illinois in 1942, the 30-year-old struck up a close relationship with Newmark. Both were emerging pioneers in analyzing the effects of seismic forces and motions on soils – and on the structures bearing on the soils. Recalled Peck, "Since my wife and I were only slightly younger than Nate and Ann Newmark, we became included in their circle of friends, and much of our social life was with them."

One particular social event in 1957, which turned into a night of intense seriousness, has stuck in Peck's mind over the years. At the time, Peck had persuaded his friend and colleague, the newly knighted English engineer Sir Alec Skempton, to spend time in the U.S. to give a series of lectures at UIUC. One evening, the Newmarks, who had just completed a new house with a large, long combined living and dining room that was suited for entertaining large groups, invited the Pecks and their famous guest over to christen the place.

After dinner, the three men moved to the living room end and the two wives settled at the far end, lost in the dining area. Since Skempton was currently heavily involved in the early design and analysis of the Mangla Dam in Pakistan – and because of Newmark's intense interest in the dynamics of all structures, including large earth dams – the men's conversation quickly turned to slope stability. Their conversation became heated and loud, and several back-of-the-envelope sketches were produced – and new theories instigated.

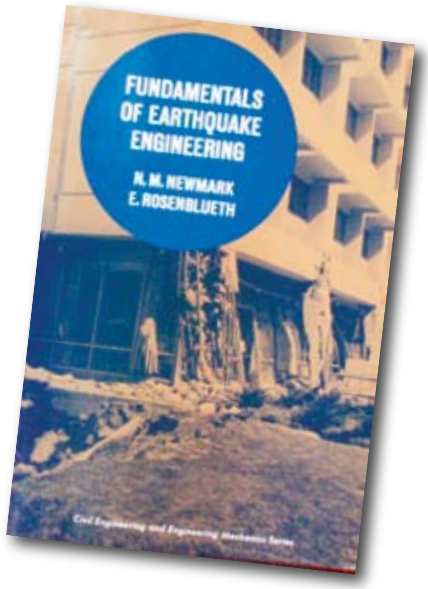
The results of that night, which led to the development of the "Newmark Analysis" for structures and slope stability, are still being felt. According to Peck, "The 'Newmark Analysis' today carries a specific meaning in the field of seismic stability of dams. As I reflect on the conversation that evening in 1957, I realize I was present at its conception, the product of the interactions of two great minds, probing and reinforcing each other."

During World War II, Newmark served as a consultant to the National Defense Research Committee and Office of Scientific Research and Development, spending part of his service in the Pacific war zone. From the mid-1950s onward, he was involved in developing key design criteria – including the hardness standards – for the Minuteman program and missile launch facilities.

In 1964, Newmark became deeply engaged in seismic resistance codes for nuclear power reactors throughout the country. He and Hall published U.S. Nuclear Regulation Committee Report NUREG/CR-0098 *Development of Criteria for Seismic Review of Selected Nuclear Power Plants*, which is still in use today.

In 1969, the pair also published a paper – delivered at the Fourth World Earthquake Engineering Conference in Santiago, Chile – on a straightforward method for computing and sketching seismic design spectra, now a classic document. Shortly after, Newmark was chosen to be the intermediary between the U.S. Department of Interior and the oil companies in shaping the seismic design of the Trans-Alaska Petroleum Pipeline. (Hall, a member of Newmark's original team, still serves as a consultant for the project.)

Trans-Alaska Pipeline in the winter. Courtesy of Alyeska Pipeline Service Company.



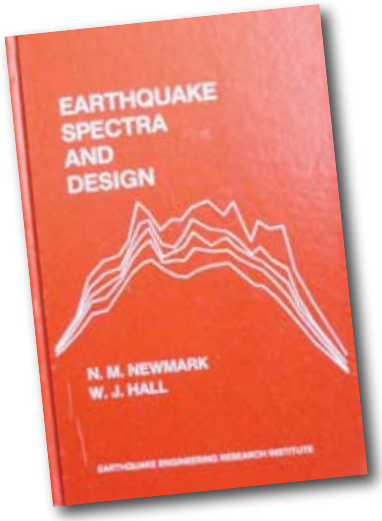
Cover of one of Newmark's most popular books Fundamentals of Earthquake Engineering. Courtesy of Richard Weingardt Consultants, Inc.

A founding member of the Engineering Mechanics Division of the American Society of Civil Engineers (ASCE), Newman received many of the division's awards for individual achievements. His ASCE honors include the James Croes Medal, Mosseiff Award, Norman Medal, Ernest Howard Award, and Theodore von Karman Medal.

In his later years, he received the John Fritz Medal, an all-engineering society award, and the Gold Medal from the Institution of Structural Engineers of Great Britain – only the second American to receive this prestigious award. The other was one of his mentors, Hardy Cross. In 2006, Newmark was named as one of the top ten U.S. seismic engineers of the 20th century by ENR and the Applied Technology Council (ATC).

Newmark was a fellow of the American Academy of Arts and Sciences, and an honorary member of ASCE, American Concrete Institute, American Society of Mechanical Engineers, International Association for Earthquake Engineering, and Seismological Society of America. He was a founding member of the National Academy of Engineering and a member of the National Academy of Sciences.

He was the recipient of honorary degrees from Rutgers University, University of Liege (Belgium), University of Notre Dame, National Civil Engineering Laboratory of Lisbon (Portugal), and UIUC. His honorary doctor of science degree from UIUC came with this citation: "Graduate study in structural engineering today bears his indelible imprint as a result of the large group that he attracted to Illinois to work with him. His style, combining rigorous analysis with a sophisticated appeal to experience and



Cover of one of Newmark's most popular books Earthquake Spectra and Design. Courtesy of Richard Weingardt Consultants, Inc.

Elevation of Trans-Alaska Pipeline. Courtesy of Alyeska Pipeline Service Company.

intuitive leaps, while inimitable, has provided generations of graduate students with a model of engineering creativity at its best."

Newmark published more than 200 papers, and numerous books and book chapters. His seminal books included *Design of Multi-Story Reinforced Concrete Buildings for Earthquake Motion* (with John Blume and Leo Corning), *Fundamentals of Earthquake Engineering* (with Emilio Rosenblueth), and *Earthquake Spectra and Design* (with William Hall).

In 1973, Newmark became UIUC Professor of Civil Engineering and Professor in the Center for Advanced Study, taking emeritus status from 1976 until his death on January 25, 1981, in Urbana, Illinois. To honor his legacy, UIUC officially renamed the Civil Engineering Building the Nathan M. Newmark Civil Engineering Laboratory later that same year.■

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