great achievements

Hardy Cross

A Man Ahead of His Time

By Richard G. Weingardt

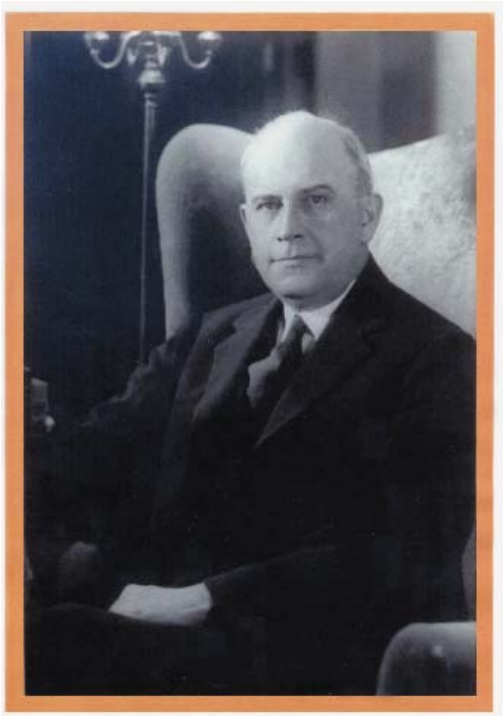
Professor Cross, the first American awarded the highly coveted Gold Medal of the British Institution of Structural Engineers, was a far-seeing innovator and structural engineering superstar who always thought outside the box. He received the celebrated British award when was 73 years old, during the Institute's 50th anniversary celebrations in 1958. During the Gold Medal ceremonies, at the group's convention in Manchester, England, Cross delivered a stirring keynote address exalting the merits of engineering in forwarding societal progress.

During the latter half of his career, Hardy often stated, "People [mistakenly] take for granted that an engineer is by definition a technocrat, somebody stumbling across campus with a pen-protector in his front pocket and a satchel full of calculations." The classically educated Cross, however, was far from fitting that mold or any other. He was one of a kind–a philosopher as well as an engineer, who meshed humanities and engineering ideas in his teachings, often sprinkling in his lectures quotes from the Bible and the classics. Many budding engineers were inspired to greatness by Cross's high-spirited words and his actions.

It was under his tutelage that the likes of Holly Cornell, co-founder of the engineering giant CH2M-Hill, developed a "great love for engineering." Hardy always challenged his pupils to constantly ask, "Why, why, why, and dig until the problem is clearly defined." Because he was deaf in one ear, eager students–and his colleagues–quickly learned which was his best side when they wanted his full attention.

Cross was without question one of the most important figures in American structural engineering in the mid-to-later-half of the 20th century, world renowned for his innovations as an educator and structural theoretician. His engineering books and papers were widely translated. They contained new and practical methods of structural analysis–at a time when complicated and highly indeterminate structures using reinforced-concrete were coming into vogue–that greatly simplified the way stresses could be calculated for continuous beams and frames. The most significant of these methods, the Moment-Distribution or Hardy Cross Method–first introduced in 1930, made use of converging approximations to rapidly distribute fixed-end moments. (A basic and simple example of the Method is illustrated in *Figure 1*.)

Essentially, what Cross's methods did was simplify the monumental mathematical task of calculating innumerable equations to solve complex problems in the fields of structural and civil engineering, long before the computer age. It revolutionized how the profession addressed complicated problems; whenever engineers in the latter part of the 20th century talked about methods for designing difficult structures, the name of Hardy Cross was always invoked with awe.



Hardy Cross (William J. Hall is the owner and "keeper" of the Cross materials at the University of Illinois.)

According to Old Dominion University Professor Zia Razzaq, "In Hardy Cross's day, if you wanted to design a highway bridge or high-rise building, you would end up with several thousand simultaneous mathematical equations. And there were no computers of the kind we have today. He developed a procedure by which, in a very short time, you could actually analyze a very complex structure and calculate all the stresses in it." Without Cross's methods, many engineering projects would have remained dreams and not have become reality when they did.

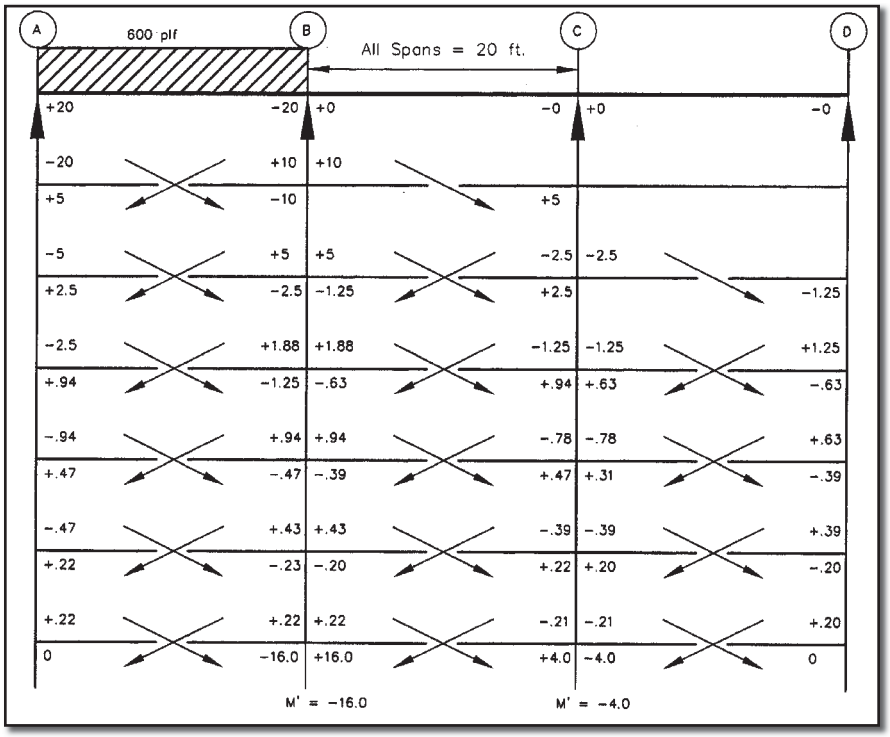


Figure 1 – A basic application of the "Hardy Cross Moment-Distribution" Method.

Born on February 10, 1885 in Nansemond County, Virginia, Hardy was the younger of two sons of Thomas H. Cross and Eleanor Wright, both from prominent southern families. His father Thomas H., a student at the University of Virginia when the Civil War broke out, dropped out of college and joined the Confederate Army. He served in it for its entirety, even though he was wounded during several bloody battles.

A dozen-and-a-half years after the war was over (and shortly before Hardy's older brother Thomas Peete was born in 1879), Thomas H. was elected to the Virginia House of Delegates. He and Eleanor then permanently relocated to Norfolk, Virginia, to raise their family, which would include only two boys.

Both of their sons–Thomas and Hardy–were excellent students. Hardy followed in his older brother's footsteps, graduating from Norfolk Academy and then attending Hampden-Sydney College to become a schoolteacher. He was just 17 when he graduated as valedictorian from Hampden-Sydney with a bachelor's of arts degree in 1902. One year later, he received a bachelor's of science degree. That same year, his 62-year-old father, who had recently been appointed the local postmaster after serving as a Deputy U.S. Marshall, died.

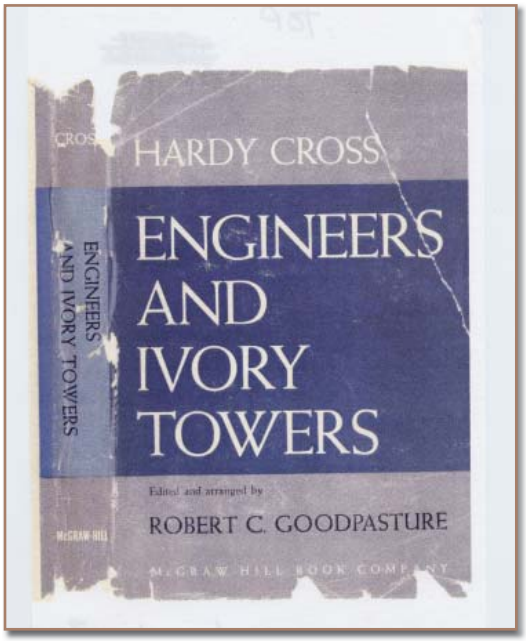
Young Cross immediately took a position with his local alma mater, Norfolk Academy, teaching English and mathematics so he could be near his newly widowed mother to comfort her – and help her run a boarding house. Three years later, Hardy was found at Massachusetts Institute of Technology (MIT) studying civil engineering. Within two years, in 1908, he had earned an MIT bachelor's of science degree.

After working briefly as a bridge engineer for the Missouri-Pacific Railway from1908 until 1909, Hardy migrated back to Norfolk to teach for one more year. He returned to Boston and, in 1911, received a master's of science degree in civil engineering from Harvard University.

Taking an assistant professor's position at Brown University shortly after, he taught civil engineering at Brown for seven years. In 1918, he left the University to get involved in the practice of structural and hydraulic engineering in the Boston and New York areas. During this period, he worked on a number of projects on the east coast and served as assistant engineer to the well-established Charles T. Main.

On September 5, 1921, 36-year-old Hardy married Edythe Hopwood Fenner from Providence, Rhode Island. They would have no children, and she would precede him in death by three years.

The year 1921 also marked Cross's return to fulltime teaching when he took a position as professor of structural engineering at the University of Illinois. By then, he was well known for his insightful writings, including a voluminous report "River Flow Phenomena and Hydrology of the Yellow River, China" and a popular monograph on the graphic analysis of arch structures, which was being used as a text at Harvard's graduate school of engineering.



Tattered dust cover of one of Cross's well-read books attests to his longtime popularity as an author.

In 1937, Cross left the mid-west and returned to the east coast, accepting his final academic position as Chair of the Department of Civil Engineering at Yale, a position he held until his retirement in the early 1950s.

Over his career, Cross was especially active in several professional groups: the American Society of Civil Engineers (ASCE), American Concrete Institute (ACI), American Academy of Arts and Sciences, American Institute of Consulting Engineers, American Railroad Engineering Association, Connecticut Society of Civil Engineers, Royal Society of Arts and Western Society of Engineers.

He was also prominently involved in the investigation of several historic engineering/construction failures, including the Tacoma Narrows Bridge and Charity Hospital in New Orleans. In his later years, Professor Cross was a much in demand speaker as well as engineering consultant.

Cross was the recipient of honorary degrees from Yale (1937), Lehigh (1937) and Hampden-Sydney (1934), and numerous prestigious engineering honors including ASCE's Norman Medal (1933) and the ACI's Wason Medal (1936).

As the first award-winner of the American Society of Engineering Education's Lamme Medal in 1944, Hardy was cited for "his insistence on the great responsibilities of the individual teacher and for his scorn of the superficial in education–and for his preeminence in building men who are carrying forward his own high standard for straight, hard thinking in the teaching and practice of engineering."

In his book *Engineers and Ivory Towers*, a collection of his talks, Cross stated that what man wants and what he needs are not always identical. "Engineering does not tell men what they should want or why they want it. Rather it recognizes a need and tries to meet it." His advice to would-be professors was, "One who is to become a teacher of engineering should be trained primarily to be an engineer, and association with the profession outside the ivory towers of learning is absolutely essential."

Less than a year after his triumph in England in 1958, Professor Cross received the Benjamin Franklin (scientific) Institute of Philadelphia's celebrated Gold Medal. It would prove to be a final tribute to a great career and a great engineer, for soon after, on February 12, 1959, the 74-year-old engineering educator extraordinaire quietly passed away in Virginia Beach, Virginia.

As a lasting tribute to the American icon–and in recognition of his wide-reaching influence–an in-depth "Hardy Cross: Illustrious Citizen" exhibit was established in 1997, at the Isle of Wright County Museum in Virginia.▪

Richard G. Weingardt, PE, CEO of Richard Weingardt Consultants, Inc., Denver, CO, is the author of eight books. His latest Engineering Legends, being published by ASCE Press, is due out in early 2005. Many of the book's featured engineering greats are U.S. structural engineers.