Creator of the "Structural Art" Vernacular

David P. Billington

By Richard G. Weingardt

David P. Billington (Courtesy of Richard Weingardt Consultants)

As the originator and popularizer of the concept "The Art of Structural Design," Princeton University Professor David Perkins Billington — a widely read author and distinguished educator for nearly five decades — has brought to the forefront the importance of structural engineers in practice and society. Billington's innovative approach to teaching structural engineering design as structural art has had a significant impact on the way the world sees the outstanding structures of today.

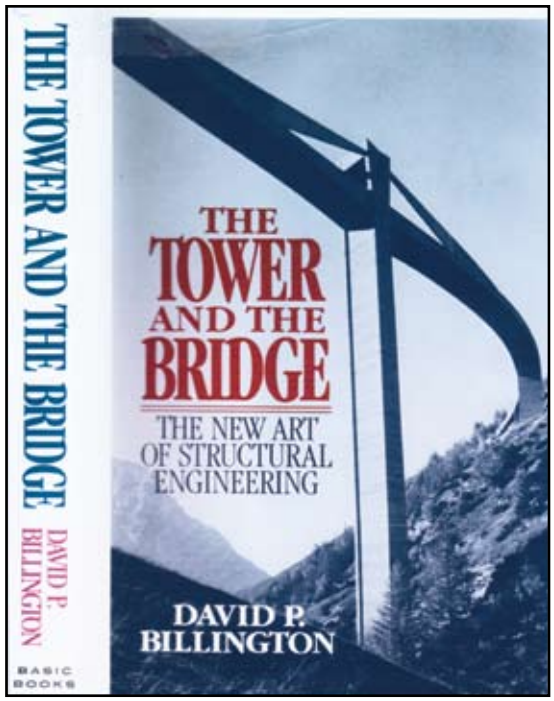
According to Professor Billington, the first fundamental idea of "structure as art" is the "discipline of efficiency, a desire for minimum materials, resulting in less weight, and less visual mass. The second idea is the discipline of economy of construction and maintenance. These results provide structures that are efficient and economical and, within these disciplines, the aesthetically sensitive engineer can then choose forms of elegance that become objects of structural art."

Through his writings, the trailblazing Billington persuades readers and students to examine how simplicity and economy in great structures make for art. In books such as *The Tower and the Bridge: The New Art of Structural Engineering* and *The Innovators: The Engineering Pioneers Who Made America Modern*, and through his teachings, he bridges the chasm between liberal arts and engineering, and integrates the two. He provides a clear understanding of the role of engineering in the world since the industrial revolution.

David was born on June 1, 1927, in Bryn Mawr, Pennsylvania, to Nelson and Jane (Coolbaugh) Billington. His father was an insurance broker and his mother a writer for the Curtis Publishing Company. David's siblings were James and John. In 1986, after serving as the director of the Woodrow Wilson International Center for Scholars in Washington, DC, James was appointed Librarian of Congress. John went into the insurance business following in Nelson's footsteps.

According to Billington, "As a boy, erector sets were my favorite toy, so there must have been some predestination toward engineering." A tall, lanky and athletic youngster, David played varsity baseball in prep school and varsity soccer in college. He enjoyed acting in student plays at Princeton, but said, "I was not a good actor although I had no stage fright."

After a brief stint in the U.S. Navy as an electronics technician's mate, he entered Princeton in 1946 with the thought of studying physics. However, he soon decided to pursue engineering. At the time the university had a program called "Basic Engineering," which consisted of courses in all engineering departments and presented engineering students with the opportunity to take many electives in the humanities.



The Tower and the Bridge

Billington graduated from Princeton four years later with a Bachelor of Science in Engineering degree. He spent his next two years in Belgium on a Fulbright Fellowship studying post-World War II innovations in bridge construction and structural design theory, much of the time with the eminent Ghent University Professor Gustave Magnel. His years in Europe allowed him to become fluent in French and Dutch.

During his first year in Europe, the 24-year-old Billington met Phyllis Bergquist, a fellow Fulbright scholar with movie star good looks who was studying piano at the Royal Conservatory in Brussels. During the summer of 1951, the pair returned to the U.S. to be married in her hometown of Chicago. After a brief stay, they returned to Belgium for a second Fulbright year.

The David Billingtons would have six children — David, Jr., Elizabeth, Jane, Philip, Stephen and Sarah. Only Sarah selected her father's profession and became a structural engineer. The other five pursued other professions.

Upon his return to the U.S. in 1952, Billington began working for the Roberts and Schaeffer Company, a consulting engineering firm in New York City, where he spent eight years as a structural engineer working on a wide-range of structures — large buildings, aircraft hangers, missile-launch facilities, bridges, piers and thin-shell tanks. The company, under the guidance of the legendary Austrian engineer Anton Tedesko, introduced thin-shell concrete roof construction into the U.S. in the mid-1930s, which exposed the young Billington to the latest thinking of the world's greatest engineering minds early in his career.

Representative projects he worked on while with Roberts and Schaeffer included (1) Lambert Field Terminal, St. Louis, Missouri, (2) Staten Island Ferry Terminal, Manhattan, New York City, (3) Hill Air Force Base Hangar, Ogden, Utah, (4) Pier 40 in New York Harbor, and (5) several early launch facilities at Cape Canaveral in Florida.

Lambert Field Terminal, St. Louis, MO (Courtesy of Princeton University Tedesko Archive)

In 1958, Billington was chosen to be a member of a six-person, T.Y. Lin-led U.S. engineering delegation to the Soviet Union to observe advances it was making in concrete construction. Billington's reports and articles about the trip received extensive coverage in *Civil Engineering*.

The same year he visited Russia, Billington began teaching a course on structural engineering at Princeton as a visiting lecturer. About his early days in teaching, Billington said that his biggest shortcoming was his lack of knowledge of the tradition of engineering. "I knew nothing about the great engineers of the past, or the great structures they had designed. Technically, I could do the calculations and make things work, but whether a specific project was really a historically important or appealing structure never occurred to me."

In 1960, after two years as a visiting lecturer, Billington joined the faculty of his alma mater as an associate professor. Four years later he became a full professor, and one year later, in 1965, he published his first book *Thin Shell Concrete Structures*. His research on thin shells has extended over many years and includes being a key consultant to several prominent groups such as the Research-Cottrell Company, whom he advised on the design and construction of high natural-draft cooling towers.

In his 45-plus years at Princeton, Billington has taught various undergraduate and graduate courses on structural analysis and design to students in engineering and architecture, and even those in the liberal arts. His teaching and research have long explored the connections between engineering and the liberal arts, resulting in the development of curriculum materials aimed at teaching engineering to liberal arts students — and fulfilling one of Billington's lifelong passions to get *both* engineering and non-engineering students to better understand the major part engineers and engineering play in advancing civilization.

Today, one of his passions is to get increasing numbers of structural engineers to see the virtue of studying the history of their field. Said Billington, "If you ask a student of architecture to name the five greatest 20th century architects, they can rattle them off with reasonable unanimity. But if you ask engineers 'Who was Maillart or Candela,' they won't know them or their work. This has a very deleterious effect on design. Structural engineers need to know their traditions."

In 1974, Billington introduced the first of what would become a three-course series at Princeton highlighting the significance of engineering in society to both engineering and non-engineering students. His first course "Structures and the Urban Environment" focused on the technology, art and social factors involved in the planning, design, and construction of large-scale structures. Central to the class was the concrete designs of Robert Maillart, about whom Billington has written three books. The course focuses on structural engineering as an art form parallel to, but independent of, architecture.

After the University of Tokyo invited Billington to visit Japan in 1989 to critique the country's new large-scale bridges, he produced a detailed report of his findings and observations. It was published in the *Japanese Bridge Journal* and became the basis for a new lecture in his, "Bridges and Culture in Modern Japan."

In 1985, Billington created the second course in the series, "Engineering in the Modern World." Although focused toward first-year engineering students, the course is open to all students at the university. The course integrates natural science, social science, and the humanities into the study of modern engineering.

Rounding out the series, he and a colleague introduced a third course in 1999, "Rivers and the Regional Environment," which combines concrete and earth dams with hydraulics and hydrology. Among its objectives are reviewing the impact civil and environmental engineering has on the built environment, and the interaction of engineering and politics in public works. A book for this course, *Big Dams of the New Deal Era* (with Donald Jackson), is scheduled for release in late 2006.

These three courses have resulted in the publication of numerous scholarly papers in refereed journals, and have led to no less than six important exhibitions in the Princeton University Art Museum.

In recent years, nearly 40 percent of the non-science and non-engineering majors at Princeton have taken at least one of Billington's courses. These courses have significantly advanced the general student body's understanding of how the nation got built, how engineering transformed American society from rural agrarian to urban industrial, and how engineering and public policy interrelate. They have also given non-engineers and engineers alike useful insight into judging engineering work.

Billington has written eight books and more than 150 journal publications. In addition to the three previously mentioned, his books include: *Structures, Models and Architects* (with Jack Janney and Robert Mark), *Robert Maillart's Bridges*, *Robert Maillart and the Art of Reinforced Concrete*, *Robert Maillart: Builder, Designer*, *Artist* and *The Art of Structural Design: A Swiss Legacy*.

He has lectured extensively throughout the U.S. and Canada, as well as in Sweden, the Netherlands, Belgium, Germany, Switzerland, Italy, Spain, South Africa and Japan. He regularly is a visiting professor and does research internationally.

The holder of honorary doctorate degrees from Union College, Grinnell College and Notre Dame University, Billington is a member of the National Academy of Engineering (NAE) and a fellow of the American Academy of Arts and Sciences. In 2005, NAE named him its Walter L. Robb Engineering Education Senior Fellow. He is an honorary member of the International Association of Shell Structures, the American Concrete Institute (ACI) and ASCE, and has actively participated in numerous committees.

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Within Billington's extensive portfolio of prestigious awards and honors recognizing his contributions to the profession are the 2004 Charles Zollman Award from the Prestressed Concrete Institute, 2003 Director's Award for Distinguished Teaching Scholars from the National Science Foundation, 1999 Sarton Medal from the University of Ghent in Belgium, 1995 Abbot P. Usher Award (with politics professor Jameson Dorg, for best scholarly work) and 1979 Dexter Award (for outstanding book) both from the Society for the History of Technology, and 1992 George Winter Award and 1986 History and Heritage Award both from ASCE.

Pier 40 in New York Harbor (Courtesy of Princeton University Tedesko Archive)

In 1999, Engineering News Record (ENR) recognized him one of the top 125 persons in civil engineering over the past 125 years, and one of the top five educators since 1874. In 1995, the Carnegie Foundation for the Advancement of Teaching named him the New Jersey Professor of the Year. In 1990, he received the Dana Award (from the Charles Dana Foundation) for pioneering achievements in education, and he was appointed an Andrew D. White Professor at-large at Cornell University for the period 1987-1993. He is a 2006 Robert Noyce History Professor at Grinnell College in Grinnell, Iowa.

In addition to teaching, Billington has been involved as a consulting engineer on wide array of projects, including design and construction of thin-shell concrete cooling towers and bridge design. He has been a consultant on highway accident analyses, on two major engineering bridge design competitions in Maryland, and on the design of France's largest overland bridge — the spectacular Millau Viaduct.

A registered professional engineer in New Jersey, Billington is currently Princeton's Gordon Y. S. Wu Professor of Engineering in the Department of Civil and Environmental Engineering, and its director of the program entitled "Architecture and Engineering."

At 79, he continues to teach his three course "inform-the-world-of-engineering" series with gusto and passion, an electrifying figure on stage. He delights in pointing out — to engineers and non-engineers alike — the magic of structural art. His eyes especially light up and sparkle when he elaborates on favorite geniuses like Gustave Eiffel, John Roebling, Robert Maillart, Pier Nervi, Felix Candela and Christian Menn.▪

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