WE WILL.

The Campaign for Northwestern

Zdeněk Bažant teaches Stability of Structures, a popular course for graduate engineering students, in November 2019.

Faculty Gift Supports Future of Engineering

Professor Zdeněk P. Bažant and his wife, Iva, give back with a major bequest in their estate plan

During his 50-year career at Northwestern University, Zdeněk Bažant has distinguished himself as a researcher, professor, and colleague at the McCormick School of Engineering. His work in the mechanics, safety, and durability of materials and structures has earned the highest national and international honors and impacted a wide range of industries, from construction to aircraft design. Since 1990, Bažant has served as a Walter P. Murphy Professor of Civil and Environmental Engineering, Mechanical Engineering, and Material Science and Engineering, and since 2002, he also has been the McCormick Institute Professor. From 1981 to 1987, he was the founding director of the Center for Concrete and Geomaterials.

Bažant is committed to ensuring that Northwestern faculty achieve research and teaching excellence for years to come. Through a major bequest in their estate, Bažant and his wife, Iva, a retired physician, will support Northwestern Engineering.

"Coming to the US, and to Northwestern in particular, was the best decision of my life," says Bažant, a native of Prague, Czech Republic. "I want to make sure that Northwestern continues to flourish, and that research and teaching in the fields of structural engineering and theoretical and applied mechanics, as well as mechanical engineering and materials science, remain strong."

Bažant's appreciation for Northwestern and the United States is due, in part, to his contrasting experiences during his three decades in Czechoslovakia. He was born to a highly educated family—his father was an engineering professor, his mother was a sociologist, and his grandfather was a university president who had survived a Nazi concentration camp. Following the communist seizure of power in Czechoslovakia in 1948, his parents were persecuted and their property was nationalized—although they were still required to continue paying the mortgage. In the years of terror that followed, Bažant watched his widowed grandmother—a successful, hardworking, self-made entrepreneur—be expropriated, vilified, and die as a pauper, and his mother's boss and friend—who served as president of the Women's Union—be executed on trumped up charges. At age 11, Bažant began dreaming of escaping to America.

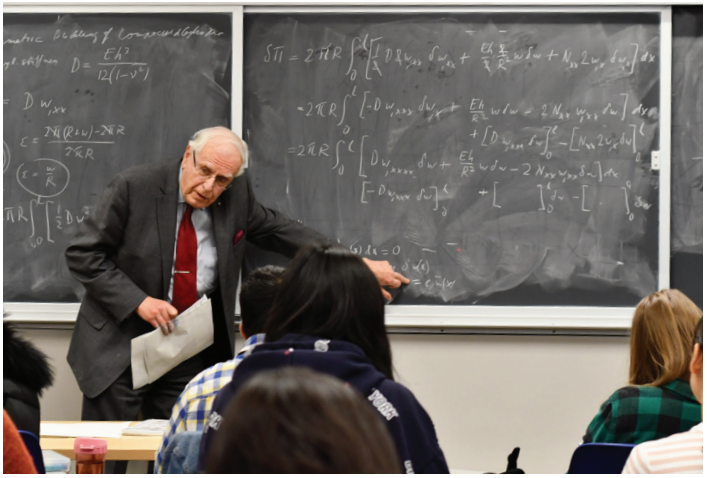
As he approached high school, Bažant was labeled as a bourgeois kid and assigned to a coal mining apprenticeship. Thanks to the intervention of his uncle, a communist with high-level party connections, he was eventually allowed to continue his education. In 1960, he graduated from the Czech Technical University in Prague as a civil engineer. Despite always being first in his class and a winner of the national Mathematical Olympics, he was not allowed to pursue graduate study. The reason: He had declined an official invitation to join the Communist Party, which made him a self-declared resister.

Yet Bažant has no regrets. He managed to get placed in a small, competent state firm, where he designed big bridges and supervised construction projects. He loved the experience, and it revealed to him several important unsolved problems that influenced his later work.

In addition, the party cell within his firm agreed to recommend him for external doctoral study. Bažant studied alone, took the required exams without attending courses, and produced—with no adviser—a dissertation on creep in concrete structures, which was later published as a book. He earned a PhD from Czech Technical University in 1963, and, thanks to an agreement between party cells, he became a researcher at the university. While researching composites, he took a two-year course on theoretical physics, which was held only on Saturdays and restricted to working engineers who had already earned their PhDs. "For my interdisciplinary work, it was invaluable," Bažant recalls.

In 1966, during the dictatorship relaxation that preceded Prague Spring, Bažant was allowed to go to Paris as a postdoc. He returned briefly to marry Iva, who had just graduated from medical school, and the two traveled to the University of Toronto.

With the hope that the restored democracy would last, the couple planned to return to Prague, but cancelled their plan as soon as the Soviet Union invaded Czechoslovakia on August 21, 1968. Instead, Bažant secured a visiting appointment at the University of California-Berkeley, which was an "eye-opening experience." Meanwhile, in Prague, he was sentenced in absentia to prison for "betrayal of socialism," and all of his property and savings for a car and apartment were confiscated. Looking back, he believes Nietsche: That which does not kill us makes us stronger.



In 1969, Bažant was hired as an associate professor at Northwestern, and in 1973, at age 35, he became the youngest full professor at Northwestern Engineering. There, "my dream was fulfilled beyond my expectations," he says. Bažant was part of a collaborative group of "bright, young mechanicians," including Jan Achenbach, Toshio Mura, Leon Keer, Johannes Weertman, Sia Nemat-Nasser, and John Dundurs—most of whom were future National Academy of Engineering members. The group's joint research and lively discussions challenged him to broaden his horizons, grow scientifically, and choose the right problems and approaches.

Bažant became a US citizen on February 3, 1976, and celebrates the anniversary of his naturalization every year. He feels fortunate to have had the freedom and opportunities of an American, including the opportunity to pursue his academic interests. During his career, Bažant conducted research that resulted in findings such as:

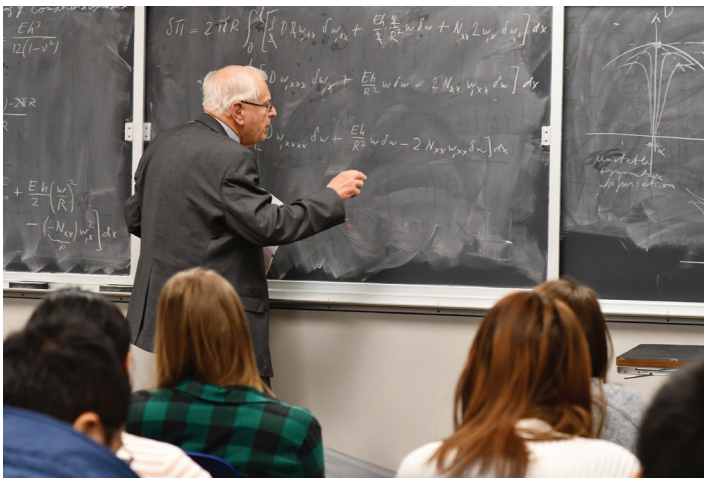
- a size effect law for the fracture of concrete and other quasi-brittle structures, which is now embedded into the American Concrete Institute (ACI) design code governing all concrete construction
- a size effect method of testing fracture energy and material length, which is now an international standard recommendation
- a crack band model for the numerical simulation of distributed cracking, which is now a mainstay of predictions of quasi-brittle fracture and strength scaling in concrete and airframes
- an age-adjusted effective modulus method for creep and a drying model for concrete, both featured in design codes
- a "microplane" damage constitutive law that now runs on large wave codes in federal labs and various commercial software
- concrete creep laws with aging, solidification, nano-microprestress and hygrothermal effects, now used in ACI as well as international standard recommendations;
- a model for fracture and size effect in fiber composites, which is used in design for crashworthiness of cars and airframes
- a stable testing method for fracture softening in fiber composites, for which he and four co-inventors secured a US patent
- the Gauss-Weibull and "fishnet" tail distributions of strength of quasi-brittle and architected materials needed to ensure required safety

- a model for high-temperature creep, fracture and moisture transport in concrete, which is often used in nuclear plant safety assessments
- a thermodynamically correct numerical analysis of stability and stress increments in inelastic solids under large deformations
- various useful mathematical results, such as an optimal numerical integration formula for a spherical surface, criteria for wave diffraction in non-uniform finite element meshes, stress singularity at the intersection of crack front edge with body surface; criteria for the stability of propagating crack systems and for branching of hydraulic cracks in shale, the isotherm of water sorption in gradually filling nanopores; and the theory of unsaturated nanoporomechanics.

Bažant is well-known for his definitive analyses of the collapse of the World Trade Center towers on September 11, 2001, and the excessive deflection and consequent tragic collapse of the Koror-Babeldaob Bridge of record span length in Palau in 1996. His work has been implemented at companies such as Boeing, Chrysler, and Ford, and has improved the safety, sustainability, and efficiency of structures such as bridges, dams, buildings, aircraft, cars, ships, sea ice, and nuclear containments. His current research focuses on designing structures with a catastrophic fracture risk of less than one in a million, the hydraulic fracturing of shale, and nano-pore moisture effects on the durability of concrete, aimed at mitigating the CO2 emissions of the cement and concrete industry, which are on the verge of surpassing those of all the cars and trucks in the world.

In a recent weighted citation study from Stanford University published in Public Library of Science, Bažant was ranked first in civil engineering, second in all fields of engineering, and within the top 0.0056 percent of six million scientists worldwide.

Bažant has been recognized nationally and internationally for his accomplishments. He was elected to the National Academy of Sciences, National Academy of Engineering, American Academy of Arts and Sciences, Royal Society of London, and national academies of seven other countries. He has received seven honorary doctorates in the United States and abroad, and numerous other awards, including the Austrian Cross of Honor for Science and Art, Medal of the American Society of Mechanical Engineers (ASME), and



top medals from the Applied Mechanics Division of ASME (Timoshenko), the Engineering Mechanics Division of the American Society of Civil Engineers, or ASCE (von Karman), and the Society of Engineering Science (Prager), of which he served as president. Bažant also was founding president of two other thriving societies: the International Association of Fracture Mechanics for Concrete and Concrete Structures and the International Association of Concrete Creep and Durability. ASCE has instituted the Bažant Medal for Fracture and Damage Prevention in his honor. Bažant is an honorary member of a number of professional societies and a registered structural engineer in Illinois. Read more about Bažant's honors and accomplishments.

Skiers might note that Bažant's 1959 patent of a safety release ski binding, mass produced in Czechoslovakia, is exhibited in the New England Ski Museum.

Bažant is grateful to be in a position to help his university, and hopes that his and Iva's bequest will help future generations of Northwestern Engineering faculty to pursue their academic passions. "Northwestern has been good to me," he says. "I want to do something significant in return."