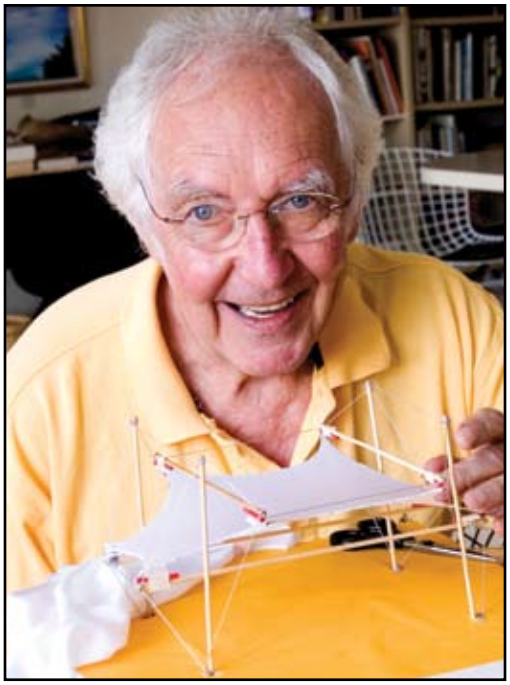


Horst Berger

By Jim DeStefano, P.E.

There have been few structural designers in history who have had the vision and insight to pioneer new structural forms and technologies. There have been fewer still who have been able to combine these skills with a keen artistic sense. Horst Berger is just such an individual, a true master of structural design who has created innovative structures that were also magnificent architectural masterpieces.

Horst Berger's contribution to the structural engineering profession has been the development of fabric tensile structure technology. Over the past four decades, he has been involved in the design of most of the major fabric structures in the world, from modest pavilions for Philadelphia's bicentennial celebration to the Jeddah Haj Terminal in Saudi Arabia. Engineering News Record has rated Horst Berger as one of the top structural engineers of the last 100 years.

The Early Years

Born in Heidelberg in 1928, Horst's youth was marked by life in war torn Germany under the Nazis. His fondest childhood memories were of spending the summers on his grandfather's farm in the countryside with wooden carts, horses, pigs and chickens – a lifestyle little changed from medieval times. But the tranquility of life in the country was soon shattered by political turmoil and World War II.

In 1944, his high school class was drafted into service manning anti-aircraft guns to defend the industrial city of Mannheim from allied air attacks. Horst saw Mannheim reduced to rubble from behind the sights of an 88 mm gun as the city was pounded by over 130 strategic bombing raids during a period of 13 months.

At the end of the war, 16 year old Horst, war weary and glad to be alive, hiked for two weeks back to his hometown amidst the chaos of the retreating German army. When he arrived home he found a scared landscape with no government, no schools, no order and no opportunities for a young man.

With barely enough food available to stay alive, Horst was able to sustain himself working as a farmhand – a position previously held by Polish prisoners of war. He worked the fields with a pair of oxen at first, and later with a pair of draft horses, one elderly and the other pregnant.

In 1946 the schools reopened and Horst was able to complete his high school studies where he excelled at math and writing. Upon graduation, he obtained a position as an apprentice automotive engineer at the Daimler Benz Auto Plant. Finding the automotive work not to his liking, after six months he was able to transfer to a bridge construction company that was replacing the destroyed main river bridge in Heidelberg. He immediately loved bridge work.

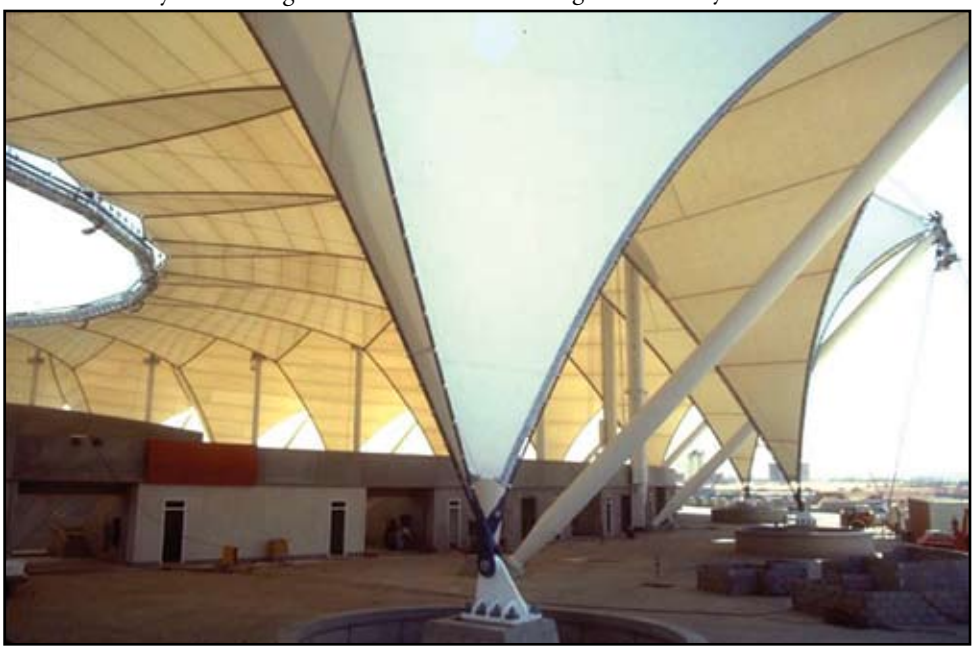
Engineering & Architecture Education

In 1949, a rare opportunity presented itself for Horst to continue his studies. He was one of 124 individuals selected from 32,000 applicants for a program that allowed German students to study in the United States. He traveled to New York on a troop transport ship along with 4,000 returning service men.

Horst went to Iowa State College where he studied architecture and psychology. Unleashed from the restrictive postwar environment that he had left at home, Horst enjoyed the free atmosphere of the U.S. He traveled whenever possible. While attending an International Student Seminar sponsored by the Quakers in Massachusetts, he met Gay, the woman who would later become his wife. After a year in the U.S., he returned to Germany a renewed person.

He attended Stuttgart University where he studied Civil Engineering. After a year at Stuttgart, Horst considered changing his major to Architecture, but his architecture professor advised him that he would have to start from the beginning – it would take five more years in school to get an architecture degree. A successful architect friend told him to stay in engineering since it was a better foundation for practicing architecture. So he continued his studies in civil engineering while a part of him still wanted to be an architect.

Gay visited Germany and shortly before Horst graduated they were married.



King Fadh Stadium – Riyadh.

A Bright Young Designer

Upon graduating from Stuttgart University, Horst's structures professor offered him a position at Wayss & Freytag, a construction and engineering firm that was well known for their work in the early development of reinforced and prestressed concrete. It was common in Europe for structures to be engineered by design-build companies where the engineers controlled the construction. The design-build arrangement offered a real incentive to design innovative and efficient structures. This proved to be an outstanding environment for Horst's professional development.

Horst and Gay settled into a comfortable lifestyle in Frankfurt. They had twins, joined the Quaker Church and enjoyed the company of many friends. Life was challenging and interesting.

As a bright and capable engineer, Horst rapidly earned respect in the company and was soon in charge of many demanding and challenging projects. One of his more noteworthy projects was a graceful, 300-foot span, concrete arch bridge inspired by the work of the Swiss engineer Robert Maillart. He was combining his technical and artistic skills to design elegant structures, although he had not yet found his own style.

After 3 years at Wayss & Freytag, Horst Berger, clearly destined for a corporate management position, decided that corporate life was not for him. Yearning for a change, he resigned and took a position with a consulting firm that was working in Iran designing reservoirs, water towers and power plants. After two years of living in Tehran, it was again time for a change. This time Gay would choose the destination – they would move to New York.

Coming to America

Horst Berger took a position at Severud Associates where he had a hand in designing many exciting structures such as the St. Louis Gateway Arch, New York's Madison Square Garden and Chicago's Marina City towers. He designed thin shell concrete structures, domes, high rise buildings and cable net structures. While working with Fred Severud on the design of Raleigh's Dorton Arena with its pioneering cable net roof, he became intrigued with the idea of designing structurally efficient, light-weight, long-span structures and began to develop his own ideas on ways to build long-span structures with cables and fabric.

It was while working at Severud Associates that Horst Berger became acquainted with a young engineer named David Geiger. Geiger worked under Horst for almost a year

Denver International Airport.

Horst Berger on the roof of the Jeddah Haj Terminal.

before returning to Columbia University for a doctorate and a teaching position. He did not hear from Geiger for several years until he got a phone call from him in 1968 that changed his life. David Geiger was part of a team that had won a design competition for the U.S Pavilion at the Osaka Worlds Fair in Japan. It would be an air-supported fabric structure. He needed to form a firm with an experienced partner to carry out the project, and he asked Horst to join him. With a major commission already in hand, Geiger remarked "we have a tiger by the tail" to which Horst Berger responded, "I am good at taming tigers."

Geiger-Berger Years (1968-1983)

It wasn't long before Geiger-Berger Associates was prospering. There was a magical synergy in their partnership. While Horst Berger was a brilliant designer who was revered by clients and colleagues alike, David Geiger, in addition to being a talented engineer, had a knack for salesmanship and self promotion. It proved to be a winning combination.

After the successful execution of the air-supported fabric roof on the Osaka Pavilion, air-supported roofs soon became popular for stadiums and sports facilities. Over the next decade, a total of 8 stadiums would be built with air-supported roofs and Geiger-Berger Associates engineered every one of them. A fabric roof could be built for half the cost and in half the time of a rigid roof structure, and the translucent quality of the fabric allowed natural light to illuminate the space.

The air-supported fabric roof designs were predominately David Geiger's creations. Horst Berger worked on the demanding related components of the air-supported roof designs, such as the huge ring beams. But his real interest was in fabric tensile structures which relied on their geometry to resist loads, and did not require mechanical systems to generate internal air pressure for stability. His fascination with tensile structures was a quest for purity of form – finding elegant structural shapes that enclosed magnificent spaces in the most efficient manner with the least material.

"Horst Berger has enlarged the knowledge and the state of the art of lightweight structural architecture – applying new conceptual design ideas with the intuition and courage of a pioneer. His work continues the structural philosophy of Eiffel, Torroja, Nervi and others who believe that aesthetics is implicit in a rational static solution – the structural form following the function. In a world dominated by vogue free form design with aesthetics prevailing over static rationality, Horst Berger remains a form-finding engineer."

– Massimo Majowiecki – Italy

Opportunities soon presented themselves to design some modest fabric tensile structures. The first were four small pavilions for an amusement park in New Jersey, followed by a collection of temporary structures for the Philadelphia bicentennial celebration.

One of the Philadelphia structures became the inspiration for Skidmore Owens & Merrill's (SOM) design for the Haj Airport Terminal in Jeddah, Saudi Arabia. The Haj Terminal was a huge structure with fabric roofs covering a total of 105 acres. The New York office of SOM at first contacted Horst Berger to assist them with the design, but after the schematic design phase decided to have the design and engineering performed by SOM's Chicago office. The specifications for the project delegated the actual engineering of the fabric roofs to the contractor. At that time, Geiger-Berger alone had the know how to handle the job. Working in collaboration with the fabric supplier, Owens Corning, and the fabric roof contractor, Walter Bird of Birdair Structures, they completed the design of the structure on an extremely tight schedule. The Haj Terminal was probably the toughest challenge of Horst Berger's career due to its novelty, scale and complexity.

Horst Berger had developed a system for designing fabric tensile structures. After making freehand design sketches of the structure's shape, he would refine the form by building models with spandex stretch fabric. Next, the shape of the structure would be accurately defined using computers with form finding software that was developed by Geiger-Berger. The form finding program would not only define the shape of the structure, but it would also produce precise cutting patterns for the fabric. Finally, a computer structural analysis would be performed for different loading conditions.

The computer software that Geiger-Berger developed for form finding and analysis of fabric structures was innovative and not available anywhere else. At the time, form finding and non-linear analysis programs were in an early state of development. Although Geiger-Berger used the most powerful mainframe computer available at the time, they were often plagued by the limitation of the computer's processor which prevented them from analyzing very large structures such as the Haj Terminal without breaking them up into smaller elements.

Following the successful completion of the Haj Terminal, numerous opportunities presented themselves for Horst Berger to design fabric tensile structures. Some of the more significant projects included the Tennessee Pavilion in Knoxville, Seaworld pavilions in Orlando and San Diego, two Bullocks department stores in California, King Fadh Stadium in Riyadh, and Canada Place in Vancouver.

By 1983, Geiger-Berger Associates had grown to a multi-discipline consulting firm with offices in four cities. Then suddenly the tide changed. The air-supported structures were plagued with deflations. Horst Berger's innovative design for a cable dome roof for a stadium in St. Petersburg, Florida could not be completed when the project was delayed due to financial troubles. Horst Berger and David Geiger drifted apart and the partnership broke up. David Geiger's health was failing and he passed away in 1989.

Horst Berger Partners (1983-1990)

Horst Berger formed Horst Berger Partners to carry on his work. A former associate, Chris Anastos became his partner. He continued to innovate new and spectacular forms for tensile structures and produced some of his finest works including the Mitchell Performing Arts Center in Texas, the Shoreline Amphitheater in San Francisco, and the San Diego Convention Center.

Horst Berger Partners was haunted by problems with the air-supported stadium roofs, and had difficulty acquiring professional liability insurance. When Chris Anastos left the partnership to start his own engineering firm, Horst Berger decided not to start over again.

Later Years

Horst Berger joined Severud Associates as a consultant to complete an arena in Phoenix and other ongoing projects. While affiliated with Severud, he designed the fabric roof for the Denver International Airport. This would be the crowning achievement of his career. But after running his own firms, the arrangement was less than gratifying so he decided to pursue a different career.

Horst took a position as a professor at the School of Architecture at City College of New York to head its structural section. For 17 years, he taught young architecture students a course titled "Structural Form in Architecture." Troubled by postmodern architectural attitudes that trivialized structure, Horst Berger inspired his students to embrace and celebrate structural form. The dean of the architecture school referred to Professor Berger as the "Poet Engineer." In 2003, the University promoted Horst Berger to "Distinguished Professor".

San Diego Convention Center.

While teaching, Horst remained active in the design of tension structures through his affiliation with the firm of DeNardis Engineering where he has headed up the firm's Light Structures Division since 1994. Most recently he has developed sculptural tensegrity designs for fabric roofs.

Horst Berger retired from teaching this past spring and lives outside New York City with his wife Gay. He has written a book on tensile structures titled "Light Structures – Structures of Light" which is in its second printing. His form finding computer program is available for free from his website **www.horstberger.com**. Horst Berger is a frequent invited speaker at national and international conferences. He is embarking on a new venture as a feature author for STRUCTURE® magazine (see article on page 37).▪

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