The Father of Synergetics

Inventor of the Geodesic Dome or not, Bucky Fuller was its greatest advocate

By Richard G. Weingardt

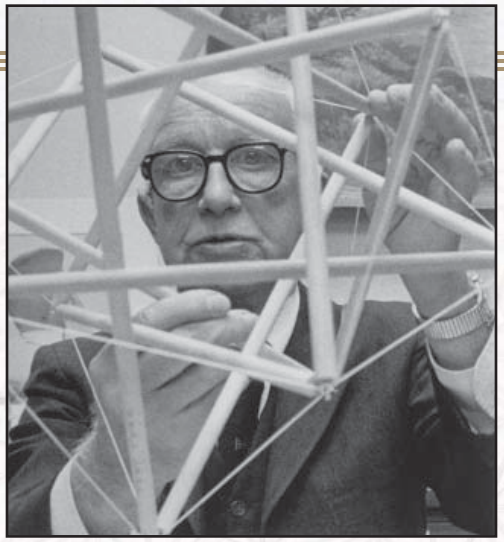
Richard Buckminster Fuller ("Bucky" Fuller) has long been hailed as the inventor of the geodesic dome. Some, however, contend that it was the German Walter Bauersfeld who should be given credit for the dome's invention. Construction of Bauersfeld's design did come first – as a small projector planetarium on the roof of Zeiss Optical Works in Jena, Germany, in 1922. Fuller's came 27 years later in 1949, on the obscure college campus in the hills of North Carolina. Fuller came up with his dome invention independent of Bauersfeld's work — and without knowledge of the German's calculations or details.

Bauersfeld did nothing with his dome design. Fuller, on the other hand, turned the world on its ear with his. He, by far, had the more comprehensive vision of the dome's geometric and engineering significance and potential. Before he was finished, Fuller was awarded several patents for geodesic domes, and was responsible for the proliferation of all types of geodesic domes globally.

Considered one of the most efficient structural systems ever devised, Fuller's geodesic domes were hailed, in the beginning, as the hope for humanity's future housing needs — and other structural uses — while being responsive to environmental and sustainable development concerns.

Fuller, who ended up being one of the key innovators of the 20th century, has been described as a modern-day Leonardo da Vinci and the Thomas Edison of his times. Although best known as the inventor/engineer who made the geodesic dome popular, his influence was much more far-reaching. He was an engineer, mathematician, inventor, architect, philosopher, global thinker, visionary, poet, and cosmologist — and one of society's first futurists.

A controversial free spirit – and a favorite of the restless youth of the late 1960s and 1970s — Fuller's presentations were always unforgettable. They were hypnotic, thinking-out-loud talks on art, humankind, engineering and the environment. A moving dynamo-on-stage, Fuller captivated listeners with a rapid-fire delivery and non-stop gestures — and the use of terms like *synergetics, dymaxion* charts and the "spaceship earth."



Bucky Fuller looking through a "tensegrity" model. Photo courtesy of the Boston Public Library, Print Department.

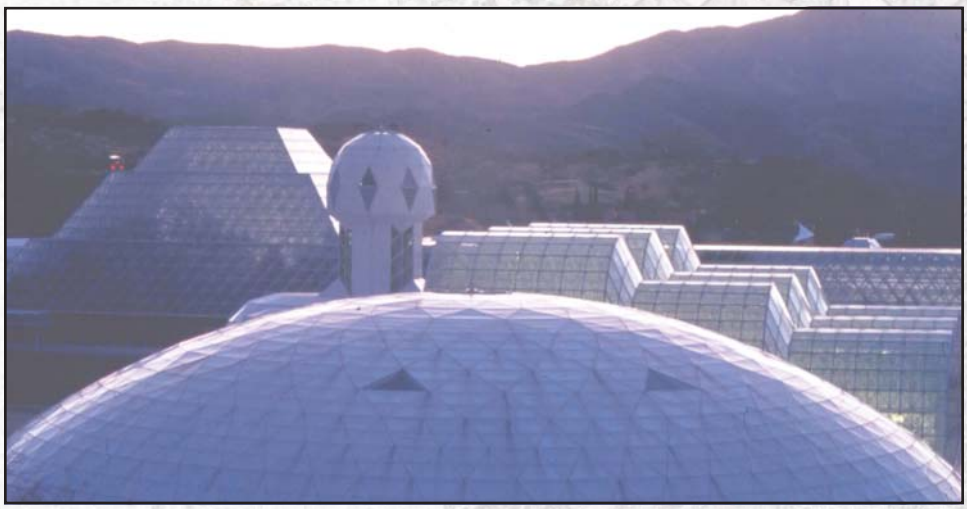
Much of Fuller's work dealt with exploring and creating synergy, which he believed to be a basic principle of all interactive systems. As the developer of the subject he called Synergetics — a "Geometry of Thinking" — he was the person most responsible for popularizing the terms "synergy" and "ecology." He also created what he called "Comprehensive Anticipatory Design Science," which anticipates and solves humanity's problems by providing more and more life support for everyone, with fewer and fewer resources.

Driven by the belief that humanity's major problems were hunger and homelessness, Fuller committed to solving them through inexpensive and efficient design. He was optimistic that, through research and development, responsible engineering and increased industrialization, humankind could generate wealth so rapidly that all people could live in peace and prosperity. He said, "Making the world's available resources serve 100% of an exploding population can only be accomplished by a boldly accelerated design revolution."

Fuller was also one of the earliest proponents of renewable energy sources including solar, wind and wave, which he incorporated into many of his designs. He claimed, "There is no energy crises, only a crisis of ignorance." His research demonstrated humanity could satisfy 100% of its energy needs while phasing out fossil fuels and atomic energy. In the 1970s, for instance, he showed that a wind generator fitted to every high-voltage transmission tower in the U.S. would generate three-and-a-half times the country's total power requirement.

A sixth-generation New Englander, Bucky was born on July 12, 1895, in Milton, Massachusetts, the son of Richard B. Fuller and Caroline W. Andrews. After graduating from Milton Academy High School, he attended Harvard University where he dropped out after partying and squandering away the money his parents had given him to attend college. After two failed attempts at Harvard, he ended up at the U.S. Naval Academy, where he did nothing spectacular. He then served in the U.S. Navy in World War I, also, without any distinguishing accomplishment.

In 1917, on his 22nd birthday, he married Anne Hewlett of Long Island, New York. They would have two children, Alexandra and Allegra, and would live in many places because of his varied jobs and whims. Shortly after WWI, Fuller went into the construction business with Anne's father. In less than ten years, poor economic conditions and missed opportunities forced him out of the company.



Top of one of two giant geodesic domes (forefront) housing the "lung" diaphragms for the space-age Biosphere 2 complex (background), Tucson, Arizona. Photo courtesy of Gill Kenny – Global Ecotechnics.

Despondent over failures at business, and grieving and blaming himself for the unexpected death of one of his young daughters from spinal meningitis, Fuller reached a defining moment in his life. Standing on the banks of icy Lake Michigan in 1927, with suicidal thoughts, he came to his senses and resolved to dedicate his energies to the search for socially responsible answers to the world's problems. Thus began his 56-year experiment to discover what he, as one person, could personally do for humanity through effective engineering and design.

Fuller's life quest evolved into developing answers to global problems by doing more with less based on the design principles of nature. He became the pioneer of whole systems thinking, analysis and design, which caused him to refer to himself as a "Comprehensive Anticipator" — a "Design Scientist" for "Spaceship Earth."

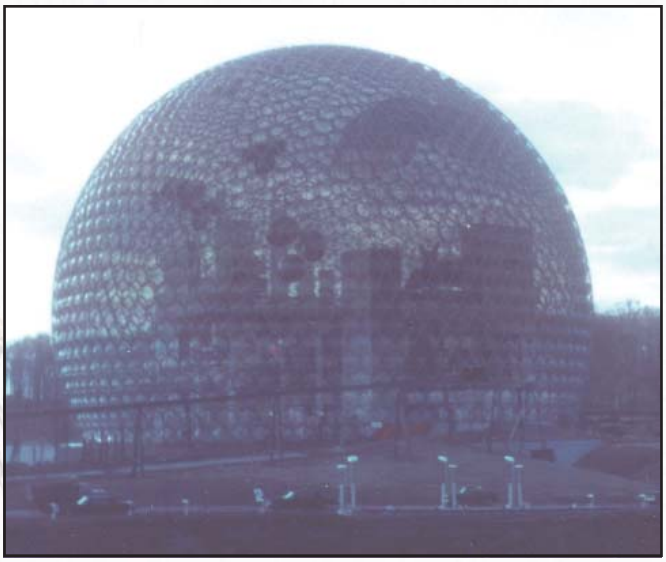
Spaceship Earth at the Epcot Center, Orlando, Florida. From opening day, Fuller's geodesic sphere served as the Center's theme structure. Photo courtesy of Richard Weingardt Consultants, Inc.

Early in his born-again career, Fuller came up with inventions like the Dymaxion House, Dymaxion Car and Dymaxion Map. His map of the world (featured in *Life* magazine in 1943) was the first to reveal the whole surface of the earth in a single view. It showed the continents on a flat surface without visible distortion — with earth as one island in one ocean.

In 1946, Fuller accepted a position as a professor at the small but progressive Black Mountain College. There, he came up with the revolutionary structural design that would make him famous internationally. In 1949, he erected the first ever geodesic dome structure built in the U.S. The 14-foot-diameter dome consisted of a series of tetrahedrons (triangular pyramid shapes), and was constructed using lightweight aluminum aircraft tubing with a vinyl-plastic skin.

Beginning with this tiny geodesic dome, Fuller began revolutionizing the design/construction industry's thinking about the efficiency of structures. To prove the soundness of his dome design, Fuller and several of his students (who had helped build the dome) would hang daringly from the structure's framework to awe his non-believers.

Fuller's geodesic domes are a complex assemblage of triangles in which all structural members contribute equally to the whole, form a spherical shape, and grow stronger as they grow larger. They can sustain their own weight with no practical limits and have the highest ratio of enclosed area to external surface area. When complete, the structures — especially very large ones — weigh less than their parts because of the air mass inside the dome. When it is heated warmer than the outside air, it has a net lifting effect like a hot-air balloon.



Expo 67 – The 20-story-tall U.S Pavilion geodesic dome at the Montreal, Canada, World Exposition 1967. Photo courtesy of Fred J. Heger

In his later years, in conversations with structural engineers and architects about the efficiency of their buildings, Fuller would ask, "What does your structure weigh?" If they didn't know or if it was heavy, he would chide them for wasting materials.

In 1953, Fuller and his patented geodesic dome were elevated to international prominence when the first commercial geodesic dome was constructed. A 90-foot diameter hemisphere enclosed the courtyard of the Ford Motor office building in Dearborn, Michigan, so the area could be used all year around.

The originally designed structure weighing 160 tons was scrapped because it was too heavy to be supported by the existing building walls and foundations. Fuller's dome, weighing 8.5 tons, became the solution. Plus, it was erected within weeks, so it could be used for the Ford Motor Company's 50th anniversary celebrations. When media from around the world gathered to cover Ford's anniversary activities, they were captivated by Fuller's dome — and word of Fuller's deed quickly spread.

The U.S. government further helped broadcast Fuller's work around the world. Recognizing the practicality of his structure, it contracted with him to build small domes for the armed forces, seemingly the world over. The U.S. Marine Corps hailed the geodesic dome as the "first basic improvement in mobile military shelter in 2,600 years."

In short time, Fuller's domes were showing up everywhere. In 1957, a large geodesic dome for an auditorium in Honolulu, Hawaii, was put up so quickly that, 22 hours after its parts were delivered, a full-house audience was comfortably seated inside the building enjoying a concert.

Today, more than 500,000 geodesic domes (and variations of them) of all types and sizes dot the globe. Notable

Terms

Synergetics (or synergy). Arrangements that are mutually beneficial to the parties involved and/or a combined entity that has a value greater than the sum of the parts (or the whole is more than the sum of its parts). In Fuller's words, "Synergy means the behavior of whole systems unpredicted by the behavior of their parts taken separately." His favorite illustration was the behavior of alloys (like chrome-nickel steel): "Synergy alone explains metals increasing their strength."

Dymaxion. A trademark Fuller word whose usage was first widely circulated by Marshall Fields Department Store, in the late 1920s, to promote an exhibit featuring Fuller's revolutionary spherical house design. The word was frequently used by Fuller to mean, "doing more with less."

ones include the 180-foot-tall Epcot Center at Disney World in Florida, a 360-foot-tall dome over a shopping center in downtown Ankara, Turkey, and a 280-foot-high dome enclosing a civic center in Stockholm, Sweden. For many years, the world's largest aluminum dome located in Long Beach, California, housed Howard Hughes's massive airplane — the Hughes Hercules (the "Spruce Goose").

Innumerable plastic and fiberglass "radome" weather stations enclose delicate radar and sensitive equipment in hostile environments globally. Able to withstand extreme temperatures and gale-force winds, geodesic domes frequently became the structure of choice for Arctic and Antarctic facilities. Similarly, corrugated metal domes became a favorite for low-cost shelter with families in third-world countries. Dome-like sculptures also now grace many civic centers, parks and playgrounds.

Radomes at Buckley Air National Guard Base, Aurora, Colorado. To non-engineer passers-by, Buckley's collection of geodesic of domes resembles "a field of giant golf balls." Photo courtesy of Richard Weingardt Consultants, Inc.

The most famous geodesic dome during Fuller's day was the 20-story dome housing the U.S. Pavilion at Montreal's Expo '67. Shortly after that success, Fuller presented the feasibility of a geodesic dome two miles in diameter that would enclose mid-town Manhattan in a temperature-controlled environment. He allowed that it would pay for itself within ten years from the savings of snow-removal costs alone.

In 1959, Fuller was appointed Research Professor at Southern Illinois University. Almost ten years later, in 1968, the Board of Trustees appointed him University Professor, only the second person in the school's history to be so honored.

During his remarkable career, Fuller received 47 honorary doctorate degrees and numerous awards including the U.S. Medal of Freedom, National Institute of Arts and Letters' Gold Medal Award, AIA Gold Medal, and Royal Gold Medal for Architecture awarded by Her Majesty the Queen of England. In 1969, Fuller was nominated for the Nobel Peace Prize. In 1999, when *Engineering News-Record* named Fuller among its 20 greatest structural engineers of the last 125 years, it described him as "an engineer and prophet who believed that technology could 'save the world'."

About his work, philosophies and inventions, Fuller wrote thousands of articles and 28 books. Among his more popular were *No More Secondhand God* (1963), *Ideas and Integrities* (1963), *Operating Manual for the Spaceship Earth* (1969) and *Earth, Inc*. (1973) in which he wrote, "In reality, the Sun, the Earth, and the Moon are nothing else than a most fantastically well-designed and space-programmed team of vehicles. All of us are, always have been and so long as we exist, always will be – nothing else but – astronauts." In *Spaceship Earth*, Fuller wrote, "Man must be educated into realizing his tremendous potential as a universe-exploring being."

Geodesic dome with plastic panel roofing for the City Recreation and Pool Building, North Platte, Nebraska. Photo courtesy of Richard Weingardt Consultants, Inc.

With his geodesic domes experiencing great success worldwide — and having proved that even his most controversial ideas were practical and workable, Fuller spent his final 15 years extensively traveling, and lecturing on ways to better use the world's resources. He presented workshops for millions of people, lectured at 550 universities and, in the course of his work, circled the globe more than 50 times. He died on July 1, 1983, at age 87. His wife Anne died two days later.

A man ahead of his time, Fuller was viewed by some as an impractical dreamer and embraced by others as a visionary genius and a brilliant engineer. By any account, he was a iron-willed individualist who profoundly affected the awareness of the social and environmental potential of humanity.▪

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