SNELSON ON THE TENSEGRITY INVENTION

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Most people who learn of tensegrity are led to believe that the structure was a Buckminster Fuller invention. In that the events surrounding it occurred some forty-five years ago the whole issue now seems to shrink to a tiny footnote in history. Even so I'd like to set the record straight about the origin of the tensegrity structure. A close reading of Fuller's writings will show that he never actually claimed to be its inventor but he told of it in such a way as to cause others to infer that he was. What he did invent is the name tensegrity, combining syllables from tension and integrity.

Now, I will tell you how I came to invent a new kind of structure which eventually came to be known as tensegrity. As happens with many ideas, I discovered the tensegrity principle out of playful experimentation not out of an aim to invent tensegrity or to solve a problem given by a professor. In this case I was playing with ideas for sculptures that could move.

The year was 1948. I was a second-year (G.I. Bill) art student at the University of Oregon when I first learned about the German Bauhaus and the artists, Klee, Kandinsky, Maholy Nagy and the rest. One of them, Josef Albers, had settled at Black Mountain College in North Carolina. Since the G.I. Bill didn't care where I went to school I quickly considered going there in the summer.

Black Mountain College was a progressive liberal arts college which, in its day, attracted artists, especially, talented people from New York who were invited there to teach summer sessions. The local population viewed it as a place of wickedness and as a hotbed of communists. The summer I arrived, there were fifty students and a quarter as many professors; among them, Willem DeKooning, Richard Lippold, Merce Cunningham, John Cage, Annie and Josef Albers.

Richard Buckminster Fuller arrived two weeks into the session, late because he was invited last minute to replace another architect who suddenly had withdrawn, leaving the college without a Department of Architecture.

Fuller's name was not yet famous so that his arrival was greeted with no special fanfare. The only clue to something special was that unlike any other faculty member Professor Fuller was to give a school talk on the very evening he arrived, having driven in from New York with a streamlined aluminum trailer full of architectural models.

Albers picked me to help the new man prepare materials for his talk, so I went to his trailer parked near the dining/assembly hall. An instant glance inside told me that assisting him would not be simply a matter of putting roofs on miniature house models. The trailer with barely room to enter was packed with what appeared to be geometrical/mathematical studies – dozens of cardboard polyhedra of all shapes and sizes, spheres made out of great circles, metal-band constructions, plastic triangular items and fragile globs of marbles glued together. He instructed and I helped as he unboxed one strange geometric model after another.

That evening when dinner tables were cleared and chairs were set up for the audience we waited to hear from the new teacher. He was a small, stocky, man with white hair in a crew cut and huge magnifying eye glasses. He began to stammer after an endless silent pause with eyes closed. Soon, though, he gathered his thoughts and one-by-one led us non-stop on a tour of his achievements. He described man, the species, in robotic terms: a mobile, multi-adaptor bi-ped. "Energy-slaves" of man's invention were more and more replacing human drudgery. He talked of design efficiency which meant tension materials overcoming heavy and costly compression materials. On that first evening we heard the outline of Buckminster Fuller's lectures-to-come that summer: light-weight buildings, a "geodesic" sphere composed of great circles, the Dymaxion car and of all the devices from the trailer which explained his Energetic Geometry which was based on the triangle and tetrahedron instead of the square and the cube; also a transformable device he

called his "quantum machine". These ideas would revolutionize mathematics – and physics too. All in all, his was a grand design strategy for the betterment of every human being on Earth.

For us art students, his message was that we were the select and gifted ones eminently skilled for designing a new world and to save mankind from self-destruction. We heard that artists were wasting their talents hiding in the corner, playing esoteric artist games and instead we should be preparing ourselves to take control and assume responsibility.

It's fair to say that the college was mesmerized with his futuristic imagery.

A few professors such as Dr. Dehn, the mathematician, grumbled that we were listening to a charlatan, but he was overruled. Most everyone, me included, thought it sounded great, especially the part about artists being poised to take over. We were to call him "Bucky".

Daily for the rest of the Summer Session, virtually the whole school, professors as well as students, crowded into his daily all-morning lectures. I kept my job as class helper. As the stimulating summer weeks slipped by I began to question if I should continue with painting. Albers' advice was that I showed talent as a sculptor.

By summer's end I was deeply affected by Fuller's Dymaxion ideas and I was teetering on becoming an advance soldier in what turned out to be a long succession of young people from schools all over the globe who, for longer or shorter tenure, became Bucky-Fullerites, or as he liked to call them, "Dymaxion Fellows".

Bucky surely was a man for his time. In those days that seem so long ago, just after World War II, the country was upbeat and Bucky was an attractive optimist who made his audience believe that the world would be okay if only things were done his way. He had the right stuff for a true cult-leader: charisma and a message. The enemies out there to defeat were ignorance and greed.

The students, many of us just out of military service, were ripe for a cause, any inspiring cause more favourable to art than communism, and Bucky described the greatest of challenges: Save humanity and solve all of its problems through masterful design using the newest of technologies. For my part it was the geometry and the structural ideas that turned me on. I had my doubts about being able to save the world. As one student put it, "When I listen to Bucky talk I feel I've got to go out and save the world. Then when I go outside I realize I don't know how". But I was willing to try.

I had lost all interest in returning to art classes at the University of Oregon so instead I went back home to Pendleton, Oregon, to think what to do next. If making art was a waste of talent, what steps might I take to try saving the world?

For the next four months I did what I had done during my childhood, spent days in the basement of our small house, building things. Instead of model airplanes though I made small mobile sculptures using thread, wire, clay, metal from tin cans, cardboard, etc.

I knew about Fuller's so-called Energetic Geometry as well as something of Bauhaus constructivism from Albers and I applied both of them. While Albers' ideas and teaching seemed freely given and in public-domain, Bucky's lessons were burdened with proprietorship: "my" geometry, "my" octet-truss. Listening to Fuller's lectures, one had the impression that he had discovered for the first time anywhere that tetrahedra and octahedra were triangulated forms and therefore were strong structures. To use any of these principles for making art was reprehensible. Students slyly noted that Bucky, quite likely, had invented the triangle. In the fall and winter of 1948-49, as I said, I made numbers of foot high studies, moving and static. They were sculptures which incorporated the attitudes of both Fuller and Albers. The three which are of special interest here were converned with stacked modules, hinged one to another as seen in photo #1.

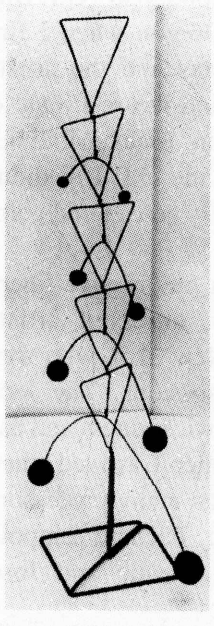


Figure 1. First Study for Moving Sculpture; iron wire and clay, $23\frac{3}{4}$" x 11" x $4\frac{1}{2}$". December 1948.

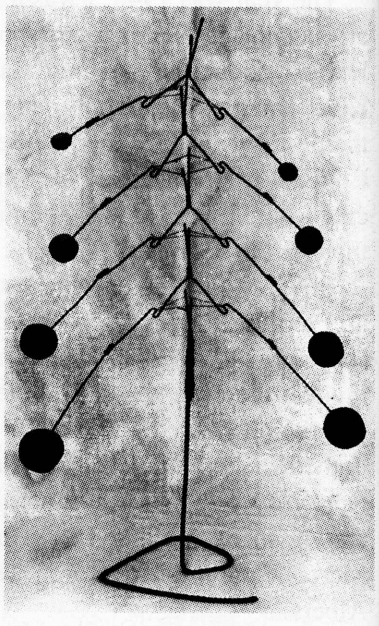


Figure 2. #2 Moving Sculpture; iron wire, cotton thread and clay, $17\frac{1}{2}$" x $12\frac{1}{2}$" x $5\frac{3}{8}$". December 1948.

This was, in fact, a variation on the familiar weighted balancing toys found in novelty shops. The wish to have the piece move freely is what caused me to resort to the modular, spinal-column, form.

The evolution of #1 to #2 appears logical enough, though one could imaging that I'd end up only with variations on Calder mobiles instead of elementary tension/compression structures – tensegrity.

Photo #2 shows how thread slings to support one form to the next replaced the wrapped-wire hinges between modules in #1.

I devised the thread slings to support the elements in order to add something like magic or mystery by making the linkages invisible, at least as invisible as marionette strings.

By another step, still looking for illusion, I saw that the piece might become even more astonishing by eliminating the balancing arms and, with four additional tension lines, tying off motion altogether. My first stable structure was made with two "C" shapes biting one another, demonstrating that the idea was workable. Clearly, the ideal shape was an X module since it provided four quadrants for adding new elements. From plywood I constructed the X-column piece shown in photo #3.

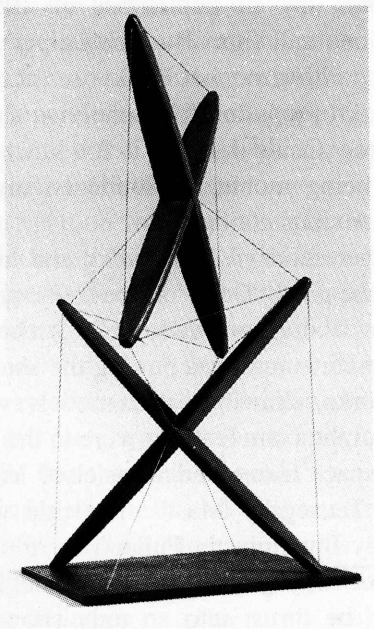


Figure 3. X-Piece; plywood and monofilament nylon, $11\frac{1}{2}''$ x $5\frac{3}{8}''$ x $5\frac{3}{8}''$. December 1948.

Even though there was no longer any movement, the static sculpture was stranger looking than anything I could have imagined: rigid parts fixed in space one-to-another only by means of threads. I was truly amazed at myself.

Though I was pleased with my collected works, I was still muddled about my direction in school so, in a desperate frame of mind, I decided to try engineering in the 1949 winter trimester at Oregon State College, Corvallis. Slide rule and data sheets were unbelievably dull – and I did poorly. Not one of those pedestrian engineering teachers could have imagined the grand and exciting Dymaxion world.

I wrote to Bucky in Chicago and told of my dilemma and also sent photos of the constructions I had done. He understood about my depression and he proposed I return to Black Mountain's 1949 Summer Session and work with him and his students from the Institute of Design who were coming as well. About the photos I had sent, he remarked only, "... they are exellent".

When I met him at the school in June, it was on a hot day and we were standing shaking hands on the dirt road that led from the dining hall to the studies building on the hill. I was carrying the plywood X-Piece (#3) from Pendleton in a cardboard box. When I showed it to him his look of fascination told me that he was quite awed by it; also, I realized that he couldn't have paid much attention to the photos I sent or he would have recognized the piece at once. For a long moment he held the fragile object, studying it from every angle. He mused that it was the realization of something he had looked for for a long time. "Ken, may I keep this?" he asked. I meant only to show it to him. Even so, I conceded, yes, of course he could keep it. In another part of me I was relieved that he was pleased and not irritated that I had used geometry ("His geometry") in making art.

Next day in his study room where all his models were assembled he told me he had given some over-night thought to my "X" structure and determined it was not right. I should have used the central angles of a tetrahedron, like spokes radiating from the centre of a regular tetrahedron to its corners.

It was ironic since it was exactly that tetrahedral module I had used in mobile #2, the one with tension slings and clay weights. Since he hadn't paid much attention to my photos from Pendleton there was not much point in protesting. The X form was, in my view, a lot better since it enabled growth in any direction from any quadrant rather than only along a single axis. But those were the days when students weren't allowed to argue with their elders, to say nothing of professors. Also I believed at that time that the Dymaxion Master possessed divine insight into

nature's intentions.

To build the modified structure I went next day to nearby Asheville's Woolworth store and picked up a dozen telescoping metal curtain rods. Completing the piece was easy and a day later Bucky was delighted and asked that his picture be taken holding his new five-foot long discontinuous-compression structure. As I photographed him with it I felt a numbing inside from what was happening but I was not yet distrustful. After all, Bucky knew as well as I did whose idea it was – and besides, teachers don't go around stealing student's ideas and claiming them as their own.

Near the end of the Summer Session he complained of a minor tragedy: someone apparently sneaked in and stole the wooden X-Piece from his room.

Buckminster Fuller was one of the most complicated of men by anyone's measure. At Christmas time, four months after we had said goodbye at Black Mountain, I received a hand-written letter dated December 23rd, 1949. In his own flamboyant style he wrote:

> In all my public lectures I tell of your original demonstration of discontinuous-pressure – (compressure) and continuous tension structural advantage; – in which right makes light in a prototype structure, the ready reproduction of which, properly incorporated in fundamental structures, may advance the spontaneous good will and understanding of mankind by many centuries. The event was one of those "It happened" events, but demonstrates how the important events happen where the atmosphere is most favourable. If you had demonstrated this structure to an art audience it would not have rung the bell that it rang in me, who had been seeking this structure in Energetic Geometry. That you were excited by the latter, E.G., (Energetic Geometry) into spontaneous articulation of the solution, also demonstrates the importance of good faith of colleagues of this frontier. The name of Ken Snelson (his underline) will come to be known as a true pioneer of the realized good life and good will.

"In all my public lectures ..." A few years later I asked why he didn't ever tell about it in print.

Next year I studied in Paris with Fernand Leger and on a warm day in August, 1951, a familiar image caught my eye at a newsstand where foreign magazines were sold. There on the cover of "Architectural Forum" was the unmistakable pattern of a geodesic dome. Inside was an article about Fuller's experiments plus a picture, taken against the sky, of my "mast", a mechanical looking one with turnbuckles and identified as a "discontinuous compression" structure. No attribution, only the name James Fitzgibbon beneath the photo and a caption, saying it was "a companion investigation by Fuller in frame construction". The plot was obvious: without actually making the claim in so many words, the structure was, by unavoidable implication, Bucky's invention. I saw at once that I had been successfully swallowed up. The damage was already done. He had access to publicity and, lesson of all lessons, the power resides in the press. (Note that the word *tensegrity* didn't appear in the article; it came into use five years later.)

For the ten years that followed I ran into Bucky from time to time when he was in New York, but I was cowardly about entering into battle, which was my problem to be sure. I made only the weakest of protests – about my name never appearing in print – and I stepped out of his world completely and into a carrer of free-lance filming. For the next ten years I worked on documentaries in New York's movie business.

Then, one day in September of 1959 came a surprise phone call from Bucky's helper at the time, John Dixon, telling me that Bucky was at the Museum of Modern Art preparing for a one-man show to open in November. Could I make it for lunch to see the exhibition being mounted? Suddenly, my head was filled with anxious anticipation.

I went there and greeted Bucky and his assistant. We toured the great "Octet" space frame and the fifty-foot green fiberglass "radome". Arthur Drexler, curator of architecture was putting the show together. Smaller works, drawings and models were to be included, but the main features were in the garden; the dome, the space frame and what else? Yes, a thirty-foot high "Tensegrity Mast". The title was "Three Structures by Buckminster Fuller".

I was suddenly gripped with fear that I would, in this instant, be thrust into an ugly showdown with Bucky over my long grievance which had festered in silence. The truth was, I was afraid of the man; that enormous father figure. Bucky was not known to abide challenges, open or otherwise, and those around him were familiar with his tantrums when he was crossed. Considering our history, it seemed uncanny that he had invited me to see "his" Tensegrity Mast. In fact it lay prone now on the walkway undergoing last

minute adjustments. Only the space frame and the plastic dome were standing. After trying our voices on the dome's inside echo, John, Bucky and I sat down for lunch at a small table in the garden.

What happened soon after we had chatted for a while during coffee, was surely not what Bucky was looking forward to. He was describing the trials of Sadao and Price's during the fabrication of the thirty-foot "Tensegrity Mast". "Pure Jewelry, Ken, pure jewelry."

In the next instant, leaping off a precipice, I heard myself say, "I hope my name is going to be on it this time, Bucky."

With his thick magnifying lenses staring at me, he stammered his assurance, "Oh, ... I know, Ken, Yes, I'm sure I've told Arthur Drexler all about you."

John, who had been only the listener during most of my visit, protested simply, "Gee Bucky, I don't think Arthur knows about Ken ..."

"Oh, I'm certain I've spoken about Ken to Arthur."

"Well, we could go ask." said John, guilelessly, yet letting me understand that he was more savvy about his master than I imagined.

I marched with John at the lead toward the MOMA's Department of Architecture. He introduced me to Drexler and told briefly why we were there, that the Tensegrity structure was my invention, etc.

The director stood listening, indicating that it was all news to him. He had little choice but to change the text to say that the tensegrity structure was the invention of Kenneth Snelson.

Inside me elation was exploding but I managed to appear calm when John and I got back down to the garden to let Bucky know that the Department was going to add my credit to the catalog as well as on the placard next to the "Tensegrity Mast". Bucky performed as best he could, nodding affably at the good news. "Yes, wonderful, wonderful" he said. Whatever he was thinking, I couldn't guess.

In any case the result of this meeting between Bucky, John Dixon and me was the public acknowledgement that tensegrity was my invention and also the inclusion of a few of my sculptures along with a replica of the much discussed plywood and monfil "X-Piece" from ten years before. (See photo of MOMA vitrine, November, 1959) (Figure 4).

> "Perhaps one of the most dramatic developments to grow out of Fuller's theories is the discovery made by Kenneth Snelson, and analyzed by Fuller as tension-integrity. Arts and Architecture (Nov. 1959).
>
> ... The principle involved in the tension integrity mast was first discovered by Kenneth Snelson in 1949 ... The mast in the exhibition was based on the same principle but employed a different configuration of parts." MOMA brochure (1960).

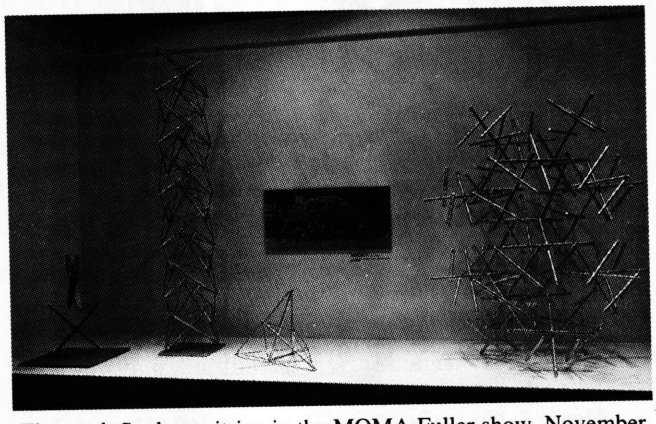


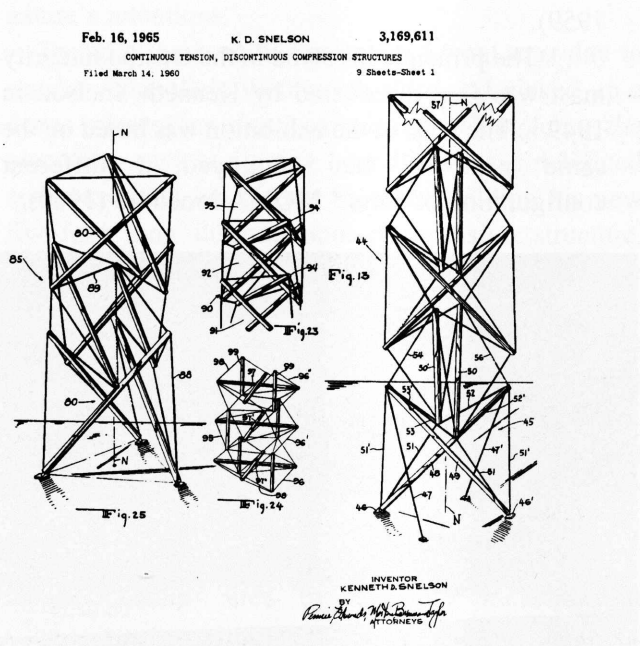
Figure 4. Snelson vitrine in the MOMA Fuller show. November 1959.

John Dixon's simple honesty as a go-between was the catalyst that changed everything that was to happen from then on, for I went back to work where I had left off and began to learn all about the magic of the X module and its infinite variations.

The rich irony not to be overlooked in this teacher-student story, is that because of Bucky's hasty and desperate decision early on to swap the tetrahedral module for my Xs, and its subsequent disappearance caused the original form to be buried completely. In the ten intervening years that Bucky's tetrahedral modification was seen and published everywhere, no one, student or disciple, reinvented the X-module. Fate or destiny or good luck safe-deposited it, waiting for my time to reclaim it.

In 1960 I applied for a patent for the principle of the X-Module and its capability to expand in all directions. Though a decade old, the structure had never been published. (Figure 5 Illustrations from US Patent 3,169,611 entitled 'Continuous Tension, Discontinuous Compression Structures', dated February 16, 1965, filed March 14, 1960.)

What followed, was the many years of my experimenting and learning about the X module's remarkable properties – and making hundreds of sculptures, many of them sited in major museums, cities and collections worldwide. (Figure 6 "Triple Crown", Hallmark, Inc. Kansas City, MO; stainless steel, 43′ x 85′ x 78′, 1991).


Feb. 16, 1965 K. D. SNELSON 3,169,611

CONTINUOUS TENSION, DISCONTINUOUS COMPRESSION STRUCTURES

Filed March 14, 1960 9 Sheets-Sheet 1

Fig. 25

Fig. 24

Fig. 23

Fig. 13

INVENTOR KENNETH D. SNELSON

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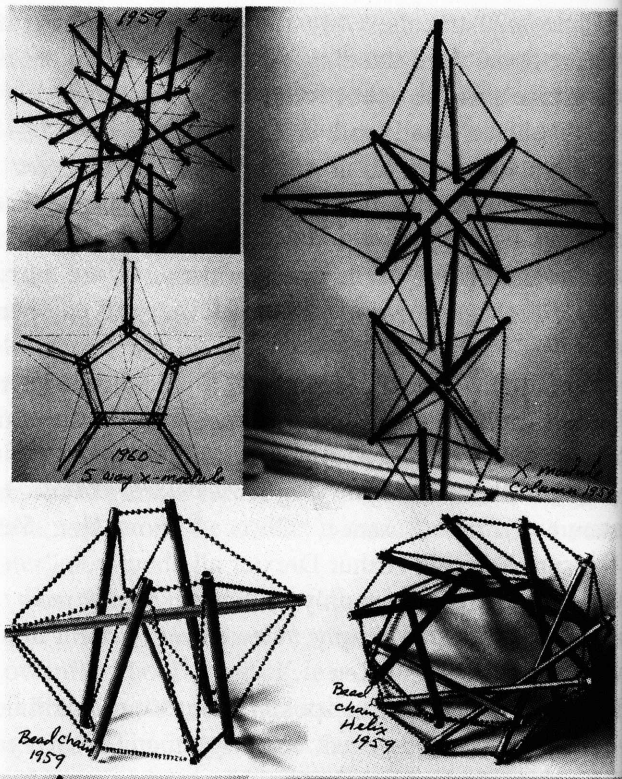
ATTORNEYS

Figure 5. Illustrations from US patent 3,169,611 entitled 'Continuous Tension, Discontinuous Compression Structures', dated February 16, 1965, filed March 14, 1960.



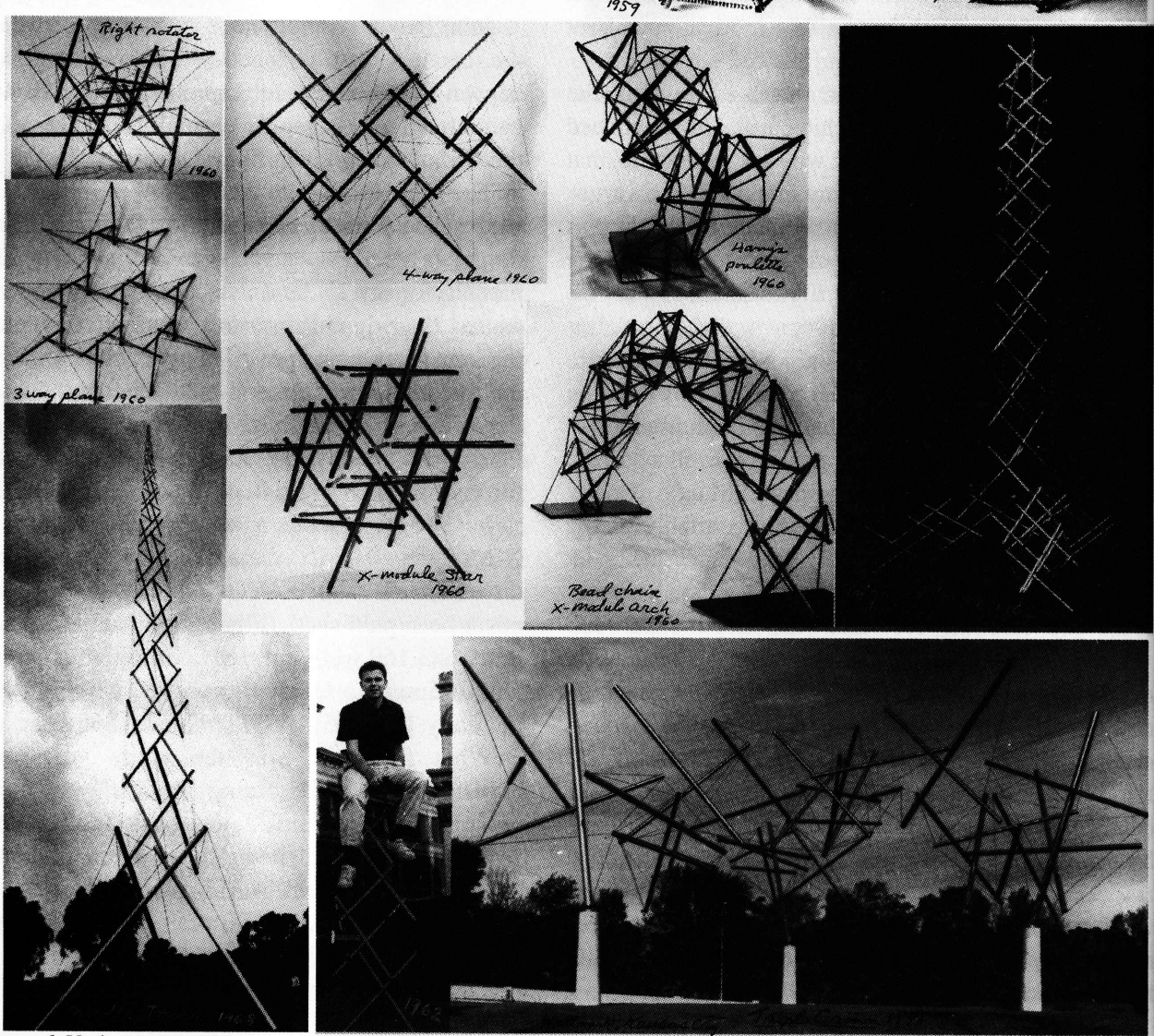


Figure 6. Various structures constructed between 1959-62; bottom left structure was constructed in 1968, bottom right in 1991.