

YOUR PRIVATE SKY

R. BUCKMINSTER FULLER

THE ART OF DESIGN SCIENCE

Edited by
Joachim Krause
Claude Lichtenstein



LARS MULLER PUBLISHERS



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The participants in this project would like to express their thanks to those responsible at the Buckminster Fuller Archive, the Buckminster Fuller Institute and the Estate of R. Buckminster Fuller for their ever greater interest and participation in our project and for their readiness to grant us access to their holdings.

We wish to thank CargoLifter AG for their openness to a theme that, we are convinced, still holds exciting possibilities for the present and future.



“Scientific shelter design is linked to the stars far more directly than to the earth. Star-gazing? Admittedly. But it is essential to accentuate the real source of energy and change in contrast to the emphasis that has always been placed on keeping man ‘down to earth’.”

Nine Chains to the Moon (1938), 67

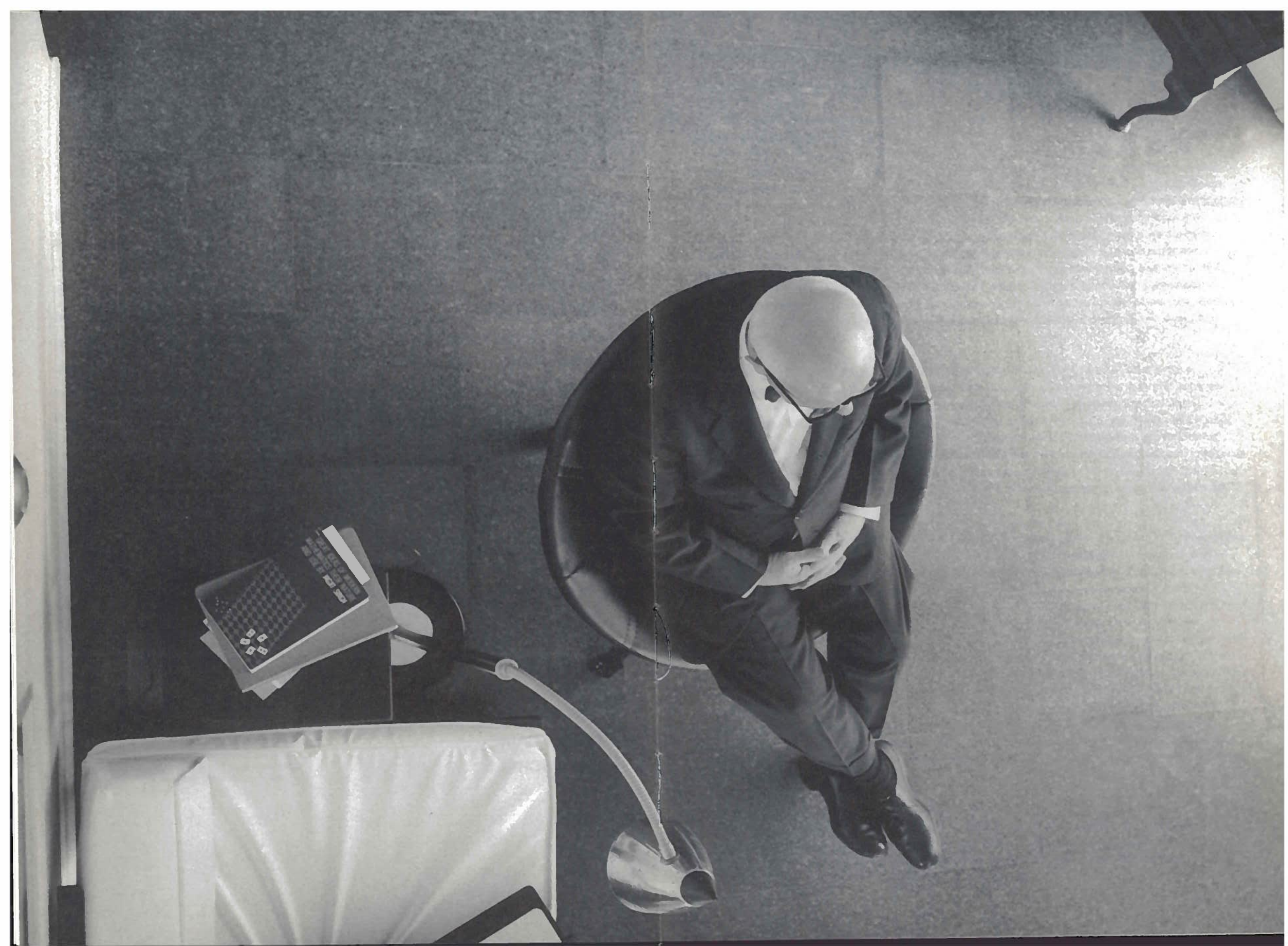
Most of the documents depicted in this book are small format (up to letter format). The sketches from Fuller's early work *4D Houses* are inventoried as *Sketch Series*. The majority of the manuscripts and sketches from the period from 1945 on are taken from the *Manuscript Files and Synergetics Papers* archival collections. Numerous photographs are prints of 7"x10", sometimes even smaller; larger photographs are the exception. Some of the photographs from Fuller's childhood years are taken from contact sheets. Some of the images in question come from the *Dymaxion Chronofila*. Others are photographs after 1945, particularly the color prints from small-format slides, whose color quality has remained astonishingly high in the time since the photographs were taken (as much as fifty years in some cases). Some of these are from Fuller himself, who enjoyed taking pictures and did so quite often, though the photographs are not signed. A large section consists of black-and-white photographs that Fuller received from numerous participants in his workshops and projects. Only sporadically are the photographs stamped on the reverse. See the illustration credits at the end of the book.

References in the form → YPS: *Discourse* are to the companion volume, *Your Private Sky: Discourse*, which together with the present book contains a correlative selection of previously unpublished texts by R. Buckminster Fuller as well as important statements about him by others. (ISBN 3-907044-94-0)

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R. BUCKMINSTER FULLER

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"How to Make the World Work"

Over the course of his life, Buckminster Fuller increasingly framed the justifications and explanations of his work in terms of the entire universe. Was he, then, a universalist? Fuller's many careers, callings, and activities would seem to suggest he was. In 1980, when the book *R. Buckminster Fuller: An Autobiographical Monologue/Scenario* was published—edited by his son-in-law, the well-known documentary filmmaker Robert Snyder—Fuller's many careers, fields of activities, awards, and titles were listed on the cover: "A sailor, a machinist, a comprehensive generalist, a doer, a new former, a student of trends, a technical editor, a businessman, an angel, a quarterback, a lecturer, a critic, an experimental seminarist, a random element, a verb, a comprehensive designer, an inventor, an engineer, an architect, a cartographer, a philosopher, a poet, a cosmogonist, a choreographer, a visionary, a scientist, a valuable unit, a mathematician, an air pilot, a Navy lieutenant, an affable genie, a geometer, a maverick thinker, a gentle revolutionist, a lovable genius, an anti-academician, doctor of science, doctor of arts, doctor of design, doctor of humanities, an amiable lunatic, a prophet, the custodian of a vital resource."

An imposing figure! This enumeration is indispensable, if one wants to do Fuller justice, because he became all of these things on his own strength. (The rest of us can still console ourselves that at least some of these terms apply to us as well.) Measured by the usual standards of a successful life, Fuller set off on a false start in his youth. He did receive a high school education, but he was not successful as a student and had no certain prospects for a respectable profession. His life demonstrated that these fears were unjustified: what range of thinking and areas of activity, indeed, what a life in general! That suffices to answer the question asked above. Yes, he was a universalist. If a different answer is given here, then an explanation is necessary.

He was not a universalist if a universalist is understood to be someone who in the course of his or her activities always reaches out to other increasingly distant disciplines, trying to find his or her self and achievements there. Universalists are expansive (admittedly, Fuller was as well, and how!), but universalists also accumulate. For all the admiration we might have for universalists, there is an element of sport in it, the drive to demonstrate multiple talents: a kind of intellectual decathlon. That was not Fuller's intention at all. It is true that as he grew older he referred, with fewer and fewer qualms, to the whole of the universe, but he discussed it as if describing something around the corner, discussing the "wisdom in the design of the universe." Of course, such far-reaching references placed excessive demands on his audience. But he had to look out into the world from the outside, as it were, because he could not be satisfied with that which lay before him. So, even if it is impossible not to see him in the context of the universal, it is precisely because Fuller did not strive centrifugally from the earth toward the universe, but rather sought the center of knowledge from outside. Naturally, he had to take a standpoint "from outside" the earth in order to present proposals that conformed to reality.

This characteristic of a viewpoint from "outside" explains why Fuller is so fascinating, but also why he is so unsettling. When, in a lecture in 1951, he spontaneously hit upon the phrase "Spaceship Earth," it seemed so direct and surprising. It seemed as if he were looking from "outside" at our blue planet—almost two decades before the public saw the inspiring

photographs from the NASA missions to the moon—and characterized it as a closed ecological system. Already as a thirty year old, he had seen the populated land masses of our planet and realized that the continents, including Antarctica, formed an inhabitable archipelago: the “one-world island” in the “one-world ocean.” No wonder, then, that he also saw the political activity on the archipelago “from outside” and viewed it as an irrational turmoil of court intrigues, of representatives of particular interests, of self-important people who purported to offer insight but who could not, in fact, see at all. Against all this he would protest, usually polemically but sometimes sadly. He also regarded academic disciplines “from outside,” less with admiration than with curiosity. And in his own activities regarding the constitution of matter and the question whether the fields of mathematics, geometry, physics, and chemistry, which are not separate in nature, should not, perhaps, simply be one field: “how Nature builds.”

Fuller first became known as an architect; his contributions were recognized and honored within the world of architecture. But these appraisals were often condescending. In the USA, where architects must be licensed, he was not permitted to construct buildings under his name alone until well into old age. When Fuller presented his *Dymaxion House*, most of the important architects from American cities who were present were not unimpressed; they envied Fuller for his intellectual freedom, but at the same time they smirked at his evident lack of “realism.” At best, they regarded Fuller’s concept as a refreshing questioning of standard ideas, brashly presented but not intended as a concrete proposal. Given all of this, it is no surprise that Fuller also saw the world of architecture and building “from outside.” Clearances, height limitations, length of escape routes, access rights—parameters that determine the design agenda of an architectural office—did not exist for him. Architecture without the neat parcels that underlie it is a very dubious prospect in the eyes of professionals, as if someone were mischievously cutting off the circulation of the unquestioned necessities.

Fuller’s early sketches—inexpert drawings when compared to the designs of others but highly forthright for precisely that reason—clearly reveal the background of his proposals in architecture. The individual building serves as a base in a concept that spans the globe, and “spanning the globe” does not simply mean that Fuller intended for many such homes to be built throughout the world. He shows us how he intends to do it: the globe is a construction site for lightweight towers that reach up to the skies. The construction site is indeed a sphere. To say “reach up to the skies” is the wrong phrase, as the sketches show, because there is no absolute up and down, but only the inside of the Earth and the outside of space. The towers reach out to space. Who else saw architecture as Fuller does here? Not Tatlin, not El Lissitzky, not Le Corbusier. The 4D towers create a network of bases, signal flares of the colonizing activity of mankind. Building becomes a strategic act of colonizing the Earth, taking possession of land as a “claim,” very much in the American tradition of a strategy for settling a place. But there was one important difference with respect to earlier history. For Fuller, the possession of land is free of its mythical claim on proprietary ownership of land and soil, a claim that has always resulted in discord, war, and destruction. For Fuller, ownership means to live in one place for a period, to use the land, no matter as a source of food or as the site for a house. This also means that the land remains available to others, just as the sea is available to others when we cross it in a ship. On the constantly moving sea, no one crossing it aspires to “possess” the water beneath the ship’s hull. Only on static land does anyone get this sort of idea, as Fuller remarks sarcastically, polemically, but ultimately in the firm belief that sooner or later it will become clear how absurd this practice really is.

Everything that Fuller thought of, that interested him, and that he researched was in some way dynamic. The child of the industrial age is mobile, living now here, now there. He or she occupies a house for a time, then moves out, and someone else moves in; or he or she moves and takes the house along. His aphorism “In architecture, form is a noun; in industry, form is a verb” was incomparably concise. He needed to imagine things in interdependent relationships, in dynamic patterns; any idea of a static order a priori was deeply implausible to him. Visible reality is always just a snapshot, never an inventory, for the reality behind the visible cannot be recognized from an inventory—because there is no static reserve—but only from a dynamic and critical comparison of various snapshots.

It becomes clear that Fuller chose the far more difficult path over that of those who operate within static certainty. He himself always emphasized the life-long influence his experience in the Navy had had on his way of thinking. Working at sea, in a group of people working together in an intense way, in a form of transport subject to swaying, where every wave makes the assault of outside forces palpable and transforms them into motion; exposed to the elements of nature but capable of accepting it, navigation as a necessary activity and the expression of a consciousness of space and time that had been gained over the centuries by those who needed it to survive: these are for Fuller the existential bases for a perception of reality that is both realistic and creative. This book begins with the theme of navigation and “sea travel” less for their biographical significance than for their deeply metaphorical significance for Fuller’s entire oeuvre.

The *Dymaxion Chronofile*

One astonishing sign of Fuller’s “consciousness of himself” is the decision he made early in life to conceive of his own life as an experiment. This is a very radical position. An experiment contains a chance not only of success but also of failure. The experiment comprises both the way in which one’s own life can fail and the way in which this can be avoided. These are the rules of a game that may have something of the typically robust Yankee style. As for the nature of this experiment, it goes beyond the usual “You can make it” of a competitive attitude to life and leads to the pioneering exploration of a true life project. The nature of this project is, to put it mildly, not without pathos: to do everything that can benefit humanity. Fuller: “I said, ‘What can a little man effect toward such realizations in the face of the formidable power of great corporations, great states, and all their know-how, guns, monies, armies, tools and information?’ Then, self-answering: ‘The individual can take initiatives without anybody’s permission.’ Only individuals can think, and can look for the principles manifest in their experiences that others may be overlooking because they are too preoccupied with how to please some boss or with how to earn money, how to take care of today’s bills. Only the individual disregards his fears and commits himself exclusively to reforming the human environment by developing tools that deal more effectively and economically with evolutionary challenges. Humans can participate—consciously and competently—in fundamental ways, to changes that are more favorable to human life. It became evident that the individual was the only one that could deliberately find the time to think in a cosmically adequate manner.” (*Influences on My Work*, 1963). This was the task he set himself. Fuller saw himself as “Guinea Pig B.” He subjected himself to an experiment and made himself an object of observation. The instrument for checking up on this task was the *Chronofile*, which Fuller kept from about 1915 on and had bound in 1930 under the title *Dymaxion Chronofile*. It consisted of a kind of “central diary,” which did not simply record and document events that had already happened

but also formulated or "crystallized" projects, as Fuller called it. Even so, the Dymaxion Chronofile was not the usual documentation of works; it combined life and work, daily life and events, the important and unimportant, which made it possible later to reevaluate the decision whether something was important or unimportant. The abscissa of the Chronofile is the time line, and only the time line, a strictly linear concept, in which there are no separated rubrics of "life" and "work," "private" and "public." The time line is one of the geometric coordinates that enable us to find what we seek.

The other geometric coordinate, the ordinate, does not exist; more precisely, it would be the knowledge of the event, and that means nothing other than the knowledge of Guinea Pig B himself. One has to be familiar with both the event and its significance in order to find it within the time line of the Chronofile. Either that or one needs to know it. Or one has to comb through the records and find the significance on one's own. Precisely because it is meant to give information about the current position at every moment, Fuller intended for the Chronofile to be like the logbook of a sea traveler. Fuller committed himself to making his life project testable at every stage, both instantaneously and retrospectively by himself as well as historically by those who would come later. This is, it must be said, a very presumptuous plan. Nevertheless, Fuller held to the archival model of the Chronofile all his life, and he invested large amounts of money, time, and strength of will into the production and continuation of this monumental journal. Up to the late thirties, he would collect the folders into leather-bound volumes; later, confronted with a rising flood of data, activities, transcripts, letters, and notes, the documents were stored in boxes. One can only imagine the quantity of letters we are discussing. There is no inventory of the correspondence; there is no index of senders and recipients. The idea of the Chronofile did not permit it. (In reality, however, the pressure of circumstances meant that an index of the late correspondence, dating from about 1970, was prepared.) The Chronofile swelled to encompass some seven hundred fifty units by the time of Fuller's death, a "diary" or a life's transcript that stretches more than three hundred linear feet. As the model of a radically linear method of notation, the Chronofile soon reached its limits; the analogy to a nautical crossing and the incomparably immodest attempt to document fully a life journey proved to be illusory when confronted with reality. It is not without irony that, of all places, in Fuller's lifework, or rather work life, the connecting thread of his own personality remained at the center—the "soul" as it were—but from the time of Bucky's forties it was increasingly populated by highly talented and appropriately motivated assistants who boldly crisscrossed the principle of linearity. To continue the metaphor, Fuller was now commanding an entire squadron, and the idea of an exactly determinable intersection of space and time increasingly became a grossly simplifying illusion, even for himself, that over the course of time threatened to lose perspective on the before and after, the cause and the effect. Still, Fuller clung to the idea of the *Dymaxion Chronofile*, even though it probably only became practicable with the age of the computer and the existence of computer disk drives.

Preventative Designer or Charlatan?

An article in *The Saturday Evening Post* of 18 October 1944, in which Fuller and his Dymaxion World Map were presented, began: "Some people say the inventor of the 3-wheel automobile and the 'dwelling machine' is an authentic 18-carat genius. Others just laugh and laugh." Buckminster Fuller was, no doubt, not the silently serving spirit in the background; he polarized opinions, and a portion of the public saw him as a charlatan. And even some early colleagues who had fallen out with him.

He was no charlatan, this has been clear for some time, but it is understandable how someone could come to this view. Fuller characterized his work as "anticipatory design science." If one reads how Buckminster Fuller in important presentations would speak matter-of-factly about things as if they existed, when they most certainly did not, it is easy to imagine how that might have come across to somewhat less imaginative audiences: as a bluff or, worse, as a scam. To give just one example, when Fuller presented his Dymaxion House in a lecture for the Architectural League in New York (presented in detail in *Your Private Sky: Discourse*), he described, among other things, the contents of the appliance room. He described a washing and ironing machine as if it already existed: you put the dirty clothes in on one side, and they come out the other side, freshly washed and steaming from the iron, and land in the appropriate basket. Inventions are made of this stuff; wish dream and imagination are the parents of innovation. (What Fuller was imagining here was quite simply the transformation of the mechanical means of processing of, say, a wheat-harvesting machine into an advanced household apparatus; it is the inventor's task to transpose the process of turning grain into flour into the transformation of dirty laundry to clean.) Fuller probably just neglected to declare the *Vor-Schein* (pre-appearance) as such, to use Ernst Bloch's word. And why should he when everything is so easily anticipated? The anticipation must have been the greatest intellectual pleasure of all for him: to imagine what was not yet visible. To imagine means to make an image of something. He seemed to be on the intimate terms with the "not yet"; he spoke of it as if the doors were already opening and as if it were entering the present. The confusion that this caused is understandable. Against the background of the cautious and circumspect design theories of the American consumer society, which then as now was essentially concerned with the degree of innovation that could be tolerated by society, a preventative designer like Buckminster Fuller was like a stone fallen from the sky.

It speaks for itself that Fuller did not encounter such difficulties at advanced teaching institutions, where the public hung spellbound on his every word. At the Design Institute in Chicago or at Black Mountain College, it was not the demonstrable reality that counted but rather the shared path to the conceivable. The *Zukunftsmusik* (literally, "future music" but meaning "dreams of the future") was not what is usually called that in German, namely, something that lies outside the realm of one's own range of hearing. The students wanted to make music for themselves, and Fuller simply gave the cues. It can be assumed that the years before and after 1950 were the most imaginative ones, both for him and for his public, and he himself had an unheard-of presence. On photographs from this period, Fuller looks younger and noticeably less staid than during the previous period in Wichita.

Inventor Bucky

Buckminster Fuller is known as the inventor of the geodesic dome. That is only partially correct. He developed it independently and received a patent for it, but that was some thirty years after the engineer Walter Bauerfeld, when searching for an eggshell-thin dome for the Zeiss Planetarium structure in Jena, hit upon a great-circle latticework. Fuller was the first to work out the complete grammar of geodesic constructions, and he made them visible.

Nor did Fuller "invent" the octahedral-tetrahedral truss. It was Alexander Graham Bell who, also decades before Fuller, had experimented with this structure for kites and an observation tower. Bell—the inventor of the telephone, among other things—was certainly a first-class eighteen-carat genius, as was Bauerfeld.

The problem of "closest packing of spheres" had already been explored by Johannes Kepler, three hundred years before Fuller. The Platonic bodies are called that because the greatest philosopher of antiquity was interested in their properties, and not because of Fuller's geometric research. And the C-60 carbon molecule was named "buckminsterfullerene" after him, but he did not discover it.

Finally, the principle of the multipolar tensegrity structure was discovered by Kenneth Snelson, one of Fuller's young students at Black Mountain College. It was a very significant and stimulating discovery that Fuller had been anticipating in his thought, but which he did not achieve himself.

Why make this list? (It could be continued: Fuller is, of course, not the inventor of the three-wheel automobile either, as stated above.) Because it is necessary to confront one of the greatest misunderstandings, namely, the notion that the value of Fuller's work lies above all in the particular inventions and discoveries. If this were the case, then one would have to ask: did Fuller discover anything in the field of chemistry, yes or no? In the field of geometry or mathematics? Or in civil engineering? Questions like these, however, miss the essence of Fuller's significance. What interested him was not the question of priority but that of plausibility. The former is an absolute value; the latter has to do with context, with a concrete problem. It presumes a newly invented context; it is a matter of innovative application. Fuller's greatest significance lay in the combination of various disciplines with an eye to solving a concrete application. Thanks to this correlative interest, he brought things to light that would otherwise have remained hidden.

His principle of the geodesic dome is not just a matter of geometry. It is a constructional problem: How, on the basis of a geodesic network, can a supporting structure be created that is suited to industrial production, permits rapid and simple assembly, uses a minimum of materials of the lightest possible weight, requires no supports, is cost effective, is capable of being disassembled and reused, can be transported by area, is suited for extreme climatic conditions, and so on? These sorts of questions about optimal use make the differences between Fuller's systematic thinking and the Zeiss Planetarium, a special case for the here and now, especially evident.

It is particularly ironic that what is perhaps Fuller's most important discovery, the Jitterbug Transformation, is also the one that for decades had no such parameters for application. Fuller took the name from a popular dance of the forties. (Is there any other discovery of such significance for science and the humanities that explicitly took its name from the so-called trivial world of popular culture?) In the Jitterbug Transformation, a cuboctahedron is placed over an icosahedron to form an octahedron (which can be folded into a triangle). For two thousand years, the Platonic bodies stood statically and proudly next to one another, and then Fuller discovered them and used the empirical model experiment of his energetic-synergetic geometry to show that they were closely related in structure, and that they could be understood as the phase transitions of a transformative "loop," specifically, a periodic swinging back and forth between two "end" phases. The demonstration of this was striking and fascinatingly manifest, but the significance of the discovery went unrecognized for some time. Only after Fuller's death did the discovery fall under the spotlight in the context of research into "dirty crystals" and superconductors. This comprised another contribution to the increasing "ephemeralization" of technical resources that Fuller had been discussing since the thirties. Ephemeralization is the principle of "Doing the Most with the Least," that is, greater

effects with decreasing expenditure of materials, constant improvements in the ratio of input to output. The example of structural research makes Fuller's astonishing obstinacy especially evident. It is difficult to imagine someone today who would be prepared on his or her own initiative to explore the unfathomable depths of hidden knowledge in the way that Fuller did. Today that would be considered infinitely naive—it was probably already somewhat naive at the time Fuller began (as a twenty year old during his Navy service), but less so than today. Today it is claimed that all essential questions are, if not already answered, at least exhaustively framed and divided into highly specialized sciences that are suspicious of the other specialized sciences and shielded from any intruder from outside the profession, so that a "random element," as Fuller jokingly referred to himself, would not have a chance of obtaining the goal at all. *Your Private Sky*: the self-confidence with which Fuller said the sky under which he stood was his sky, and encouraged us to do the same, is also the attitude of an artist who produces something, not that of a scientist who recognizes only what already exists. How else could one begin a project with the title *Everything I Know*, a video recording of a forty-two-hour-long extemporaneous speech from 1972? (It is also another example of the speed with which Fuller and his circle responded to technological development: the transportable and inexpensive medium of the video cassette was a prerequisite for a project like *Everything I Know*.) In its faith in the greatest possible presence of mind and the authenticity of the moment, this work is an artistic act, so much so that it could never have been at home in the world of science. Bucky as an epic poet who elaborates on his life and experiences. If this is taken literally, it is easy to criticize the monomania of such an enterprise. Still, it is an open question whether this perception is the right one. *Everything I know!* Isn't this an imaginative question that anyone could ask? (Can it really be that the question was first posed by Guinea Pig B? Socrates must have known that he did not know nothing when he said that he knew nothing; his followers were quick to interpret his coquetry as a modesty from which they themselves could profit.) *Everything I know!* The question is relevant to the *Chronofile*, but in an inverted relationship. The latter is diachronic and accumulative, a chain of immeasurably many constituent parts that only gets its meaning when seen as a whole. *Everything I Know*, by contrast, recapitulates and radically synthesizes. Fuller calls this imparting of information "thinking out loud." There are two ways of approaching language: as information about thoughts and as provocation of thoughts. The latter is poetic, and this is what Buckminster Fuller does. As a successive production of thoughts, speaking is related to industrial production in surprising ways, even though it is not the production of a repetitive series of the same thing. Speaking means the constant "sub-assembly" of words into sentences and their "assembly" into meaningful statements that are both more than and something other than the sum of their constituent parts. This is the essence of synergetics, the true driving force behind technical and civilizing progress, and thus the progress in the circumstances of human life. All this begins with language. The decisive term *comprehensiveness* is founded in this. What Fuller meant by *comprehensive*, a word he used often and repeatedly and tirelessly insisted upon, is essentially about an understanding that does not remain stuck in the rational but becomes a comprehensive and inclusive grasping of the whole person, becoming a physical experience. These were also questions that received isolated and local attention in the pedagogical reform movements in Europe and the United States in the early twentieth century. Fuller's childhood had been affected by them.

At this point, it is necessary to discuss the "architect" Fuller again. His projects and realizations are among the most independent contributions to architecture. If he had not himself presented his concept of the energetic-synergetic geometry of geodesic structures in an unusually active lifetime of lectures around the world, then one would also have to speak of

one of the most unmediated contributions to architecture. The theme of the geodesic dome touches on spatial thinking and feeling more deeply than one would think if the dome is seen as simply a screen stretched over a plot of land. Here, too, seen again "from outside" (and that means peering into Fuller's thought) the conclusion is obvious. It is a unique achievement that (and how) he was able to generate an "architectonic" concept that developed into a totally different conception of space than our usual, familiar, and self-evident one. In a long process, Fuller moved away from the Euclidean premises of space structured as rectangular. The first step was the choice of the hexagonal floor plan of the 4D House, and twenty years later the second, far more radical step of the use of the energetic-synergetic geometry with great-circle arches as supports. Architecture's entire connection to the "supremacy of verticals" (Sigfried Giedion) had to be exploded, and thus also the connection between architecture and the upright stance of human beings. Fuller did not shy away from challenging the validity of the image of the surface of the earth as a planar ground plan: why speak of a "plan" when it is really a spherical (if only slightly so) section! Plans are evidence of a "radial" way of thinking, said Fuller, so and so many meters out from the corner and then at right over to the side and so on so many meters high. He did not make fun of it, but the fundamental difference to his theme was completely clear to him. What interested him were the energetic events in the limitations of space, that is, the "circumferential" moment. Lest there be any misunderstandings: The approach resulted in many beautiful spaces, breathing, rising, round, translucent, and firmly fastened, and spacious, colorful, airy, and protective. Fuller almost always spoke of technology, mentioned distinguishing quantities like weight tolerance and degree of effectiveness. But he certainly possessed a highly developed sense for such aesthetic and sensory characteristics, as the statements found in this book demonstrate.

The World as a Game

The image of Spaceship Earth rushing through space, with no operating instructions included, is one of Fuller's countless graphic and palpable metaphors (*Operating Manual for Spaceship Earth*, 1969). Is it an image of catastrophe? No, but it plays skillfully with the possibility that it could become one. It is our task to avoid that possibility. The title of Fuller's first proper book, *Nine Chains to the Moon* (1938), set the tone for the significance of this planetary worldview against a universal measuring stick. Even before that, his privately printed *4D Time Lock* (1928) did the same: confidence, faith in progress, specifying the tasks, but no panic under any circumstances, exactly as he had learned as a sailor. "Emergency" means a serious or threatening circumstance, it does not mean accident. Is it permissible to include in the same trajectory two books separated by the greatest catastrophe yet to befall mankind? The confidence of *Nine Chains to the Moon* is expressed in the image that the whole of mankind could make a chain that would reach from the earth to the moon nine times, if we all just joined hands. In 1969, moon travel had become a reality. But it was just a technological fact and not yet an anthropological one, which is evident today in that this immense technological achievement has remained equally immense in its abstractness. Military technology was indispensable in achieving this goal, even if it was not exactly the same technology that had produced the atom bomb, armed it, and dropped it on cities. Nine chains that reach to the moon. Some believe the image became old-fashioned in 1969. We don't believe it was so for Fuller.

Fuller's thinking is bipolar. On the one hand, there is his faith in technology, quantification, the proof of inches, feet, and pounds, of meters and tons, "man hours" and transportation times. He was a passionate statistician who knew how to read the statements in a curve relating mass

and number, about quantities, about increases and decreases, acceleration or deceleration of increase, acceleration or deceleration of decrease as a trend or a pattern of development. He had a lifelong, vital interest in quantifiable facts. But that was not all. He always subjected statistics to the question of their significance. An early example: During his work on the 4D House, in June 1928, he wrote his father-in-law, J.M. Hewlett: "We observe the even greater capital purchasing ability of the increasingly available (both as to time and space) and more attractive fresh fruits and vegetables, as against the diminishing capital equivalent of meat purchases, and realize that with the atmospheric control of the 4D House the necessity and desire for meat will vanish." (*Chronofile*, vol. 34 [1928]). This reveals the second pole of Buckminster Fuller's relationship to statistics, which was nothing less than sensuous: a strongly metaphysical faith in the meaning of life and in its unquestionable right to succeed. The sickness and death of his first daughter, Alexandra, was for him and his wife, Anne, clearly a consequence of living circumstances that were hostile to human life. His ambitions for an architecture that was up to date, for a chance to grow up healthy and live a beneficial life in its buildings, were as valid as ever. There could be no separation between architecture for people and for the universe. The latter would be the highest instance, and he saw his task as recognizing its will: in this way, he came to want to research "how Nature builds." Although, as we noted, when naming properties or objects, Fuller himself preferred to derive in to derive them from verbs rather than nouns, he chooses not to use the verbal noun *creation*, but speaks rather of universe and of the wisdom of its design. His way of expressing himself was like that of Albert Einstein, whom he greatly admired and whose religiosity sublimated by science was quite close to his own stance.

Fuller believed he recognized the driving force of the development of civilized societies, and thought that the impetus was right but not the course. There is a tendency from the elementary to the complex; Buckminster Fuller analyzed the development of civilized mankind and in a path through different ages became convinced that there was a regularity function at the deepest levels. Mankind's energy for design had long focused on the question of how to make the solution lighter, faster, and better: lighter, faster, more comfortable—no matter whether it is getting from here to there or making a utensil, a tool, or a weapon. As early as 1938, in *Nine Chains to the Moon*, Fuller called this process an ephemerization, and he analyzed its essence and significance much more profoundly than a purely aesthetic understanding of the ephemeral would lead one to believe (→ YPS: *Dymaxion Discourse*). The triumph over feudal structures was in his eyes the political prerequisite for the welfare of society. But it was just the first step that would bring the emancipation of modern societies and industrial nations. The second step was still to be taken, namely, the emancipation of world society from the feudal relationships among the countries and the elimination of the unbelievable inequities in the standards of development. When Fuller said that politics was incapable of filling this task, this was just one side. What was incapable was the politics of self-interest, that is, the so-called *realpolitik* employed by all governments in this world. Fuller's critique of the political self-conception was itself highly political, even if he did not say so or perhaps even realize it. He called it "making the world work" or, more precisely *How to make the world work*. This is not the cry of warning of the cult leader who wants to urge his followers by predicting the end of the world. Fuller's working life began with an apprenticeship as a machine fitter in Québec, assembling textile machines that were delivered from Europe in parts; sometimes he had to repair them and make them run again. "How to make the world work" derived from that experience. Let's get to work on this world! Seen in this light, the question is not presumptuous at all, but simply self-confident composure. Let's get to work on this world.

DYMAXION
CHRONOFILE
BUCKMINSTER FULLER
1895 - 1915
VOL. I

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1915 - 1916
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Chronology

12 July 1895

Born in Milton, Massachusetts. Son of Caroline Wolcott and Richard Fuller, owner of an import company in Boston and descendent of a respected family, rich in traditions and active in politics, that had been resident in New England since 1632. Great nephew of Margaret Fuller (1810–50), writer and founder of the American women's rights movement. Second of four children: older sister, Leslie; younger brother, Wolcott; and youngest sister, Rosamund. RBF suffers from extreme farsightedness from birth.

- 1895 Discovery of X-rays by Conrad Wilhelm Roentgen.
- 1897 Discovery of electron.

1899

Attended Froebel Kindergarten.

- 1900 Founding of quantum theory by Max Planck.
- 1903 First flight in motor airplane, by Wright brothers, Kitty Hawk, N.C.

1904–13

Attended school at the Milton Academy. Grandmother Matilda Wolcott Andrews purchases Bear Island, Compass and Little Sprucehead Islands, Penobscot Bay, Maine, as summer residence. Bear Island, several miles off the mainland, becomes an important site of relationships and experiences for the family. The young RBF builds many model boats and begins to develop his strong affection for sea travel.

- 1905 Special Theory of Relativity by Albert Einstein.
- 1906 Radio tube and crystal detector.
- 1907 Einstein's $E = mc^2$; equivalence of mass and energy.

1908

Death of father, Richard Fuller. RBF decides to keep all of the letters written to him and the drafts of letter by him. Over the course of his youth, this develops into the *Chronofile*: a chronological collection that is intended to document the entire life of RBF in model fashion.

- 1909 North Pole reached, Peary.
- 1911 South Pole reached, Amundsen.
- 1912 Sinking of the Titanic. Emergency signal SOS.
- 1913 Atomic model by Nils Bohr. Ford's Model T; first assembly-line production.

1913–15

RBF finishes school at Milton Academy. Studies at Harvard University; is expelled twice and considered a failure.

- 1914 Radio: Armstrong's Regenerative Circuit. Development of chrome-nickel steel.

1914

Apprenticeship as machine fitter of imported weaving machines in his cousin's cotton factory in Sherbrooke, Québec (Canada). RBF keeps a technical sketchbook, in which he reflects on his technical and mechanical learning.

- 1915 General Theory of Relativity by Albert Einstein. Woolworth Building, highest building, 800 feet. Determination of electron distribution with closest packing of sphere, W. H. Bragg.



26 RBF as youth, Bear Island, Maine



Younger brother, Wolcott, Equitable Building, NYC



RBF (with glasses) as machine fitter, Canada, 1914

1915–17

Transportation worker, later assistant cashier in canned meat company Armour & Co., New York and New Jersey. Important insights into the relationship of production, distribution, and consumption; interested in logistics. Meets his future wife, Anne Hewlett. Engagement.

- 1917 October revolution in Russia. The USA enters the war. D'Arcy Thompson, *On Growth and Form*.

1917

Volunteers with the family boat, *Wego*, for wartime service with the Navy. Patrols off the coast of Maine. 12 July 1917 On twenty-second birthday, marries Anne Hewlett, the daughter of the well-known and respected New York architect and painter James M. Hewlett.

1918–19

Cadet at the Navy Academy in Annapolis; becomes lieutenant.

1918

Birth of daughter Alexandra. Communications officer in units of the U.S. Atlantic fleet. Editor of the Navy newspaper *Transport*, which is published at sea. Participates in the radio telephone experiments of Lee de Forest, at sea, 1919. Commander in the gunboat *Eagle 15*, built by the Ford Company in mass production. Accompanies Admiral Gleaves to Europe for the signing of the Versailles treaty. Subsequently resigns from active service, but remains a reserve lieutenant of the Navy. Serious illness of daughter Alexandra.

1919–21

Export manager at Armour & Company. Until company is liquidated, sales manager at Kelley-Springfield Truck Company.

- 1920 Discovery of neutron. Beginning of commercial radio broadcasts.
- 1922 Zeiss Planetarium in Jena, Germany: network cupola as reinforcement for concrete shell (W. Bauersfeld).

1922

RBF as pilot: flies with Anne in aquatic monoplane by Vincent Astor from N.Y.C. to Bar Harbor, Maine, record time. Journey continues to Bear Island and Boston. Death of daughter Alexandra by polio. RBF reads Christopher Morley's poem "To a Child," which he will cite frequently later.

1922–23

Courses at Graduate School of Business Administration.

1922–26

Cofounder (together with his father-in-law, the artist and architect J.M. Hewlett) and director of the Stockade Building System, producer of filling material and a patented system of light-construction elements. By 1927, 240 houses have been constructed along the entire east coast.

- 1923 Hubble discovers another galaxy beyond the Milky Way.



27 As ensign, around 1918



Alexandra Fuller, 1918–1922



Stockade Building System: Load trial, pressure test

1924

Moves into an apartment on East 94th St., N.Y.C.

- 1925 A.N. Whitehead, *Science and the Modern World*.
 1927 Lindbergh crosses the Atlantic nonstop in *The Spirit of St. Louis*; photoelectric cell; Le Corbusier's book *Vers une architecture* appears in an English translation by Etchells; Weissenhof housing estate in Stuttgart, Germany. · Heisenberg's uncertainty principle. · Ford introduces the Model A.

1927-28

Stockade Building Co. is bought by Cellotex, and RBF loses his position (resigns as president on 10 February, leaves November 1927). · Anne comes to Chicago, Belmont Ave., 7 August 1927 and keeps a diary. · Birth of second daughter, Allegra, 28 August 1927. · Serious personal crisis. Concentrates on beginning a new job. · Discovers the importance of his great-aunt Margaret Fuller and the other New England Transcendentalists (Emerson, Thoreau). · Reads Le Corbusier's *Vers une Architecture* in English translation (*Towards a New Architecture*, 1927). · Anne notes in diary: conversations about "Fuller Houses," December 1927. · *Designs and manuscripts for Lightful Houses* (January to March 1928). · Develops 4D Philosophy (architecture as part of a four-dimensional world); published privately under the title *4D, Time Lock*. Distributes the work at a meeting of the American Institute of Architects (AIA) in St. Louis, Missouri, on 17 May 1928; the AIA pronounces against industrial construction. RBF calls for a *Spirit of St. Louis* in architecture. Sends the 4D book to friends, acquaintances, and influential people, beginning on 28 May 1928; later editions beginning with 28 July include mimeographed sketches. · Patent for the 4D House is submitted, but not pursued to completion. · Series of sketches for the 4D Concept (4D Houses, 4D Transportation).

- 1928 Henry Ford publishes *My Philosophy of Industry* (March-April). · Amelia Earhart, a friend of RBF, crosses the Atlantic. · Airship *Graf Zeppelin*, Atlantic flight to America. · Five-year plan for the industrialization of the USSR.

1928

September: First presentation of the 4D sketch, called "Hexagonal House," Le Petit Gourmet Restaurant, Chicago. · December: First publication of Fuller's 4D sketch in *The Chicago Evening Post*.

1929

Work with design students in Chicago. construction of second *4D House* model. · April: Two-week exhibition of the 4D House in the Marshall Field Department Store, Chicago. · Creation of the *Dymaxion* concept by the Marshall Field advertising staff. RBF holds six half-hour lectures daily. · May: Exhibition at the Harvard Society of Contemporary Art, Cambridge, Mass., then at several locations in Chicago and New York. · Spends the summer on Bear Island and buys the motorboat *Lady Anne*. · Publication of the *Dymaxion House* in *Architecture* (published by Charles Scribner, N.Y.C.). The publisher plans a book on the *Dymaxion House*, for which a Fuller lecture is scheduled in July and recorded by a stenographer; the book was not published. (→ YPS: *Discourse*). October: Fox Movie Tone, news reel shows RBF with models of the *Dymaxion House*. · Fall: The family moves to Long Island, N.Y. RBF remains in New York City. · Meets the Japanese-American sculptor Isamu Noguchi, a student of Brancusi. Noguchi



28 House using Stockade building techniques, around 1926



The author Margaret Fuller, 1810-1850, RBF's great aunt



RBF with structural model of 4D House, 1928

becomes one of RBF's closest friends. Noguchi makes a portrait bust of RBF in chromed bronze. · Active in the Greenwich Village scene of artists and intellectuals. · November: Series of lectures in Romany Marie's Tavern, Greenwich Village, N.Y.C.; RBF designs the interior for Romany Marie's. · December: Exhibition of the *Dymaxion House* model in the studio of Isamu Noguchi. Exhibition and lecture by RBF in the studio of Dorothy Moise, N.Y.C.

- 1929 British airship R 100 with geodesic construction (Barnes Wallis). A.W. Whitehead, *Process and Reality*.

1930

In addition to the family apartment in Woodmere, Long Island, Fuller rents a space on the roof of the Lehigh-Starret Building in N.Y.C. Designs a *Tension Room* for Eli Jacques Kahn as a gallery space for Noguchi's sculptures. · Numerous one-man shows with the house model and lectures in New York, Chicago, Cambridge, Washington, D.C., etc. · Hugo Junkers takes notice of RBF and evaluates the construction of the *Dymaxion House*. Notices on the industrialization of building. · Contacts with a group of engineers and scientists at Columbia University (Technocracy, Inc.); distances himself from Howard Scott and his technocracy movement. Contacts with Diego Rivera and the John Reed Club; distances himself from communism.

- 1930 Construction of the Empire State Building, at 415 meters to the tip of its mast, it is the tallest building in the world. · Founding of *Fortune* magazine (editor: Henry Luce). · Albert Einstein, "Religion and Science" *The New York Times Magazine* (9 November 1930).

1931

Designs a bathroom unit for American Radiator's Pierce foundation that can be industrially produced. · RBF reads Albert Einstein's essay "Religion and Science" in *The New York Times Magazine*, and it impresses him deeply.

- 1931 Gödel's theorem of the undecidability of propositions. Piccard's balloon flight into the stratosphere. · Three-engine aluminum airplane by Ford (Stout).

1931-32

RBF cashes out his life insurance and purchases the architecture magazine *T-Square*; renames it *Shelter*; publishes his own contributions (e.g., the series of articles "Universal Architecture"). · Isamu Noguchi creates the sculpture *Miss Expanding Universe* (December 1931), which is used on the cover of the November 1932 issue of *Shelter*. · After Franklin D. Roosevelt is elected president and the New Deal is introduced, the magazine ceases publication.

1932

Foundation of the Structural Studies Associates (SSA), which RBF along with, among others: Archibald MacLeish, Knud Lönberg-Holm, Frederick Kiesler, Simon Breines. · Criticism of International Style. Lecture series for the SSA. Museum of Modern Art rejects and exhibition of the *Dymaxion House* model. Shows in N.Y.C. and Philadelphia. · RBF participates in a project with Simon Breines, in which an office building abandoned during the Depression is converted to shelter for the homeless.

- 1932 Isolation of the ninety-second chemical element, completing the periodic system. · The *International Style*, book and exhibition by Hitchcock and Johnson at the NY Museum of Modern Art.



29 RBF with second model of Dymaxion House, 1929



Mobile Shelter for the Soviet Union, sketch, around 1932

1933

February: Planning commission of the USSR is interested in the Dymaxion House.

1933 Hitler becomes chancellor of the Reich. Franklin Delano Roosevelt becomes president of the USA: New Deal. Henry Luce founds and publishes the illustrated magazine Life. Roosevelt introduces a moratorium on banks, closes all the banks in the USA (March). Century of Progress World's Fair in Chicago.

1933-34

With \$5000 in cash from the stockbroker Philip Pearson and the enthusiastic support of Pearson's wife, Temple, RBF is able to build the Streamline car published in *Shelter*. Founding of the 4D Company. March: Construction of the prototype for the *Dymaxion Car* begins in Bridgeport, Conn., with the ship designer Starling Burgess and a group of former Rolls Royce mechanics. In addition to Fuller, the renowned yacht builder Starling Burgess decisively influences the design. First trip in the completed car in July 1933. First presentation at the Automobile Show in New York. Involvement in a serious accident results in negative headlines for the Dymaxion Car. Dymaxion Car No. 3 is introduced with much publicity at the World's Fair in Chicago (1933-35). RBF meets the writers H.G. Wells and Christopher Morley; the latter will become one of RBF's best friends. Morley writes the essay *Streamline: Thoughts in a Dymaxion* (1934).

1934 Electrification project of the U.S. Tennessee Valley Authority.

1934

Death of RBF's mother. Friendship with Martha Graham, for whose dance performance Frontier Isamu Noguchi designed the original stage design (1935)

1935-36

Collaboration in the construction of the research and development division of Phelps Dodge Corporation, the third largest copper company in the world. Works out the research program and completes statistical and historical analyses and maps on extracting and working strategic metals. The results are used by *Fortune* magazine and the Bureau of Standards in Washington, D.C. Conceptual work on a prefabricated bathroom; production of twelve prototypes of the *Dymaxion Bathroom*; applied for patent in May 1938. Exhibition of the Dymaxion Bathroom at the U.S. Bureau of Standards (1936-38), NY Museum of Modern Art, etc.

1936 The term automation is introduced at General Motors.

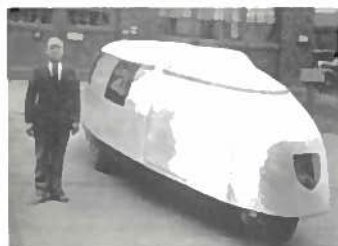
1936

Participates in experimental television broadcasts at the CBS experimental studio, under the direction of Gilbert Seldes. RBF explains to his friend Nogouchi the equation $E = mc^2$ in a telegram. During the summer works on the manuscript of his first book, *Nine Chains to the Moon*, which was published in 1938. Meets with Albert Einstein to discuss the manuscript.

1937 Splitting of the atom, Hahn, Meitner and Strassmann. Jet gas turbine (Whittle); nylon.

1938-40

Technical advisor on the editorial board of *Fortune* magazine. Collaborates on a series on the topic "The New U.S. Frontier" and on the anniversary edition celebrating ten years of *Fortune*, with "USA" as the theme and "U.S. Industrialization" as the lead article. Advisor to *Life* magazine.



30 RBF with the Dymaxion Car, 1933



RBF with Gilbert Seldes, TV transmission test



Publicity poster for book 'Nine Chains to the Moon', 1938

1939

Unpublished book manuscript: *Ballistics of Civilization*. Dymaxion Bathroom is exhibited in a newly opened building for the NY Museum of Modern Art. (1939).

1939 O. Neurath, *Modern Man in the Making*. Long-range bomber of the R.A.F. Wellington uses geodesic construction (B. Wallis) in serial production.

1940

Untitled Epic Poem of Industrialization: extensive manuscript, first published in 1962. Model of the Dymaxion House is destroyed while being transported to Rockefeller Center. Studies commissioned by the Industrialist Henry J. Kaiser. Reengineers metal grain bins as shelters: *Dymaxion Deployment Unit*.

1940-42

Request from the British War Relief Organisation to design emergency shelters for war homeless. A prototype is built by the Butler Manufacturing Company. The design for the *Dymaxion Deployment Units* is patented. Because of wartime restrictions on metals, the design is not mass produced. DDU exhibited in Washington, D.C. (1941). Production of a small series for the Air and Signal Corps; employed in Alaska and Iran.

1941 Japanese attack on Pearl Harbor; USA enters the war (December).

1942 Halford Mackinder, *Democratic Ideals and Reality*. Uranium atom split at the University of Chicago, the Manhattan Project. V2 rockets. New edition of D'Arcy Thompson, *On Growth and Form*.

1942-44

Leading engineer on the Board of Economic Warfare in Washington, later Foreign Economic Administration. Studies on wartime economy, for example, an investigation of the industrialization of Brazil. Twice weekly lectures on world energy and geography for coworkers in the departments and administrations in Washington. Works out the *Dymaxion World Map*; in 1940, the world energy map appears in *Fortune* (February issue); in 1943, first version of the Dymaxion World as a tear-out sheet in *Life* magazine. Geometric investigations, or preliminary studies to energetic geometry. (→ *YPS: Discourse*). Sleep experiments (1943). Lectures in the Cosmos Club, Washington, D.C., for scientists and engineers, on the history of discoveries and inventions (1943). Contact to Vannevar Bush (Office of Scientific Research and Development) and the scientists of the Manhattan Project. Display panel "Profile of the Industrial Revolution" (1943). Publication of an essay on the World Map *Fluid Geography* (1944) (→ *YPS: Discourse*). First manuscript on energetic geometry (1944).

1943 Sikorsky Helicopter. Wendell L. Willkie, *One World*. Liberty Ships produced on assembly line (Henry Kaiser).

1944 E. Schrödinger, *What is Life?* Predicts DNA.

1944-47

Planning and development of the Wichita Dwelling Machine in Wichita, Kansas. Uses primarily light metal. Production of prototypes in a special program of the *Beach Aircraft* plant in Wichita. Founding of the Dymaxion Dwelling Machine Company, for the purposes of patenting, licensing, coordinating with government offices and the defense industry, as well as building



31 Advertising prospectus for DDU: Better Homes for Lower Incomes, 1940



Test of acoustics in Wichita House, 1940

a network for sales and distribution. Despite diverse efforts, serial production is never started. The members of the development team for Dymaxion Dwelling Machine, Inc., include, among others, Cynthia Lacey, Herman Wolf, Edward Applewhite. In 1945, renamed Fuller Houses, Inc.

- 1945 Death of F.D. Roosevelt, succeeded by H. Truman; Vannevar Bush, *As We May Think* (computer concept). · Destruction of Hiroshima and Nagasaki by atom bombs. End of World War II. · Truman's concept *Intellectual reparations*.
1946 Eniac computer. · Regular transatlantic service of passenger planes (DC-4).

1946

Obtains patent for the map projection of the Dymaxion World Map. · Founding of Fuller Research Foundation with the goals of basic research in geometry, Fuller documentation, and the preparation of patents. · Private printing: *Designing a New Industry* (1946). · Private printing: *Earth Inc.* (1947) (→ YPS: *Discourse*).

1947-48

Return to Forest Hills, New York. · Two-year period of work on *energetic-synergetic geometry*. · Discovery of "Jitterbug" Transformation (March-April 1948). · Work on the concept of geodesic domes. · Application: true planetarium *Your Private Sky* (July 1948) · First great-circle model with four-foot diameter. · Summer 1948: Failed attempt to construct a prototype with a diameter of fifty feet, together with students at Black Mountain College, North Carolina. First lecture on energetic geometry. RBF befriends Ruth Asawa, John Cage, Merce Cunningham, Josef and Anni Albers, and others. · Inspired by RBF's lectures, Kenneth Snelson discovers the principle of multipolar *tensegrity structures* (1948-49). In the "magic summer" of 1948, the core of a genuinely American form of art develops at Black Mountain College. · Meets Konrad Wachsmann, Serge Chermayeff, and Peter Blake in Chicago. Construction of the first *Necklace Dome* there (collapsible structure, i.e., flexible nodes) with a diameter of fourteen feet. · Student projects "Autonomous Package, Autonomous Dwelling." · Teaches regularly at the Institute of Design, Chicago, beginning in September 1948.

- 1947 Commercial television broadcasts being in the USA.
1948 Linus Pauling, *The Nature of Chemical Bond*. · Norbert Wiener, *Cybernetics; or, Control and Communication in the Animal and the Machine*. · Sigfried Giedion, *Mechanization Takes Command*.

1949

Teaching at Institute of Design, Chicago, and the University of Illinois, Champaign. Visiting lecturer at Illinois Institute of Technology: energetic geometry. · First seminar at North Carolina State College. Construction of *Necklace Dome* in the Pentagon Garden, Washington, D.C. (February 1949). · RBF is dean of the Summer Institute, Black Mountain College; construction of the *Skybreak Dome* with transparent plastic skin. Meets Robert Rauschenberg. · Essay: "Total Thinking." · Visiting Critic at M.I.T. Seminars and visiting lectures at Bennington College, University of Michigan, Harvard University, University of Toronto.

- 1949 Mainframe computer for war aims: *Cold War*.



32 Early study model of Geodesic Domes



Construction of the dome from top to bottom, assembly mast, around 1948



1949-53

Extended lecture tours and teaching in the USA, including North Carolina State University, School of Design. · Study project: Automatic cotton factory. · Under the of "anticipatory design science," he subsumes a mathematical-structural model theory with a preventative planning and design theory. Anticipation of global environmental problems. · Meets Duncan Stewart (1949). Other important collaborators during the years 1949 to 1955 include T.C. Howard, James Fitzgibbon (Synergetics, Inc.), Don Richter, Kenneth Snelson, Jeffrey Lindsay, Shoji Sadao.

- 1950 L. von Bertalanffy, *Theory of Open Systems in Physics and Biology*.

1950

December: Construction of the first full-size geodesic structure: a semispherical dome in Montreal with a diameter of forty-nine feet, made of aluminum tubes, each of which weighs one pound. Developed by the Fuller Research Foundation, Canadian Division (Jeffrey Lindsay). Aluminum was still rationed in the USA, and thus was not available to RBF, so he turned to Canada. Unpublished manuscript *Noah's Ark 2* (→ YPS: *Discourse*).

1951

Fuller's first use of the metaphor "Spaceship Earth." Press reports on geodesic domes. · NY Museum of Modern Art exhibits a geodesic dome. Patent application (December 1951).

1952

Study project *Geoscope*, Cornell University, Ithaca, N.Y. · Paperboard Dome, Princeton University. · Elaine de Kooning, *Dymaxion Artist* (→ YPS: *Discourse*). · RBF meets Shoji Sadao at Cornell University, Ithaca, during the construction of the geodesic globe *Geoscope*; they collaborate closely from that point on. · Meets Thomas T. K. Zung.

1953-54

Fulfillment of a commission from Ford Motor Company to build a dome over the corporate headquarters in Dearborn, Michigan; first commercial application of the principle of the geodesic dome on a lightweight metal framework; duration of project: four months from receipt of commission to completion. · Hyperbolic-parabolic wood construction for the *Geodesic Restaurant* in Woods Hole, Massachusetts (G. Peterson). · Extensive teaching activity at many universities in the USA, as in subsequent years. · First *Tensegrity Sphere* (1953).

- 1953 Herbert Bayer, *World Geographic Atlas*.
1954 DNA double helix; discovery of the genetic code by Watson and Crick. · Linus Pauling, *Modern Structural Chemistry* (Nobel Prize for Chemistry).

1954

Icosahedron projection of the Dymaxion World Map. · Patent awarded for the construction of geodesic domes. Test and acquisition of geodesic domes by the U.S. Marine Corps and Air Force. · Development of a dome type without metal for radar stations at the Lincoln Laboratory



33 Fuller's studio at a university



RBF with model of "Skybreak", 1949



Testing load with students, around 1950

(in parallel with computer research there). The polyester-fiberglass construction is superior to tires. First Radome Installation on Mt. Washington. · Production and assembly of Radomes for the DEW line (Distant Early Warning). · Grand Prize at the Triennale di Milano for the two Cardboard Domes (corrugated paperboard). · Prizes and honors from, among others, the American Institute of Architects, the Marine Corps, Michigan State University, as well as honorary academic degrees; Visiting Professor at the University of Michigan. Lectures on Synergetic Geometry.

1955

Founding of Synergetics, Inc., Geodesics, Inc., with the goal of exploiting the patent, licensing, and carrying out commissions for industry and the state.

1956 Introduction of transistor devices on the market.

1956

State purchases domes for U.S. exhibition pavilions at industrial and trade fairs. First geodesic pavilion for the Miel Continent Jubilee, St. Louis, Missouri.

1957 October: First artificial satellite (Sputnik). Sputnik Shock! in the USA; founding of NASA. Radar early warning system, DEW line installed along the polar circle; first use of computers. · International Geophysical Year. · First civilian atomic power plant.

1957-59

Construction of large geodesic domes for, among others, Kaiser Aluminum and Union Tank Car Company, Baton Rouge, Louisiana. By late 1959, more than one hundred licenses to construct geodesic domes have been awarded on the basis of Fuller's patent rights (5% of sales).

Play Domes, climbing frames for playgrounds, are mass produced. *Plydomes*, domes with plywood panels, are produced commercially. Dome built for Synergetics Inc.'s Society of Metals. · Construction of the U.S. pavilion of the American exhibition in Moscow, Sokolniki Park, 1959: geodesic dome, inside the first multivision with film and slide projects by Ray and Charles Eames. · Lecture tour through South Africa, Japan, India, England, among other places, and visiting lecturer. · Exhibition in the NY Museum of Modern Art in New York (1959).

1958 First American satellite. · Invention of laser. · Atomic submarine *Nautilus* crosses under North Pole.

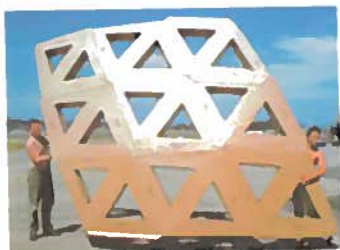
1958

Invited to England by the Independent Group, Institute of Contemporary Art (Richard Hamilton, John McHale, Peter and Alison Smithson, Reyner Banham, and others). · Lecture R.I.B.A., London.

1959 Worldwide passenger service with jets; Boeing 707 · Luna 3 transmits photos of the far side of the moon. · Integrated circuit (Kilby/Noyce).

1959

Professorship at the Southern Illinois University, Carbondale; research and teaching at the Department of Design. · Participates in first Delos Symposium, organized by Doxiadis. · Memorial speech for Frank Lloyd Wright in Tallahassee, Wisconsin. · Correspondence with the virus researchers A. Klug and T. Fink on the icosahedron-geodesic structure of the polio virus. Tensegrity mast is exhibited in the NY Museum of Modern Art.



34 Preparing for the Triennale di Milano, 1954



Dome of the Union Tank Car Company, Baton Rouge 1956



American Exhibition, Moscow 1959

1960

Project *Dome over Manhattan*, two miles in diameter. · RBF and Anne occupy their home in Carbondale: Home Dome, a geodesic dome of wood, a series model by the Pease Company of Ohio, design by Al Miller. · Receives several honorary doctorates. · Publication of *The Dymaxion World of Buckminster Fuller* by Robert Marks.

1960 John F. Kennedy elected U.S. President. · J.C.R. Licklider, *Man-Computer-Symbiosis*.

1961

Patent for *Octet Truss* granted.

1961 Genetic code deciphered. · Yuri Gagarin first man in space.

1962

Meets Marshall McLuhan at Delos Symposium.

1963

RBF is Charles Eliot Norton visiting professor for poetry at Harvard University.

1962 John Glenn first American astronaut in space. · Photographs of viruses with electron microscope are compared to geodesic domes.

1962-67

Initiative for a ten-year study program of *World Design Science Decade* with the support of the Union of International Architects (UIA). · Construction of the research, planning, and coordination center inventory of World Resources, Human Trends and Needs at Southern Illinois University, in which the motifs of global projects are intended to run together. · Executive Director John McHale. His book *R. Buckminster Fuller* appears in 1962. Tensegrity patent awarded in 1962. *Education Automation* published (1962).

1963 Telstar communications satellite. · John F. Kennedy assassinated. He is succeeded by Lyndon B. Johnson. · Vietnam War. · World Congress of Virologists in Cold Spring Harbor, N.Y. Announcement of the discovery of the protein shell structure of viruses; accords with RBF's formula $10 F^2 + 2$.

1963

Lecture at the Sixth World Congress of the U.I.A. in Mexico City (*Mexico Lecture*).

· RBF publishes autobiographical writings and essays under the title *Ideas and Integrity*; publication of *No More Secondhand God*. · Research project: Advanced Structures Research for NASA. Scholarship for RBF's student Joseph Clinton. · 1963-68 RBF advisor to NASA.

1964

Time magazine dedicates a cover story to RBF; cover by Artzybasheff volume. Series of articles, "Prospects of Humanity" in *Saturday Review*. · BBC television broadcast with RBF, on science program of Channel Two. · Participation in the Dartmouth Conference in Leningrad, a meeting between leading personalities of the USA and USSR. Founding of the architectural office Fuller & Sadao. · Project Geoscope with John McHale.

· 1964 Free Speech movement, Berkeley, California.



35 RBF with Charles and Ray Eames and Konrad Wachsmann, around 1960



RBF with George Nelson, around 1950



Exhibition at NY Museum of Modern Art, 1959

1965-75

Together with John McHale, editor of *World Design Science Decade* (six volumes), with lectures by Fuller as well as statistical material, maps, diagrams for an inventory of the planet, its population, sources of raw materials and energy, its industrial use and circulation, and so on.

• Patent awarded for geodesic Monohex Structures (*Fly's Eye Project*) and Laminar Domes with folding skin.

- 1965 First commercial news satellite in orbit. • Space walks by cosmonauts and astronauts. • Photos from Mars. • California becomes the most populous state in the USA • U.S. carpet bombings in Vietnam; napalm. • Marshall McLuhan, *Understanding Media: The Extensions of Man*.
- 1966 Soft landing of one Russian and one American moon vehicle. Television images of the far side of the moon. • Barbara Ward, *Spaceship Earth*.

1965

At Southern Illinois University Fuller inaugurates the project World Game, a computerized display of the world whose concept is modified in a series of variant projects and then later expanded to include project courses and workshops.

1966

Lectures in Cape Kennedy on transformation and use of the fallout of technology from space travel for an industrialized production of dwellings. Project Yomiuri Tower, tetrahedral tower that is two miles high (not realized). • RBF profile by Calvin Tomkins appears in *Saturday Review*.

1965-67

RBF proposes *World Game* as the U.S. contribution to the World's Fair in Montreal; rejected by the U.S. Information Agency. • Fuller & Sadao, Inc., obtains commission to plan and design the U.S. pavilion for the World's Fair, Expo '67 in Montreal, Canada. Motto: "Creative America." • Construction of a geodesic dome as a three-quarter sphere with a diameter of seventy-six meters and a height of sixty-one meters.

- 1967 Cultural Revolution in China. • Heart transplant (Barnard). • Record number of visitors at Expo '67 in Montreal, Canada: more than fifty million in six months.

1967

The Expo Dome makes Fuller and his geodesic domes world-famous. Jasper John's painting of the Dymaxion World Map is exhibited in the Expo Dome • Special issue 2000+ of *Architectural Design*. • RBF and Anne celebrate their Golden Anniversary. • Purchases sailing yacht *Intuition*. • Fuller interviews printed in American and English underground magazines. Student groups and youth communes build their own geodesic domes. Project *Tetra City* as floating city with growing tetrahedral structure. • Founding of *Whole Earth Catalog* by Stewart Brand, inspired by RBF. "The insights of Buckminster Fuller initiated the *Whole Earth Catalog*." • John Cage visits RBF to discuss Cage's manuscript for *A Year from Monday*. • Following a lecture by RBF, the idea to found *Drop City* (drop-out community) is developed; domes and zones of junk parts.



36 RBF with Marshall McLuhan, 1962



Time Magazine, cover by Artzibasheff, 1964



World Game Seminar, 1969

1968

Honorary degrees in USA and England; received by Queen Elizabeth. • Christening of ship *Intuition*. • Construction of the Caterpillar Dome in Cleveland (with Thomas T. K. Zung). • RBF and Norman Foster meet; begin collaborating on many projects. Design for the Samuel Beckett Theater.

- 1968 Serious student unrest at American universities. • Paris - May 68 • *A Year from Monday* by John Cage is published; it makes reference to the ideas of RBF. • Apollo 8 orbits the moon. Tet offensive of the Vietcong; resignation of U.S. Secretary of State McNamara. • Assassination of Martin Luther King. • Hippie movement in San Francisco. • L. von Bertalanffy, *General System Theory*. • Development of ARPA-Net as the precursor of the Internet. Computer networks. • First edition of *The Whole Earth Catalog* appears. Later becomes the most successful publication of the American alternative scene. • 2001: *A Space Odyssey* by Stanley Kubrick, screenplay by Arthur C. Clarke (final sequence with the star child), RBF: "the new life."

1969

Pilot project studies for World Game at the New York Studio School of Painting and Sculpture with an interdisciplinary group of students. RBF develops the concept of a global electrical circuit. • Project with homeless youth and slum tenants in New York and St. Louis. • June-July: First World Game Seminar (with Ed Schlossberg) at the New York Studio School. Preliminary stage for a computer patent. Consultation with a patent lawyer. • Project World Man Center, conference building for Cyprus. Fuller & Sadao (not realized). • October: *Operating Manual for Spaceship Earth* appears as a book, as does *Utopia or Oblivion*. • Nehru Memorial Lecture, New Delhi. Friendship with Indira Gandhi. • Fuller nominated for the Nobel Peace Prize. • Construction and opening of ecumenical Religious Center in Edwardsville, near St. Louis, Missouri, a building with a concrete pedestal and a geodesic dome, in whose plastic outer surface the outlines of the continents appear. Design by Fuller & Sadao, Inc.

- 1969 Theory of "black holes." • M. Gell-Mann receives Nobel Prize for discovery of quarks. • Rock festival in Woodstock (400,000 participants). • First moon landing (Apollo 11 Mission, 20 July, 1 billion television viewers of a world population of 3.5 billion). • Design for distributive networks: Problems with networking computers are solved (Paul Baran).

1970

The CIA searches RBF offices in Carbondale on a "fact-finding mission." Fuller is suspected of sympathizing with the rebellious students. RBF's research budget at Southern Illinois University is cut. • Research report for NASA prepared by Joseph Clinton: *Advanced Structural Design Concepts for Future Space Missions*. • Book on John Cage by Richard Kostelanetz is dedicated to RBF. • October: Meets Ezra Pound in Venice. • December: *Dome Book* (1) appears, edited by Lloyd Kahn. Contains examples of and instructions for geodesic domes; Joe Clinton compiles the data and calculations for the rod measurements. • Patent awarded for the catamaran construction *Rowing Needle*.

- 1970 Police activity at several American universities. • Southern Illinois University is temporarily closed because of violent confrontations.

1971

NBC television program *Buckminster Fuller on Spaceship Earth* (R. Snyder). • Climatoffice project together with Norman Foster. • Old Man River's City project for the renewal of a slum in East St. Louis. • Concept: "An Umbrellaed Town" 1970-74. • Book *Drop City* appears (Peter Rabbit,



37 RBF on Bear Island, around 1967



RBF with Isamu Noguchi and Ezra Pound, Venice 1970

pseudonym). · RBF's budgets at Southern Illinois University cut back sharply. RBF finances World Game from his own pocket; Medard Gabel is his collaborator. · Special issues of *Architectural Forum* and *Architectural Design* on RBF.

- 1971 Twin towers of the World Trade Center in N.Y.C. now highest building in the world.
· Book by Victor Papanek, *Design for the Real World*.

1972

Planning of *Spaceship Earth* at Disney World, geodesic full sphere, main attraction of the Epcot Center. · Do-it-yourself dome construction of wood slats and plywood, design Fuller & Sadao, published in *Popular Science*, a success with the public. · Book *Intuition* is published. · With RBF Hans Meyer develops a windmill construction to be mass produced at low cost. · RBF is editor of *World Magazine*. He is offered a position in Philadelphia as World Fellow in Residence. Moves residence and research office to Philadelphia.

- 1972 Zero population growth in USA. · Bay Area Rapid Transit in San Francisco, first new subway system since 1907. · U.S. research station at South Pole with geodesic dome. · *Life* ceases publication.

1973

RBF criticizes *Limits to Growth* as Malthusian. · Hugh Kenner publishes the book *Bucky: A Guided Tour of Buckminster Fuller*. · Patent for tensegrity dome granted.

- 1973 Energy crisis: oil shortage and the first recession in Western industrial nations since 1945. · E. F. Schumacher, *Small Is Beautiful*. · The book *Limits to Growth* by Dennis and Donella Meadows appears as a report to the Club of Rome.
1974 Watergate scandal: President Nixon resigns. · Manipulation of genes is debated. · Search for intelligent life in space. · Theory of fluid crystals (P.-G. De Gennes) as a transitional phase in complex physical systems.

1975

January: Two-week-long lecture: *Everything I Know* is recorded on video: playing time is forty-two hours. Patent awarded for asymmetrical tensegrity construction. · RBF receives his first license as an architect, from the State of New York (at the age of seventy-nine). · Fuller's magnum opus *Synergetics* appears as a book (vol. 1), collaborator E. J. Applewhite. · RBF professor emeritus at Southern Illinois University and University of Pennsylvania. · Project *Fly's Eye*, Fuller's last design for an industrially produced dwelling at low cost; geodesic dome of standard shell elements, round openings are left out, monohex principle.

1976

Hugh Kenner, *Geodesic Math and How to Use It*. · Synergetics exhibition for the opening of the Smithsonian/Cooper-Hewitt Museum of Design. · RBF publishes book *And It Came to Pass - Not to Stay*. · *Tetrascroll* published as artist's book in limited edition by Tatyana Grosman's U.L.A.E. · August: Unpublished manuscript: *Sense of Significance: A Memoir of Friendship*, dedicated to the friendship between the poet Christopher Morley and RBF, written by Louise Cochran, Morley's daughter.

- 1977 Star Wars · Alaskan pipeline put in service. · Military research: Cruise missiles, neutron bombs, laser cannons. · Fiber optics for data transfer, tests conducted by Bell Laboratories.



38 RBF drawing in wet cement, Bali, around 1975



John Cage, RBF, Merce Cunningham, around 1978

1979

Second volume of *Synergetics* is published (collaborator: E. J. Applewhite). · Project RBF/ N. Foster: International Energy Exhibition, Knoxville, USA. · Arthur L. Loeb teaches geometry to design students at Harvard University on the basis of RBF's *Synergetics*. · World Game Laboratory founded. · Medard Gabel publishes the books *Ho-Ping: Food for Everyone*, 1979, and *Energy, Earth, and Everyone*, 1980. · Foundation of the architectural office of Fuller, Sadao & Zung (Cleveland, Ohio).

- 1979 Atomic reactor accident near Harrisburg, Pa., leads to a reevaluation of the atomic energy program. · The engineer Paul MacCready crosses the English Channel with muscle-powered airplane *Gossamer Albatross* and dedicates a photo documentation to RBF. · Gaia thesis of James Lovelock: Earth as living creature, biological parallels to Fuller. · First Personal Computer. Rank Xerox (Menlo Park).

1980

New edition of the *Dymaxion World Map* by R. Grip, C. Kitrick. · Moves residence from Philadelphia to Pacific Palisades, California.

1981

RBF: *Critical Path* (St. Martin's Press, N.Y.C.)

1982

Fuller/Foster: *Project Autonomous House*, a project for Fuller himself. Double shell, the idea of the Garden of Eden. · Disney World Epcot Center with geodesic sphere *Spaceship Earth* opens. · 23 February: Fuller is awarded the U.S. Medal of Freedom by President Reagan.

- 1982 Nobel Prize for Chemistry to Aaron Klug for research on the structure of viral protein shells. B. Mandelbrot, *The Fractal Geometry of Nature*.
1983 Construction of the "Spruce Goose" geodesic dome, with a diameter of 415 feet: the largest self-supporting cupola in the world (Don Richter, Temcor).
President Reagan initiates the Star Wars defense program SDI (Strategic Defense Initiative).

1 July 1983

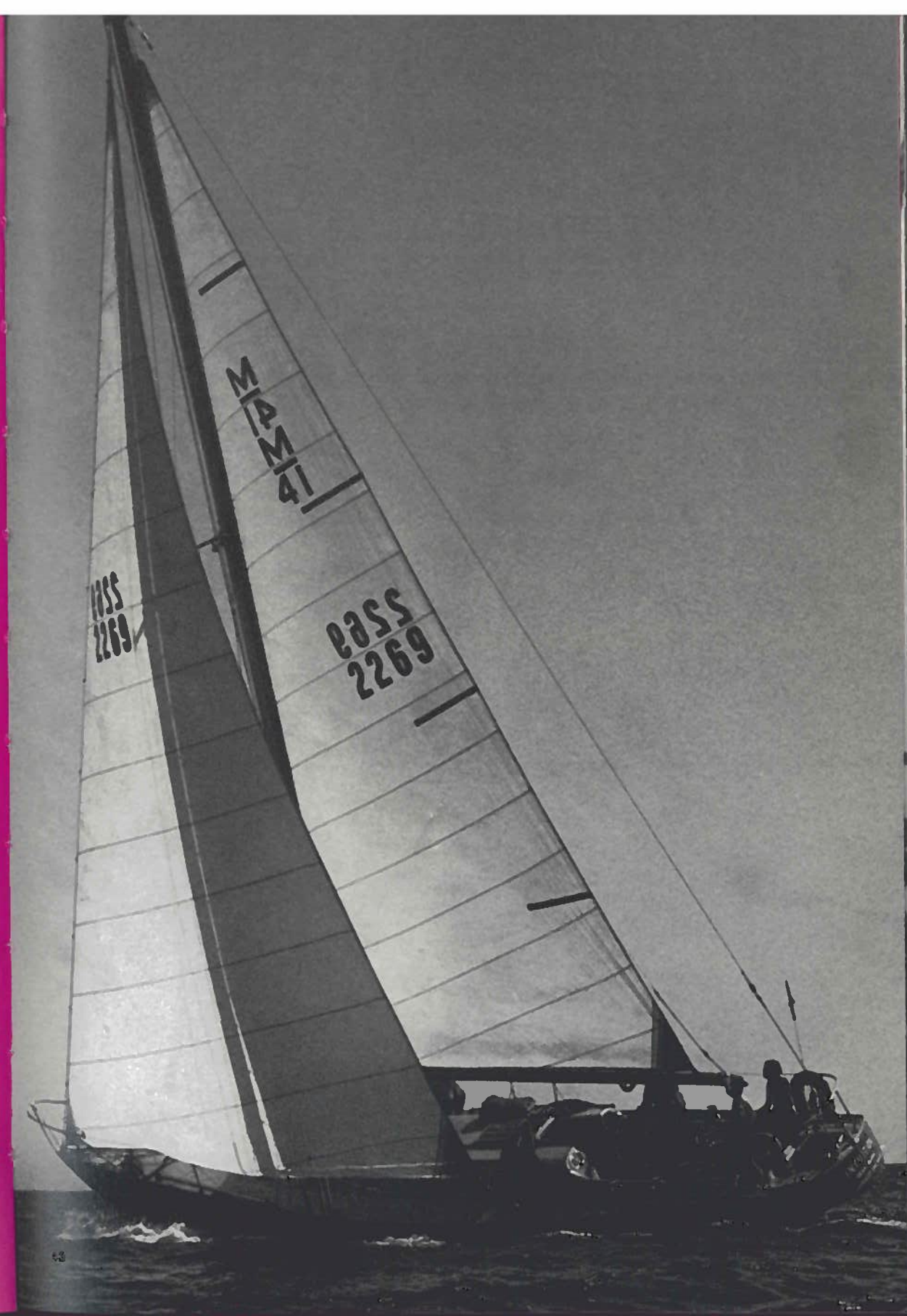
Death of Buckminster Fuller from a heart attack. His wife, Anne Hewlett, dies just two days later, on 3 July.

- 1984 Founding of Buckminster Fuller Institute, Philadelphia, later Los Angeles. Discovery of quasi crystals by Dan Shechtman: for the first time crystals also have five-point symmetry. · Boom in chip production in Silicon Valley, California. Personal computer becomes widespread.
1985 E. J. Applewhite, *Cosmic Fishing*.
1985 Adrien Fainsilber, Félix Chamayou, "La Géode," Parc de La Villette, Paris: geodesic dome with a polished metal outer surface that curves continuously, diameter twenty-six meters. · Founding of the first public online service, *The Well*, started by the Whole Earth group around Stewart Brand and Larry Brilliant: the first virtual community in the world. · Discovery of the carbon C-60 atom *Buckminsterfullerene* by the British-American research team of Harold Kroto, Richard Smalley, and Robert Curl. In recognition of the inspiration they received from Fuller's Expo Dome, they called the C-60 molecule *Buckminsterfullerene* and the molecular family *Fullerene*.
1986 K. Eric Drexler introduces the concept of *nanotechnology* for technical operations on the molecular level. · Accident at the nuclear power plant Chernobyl.
1990 Kretschmer, Stephanopoulos, Houffman: simple methods to produce Fullerenes for research. Feverish fullerene research worldwide. Applications are conjectured in the field of semiconductor and superconductor technique and in carbon chemistry generally. · Popularization of the Internet with WWW software. · Fall of the Iron Curtain and the collapse of the USSR. · Discovery of the Fullerite (carbon-metal compounds).
1991 Experiment Biosphere II in Arizona: Four women and four men live in a closed ecosystem; the experiment lasts for several years. The construction of the large glass house in the form of a stepped pyramid. · Made use of the octet truss, designed by RBF's student Peter Pearce.
1992 RBF's book *Cosmography* is published posthumously.
1994 Buckminster Fuller Institute moves to Santa Barbara, California.
1997 Nobel Prize for Kroto, Smalley, and Curl for the discovery of the *Buckminsterfullerene*.
1998 Mathematical proof of Kepler's assumption that cubo-planar-centered packing of spheres is the closest possible one in space (Thomas Hale).
1979 Foundation of the architectural office of Fuller, Sadao & Zung (Cleveland, Ohio).



For Buckminster Fuller, the origin of civilization lay in the oceans. Sea travelers faced different challenges than the home-bound "landlubbers" (as he polemically called them); they endured the risks posed by the environment: the endless sea, strong waves, darkness and cold, storms or lulls, shallows and currents. The technologies associated with the rise of science include, for example, navigation by the stars, tacking against the wind, exploiting the trade winds. For millennia, technology took the form of the evolution of effective ships and their "cybernetic" instrumentation. Fuller's term of service as a naval officer in World War I was a decisive influence on his life and work.

NAVIGATOR



My First Invention

My teleologic stimulation first grew out of boyhood experiences on a small island eleven miles off the mainland, in Penobscot Bay of the state of Maine. There, floatable at will, in and out of nature's tidal dry docks, with a fifteen-foot flood rise twice a day, boat-building was the parent technology, and the devices for its original design and fabrication, together with its subsequent sparring, rigging, beaching-out, wintering, cardling, rebuilding, launching, and upkeep in general were so broadly effective as to govern spontaneously almost any technical tasks to be effected on the land, whether this was building of dwellings, barns, well houses, or water-course controls (for water conservation on the island was as essential to survival as was our ability to pass successfully over the waters around the island, away to other islands, or to the mainland). Fishing was the primary local industry, and such tension systems as seines, trawls, weirs, scallop drags, lobster pot heads, and traps, together with all their respective drag and buoy gear, insured an ever-present abundance of stout cordage and light lines as well as experience in net-weaving, tying, splicing and serving. Here men "passed a line" and "took a turn" in deft tension techniques as spontaneous as those of spiders.

This boyhood experience on an island-farm included those first turn-of-the-century days of individual, or family, small tonnage water transportation almost exclusively by sail or rowboat, leading to the experimental inclusion of the newly-invented internal combustion engines. We had in our sloop one of the earliest auxiliary gasoline engines within many miles, and this induced a whole line of inventiveness, along with gallons of sweat, relevant to priming the engine, testing the spark, and rolling over a flywheel. But the rowboat had to serve its complementary tasks, and as I had to row each day on a four-mile round trip to another island for the mail, my first teleologic design invention was a mechanical "jelly fish," or teepee-like, folding, web-and-

sprit cone which was mounted like an inside-out umbrella on the submerged end of a pole. This pole could be hand-pulled through a ring over the stern, drawing the self-folding cone on the pole's water end through the water with little resistance. When pushed by the pole, the cone opened and gave inertial advantage, almost as though touching bottom, to push-pole the boat along far more swiftly and easily than by sculling or rowing.

These trips were frequently rowed in the fog and across strong tidal currents which involved complete dependence upon calculations and compass. The push-pole made it possible to see ahead, having been frustrated in back-towards-bow rowing.

"Influences on My Work", in: *Ideas and Integrity* (1963), 9f. (+ YPS: Discourse)



44 - Ed. Buckminster Fuller's Yacht (raft) off Bear Island, Maine, around 1970.

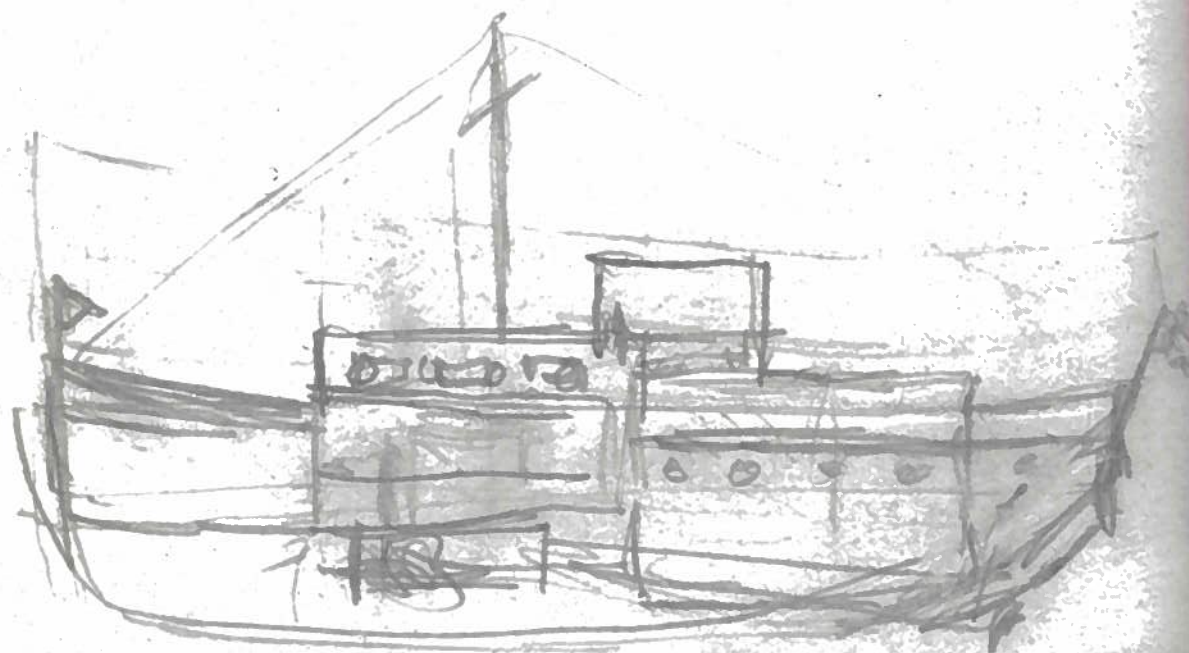
REF. to self-built canoe (full-wood frame, cotton covering), 1952.
REF. to Bear Island (Maine), 1974.

"But chiefly the seashore has been the point of departure to knowledge, as to commence. The most advanced nations are always those who invigilate the coast. The power which the sea requires in the sailor makes a man of him very fast, and the change of shores and population clears his head of much nonsense of his wigwam."

Ralph Waldo Emerson, *Society and Solitude* (1870)



816



46 Sketch on the backside of a photograph of an old ship. RIF bought inexpensively and re-registered as *Lady Anne*.

47 The ship *Lady Anne* which RIF acquired second-hand and refurbished.



52 Rear of the helm of the patrol boat *USS Wago*, April 1945, shortly after entering the Navy.

“I had learned in the Navy that when we wanted to light a cigarette on board ship, you would go up in front of the nearest housing to discover almost still air.”

1945, *Designing a New Industry* (1946)



50 - Rescue of airplanes downed at sea (photo: RBH)
 -RBH ▲ will rescue team

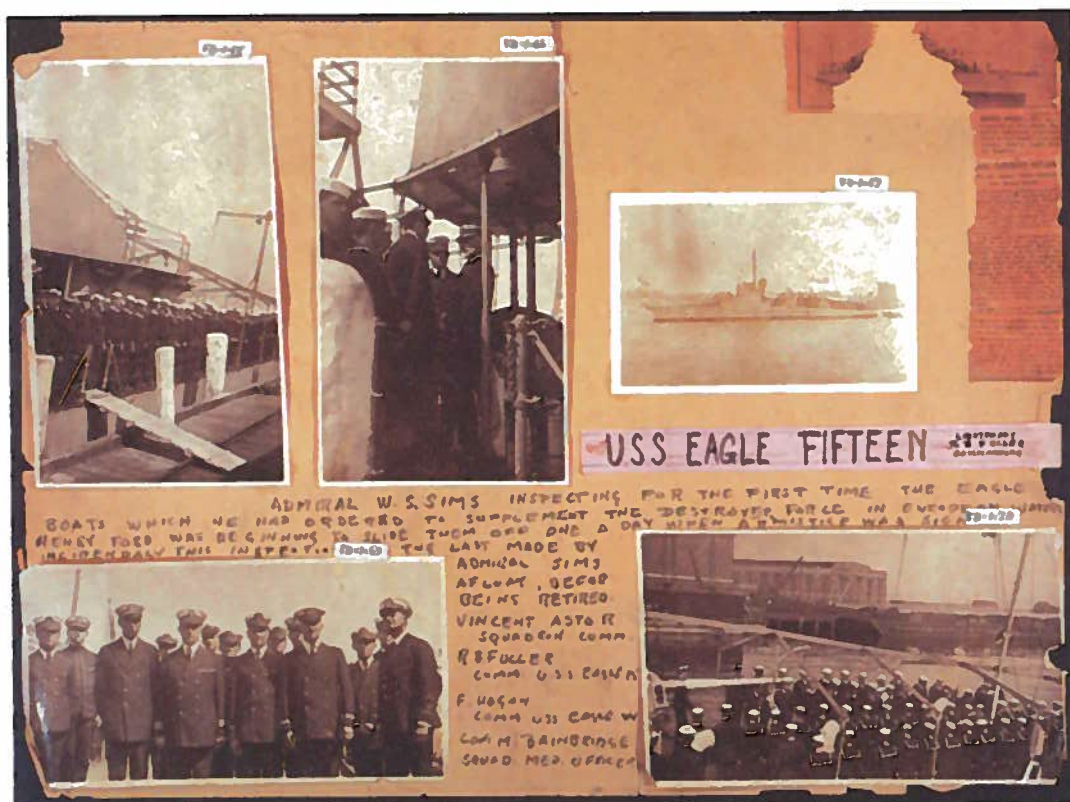
RBH piloting the patrol boat U.S.S. Ketchikan, left

Letter to Vincent Astor

I have always liked you so sincerely well, and admired your unostentatious love of the sea, marked ability as a sailor, and mastery of mechanics, which I recall as absolutely natural in you. Indeed, your interest in these affairs was the fundamental background of our friendship.

Of this real significance of yourself I find the public has little or no knowledge. If the public were aware of such significance, it would be unappreciative. The public is still so enveloped in bunkum, as to relative values, that it vaguely prizes you more for the value of a name, long connected with wealth, than for your own character, ability, and individual identity; more as an institution than the damned fine person you are.

For instance, I know none who recall that you commanded on its post-war voyage to this country, the German submarine sea raider, U-34, demanding more than ordinary ability, even amongst professional seafaring men. There are few of the public who, thinking of submarines at all, other than to picture them as a form of hell trap, realize the accidents that have come upon them, were of personal equation origin, usually external, and no more the fault of the machine than of a Rolls-Royce in a street smash, the submarine machinery having functioned, internally, far beyond expectation in such accidents. The public fails to perceive the "hell trap" idea to be undeserved by the submarine, as a mechanical unit itself, "the elder" portion of the public being mechanically incompetent mentally. They do not know that the submarine is the greatest single concentrated grouping of mechanically perfected units, devised to date, and, whether eventually useful as a war weapon, or not, at least it has been the proving ground of many of the most beneficial of mankind's mechanical servants. Unaware of the intricacy of a submarine they are naturally unappreciative of your ability in commanding one.



52 Album page from the Navy, years around 1919

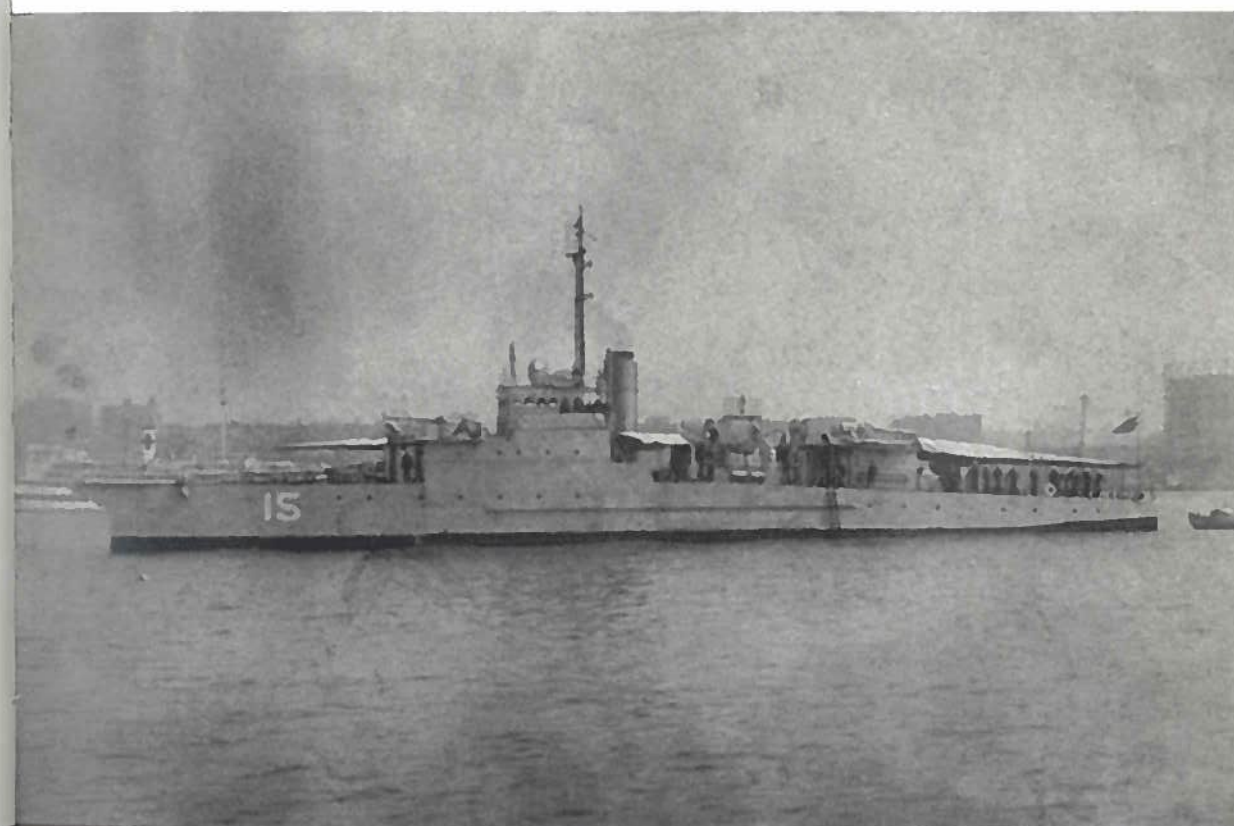
USS Eagle Fifteen, manufactured by Ford Motor Company, commanded by RBF, 1918

Again, few know that you were one of the first to patronize flying, as an every day accessory to life, by purchase and practical commuting use of a plane; to wit: - An Hearst paper editorial here, in Chicago, a short while ago, which queried, scathingly, as to why some of the rich men of today were not taking up aeroplaning as a good example to the public, after the fashion of Mr. Vanderbilt with automobiling in its early days.

I remember discussing with you one evening at your house in Newport, with pleasurable revelation of each other's fund of thought on the subject, our mutual interest in everything to do with boats and mechanical developments. Commonplace as this may seem now, it was actually significant then as being considered slightly moronish, and quite flavoring of the "garage man," for people to be really interested in mechanical developments.

That you were honestly interested in naval mechanical organization and perfection, not in just "dressing up in uniform to play officer" as is the customary unthinking accusation, to the extent of sincerely taking part in, and living aboard the Eagle boats, not having your quite available, and far more comfortable, yacht trail us; that, with me, you were as interested in the perfection of cooking and feeding, in mechanical solutions, in maintenance ability of sanitation in living quarters, and in mental organization able to subordinate an intricacy of mechanics to the useful and easy service of the mind; plus your ability to play, unhyprocritically, exhibiting a profound yet happy understanding of a life, was a great, corroborating, inspiration to me, which I have always carried with me, with great elation in reflection upon it, for there was then, and for that matter, still is, little comprehension and appreciation of these things by our "socially smart" acquaintances.

Incidentally your attitude of responsibility, pride in ships, sure, easy, cooperative command that made infinite detail of orderly compliance an industrious pleasure to your ship commanders and crews upon the occasion of minor, though none-the-less of historical interest in navy



53 54/55: Vincent Astor's airplane, on loan to RBF for five weeks in 1918. Astor was a Navy comrade of RBF's and one of the first private pilots in America.

54/57: RBF ▲ U.S. Naval Academy, July 1918. RBF, for U.S.S. George Washington, RBF accompanying Admiral Giesse to the signing of the Versailles Treaty, 1919.

annals: to wit the first inspection by Admiral Sims of the Eagle boats, then under your squadron command, which he had ordered to supplant the destroyer forces; which was as well, the occasion of his last inspection, afloat, before his retirement from the naval service. This event was typical of your subordination of extra prejudicial conditions to the best interests of all, your identity being solely that of squadron commander, your ships and their personnel thereby revealing themselves to the best advantage of the service. I have the Admiral's flag, which was flown at that time and which we also flew on our memorably pleasant "cruise," with Admiral Cleaves as our guest, in the Eagle Nr. 15.

Sailing boats were, at that time, naturally "quite alright" as something to play with personally. They had historic precedent, but anything mechanical seemed to smack of poor sportsmanship to the dictators of "what is being done." Steam and mechanical yachts were something to have operated by paid hands. Navy activity outside of war time, to say the least, was termed "naive." In inferring their error I am laying no stress on motor boat racing as being alluring, though a means of mechanical test, for the same thoughtless element are interested in horse racing, not for the love of the racing unit itself, but for the lazy men's hope of getting something for nothing, and the inherent fascination of speed in any form. Speed is the progressive essence of temporality. That our sympathy with these and other interests have been so similar, I have always born with me. Once a really concordant friendship is created, upon such a reasonable basis, I doubt if it may become broken. For this reason I write you at such length on the subject which I perceive to be the most important that will ever confront either of us, that you may serve as you best see fit.

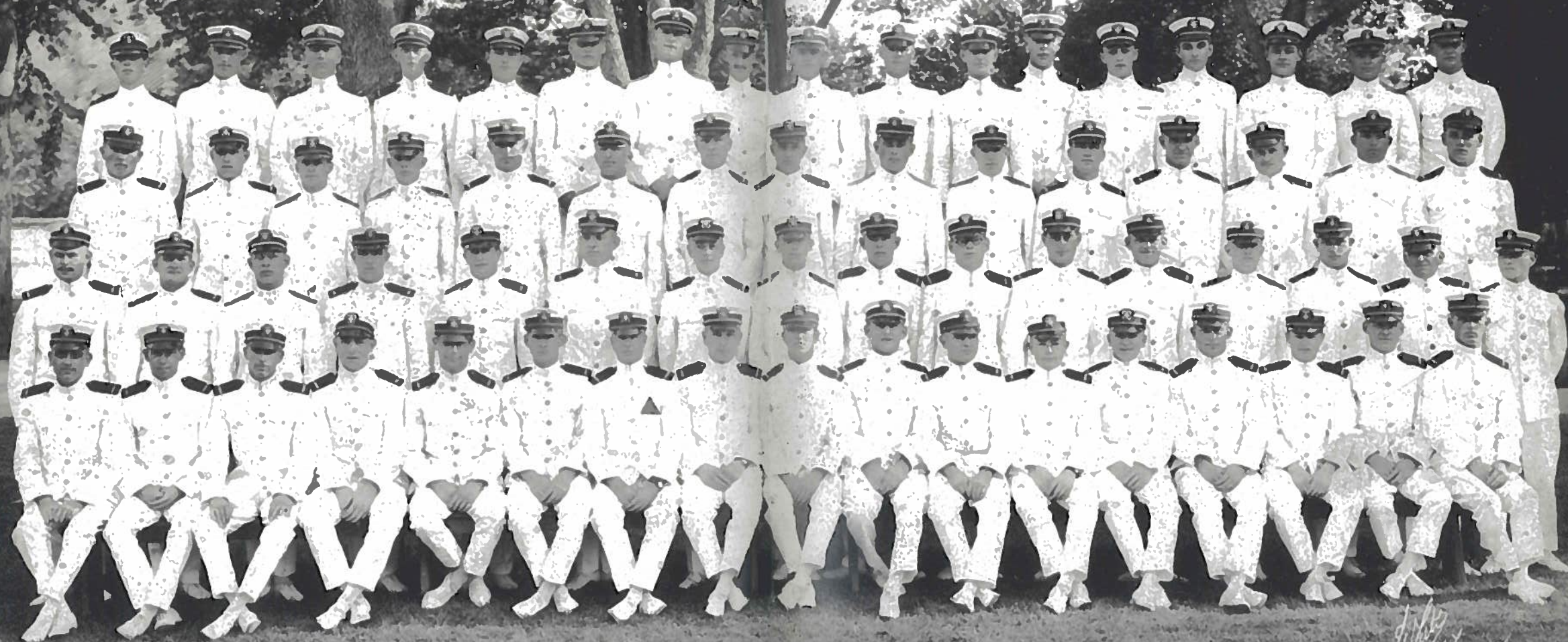
It was actually suggested to me, not long after I had given up command of the 15, that you were a little queer to be "fooling around" with the Navy.

Compare such supercilious attitude, as that, to the words of so distinguished a publicist as Richard Washburn Child, in an article written during the world war, commenting upon the congressional investigation of the War Department, a quotation from which was used in the Foreword of our Annapolis Naval Academy Memory Book: "Are all the good things they are saying about the Navy true? Plenty of Americans are asking. The answer is an emphatic 'yes.' If it were all as good as the Navy, as clean, as simple, as free from buncombe, boasts, and botches, then we would have a war machine indeed; ten minutes with the Navy is enough to convince any observer that the Navy organization bears to the War Department organization the same relation that a Greek Temple bears to a dish of scrambled eggs... Armies are sensational. But it was and is the British and American Navies which can and will save the world... The Navy is the key to our self-respect and our self-defense. So it will be until the sea is solid... the Navy - praise be - has it."

While written under far different world conditions than those of today - Mr. Child was inadvertently forecasting the events which I now perceive to be close at hand, wherein the naval officers will, with their training, far superior to any other which I know of (and which incidentally showed many of our Harvard men to disadvantage under the grueling requirements of the Naval Academy), be called into executive activity of which the run of business executives are incapable.

Relative to the same thought the entrance of Lindberg and Lanpierre into commercial aviation direction, is significant of the step-up of the caliber of world industry management from bullying management without technical knowledge, in hit-or-miss-with-a-bang, to wide scientific and practical knowledge (not worn on the surface, any more than on a neatly uniformed officer, of vast training).





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Returning to the crux of my argument, Naval officers, capable of handling fleets made up of a myriad of battleships, destroyers, submarines, airplanes, supply and hospital ships, with crews of thousands of men, who must be fed, rested, clothed, employed, entertained and trained, moving in orderly fashion in fair weather or foul, divested of all reference to so called "land advantages," beyond an orderly delivery and equally orderly distribution of supplies; these naval officers, trained to ably handle any and all mechanism of this service, through the whole range from submarine signal and torpedo mechanism, etc., to the most delicate of range-keeping instruments, trained in instantaneous logic as to "what do," in an infinity of emergencies, from "man over board" to "enemy submarine reported on the port bow," will be called into the handling of centrally manufactured, decentralized-hook-up housing, which none of our "smart" businessmen, who primarily cannot even drive their own automobiles, let alone conceive of such a housing industry, have naturally missed. The naval officers who have been "admitted" to business life, to which they have tried to adjust themselves, truly "settling down to business," have had their senses so dulled and befuddled by the disorderly and colossal ramification of business, which they had been led to "believe" were so business-like, in comparison to the Navy, by its blustering thick-headed feudal leaders whom they honored, and they had learned to honor their seniors in experience, as to have been forced to consider themselves "stupid" for, being unable to detect the "system," being unaware of the colossal bunkum that hid from them the fact that there is little or no system in business in comparison to the orderliness and efficiency of the Navy, outside of the money collecting systems of the bankers.

Letter to Vincent Astor, 1928, in *4D Timeclock* (1928/1972), 88

"The inventor has natural and immediate access to all the potentials of the universe. Edison, Bell, Marconi and the Wrights needed no licences from anyone to light the night, to shrink the earth and interlink all of humanity."

Utopia or Oblivion (1968), 343



Communications Officer at Sea

"For the landsman, a trip around the world means the conversion of a bank account or an Irish Sweepstakes prize into a procession of hotels; to the seaman, it is the logical fulfillment of his work, punctuated by his visits to the beach." Or: "For the land dweller, 'the East' and 'the West' are places; for the sea traveler, they are directions in which he can move." Fuller expressed himself with this kind of acerbity in his important text "Fluid Geography" (1944, -YPS: Discourse). For Fuller, there is an irrefutable difference between those accustomed to the sea, who have to deal with the constantly moving element of water, and those who live within the dull certainty of the mainland. Everything man has produced in terms of progress, according to Fuller, either came directly from sea travel or from a hunger for scientific knowledge that is an extended sense of the desire to break away from the known to reach new shores. For Fuller himself, the stimuli derived from his years with the navy were decisive for his life: experience with navigation, with anticipating turning or breaking maneuvers; planning supplies of food, fuel, and water, plotting routes, schedules, and the daily routine; sensing the time of day or the season, of phases of the moon, of tides; and not least the personal experience of crossing the ocean in day and night travel, slowly but steadily. Not only did he know what the map of the world represented, he was familiar with it as well.



11 KBF as the Commander of the ship U.S.S. *Itasca*





62 • REF as a communications officer on board the U.S.S. *George Washington*, 1919

My Navy experiences ranged all the way from those small commands to subsidiary functions within much larger command patterns. The assignments and commissions brought, for instance, incidental participation in the first development of ship-to-plane radio-telephony. They also brought subsequent participation in the conversion of radio-telephony from seventy-mile-range spark sets to long-distance, arc-type equipment. The first instance of the above electronic experiences occurred when a small ship I commanded was selected for the experimental work of Dr. Lee de Forest. While aboard, he established the first successful voice communication ever heard between a ship and an airplane.

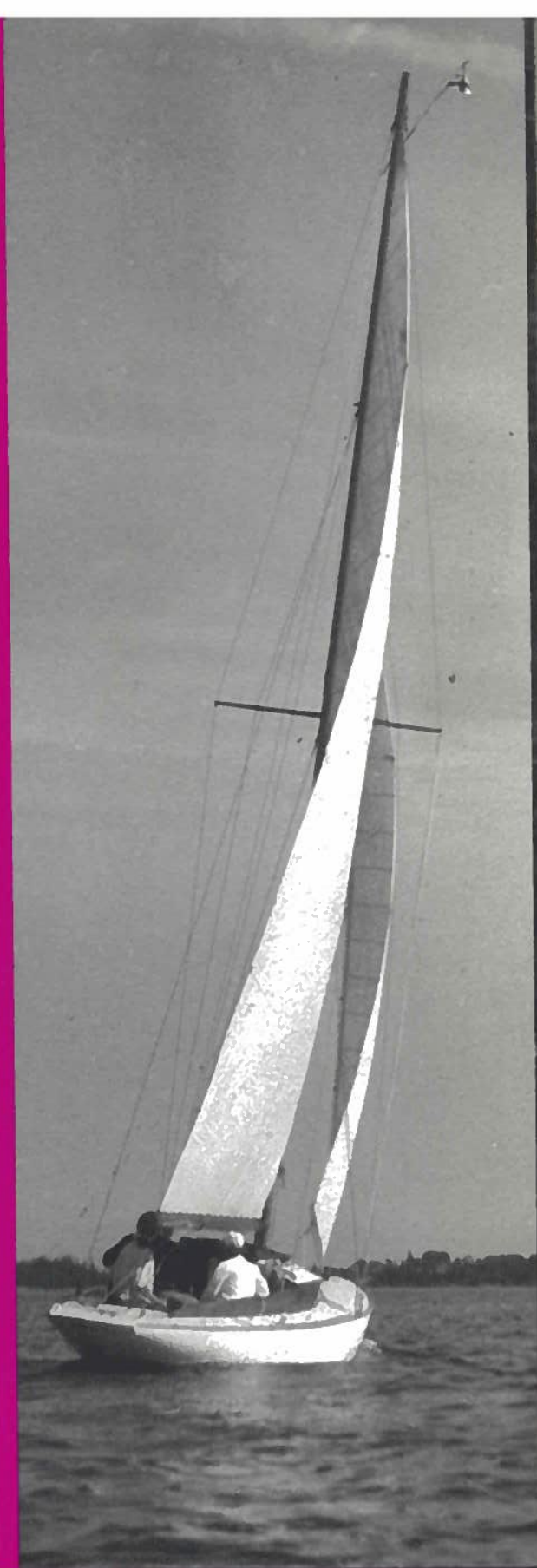
I was later fortunate to be Force Radio Officer for the Cruiser and Transport Force of the United States Atlantic Fleet which carried and escorted the American troops across the Atlantic in World War I, and, as personal aide for secret information to its commanding admiral, had intimate experience in large teamwork maintenance of colossal dynamic pattern: for instance, that of maintaining the high-velocity trans-Atlantic turn-around of 130 major troop-carrying ships, together with their cruiser and destroyer escorts. Here was the pattern of secret high-speed exact communication and the strategy of sea group formation, all logistically maintained by expertly scheduled supply and maintenance men at their inspired best, accomplishing the impossible under war-induced spontaneous cooperation. After the war I compiled the official Navy statistics of that operation. During the war I had been editor of its sea-printed publication *Transport*, which had monthly circulation in our fleet of 130,000 copies.

Immediately after the Armistice of World War I, the *U.S.S. George Washington*, one of our ships, was selected for President Wilson's trip to France to attend the Versailles conferences. In the *George Washington* we installed the first long-distance wireless arc telephony which dramatically graduated the ship-to-ship telephone from a seventy-mile-range spark set squawk to an effective two-way trans-oceanic voice communication. On President Wilson's second trip to France, the human voice was transmitted trans-oceanically for the first time in history, as a man was heard through the receiving instrument in Arlington, Virginia, speaking over the transmitter in the radio shack atop the *U.S.S. George Washington* at anchor in Brest, France.

"Influences on My Work", in: *Ideas and Integrity* (1963), 15 (→ YPS: Discourse)

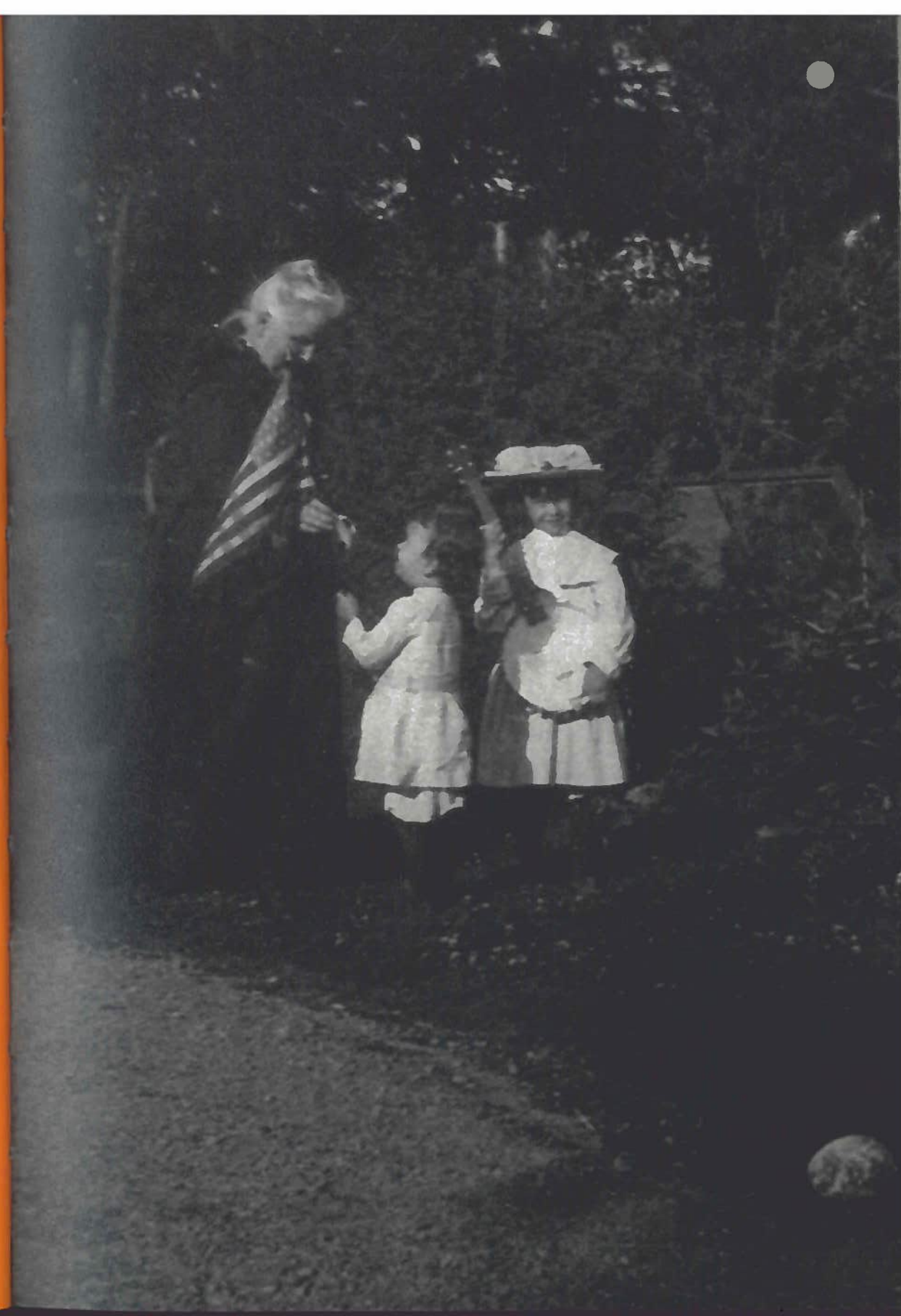
“A sailing ship
opens up the
sea, but unlike
a bulldozer
it doesn’t hurt
the sea.”

An Autobiographical Monologue Scenario (1980)



Though not a state unto itself, it is nevertheless the heart of America's self-image: New England, the coastal region of the northeast. The place where the Puritan immigrants from Britain settled. Where Europe is still palpable, but also palpably on the other side of the water, part of the past. New England, the place where America became aware of itself, where the new is held up to the old and consciously chosen over it – or consciously rejected. Buckminster Fuller, the son of a respected family, saw himself as the enterprising heir to the affairs of the Transcendentalists of Concord, Massachusetts, in which his great-aunt Margaret Fuller-Ossoli had played an essential role alongside Emerson and Thoreau.

NEW ENGLAND





R. Buckminster Fuller came from a respected family that had lived in New England for many generations. One of his ancestors, Thomas Fuller, came to America in 1632 as a British officer, a member of the first generation of colonists. The Fuller family distinguished itself especially as part of the abolitionist movement. Fuller's paternal grandfather, Timothy Fuller, died as a high-ranking officer in the Civil War between the Yankees and the secessionist states of the South. The Fullers occupied political offices as members of government or ministers; several of them were respected jurists. Generations of the talented male members of the family studied at Harvard. Fuller's failure at this renowned university was an especially painful break in this family tradition. It is remarkable, though, that even female members of the family managed to develop within the confines of proud Puritanism. Fuller's great-aunt Margaret Fuller (1810–1850) was extremely important as an advocate of women's rights, as a literary critic for the "New York Herald Tribune", and as a member of the Transcendentalists of Concord, Massachusetts, around Ralph Waldo Emerson, Henry David Thoreau, and others. Within this circle, she was surely the thinker who was most unbiased in confronting the question of keeping current with respect to dynamic technical and social progress. During the late twenties Fuller learned about the significance of his great-aunt by examining her writings. He wrote about that discovery in a letter to his younger sister Rosamund.

Letter from RBF to his Sister, Rosamund Fuller

"What I wanted to say to you is that I have been absolutely astounded at the significance of Margaret Fuller which none of us (present generation of our family) have realized, and upon which I have more or less stumbled at this distant point from home. It is exciting to find Women's clubs 'in these parts', and in many parts of the world, named Ossoli Club, after her. The Library here has many books about her, being published from time to time by Philosophy professors, popular writers, biographers, etc., as well as the earlier biographies written by Emerson, Channing, Thomas Wentworth Higginson, Olcott, Howe, and Grandfather Fuller. It is because of the generations of the Fuller family have been so drawn out, and because Grandfather Fuller, whom she brought up and affected so deeply, was killed in the Civil War, when Father was but a little boy, and because Father died while we were so young, that, with the usual casualness of people to that which is closest to them, we have missed her importance entirely.

She was, it would seem to me, almost as important to civilization as such men as Lincoln, but her efforts were so much more abstract and indirect, being applied primarily to the small coterie of thinkers who formed the original nucleus of an American culture, freed from the feudalistic oppressiveness that characterized its literary work up to that time, under her directive effort, known as the Transcendentalists. These people translated and wrote down many of her truths which are now materially benefitting the whole world, through their brain child, the "Natural Recreative Industry" of present-day America. Her genius was as a rule revealed only in conversation. This method while by far the most unselfish form of creation, thinking nought of capitalizing new truths for self, but seeking untiringly to give off and thus ever increasing the river bed through which the truths may flow with natural facility, has by far the greatest influence, but is often temporarily halted by those seeking to redistribute the truths, as of their own making, there being no material testimony contrarywise.

In fact, those doing the latter may not do so consciously, but are rather of the great army of mental kleptomaniacs, who bundle off truths, and later, by virtue of the fact that the truth has been stored in their brain cells, perceive them to be their own. Margaret Fuller's one great temporal fault, in my opinion, was her intolerance of her father. Had she in addition to her other great powers the ability to see the raft of advantage heaped upon her by her father's tremendous if well suppressed love (in the best New England fashion), she would be on everyone's lips today. Tolerance is a great virtue and will eventually be greatly rewarded by even keener perception, by virtue of the impassionate reasoning which it makes possible. The most perfect example of what I am pointing out is that of Christ, whose unselfish existence, mythical, symbolical, or real (inasmuch as material temporality is only of secondary or temporary consideration, it does not matter) has for its greatest significance the fact that he left behind not so much as one written word, not one material token. His significance lies in his complete faith in love to perpetuate its recreation to eternity without resort to any temporality whatsoever. It is my opinion that the testaments of his teachings and existence have done more to retard the truth of Christ than to aid it. It is like the hypocritical nurse maid testifying to the goodness of the little child. If Christ had wanted his word written he would have written it himself. If he had done so it would have been done in one word, I am sure – Love. The actual writing of his teachings in the form of scriptures, arbitrarily selected for publication, and certainly exquisitely beautiful as word composition, as are the carven images of other eras handed down from generation to generation, ever and anon, acquiring an additional beautifying artistic touch, and always the beauty of patina, are to me much the same, when reasoned out, (with full faith in love) as the correspondence school courses on how to be as successful as Washington or Ford. Everyone of the Saints who wrote the scriptures was temporal and as such committed many sins. While the motive in their writing of his word was well covered by the beauty of the truth of which they

wrote, it would have been far more lasting and beautiful if handed on by them in the form of word and deed alone, instead of being confined to a cliquish group of politicians, as it eventually was, who alone are capable of reading the written language, and were able to mete it out to their self-aggrandizement. We find the action of the Saints continually portrayed in the action of contemporaries, who no sooner than a person dies heap laudation upon that person, at the same time discreetly revealing their own intimate relations with that person (usually exaggerated or fictitious), that the dead person, unable to deny the allegations, the merits heaped upon them may redound to the 'fine' influence of their speaker. I feel that this is the fundamental basis of the majority of public funerals. Lord help me I credit the grief of the intimate minority of these occasions. All the scriptures or correspondence school courses, no matter how well done, are but one-track formulas for reestablishing the complete faith in love with which children are born, and live in "unconsciously, and therefore perfectly, until it is broken by their elders; who drudge worn, by the every-day immediate living conditions, suddenly blaspheme that perfection of faith and love, which, once broken, cannot become perfect again in the realm of temporality. All the drudgery can be mechanically removed from our living, with the realization of the stylistic bunk that "aesthetically" controls its design in archaic form, in the tailor-made practice still employed in house building, self-consciously, which is selfishly, thought to indicate distinctive personality to its owner.

All this is the basis of our 4D house philosophy.

Emerson, who is ever more often acknowledged the greatest of philosophers to date, said to Margaret Fuller, who, as first editor of the Dial and literary critic of the New York Tribune, (in which her articles were always featured on the front page), had verbally lashed him into exquisitely unselfish thinking, 'Of those for whom I would wish immortality most, there is none for whom I would wish it more than Margaret (Fuller), for it is she whom we can least be without.'



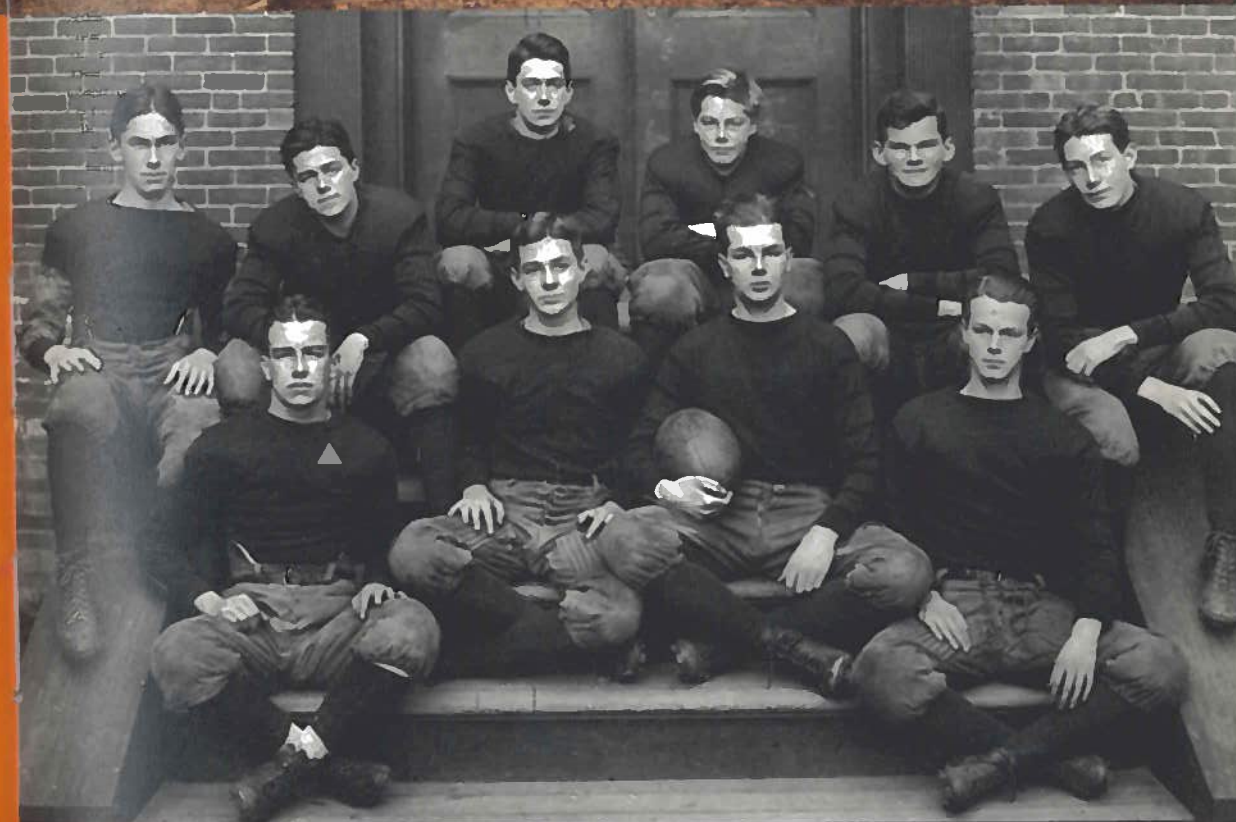
• RBF and his friend, Summer 1897
• RBF and his youngest sister Rosamund in self built
play-yard, Bear Island 1908

• RBF and his brother Wilcoff, 1904



“I thought I was going to be a great athlete, and then I busted my leg playing football...”

RIBA discourse 1958



71 RIBA amidst his classmates, with bicycle, ca. 1906

Milton Academy Football Team



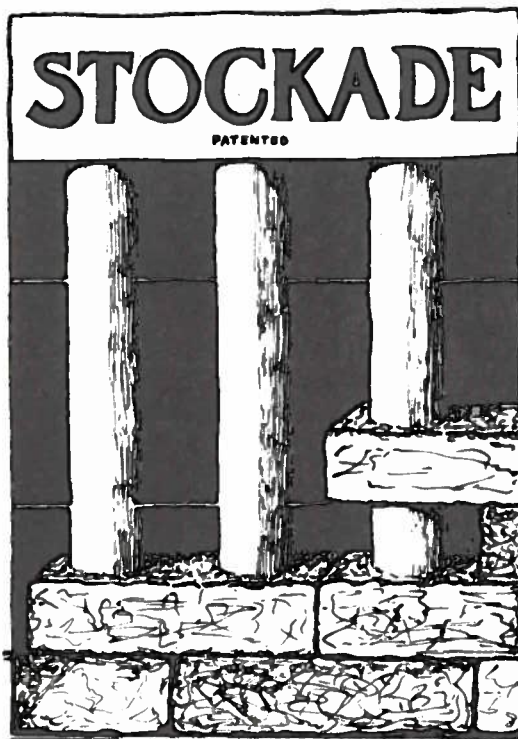
It seems to me, Rosy, that you should learn as much as possible about her. She was well known abroad, too, having been received by Carlisle in England, as the head of a deputation from Emerson; and done heroic work in Italy, while her husband Marchese Ossoli fought in the civil war there, just before their final return to this country, on the voyage which ended in their being shipwrecked and drowned off Fire Island, L.I., where the Women's clubs of America have erected a memorial to her. There is not self-aggrandizement in recognizing these facts about her, which, by the natural law of inheritance, may be taken up where left off, when the personal-equation and circumstances are sufficiently licked to allow the truths to come forth, and the work taken up where it was left off.

Of the many books about her there are two particularly good and short ones, as a preliminary study of her. The chapter in Gamaliel Bradford's "Portraits of American Women" and "Margaret Fuller and Goethe" by Professor Braun, published by Holt in 1910. Both are in the public library. I tell you all this, before you go abroad, as I think the effort and time expended by you in reading these, before going, will be amply rewarded by your greater appreciation of all that you observe, in your first vivid impression, of foreign travel. It is fortunate that you go without an older guide. There could be nothing sadder than the truth indicated in the picture (living) which I witnessed the other day of a little girl dragging a still littler group of brothers and sisters through the zoo, whirling and wheedling them by the cages to which they were drawn with natural fascination, it being their first trip to the zoo. The reason for her tenacity and interference with them was that she wanted to get them to look at the zebu, which bore greater significance to her because it had been pointed out to her on her first trip by a favorite uncle, who, unknown to her, picked on it as a target for his own 'smart' remarks. This is the way I heard it, and it illustrates the overemphasis of personal equations. Beware Zebu bally-hooists in your travels.



I am sending you a copy of 4D which has been added to since the copies sent to mother and Wolcott. I hope you will find time to read it, and to bring me comments on your return, brought about by your observations abroad, relative to it.

4D Time Lock (1928/1972), 79



Stockade

The stockade construction system was developed and patented during World War I by Fuller's father-in-law, J. Monroe Hewlett, and Fuller continued to develop it. It uses large but light bricks of straw pressed and cemented together. They were made with round holes that would line up in the bond so they could be filled with concrete. The concrete columns that resulted provided the support; the remaining material in the brick served as insulation. The columns remained hidden inside the wall and gave the process its name (a stockade is a structure made from posts). The Stockade Building Corporation conducted tests on materials – weight stress at collapse – and beginning in 1922 constructed 240 buildings under its young director Fuller before it was bought by Celotex in 1927 and liquidated shortly thereafter. The two main concerns that Fuller had about the process were construction delays caused by weather and the ability to bear compressive loads.



FR
-RBF's father-in-law James Monroe Hewlett, painter and architect
-Stockade lightweight construction technique, developed

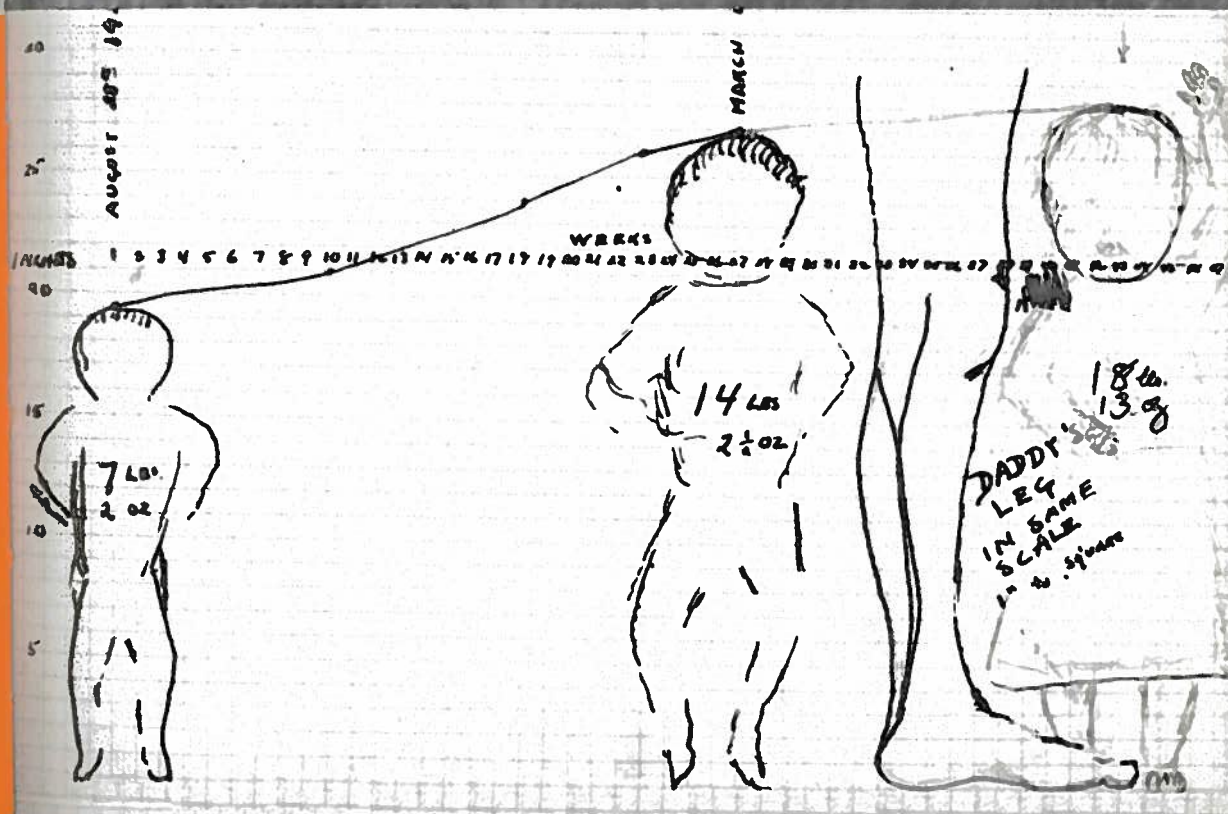
by J.M. Hewlett and RBF (building blocks of cement-bound straw, joined together by concrete posts cast on site).
Title page of the firm's brochure, ca. 1923

Two of the 240 houses built using the Stockade-System, between 1922 and 1927 (Chronicle 31/1927)



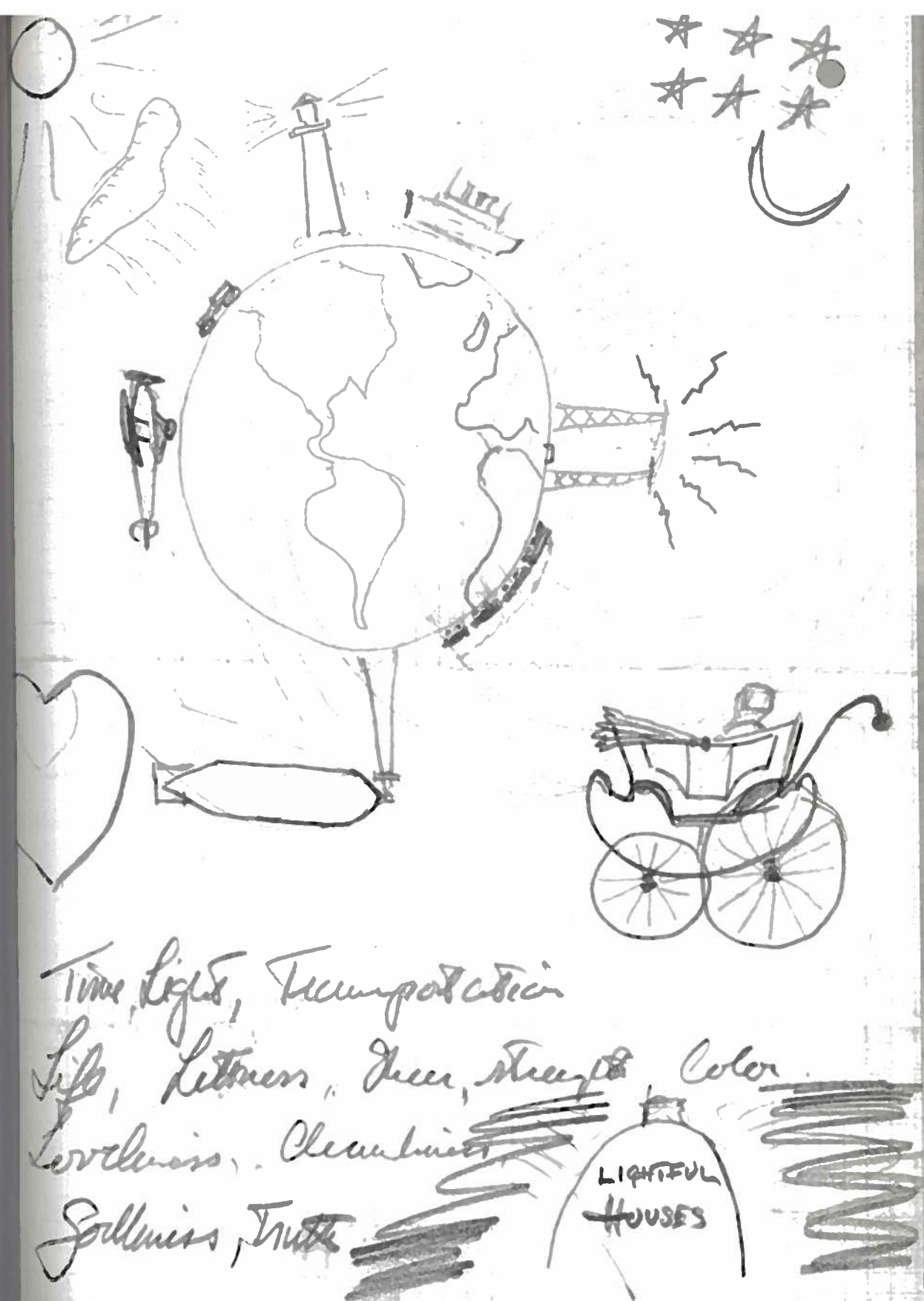
"Baby's Record"

In spring 1927, Fuller received the news that his position as president of the Stockade Building Corporation would soon come to an end. His departure followed in December. For three quarters of a year, that departure weighed heavily on Fuller, as was clear from a long correspondence. In August 1927, his daughter Allegra was born. Fuller began to compile statistics, marking a time line with the child's growth, weight, and important firsts like the first smile or the first articulated sounds. In the course of this difficult year, Fuller had a kind of mystical experience that showed him the direction for his future life. These statistics have a significance that is typical for Fuller. They contain among other things notations of accompanying temporal events. For example, on one of the three sheets that show the child's growth curve, "Daddy's leg" is drawn in as a basis for comparing size. For Fuller, statistics were not just a matter of numbers, instead he tried to relate them to himself. Fuller was not a positivist. This detail expresses how attentive he had become to the question of coordinates during this period; he sought coordinates for his life and his task, and the newborn child was a guiding star in that effort.



The circumstances of Fuller's life led him into a deep crisis out of which he found his way by setting himself no less a task than redesigning the house for the world. He called this program to find a new way of housing mankind "Lightful Houses." It stood for "full of light," "lightweight," "de-lightful," "light-Fuller," and so on. From it, he derived the concept of 4D. Fuller wrote his polemic "4D Time Lock", which he had copied and sent to relatives, friends, and selected exponents of American intellectual life. In it, he sketches a vision of a united world: The continents together form an archipelago beneath the "air ocean." It is made accessible by the most modern means of transportation and telecommunication. People live in 4D lightweight-construction towers that are transported and set down everywhere by airships. Henceforth, Fuller took the name 4D to mean design that was always based on time.

LIGHTFUL HOUSES/ 4D





Programmatic drawing of *Lightful Houses*

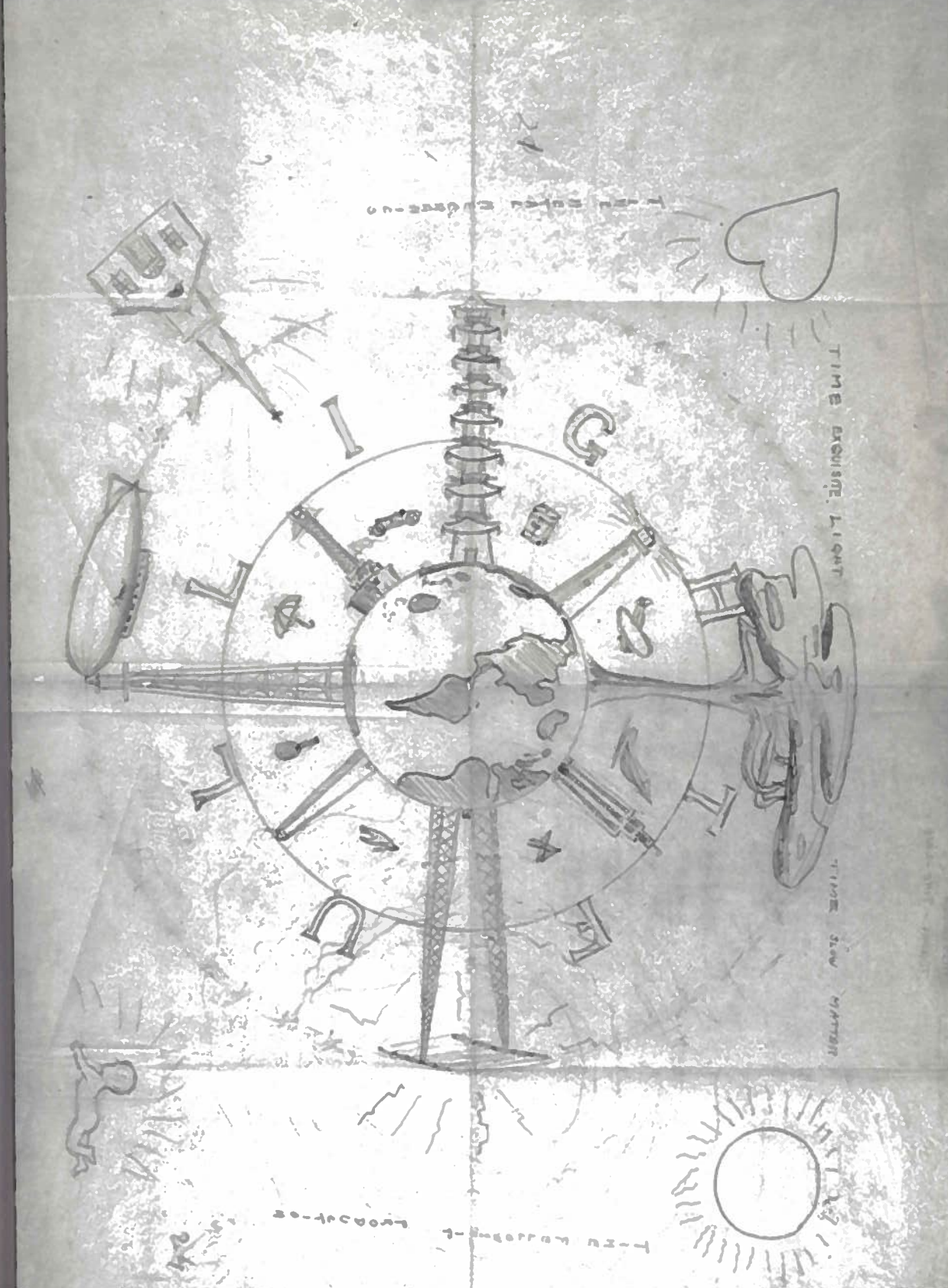
Main coordinates:
Heart/Baby/Sun/Spirituality

Inner circle: everyday objects
(foldable, tension-stressed, convertible,
movable):

tennis racket
umbrella
auto
steamer trunk
airplane
sailboat
folding chair
bird

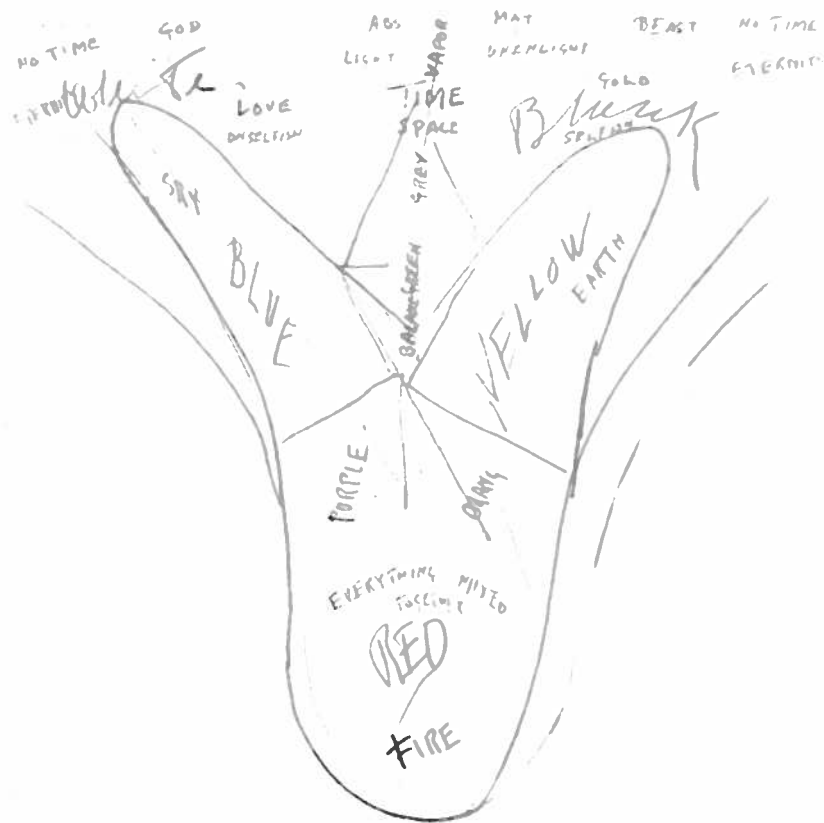
Outer circle:
world tree
Schenectady experimental high-voltage plant
mooring mast with dirigible air ship
pagoda

In between:
skyscraper
obelisk
ship with transmitter tower (Suchov type)
lighthouse



82 83 Sketch of *Lightful Houses*, early 1923

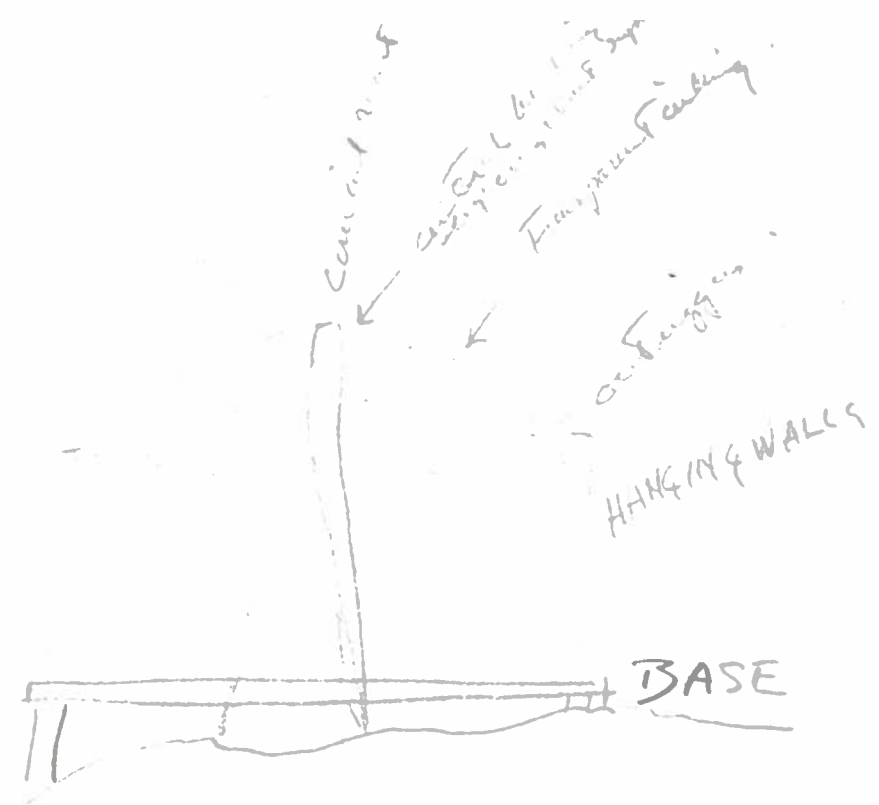
Programmatic drawing of *Lightful Houses*, early 1923
(probably February)



Fountain of life

"... there is in every creature a fountain of life which, if not choked back by stones or other dead rubbish, will create a fresh atmosphere, and bring to life fresh beauty. And it is the same with the nation as with the individual man."

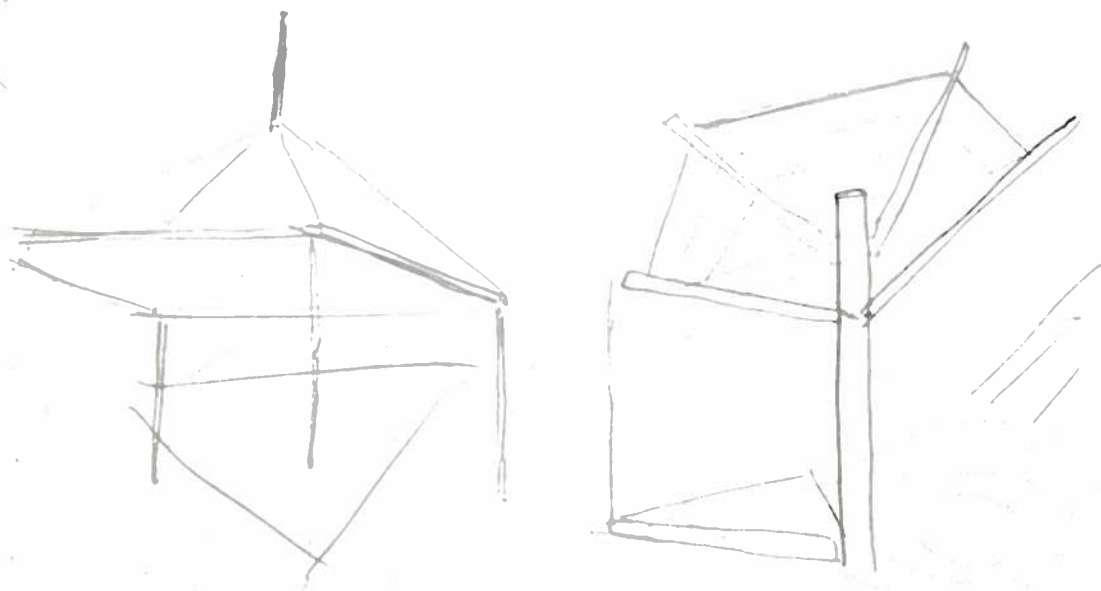
"Margaret Fuller's 1842 Prediction", in: *Ideas and Integrity* (1963), 70



Chassis Construction

In a folder containing manuscripts and a few sketches from the time of the birth of the concepts that led to the 4D house and the 4D book, there are hints about Fuller's beginnings as a designer. It is highly likely that none of Fuller's manuscripts and drawings date from before 1928. All of the dates with the year 1927 were added later and are incorrect.

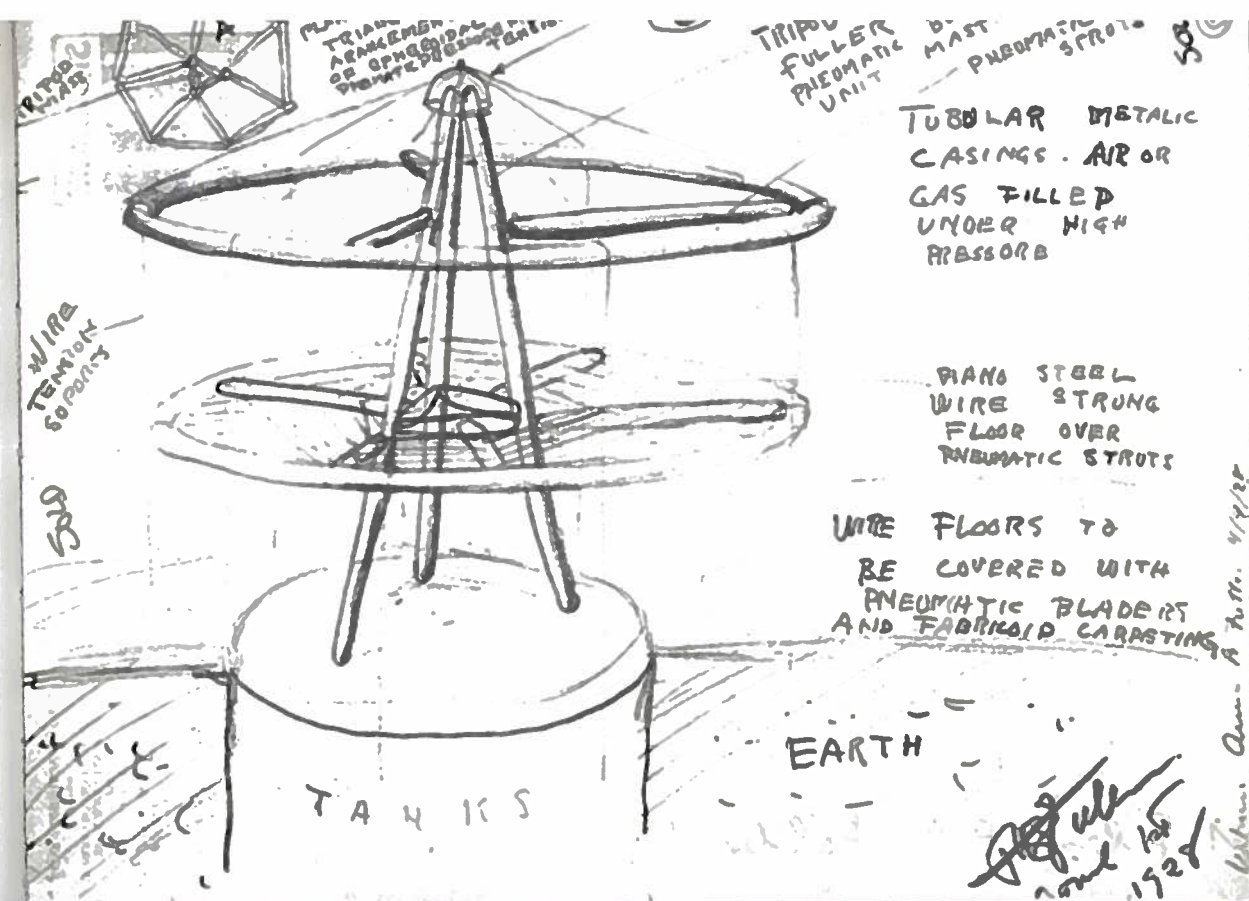
The first reflections on the planned house – originally called the "Fuller House" within the family, and its subsequent manufacturer was sometimes called the Cosmopolitan Home Corporation and sometimes Fuller Houses – were written down in January 1928. For the trademark and trade name, Fuller used the word "Lightful" he had devised. He called the houses "Lightful Houses" and the furniture, household items, and so on, "Lightful Products." Fuller dictated the script for the first approaches and development of the 4D house. Fuller sees three classes of buildings in contemporary architecture: (1) industry buildings, (2) office buildings and large apartment buildings, (3) small private dwelling. As for the first class, stimulated by reading Le Corbusier's "Vers une architecture" (translated into English as "Towards a New Architecture", 1927), Fuller saw the origins of the new style of architecture in factories, power plants, and so forth. In the second class, the skyscrapers of densely populated cities are constructed using the new materials steel and reinforced concrete and use electricity and modern methods of transportation. The third class includes the small, private dwelling, the "American Home," which is technically the most conservative and is based on local handicraft production. Fuller started with the third class and proposed introducing a new method of construction that the various manufacturers of materials could help to develop. The new construction would have the



chance "to serve the architect in building the utilitarian portion or the chassis of a house that would correspond to the utilitarian framework of the second class of buildings, i.e., the city skyscrapers." Fuller had in mind to combine forces for research, development, and marketing. "The final manufacturing of the product for market of mass goods and the preparation of a considerable market for the 'utility chassis' for various price classes. The mass production of 'utility cabinets' with a market not just for the small one-family house of the third class but also of the first and second class of buildings."

Fuller began with the technical core for the buildings, the supporting structure and the units of the systems for provisions. Independently of the class of building, he looked to industrial mass production for these things. Elsewhere, he developed the idea of gradations of prefabrication and so he divided the houses into four categories, from A to D. Class A contained only the delivered "chassis"; B also contained additional installations; C is delivered finished; and D also contains the complete fixtures, including furnishings. Class D is intended for the "well-paid worker." Four months later, the 4D house would develop out of it, and a year later the Dymaxion House.

He concerned himself first with "chassis construction." The precursors or points of reference for it can be seen in the drawing "Lightful Houses," from February 1928, in a typology of towers that spans the globe. Fuller's "chassis" was based especially on the airship landing pylon that appears on the sheet pointing downward. This pylon was first developed by the British airship and airplane designer Barnes Wallis during World War I. Fuller selected its three-legged, tetrahedral form for his chassis construction. He describes its features as follows:



"The Benefits of 'Chassis' Construction": The basic idea of the construction is that all elements shall be suspended from above rather than rest upon support from below.

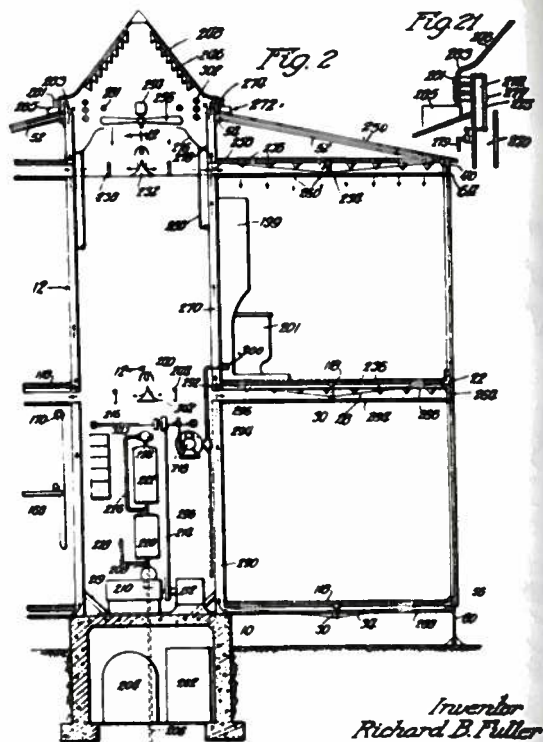
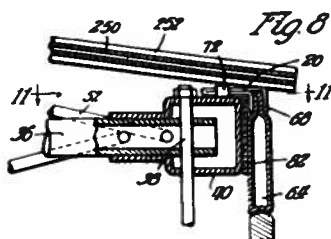
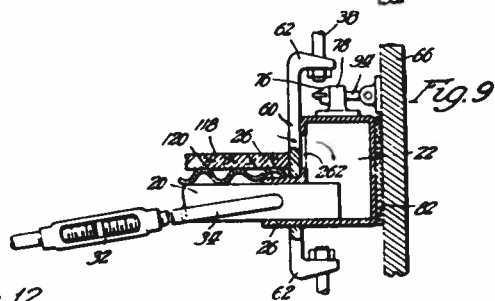
In a small house a central mast of reinforced concrete or steel will envoy trusses which will intersect at such an angel that their extremities will mark the four corners of the body of the house. The guy cables for this mast will run down through the partitions so as to be invisible, and the mast itself can readily be marked in a similar manner. From mast and trusses will depend walls, floor and all other elements of the construction.

The bearing load of the outer wall will be eliminated. Thick walls of brick or stone will not be needed. The wall of the house, instead of serving the double function of a protection from the natural elements and a support for the upper stories, will become merely a jacket for protection purposes, insulating the living quarters from rain, wind, heat and cold, fire and frost.

This concept was developed while Fuller was already hiring someone to complete the drawings for a patent application.

• YPS: Discourse: "Lightful Houses"

Fig. 12

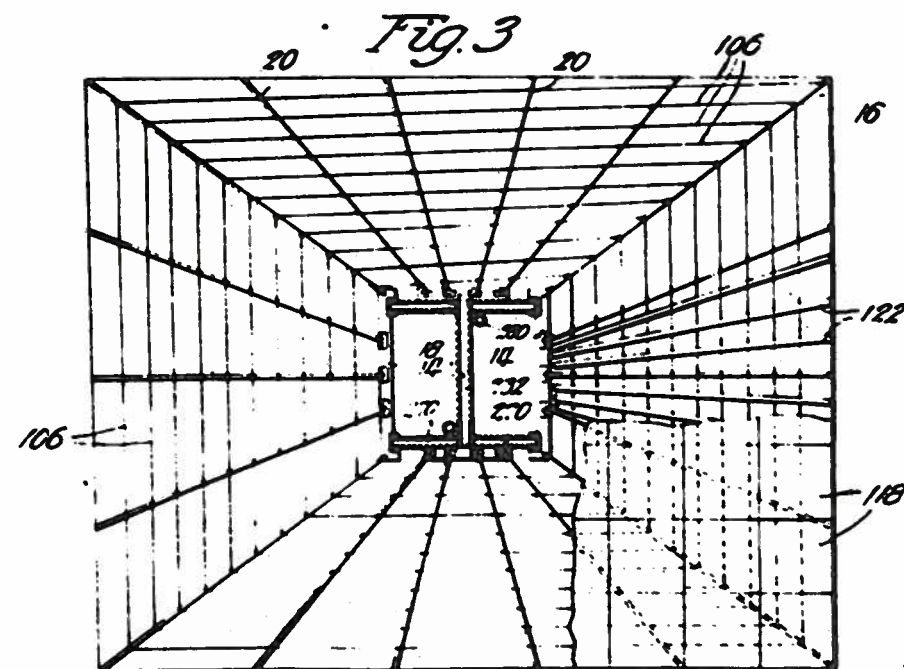
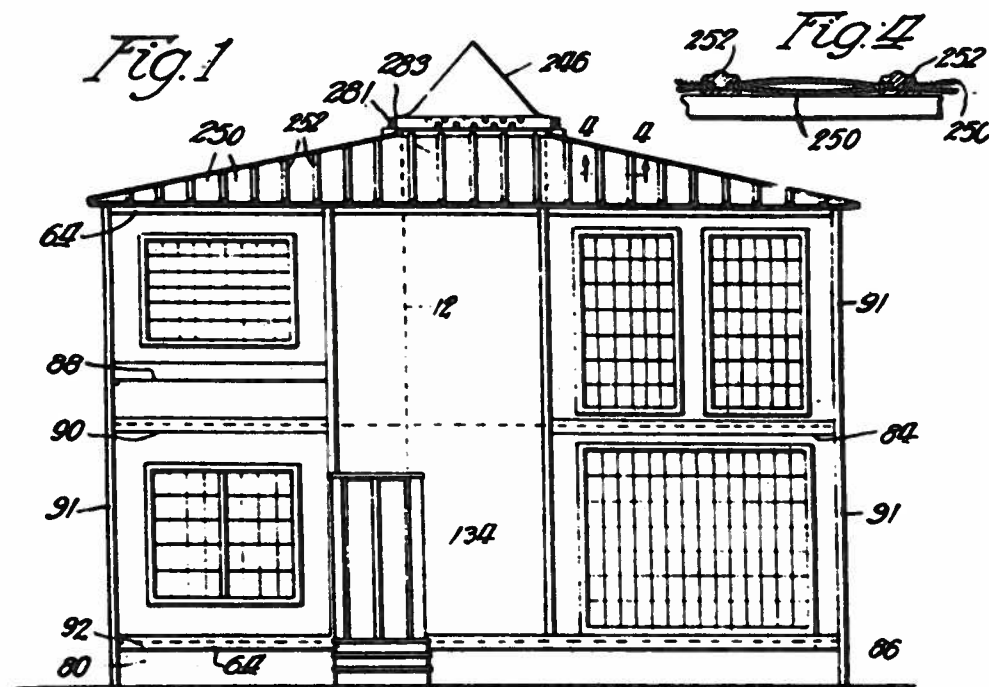


Inventor
Richard B. Fuller

By Emory, Bostell, Janney & Harney Attys

4D Patent Application

The drawings for the hoped-for patent are from spring 1928. By the time they were completed, in late March or early April, they were already superseded by the development of the chassis concept. Fuller was still thinking of a rectangular floor plan. The central supporting shaft can be seen clearly, but the drawing does not yet represent the system of stays seen in the later version of the concept, but is rather a cantilever construction that was also seen in the early sketches. Fuller later referred to these drawings, especially the rectangular floor plan, as a pragmatic compromise to make the 4D House seem less shockingly new. In reality, they are evidence of the dynamics of the design process in which a series of momentous decisions about the plan followed one another in just a few weeks. The main difference between the rectangular and hexagonal floor plan is that the former does not allow the forces to abate symmetrically, and so it requires cantilever arms in the diagonals of the rectangle, i.e., in two different corners. The center symmetry of the hexagon, by contrast, achieves equality on all sides. There is extensive correspondence on the content of the patent. Fuller was not able to obtain binding patents on the ideas visualized in the drawings, so he withdrew his application. Surely he did this thinking that the other, later innovations also deserved to be included in an updated patent application.

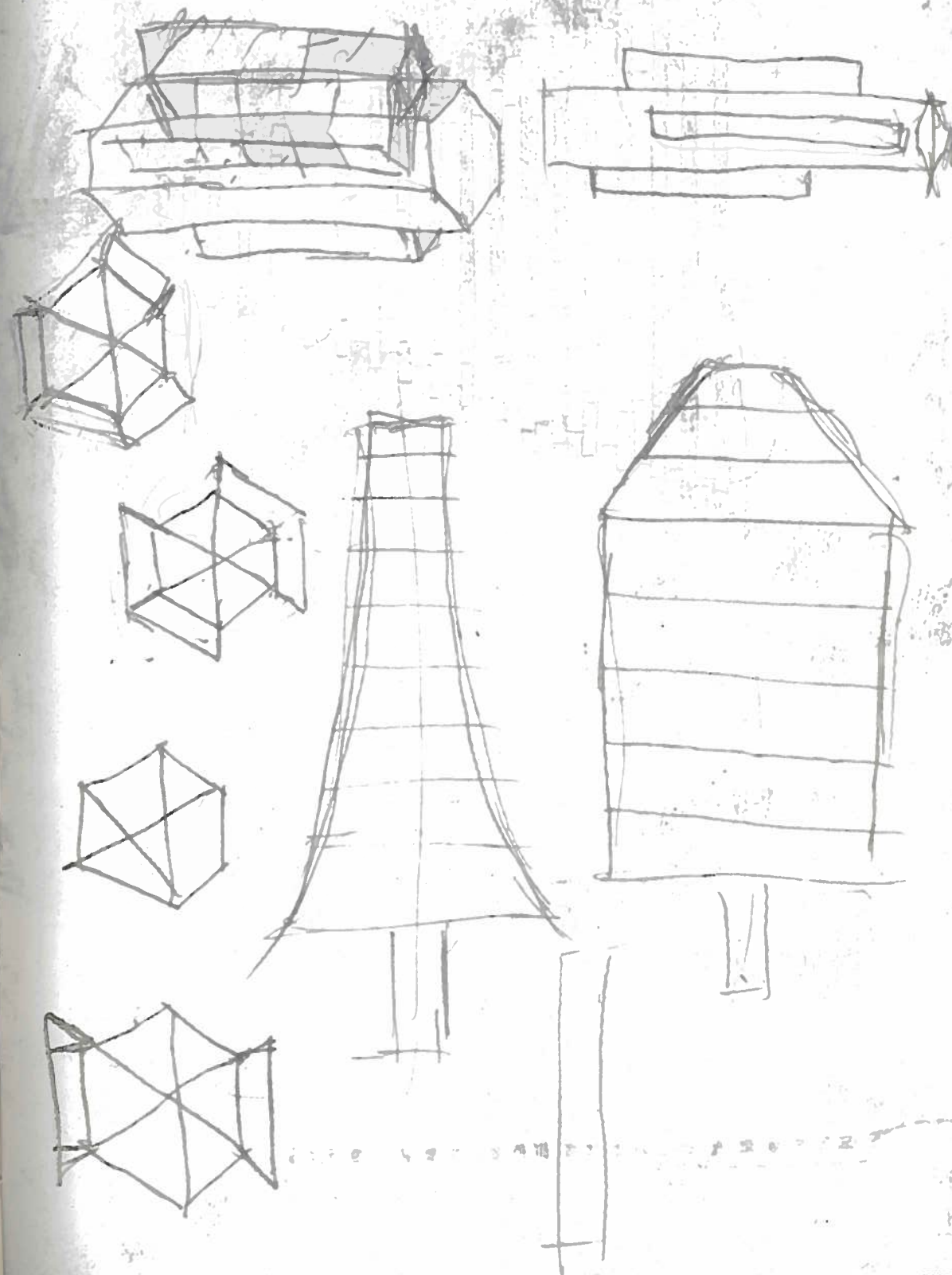
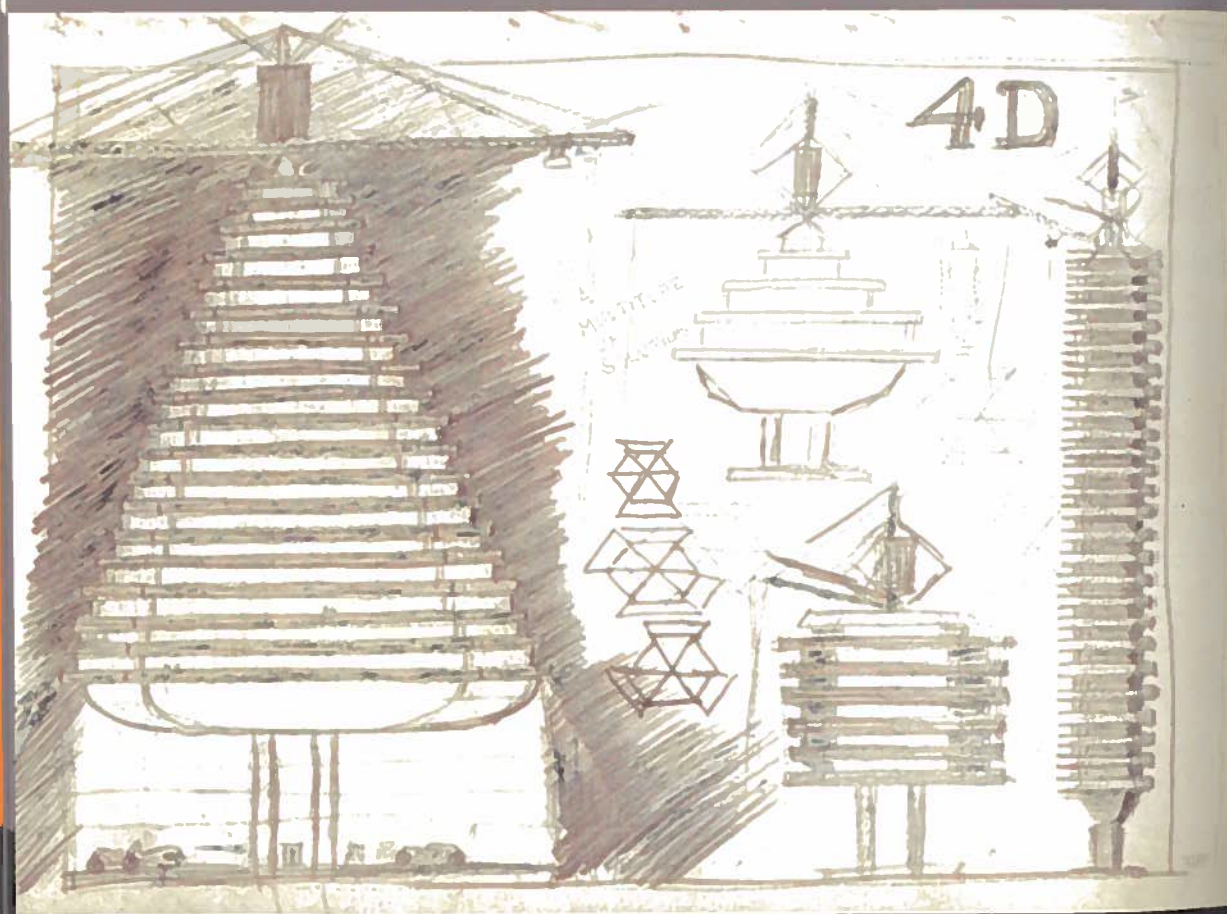


Inventor
Richard B. Fuller

By Emory, Bostell, Janney & Harney Attys

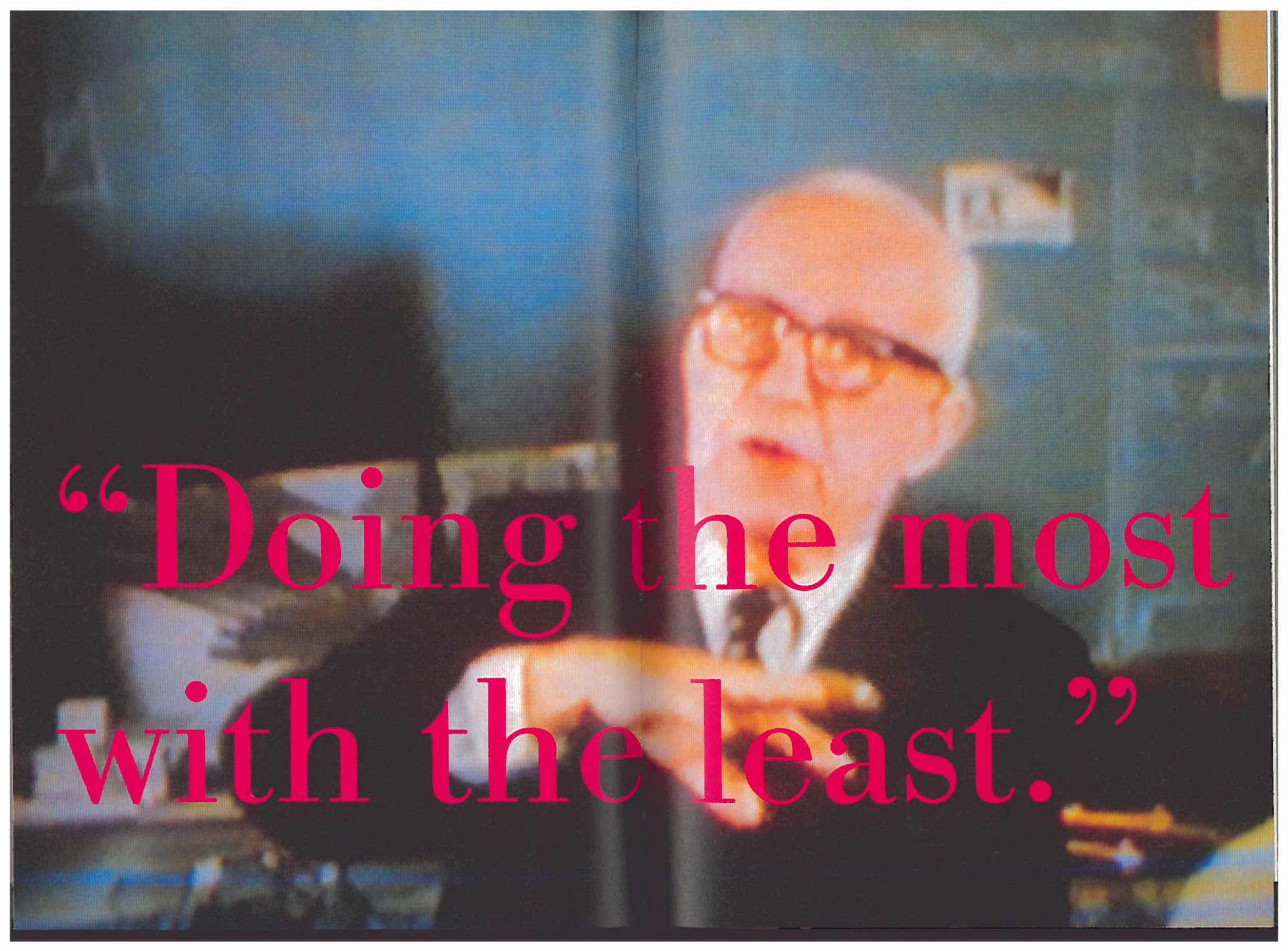
On the Evolution of Tower Construction

At first, Fuller did not in any way take it for granted that the supporting structure of the 4D towers had to be a hanging construction. Sketches from the early planning stage show the initially uncertain exploration of hexagonal symmetry (p. 91) – i.e., a property of crystals – and the criterion of a cross-section that tapers off as it moves from the bottom to the top – i.e., the principle of the world of plants. On this side, the sheet documents the attempt to find a synthesis of both these principles: The drawings depict various types of towers, short and tall, slim and compact. It seems more likely that Fuller was thinking of phases of the construction process. The integrated construction crane that sticks out on either side is to install the hexagonal floors of either equal or varying size. The tower results out of this stratification, in which the lowest floor nevertheless lies well above the ground on an enormous construction of props. On the right is a sketch of a variant using equal-size floors. It seems that Fuller viewed the core of the building as a shaft that was continually being driven upward, and upon which the beams of the crane could climb as the floors are built in succession.

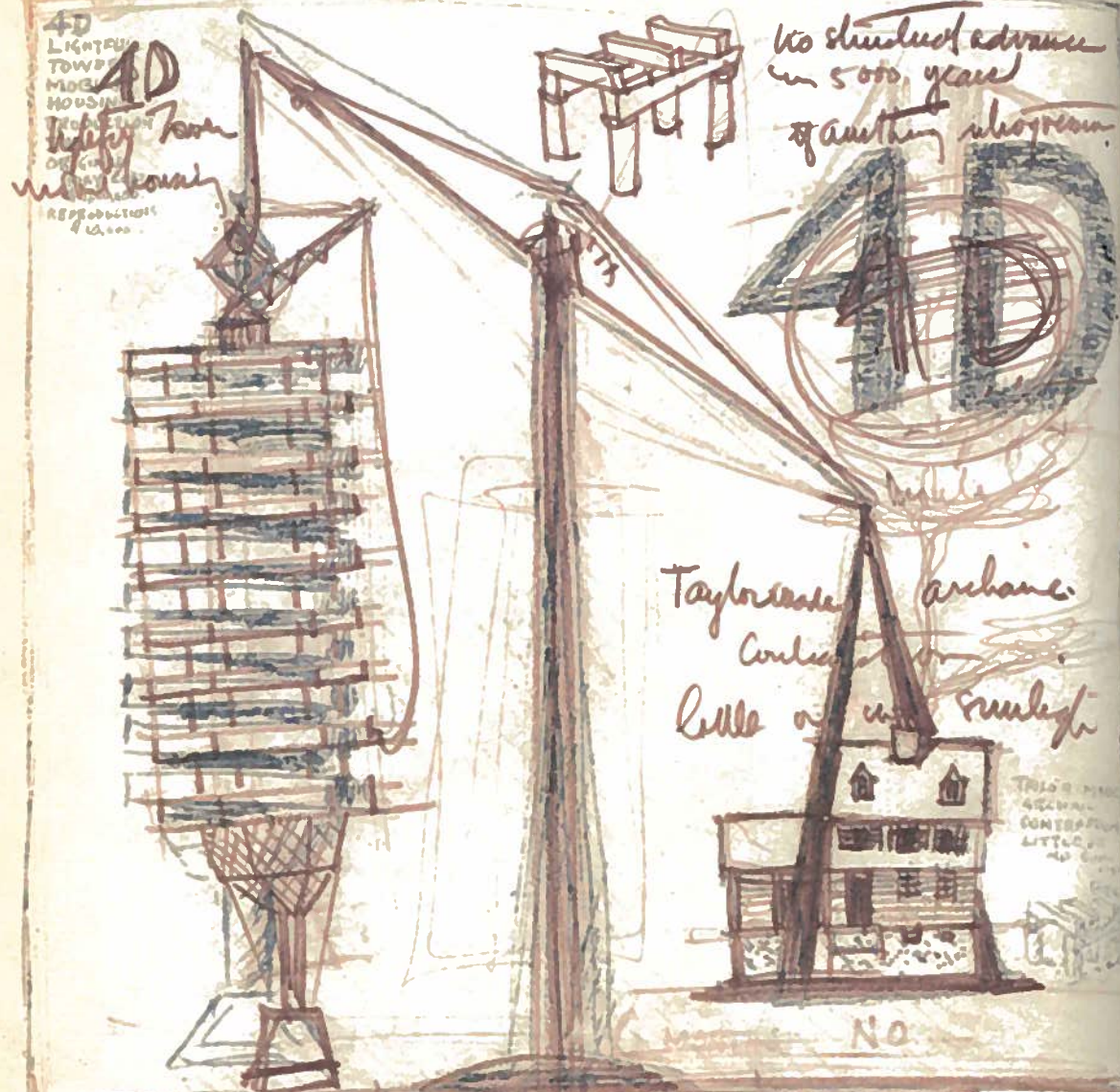


41. 4D tower houses: development of the tower typology and morphology, early 1928. Transition to hexagonal floor plan. Integrated assembly crane.

46/47. The new versus the old programmatic sketch. The effect of a house's weight is visualized. Early 1928.



“Doing the most
with the least.”

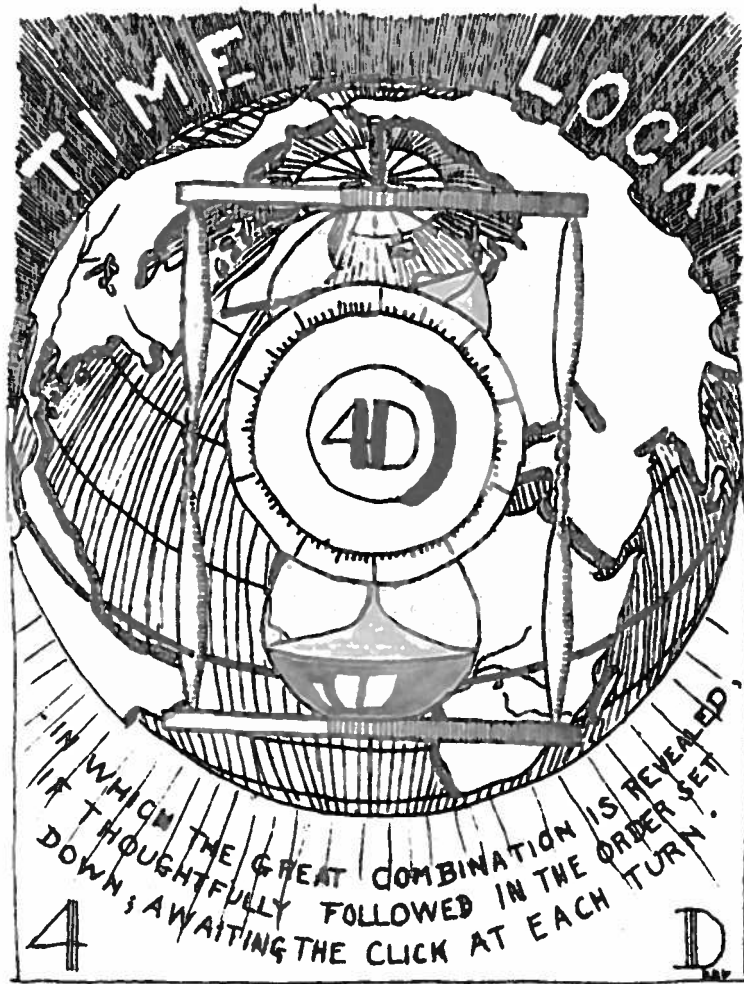


TIME TO ERECT — 1 DAY — 6 MONTHS
FIREPLACE — YES — NO
OPERATING COST — 1 — 10

NO STRUCTURAL
ADVANCE IN
5000 YEARS
(IE ANYTHING R. T. TAYLOR)

COMPLETELY INDEPENDENT POWER
LIGHT, HEAT, SEWAGE DISPOSAL, ETC.
12 DECKS AVERAGE 60' x 90' FT.
ALL IN AIR ABOVE DECK AREA ETC.
ALL FURNITURE BUILT IN, SWIMMING
POOL, GYMNASIUM, etc.
no floor & land area as a port.

Tied up to city sewerage system
the coal, coal company — THE UTILITY
the power, etc.
12 rooms, etc.
all built on ground, each part a unit.
no maintenance, etc. in less than 100 years
the furniture, including, the house, land.



26% of earth's surface is dry land.
 85% of all earth's dry land is here shown.
 86% of all dry land shown is above
 equator.

The whole of the human family could
 stand on Bermuda.

All crowded into England they would
 have 150 sq. feet each.

"United we stand, divided we fall"
 is correct mentally and spiritually but
 falacious physically or materially.
 2000 000 000 new homes will be
 required in next 80 years.



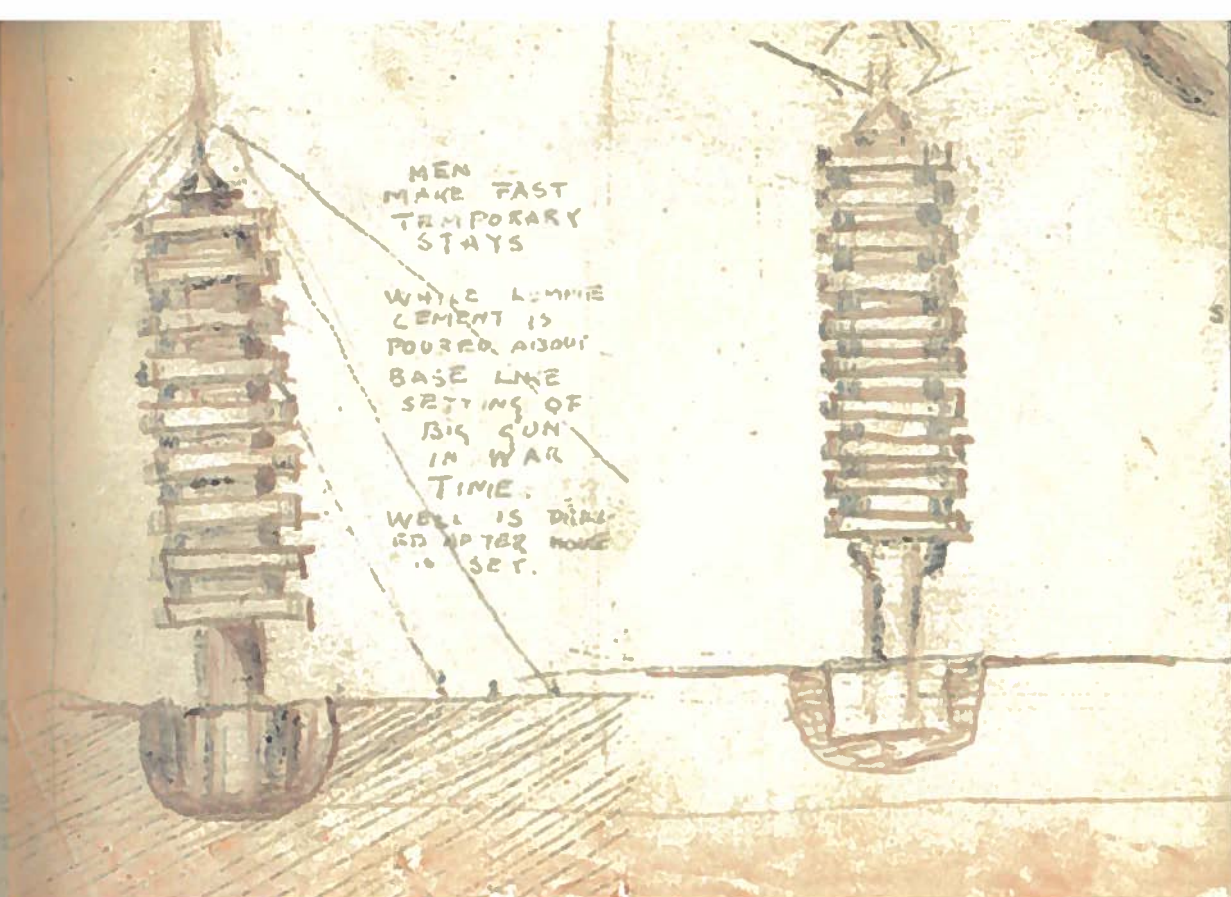


ANCHOR OUT

THE BOMB
IS DROPPED.

VIEW OF THE SHELL CRATER
AND ANCHORED ZEP. FROM A BO
HOUSE BEING MANOEUVRED IN
POSITION.





Comics (Funnies Philosophy)

"Undeniably the 'funnies' are at the most generally inspected portions of our daily newspapers, and may be considered the economic frosting that sells the cake. It is more than significant that these funnies have completely lost race of 'slapstick' and have become serials of handy philosophy. The laughs are being turned on self and improve proportions of life, its pleasures and necessities."

"World Design Initiative" (Mexico Lecture, 1963), in: WDSO: 2 (1964), 63

Dirigible

"In 1927 I gave myself a theoretical problem which turned out to be feasible in high performance per pound engineering. I gave myself the problem of delivering large structures by air. Why? We can assemble large structures under preferred environmental and mechanical conditions as for instance we build airplanes at high advantage in the controlled environments within a factory and with a galaxy of efficiently arranged jigs, fixtures, templates and powerful tools. I can deliver an ocean ship from the 'ways' into the sea with ease and without obstructions. There is nothing to obstruct the ship; I can deliver an airplane into the sky, nothing to obstruct it; but if I try to make large buildings in a factory and try to deliver them over highways or railways, they will run into highway or railway tunnels and bridges which are too small for

their passage. These holes through mountains occurred because of man's having to transport heavy loads overland at almost level grades pulled only by friction-overcoming locomotives. To accommodate the latter man punched holes through mountains etc. Therefore in 1927 I thought of the idea of trying to deliver large structures by air to be above all obstacles.

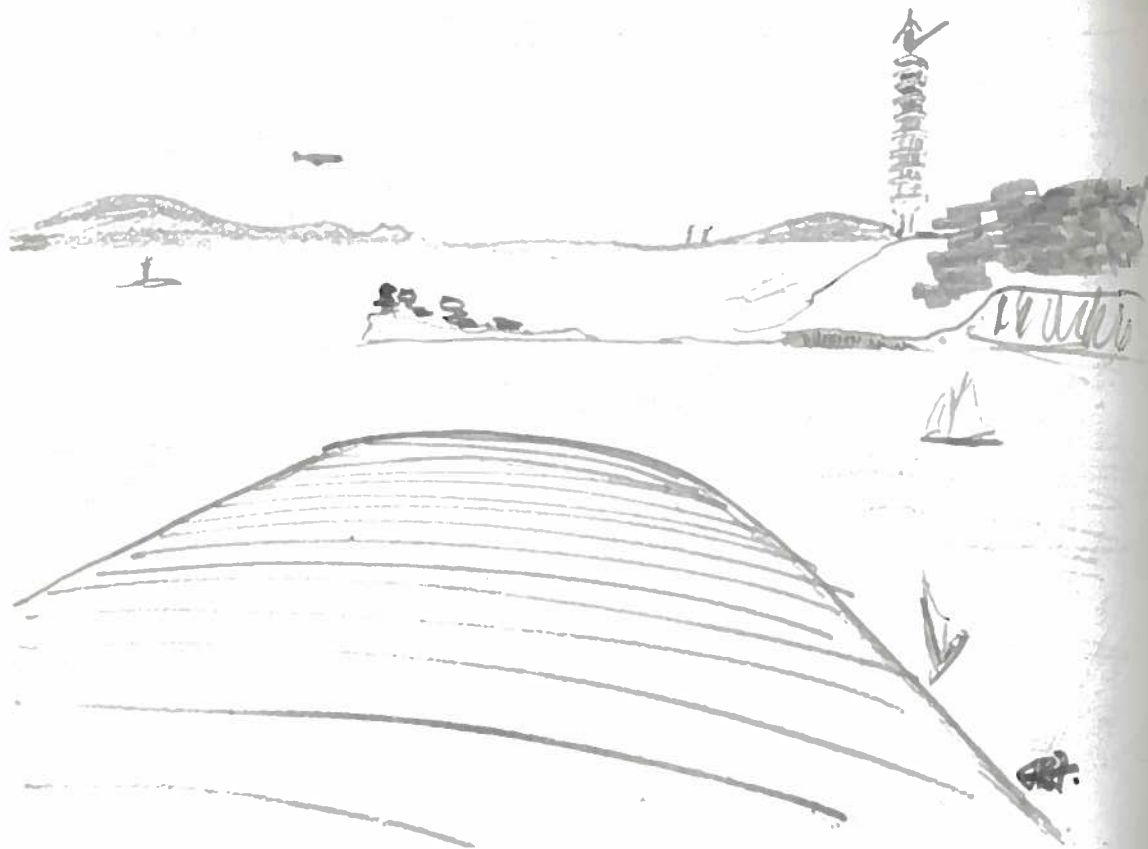
Therefore I gave myself a problem in 1927 of delivering a ten-deck apartment building to the north pole, during the arctic summer. In designing my ten-deck apartment I used the wire wheel principle. The wire wheel is a tensegrity structure because the island of compression in the hub is completely islanded from the compressional 'atoll', - the rim. These two compressional areas are cohered in stability by the minimum of twelve tensional spokes. I found I could make a ten-deck building so light that it could be carried by the Graf Zeppelin, suspended horizontally under the Zeppelin's belly. The Graf, upon reaching the arctic site, could drop a bomb, make a crater, lower the building into the crater, plant it like a tree and fly back home leaving the building occupied. I saw that all this was feasible even though in reality I would not be enabled to use the Graf Zeppelin and even though I would not have, for another quarter of a century to come. The necessary high weight-strength alloys which I had assumed to be available by 1952 in making my 1927 calculations."

4D Time Lock (1928/1972), 1

THE SKY
HOLE RACE
PLANTING
TREE



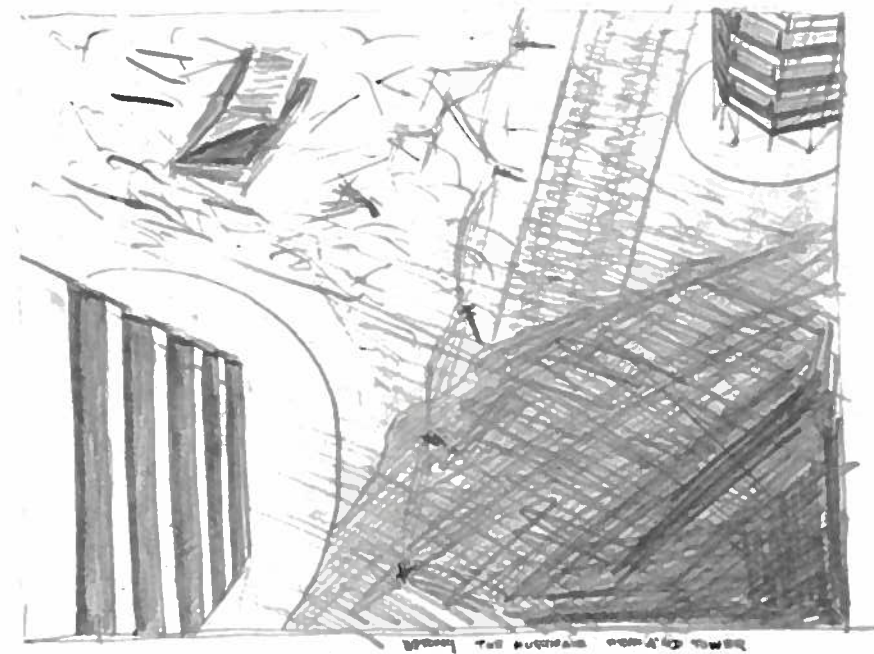
12
R. B. Fuller



Buckminster Fuller's 1928 Prophecy

"There will come a time when in our individualistic harmonious state all work will consist of thinking and crystalizing thought into sound or directionable spheres which will set in motion machinery or controled fourth dimensional design. In our individual homes no matter where we may be we can speak into our combination radio-telephonic-recording-dictator recording our commands graphically (word or picture) to our machines which will involve only real thinking and study of statistics by the directors of industries machines. The rest of the world will be free to do what it wishes so long as it is truthful, harmonious, unselfish. The stock markets will grow vastly and attain more and more machine practice and eventually will be the voting place rather than in politics. People then will survive through not being lazy and through constant consideration of what the rest of the world is doing and by recording their votes by way of purchase or sale of shares of industry. They will have to vote then or they will starve. As long as they play the game they will have most of the time to themselves for harmonic creation in art, philosophy etc. or science which will become an art when we have properly analyzed the fourth dimension which has already been researched. As we save time we increase our speed and we compass the world faster the world being of a fixed fourth dimension and humans with the power to board any dimensional unit by proper control of it. This is relativity."

"Lightful Houses", manuscript (1928), 27 (-> YPS: Discourse)

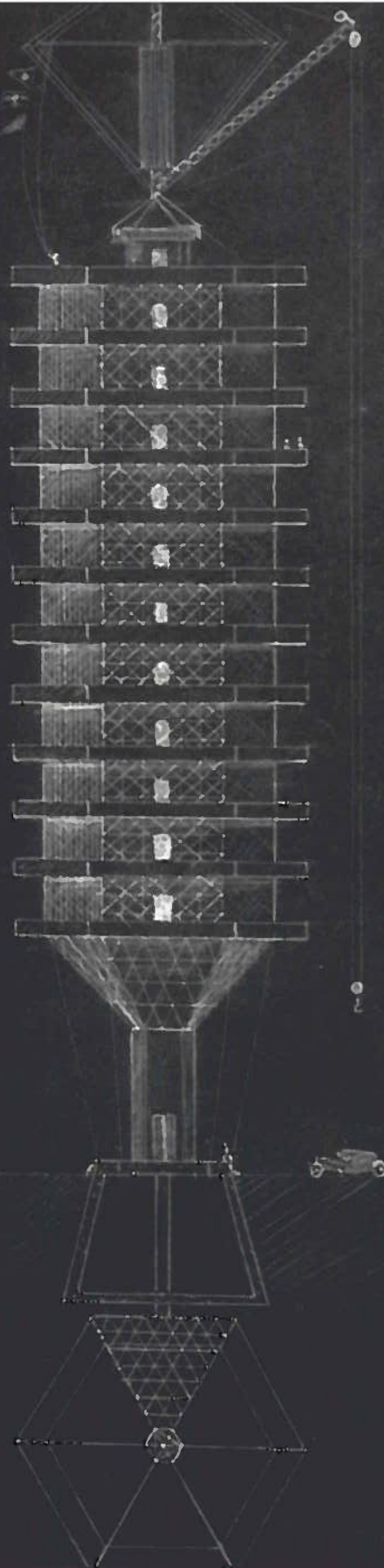


"Ferro-concrete architecture may be likened unto the plastic cocoon of the archaic worm from which will emerge the 4D butterfly."

4D correspondence, letter to his sister Rosamund Fuller, August 1928, in: 4D Time Lock (1928/1972), 78

4D

MODEL
Y T
12 PLANE



AIRPLANE 500
RADIO
FLYING AIR
MIL
POWER - 1000
WATT

- 1 SKY - PEDESTAL
- 2 POWER RADIO
- 3 GULF OF MEX
- 4 STORAGE
- 5 LIVING ROOM
- 6 " "
- 7 " "
- 8 KITCHEN
- 9 HOSPITAL SERV
- 10 GYMNASIUM
- 11 DINING PLAT
- 12 PORCH

THIS MODEL
ANALOGOUS
TO FORD
AUTO IN
AUTOMOBILE
INDUSTRY.

THIS DESIGN
TO SHOW
CABLE LOADS

UTILITY UNITS,
AND EXTERIOR
SHELL REMOVED
ALSO ALL
PARTITIONING

SEE PATENT
DRAWINGS FOR WIRE
WOOD FLOORS

TOWER AND ELEVATOR
AND ARTERIAL SYSTEM
HAVE BEEN CLOSED
IN BY HANGING 16
EQUILATERAL TRIANGULAR
PLATES.

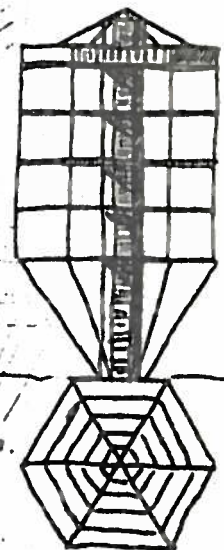
4D

MODEL
5 T-97

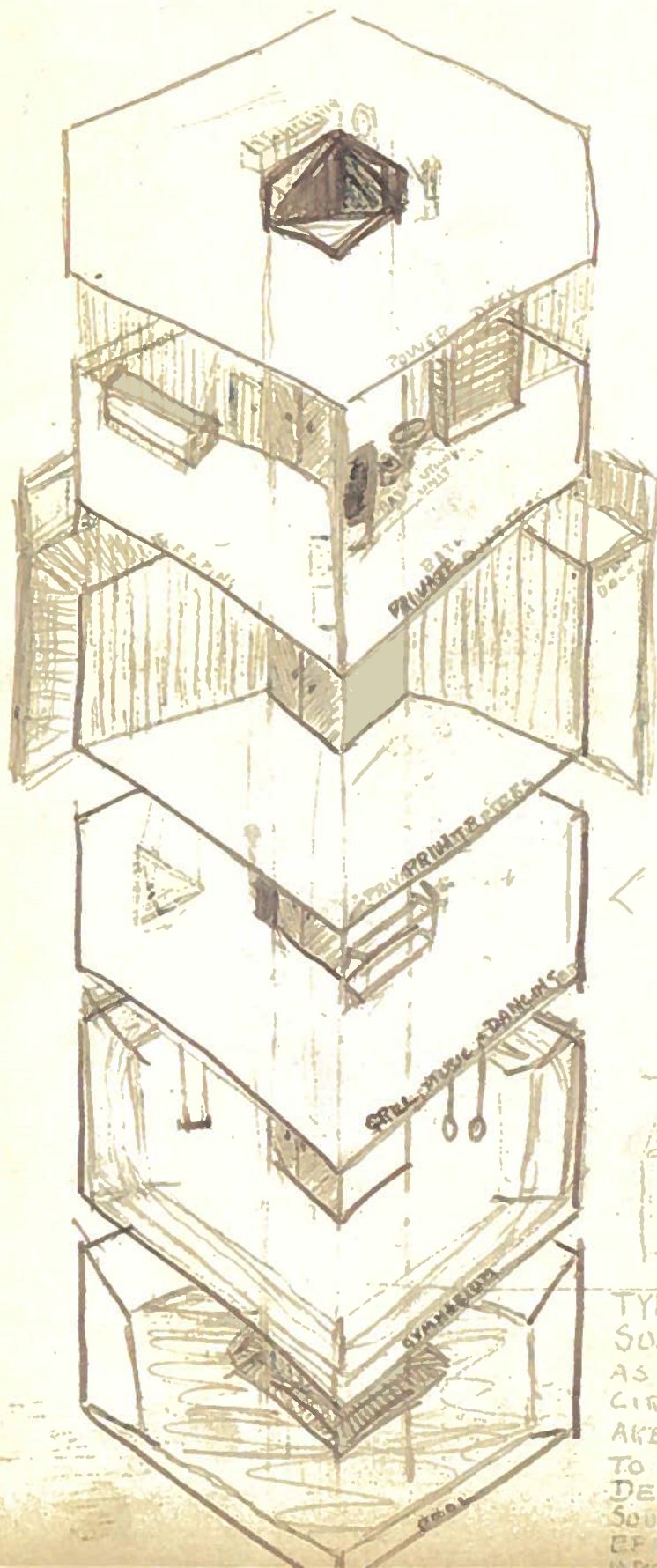
10 METERS
HIGH - 10
METERS DIAM.

BIRDS-EYE PROSPECTIVE.

R.D. FULLER.



103 The transition from the tower enclosed by cast-iron
balcony galleries to pure suspension, 1923.
Specified rail of measure one meter.



40

TRIANGULAR ELEVATOR
CONSTRUCTED WITH 40
PRINCIPLES
USE METAL FOR
FIGURE 172
TENSION
COMPRESSION

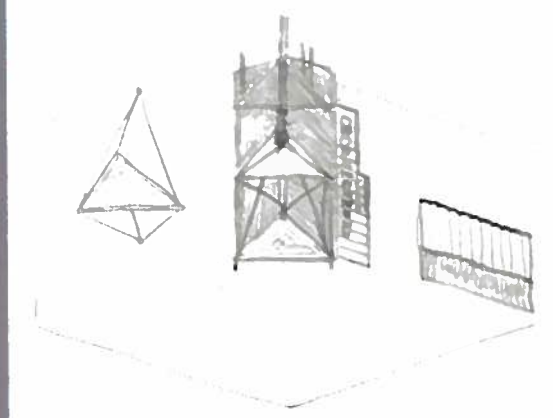
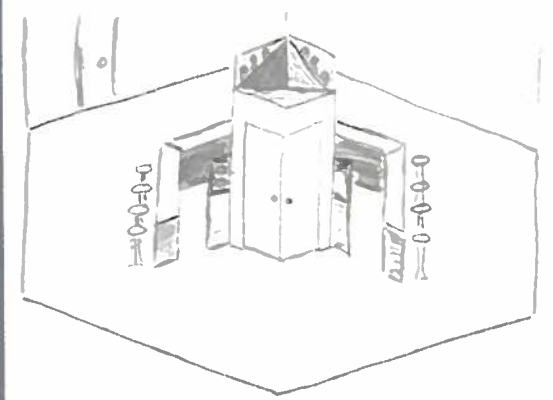
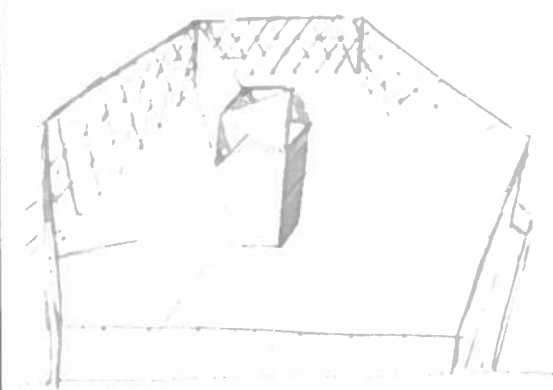
SEE
PATTERNS
FOR
AIR +
LIGHT +
HEAVY
CROSS HANGING
TRIPLE FOLD
TRILL CHANGE OUT
OF WAY



TYPICAL 40 INTERIOR
SOLUTION SKETCH
AS ABOARD SHIP THE
CIRCULATION DIRECTIONS
ARE SO SIMPLE AS
TO PROVIDE ENTIRE
DETAIL, COORDINATE
SOUND AND OTHER
EFFECTS IN NO WISE

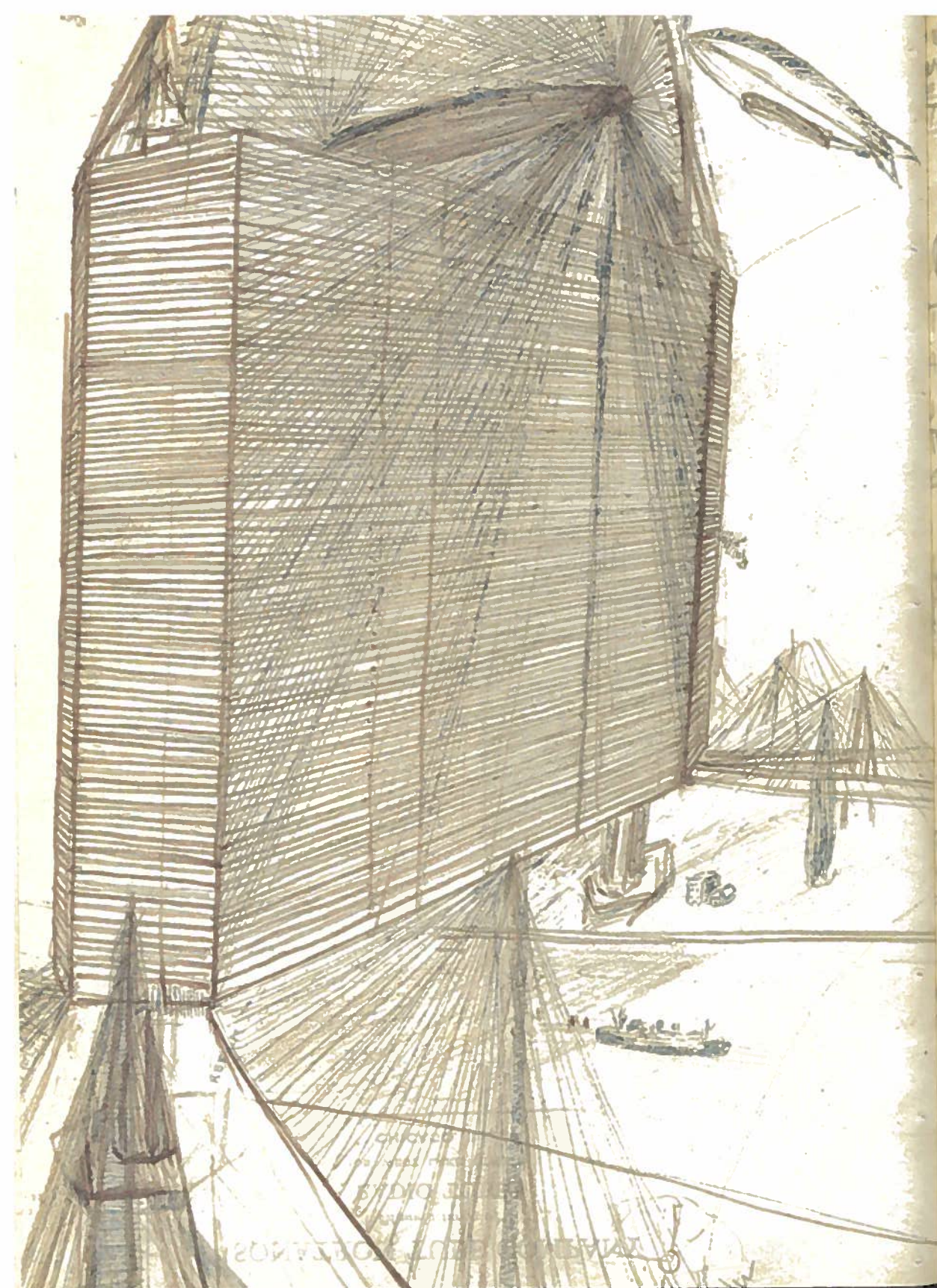
"A room should not be fixed, should not create a static mood, but should lend itself to change so that its occupants may play upon it as they would upon a piano."

"Romany Marie's" in: *Chronicle* 36/1929



These sketches were made in late 1928, probably in connection with Fuller's designs for the Romany Marie Tavern (see p. 154). The later *Dymaxion House* was for Fuller a minimal house. His idea, however, was also intended for multistory houses with floors designed for various functions. Here, the swimming pool is on the lowest level, above it is a space for gymnastics, then a bar, and finally two floors marked "private" with pneumatic and suspended furniture.

171 Hexagonal floor plan; elevator with triangular cage provides access to floors; each with different uses: swimming pool, gymnasium, bar, living area. Drawn in late 1928



112. Combination of suspension bridge and office building. Attempt to synthesize Roebling's Brooklyn Bridge and Park West, 1928

PERFECTION THAT CITIES
WOULD NEVER BE ABLE TO
PERMIT THAT IS WHY WE
START WITH COUNTRY WORK.

SELF
PARKING
KEEP ON UP
TILL YOU FIND
SPACE.
UP & DOWN
RAMP'S NEVER
CROSS



PLAN
SHOWING
TOWER
SUPPORT &
ELEVATOR
WHEELS
FOR
PARKING
OR
LOWER
FLOORS
TO
TOP.



FULLER
4D
TOWER

GARAGE
SEPARATE
RAMP'S UP
AND DOWN.
CENTRAL
TOWER SUPPORT
AND HOUSES
ELEVATOR
TO AND FROM
CARS.

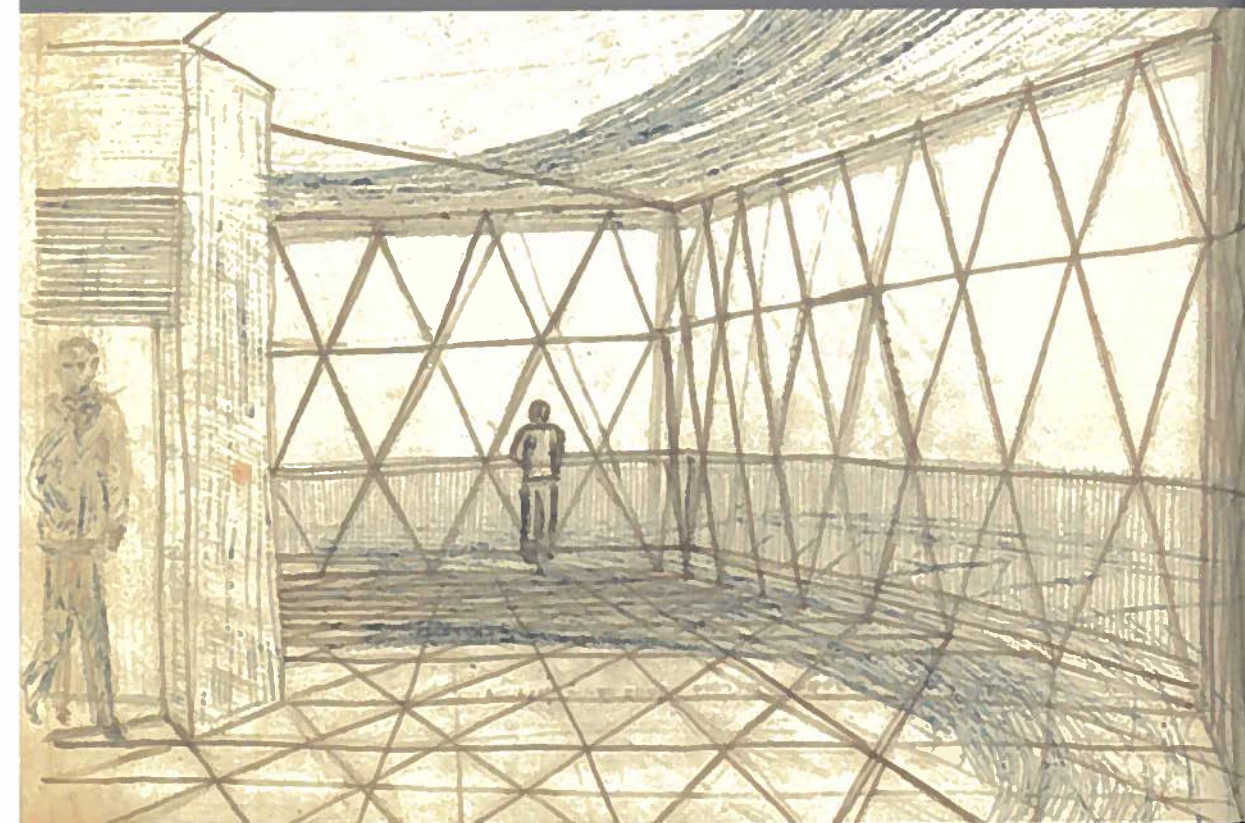
FENCE ALONG
BOTTOM TOLL
HOUSE.
FLOORS
SUPPORTED
BY CABLES.
COULD BE
MADE
100 DECK
HIGH
AND BE
COLORFUL
BEAUTIFUL

113. Proposal for the 1933 World's Fair in Chicago (A Century of Progress). 50 Tower as an auto garage.

(Compare to Phil Nelson's Edison suspension, Paris 1904; Frank Lloyd Wright among other designs, Tugendhat Museum, 1929; Norman Foster's Dome of the Reichstag, Berlin 1999)

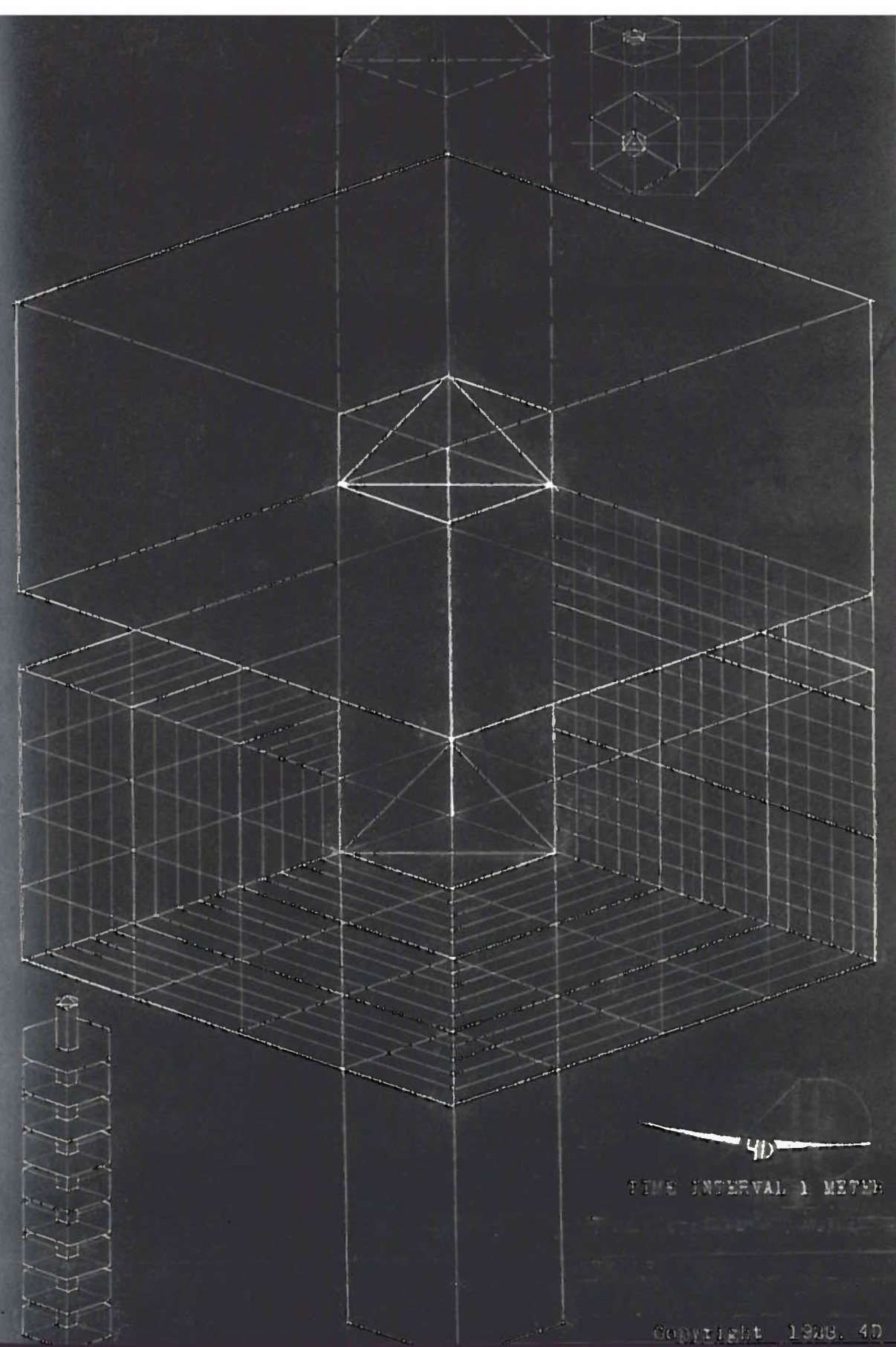
“The basic idea of the construction is that all elements shall be suspended from above rather than rest upon supports from below.”

“Lightful Houses”, manuscript (1928), 13



114 Time-based plan of the 4D House: triangulated floor and facade elements. “Time Interval 1 Meter”, measure

of length understood as a measure of time away from the central axis; sketch 1928.



4D
TIME INTERVAL 1 METER

COPYRIGHT 1928. 4D

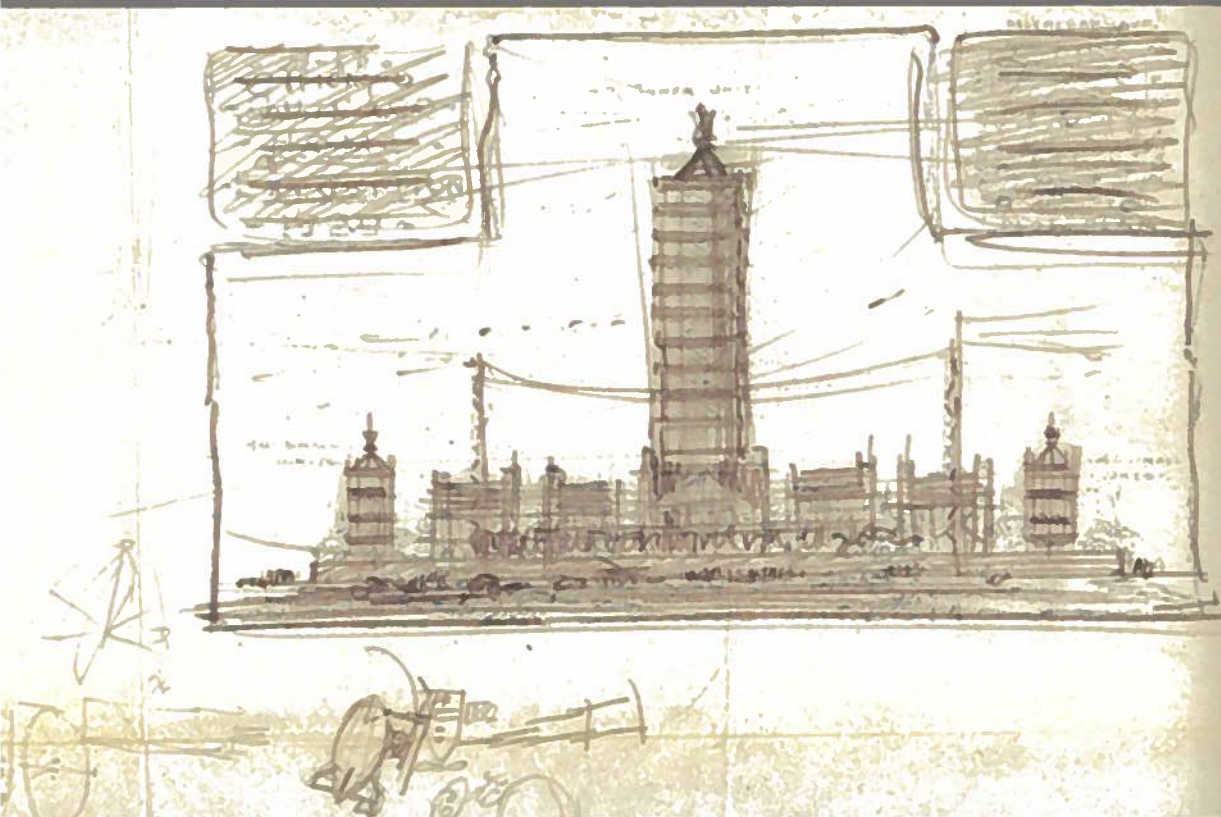
Ephemerization

"There will be of course opposition by such of the interests to whom progress seems to spell disaster. For instance, just as 'one track' or confined transportation of railroad or trolley is being supplanted to trackless bus, auto and airplane; and wire or fixed line communication is being replaced by wireless broadcasting, so will steam pipes, electrical wires, etc. in the home be supplanted in the new house by indirect central broadcasting systems. This will be stubbornly opposed by vested interests in conduit, etc."

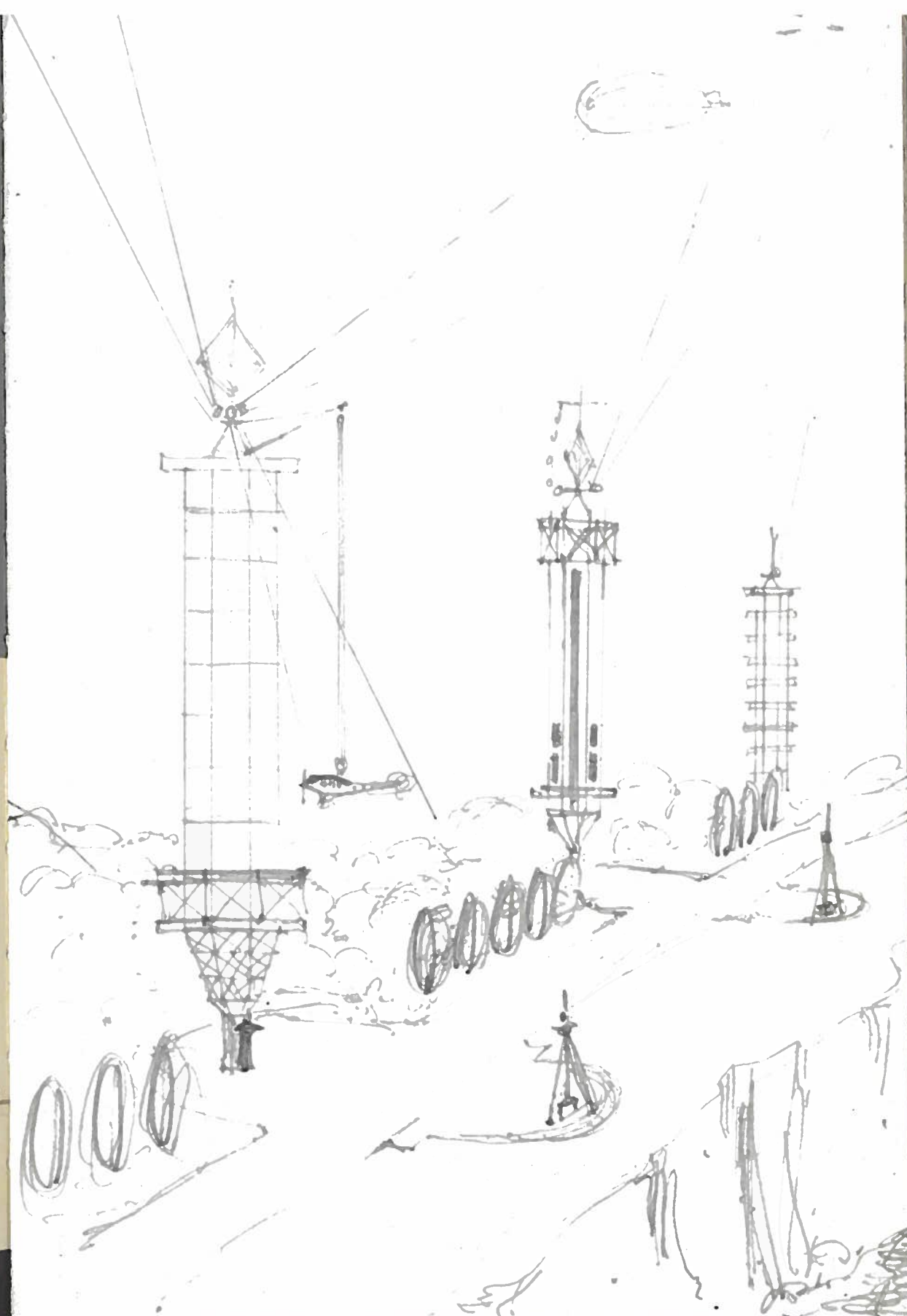
4D Time Lock (1928/1972), 5

"We are concerned with
mooring first class habitation
to the earth's surface."

Designing a New Industry (1946), 30



198 Chicago, sketch, end of 1923
or early in 1924

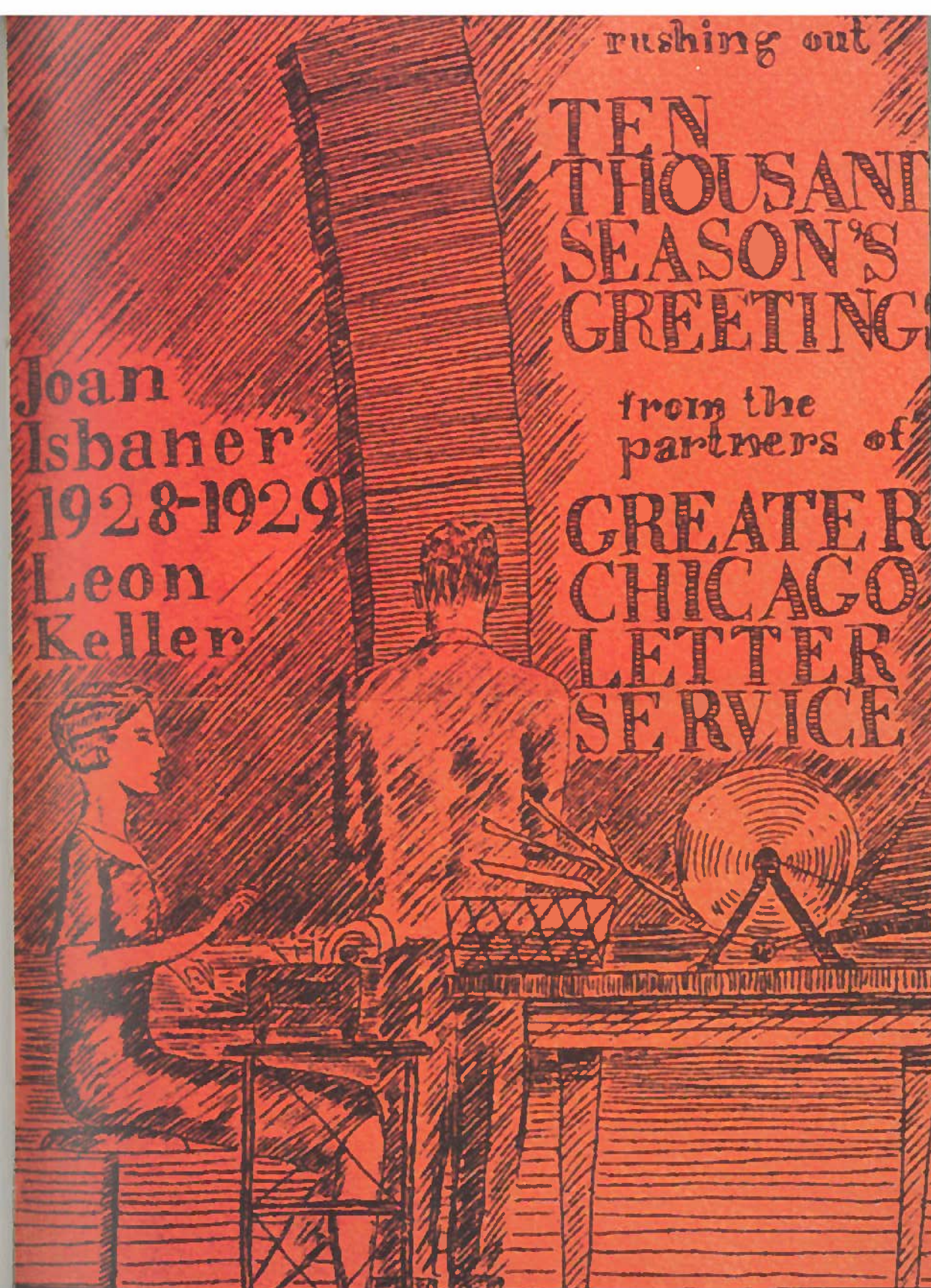


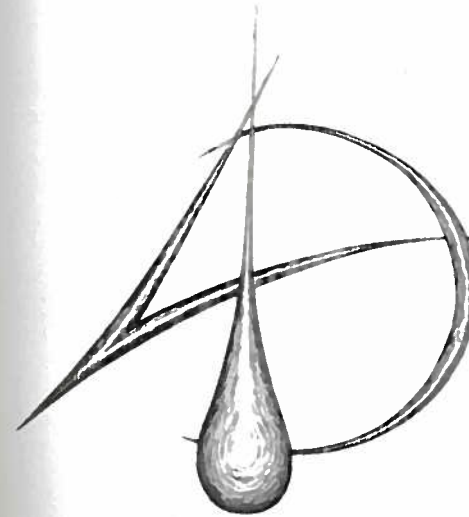
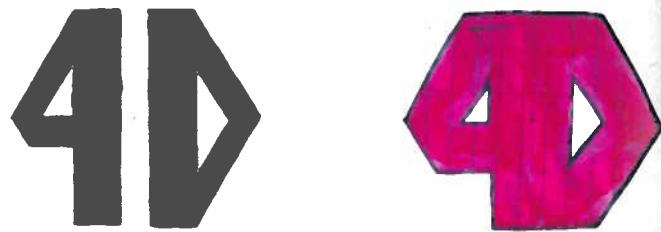
50 Towers, communicating by radio. Drawing presumably
by Fuller's coworker Lee Atwood, 1923 or 1924

On Mimeographing

Synchronously with the development of his industrial machine-wrought architecture, Buckminster Fuller has developed a new method of mimeographed drawing. To be found in almost any American office of size is the Mimeograph Machine. Its work has, as a rule, been confined to turning out something "cheap," - propaganda for the waste-basket. Mr. Fuller feels this is profoundly unjust to the machine. Instead of "going back" to woodcutting or etching to present an artistically reproducible composition, which is by nature limited in reproduction, he has developed a mimeograph-cut, which is very reasonable of realization. The 14 compositions shown in this exposition are typical of the proper field for mimeographing. It is in reality the field of multiple sketching - reproduction of useful sketches which one could ill afford to duplicate except on the mimeograph.

"Buckminster Fuller's Dymaxion House", in: *The Harvard Society for Contemporary Art*.
Leaflet, May 1929, text presumably written by RBF





Media and Publication Strategy

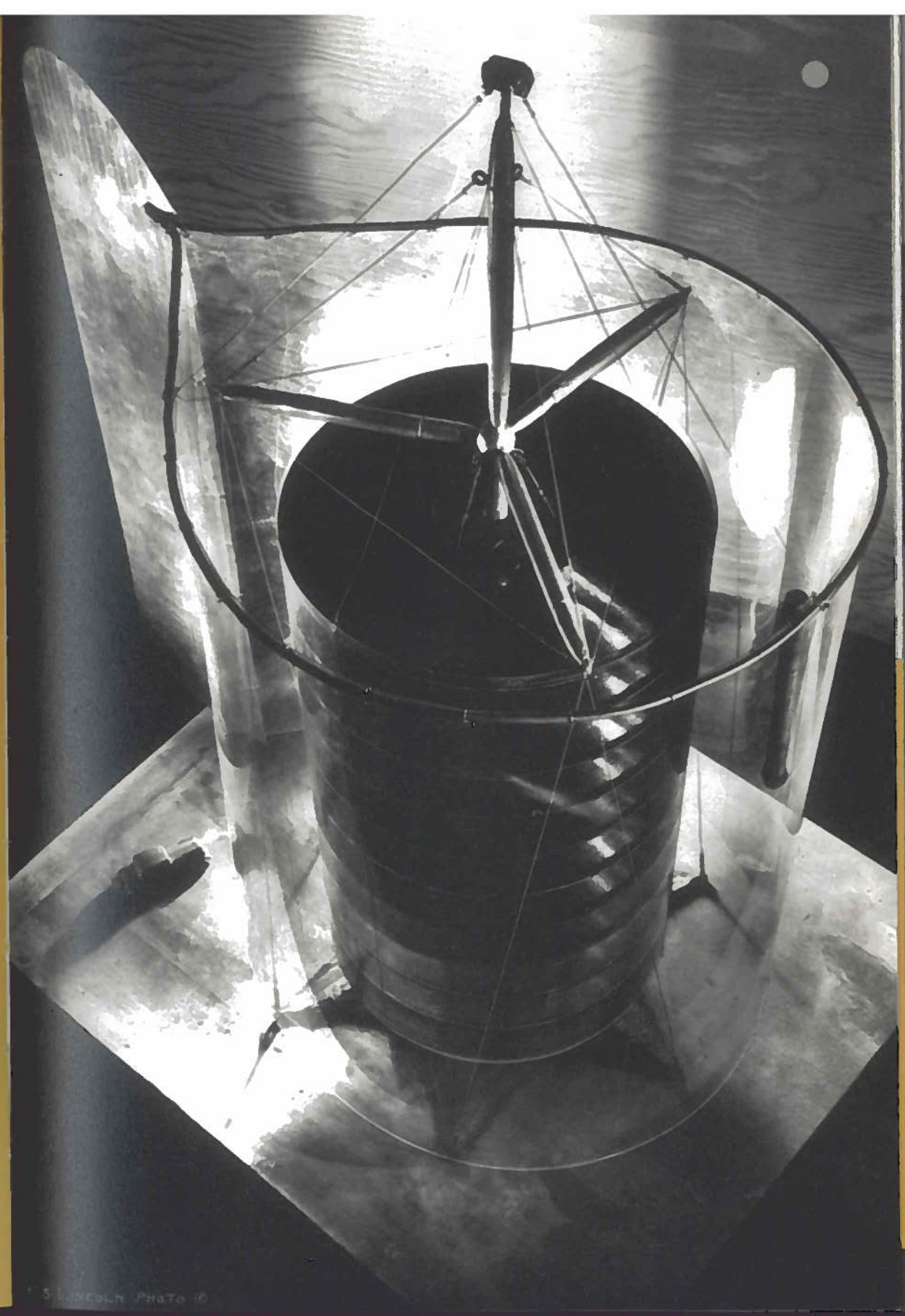
In order to disseminate his design philosophy, Fuller developed in 1928 an original publication strategy and forward-looking ideas about the use of modern media. Lacking money and unknown as a designer and author, Fuller developed a method using mimeographs, the cheapest means of reproduction available, to put his 4D manuscript and his other sketches into circulation in limited editions. Isbaner's Stationery and Copy Shop in Chicago helped him to do this. To express his thanks, he designed a New Year's card for the small shop to give its customers. Fuller sent the printed 4D books to family members, friends, acquaintances, and prominent members of society and their intermediaries. In this way, he hoped to make his multifaceted manuscript familiar to Henry Ford, Bertrand Russell, Le Corbusier, Christopher Morley, among others, but also to publishers, university presidents, manufacturers, and architects. According to American law at that time, copyright was binding when it could be shown that 200 copies had been received, which required proof that the addressee received it. On 30 July 1928, only 128 copies of the 4D book had been sent; only in 1929 did it reach 200 copies, so that Fuller obtained copyright for his book.

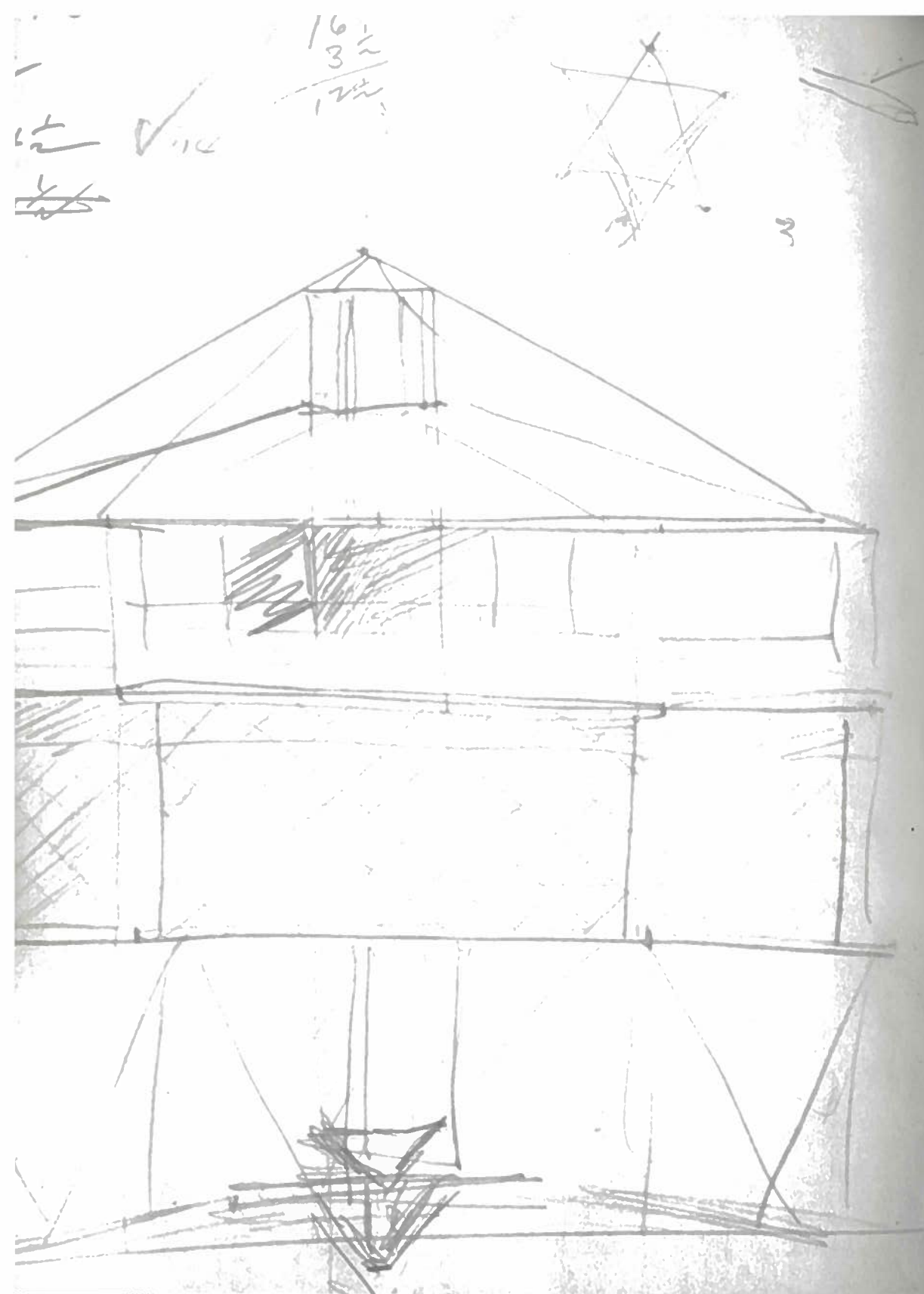
This procedure resulted in an extensive correspondence with the recipients, which Fuller published as a supplement to the text in later editions of the 4D book. The recipients themselves often exchanged letters that Fuller included in the growing collection if they related to 4D. The combination of the process of mimeographed copies and the correspondence used as an open letter results in something that in an editorial in the magazine "Shelter" Fuller would later call a "correlative medium." Everyone should be able to get involved with everyone else in intellectual exchange.

Beginning in 1928, Fuller always had an eye on the possibilities for a network of communications. His Conning Tower of 1932 was the prototype of a multimedia center. Ever since Lee de Forest's experiments during World War I with radio and radiotelephone, in which Fuller took part as a Navy officer, he knew that the roles of sender and receiver were technically interchangeable. In 1936, Fuller learned about the beginnings of television from Gilbert Seldes, who was running the first experimental studio for television in the USA. In the early sixties, Fuller predicted a future with two-way channels; in 1969, he was involved in a patent for a computer. In the same year, he wrote about embryos connected by telecommunications network, which did not want to come out of the womb until peace ruled on earth. It was the first generation that grew into the age of the PC and the Internet. And Fuller is, just as much as McLuhan, one of its mythologizers.

The publication of the Dymaxion House in 1929 made Fuller suddenly famous on the American architectural scene. The house was more uncompromising than anything that had come before it: a turn away from the orthogonal plan, hexagonal symmetry, a tripod supporting pole in the center from which cables stretch out to the decks – like spokes and rim from the hub of a wheel. Fuller conceived the floors as stretched piano wires with a pneumatic layer over them. The outer walls of vacuum casein elements are a non-load-bearing screen – opaque, transparent, or translucent. The rooms are lit indirectly by a system of mirror prisms. Fuller thought of the house not as private property but as something available long-term, a service product like a telephone. “Something New under the Sun” was Fuller’s title for the announcement of his lectures. How true!

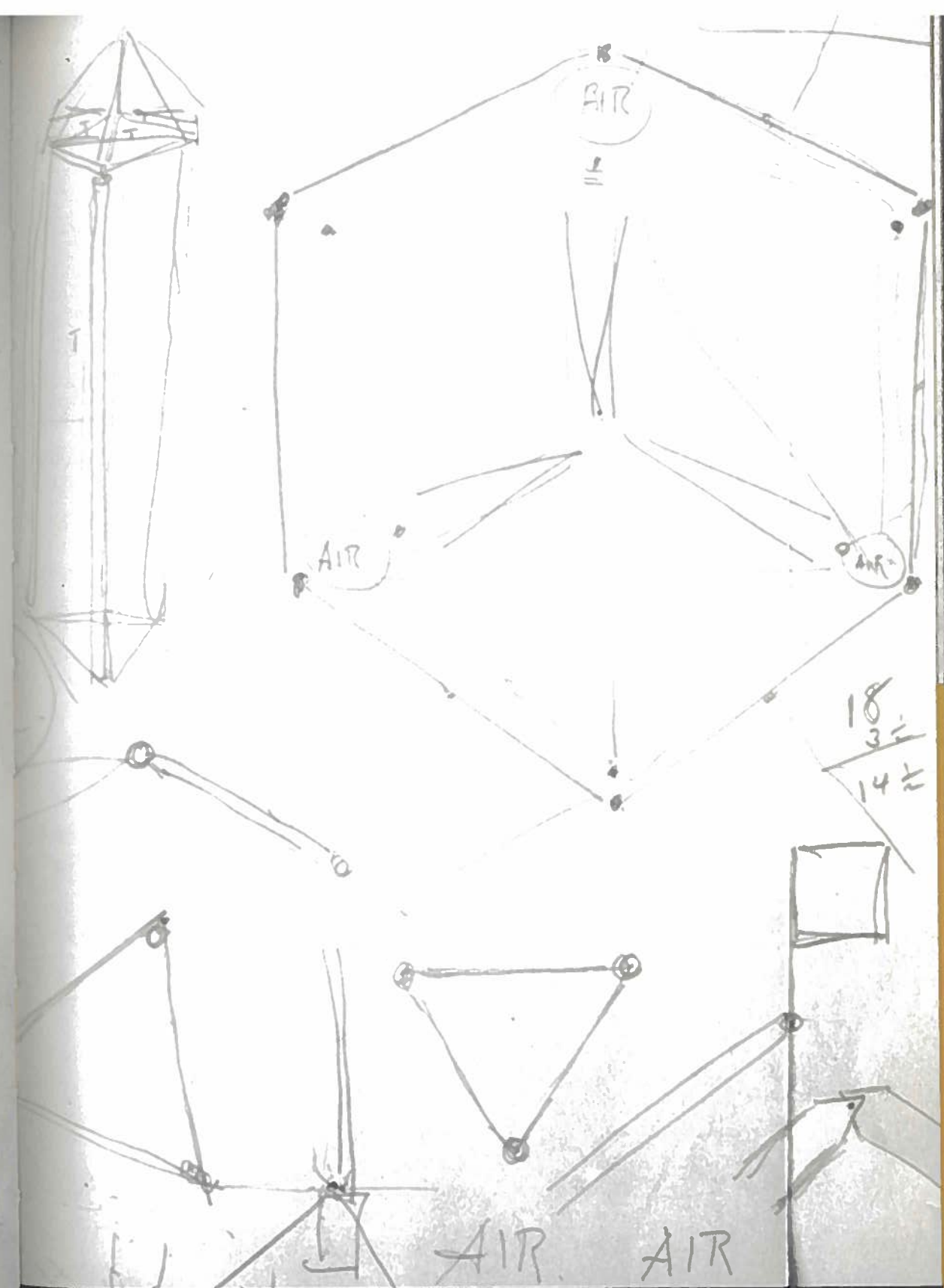
DYMAXION HOUSE



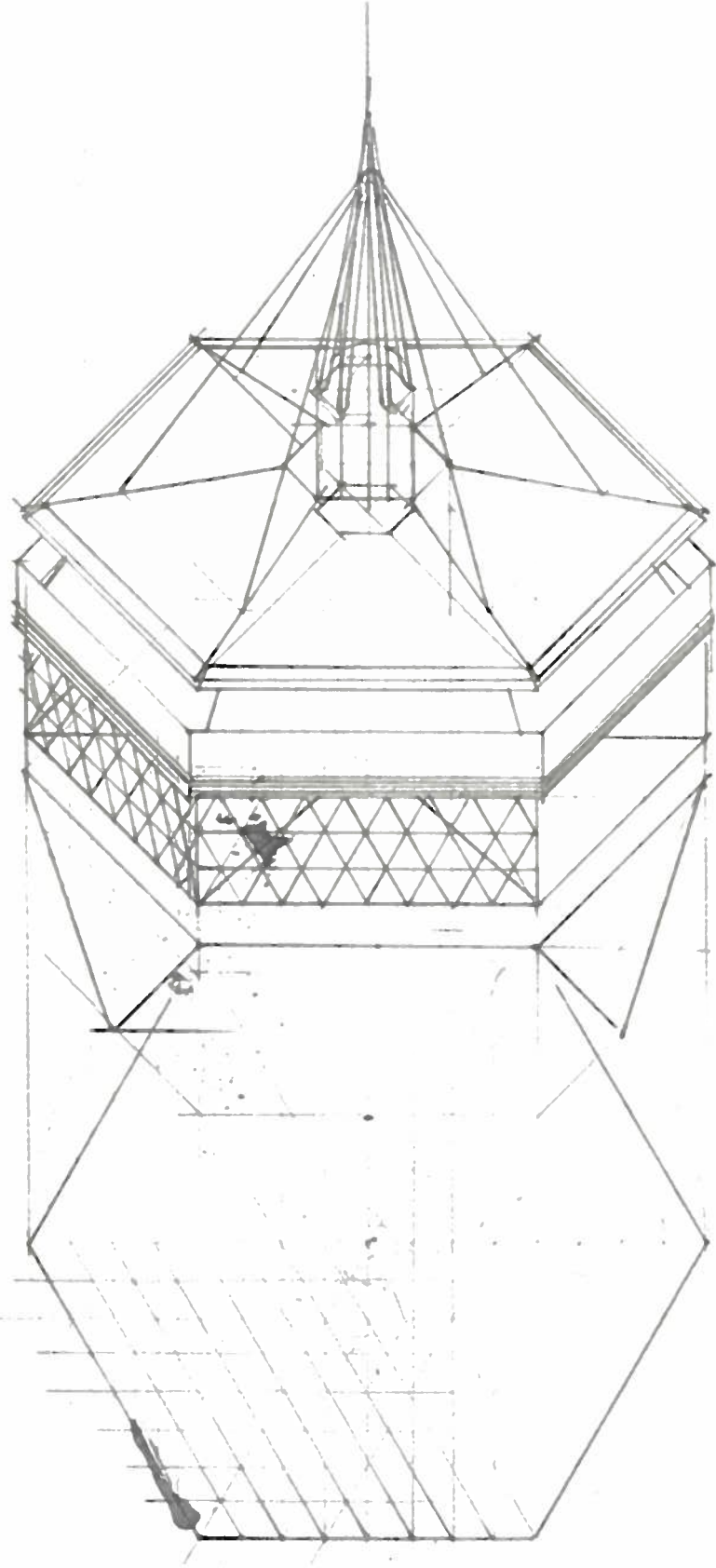


124 Model of the 10-deck Streamlined Dynamite Shelter, 1942

Dynamite House. Elevation with support mast and suspended elements; roof screen shown as a supporting ring. Sketch (Chronoflex 36/1942)

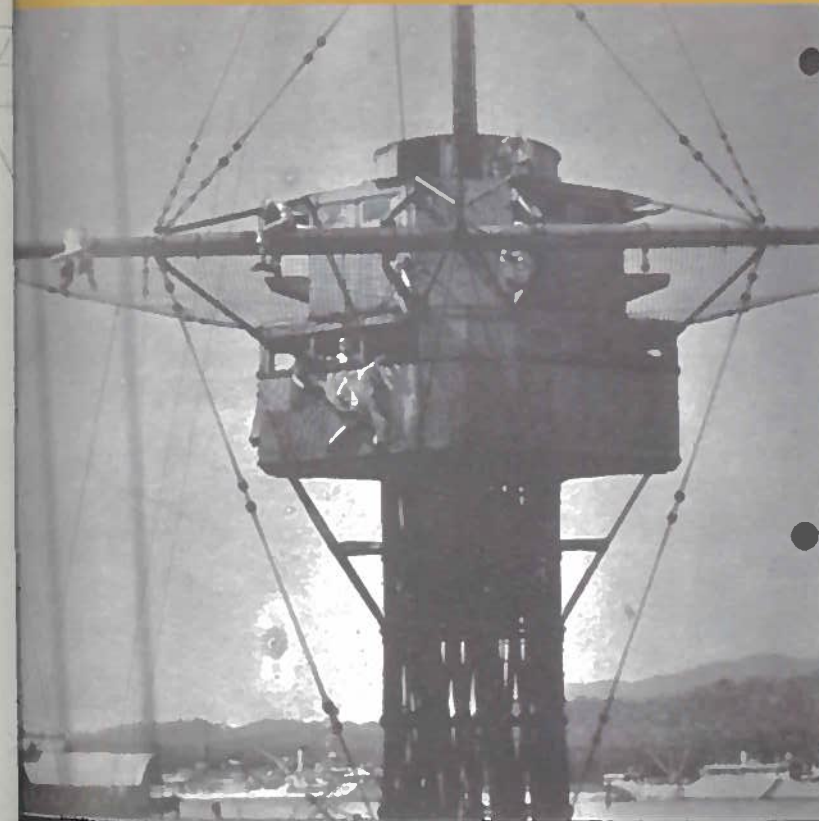


125 Dynamite House. Studies for the construction of the mast and floor covering (pneumatic valves). Sketch (Chronoflex 36/1942)



“A home, like a person, must as completely as possible be independent and self supporting, have its own character, dignity, and beauty or harmony.”

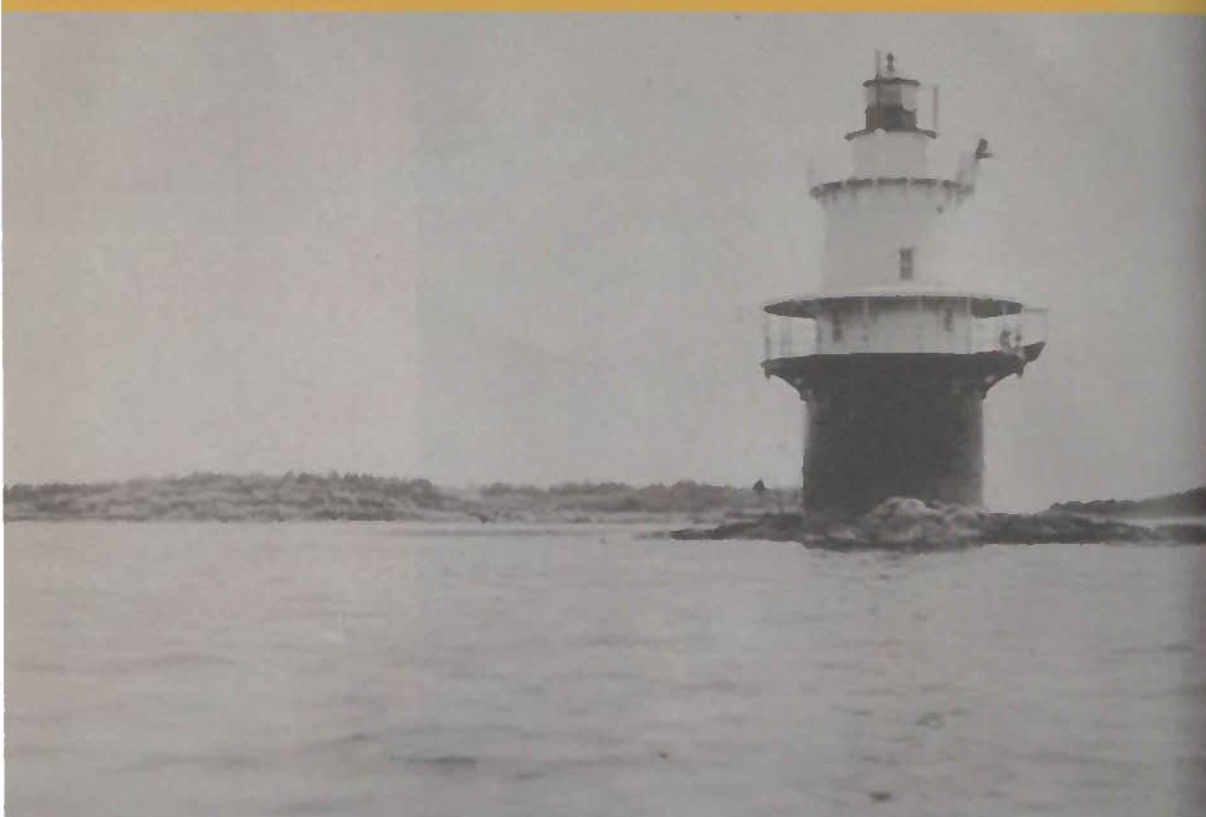
“Lightful Houses”, manuscript (1928), 22



117 *Dynamite House: Analogy*

Analogy: Ship's mast with Sackow support structure and look-out enclosure. (Chronicle 30/1929)

The postcard with the lighthouse and the images on the following double-page spread are documents from the *Chronofile*. Fuller glued them in, along with his own sketches, letters to him, by him, overdue-payment notices for the membership dues from his tennis club. Everything is not equally important, but nothing is unimportant. They seem to be merely glued found objects from life in America, without any commentary, but, in fact, the act of collecting them is the commentary. The lighthouse, the lookout onto the lattice pylon or the rotating storage container for tools, nails, and screws – for Fuller, these things were like fingerprints of the civilization process, evidence of practical applications that corresponded in some hidden way to his thinking, an inner correlation that revealed itself to him, and which he was reworking out of this perception and into something else. The lighthouse stands for autonomy; it is an aid to navigation, freestanding and dependent only on itself – an image of proud independence and, in addition to its functional justification, a metaphor for the true – that is, intellectually independent – human being. The Revolve Display Stands are another example for the significance of Fuller's work that almost always transcends the functional. Fuller came across these representatives of a typically American view of reality at a trade fair and then corresponded with the manufacturer. They gave him an idea how the occupants of his house could store their appliances in a space-efficient way. They were certainly not appliances that he intended to use exactly as they were. And yet they were clues that brought him further. The symmetry of the round stands, which require that the contents be distributed in approximate equilibrium, points beyond the simple practical aspect of the installation and gets at the essence of the house as a whole, and that is itself something spiritual.

Automatic
Display
ALL-BEARING

Revolve

The
Economy
Way
STABILIZED

Not Cost

DISPLAY STANDS

They Pay

ALLS MERCHANDISE

Stands are of outstanding value. They are displayed where customer can see them. "Revolve" Stands make better use of space, save valuable time, give more and increase sales and profits. Can be used where ever wanted. Every item is demonstrated practical, useful and thousands of users.



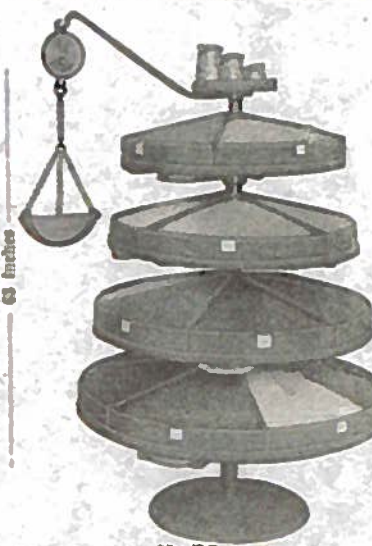
No. 5. No. 5 Universal Stand sections with 1 in. band running full round. Each section has holders at given intervals. Equipped with removable bins. Each is wide at front, 4 in. front, 12 1/4 in. deep at back. Weight 275 lbs. Price \$85.00



No. 40-40, a display stand of four under braced, flat top sections, is equivalent to 27 ft. of shelving or bin display. It requires circular floor space of 2 1/2 ft. in diameter.

Shipping Weight 160 lbs.
List Price \$60.00

No. 5—Display stand for paints, oils, aluminum and many other kinds of merchandise. Five sections of display, require circular floor space 36 in. in diameter and are equivalent to 47 ft. of shelving or bin display. Sections are adjustable up or down on center standard at various intervals.



No. RC-4

No. RC-4, "Revolve" Combination display stand is used for seeds, bulk merchandise, canned goods, paint and other stock. Comes equipped with four sections and 20 removable bins each with a capacity of 1/2 bu. Paper bag pockets under each section. Occupies circular floor space 44 in. in diameter and is equivalent to 29 ft. shelving display. Can be bought without removable bins.

Shipping Weight 610 lbs.
List Price \$100.00

Shipping Weight—295 lbs.
List Price, \$90.00



Removable Bin for No. RC-4 and No. RC-4
Net Price 30c each

No. 534-A has the same construction and specification as No. 534 excepting a 1/2 in. round steel guard, elevated 1 1/2 in. above sections, runs full circumference.

Shipping Weight 280 lbs.
List Price \$90.00

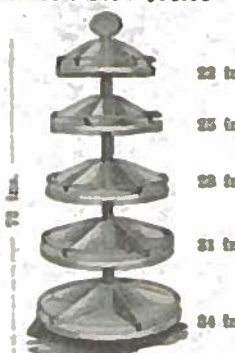
CONSTRUCTION

Stands are all steel. Center stems supporting sections are double strength steel molded solidly into stabilized circular, cast iron base. Sections are made of heavy gauge, roller leveled sheet steel, bolted and electric welded and revolve either way, independently, on ball bearings. Patented stabilizing features prevent sections from sagging or getting out of line. Usage has not set a limit on "Revolve" serviceability. Will work a business lifetime.



No. 534. Another display stand of five revolving sections requiring circular floor space 34 in. in diameter and equivalent to 36 ft. of shelving or bin display. Five wings anchor each section to central casting. Each wing is 7 in. high at casting and tapers down to 1 1/2 in. at edge of section. Bound by 1 1/2 in. retaining band. There are 25 compartments.

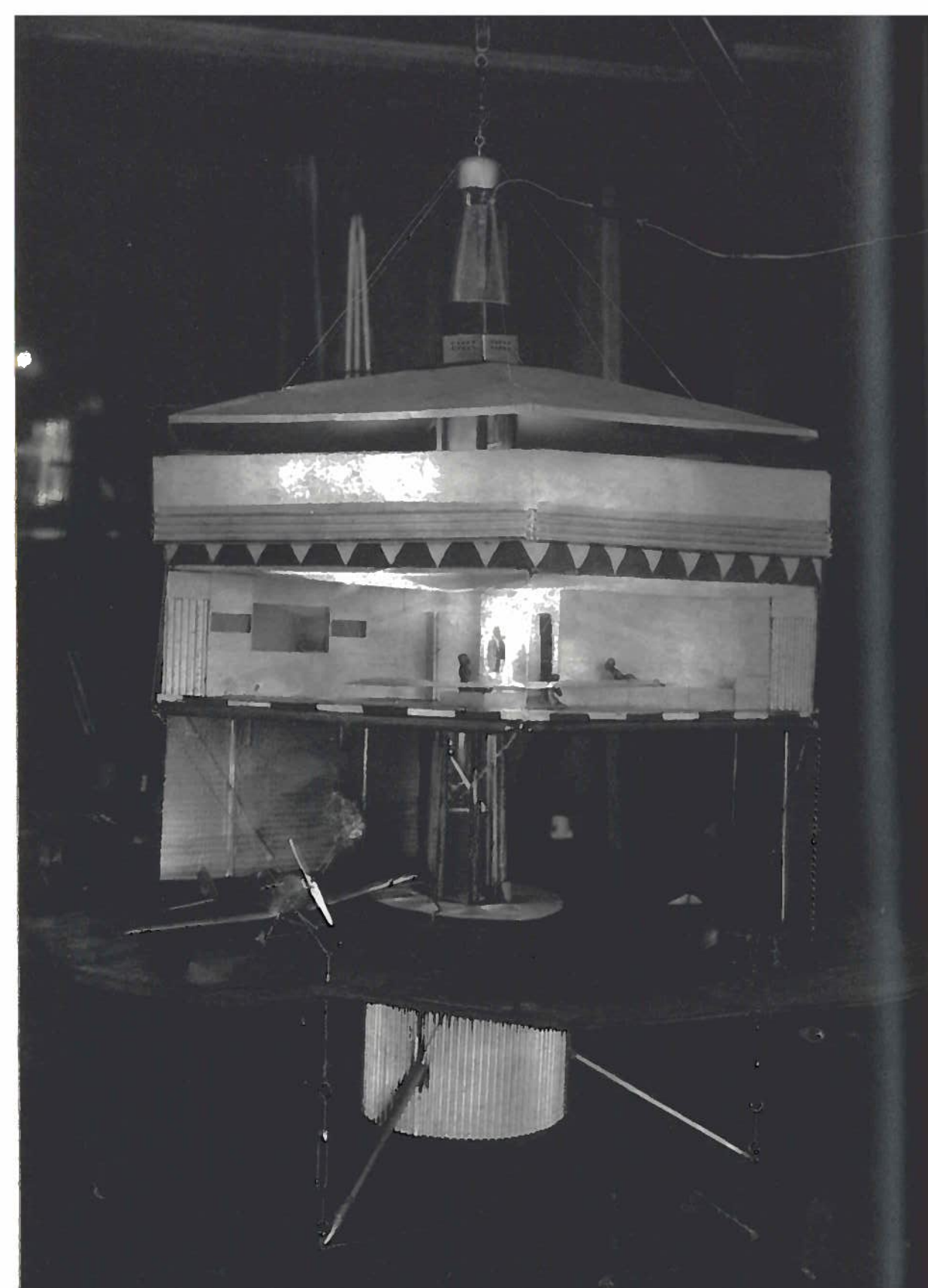
Shipping Weight 264 lbs.
List Price \$90.00



No. 534-A

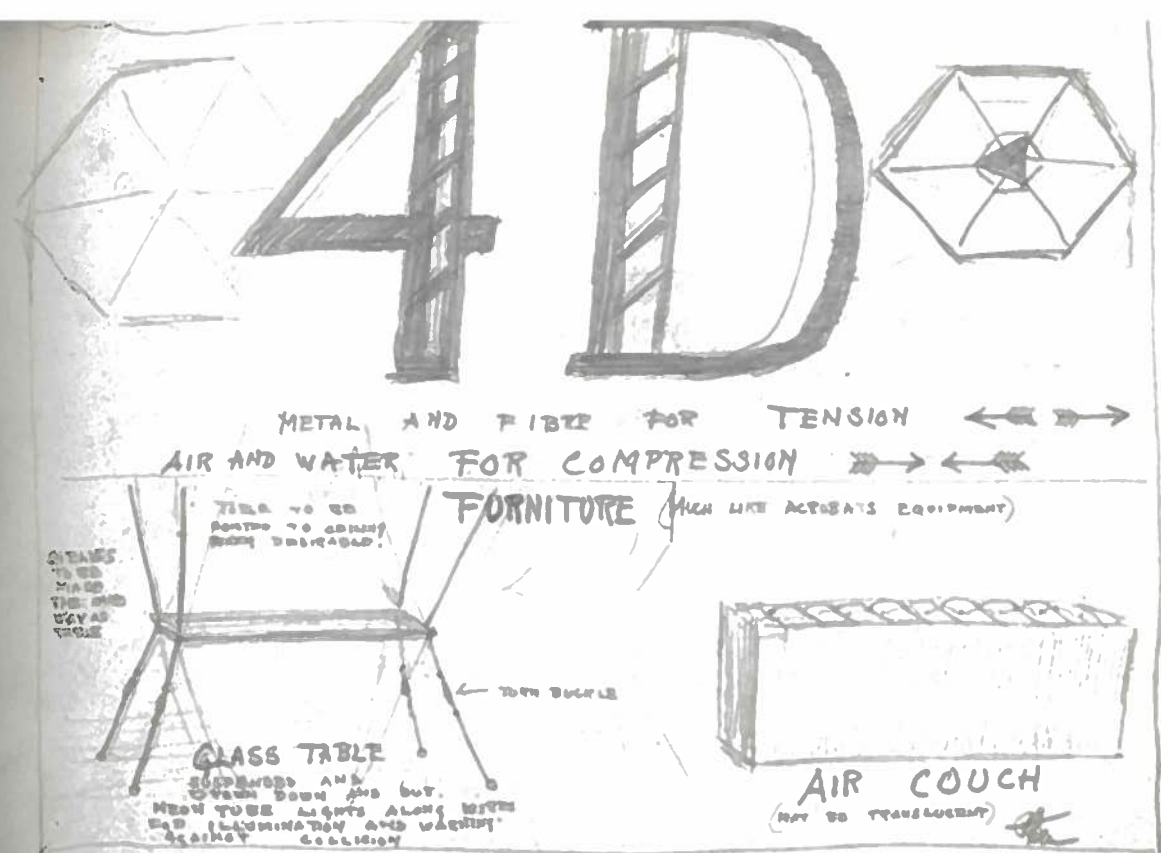
ALL EQUIPMENT
P. O. B. FACTORY

SEE DISCOUNT SHEET



120 *Opuscula House*. Second model, following the 1928 structural model. Depicts the underground building

elements (foundations and tanks). Fuller utilized this model for lectures he gave in 1928.



The House as Fountain

"We will have arrived at our new artistic era of architectural expression when our buildings have lost their last trace of feudalistic depression; when we arise in our buildings in concentrated area of compression in opposition to gravity by means of mast or caisson reach out in space from the vertical by tension and compression, compression diminishing as we fall off from the vertical, until we finally flow downward in direct tension. Then will our exteriors, hanging from the outward flow of the top like a great fountain be full of lithesomeness, light and color."

4D Time Lock (1928/1972), 15 (- YPS: Discourse)

121 Sheet of sketches of 4D furniture: hanging glass table, inflatable couch; metal and fibre material for tension, air and water for pressure. Sketch, 1928 (4D-Sketch Series)

DY(NAMIC)MAX(IMUM)ION

The Name "Dymaxion"

"... It was in Chicago that the name Dymaxion was born. G. Ray Schaeffer, then the Marshall Field promotion manager, asked Fuller to demonstrate his house in the interior-decorating galleries of the store, and Fuller agreed to do so.

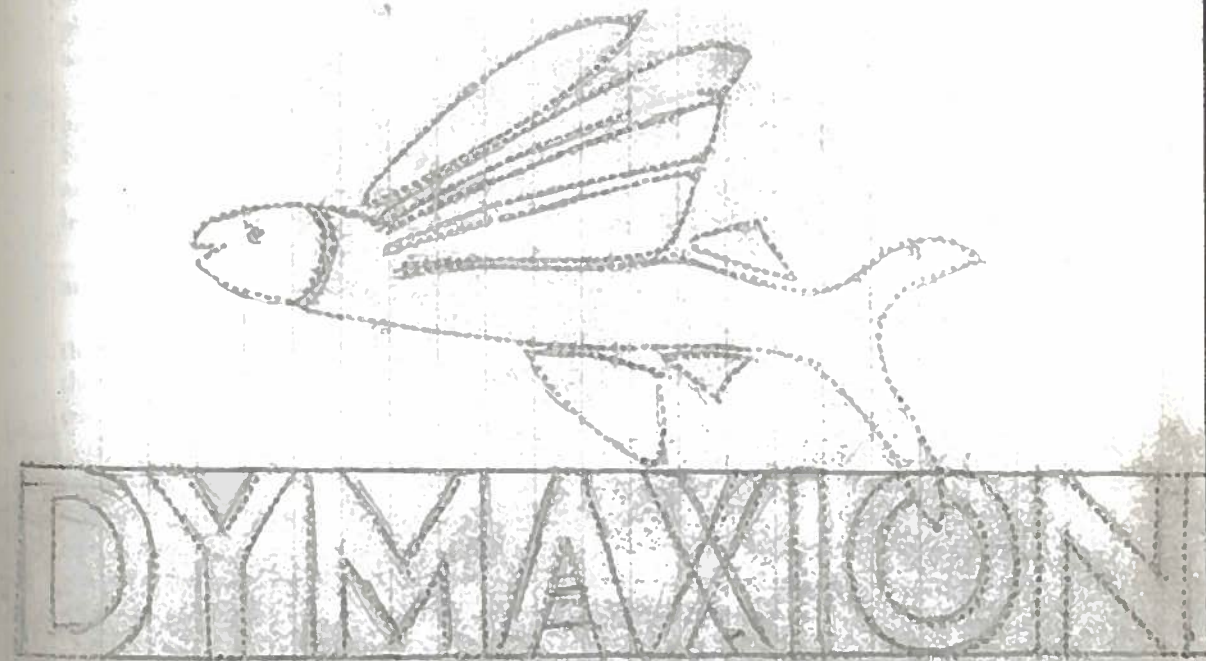
Before the house was displayed, however, it had to be given a name. Marshall Field wanted all its merchandise, if possible, to have a name.

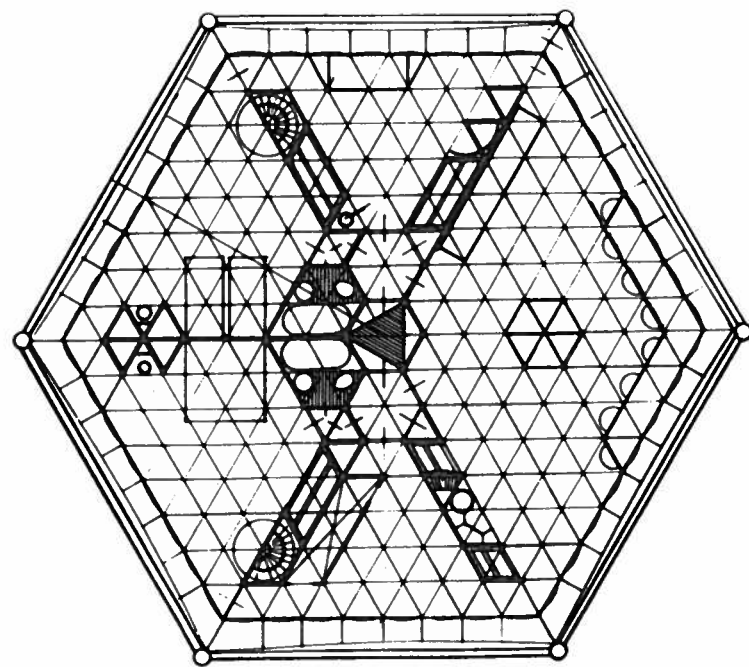
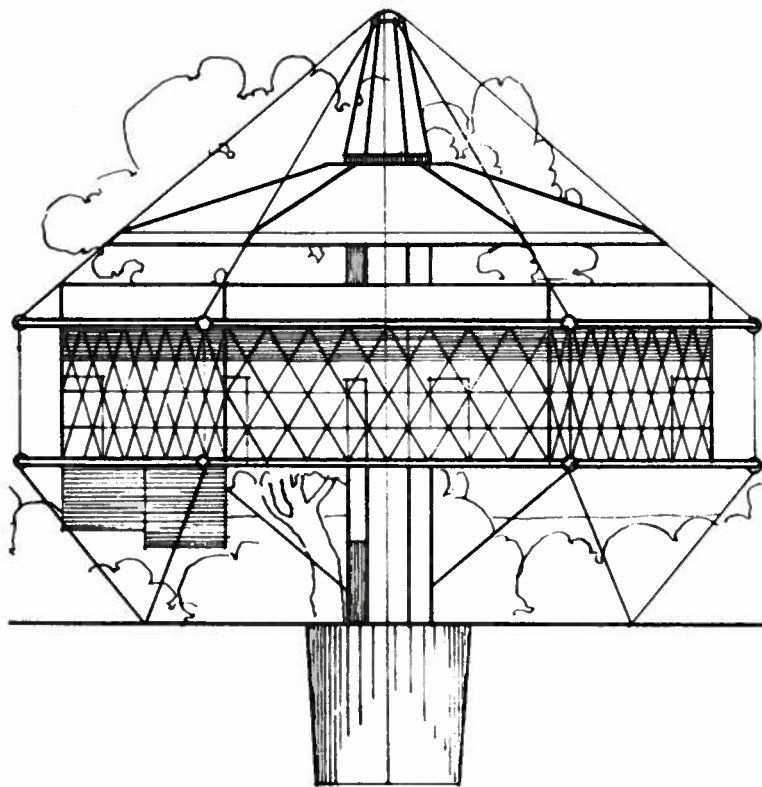
Schaeffer called in the late Waldo Warren, a merchandising namesmith who had won considerable renown for coining the word 'radio' to take the place of 'wireless'. There was an instantaneous meeting of minds. Fuller was an amateur namesmith himself, having just coined the word 'debunk' in order to point out the flaws in traditional architecture which his type of housing was intended to correct. Warren agreed that 'debunk' was a very good word indeed, and so did everyone, for, like radio, it quickly became a part of the American language.

Warren spent two days listening to Fuller talk, jotting down such typical Fuller jargon as 'maximize', 'sumtotally', 'earthian', 'dynamic', and 'teleologic'. After he had compiled a list of several hundred words, Warren turned to Fuller and said: 'You're obviously a four-syllable personality, and you'll have to have a four-syllable name for your house.'

He returned a few days later with the word of words. 'Dymaxion' was it. Warren had formed the word by making endless combinations of nonsense syllables taken from Fuller's lingo until he had struck the word which seemed to him to dramatize the Fuller personality."

Leigh White: "Buck Fuller and the Dymaxion World", in: *The Saturday Evening Post*, 14. Okt. 1944





134 Dymaxion House. Project phase: W20. Elevator and floor plan. Roof screen is not weight bearing but springs back upwards, hung on tension cables; tension struts with

ground-level anchor points set slightly set inward. Floor plan, clockwise from above: library, living room, utility room (kitchen, laundry), two bedrooms. In center, elevator, two bathrooms.

The Dymaxion House

(...) Having once freed our minds of the customs and traditions that have bound us since the days of the earliest shelters, we can attack this dwelling problem just as we would attack the problem of building some other device or piece of machinery that had never before been made. The dwelling, after all, should be a machine for the efficient and comfortable conduct of family life under shelter. Whatever will contribute most effectively and economically to that end merits our consideration; whatever does not so contribute, though it be hallowed by centuries of tradition, need not concern us. There is one important point here that we should recognize at the outset; we can ignore all considerations of cost. The old necessity of "cutting our coat to fit our cloth" - the ever-present cloud that hangs over every home-building operation - is gone. The world's greatest tool, quantity production, will make possible for all what would otherwise be possible only for the very few. (...) It is said that Mr. Ford's new model, if but one car had been built, would have cost \$43,000,000. Reproduction of that first unit costs but \$500, or approximately twenty-two cents per pound for completely harnessed synthetic and mechanically coordinated materialism. There is no reason to believe that a dwelling should cost more.

This talk of "cost per pound," however, brings us at once to the realization that for our reproducible dwelling we are going to have a minimum of masonry. Our house must have lightness of weight, for easy distribution, combined with strength sufficient for all exigencies. Fire, flood, wind must be resisted with unquestioned superiority of defense.

(...) The Dymaxion house is the product, not of a whimsical dream but of years of concentrated study. The design here shown is by no means offered as the sole solution of the problem. The modern automobile changes year by year, as we discover and develop new ways of improving it; so with the house. As a start, however, the design herewith is developed somewhat along the lines suggested by the natural system of human beings and trees - a central stem or backbone, from which the structure depends and in which are the supply, distribution, and waste systems. The central tower, or mast, is made of duralumin tubes, inflated to high pressure, in triangulation with piano-wire steel - similar to the battleship mast or dirigible mooring. With this employment of steel in its most effective condition - that of tension - we are able to construct the complete mast for a twelve-deck house which, together with its tubular perimeter beams, has a total weight of less than one thousand pounds.

Starting with the central mast principle, we discard at once all rectangularity of plan. The logical development from the mast as our functional centre is radially on successive levels. For reasons into which there is not space here to go, the hexagonal plan results - equilateral triangles in three-point suspension. This plan is capable of expansion radially and in a number of levels, providing flexibility of extent without deviation from the unit principle.

The mast is anchored to the ground by its base, in which are fuel and septic tanks, the heat and power generating units, air pump, air filter, and water supply from an artesian well.

The ground level is utilized only for the storage of automobiles, airplanes, etc., and access to the house is by means of a triangular elevator in the mast. This is propelled by a motor, but if the latter should fail, the elevator may be operated by hand more quickly than one can walk, travelling as it does upon a worm gear, and without counterbalance weights.

The exterior walls, having only their own weight to support between floor levels, as in the modern steel-frame building, are here made of two thicknesses of translucent, transparent or opaque material such as we make from casein, with a vacuum between, providing ideal insulation against both sound and heat. The floors likewise, in tension between their triangular supports, are softened by pneumatic pressure between two flexible shells, the upper one of which might be something like our synthetic approximations of leather.



Illustration of 10-deck *Dymaxion House* in *Fortune* magazine, July 1932. Right, the *Streamlined Dymaxion Shelter*

A series of light sources in the mast, one at each story level, gives diffused lighting through the whole ceiling areas by means of simple prisms, mirrors, and color screens. In the scale model shown the smallest procurable bulb serves to light a whole floor by this method.

Incidentally, the heat generated by the lighting system is all utilized, the air supplied to the various rooms being passed about the lights on the way. Mr. Fuller believes that, with the almost perfect insulation secured by this construction, the house can be heated merely by the heat generated in the lighting and power requirements. The air is mechanically circulated, cleaned of all dust and obnoxious gases, and replenished.

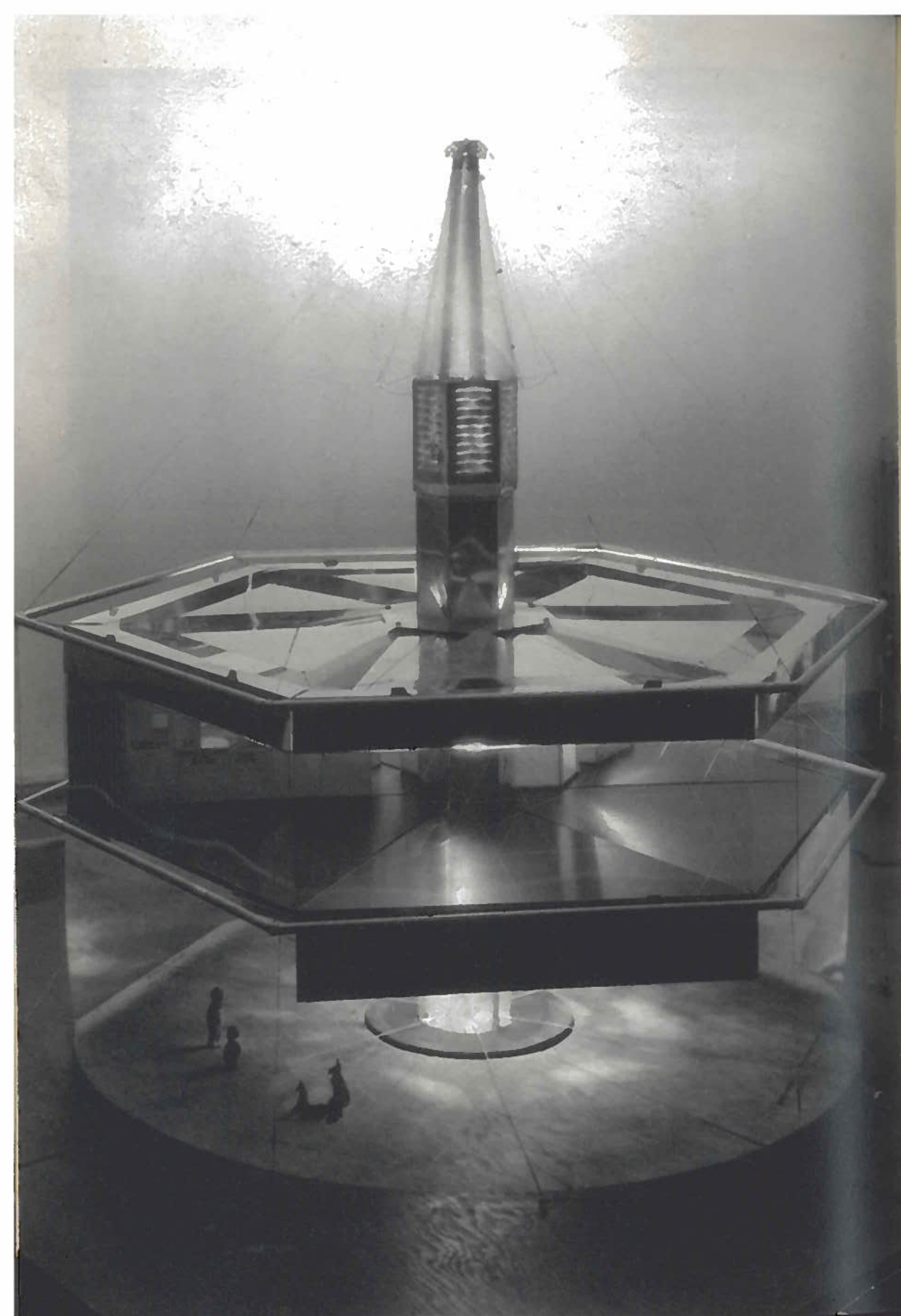
Through the arterial system in the central mast, all connections naturally would be at standardized points, so that an integral bathroom unit is attached without piping. In the same way the other various utility units are made as integral sections, merely requiring attachment in order to begin functioning. Laundry and grill are thus made, with a degree of mechanical perfection hitherto impossible of achievement. The grill is equipped with electric-vacuum range, electric refrigerator, dishwashing machine, indirectly lighted glass cases for food storage. Every one of mankind's furthest developed appliances for doing away with household drudgery can and will be made a standard unit of the system, an achievement possible only through industrial reproduction on standardized patterns.

In a living-room combination, for example, an integral assembly consists of desk, filing-cabinet, typewriter, calculating machine, telephone, radio-television receiver, dictaphone, phonograph, and safe. Just as has long been the practice in unit bookcase and unit office-cabinet construction, making available a personal choice without affecting the principle of mass production and co-ordination of sub-units, so here the standardized system rather than the old style-complicated, tailor-made system will make every convenience available for all.

Such a house would of course be immediately available, erectable in a period measured by hours rather than by months. (...) A house of the size represented by the model illustrated could be had for about \$3,000, and the application of the time-payment scheme would bring such a house within the reach of practically all mankind.

(...) Another question that must arise in the minds of this magazine's readers is: What is to become of the architects? Possibly the answer lies in a consideration of the fact that industrial mass production is to-day requiring more designers than were ever found necessary in the periods when arts and crafts were concerned with individual piecework. The architect's efforts to-day are spent in the gratification of the individual client; his efforts of to-morrow, like those of the composer, the designer of fabrics, silver, glass and whatnot, may be expended for the enjoyment of vast numbers of unseen clients. Industrial production of housing, as contrasted with the present industrial production of raw materials and miscellaneous accessories, calls for more skill and a higher development of the design element, not its cessation.

"The Dymaxion House", in: *Architecture* (Chicago), June 1929, S. 335ff., editorial commentary following a text submission by RBF



**B U C K M
I N S T E R
F U L L E R ' S
D Y M A X I O
N H O U S E**

**T H E H A R V
A R D S O C
I E T Y F O R
C O N T E M
P O R A R Y
A R T I N C**

D

“He Plans Houses Like Trees”

Chicago Daily News

“Pneumatic House, Built Like Tree,
Proposed For Mechanical-Age Folk”

Christian Science Monitor

“A Press-The-Button Home For Our Age”

The World (NYC) Women's Section

“Houses Made Of Milk”

Daily Mail (London)

“Housekeeping in the Air”

Brooklyn Daily Eagle (8-10-1932)

“Houses You Will Carry When You Move!”

New York Evening

“House of 1982 Built Like a Ship”

Brooklyn Eagle Magazine, 11-4-1932

“When We Live in Circles and Eat
in Merry-Go-Rounds”

New Orleans Tribune, 12-6-1932

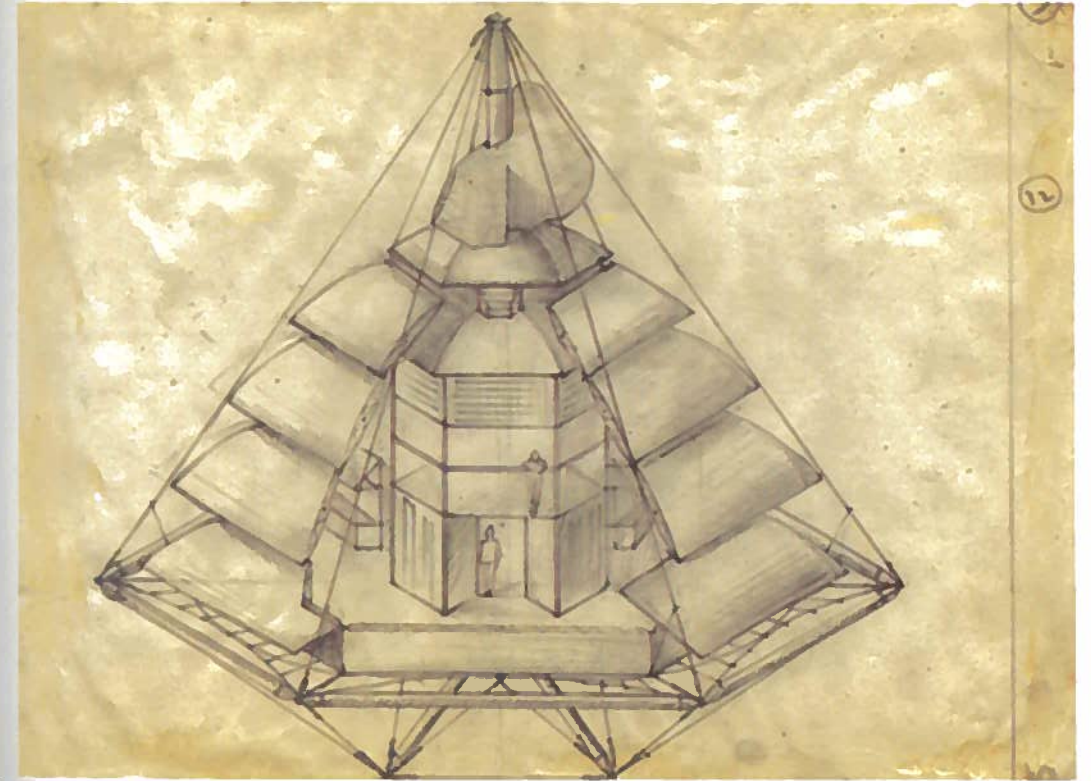
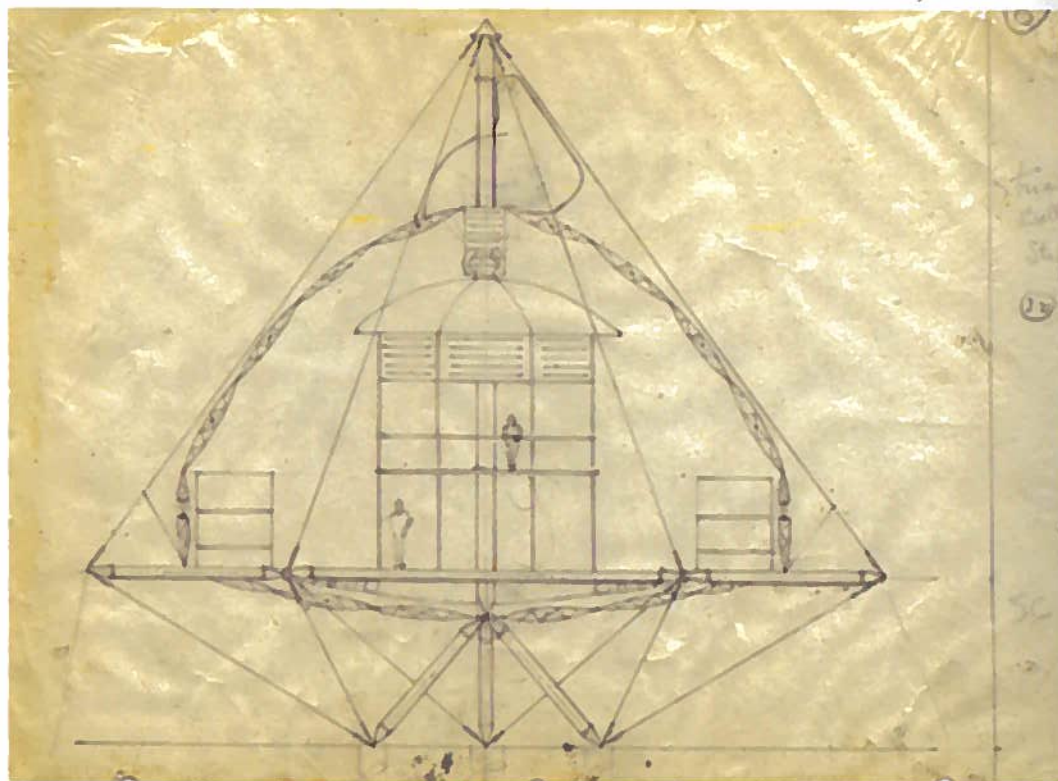
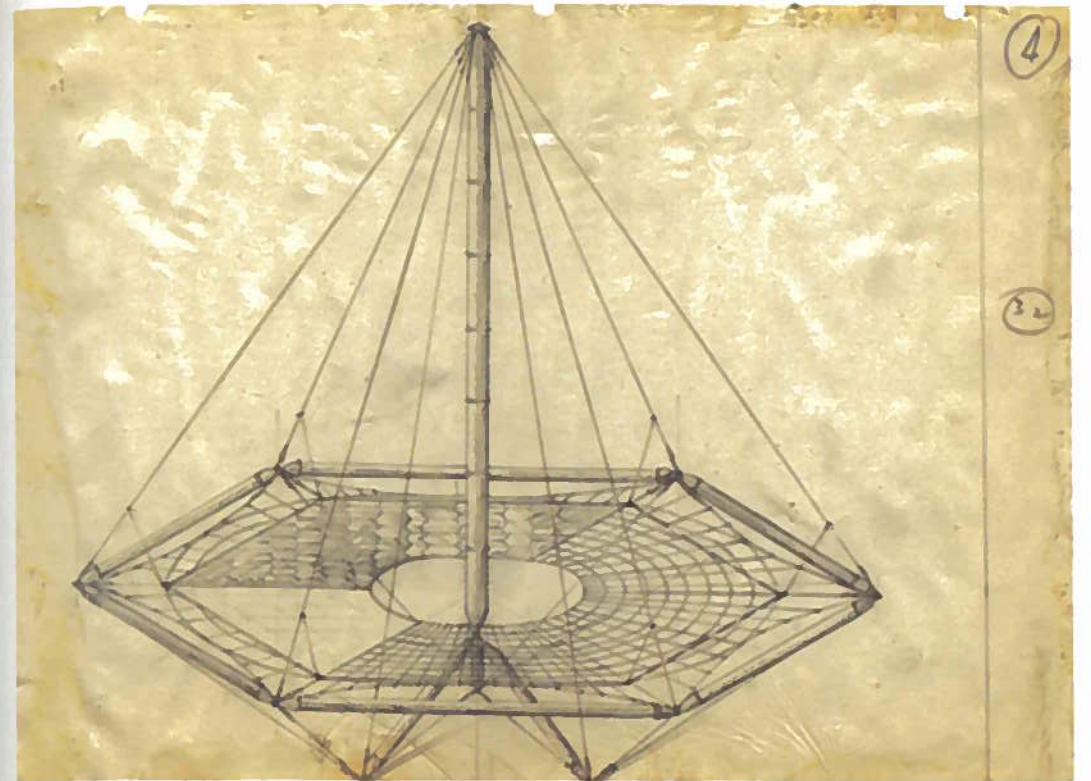
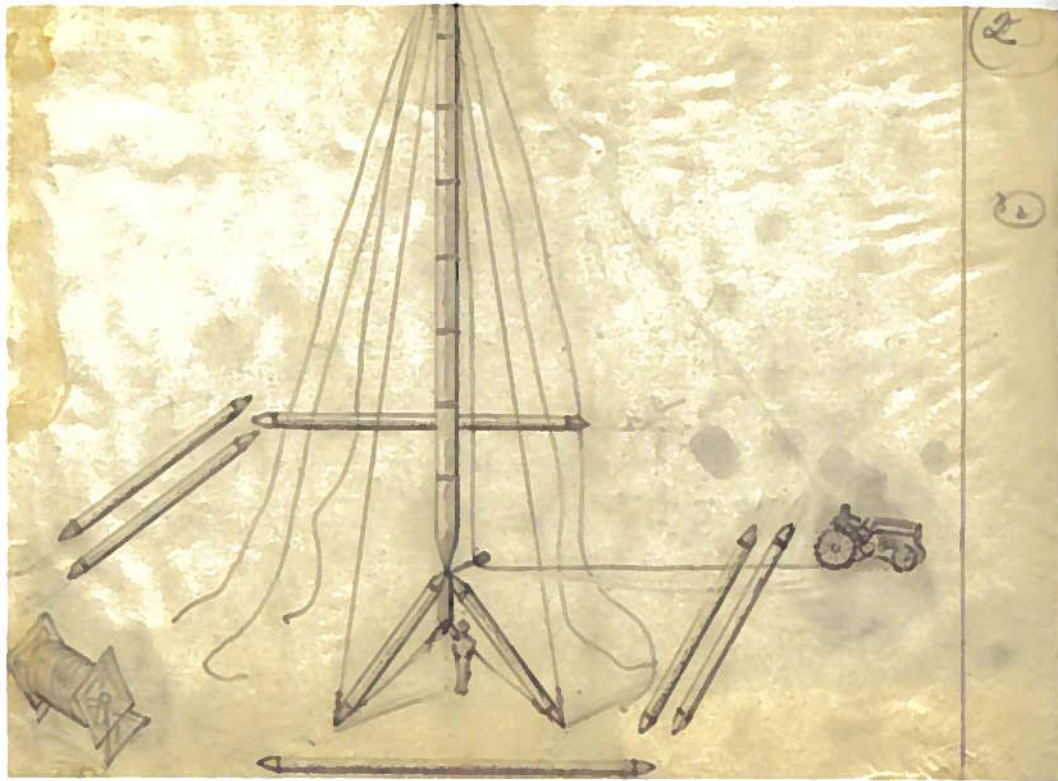
“Machine For Living - Revolutionary House”

The New York Sun, 26-8-1932

“Houses that Hang From a Pole”

Modern Mechanic and Inventions, Sept. 1937





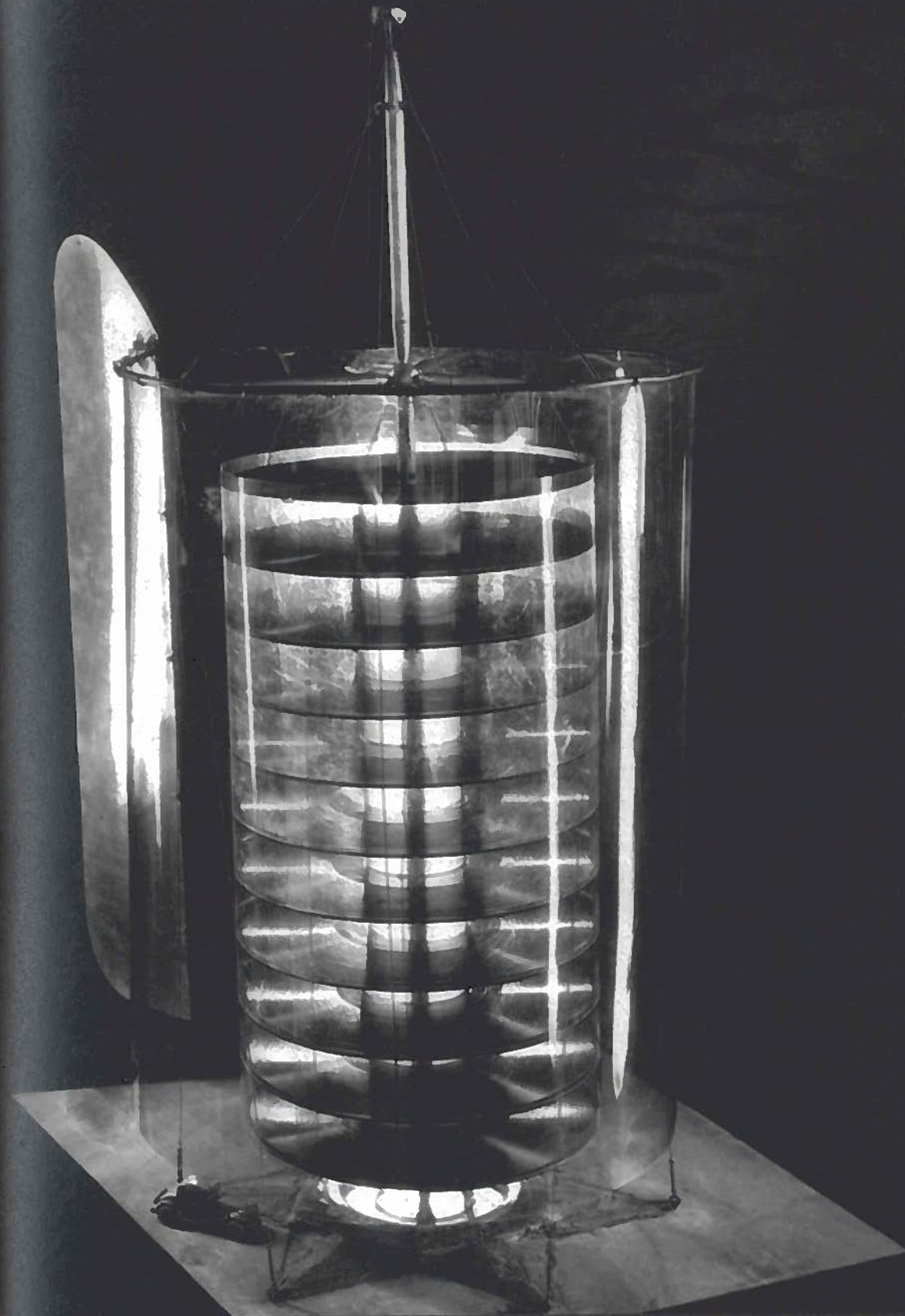
Streamlining

"Now when we came to the studying of winds, and of wind relative to house, it becomes evident that there was the possibility of shaping houses so that we might diminish the amount of drag. It seemed impractical to consider a streamlined house that would revolve around. Therefore I made a number of wind tunnel tests with streamlined shields around buildings, and I was able to reduce the drag on those square skyscrapers by wind stress by at least 87 percent by placing streamlined shields around their models, which also reduced their heat loss by 87 percent."

Designing a New Industry (1946), 33

"Winds are drafted
and not blown"

Designing a New Industry (1946), 35





Many people thought I was some kind of a nut because I was talking about air-conditioning, packaged kitchens, and built-in furniture. But there were some architects who didn't go along with the AIA and my image as some kind of wild man, and I began to get invitations to come and lecture about my ideas.

I decided to make a complete experiment of peeling off from society in general, and started wearing T-shirts which nobody was doing then, went about without a hat and in sneakers – absolutely comfortable clothes. Then when people started getting interested in my Dymaxion House, very nice people with influence, and they'd say, "I'd like to give a dinner party for you" and so forth, I would show up in khaki pants and they'd be very shocked. And when Mrs. John Alden Carpenter, head of the Arts Council in Chicago, gave a beautiful dinner party, I showed up and rudely announced, "I don't eat that kind of food," and was in every way obnoxious.

I was putting self and comfort ahead of my Dymaxion House, and I said, "You're not allowed to do that. You must get over that. You must stop that looking eccentric, with everybody pointing at this guy."

So I decided the way to do that was to become the invisible man, and that means a bank clerk – so I put on a black suit, bank clerk's clothing; then they would focus on what I was saying instead of my eccentricities. I said, "I must get rid of continually making too much of myself."

Anyway, by 1928 I was back in New York and I began to hang around in the Village. I used to go to Romany Marie's, a restaurant I was introduced to by a friend even before I went to Chicago. It was probably the last of the really great Bohemian cafes I know of in the world – very much like the Paris of the '20s. The Village was loaded then with great artists and great intellectuals, and Marie had by far the best place in town. That's where I carried on and developed my ideas. Certainly, in Greenwich Village they took me and my ideas seriously.

What I found so exciting there was that for the first time in my life I had a grand strategy and could try out my thinking against the best of the intellectuals.

Many intellectuals became communists, and I'd say about one-third of the people who came there regularly were communists. I was very apolitical and they were very political.

And they would give me a great battle, and a chance to defend my position. They would really battle me hard. It was probably one of the best conditionings I've ever had.

And they liked the Dymaxion House.

They didn't quite see how we could ever get it going, but they liked the feel of it.

After the great stockmarket crash in 1929 and the Depression that followed, anyone could see that the economic system here in New York as well as everywhere else in America had broken down. People slept in subways; unemployment was everywhere. Some restaurants were down to one-cent meals, and you could buy a whole suit of clothes for a dollar.

Even at that, no one could sell anything. No one had any money!

They were fantastic times.

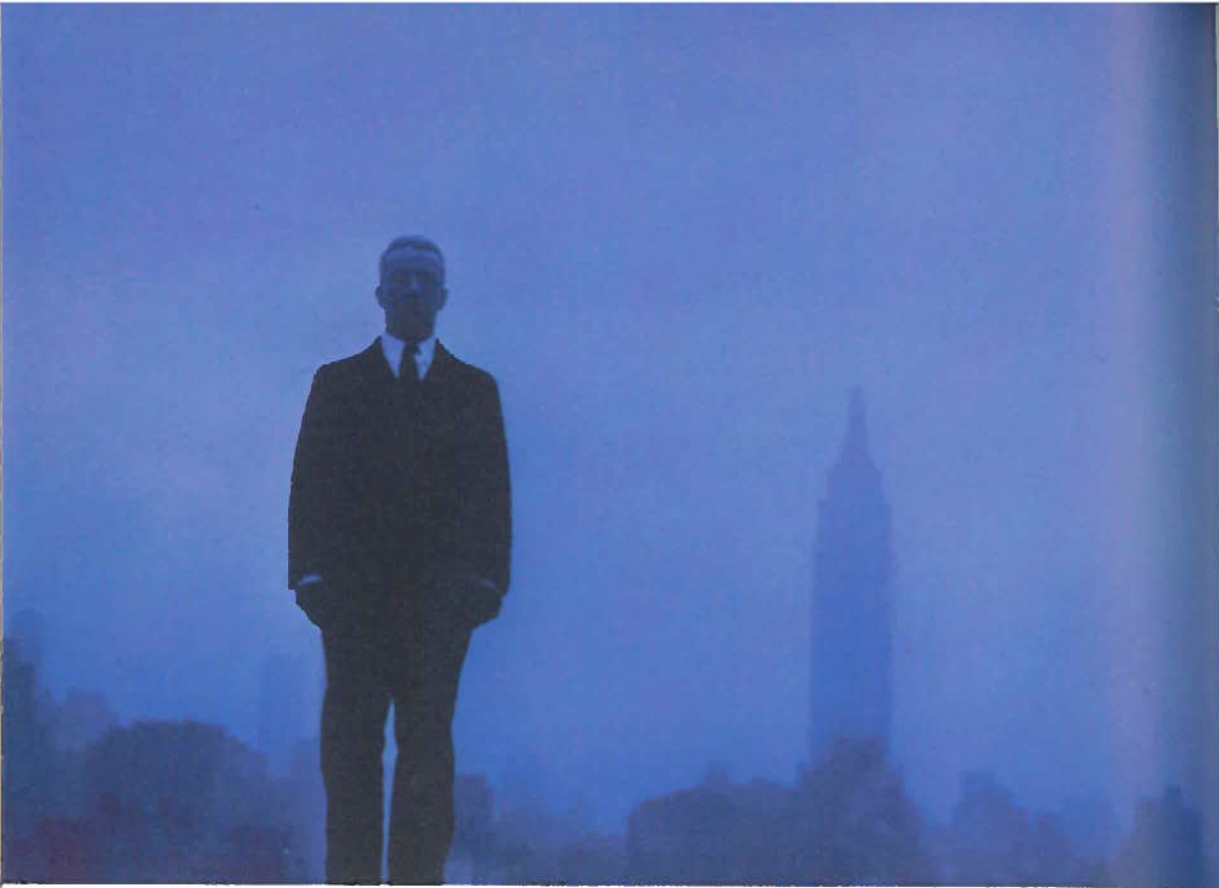
I made some furniture to decorate Romany Marie's in the Village – she was then at Minetta Lane – and she would give me a meal every day instead of money. She would keep a big pot of vegetable soup cooking all the time, constantly adding water and pieces of meat. It was delicious, but I didn't want to overdo it so I only came every other night. There I would stay, a table-sitter, all evening, until very late into the night. It was the Greenwich Village of the late '20s and early '30s that generated great new thinking – and I gained many friends for my concepts, and lost none.

Marie was very interested in me and my work. By this time she had moved her place to South Washington Square, down in a basement, and she ran it together with Puck Durant, Will's wife.



148 • 2 Hours for Lunch Club at Curls Saller's, from left Mordith Blagden, Buckminster Fuller, Haley Place, Curls Saller

Romany Marie, Patrons of Romany Marie's Tavern, around 1929



They asked me to have an exhibition of my Dymaxion House. I had a model, d'ye see, a beautiful model that I made for the Chicago show, and in the summer of 1929 I gave my talks down there.

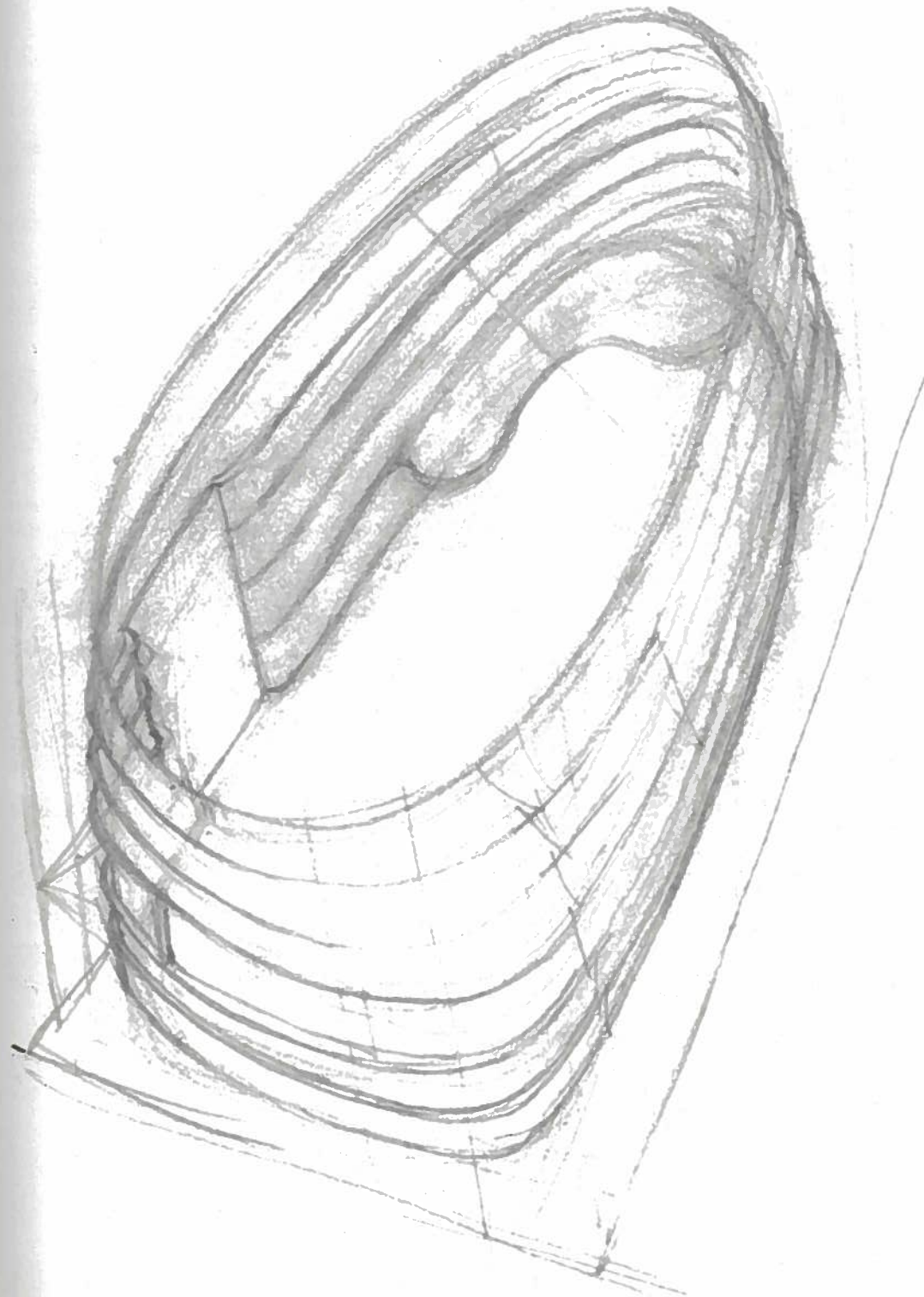
I met a you man there who had just come to New York from Europe where he'd been studying with Brancusi - and this was Noguchi.

"I first met Mr. Fuller, as I used to call him," said Noguchi, much later, "at Romany Marie's in 1929. Some time later I got an old laundry room on top of a building on Madison Avenue and 29th Street with windows all around. Under Bucky's sway I painted the whole place silver - so that one was almost blinded by the lack of shadows. There I made his portrait head in chrome-plated bronze - also form without shadow.

"Bucky was in a continuous state of dialectic creativity, giving talks in any situation before any kind of audience... He would talk to me as though to a throng; walking and talking everywhere - over the Brooklyn Bridge, over innumerable cups of coffee. Bucky drank everything - tea, coffee, liquor - with equal gusto and would often be in a state of wide-awake euphoria for three days straight. Drink did not seem to affect him otherwise.

"He used to drink like a fish. He had become a God-possessed man, like a Messiah of ideas. He was a prophet of things to come. Bucky didn't take care of himself, but he had amazing strength. He often went without sleep for several days, and he didn't always eat either.

"Bucky's zest for life is part and parcel of his creativity. However, he has the capacity and resolution to come to grips in unknown hours and retreats of the mind to fathom new secrets from the universe."



He absolutely fell in love with that house and everything I said; and he said, could he make a head of me? and I said I'd be glad to have him do it.

So posing for him day after day gave us a chance to build up our friendship that went on and on from there.

Noguchi used to do real well. He was a bachelor, and he always got big money for his commissions. He made these heads of the most beautiful people. So Isamu was OK; I was continually bust, and he used to let me sleep in his studio - usually on the floor.

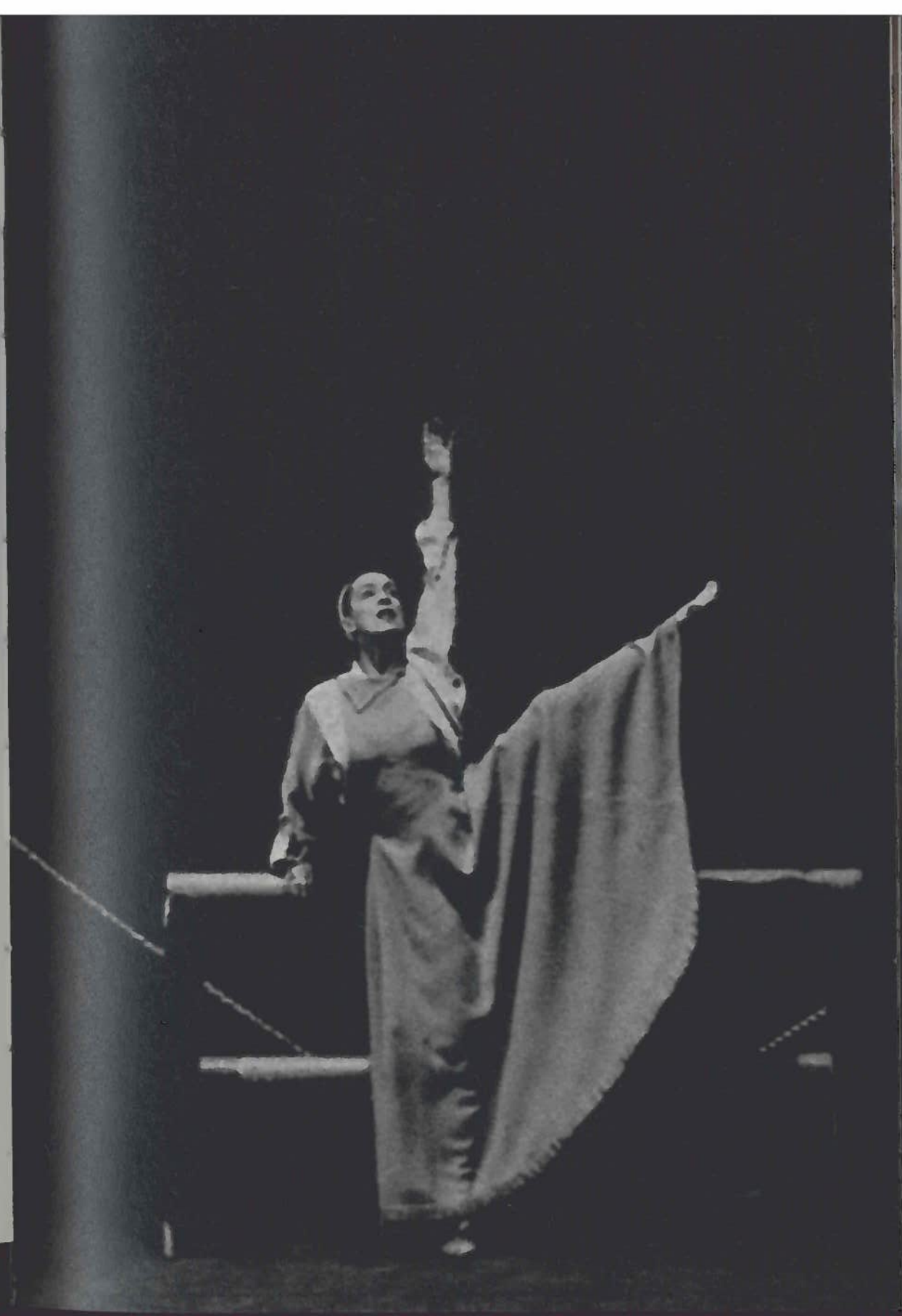
When the Depression set in seriously and most of the New York hotels were empty and looking for something to attract people, they'd ask me to come with my Dymaxion house to be on exhibit. They would give me a beautiful room or apartment to use as an exhibition room and Isamu and I would sleep on the floor - no bedclothes or anything. They gave us a bathroom to go to, and we'd literally live on coffee and doughnuts every other day or so.

"We would move in with our air mattresses and a drawing board and that was it. The less the better was his credo. His Shelter magazine was produced under such circumstances (1930-1932)," recalled Noguchi.

It was really tough going. I had Anne and Allegra down in the country. My mother helped me a little with an allowance to look out for them; but I lived on the minimum you can possibly get on with.

In 1930, I sold all my life insurance and took over a magazine called *T-Square*. I changed its name to *Shelter*, and published it for the next two years - up to the '32 election of Franklin Roosevelt and his New Deal which followed the absolute disaster of the previous laissez-faire economy. With the New Deal's dedication to "the forgotten man," I decided to cease kibbitzing.

An Autobiographical Monologue/Scenario (1989), 58ff.



Romany Marie

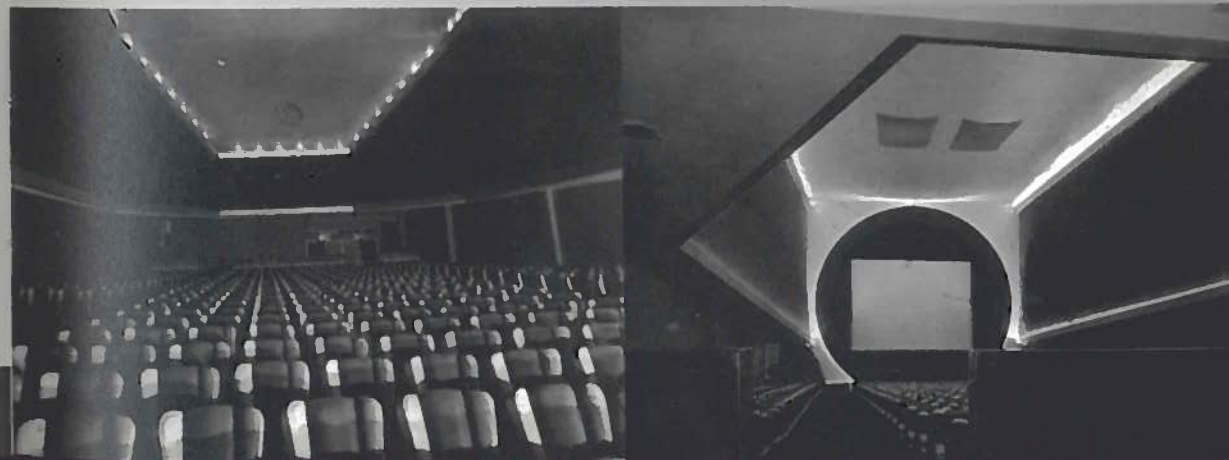
"The friends of Romany Marie wish to announce that she is no longer at Washington Square, but has returned to 15 Minetta Street, and herewith invite you to come and celebrate the opening of her tavern on Saturday, October the fifth. She will continue to serve dinners, Turkish coffee, tea and supper.

There is no tavern in all of New York like the one in which Romany Marie acts as hostess. Always, at her tables, people from all parts of the world, and from all walks of life gather to talk or dream. Old friends meet again and new ones are made. In fact as one watches Romany Marie, colorful, vivid, dynamically strong, move from guest to guest, it is easy to understand why groups of sensitive people constantly circle about her.

And so it is very fitting that Romany Marie - who has ever been eager to sponsor the new life and art - should bravely return to her old tavern and turn it into a new one. No longer heavy oriental draperies and dim lights. A gipsy recognizes no bounds, and when she must renounce ancient customs she does so with a free gesture. Buckminster Fuller, an inventor with vision who has designed the Dymaxion House of the future, a house hung from a mast, has been invited to decorate the tavern. He has covered the walls with aluminum paint and arranged the lighting effects so that there is a sense of space and sunlight and air. He says, 'a room should not be fixed, should not create a static mood but should lend itself to change so that its occupants may play upon it as they would upon a piano.' The result is that the color, form, expression of each individual is accentuated, and there is an interplay of spiritual vibration which is both stimulating and creative. Here paintings are to be hung on the walls, and their intrinsic value allowed to free birth. What is more, exhibitions are to be changed frequently so that the tavern will be largely in the nature of a picture gallery salon.

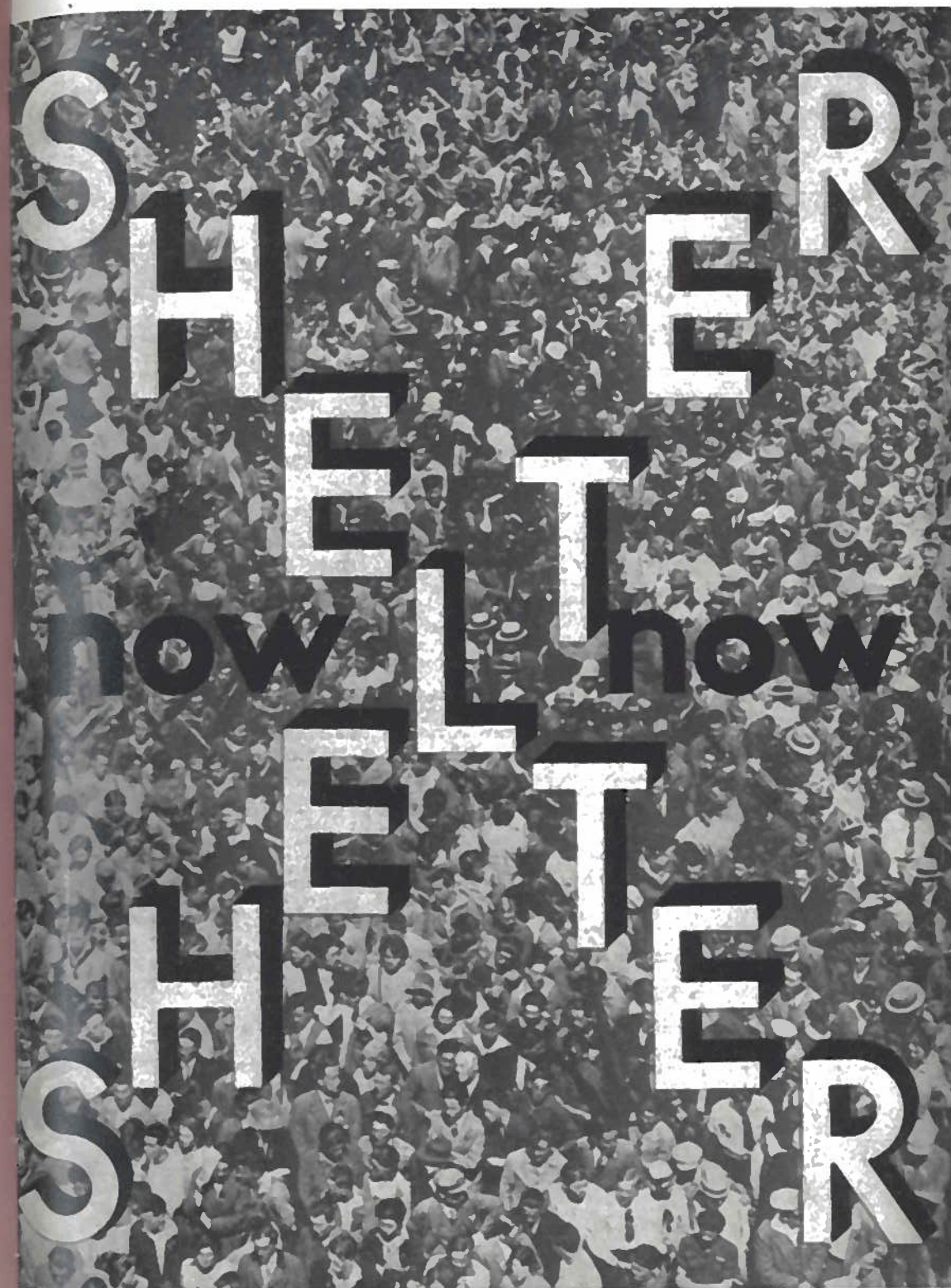
Come and see for yourselves and tell Romany Marie what you think of it."

Typescript, Chronofile 36/1929



The recognition of modern architecture as an "International Style" was not what Fuller conceived as the new architecture. His slogan "Doing the Most with the Least" was not a formal criterion for him. He turned the small, progressive architectural magazine "T-Square" into the organ of his Structural Studies Associates (SSA), called it *Shelter*, and used it to argue a line that in 1938 he would characterize as "In architecture, form is a noun; in industry, form is a verb." *Shelter* was supposed to be a "correlative medium" that would help the world of architecture to reach a breakthrough. The content was original and provocative. Fuller did not feel that the magazine had to pay for itself, but the important fifth issue of November 1932 proved to be the final volume.

T-SQUARE/ SHELTER



Despite the great public response to his lectures and demonstration of the model of the Dymaxion House, Fuller's 4D philosophy was only accessible to a few people and in general remained quite obscure. He failed in all his efforts to turn the 4D papers into a book. The publishing house Charles Scribner's Sons in Chicago was even willing to try the experiment of producing the book on the basis of stenographic notes of Fuller's lecture before selected members of the Architectural League in New York (see *Your Private Sky: Discourse*). But the book never came about, even though Scribner's tried to secure Lewis Mumford as a collaborator or ghost writer. As brilliant as Fuller could be in extemporaneous lectures and in his correspondence, his theoretical writings were considered unintelligible and unreadable.

Fuller needed a medium in which to disseminate his theoretical discourse and a discussion platform that would attract a like-minded audience and be suited to explore the controversies with exponents of the new architecture and design. *Shelter* was to play that role.

The slow transformation from *T-Square* to *Shelter* that Fuller began in 1932 was reflected in the removal of all advertising, modern graphic design, and editors that changed from issue to issue. This was at the same time a sign of the reformation of the American architectural scene that resulted from the importation of modern architecture and design from Europe. Thus, Fuller gave editorial responsibility for the April issue to Philip Johnson, who, together with Henry-Russell Hitchcock and Alfred Barr, had organized the exhibition "Modern Architecture" at the Museum of Modern Art, and who, in the exhibition catalogue he wrote with Hitchcock, had attached the label "International Style" to the new movement. *Shelter* documents not only the debate between Americans and Europeans but also the controversy between the "stylists" and the "structuralists" that cut across that division. The latter had formed a loose organization in 1932 in the *Structural Study Association*, whose guiding spirit was Buckminster Fuller. The many voices of that position were expressed in the May and December issues of *Shelter*. In his rejection of a superficial, i.e., merely aesthetic or stylistic, modernism, Fuller found a sympathizer in Frank Lloyd Wright and a committed fellow in Knud Lönberg-Holm of Denmark, who was personally acquainted with the protagonists of *Neues Bauen* (the New Building movement in Germany) and was very familiar with the European context. Lönberg-Holm's influence was also felt in the modern design of *Shelter*: generous covers, clear divisions, and controversial photo essays defined the new face of the magazine.

In *Shelter* Fuller advocated not only "industrial building but also scientific research of home and household, of the technology and economics of housing." We find here the beginnings of a theory of climatically controlled shells, and we find here, unmistakably, a new programmatic slogan: ecology. "*Shelter* means the instrumental safety and the service of ecology and economics combined."

The overall philosophy of *Shelter*, as a correlative medium, is "to do the most with the least." Interpretive conditions of this philosophy involve the intelligent use of forces already manifest which to-day might be hampered by a lack of awareness of their potentiality in their relation to the evolution of a world-encompassing shelter industry.

T-S Q U A R E

Sent by Request of
BUCKMINSTER FULLER
See Page 22

T-SQUARE February 1932
Maxwell Levinson, Editor
L.J. Levinson, Managing Editor

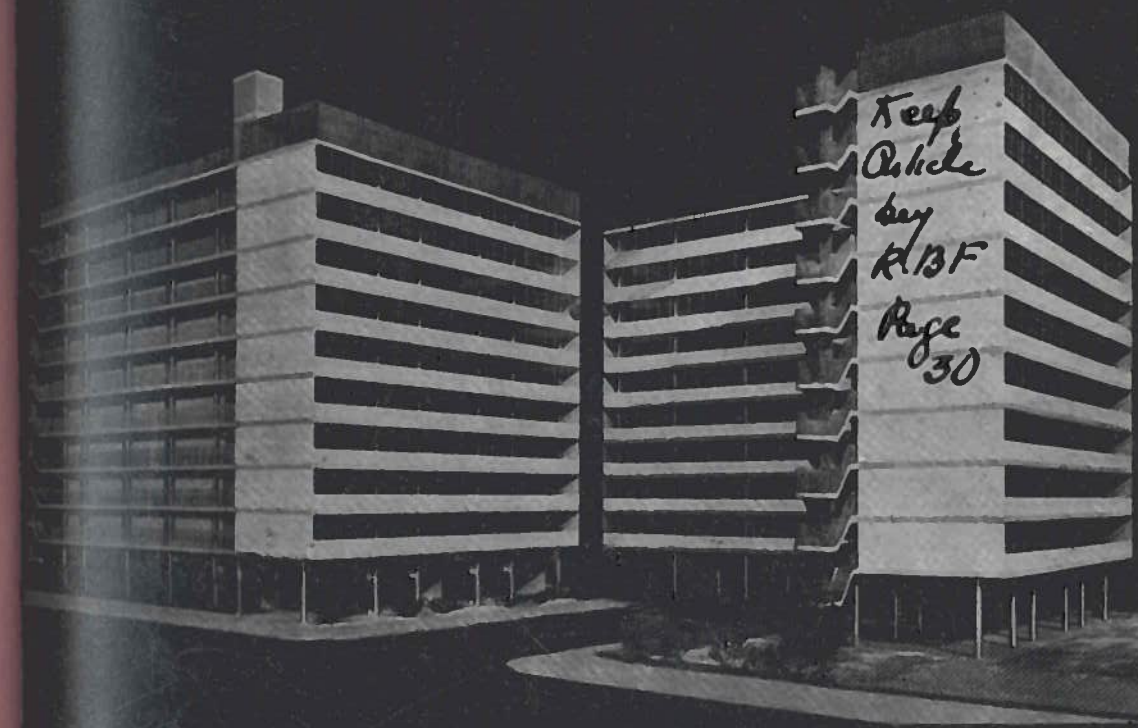
Frontispiece by Diego Rivera
Editorial, George Howe

Articles
For All May Raise the Flowers Now, For All Have Got
the Seed, Frank Lloyd Wright
Moses Turns Pharaoh,
George Howe
The Effect of the Regional Plan on Urban Architecture,
Arthur Kallet
We Are Entering Upon A New Era,
Le Corbusier
The Myth of Building Laws,
Irving H. Bowman
A Cooperative Dwelling,
R. M. Schindler
Universal Architecture,
Buckminster Fuller
Biographical Sketch: Richard J. Neutra,
B. E. McLoney
Let Us Know What Is Being Done,
Ely Jacques Kahn
I Do Not Believe,
Henry S. Churchill
Exhibition of Modern Architecture
Letters to the Editor,
Arthur T. North, Frank Lloyd Wright

SHELTER, April 1932, Vol. 2 No. 3
Maxwell Levinson, Editor; George Howe, Henry-Russell
Hitchcock, Jr., Alfred Barr, Jr., Philip Johnson, Associate
Editors; Leon Levinson, Managing Editor

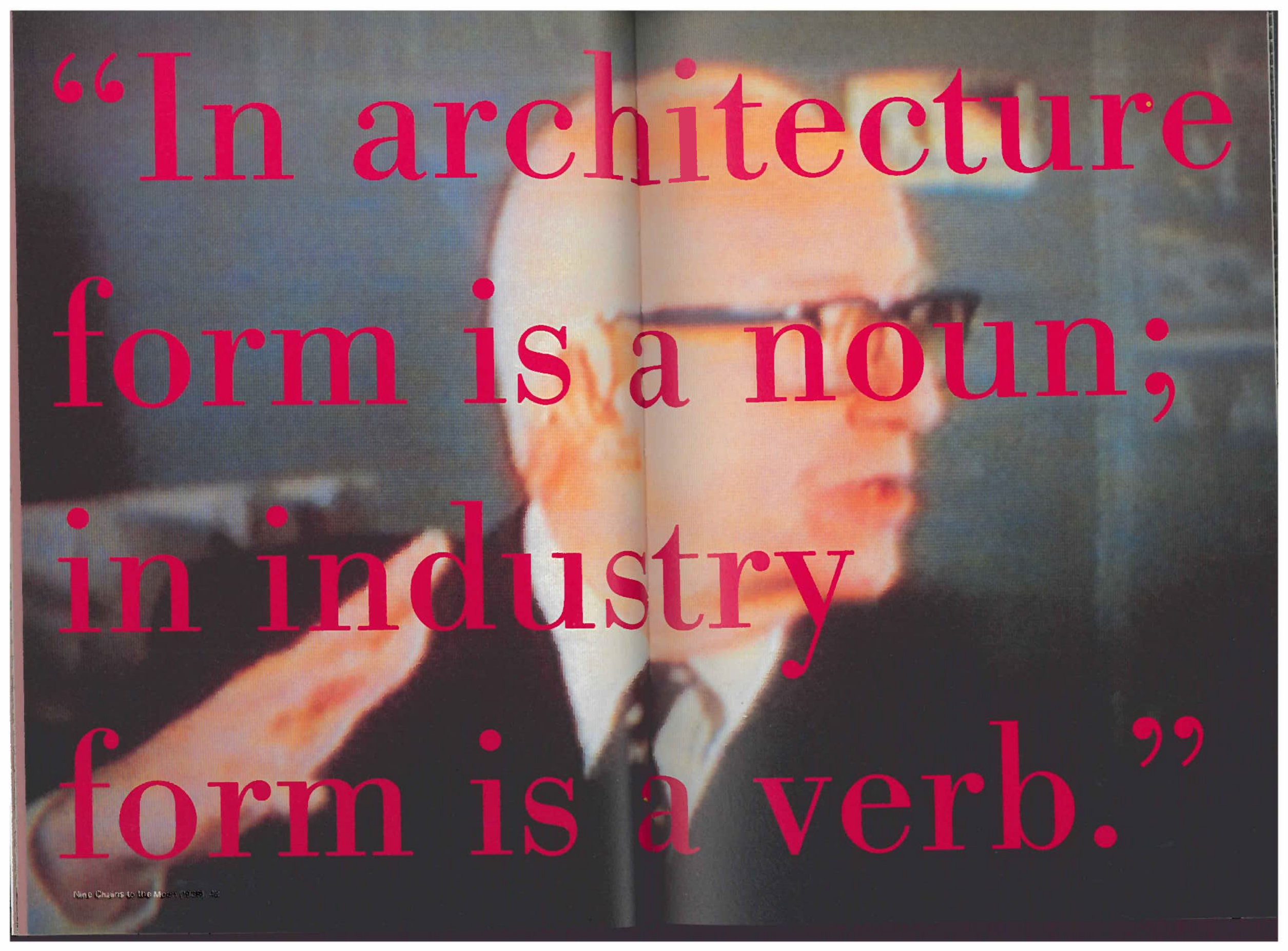
Cover, Photo.
Typical Unit for Chrystie-Forsyth Area, N.Y.C.,
Howe and Lescaze, Architects
Editorial, in Architectural Criticism,
Henry-Russell Hitchcock, Jr.
Symposium "International Style", Exhibition of Modern
Architecture, Museum of Modern Art,
Lewis Mumford, Henry Wright, Raymond M. Hood, George
Howe, Harvey W. Corbett
Of Thee I Sing,
Frank Lloyd Wright
Old New Stuff,
Arthur T. North
Two Shows: A Comment on the Aesthetic Racket,
K. Lönberg-Holm
Imagination In Community Planning,
Henry Wright
Housing Development, Chrystie-Forsyth Sts., N. Y. C.,
Howe and Lescaze, Architects
Modernism and Publicity,
Chester Aldrich
Notes on the Manufactured Ring Plan School,
Richard J. Neutra
Creation and Criticism, The Frank Lloyd Wright Autobiography;
International Style: Architecture Since 1922, Two Book Reviews,
George Howe
The International Congresses For New Building,
Richard J. Neutra
In Memoriam, Theo. Van Doesburg,
Frederick J. Kiesler
Appeal to Reason,
Kenneth M. Day
Universal Architecture, Essay No. 2,
Buckminster Fuller

SHELTER



APRIL 1932 VOL. 2 NO. 3

159: T-Square, February 1932, cover. The last issue
under the name T-Square.



“In architecture
form is a noun;
in industry
form is a verb.”

Shelter, May, 1932, Vol. 2, No. 4

A correlating Medium for the Forces of Architecture
Maxwell Levinson, Editor; George Howe, Associate Editor;
Leon Levinson, Managing Editor

Covers (Photos, Curtiss-Wright, Acme, Vanity Fair)

Knud Lönberg-Holm

Shelter's Editorial and Economic Policy

Editorial, Correlation

Buckminster Fuller

Building With Money

Douglass Haskell

Structural Study Associates

Henry Churchill

Monuments and Instruments

Knud Lönberg-Holm

Emergence

Theodore Larson

The Emergencies

Simon Breines

Empire State Apartments

Simon Breines

Transition

Roger Sherman

Tooling Up

Peter Stone

Universal Architecture, Essay 3

Buckminster Fuller

A Festival Shelter

Frederic Kiesler

Critical Judgment

Eugene Schoen

Face The Facts

Howard Robertson, Director, The Architectural School,
London

Re-Search vs. Research

Henry Wright

After Functionalism: Function

Dr. Alvin Johnson

At A General Trend

William A. Delano

This Freedom

Electus D. Litchfield

Aluminaire: A House for Contemporary Life

A. Lawrence Kocher, and Albert Frey

4D Essays

Buckminster Fuller

SHELTER



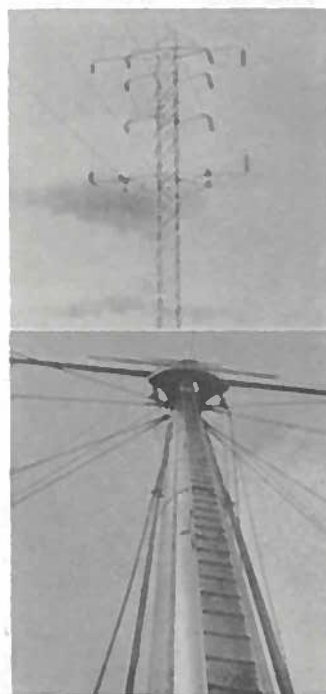
STRUCTURAL STUDY ASSOCIATES SYMPOSIUM & 4^D ESSAYS



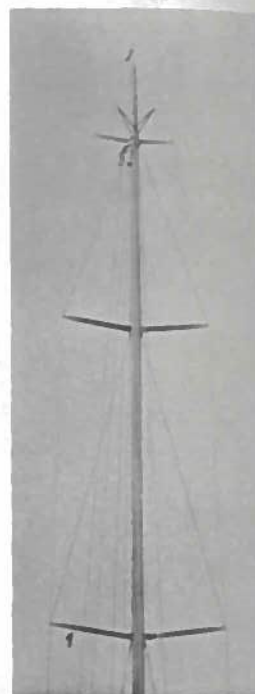
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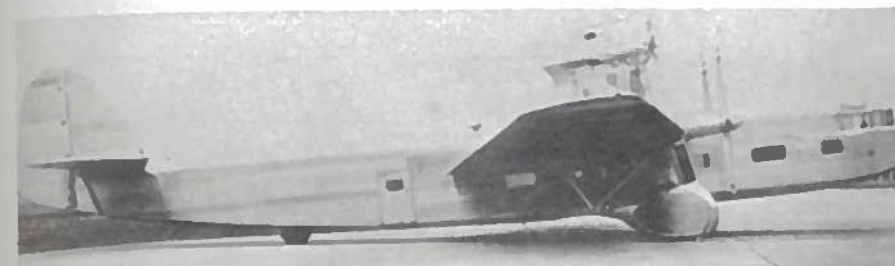
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7

Doing the Most with the Least—Segregated compression and tension members, flexible joints, stabilized force triangles—not scientific structure in One annihilating transportation, communication, and power harnessing. (1) The Detroit Bridge—Central Span 1,800 feet, two cables 19-inches diameter each, two masts total 12½ square feet net compression cross section—Able support total traffic city of 500,000. (2) Acropolis' Mast, County Feb. (3) High Tension Power lines. (4) Mast and through of the S. S. "Denver". (5) Mast of "White Wind", cap defense contender. (6) Lakewood Steel Tower and concrete cladding equipment—Pawnee Dam—Masts 500 feet high—One of largest ever erected. (7) London, England, to Capetown, Africa, passenger service. Note large compression struts flexible joints and tension diagonals of ephemeral weight.

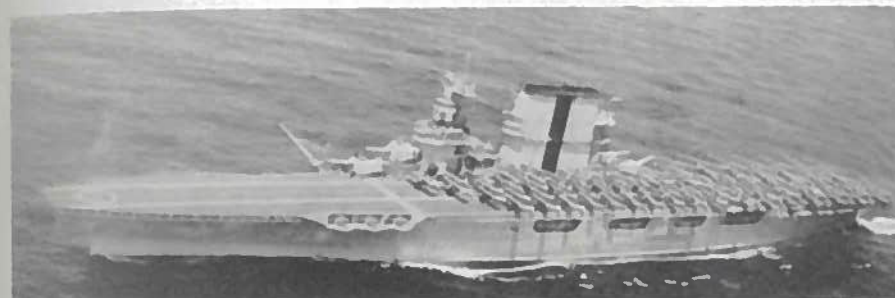
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SHELTER, MAY, 1931



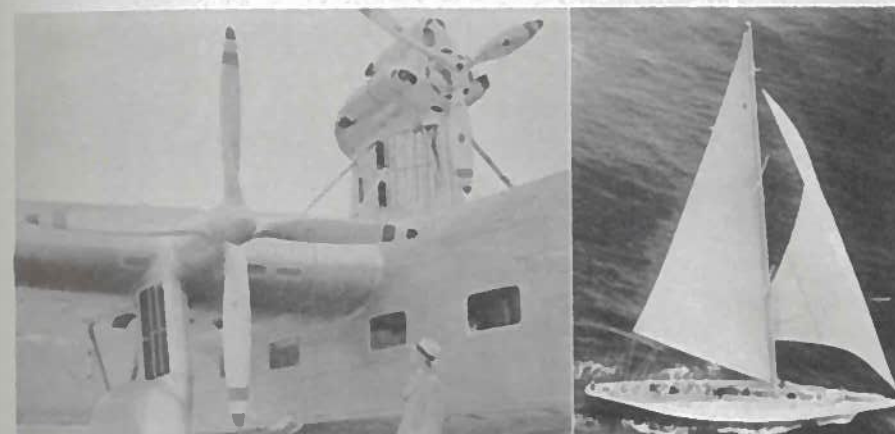
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Arno Dign



2

Arno Dign



3

Arno Dign



4

Arno Dign

Mobile Shelters—Designed for what they will do, not for what they look like. All products scientific-totally date of time, no arbitrary withdrawal of efficiency. Glance of Strength in which factions occur considered. No Dogmatic Order. Successive designs evolutionary. (1) New Ford Abtline 14A. Bearing no resemblance to predecessors. Fullman like accommodations. General saloon, 4 private compartments, smoking, lounge, dining and navigational compartments, two toilets, galley, pneumatic furniture, noise-proofed. 15 tons net, 3 tons (40) passengers, 8 tons fuel. Total 80 tons, 2,500 H.P. Note simplified window and opening design to 1. (2) Abtline Center "Savona": mobile shelter and Marine Field (weekly) comparable non-buoyant Baza An Concrete Architecturalized Sea Domain. (4) America's Cup victor "Entourage" with \$50,000 dual mast saving equivalent ton weight hoisted ballmast. Triangular boom. Total masterpieces and hydro dynamics all multimillion dollar laboratories for Shelter knowledge not pattern.

SHELTER, MAY, 1932

39

-It is a fact- - there is none.
 -It came to pass- - in the continuity language of evolution - 4D.

Covers, Photographs by F.S. Lincoln, Sculptures by Isamu Noguchi. Front: -Miss Expanding Universe-, Back: -Glad Day-.
 Inside Covers, Photographs by F. S. Lincoln, A Streamlined Dymaxion Shelter.

Pass-age 1
 -Putting the House in Order
 Pass-age 2
 -Behind the Scenes
 -Our intimate Journal of Summer Events
 Pass-age 3
 -Fiscal Figs
 Pass-age 4
 -Ecovolution
 -The Dawn of a New Era,
 R. E. Johnson
 -Journal of the Space Hotel
 -When Winter comes
 Ralph Left
 -Conning Tower
 -Potentials to Initiative
 Pass-age 5
 -Streamlining
 Pass-age 6
 -Pan-Continental Shelter Service
 -USSR - on the Problems of Architecture
 S. T. Woznicki
 -SSA to USSR
 Simon Breines
 -An Architect in Russia
 O. K. Fulmer
 -An "international" Ghost
 M. M. R.
 -Wreath to Wraith
 Theodore Larson
 -Our Russian Correspondent
 Mathew Ehrlich
 -Scientific Shelter for U. S. S. R.
 -Shelters of the Orient
 Isamu Noguchi
 -New Building in Japan
 Richard J. Neutra
 -Basic English
 C.K. Ogden
 -Olympic Village
 C.K. Ogden
 -California Ingenuity - National Steel Homes
 -A Library on Wheels
 the N.Y. Public Library
 Pass-age 7
 -Teleology
 Pass-age 8
 -Colloids in Time
 -Isamu Noguchi, F. S. Lincoln
 Pass-age 9
 -Foil, Epee, Broadsword and Sabre
 -Concealed Plumbing

(Pass-age was a pseudonym for RBF)

SHELTER



VOLUME 2 NUMBER 5

Based on observations at Mount Wilson Observatory, the American astronomer Edwin Hubble discovered that extragalactic systems can be identified in cosmic nebulae, i.e., other galaxies exist beyond our Milky Way.

In 1929, it was revealed that Hubble could estimate the distance to eighteen additional galaxies based on the apparent brightness of their brightest stars. In the process, he noted shifts in their spectral lines at the red end of the spectrum, which he interpreted as a Doppler effect on the waves that are put out by stars moving away with increasing speed. This simplest explanation for the observed phenomenon was the basis for his thesis, still valid today, of an "expanding universe." After Hubble had presented diverse proofs that the speed and distance of galaxies were directly proportional, that the speed with which galaxies moved away divided by their distance was a constant, this "Hubble constant" became a central element of modern cosmology and a topic of public discussion from 1931 on.

Fuller had an extraordinary sense for the significance of such discoveries. His speculative space-time model of the "expanding sphere," which was already described in his manuscript "Lightful Houses" and is reminiscent of Emerson and Edgar Allan Poe's "Heureka," now seemed to be confirmed by science and was thus a topic of discussion in the avant-garde circles for which Fuller was already providing slogans. On returning from a trip to China and Japan in October 1931, the sculptor Isamu Noguchi met his friend Buckminster Fuller in New York. The exchange he had with his friend was reflected in the title of his latest sculpture, a streamline flying female figure with outspread arms and legs: Miss Expanding Universe. Noguchi made it for the dance Ruth Page, who in turn was inspired to create a dance with the title *Expanding Universe*. A photograph of the sculpture, which has not survived, was used for the cover of the November issue of the magazine *Shelter*, which contained Fuller's programmatic essay "Streamlining," with preliminary studies for the Dymaxion Car, for which Noguchi had made plastic models (page 188).

Noguchi took up the theme again in 1943, this time for an abstract portrait of Buckminster Fuller. The sculpture titled *Bucky* stretches a body reduced to a torso into a cable structure of rod triangles that do not touch each other. It is an articulation of the principle Fuller would later call *tension integrity* or *tensegrity*. The discovery of this principle of the complementary effects of continuous tension and local pressure was something had always understood, even in his contribution to cosmology. "The universe is a tension integrity," he wrote in 1949.

STREAMLINED "UP"

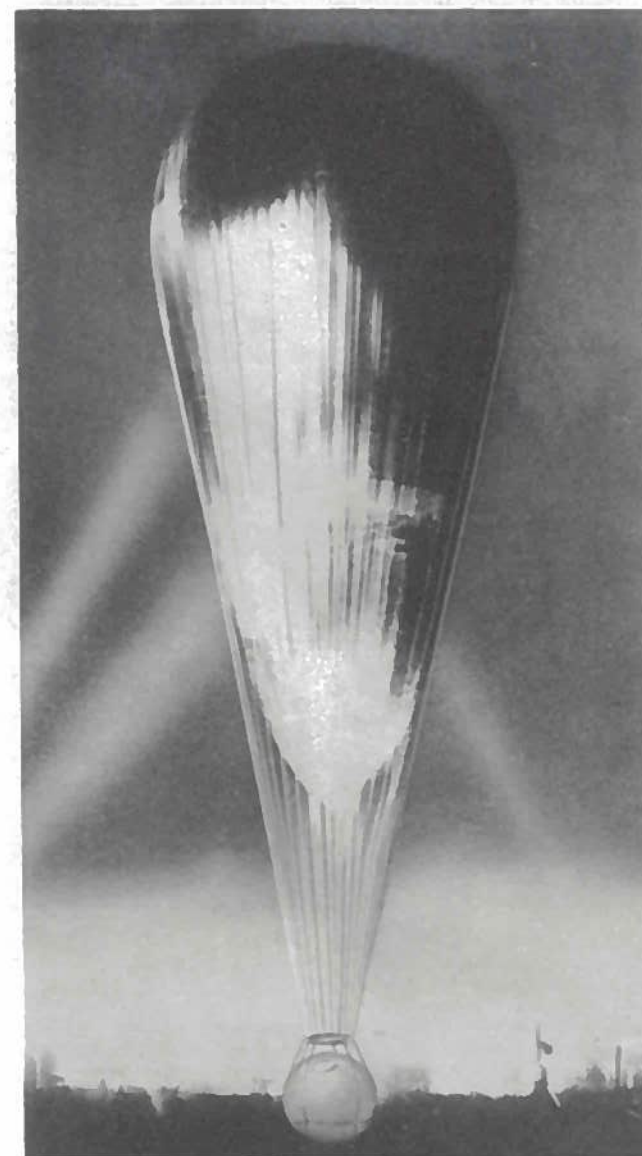
Dr. Piccard's Stratosphere Transport, an unintentional advantage secured incidental to slack of balloon at starting level allowing for great expansion of gas in relatively low pressures of high altitudes. This streamline observation a teleological correlation.

Similar correlation observation found in similarity this picture to a carrot, also streamlined "up". Carrot moves slowly up through earth, held down as balloon by guy lines (roots) during growth period. Roots grow in way at season's end so that with least motion of ground carrot moves in direction least resistance, up to earth surface to rot and fertilize soil.

Since the last issue of *Shelter* a multitude of scientific attainments have been recorded of which this incident is but one.

Here are a few more that should eventually be correlated with *Shelter* service.

X-rays discovered capable of reversing as well as speeding up evolutionary processes. Cosmic radiation has energy of 40,000 million volts, 40 times previous estimates.—Cosmic rays found stronger with increasing distance north and south of earth's equator.—Certain types of diamond found photo-sensitive and productive of electric current. Effect differs from "electric eye" electron discharge.—Visible light ray of longer wavelength will pass through nearly a foot of water with a loss of half their energy, whereas infrared radiation, with wavelengths only a little greater, have only one ten-thousandth as great a penetrating power. Most effective light-penetrating radiation found to be in very narrow band of wave lengths between darkest visible red and invisible infrared.—Marconi "beams" their waves interbreeding.—Heisenberg expounds new theory of neutron as "union" of electron and proton.—Einstein estimates age of expanding universe, including earth, as 10 billion years.



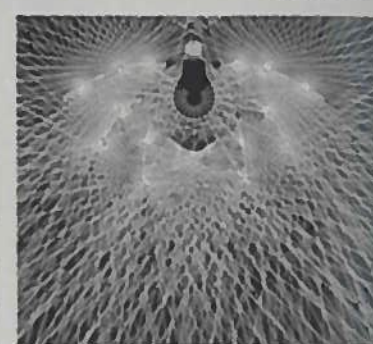
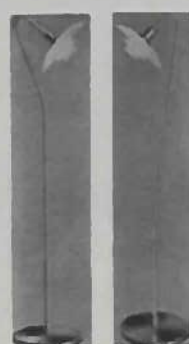
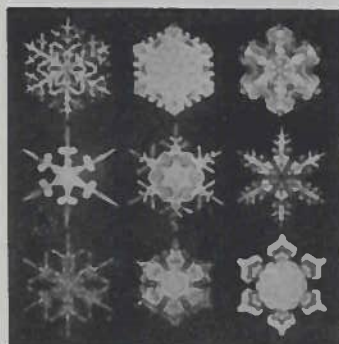
Times Weekly World

TELEOLOGY

SHELTER, NOVEMBER, 1932

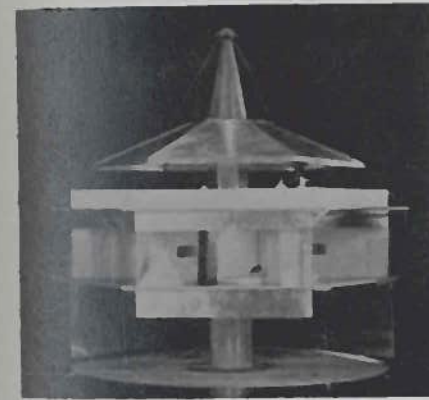
PASSAGE 7

105



"WHAT DO YOU SEE?"—TELEOLOGICAL-DEMONSTRATION

Tension, gravity, timing, streaming, continuity, evolution, rhythm of relative identity, etc.—Typical specific correlation.—The dynamics of the hexagon (force diagram of circle) found in (A) "Centralization" as demonstrated in unification by circular-agglomeration (cable strand); in (B) "Decentralization" as demonstrated in expansion—by crystallization (snowflake); in (C) "Abstraction" as demonstrated in elemental-synthesis (hydrocarbon-coronene). (Coronene recently developed, unknown in nature. Atomic structure: circle of 6 hexagons ("snow"), each consisting of 6 carbon atoms with 18 hydrogen atoms on circumference.) Pictures above—(1 and 2) Olympic games events—girls diving, and sailing races. (4) Snowflakes, invariably six-sectored, never identical. (5 and 6) Scientific P. H. diffusing lights.



(5) Dynamism House designed to withstand all forces which seek to penetrate or destroy human life process, and further to abet growth. (6) "Pig Incubator"—Economy Housing Corp., West Chicago, Ill., capacity 6 sows—sixty pigs—saves your pigs in coldest weather—farrows two litters per pig per year. Little pigs can huddle round heater in central ventilator—windows of cello-glass—allowing majority ultra-violet ray penetration—Price, \$175.—Hogs have "money" value therefore have had a scientific "break". "This little pig went to market."



1 Hurricane—Texas



2 Earthquake—Argentina



3 Fire—Philadelphia



4 Flood—Georgia

HABIT SOUND INADEQUACY

(1) Hurricane—Texas.
(2) Earthquake—Argentina.
(3) Fire—Philadelphia.
(4) Flood—Georgia. Thousands dead and homeless—2,000,000 annual human victims these elements, 1929 estimate. Yet it is scientifically feasible design and fabric relatively "proof" shelter against these forces as well as against marauders, gas attacks, tornado, pestilence, selfishness.

FORCE POTENTIAL BALANCE

(5) Note able design Horton Spheroid. Its shape found most ideal for combination of gas and liquid pressures—and for this reason it requires the least amount of stiffening and can be constructed of thinner material than other shapes with the same safety factor—"Most with the Least"—shape arrived at by filling large rubber ball with liquid and laying on ground allowing it to develop dynamic-bulge.

WORLD EMBRACING FORCE UTILIZATION

(6) WABC's 600-foot radio—CBS Station, Wayne, N. J. (7) New self propelling telescopic dirigible mooring mast, U. S. N., Lakehurst, N. J. (8) A 250,000 volt rotated tower to stand broken line distortion. (9) Hench Henchy transmission line. (10) Snow type dead end suspension tower. (11) Snow type. (12) Eagle-bell trans-line Pacific Coast Steel—Mast erection by halves.

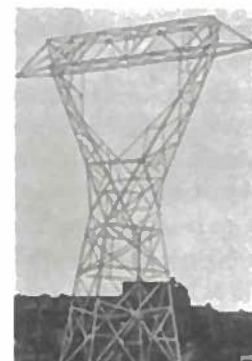
"DON'T FIGHT FORCES, USE THEM"—40



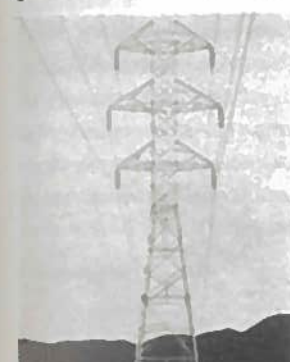
6 WABC's 600-foot radio



7 New self propelling telescopic dirigible mooring mast, U. S. N., Lakehurst, N. J.



8 A 250,000 volt rotated tower to stand broken line distortion



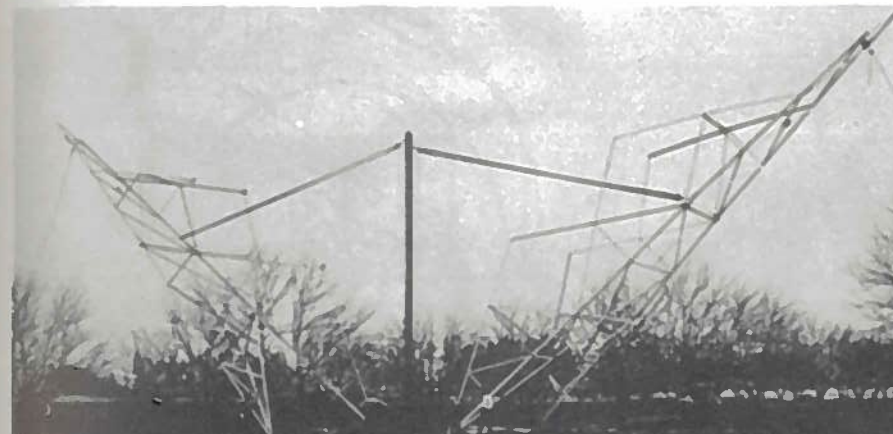
9 Hench Henchy transmission line



10 Snow type dead end suspension tower



11 Snow type

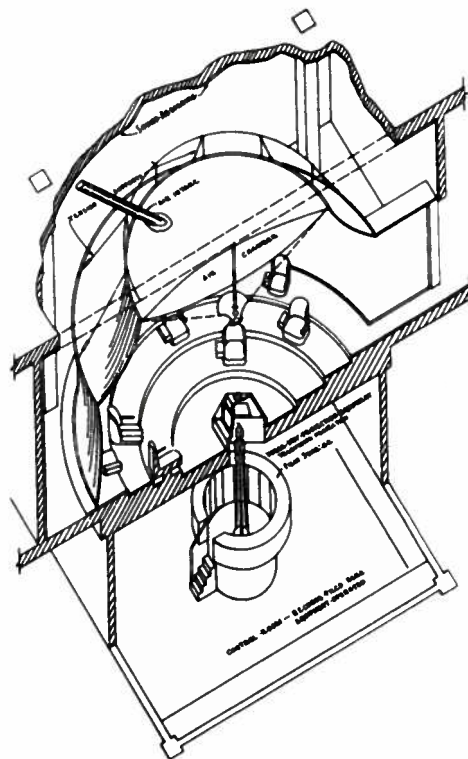


12 Eagle-bell trans-line Pacific Coast Steel—Mast erection by halves

Conning Tower

A mechanical layout for the new "industrial conning towers", showing how, with currently available mechanics, information routing and correlating activity in general may be expedited with a hitherto incredible acceleration, accuracy, and lack of human effort. For instance, it is suggested that all industrial headquarters be equipped with a conference room, to be designed as the 4D "Hoop Skirt" for broadcasting stations as compounded with the latest mechanics of movie headquarters, that all conferences may be recorded by film, visually and orally. The duplication to be eliminated by such mechanics is extraordinary. Conferees who tend to recite acknowledged history, convergent in the specific conference involved, may rapidly be enlightened by a talkie, quite interestingly runnable in a few moments, as the net result of hours of conferences in which there is multitudinous lag for cigarette lighting, banalities, etc. There could be mechanical hookups of industrial until production headquarters by teletype, telephoto and television with central publishing headquarters of industrial units, who in turn would be tactically hooked up in like manner with information sources such as Bureaus of Standards, Navigation, Department of Commerce, etcetera or corporations such as Standard Statistics, Consumers' Research, Science News Service, etcetera, as well as university hook-ups.

The conning tower is free of private records, superfluous accounting, checkup methods etcetera, as the "bridge" of a giant liner or dreadnought, with simple "log" or "continuity notes" of O.D. Economic and elemental mechanical indicating and reporting systems of universal interest are incorporated, such as intramurally integrated ticker services, weather forecasting instruments, economic traffic indicators, elemental availability indicators, storage indicators, storage pile-up indicators, dominant news indicators, harmonic trend indicators.



116 Conning tower - "Hoop-skirt" Room. Design of a common mechanical control center for contemporary lines, text and design REF. Shelter No. 5, 1932, beginning on p. 64.

Isometric air-conditioning by means of fabric cover - no overexposure - text - diffusion of light from a central apparatus using convex testing range of metallic silver fabric.

Section and Plan of Conning Tower showing two deck relationship of tented conference room above and mechanical control room below. "Conference" divided into 3 team-sectors on principle "3's a crowd", and that "correlation of 3 forces essential to stabilization." - 4D.

"Hoop Skirt" designed to compensate cubical structure "interference" factors of sound and light control. Light diffusion enables operation of 3-way movie mechanism concealed in triangular shield of central recording device containing also microphone. In same device are housed speaker for "incoming" sounds and 3-way screens for trans-lux visible displays as required by conning group. Air intake through top envelope - exhaust through step risers.

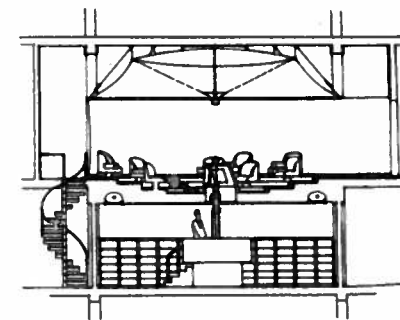
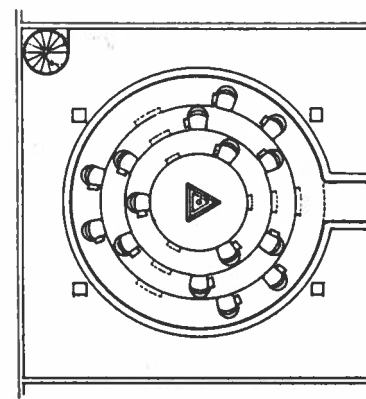
Circular stair leading from mechanical control room to tent exterior enabling operators to circulate around conference without disturbance to conferees. Two-deck segregation obviates visiting conferees conduct alteration as result exhibition-consciousness if aware of recording devices. Mechanical operating room allows of television "in" or "out" operation and provides for storage pertinent film - for immediate conferee reference.

1. Conning Tower designed to preserve the integrity of intellectual progress by freeing the enthusiasm momentum of hitherto stultifying effects of constantly repeated disclosures of "purposes" and "results" which through medium of "conning tower" require but one disclosure for their potential social diffusion.

2. To obviate possibilities of misunderstanding not possible in conference records by written word only - sight, sound, continuity, and delicate gesticulation punctuation made available for reference.

3. To allow of new perspective "to see ourselves as others see us". Not only would this be potential to extraordinary individual development, but also to whole human welfare as conferees would incline to elimination of esoteric idiosyncrasies, and obvious selfishness.

Shelter 5, Nov. 1932, 641.

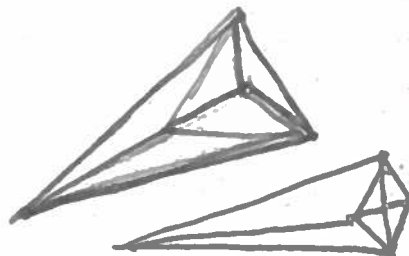


117 Floor plan and section "In" and "Out" - visual and acoustic absorption apparatus. Mechanical control spatially separated from conference room.

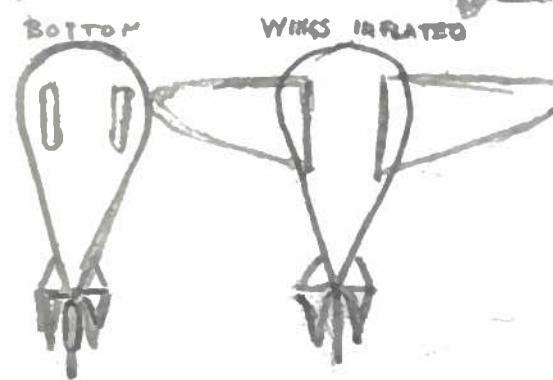
The 4D world lies at our feet. Gone are the leisurely times when an average individual lived in an area with a diameter of twenty miles. Our forms of transportation carry us wherever we are going. Flying is best, but if not flying, then something as much like it as possible. The three-wheel Dymaxion Car developed from the idea of a means of transport guided by side rudders that would roll in front and fly in back. Fuller enlists Starling Burgess, a recognized expert in the construction of high-performance yachts. The form is sensational. The car causes a stir; it is unusually fascinating; it is "amazing." The second coup for Dymaxion, even more resonant with a broad audience than the house was. Not a finished product, but a built sketch with a long life.

DYMAXION CAR

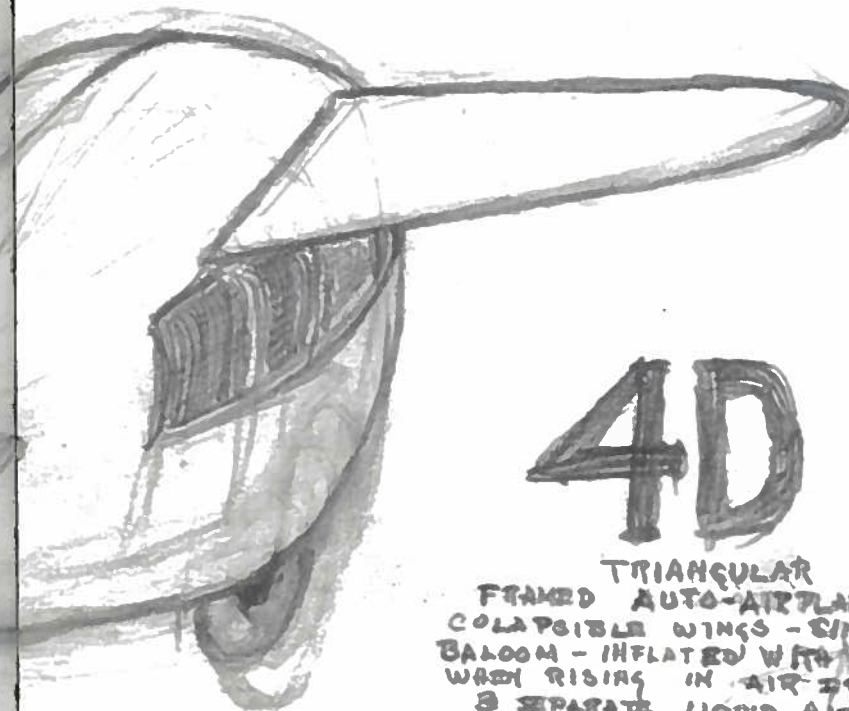




WINGS ARE AUTO
HIGH SPEED
SHIMMY AND HEAVY
TURNING THUS ELIMIN-
ATED



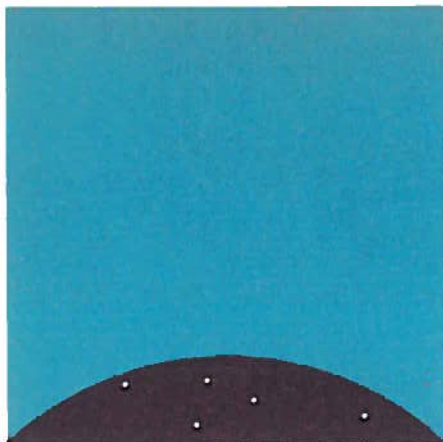
WINGS ARE
INFLATED RAPIDLY
BY LARGE AIR
INTAKE ON NOSE
OF PLANE THEN
PRESSURE IS
BOOSTED BY
AIR PUMP.



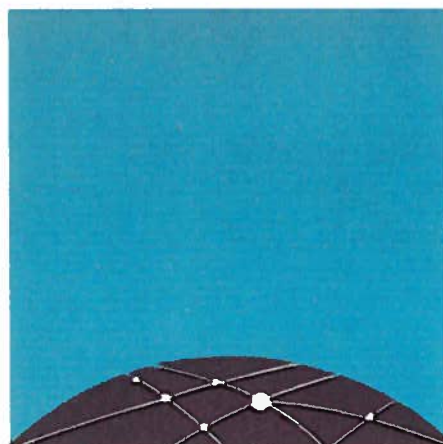
4D

TRIANGULAR
FRAMED AUTO-AIRPLANE WITH
COLAPSIBLE WINGS - SIMILAR CHILD'S
BALLOON - INFLATED WITH AIR OR GAS
WHEN RISING IN AIR FROM ROAD.
3 SEPARATE LIQUID AIR TURBINE
CONNECTIONS TO EACH OF FRONT
WHEELS AND TO PROPELLER.
PROPELLER LOCKED IN
STATIONARY POSITION
UNTIL ELEVATING.

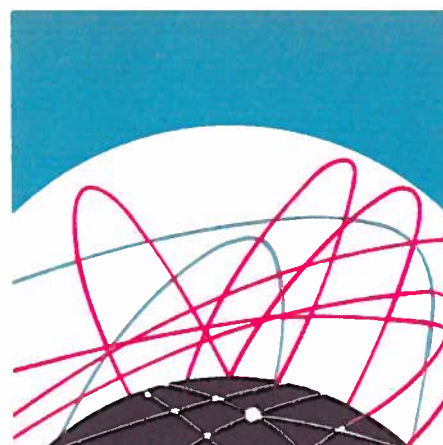




500 000 v.Chr. - 1850



1850 - 1950



1950 - ...

Man on Earth

Shown above are the three most distinct pictures of the history of man's years on earth. Picture one may be called, "The first half million years were the hardest." Ignorant and isolated, man was unaware of other men and of the potentials of friendship, integrated resources, and mutual survival. The first picture is of a microbespeckled, enormous sphere, an arithmetical isolation, a physical impasse, escapable only through intellect, instrumented - through science.

Picture two shows man linking up resource and survival by lines of transport and communication. Wealth is generated astronomically. Standards go up. Health and life expectancy tend to double. But in these 100 years the velocity of integration and increased energy flow leads to an arterial clogage and explosive high pressure. The two-dimensional picture is a neat limited equation, fulfilled - and again occurs an impasse escapable only by intellect.

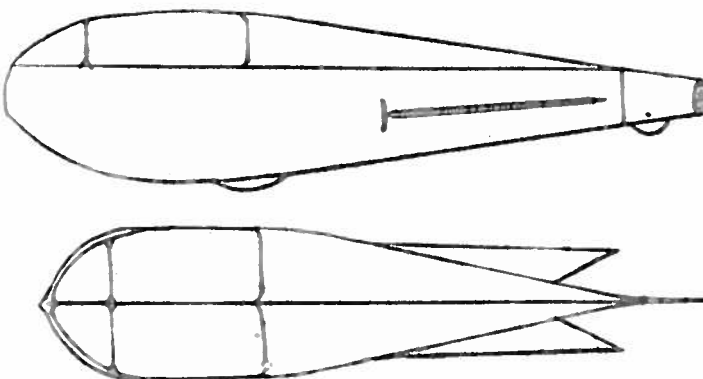
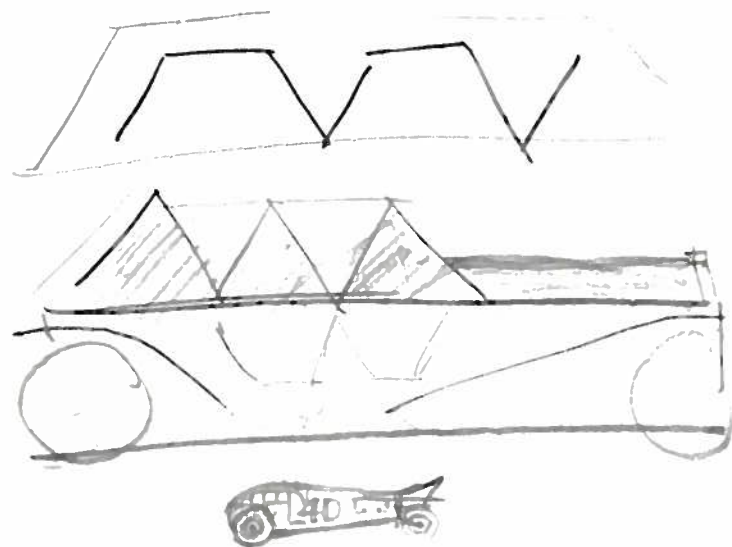
Picture three shows the intellectual answer - a new volumetric and dynamic dimension - wireless, trackless, omnidirectional. It is a high-frequency interaction of time synchronized, relaying from resource to logically dispersed processing centers for physical separation, reintegration, and unimpeded direct flow to next function. It bypasses all constrictions, yet in every way facilitates man's range and frequency of voluntary assembly and separation in a continuity of ever higher standards of environment and process control.

Picture three is a moving picture. Everywhere its physical facilities move with ever-increasing velocity and synchronized knowledge, allowing man to choose when and how and where he wishes to move. He specifically controls his own accelerations and decelerations. Picture three's scientific key is: to serve an ever-increasing number of functions of more people more of the time, with an ever-decreasing investment of energy, matter, and numbers of parts per unit of function, by ever greater intellectual re-investment of man's unique capital asset, "hours of time of his life."

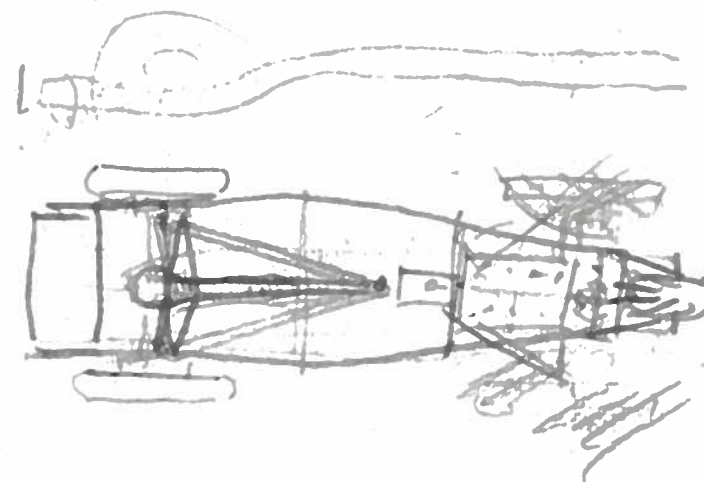
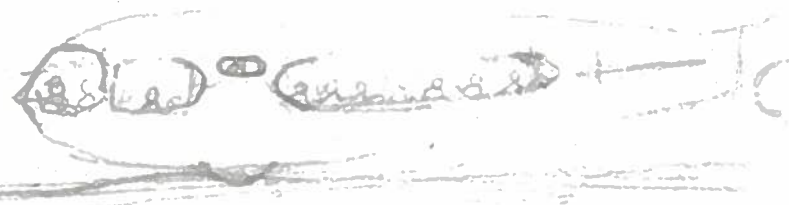
Picture one is very long, as it was "against forces." Picture two is very short, as it was "transitional." Picture three will again be very long, as it is truly "natural." It synchronizes with the dynamic universe. The evolution of its "transport species" is multiplying. Here we go ... but you need not hold your hat ... It won't blow off.

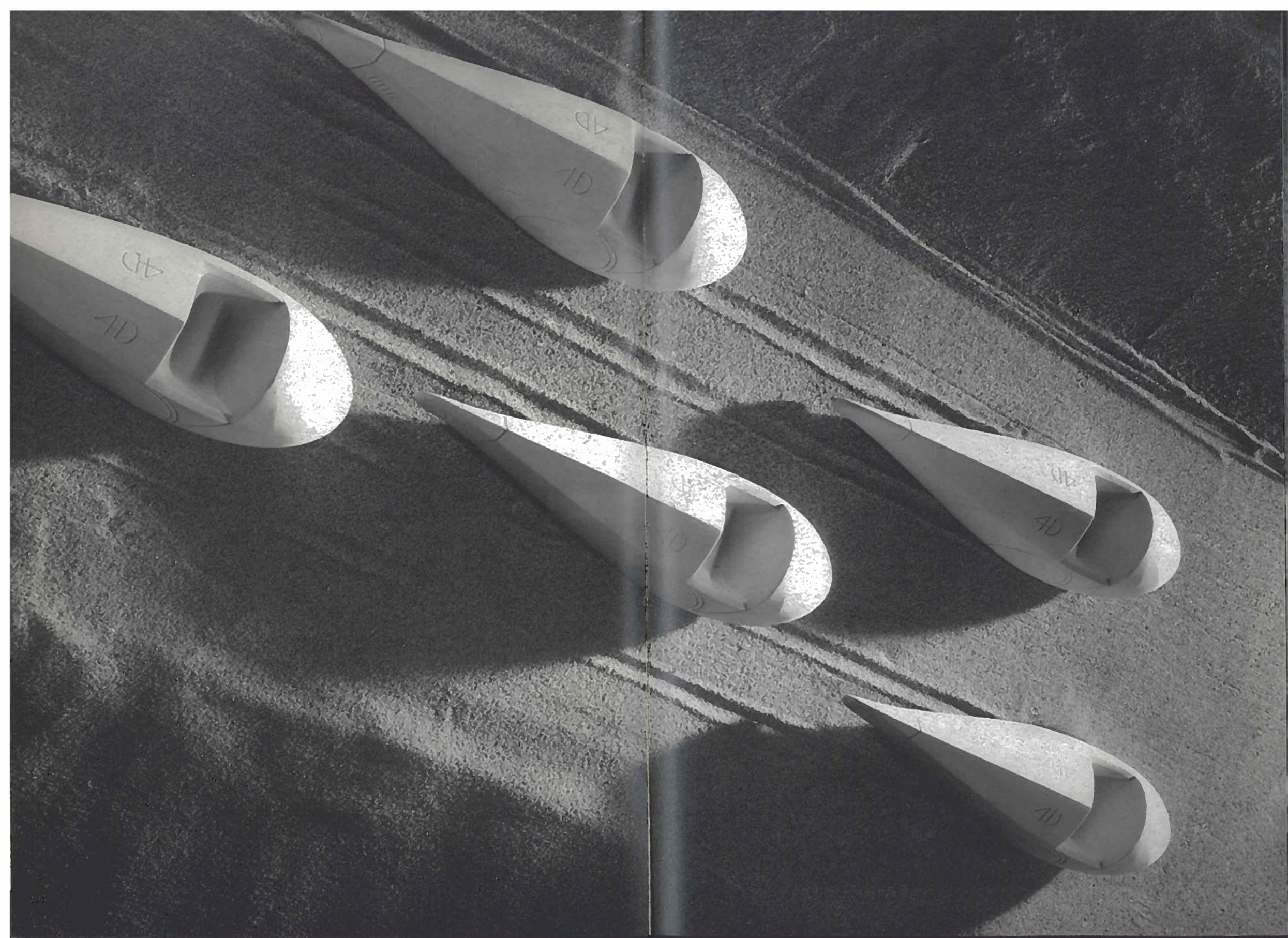
"Man on Earth" (1950), in L. Sutnar: *Transport* (Preface RBF)

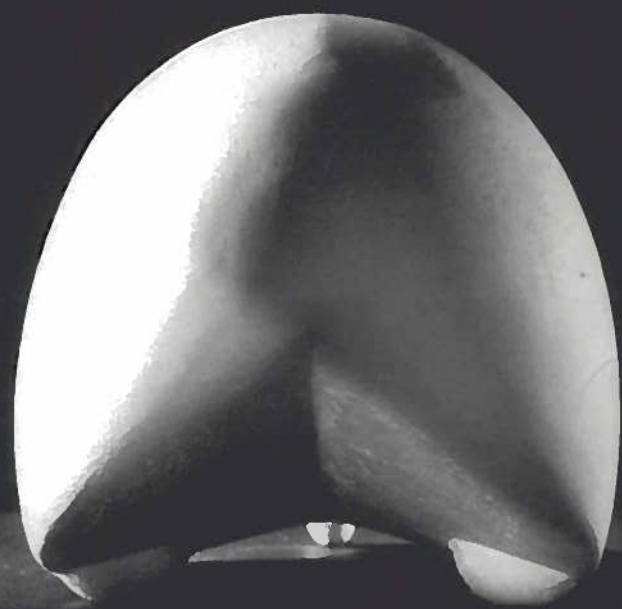




4D TRANSPORTATION UNIT
MAGEL

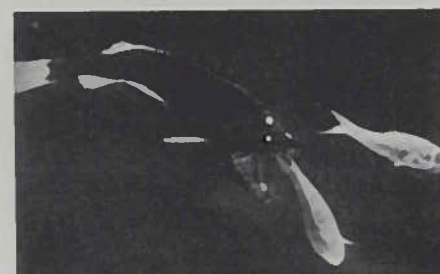
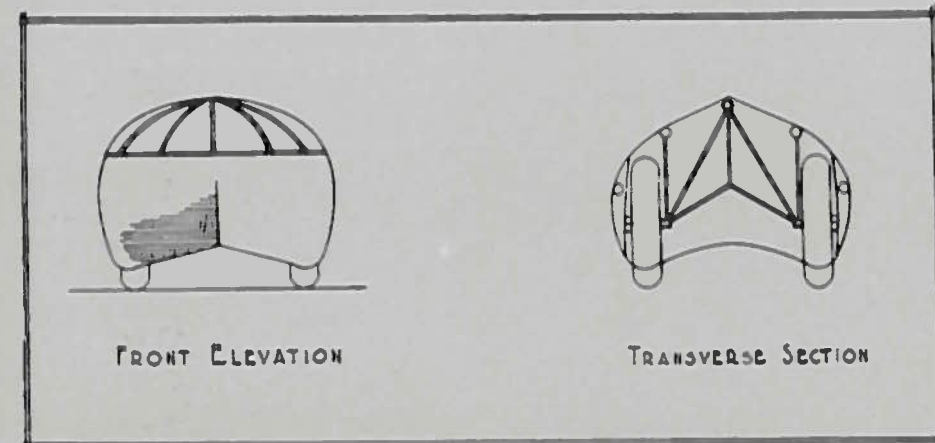
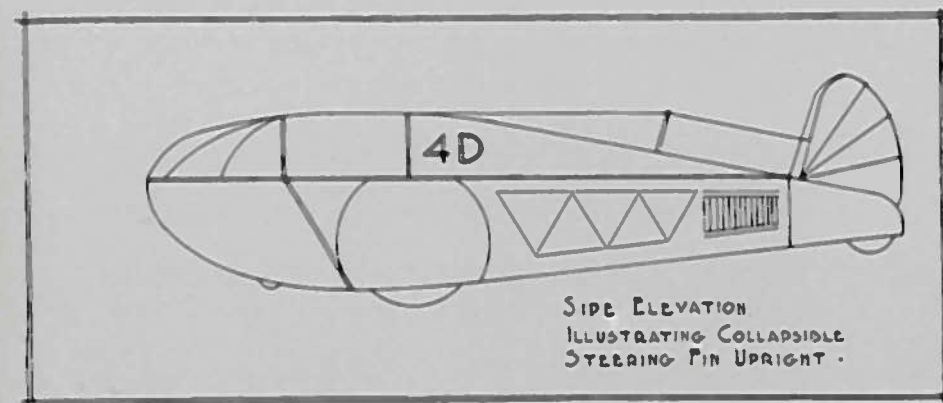






188' 4D Transport Unit, gypsum model, side and front views; negative mold should generate air cushion and lift

188' "Streamlining," page from article in Shelter No. 8, 1962, 78



(c) H. G. B. N. Y. Times.



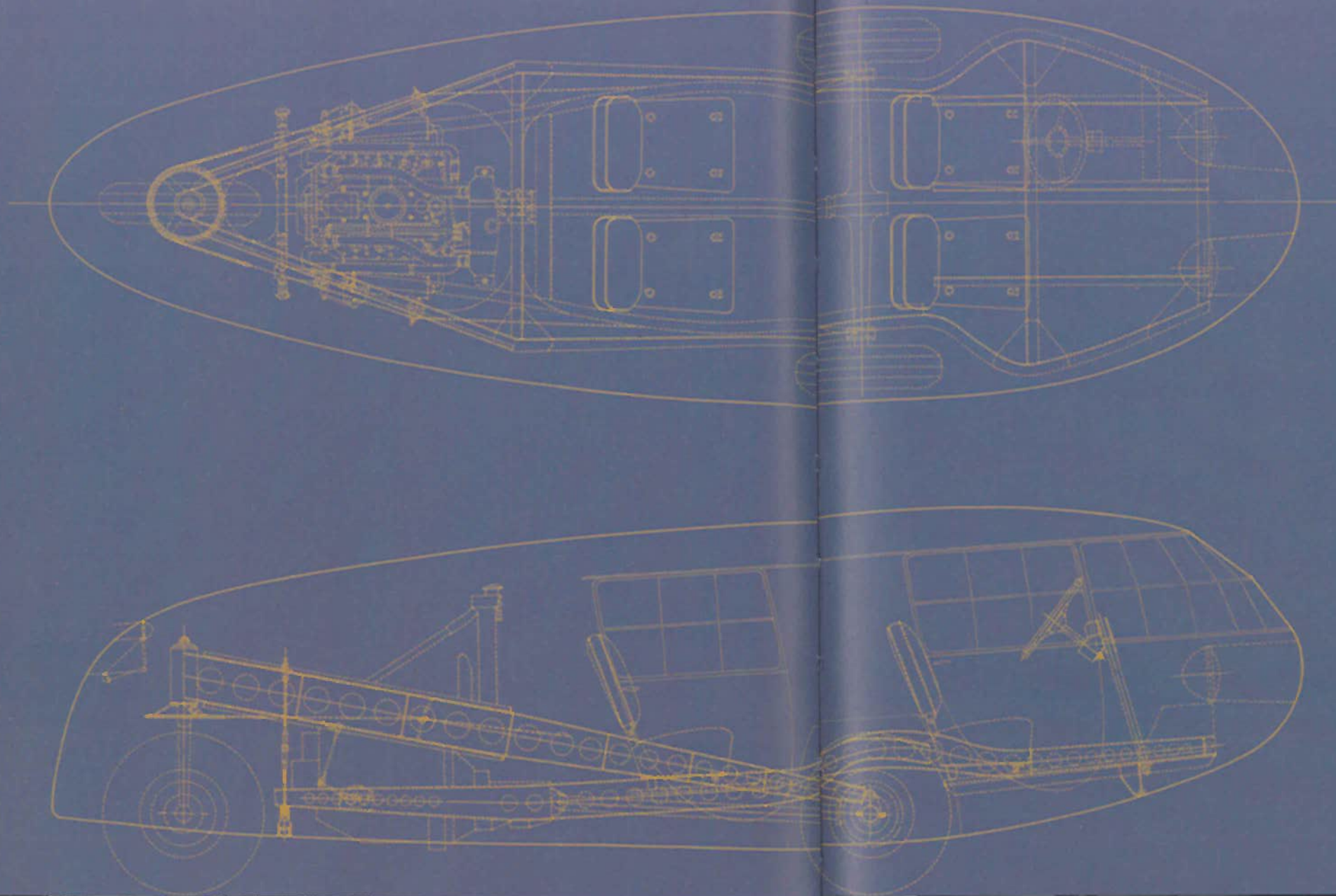
Courtesy Hamburg-American Line.

4D TRANSPORT - DIAGRAM ABOVE SHOWING FAN-TAIL RAISED X SECTION AND FRONT VIEW

Note similarity to luminous fish (below) large fish streamlined contour even with mouth open by inclusion victim; also (lower right) streamlining of palm tree as well as of Graf-Zeppelin in Germany to Brazil 3 Day Service.

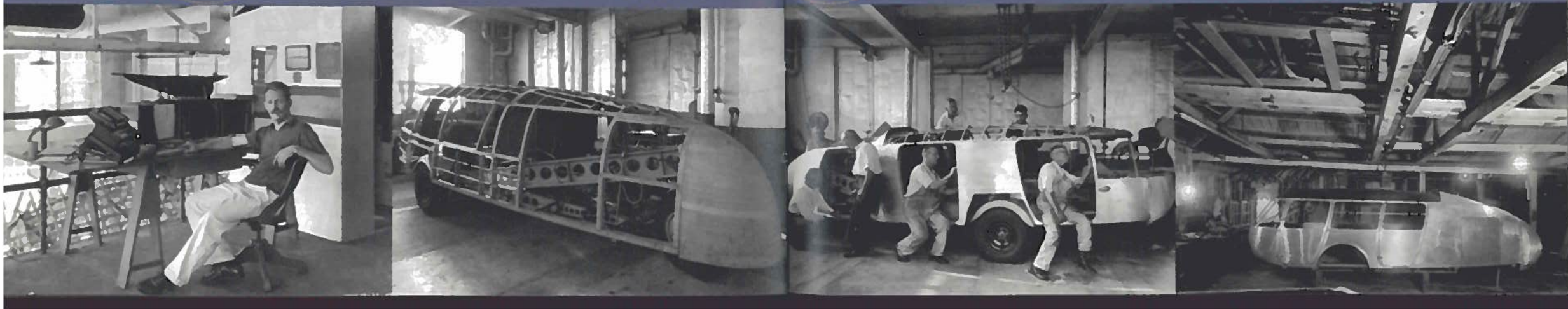
SHELTER, NOVEMBER, 1938

75

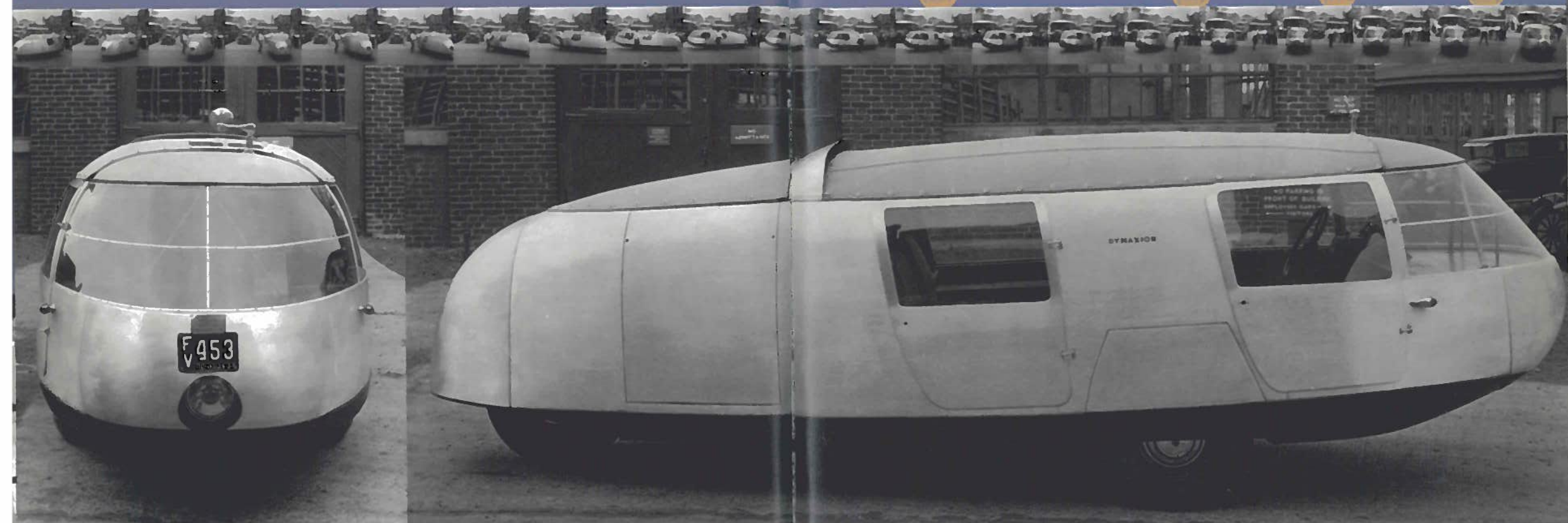
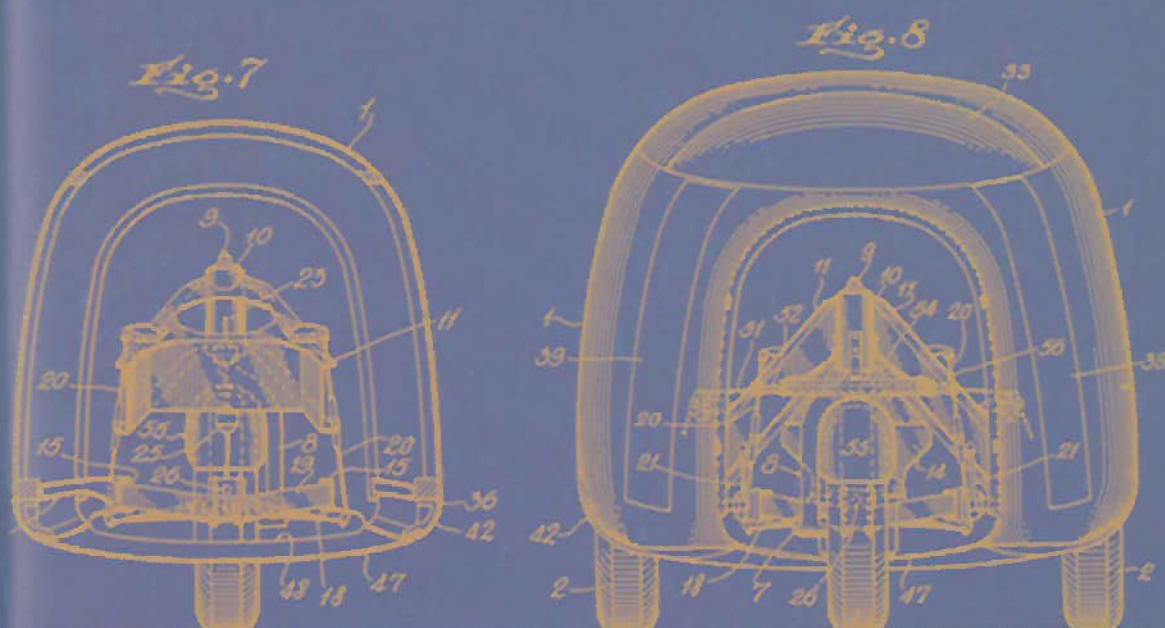


-Dymaxion Car No. 1 (1933), plan and sectional elevation. Three wheels, rear-wheel steering. Front-wheel drive using Ford motor. Streamlined body work developed in collaboration with the shipbuilder Starling Burgess. Wooden framework, aluminum planking, roof made of fabric; Total length 5.80 m.

-Below: workshop building in Bridgeport, Connecticut, and three phases of the manufacturing process. Left: Starling Burgess in the shop.



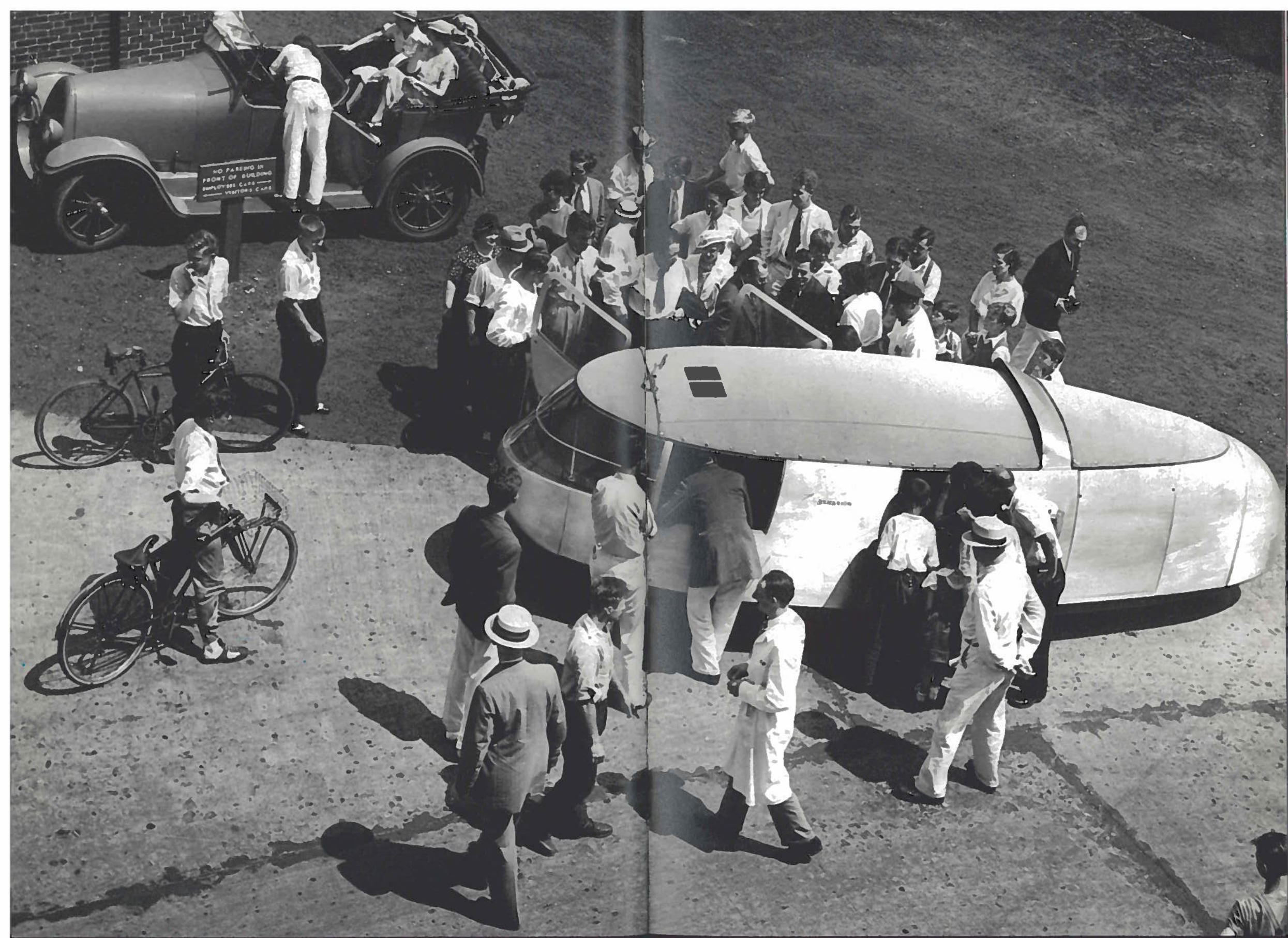
If this car had been the only thing Fuller designed, then he would have been just one among many who wanted to give the automobile a fundamentally new architecture – and this included other exceptional engineers. As a technical construction, the Dymaxion Car was not a success, but it is still significant as evidence of his wide-ranging search for innovation. Fuller was seeking a scientifically determined streamlined body. In his essay "Streamlining" in *Shelter 5* (November 1932), he established a direct connection between the ships, planes, and streetcars of the future: "Planes and ships are steered from behind; if they had a rudder in front, it would break off." The main feature of the Dymaxion Car is that it has three wheels – the rear wheel is for steering, and the rigid front axle is driven by a motor in the rear. This scheme is problematic, first, because of the adverse distribution of weight, and second, because of the direct transfer of physical laws of fluid dynamics – of liquids and gases – to a vehicle that is limited to streets, a type of motion in which no drift can be tolerated and reliable traction is the first requirement of safety. Three of these cars were built, all of them different. None of them is a "prototype" in the usual industrial way of thinking that was so important to Fuller. Nevertheless, the external appearance of the car was electrifying; its aesthetic is still strong today (the contribution of the ship builder Starling Burgess), and the work as a whole had an enormous impact on the subsequent questioning of the norms of the "horseless carriage." As late as 1943, Fuller designed a small car for the industrialist Henry J. Kaiser using the same principles (it was not built). The dance of the car around the traffic policeman in an intersection on Fifth Avenue, recorded in 1934 for the weekly newsreel, was an early sign of the showman in Fuller.



192 Dymaxion Car No. 1, front and side views

196 Two cross-sectional views (with aerodynamic profile) from the patent application

198/199 Dymaxion Car No. 1, after its completion, July 1933



DYMAXION

The First Stream Line Car in the World

THE FIRST STREAM LINE CAR IN THE WORLD IS HERE ON ITS TRIAL TRIP FROM BRIDGEPORT, CONNECTICUT PRIOR TO ITS EXHIBITION AT THE CHICAGO WORLD FAIR.

ITS DESIGNERS WILL TAKE PASSENGERS ON A SHORT RIDE AT 50c FOR ADULTS AND 25c FOR CHILDREN FROM 2.30 TO 5.30 P. M.

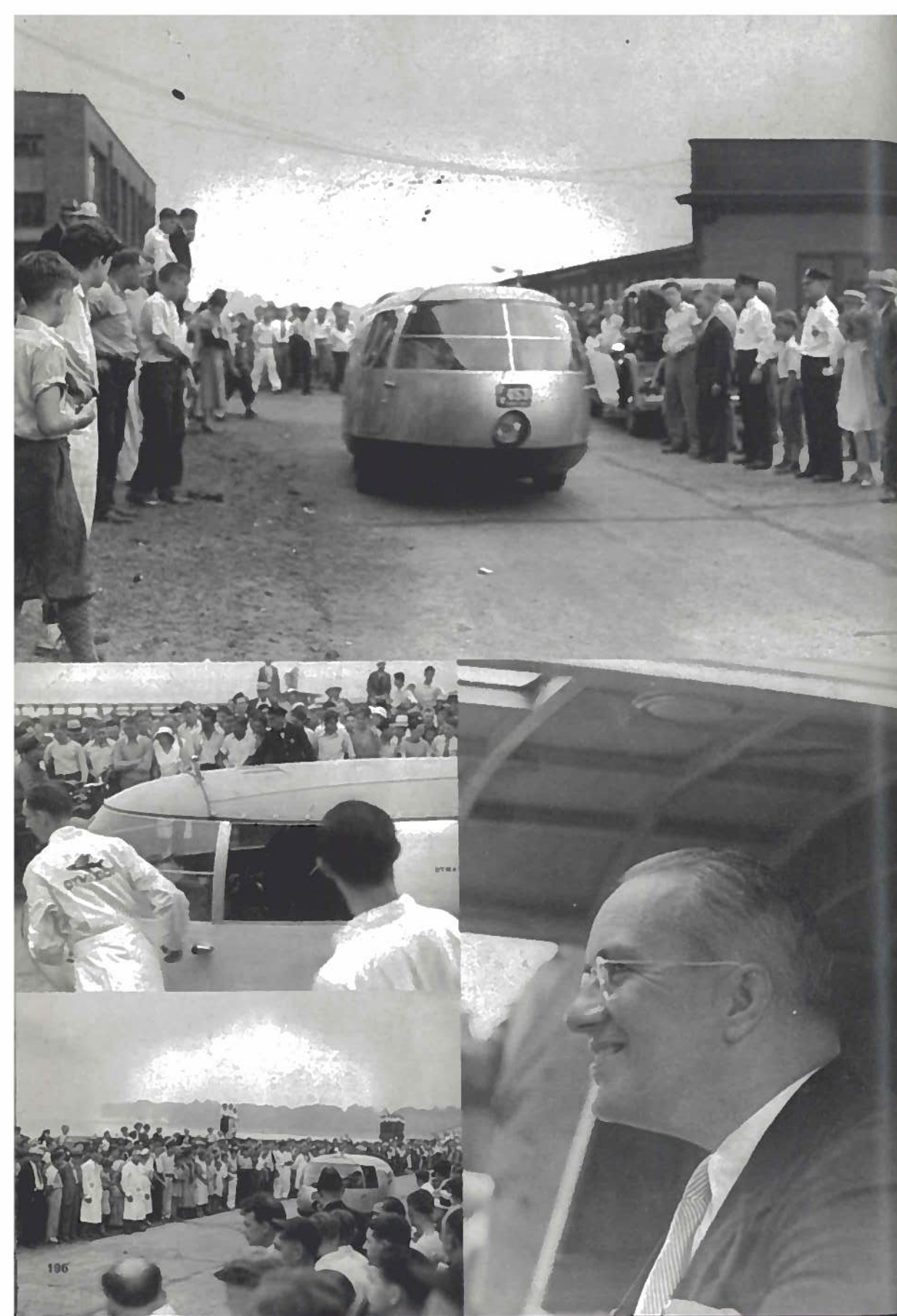
Friday, July 28

Under the Auspices of the
Damariscotta Mills Library

BISCAY CHARITY FAIR Bremen, Maine

187 First test and demonstration drives, July 1933;
R&F of the wheel

Sign announcing the public demonstration
188/189 View from the interior; Schematic drawing defining
specific steering characteristics, 1933





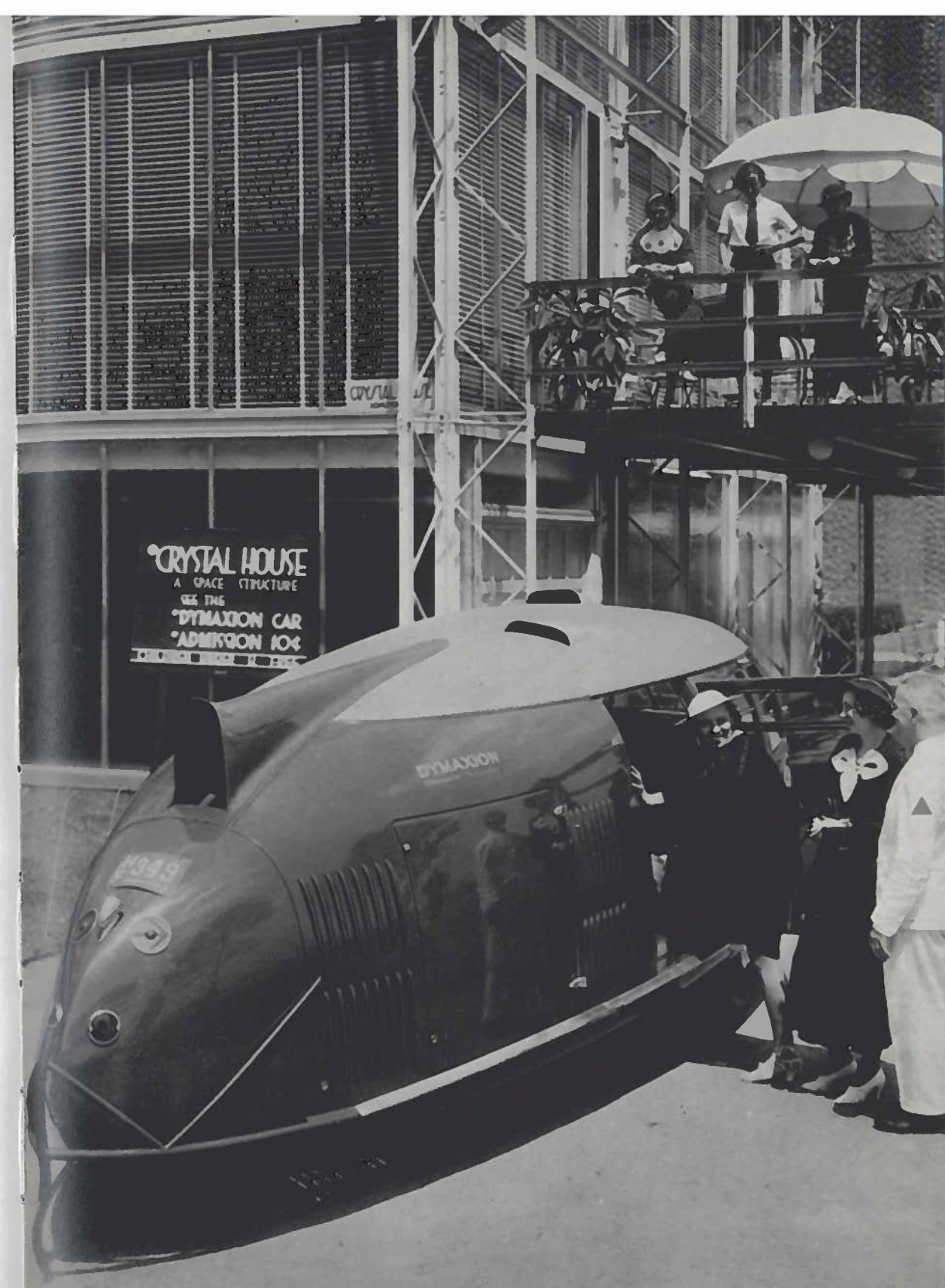
The House, the Machine for Living, and the Veranda on Wheels

On the old farmstead there were a great many buildings to be seen – the great barn, containing hay and cows, the stables, corncribs, silos full of wet fermenting ensilage, the woodshed, pigsty, the carriage house, the cold cellar and the warm cellar. All these buildings and many others on the farms are disappearing or have disappeared because machinery in the house has displaced the functions carried on by the so-called “buildings.” The small electric refrigerating device took the place of ice, the icehouse and icebox system. The electric current took the place of the wood, the woodshed and stove system, etc. In two decades the windmills, formerly on every farm, have gone.

In this way, we discover that the buildings, which controlled energy conditions of heat, cold, dry, and wet, were in effect machines because machines process and control energy. All those machines known erroneously as “buildings” have now been replaced by machines more readily recognized by us as machinery. Now, however, the recognizable components are decreasing as technology employs more and more of the invisible capabilities of electronics. What we are witnessing is the disappearance of the ever less economic “housing” or slow-motion phase of machinery as its functions are taken over by the high-speed machinery that brings about and maintains the preferred environment conditions at ever less cost and personal effort. This evolution is well underway, but we hide it from our awareness through semantic error, typical of which is society’s noncomprehension of what Le Corbusier meant when he said, “A house is a machine for living.”

(...) When tools, and more tools, came to shorten the time taken to do a given job, the farmer gained more time of his own. Finally, he had enough time before twilight to sit and look at the scenery, and he built porches around his house. As he began to have more and more time, he began to put screens on the porches. With ever more time, he began to put glass windows on the porches. Sitting on his porches, he watched other people go by. Then came the automobile, which in effect put wheels under his glassed-in front porch, so instead of waiting to see people go by he drove down the street to see the people. In a very real sense, the automobile was part of the house, broken off, like hydra cells going off on a life of their own. The young people who used to court in the parlor, then on the glassed-in front porch, now began to do their courting in the automobile, or the porch with wheels. Today, the young people do their courting in their parlor on wheels, driving it to the drive-in theater. Because we are conditioned to think of the house as static, we fail to realize that the automobile is as much a part of the house as is the addition of a woodshed.

Utopia or Oblivion, 1969, 357



201 Dymaxion Car No. 3 at the World's Fair in Chicago 1933-34
A Century of Progress. Photograph taken in front of the
Crystal House designed by George Fred Keck, REB.

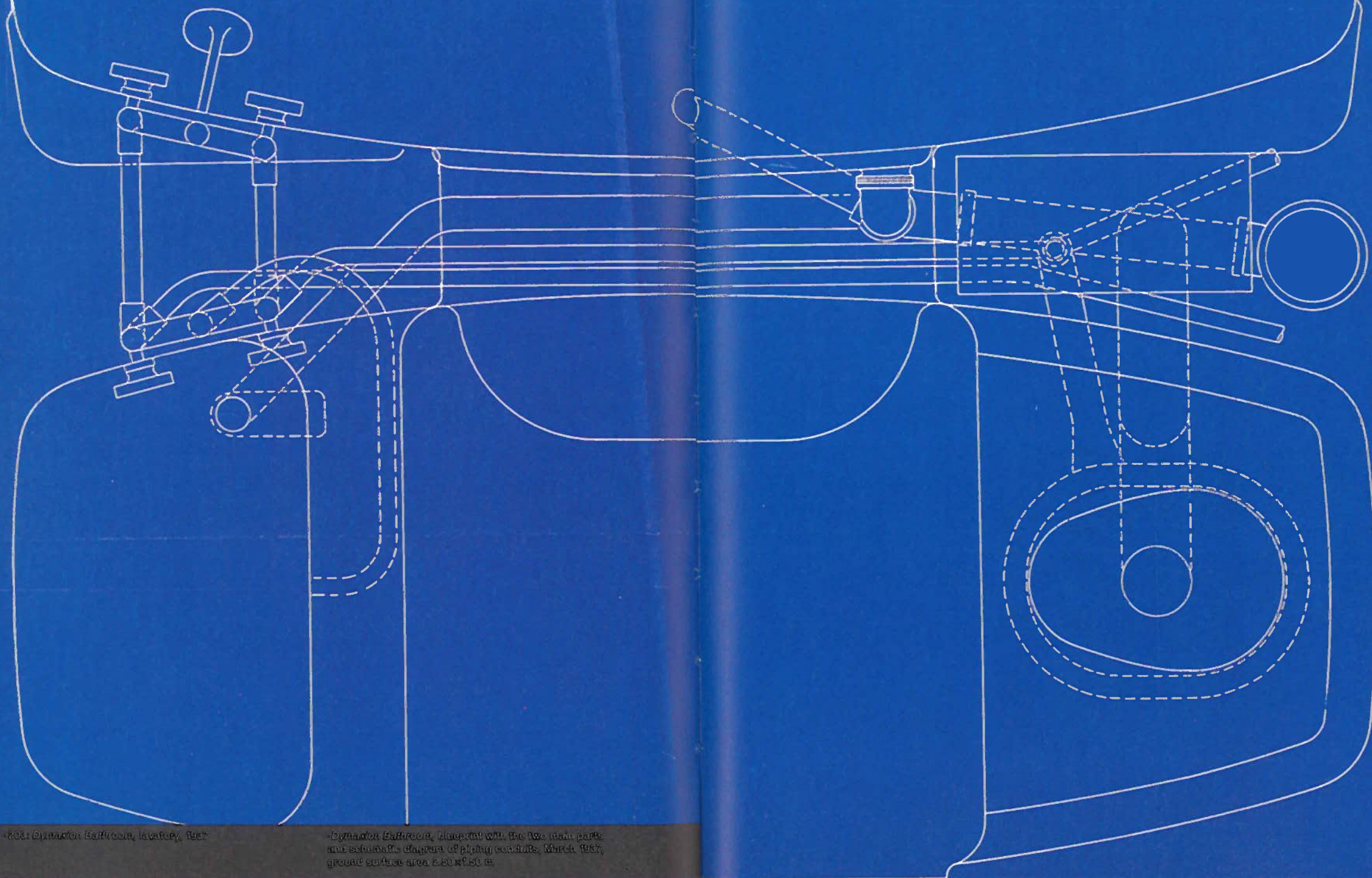
The project for an industrially manufactured bathroom came closest of all the Dymaxion projects to implementing industrial production in series, but it foundered because the plumbers resisted it, fearing for their jobs. The bathroom was designed to work both as a part of the Dymaxion House and in renovating older buildings. Its elements (bathtub, toilet, sink, integrated lighting, ventilation, and plumbing) were designed with an eye to minimizing the number of parts used in construction. The design shows what industrialization meant for Fuller: high investment cost and low part cost thanks to mass production. A built-in version without the upper section was also completed and patented.

DYMAXION BATHROOM



In 1936 I developed a much improved unit for Phelps Dodge Corporation which weighed less than a single bathtub of that time ... However, I have never felt that this project was really worth pursuing because there are other better ways of cleaning ourselves. Today we have learned from industry that when we clean a watch or a gyroscope we do not have to dunk it in a bath tub ... We found that it was possible to get along without a piped-in water supply by using atomized water under air pressure. In this manner we can do a very successful personal cleaning job with a pint of water brought to our residence.

"Architecture Out of the Laboratory" (1958)



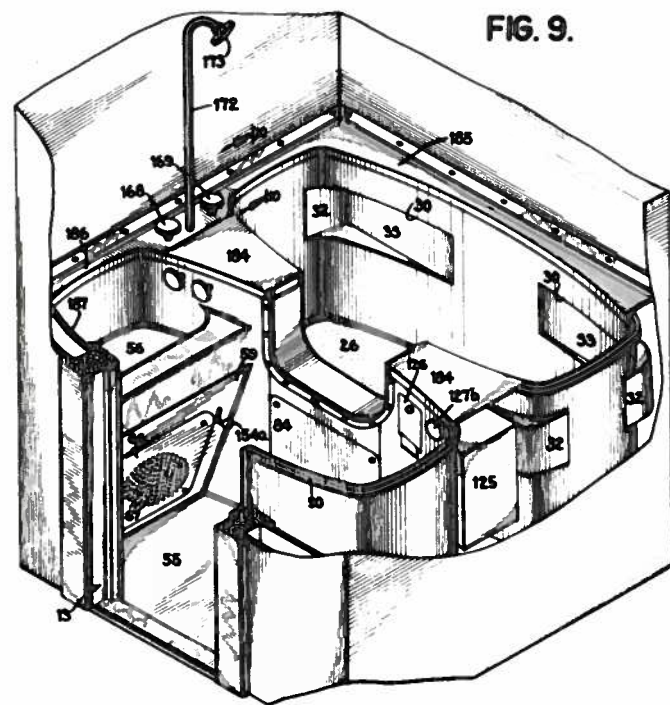
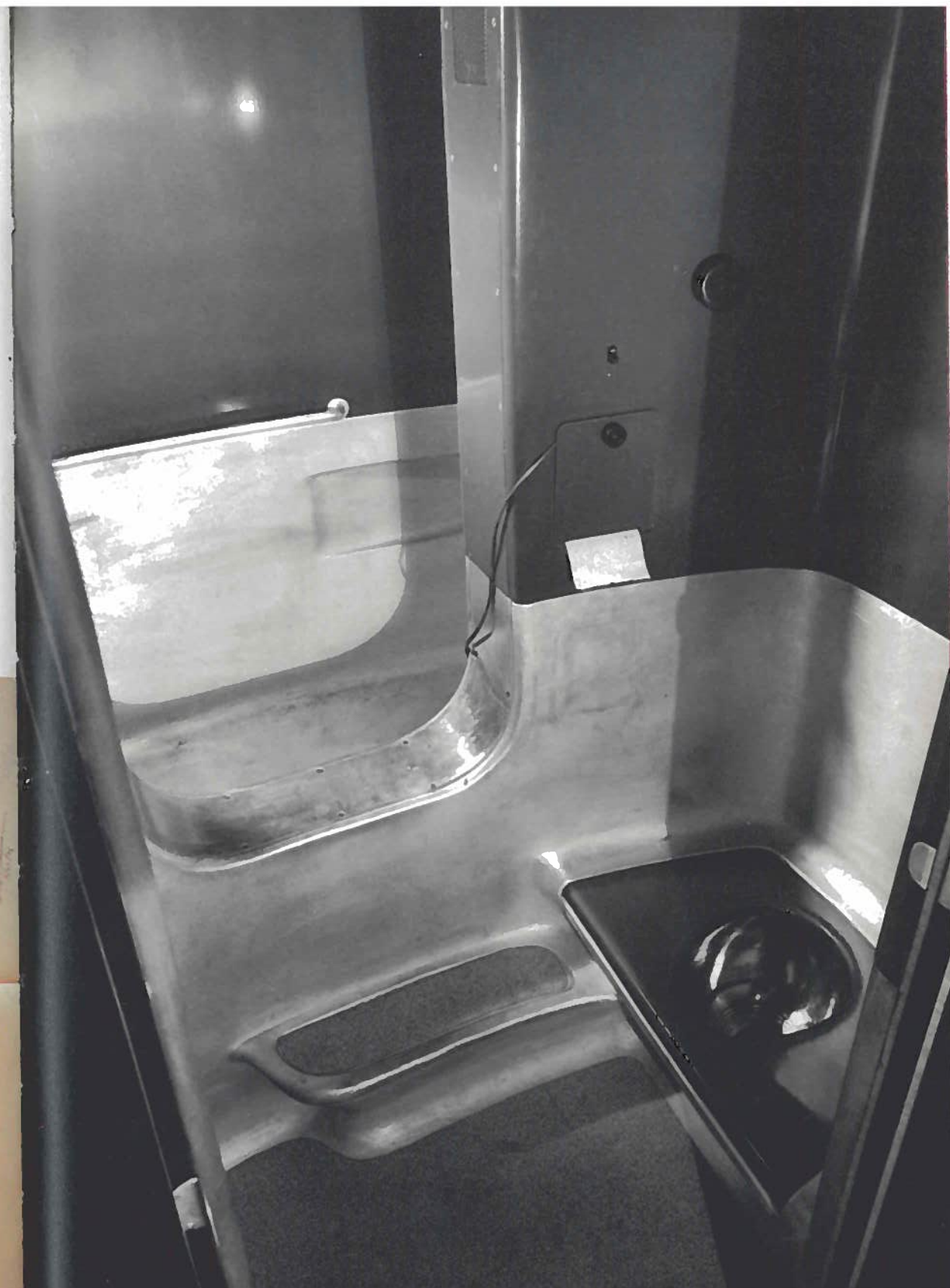
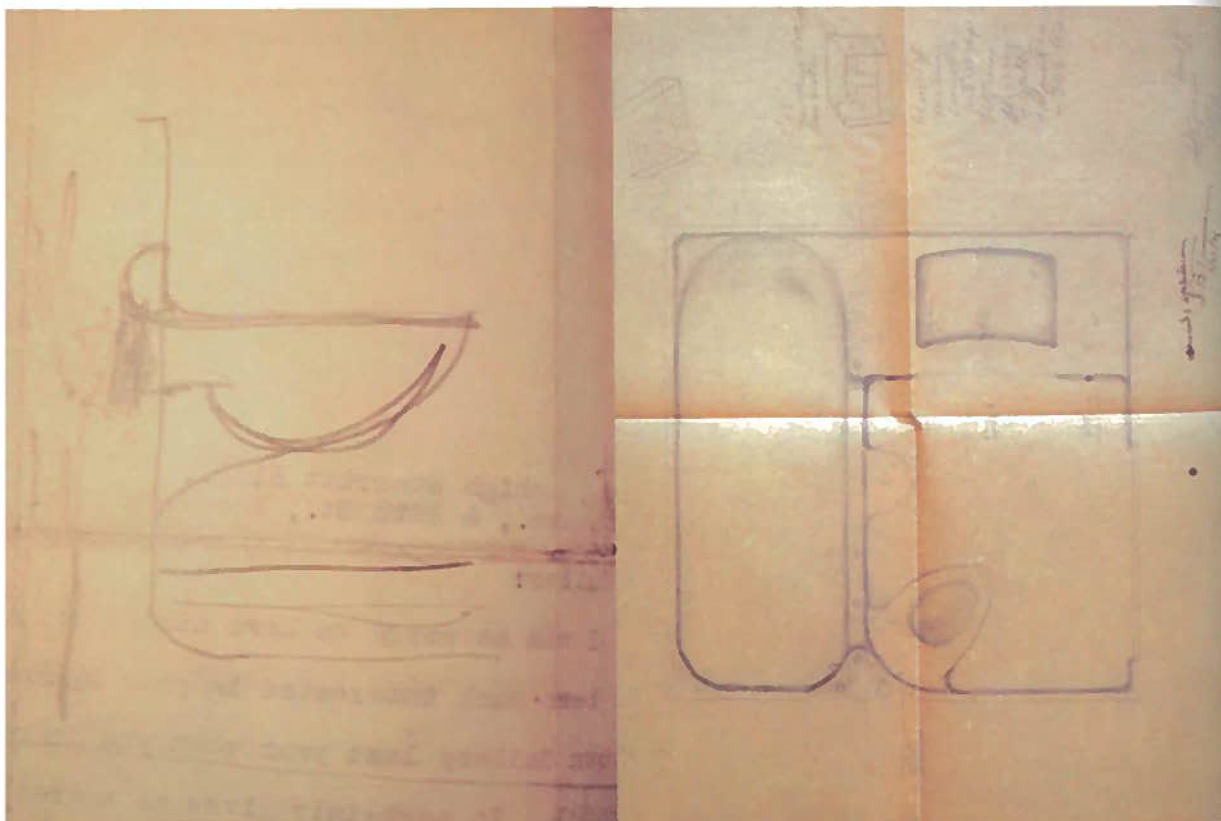


FIG. 9.

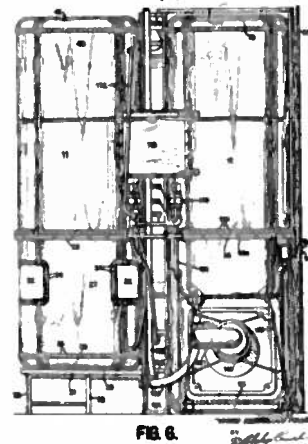
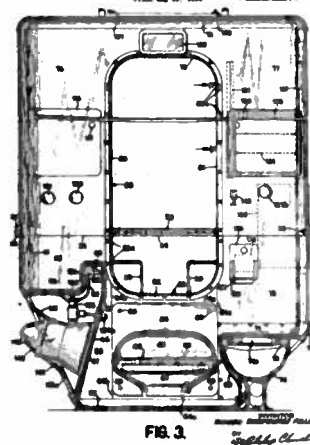
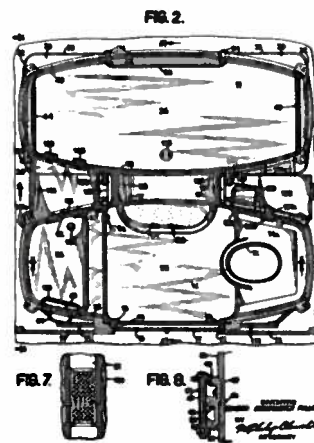
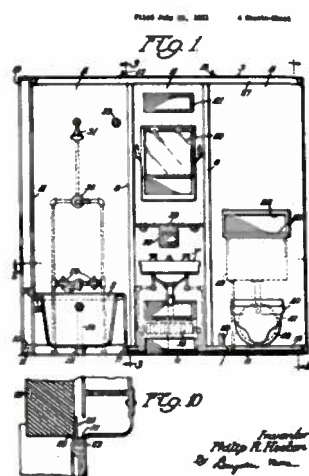
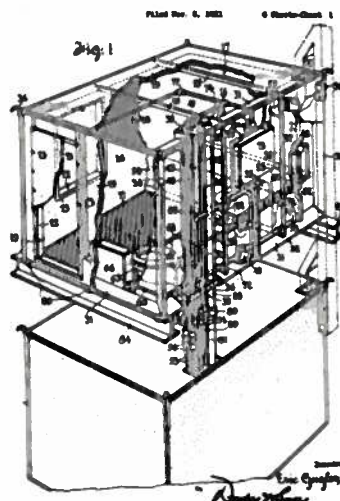
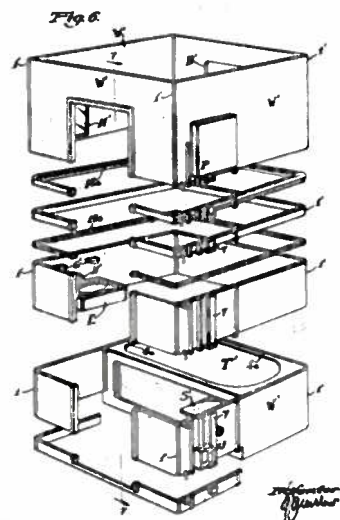


207. *Dynastion Bathroom, 1967, photograph of interior. The two sections of the sofa, each die-stamped in one piece, are joined along seam by U-shaped connector component.*

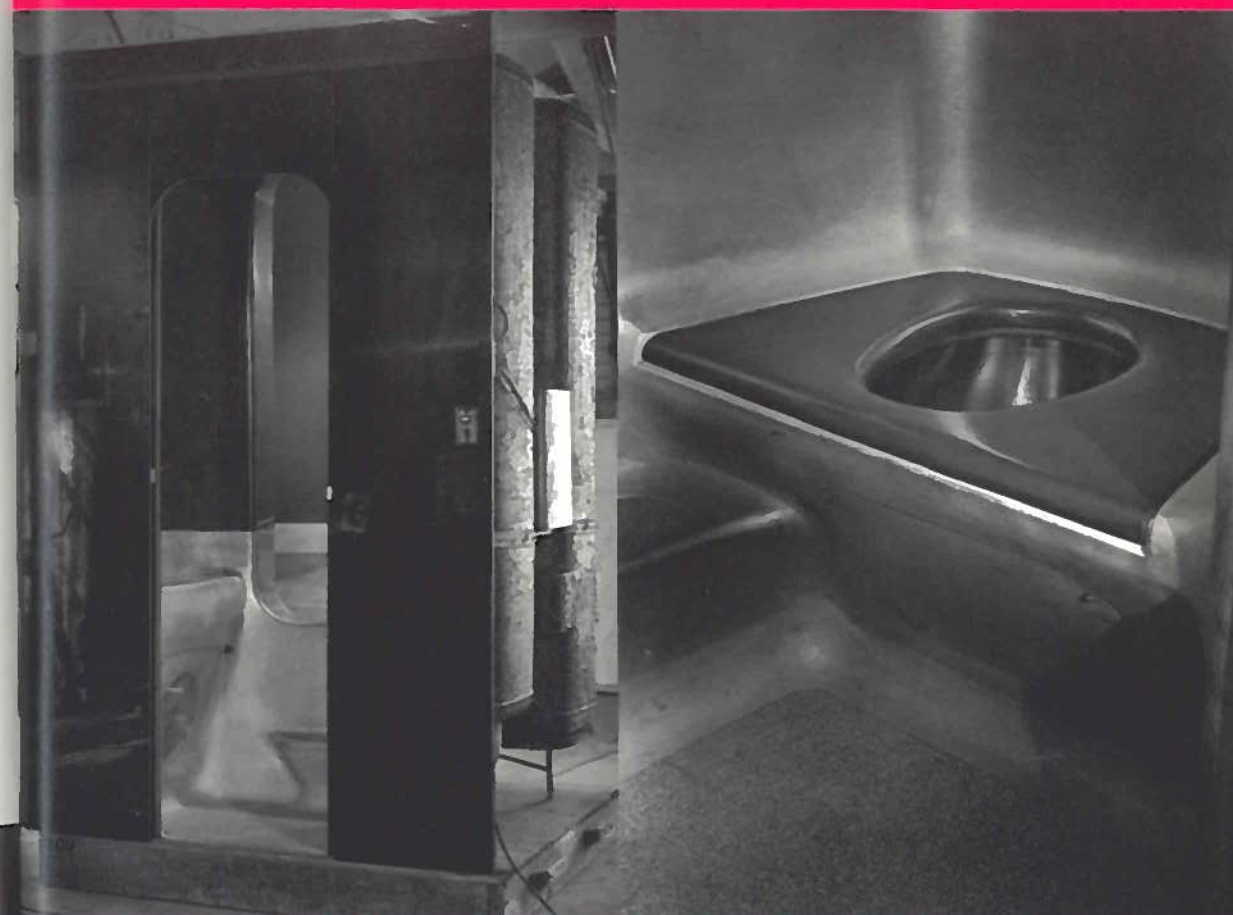


206. *(above) Dynastion Bathroom, prefinalized version (without need to be inserted into existing structures, patent application, 1966).*

(below left) Dynastion Bathroom, detail: toilet seat, sketch from Chronofix 1966. (below right) Dynastion Bathroom, early sketch, 1966, Chronofix 1966.



The Dymaxion Bathroom is an unsurpassably clear expression of Fuller's understanding of design. It is not a matter of giving something form but the recognition of the possibilities for mass production inherent in construction. In contrast to other contemporaneous efforts to design a serially manufactured bathroom, the Dymaxion Bathroom was not conceived as a serially produced addition of individual parts but as the integration of partial aspects into an archetypal, seamless unit. The bathroom consisted of four main parts, two die-stamped tubs for the lower part, two laminated hoods as a cover, but the basic shaping process of die-stamping is more highly developed and more complex than simply trimming and folding sheet metal. It requires high investment in the production of tools and the necessary machinery; on the other hand, it provides the means for genuine industrial fabrication, so it has a low part cost. Moreover, the shell is self-stabilizing and light, and is thus itself an optimizing factor. These features were central to Fuller's conception of industrial design. The resulting look anticipates some of the features of the toilets used decades later in today's airplanes and trains.



It seems to me then that the factor of enormous improvement in performance inherent in transfer from the craft to the industrial system was a very important factor and that the fantastic increase in performance required to dislodge the old way of doing things, was as important in principle as the other principles already cited. You must remember that man didn't think he wanted other men to go five miles an hour, or possibly ten miles an hour, but no faster. It took a lot of courage to buy a car. (...) In short, the gain had to be enormous to offset the inertia of man against himself. Therefore, in principle, if we are to get houses into industrial mass production, they will have to be so much better than anything man ever thought of having before as to be able to offset that inherent mental inertia.

"Better than" brings us abruptly to the matter of performance of house. We find that people haven't classified to any important degree the standards of performance of house, and for a very good reason. As engineers you certainly understand that man is born "inside the frame of scientific measurement reference," therefore, it is impossible unless he gets "outside" of the whole phenomenon house for him to be very critical of his performance standards. (...)

Man starts life crawling around on the floors and associating the smell of the floor and the color of the walls with the most important events in his life which are warmth of understanding and love. I found it very hard to discuss house scientifically with people. Architects were very tactful with people and knew how to discuss these delicate things, but compromised science at every turn to please the ignorance of a well-dollared patron. You could, however, discuss big buildings and hotels scientifically, which man had evolved from houses and which had perforce to discard the idiosyncracies of the one for service to the common needs of the many. Because the hotel "guest" found public buildings impersonal affairs, he also found himself inadvertently "outside the frame of reference" which quickly aroused his critical faculties and advanced his desired standards. He might for instance, have a privy at home, but he insisted on his private bath with modern plumbing at the hotel, or he would not think of having the sponge and lace curtains in his bathroom at the hotel that he found at home. When he went traveling he manifested to his own surprise a high set of standards, but at home, no, you could not get him to see that critically. So we had to take advantage of his inadvertent out-of-house behavior in learning about converting the house into the advantages of industrial technology.

Designing a New Industry (1946), 16

1.
THUD



2.



CLICK

3.
SNAP



4.
PRESTO!



THE NEWEST prefabricated bathroom IS ALSO NEAREST

On the 25th floor of 40 Wall St. there sits the finished model of a new plumbing fixture that might well beg the eyes of any bystanding master plumber. A fixture that to all intents and purposes constitutes a one-piece bathroom. Designed by Architect Buckminster Fuller (Dymondor House, Dymondor Court) it accomplishes, by the simple connection of four basic parts, a complete bathroom weighing 404 pounds, with integral lavatory, toilet and bath. First known as the "Five by Five" (because that's the space it takes up), the official designation is now "The Integrated Bath".

In the research department of the Phelps Dodge Corporation it sits, ready for moderate production (100 units) in 1937. Architect Fuller has assigned his patents to the PD organization, and rumor distills a new manufacturing and marketing subsidiary in the immediate offing. The range of uses for the unit is broad: palaces, planes, trailers, trains, but mainly small homes. In fact, Mr. Fuller hopes this light, compact, complete bathroom will even inspire renters to install copies in their apartments, and remove them when they move. All of which lies in the realm of speculation. For the immediate future the device will probably induce fewer orders than conversations. None the less the fact remains that this prefabricated bathroom comes closer to commercial reality than any of its predecessors.

The Integrated Bathroom consists roughly of two oblong sections that form a partition where they join, which conceals the piping and other mechanical appearances. The sections (each

a monometal stamping) are each split in the middle, the top being aluminum and the bottom 275 pounds of sheet copper unmetallized and tinned by a coating of silver, tin and antimony alloy. The bottom of one section is the lavatory and toilet, of the other a full bathroom tub.

The toilet, though reminiscent of the old backyard one-baiter, is fully sanitary. The seat lifts and remains upright by compression against the walls. Underneath is a standard form of bowl (though chrome nickel bowls are also available).

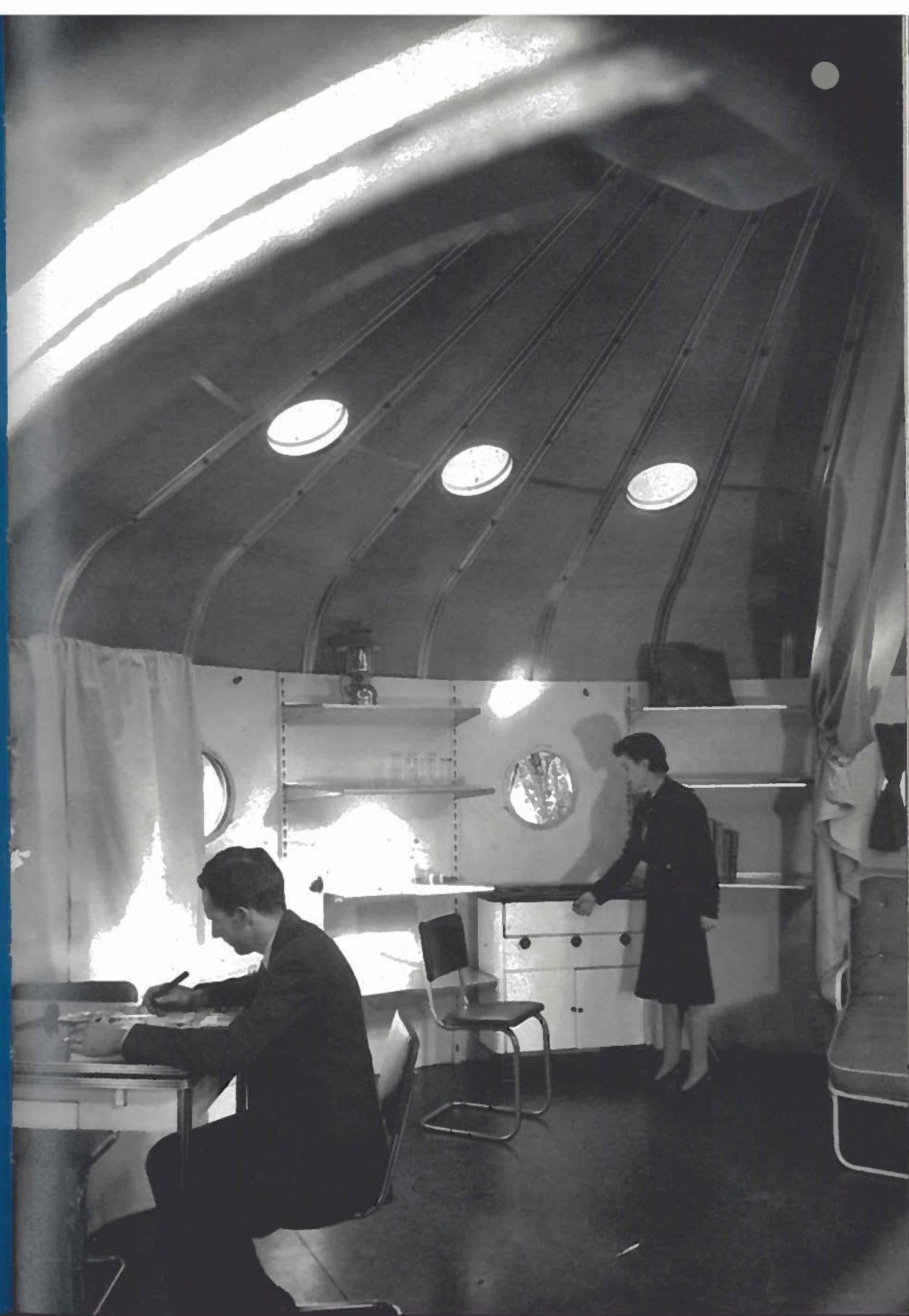
Two men can handle an installation in three hours, for all piping except a minimum amount of connection material is "integral with the unit." So are electric connections, ventilation equipment, etc. Fresh air is drawn by a motor under the lavatory from the nearest room, and exhausted—wherever circumstances permit.

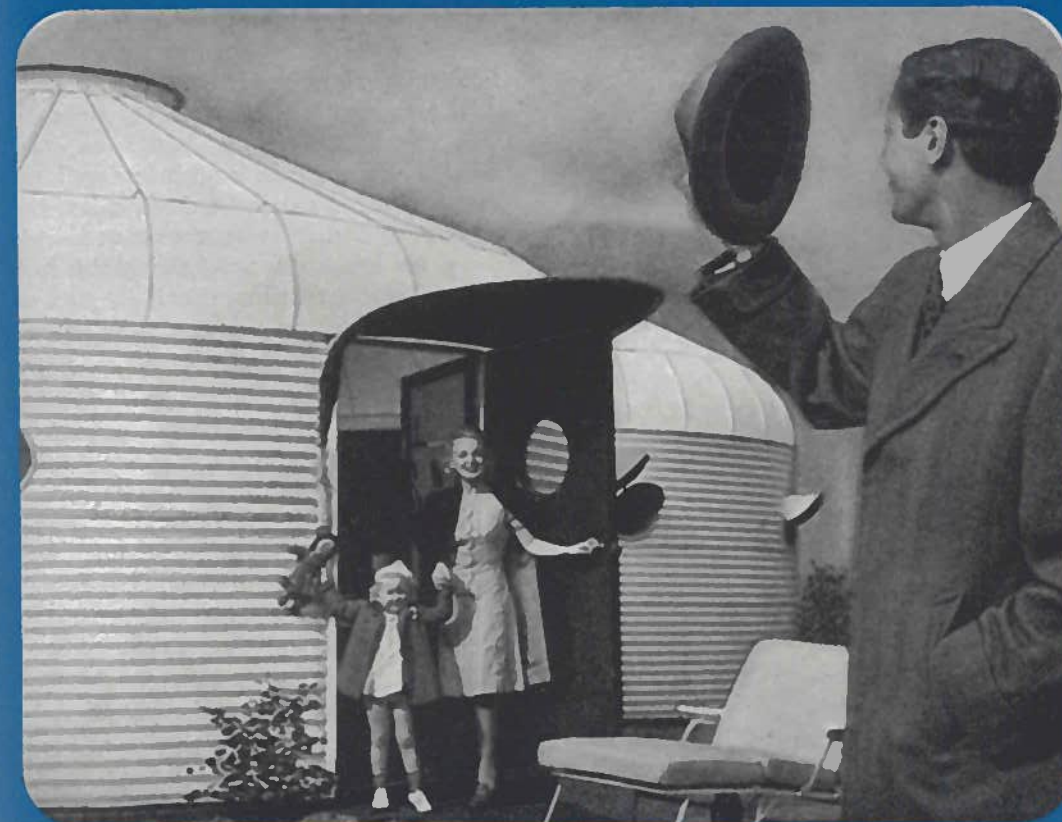
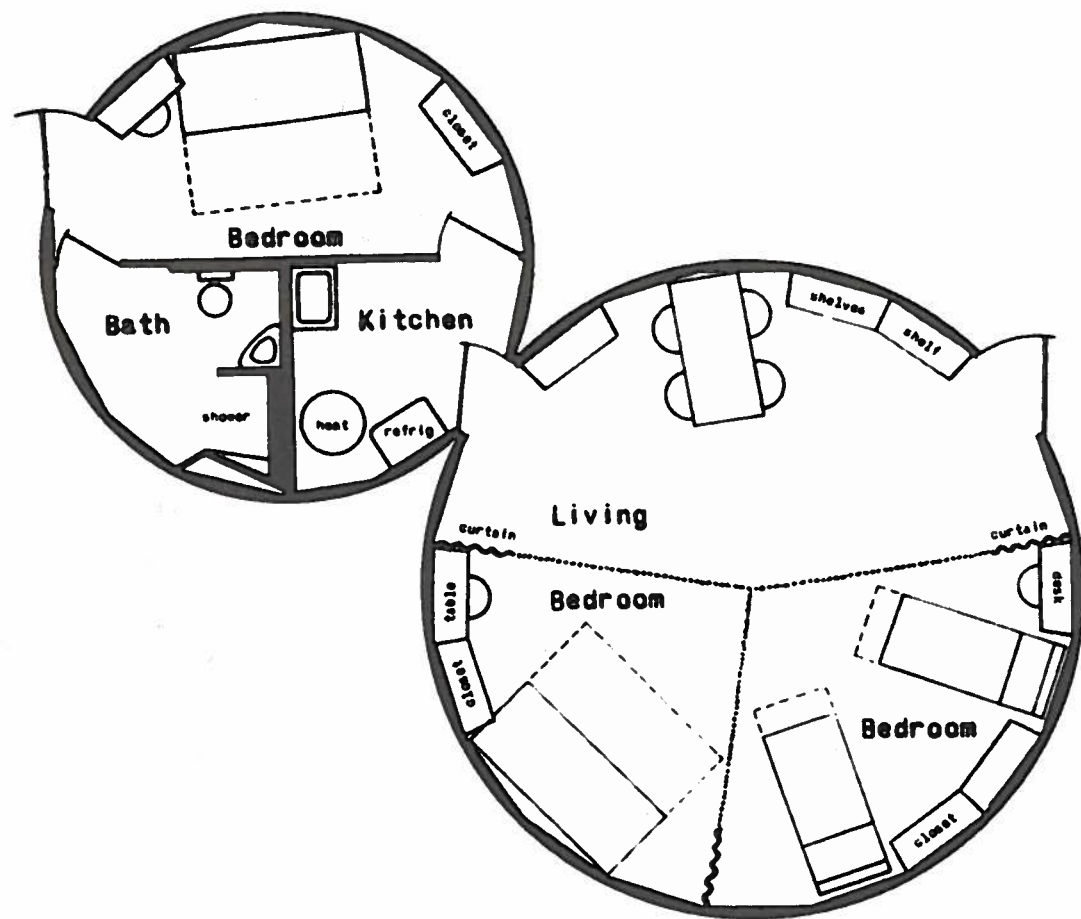
Miscellaneous features: A composition Venetian blind gives privacy to the bath, and, while permitting the escape of steam, prevents the escape of water. The door-frame between the two sections is six inches thick, permitting use as seat. Complete cleaning of tub is easily attained. The plumbing layout was devised in collaboration with a local master plumber, copper tubing being used for water lines. Particular care was used to avoid back-siphonage possibilities. Sliding doors conserve space. The metallic finish has a "hammered" appearance while at the same time being thoroughly sanitary, the invisible drains. Under surfaces of the base metal are covered with Duro-dur, a sound deadening material. An electric heating system between the two walls warms the metal shell, radiating heat to occupant of bathroom. Removable panels permit access to plumbing traps and connections under toilet and lavatory.

Reprinted from the April, 1937, issue of *THE LADLE*
official publication of the New York State Association of Master Plumbers

In anticipation of the bombing of British cities in 1940, Fuller was asked by the British War Relief Organisation to design an emergency shelter. He created the design for the Butler Company of Kansas City, which manufactured grain silos of galvanized steel. The refinement in the move from the epitome of the rural economy to housing for people is characteristic. The conic roof is converted into a highly sophisticated shell; the bent tin of the cylinder cover becomes curved galvanized steel. It is designed to be easily set up and taken down. The British government did not, however, make metal available for its construction, as it was needed for the production of armaments.

DYMAXION DEPLOYMENT UNIT





Fuller originally developed the Dymaxion Deployment Unit beginning in 1940 as a small house for families. In the course of developing it, the possibility of using it as emergency housing for members of the army became more important; with the entry of the USA into World War II, the development took a new direction. A number of units were produced and employed – in the Persian Gulf, for example – but they were not produced on a large scale. In its conception, Fuller started with an existing industry that he hoped to upgrade technologically. The Butler Company produced grain silos of curved corrugated metal. The round plan of these containers was the right starting point for both static and economic reasons: bent sheet metal is self-supporting, and the circle has the most advantageous relationship of circumference to interior space. The sanitary unit is enclosed in a separate cylindrical element. Two units can be attached directly to each other. The pylon is important, though originally Fuller conceived of it merely as a simple way to set it up: it holds up the dome that is built beneath it. From a constructive perspective, and even more from a structural perspective, Fuller was breaking a path that years later would lead away from the idea of a central supporting mast to the supporting shell of the geodesic domes.



214 - Left: Dymaxion Deployment Unit (DDU), 1940, interior view, looking from the connector opening into the secondary unit. Double unit, ground plan; room partitioning by means of curtains.

Butler Manufacturing Corp. grain bin, 1930s. Assembly of DDU's.

215 - The DDU was envisioned not just for military purposes, but also for civilian use, from an advertising prospectus.

216/217: DDU, overall view, curved sheets of galvanized corrugated iron provide high stability; central rooftop air-vent.



A photograph of a man in a dark suit and glasses sitting at a desk, looking towards the camera. Behind him, a group of people are standing, some looking at the camera and others looking away. The background is a blue wall with a red circular logo. The text "Reshape environment; don't try to reshape man" is overlaid in red.

“Reshape environment; don't try to reshape man”

RBF: New Forms vs. Reforms (1963)

From 1938 to 1940, Fuller worked as a technical advisor for the editors of the renowned magazine *Fortune*. The articles he produced had elaborate layouts and contained thoughtful treatments of themes from the world of technology such as the electronics industry, plywood, the Sperry gyroscope, television, Chrysler Fluid Drive, and so on. For the magazine's tenth anniversary issue, he put together elaborate statistics to show in essence that the old economic data for coal and oil requirements should be replaced by production figures for electricity. Fuller's analytical interest in all experiments also applied to models for the development of industrialization. His attentiveness to historical developments was guided by an eye to the future; he used the retrospective as the driving force for the prospective.

FORTUNE

WORLD ENERGY

A Map by R. Buckminster Fuller

○ — 21,250,000 human beings
● — 268,500,000 inanimate energy slaves

Mechanization, the harnessing of energy, is man's answer to slavery. Man, whose population totals about 2,125,000,000, now possesses the equivalent of some 268,500,000 inanimate energy slaves. Their number is estimated by dividing total energy consumed by industrial man from mineral sources and waterpower, by the energy output of one human per year. Each white dot on the map represents 1 per cent of the human population; and the dots are located at centers of population. Each red dot represents 1 per cent of the inanimate slaves, located at focal centers of consumption. Each red dot represents about seventeen times the effective power developed muscicularly by a white dot. The U.S. has 54 per cent of the energy slaves, an army of 145,000,000.

The faint blue line north of the equator is an isothermic line representing the zone of 32° Fahrenheit mean low. While all of industrial Europe lies to the south of this thermal zone, the heart of U.S. industrialism lies just to the north of it. History has made a clockwise spiral of civilization from East to West and northward.

Revised by Philip Hagen

Tonnage to Energy Wealth

Between 1938 and 1940 I was on the editorial staff of *Fortune* magazine as its science and technology consultant, and my researchers harvested all the statistics for *Fortune's* tenth anniversary issue, "U.S.A. and the World." In that issue I uncovered and was able to prove several new socioeconomic facts - for the first time in history of industrial economics: (1) the economic health of the American - or any industrial - economy was no longer disclosed (as in the past) by the total tonnage of its product output, but by the amount of electrical energy generated by that activity; tonnage had ceased to be the criterion because (2) we were doing so much more given work with so much less pounds of materials, ergs of energy, and seconds of time per given function as to occasion ever newer, lighter, and stronger metallic alloys, chemicals, and electronics. Though at that time universally used as the number-one guide to the state of economic health of any world nation, tonnage no longer represented prosperity. The amount of energy being electrically generated and consumed became the most sensitive telltale of economic health.

Critical Path (1981), 103f.

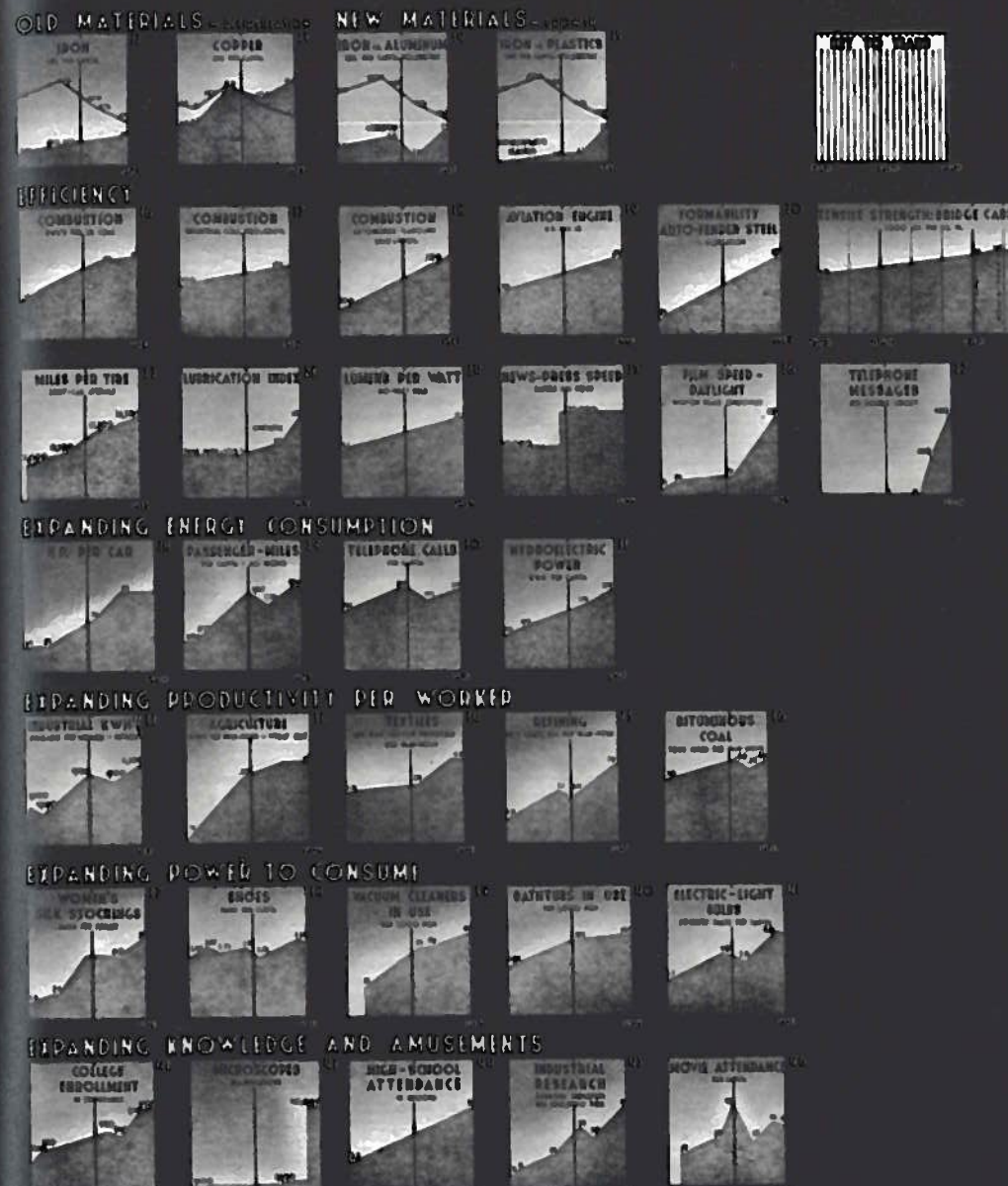
Metals

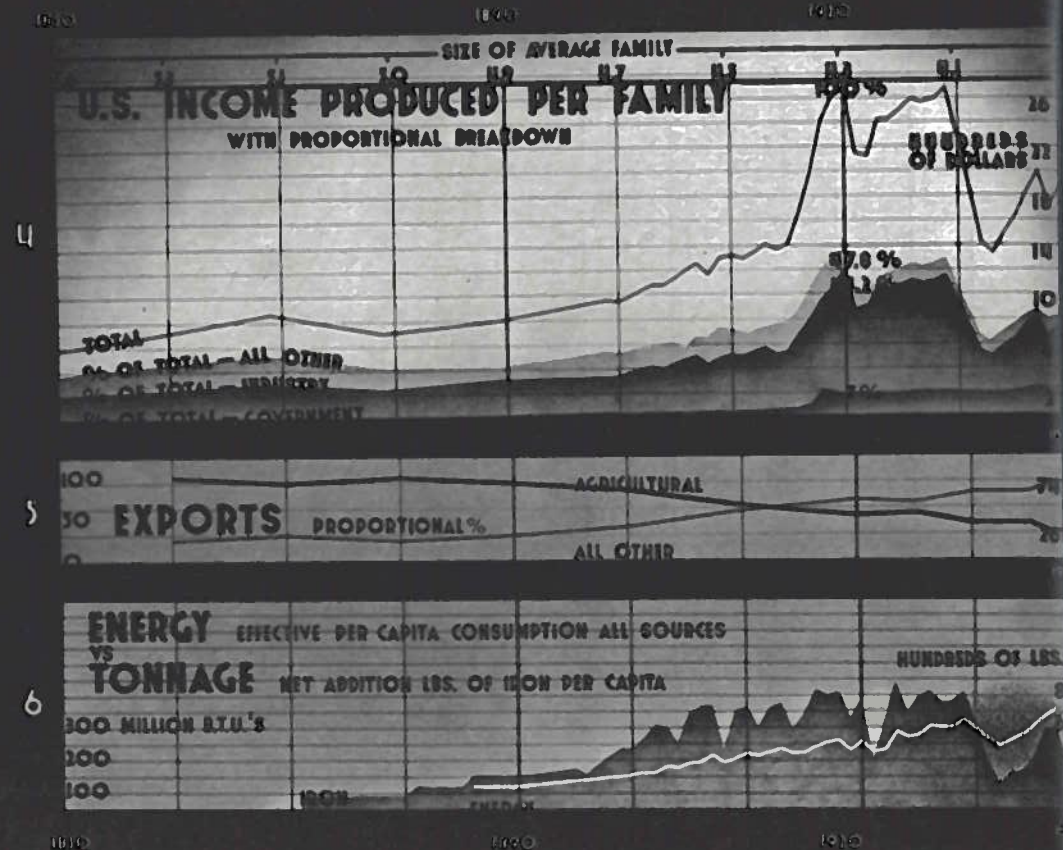
If you are not familiar with the world of metals, you might not be familiar with the fact that our metals do not go down a one-way street. When I was young, I was brought up with the idea that we could and probably would use up all the world's iron. I was brought up to think that after we finished using something made of iron that the iron went into the trash heap to rust away to dust in the city dumps and could never be used again. The fact is that it came as a surprise, even to world industry, in the nineteen-thirties of this twentieth century, that all of the metals are continually being melted up and recirculated. For instance, out of all the copper mined in all the history of man, only 14% is not at present in an averagely recirculating twenty-two year cycle of use; and the 14% which is not in present recycling use is now in munitions ships lying on the bottom of the ocean. We know where that copper is, and in due course, it will be brought back into use, and within decades, as much as 98% of all the copper that has been mined by all man will be in continual recirculation. The recirculation of the entire copper inventory of man, as well as approximately all the other metals, occurs at an average rate of twenty-two years.

The chief engineer of the American Telephone Company was able to state to me in 1935 that while the telephone company had so much copper in wires and dynamos, etc., the telephone design science was increasing the messages per cross sections of wire so rapidly (going for instance from one message to twenty-eight and then to a thousand per given cross section of a copper wire circuit and finally from wire to wireless), that the telephone company is continually increasing its copper scrap inventory out of old and obsolete equipment. He said, therefore, that the telephone company would not have to buy any more copper or take any more copper out of the mines in order to expand the telephone service from serving only the population of the United States, to serving all of humanity, at an equal per capita frequency of high standard communication. The American Telephone Company's chief engineer went on to say that the company's copper resources, either in use or in scrap, were in such constant surplus through improved performance per pound that the company would be continually selling excess copper while expanding its service from a domestic to a world service without, in effect, having to buy any more copper. It would, he said, however, be commercially more feasible to buy new wire and sell scrap due to the non-matching of the geographical operations of scrapping, briquetting, smelting and fabrication operations.

DYNAMICS OF PROGRESS

GROUP III





THE EVOLUTION OF AN INDUSTRIAL ECONOMY

The above charts provide a capsule description of the U.S. economy. Chart 4 (top) shows income produced per family, 1900-1940. Chart 5 shows the relative gain of "all other" (chiefly industrial) exports over agricultural exports. Chart 6 provides the key to the present article. Abstaining dollar figures, it shows the net addition of new iron to the economic system (black line), in hundreds of pounds per capita, versus the effective consumption of energy (white line) from mineral fuels and waterpower in B.T.U.'s per capita. The decline of the iron curve, coupled with the rise of the energy curve, is symptomatic of the basic change from a savings or producer's economy, to an energy economy dependent for its growth upon the consumer.

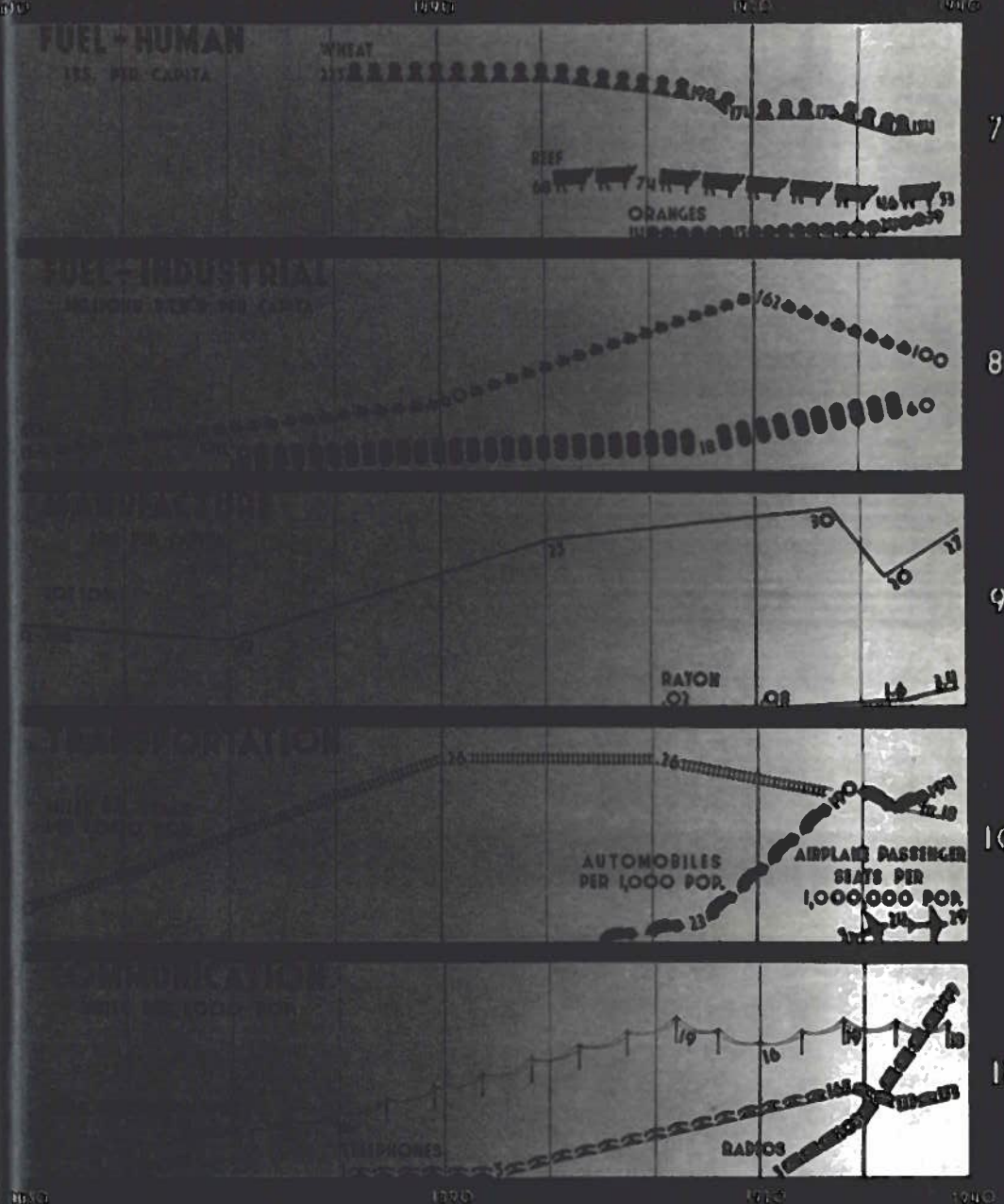
solution for the present "stagflation" would be an increase in capital investment. There is no question that this would help the economy; money would be spent, and this would increase the actual power to consume. But an increase in the rate of investment, or any other such measure, would not necessarily increase the potential power to consume. It would not necessarily advance the progress of industrialization in this most basic sense. The progress of industrialization will depend rather upon what kind of investment is made. The potential is not at all increased when a railroad buys new cars that are obsolete in design; it is very little increased when the federal government builds a new post office

where the old one had served; but it is very much increased when the chemical industry puts a fraction of the above investment into the development of a new solvent; it is very much increased (or not, during the growth of the automobile) when the government builds concrete highways. Some capital investments increase both the potential and the actual power to consume. Others increase only the actual. And projects can be imagined that might have relatively little effect upon either.

Thus, in measuring our industrial system and in proposing solutions to its problems, it is necessary to use industrial measurements as well as dollar measurements. It is necessary to measure with such ele-

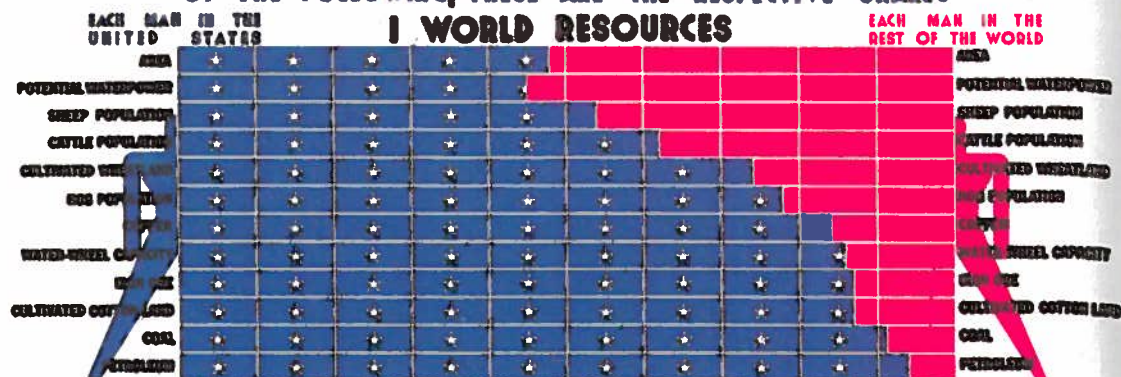
ments of progress as units per capita, tons, thermal units, kilowatt-hours, watts, and engineering indexes of viscosity, flux, torque, and efficiency. To talk about income and expenditure, price, capital promotion, or investment without taking the engineering factors into account, is both futile and confusing. For while the power to consume—in both senses—is certainly affected by the economic factors, it does not spring from them.

The measurement of industrial progress is the purpose of the accompanying portfolio of charts. Beginning with the simplest static charts on page 51, and ending with the extraordinary illustration of U.S. industrial power on page 57, the portfolio

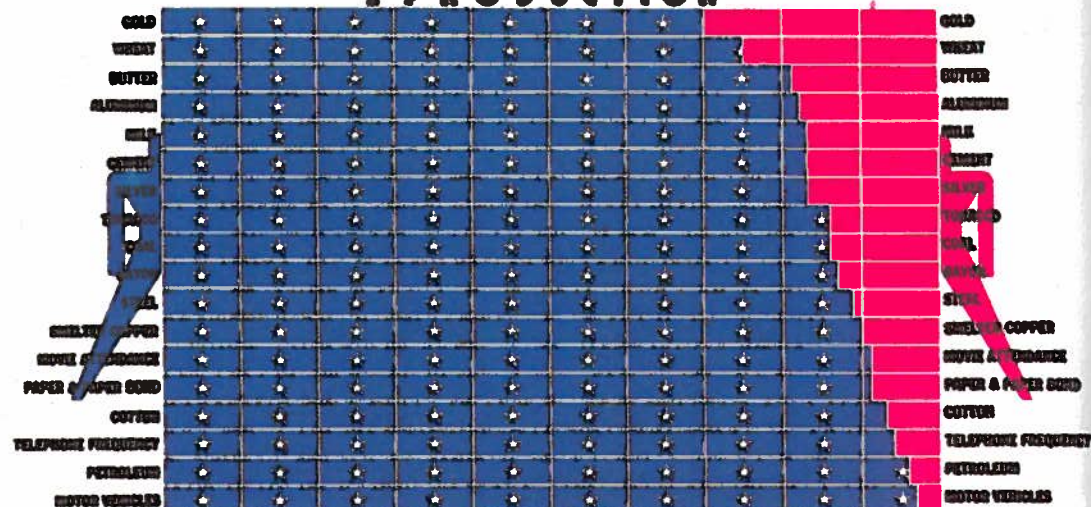


THE U.S. vs. THE WORLD

OF THE FOLLOWING, THESE ARE THE RESPECTIVE SHARES



2 PRODUCTION



3 PRODUCTS IN USE



Sixty-five per cent of all our steel is now made out of scrap. That is very roughly the ratio of recirculating metal to new mine production metal in all of the metals categories. It is perfectly practical to think about taking the metals out of obsolete automobiles, taking all the two-ton automobiles off the road, melting them up and making twice as many higher performance one-ton automobiles from the same metal. You may say that you don't want more automobiles, that the parking problems are too great. In speaking of automobiles I have chosen an industrial tool that you are familiar with. I am not advocating more autos. I am simply considering the feasibility of the principles involved through which we can, by design science, take care of twice as many people in a given function with a given obsolete scrap resource. I have learned by experience that it is possible and feasible for the world of architectural students to undertake an amplification of the functional effectiveness of the world's resources through design science.

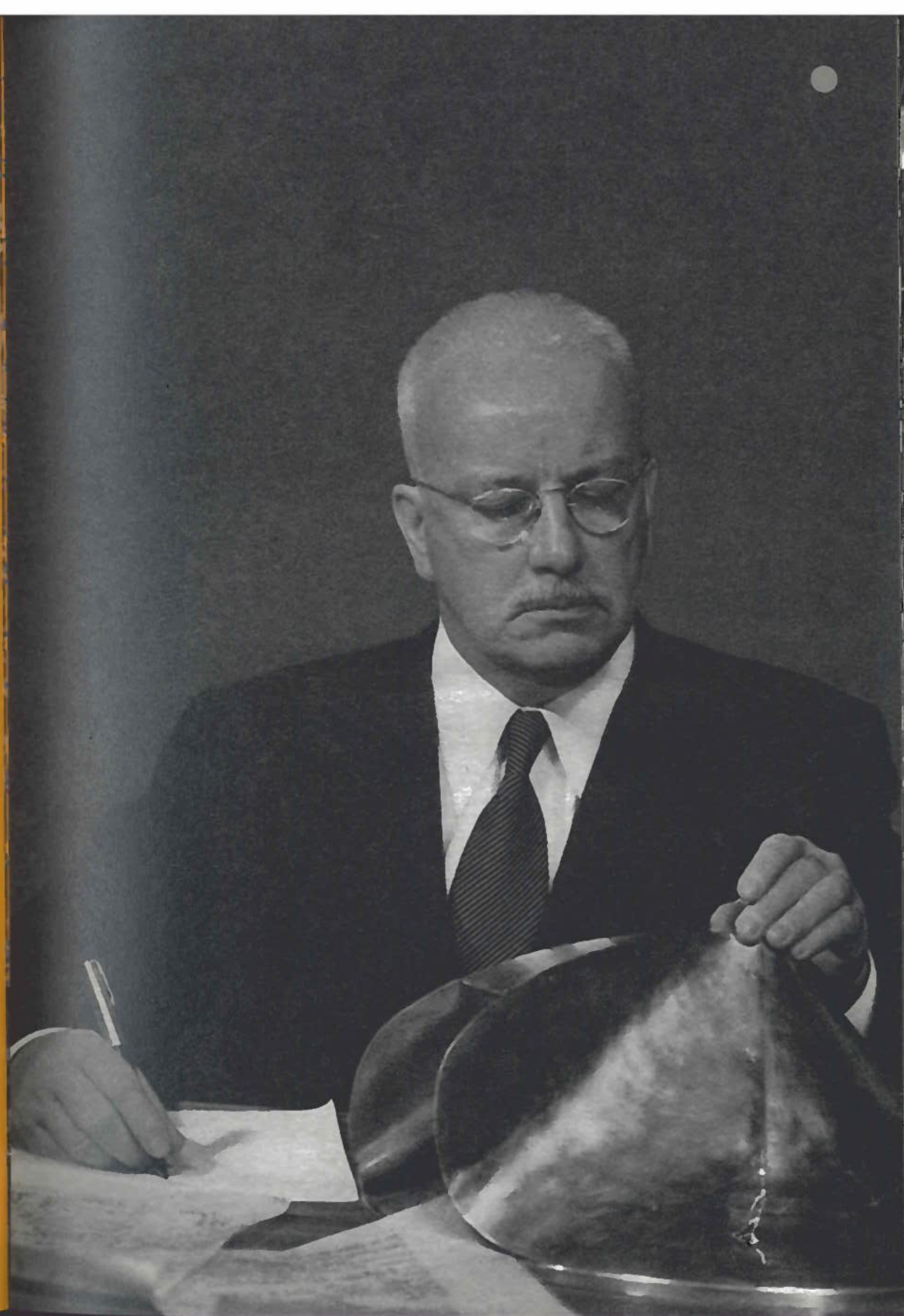
I realized a year ago, from my own experience, and from the frustrated attempt on the part of enthusiastic architectural students in various schools around the world to get going with the world redesign, that it is not going to be a practical matter for the world's architectural students to take a world inventory of resources as well as an inventory of all the trend patternings and needs of men in order to learn how to reorganize the designed use of the total resources to highest advantage. Such economic intelligence harvesting is not within the present training or even the extra-curricula experience of architectural students.

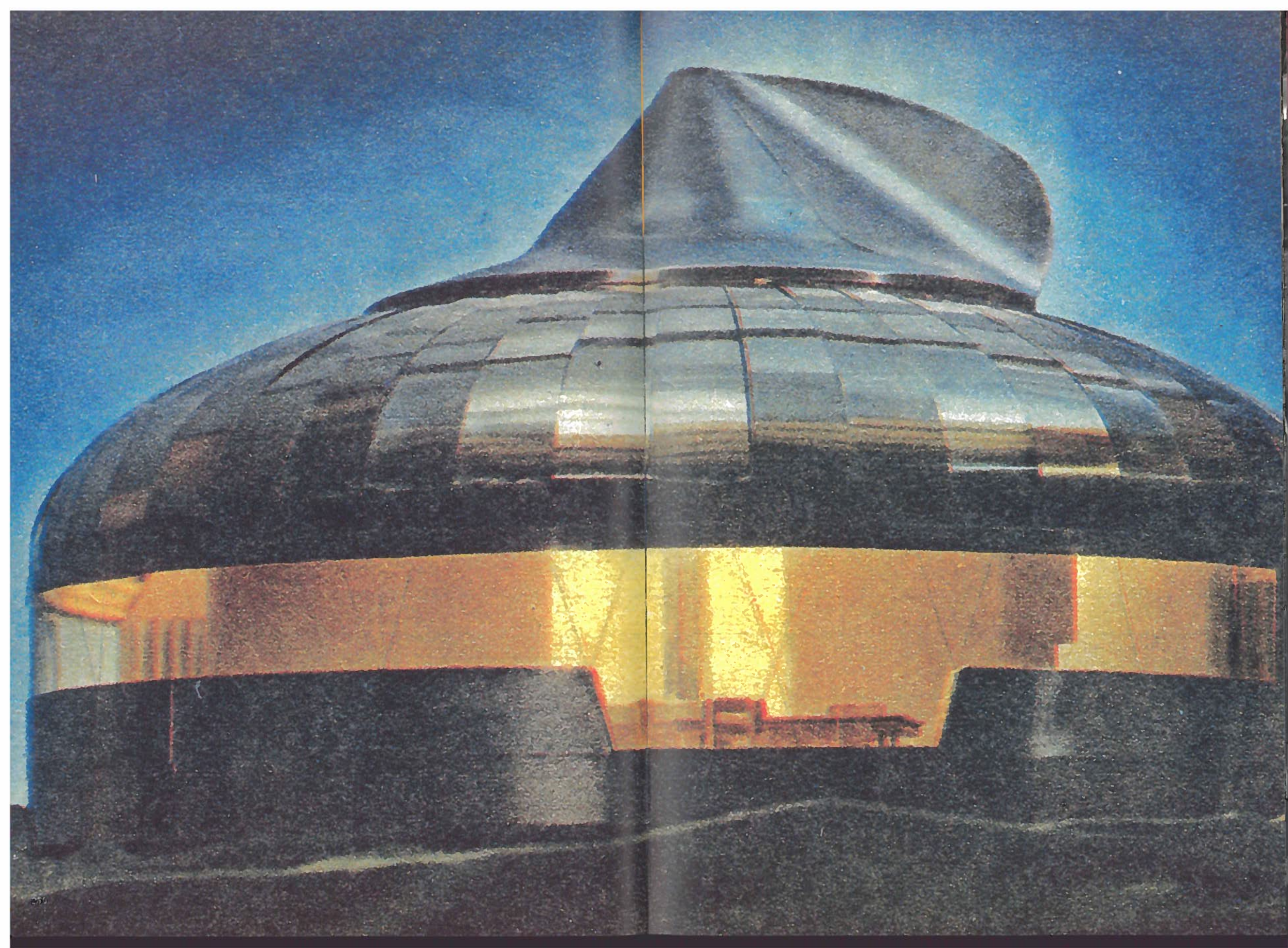
On the other hand I have had extensive experience in making such inventories - in 1936 - for the world copper industry, in 1940 for "Fortune Magazine", and in 1943 for the United States Board of Economic Warfare. Therefore I have undertaken with the help of Southern Illinois University and the assistance of my colleague, John McHale, to prepare for this congress and for the world architectural students, a very complete inventory, not only of the world's resources, but also of the patternings of men's trendings and needs.

"World Design Initiative" (Mexico Lecture, 1963), in: WDSO: 2 (1964), 19f.

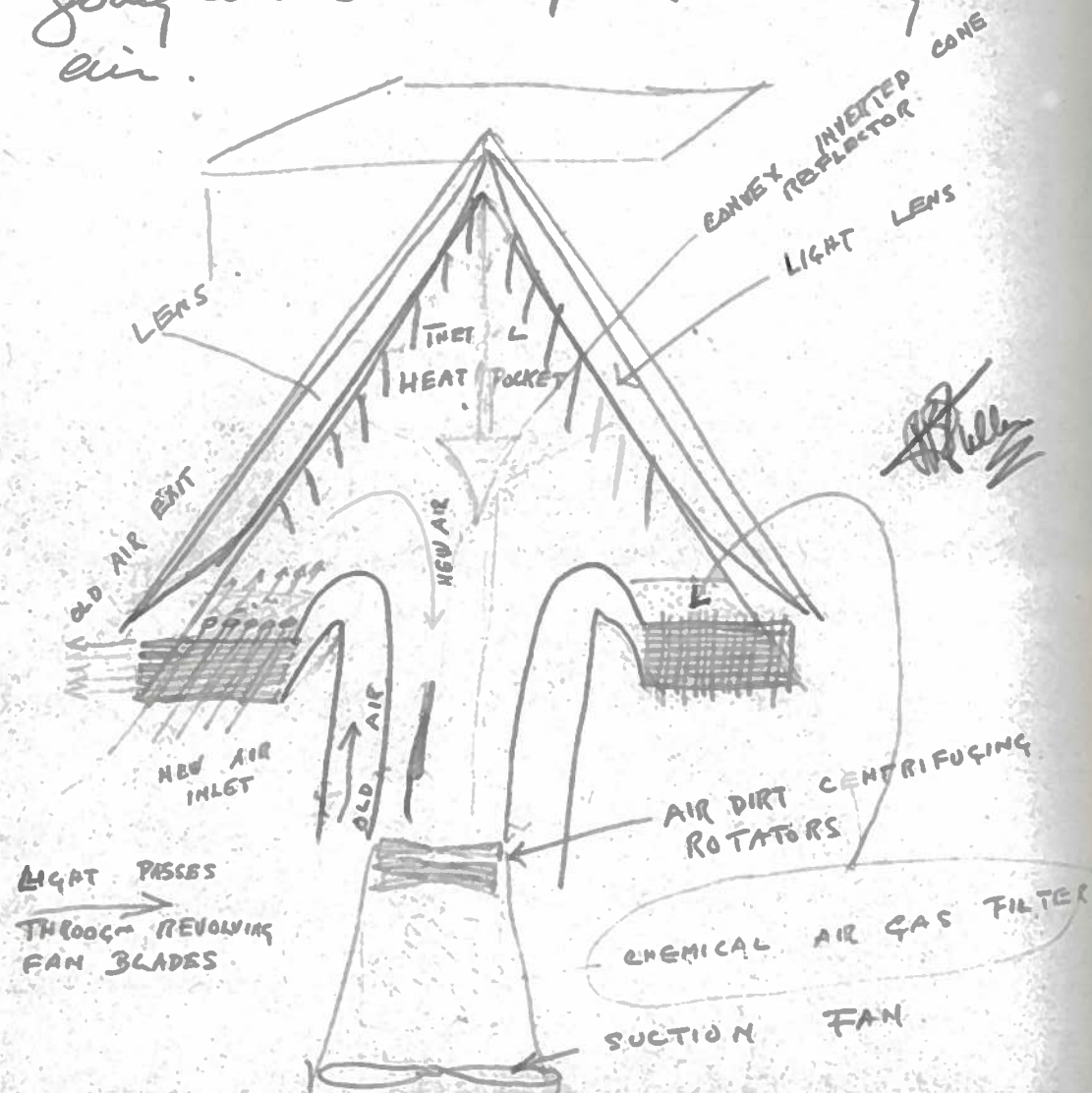
During World War II, Fuller was the head engineer on the Board of Economic Warfare. With the end of the war in sight, he realized the theme of his lifetime in a light-construction (and thus cost-effective) dwelling for everyone. He found a technologically advanced site for development and production in the Beech Aircraft factory in Wichita, Kansas, and he surrounded himself with a highly motivated team. The project continued to develop the technological background of the concept behind the Dymaxion House (for example, a round floor plan now replaced the hexagonal one). The development lasted from 1944 to 1946. The reactions to the prototype were extraordinarily positive; nevertheless, it was not put into industrial production, because Fuller insisted on the kind of perfection necessary for mass production, and they lacked the financial means for an uncompromising tooling-up and technology. The onset of the Cold War put a quick end to this conversion project.

WICHITA HOUSE



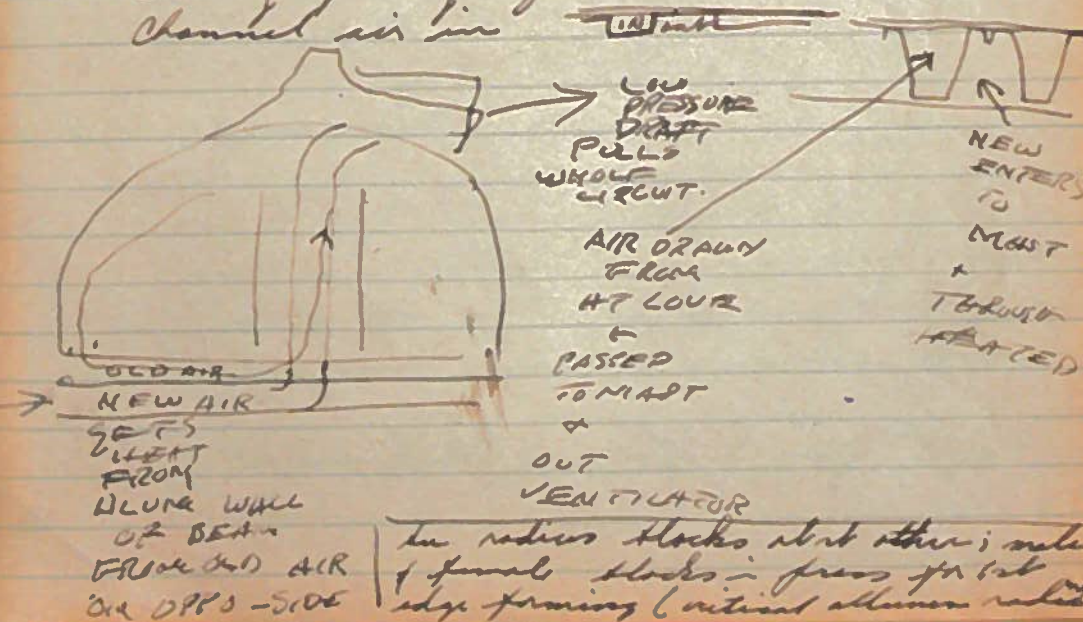


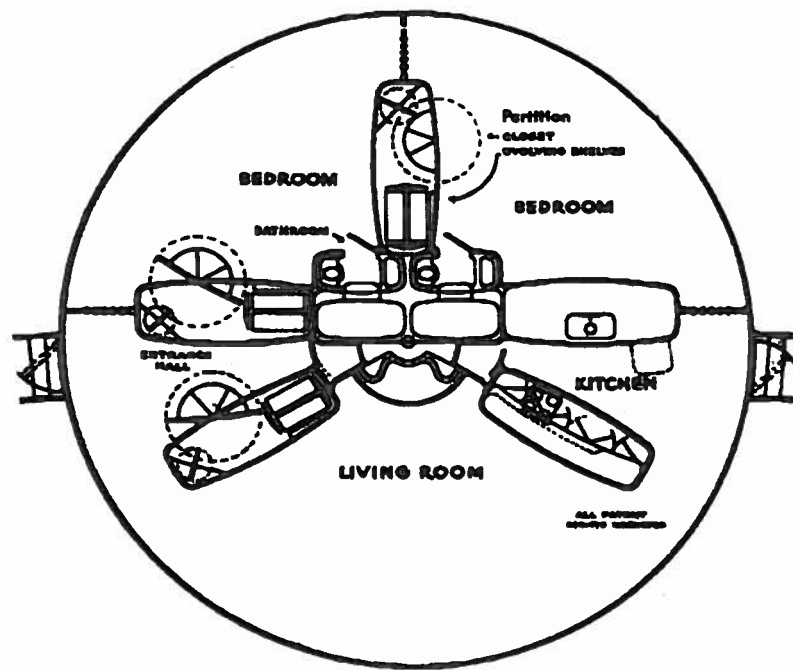
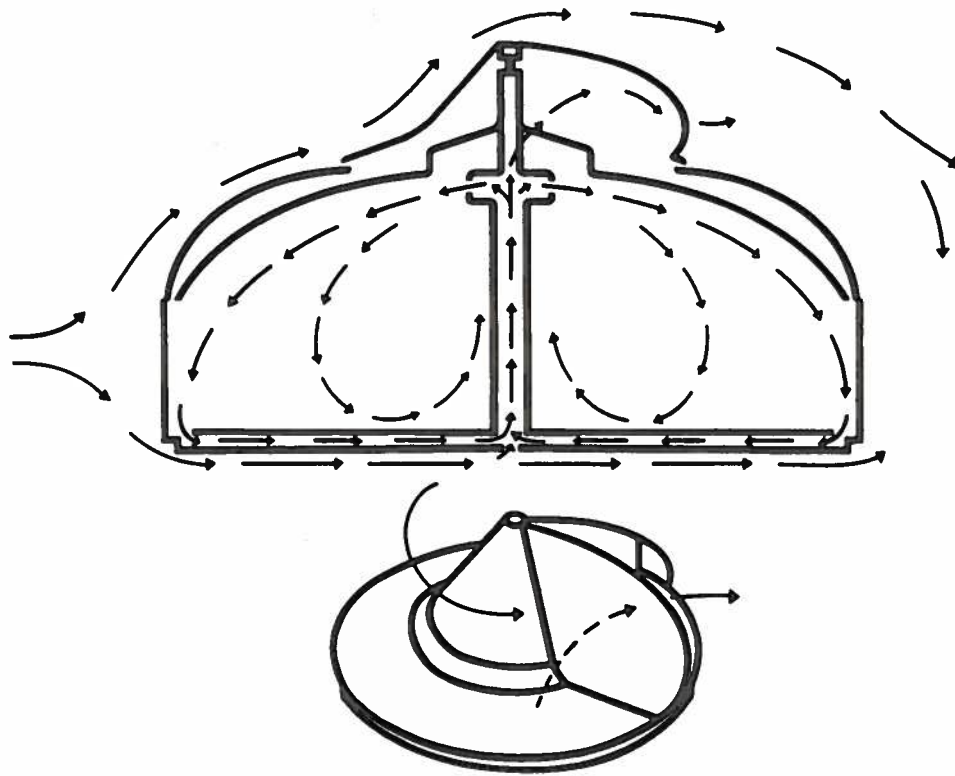
new
For air inlet and old air
outlet. use radiator similar to stack
of auto radiator ~~test~~, which will
transfer the temperature of the out
going air to that of the incoming
air.



Wichita

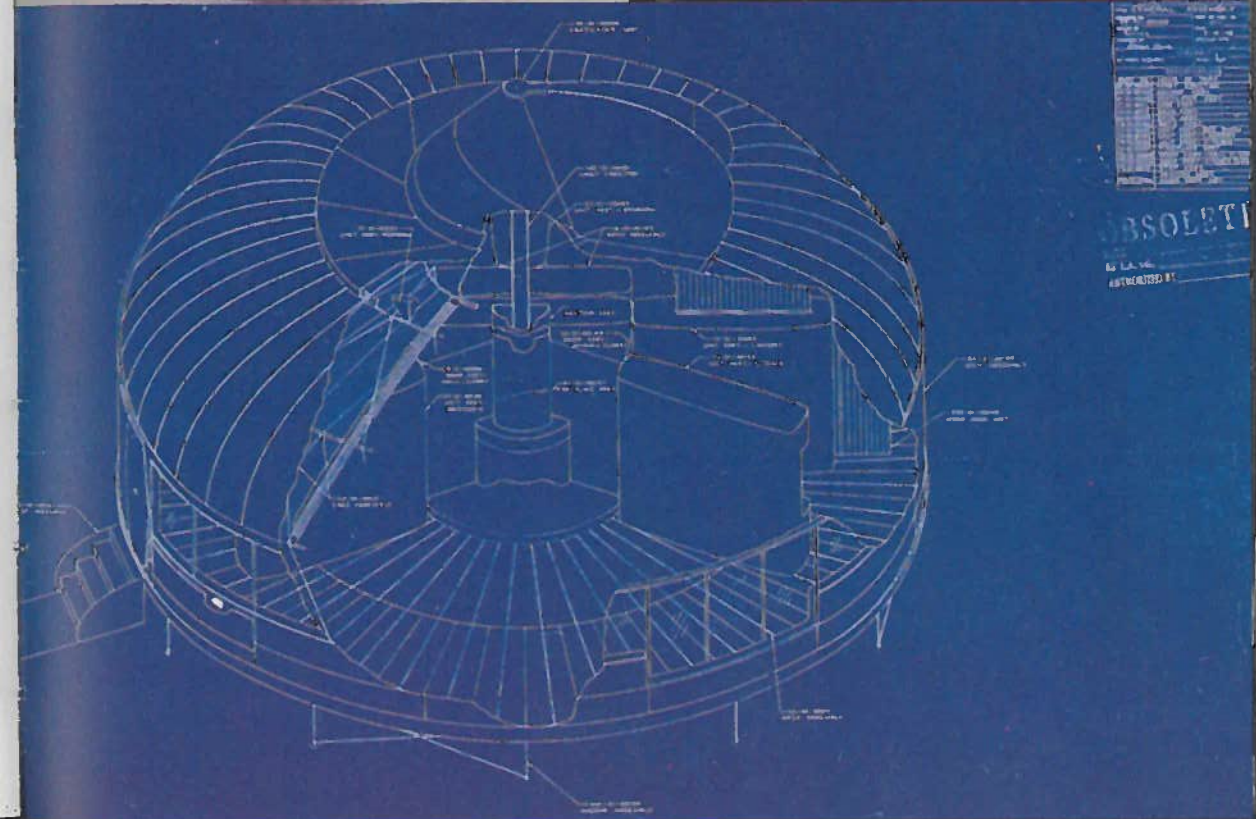
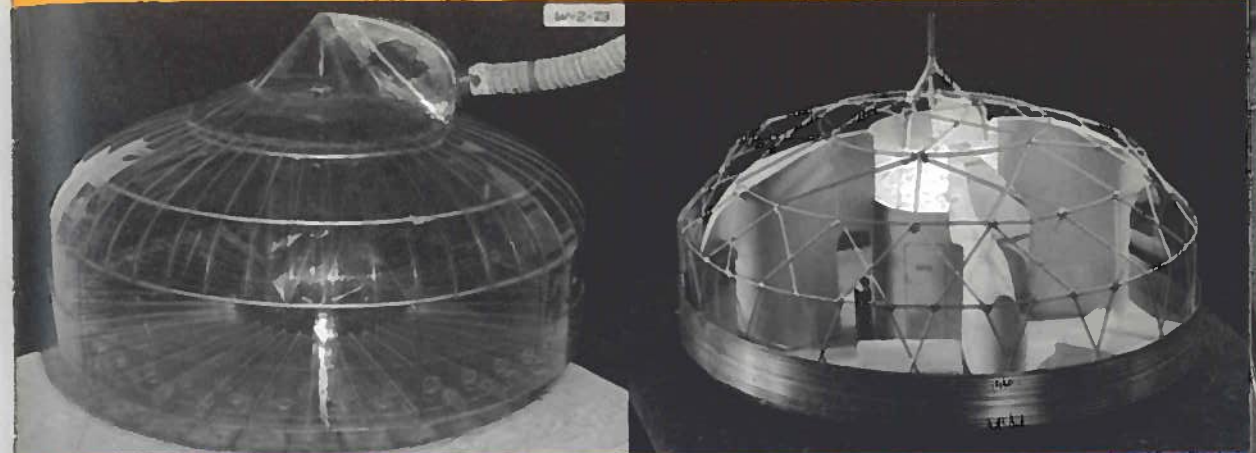
- 1 ✓ Take forming cage ring tubes
- 2 ✓ Same 3-ring being drilled
- 3 Drilling cage early at 2nd lat section
follows struck press
- 4 ~~omit~~ ^{add} Pipes with pour flowing water up
into ventillator (see 23)
- 5 Power take ^{20'} ~~10'~~ hole
beam 14 ft. 10th
- 6 Same beam inspection w. test gage
checky forming of beam
channel air in ~~vent~~





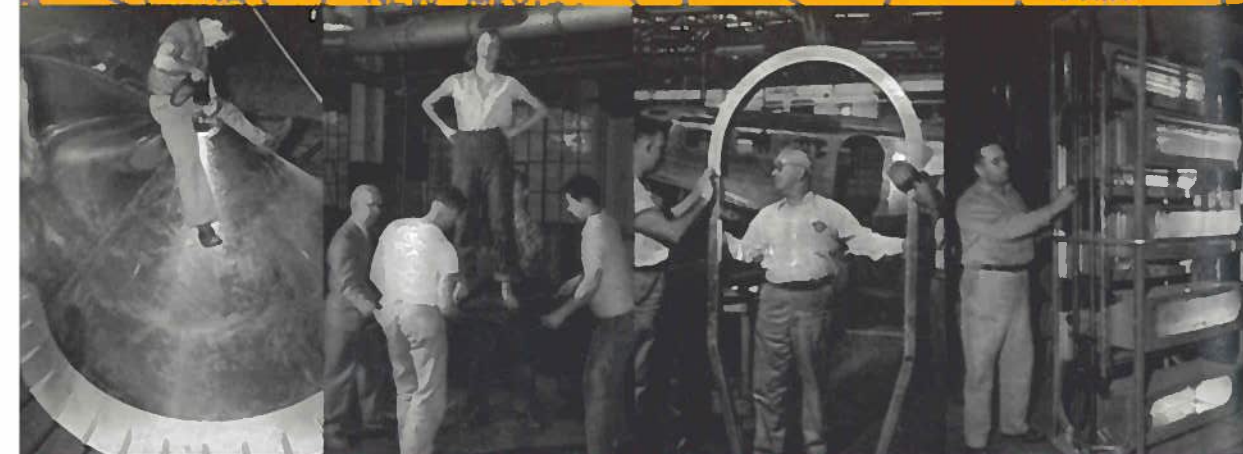
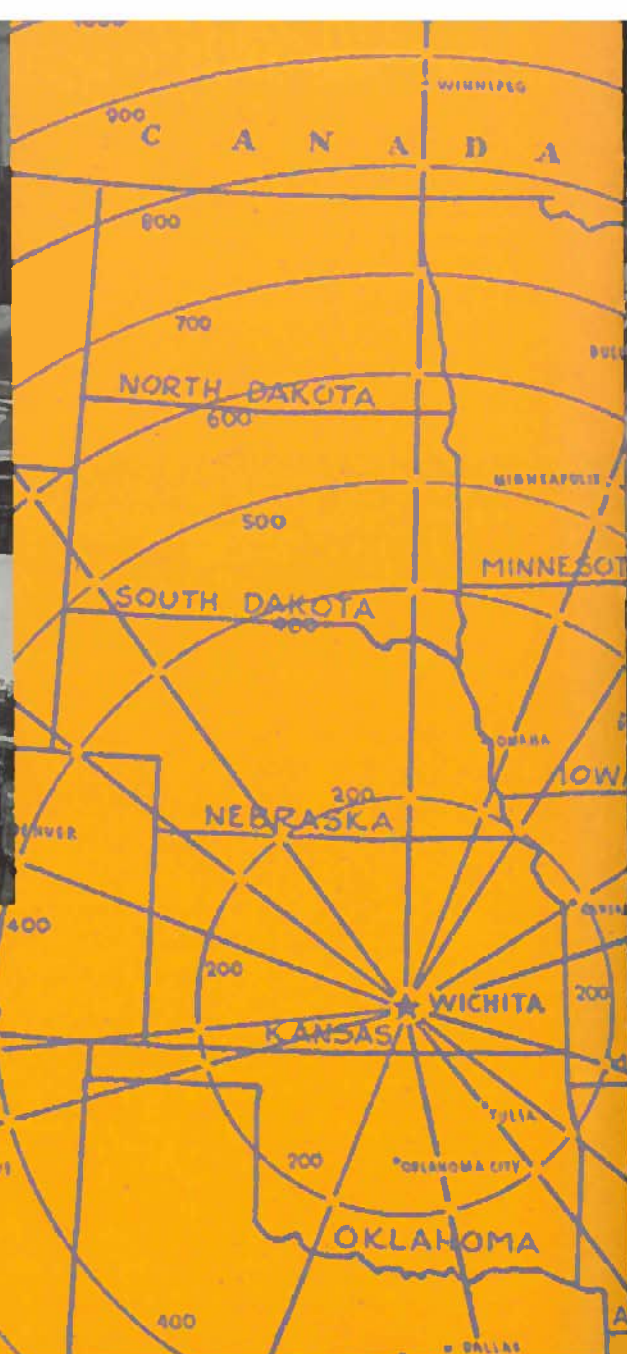
254 • *Walter Gropius*: schematic illustration of the air circulation. Ventilator mounted on supporting mast. Floor plan with two entrance ways, two bath cubicles, kitchen

unit and electrically operated "evolving shelves" modelled after the palaeolithic principle.



255 • Model study: test of the aerodynamic characteristics outside and inside in wind tunnel trial.
Model study: structure and power circuitry.

• Sectional view: support mast, network of rings, shaft positioned in the ground; radial floor construction, 1941.



237 Photos of tooling-up in the Beech Aircraft Company, Wichita. The leading role of the aircraft industry for all of society. Stationery for the Dymaxion Dwelling Machine Inc. showing the Dymaxion Industrial Strategy Map. Wichita (Kansas) in the center of the USA. Assembly of Beech Aircraft, Wichita.

(...) The first house I designed in 1927 was a hanging one, but I had to keep my sling pitch very sharp because the tensile strength of the materials available was then so inferior. My mast and tension members therefore had to protrude out beyond the enclosure as those who have seen pictures of the 1927 Dymaxion House will remember. However, as I started this new house in Wichita in 1944, the increase in tensile strength of the materials available was so great, it became very practical to enclose the tension members by having them at relatively flat sling pitch, so you didn't even see those tension members because they could be enclosed within the roof. I didn't do it for looks, though. I did it because as we increased the angle of sling from vertical toward horizontal the stress was increased very rapidly, and as we increase the stress, we increase the rigidity.

I wanted to have a relatively rigid affair, a composition of tension and compression that would not give like a bed spring. The rigidity advantage was gained by positioning a compression ring, i.e. a horizontal arch, at a considerable distance outward from the mast and at as flat an angle as was reasonable within the limitation of tension metallurgy. So that is what we did here in Wichita in 1944 and 1945. By this method we can enclose a large space very rapidly, that is why circuses and armies employ tents. However we think of tent not as a principle but in association with the relatively flimsy materials with which the armies and circuses have occasion to build them. Golden Gate Bridge and a wire-spoked auto wheel layed horizontally are tent structures in principle. We don't think of them as flimsy nor is our house flimsy. It is designed to withstand fire, tornado, hurricane, and earthquake.

It was next important to develop a structure from the top of the mast downward which would be triangulated all the way for rigidity - thus we criss-crossed our tension members, as are the spokes of the wire wheel, out from the mast head to the first horizontal compression arch and downward again criss-crossing to the successive horizontal compression rings and finally all the way to the ground anchoring to the ground and using the inertia of the earth. (...) Anchor rods must be both vertical and diagonal in order to avoid swing or torque of the whole building.

We come now to a second argument about circle. As the steel world took over progressively from the old wood world by providing stronger structural shapes it went on also to provide rolled steel to replace boards. At first they rolled steel thinly enough to make steel plate which was used for ship siding and for trains, but they were able to roll the steel much thinner than plate which at minimum is $\frac{1}{8}$ of an inch thick. Below $\frac{1}{8}$ of an inch steel is called sheet, and steel sheet, if thin enough, was as light as a board per square foot. Plate was, however, no substitute for wooden boards in their function as sheathing, siding, boxing or partitioning for if thick enough to equal a board in stiffness it was much too heavy and if not too expensive as bulk, it was much too expensive to handle and to support structurally because of the great weight.

(...) The sheet principle can be used when curved into an arc. In curving the sheet it is made to fail as a column which throws the outer side of the arc skin into tension, which in effect is wrapped about the inner surface which represents a compression arch composed of the individual molecules of the material acting separately as do stones in an arch. Such a curved sheet then presents a strong, stiff, cylindrical form; strong against the exterior pressure of wind and enormously strong against interior pressures which explode conventional structures by hurricane's or bomb's or tornado's low pressure outside.

(...) Then we discover additional mutual advantage to our house inherent in combination of the geometry of circle and the curving of sheet, not by virtue of the respective unique properties but by their interactive virtue when associated for purposes of housing. This new advantage is discovered as we consider the second major stress applied to house by nature. Second to gravity is wind stress.

The average wind speed over the United States as computed by widely reported recordings is considered aerodynamically as little ships whose standard cruising speed is 12 miles an hour,

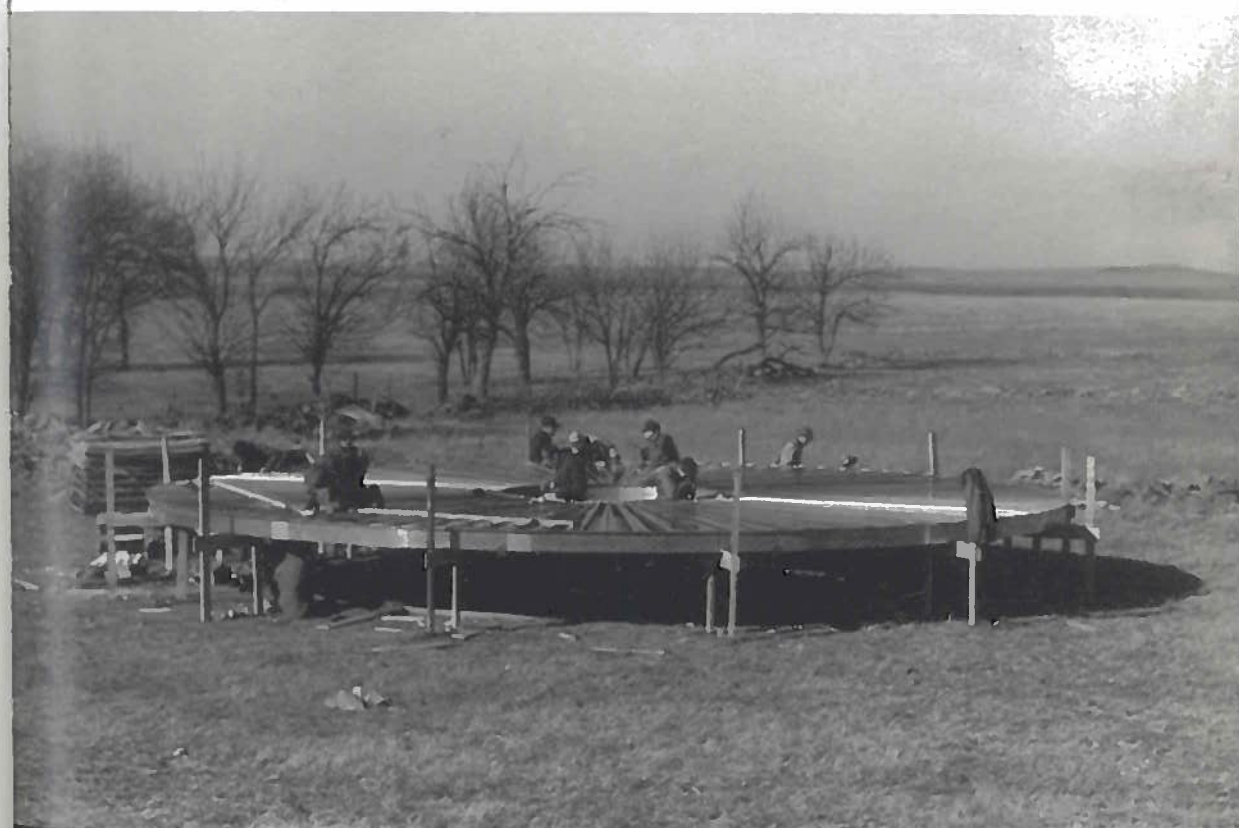
but which suddenly are accelerated to 30 miles an hour, and then suddenly again have to go 50 miles an hour, and sometimes suddenly they have to go 70 miles an hour and then the flat planking begins to fly off as flat boards develop lift in parallel with the wind, which lift is opposed only by the friction of the nails amounting to but a few pounds in tension as nail pulling experience confirms.

Designed to look secure by guess and by prayer to the gods of inertia, conventional houses are not engineered from measured data to cope with the greater wind speeds which they sometimes encounter.

Looking for chances to take advantage of high tensile ability of the new sheet, I became interested in the effects of wind stresses on houses and discovered in wind tunnel tests that a cube and hemisphere of equal volume indicate a drag advantage of ten-to-one in favor of the hemisphere, that is the drag is ten times greater on the cube. That indicates that we might either cut down the size and weight of our original structural members in hemisphere to maintain equivalent wind strength to that of the cube or we might take part of the increment and turn it to greater strength advantage. (...)

Another interesting discovery in the wind tunnel was that the heat losses were in direct proportion to the drag. It was indicated that you might be able to reduce your amount of heat necessary to heat the building, to a very high degree, by employing efficient aerodynamic shape. Shape factors are used very little today in heating and ventilating, they have been toyed with to date only by higher mathematics which concludes that there are great potential efficiencies to be had by measured evolution of shape control. In our own tests we had discovered the relative degree of that shape importance to heat savings in the coincidence of the drag and heat loss curves.

Having been in the building business in the '20s, I was particularly interested in heat losses because my material, as I told you, was a very good insulating material. Insulation was a brand



232 Construction of the first prototype erecting the flooring on spot foundation supports

new selling word, in 1922, something I could talk about in trying to sell my building system despite the traditional handicaps. I frequently had heat loss tests made at different laboratories. We discovered that we had an advantageous heat loss "factor" in our material, almost as favorable as in an 8 inch cork wall. However, in 1926 some of the weather stripping people had tests made to see what savings they could make with their material, and they suddenly shocked the whole insulation world by proving that savings two to three times as great could be obtained by putting weatherstripping in the window and door cracks as could be effected by an 8 inch cork wall. The wall insulation people had to kind of shut up.

(...) The phenomenon seemed well explained when we discovered that the losses of buildings of comparable tolerance of joint fittings was directly proportioned to the drag. Houses represented very large obstacles, and the low pressure tails on buildings are very long. They stream out two to three hundred yards in relatively mild winds. Houses are usually surrounded by trees and other houses and those tails get mixed up with each other but if you discover a house out in the open you can observe this 300 yard pattern in the snow shaping as seen from an airplane.

Air being highly compressible as it goes around large objects like houses you get a fairly high degree of compression at the widest beam of the obstacle to the wind. The result is a very long low pressure tail because the pressured air shoulders dissipate their pressure outwardly as well as into the wake. You have a long lag in the rate of reestablishment of pressure equilibrium in the wake and much energy is required from somewhere in the form of high pressure to satisfy the long low pressure streamer. (...)

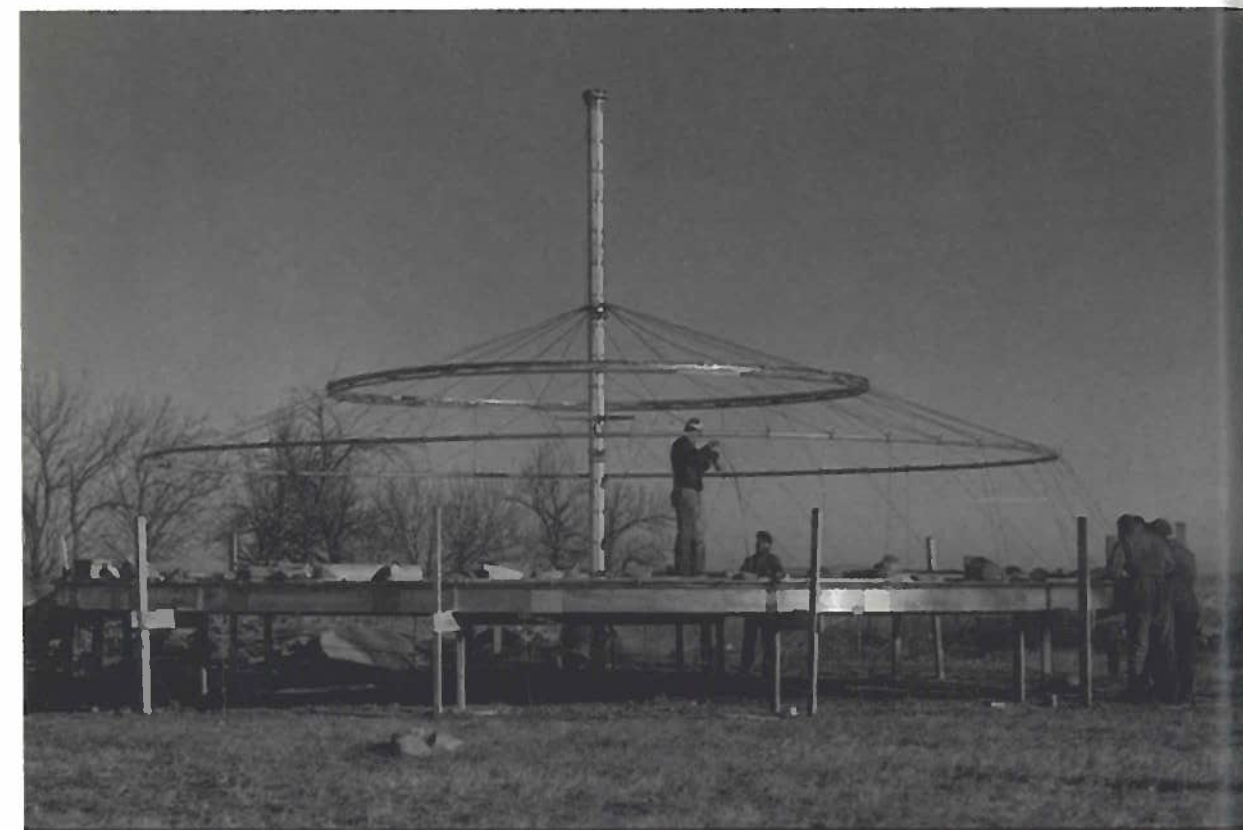
The heating energy inside buildings is converted in the air of rooms into the work of expanding air, and expanding it within enclosed chambers necessarily develops an increase in pressure. So you have a high pressure on this side of your house wall and an enormous low pressure tail on the outside to be satisfied, and your high pressure inside the house simply is extracted by

successive energy conversions right through a masonry wall to satisfy the low pressure as does gravity pull the water down Niagara Falls. The high pressure is drafted directly through chinks or cracks, ergo the fine showing of weatherstripping. (...) However, people still say that cold comes into houses. (...)

One way you ought to talk about the phenomena house and cold is that cold and vacuum are in physics almost identical – that is you have energy in the presence of cold and in the presence of vacuum and when your energy – either as heat of kinetically accelerated gas molecules or as radiation – is eliminated, cold or vacuum alone remain. That is the best way for you to look at it. You see, when they say, "cold is coming in," it is because energy as heat, is dissipating so fast as to leave cold gases in your presence. Air that is cold because low in energy, content moves to you so you seem to feel cold draft but there is no physical entity "cold." Temperature should be thought of as relative heat concentrations or dissipations.

(...) We discovered that the motion of wind along the surface of the earth is a turbulent affair rising here and hitting the earth's surface there and rising again. We discover that the wind instead of being considered as blown horizontally along the earth from a god's mouth or by a mysteriously hidden blower, should be recognized as an enormous system of many up or down drafts (similar in picture to many water spouts) converging to form bigger single up and down drafts. We discovered then that these columns should be recognized as enormous convection columns in the thin atmospheric layer surrounding the earth and caused by a warm earth in the presence of a cold outer space. (...)

As a net result of these convection column tests it was discovered that the rising winds tend to greater velocity than that of the lowering air (...), and therefore that the resultant of focus of wind stress near the earth's surface is in an upward direction in the lee of an obstruction – such as a house at the earth's surface. The large low pressure area in the lee of the house, of course,



240 Construction of the mast made from bundled rees and the network of rings: suspension of the support rings.



241 Cladding the structure with thermal felt on the inside; aluminum sheeting on the outside.

“Efficiency of umbrella and bicycle”

RBF: handwritten notice (1926)

242 View inside the mast showing the mounting point for the ventilator.

Detail of the interior room partitions: window with adjustable sun-shading blinds.

tends to float upward thus adding to the upward angle. Trees are also aerodynamic design structures to permit a large frontal area necessary to the functioning of the trees. Trees tend to avoid destruction by the wind by rounding their lower frontal branches to the approaching air and by coning their upper branches to point in the direction of the leeward and upward draft, thus reducing drag to a vital degree.

In the same way it became evident that a large ventilator could be designed to rotate upon the top of the house in such a manner as to focus the low pressure – caused by the air passage about the building – at a point about 45 degrees leeward and upward from the center of the house. The ventilator was developed through a series of assumptions and tests in the wind tunnel, until successful design was arrived at which reduces drag to a minimum and prevents oscillation of the ventilator, while at the same time putting the focused low pressure to work in pulling a draft out of the building through a duct system that induces the draft to create an air conditioning circuit, as well as to remove dust from sweeping traps in the floor and odors from the kitchen and bathroom, etc.

(...) With the central vantage point for generating air, light, sound and work services, we discover that those services when in operation describe fountain-like flows upward, outward, downward in all directions with concentric flow for recycling below. We discover also that this fountain flow can be reversed but in either case, maximum coverage with least distance is effected.

The fountain flow is appropriate for maintaining relatively warm atmospheric flow in winter, and reverse fountain is most efficient in maintaining relatively cool atmospheric flow in summer. In neither of these fountain flow cases does energy set up a chaotic echo system as we find it doing in the indiscriminate, cubical, squash racquet court shaped chambers in which we now live. (...)

Complimentary handling of dynamic flows teaches that the same principles control the structuring of energy flows as controlled the structuring of our building members: that in effect the principles of push and pull and their unique characteristics of distinctly limited compression behavior and almost unlimited tension behavior hold true also in hydraulics, pneumatics, sonics, and electronics. You can pull or draft air over vast distances but you can push it only a few feet by blowing. Winds are drafted and not blown; we should speak of the southeast draft instead of the northwest wind. (...) In the same way, visible light is a pushed phase of radiation and is limited to relatively short distances through atmosphere and requires enormous power to push it, while what we call electricity is tensed or pulled radiation and the distances over which radiation can be drawn by wire is very great compared to searchlight beaming, but, drawn by wireless tension control the limit of distance is unpredictably great. Even as a tension controlled lasso can be gyrated and thrown and wave impulses can be sent out controllably over it, as a snake whip may receive a wave by the wrist to hit an object and return the wave as a tension circuit again to the sender, so does radio and radar tensively induce circuits to pull radiation phenomena over almost unlimited distances.

By simple attention to and comparison of this phenomena of push-pull, enormous advantages can be gained by man over his environment through the initial advantage provided him to by our dwelling machine.

We associate the idea of air conditioning with very large apparatus and when anybody talked about air conditioning for small houses they found it way out of their price range, because of the apparatus and expensive quantities of energy to accomplish that task. Now with our ventilator employing outside air motion to accelerate interior dynamic fountain motion it becomes an inexpensive feat to provide excellent air conditioning.

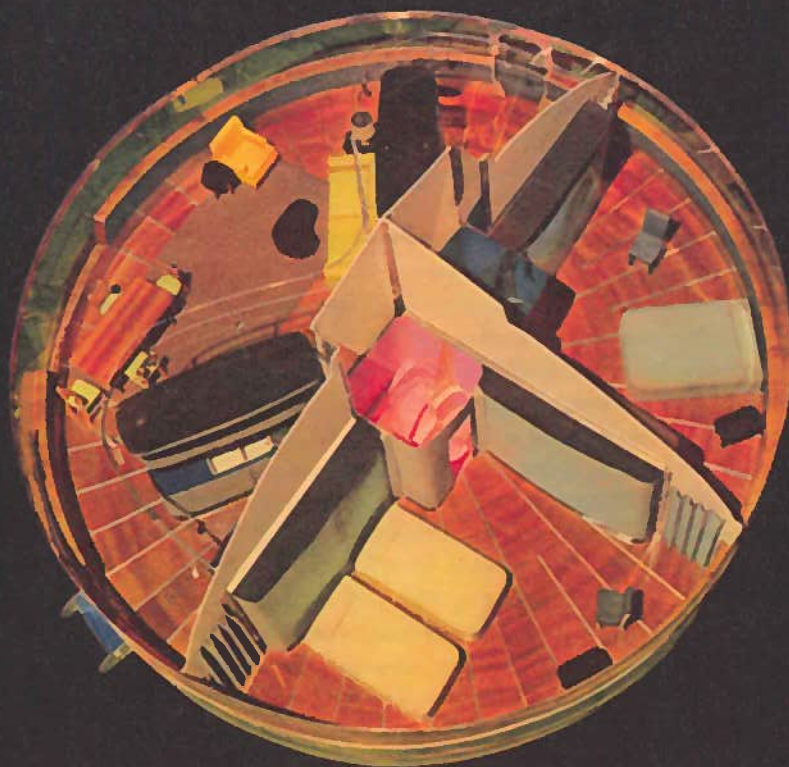
Designing a New Industry (1946), 31 ff.



844 The dome is hoisted up on the mast.



845 The ventilator is pulled in place. Parapet and windows have been assembled.



Wichita Dwelling Machine

For Fuller, design did not present an aesthetic problem but only the question of a teleologically clearly formulated task and its logical solution. There is probably no other plan for a model home that has moved as far from traditional architecture and as close to industrial design as the Dymaxion Dwelling Machine, as Fuller called this project. With its round form, the surrounding band of windows in the thin-skinned wall, its airspace between the ground and the floor, and the ventilator in the roof, it is like a civilization station inhabited by people outside of any urban context. Architectural journals reported extensively and with great fascination on the house. Still, as radical as it was, the house still did not make the step from a built sketch to a serially produced model: only two prototypes were built at full size, and it never made it to production. There are several reasons for this. First, the responsible parties at Beech Aircraft could not or would not make the immense investment that would have been required to achieve true serial production. Second, and not unrelated, the rapid development of a Cold War between the former allies hindered any hope of retooling the armaments industry for civilian uses. Third, probably Fuller himself, having immersed himself in his energetic-synergetic research on structure, realized that he did not really want to become a businessman.

246 Photograph of model with furnishings. The prototype in Wichita after completion. Weight including internal subparts and technical aggregate 8000 lbs., diameter

36 feet, floor space 1,037 sq. ft., interior volume 12,100 cubic ft., maximum interior height 16 feet, overall exterior height 22 feet. Title page of Beech Aircraft's employee magazine.



Beech Log



247 248, 249 Interior of the prototype with standard commercially available, tastefully modern furniture. Following a well-orchestrated campaign to publicize

Prefabrication

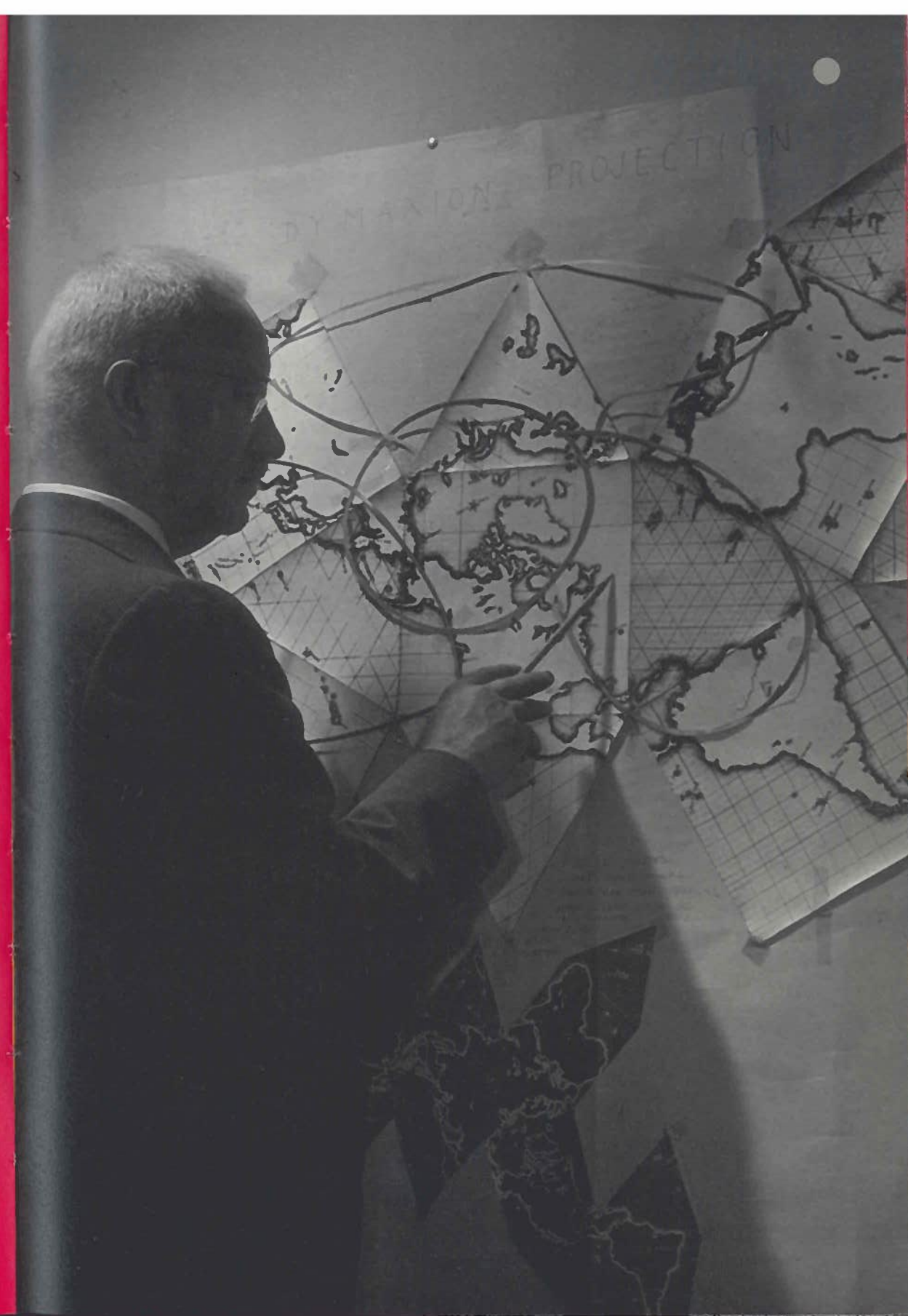
Fuller considered it important that the Wichita House was not a prefabricated house in the usual sense. The building trade defines as prefabrication the fabrication of panels and parts, that is, semifinished products, that are used at the construction site, that is, sub-assembled. The Fuller House, by contrast, consists entirely of industrial prefabricated units that are assembled at the site. The difference between subassembly and assembly is fundamental. In his view, only the assembly of fully standardized parts and complete units will result in the costs savings that come from mass production.

The Wichita House, Fuller Houses, Inc., received more than 30,000 expressions of interest from all over the country.



Ever since the statistical research into global distribution of resources he conducted during the thirties, Fuller had been working on a design for a world map that would be suited to represent global data and relationships. At the beginning of World War II, he noted a dangerous gap between the conventional picture of the world and a reality defined by air travel and "blitzkrieg." He wanted to correct the mental map that had been formed by four hundred years of using the Mercator projection. The Dymaxion Projection was intended to produce the key to an all-round logistics on the globe. As a topological way of transferring data from a globe to a flat surface by means of great-circle grids, it was a magnum opus for Fuller: the fundamentally important weigh station on the way to energetic-synergetic geometry and the geodesic domes.

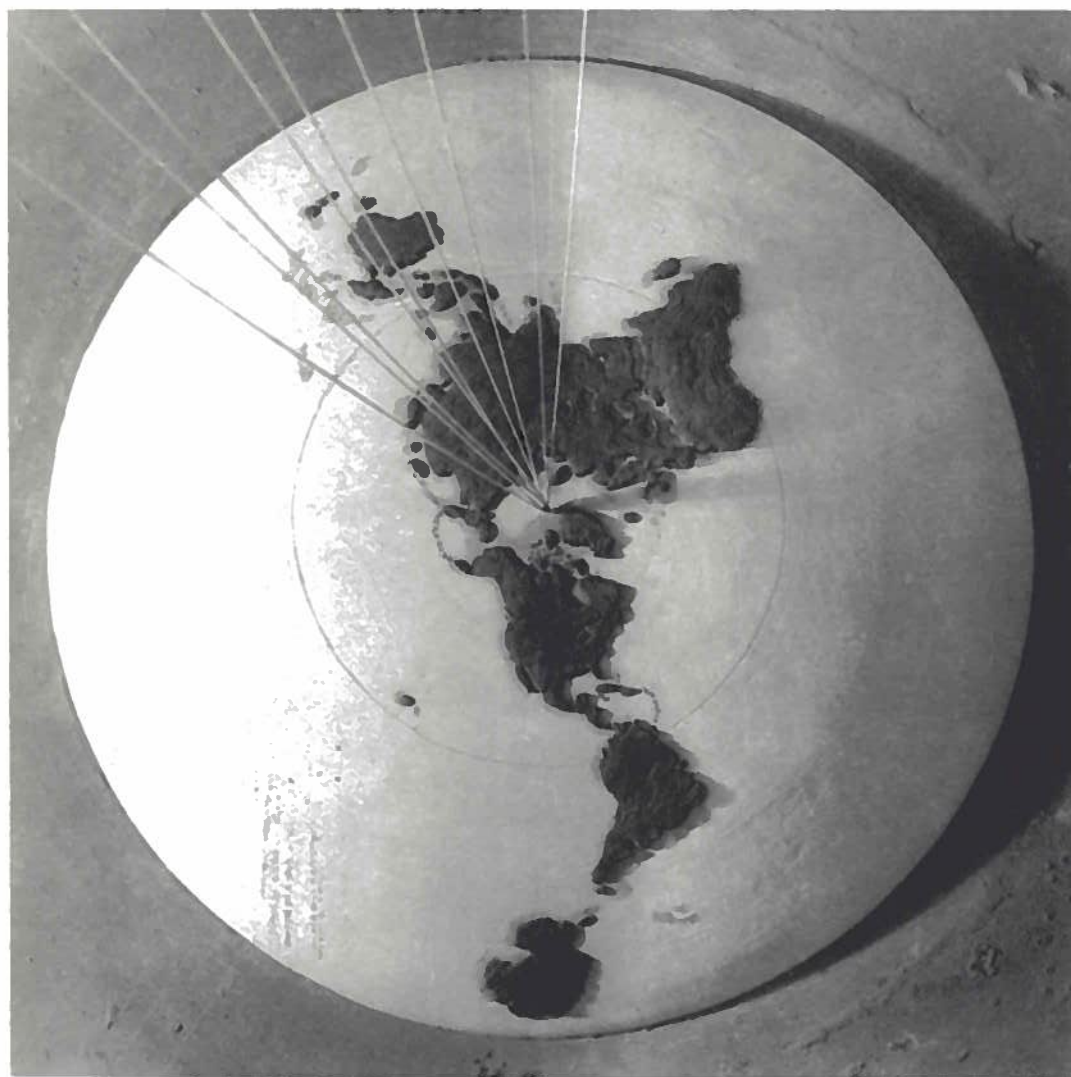
DYMAXION WORLD MAP



A New Way to Cope in This World

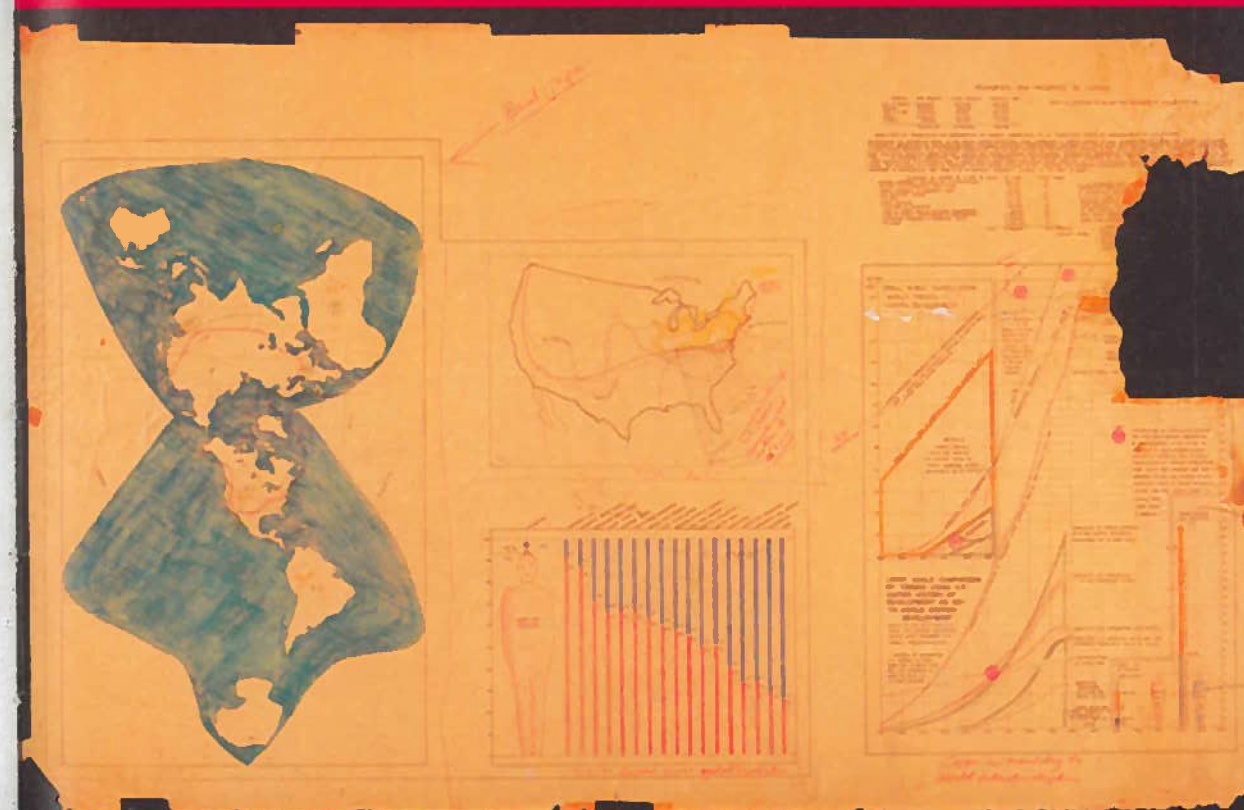
Suddenly, within months, people have come to realize that they can girdle the planet in an infinite number of directions. The world has been surprising itself by coming in its own back doors and down its own chimneys from every unlooked-for direction. This has called for a revolution in map making and in cartographical principles such as history has never seen. A need has risen for new methods of peeling data off the globe and for assembling the peelings in such a manner as to gain useful knowledge of the spherical coursings.

"Fluid Geography" (1944), in: *Ideas and Integrity*, 143



256 - RBF presents the Dymaxion Projection of the world map, 1943

- RBF'S World: "one-world island in a one-world ocean," gypsium model fabricated by RBF's friend, the marionette performer Eli Board, 1957



258 - World map with statistics, around 1964. RBF used the map as the endpaper for his book *Rise Charts to the Moon*, 1968

Fuller's Dymaxion World embodies his effort to resolve the dilemma of cartography: how to depict as a flat surface this spherical world, with true scale, true direction and correct configuration at one and the same time.

Orthodox cartography demands that the world be projected correctly in at least one of these aspects, even to the sacrifice of the others by distortion. This is a reasonable requirement in maps that are to be used for navigation, statistical work and other precise purposes.

On his map, Mr. Fuller adjusts the requirements of scale, direction and shape in a compromise which distributes distortions evenly between them and around the globe. For the layman, engrossed in belated, war-taught lessons in geography, the Dymaxion World map is a means by which he can see the whole world fairly and all at once.

President's Big Globe rests in ball-bearing mount. It can be revolved in any direction and studied in the changing perspectives of war's strategy.

Dymaxion Globe, a cube with its corners cut off, has shape of irregular solid first constructed by Archimedes. Its scale, constant on edges of segments, is similar to that of a 12-in. globe. It is designed for political geographers.

The President of the U.S. keeps a 50-in.-diameter globe close enough to his desk so that he need only swing his chair to consult it. As a political geographer, the President knows that no standard flat map can give him all the information he requires. The student – and master – of political geography is interested in the true, relative geographical locations of the Great Powers, and in the strategy of communications on the great-circle (shortest distance) routes between them. He must be able to visualize the world's geographical layout not only from his own vantage point, but in the divergent perspectives of other nations and their political geographers.

R. Buckminster Fuller designed his Dymaxion World map to fit exactly these requirements. Like all flat maps, it evidences the distortions that result from the translation of the three-dimensional surface of a sphere to a flat plane. Its distortions, however, are distributed proportionately within each of its 14 segments and are nowhere extreme. Greenland on the Dymaxion map appears close to its relative size, in contrast to its inflation to six times that size on the Mercator projection. The segments, plotted on an entirely novel grid of great circles, are constant in scale along their edges. Distortion increases toward the center of each segment.

Thus, though it does not easily yield precise calculations, the Dymaxion World used as globe or flat map, satisfies the need, short of a perfect sphere, for a visually correct picture of the earth.

Life, March 1, 1943, (editorial staff's contribution)

DYMAXION WORLD (continued)



256 • "The Globe of the President"
• Globe following the Dymaxion Projection method,
1st version 1942

• REF with the Dymaxion Map in the one-continent layout

HOW TO ASSEMBLE THE GLOBE

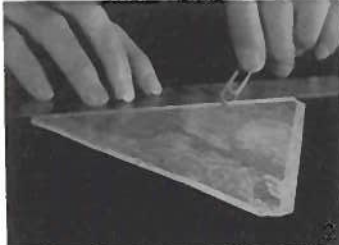
Here demonstrated is the simple procedure by which the segments of the Dymaxion World map are assembled into a visual approximation of a round globe. The opposite page is the reverse side of the round of the triangular center sheets on which the map is printed. First step, removal of center sheets from magazine, must be taken with care to avoid tearing map on staples. Segments cut out are best fastened together by paste

or mudclips. Because they warp the paper, pins should not be used. For contact product, sequence of assembly here illustrated should be followed. Marginal letters of triangles match marginal letters of squares. The map, thus assembled into a 14-sided solid, has many of the advantages of a globe. Like a globe it can be viewed from any perspective to bring geographical relationships into new relief—to show that the South-

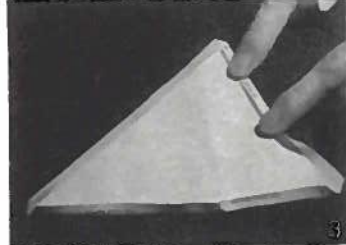
ern is the water hemisphere, that Chicago and Seoul are fairly close together over the top of the world, that Dutch Harbor lies closer to the shortest than Pinaro-Tokyo route than Pearl Harbor. Before they are hidden inside globe, statistics on reverse of each segment are worth inspection. For example, the North Pole square's 8.0% of world population contrasts dramatically with the South Pole's .0004%.



REMOVING OF STAPLES is first step in removing map from copy of LIFE. Best technique, staples held very tight.



SCORING OF MARGINS of colored lines of copy must with clip or dull ballpoint pen. Folds of map made by hand.



FOLDING OF FLAPS should follow margin of map precisely. Flaps of segments to be joined are held by bottom.



HOUSEHOLD WASTE or scraps in best source for coloring flaps. It should be spread thinly to avoid warping.



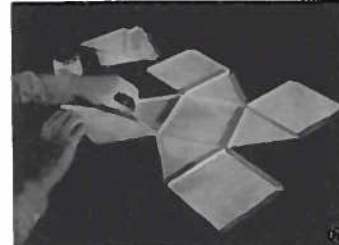
FINISH CLIPS, easy to apply, permit elasticity of globe. If dimensions not exact must be taped around in.



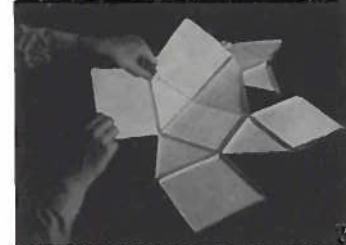
CELLOPHANE TAPE is substitute for paste and clips. It must be applied inside and out to keep edges together.



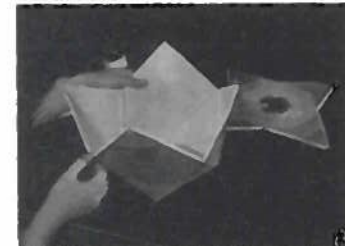
POLAR SQUARE and triangles should be assembled into unit. Care should be taken to keep edges in register.



EQUATORIAL SQUARES are then joined to polar square-triangle assembly. Key letters simplify matching.



MOST DIFFICULT is this step in which square is joined to triangle. Polar square should be held flat on table.



SQUARES AND TRIANGLES are now fastened and structure is self-supporting. Paper has surprising elasticity.



SECOND POLAR ASSEMBLY is completed. Paper should be allowed to dry a little before the flaps are joined.



LAST TRIANGLE is left unfastened until other flaps are secured. It can then be set by pressure from the outside.

—OR YOU CAN USE SEGMENTS FOR A FLAT, MOVABLE MAP (SEE PAGE 53)

GOOD HOPE

0.6% of world's land area 338,800 sq. mi.
8.9% of world's water area 8,282,100 sq. mi.
0.3% of world's population 3,974,700 inhab.

SQUARE MILES **POPULATION**
AFRICA 3,814,000
NORTH AFRICA 3,814,000
SOUTH AFRICA 3,814,000

NEW ZEALAND
0.0% of world's land area 178,800 sq. mi.
0.0% of world's water area 8,282,100 sq. mi.
0.0% of world's population 3,974,700 inhab.

SQUARE MILES **POPULATION**
AFRICA 3,814,000
NORTH AFRICA 3,814,000
SOUTH AFRICA 3,814,000

EUROPE AND AFRICA
12.4% of world's land area 6,282,100 sq. mi.
1.4% of world's water area 8,282,100 sq. mi.
27.0% of world's population 37,418,000 inhab.

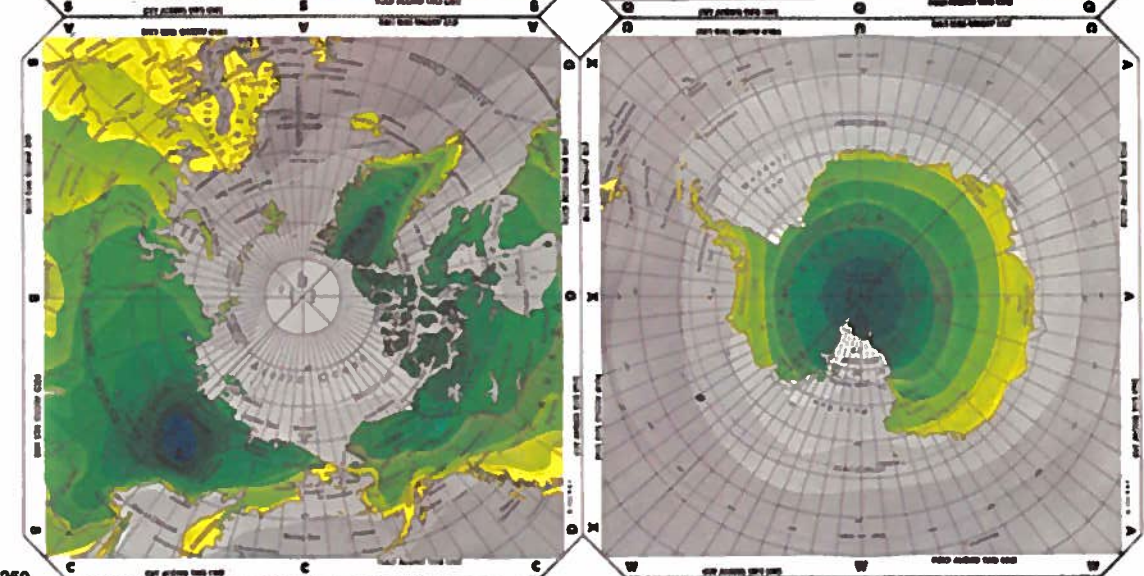
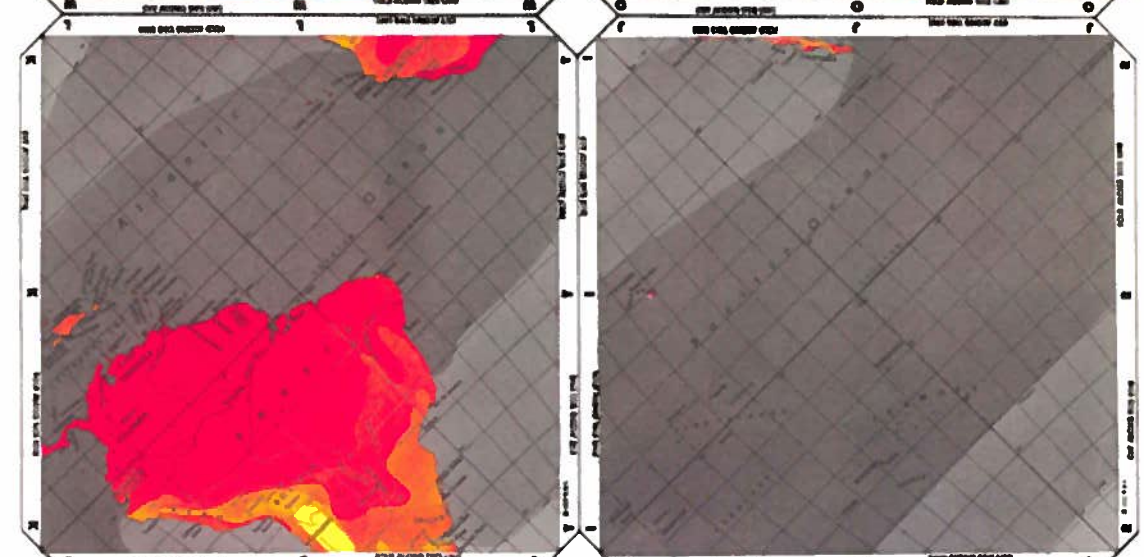
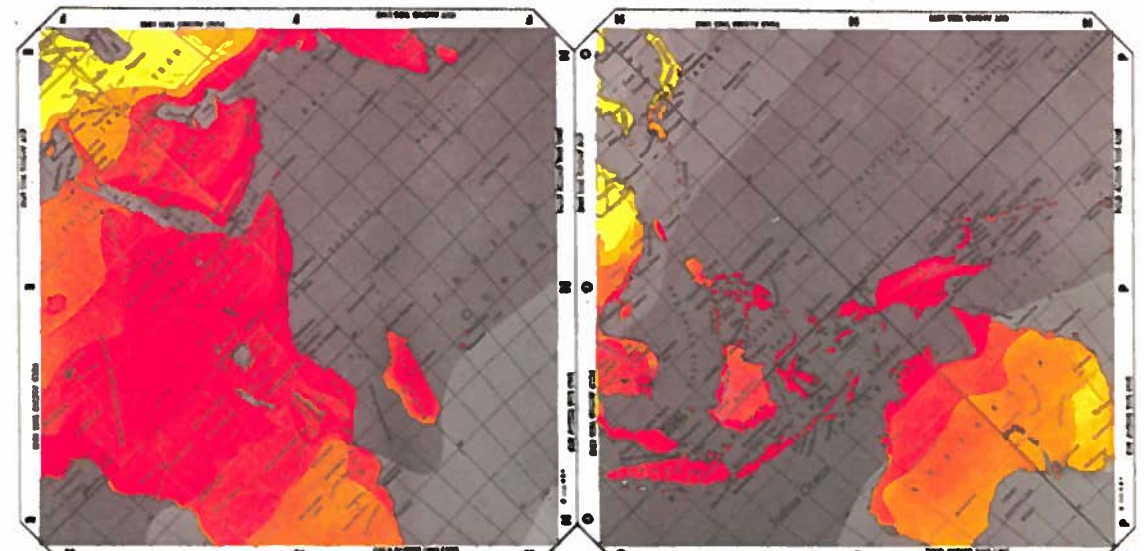
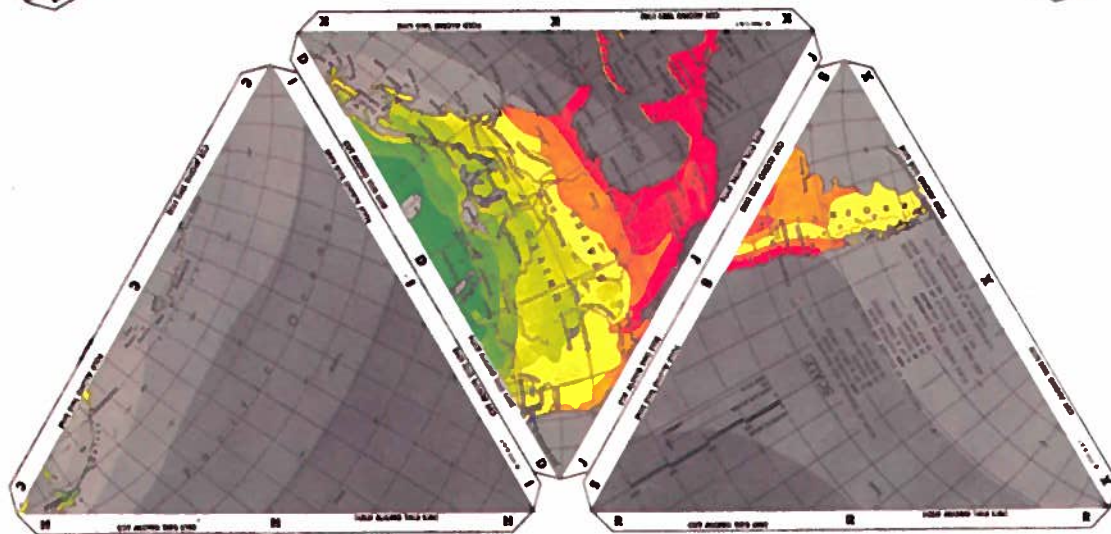
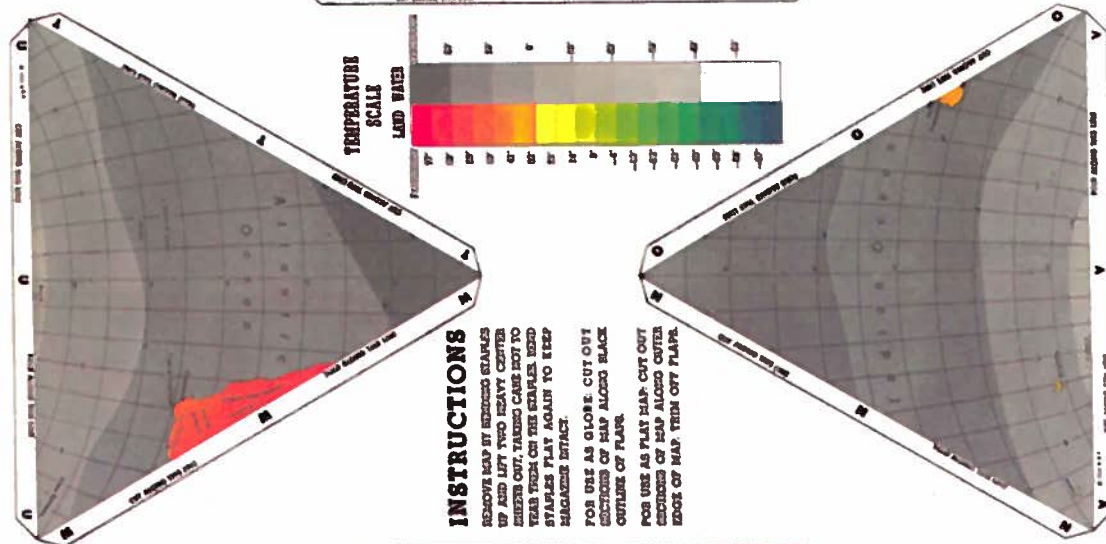
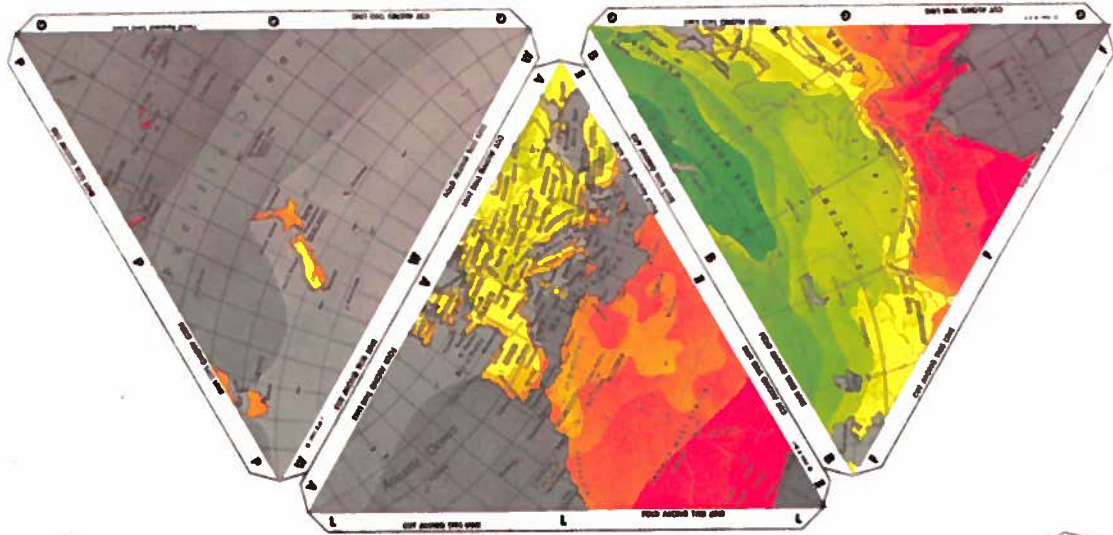
ASIA
12.4% of world's land area 6,282,100 sq. mi.
1.4% of world's water area 8,282,100 sq. mi.
27.0% of world's population 37,418,000 inhab.

INDIAN OCEAN
0.0% of world's land area 47,000 sq. mi.
8.1% of world's water area 8,282,100 sq. mi.
0.0% of world's population 37,418,000 inhab.

MIDWAY
0.0% of world's land area 178,800 sq. mi.
0.0% of world's water area 8,282,100 sq. mi.
0.0% of world's population 3,974,700 inhab.

U.S.A. AND NEIGHBORS
8.9% of world's land area 8,282,100 sq. mi.
2.6% of world's water area 8,282,100 sq. mi.
8.0% of world's population 173,084,700 inhab.

CHILE AND ARGENTINA
0.0% of world's land area 178,800 sq. mi.
0.0% of world's water area 8,282,100 sq. mi.
0.0% of world's population 3,974,700 inhab.



AFRICA AND ASIA

19.3% of world's land area 11,083,800 sq. mi.
7.3% of world's water area 10,219,800 sq. mi.
12.0% of world's population 268,883,900 inhab.

SQUARE MILES	TERRITORY	POPULATION
3,881,300	BRITISH AFRICA	45,678,200
284,400	AFRICA SOUTH	8,775,800
379,100	EGYPT	15,742,000
1,188,800	INDIAN AFRICA	8,884,700
1,188,800	PORTUGUESE AFRICA	3,464,600
771,300	ETHIOPIA	12,100,000
250,000	MAHAGASCAR	1,700,000
1,041,000	INDIA	79,391,200
645,000	CHINA	6,478,200
137,200	TURKEY	1,102,700

SOUTH AMERICA

11.7% of world's land area 6,708,000 sq. mi.
10.4% of world's water area 14,967,000 sq. mi.
4.0% of world's population 94,897,000 inhab.

SQUARE MILES	TERRITORY	POPULATION
3,276,000	PERU	4,100,000
533,000	ECUADOR	7,081,500
448,000	COLOMBIA	8,831,200
318,000	ARGENTINA	1,531,200
378,000	CHILE	1,504,000
308,000	PARAGUAY	1,148,000
141,000	URUGUAY	1,054,000
86,000	CARIBBEAN ISLANDS	8,666,000
28,000	AFRICA	6,104,000

NORTH POLE

17.2% of world's land area 9,789,100 sq. mi.
8.4% of world's water area 11,473,900 sq. mi.
8.9% of world's population 191,988,700 inhab.

SQUARE MILES	TERRITORY	POPULATION
4,881,000	U.S.A.	123,891,000
1,034,000	CANADA	1,838,000
78,000	GREENLAND	17,000
620,000	RUSSIA	71,000
38,700	SCANDINAVIA	18,891,000
14,200	ICELAND	106,000
14,200	SPITZBERGEN	1,000

WARNING

DO NOT REMOVE THESE PAGES UNTIL YOU TURN
TO CENTER SPREAD AND READ THE INSTRUCTIONS

PACIFIC WAR AREA

9.6% of world's land area 5,477,600 sq. mi.
11.3% of world's water area 18,263,000 sq. mi.
19.0% of world's population 402,462,800 inhab.

SQUARE MILES	TERRITORY	POPULATION
3,188,400	AUSTRALIA	6,387,400
728,000	NETHERLANDS EAST	49,343,700
382,000	CHINA	204,000,000
116,000	JAPAN	63,328,000
117,000	THAILAND	7,078,700
171,000	INDONESIA	100,000,000
114,000	PHILIPPINES	18,971,100
49,000	MALAY FEDERATION	5,624,200
800	JAPANESE MANDATES	101,000

PACIFIC OCEAN

0.1% of world's land area 63,700 sq. mi.
19.1% of world's water area 21,209,300 sq. mi.
0.05% of world's population 1,196,800 inhab.

SQUARE MILES	TERRITORY	POPULATION
10,700	U.S. PACIFIC COAST	694,000
42,000	WESTERN AUSTRALIA	423,000
1,000	HAWAIIAN ISLANDS	1,200
1,000	GALAPAGOS	1,200
600	SOCIETY ISLANDS	1,200
600	MARSHALL ISLANDS	1,200
1,000	FIJI	1,200
700	OTHER ISLANDS	34,200

SOUTH POLE

8.7% of world's land area 5,000,000 sq. mi.
11.3% of world's water area 18,263,000 sq. mi.
0.0004% of world's population 8,400 inhab.

SQUARE MILES	TERRITORY	POPULATION
1,000	RUSSIA	1,000
1,000	NETHERLANDS	1,000
1,000	NETHERLANDS	1,000
1,000	NETHERLANDS	1,000
1,000	NETHERLANDS	1,000
1,000	NETHERLANDS	1,000
1,000	NETHERLANDS	1,000
1,000	NETHERLANDS	1,000

Flat map shows world in many perspectives

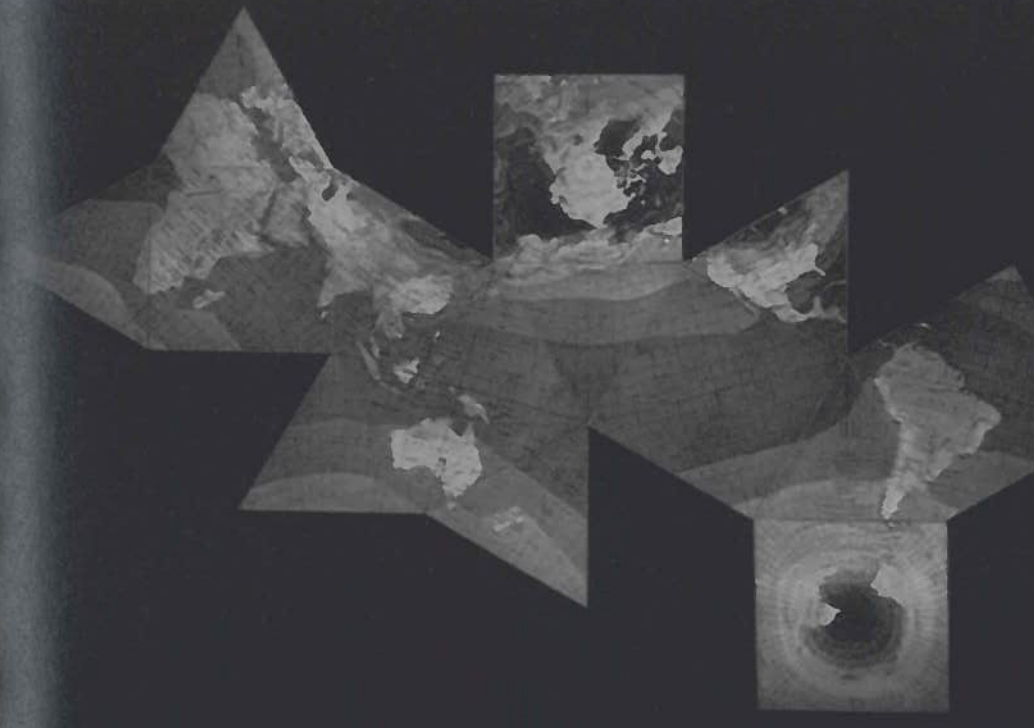
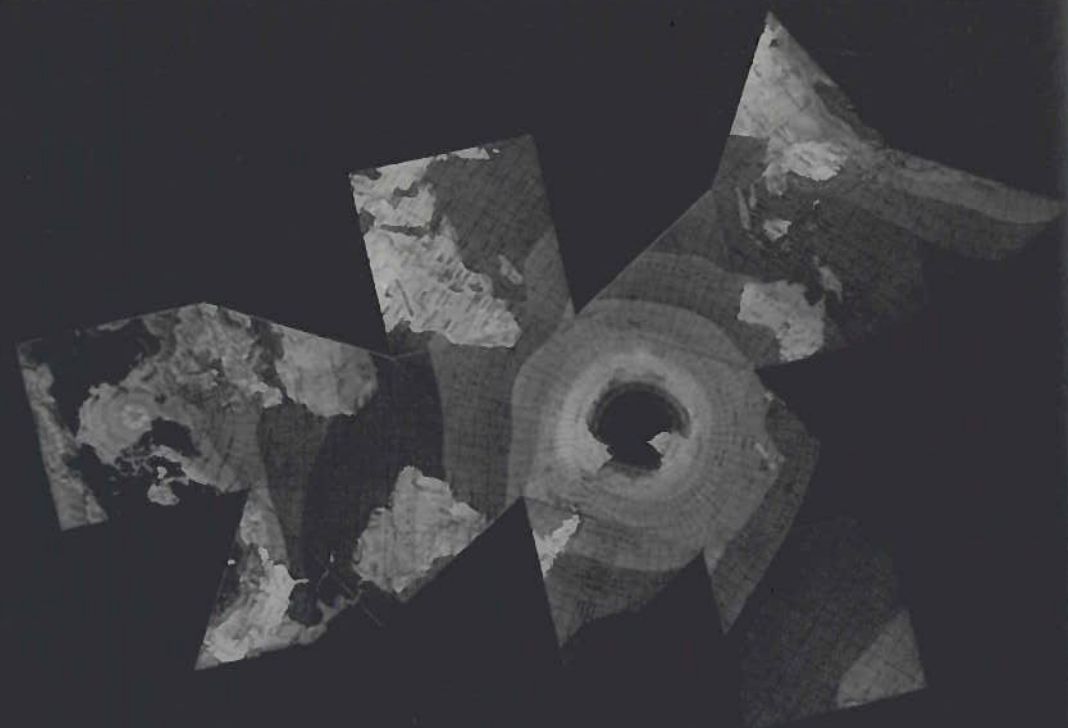
In its role as a flat map, the Dymaxion World holds fascination as endless as the possible combinations of its 14 segments. [...] Matched together, as below, the tiles can be arranged and rearranged to animate the facts of geography and clarify many of its obscurities. The layout may be centered on any world power, and it will suggest at once the geographical considerations that dictate its strategy and ambitions. Thus the motivations of Jap imperialism and Argentine isolationism can be spread out for inspection, and the recent revolution in the U.S. world-view can be set down in graphic narrative.

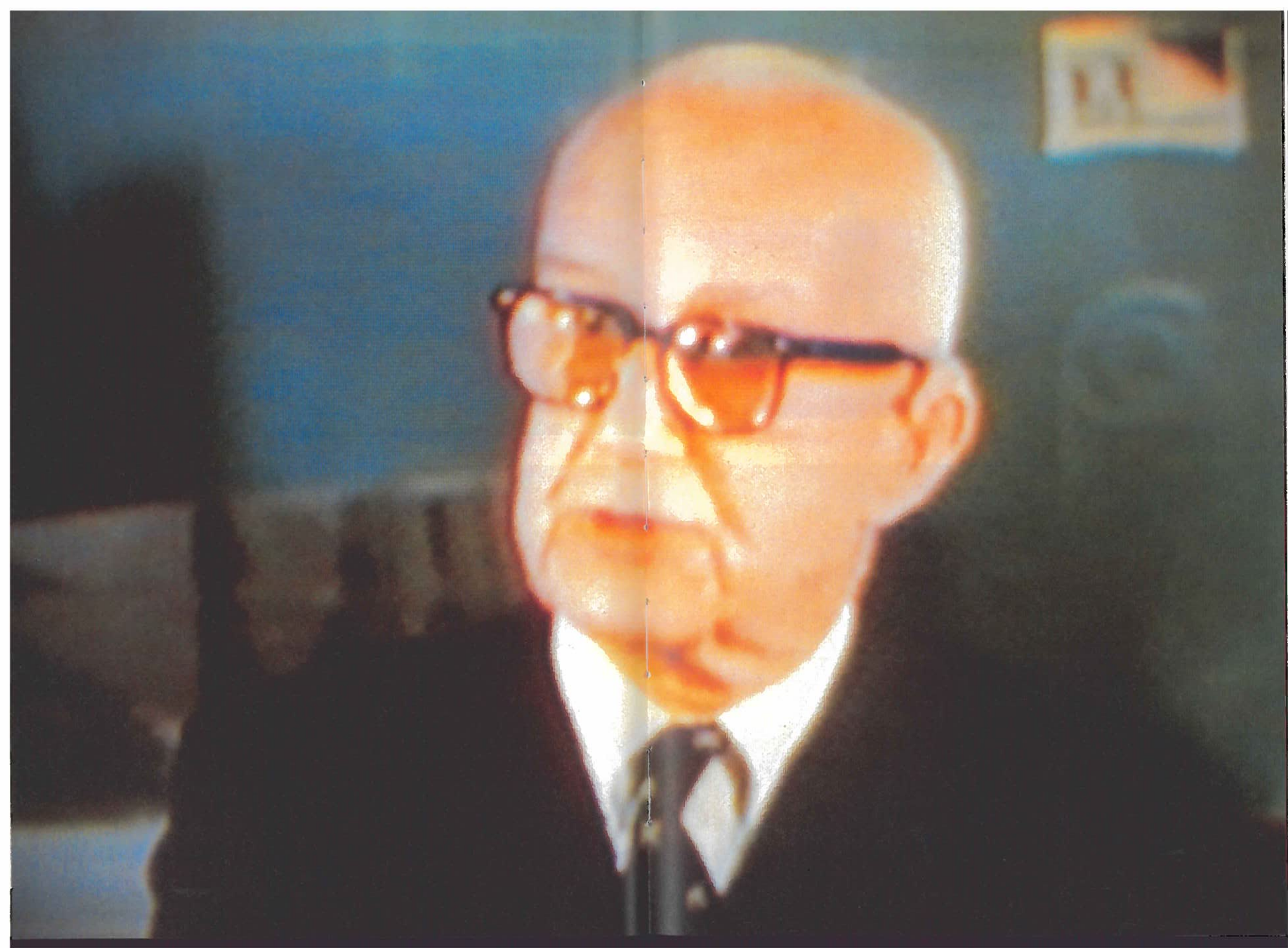
North Pole Layout of segments shows the world in new focus of air power. The U.S., Canada and Russia control almost the whole coastline of the Arctic Ocean. One of the first to recognize the strategic importance of the Arctic region, Mr. Fuller designed his first polar projection as an end paper for his *Nine Chains to the Moon*. (Lippincott, 1938)

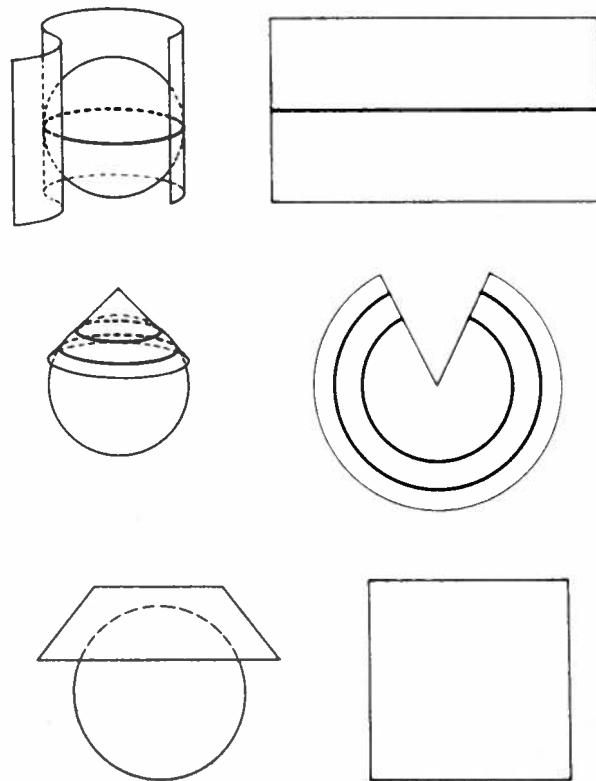
Mercator World. Here the tiles are laid in a pattern that approaches the familiar appearance of the Mercator projection. The equator is a continuous line, orienting the world east to west. Not shown on the true Mercator are the poles, which appear here. The Mercator is still the best and standard base map of navigation, but its perspective is that of the 18th, not the 20th Century.

DTMAXION WORLD

(continued)







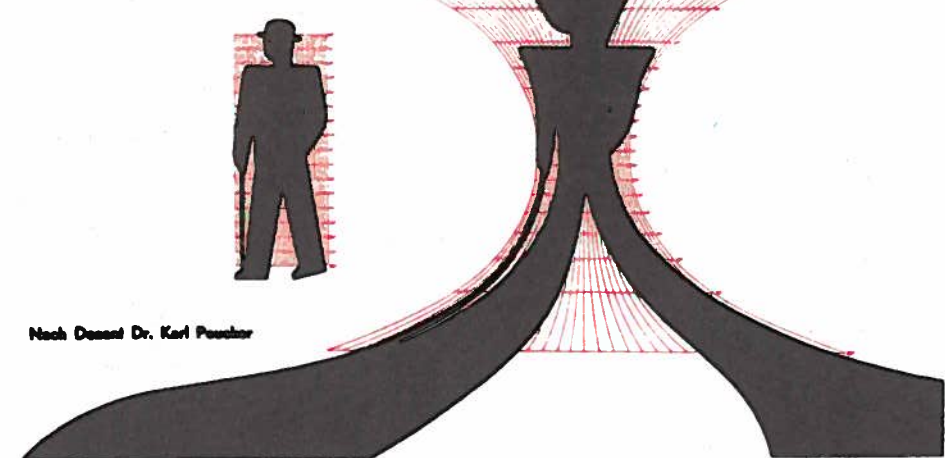
This Dymaxion map approximation of the Mercator projection brings the character of the Renaissance world into bold relief. Most striking is the vast expanse of ocean, the world's highway. Though a few hardy explorers hunted a Northwest Passage, the course of empire and trade was southward along the coast of South America and eastward around Good Hope into the Orient. It was in this period that the Dutch cartographers and Papal fiat divided the world in hemispheres.

British Empire: The British Empire was built by generations of mariners in the Royal Navy and merchant marine who knew not only ships but oceans. This layout of the Dymaxion map is not so much a picture of what they accomplished as it is a demonstration of how they did it. They found the secret to power where no one else thought to look - on the bottom of the world.

Due primarily to the rotation of the earth, the prevailing winds and ocean currents around the Antarctic region move from west to east, clockwise on the map. Sailing southward around Good Hope, British ships moved into the winds and currents as onto a turntable. From the turntable the waters opened out to the Indian peninsula, the Indies, the Pacific islands and the western coast of the Americas. Suez, after 1869, moved the lifeline northward through the Mediterranean Sea.

Heartland. Central Eurasia is the Heartland, the prize for which the German Army has once more marched against the world. It is a concept first expounded before World War I

VERZERRUNG DURCH MERCATOR-PROJEKTION



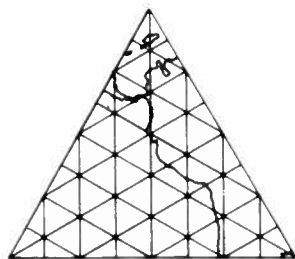
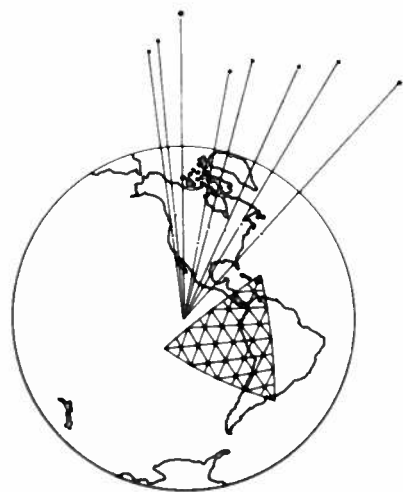
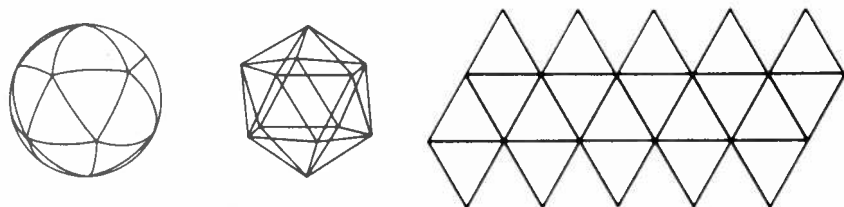
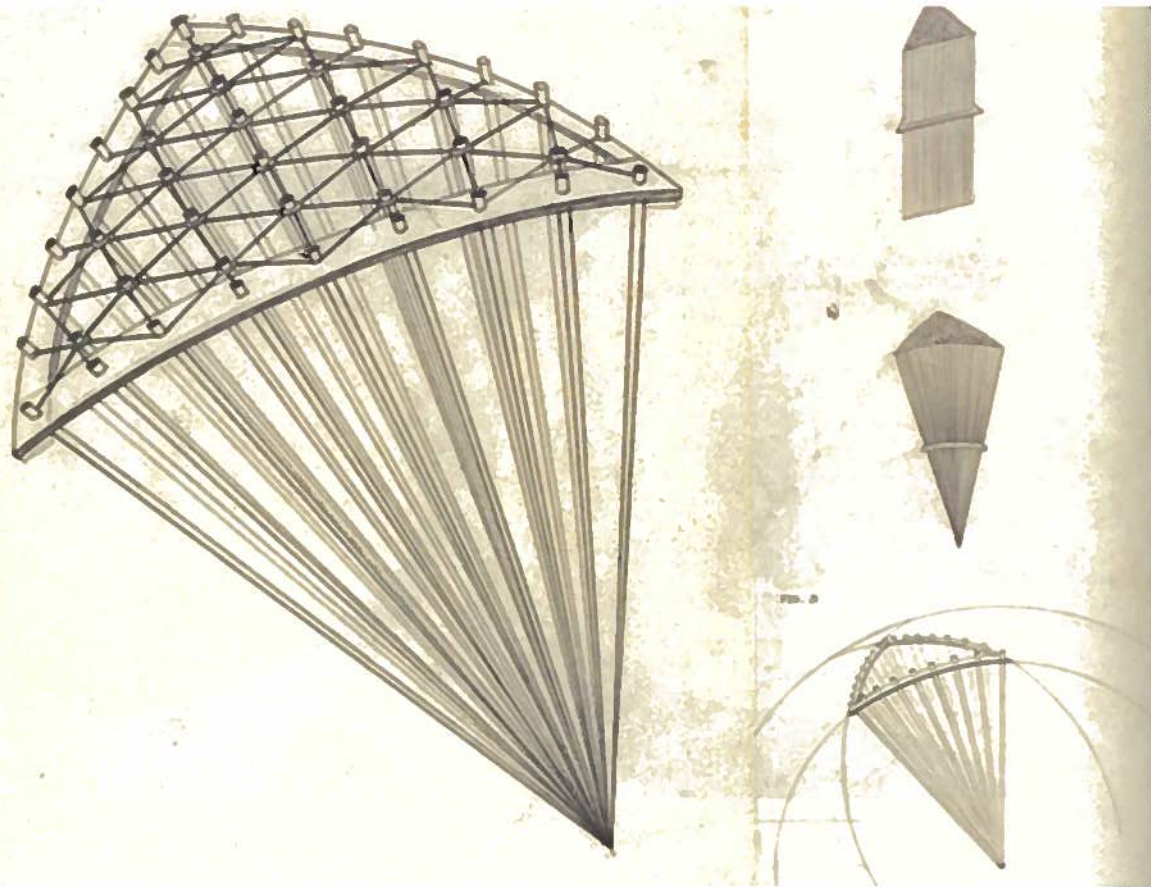
by a British, Sir Halford Mackinder, who envisioned the decline of seapower before terrain-covering mechanized land armies. For land-bound Germany it was a ready-made program for World War II. The Nazis inflated it into something called "geopolitics," and set out to make it a terrible reality.

The world of geopolitics, as shown here, consists of one big continent on which hang the peninsulas of Europe and Africa. Australia, North America and South America are unimportant islands. The oceans, separate basins on map, lose strategic significance. "He who controls the Heartland controls the world," because he has outflanked seapower by capturing all its bases.

Jap Empire. The ruthless logic of the Jap imperialism is exposed by this layout of the Dymaxion World map. The seapower-minded Japs want nothing less than the Pacific. Control of the ocean and its shoreline, they calculate, will give them control of the hinterlands. Their thinking strikes an obvious contrast to the landlubber geopolitics of their German allies (above).

The Japanese can boast that they are closer to their goal than the Germans. Already they are masters of the western shores of the Pacific, from their northern toe hold in the Aleutians to their outposts in the Solomons. Consolidated there, they would be ready for the attack on North America as predicted by Ambassador Joseph C. Grew. On our side of the Pacific they saw foundations of their dream laid by colonies and trade on the U.S., Mexican and South American coastline.

Life, March 1, 1943, (editorial staff's contribution)



Jan. 29, 1946.

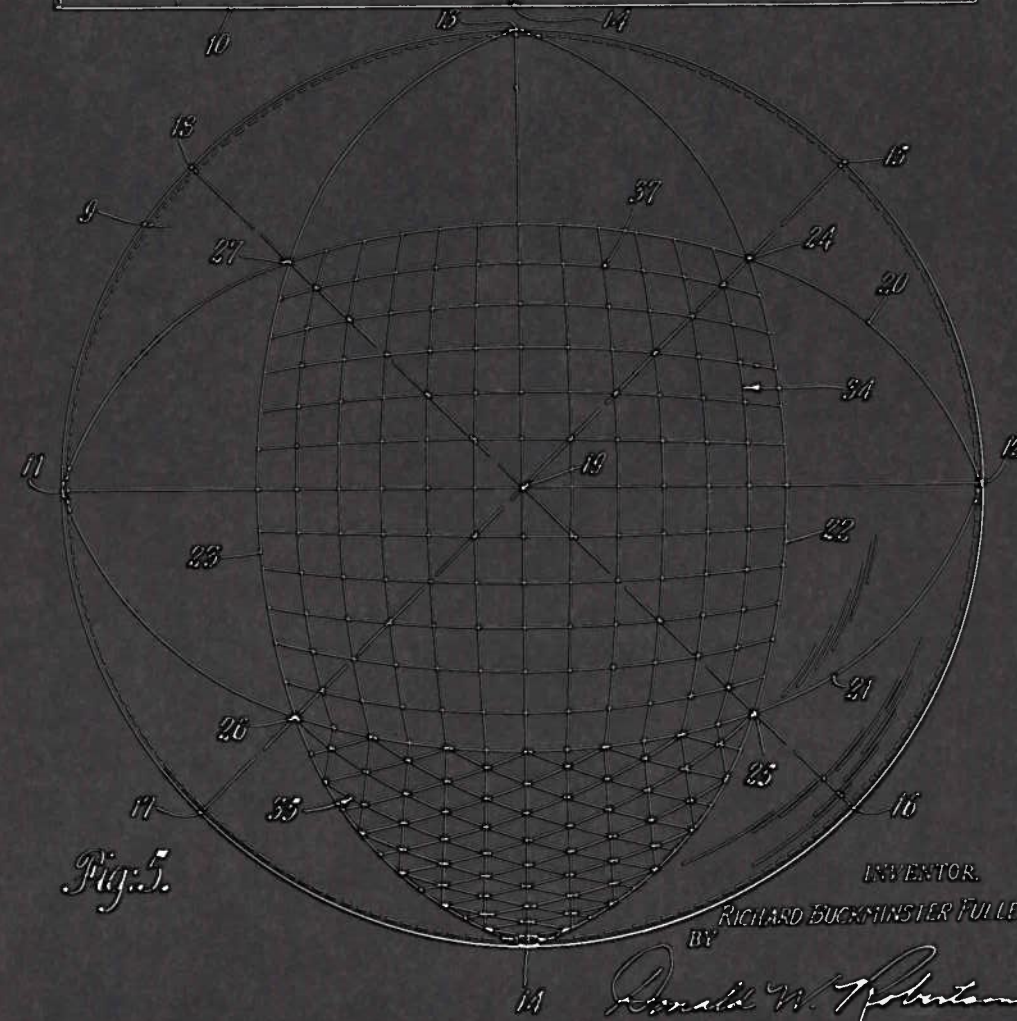
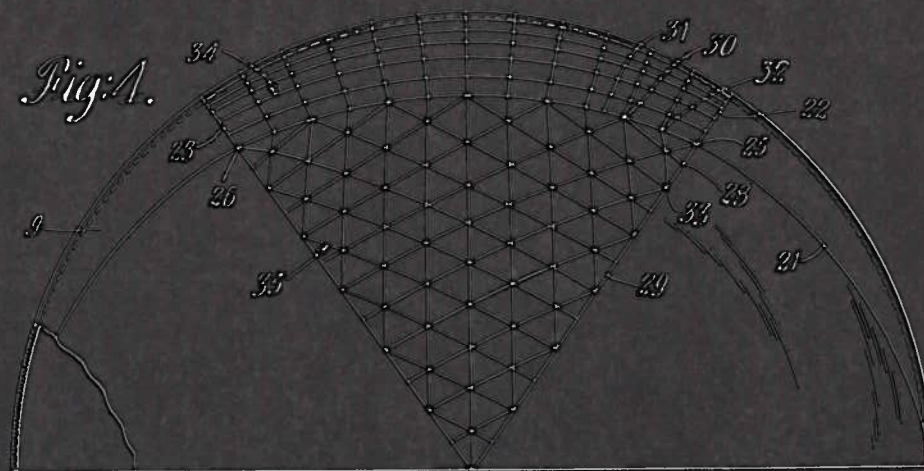
R. B. FULLER

2,393,676

CARTOGRAPHY

Filed Feb. 25, 1944

5 Sheets-Sheet 4



INVENTOR.

RICHARD BUCKMINSTER FULLER

BY

Donald W. Robertson

Construction of Dymaxion World Map

People are learning that "via the North Pole" is the shortest great-circle distance from America's midst to the center of population of the world. But when they were told during the war that Tarawa represented the first major gain in the direction of Tokyo, they were not well enough versed in their geography to realize that announcement that the Marines had taken the North Pole would have put the United States closer to Tokyo's center, and that the Marines were actually farther from Tokyo than Chicago is from London. And even those professional geographers and military tacticians who did know that these were the proportionate distances by great circle, have not, unless skilled in the dynamic sailorman's thinking, realized that in the terms of the air motions which twist the great circle courses all out of shape, the North Pole is a third nearer to Tokyo than Tawara, when full advantage is taken of atmospheric motions.

Because of this latter fact, it becomes obvious that the kind of map that static cartographers produce can only partially educate the people - that is, up to the realistic great-circle concept. All known traditional projection methods fall far short of providing a comprehensive, sectional cartographical device which may be mutably arranged in any direction in such a manner as to bring focus to bear on any of the dynamic inter-relationships of the world's surface affairs.

One such sailorman's mid-twentieth-century invention is the mutable map presented here. Appropriately, its faces represent the facets of the monometric construction shown in the accompanying drawing, which drawing represents the vector equilibrium of a sphere.

Unlike all known preceding projections, which represent transfers of spherical data to plane surfaces tangent to the sphere only at one point, as in the case of the azimuthal or gnomonic projection methods, or only along one central line, as in the case of the Mercator, or only along one



or two segmental arc lines, as in the conics, this projection is one in which the coincidence with the projected sphere occurs all along the complete boundary of each section of the projection, thus retaining the unique cartographical feature of being the only projection in which uniform great-circle scale characterizes the logical terminal edge of each section to be projected, that scale being maintained intact after transfer from the sphere to the flat surface of the map.

Sailorwise, this new projection is made from the cosmic viewpoint – that is, the astronomical zenith and the center of the earth always remain, respectively, vertically above and below each and every point of the surface of the cartographic data. Not only is this true in its spherical arrangement but also in its planar projection into the sections of the comprehensive map.

Because the enclosing border scale cannot be elongated, distorted or contracted, and represents a great circle bent flat into a one-dimension line, the adjustment of the contained spherical surface segment to a plane surface segment must be satisfied by interior contraction of the data instead of by exterior stretching, as in all other methods of projection. Because of this feature the several pieces fit neatly together, being the mutual sides of adjacent polygons and being separated by the same great circle or straight line. Because the area of a circle increases as the square of its radius, the same error outwardly disposed must be distorted to four times greater extent than by inward disposition.

The segmentation of the earth's surface into eight triangles and six squares is not in any sense a matter of esthetic choice. It represents one known subdivision possible by means of this universal-projection viewpoint, for the radial and chordal lengths must be identical in order to allow this symmetrically hinged opening of the sphere.

Having six axes and four dimensions, its parts may be rearranged to unpeel the globe continuously in all directions. Gnomonic projections through the surface facets of any of the regular polyhedrons will serve to provide a variety of sectional world surface maps. Striking an optimum between angular contraction and numbers and sizes of pieces, an icosahedron is the least distorted, for these projection purposes, of any of the regular solids. However, the spherical vertexes of the icosahedron's twenty triangles must be reduced from 72° to plane triangular vertexes of 60° , a reduction of twenty per cent, which percentage times the number of pieces gives the total distortion. On the other hand, the Dymaxion's fourteen pieces accomplish translation with a distortion of only sixteen per cent, the Dymaxion's spherical triangles being only 70° and the vertexes of the square bearing the same percentage relationship between the spherical and the plane figure.

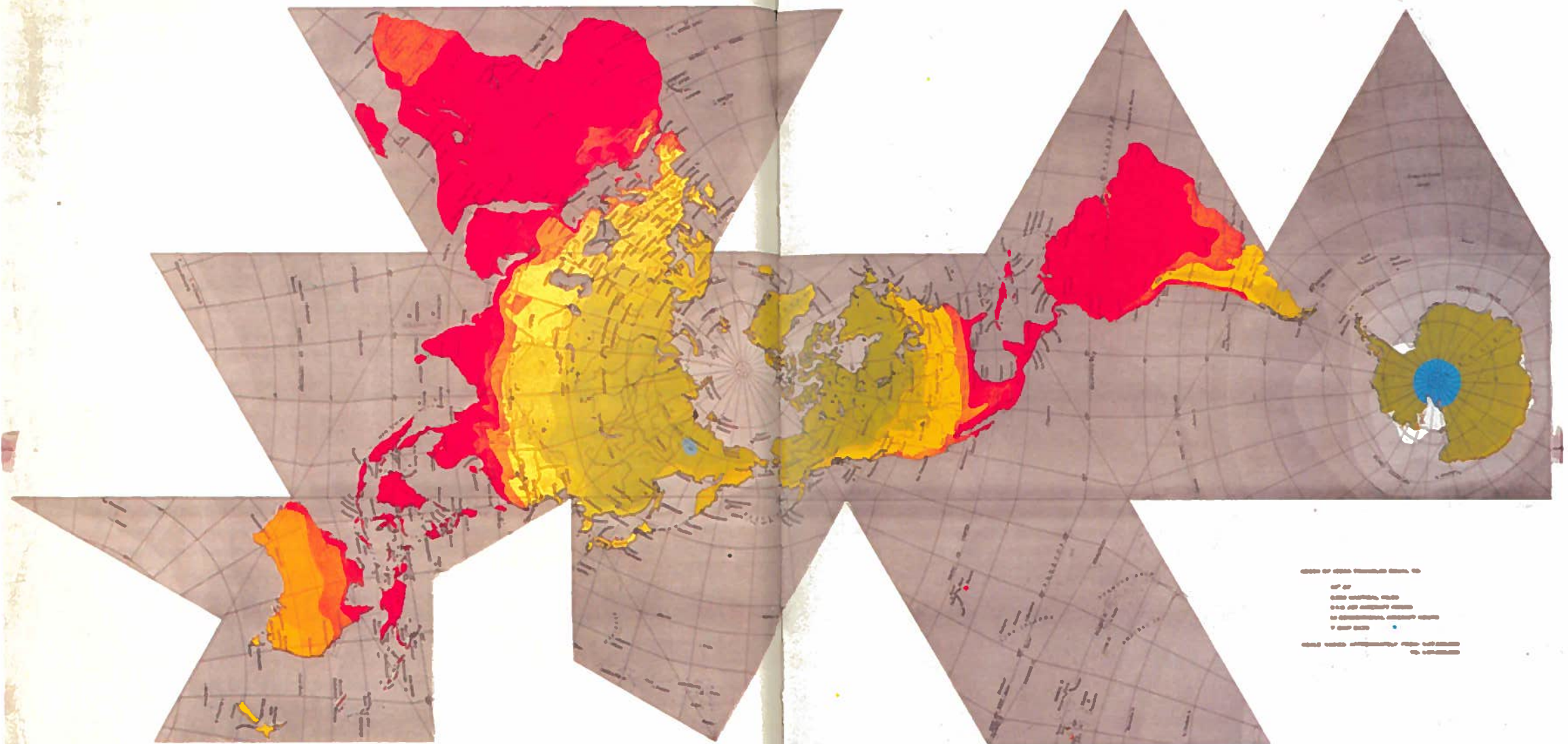
The Dymaxion projection method of transferring spherical data to the plane surface is extremely simple. Because of its universal viewpoint, it need deal only with the surface of the sphere and the plane surface of the map. A lattice of four great circles is formed about the sphere, each intersecting the other in such a manner as to subdivide each circle into six symmetrical arcs of 60° . This lattice provides fourteen spherical surface areas, eight of them triangular, six of them quadrangular. These spherical triangles and squares are equilateral. The surfaces of these triangles and squares are then interwoven with great circle grids, the triangles by a three-way grid of great circles and the squares by a two-way grid of great circles. These grid lines spring from uniform scale modular subdivisions of the 60° arc sections in as fine a degree as is desired.

The geographical data coinciding with these grids is then transferred to eight equilateral plane triangles and six plane surface squares. For purposes of this translation, the plane triangles and squares have been prepared as follows: Their surfaces are subdivided by respective three-way and two-way grids of straight lines. These straight lines spring from modular subdivisions of their boundaries which correspond in scale and number to the subdivisions of the original spherical arc segments of 60° . The spherical geographical data is then posted to corresponding positions in the appropriate plane grid spaces. The spherical great circle grids are thus treated as constituting straight lines in the plane geometrical surface. The principle of treating great

circles and straight lines as constituting one and the same thing effects the distribution of the angular contraction in a concentric disposition on the plane sections.

The key to understanding why this method accomplishes its translation with a minimum of distortion is that it treats the 180° spherical gores in two ways. The irreconcilable conditions of convergence and parallelism, characterizing the terminals and mid-part of the 180° gores, are treated separately and symmetrically as triangles and squares respectively. All other projections impose the advantage of one feature against the advantage of the other by trying to solve both convergence and parallelism by one grid. These resolved gore parts of the Dymaxion map, by treating these conditions separately, allow four-dimensional unwrapping of the sphere.

"Fluid Geography" (1944), in: *Ideas and Integrities* (1963), 136ff. (→ YPS: Discourse)



D Y M A X I O N A I R O C E A N W O R L D
 N. C. STATE COLLEGE SCHOOL OF DESIGN EDITION OF FULLER PROJECTION
 R. BUCKMINSTER FULLER & SHOJI SADAO, CARTOGRAPHERS
 PUBLISHED BY STUDENT PUBLICATIONS OF THE SCHOOL OF DESIGN
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 U. S. PAT. 2,303,676

TEMPERATURE



100° or
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Even during the Wichita House project, Fuller began to intensify his geometrical research more and more. As an autodidact, without any respect for academic specialized research, he developed his own, fundamental research into structure. He sought a geometry of nature. The two main paths in Fuller's research are, first, his explorations of the closest packing of spheres, from which he derived basic configurations in space that are by and large identical to the Platonic bodies. In particular, he obtained a matrix to determine space-time configurations. The second path concerned the division of the sphere (for example, in the map projections) into great-circle models, how they can be folded, and finally how they can be quantized into a geodesic network. This fundamental research, however, was meant to be followed up by practical inventions and applications. To that end, he established the Fuller Research Foundation in Forest Hills, New York, in 1946.

FULLER RESEARCH



way that the successive layers outside of the 92-sphere layer begin to penetrate the adjacent systems, and that only the concentric system of spheres within and including the layer of 92 are unique and individual systems.

It will be found that the number of spheres in any complete layer around any nuclear group of layers always terminates with the digit 2; first layer 12, second layer 42, third layer 92, fourth layer 162, fifth layer 252, sixth layer 362, and so on to infinity. The digit 2 is always preceded by a number which corresponds to the "square" of the number of layers surrounding a nucleus. The third layer's number of 92 is comprised then of the number 3 multiplied by itself ("squared") with digit 2 as suffix. This third layer is the outermost of the symmetrically unique nuclear system patterns, and may be identified with the 92 unique atomic systems, and with the 92nd element, uranium. The geometrical form thus most compactly developed is not that of a composite sphere, but is always a polyhedron of 14 faces, comprised of six squares and eight triangles, and 12 points extending in tangential radius from the original 12 spheres surrounding the nucleus.

These successive layers, which permeate each other in all directions, may be identified with energy waves radiant in all directions from a nucleus. The volumetric measurement of any one wave is (variously) determined by the "square" of the radius multiplied (constantly) by the nuclear 10, plus (constantly) the nuclear biological unity: 2. Ergo Einstein's formula is E (energy) equals M (for the particular mass whose relative value is being measured) multiplied by - or comparisoned to - C^2 (where C is the speed of radiation in any one direction - radially - squared).

"Energetic Geometry", in: *Earth Inc.* (1947), Appendix 1, 171.

Handwritten notes on lined paper:

Top left: $2 \frac{1}{2} \frac{1}{2}$

Top right: LN (circled), $80/$, 75 , $21/$

Center: A hand-drawn diagram of a polyhedron (truncated octahedron) with 14 faces (6 squares and 8 hexagons) and 12 vertices. The faces are filled with a pattern of small circles, representing spheres in layers.

Right side: "See good drawing in color next day - 1/10/48"

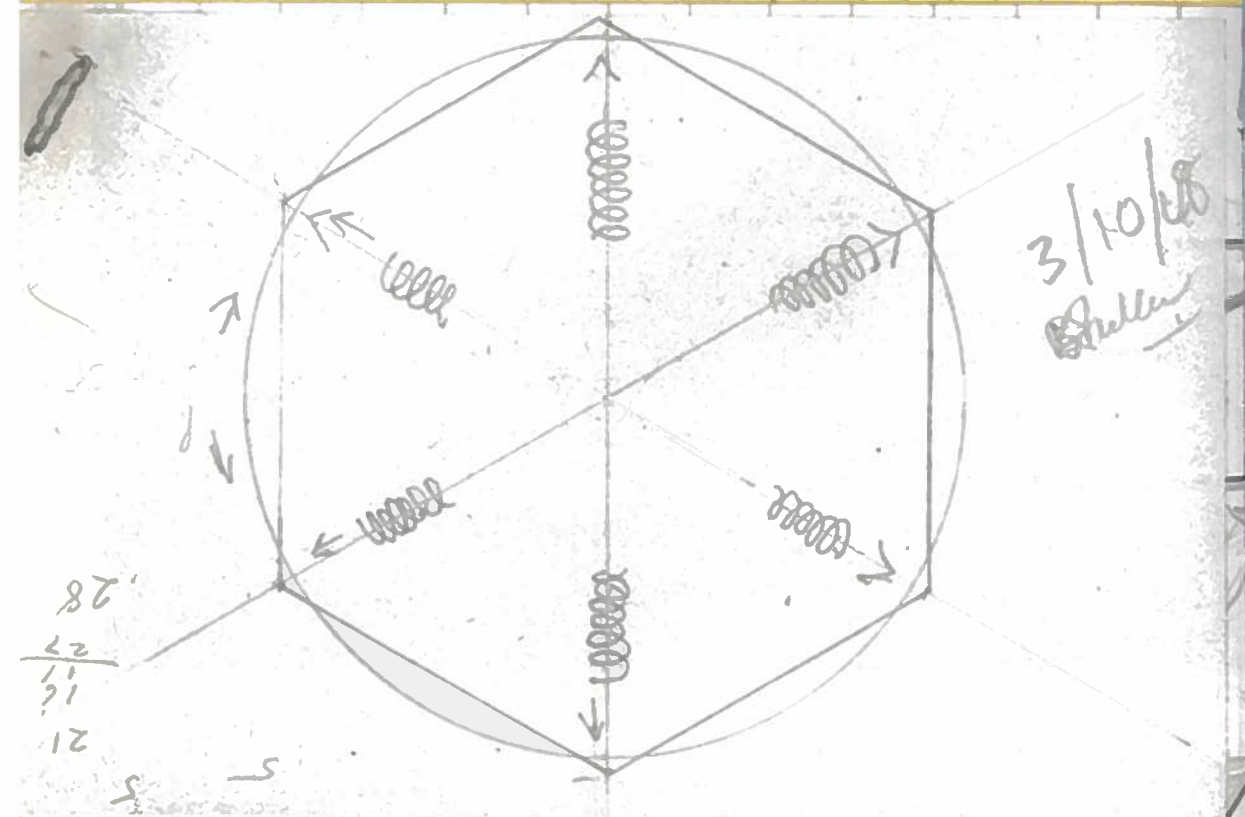
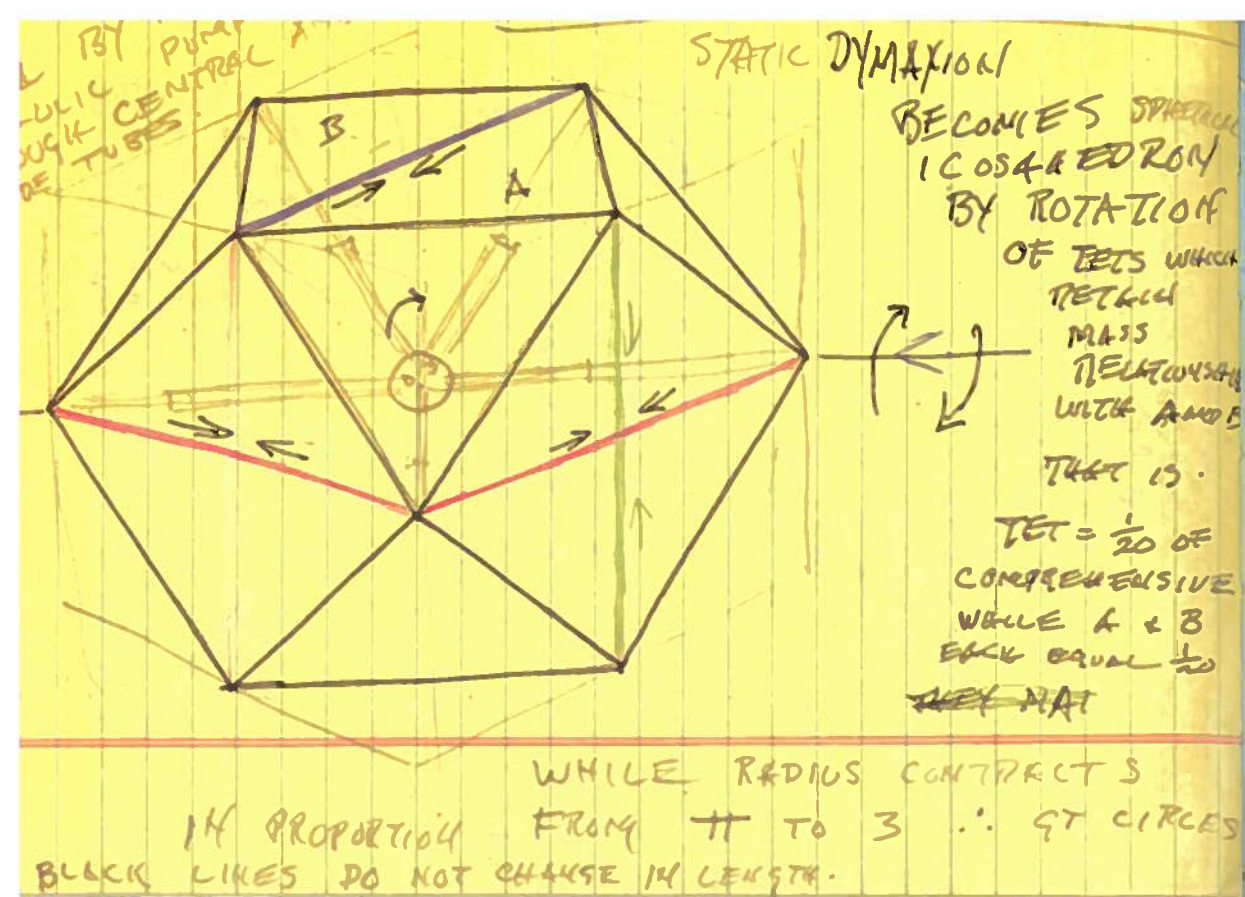
Bottom left: $3 \frac{3}{8}$

Bottom center: $27/8 \rightarrow 27/16 \rightarrow 27/32$

Bottom right: $23/16 \rightarrow 11.5/16 \rightarrow 6 \frac{1}{2} \frac{1}{2}$

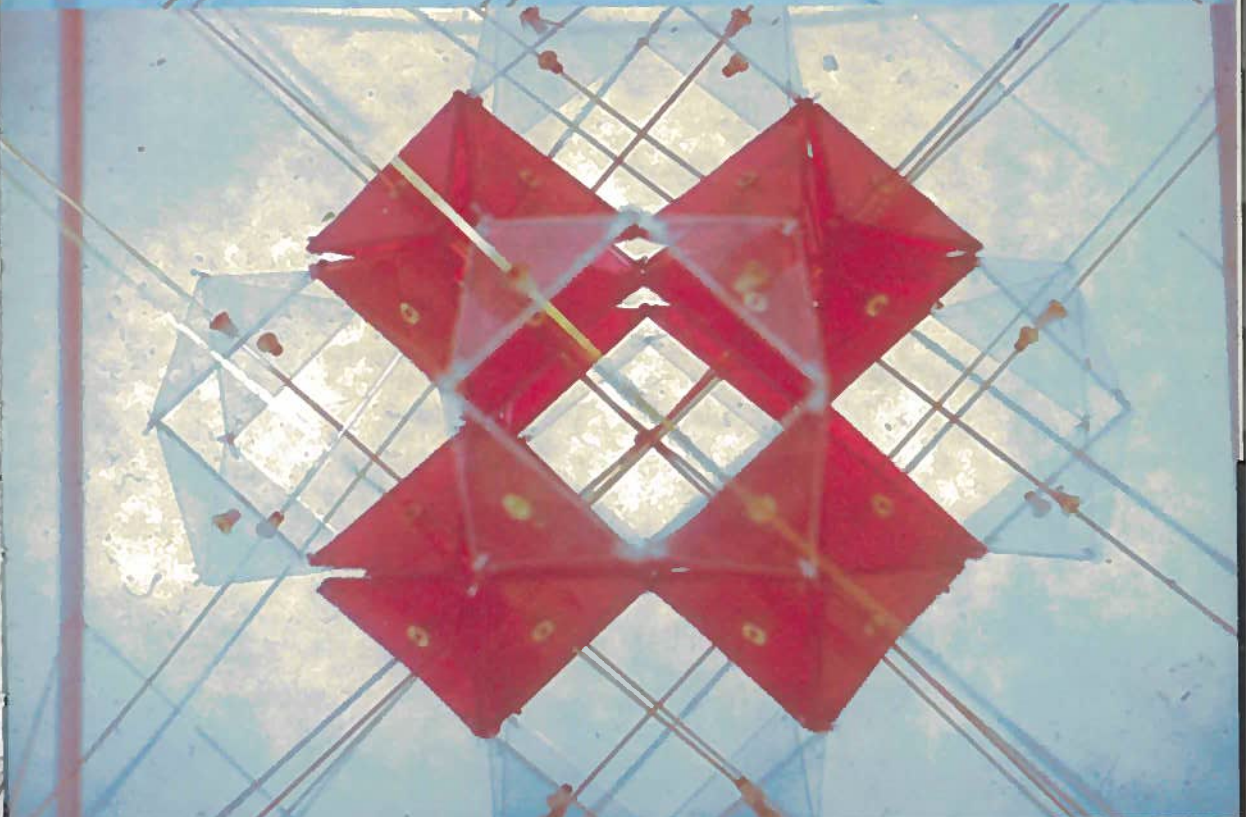
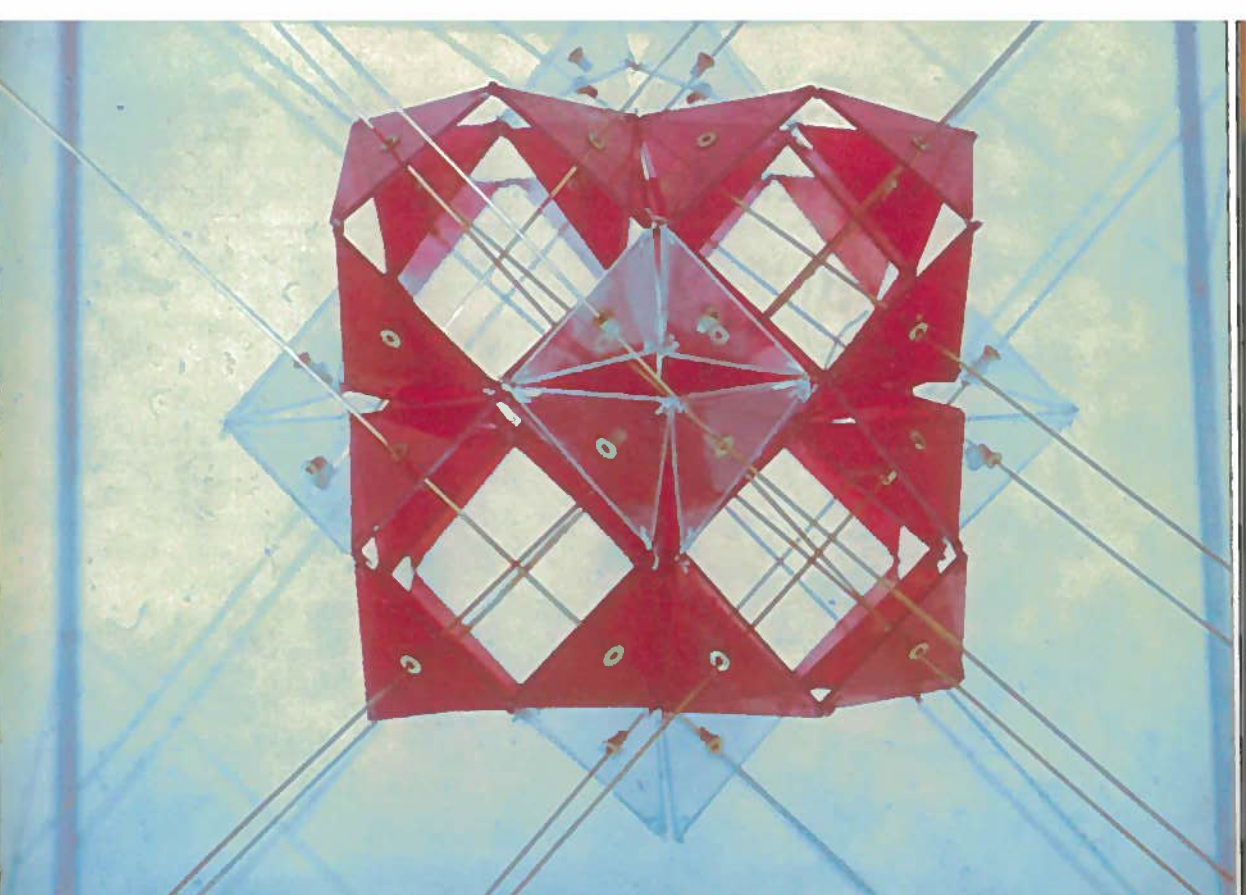
Bottom right: "Jan 9th 48"

Bottom right: 71



284 - Sketch of *litterbug*: Transformation of the cuboctahedron
 into a foreshortened through symmetrical contraction;
 interpreted as a model of wave mechanics. 1968

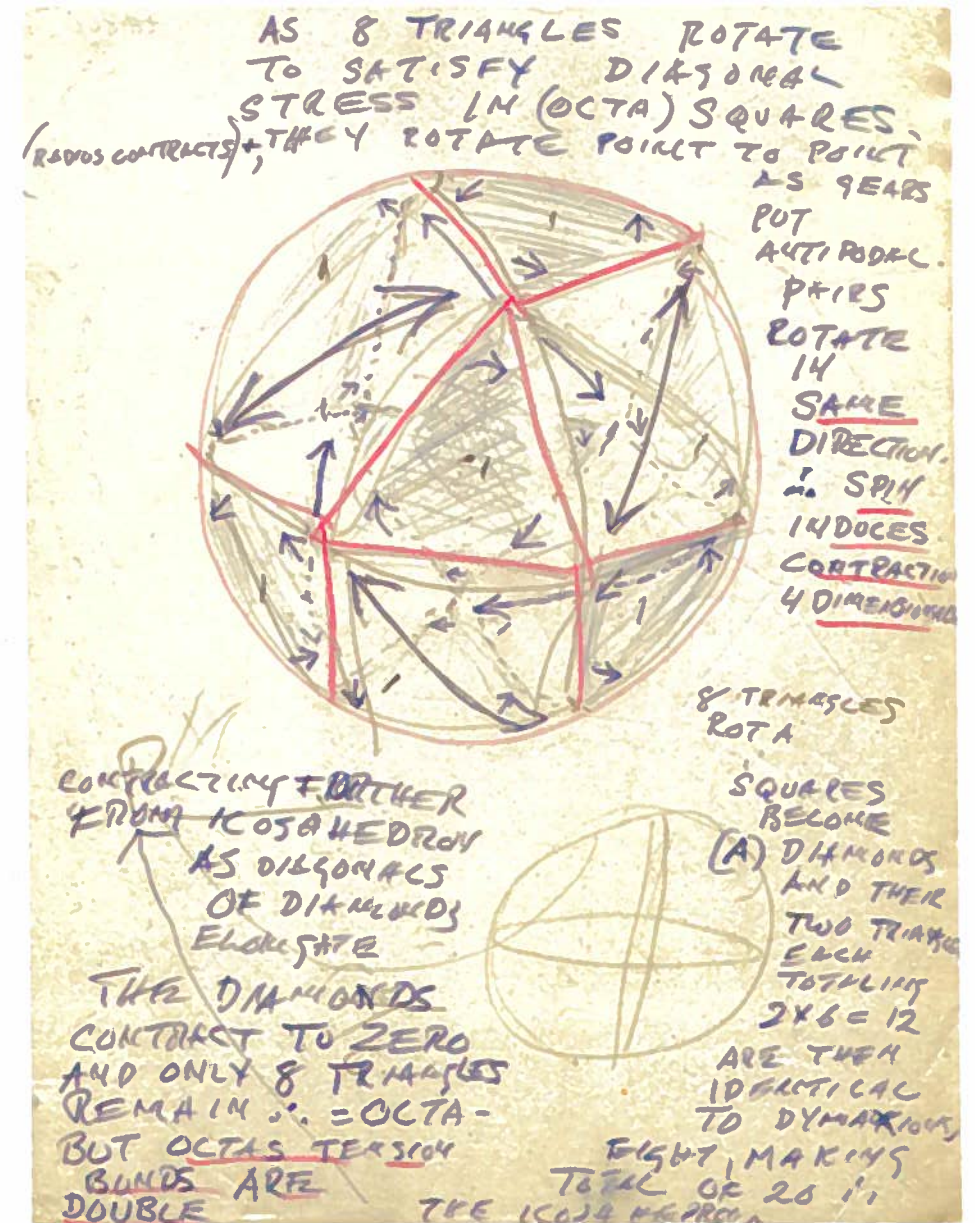
Schematic drawing: sectional view of cuboctahedron
 with variable radii. 1968



285 - First *litterbug* model with rotating surfaces
 around the cubic symmetry axes. 1968

"Jitterbug" Transformation

The basing of architecture on time in the 4D concept was a challenge to standard geometric modeling. Observations since his youth added up to give rise to the suspicion in Fuller that the development of natural forms operates with coordinates other than the Cartesian system. He was on the quest for a geometry "as Nature uses herself." For a long time, the theme remained in the background, and in the polyhedron studies and great-circle designs of the world map first came to a breakthrough: that the half-regular cuboctahedron, utilized for the map projection as a globe divider, has geometric properties that make the figure usable as a vector matrix. The cuboctahedron, which Fuller named "the Dymaxion," results as an invariable configuration from the "closest packing of spheres" around a nucleus. Fuller examines this method, known since the time of Kepler, with a view toward nuclear physics and chemistry, and in April 1948, he was successful in modeling quantum effects that brought out Platonic bodies in a new light. Fuller interpreted them as phases of a dynamic transformation process that manifested itself in a spiral-shaped contraction. The system oscillates, expanding and contracting over tetrahedrons, octahedrons, icosahedrons to again end with the cuboctahedron. This central discovery, that implied a new science of forms, was given the name "Jitterbug" by Fuller - after a popular dance of the 1940s. His model of a "quantum machine" formed the conceptional background of most of his discoveries.

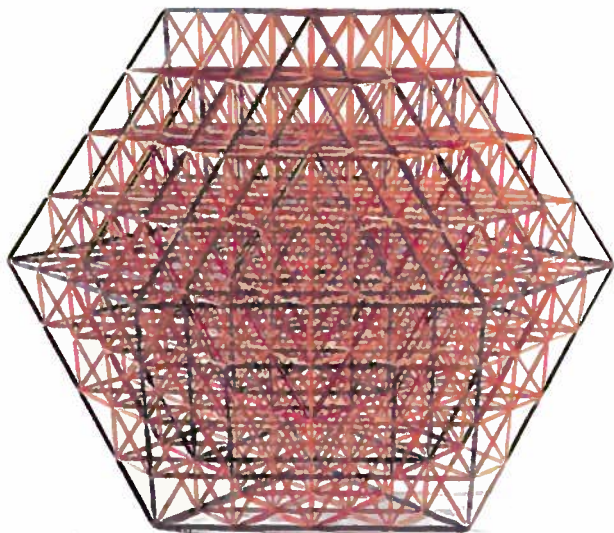
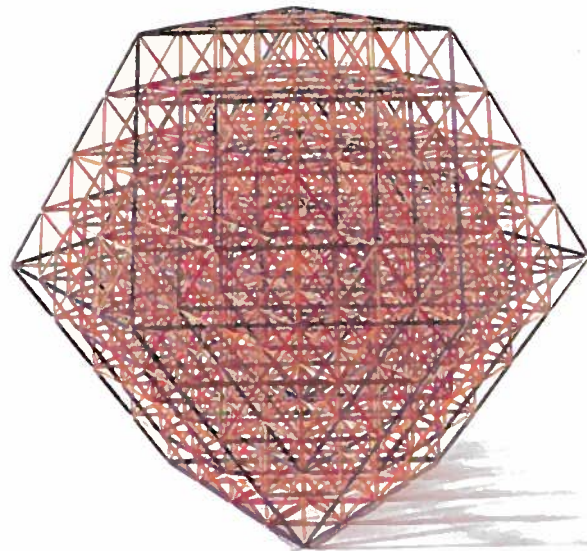


280 "Jitterbug" Transformation: the phase of maximal expansion (left) as cuboctahedron and the zero-phase of minimal expansion as a folded-together triangle. modeled

Color sketch of Jitterbug Transformation: with the rotation of the triangular surfaces, the diagonals of the square contract in the cuboctahedron. modeled (1948)







Two views of the isotropic vector matrix, model constructed out of toothpicks, handmade around 1970

Manuscript sheet from April 28, 1948: Discovery of the formula for the law of transformation of the Vector Equilibrium, derived from the closest packing of spheres; discovery of the transformation sequence of the Jitterbug.

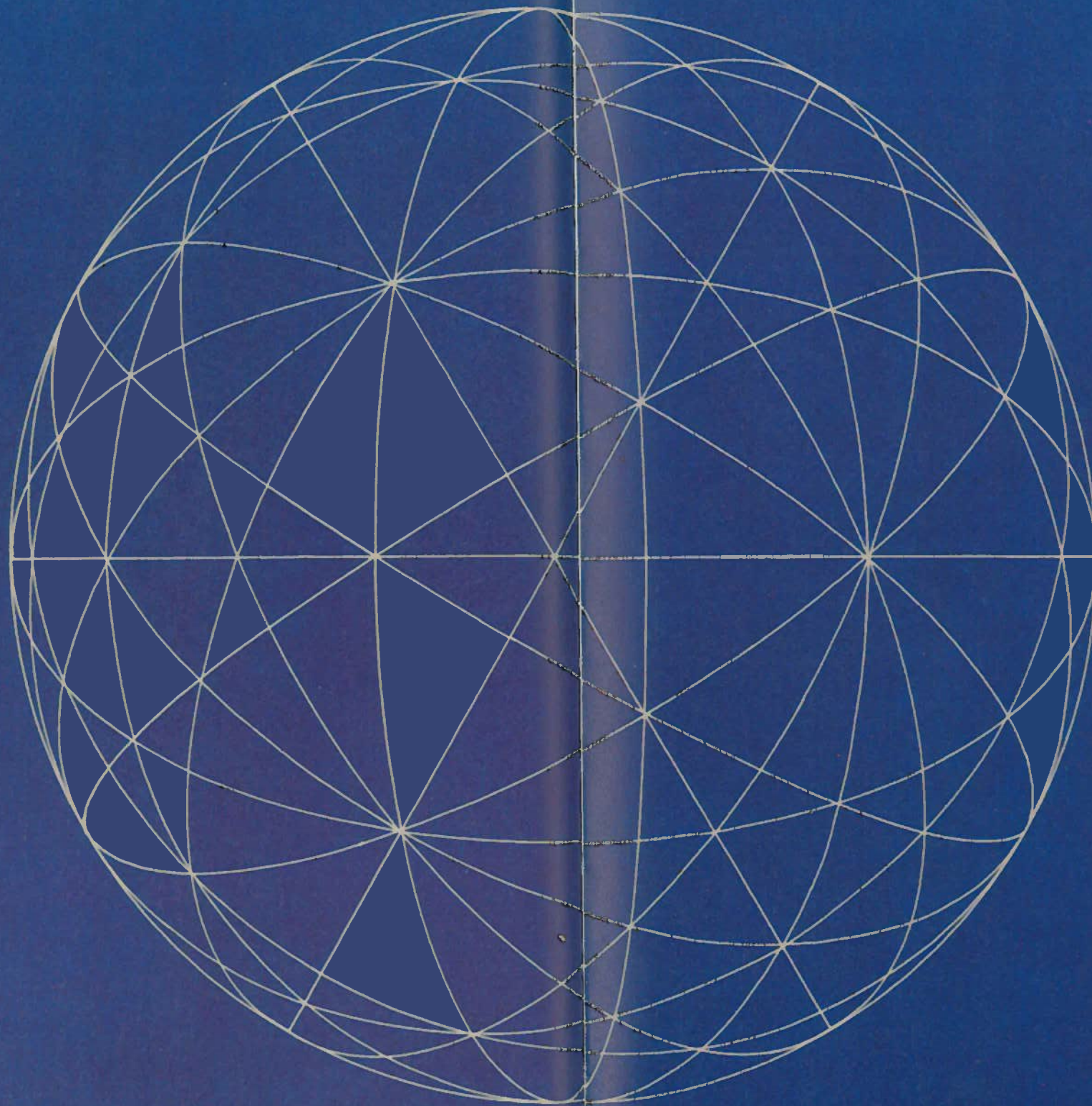
RBF demonstrates the Jitterbug transformation using a model with flexible node points, film sequence, ca. 1960.

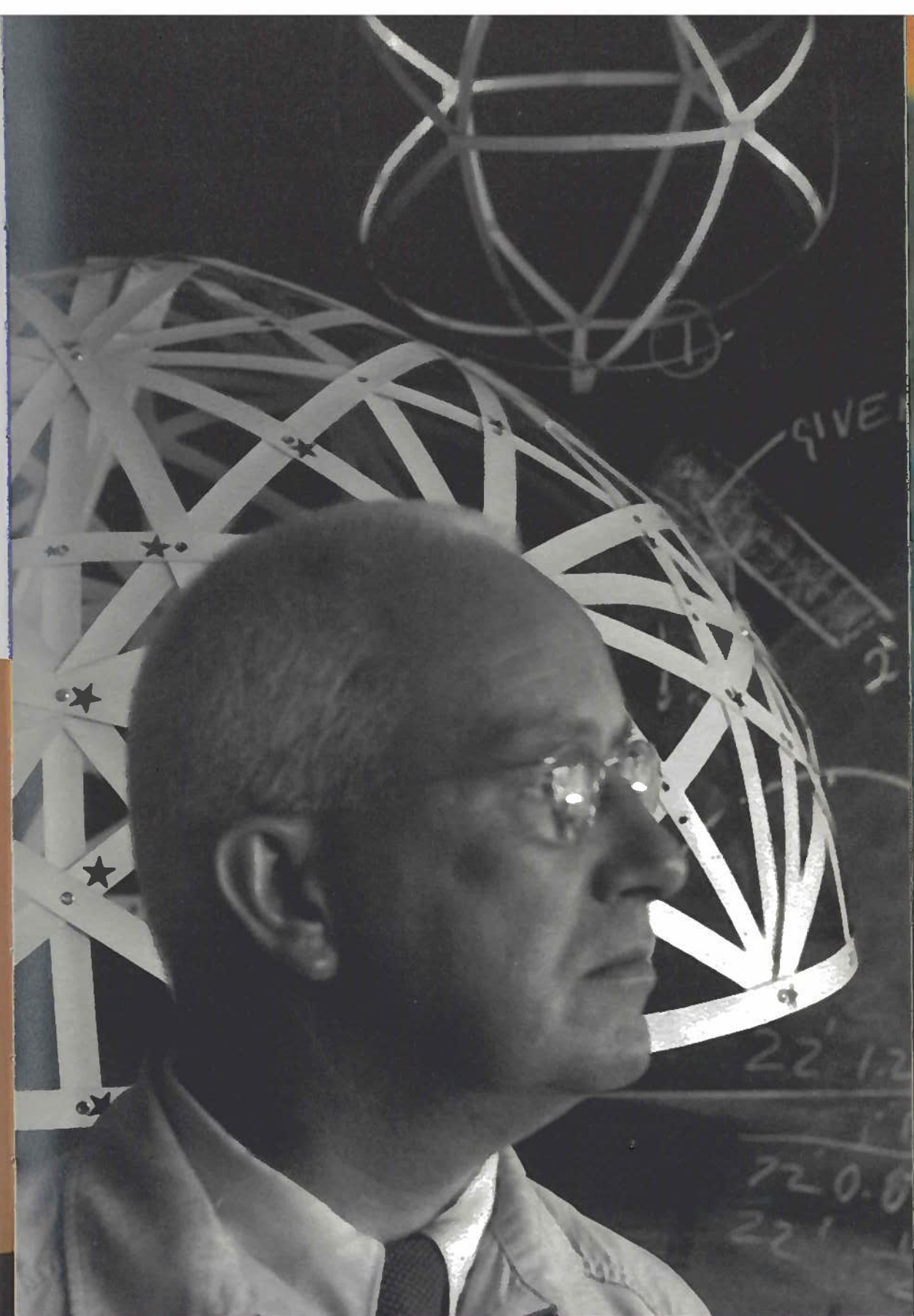
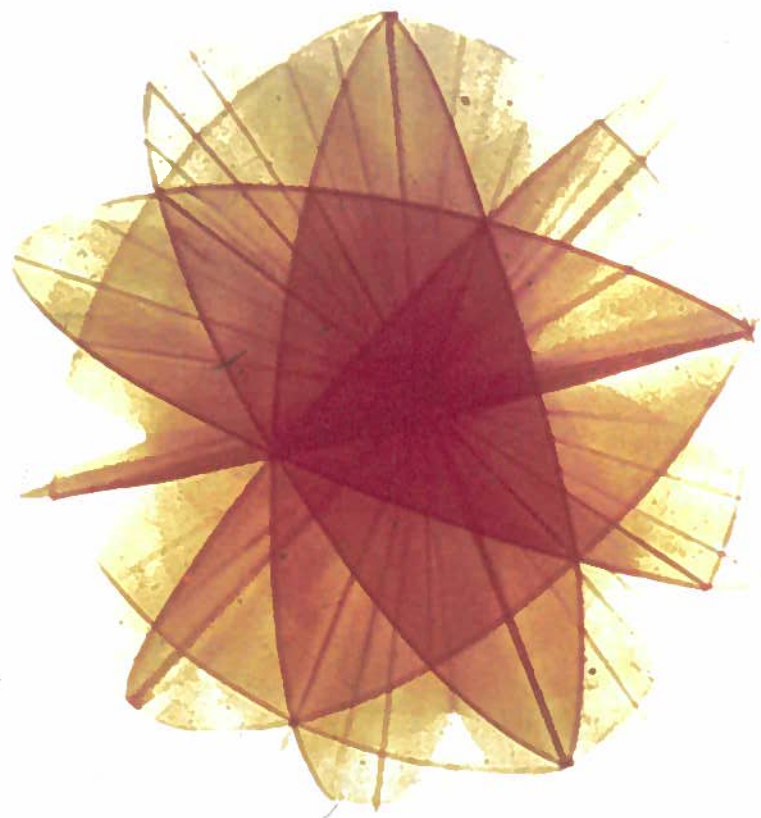
EUREKA - EUREKA
 THIS IS WHAT I'VE BEEN SAYING FOR YEARS
 AND NOW IT'S HERE 1/25/1949 J. R. Brown
 NO Eureka Again!!!
 I've just found out how to find answers
 to all the questions of geometry.
 I've found the law of transformation of the Vector
 Equilibrium. I've found the law of transformation of the
 Jitterbug. I've found the law of transformation of the
 relationship of growth of cells
 $= 60R^2 + 2$ and growth of organisms
 $= 60R^2 + 2$ and volume of organisms
 Cumulative Mass Vol. $= R^3$ in terms of
 models of R in word lengths - from
 nucleus to 1000 or 100,000 or 1,000,000
 nucleus we have seen this
 It is possible to convert all
 the absolute geometric reference units
 from their inception in terms
 reference to linear 3 dim. of centers
 and size and its volume and its
 growth and reference to whole
 comprehensive system of measurement
 to basic word length from
 nucleus and to basic numbers of
 spheres and layers to numbers of
 molecules or atoms. as they grow
 and then to basic new number
 in flow of decaying number which
 a highly relationship exists
 or integral number grows
 homogeneously to spheres and
 then to all the more relative
 heat, energy, motion and
 growth and evolution laws
 (R²) come into some integral
 expression.

We discover that cannot leave of leaving anything in form word models
 be needed in appearing outside structure on appearing in form
 We find pattern law of 1/3 law of nature of all numbers in vol. to a sphere

Original April 28, 1948
 J. R. Brown

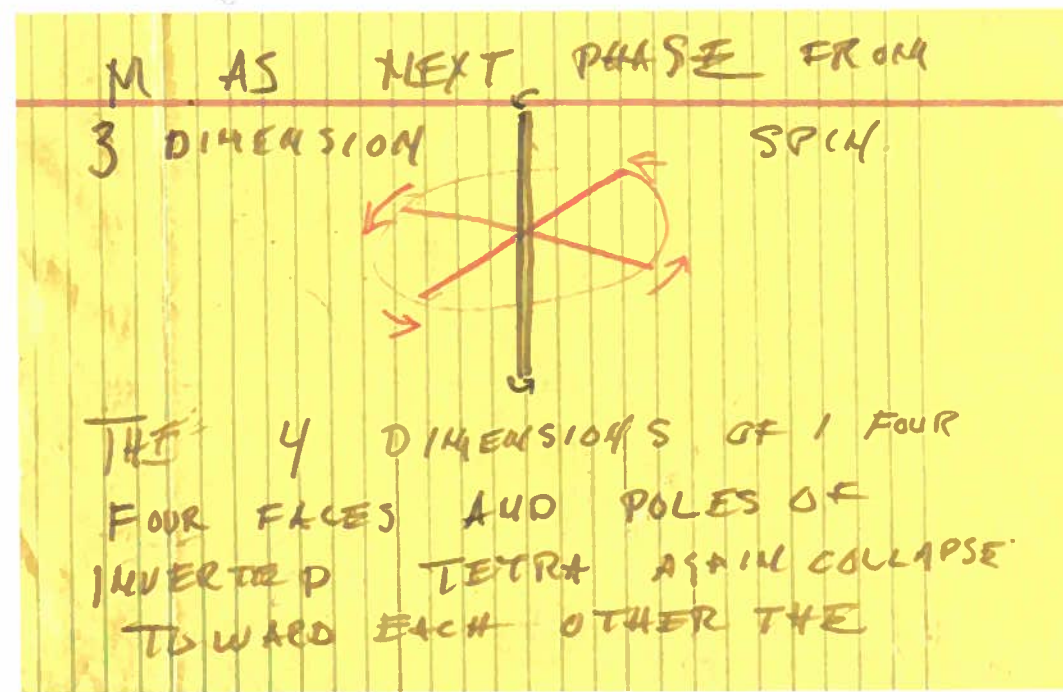
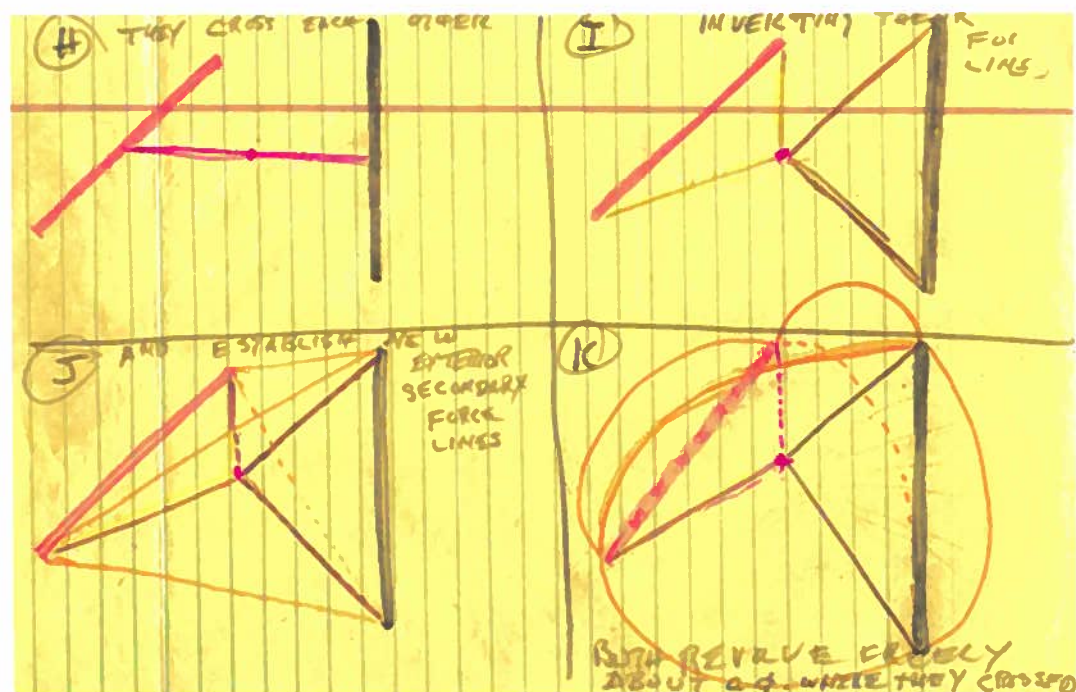
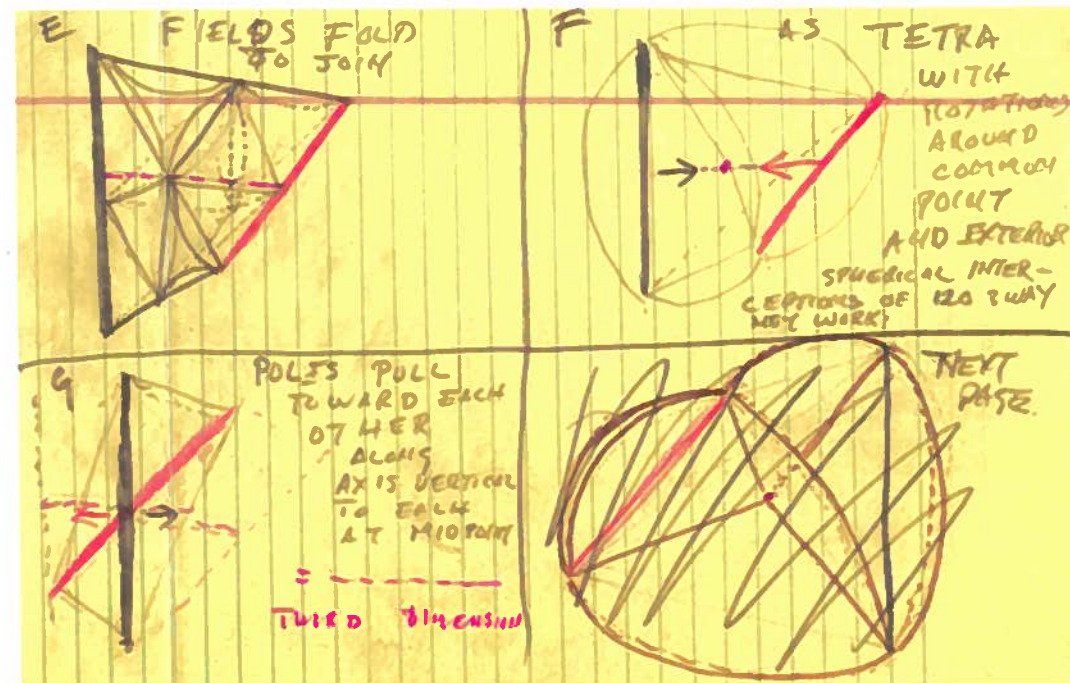
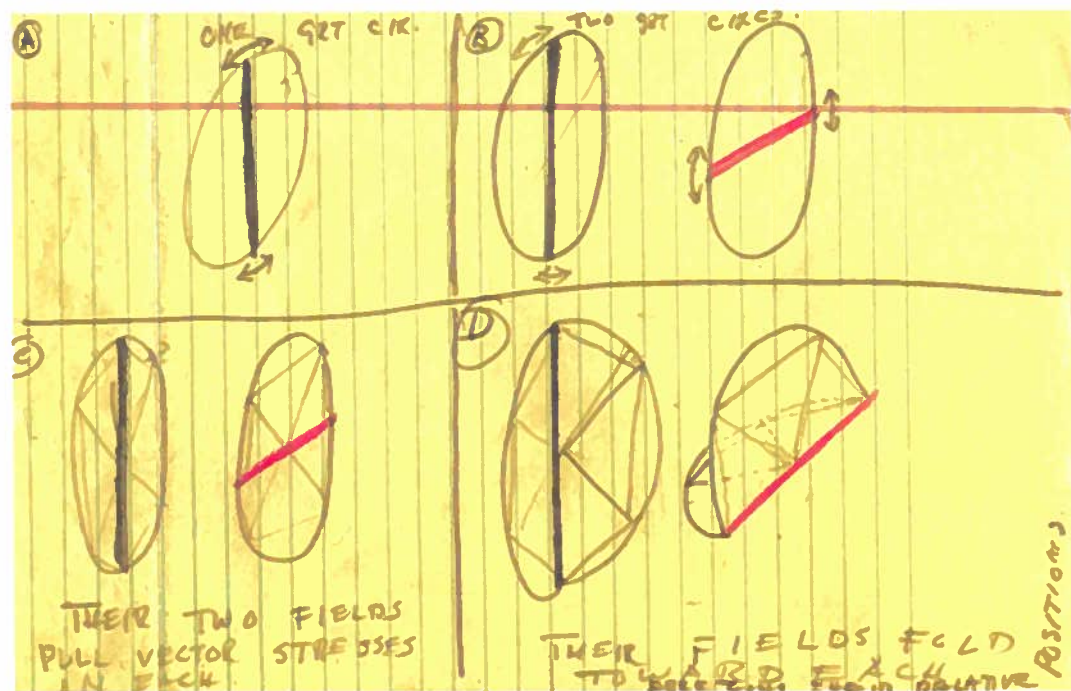


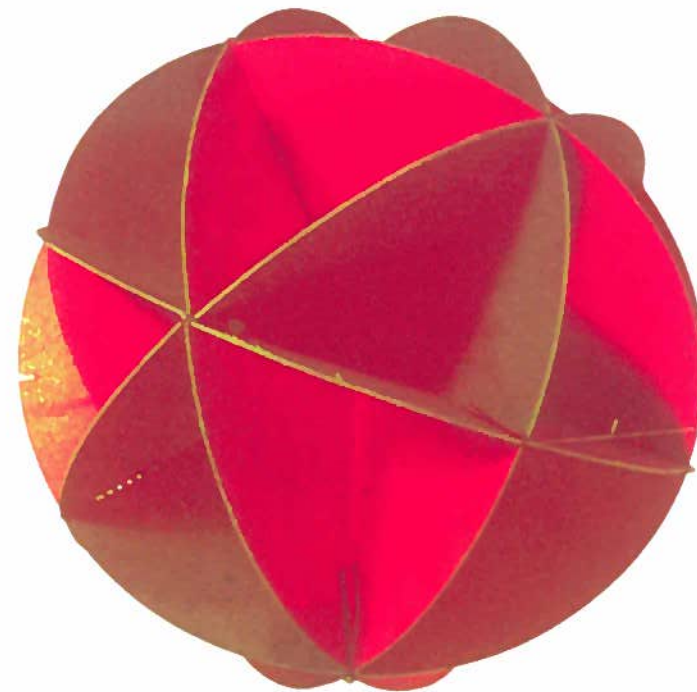




294 1922/23: Technical drawing of the 31 great circles of the spherical tessellation.
Study model of the great circles out of transparent sheeting.

• RBF in studio, Black Mountain College 1948; in background, large-scale hemisphere as model for the first geodesic dome.





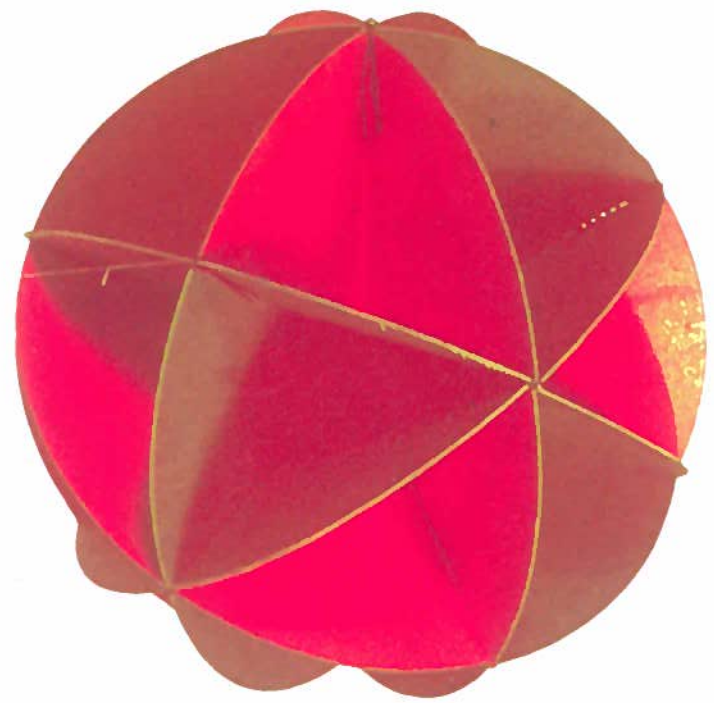
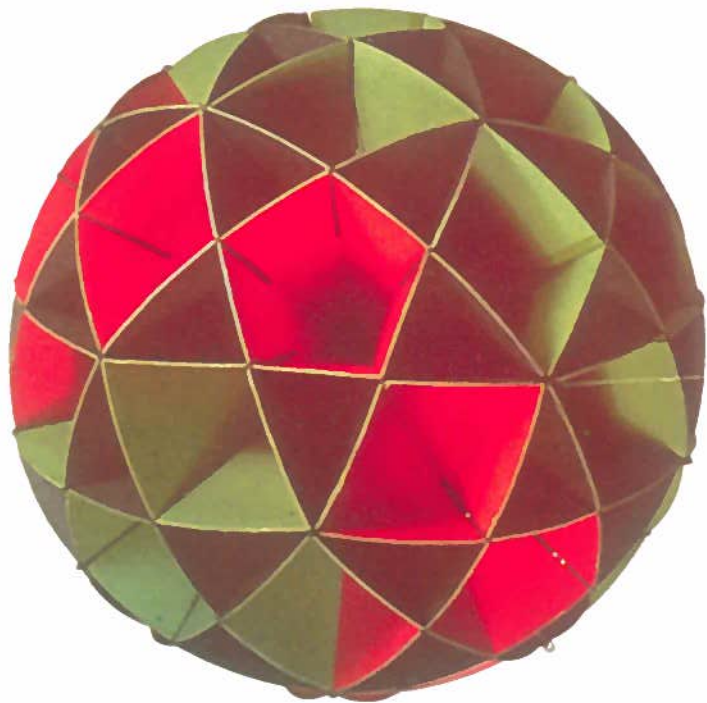
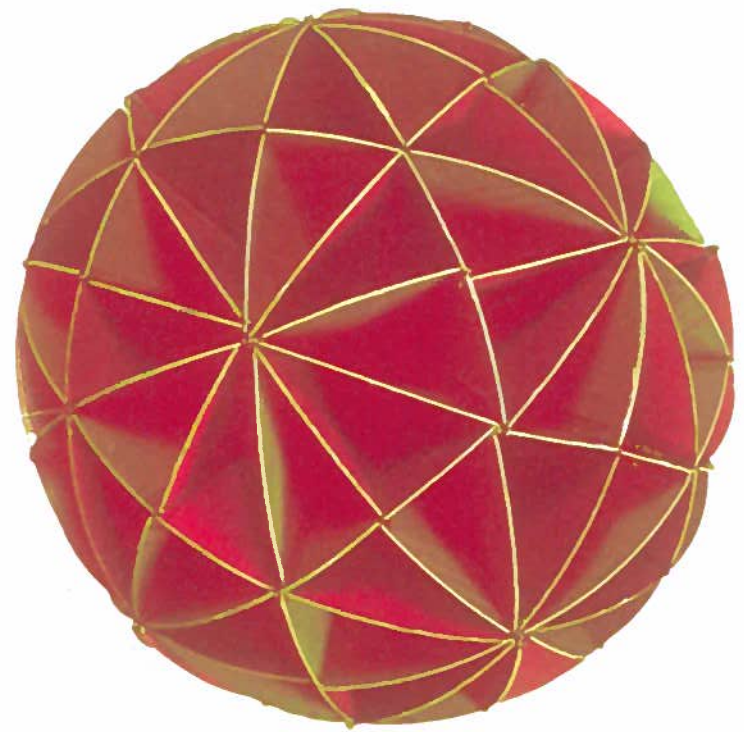
EXTERIOR FIELDS

CONVERGE AT COMMON C.O.
AND PROVIDE (DYNAMION
COMPREHENSIVE OF 7 DIM.

3 ORIGINAL PLUS NEW FOUR

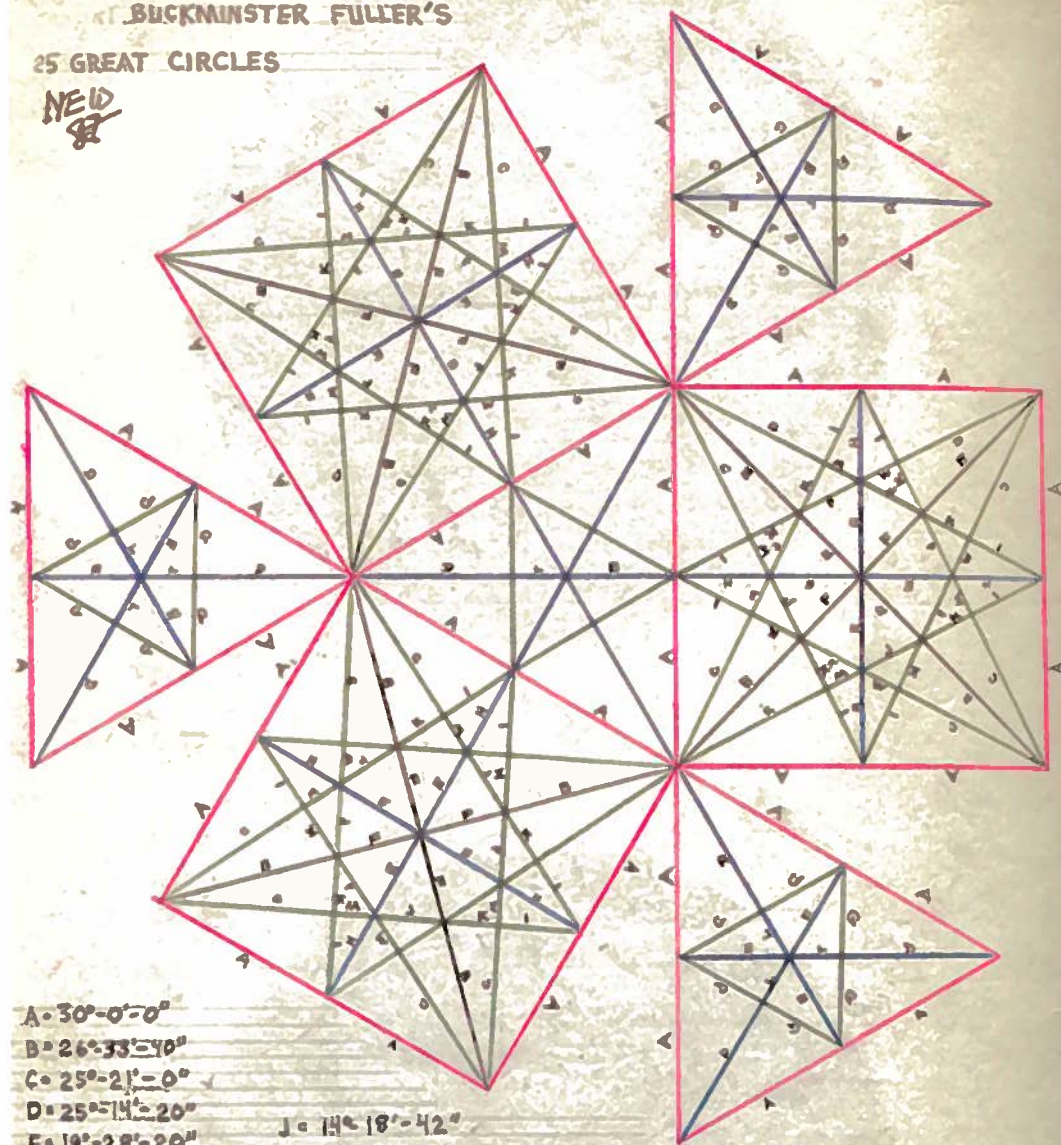


AND WITH INTERNAL
109°28' ANGLES OF SPHERICAL
TETRA NOW EXTERNALIZED
(TURNED INSIDE OUT
AGAIN TO EXTERIOR
VERTICES OF SPHERICAL
SQUARES



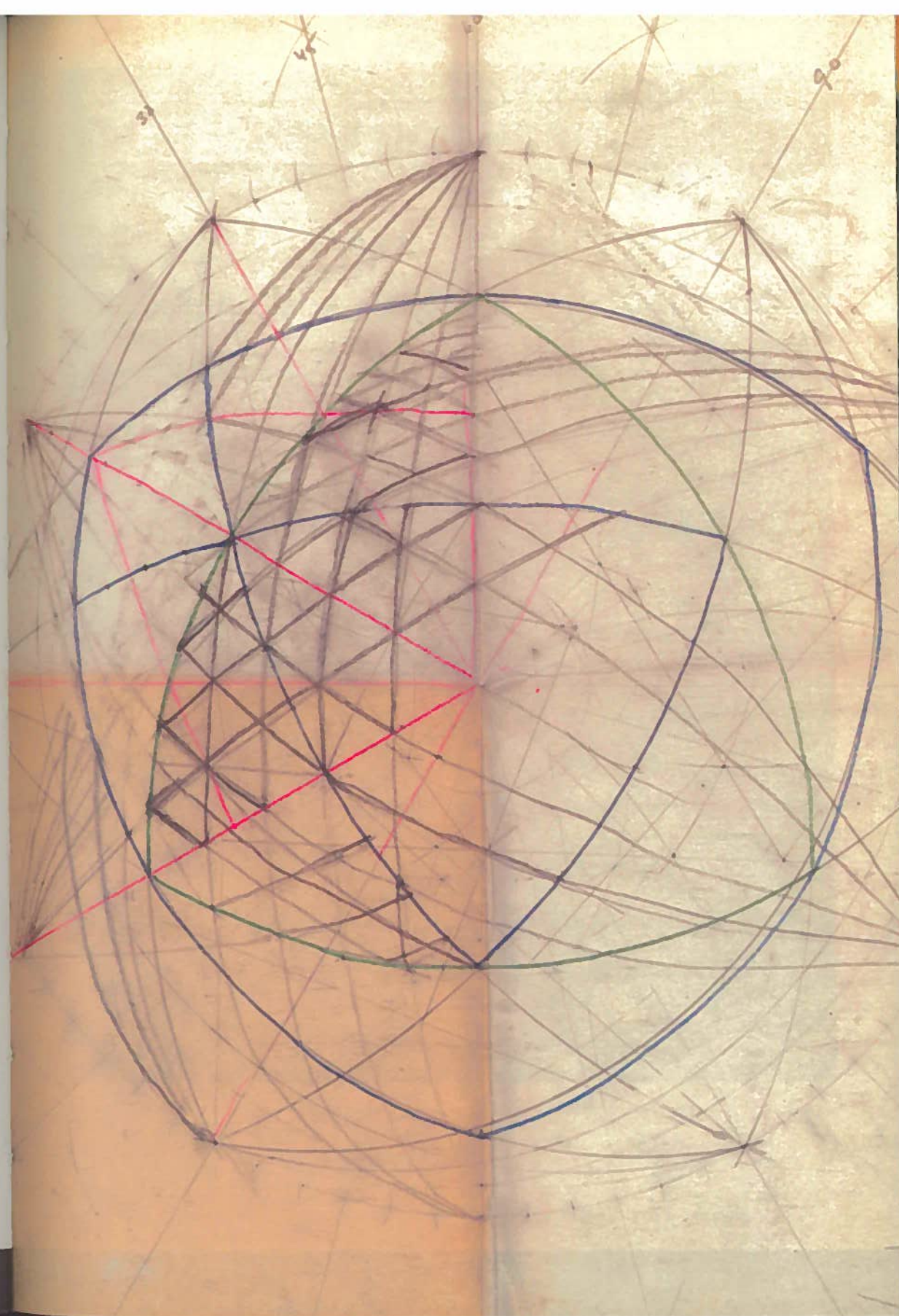
BUCKMINSTER FULLER'S
25 GREAT CIRCLES

NEW
82

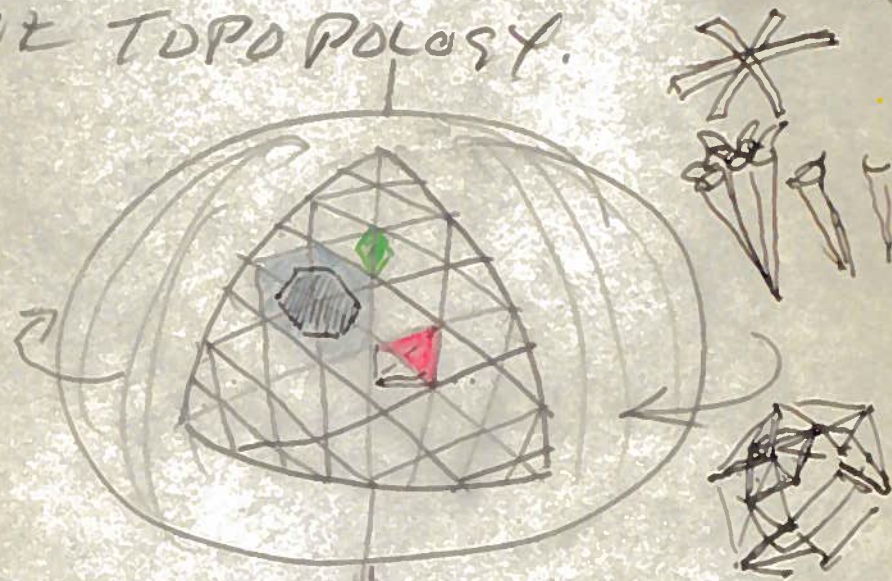


A = 30°-0'-0"
B = 26°-33'-40"
C = 25°-21'-0"
D = 25°-14'-20"
E = 19°-28'-20"
F = 18°-26'-20"
G = 16°-46'-40"
H = 15°-47'-40"
I = 14°-18'-40"

J = 14°-18'-42"
K = 11°-2'-15"
L = 10°-1'-30"
M = 8°-12'-10"



Whenever we see
 Spheres, ^{TRIANGLES} Diamonds,
 Squares, Pentagons & Hexagons
 we may identify them
 uniquely with their ^{PRIMARY} ~~primary~~
 DIFFERENTIABLE FUNCTION
 OF TOPOLOGY.



P =  = SPHERE - CIRCLE AS AXIAL EQUATOR

V =  VERTICES

F =  FACES



1084 SPUN TO 15 ST. CIR.
 BECOMES INDIVISIBLE 2
 TETRA (POS + NEG) DODECA +
 2 OLTA (POS + NEG.)

STRUCTURALLY REALIZING
 EMPHASIZED

VERTICES BECOME
 SURFACES COMPLETIONS 4.5



SQUARES, PENTS + HEXAS

EMPHASIZED
 EDGES (EXTERIOR) BECOME



EMPHASIZED FACES
 BECOME



EMPHASIZED POLES BECOME
 SPHERES OF GYRATION
 OR DIAMETRIC RADI TOTALITY.

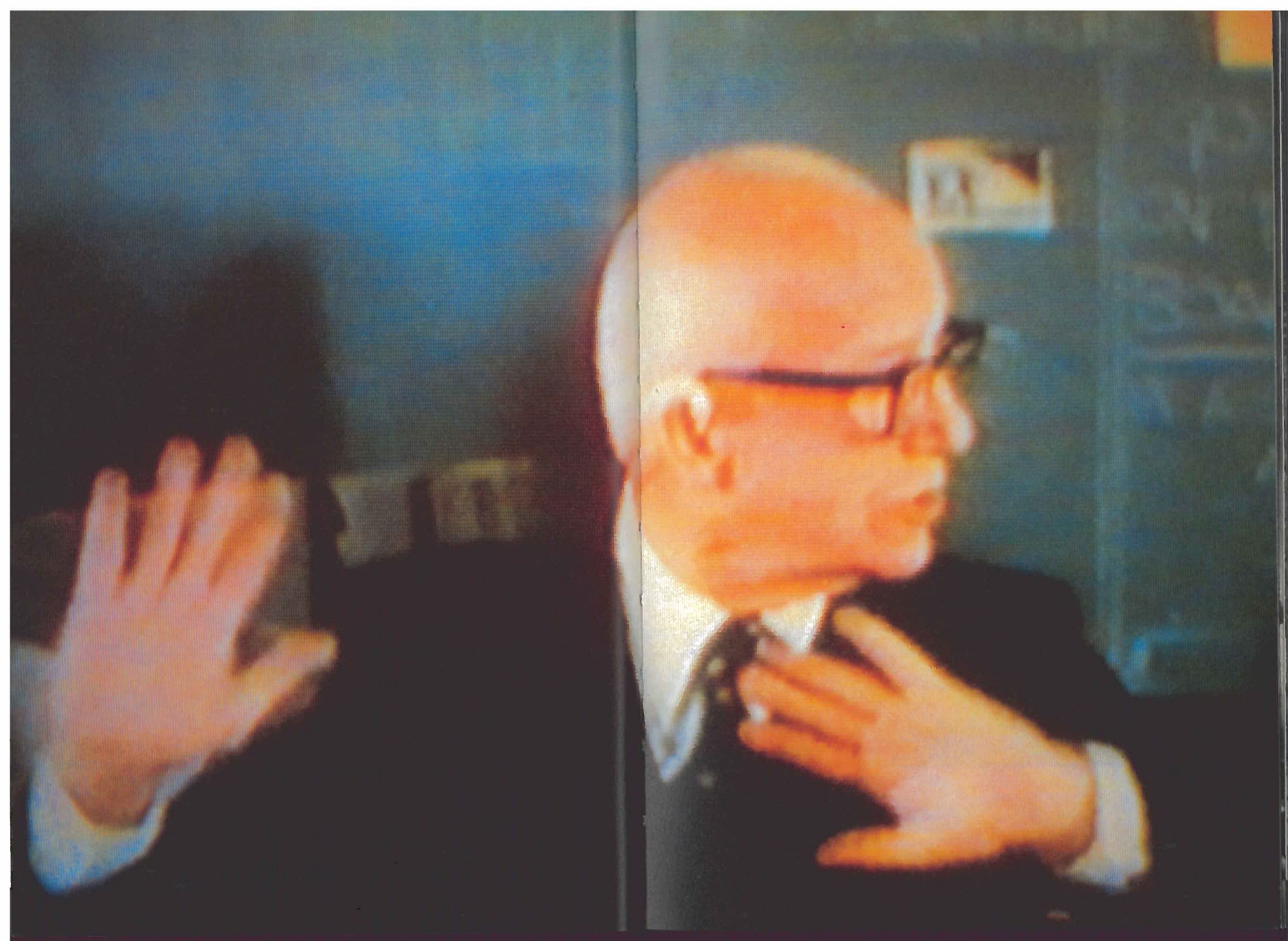
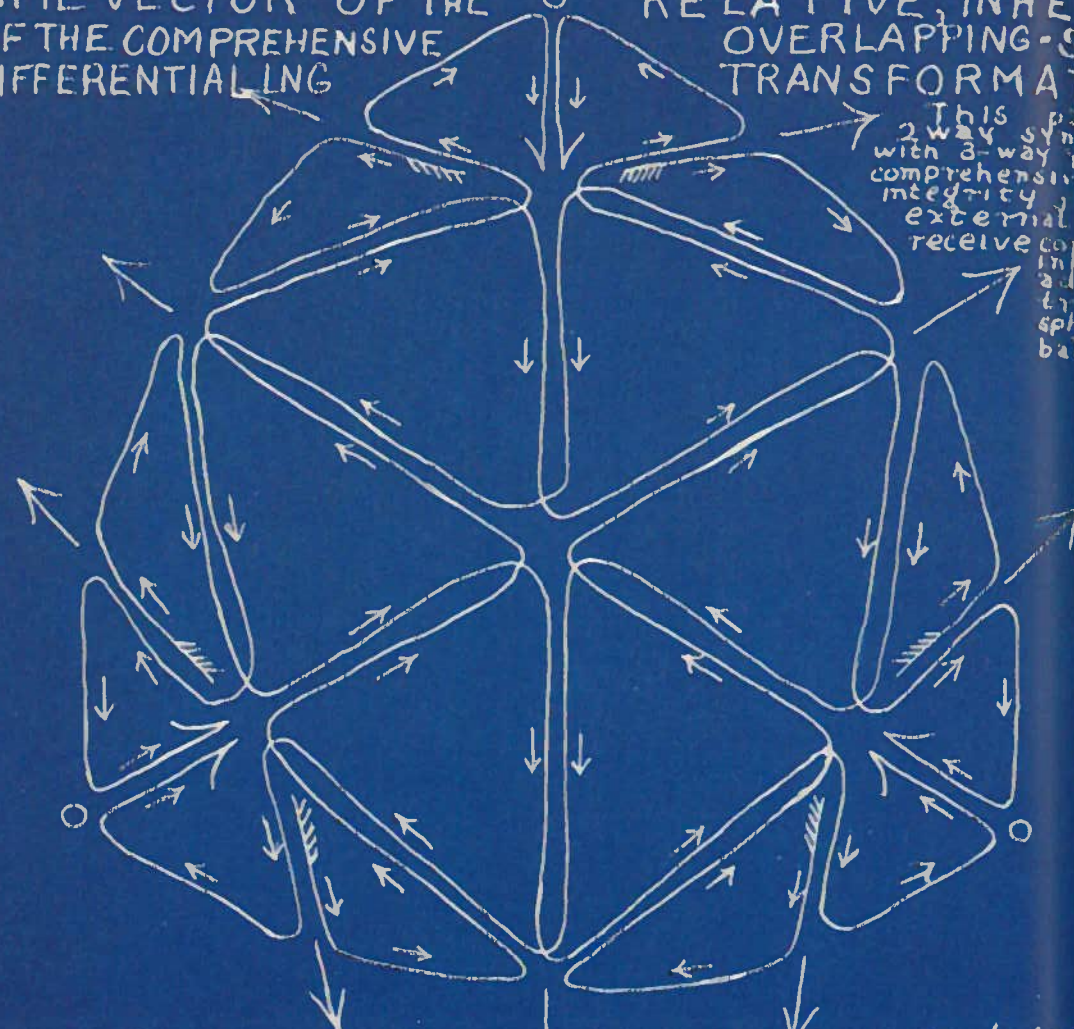
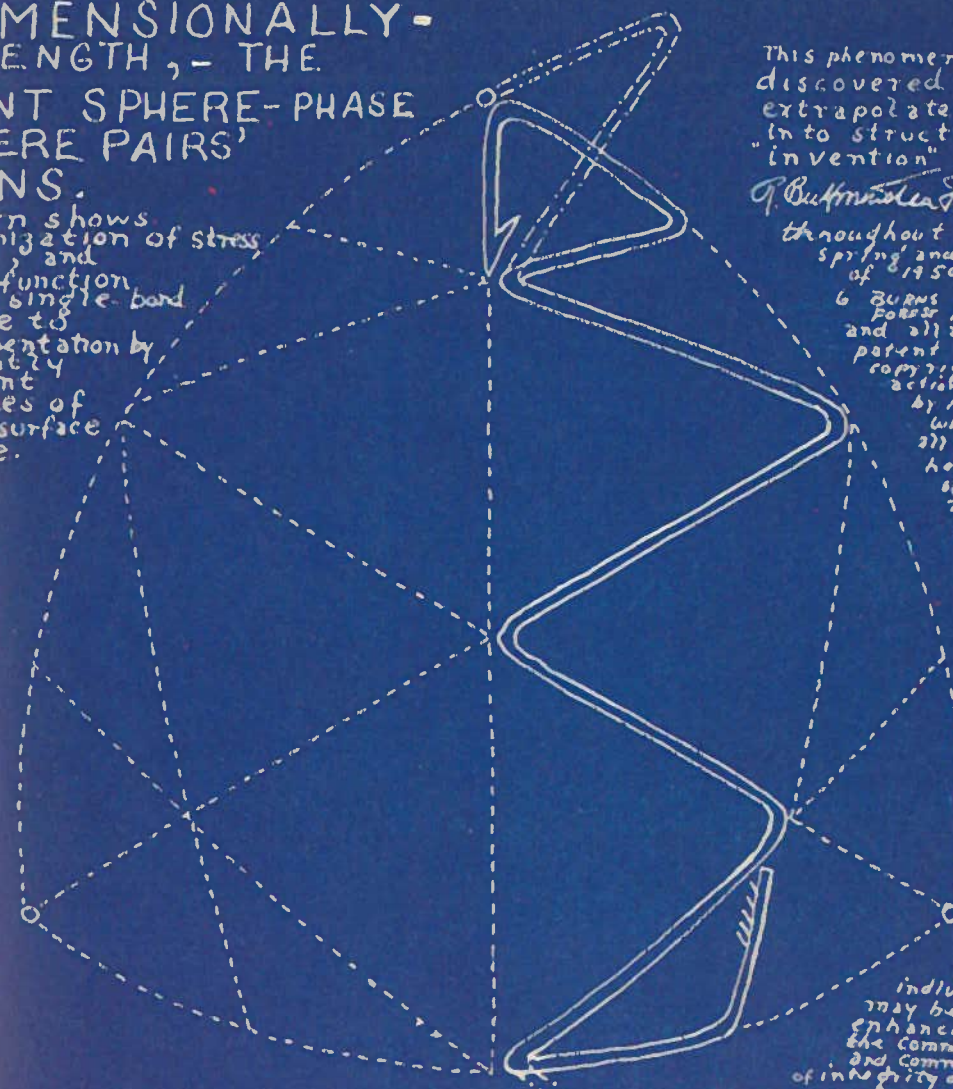


FIGURE O STRESS-FLOW ENERGY BALANCE OF DOUBLE-BONDED SURFACE
3-WAY GEODESIC GRID, 4th VECTOR-Dimensionally-
POSITIONED, BY SELECTED RADIUS-WAVE LENGTH, - THE
TIME-VECTOR OF THE O RELATIVE, INHERENT SPHERE-PHASE
OF THE COMPREHENSIVE OVERLAPPING-SPHERE PAIRS'
DIFFERENTIALING TRANSFORMATIONS.



This pattern shows
2 way synchronization of stress
with 3-way field, and
comprehensive 6 function
integrity, with single bond
external edge to
receive complementation by
adjacent
triangles of
sphere surface
balance.



This phenomena
discovered and
extrapolated
into structural
"invention" by

Q. Buckminster Fuller

throughout
spring and summer
of 1950 at

6 Dupont St.
Forest Hills, N.Y.

and all appropriate
patent and
copyrighting
action taken
by him,

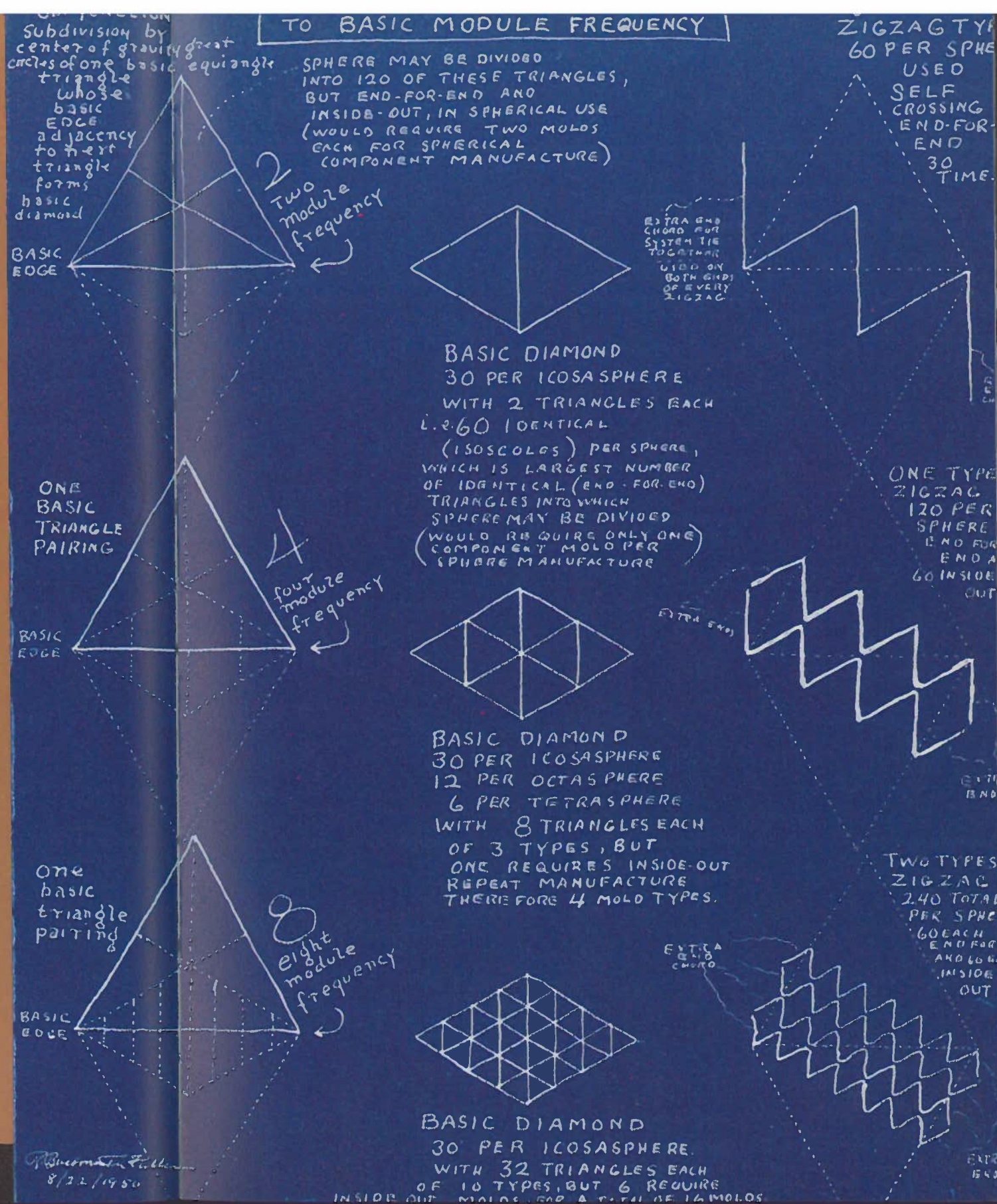
wherefor
all rights
herein are
specifically
reserved
by him,

within the
full limits
of enacted
and
common law
and
"Bill of
Rights",
intent,
to protect
the
individual
and his
natural
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ianship
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that his
individual life
may be freely
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the Commonwealth
and Commonwealth
of integrity of growth.

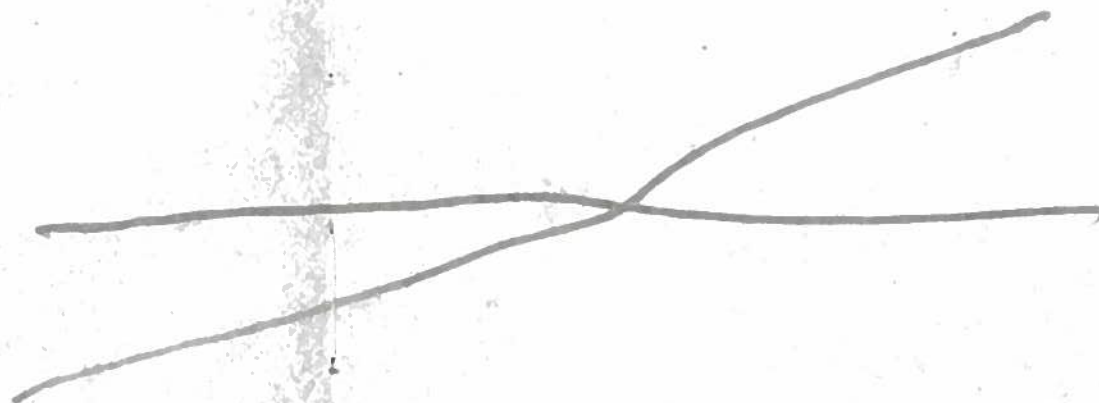
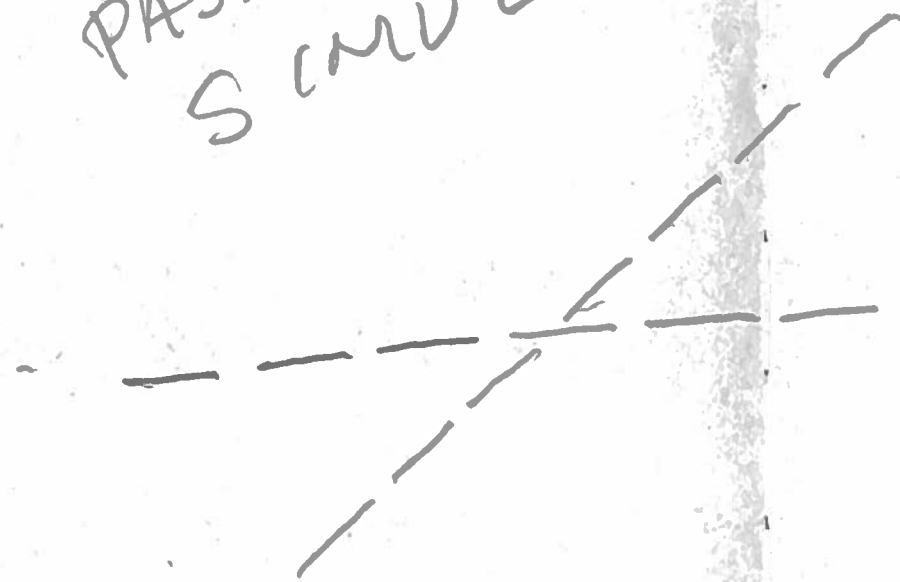
As is shown in text-table on page 21, with a 4 fold basic module frequency this one will articulate the three pairs (six, total) of trigonometric aspect-emphasis of function of 3 rotations and 3 inside-outings, and may thus complete the spherical triangles here shown. And if, for instance the phase of the inherent sphere is icosahedron the ZIGZAG component may be opened up (see dot-and-dash ghost vectors, of right diagram above) they will three way grid the sphere with 240 (approximately equiangular) spherical triangles. As described in text, especially on pages 20 and 21, and on drawings 22, 23, 24, an increase in module frequency of basic edge subdivisions may be infinitely reintroduced, with similar results, of all sphere gridding by a relatively few, self locking double-bond, rate of change-vector, ZIGZAG-DIFFERENTIALS.

The research into the fundamentals of geometry during the years 1947 to 1949 can be seen as an ambitious attempt to translate phenomena from the world of solid bodies and static forces into phenomena with a regenerative pattern and energetic dynamics. The goal was to produce a deeper understanding of the behavior of dynamic systems.

Fuller devoted special attention to the analysis of the distribution of local stresses along the overall structure of the network, a feature that is characteristic of geodesic domes and that accounts for their capacity. Fuller explained it in terms of the interaction of complementary components. Their overall performance is more effective than the sum of the capacities of the individual parts. To describe this increase in capacity, he introduced the term "synergetic" in *Noah's Ark 2*.



TWO VECTORS DO NOT
PASS THROUGH SAME POINT
SIMULTANEOUSLY.



add turning sphere - 30 struts (edges of icosahedron)

Immediately following the geometric discoveries of the spring of 1948, Fuller took teaching positions at the Institute of Design in Chicago and at Black Mountain College. His research activity merged seamlessly into his modeling-based work with students. It was the start of an unparalleled level of teaching activity at a growing number of art and design schools, universities, and colleges. Fuller had a talent for inspiring his students to achieve genuine innovations and inventions. Without the innovative contributions of numerous students and colleagues – students like Kenneth Snelson, Jeffrey Lindsay, Ted Pope, Don Richter, and Shoji Sadao and colleagues like Duncan Stuart, James Fitzgibbon, T.C. Howard, and many others – Fuller's success of the fifties would have been all but unthinkable. He established life-long friendships in the unique atmosphere of Black Mountain College: Fuller shared with John Cage, Merce Cunningham, and Josef and Anni Albers a profound intellectual accord.

ARCHITECTURE OUT OF THE LABORATORY



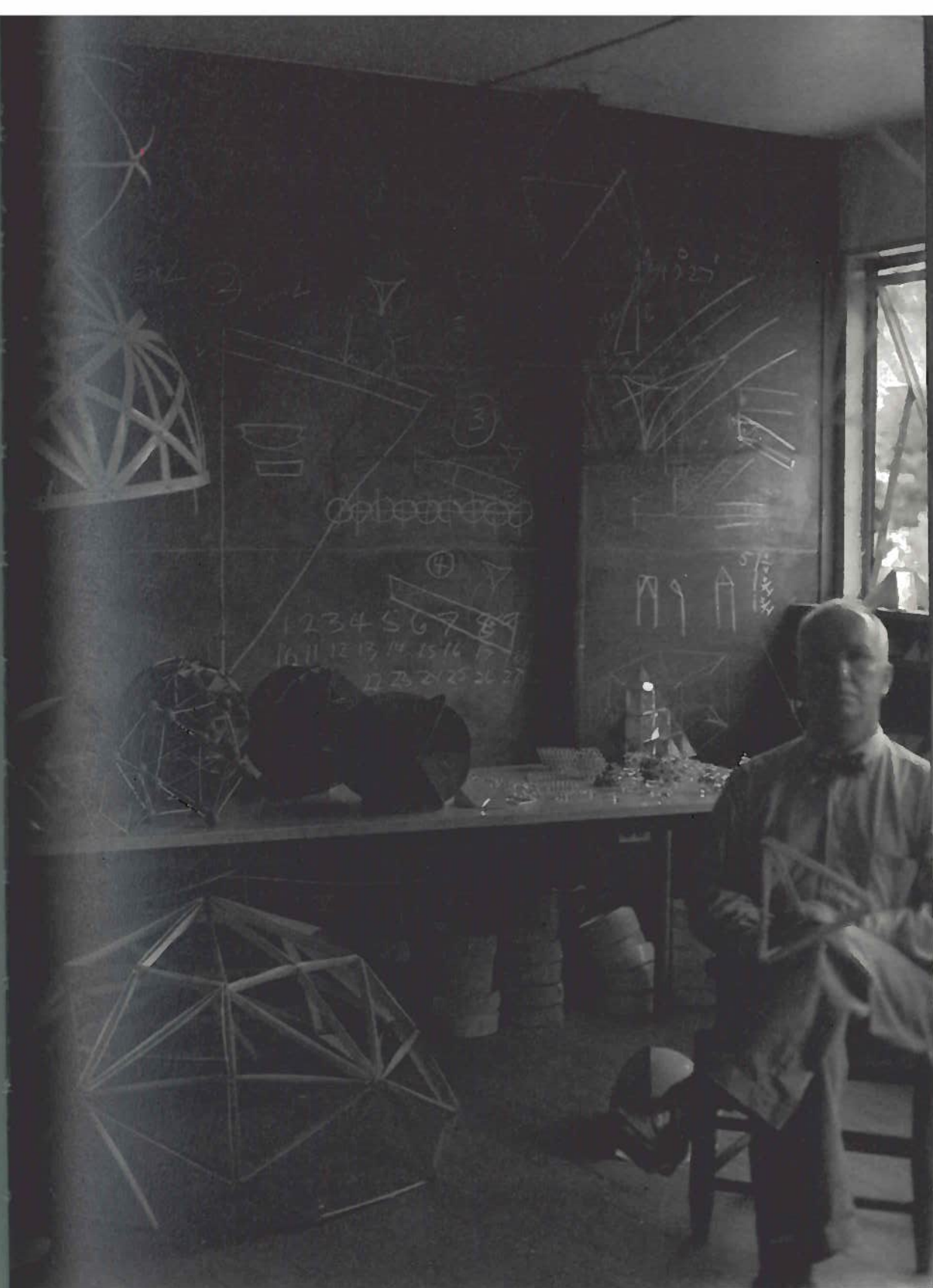
Fuller at Black Mountain College

It was more or less coincidence that Fuller came to Black Mountain College, a tiny art school in North Carolina, where Josef and Anni Albers were carrying on the Bauhaus tradition. At the last minute, Fuller stepped in for Bertrand Goldberg, whose partner in the Chicago architectural firm, Leland Atwood, had suggested Fuller as a substitute. Atwood had helped Fuller in the 4D Houses Project.

Fuller came with his aluminum mobile home trailer, packed full with his mathematical models. His laboratory was now mobile, his research nomadic. According to reports from participants, including Elaine de Kooning, Kenneth Snelson, Richard Lippold, and Merce Cunningham, Fuller's first, three-hour-long lecture must have had an electrifying effect on the audience. "Bucky," Elaine de Kooning recalled, "whirled off into his talk, using bobby pins, clothespins, all sorts of units from the five-and-ten-cent store to make geometric, mobile constructions, collapsing an ingeniously fashioned icosahedron by twisting it and doubling and tripling the modules down to a tetrahedron; talking about the obsolescence of the square, the cube, the numbers two and ten (throwing in a short history of ciphering and why it was punishable by death in the Dark Ages); extolling the numbers nine and three, the circle, the triangle, the tetrahedron, and the sphere; dazzling us with his complex theories of ecology, engineering, and technology. Then he began making diagrams on a blackboard. He drew a square, connecting two corners with a diagonal line. 'Ah,' he said affectionately, 'here's our old friend, the hypotenuse.'"

Elaine de Kooning, quoted in: Mary Emma Harris, *The Arts at Black Mountain College* (Cambridge, Mass., 1987), p. 151

In addition to his models, Fuller came to Black Mountain packed full of ideas and projects. Shortly before his departure, he had sketched out a project on June 15: the construction of a transparent geodesic dome that would enable its occupant to locate his or her correct position in the universe. This was clearly the origin of the idea that was connected to the construction of geodesic domes. Fuller called it "Your Private Sky" (see *Geoscope*, p. 344). At Black Mountain College, he planned to execute the small great-circle model on a larger scale, utilizing lightweight metal Venetian-blind sashes to create the first dome.



317 -316 The Hartford Dome, December 1950, the first geodesic dome construction realized by Fuller

Black Mountain College: RUF surrounded by study models from his teaching and research, 1949

Merce Cunningham

"The lecture at Black Mountain College that Bucky gave was about his work, but also about his way of thinking of the world even at that time, as a single entity... I remember that marvelous idea of his about how people traveled either with the wind or against the wind. And the first part of the lecture were the ideas that he had been concerned with over his life. And the second part... He began to demonstrate with these small models which were made of paper... they were quite small, on the table... he would pick up one of these, I remember, and turn them around slightly to show us how one thing could work against another in that way he had about building... Yes, he built one of those geodesic domes, and my recollection about it is that he asked for a specific kind of material but the width was less. So he was heard very quietly to make this remark as they were trying to put it up: Well it won't work but we'll go right ahead and do it anyway. And it did fall down. But it was such an experience for any of us who watched."

- Interview with choreographer Merce Cunningham, in *Thinking Out Loud: Buckminster Fuller*, a documentary movie in the series *American Masters*, directed by Simon and Goodman, New York, 1995



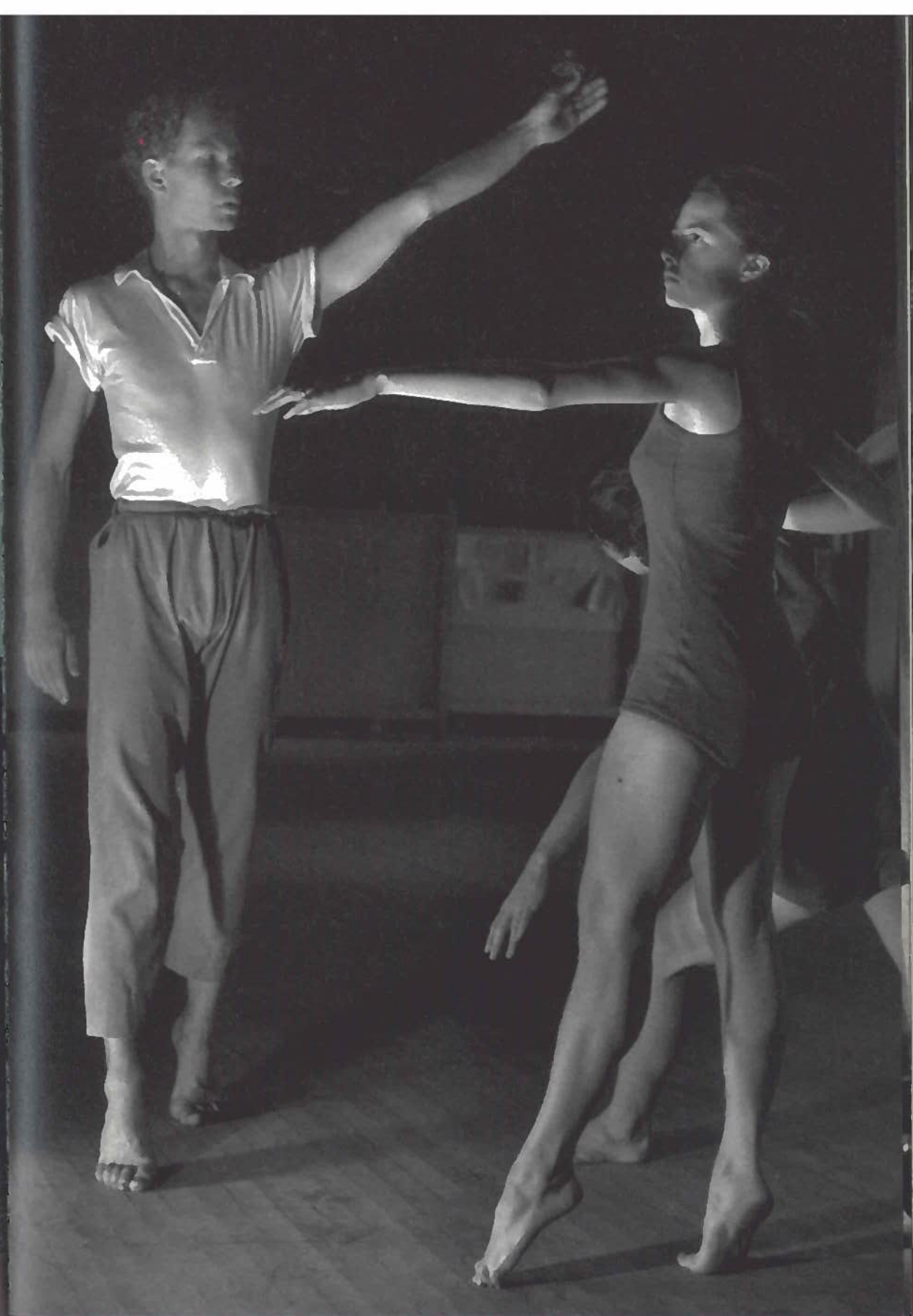
“The whole world
has to be turned into music
or into a Fuller university.”

John Cage



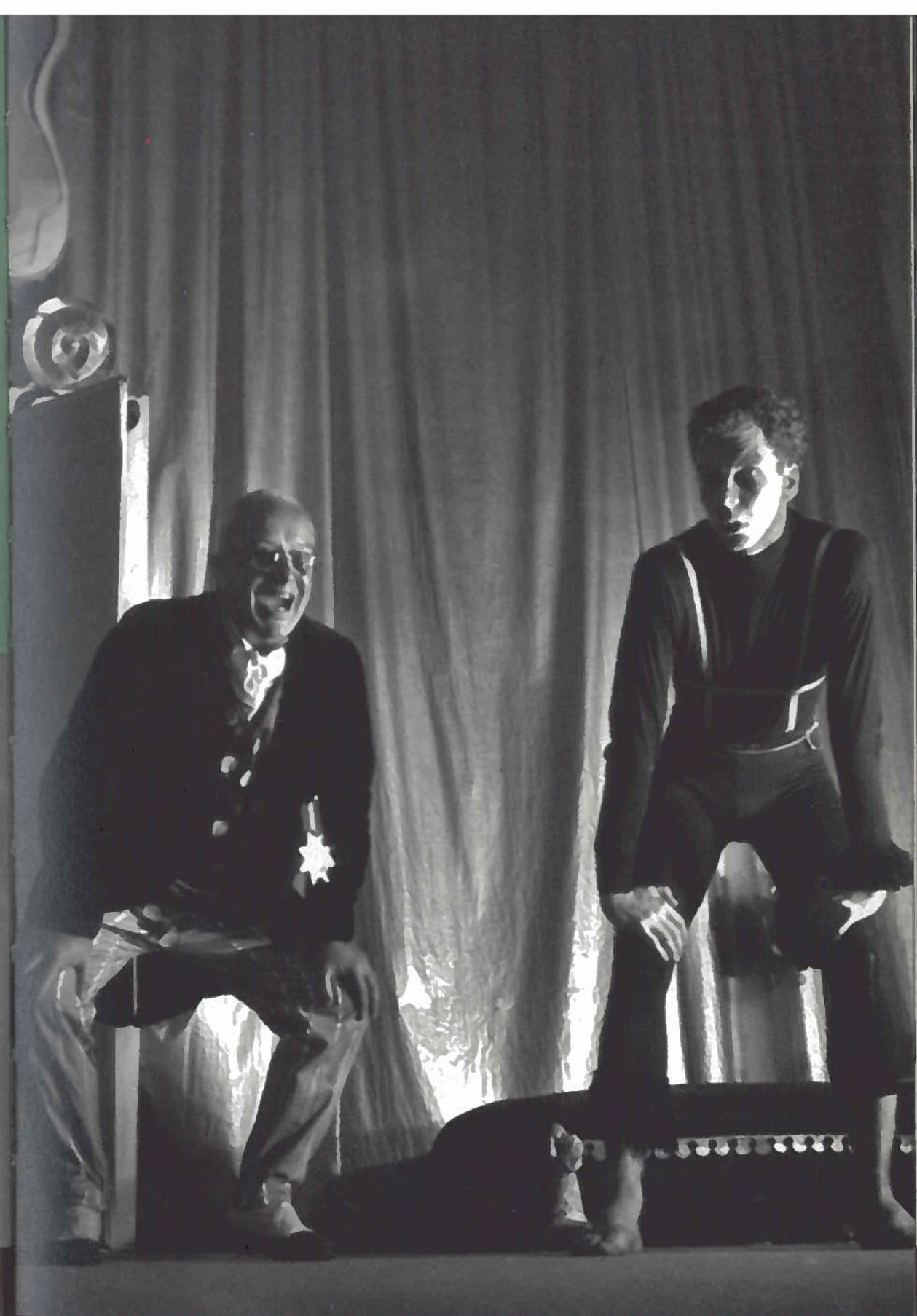
320 - 375/312: Workshop at Black Mountain College, summer school 1966: constructing a geodesic dome out of the metal striping used for Venetian blinds

(RBF) with Monds, Black Mountain College, 1966, tentlike: front left, Nancy Kewhall; front right, Ann Albers and to her right, RBF Wilhelm Dehn



One high point in the program of the Summer Institute of 1948 was the performance of Erik Satie's *Le piège de Méduse* under the direction of John Cage. Cage gave a lecture defending Satie and organized a Satie festival using amateur performers. Fuller and Elaine de Kooning took the main roles; Merce Cunningham choreographed it and played a mechanical monkey; Arthur Penn directed it. The reworking of the piece was noteworthy: It was a magnificent time...

Arthur Penn, quoted in Mary Emma Harris, *The Arts at Black Mountain College*, Cambridge, Mass. 1967



330 1331: Merce Cunningham at Black Mountain College, 1948

1332: John Cage, (at left) with Merce Cunningham and (above) with Elaine de Kooning, in the piece *Le piège de Méduse* by Erik Satie, Black Mountain College

for Sunday at 85 with love

My dear people Be
with

Camera

now we know

what comes

to it

Not morning

he pursued the sea

highest

serve

the nation did it

and on the sea. Film next door

mus. Vennels

with Les d'art

and all

of the

of the more familiar

he said i. Enrich

work with it. work

at

in the nation

if we must

otherwise

earth. i. M.

Spring

as things

following his advice

he had gone into general

Feeling

known with it

up

on a chair

love

before it. hand

One of the most beautiful. Love

Cage's mesostic: The letters along the central axis, when read from top to bottom, spell out the name Buckminster Fuller twice.



324 John Cage: Poem for Rite, on the occasion of his 85th birthday, July 1960

John Cage at Black Mountain College, around 1950

Necklace Dome

It was a big task to get from great-circle models of globes to a practical supporting structure. The first step in the process was creating the models that Fuller called necklace dome structures. The great circles were produced from straight lines, namely, tubes with a cable running through the hollow cavity that tied them together and gave the structure its name. The individual great circles had joints, and the structure as a whole was meant to fold out and back together. The points of intersection were covered with plate-like fittings. One of the main points of Fuller's theory said that as the diameter of the dome increased, the force on the individual strut decreased, and the synergetic principle of the diffusion of force became more and more effective. The increasing size of the models and experimental domes, which were always subjected to weight-stress tests, was an important criterion in this phase of successive exploration of the characteristics and possibilities. The structure in the upper right of the illustration (at Black Mountain College) had a suspended platform and was subjected to irregular impacts to test its response to an artificial earthquake.

The discovery of the tensegrity principle at Black Mountain College was due to the magical atmosphere of learning of this school and its teacher Fuller. The wire-spoke wheel had always been important to Fuller: "I saw that the exterior of the equatorial compressional island rim-atoll of the wire wheel must be cross-sectionally in tension as also must be its hub-island's girth" (*Synergetics*, 353); the step from monopolar to multipolar tensegrity was the discovery by his young student Kenneth Snelson. (See *Tensegrity*, pp. 392 ff.)

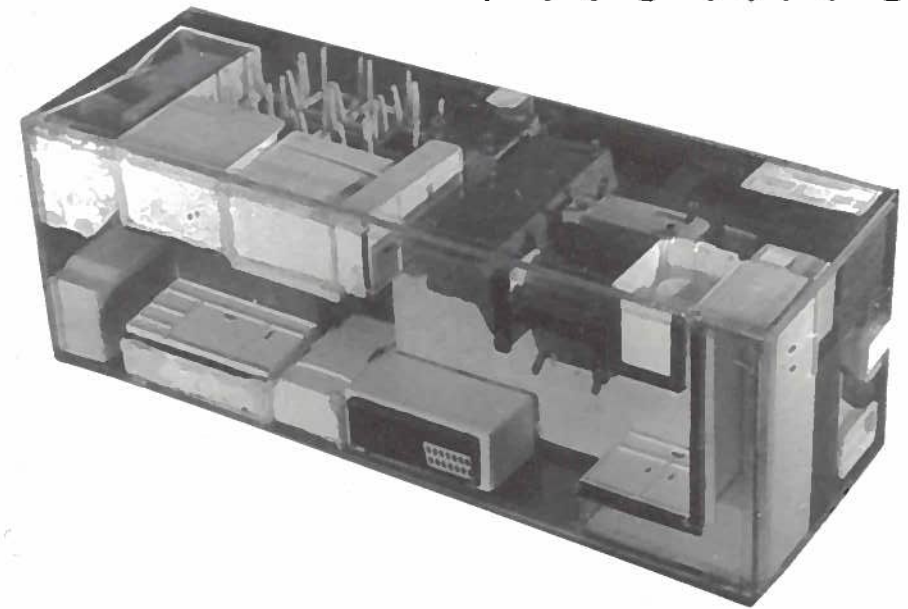
Work on early geodesic structures, the discovery of the tensegrity principle and the problem of a support structure's foldability (1947 to 1950)

Multipolar tensegrity; this principle was discovered by RBF's student Kenneth Snelson. RBF with students and his Airstream Trailer, with rolled-up great circle sphere. Necklace Dome geodesic structure that folds together.





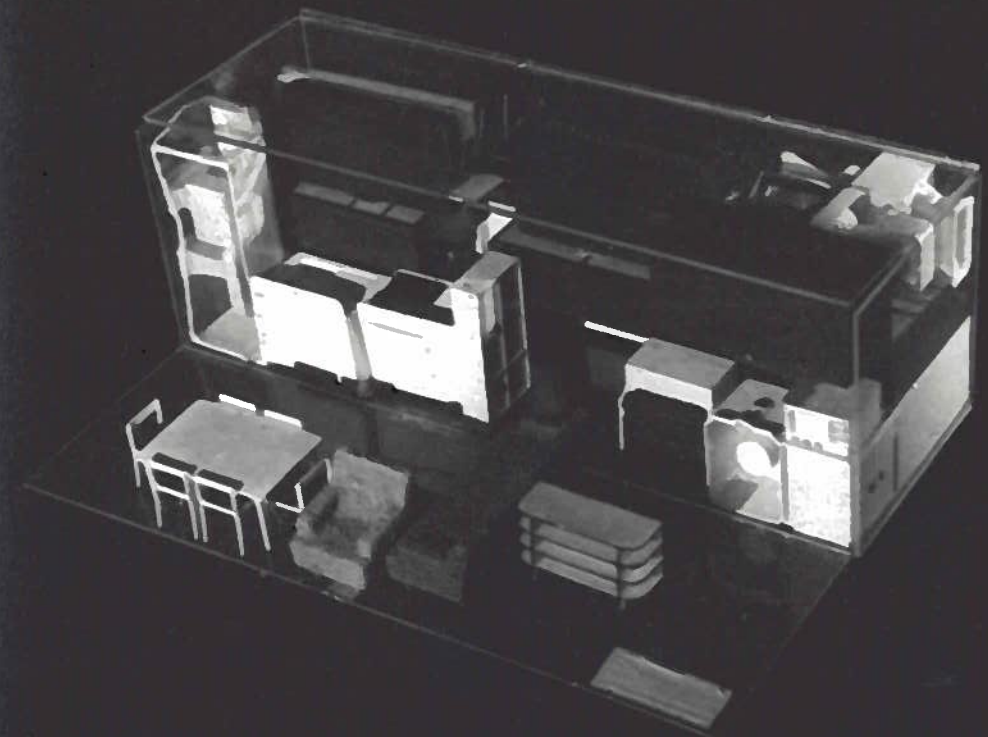
STANDARD OF LIVING PACKAGE



Standard of Living Package

Fuller assigned this design project at the Institute of Design in Chicago in 1948: To make the complete furnishings for a household of six people that could be packed into a container and transported with a trailer. The students developed a box that was eight yards long and two yards high and wide, with collapsible walls that were fastened by hinges. When folded down, the walls also served as the floor for the furniture and household items, as well as for the corresponding zones of the floor plan: bedroom, living room, two baths. The overall useable area was ninety square yards. The exercise was influenced by the technique developed during the war for transporting delicate airplane parts in trucks that were packed full; it is also another attempt to deal with closest packing (see pp. 278 ff.).

This exercise was also related to the design for the Sky Break, an easily constructed house whose climatic skin is a geodesic cover, designed according to the necklace principle, that stretches over the unfolded – in this case two-story – living space and storage compartments. The model shown here was built at Black Mountain College in 1949.





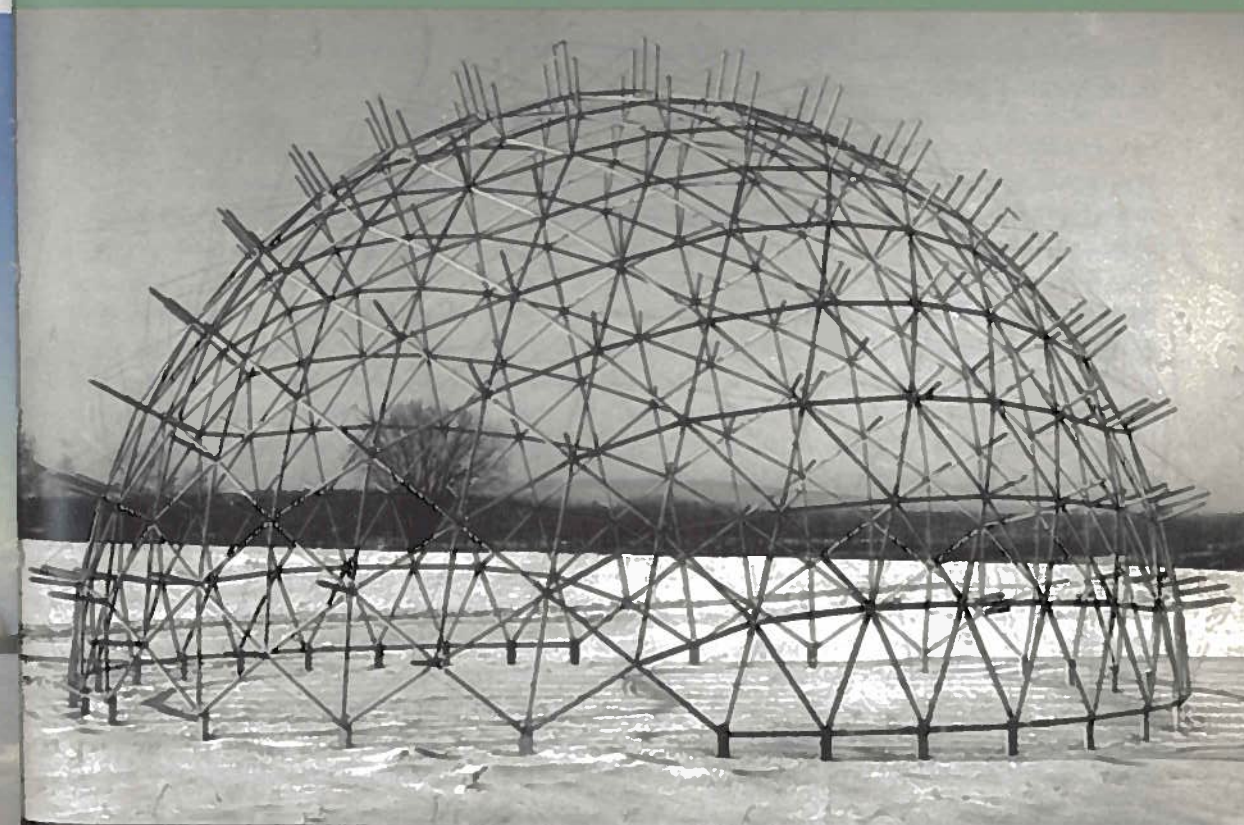
332 Dome in Aspen, wooden slats and outer plastic skin, 1958

View from interior toward the ventilation opening in the zenith.
(below) Charles Farnes filming in Aspen, 1958. RBF on right.

Geodesic Structures

In the fall of 1947 I assembled a four-foot diameter three-way grid geodesic structure at my Forest Hills New York apartment, and that winter and spring I made two more four footers. In the summer of 1948 the first generalized prototype model of a 50-ft. Geodesic structure was assembled at Black Mountain, North Carolina. In December 1949 a 14-ft. necklace Geodesic was assembled at 6 Kinzie St., Chicago, at the request of the Air Force, and in February 1950 it was installed in the Pentagon Building garden at Washington, D.C. In December of 1950 the prototype of a specialized geodesic structure 49 feet in diameter was built in Montreal. I designed it to be an Arctic installation. The components of the structure were tubular aluminum struts weighing about one pound each. The structure was so light that we did not need a mast to lift it. Instead it was lifted locally in order to add more struts to the bottom. When the structure was completed we looked up at the blue sky through this thing and began to realize that something very pleasantly exciting was happening to us. We knew that it was light, knew that it was strong, but we did not know that it was going to do just that to a blue sky. Those are the very typical sensations we get when we tend to solve only the scientific side of the problem. The qualities of economy that are synergetically resultant in the end do something to us in the way of challenging our sensibility to new sensorial limits. Looking over against the birch trees, the slenderness ratios of these very high strength trees and of the Geodesic struts seemed to be very much akin.

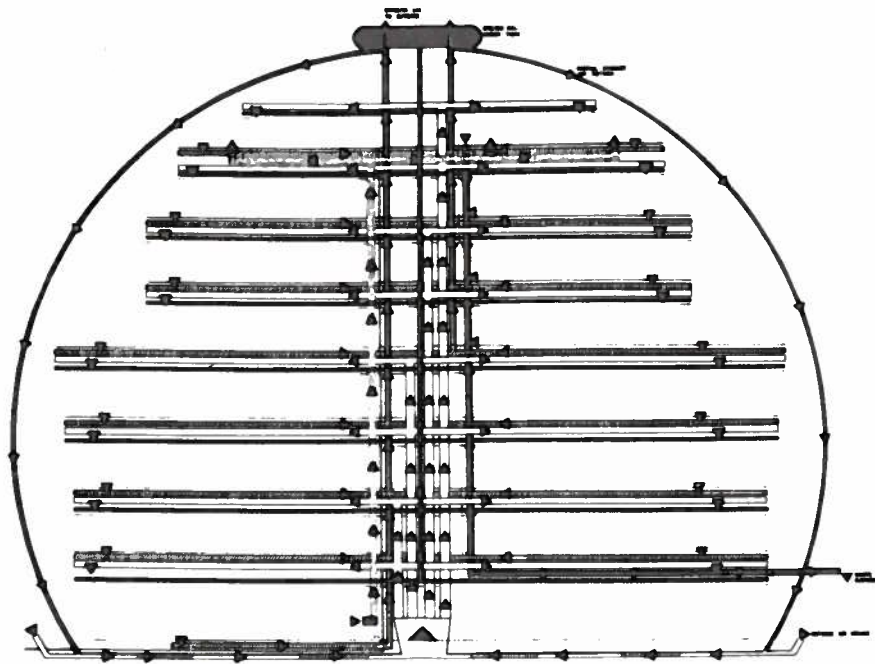
"Architecture Out of the Laboratory" (1955), 17



235 Before the inside skin is put in place, the metal rods form the pressure-resistant domed vaulting, the fairly strong wires form the tension-resistant outer shell



234 Geodesic dome near Montreal, December 1950. Sketched by Fuller Research Foundation, Canadian Division



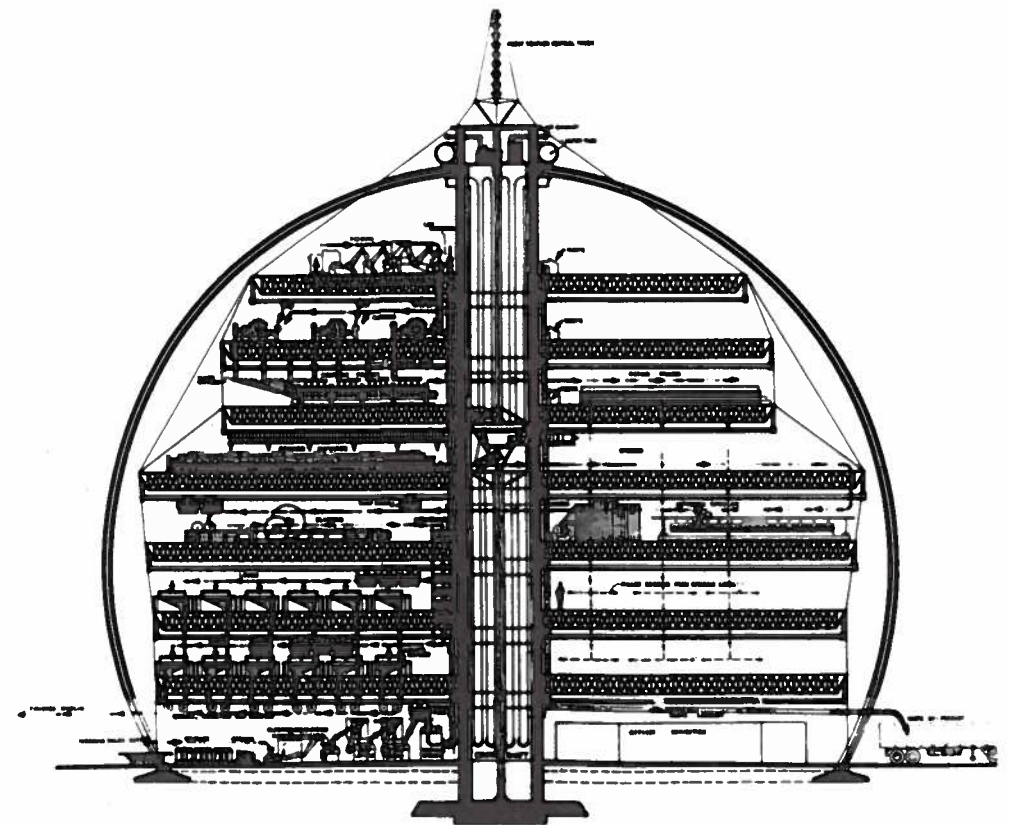
**90% Automatic Cotton Mill: Project Announcement
North Carolina State College 1951**

How an entirely new factory architecture may precipitate the mechanical evolution.

A new cotton mill as a specific prototype problem generic to the greater imminent problems of the widely deployed semi-autonomous elements of an invulnerable industrialization.

(...) The first assumptions of cotton manufacture were that cotton mills must be installed beside mill dams because their machinery would "always" be powered by water wheels, requiring translations of power by belting pulleys and meticulous paralleling of shafting in the most geometrically economical patterns, consistent with all the functions of picking, carding, combing, twining, spinning and weaving. Obviously logical for the preservation of the expensive machinery was its housing: One hundred percent compressively conceived stone masonry for vertical components and heavily sectioned wooden platforms for the horizontal components. The natural clustering of the necessary mechanical stages of the manufacturing called for a geometry of four or five tiers of flooring.

(...) The whole early concept of factories assumed flooring requirements able to carry 200 lbs. to the square foot at any square foot, because which foot might be eventually employed, could not be foretold. The revolution of new cotton mill design, characterizing the switch from New England to the Southern States for economic reasons occurred after electric motors were introduced and steel structuring was available, and made possible by air conditioning and large spans of steel trusses, etc. However (...), the machinery itself, though now installed on one floor, represented widely separated operations (...). Due to their enormous foundation layout



and assumptions of "anywhere-everywhere"-loading, the cost of buildings has continuously risen and along with it their maintenance cost.

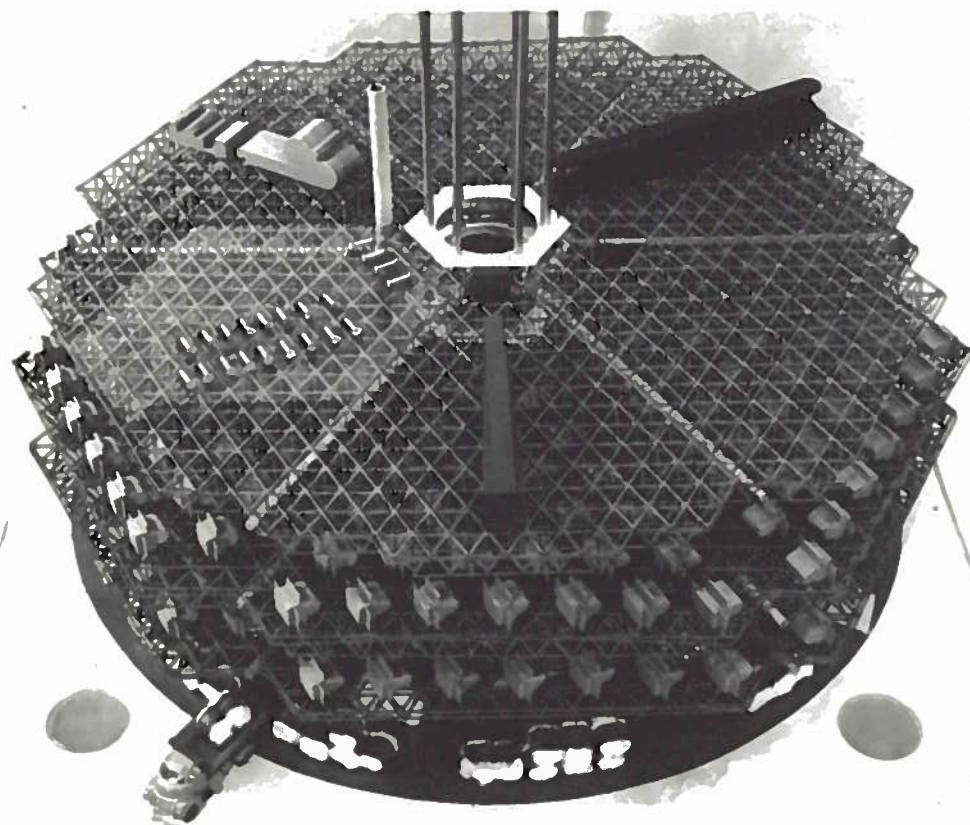
Two industries with more recent starts than that of cotton manufacture and therefore with less accumulated tradition of conceptioning and operating strategy have shown far greater susceptibility to scientific treatment and therefore to acceleration in evolution of both general and particular physical mutations, i.e. the chemical manufacturing industry and electrical power generating and distributing industry. (...)

No. 1. The chemical manufacturing industry soon took scaling ladder advantage of its own generally advancing chemical knowledge of natural association-dissociation principles by developing non-deteriorating all-weather and continuously operating machinery, and like a chicken, burst out of its own classical arch corniced brick egg to stretch out nakedly and majestically in the local day and night sky with its omnidirectional system of receiving, self-meteringly valved, fractionating, accumulating, regeneratively circuiting and distributing facilities.

No. 2. The relatively very new electrical generating industry and its distribution system (and its by-product coke and coke-derivative chemical processing) have been repeating the out-of-egg process and are now better than half emerged. Its greater transformers and other major apparatus are now in open-air switchyards.

A totally new start in cotton mill conception is now proposed in which only the essential articulating and reciprocating mechanical components of the various stages of manufacture are separated out from their pre-conceived separate chassis, which now obsolete chassis assumed their parallel and "standing" placement on floors, relative to shafting.

Instead, it is proposed that a unitary, three-quarter spherical air conditioned enclosure be provided, with a secondary three-quarter sphere interior geodesic structuring entirely indepen-



dent of the enclosing structure, which shall serve only to support the articulating mechanisms to be suspended in preferred four-dimensional arrangement within. Thus a true flow pattern, similar to the digestive, shunting, secretive, and regenerative pattern of the human anatomy, will digest and process the cotton, taking advantage of ample height and gravity to drop-lead, space-accumulate and meter the progressive bars, slivers and threads and thus eliminate the primary "re-introduction" chores of workers, and the enormous and heavy floors around which roll the relatively light loads. The savings in amounts of metal required to permanently trussing the apparatus into the preferred flow patterning positions will be of dramatically significant magnitudes, and the heavy flooring itself will be eliminated. The free space positioning of the apparatus will be such as to permit its interpenetration by swiftly conceived mobile staging and to bring the few expert attendants into intimate advantage relative to any stoppage in the automatic processing. The whole process may be kept in constant review from central space advantage. The preferred aerodynamics of the three-quarter sphere in its economy of laminar circulation will provide highly efficient air conditioning and illumination, etc., and a minimum of concentrated foundation to support the base of the geodesic structuring.

This seminar will involve research, on the part of all its architectural students, within the N.C. State Engineering, Textile, and Business Administration Schools and expert consultation in establishing the entirely new fundamental assumptions and a trial-balance-design must be taken involving a working familiarity with all the functions. Within thirty days a general assembly, and primary sub-assembly, set of drawings must be developed, clearly revealing the fundamental scheme and cogently demonstrating the net economic gains in pertinent industrial logistics in metals, energy and time investments of original installation and subsequent operation, etc. To realize so comprehensive a program in so short a period, the participating students will

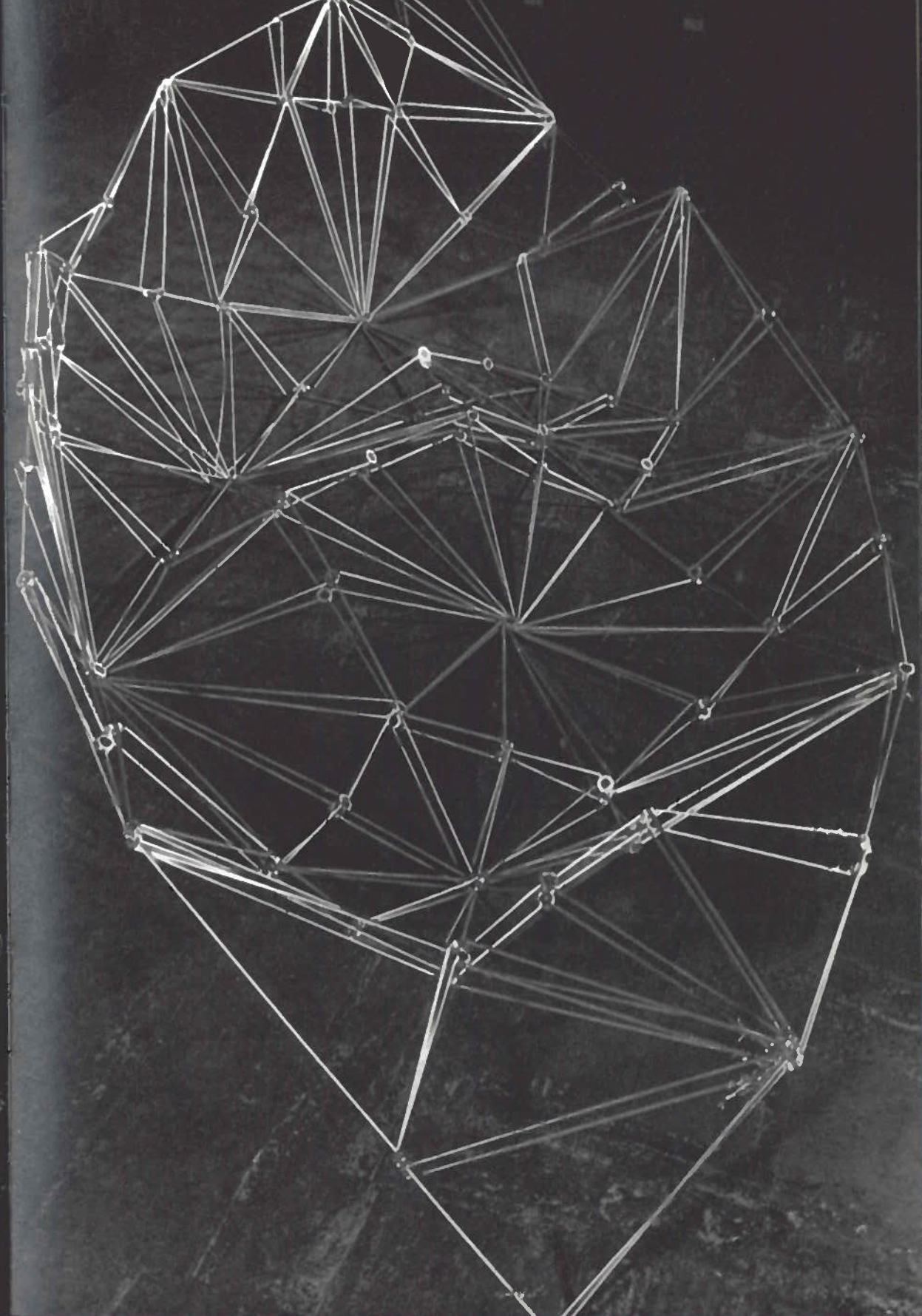
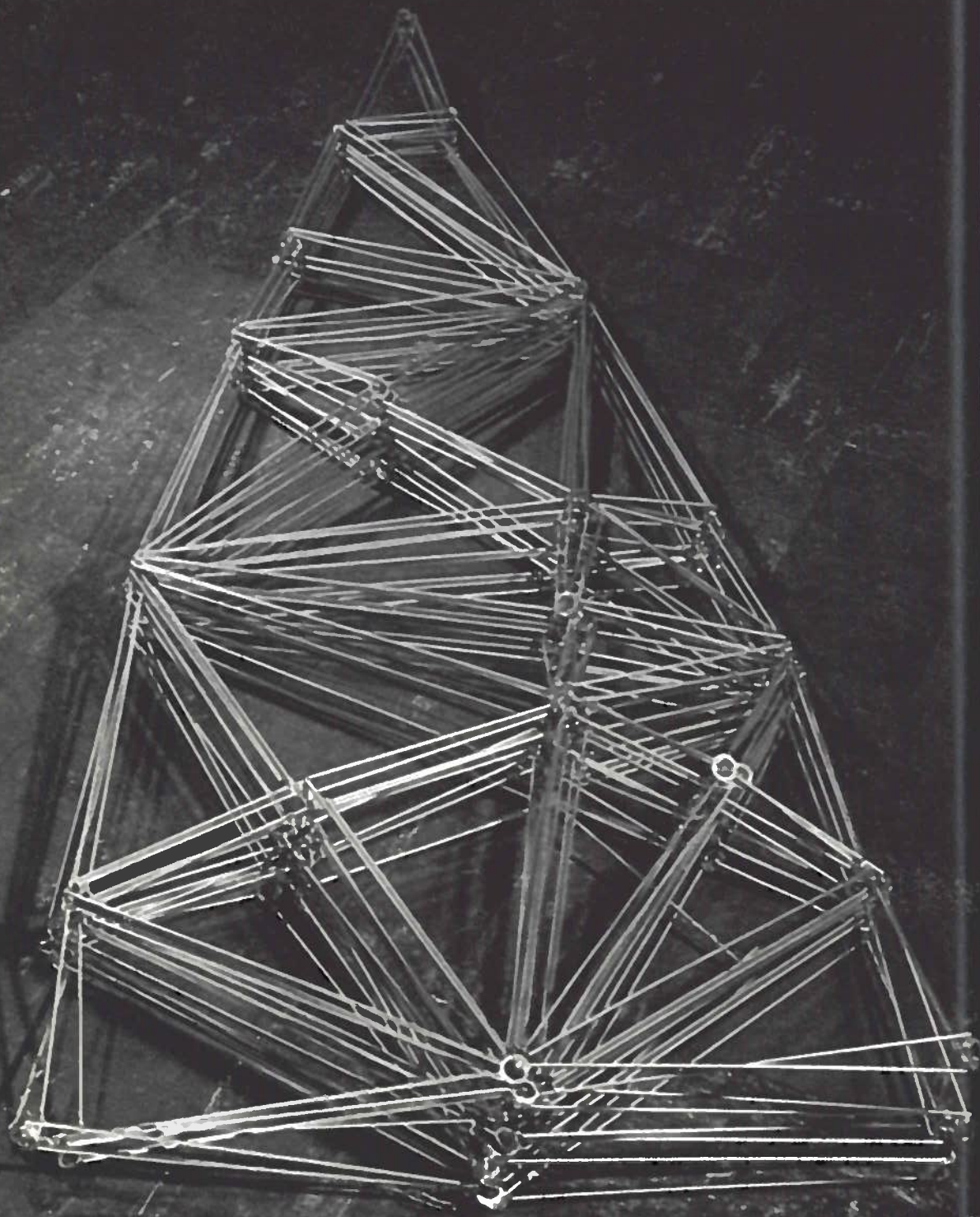


have to establish procedural team discipline in which they will sub-divide the special tasks, but will avoid isolation from comprehensive responsibility by frequent convening of teams, reporting to the whole group and group discussions and tactical decisions.

It is hoped that the time budget will provide enough margin to undertake a few schematic sketches on the part of each student in which he himself applies this principle of automatic and integrated mechanics suspension to other fields of manufacture. It will be clear, as the problem develops, that this omni-directional, multi-dimensional spherical patterning introduces relationships and energy efficiencies that are not only novel but to be contrasted to the present 1-, 2-, and 3-dimensional geometry limitation of intermittent batch and production lines.

(Richard Buckminster Fuller, Visiting Seminar Director)

Project announcement, in: *Student Publications of the School of Design*, North Carolina State College, fall 1951, 28ff.

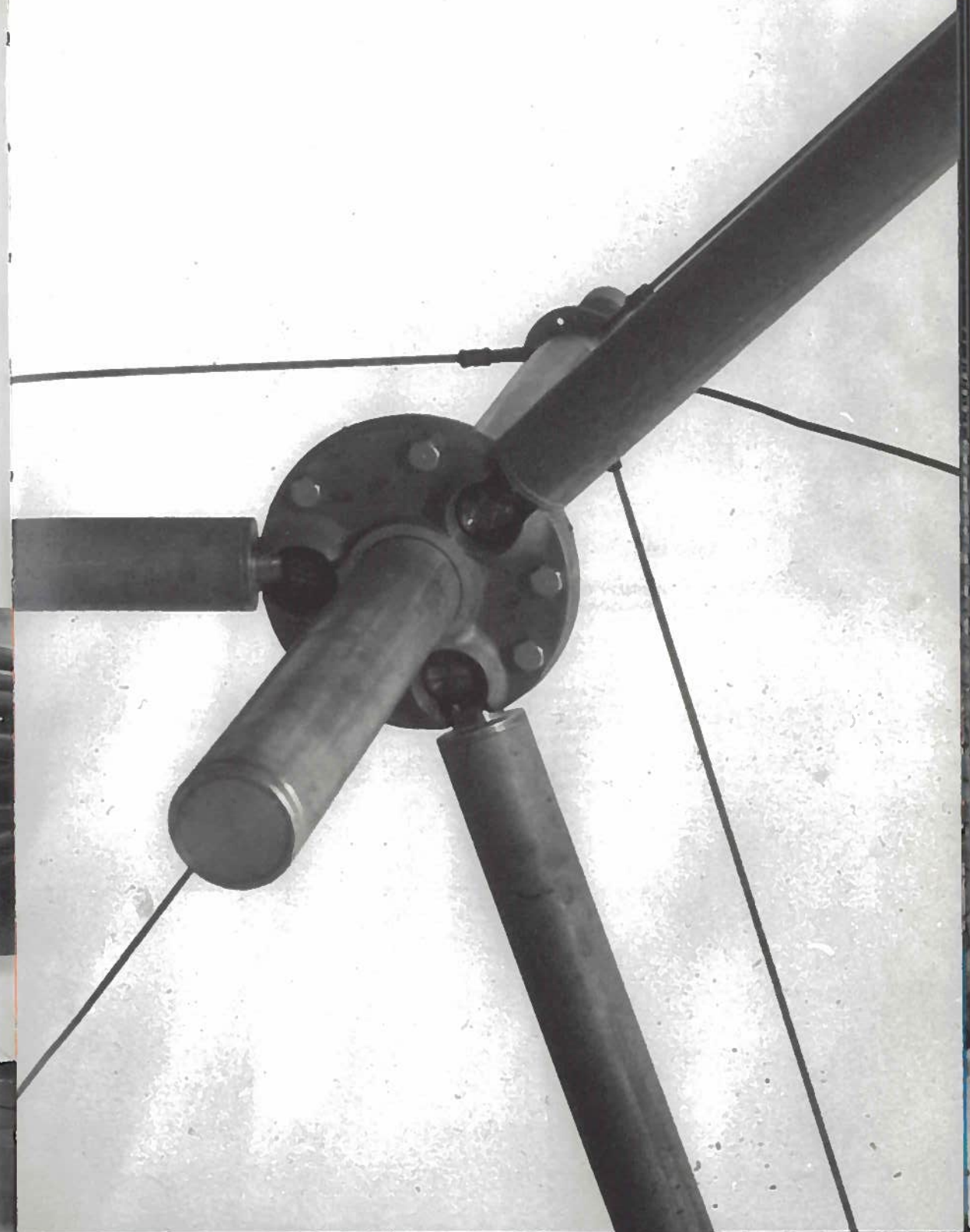


380 Richard Dene, geometric structure that folds together,
1950. Compare to *Wool's Ark 2* (p. 306)

Flying Seedpod

This structure was made at Washington University, St. Louis, in 1953 under my invention and design instruction. You may possibly be looking at the prototype of the structural principles that we may use in sending history's first (little) scientific dwelling to the moon. As you see all the structural members are tightly bundled together in parallel so that they may be transported in minimum volume within a rocket capsule. The parallel-strut bundles of light-weight magnesium alloy consist of sets of three, fastened together at one end with ball joints clustering them in tripods. Each set is like a camera tripod with three, tubular magnesium, legs. Each set has ball joints at the tripod head. All the tripod's feet are also fastened together with ball joints in clusters of five and six tubular-tripod feet per ball joint. We have a little mast coming out of the top of each tripod. This mast is pushed out automatically by a piston in a cylinder mounted in each tripod head. We put 200 pounds of gas pressure inside the cylinder and the gas pressure, (when triggered by a lanyard), will push the masts of all the tripods outwardly from each of the tripod heads. The pushed-out masts each have three tension members leading to their respective tripod's feet. As the masts are pushed out by the 200-pound pressure the tension members pull the legs of the tripods outwardly from one another. The tripods all open wide with their ball joint feet fastened together in hexagons and pentagons. There is a triangular net of aircraft cable in a regular, geodesic, 'star', spherical grid that restrains the tripod legs from moving any further outwardly from one another than is necessary to form a symmetrical geodesic dome or sphere.

"World Design Initiative" (Mexico Lecture, 1963), in: WDSO: 2 (1964), 51



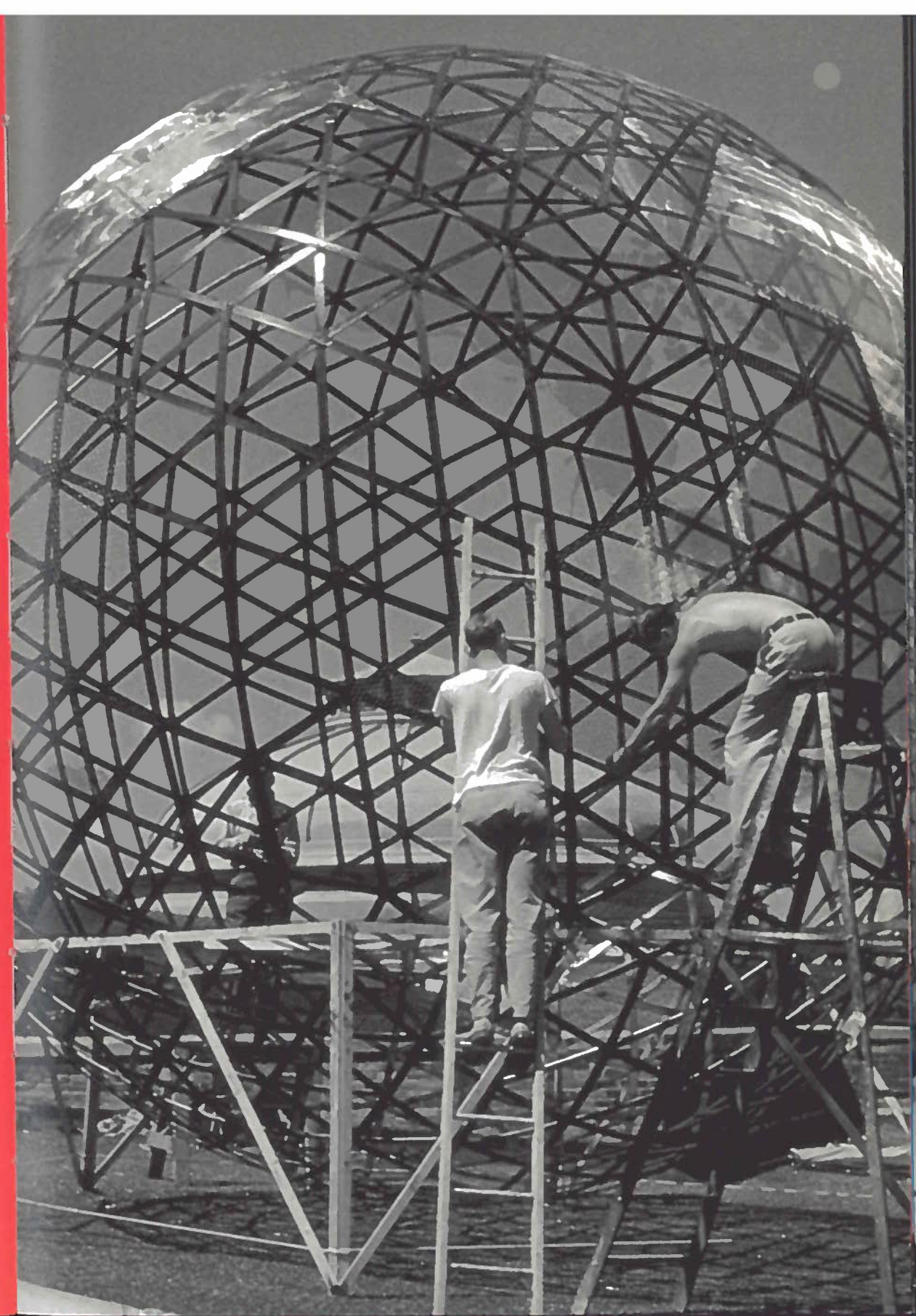
848 - Flying Seedpod: project at Washington University, St. Louis, 1953; geodesic structure able to fold up, developed with an eye toward later use in space travel

- Phases of the assembly process
Detail: function of the compression rod and tension members



In 1952, students at Cornell University under Fuller's direction built a seven-meter sphere for a planetarium called a Geoscope. From inside the sphere, it was possible to observe the moon and the stars. The point behind it was, however, only partially the view looking away from Earth toward the stars; ultimately, the point was to look at Earth itself. The name Geoscope had precisely this double meaning. Years before the first photographs of our planet from space, the installation sketched a view of the globe "seen from outside"; it was meant to unsettle the cherished image, used even by professed academics, of the sun rising and setting. In general, the Geoscope can be seen as an appeal to a perception of a global reality in the universe that was critical and intellectually independent.

GEOSCOPE



Your Private Sky

Your sky may be surfaced inside with sections of global map with zenith of "sky" and oriented accurately to the north. Thus the inhabitant may "see" his geography correctly. Can have his swimming pool at center a hemisphere with his antipodal data.

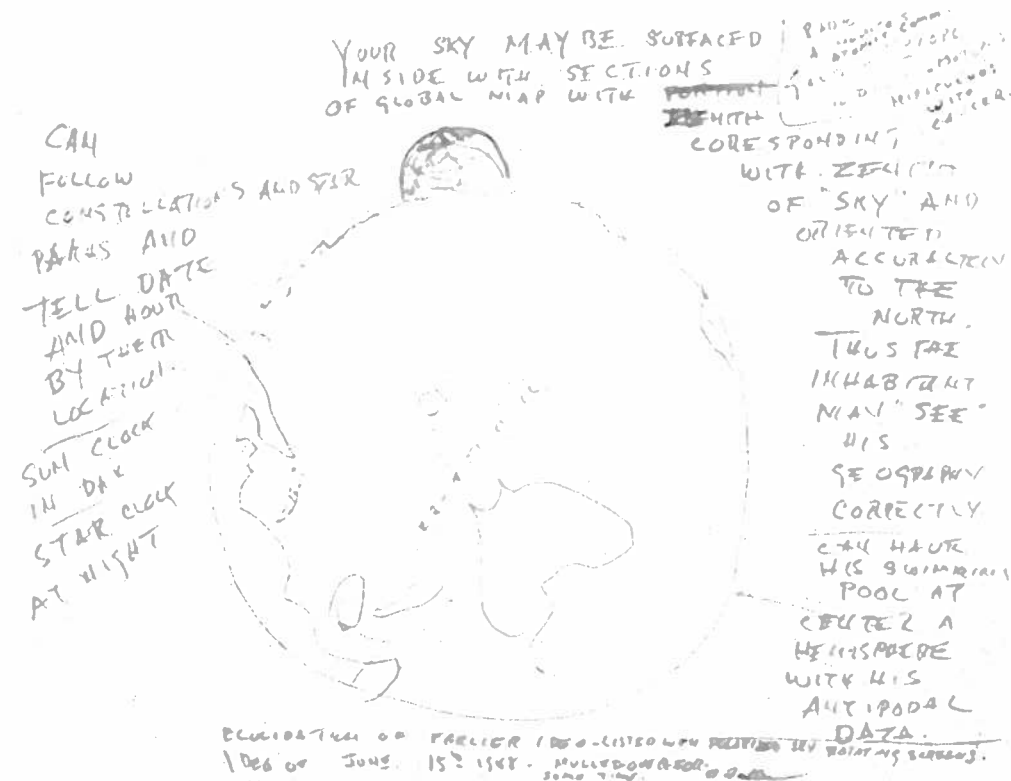
Can follow constellations and star paths and tell date and hour by their location.

Sun clock in day

Star clock at night.

Elucidation of earlier idea - listed with polarized sky rotating screens. Idea of June 15th 1948 mulled over for some this. - B. Fuller

Manuscript and sketch, "Geodesic Structures - Your Private Sky", 1948



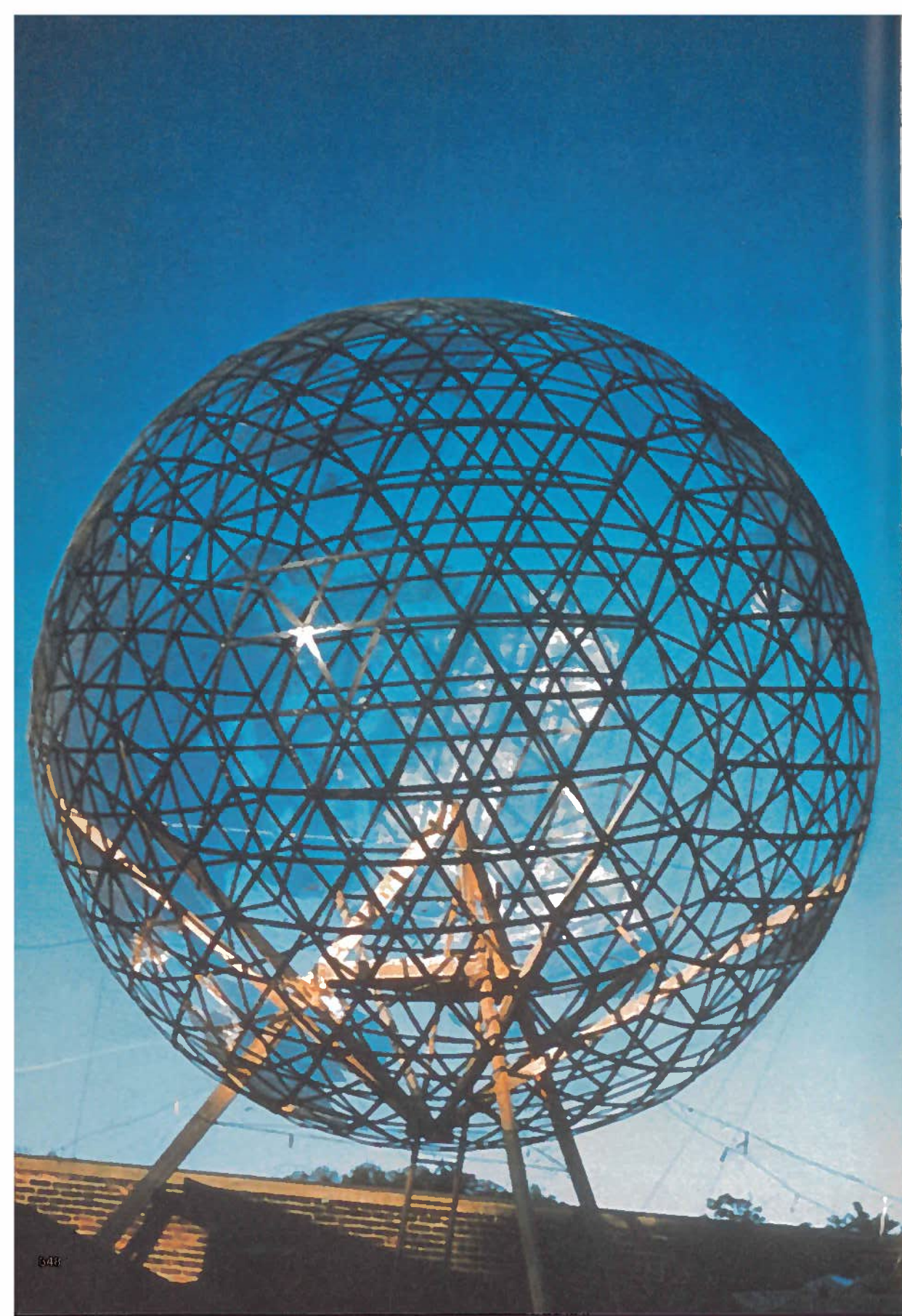
Geoscope: Point of View

"The point of view, through introspection, unlimited to the segmental area of our temporal eyes, is our abstract central position in the center of the universe, looking or building from inside out, as from the center of a great glass globe of the earth. Through this globe may be viewed the progression of relative positions to the starry universe, looking along the time lines in all directions. The separate paragraph thoughts are only connected by their common truths, which are the material crystalline spheres of sensible and reasonable fact, through which the radial time lines of individualism must inevitably pass in their outward progression towards the temporal infinity."

4D Time Lock (1928/1972), 31

Glass Globe of the Earth

The earliest formulation of the Geoscope concept goes back to the year 1928, as a speculative concept in the 4D book. Fuller tries to clarify theoretically what design "from inside out" can mean. He handles the question in such a way that a determination of the human's position in the universe is made necessary. In the absence of a world design, likewise no house can be designed "from inside out." The "from inside out" in the model of the "expanding sphere" also implies, however, a founding of a time-based design methodology, already given expression to in the 4D program. The geodesic hull of the Geoscope supplies the adequate model of an expanding universe.

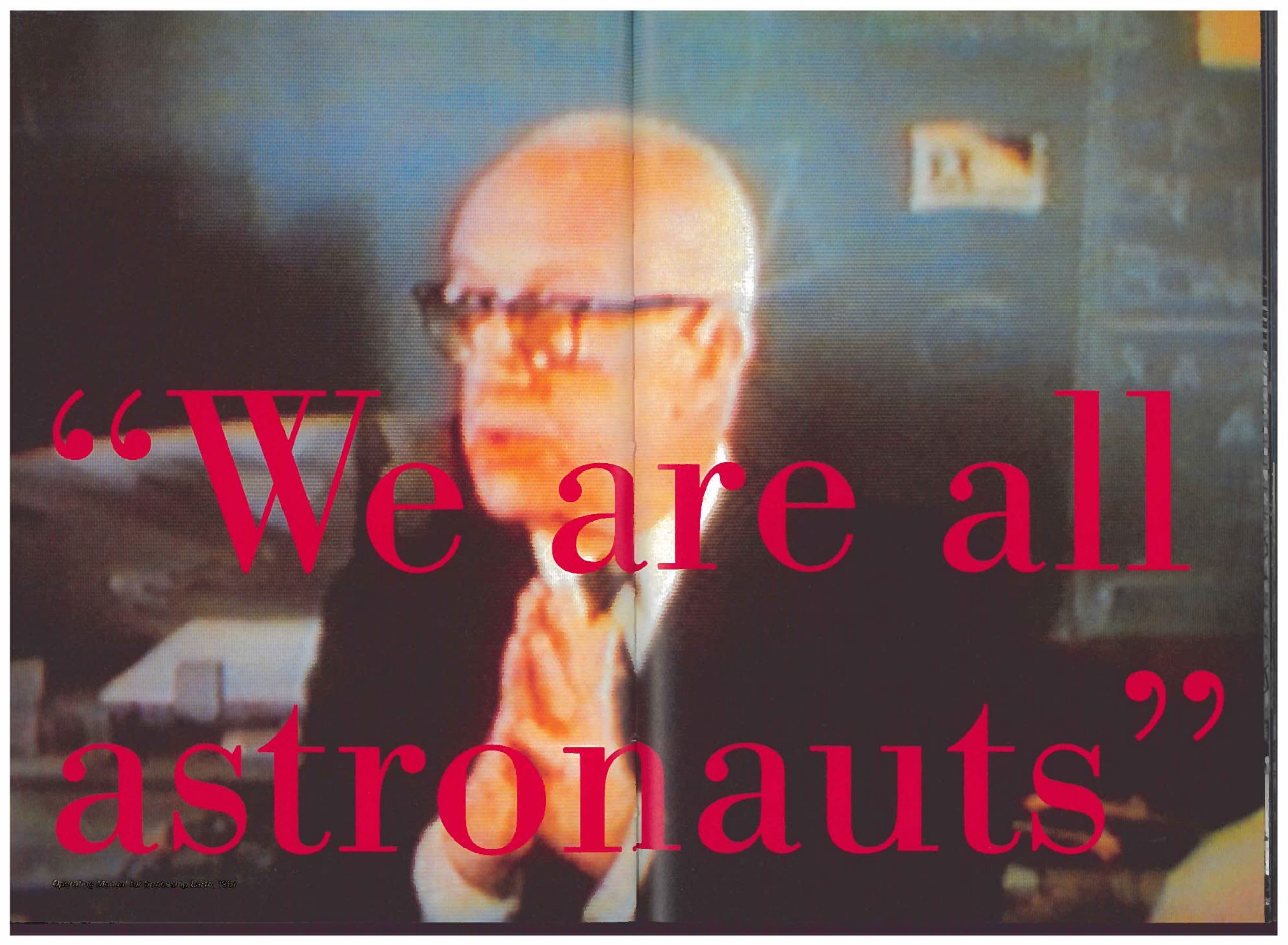


·348: Completed Geoscope, Cornell University. Geodesic structure (diameter 21 ft.) with observation platform in center. The land masses of the continents are represented as cut-out pieces of transparent mesh wire-netting. Their positioning on the surface framework is true-to-reality, so that an observer can correctly perceive the real relationship between places on the earth and the stars.

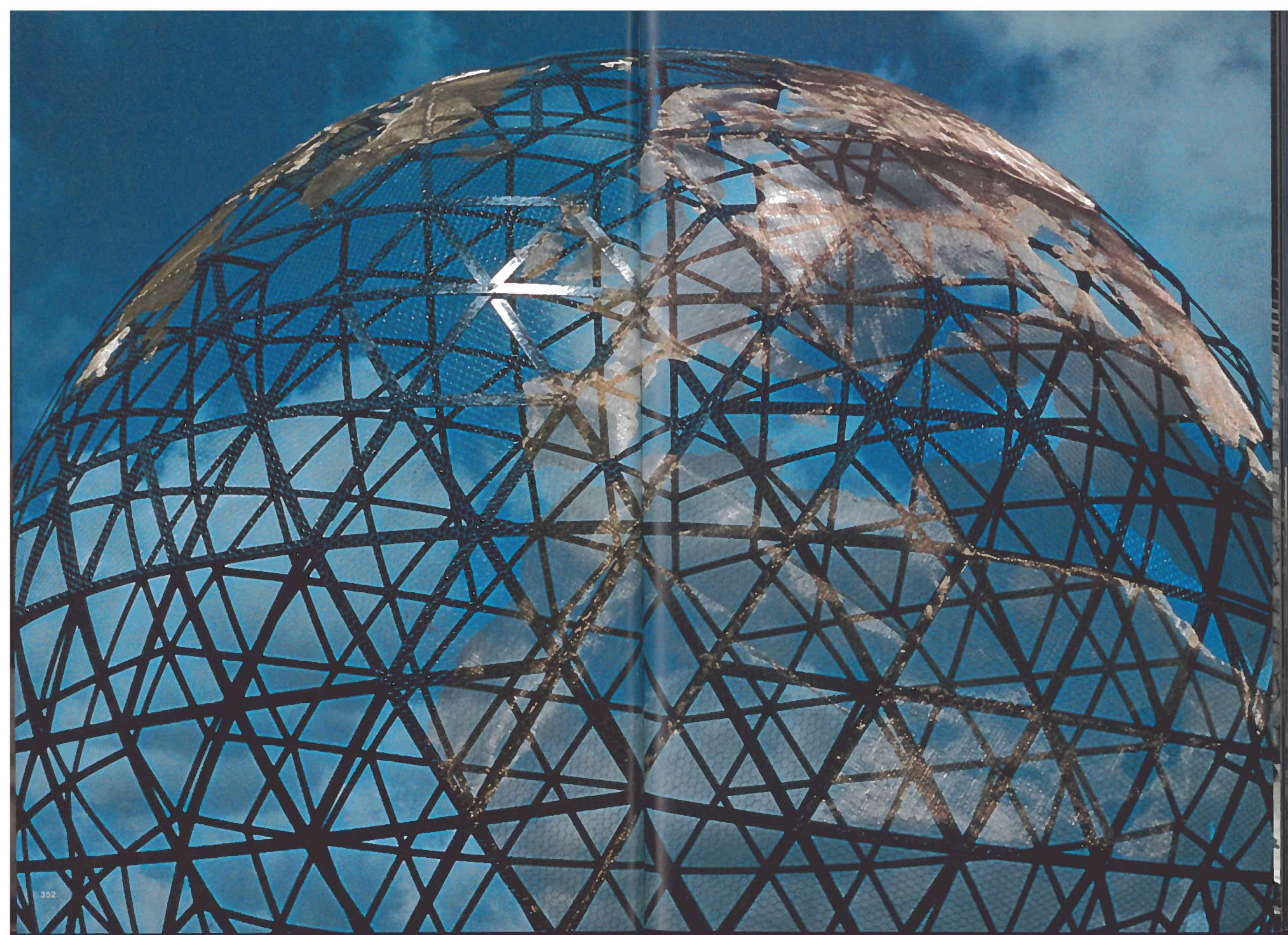
·349: Geoscope Workshop: Pre-assembly and completion of the geodesic framework with rhomboid-shaped facets. Installed on the roof deck of one of the brick buildings on campus.

·352/353: Geoscope land masses as a transparent screen.



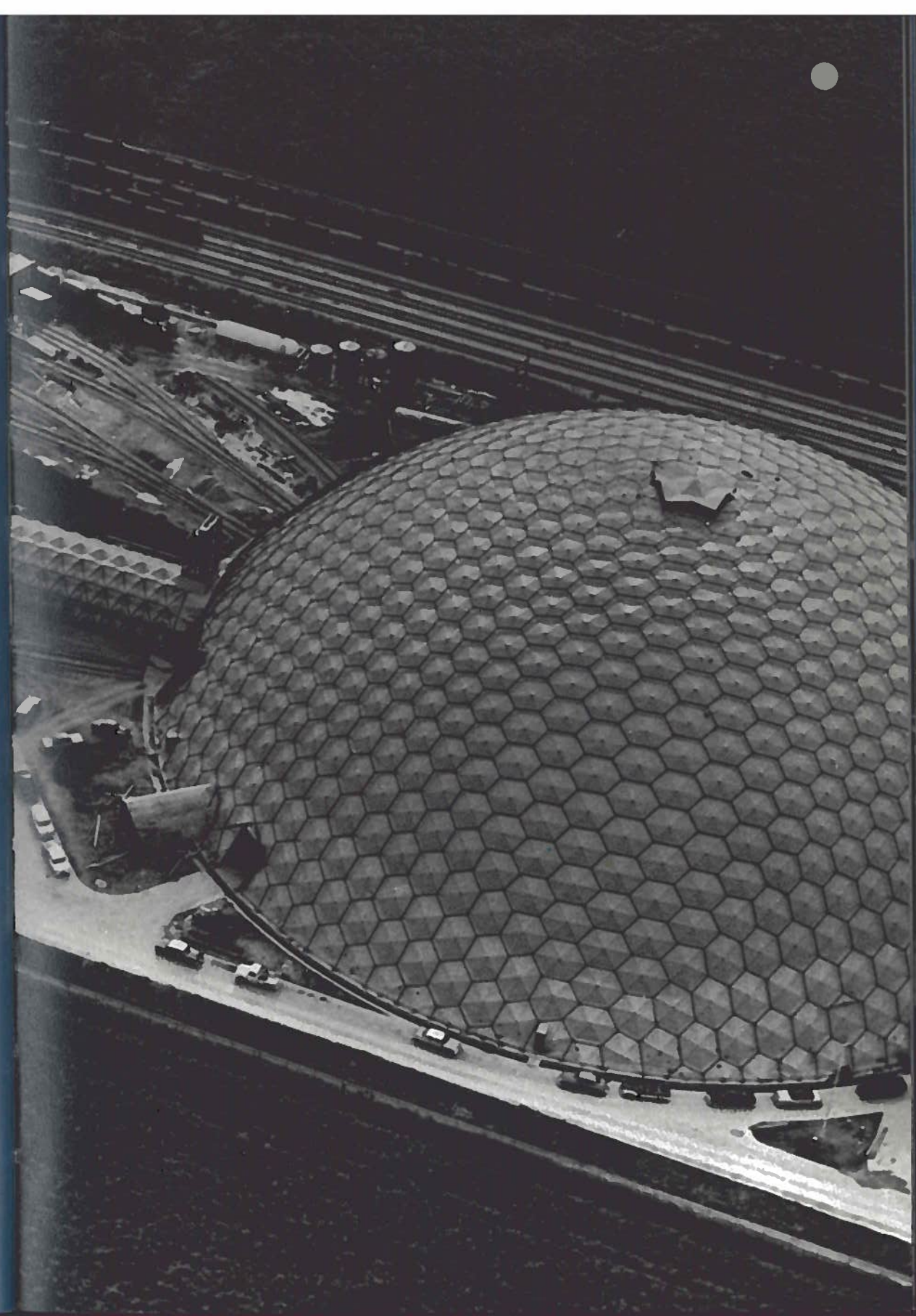


“We are all
astronauts”



Geodesic domes have become Fuller's trademark. Patenting them was the only financial success of his life. Since they were introduced, the domes have been significant in two different ways. As technical artifacts, they aimed at maximum efficiency in the relationships of volume to weight, use of materials to useful surface, and assembly time to mobility. As sociocultural alternatives to typical rectangular architecture, the domes crystallized society's dreams of a life liberated from constraints and tutelage.

GEODESIC DOMES





366 Union Tank Car Company, Baton Rouge, Louisiana: dome with span of 130m, red structure with suspended metal elements

Ford Rotunda, exhibition building, Dearborn, Michigan: Originally built for the 1955 Chicago World's Fair. Aerial photograph showing BBP's dome.



Ford Rotunda Dome

In February and March 1953 I was flying back and forth to Detroit working on the Ford Rotunda in Dearborn. I made the preliminary design of the dome with a crew from Yale and M.I.T. The testing of the Octet trussing for the dome was done at the aeronautical engineering laboratory at the University of Michigan. We put electric strain gauges on the truss members during static load testing of the central tetrahedron of the whole group. The Ford structure was designed using only six different lengths of members and all

the holes were pre-punched to a tolerance of 1/1000 of an inch. There were 72 different orientations of end holes. When the structure was erected the holes lined up perfectly for a very right riveting job.

The first step was making up the triangles and then combining them into octahedrons. The octahedrons were fastened together and thus formed the grid structures. The aluminium spines of the primary structure were fastened together with four different types of hubcastings. Three spines put together made one large triangle. Inside this triangle we had ten octahedra which were placed on a flat plane and then lifted up. The octahedrons cluster together in an octahedra-tetrahedra-system, a system that is self-centering and self-aligning in such a way that you can lift up the whole group without putting a single fastening in. No triangle will fall out. However, they were firmly fastened together to reinforce the spines.

The second sequence of operations consisted of putting the gusset and shear plates into the Octet truss. The workmen installed them very rapidly. It was estimated that the total work on each truss would take two hours, but they were riveted together at the surprising rate of one every 20 minutes.

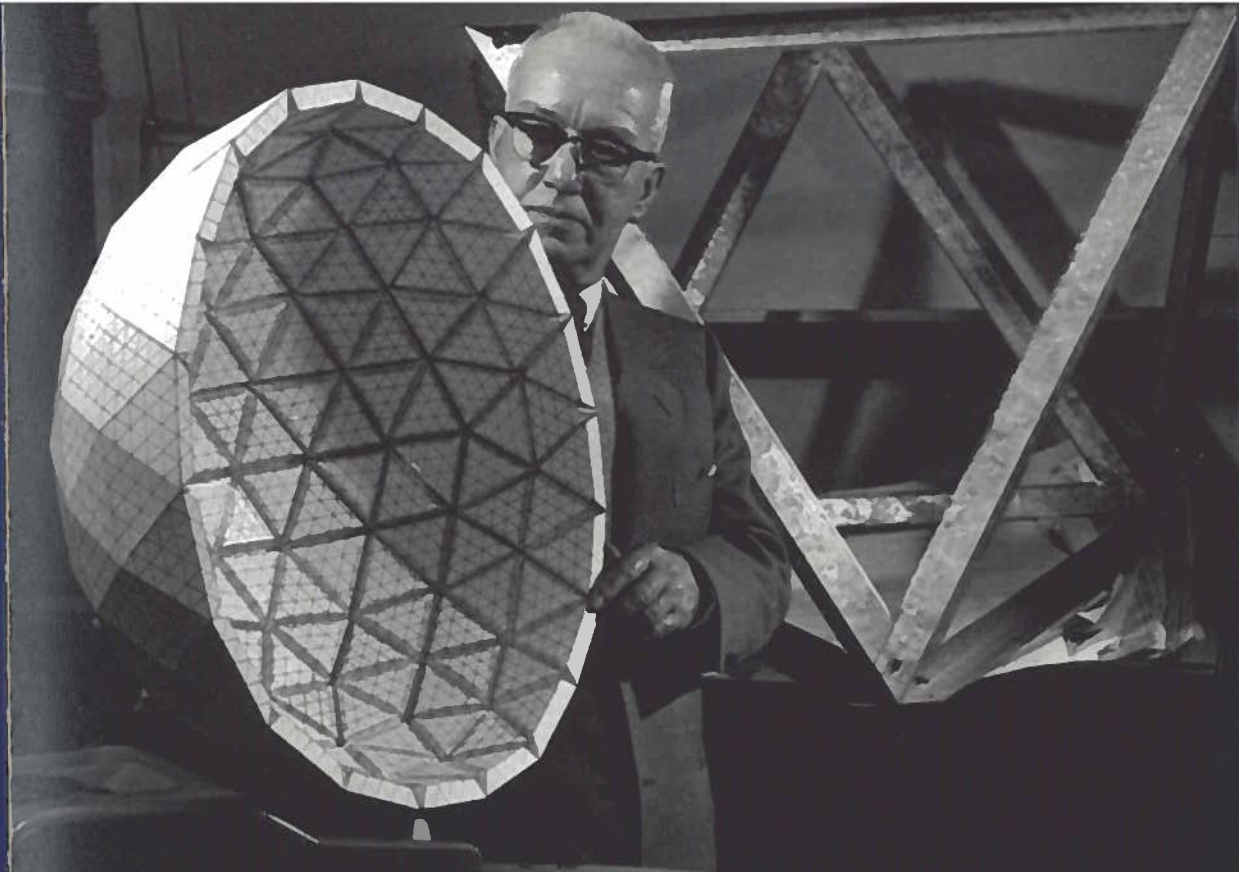
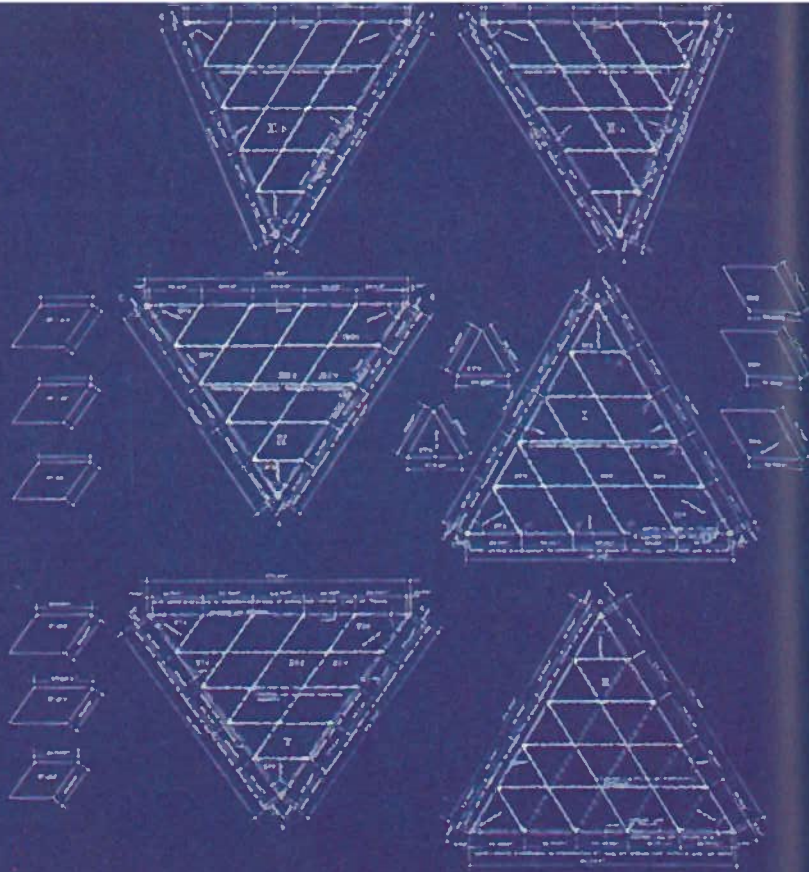
After the dome was designed we put up scaffolding which consisted of a 30 by 100 foot deck with a turntable on ball bearings and hydraulic lift so that the dome could be sent aloft and by doing so use my system of working from top to bottom. The Ford Dome workers never had to leave the deck to assemble the dome. When it was finished they were able to climb safely on the feather-weight parts. As the structure went up, looking at it from the court, it took on very interesting patterns. We saw a larger and larger dome turning and rising away.

The dome was to be covered with polyester fiberglass that was supposed to be prefabricated in a shop, but the manufacturer could not get the material in time. For this reason, all cementing work was done outdoors and proved to be unsatisfactory. When the dome was finished we put a vinyl skin over the whole thing and it seems to be doing all right.

It is significant that in this dome we obtained very reliable data on the structural performance of domes. (...) The dome was finished in 5 weeks, and as soon as the electricians put on the lights, we took some pictures, and it really looked exciting. The effect under the yellow lights was extraordinary.

"Architecture out of the Laboratory" (1955), 19

367 BBP on the roof of the Rotunda.



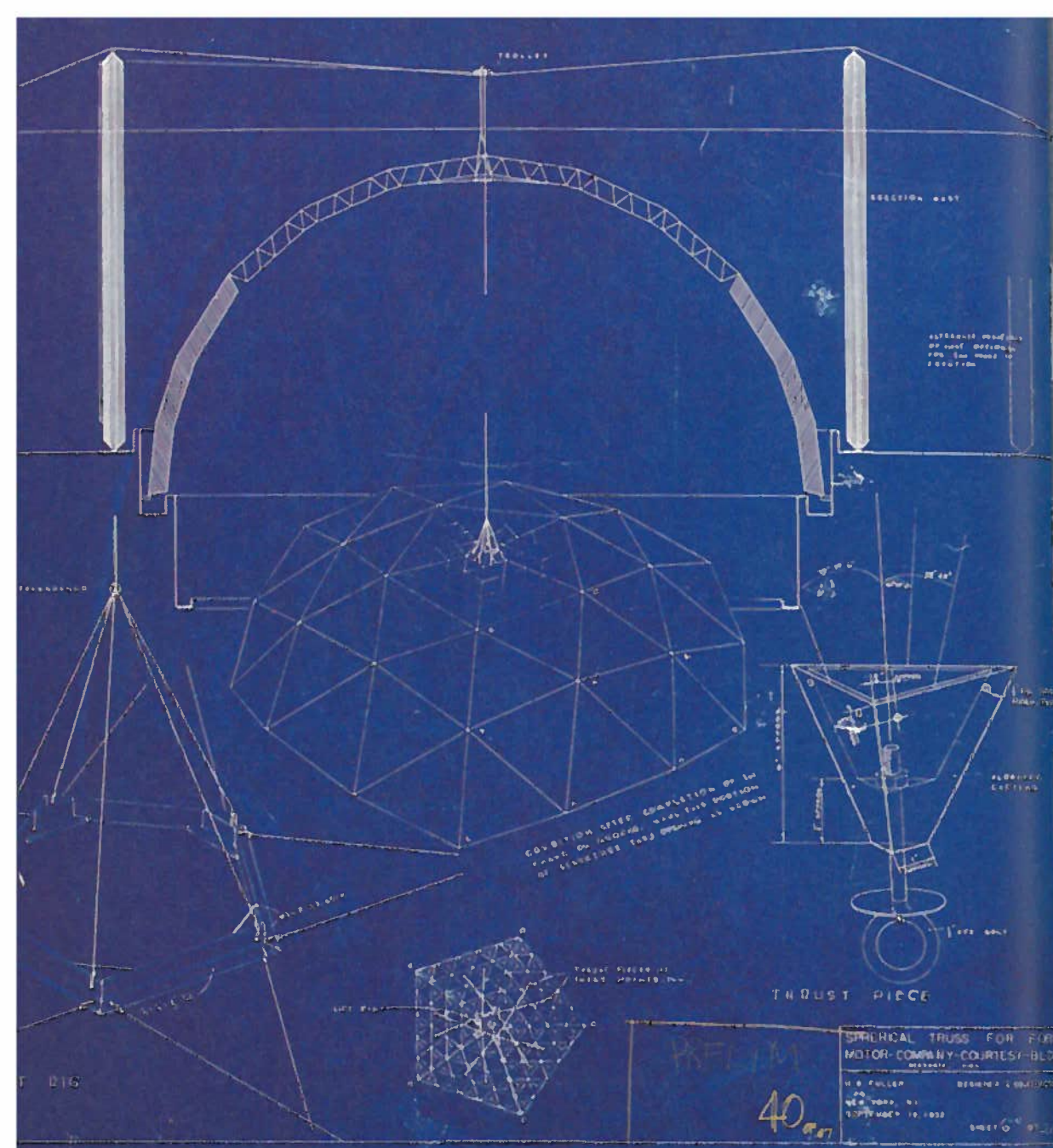
The Octet Truss

Even before the patent for the principle of the geodesic dome had taken effect, Fuller was commissioned to design a dome for a popular tourist attraction, the Ford Rotunda. This building, a light-construction steel building by the architect Albert Kahn had been a decorative, colorful night attraction at the Chicago World's Fair in 1933 ("A Century of Progress"). For the fiftieth anniversary of the Ford Motor Company, Fuller was to design a cover for a circular interior courtyard of 28 meters in diameter. They chose Buckminster Fuller because the alteration could result in significant additional stress on the building's support structure. So, at the age of fifty-eight, Fuller received his first important commission, for which there was little time available for development. "Bucky Fuller Finds a Client" was the title of a small piece in *Architectural Forum* about it. Because of the large span, Fuller opted for a construction of spatial supports in a triangular arrangement: the octet truss (octahedral-tetrahedral structure). That was his name for a spatial framing with sides of equal length comprised of tetrahedrons and octahedrons in alternation that define a volume with the height of the tetrahedron and a normal projection that forms a large triangle by means of the inclusion of additional tetrahedral cells. Fuller saw the octet truss as intimately related to the problem of the "closest packing" of spheres. The octet truss has two parallel main surfaces, but its structure is fully triangulated, and thus it abandons the usual patterns of Euclidian space. In the interest of minimizing the weight, Fuller and his colleagues selected aluminum as the material and shaped it into rods with a triangular cross-section. (Louis I. Kahn, who met regularly with Fuller at that time, used the octet truss in the Yale Art Gallery in New Haven, Connecticut, as a cast concrete construction method, that is, not in Fuller's linear pattern but with "interpenetrating" concrete bands.) This



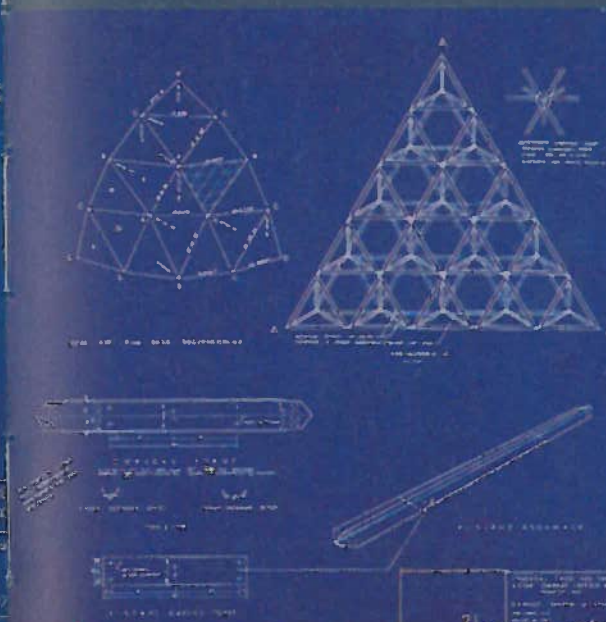
BBB: Octet Truss, Octet Grid, geometry of several models, August 1947

The elements of the Octet Grid, octahedral and tetrahedral volumes
BBF with the model of the Ford Dome, 1954



was the only time that Fuller applied the octet truss, with its horizontal construction that is somewhat reminiscent of the molecular structure of graphite. Even at that time, however, Fuller tended more to "spatial" structures, that is, structures that developed on all sides. In Dearborn, Michigan, the decision was probably driven by the intention to use a continuous skin of synthetic material, which was well suited to the flat facets of the octet truss. The dome was covered with a vinyl skin, because the polyester fiberglass that had originally been selected could not be produced to adequate standards.

In 1960, Fuller realized another dome for the Ford Motor Company, this time with a diameter of about thirty-five meters at the base and approximately one thousand square meters of floor space. It was thus almost twice the surface area, but it weighed only a quarter of the Dearborn dome, something that Fuller, ever the statistician, immediately emphasized, as it represented an improvement of a factor of eight in just a few years.

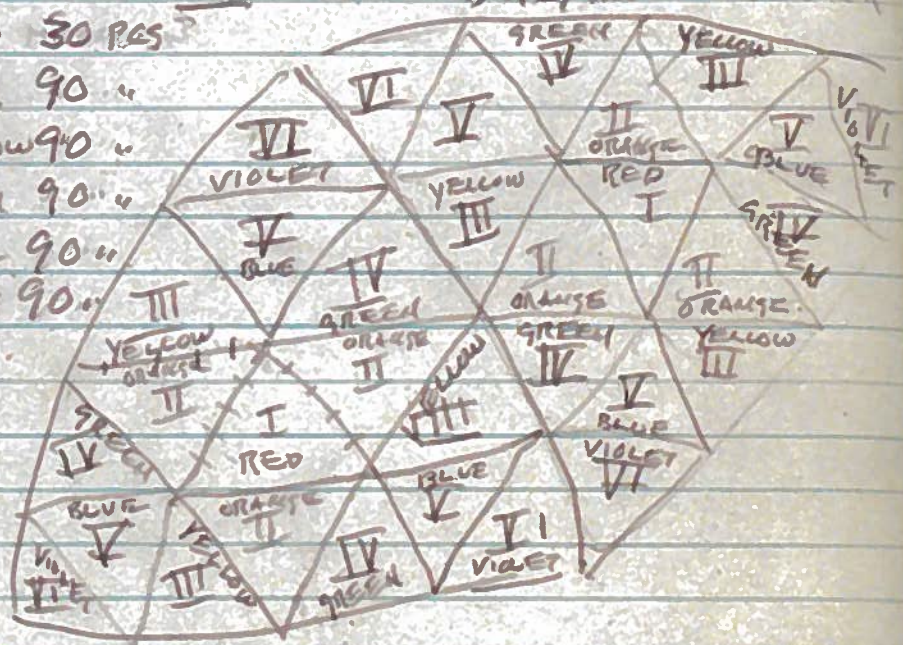


360 Photographs of the drafting office and the building site: complex mathematical calculations, high-precision production

361 Detailed illustration of an Octet Module, blueprint

TYPE 21 (SPECIAL 90° STRUT) (ALL IDENTICAL ENDS AND LENGTHS)
 WILL BE PAINTED SAME AT MIDBAND AND ENDS
 PACKAGES WITH 30 PCS IN RED PACKAGE = 480 PCS
 AND 90 " " OR, YL, GR, BL, VI, EACH

- #45 1/3 RED 30 PCS
- #46 1/4 ORNG. 90 "
- #47 1/5 YELLOW 90 "
- #48 1/6 GREEN 90 "
- #49 1/7 BLUE 90 "
- #50 1/8 VIOLET 90 "



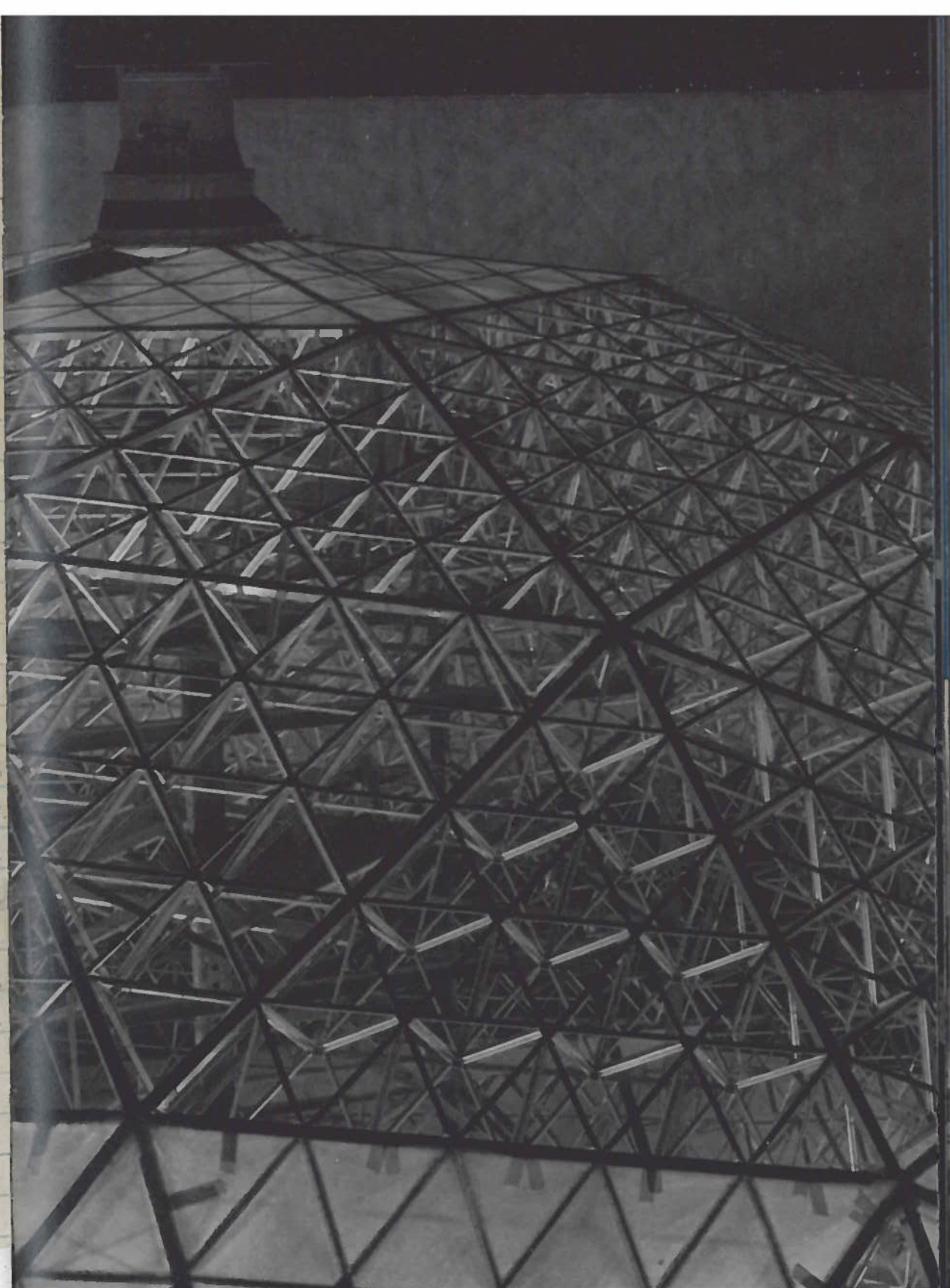
TYPE 29
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PACKAGE TYPE 29 CONNECTOR PACKAGE CASES

- #79 I-III RED TO ORANGE. $4 \times 3 \times 10 = 120 = 90$ PCS
- #80 II-III ORANGE TO YELLOW $(4 \times 3) \times 10 - (4 \times 10) = 75$ PCS
- #81 II-IV ORANGE TO GREEN $(4 \times 3) \times 10 - (4 \times 10) = 75$ PCS
- #83 III-IV YELLOW TO BLUE $(4 \times 3) \times 10 = 120 = 90$ PCS
- #84 IV-V GREEN TO BLUE $(4 \times 3) \times 10 = 120 = 90$ PCS
- #82 III-IV GREEN TO YELLOW $(2 \times 5) + (1 \times 4) \times 4 = 90$ PCS
- #85 V-VI BLUE TO VIOLET $(3 \times 4) \times 10 = 90$ PCS
- #86 VI-VI VIOLET TO VIOLET $(6 \times 5) \times 4 = 120 = 90$ PCS

↑
 WHITE

490 PCS



362 REF: Sheet of sketches and notes on the typology of Octupedents, undated (1963)
 365/366: Look from below at the Ford Dome

The Ford Dome after completion, on the 50th anniversary of the Ford Motor Company, 1953, with city lights of Detroit in the background

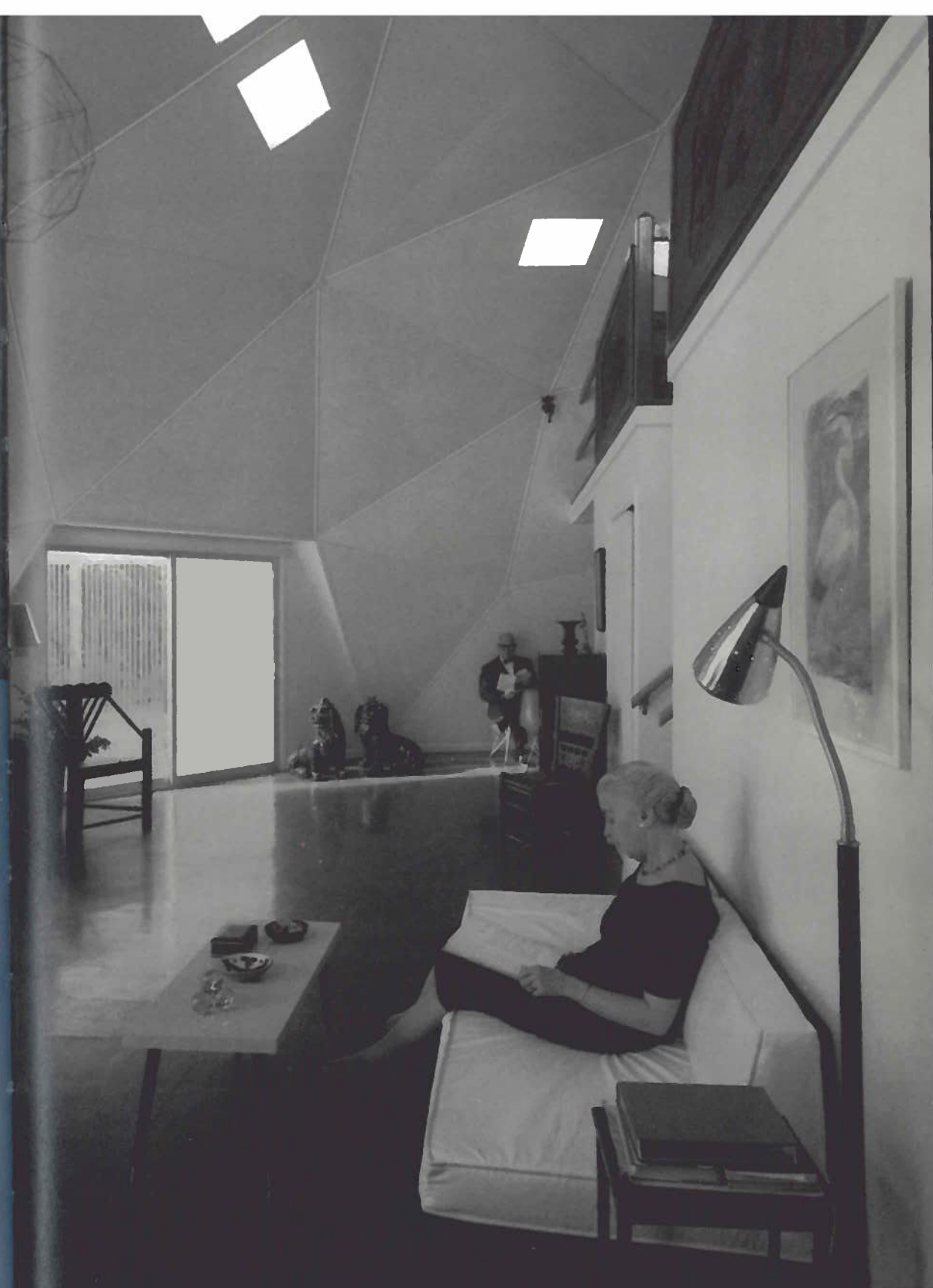


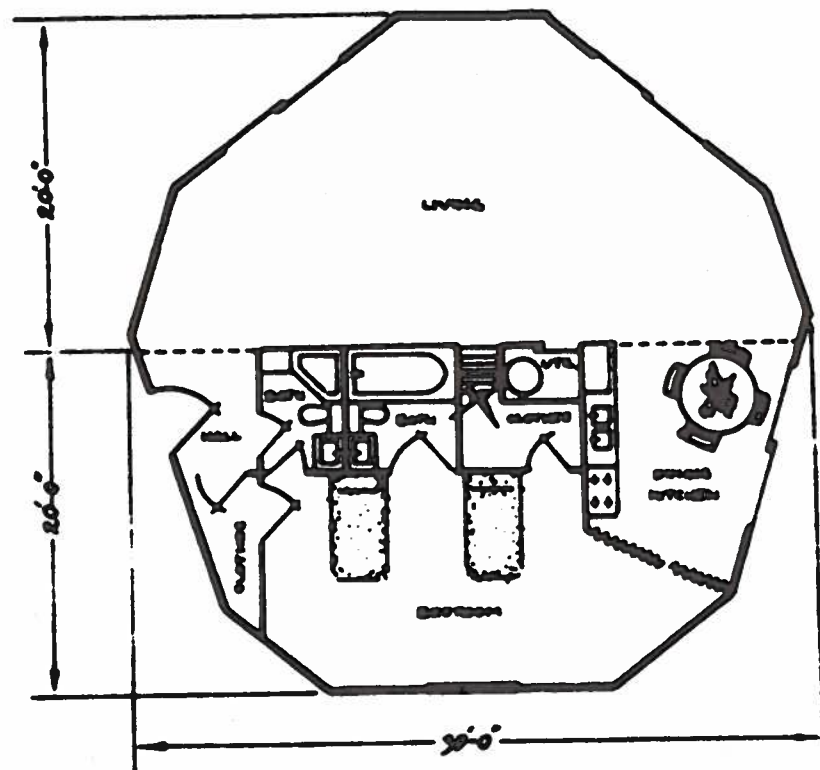


Fuller's Home Dome

"At the end of the day, Bucky and I drove the few blocks from his office to his geodesic dome house on South Forest Street for dinner with Anne. The house was a nice Microcosm of Fuller's universe: spherically coordinate, uncompromisingly simple in design, and at home in its environment. Its scale and weathered-wood framing were quite in harmony with the conventional houses with front porches and side yards that composed the rest of the elm-shaded neighborhood. As you enter the house the first impression is the absence of the familiar four-square cubical framework of rectangular floors and straight walls. The effect is total disorienting to our reflexive assumption that rooms should be shaped more or less like shoe boxes. The result is that Fuller as an architect has created an artifact – like all of his inventions from the Dymaxion Car to the vast dome at Montreal's Expo '67, an artifact intended to instruct. You cannot enter the house on South Forest without receiving a lesson on how we might organize our environment with spherical and hexagonal economics simply not available in a structure where all the rooms have to be cubes. The dome leads our eye in, out, and around – not up and down like the box. The interior walls of the house are a complex of prisms (...)"

E.J. Applewhite, *Cosmic Fishing* (1972), 13

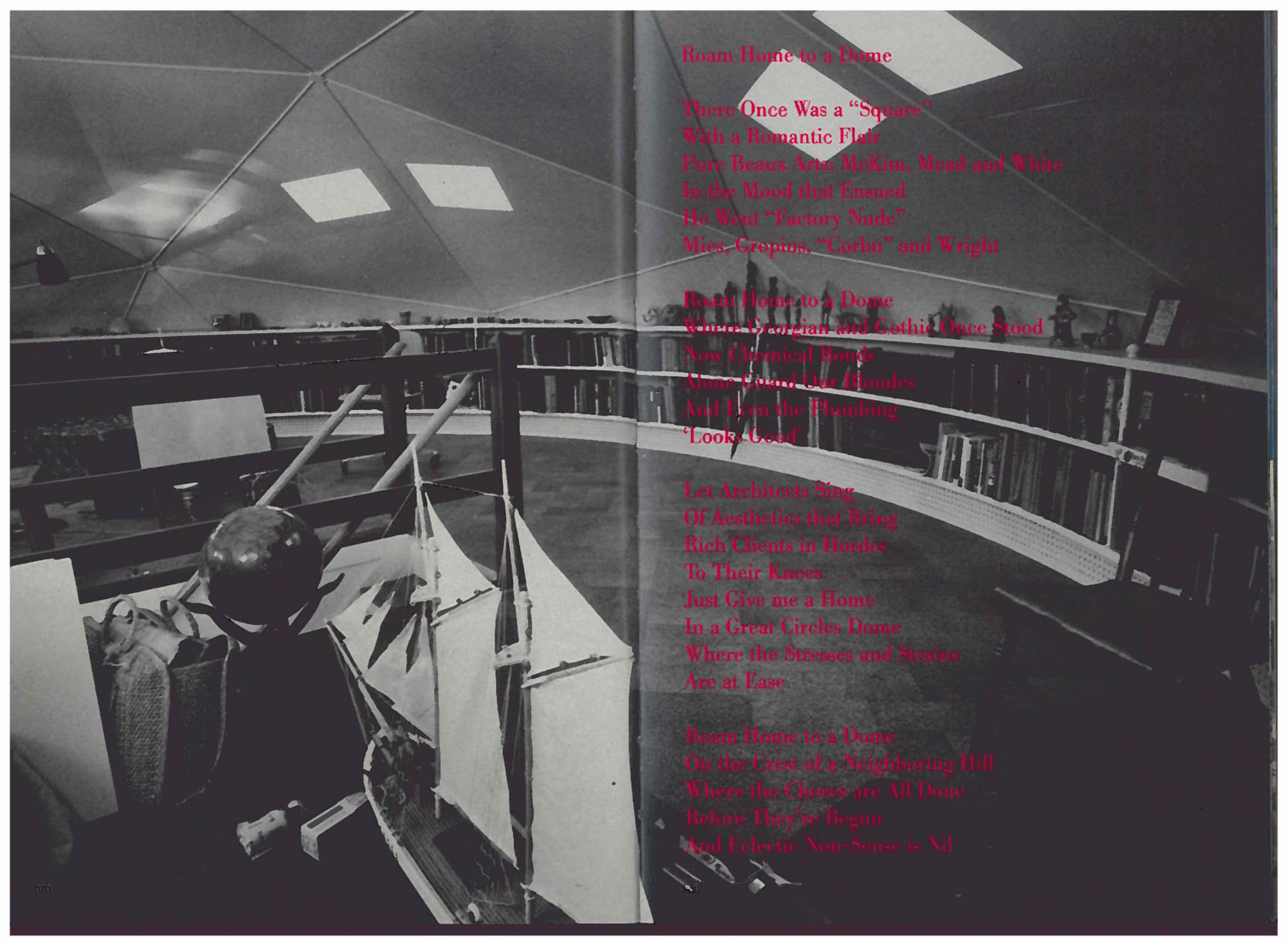




368 Home Dome, floor plan of the ground floor
(below) Exterior view

369 Home Dome, view of living room from gallery,
during student visit

370/371 Home Dome, library



Roam Home to a Dome

There Once Was a "Square"

With a Romantic Flair

Pure Beaux Arts; McKim, Mead and White

In the Mood that Ensued

He Went "Factory Nude"

Mies, Gropius, "Corbu" and Wright

Roam Home to a Dome

Where Georgian and Gothic Once Stood

Now Chemical Bonds

Alone Guard Our Blondes

And Even the Plumbing

'Looks Good'

Let Architects Sing

Of Aesthetics that Bring

Rich Clients in Hordes

To Their Knees

Just Give me a Home

In a Great Circles Dome

Where the Stresses and Strains

Are at Ease

Roam Home to a Dome

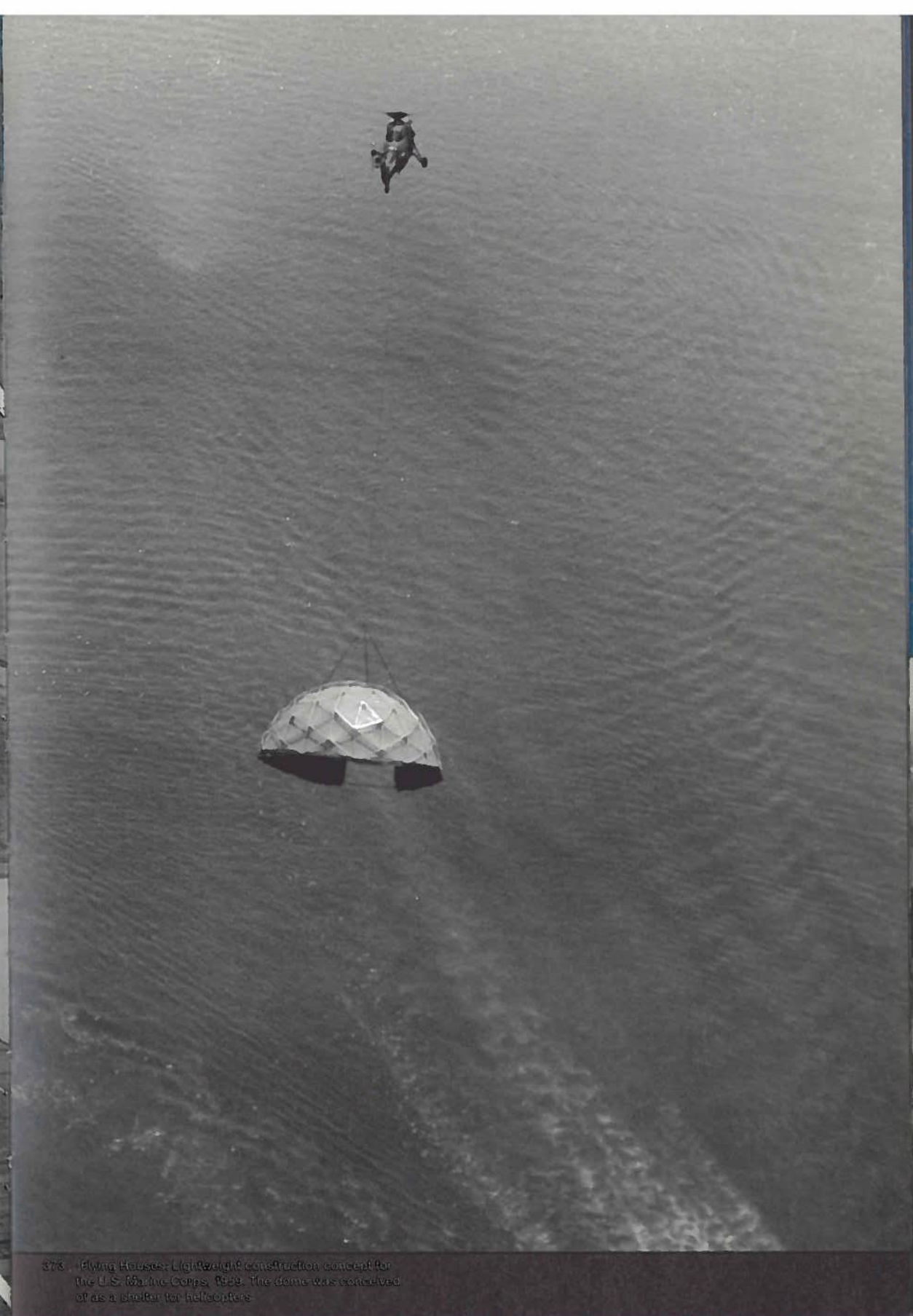
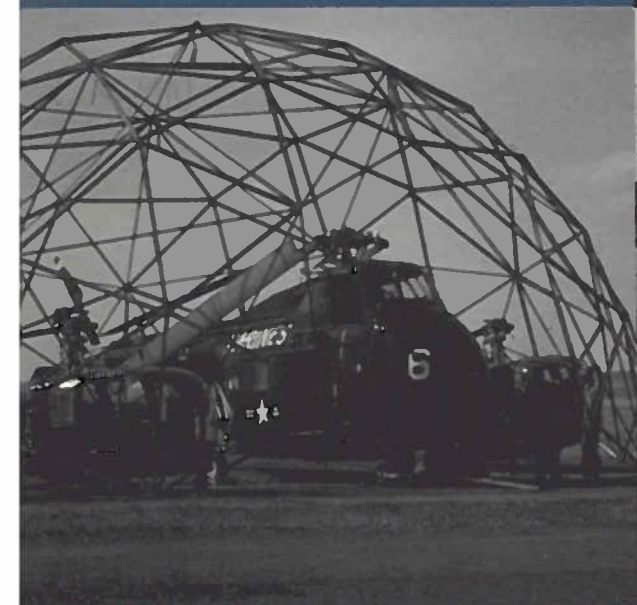
On the Crest of a Neighboring Hill

Where the Chores are All Done

Before They're Begun

And Eclectic Non-Sense is Nil

The theme of transporting light constructions by air continued to occupy Fuller's interest because of the logistical possibilities it represented. The only difference was that in the fifties helicopters replaced the airships that, a quarter of a century earlier, were supposed to transport his 4D House. The difference between the physical law of an airship—namely, climbing by the principle of "lighter than air"—and the mechanically generated lift of rotor blades seemed to Fuller to be a logical step in the technological development from a passive principle to an active one of "performance." In his eyes, it had always been weapons makers and later the defense industry that were most open and active with respect to new technological developments and that had caused them to accelerate. That, in view of this realization, Fuller did not turn away from the military and find another vehicle for his plans to reform the world, but instead looked to the Army—and, characteristically, the Navy, which was in his view the creative head on the military body—opened him up to criticism, even from his friends. His answer to this was to say that when the world had been shown its problem and the clearly designed model for its solution, it would immediately step in for the "livingry" and abandon the "killingry." These neologisms are typical for him, and they carry the punch of the apt slogan. This inventiveness with language was his way of showing the industrialized world how to turn swords into ploughshares.



376 Flying Houses: Lightweight construction concept for the U.S. Marine Corps, 1959. The dome was conceived of as a shelter for helicopters.

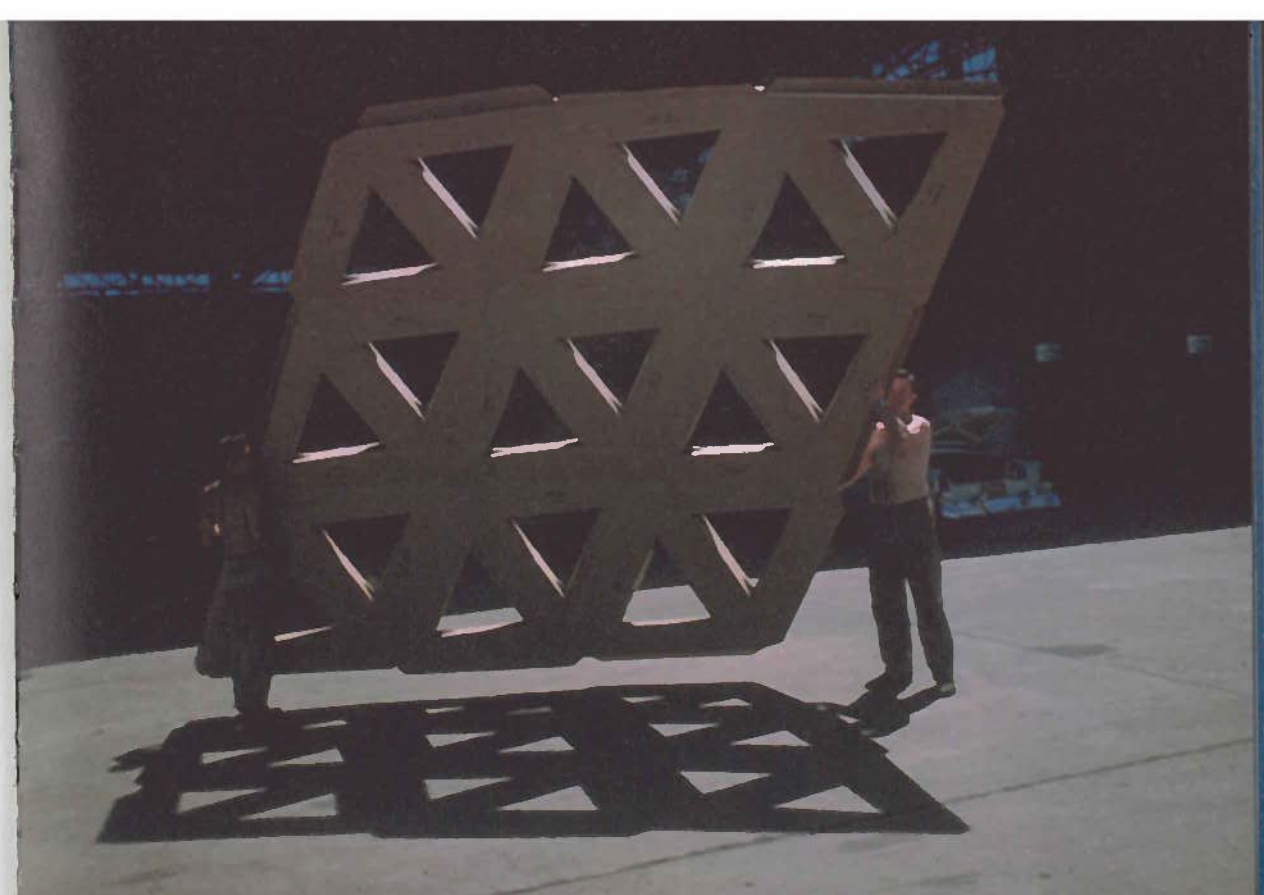
Paper Domes

Last spring we studied and produced a polyester paperboard dome which was assembled without a mast. It was so light that it could be lifted by one person. This dome was made out of flat pieces of corrugated cardboard cut in triangles, coated with polyester and stapled together. This process simplified erection considerably. A second dome was made for the Marine Corps, and although at the beginning they were rather astonished by it, they ended up liking it very much. One of them is now being used in Quantico as a children's playhouse.

On July 1, 1954, the Container Corporation of America told me that they were willing to manufacture two paper domes of my design which I had been invited to do for exhibition at the Triennale of Milan. I developed them so that they could fit into a small packing case. The case had six types of components which could be folded to form diamond boxes with a six inch interior dead space. The diamonds' edges turbinated around each other so that nine of them could make a bigger sized diamond. Triangles printed in the diamonds' faces could be cut open on three radial lines so that they made a triangular set of windows. The outer diamonds fold inwardly, and the inner ones fold outwardly making it possible to have windows wherever one needs them. In the Triennale domes every triangle window was open and translucent bathing cap skins fabricated at our Geodesic shops were very tightly stretched over them. These domes were erected without a mast, starting at their equators and then building them up. When the domes were lighted from the inside they gave a jewel-like effect.

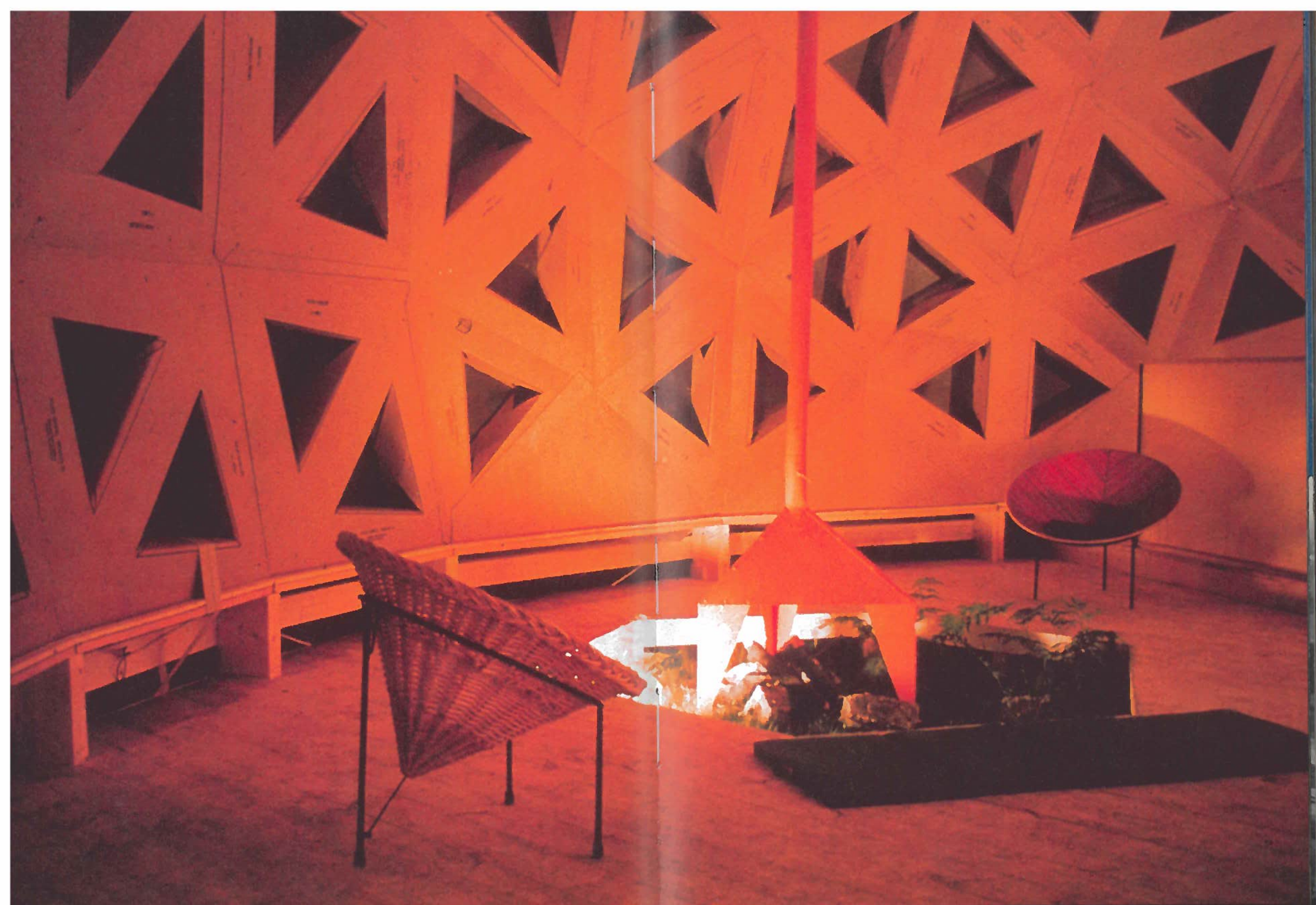
I am quite happy the two domes went out of the country and also that they were produced in relatively few days. The process of manufacturing them included moving from one place to the other, and calculating their exact dimensions on calculation machines. Later it may be possible to produce such domes at the rate of 3000 a day, and with the new developments it will be possible to have a strong, waterproof structure which would be very light and very cheap. The domes produced a critical effect in Italy. At the Triennale there were people from all over the world, including representatives from the Iron Curtain countries. They were aware of the mute message that excited them and caused them to realize that somehow that kind of low cost package which produced a high standard of living and environment control, and living was coming out of American initiative and industry. It also indicated to them a new departure in the overall attitude toward Architecture. The Italians gave it that new name which I mentioned at the beginning: "Architecture Out of the Laboratory".

"Architecture Out of the Laboratory" (1955), 30



378 Two workers carrying a section of the dome's shell across the runway prior to its transport for Europe.

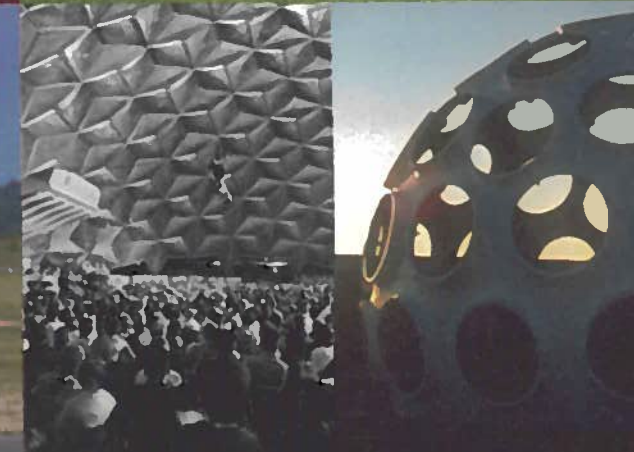
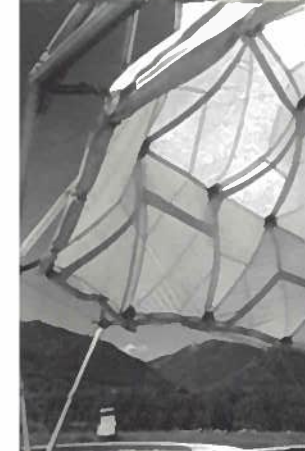
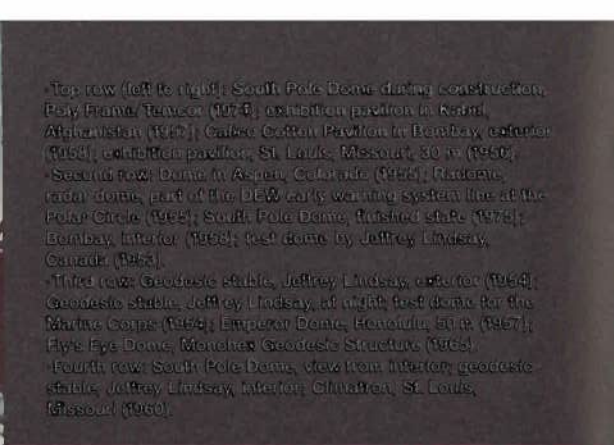
Triennale di Milano, 1954, one of the two large domes made of corrugated cardboard, approximate diameter 32 ft.

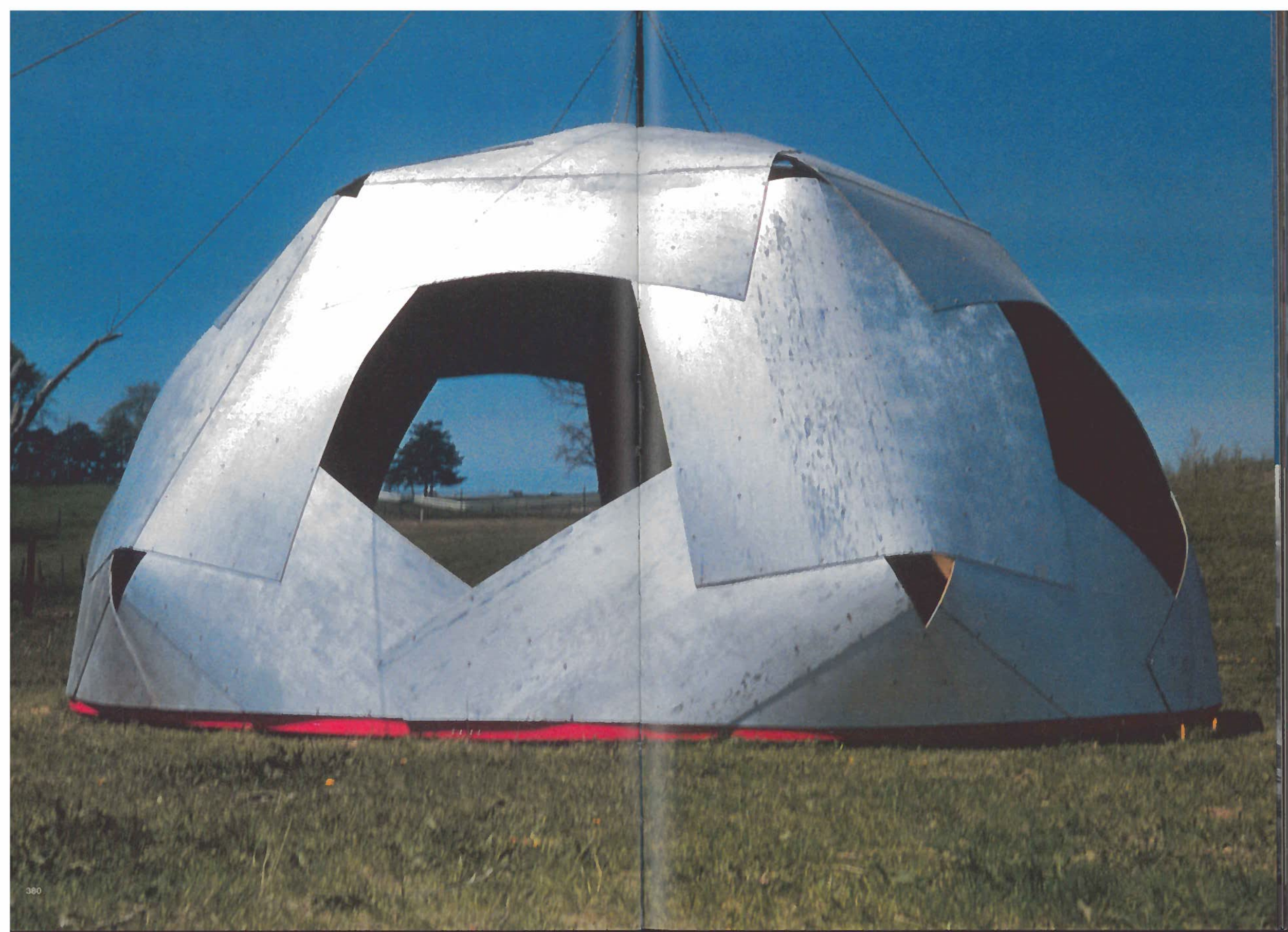


370 - Interior of one of the corrugated cardboard domes for Kikuta, 1984: "Architecture Out of the Laboratory"

377 - 380/381: *Syntaxe*, experimental construction out of molded plywood, around 1967. The resulting square, triangle and pentagon patterns are typical

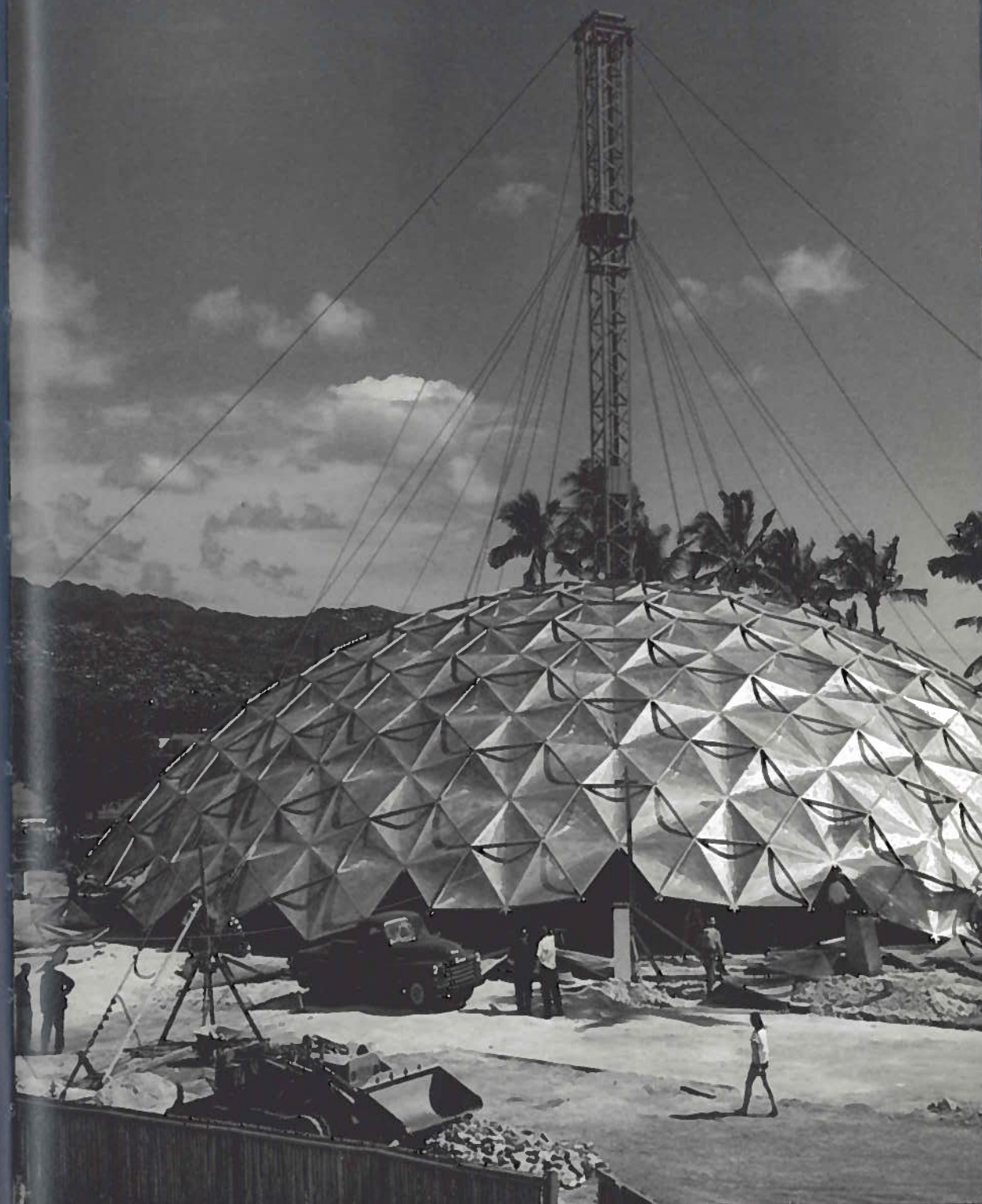
Top row (left to right): South Pole Dome during construction, Poly Frame, Tucson (1974), exhibition pavilion in Kabul, Afghanistan (1967), Calico Cotton Pavilion in Bombay, exterior (1964), exhibition pavilion, St. Louis, Missouri, 30 ft (1960).
 Second row: Dome in Aspen, Colorado (1976), Radianc, radon dome, part of the DEW early warning system line at the Polar Circle (1964), South Pole Dome, finished state (1976), Bombay, interior (1968), test dome by Jeffrey Lindsay, Canada (1975).
 Third row: Geodesic stable, Jeffrey Lindsay, exterior (1964), Geodesic stable, Jeffrey Lindsay, at night, test dome for the Marine Corps (1964), Emperor Dome, Honolulu, HI & (1967), Fly's Eye Dome, Monahan Geodesic Structure (1968).
 Fourth row: South Pole Dome, view from interior, geodesic stable, Jeffrey Lindsay, interior, Chiverton, St. Louis, Missouri (1960).





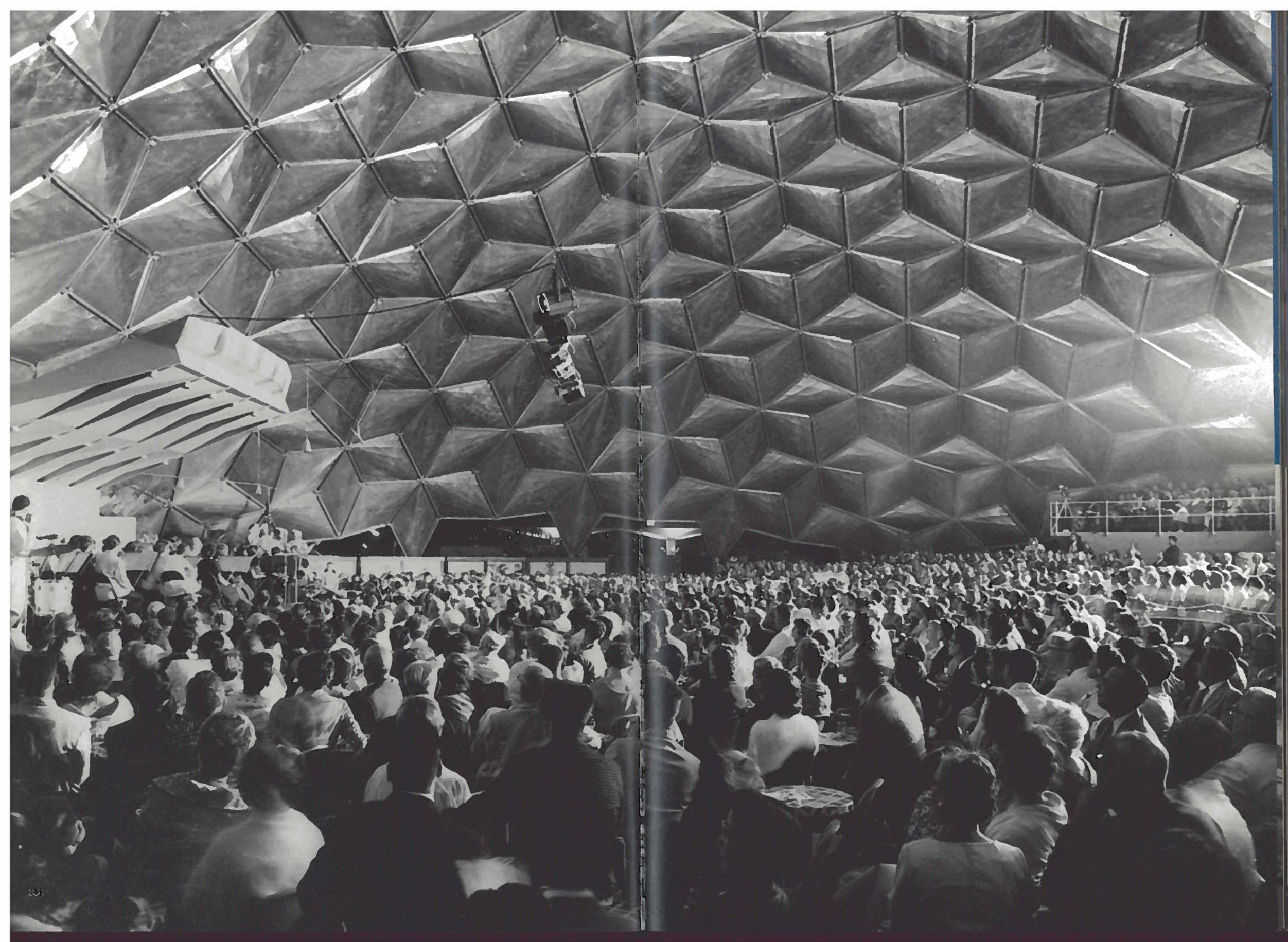
Just-in-Time – Architecture

The industrial magnate Henry J. Kaiser – among other things a producer of aluminum – was one of the many licensees of the geodesic dome structure. In order to demonstrate the superiority of the new principle of construction, he thought up a presentation to generate publicity. In Honolulu, Hawaii, a building was to be constructed in a single day. Together with his former student and longtime collaborator Donald L. Richter, Fuller designed a dome just under fifty meters across, the collapsible structure was made of aluminum sheets that were braced by rods on the outside. The individual parts were premanufactured in California and shipped across the Pacific to Hawaii. The assembly proceeded seamlessly; the folding elements were first combined into rings on the ground. These rings were then successively raised on the assembly mast and formed into a dome; the dome was built from the peak down to the ground. In contrast to the thousand-year-old tradition of building in stages from bottom to top, this is probably the most striking articulation of Fuller's conviction that the tensile principle is vastly superior to the principle of pressure. The hoped-for success of this demonstration was modest. After twenty-two hours of construction, the structure was opened with a symphony concert, as a demonstration that they had an ear for a good drum roll in both the literal and figurative senses. Fuller would long continue to praise the excellent acoustics of this space, and its many facets do certainly create an unusually "dry" sound. This project led to the creation of the Temcor Company (Carson, Calif.) whose director, Don Richter, would help Fuller realize many important large-scale domes.



368 Kaiser Dome, Honolulu: 50m-diameter dome, faceted surface; support structure, designed for industrial magnate Henry J. Kaiser, erected in a single workday, photo taken at midday

369 369: Grand opening of the Honolulu Dome with evening symphony concert, February 1957, the same day the structure had been completed within 24 hours after the components had arrived



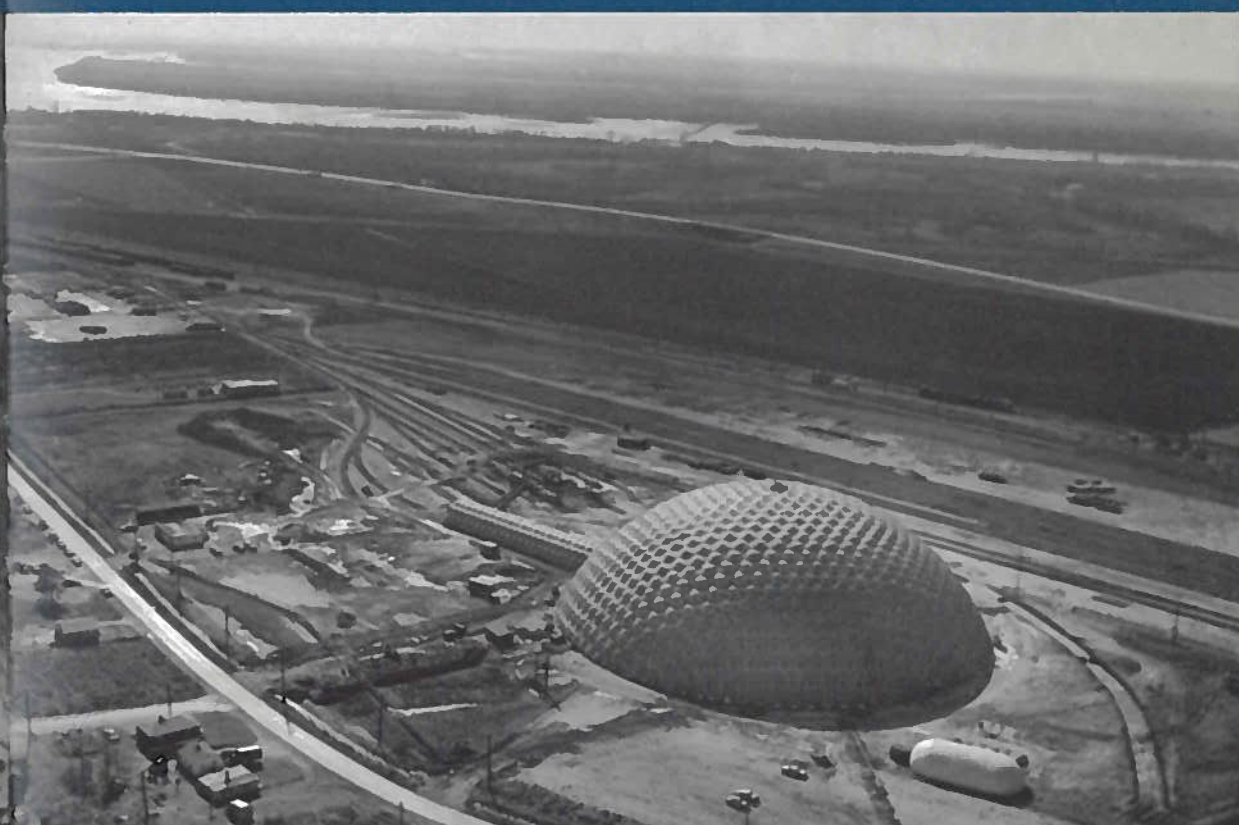
The Union Tank Car Company was one of the licensees of Fuller's patent. It needed a large space for the overhaul of its container cars. In 1958, the geodesic supporting structure became the largest unsupported covered surface, with a diameter at the base of almost one hundred thirty meters. In contrast to the dome in Honolulu, the one here was an external tractive vault from a supporting structure of tubes arranged in hexagons from which were anchored sheets of metal that were folded inward. Fuller mentioned the remarkable diameter of the supporting tubes, just twenty centimeters, which are not visible in the aerial photographs. The aerial photographs reveal a bold, rounded form of abundant plasticity in terms of the effects of light and shadow. Fuller was conscious of the morphological proximity to sea creatures like radiolarians. A second, identical dome was built shortly afterward by the Union Tank Car Company in Woodriver, Illinois. Fuller used the dome structure from Baton Rouge in a context that was highly significant. He spoke of a visit he had long been planning to the Andalusian city of Seville, which he finally made in 1962. He had long been aware of the history of the construction of the cathedral, the second largest after St. Peter's: a struggle with the material world that lasted through five generations. Fuller learned that the cathedral of Seville would easily fit within the Union Tank dome of Baton Rouge, even its height. Yet the dome weighed only as much as four of the more than one hundred stone columns that make up the structure in Seville. Fuller tirelessly emphasized such facts, thoughtfully contrasted the one to the other, the past to the present, the old to the new. He himself placed the argument heavily on the technological and on the efficiency of the structure. The interior of the Baton Rouge dome is, in technical terms, a suspended calotte, but it suggests more than that. It suggests the vault of the sky, and it documents one way in which "limitlessness"

can be put to form. This idea is also reminiscent of Schinkel's stage design for Mozart's *The Magic Flute*. It is not important here whether Fuller was familiar with the design – probably he was not. What is important is the expression implicit in a building that is so technical. The collection of these raw container cars smelling of grease beneath this overarching screen is more than a chance arrangement. It is astounding as a sign of a kind of thinking that is always discussing how to transcend technology into a new world.



330 - Dome for the Union Tank Car Company, Baton Rouge; aerial photograph after the beginning of construction (Fall 1958) and photograph of the finished dome (October 1958)

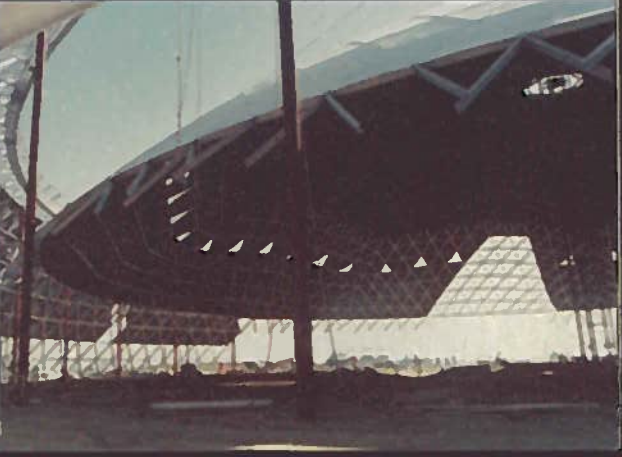
333/334: Interior of the Baton Rouge dome, diameter 130 m, height at peak 41 m; in center, the service equipment for overhauling of its container cars



337 - 340/351: Spruce Goose Hangar, dome for Howard Hughes' plywood airplane Spruce Goose, Long Beach, 1936. Built by Donald L. Rickfus for the Tanager, The Queen Mary

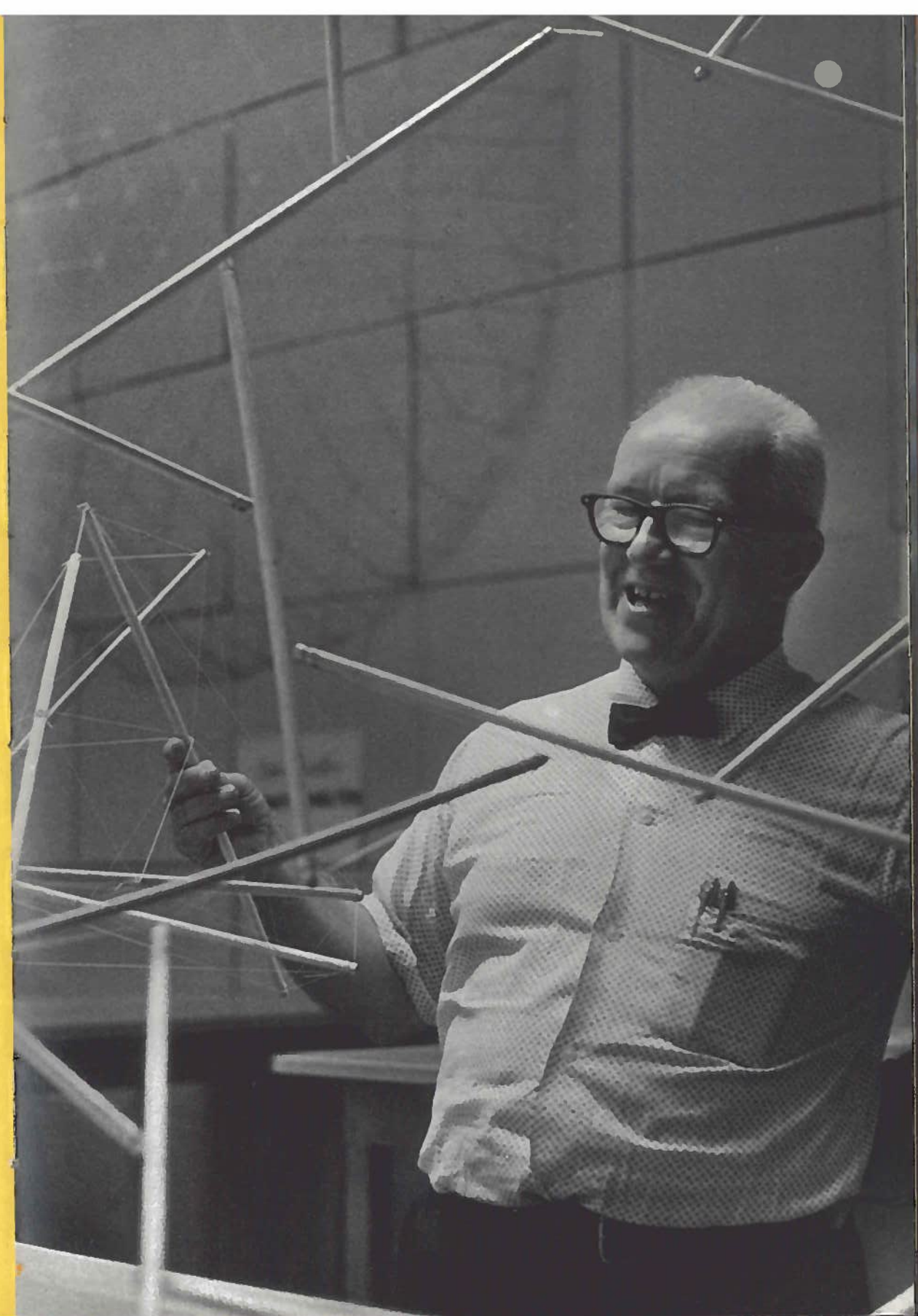
seen in center next to the dome. (below) Three phases of the construction and interior view of the completed dome.





Tensegrity is a concept whose terminology and theory derive from Fuller, but in whose formulation and constructive elaboration many others took part, especially Fuller's students. Tensegrity is an anticlassical approach to structure and construction, and it implies a reversal in perception: what appears to be compactly standing and solid proves to be suspended and ephemeral. Fuller was the first to notice this reversal with respect to the wire wheel, and he recognized it as a revolution in construction. However, for him, tensegrity is also a philosophical model of coherence. By what is something held together, then, if not the compact mass? By increasingly thin tensile members that border on the spiritual.

TENSEGRITY



Wire Wheel

In the high- and low- tide cooperative precessional functionings of tension versus compression I saw that there are times when each is at half tide, or equally prominent in their system relationships. I saw that the exterior of the equatorial compressional island rim atoll of the wire wheel must be cross-sectionally in tension as also must be its hub-island's girth. I also saw that all these tension-vs.-compression patterning relationships are completely reversible and are entirely reversed as when we considered the compressively spoked "artillery wheel" vs. "The tensionally spoked wire wheel." I followed through with the consideration of these (...) functions of structural systems as possibly disclosing the minimum or fundamental set of differentiability of non-redundant, precessionally regenerative structural systems.

As I considered the 12 unique vectors of freedom constantly and non-redundantly operative between the two poles of the wire wheel – its islanded hub and its islanded equatorial rim-atoll, in effect a Milky-Way-like ring of a myriad of star islands encircling the hub in a plane perpendicular to the hub axis – I discerned that this most economic arrangement of forces might also be that minimum possible system of nature capable of displaying a stable constellar compressional discontinuity and tensional continuity. A one-island system of compression would be an inherently continuous compression system, with tension playing only a redundant and secondary part. Therefore, a one-island system may be considered only as an optically illusory "unitary" system, for, of course, at the invisible level of atomic structuring, the coherence of the myriad atomic archipelagos of the "single" pebble's compression-island's mass is sum-totally and only provided by comprehensively continuous tension.

This fact was invisible to, and unthought of by, historical man up to yesterday. Before this mid-twentieth century fact discovery, there was naught to disturb, challenge, or dissolve his "solid-rock," and other "solid things" thinking. "Solid thinking" is even dominant (...) over the everyday logic of many otherwise elegantly self-disciplined nuclear physicists.

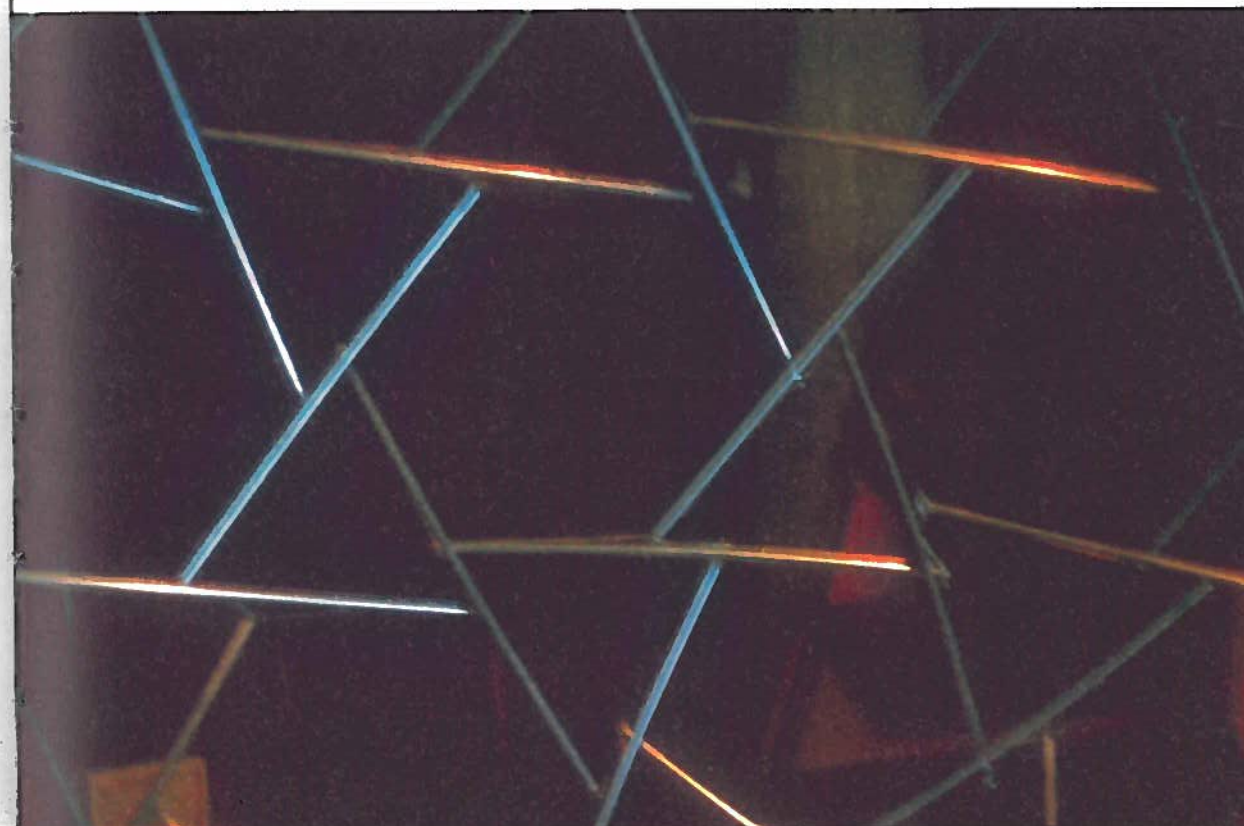
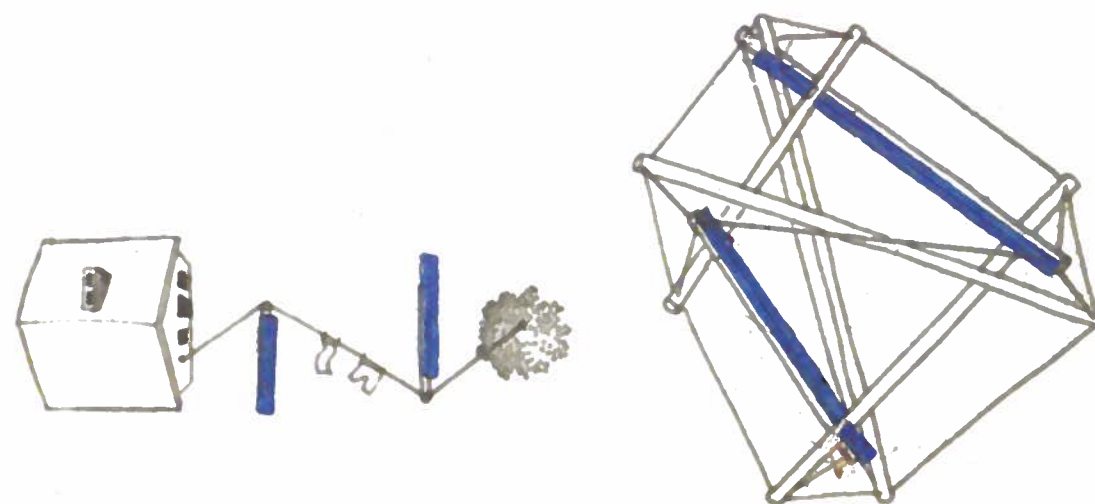
As I wondered whether it was now possible for man to inaugurate an era of thinking and conscious designing in terms of comprehensive tension and discontinuous compression, I saw that his structural conceptioning of the wire wheel documented his intellectual designing breakthrough into such thinking and structuring. The compressional hub of the wire wheel clearly islanded or isolated from the compressional "atoll" comprising the rim of the wheel. As these compressional islands were only interpositioned in structural stability by the tensional spokes, I said that this was clearly a tensional integrity where tension was primary and comprehensive and compression secondary and local. This reversed the historical structural strategy of man.

Synergetics (1975), 353



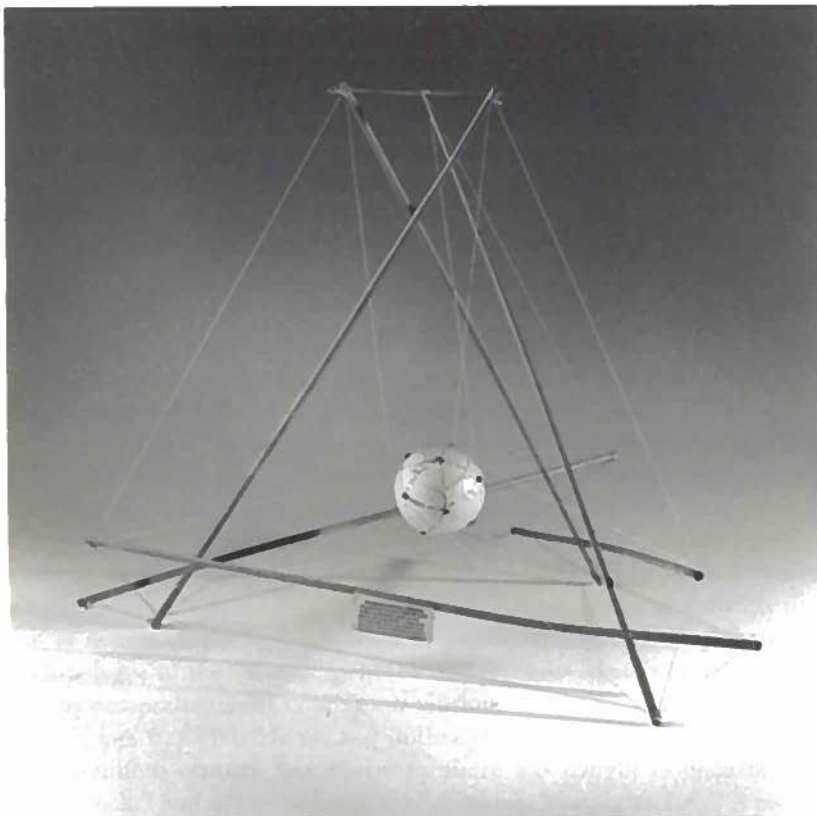
386 - 383: RBF with Tensegrity models, Southern Illinois University, 1988

-Wire-spoke wheel with tangentially braced spokes, identified by RBF as first tensegrity structure.



386 - Placing electrified under tension using two poles, the line tends to move away from the end of the pole. In spherical tensegrity, the rods pull the line to form

an angle of the rods to the line. No rod touches another. Digital from a geodesic Tensegrity Sphere.

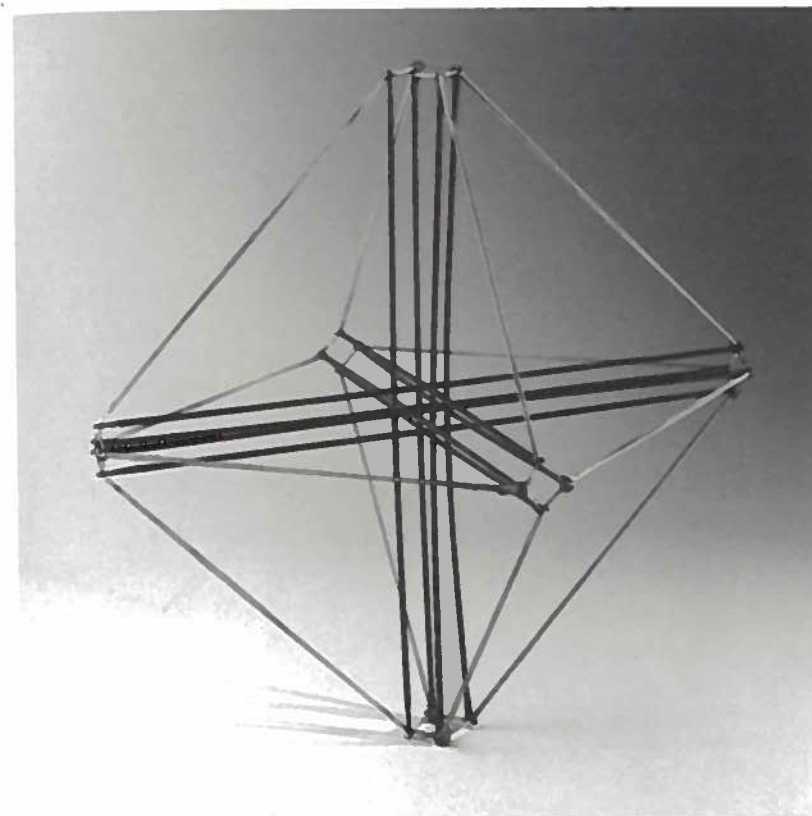


Tensegrity

I do have patents covering geodesic structures in America and in many other countries, including England. One cannot patent geometry per se nor any separate differentiated out, pure principle of nature's operative processes. One can patent, however, the surprise complex behaviors of associated principles, where the behavior of the whole is unpredicted by the behavior of the parts, i.e., synergetic phenomena. The latter is what is known as an invention, a complex arrangement, not found in nature, though sometimes superficially similar to nature. Though superficially similar in patternings to Radiolaria and Fly's Eyes, taken out of water. Fly's Eyes will not provide structural precedent or man-occupiable structures.

The processes of engineering, up to the moment of introduction of my invention of geodesic structures, are predicated upon the stress analysis of individual beam and column behaviors, as separate components and thereafter upon comprehensively organized beams, columns, and cantilevers as a solid compressional overall integrity of cohesion, aided here and there by tensionally exaggerated sinews – tension being subordinate and local. Therefore, engineering as academically constituted in 1951 could in no way predict the associated behaviors of geodesics, in which any one, several or many of the components could be removed without, in any way, jeopardizing the structural integrity cohesion of the remaining primary structure.

I have visited approximately all the leading universities and engineering schools in the U.S.A. (only as their spontaneously invited guest, as I allow no promotion or agency solicitation of engagements) and I have been a guest of major architectural and engineering societies around the world. I am able to state from the direct testimony of its leaders, that world engineering not only was surprised by the geodesic behavior but clearly stated that it was unable to explain or predict



the unprecedented performance per pound efficacy of the geodesic structures by any of the academically known mathematical principles of analysis. Engineers professionally charged with the responsibility of validating my (or my companies') geodesic dome undertakings have only on recourse, in lieu of an extant and proven theory of geodesics and their stress analysis strategies, and that is to direct static load testing accompanied by progressive electric strain gauge readings with loading carried through to "failure." Thereafter formulas are derived, which do not provide any general theory but only special knowledge concerning this particular case.

For these reasons I have had to develop a completely new strategy of educational exposition of synergetic behaviors. It is because I have developed the geodesic theory and not only the invention but this effective strategy of exposition, that I am, and have been, invited to conduct original seminars in the primary educational institutions around the world, as well as before the important annual professional conventions of primary engineering-architectural bodies of these countries.

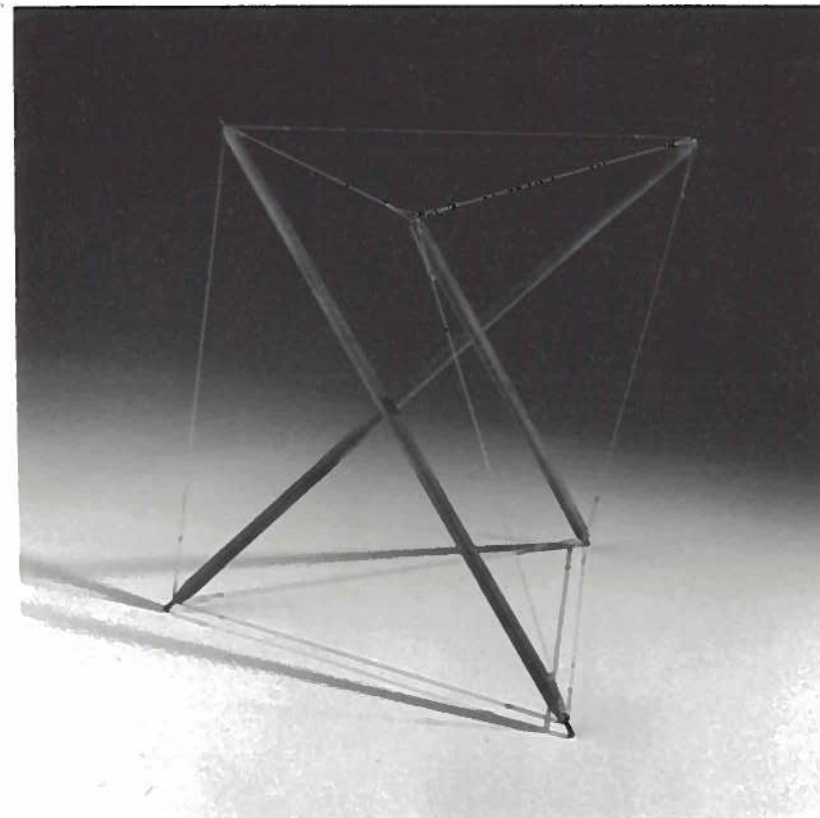
Whereas, engineers told me before my full-scale demonstrations of geodesic structures, that geodesics would not work, now after one-third of a century of such expositional engagements, discourse and demonstrations, and their consequently mounting journalistically worldwide reportage, it should become increasingly logical that there should now be such an effect upon the general climate of technology that a spontaneous association of the plurality of factors entering into geodesic componentation should be employed by individuals with the now well established foregone conclusion that satisfactory structural stability will thereby result – without the individuals even having to know why. It would result simply because of a new subconsciously established conviction generated by hundreds of experiences of news photographs of successfully standing structures, ranging from desk models to the largest clear span enclosures of all history, many of them flown into installation sites at the world's formidable polar, mountain and desert regions.



All these have been news simply because these results were synergetic surprises and therefore not obvious. The ability to copy patterns or to make new ventures in higher frequency or more asymmetrical employment of the geodesic structural integrity than has yet been undertaken, is neither invention nor warrant of exemption from the temporary economic, political authority granted to individuals as patents around the world. Patents are the result of all the progressive evidence of history that the majority's commonwealth is benefited by the few in increasing degree in direct proportion to the degree of incorporation of social means of establishing the regenerative initiative of the legally demonstrable inventors. Patenting, though not interoperative, between the countries on either side of the world's Iron Curtain, has survived and is being extended on both sides of the Iron Curtain, with separately total integratability in respect to their two prime domains.

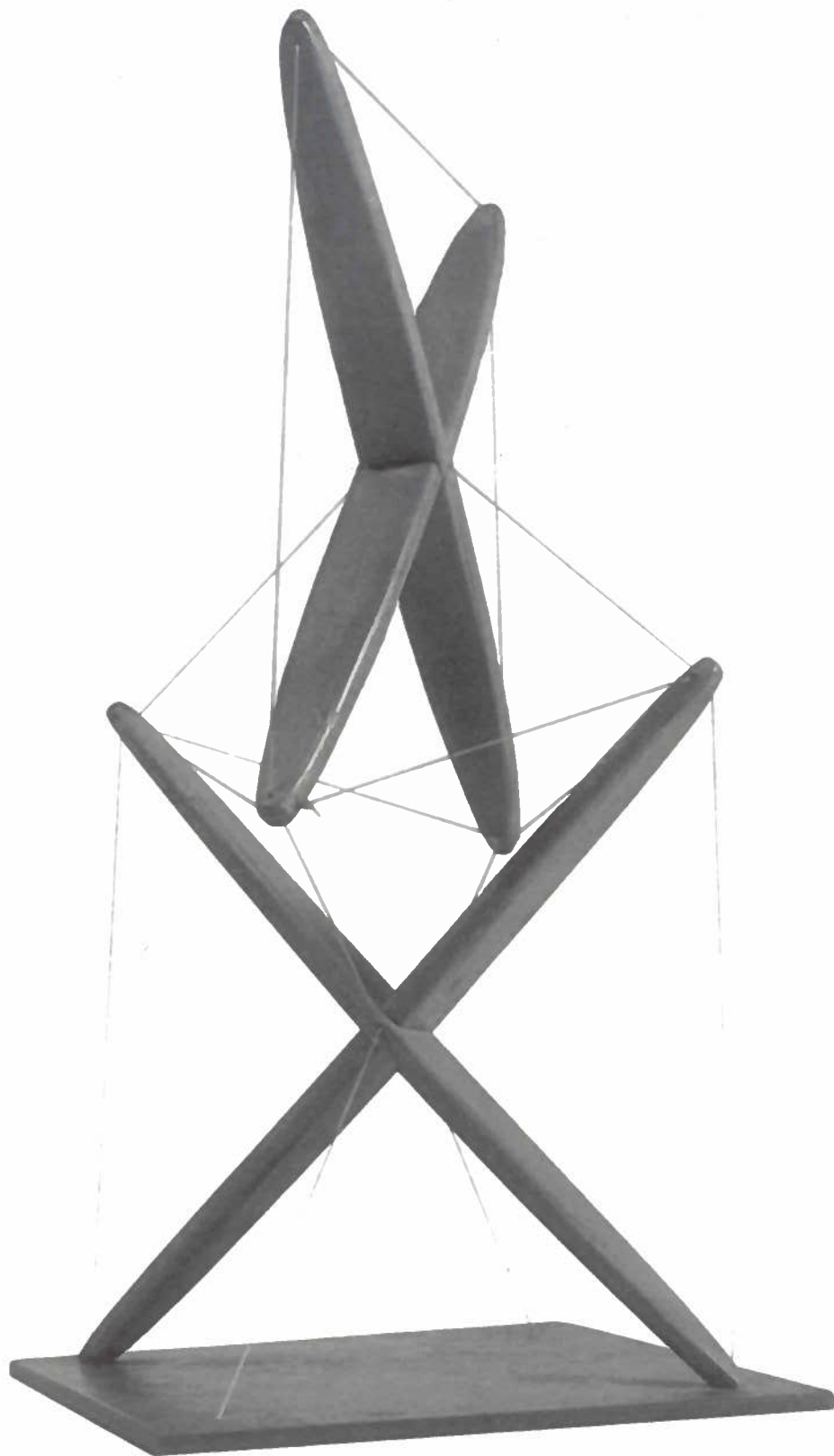
The reports you have received are correct regarding the structures which I have designed for firing to the moon. Your 600 lb. is top for what will be our openable structure of 36' diameter. It may be as low as 300 lbs. There can be larger units. Of primary interest to engineering is the fact that my potential prototypes of satellite and moon structures (on which some patents have been granted and for which others have been applied) are tensional integrity, omnitriangulated, high-tensile-cabled, spherical nets in which local islands of compression act only as local sprit stiffeners. The stiffeners are so oriented that they angle inwardly and outwardly between comprehensively finite, exterior and interior, tensional, spherical nets, thus producing positive and negative waves of action and reaction in inter-stabilized dynamic equilibrium.

Recourse to this discontinuous-compression, continuous-tensioning structure was not obvious to man, therefore the following needs to be observed.



Whereas compression members have an inherent limit ratio of section diameter to length, tension members have no inherent ratio of section diameter to length. The Greeks, who built entirely in compression, discovered that a stone column's slenderness ratio was approximately 18 to 1 of length to diameter. Modern structural steel columns with an integral tensional fibering unpossessed by these stone columns have a limit slenderness ratio of approximately 33 to 1. If we have better metallurgical alloys we can make longer and longer tension members with less and less section - apparently ad infinitum, but not longer compression columns, ad infinitum.

"Tensegrity" (mimeographed typescript, 1958), 1ff. (→ YPS: *Discourse*)

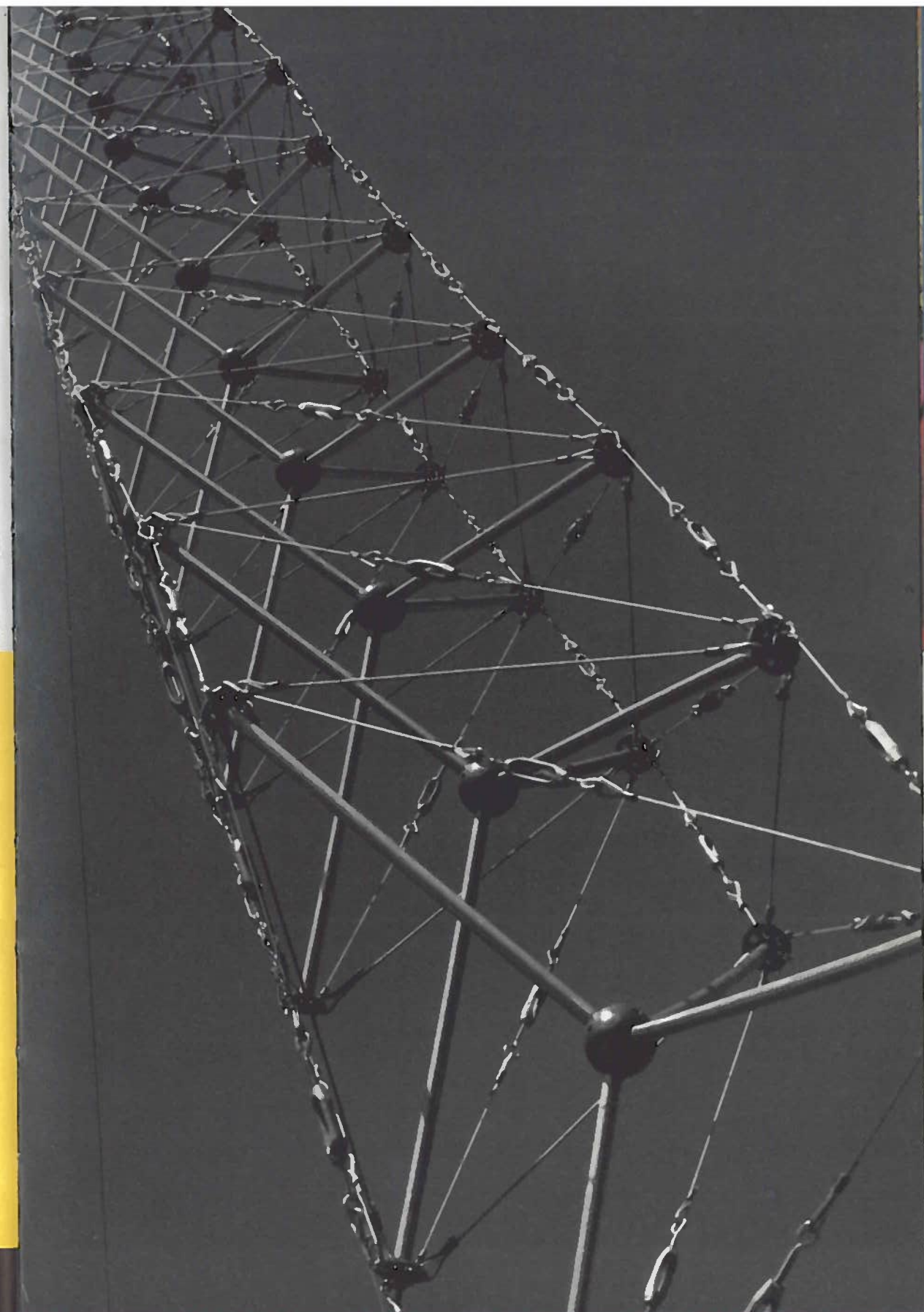
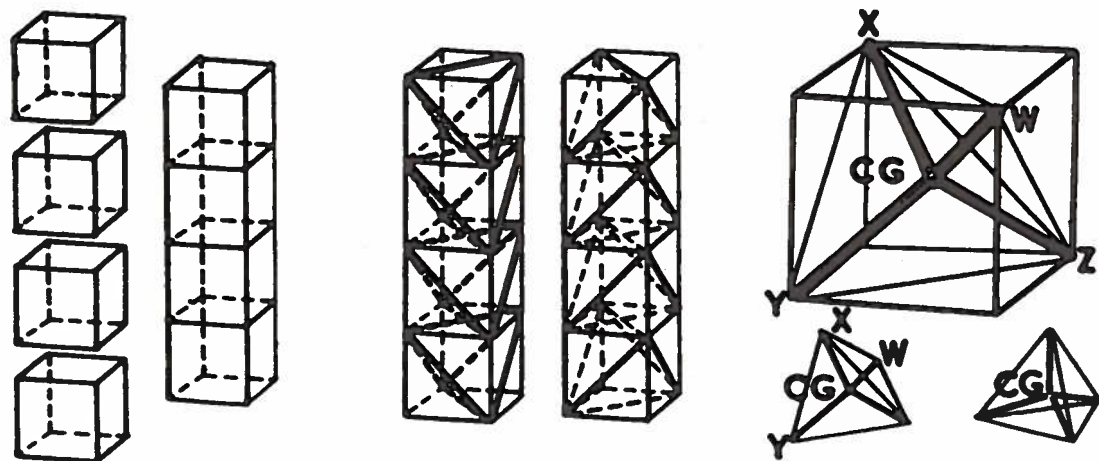


Experimental Breakthrough: Tensegrity

Fuller recognized the contribution that Kenneth Snelson made, while still a very young student, to the discovery of the tensegrity principle. In Fuller's view, the Dymaxion House was a preliminary step to this principle of tension-integrity, where continuous tensile stress and discontinuous tractive tension interact with a maximum of distribution of labor. Still, the difference between the mast principle of the Dymaxion House and a tensegrity mast is that the former is hierarchical and the latter is not. The anchor mast goes up, and the tension cable goes down from its tip; thus, it is related to a fountain as Fuller himself emphasized in 1928. In a fountain, there is a moment of transition between the deceleration during the ascent and the acceleration of the descent. Fuller called this principle polarized. In the tensegrity principle this hierarchy becomes fragmented; the principle is multipolar. Either the sphere is rounded in the equilibrium of the whole that results from many local forces, or the tensegrity mast ascends from below into a height (or into a distance), push and pull working into a growing dimension by means of antagonistic equilibrium and in regular phases. The image of a rope team of climbers, which Fuller later used for the World Game, is already suggested here – in the truest sense of the word.

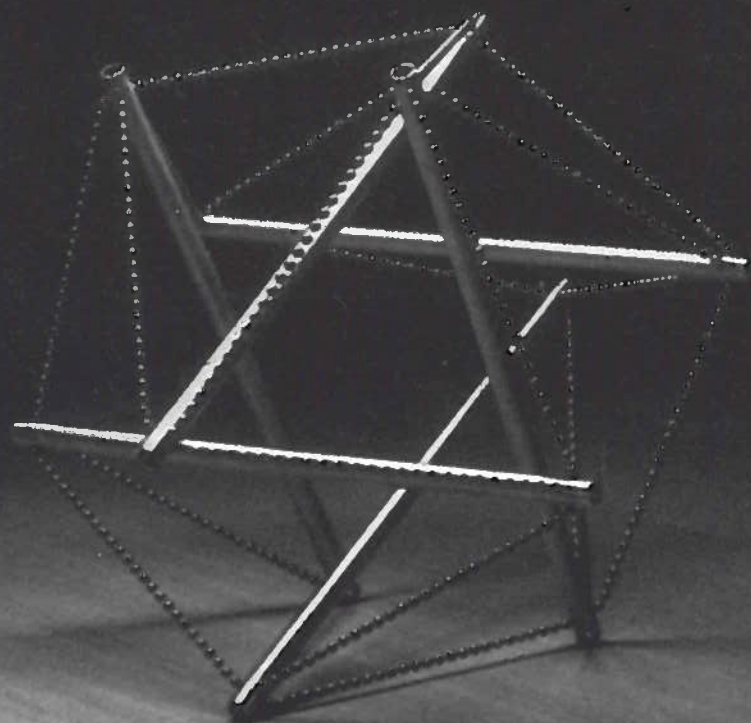
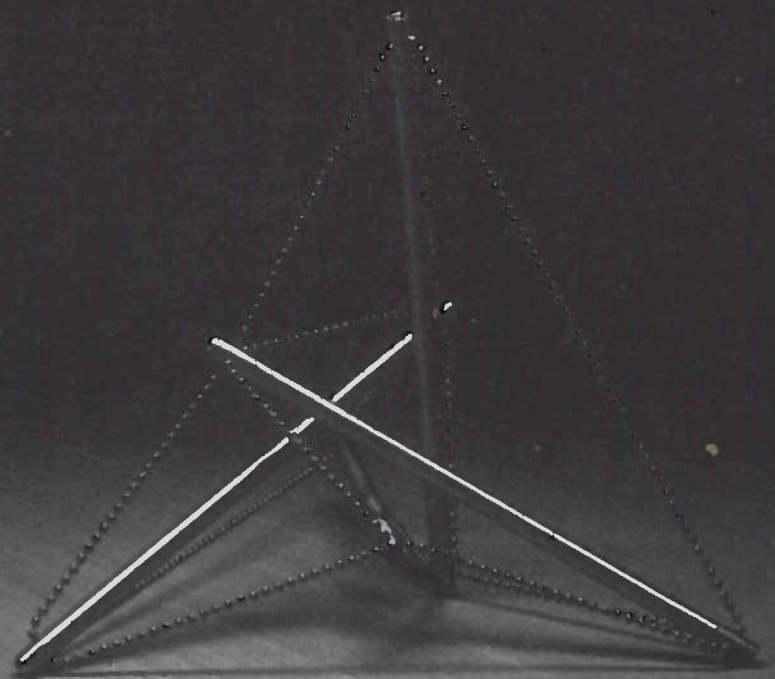


“Don’t fight forces,
use them.”



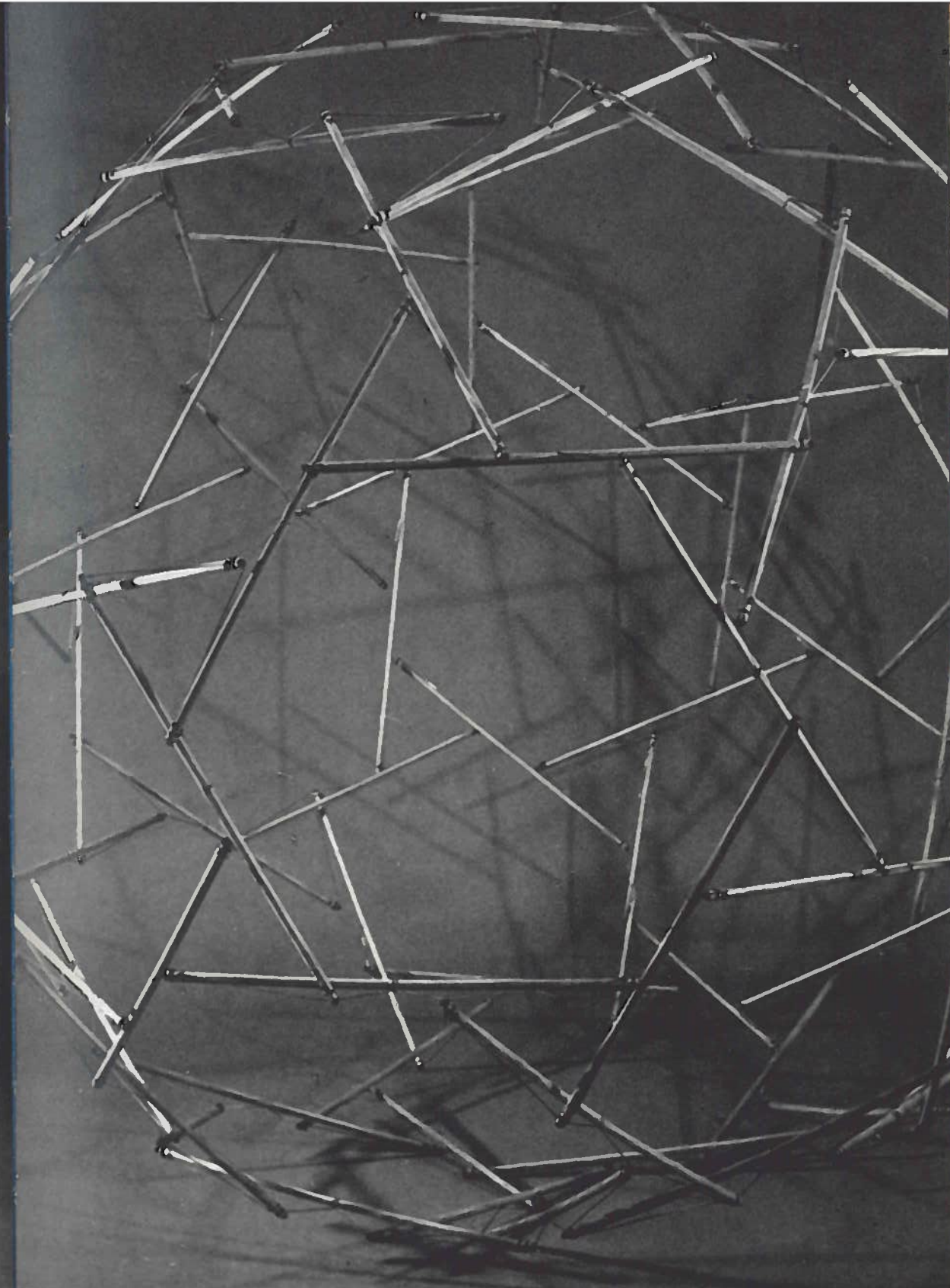
404 Schematic construction of the *tensegrity Mast* out of a "positive" and a "negative" column of cube-inscribed tetrahedrons, which spread linearly and vertically out

of two rod-pairs in center, connected by a posistorable ball-joint, so that the alternating cells hold together only through the tensionality of the cables.



406 All polyhedrons can be modeled using tensegrity structures. The beaded curve curve is a visualization of the functionality. Below: Tensegrity-icosahedron

fastened from three pairs of parallel rods. Model RBF, Black Mountain College, N.C. 1968.



407 Tensegrity Hemisphere using the same components. The multi-rod tensegrity structures are composed of sub-groups of three rods each. These sub-groupings

form triangles, which are sometimes more narrow, sometimes wider. Model ca. 1968.



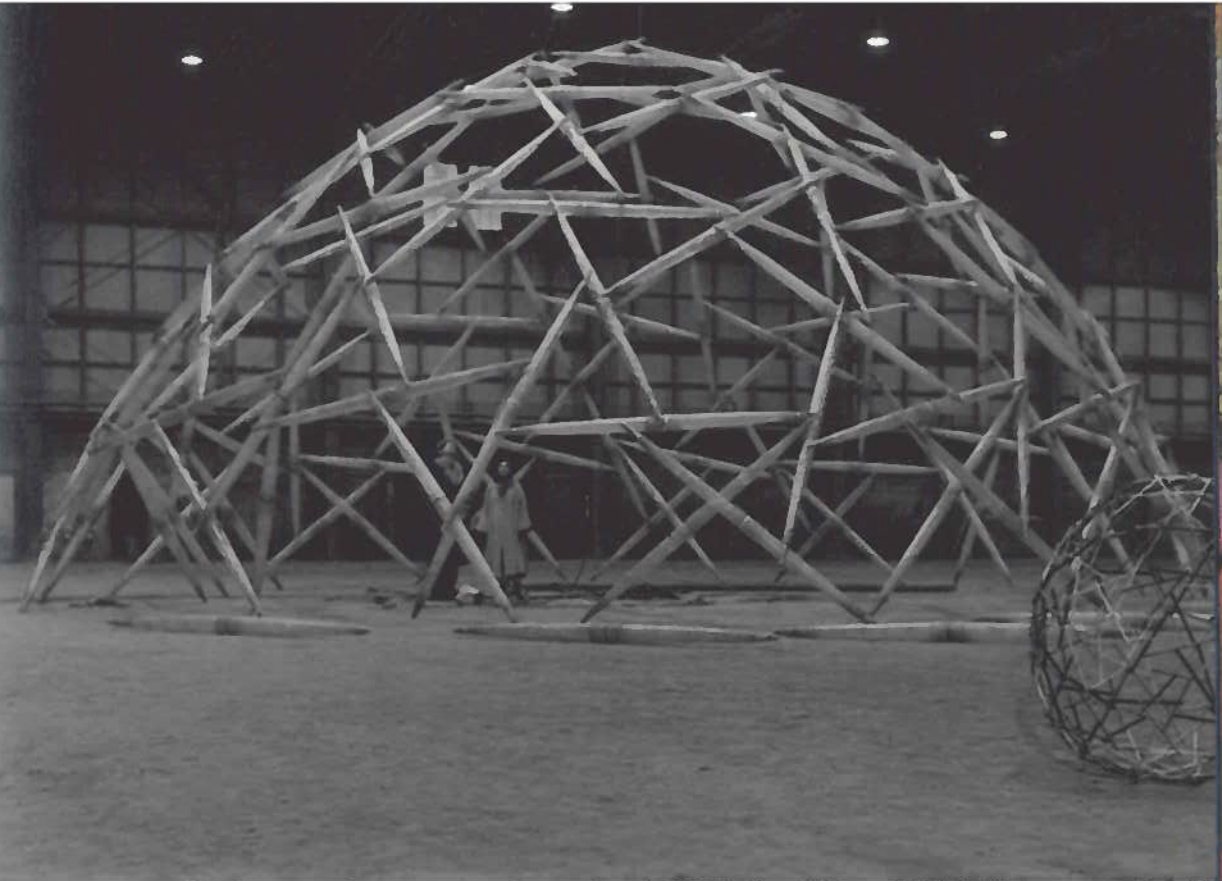
Nothing Touches Anything Else

Nothing in Universe touches anything else. The Greeks misassumed that there was something called a solid. Democritus thought it could be that there were some smallest things in those solids, to which he gave the name atom. Today we know that the electron is as remote from its nucleus as is the Earth from the Moon in respect to their diameters. We know that macrocosmically none of the celestial bodies touches each other. So, both microcosmically and macrocosmically nothing touches. It was Kepler who discovered the tensional coherence of the solar system despite the millions of miles that intervene between the celestial bodies. Isaac Newton hypothesized the formula for the rate of variance of the interattractiveness of celestial bodies, which proved on

comprehensive employment to be correct.

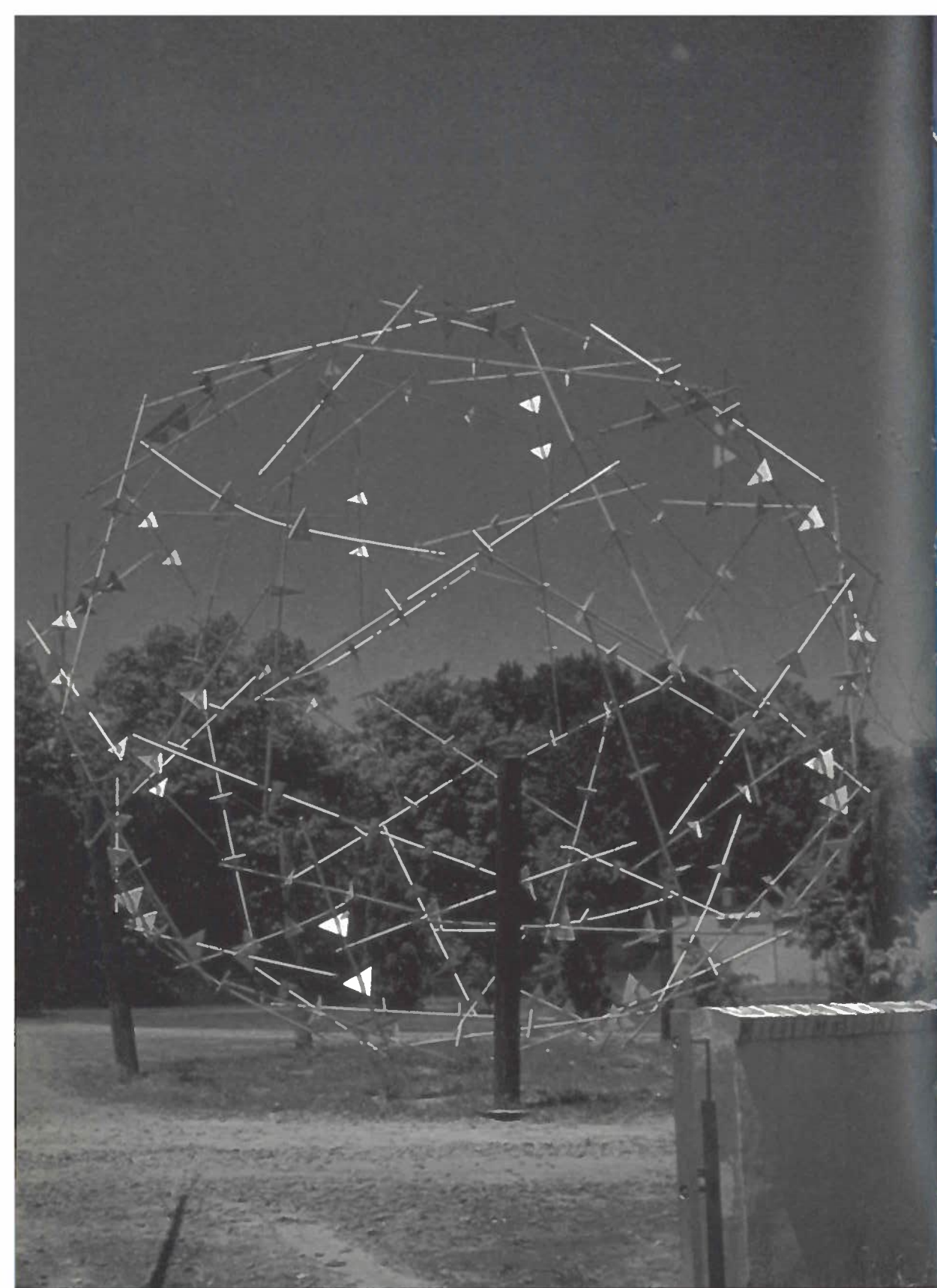
From 1927 on I sought to discover how to produce what I call tensional integrity structures. I have said many times, at some of the top engineering schools in the world, structural analysis is predicated on compressional continuity and nature doesn't use it ever. There is no way for structural analysis to analyze a geodesic dome. This still continues to be true. I think it is reprehensible. The only way to analyze it is with pneumatics and hydraulics. At the molecular level, this is the method of quantum mechanics; it could never be done with crystalline continuity, for such continuity does not exist in Universe.

This brought about my tensional integrity structures, which name I contracted to tensegrity structures. Tensegrity structures are the essence of all geodesic domes. When we increase the frequency of modular subdivisions of geodesic domes the edges of the triangles, representing the chords of central angles, get shorter and shorter and the interval between the mid-chord and the mid-arc of the central angles also decrease with the increasing frequency of the modular

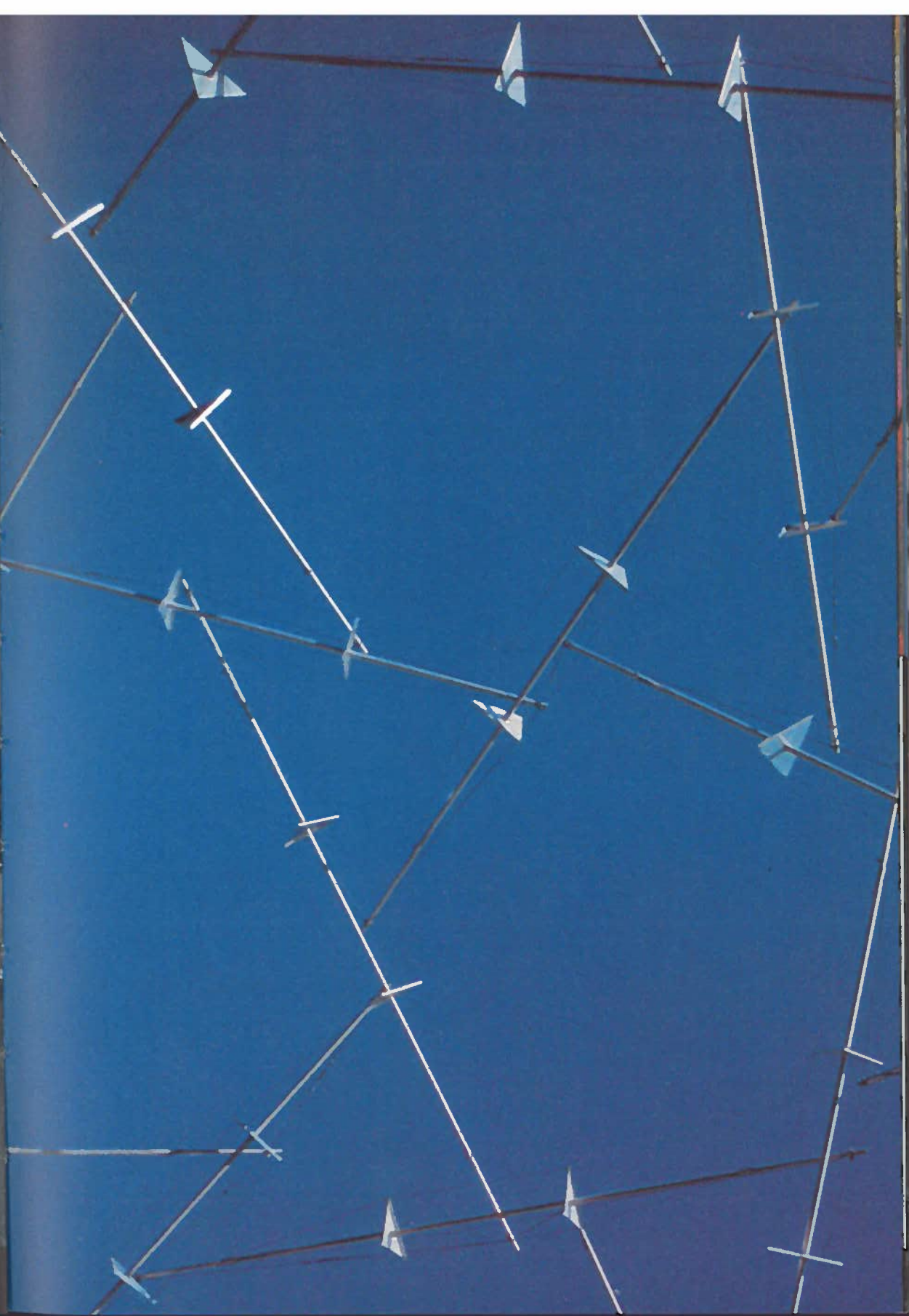


subdivisions. Because the materials used in the construction of the dome have some substantial dimension, we get to the point where the high-frequency production of the arc-altitude is such that the materials (the individual tensegrity components) touch one another. Every one of these elements is where it wants to be within the structure - there are no tensions anywhere, no slacks, all of the stresses are absolutely even - so we then fasten the two structural components together where they touch and want to be. This takes out the springiness of the geodesic domes and makes them rigidified. Because tension and tensegrity have no limit of clear spanning, tensegrity structures open up completely clear-spanned dome structures of any size.

Inventions. The Patented Work of R. Buckminster Fuller (1983), 179



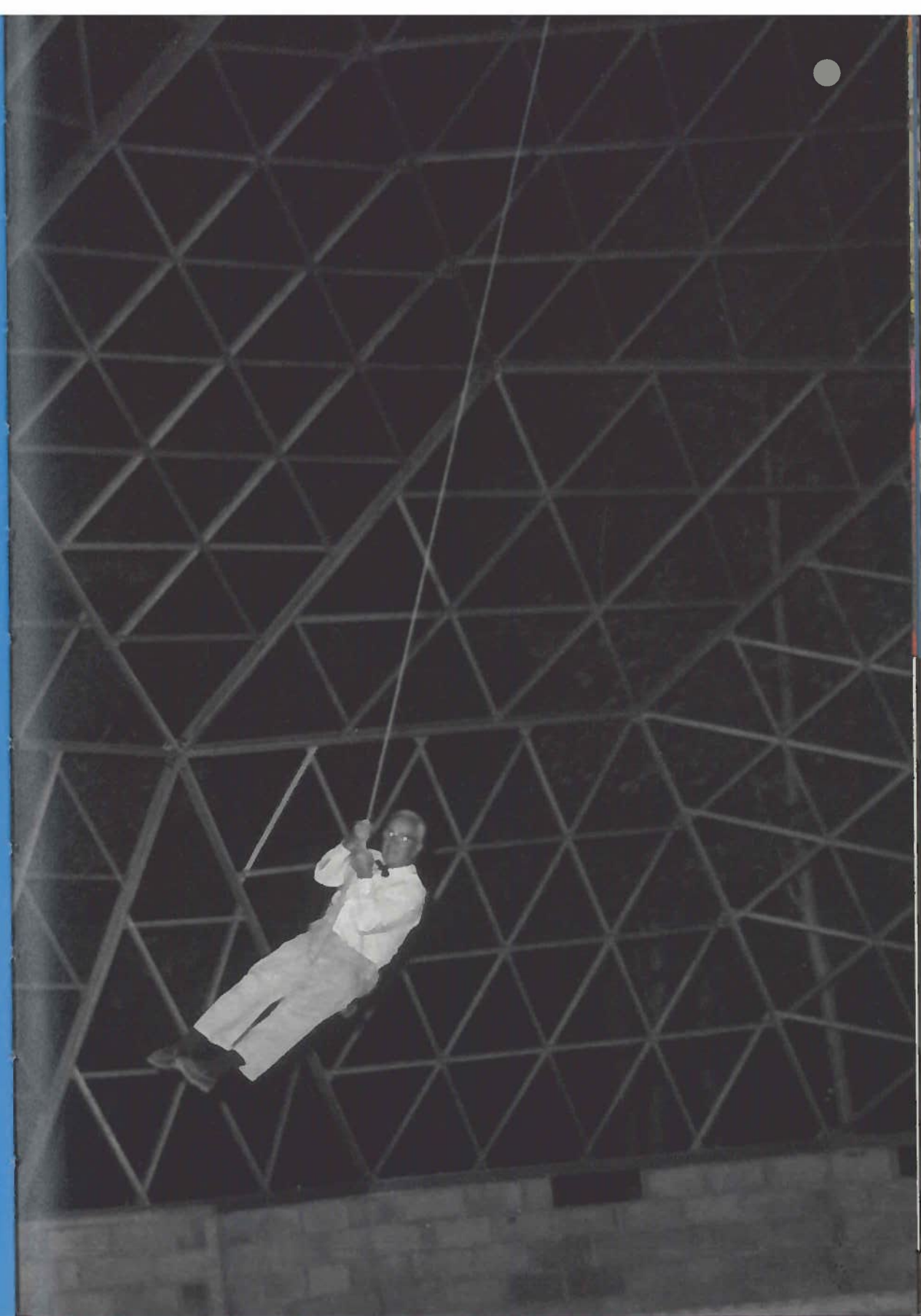
410 Integrity Sphere (Event/Configuration) composed of 80 rods, Princeton University 1966

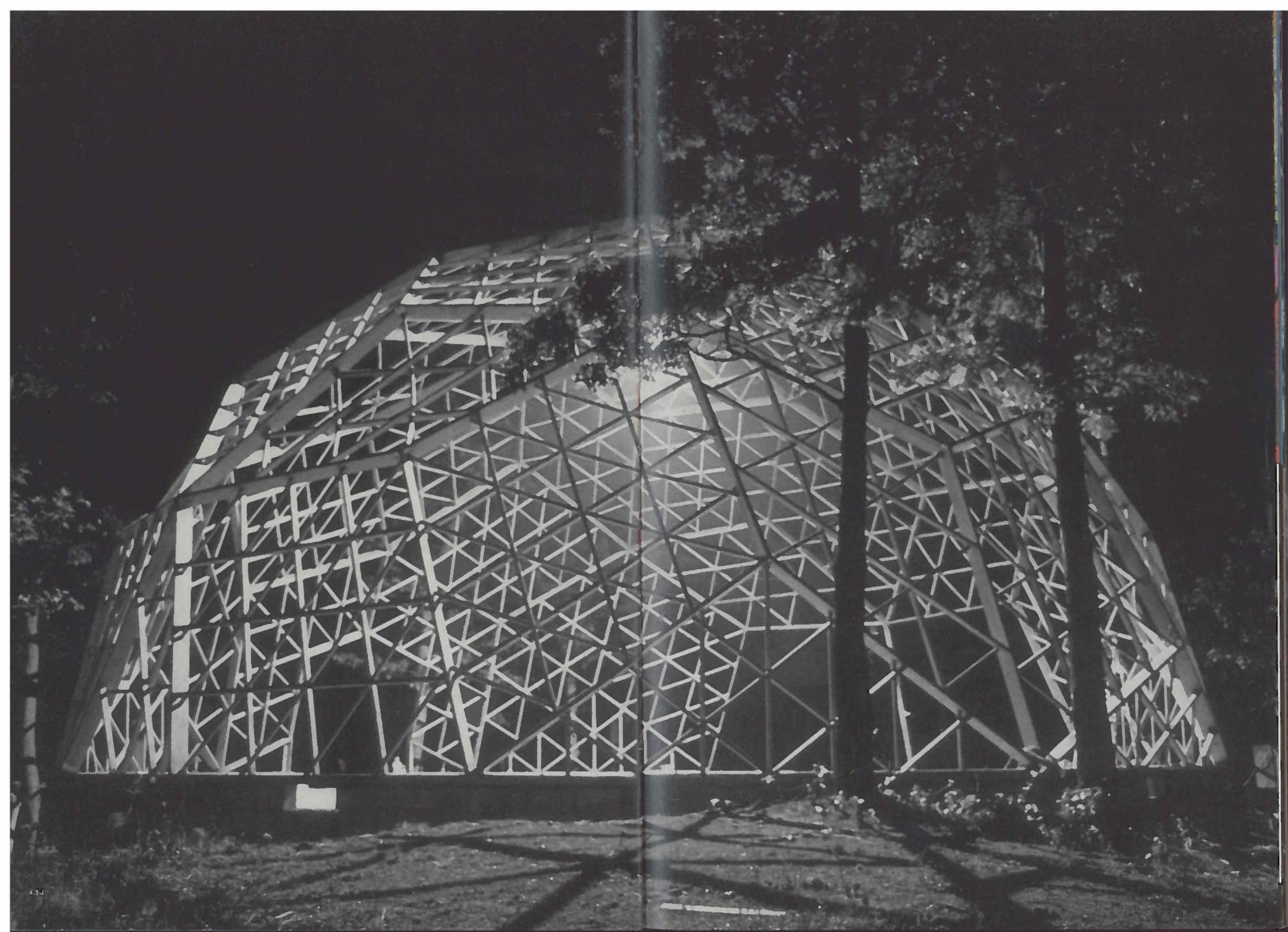


Walter Benjamin spoke of living in a glass house as the revolutionary act par excellence. It also encompasses a terror of total transparency. The Geodesic Restaurant in Wood's Hole, with its completely transparent acrylic glass had to be darkened subsequently, as few guests could tolerate total transparency.

In "Garden of Eden" Fuller pursued the goal of the optimal development of geodesic domes as "environmental controls," as spatial and climatic skins, as regulators and valves of the desired exchange with the environment. With two revolving geodesics placed inside one another, each of which has glass on only one side, it is possible to open and close them as needed. In the intermediate space between the two, more shade could be created in the summer or more light in the winter. The idea was to work together with nature.

GARDEN OF EDEN







416 -418: RHP in the dome of Wood's Hole Restaurant, Cape Cod (Massachusetts), before the final construction phase, 1955



Woods Hole Restaurant

We spent four weeks designing and fabricating the parts of this dome at Cambridge, two weeks subassembling the diamonds at the Wood's Hole site, and one week fitting them together to form the dome. Most of the time for assembly was spent in shifting the little jack mast that we used to hoist the individual diamonds aloft. We will never do it that way again. We learned from then on to use a boom universally jointed at the center to carry up the members. The members were wood sections, 2"×3" and 1"×8", all very light and delicate. The structure was skinned in during the following spring and used as a restaurant seating 150 people. The completed dome was 54' in diameter and weighed 3 1/2 tons.

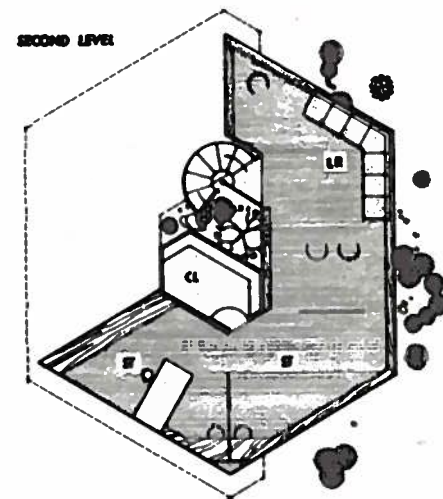
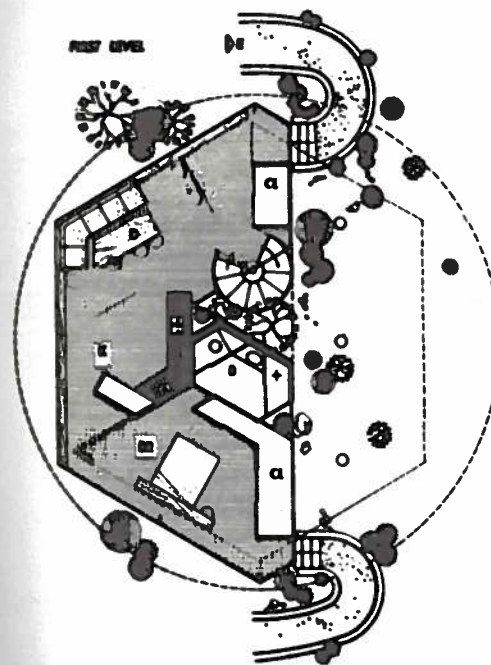
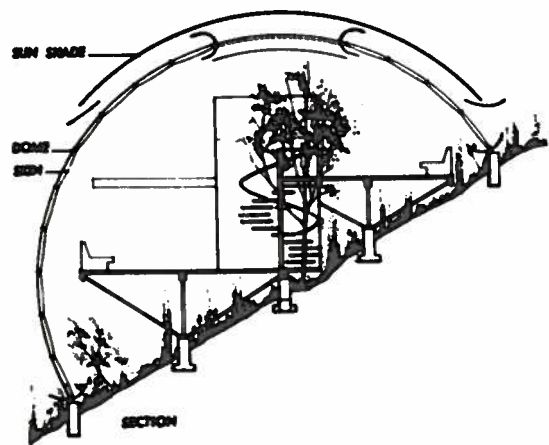
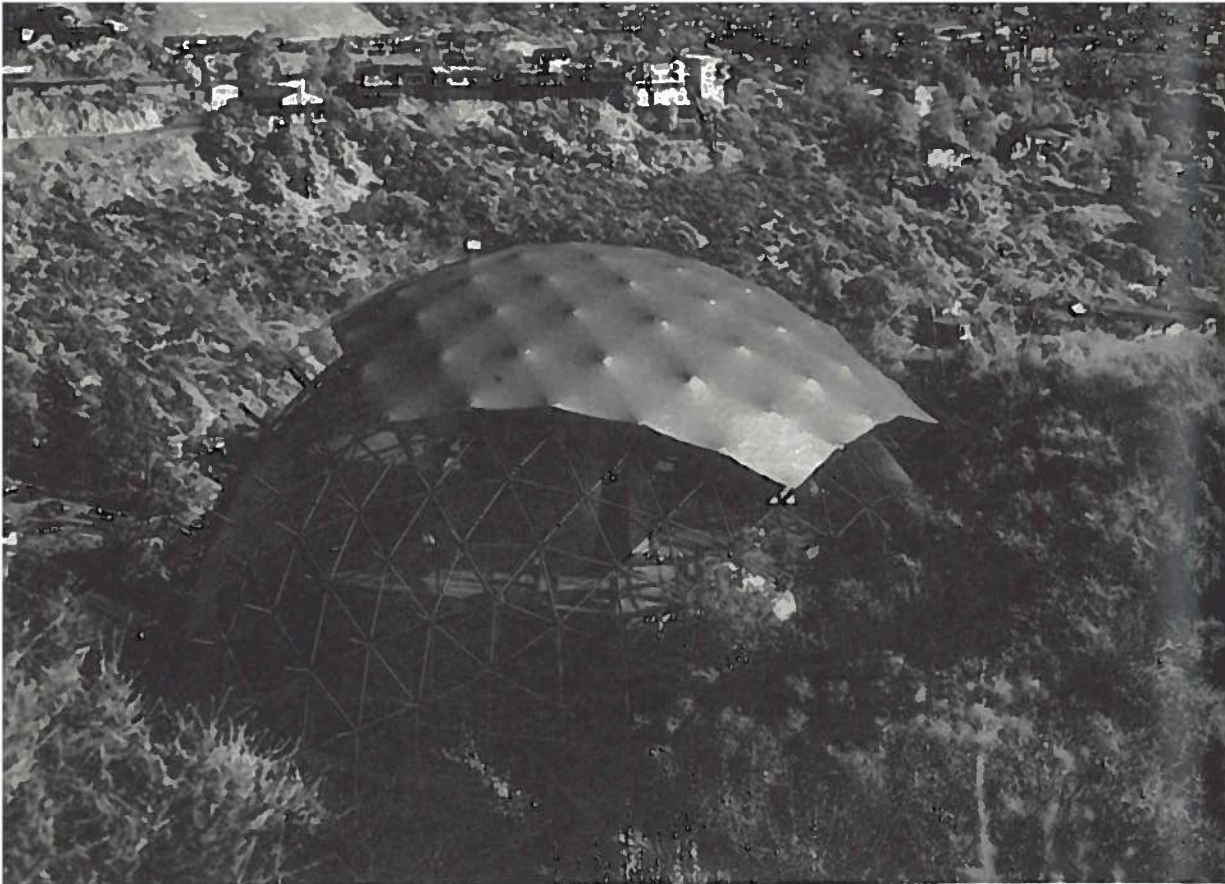
The night pictures give us a sense of isolation of the light weight structure from the surrounding environment. We tried several skins on this dome, one of them being a three mil Mylar. The structure was painted white so that the whole effect was very unified, ephemeral and pleasing.

When the hurricane came this fall, heterogeneous missiles pierced nine of the forty-five diamonds with three mil Mylar skins. They burst with quite an explosive sound, but only the skin and not the structure was hurt. The balance of the Mylar skin remained undamaged, and the DuPont Company tells us that they are very pleased at the test because the skin, which was simply glued in place, did not tear off entirely. It dilated in and out like a lung, but did not pull away.

"Architecture Out of the Laboratory" (1955), 21

417 -Wood's Hole Restaurant in operation

414/415: Wood's Hole Restaurant, night-time photograph after the completion of the dome, before being fitted with furnishings, 1955



#16 - Geodesic dome, Hollywood Hills, 1958. The same dome as from Monterey 1950 (1951's first geodesic dome, see p. 83-8), transferred from the original level site to

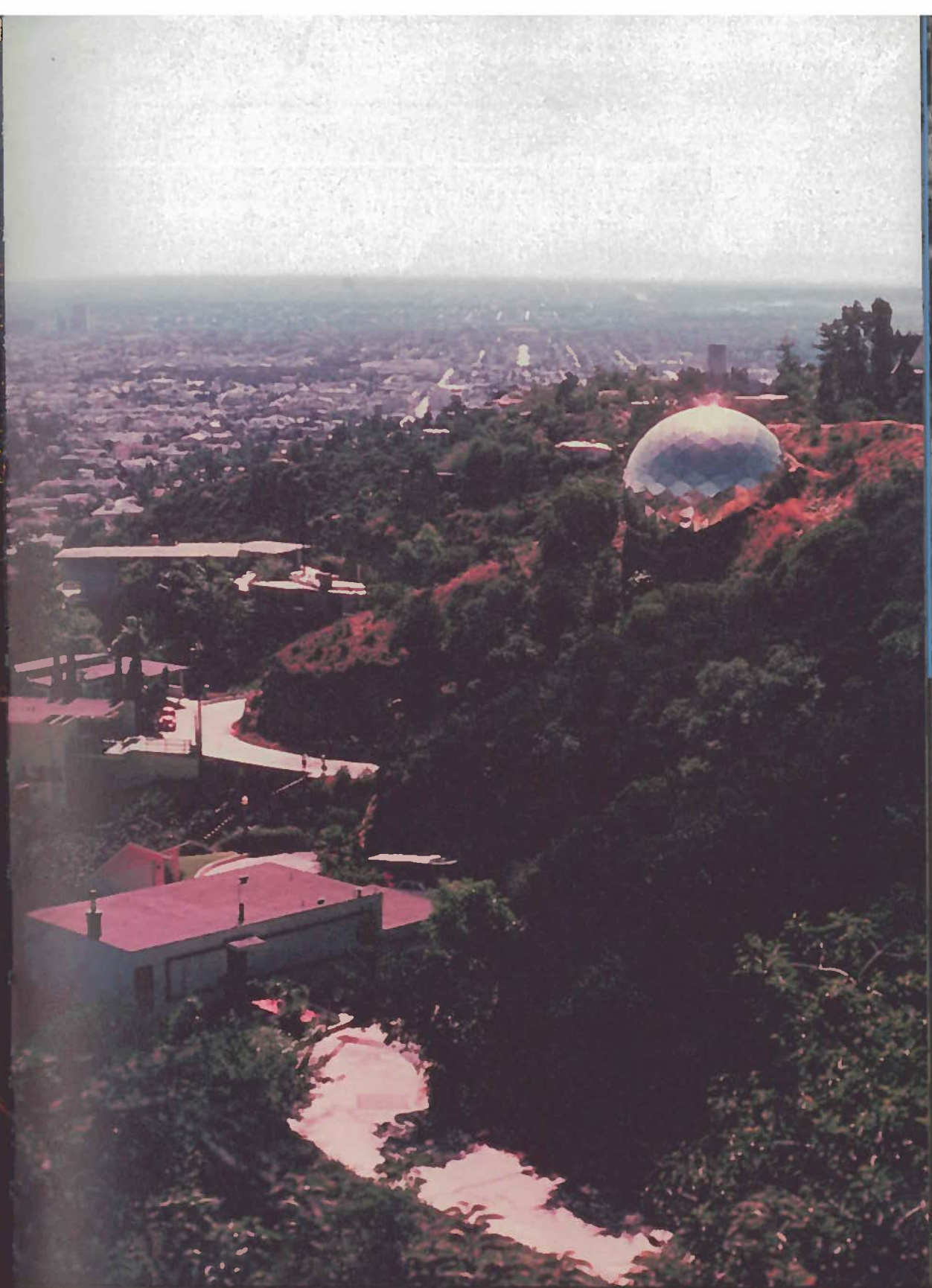
the steep California precipice

#17 - Floor plan of the upper and lower levels, sectional elevation

Home

**A bubble of plastic high
in the Hollywood hills**

Designs in steel & silver



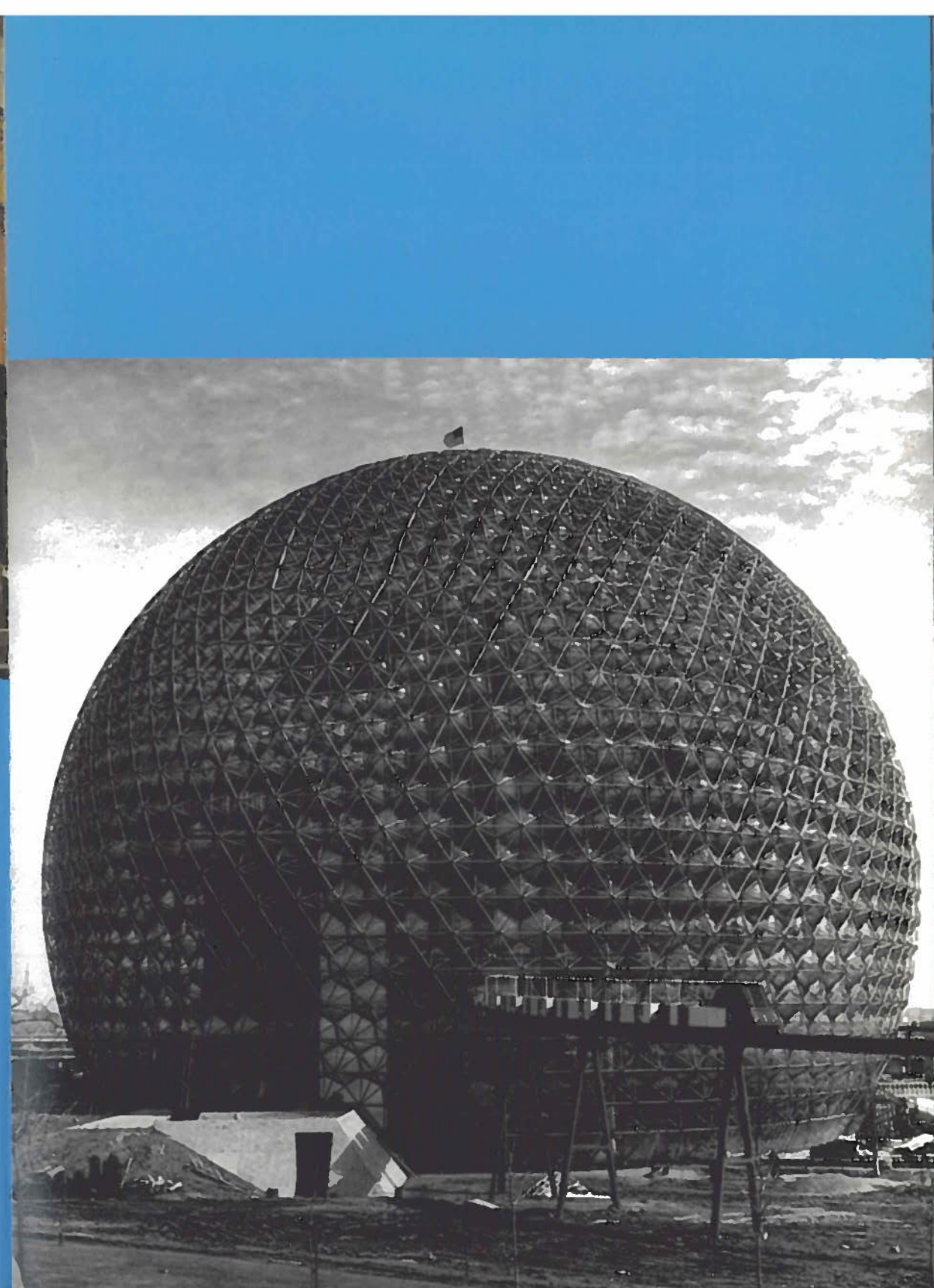
4M - "Home" section of the Los Angeles Times, with a story about the dome

The dome, seen from Hollywood



Expo Dome 1967

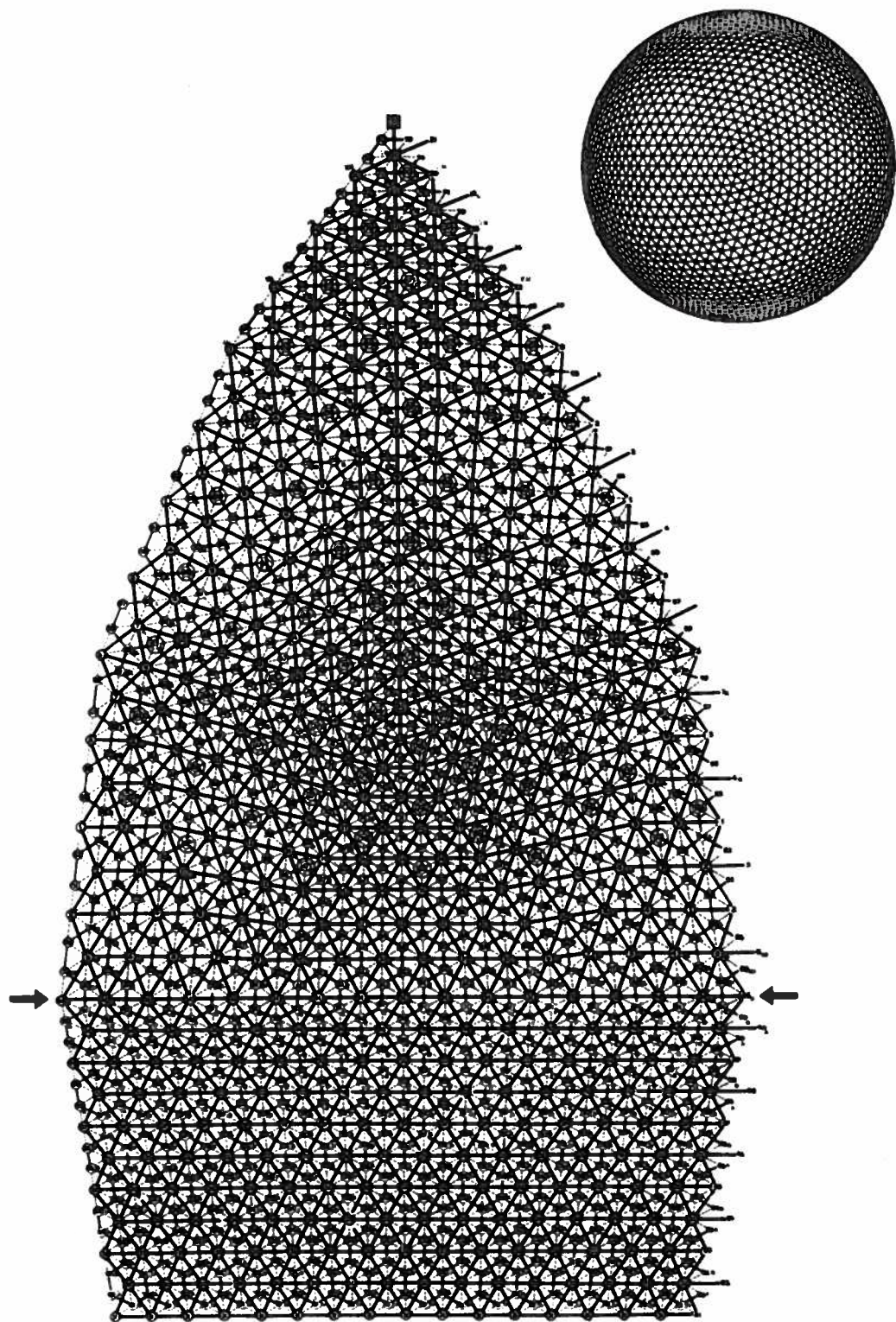
In 1965, Fuller was commissioned by the U.S. Information Agency to design the U.S. Pavilion for the World's Fair in Montreal in 1967. After rejecting his proposal to install World Game, Fuller and Sadao, Inc., worked out the design for the Expo Dome: a geodesic three-quarter sphere with a diameter of 250ft and height of 200ft, made from a two-level fillgree network of steel rods. In the outer layer, they formed triangular units, and hexagonal units in the inner layer. The dome was sealed with a transparent skin of acrylic glass panels, and the amount of light allowed in could be controlled by moveable, triangular sun shades on the inside, that changed according to the position of the sun, so as to avoid blinding effects. A computer program saw to it that a minimum of facets was closed at any time, and the blocking out of the sun is tracked, so as not to adversely affect the transparent and floating character of the dome. The dynamic adjustment of the interior climate and the unhampered view outward were part of Fuller's program for a structural skin as a valve for the surroundings. The Expo Dome was Fuller's masterpiece, his Taj Mahal, dedicated to his wife, Anne.



422. (R&F) presents President Johnson and Members of Congress with a model for the '67 Expo Dome, 1965. The Montreal dome shortly before the opening of the

Expo. Up to the level of the equator the construction is a network of horizontal metal rings arranged in parallel; above it is a geodesic structure.





426 42-4426 The U.S. Pavilion backlit (from *Pure White*, 1967), diameter of dome 250 ft

"Development" of a segment of the dome with angle and frequency modulation. The arrows indicate the position of the equator. Small graphic view of the dome

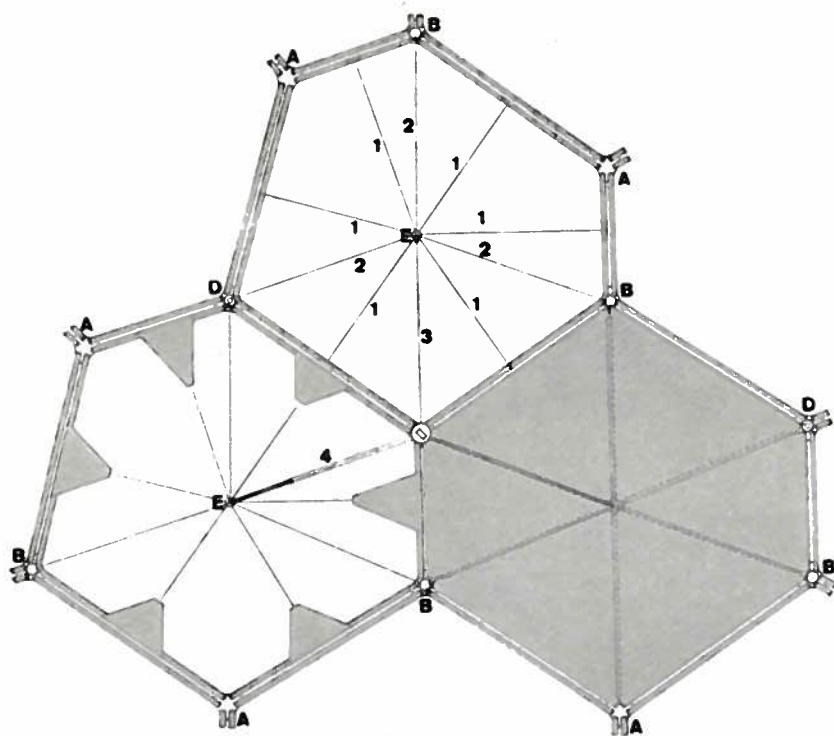


427 View of the platforms inside the dome, Cambridge and Partners architectural bureau

Geodesic Domes: A Human Being's Skin

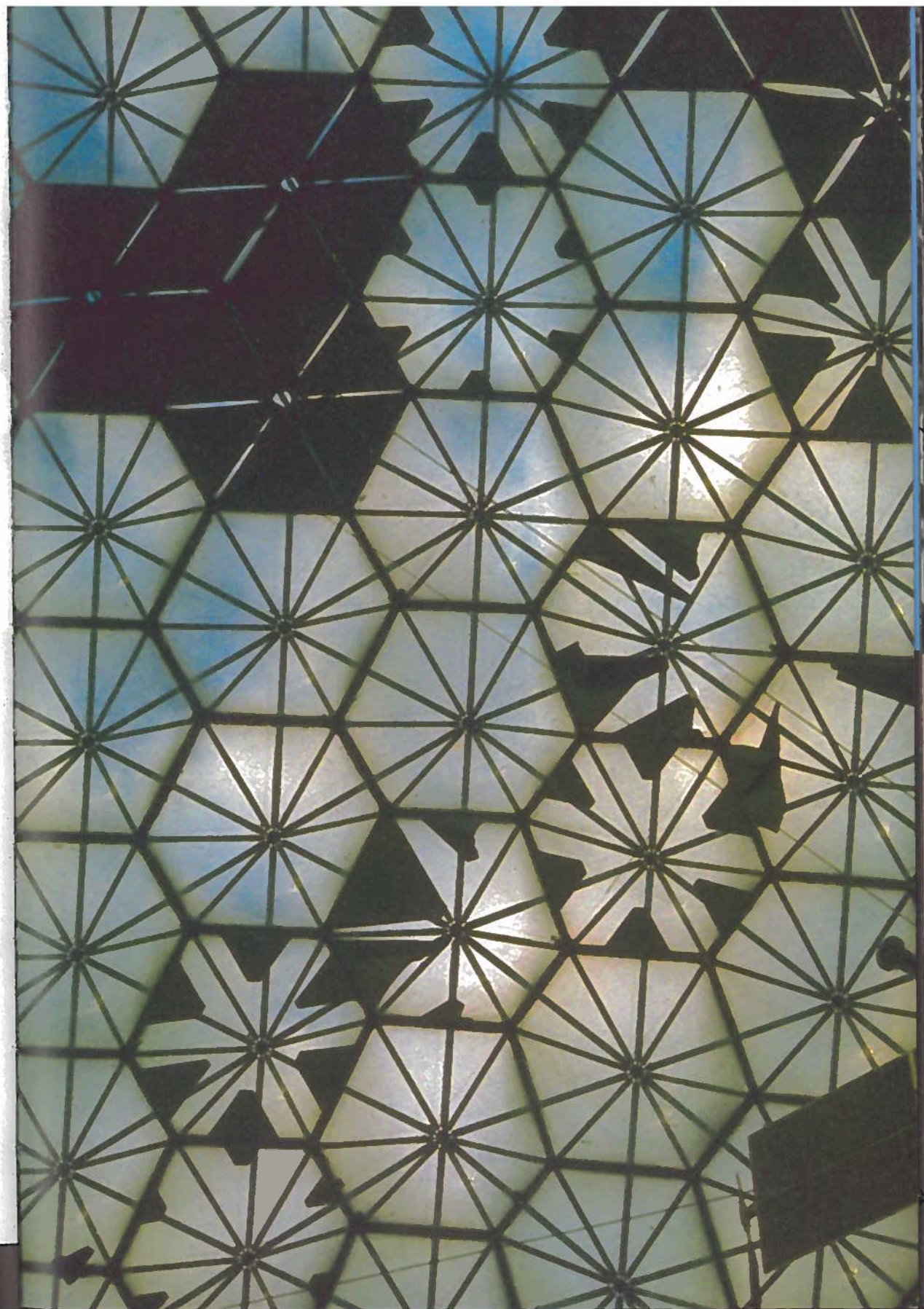
(...) If industry was to take it on, there are things that we could do in geodesic domes that are spectacular. I haven't let much of it be visible except that anyone looking at the geodesic dome in Montreal saw a very beautiful piece of mechanics. It did all kinds of things to your intuition. You saw there were curtains that could articulate by photosynthesis and so forth, could let light in and out. It is possible, as our own human skin, all of our pores, all of the cells organize, so that some are photo-sensitive and some are sound-sensitive, and they're heat-sensitive, and it would be perfectly possible to create a geodesic of a very high frequency where each of these pores could be circular tangencies of the same size. One could be a screen, others breathing air, others letting light in, and the whole thing could articulate just as sensitively as a human being's skin. And I really think geodesic domes such as that will be developed.

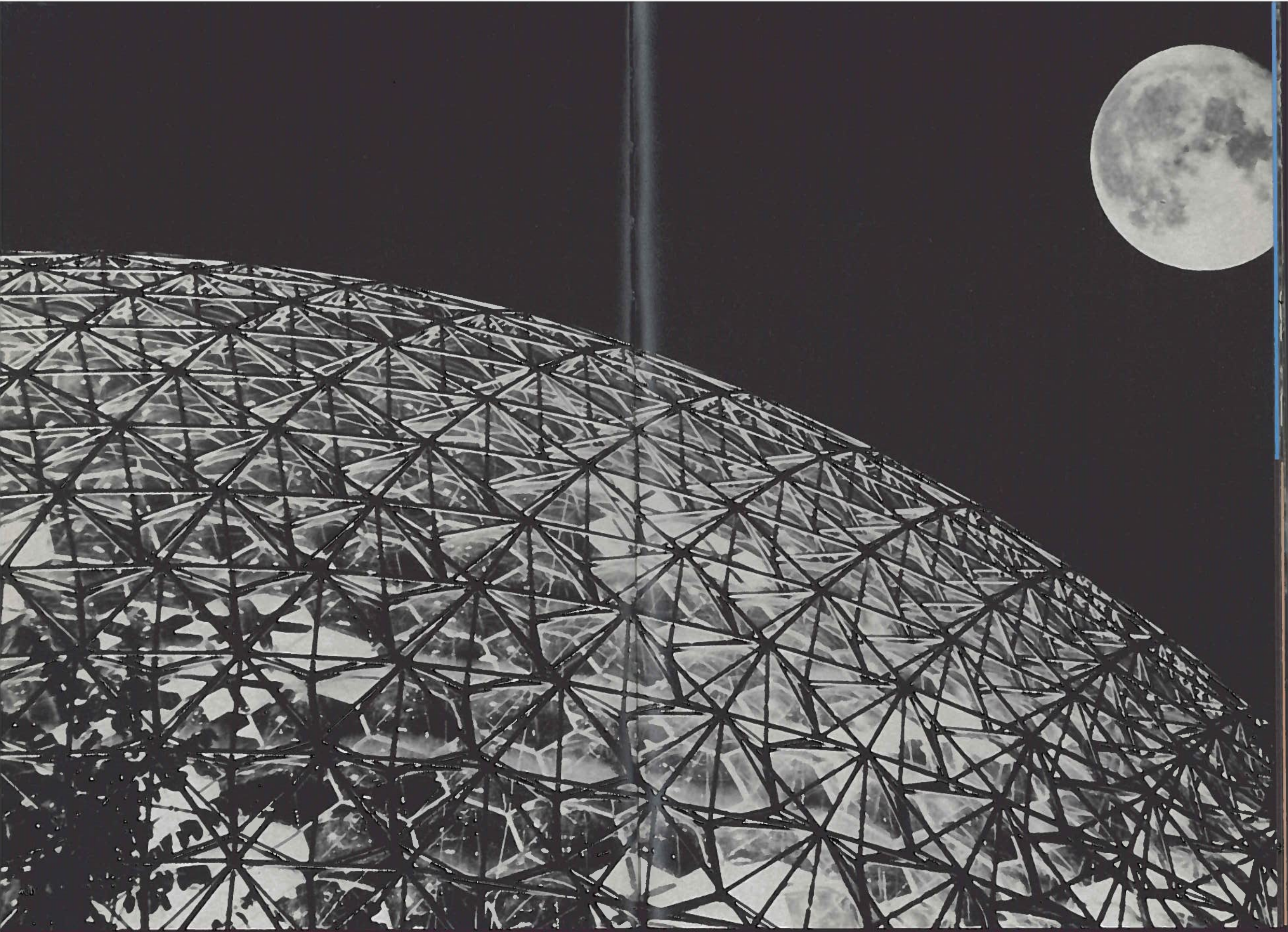
Domebook 2 (1971), 91



425' Detail of the dome's outer skin showing three phases of opening for the automatically controlled blinds

Section of the dome, viewed from the interior
450' / 451' Expo Dome with full moon







Domed-over Cities

Domed-over cities have extraordinary economic advantage. A two-mile diameter dome has been calculated to cover Mid-Manhattan Island, spanning west to east at 42nd Street from the Hudson River to the East River, and spanning south to north from 22nd Street to 62nd Street.

When we wish to make a good air-cooled engine, we design it with many fins and spicules to carry away the heat by providing the greatest possible external surface area. The dome calculated for mid-Manhattan has a surface which is only 1/85 the total area of the buildings which it would cover. It would reduce the energy losses either in winter heating or summer cooling to 1/85 the present energy cost obviating snow removals. The cost saving in ten years would pay for the dome. Domed cities are going to be essential to the occupation of the Arctic and the Antarctic.

Utopia or Oblivion (1969), 353

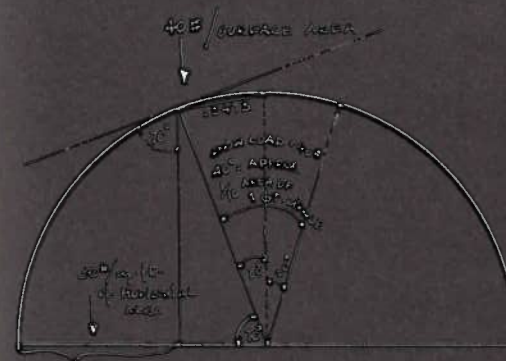
-432/433: Norman Foster and RBF: *Autonomous House*, 1982: Project for a house unrelant on external energy sources, constructed as a double-hull geodesic dome with movable positioning (as a climate-controlling shell) and three freely positioned upper stories. The autonomous house can open and close itself through rotating of the shells, and can thus harvest energy or give it back off to the environment. The house is the culmination in Fuller's work of the theme "house as valving," which was already touched on in the Dymaxion House.

-435: In Fuller's work that house mediates between inside and outside, it is a valve. The theme was developed more and more from the time of the Dymaxion House.

-436/437: Dome over Manhattan, project, 1950 and 1960 (photographic montage). The dome would have spanned a diameter of two miles and, among other things, would have allowed for the elimination of automobile traffic.

-438/439: *Tetra City*: project for a floating city, planned for a million inhabitants (Fuller and Sasaki, 1965).

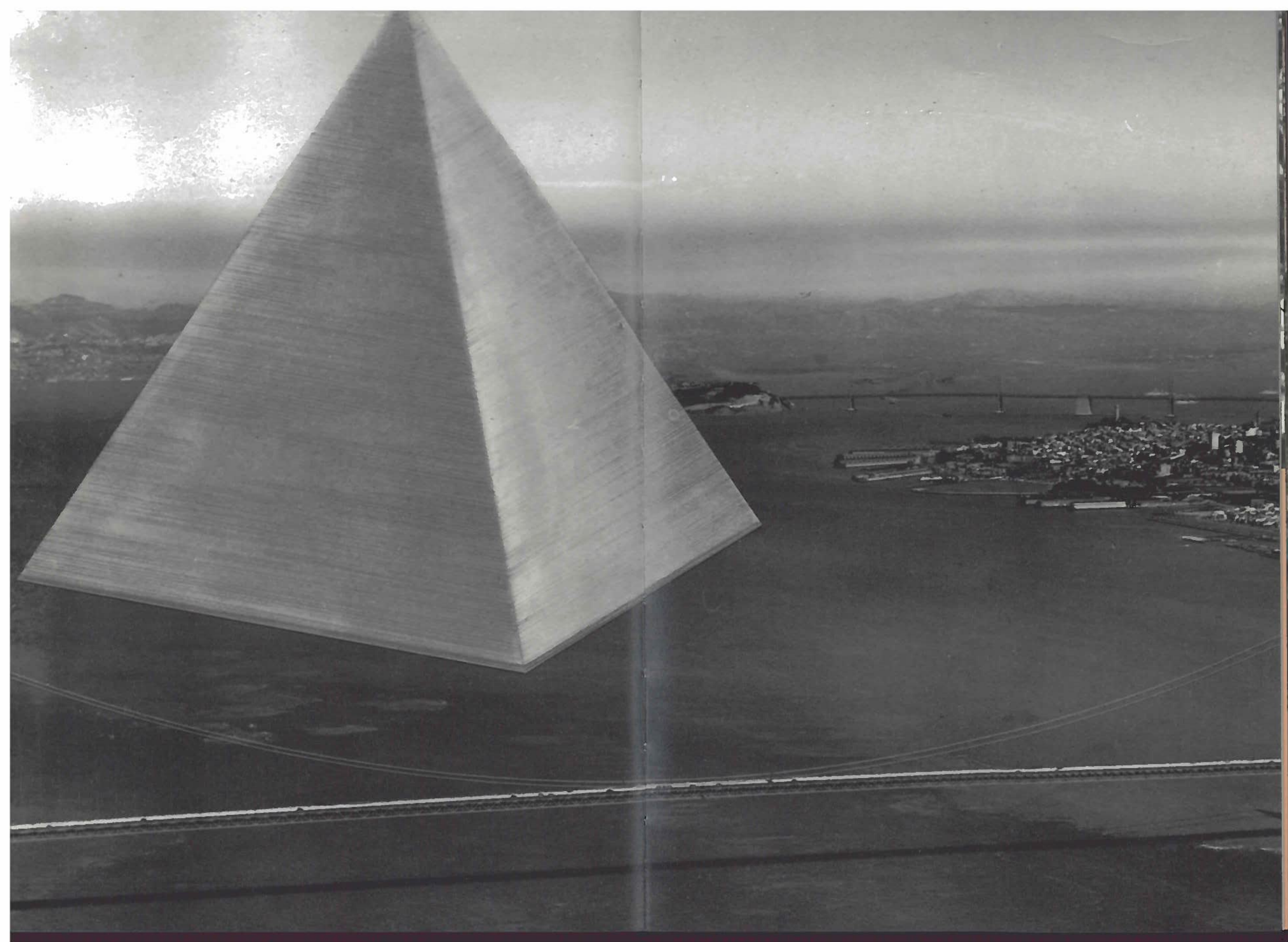
-440/441; Cloud No. 6: the greater a geodesic dome, the lighter its structure in comparison to the air it contains. When heated by the sun, some of the expanding air escapes, allowing the 1.5 mile diameter sphere and its thousand inhabitants to float through the air (with Shoji Sadao, 1962).



R.V.C. L16E L050 = 72 72

45) $\frac{\text{BASE}}{\text{AREA}} = \frac{141.972}{1590.4}$



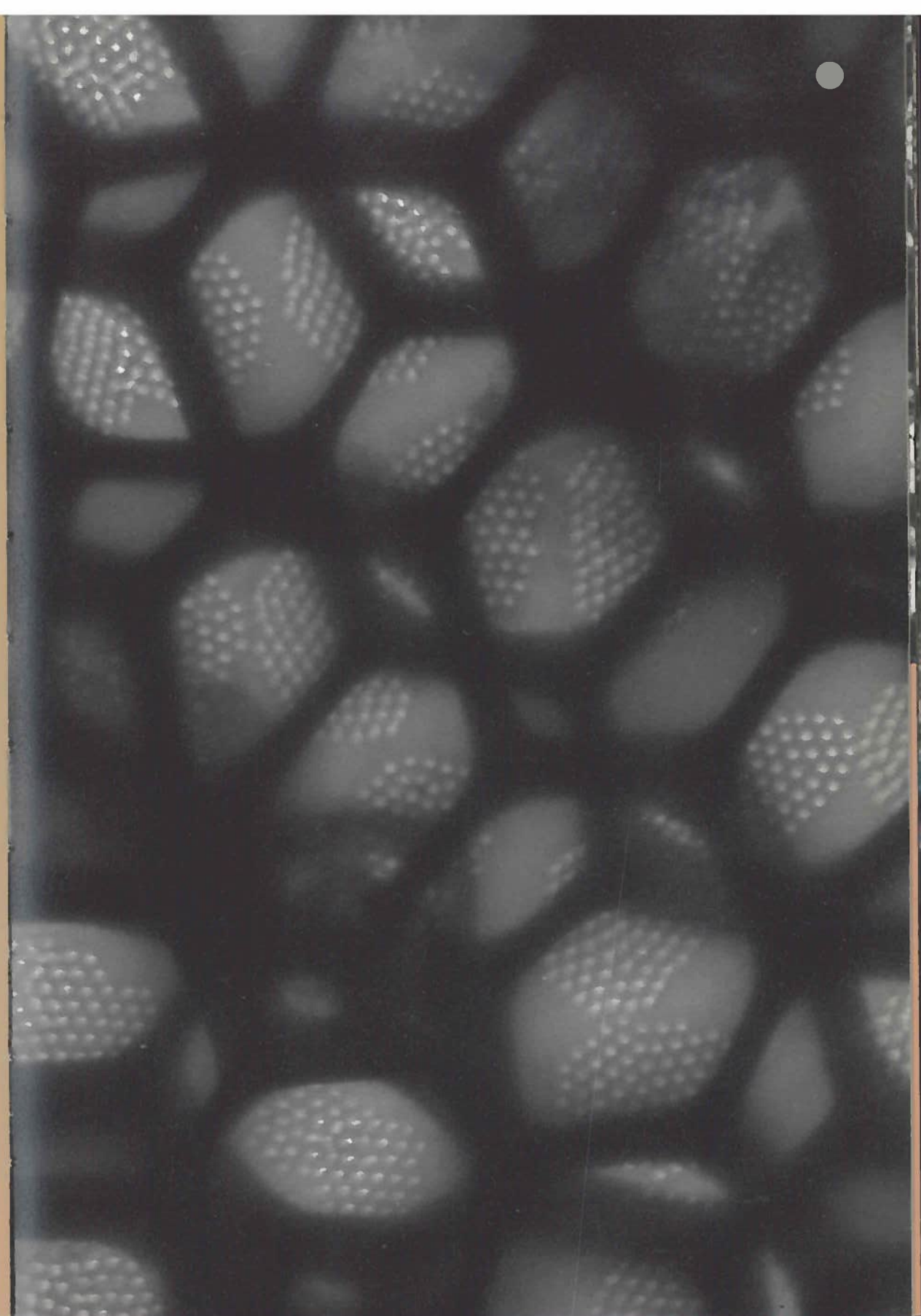




After Fuller had become famous for constructing large geodesic domes, scientists and doctors began to provide examples of geodesic and tensegritic structures in microorganisms. Virus researchers asked for Fuller's advice in explaining the structure of protein shells. Examinations of human tissue showed structures that resembled geodesic and tensegritic basketwork. The interaction of muscles and bones could be understood as a tensegrity structure as could the filaments and needlelike cytoskeletons of cells.

The most spectacular discovery was of the "Buckminsterfullerene", a spherical cage molecule of pure carbohydrate. Its discoverer had been inspired by Fuller's Expo Dome to spot the pattern. The "Fullerene" family of molecules is expected to have important consequences on chemistry, electronics, and nanotechnology.

HOW NATURE BUILDS



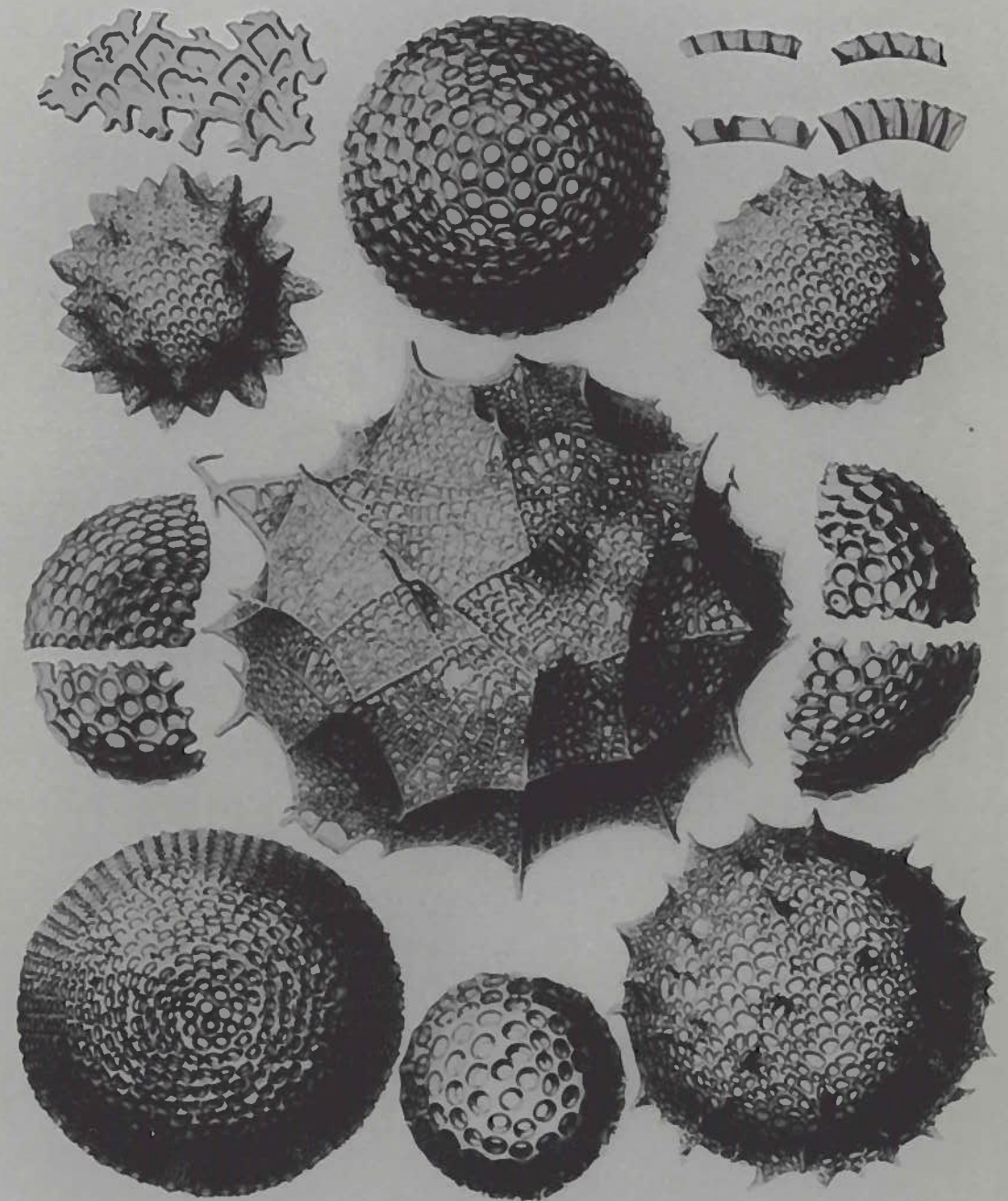
Today I have given you first some fundamental structural principles and subsequently shown you their use by nature. I didn't, however, start by studying these structures of nature seeking to understand their logic. The picture of the radiolarian has been available for 100 years, but I didn't happen to see it until after I had produced the geodesic structures from the mathematical sequence of developments which I reviewed for you earlier. In other words I did not copy nature's structural patterns. I did not make arbitrary arrangements for superficial reasons. What really interests me therefore in all these recent geodesic tensegrity findings in nature is that they apparently confirm that I have found the coordinate mathematical system employed in nature's structuring. I began to explore structure and develop it in pure mathematical principle out of which the patterns emerged in pure principle and developed themselves in pure principle. I then realized those developed structural principles as physical forms, and in due course applied them to practical tasks. The reappearance of these structures as recent scientists' findings at various levels of inquiry are pure coincidence, – but excitingly validating coincidence.

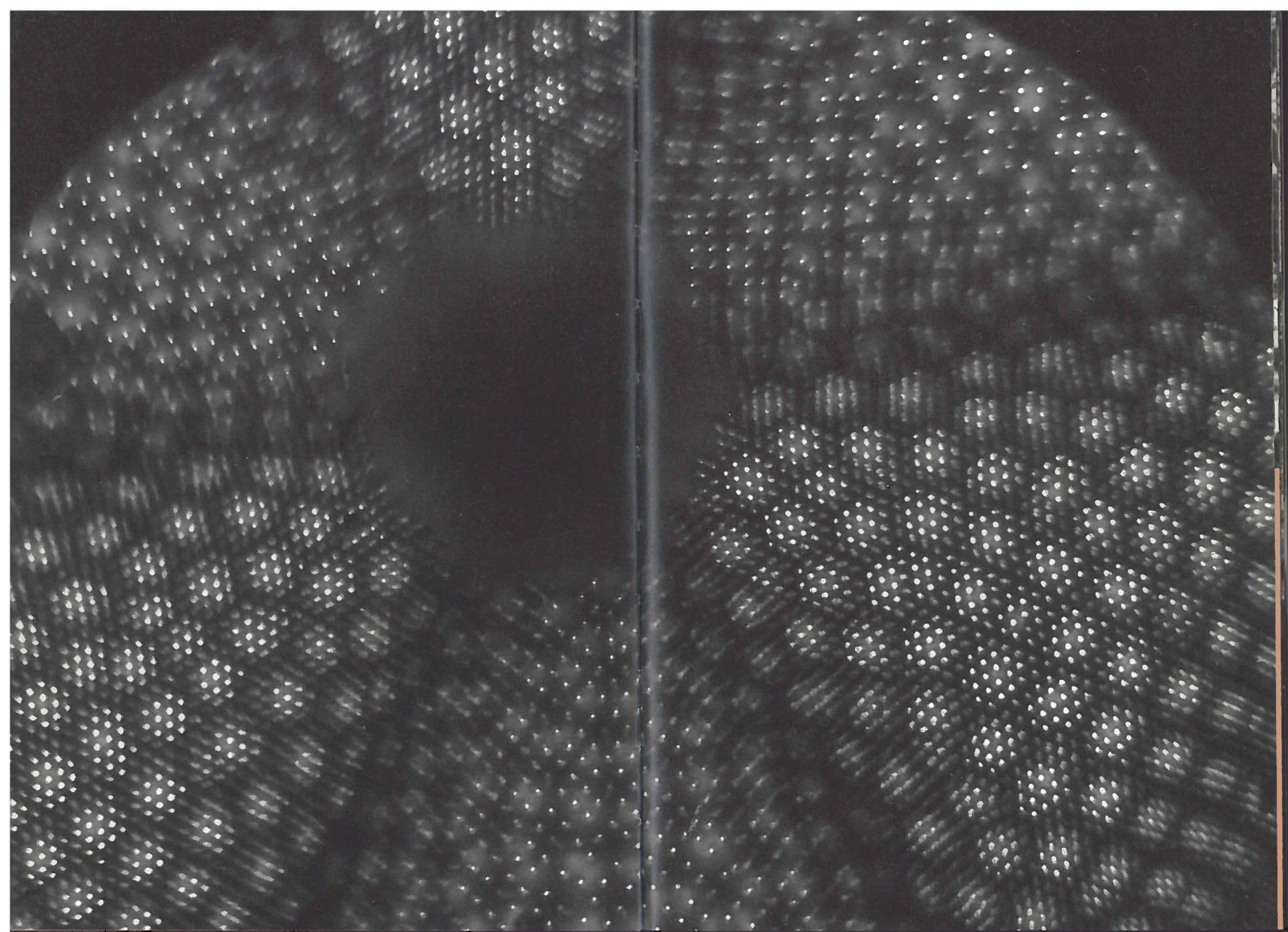
"World Design Initiative" (Mexico Lecture, 1963), in: *WDSO*: 2 (1964), 59

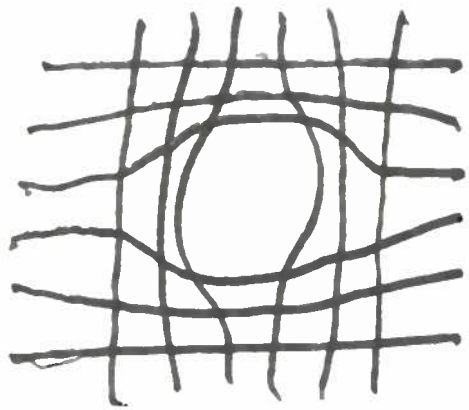
-443: Micro-morphologic exploration with electron microscope yields numerous indications of geodesic structures in nature. Diatoms (algae) with 3500-fold magnification. The recorded image was provided to RBF in 1962 by Dr. Helmcke, TU Berlin.

-445: The German zoologist Ernst Haeckel (1834–1919) discovered numerous marine microorganisms and produced drawings to document his examinations under the microscope. His illustrations of Radiolarian became well-known, showing a structure that exhibits the icosahedral symmetry of geodesic domes. Drawing from Haeckel's contribution to an English expedition report, London, 1887.

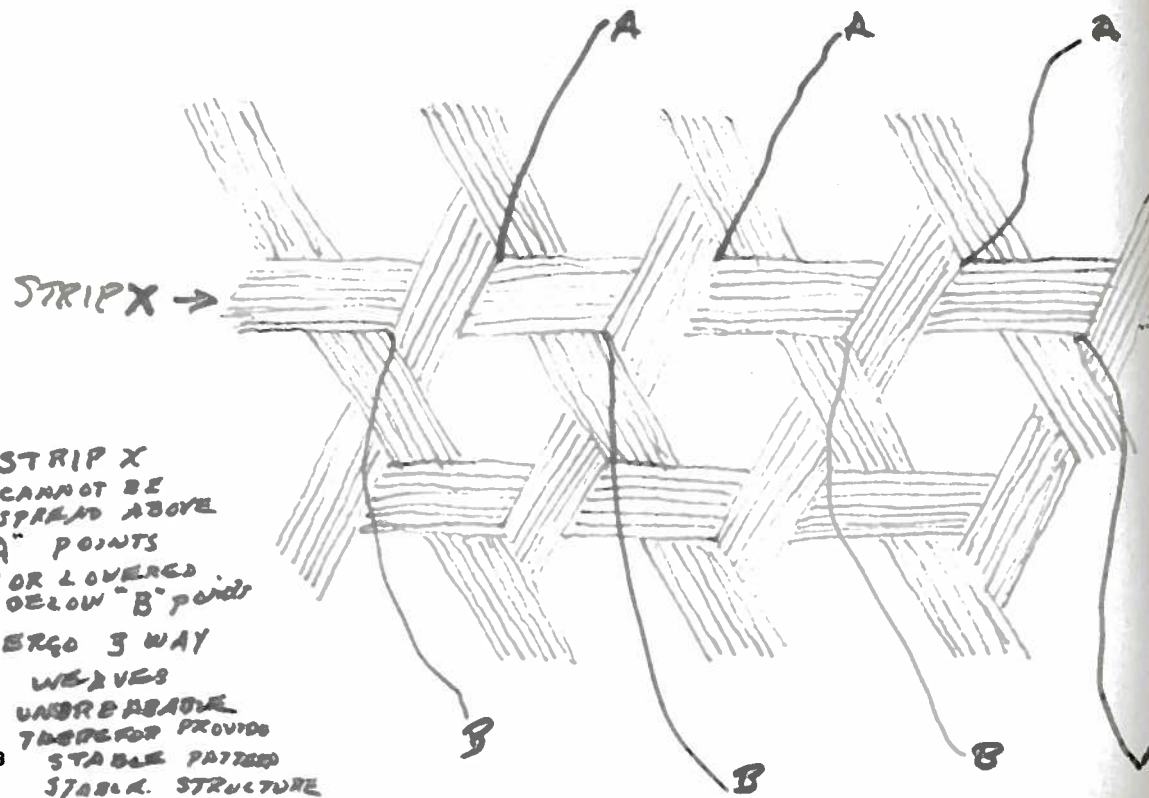
-446/447: Diatom under the electron microscope, Helmcke 1962. The circular opening at the vertexes of the pentagonal and hexagonal facets was utilized by RBF in his Monohex patent (1965) and the "Fly's Eye" construction, which developed out of Monohex.



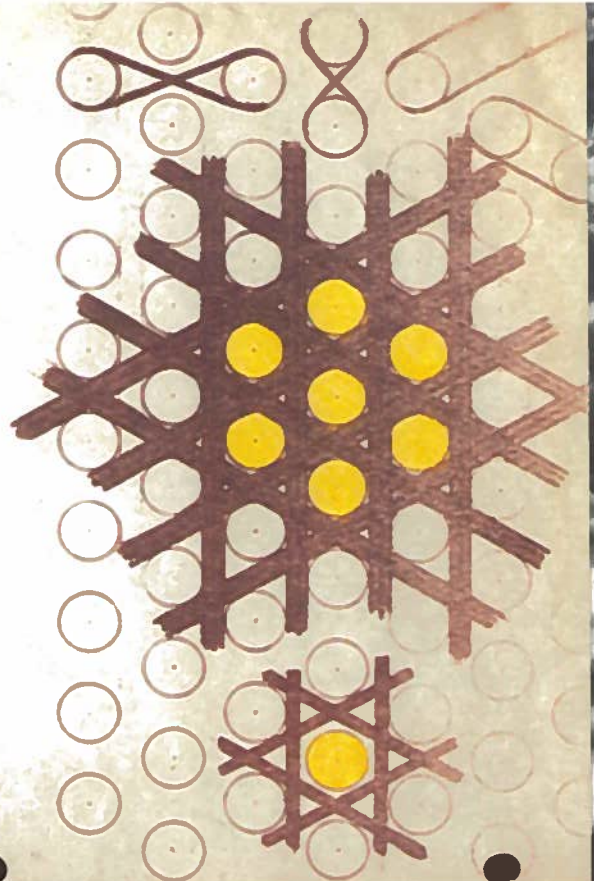
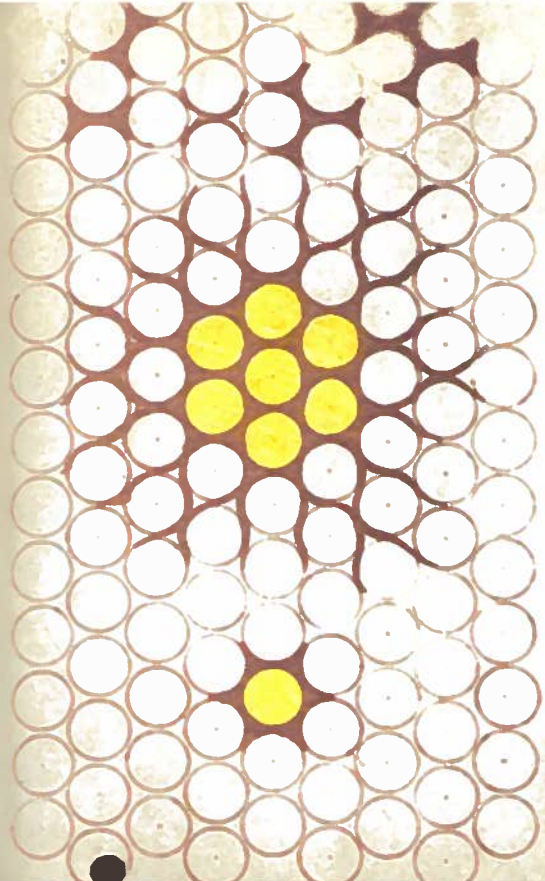




WEAVES
ARE
SPREADABLE
ERGO DISTORTABLE
ERGO UNSTABLE.

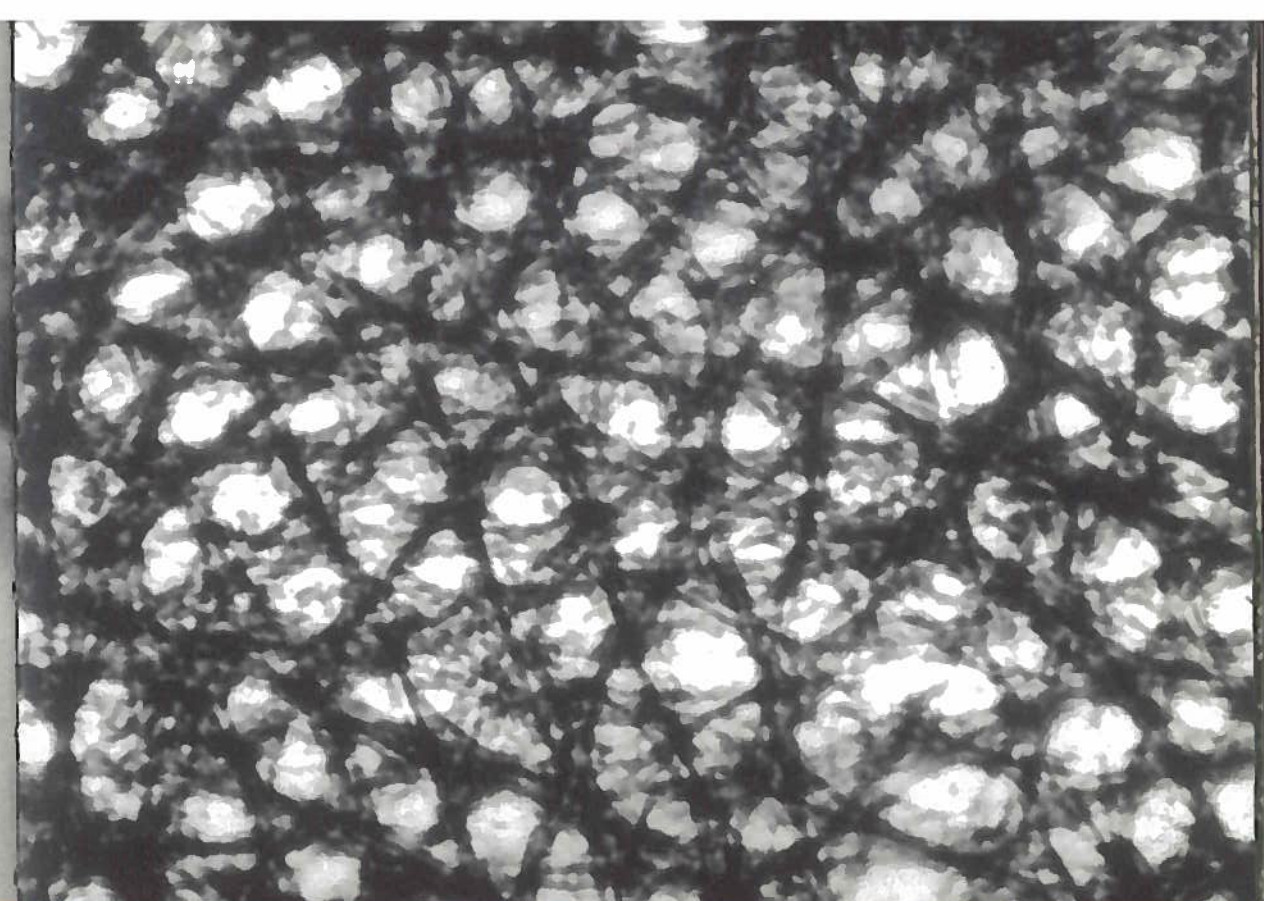


STRIP X →
STRIP X
CANNOT BE
SPREAD ABOVE
"A" POINTS
NOR LOWERED
BELOW "B" POINTS
ERGO 3 WAY
WEAVES
UNSPREADABLE
THEREFORE PROVIDE
STABLE PATTERN
STABLE STRUCTURE



-Synergetic weaves in comparison to euclidian-cartesian weaves. Fuller's arrangement of 60-degree angle modules is found in all weave-types in nature, but also in the wicker-work of primitive cultures. Drawing RBF, undated.

-Weave-analysis by Arthur H.C. von Hochstetter, M.D., who found "principles of a 60-degree lightweight structure" embodied in human connective tissue and, in 1962, entered into a lively exchange with RBF.



-Geodesic weave-structures: cornea of the human eye (left);
fibrous capsule of the human testicle (right).
v. Hochstetter 1962.



Construction of the double-shelled Hexagon-Pentagon Dome Construction for the American Society of Metals, Cleveland, Ohio, 1959. Architect John Kelly, construction by Synergetics, Inc.

The Tensegrity Dome provided for the Garden of Eden project, in which Geodesic Domes approximate pneumatic structures and membranes.

In recent times, there has been an increase in examples of successful modeling with geodesic-tensegritic structures. Donald Ingber's examination of cell growth with Tensegrities, cover page *Scientific American*, January 1998.

Deformation of the cytoskeleton of cells through application of load: as with a Tensegrity structure, the cell fabric permits a temporary distortion, but goes back into its original form. D. Ingber 1998.

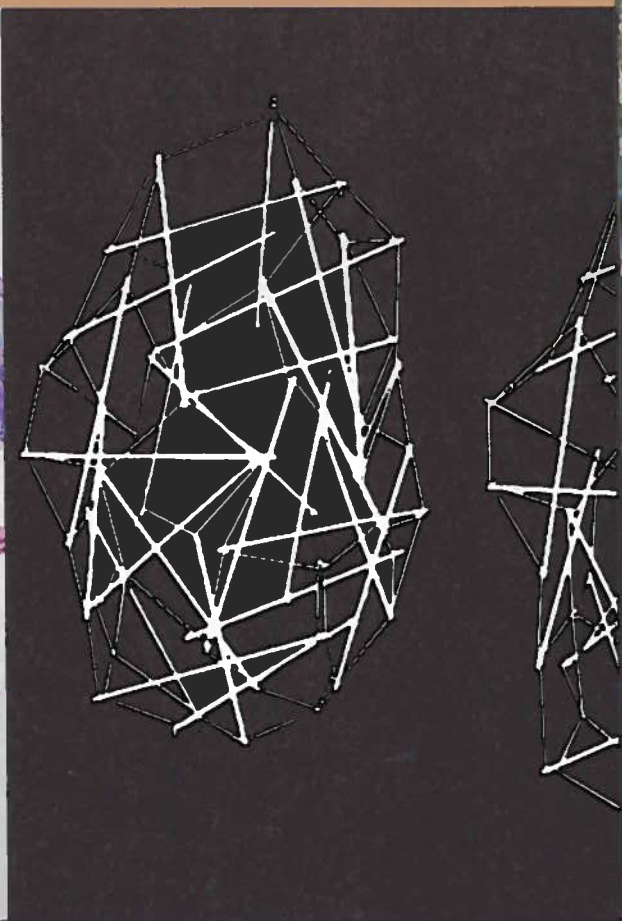
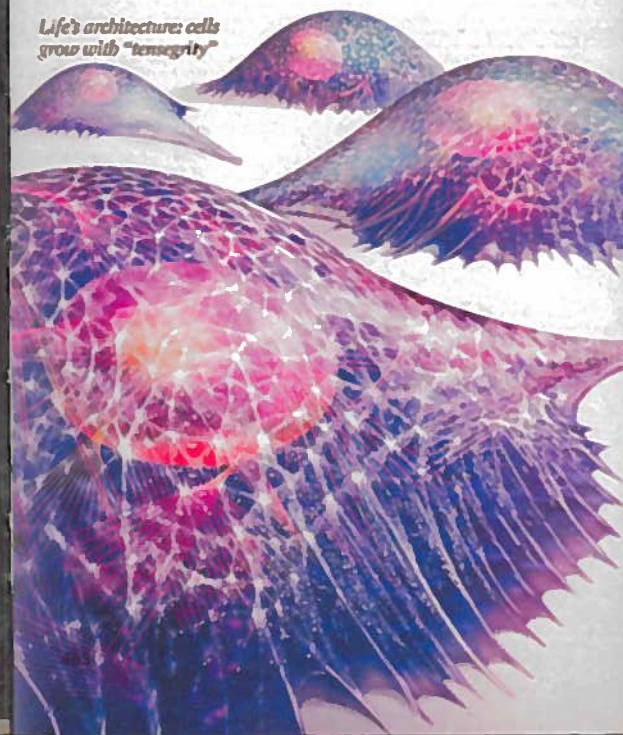


SCIENTIFIC AMERICAN

JANUARY 1998 \$4.95

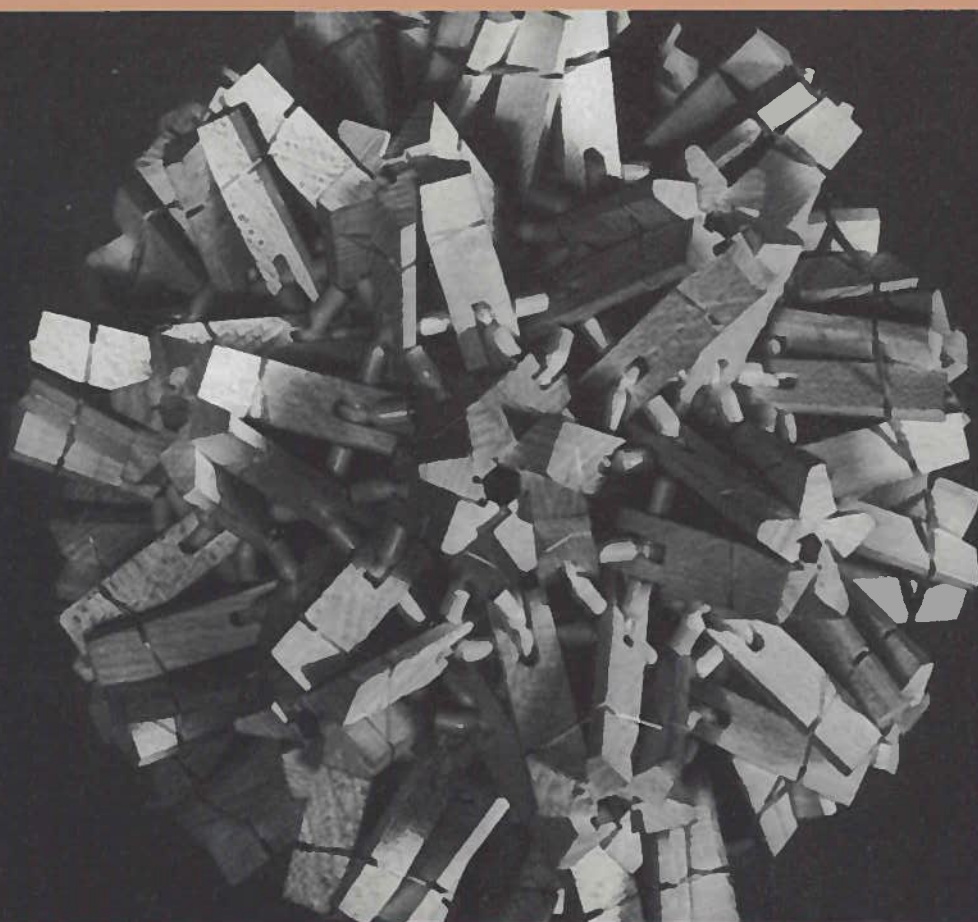
FLYING OVER
THE SOLAR SYSTEM
THE ULYSSES SPACECRAFT
GOES WHERE NO PROBE
HAS GONE BEFORE

Life's architecture: cells
grow with "tensegrity"



Fuller's buildings were never to be understood as merely utilitarian but, rather, were meant to instruct. In the case of two scientific discoveries, both of which were honored with the Nobel Prize, Fuller's constructions played the role of the catalyst:

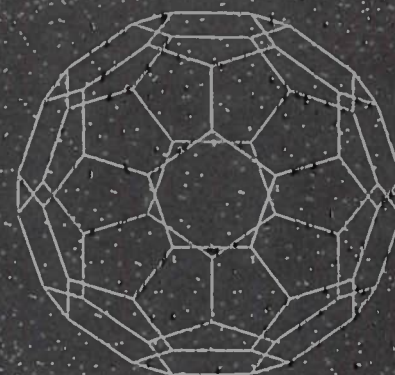
Discovery of the protein shells of viruses by Donald Caspar and Aaron Klug, 1962, Nobel Prize 1982. Wooden model of the polio virus by D. Caspar, presenting an inverse form of Fuller's *Flying Seedpod*. (Compare to p. 342).



nature

INTERNATIONAL WEEKLY JOURNAL OF SCIENCE

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SIXTY-CARBON CLUSTER

AUTUMN BOOKS

Harvey Brooks
Transformation of MIT
H. N. Johnson-Evans
Dream and mind
Anthony W. Chan

Donald B. G. Casper
Physics and physiology
Gordon Thompson
Microcosms of nuclear proliferation
John H. Hines

The spectacular discovery of a new class of carbon molecules, the Fullerene, by Kroto, Smalley and Curl 1985, Nobel Prize 1997. The Expo Dome, which Kroto and Smalley had both seen in Montreal in 1967, led them onto the right track in their search for the unknown molecular structure: to the icosahedral symmetry of the ball-shaped cage molecule.

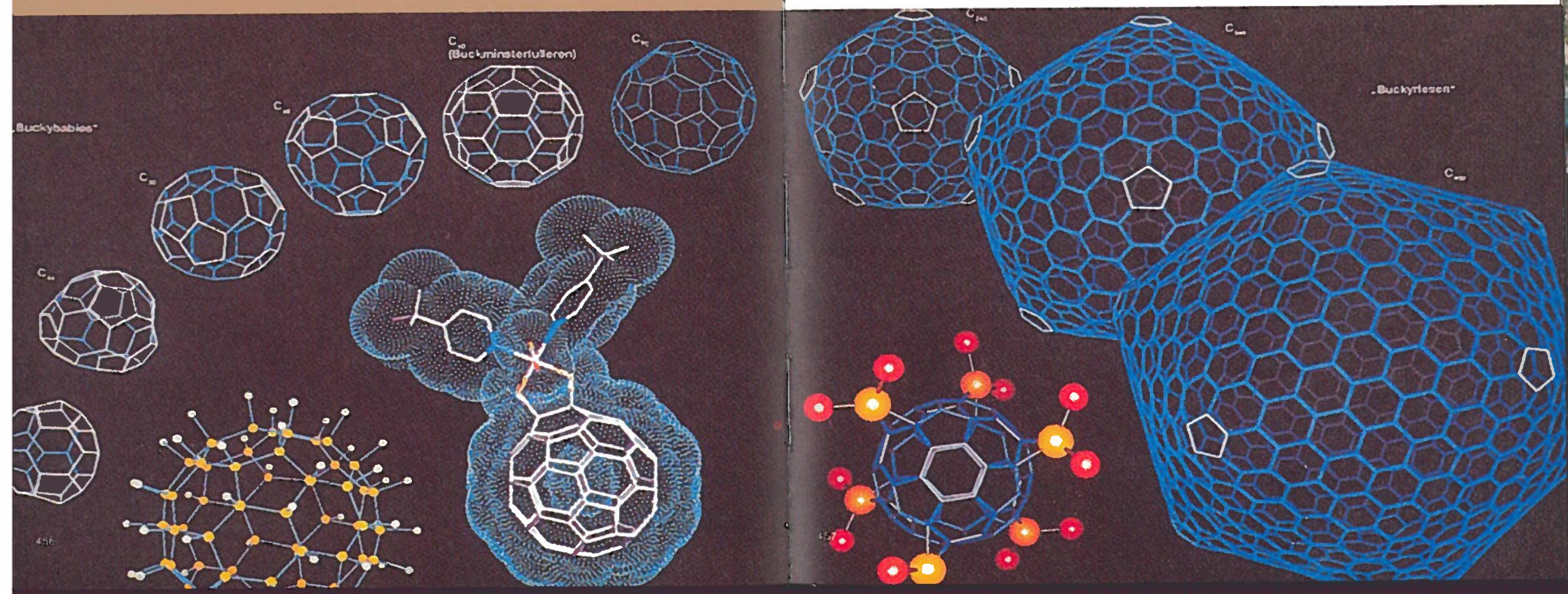
Corresponding to their varying number of atoms, there are molecules smaller than the 60-atom *Buckminster-Fullerene*, C-60, as well as much larger cage-like molecules of 70, 240, 540 and 960 atoms. Nevertheless, all feature the 12 pentagons that generate the closed volumetric form; the lattice-work of a uniform hexagonal grid permits no second degree curvature. Fuller's nickname "Bucky" was once again a fitting choice for popular names like "Buckyballs," "Buckybabies," etc. Aside from pure carbon molecules, what is of the highest research interest are the metallic compound, Fullerite, and numerous derivatives. Chemists contend that the discovery of the *Fullerene* has huge consequences for the whole of organic chemistry, speaking of an "end to flat chemistry."

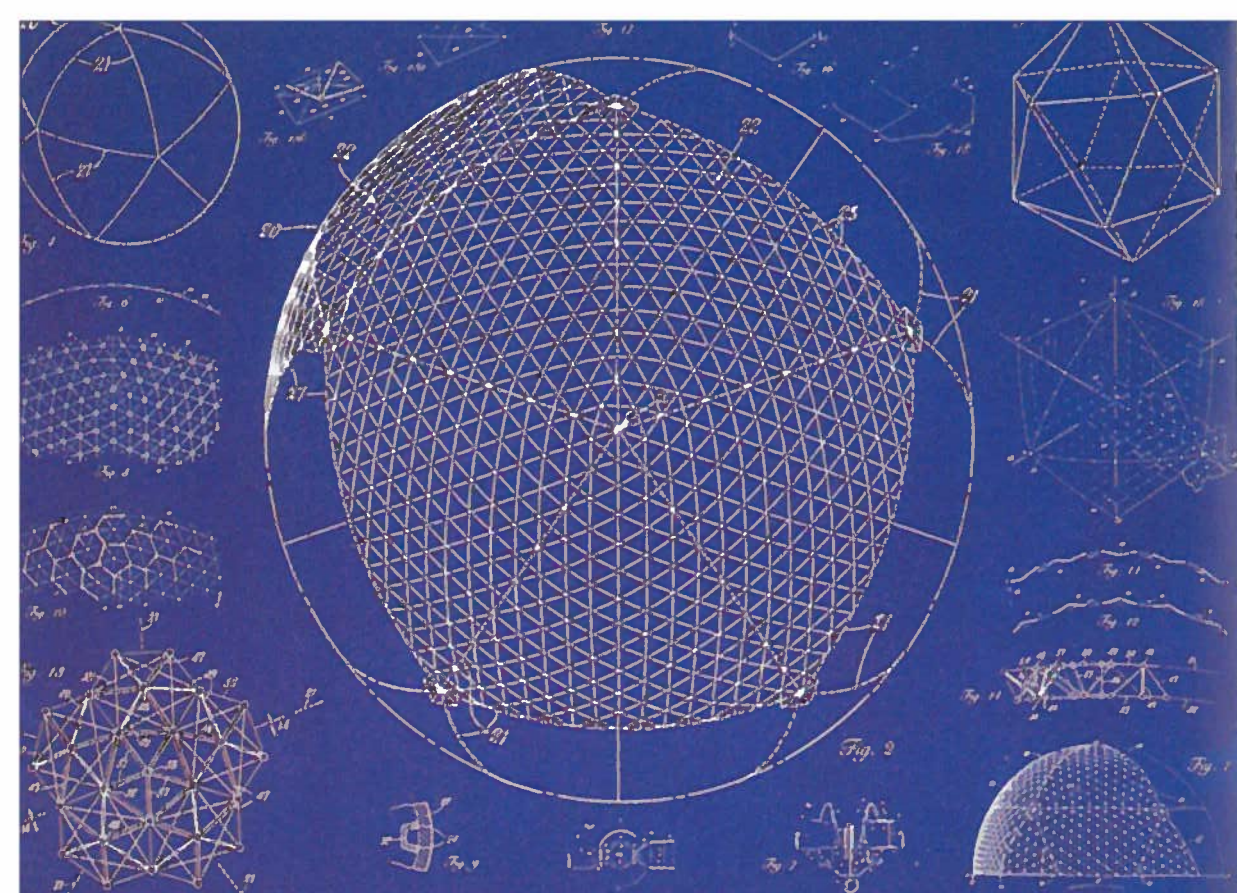
The Beauty of Bubbles

Looking back at the wake of my ship one day in 1917, I became interested in its beautiful white path. I said to myself, "That path is white because of the different refractions of light by the bubbles of water -H₂O (not H π O). The bubbles are beautiful little spheres. I wonder how many bubbles I am looking at stretching miles astern? I began to make calculations of how many bubbles there were per cubic foot of water. I began to find that in calculating the ship's white wake I was dealing in quintillions to the fourth power times quintillions to the fourth power or some such fantastically absurd number of bubbles. And nature was making those bubbles in sublimely swift ease! Any time one looks carefully at a bubble, one is impressed with the beauty of its structure, its beautiful sphericity glinting with the colors of the spectrum. It is ephemeral - elegantly conceived, beautifully manufactured and readily broken."

Inasmuch as the kind of mathematics I had learned of in school required the use of the XYZ coordinate system and the necessity of employing π in calculating the spheres, I wondered, "to how many decimal places does nature carry out π before she decides that the computation can't be concluded?" Next I wondered, "to how many arbitrary decimal places does nature carry out the transcendental irrational before she decides to say it's a bad job and call it off?" If nature uses π she has to do what we call fudging of her design which means improvising, compromising. I thought sympathetically of nature's having to make all those myriad frustrated decisions each time she made a bubble. I didn't see how she managed to formulate the wake of every ship while managing the rest of the universe if she had to make all those decisions. So I said to myself, "I don't think nature uses π . I think she has some other mathematical way of coordinating her undertakings."

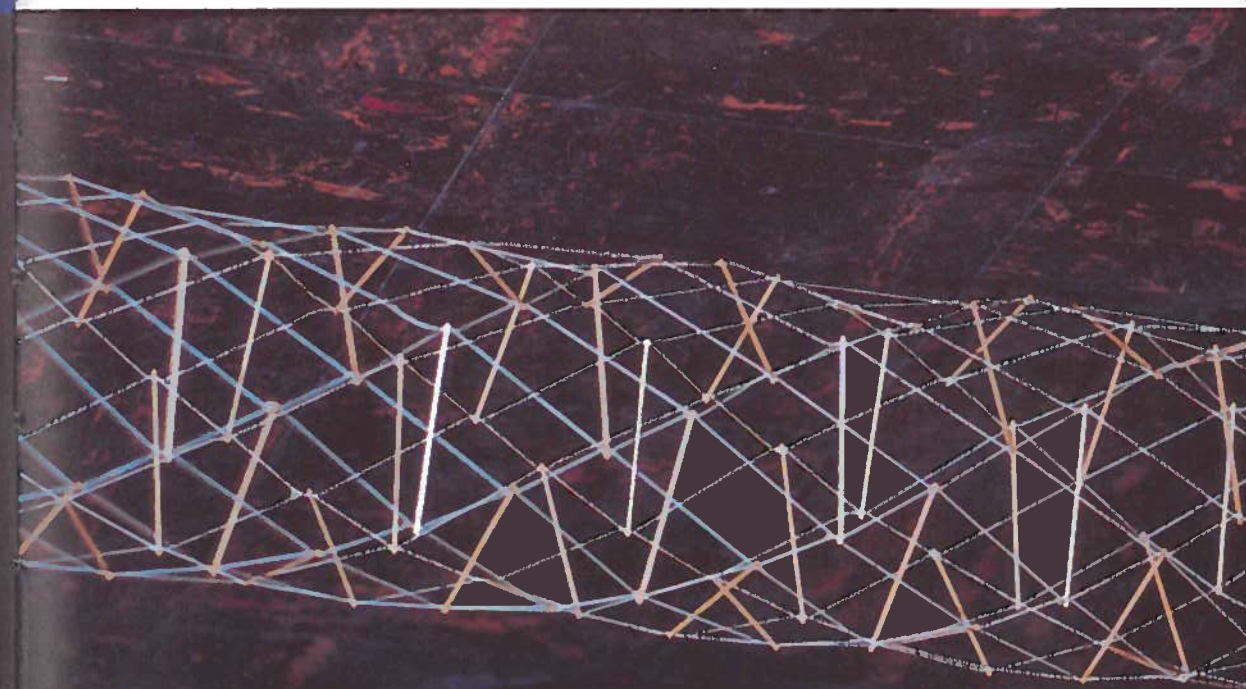
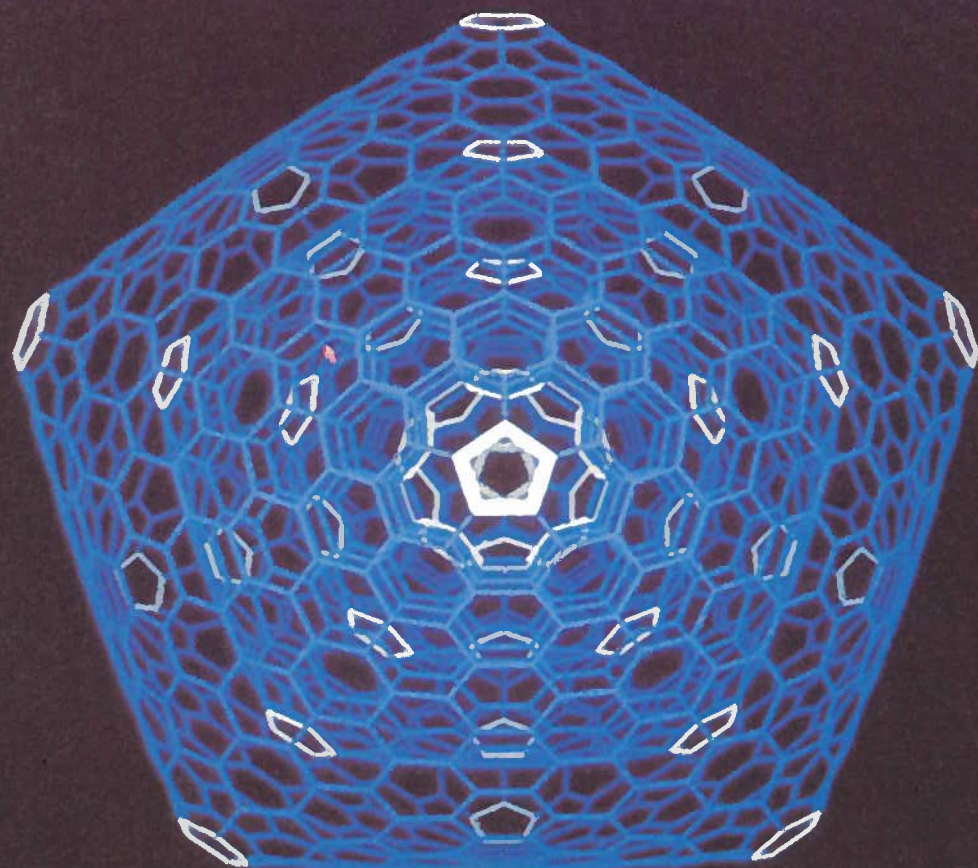
"Conceptuality of Fundamental Structures" in: G. Kepes: *Structure in Art and Science* (1965), 66

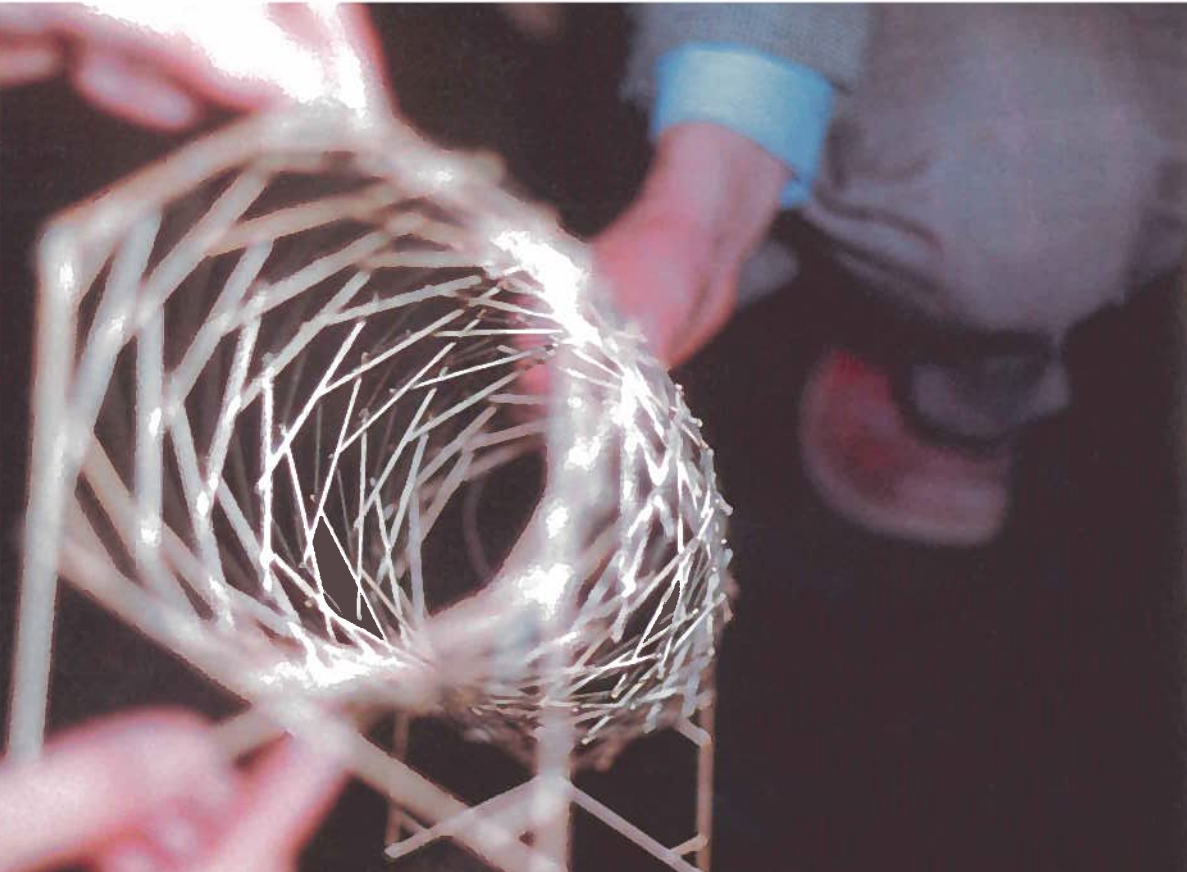




-458: Icosahedral Symmetry: drawing from RBF's patent application for "Geodesic Dome," U.S. Patent 2, 682, 235 (1954) - above - and intertwined carbon molecules in a *Hyperfullerene* (taken from F. Curl and R.E. Smalley 1991).

-459: As early as the 1950s, RBF was conducting experimental work with students applying synergetic principles in linear structures such as masts, tubes, etc. Experimental model of a Tensegrity-Tube with spiral torsion. Undated.





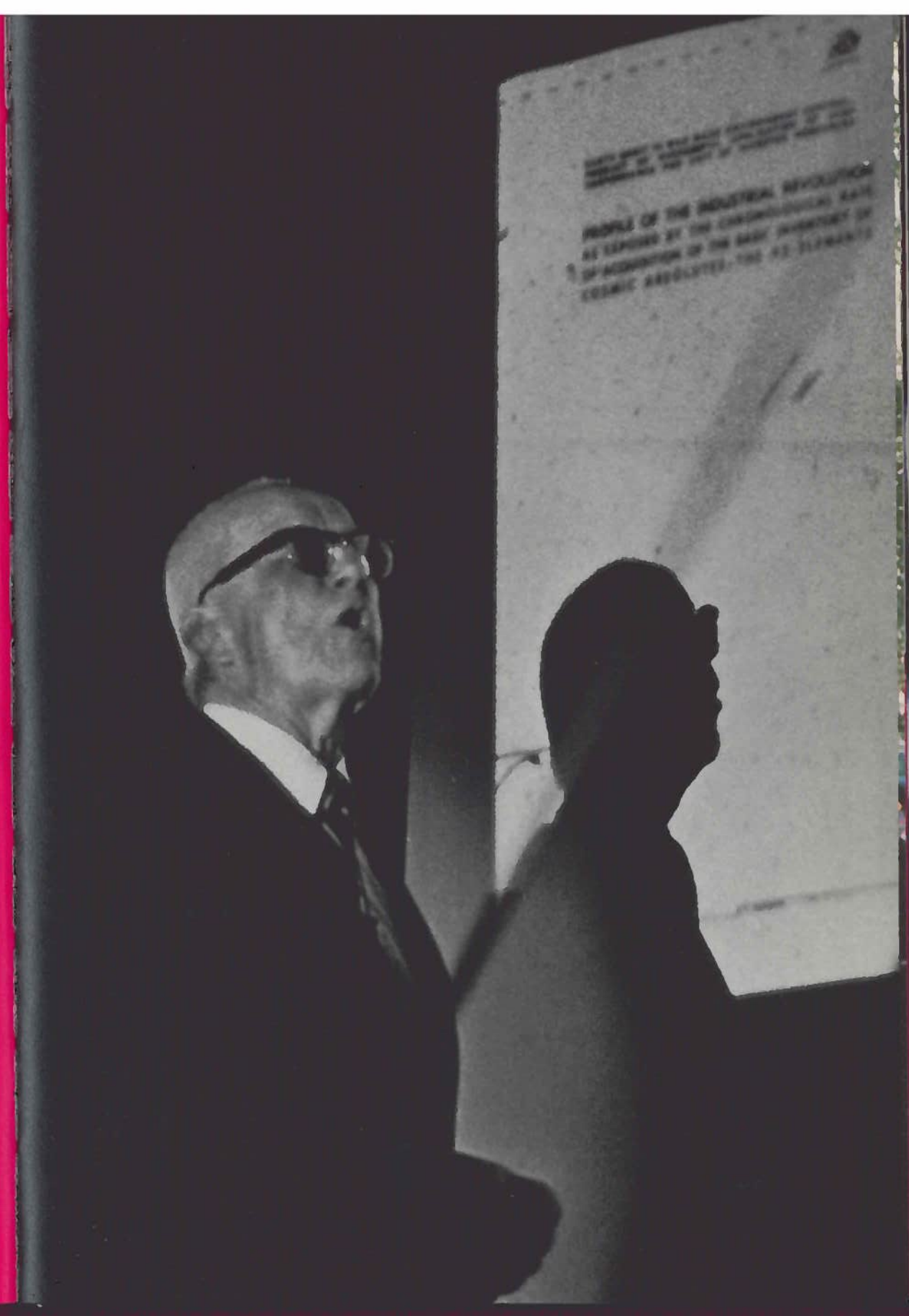
RBF's modeling of linear structures was made current in 1991 with the discovery by S. Iijima of Nano Tubes made from carbon molecules. With Fullerenes and "Buckytubes," Fuller's geometry suddenly became a central component of the rapidly evolving field of Nano technology. Photograph of model (undated).

Fuller's work emanated from a study of geometric principles, not from just copying forms from nature. Out of the sequencing of triangles and tetrahedrons, he came upon helix-cycles, each made of ten triple-bound tetrahedral cells. When turned in the same direction, they nest into each other, and tetra-helix cords formed of five-tetrahedron clusters are held together under tension around the transverse axis, but spring back apart from each other as soon as the tension ceases. In 1962, Fuller tried to use this to produce a geometric-theoretical explanation for the replication mechanism of the DNA double-helix.



All of his projects were always developed against the background of a planetary consciousness. Already in 1951, Fuller was using the idea of a spaceship Earth, which has long since become commonplace. We live in an integral, interdependent ecological system with problems we produce ourselves but also with inherent approaches to solutions. One needs, however, an idea of the whole in order to find the right partial solution. World Game was intended to make the conditions of global interaction manifest and to use computer simulation to make the consequences of decisions transparent to all.

WORLD GAME



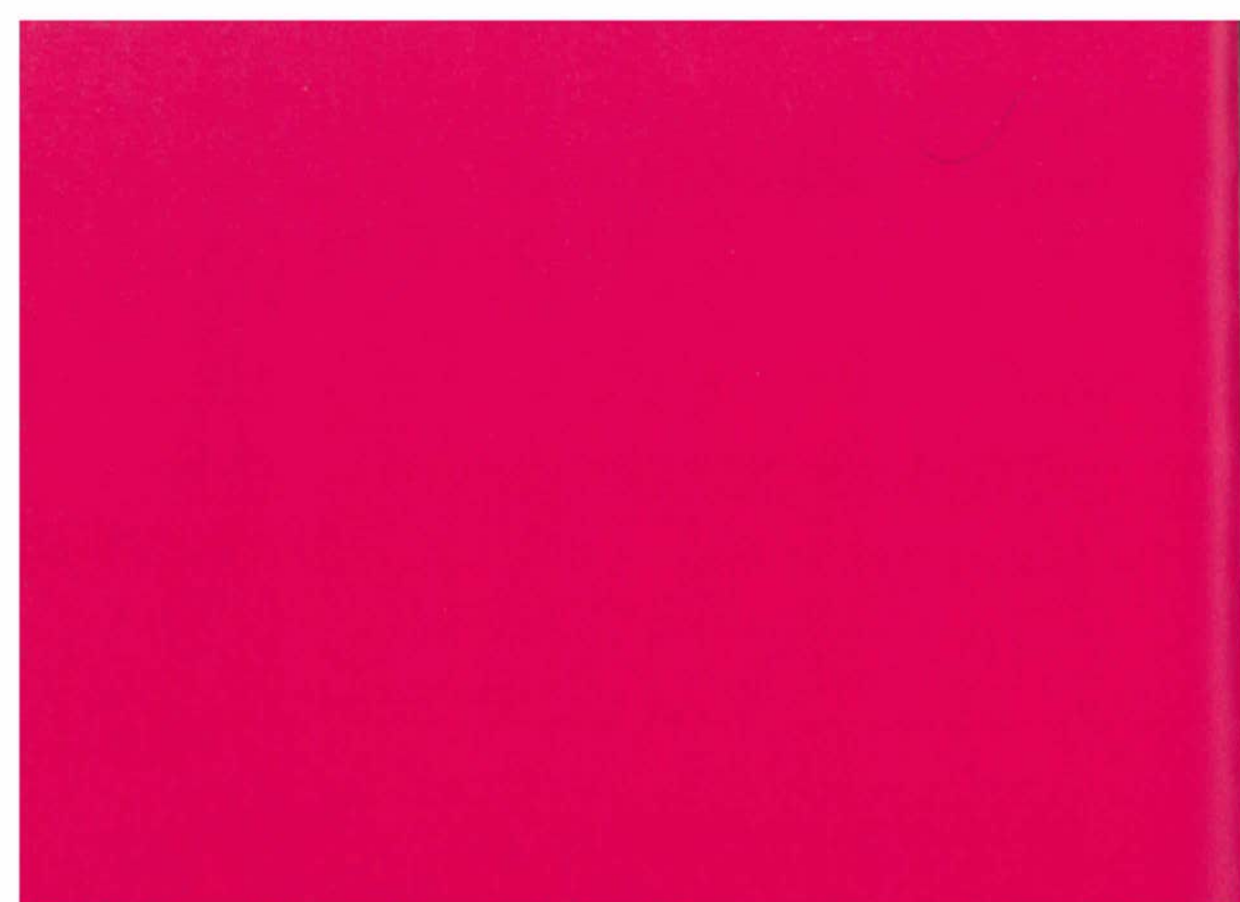


WORLD DESIGN SCIENCE DECADE 1965-1975

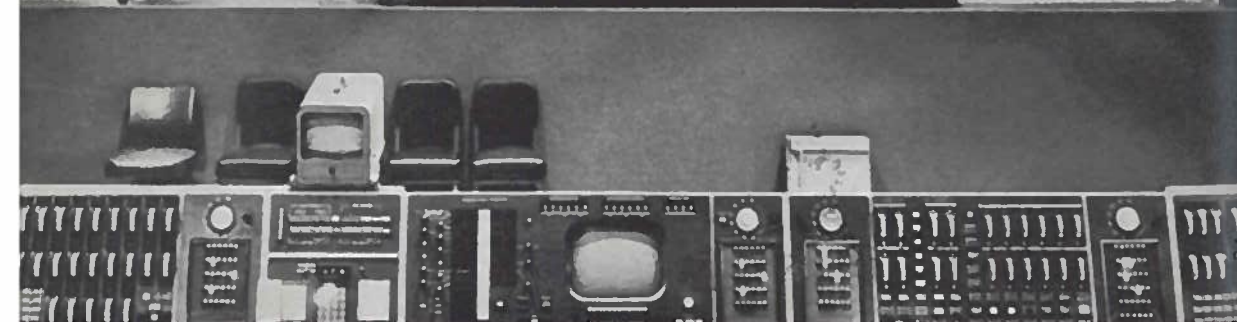
The *World Game* project originated in 1965 as a proposal for the U.S.A. contribution to the 1967 World's Fair in Montreal: an interactive game, supported by a large computer, shown on a large dynamic display of the Dymaxion World Map. It is played by trying to generate the best strategies for improving living conditions for all the earth's inhabitants. The starting point should be the distribution on the globe of natural resources, population, energy, means of transport and communication, etc. Participants – also out of politics – have the chance to play through their own concepts, to then be confronted with a display of the consequences their decisions have on the rest of the world.

For Fuller, *World Game* is meant to give an answer – or more than one answer – to the mounting social and ecological crisis, which he had been predicting since since around 1950. The crisis resulted from the fact that, on the global scale, only a minority had profited from industrialization. In order to make winners, not only must the social system be changed, but first, once, the way of thinking. Indeed, Fuller planned to adopt the technology of War Games, the mainframe computer, but he aimed to break through the game logic of War Games: in place of the *Drop Dead* ethic of a merciless society, instituting an ethic of acting together for the advantage of all.



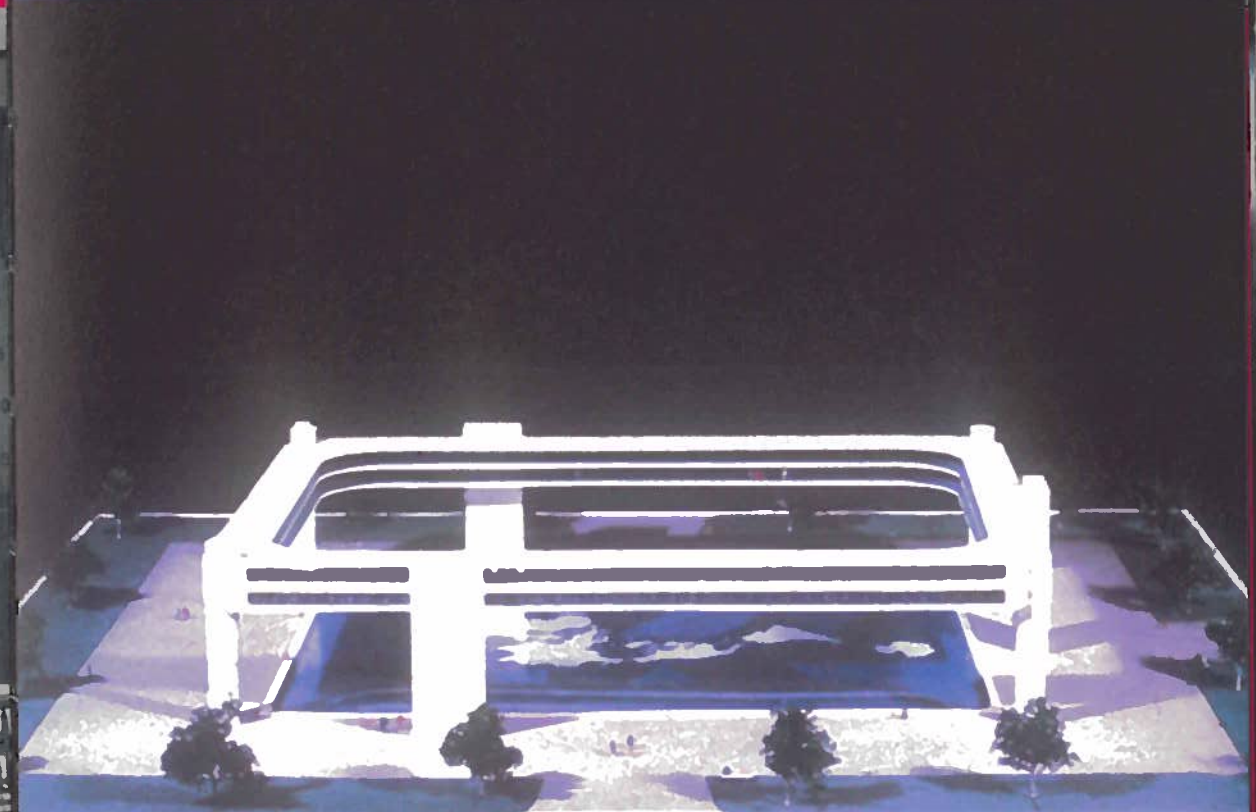
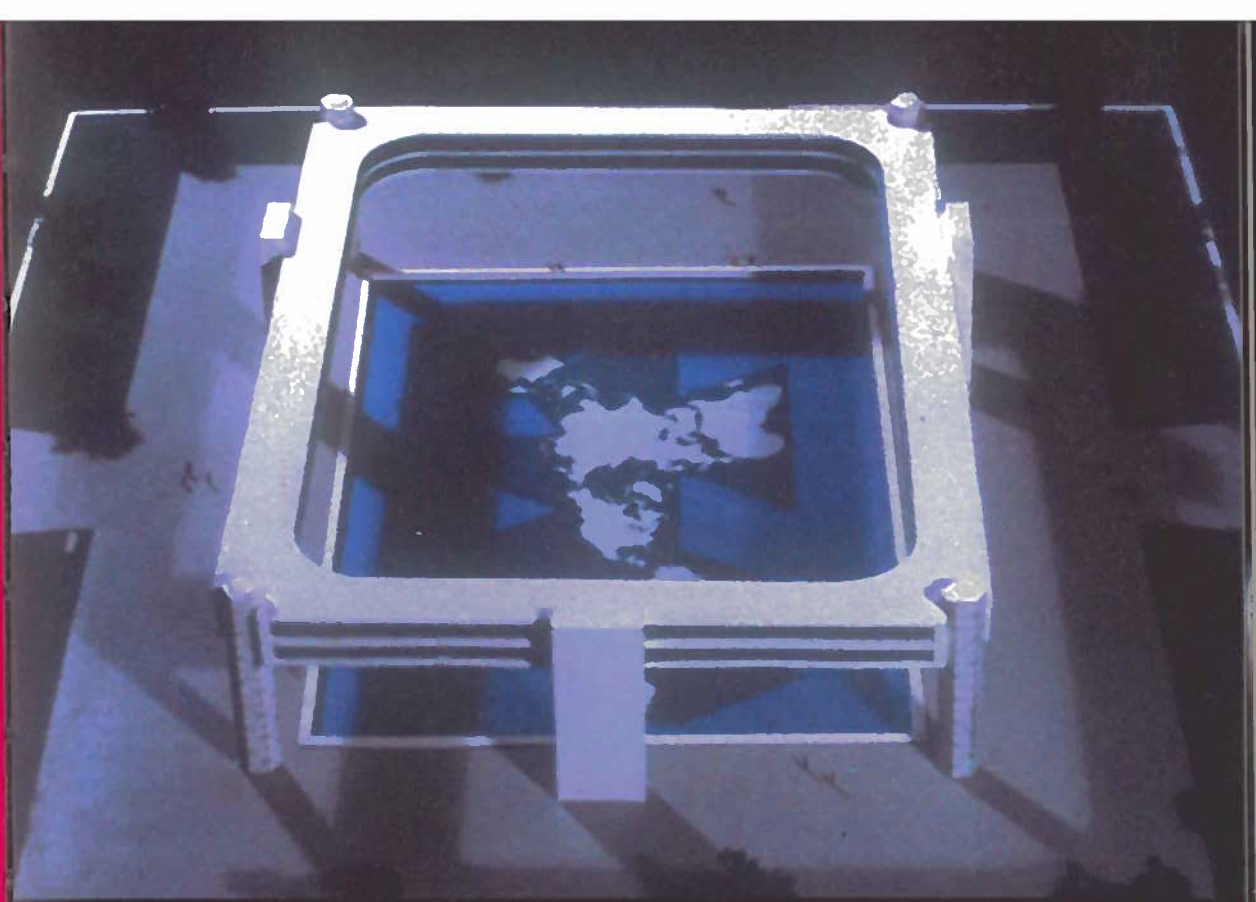


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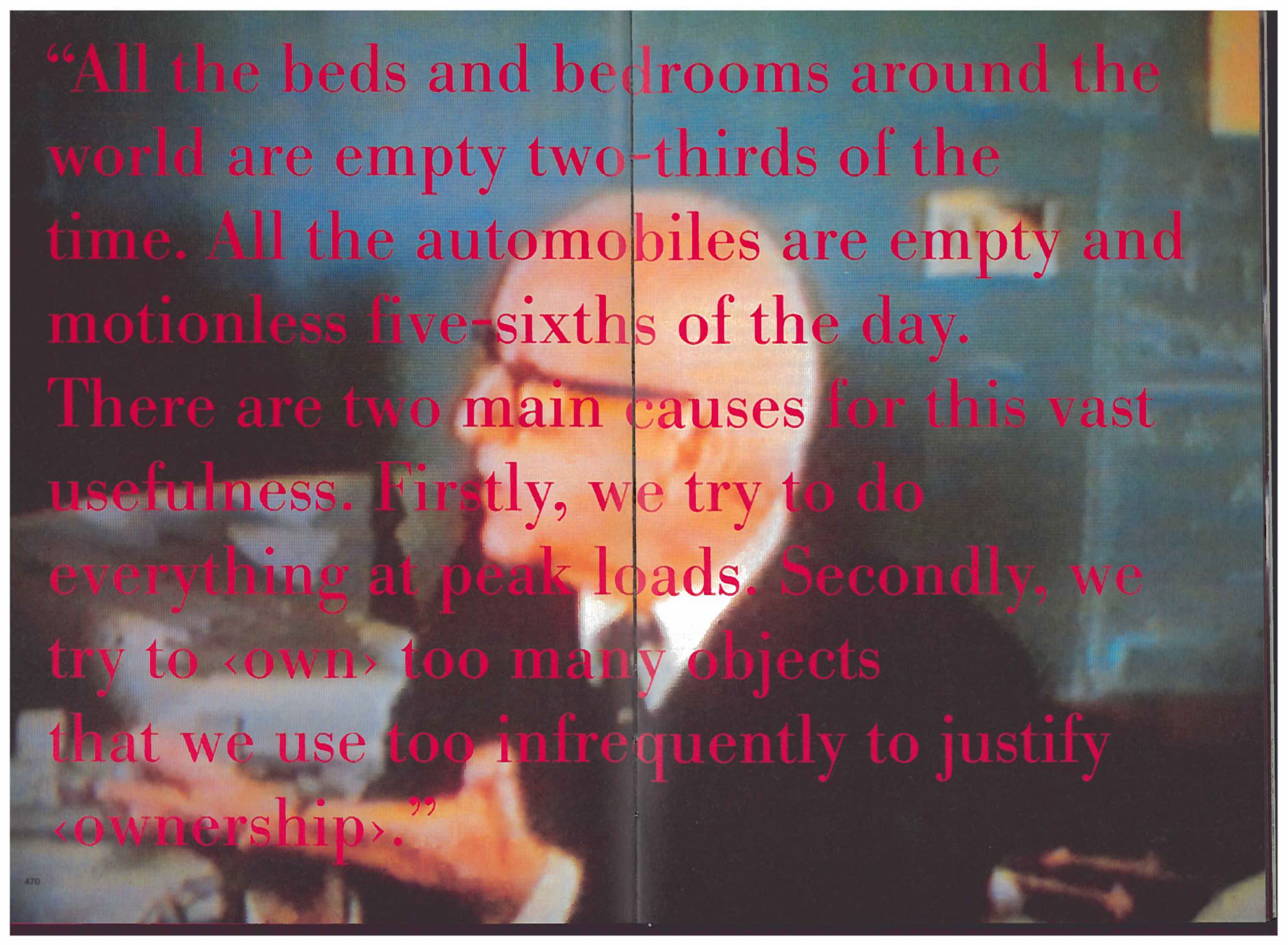
468 NASA control center: example of computerized global data integration; served as a technical model for Fuller's

co-worker John Mohrle for the installation of *World Game*. Photograph ca. 1965.



469 First project proposal from Fuller & Sasaki for Expo '67: *World Game*, interactive game with large-scale computer simulation and *Dynascan* world map as a dynamic display

of the world's resources. The proposal was rejected by the U.S. Information Agency. Model 1965



“All the beds and bedrooms around the world are empty two-thirds of the time. All the automobiles are empty and motionless five-sixths of the day. There are two main causes for this vast usefulness. Firstly, we try to do everything at peak loads. Secondly, we try to <own> too many objects that we use too infrequently to justify <ownership>.”

How It Came About (World Game)

In 1964 the United States Information Agency asked me to consider the design of a building and an exhibition which might be adopted as the United States entry in the Montreal World's Fair of 1967, later known as "Expo'67."

I made a proposal and the exhibition part of it was rejected. I was asked to continue, however, as the architect of the U.S.A. building to house an exhibition designed by others. (...)

Fortunately my U.S.A. geodesic dome for Expo '67 proved a success. Also, but more gradually, however, it is being realized by many that my rejected idea for the American exhibit is looming into ever greater prominence as a highly desirable social facility. I will therefore review the concept and development of my original idea.

I told the U.S.I.A. in 1964 that by 1967 the regard of the rest of the world for the United States would be at its lowest ebb in many decades - if not in the total two centuries of the U.S.A.'s existence. Since each country's World's Fair exhibit would be well published all around Earth, I felt that it would be very important that the United States do something that would tend to regain the spontaneous admiration and confidence of the whole world. (...)

What I proposed was based on my observation that world people had become extraordinarily confident in the fundamental reliability of the computer and its electronically controlled processes. I know that a great many people will contradict me, but I had predicated my conviction - of society's subconsciously established confidence in the computer's reliability - upon vital, therefore undeniable, behavior facts.

I refer to the equanimity with which world-around air jet travelers now commit their lives to the computer's reliability. (...)

As I now fly around the world in jets in the company of 125 to 135 passengers, we frequently find ourselves coming in for a landing in the night and fog. But everybody is occupied in reading, sleeping, listening to the music or talking. (...)

On the working assumption that humanity now has established implicit confidence in the computers and automated instrumentation, I proposed in 1964 that the United States' Expo '67 exhibition should have a 400 foot diameter 5/8 sphere building similar in shape to the 250 foot diameter building actually built for Expo '67. In the basement of this building would be housed an extraordinary computer facility. On entering the building the visitors would arrive upon a great balcony reaching completely around the building's interior quarter-mile perimeter. The visitors would see an excitingly detailed one hundred foot diameter world globe suspended high within the 400 foot diameter 5/8 sphere main building. Cities such as New York, London, Tokyo, and Los Angeles would appear as flattened out basketball sized blotches with the tallest buildings and radio towers only about one-sixteenth of an inch high.

Periodically the great spherical Earth would be seen to be transforming slowly into an icosahedron - a polyhedron with twenty (equilateral) triangular facets. The visitors would witness that in the processes of these transformations there are no visible changes in the relative size and shape of any of the land and water masses of the 100 foot diameter miniature Earth. Slowly the 100 foot diameter icosahedronal Earth's surface will be seen to be parting along some of its triangular edges, as the whole surface slowly opens mechanically as an orange's skin might be peeled carefully in one piece. With slits introduced into its perimeter at various places it would be relaxed to subside into a flattened-out pattern. The icosahedronal Earth's shell thus will be seen to gradually flatten out and be lowered to the floor of the building. The visitors would realize that they were now looking at the whole of the Earth's surface simultaneously without any visible distortion of the relative size and shape of the land and sea masses having occurred during the transformation from sphere to the flattened-out condition which we call a map. My cartographic projection of the "Sky Ocean World" functions in just such a manner.

This stretched out football field sized world map would disclose the continents arrayed as one world island in one world ocean with no breaks in the continental contours.

The great map would be wired throughout so that mini-bulbs, installed all over its surface, could be lighted by the computer at appropriate points to show various, accurately positioned, proportional data regarding world conditions, events, and resources. World events would occur and transform on this live world map's ever evolving face.

I proposed that, on this stretched out reliably accurate, world map of our Spaceship Earth, a great world logistics game be played by introducing into the computers all the known inventory and whereabouts of the various metaphysical and physical resources of the Earth. This inventory, which has taken forty years to develop to high perfection, is now housed at my Southern Illinois University headquarters.

We would then enter into the computer all the inventory of human trends, known needs and fundamental characteristics.

I proposed that individuals and teams would undertake to play the "World Game" with those resources, behaviors, trends, vital needs, developmental desirables, and regenerative inspirations. The players as individuals or teams would each develop their own theory of how to make the total world work successfully for all of humanity. Each individual or team would play his theory through to the end of his predeclared program. It could be played with or without competitors.

The objective of the game would be to explore for ways to make it possible for anybody and everybody in the human family to enjoy the total earth without any human interfering with any other human and without any human gaining advantage at the expense of another.

To accomplish the game's objective, the resources, pathways and dwelling points around the surface of our eight thousand mile diameter, spherical Spaceship Earth must be employed by



Fig. 1 - First World Game Session, led by RFP and Edwin Schlossberg, New York, July 1964.



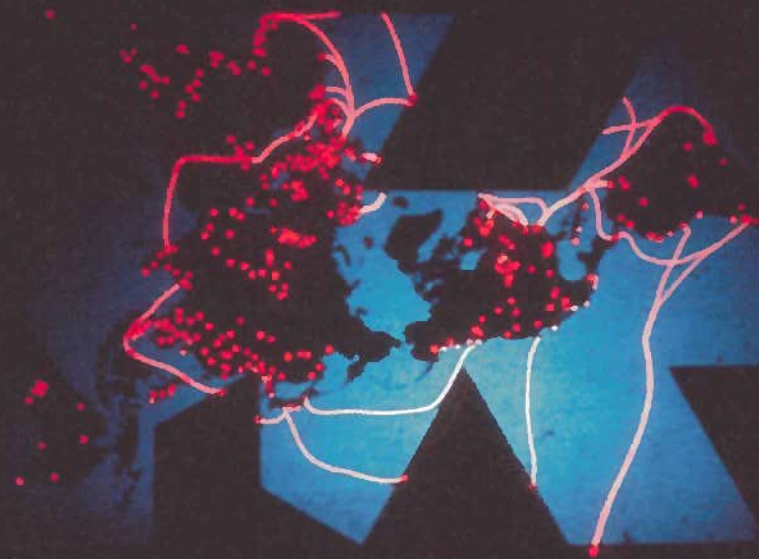
7 - ENERGY SLAVES - 1970



17 - FOOD MOVEMENT - BREAD GRAINS — 5×10^5 TON/TR



9 - COPPER - 1970 * - SITES — DISTRIB



5 - IRON ORE * - SITES ▲ POTENTIAL — DISTRIB

24 POPULATION - 1970

0-150,000

25 POPULATION - 2000 PROJECTION

0-150,000

27 ENERGY SLATES - 1970

28 SHIPPING LINES - 1970

31 RAILROADS

34 TRANSOCEANIC CABLES - 1964

33 AIRWAYS - 1970

32 MAJOR INTRAL AIRPORTS

20 SATELLITE COMMUNICATION (GROUND) STATIONS

25 TELEVISION RECEIVERS

0-250,000 [2,500,000 TOTAL]

22 COLLEGES - 1970

27 % LITERACY

16 FOOD DISTRIBUTION - VEGETABLE PROD - 1970

15 FOOD DISTRIBUTION - ANIMAL PROD - 1970

11 FOOD MOVEMENT - RICE - 1970

29 CENTERS OF INFO AND COMMERCE

19 WATERWHEELS 1960 20000³ (CAPACITY MW)

25 EARTHQUAKE ZONES AND STABLE LAND MASSES

9 COVER 1970 SITES DISTANCE

10 THERMAL ELECTRIC PLANTS 1970 10³ MW 10³ MW

14 HYDROELECTRIC STATIONS 10³ MW

21 POTENTIAL ENERGY SOURCES WIND GEOTHERMAL

22 POTENTIAL ENERGY SOURCES TIDAL CURRENTS

11 INTERCONNECTING ELECTRIC NETS 220 MW

the players in such a way that the world's individual humans would each be able to exercise complete actional discretion; and would have such freedom of decision regarding the investment of their time in their waking hours that they would be able to travel independently, or in groups, either to-and-fro locally, or continuing intermittently on around the world, dwelling from time to time here or there, finding everywhere facilities to accommodate their needs in an uncompromising manner. The game would seek to use the world's resources, interprocesses and evolutionary developments in such a way that all the foregoing would be possible. It might involve moving whole city-sized groups of buildings from here to there in a few hours.

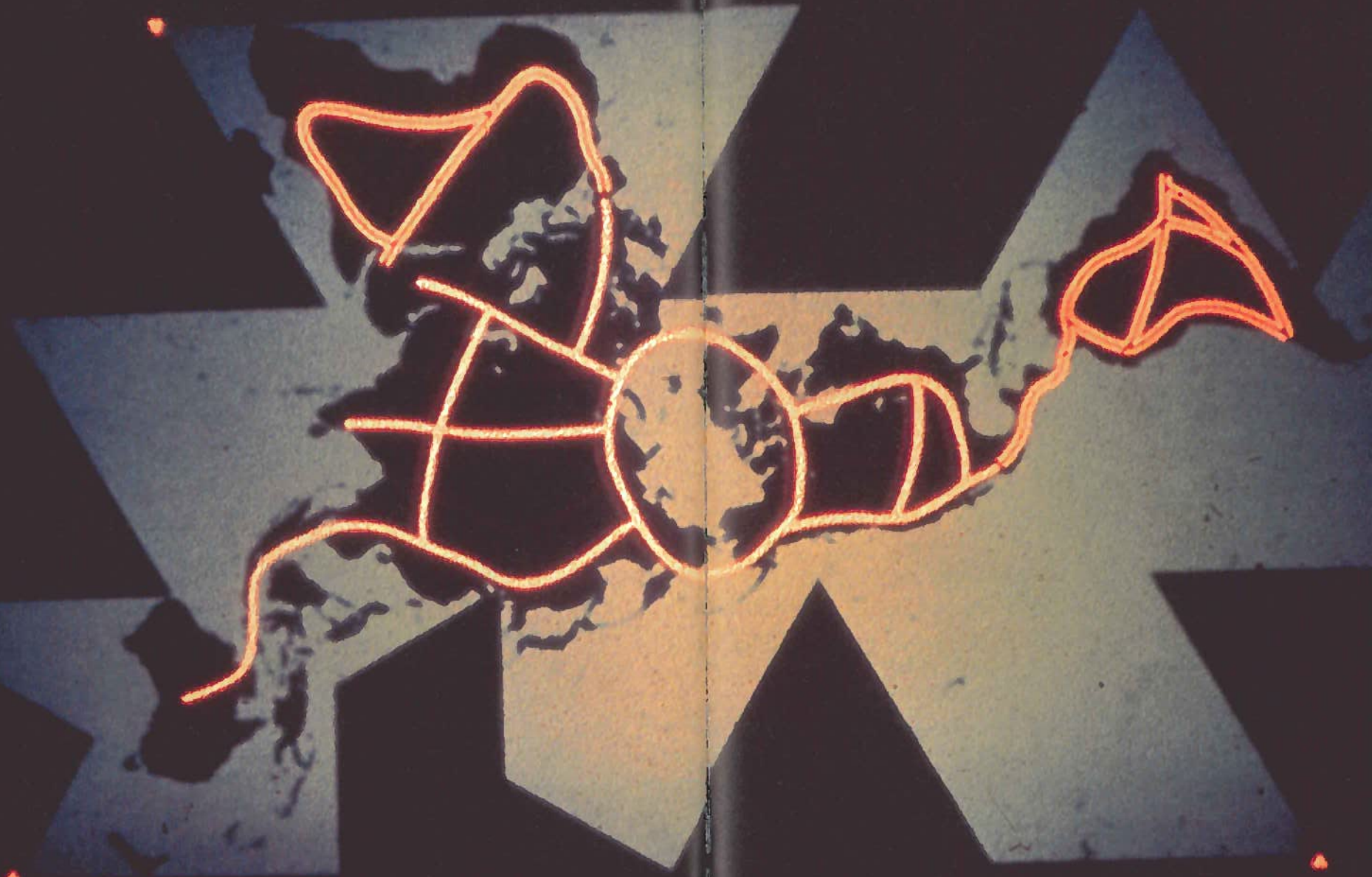
Let us assimilate World Game playing as I envision it, in order also to envision the kind of information most probably to result from such forward re-integration of our present world inventory of systematically differentiated-out physical and metaphysical variables.

(...) Amongst other grand strategies for making the world work and taking care of everybody is the design science revolution of providing ever more effective tools and services with ever less, real resource investment per each unit of end performance. For instance, a communications satellite, weighing only one-quarter of a ton, is now out-performing the transoceanic communication capabilities of 175 thousand tons of copper cable.

The World Game will explore for, and experiment with, more-for-less uses of our resources so that instead of taking care of only 44% of humanity at a high standard of living, we can take care of all of humanity at an even higher standard of living than man has as yet conceived.

In playing the game I propose that we set up a different system of games from that of Dr. John Von Neuman whose "Theory of Games" was always predicated upon one side losing 100 percent. His game theory is called "Drop Dead." In our World Game we propose to explore and test by assimilated adoption various schemes of "How to Make the World Work." To win the World Game everybody must be made physically successful. Everybody must win.

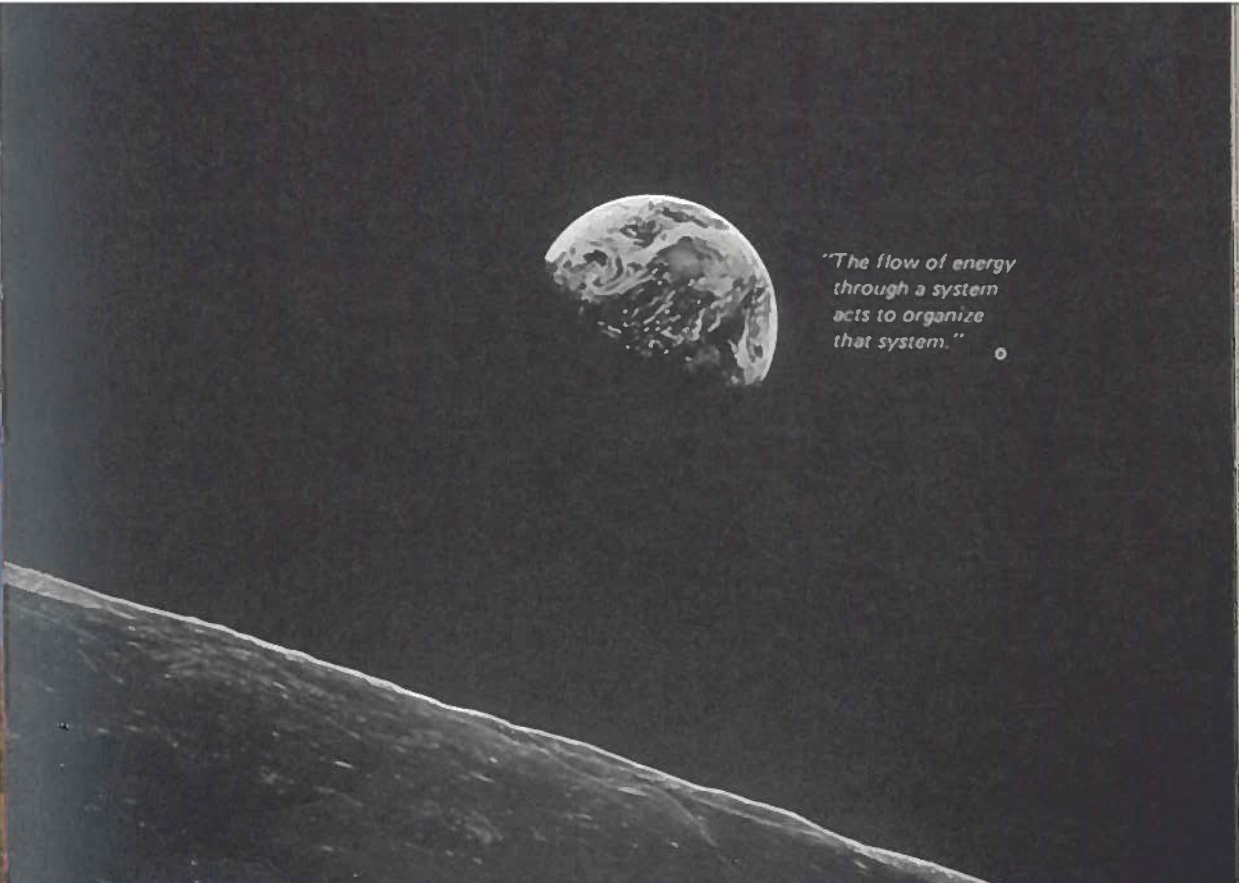
"How It Came About", in: *50 Years Design Science Revolution and the World Game* (1969), 111



10⁷ HIGH VOLT INTEGRATED GRID • PROJECTED

480 World Game Sentinel 1972; project for a global network of ultra high-voltage highways. Increase in efficiency up to 100 percent through day-night balancing.





"The flow of energy
through a system
acts to organize
that system."

#67 - #68, #69, Buckminster Fuller speaking to a group of hippies, San Francisco 1968. Living in domes as alternative to establishment.

Proa City commune near Trinidad, Colorado, founded 1968. Dome constructions out of pieces of scrapped nukes, adaptation of the geodesic model and cluster form. Beginning



#68 - at the Domes movement as a part of the alternative scene. Inner page of the Whole Earth Catalog, 1971. "The flow of energy through a system acts to organize that system."



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WHOLE EARTH CATALOG

access to tools



Spring 1970
\$3



Access to Tools for the Whole Earth

In 1968 Stewart Brand, together with some friends from California's "counterculture," founded *The Whole Earth Catalog*. With print runs in the millions, it became the most successful and longest-lived print medium of the alternative scene. The inspiration for the company derived from Buckminster Fuller's thought and from the first satellite photos by NASA of the whole earth. Earth could finally be seen like the moon, waxing and waning, and above all as a totality, a whole system, just as Fuller had always seen it.

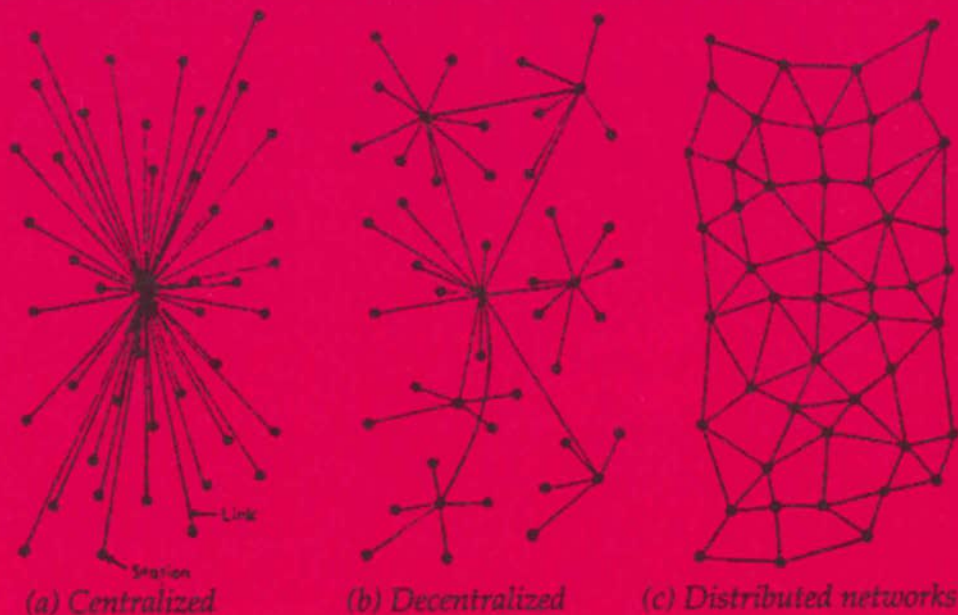
"Buckminster Fuller's views initiated *The Whole Earth Catalog*," wrote Stewart Brand, "the ideas of 'access,' 'tools,' and 'whole systems' came from him. And there is a lot more to it." It resembled a mail-order catalog, but the subtitle, "Access to Tools," shows that it was not primarily about the sale of goods but about access to intellectual and material tools for life. The catalog, constructed like an encyclopedia, provides information about access and thus fundamentally adopts the standpoint of the user; it takes the user's feedback and experience into account.

Building on the growing network of readers and users, the magazines *Co-Evolution Quarterly* and *Whole Earth Review* are begun. In 1985 Stewart Brand and Larry Brilliant found the first civilian computer online service, *The Well*. In networking the first virtual community certain procedures of usage it began to develop that have since, with the advent of the Internet, become the standards of interactive communication.

T H E M I L L E N N I U M

W H L E
E A R T H

C A T A L O G



Shrinking Planet Earth

Disparity of the successive present generation's norms with those of previous and yet living generations is swiftly widening the gap between aspirations of the old and newer generations.

To make this disparity and its potential solvability clearer for study, I made some figures that I now find useful in comprehending the enormous velocity of change wrought in our evolving relationship to our respectively altering a priori universes. I started with a sphere twenty feet in diameter as a model, which was meant to represent the slowest relative rate of negotiability of the earth as gauged by the following calculations.

First, I supposed a path to be put about the earth, there being no dry path around the earth. But I wanted to allow a man to walk around the earth at the rate at which the Army says a man can walk daily, and rest and feed. The twenty-foot globe represented the rate at which he would be able to walk around the earth. Then I gave him a horse. The horse also had to sleep and rest and eat – and, using the Army figures again, I found man can negotiate the earth with a horse so fast that the relative size of the earth is reduced to a ball six feet in diameter.

I gave man a fast-sailing clipper ship and the earth came down to the size of a basketball.

When I obtained these figures I realized the historical economic advantage that a man with a ship had over a man with a horse and how much greater advantage they both had had over a man on foot, throughout all history. The clipper ship, of course, was a tool; it was the first really large industrial tool that could not be produced by one man. And it did not have to stop to sleep at night like the horse, but kept on going twenty-four hours, day after day.



Now when you give men railroad trains and steamships, which can negotiate about the same distance daily, because the railroad train has to be replenished very frequently, we find that the relative size of the rate of negotiability of earth comes down to the size of an American baseball. Taking the jet planes, the relative size of man's negotiable earth comes down to the size of a 3/4-inch marble. Projecting the present rate of acceleration of commercial air transport speed for just five years and taking the figures now adopted for 1968 by the International Aeronautical Union and the American Air Force, the relative size of man-negotiable earth will be the size of a pea, and that is the smallest we need now consider, for it will inaugurate an entirely new era of man-around-earth.

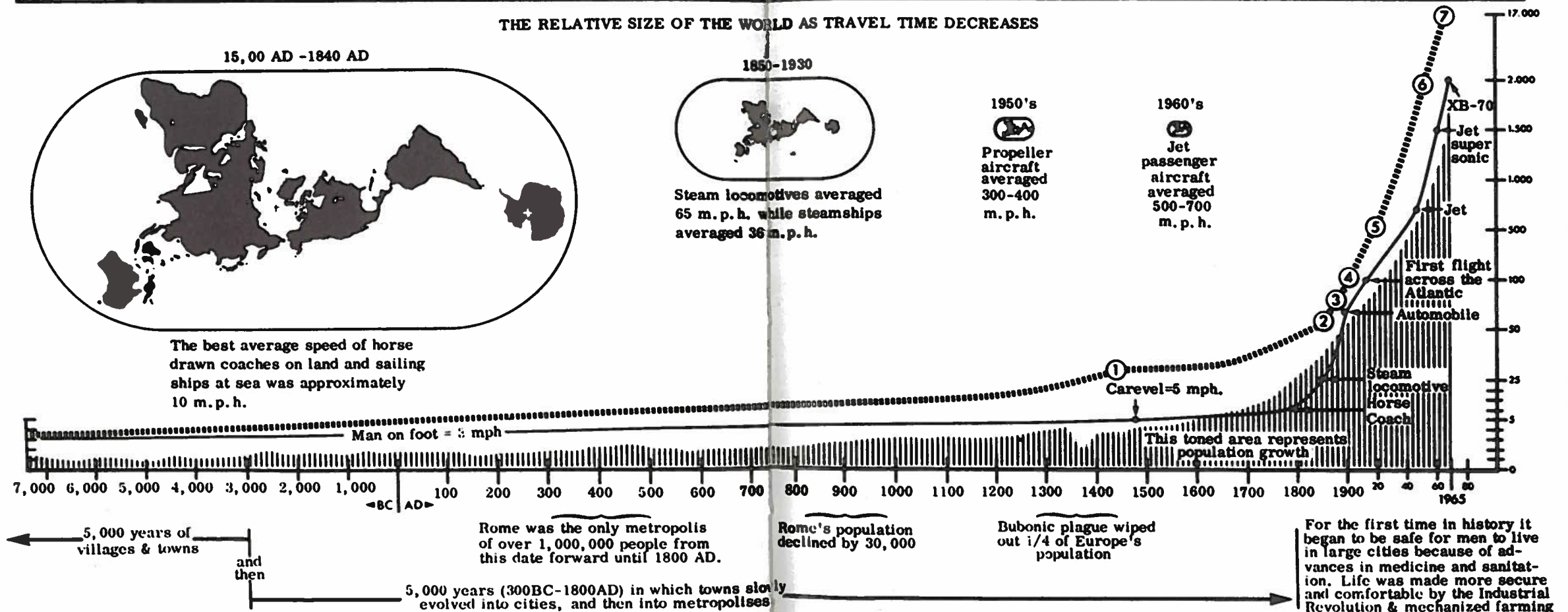
"RIBA-Discourse", in: *Ideas and Integrity* (1963), 501.

SHRINKING OF OUR PLANET BY MAN'S INCREASED TRAVEL AND COMMUNICATION SPEEDS AROUND THE GLOBE

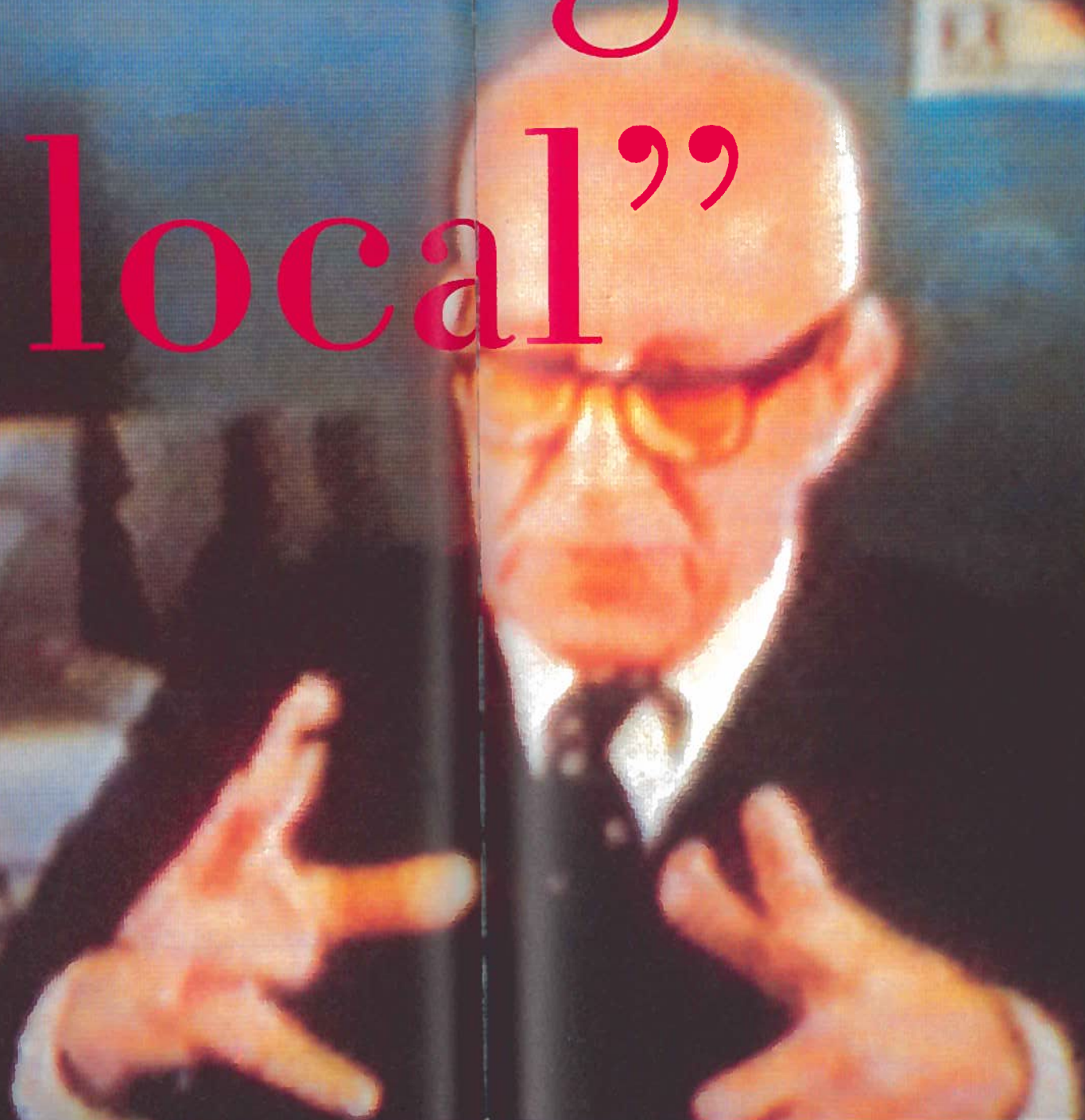
YEAR	500,000 BC	20,000 BC	300 BC	500 BC	1,500 AD	1900 AD	1925	1950	1965
Required time to travel around the globe	A few hundred thousand years	A few thousand years	A few hundred years	A few tens of years	A few years	A few months	A few weeks	A few days	A few hours
Means of transportation	Human on foot (over, ice bridges)	On foot and by canoe	Canoe with small sail or paddles or relays of runners	Large sail boats with oars, pack animals, and horse chariots	Big sailing ships (with compass), horse teams, and coaches	Steam boats and railroads (Suez and Panama Canals)	Steamships, transcontinental railways, autos, and airplanes	Steamships, rail-ways, auto jet and rocket air-craft	Atomic steamship, high speed railway auto, and rocket-jet aircraft
Distance per day (land)	15 miles	15-20 miles	20 miles	15-25 miles	20-25 miles	Rail 300-900 miles	400-900 miles	Rail 500-1,500	Rail 1000-2000
Distance per day (sea or air)		20 by sea	40 miles by sea	135 miles by sea	175 miles by sea	250 miles by sea	3,000-6000 air	6000-9500 air	408,000 air
Potential state size	None	A small valley in the vicinity of a small lake	Small part of a continent	Large area of a continent with coastal colonies	Great parts of a continent with trans-oceanic colonies	Large parts of a continent with transoceanic colonies	Full continents & Transocean Commonwealths	The Globe	The globe and more

Communications	Word of mouth, drums, smoke, relay runners, and hand printed manuscripts prior to 1441 A.D.	① The Gutenberg 1441 printing press	② The rapid print Web 1863 newspaper press	③ The Bell 1876 telephone	④ The Marconi 1893 telegraph	⑤ First commercial 1920 radio broadcast	⑥ National 1950 Television	⑦ Transcontinental T. V. with the introduction of Early Bird satellite 1965
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THE RELATIVE SIZE OF THE WORLD AS TRAVEL TIME DECREASES

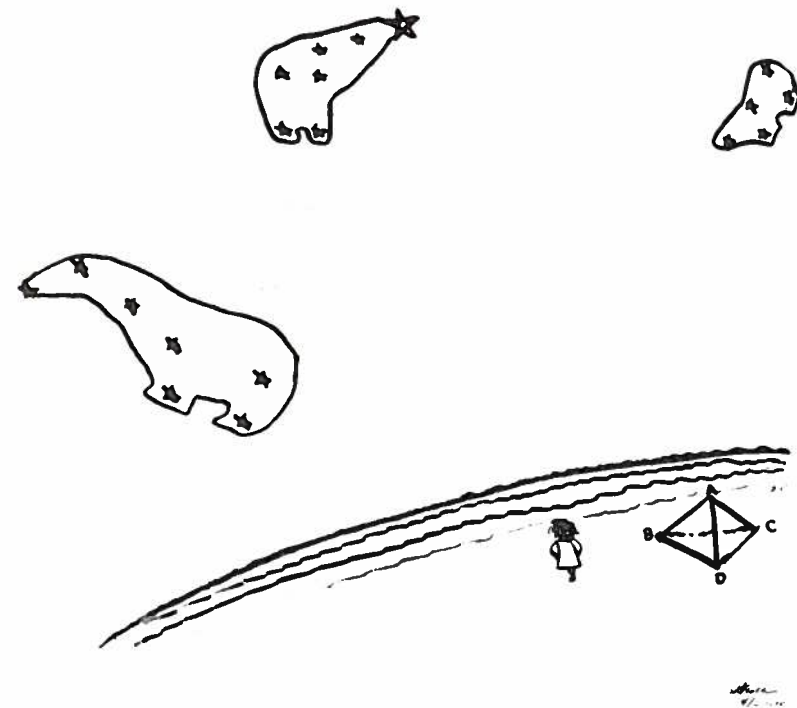


“Think global,
act local”



"Children are born true scientists," said Fuller in old age. Nowhere else is the desire to learn so sincere and receptivity so intact. From children we can learn how we learn. As an eighty-year-old, Fuller became a lithograph artist. He sketched for Tatyana Grosman and her United Limited Art Editions (ULAE) a series of sheets called "Tetrascroll" on the story of "Goldilocks and the Three Bears," which he had begun to draw forty-five years ago as a picture book for children. In twenty-one lithographs and the accompanying commentaries, Fuller summarizes decades of research. The little girl Goldilocks explains to the bears the laws of geometry in nature and the development of human civilization from sea travel.

TETRASCROLL



Stone 1

Here is Goldy having a sky party with her three friends, the Polar Bear family. Goldy says the sky party is a "system" because Goldy plus the Three Bears equals four entities (or star events), and it takes four events to produce a system. A system divides all the universe into six parts: all the universe outside the system (the macrocosm), all the universe inside the system (the microcosm), and the four star events A, B, C, D, which do the dividing.

The tetrahedron's four-corner star events do not have to occur at the same time. Goldy found that light traveled six and one-half trillion miles in a year, and was fascinated when an astronomer told her that the star in the nose of the Big Bear is a live show taking place 210 light-years away-and-ago, as the American colonists are first thinking about revolting from English rule: and the pole star at Mommy Bear's nose is a live show taking place 680 light-years away-and-ago, as Dante is writing *The Inferno*: and the star at Wee Bear's front toe is a live show taking place 43 light-years away-and-ago as Franklin Delano Roosevelt is being elected to the USA presidency for the first time, at the depth of the great 1929-39 Depression: While she, Goldy, is also a live show taking place no time away-and-ago. Altogether Goldy's four live shows constitute a scenario of nonsimultaneous but omni-interrelated events, which can and do define the four corners of a minimum system - the tetrahedron.

She now understands Einstein's concept that Universe is a scenario and not a single simultaneous structure. One picture of a caterpillar does not tell you it is going to transform into a butterfly, and it takes many frames of the cinema to inform you that the butterfly can fly.

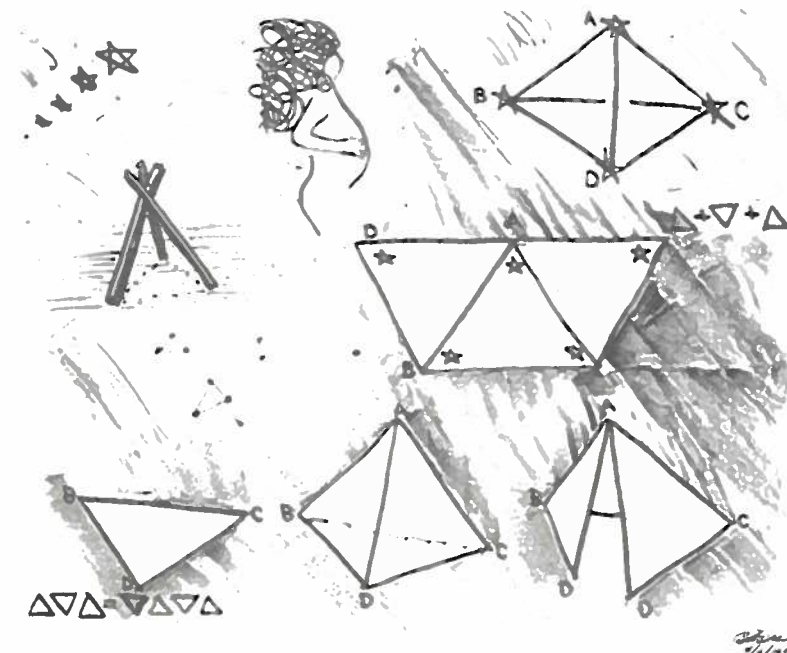


Stone 2

Using the vast, water-smoothed surface of the many-miles-long sandy beach, and walking along as she talks, Goldy keeps drawing pictures large enough for the bears to see. Goldy says to the bears, "Let's try an experiment with our tetrahedron."

By pushing successively on the tetrahedron's top vertex, Goldy keeps rolling the tetrahedron ahead of her across the beach. This succession of rollings makes a long, parallel-edged ribbon with a line zigzagging between its edges to produce a succession of adjacent triangles.

Goldy says to the bears, "We have discovered a triangularly subdivided ribbon-printing machine - a wave-printing machine." And Daddy Bear says, "That is also the sand print patterning made by our four (A, B, C, D) bear's feet when we are running. We can start our run with our right hind foot D elevated. We then lunge forwardly over the hinge line running between our two front feet C, D, as foot A goes forwardly and down while foot B is elevated. Because a bear's foot is itself a triangle, Goldy makes a pattern of Big Sky Bear's footprints as he walks or runs eastwardly along the beach. Goldy uses the successive triangles as the frames for the succession of illustrations of her conversation with the bears. She says the ribbon is like a scenario filmstrip with the successive triangular pictures overlapping instead of being vertically separated.



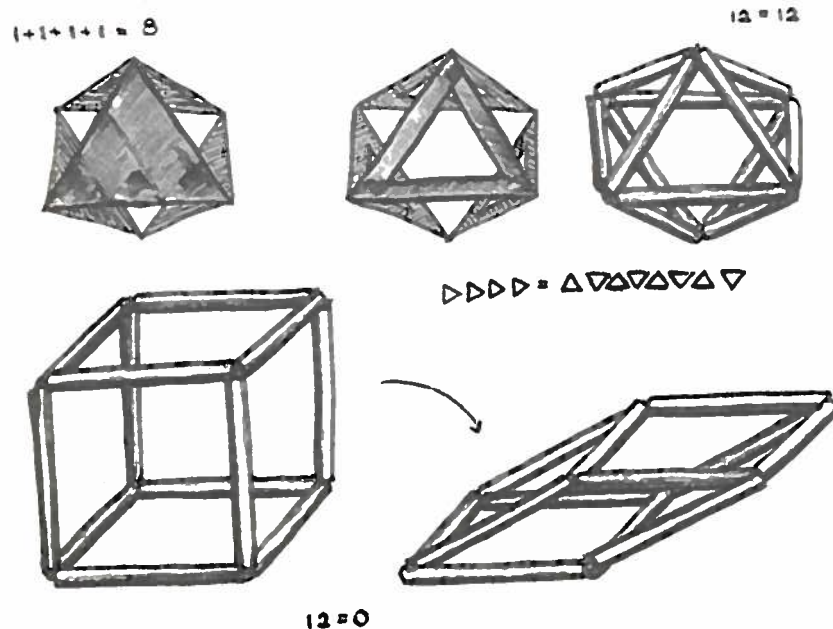
Stone 3

Goldy explains to the Three Bears that synergy means behavior of whole systems unpredicted by the behavior of any of the system's parts when each is considered only by itself. Goldy takes three triangles and brings them together edge-to-edge around a single corner and inadvertently produces the fourth base triangle. Thus she discovers that one-plus-one-plus-one equals four.

Goldy says her mommy is a system and so is her daddy. They both have insides and outsides. Goldy says parents are synergetic: 1 system + 1 system = 3 systems. One outsider plus one insider produces an additional inside-outer - Goldy.

Goldy says to the Three Bears, "If you don't understand any of my words, you can find them in the dictionary." Wee bear replies, "Out here we use cosmic thought communication. We don't have to find words in special-language dictionaries. We use a cosmic thinktionary. All your dictionaries express the universal concepts of our thinktionary but only in special, ethnic-language, sound words. The concepts such as mountain or star or nuance are the same experience engendered concepts in all languages. We understand you perfectly, Goldy."

Concepts are always synergetic systems. Systems are minimum-maximum sets of thinkable, conceptual, omni-interrelevant experience recollections, intertunably differentiated only by time out of nonsimultaneous, unitarily nonconceptual Scenario Universe.

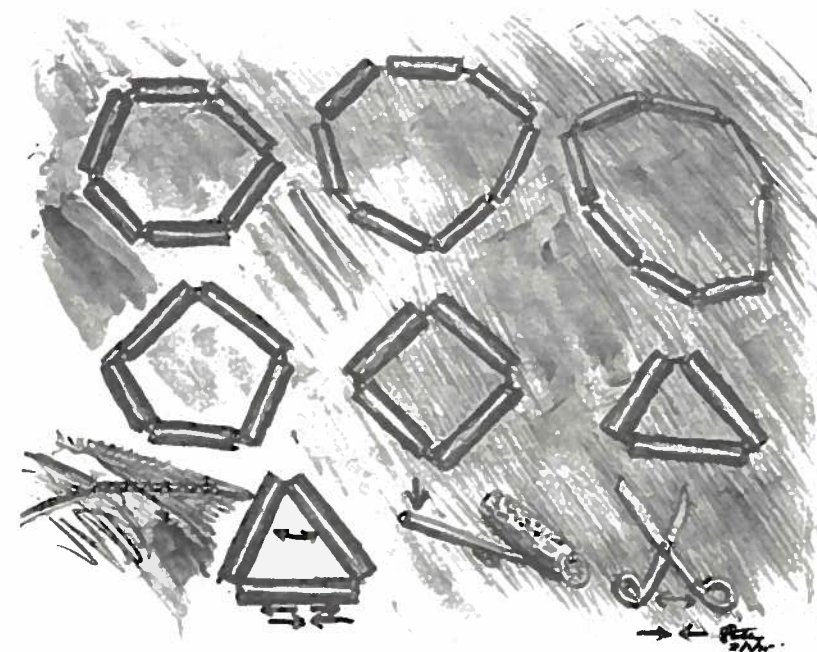


Stone 4

Exploring synergy further, Goldy takes apart the four edge-bonded triangles of the tetrahedron and reassociates them, this time joining them only by their vertexes, which produces the octahedron, or eight-triangular-faceted polyhedron with four inadvertently produced, structurally stable, empty triangular window facets. Here is synergy again with $1 + 1 + 1 + 1 = 8$. This clearly seen structural system's symmetrical intertransformation from 4 to 8 - i.e., 1 to 2 - Goldy explains, is the simple principle which, being nongeometrically conceptualized by the physicists, is called by them "a quantum leap." The scientists continue to "fly blindly on instruments." In addition to the eight triangular facets the octahedron has six vertex (star-entity) events and twelve structural edges.

Since half the triangles are empty and only half are filled, Goldy becomes curious and cuts four triangular windows in each of the four filled triangular facets, and she finds the octahedron as yet stable. It seems to Goldy that the twelve edges held together by the six vertexes must be producing the structural stability.

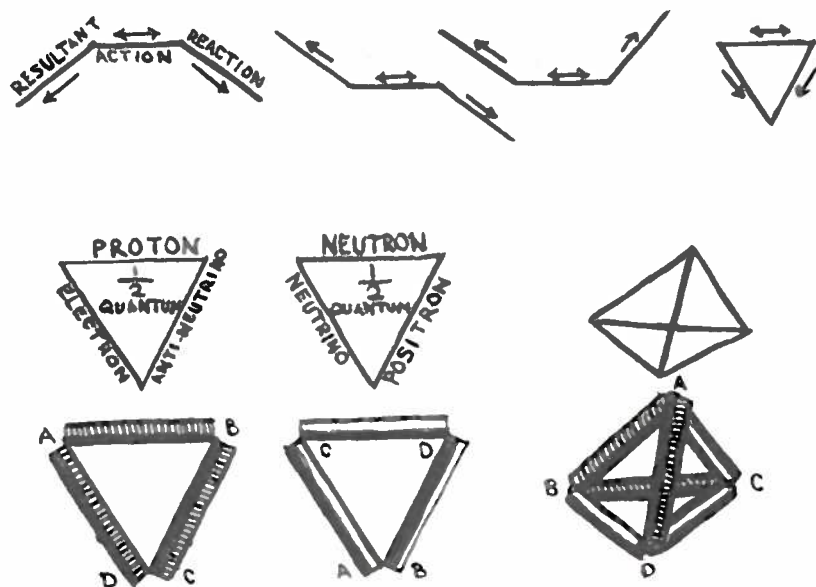
So Goldy next takes two sets, each of twelve equal-length tubes, threads a string through the tubes, and fastens them together in two different ways: (1) with four tubes joined at each of six corners to make the octahedron, which is structurally stable, and (2) with three tubes joined at each of eight corners to make the cube, which proves to be structurally unstable and collapses.



Stone 5

This brings Goldy to her necklace experiment, to discover, if possible, what produces structural stability. When the necklace flexes, the tubular beads do not bend or change their lengths. It is the tension connector angles between the tubes that change and accommodate variable draping of the necklace. One by one Goldy takes the inflexible tubes out of the necklace, which keeps on flexing around her neck and draping over her shoulders until there remain only three push-pull tubes and three tension connector angles. Now for the first time the necklace does not flex or drape around her neck. It is rigid. It is in the form of the triangle, which is the minimum polygon. There is no polygon of two sides and two angles. The necklace triangle has six separate parts: three rigid, push-pull tubular sides and three flexible tension angles, all six of which separate entity-events are interacting to produce a stable pattern. How do they do so?

Any two sides of the triangle constitute a pair of levers fulcrumed tensively together at one end - like a pair of scissors. The longer the two lever arms, the more powerful the shears. So the third side of the triangle is a rigid, push-pull strut taking hold of two adjacent lever arms at their maximum lever-advantage ends, thereby stabilizing the angle opposite with minimum effort. So does each side of the triangle most effortlessly stabilize its opposite angle. Since a structure is a pattern-stabilizing complex of events, a triangle is structure. Structure is triangle. There are no other such minimum-effort, six-foldedly combined, minimum-limit-of-a-series, cosmic cases such as this one.



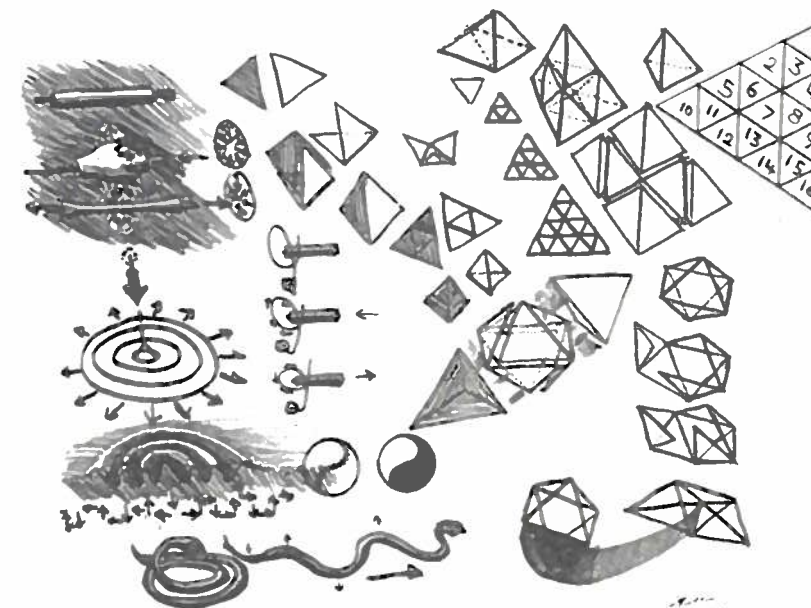
Stone 6

In nonsimultaneous Scenario Universe every event action has both reaction and resultant "side effects" (precessions), which may be graphically represented by three angularly associated vectors that can take either open or closed forms.

The atomic proton and neutron are unique, always and only co-occurring, prime energy events of Universe. They have different mass but may be co-intertransformed by means of their two different actions and the latter's, two each, different energy "side effects."

The proton and the neutron are both actions, and each has its respectively different reaction and resultant "side effects." Each of these two, three-vector teams equals one-half of an energy quantum (or one half-spin).

Because it consists of two such half-quanta of energy, the vector-edged tetrahedron exactly equals one quantum of energy and is also one minimal structural system of Universe. The six-vector tetrahedron is also synergetic in that two vector triangles combine to make the four triangles of the tetrahedron. This is not magic. The two additional invisible triangles that become visible by associating the visible pair are always secreted in the invisible complementarity reserves of the 99.9 percent invisible Universe of utterly abstract weightless principles. Employing vectors, the two convergent sides of any given angle can only be considered as potentially realizable by a third and invisible vector which invisibly holds apart the outer ends of the angle describing convergent vectors.



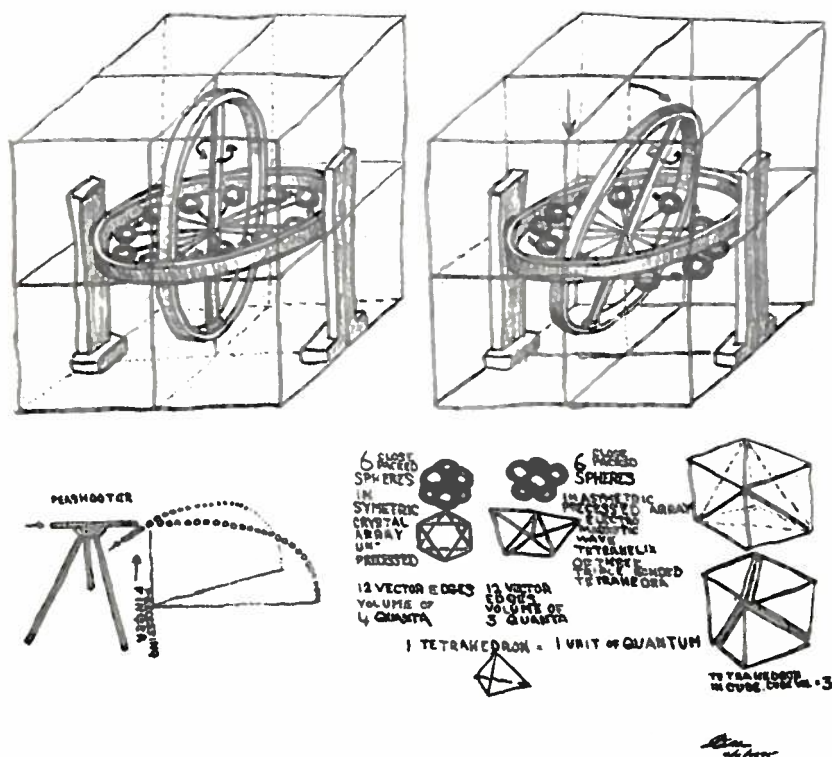
Stone 7

Next Goldy says to the Three Bears, "Unlike you constellations of stars who intercoordinate with combined gravity and precession and know the most about both, few people gravitationally cohered around precessionally steered planet earth comprehend either gravity or precession."

Goldy takes a closed cylinder made of flexible rubber which is filled with water. She presses its ends toward one another, and the cylinder bulges outward radially at its mid-girth, tensively stretching the rubber outward radially in a plane perpendicular to the axis of Goldy's compressing. Next she pulls the two ends of the cylinder away from one another, and the cylinder contracts radially at its mid-girth, becoming compressed in a plane perpendicular to the axis of Goldy's pulling.

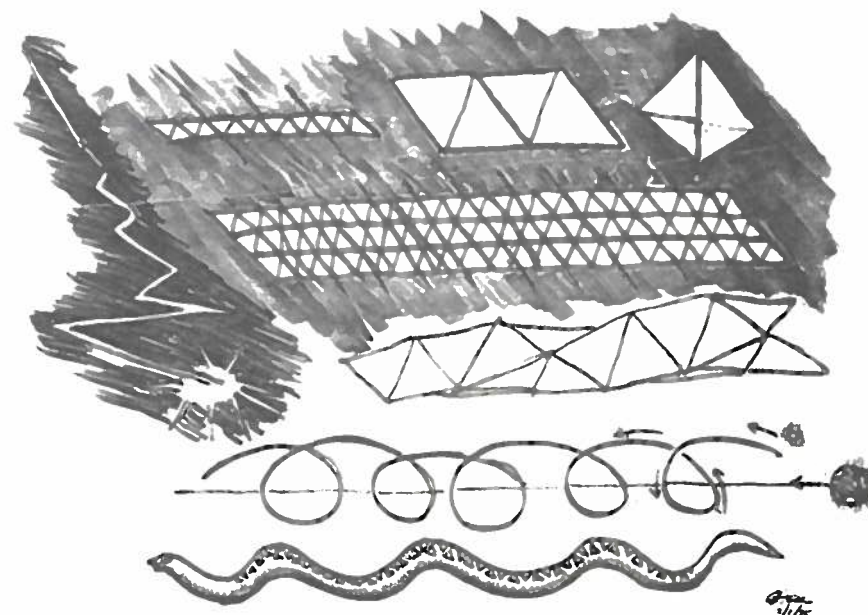
These right-angle results of applied effort are called precession. Precession is the integrated effect of bodies in motion on other bodies in motion. The gravitational interattraction of the sun and earth results in the earth traveling around the sun in an orbit perpendicular to the line of the sun's and the earth's gravitational interattraction.

Precession is regenerative. Goldy drops a stone into the water. A circular wave is generated, growing outwardly in a plane perpendicular to the axis of the stone's line of fall. Then the outward motion of the wave precesses the surrounding water, causing the water to rise as a complete circular ridge in an upward direction perpendicular to the plane of the wave's horizontally outward growth, and the rising water in turn immediately reprecesses the surrounding water into further outwardly radiating horizontal growth.



Stone 8

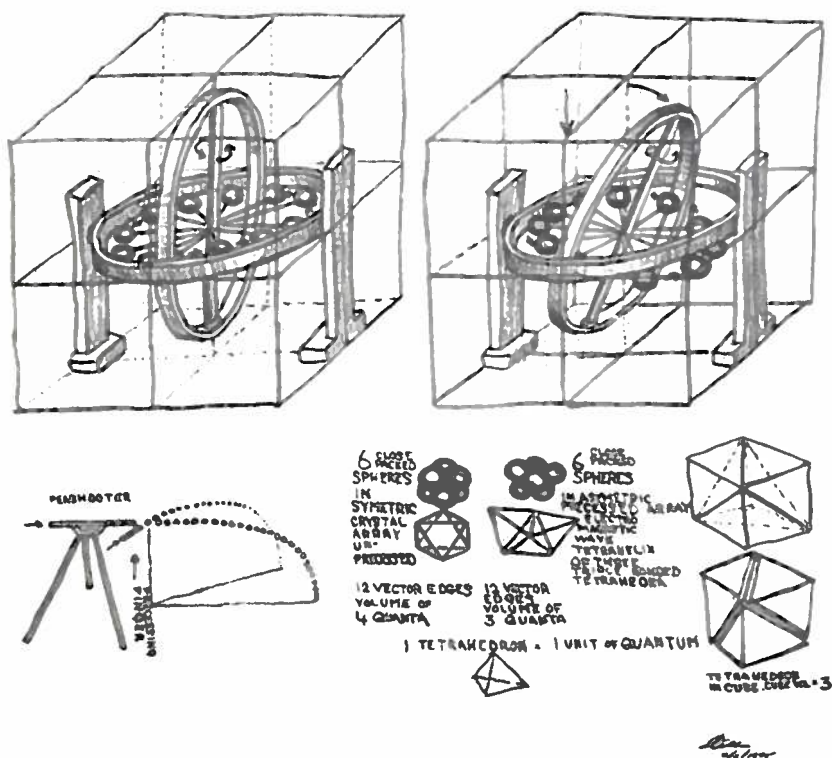
Goldy starts the air gun's impelment of the rotatable shaft's turbo-blades, and the "grass-skirt" ring of balls rises to a vigorously maintained horizontality of rotation. Goldy lowers a mechanically guided steel finger to touch downwardly, around axis Y, once only on the top of each of the balls as each passes horizontally and tangentially by the point in the plane of rotation nearest to Goldy. Each separate ball is deflected downward a discrete angular amount, which results in the plane of the ball's rotation tilting downward to the right around axis X as the powerful angular momentum of the ball's pulling outwardly on the rotating shaft causes the shaft to rotate rightwardly from its previous verticality in plane C, having rotated the same discrete angular amount as that which the plane of the rotating balls has deflected downwardly and to the right around axis X to accommodate maintenance of its tensionally enforced perpendicularity to the plane of the ball's rotation. Thus in turn, the inner rotatable annular ring in which the shaft is mounted is forced to accommodate the shaft's reorientation, and it rotates the same exact angular amount around axis X in plane C as the angular change of the plane of the rotating balls and the shaft. Goldy stops the rotation and returns the shaft and inner annular ring to their vertical starting point, with the same "grass skirt" of attached balls hanging down limply around the shaft. Once again Goldy starts the air gun's blowing of the turbo-blades. She finds that as she pulls the top of the annular ring rotationally toward herself around axis Y, it refuses to yield toward her and yields instead only leftward, as its rotating shaft and the plane of the rotating balls all tilt rightward and downward around axis X, X' as before in plane C in a direction at right angles to the plane of rotation of her pulling. With the machine in static (motionless condition) Goldy pulls the top of the vertical shaft toward her, and both it and the inner and outer rings immediately rotate toward her around axis Y between the two main stanchions.



Stone 9

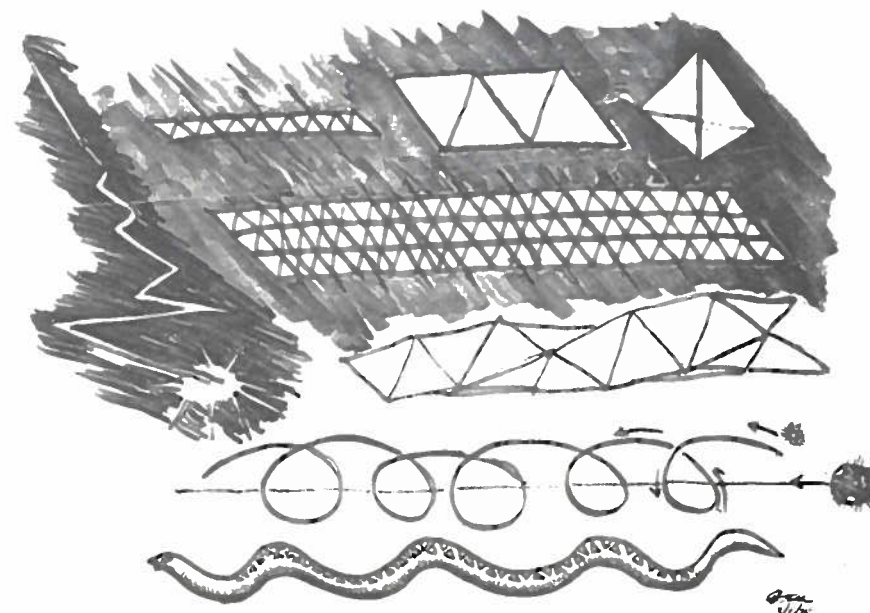
Goldy next shows the bears how the three-face-bonded tetrahedra-arc in its initial, neutral, nontransmitting state becomes spirally extended positively or negatively to attain its information-transmitting state, only with the addition of one more face-bonded tetrahedron. She then shows that with every twenty tetrahedra the tetrahelix completes approximately one 360 degree helical revolution ($352^{\circ} 40'$ exactly), which tetrahelix is the mathematical model employed by the DNA-RNA helix, discovered by virological scientists (Watson-Crick-Wilkerson) to be always transmitting the specific information controlling the design of all biological species, with that $7^{\circ} 20'$ of angle (less than 360°) being twist-sprung to introduce the unzipping force necessary to offspring (or give birth to) any given species' off-molded offspring from the parent.

Goldy shows how the extended tetrahelix's skin can be stripped off and laid out flat as a three-row, omni-triangulated, wavilinear ribbon. Goldy then identifies the positively or negatively asymmetrical tetrahelix patterning with lightning. Goldy then introduces Naga - the sea serpent - god of the oceanic world of the ancients. Naga is the wave. Naga is a live tetrahelix. At sea the wavilinear profile of Naga's back always rims the horizon. The ancient Hebraic language of the earliest biblical scripture came to contain the word "nachash", which means serpent, or "whisper," or "divine" (the ch being a guttural or g sound) - i.e., Naga and Nachashol (or Nagashol) means "the sea," and the root verb nacha (= Naga) means to "lead," "conduct," "guide," and Nacha - pronounced Naga - is also the name of the ancient seafarer N(O)(A)(C)H - Noah.



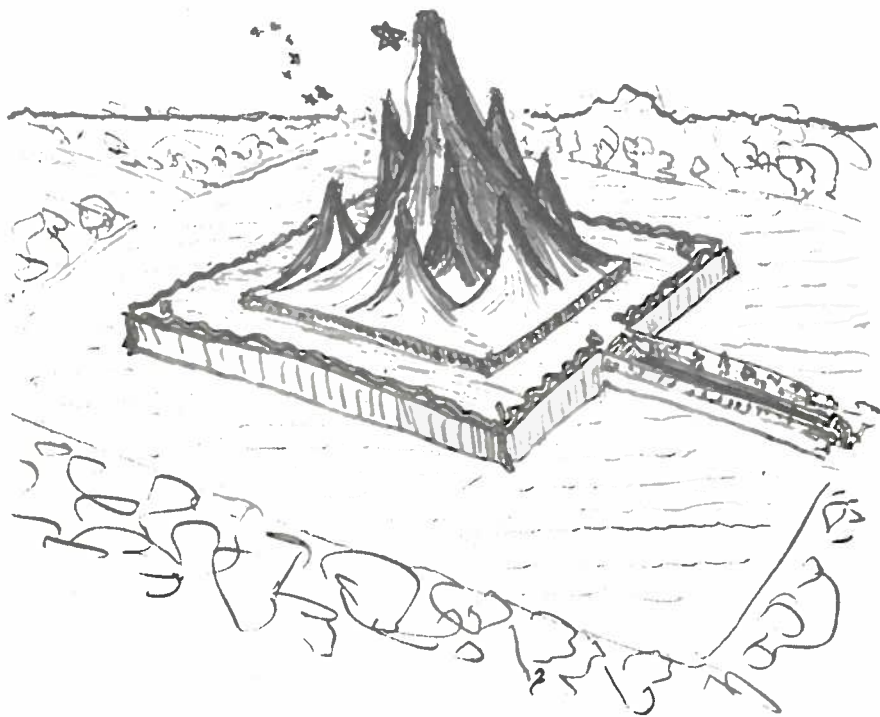
Stone 10

When the god of the sea Naga tidally penetrates the river mouths of the land, as seen from the high mountain, his snakes shape is clearly revealed by the river's shape. The Japanese word for river, Nagala, indicates that the ancient water people looked upon the riverbanks and beds as constituting the female organ of the land being sexually intruded by Naga, god of the sea, as the oceanic tides pulsed inwardly and outwardly for great distances at the lower extremities of the rivers. The early humans sensed and revered the greater pattern events of Universe as manifesting an ever and everywhere presence of a knowing and life-giving, supporting, and terminating competence vastly greater than that of humans. They saw themselves and all that they could see including the sun, moon, and stars as having only minuscule local parts in an organic whole whose shape and size transcended both the ranges of their vision and the scope of their imagining.



Stone 11

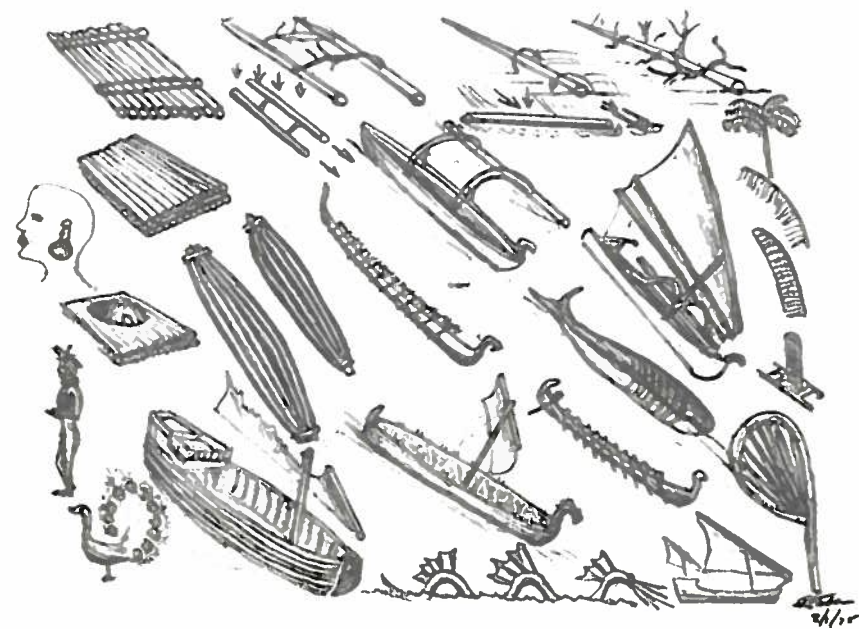
Goldy reasons that because all human beings are always born naked, ignorant and helpless yet chromosomally programmed to experience periodic hunger, thirst, curiosity, and the procreative urge - and are thereby provoked to search and learn only by trial and error, to discover for themselves how best to cope in general - their nakedness and organic structuring primarily 60-percent water, which requires frequent replenishment, combines with the fact of water's small temperature range between freezing and boiling to make it immediately clear that naked humans could not be born nakedly and survive north of the freezing line or in arid desert or where any large carnivorous animals could swallow their for-months-helpless babies. By far the most favorable localities and conditions for successful inauguration of human life, to be found anywhere around planet earth, would be those environmental conditions unique to the barrier-reef-encircled and mountain-island-centered coral atolls formed atop extinct volcanoes in the southern seas of the Pacific and Indian oceans. Here we have the beautiful, clear, shoal water lying protected within the circular Great Barrier reef of coral against which great ocean waves thunder and spend their massive power. Lagoons, temperatured ideally for prolonged human immersion, lie inside the reef and abound with fish and all other most ideal primitive environmental conditions for nurturing naked humans. Beautiful shoal beaches make easy walking into and out of the water while high palm-tree coconuts, full of milk, fall thumping to the ground, and humans may find a host of fruits and no wild animals. Here humans quickly learned that wood floats and stones sink.



Stone 12

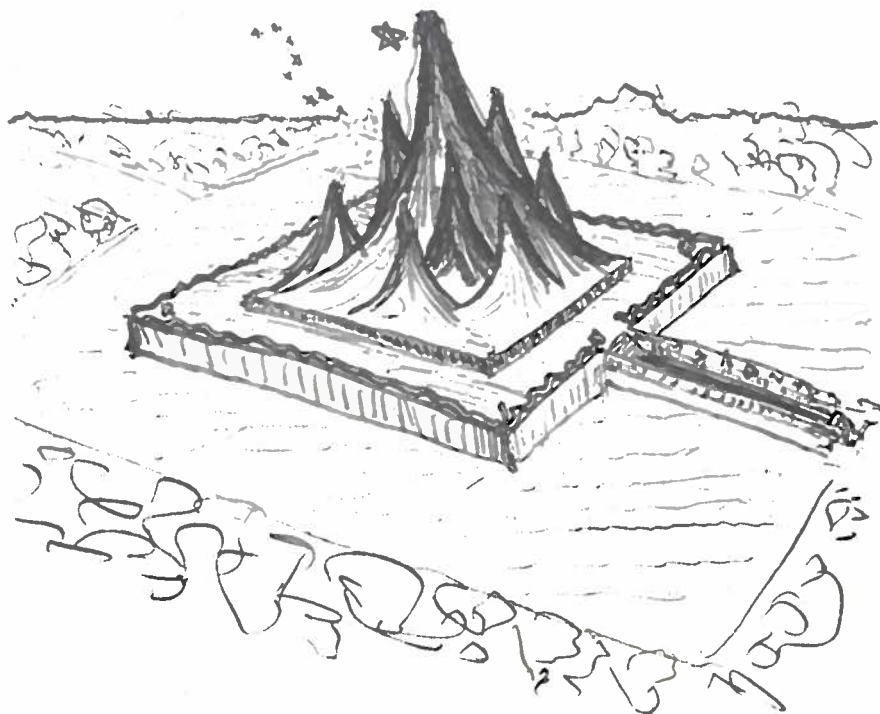
Goldy and the bears now discuss the fact that when the atoll-incubated humans first began to penetrate the mainland, they dug vast systems of canals into the shorelands to extend and complement their normal sea life support with additional life support grown in the freshwater-fed fields and paddies lying adjacent to their saltwater canals, which latter served to float their life-support boat cargoes to their floating water markets. Their half-water, half-land life gave these oceanic people the opportunity of capturing, taming, and domesticating both animals and vegetation by inbreeding them for emphasis of desired life-support characteristics. Thus developed the earliest, primarily waterborne, canal states which were ruled by kings who were, by demonstrated facts, the most physically capable of protecting their kingdoms against invaders. Because no one knew why the physically big and strong ones happened to be born big and powerful, the legend readily developed that the kings were divinely selected – ergo, were living demigods.

Goldy now draws a picture of what is often mistakenly spoken of by twentieth-century European and American tourists as “temple.” Goldy says, however, that these local demi-universe models were only to serve the monarch at the time of his death – as a great “step” ladder into heaven their cosmological model started with a large watery lake surrounding the miniature world. Centrally within this lake the god of the sea, Naga, sculptured in stone, completely surrounded the perimeter of their square, islanded world. Angkor Wat in Cambodia is the best remaining example of these cosmological models. It is completely surrounded by a square body of water which long ago led off by canals to the sea.



Stone 13

Atoll humans quickly learned that wood floats and stones sink, that a single floating log rolls and that two floating logs held cross-connected by their branches do not roll, but provide a structurally stable floating device from which they could fish or dive for edible mollusks. The atoll dwellers soon learned to build both multilogged rafts and dugout log boats as well as outrigger-stabilized dugout canoes. Then they learned how to stitch together the palm tree's fronds to make combined masts and sails and found that their outrigger canoes could sail zigzaggingly to windward while rafts could only ride with the ocean currents or drift to leeward with the wind. The outrigger canoes could be worked (or could “beat”) to windward by a succession of individual “tackings,” ... at a firmly sail-filling angle, which is about thirty degrees one side or the other of the direction from which the wind is coming. This produced a low atmospheric pressure on the forward and leeward side of their sails, which, as with twentieth-century airplane wingfoils, pulled their boats forward in the direction of least resistance, which direction could be modifyingly controlled by steering oars or paddles. The atoll sailors, ... in their much-earlier-developed, large, dugout, outrigger canoes, learned to paddle them into the wind to become, undoubtedly, the first successful westward sea travelers against the prevailing winds. But this windward travel against the waves took both musclepower and much food to support it, which curtailed the length of voyaging. Nonetheless, it did make possible for the first time in history the predetermined (and celestial-navigation-maintained) direction of travel independent of the direction of winds and ocean currents. Team paddling powered their voyages of discovery around islands, along seacoasts, and inland to explore the rivers. It established the principal mode of travel of the canaled, water-state kings of those four-cornered cosmological models (of kingly ascent into the realm of the gods).

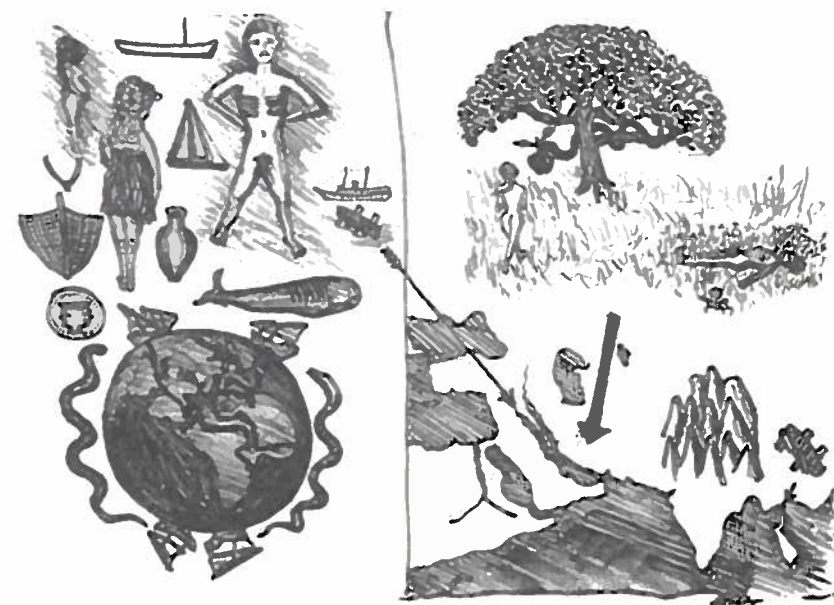


Stone 14

Thus the human sailormen worked ever westward and ever farther off shore until in the lower latitudes of the Indian Ocean their westwardly headed voyaging was reversed by the powerful, eastwardly flowing Antarctic's world whirlaround of wind and water. Six thousand miles south of, unbeknownst to any other, terrestrial humans this eastward world whirlaround distributed those voyagers into the Pacific, Atlantic, and Indian oceans.

Many of those sailors not washed overboard from their craft and drowned were wrecked and marooned on the myriad of lonely, barren islands scattered widely apart in the world's southern seas. Thus we find waterborne humanity first paddling, then rowing, then sailing determinedly westward into the wind to follow the life-giving sun's sky course, gradually working farther off shore and at their southern extremes of voyaging being unexpectedly caught in and swept along by the world-around eastward forces to bring about human occupation of many of the very remote islands of our planet. Those voyagers marooned on lonely islands who found the food, water, and sheltering means to survive became scavengers of subsequent shipwrecks on the treacherous rocks of those islands. Hundreds and even thousands of generations of remote inbreeding developed highly differentiated physical and cultural features.

The historically unprecedented swiftness of 20-century development of the world around integrating transportation and communication means is now trending to rapidly integrate and cross-breed back to an average world-human all these isolated increments of humanity of the islands as well as of those inbred among isolated inland tribes. In this way ever-evolutionary Universe has contrived first to conserve by isolation all the lessons learned regarding humanity's artifact-inventing ingenuity in coping with the most extreme conditions and secondly to synergistically integrate all knowledge for the mutual advantage of all humanity.



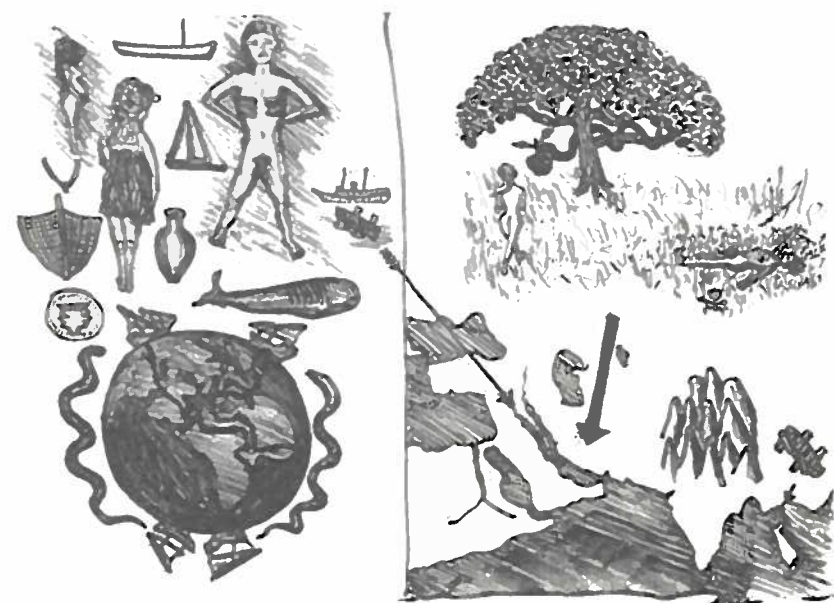
Stone 15

Traveling ever farther westward against the prevailing winds seemed to say that merchants and those who patronized them were deliberately contradicting the winds of God's will. This sailor-popularized apprehension greatly frustrated realization of the vast wealth potential in the east-west high-seas trade. For the miracle answer the kings, nobles, and merchants of Mesopotamia turned to the navigator-astronomer-priests of Babylon. To convince everyone in the new western world that accounts of any earlier religions or people elsewhere on earth were false, the priests said that the beginnings of humans in Universe had occurred nearby to Babylon in a garden called Eden. Their story from then on is well known. What seems pure nonsense in the Garden of Eden story of the creation of a woman from a man's rib is explained as follows. Vessels of the sea are always female because they contain their crews in their interior wombs. The female "Eve" was the high-seas, world-around-sailable vessel; her great strength developed when navigators discovered the backbone-mounted rib cage employed by Nature in the design of whales, porpoises, seals and other sea creatures. So man built his high-seas vessel, "Eve," with strong wooden ribs rising sidewise from her keel, planked "her" in, then leather-thong-fastened the planks' edges together, tied them tightly into the ribs, and pitched her seams. Thus "Eve" the ship, built from Adam's rib cage design, was temptingly "led on" by Naga the serpent, god of the sea, around the world, with Adam aboard. Thus Naga showed Adam, by means of Eve, that the earth is as round as the apple.



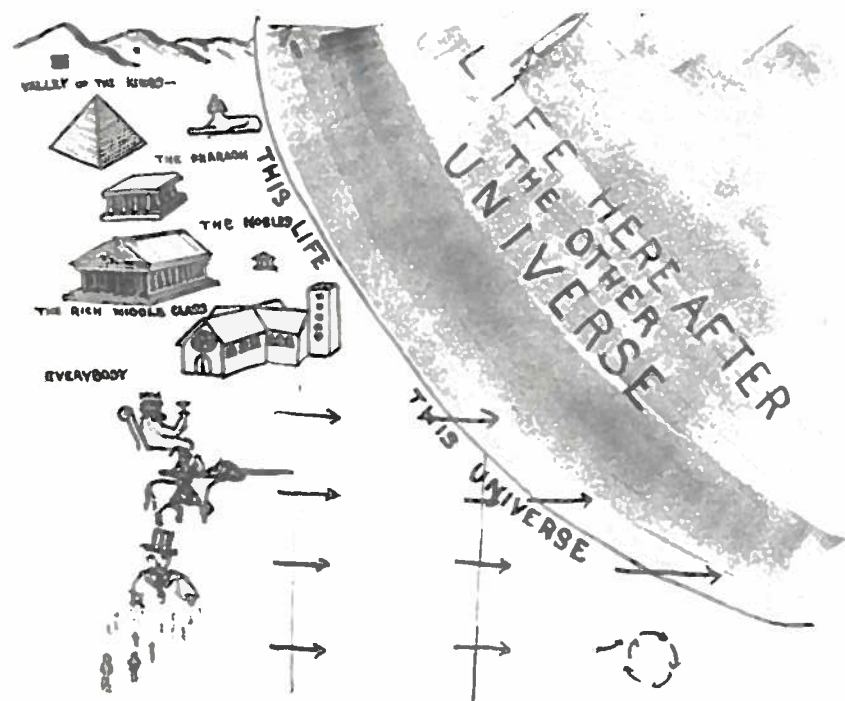
Stone 16

When the blond-haired Vikings reached Scandinavia, they beached and overturned their large, powerfully keeled, transversely ribbed, thong-tied and pitch-seamed, longitudinally lap-straked boats to provide a watertight roof for their snow-covered winter homes. Mounting the boat ends on wooden "horses," the Vikings often clustered four boats end to end in the form of a cross and draped skirts of skins from the gunwales to the ground. This became the cruciform prototype of subsequent cathedrals, whose stoneribbed ceilings' eaves (Eves) became known as the "nave" - the boat. Most of Austronesia was tropical. There were no snow loads to be supported. The beached boats were not overturned. The Japanese Austronesians also had reached far enough northward to have to cope with winter snows in the same manner as had the Vikings. The Japanese name for the house "roof" is the same as that meaning "bottom of the boat." During their long years of voyaging, having no written means of amassing records, the water people composed many verses chronicling their experiences and those learned relayingly from previous generations. The Naga chants became the ragas of the Japanese and Balinese, meaning "the tales of the old people" or the sagas of the Vikings. Rehearsed daily, millennium after millennium, successive verses were identified with successive ancestors and logs in their rafts or ribs in their boats. Later turning their boats upside down on the land to protect against the storms, they developed therefrom ribbed, roofed, and columned buldings for non-seagoing communal purposes, with the ancestors' features carved on their respective columns.



Stone 17

The Austronesians caught and domesticated mainland animals millions of years ago. Their horsemen hunters penetrated inland earliest and fastest, reaching Europe, dwelling and painting in caves wherein they bleached out during the last Ice Age. In the subsequent Stone Age these horsemen built strategic citadels, exploited the herders and the fruit, nut, leaves, and root gatherers. Goldy now draws a map for the Three Bears showing the horsemen's multimillennia-earlier five east-to-west caravanning routes and how the evolving Indian Ocean ships could more swiftly carry much larger cargoes than caravans and how, despite the religiously biased way in which the priests and scribes chose to write Eurasian history, all of its military struggles were waged between empires secretly puppeted by the grand masters of the alternate east-west overland and water routes. Thus was Emperor Constantine puppeted into shifting Roman Empire headquarters to command the Bosphorus and reestablish the overland route. Seeking to reestablish the water route the "Holy Grail" drive of the "Crusaders" sought to wrest overland access to the Indian Ocean from the Moslem Saracens. After 4,000 years of struggling all Near-East-transiting trade was mothballed when Henry "The Navigator" of Portugal inaugurated sailing from Europe to the Orient via the Atlantic around Africa. Thereafter, a succession of world-ocean masteries culminated in the East India company's "British Empire"-puppeted supremacy over all the world's oceanic trade routes. This oceanic mastery suddenly terminated in World War II, when the line-of-supply control shifted into the air and is now shifting again into the airless ocean of outer nothingness, intervening relativity's cosmic events.



Stone 18

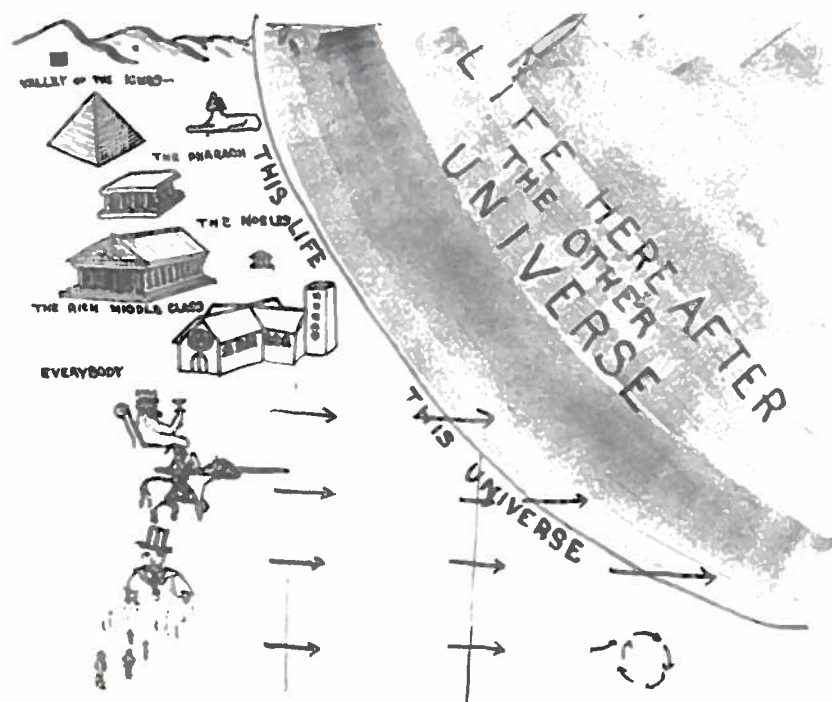
The Austronesians assumed that the gods were not concerned with the people but only with posthumous deifying of the king. With a few millennia of development and proliferation of technological know-how, tools, physical materials, and building capability, civilization realized that in addition to equipping the god-monarch for safe passage into the afterlife, it would be feasible also to assist the nobles to reach the next world. This was done by preparation of elaborate tombs in which were secreted all the riches, food and tools that the king (and later, nobles) would need in the next life. As millennia passed, so much know-how was accumulated in this life that during the last millennium B.C. it became technologically feasible to prepare elaborate mausoleums to enable the rich middle class to migrate safely into the next world. Finally it became technically feasible to prepare all of humanity for entering into the afterlife. This occurred at year zero. The concept of a cosmic intellectual integrity governing all Universe that is utterly concerned only with all humans which cosmic integrity, if properly worshipped and served, could arrange for the happy afterlife of every devout believer, inspired inception of a plurality of new people's religions and two millennia of church, cathedral, temple and mosque building. In addition to getting all "worthy" people into the next world, ever-multiplying technical know-how made it successively feasible to take care of the present life, first of kings (divine right of kings), then nobles (magna carta), then of the well-to-do middle class (Victorian period) and in the twentieth century for all humanity. This eliminated the necessity for two worlds – one universe now embraced all.



Stone 19

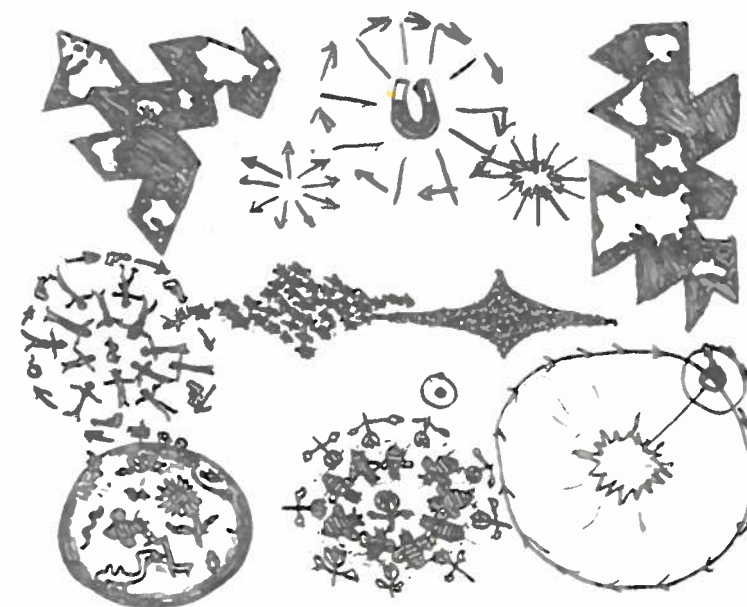
Goldy now elucidates some post-Eden history for the bears. Mycenae was able to control the floatable line of supply to besiege the static walls of Troy. Homer's epic probably represents the first introduction to public knowledge of the changeover in the grand strategy of the world's power structure from supreme dependence on the power of the almost invincibly massive high walls of the great city-states to supreme dependence on the naval architects' engineeringly superior control of the lines of supply by deep sea vessels – the waters covering three quarters of planet earth reached all the river mouths of all continents and islands, outperforming the separate land-terminalled overland routes. For long the local, fertile lands commanding, city-states masters had starved the famished outsiders to death. Now the more-with-lessing Mycenaean sea masters starved the Trojan city-state insiders. Because the Trojans were the progeny of the overland horsemen, the Mycenaean sailormen produced the famous Trojan Horse within which symbol of seeming acknowledgement of Trojan superiority they hid some fighting men while deceptively withdrawing their maritime fleet.

Goldy and the bears soliloquize on the fact that this 2000 B.C. historically lethal moment of conversion of supremacy from absolute dominance by massiveness to a doing-more-with-less mastery marked the beginning of a four-millennia development that would culminate at the end of the twentieth century A.D. in doing so much with so little as finally to be able to support all humans at an economically sustainable higher standard of living than any have ever experienced, thus to eliminate altogether the fundamental scarcity syndrome and all lethal interstruggling of humanity, allowing humanity to become preoccupied with greater problems of Universe, with which ultimately to cope, humans had been given their minds.



Stone 20

Goldy says that with the first coinages of humanity now being brought out from Mediterranean ocean bottoms, one of the most frequent is that of the Phoenician sailor's symbol – the double-headed, two-way-facing Janus whose overall contour is that of the Cretan king's symbol, the vertical-axis hexagon. Dry-land anthropologists and archaeologists have misinterpreted the Janus symbol as meaning only that the sailor was a notorious liar, professing to be going one way but actually going the other. To the maritime archaeologists and anthropologists the Janus symbol clearly reveals that the sailors knew that they could face in any direction and, traveling constantly in that great-circle direction, come back to where they started because the earth is a sphere. The sailor's symbol was the six-triangle hexagon, for only triangles are structurally stable. With their keeled, triangularly trussed framing and triangularly rigged ships, navigators have encircled the spherical earth for aeons. Land people have been historically local and ignorantly subservient to the earth's sphericity, commencing their wall buildings with stone, the landholding and -guarding people build compressively, squarely, redundantly and heavily, commencing their shipbuilding with wood, water people build tensively, curvilinearly, triangularly, and with utmost efficiency of realized function per each ounce of weight, minute of time, and erg of energy designedly invested in their "environment controlling" vessels. They must do ever more with ever less in order to float controllably in any manner of storms while doing so much with so relatively little.



Stone 21

Goldy and the bears agree that the Austronesian water people constitute the prime ongoing organism of human evolution designed and conditioned by multimillion years of experience to withstand the mania of rationalized selfishness and eventually capable through ever-more-with-ever-less artifacts of rendering altogether obsolete opportunistic myopia in general. The water people cannot pretend to themselves, as do the businessmen, that a rectangle is an inherently stable structure, that the wind, sun, or any other operating facilities of Universe belong to anyone, or that there exists a seemingly forever lethal inadequacy of human life support purportedly inherent in the metabolics of planet earth's biospheric system.

As long as humanity has been convinced of the existence on our planet of an unalterable, lethally human-life-support inadequacy, just so long is selfishness to be rationalized as being not only "realistic" but essential in securing the vital needs of those dependent upon the family "bread-winner" or "bean-guardian," those who eschew selfishness and commit themselves to the golden rule are considered to be either ignorant or foolish. Since, however, it is now looming into ever more widely held knowledge that there is and can continue to be ample life support for all, both today and tomorrow, for the first time in three million years of known human presence on this planet, selfishness can no longer be rationalized as inherently valid. This is one of the most dramatic changes in all history.

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Abbreviations

BFA	Buckminster Fuller Archive
DCH	Dymaxion Chronofile
DI	Dymaxion Index
HE	Hamilton Extracts
MF	Manuscript Files
RBF	Richard Buckminster Fuller
SP	Synergetics Papers: BT (Blue Trunk), GT (Green Trunk)
WDSO	World Design Science Decade
YPS: Discourse	Your Private Sky, R. Buckminster Fuller: Discourse

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Your Private Sky

R. Buckminster Fuller
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