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R. BUCKMINSTER FULLER

THE COMPREHENSIVE MAN

Editor's note: *Mr. Fuller is a creative thinker and engineer whose ideas, often unorthodox and even revolutionary, have made him peculiarly influential. His invention of the geodesic dome in particular has brought to him international attention. Widely applied, and designed on the principles of energetic geometry, the geodesic dome is being used in such diverse ways as in the construction of theaters, in industrial architecture, and in the building of disposable Marine Corps battle shelters.*

The following article is Mr. Fuller's revision of an extemporaneous discourse which he gave recently before the faculty of the School of Architecture and Allied Arts in the University of Oregon. The article is approximately one-quarter the length of the transcription from a tape recording.

I. EDUCATION

Alfred North Whitehead, in a pre-World War I statement on education, noted that the processes of education were increasing the numbers and sizes of graduate schools and were at the same time selecting students of highest intellectual promise to enter into those postgraduate schools and thereafter into careers of expertness in specialized fields.

He then said this process would develop increasing numbers of exceptionally capable men as brightly shining stars in very special and remote parts of Heaven—but unworldly stars, precisely because as stars they would be "out of this world."

Whitehead went on to say that, whereas every action has its reaction, such selecting of the intellectually strong men for specialization must of necessity leave a weaker intellectual residue upon which would fall the task of coordinating the everyday affairs of man—that is, the swiftly multiplying inventory of special capability potentials produced by the specialists would be harvestable only to the lesser limit of discernment and comprehension of the residual lower-mentality integrators of mundane affairs, regardless of how charming, loving, courageous, energetic or cunning the latter might be.

Whitehead then foresaw an ultimate crisis in our society, wherein the people who were responsible for putting things together, though themselves subjected to improved educational techniques, would have fallen so relatively far behind the more swiftly regenerative reaches of the specialists in exquisite knowledge extension as to be practically

incapable of comprehending the integrable significance of the specialized findings. Ergo, the integrators would be unable to coordinate and realize the commonwealth potentials opened up by the differentiators. Ergo, our society would come to technical and economic stalemate in the face of magnificent potential.

Quite possibly we have reached that era which might be properly identified as "Whitehead's dilemma." Our scientists are worrying about the exclusively negative and possibly lethal uses of their various special discoveries. At the same time we find society unable to translate the scientific discoveries into realistic magnitudes of comprehensive commonwealth advantage. The macro and micro reaches of the physical universe, whose energy may neither be created nor lost, have been so successfully tapped by the scientists that the approximately unlimited energies of a universe capable of doing realistically unlimited work, ergo of producing realistically unlimited wealth, now need only their social comprehension and orderly social initiatives for turning on the valves of unlimited wealth for all humanity. It is precisely the educated social comprehension and self-disciplined orderliness of coordinate initiative which are lacking. Only the profound inertia of ignorance common to all of man's everyday preoccupations and to all of his as yet known and employable means of solving problems by private or public enterprise and by any and all of his political and cultural systems anywhere in existence around the world now withholds the practical realization of successful physical survival of all of humanity, all at higher standards of living than have as yet been conceived by any man. The problem is indeed a comprehensive educational problem.

In unique exception to the overall educational evolution depicted by Whitehead, there are a few educational undertakings of the last century which select the most promising students for advanced integrative capability. Notable amongst these exceptions have been architecture, international law and military logistics, particularly the world-ocean logistics. But architecture since 1500 (Leonardo's time) has functioned only as an accessory after the fact of successful commerce and industry enterprise, which latter were entered into without benefit of architects in their initial conceiving. Comprehensive world-ocean logistical capability dropped from the curriculum of naval establishments in World War I when the autonomy of ships' captains and admirals vanished with the introduction of world-around radio communication. This leaves only the international lawyers and hot- and cold-war militarists as halfway specialists exploiting extreme scientific specialists while wrestling unilaterally with the comprehen-

sive survival-destruction paradox and accelerating tempo of exclusively negative crises.

For many years I have had the intuition that in the world of architecture there lies the possibility of the development of brilliantly educated men capable of a generalized comprehensive anticipatory science of design, which both can and may be as effective in bringing about man's general well being as has specialized education been effective in bringing about only isolated successes within an otherwise general environment of chaotic dismay, frustration and high frequency failures. I intuited that such a generalized architectural education could be accomplished by employing the comprehensive-academic and educational strategy exclusively reserved, prior to World War I, for the few most promising students found amongst the Naval Academy's midshipmen, and since World War I, non-existent as an educational strategy. Such an academic and postgraduate strategy involves the working assumption that the individuals concerned may at some moment in their lives be confronted with the opportunity of taking the supreme initiative in the conscious and comprehensive formulation of mankind's critical participation in universal evolution.

II. DIRECTIONS FOR THE STUDENT

I have often urged boys graduating in architecture to go into the aircraft industry, not just to learn the stress-analysis which they would immediately be taught, for the company would invest its time and money to teach them, but if possible to get into production engineering and to learn about the whole family of tools and the chemistries, the alloys—all the strategies of very advanced technology. In other words, these advanced aircraft industry tools would be the builders' tools of our day, suitable to these innate integrators who really want to know what they can do in our moment of history.

Then, too, I have urged star architectural graduates to go into other economic experiences tending to give them a sense of world-around distribution patterning and the very high-speed deliveries with air-transport. I have urged them to get experience in any and all patterns related to the whole world and to the most advanced tools. Particularly I have urged them to learn what they can of chemistry, for I feel that chemistry is basic structure, ergo architecture. I really am surprised to find at the architectural schools that, despite the prevalent intuition that one certainly ought to know a lot about technology to be a good architect, the curricula tendency established to gratify that intuition

is only to give much more mathematics. For instance, at M.I.T. architectural students do not have to take chemistry after their first year but do have to take five years of calculus, and I don't think any of those students after graduation ever again use the calculus. Architectural students are taught about a few dozen natural and so-called artificial materials which are only the superficially identifying aspects of invisible chemical structuring.

With World War I the great chemical revolution brought to availability a quarter of a million chemical substances. All of those substances were comprised of the ninety-two regenerative chemical elements. They were complex, structural behaviors permitted by Nature. They were not nature substitutes, though many were called substitutes. Again in World War II, when the large resource mobilization program started, it was found that the inventory of chemical substances known to man had passed two million in number. But many of these substances were as yet called "substitutes" in political, administrative and military Washington. Even today, despite interim development of fundamental knowledge to the contrary, we speak erroneously of "artificial" materials, "synthetics," and so forth. The basis for this erroneous terminology is the notion that Nature has certain things which we call natural, and everything else is "man made," ergo artificial. But what one learns in chemistry is that Nature wrote all the rules of structuring; man does not invent chemical structuring rules; he only discovers the rules. All the chemist can do is to find out what Nature permits, and any substances that are thus developed or discovered are inherently *natural.* It is very important to remember that.

III. THE MYTH OF INDUSTRIAL DESIGN

The name "industrial designer" was invented about 1926, and it was invented by the professional advertising company forefathers of what is now known as "Madison Avenue" on behalf of large banking groups investing in the automobile industry. The banking groups were getting together all the machine tools, production tools, jigs, fixtures and buildings in Detroit that had originally belonged to one hundred and twenty-five starters of the now eighty per cent bankrupt automobile companies' roster. The idea was that if they put enough tools together they might reach the point where the production capacity would be of adequate magnitude to sustain courting of the mass market price. By 1926, Wallstreeters had learned, after billions of dollars of trial and

error failures of the early 1920's, the fact that one hundred and thirty-five thousand cars a year by any one company was the minimum production rate required to amortize capital investment and make a sustaining profit.

The bankers dismissed from Detroit all the inventors of automobiles. They didn't want any more inventing of automobiles. They wanted only economical production of transportation units from those tools which themselves were immune to the devastation of dollar bankruptcy. But the big investment banking houses knew that the American public had learned to go to automobile shows annually to see the new cars, and saw in the swift advance of automobile inventiveness that a new era of man was in the making. There was something emotionally essential and satisfying to the American in those new cars. The cars embodied whole constellations of ingenuity and invention and the users learned intimately about the parts. They understood thoroughly by direct experimentation regarding the significance of seven main bearings as against four; they knew because they were both the active laboratory workers and underwriters of the costs. They could adjust their own carburetors and grind their own valves. The public was intimate not only with the cars but also with the methods used in making them. So the question the banking houses had to face was, "What are you going to do about the American public's desire to have a *new* car each year now that the inventors have been kicked out of Detroit and production men put in as the managing authority?"

The pre-Madison Avenue public mind-molders then said, "This is very easy; there's a new invention called the airbrush. We will use it in our advertising work. Pictures of the automobiles are going to appear to be advanced—but as pure camouflage. The changes will be as superficial as fashion changes, but people will think they are looking at a new car. The public has now an appetite-momentum for automobiles, so all that is needed from here on in is a familiar lure for his conditioned reflex. This superficial rather than fundamental design function will be effected by a new industrial showman to be called an industrial designer."

This was the beginning of the greatest betrayal of mass communication integrity in our era of history. Progressively rationalized, it seemed to justify every manner of mass self-deceit of world peoples by their own self-ventriloquized corruption of their democratically tried and accepted institutions and their conventionalized characteristics and symbolic abstract beings. We are now paying the price. We have learned to kid ourselves in so complete a manner that we are liable to have a great economic bust—led by four hundred horse power,

two and a half ton chariots of guaranteed "supreme distinction." The self-deceit which we have practiced may cost democracy a major cold war defeat falsely to be charged to democracy's bamboozled account. Obviously, I think industrial design is a very tarnished affair. I'm terribly sorry that many young students, fooled by the words "industry" and "design," which independently are healthy words, think that because the words have been linked and there is a course called "Industrial Design," they are going to learn something about the fundamentals of design initiation in industry. I assure you that no aircraft company will let an industrial designer through their engineering front door. They consider industrial designers pure interior and exterior decorators. And yet I've listened to industrial designers assert that they designed the new steamship, *United States*. If you were to exhibit schematically all the items that the industrial designers designed for the *United States,* you would have sailing down New York harbor an array of window curtains, chairs, paint clouds and bric-a-brac floating in space. Nothing really to hold it all together. To assert that they designed the *United States* could not have been more dishonest.

Some naval architects designed that ship—naval architects of extraordinary capability. No industrial designer was allowed near until the ship was built. The industrial designers were not even allowed to touch the exterior color of the ship, because the color depended on such things as whether the ship would be in northerly, temperate, or tropical waters—black if the former and white if the latter. The black absorbs sun heat, white reflects it; the right colors save thousands of dollars of air-conditioning costs. The naval architects were not given control of interior decoration because they were not the operating riskers who decided to build the ship. And the people who put up the money want to be really sure they are going to be able to sell their rooms as against the other fellow's, so they don't dare trust the engineer. And, after all, the engineer is inclined to say, "This bed will hold you up." Engineers are inclined to tolerate the crude but "safely adequate." So the advertising and public relations men said, "Go over here, boys, and hire the ones who know how to design the man of distinction's brothels." The sure-sale conditioning is really that bad.

IV. A ONE-TOWN WORLD

At our present moment in history, whether we in America like it or not, we are no longer geographically isolated. Within six years from

today you will be able to go in the morning to any part of the earth by public conveyance, do your day's work, and reach home again in the evening, and by the Treasury Department's income tax allowance for traveling expense, you will not have been out of town. We will be realistically, legally in a one-town world for the first time in history. Not only that, but we will have a trebling of our world population, as against the population at the beginning of the century. We will have a world population working very close to four billion, and by most extreme estimates, heading toward fifteen billion by the end of the century. The design students who are now graduating are going to have to handle billions of additional people. Town-planning is now meaningless if it is not also world-planning.

So we must start comprehensively with all men. Mobility is man's first positive and negative kind of security—his innate ability (unlike that of a vegetable or a tree) to advance or retreat. Soon man will be able to advance and retreat all the way around the world, and will do so; he can both associate and disassociate to extraordinary advantage. Architects, if they are really to be *comprehensive,* must assume the enormous task of thinking in terms always disciplined to the scale of the total world-pattern of needs, resource flows, its recirculatory and regenerative processes.

Comprehensively anticipatory design science architects will have to think in the terms of *great patterning* envisioned by Sir Halford Mackinder, who was a very great geographer in England. Sir Halford Mackinder said in 1900 to the British high command, "The land railway is a surprise child of the age-old marine railway, which was invented to launch heavy ships upon the water, only within which ships supported by water could carry the large and heavy cargoes to be transported, which were greater than those that could be transported on the backs of men or animals. The grand strategy of the world-around British empire is predicated on the proposition that the world's waterfront is the terminal of heavy logistical mobility. But now if you think the 'waterfront' is where the ocean stops, you are getting very much fooled, because the 'waterfront' is now where you can carry the kind of cargoes that do the missions you used to do on the water. The marine railway in reverse finally launched the railroads upon the land, and the railroads are using the land for a new kind of ocean. Your 'waterfront' is retreating to the terminal of the railroads and even beyond as the cargoes go in the auto-trucks, which are pneumatic-tired canal boats." He scared the British into realizing that technology was indeed altering basic considerations, but after World War I the British were too physically tired to listen to Halford Mackinder's further

theory. Mackinder, however, had developed some now famous concepts, such as "heartland." "Who rules the Near East rules the heartland and who rules the heartland rules the world." He looked at the whole of the earth and at all the waterfronts and he showed how the people in the north had the highest stimulation to invention because they were exposed annually to many more severe climatic changes than were tropical peoples, and they tended to invent in response to the greater extremes. These were typical of Mackinder's comprehensive thoughts and they became the very essence of the pre-World War I British Empire's strategy. The British, spent by World War I, paid little heed to Mackinder's post-1918 thoughts. He said, "Gentlemen, there's something very much bigger happening now. Airplanes, used up to now only for war purposes and stunting, are going to fly the world skies as passenger and cargo transports. In effect the primary logistical ocean now flows completely up and over the whole land. Our dry land is simply the bottom of the world's one airocean. Your 'waterfront' is gone completely. How now are you going to hold your heartland? You had better change your strategy greatly and look principally to the air."

Though the British paid little attention to Mackinder at this time, he had one student who paid a whole lot of attention. He was a German named Haushofer. Haushofer went back to Germany and became the great strategy counsel to Hitler and to Göering. He told them of Mackinder's unheeded counsel to the British, which he translated into German as "geopolitics," the word best known today as identifying Mackinder, its inventor, and the Luftwaffe and blitzkrieg strategy was paradoxically predicated upon Mackinder's warning to their proverbial enemy, England.

Mackinder's books dramatically emphasize a powerful discipline in treating with whole-world problems. As we are now concerned with the whole world, your students must gain working familiarity with the whole earth and its comprehensive evolutionary processes in all departments. Their home towns, or where to get a job, the state boards—all are secondary or lesser levels of consideration.

Long isolated from the rest of the world, we could get by despite our great ignorance; we could make bad mistakes without visible consequence. We are now only seven per cent of the world's population and we are gradually learning that at least fifty-one per cent of the earth's population doesn't like us at all any more. They once loved us for our pro tem innocuous naïveté; today they are bored or disdainful of our irresponsibility. Apparently we are unable to formulate aught but defensive policy. It is now essential that we expose our students direct-

ly to the big show. What we need is positive design, which politicians neither dare to make or are capable of making. Inasmuch as we have the students with a proclivity for becoming advanced in the disciplines of architecture as resource integrators, it is in evidence that their highest capability may be developed only by exposure to the full breadth of economic geography and to the comprehensive array of front line science and technology potentials scientifically comprehensive and economically effective in our day. But I am of the conviction that it can be done only by applying our highest technical competence directly to the satisfaction of all humanity's needs and satisfactions rather than giving priority to military preparedness incidental to which there follows the second-hand inept conversion of war-production-born technology to peaceful needs, after enormous wasting of technical potentials in obsolete war goods. As we employ the total science and resource potential directly to world-man's peaceful advantage, the numbers of those participating in the total capability will swiftly increase from the present thirty-six per cent to one hundred per cent. The new self-employed architect is the one fellow in all the world who may accelerate realization of a high-standard survival for all, as now completely practical within the scope of available technology. The self-commissioned architect is the obviously exclusive potential, for as at present used, or designed, the world's resources are capable of serving only forty per cent of humanity. Politics can only redeal the inadequate cards, but scientifically known principles may employ those same resources by new design in such a manner of increased ratio of performance per pound of resources as to make the same overall tonnage of world resources serve one hundred per cent of humanity and at higher standards of effectiveness and satisfaction than any as yet experienced by their most hitherto advantaged of men. It is new design by architects versus world revolution by political leadership.

V. ARCHITECTURAL RESEARCH IN UNIVERSITIES

In the terrific depression of the thirties every architect was unemployed, as well as all the new architectural graduates. Many went to Russia and to other world places trying to find something to do. Then the New Deal came in and socialized building by taking over the underlying mortgage base, the economic base of last recourse of so-called real wealth. The government put some new equity into building through technical renovation. The government has nearly 100 billion dollars worth of mortgages right now on its hands, and in order to keep

inefficient building arts alive, has to extend payment to thirty years for homes which could be so economically produced (under comprehensive architecture) as to be paid for in one year. So in the U.S.A. socialization of building led socialization of industry, and all economic initiative is now led exclusively by the negative credit billions for defense undertakings. We should not be misled by this. Though the government allows its so-called private banks to issue the mortgage money, it is the government which underwrites the mortgage. Building has been completely socialized. The money has not been risked by the bank; it has been put up out of government guarantee depositors' accounts as a convenience to a government by a people who like to pretend that they are against socialism. Naught has been risked by the individual loaner, only by the individual as "buyer."

The fact that there seems to be employment for architects in the post-World War II years is then a product of a socialism that has an increasingly bad risk for which it has to give longer years and easier terms to buyers while paying higher and higher rates of interest on its government borrowings. Look, then, at the times when the architects' offices may not be busy due to the inflationary spiral generated by government underwriting of continually more obsolete and relatively more inefficient building art. In order to contract with the defense generated dollars, architects need a lot of draftsmen, and a great many architectural schools have been turning out architectural graduates only to be draftsmen. Extraordinarily talented boys become drafting machines or catalogue searching machines. Architectural schools are then providing socialism with functions, which in the era of automation will become as obsolete as human functions as are aviators to the guided missiles.

I am frequently invited to speak at the A.I.A. regional conventions to discuss problems of the architectural future and Mr. X, of a prominent firm, will ask, "Do you advocate our inaugurating a research department in our firm?" My answer is, "I'm perfectly sure you do not have enough money to do so, as research and development cost far more than the money which could be saved from architects' profits."

There is an effective strategy open to the architects. It is to be discovered in the following generalized statement. Whereas doctors deal with the interior organisms of man, architects deal with the exterior organisms of man. Architects might join with one another to carry on their work in laboratories as does anticipatory medicine. Architects might solve design problems of world-resource use before people get into resource troubles. Architects might thus join forces as do scientists with the integrity of inter-self accrediting of the respective abilities

of each individual on the team. Architects might begin the laboratory pooling of their resource capabilities at the university level.

At present the architectural schools are under the impression that practicing professional architectural firms want them to produce draftsmen. Architects should tell architectural schools that they also favor research and development in the university (where society has already provided the multi-million dollar facilities). Architects might find themselves returning to participate in the research instead of dreaming about it in their offices.

Such a policy has already met with favor. Last year in several regional conventions I proposed such architectural participation in our university research program, which was later carried out as a practical matter with considerable satisfaction and enthusiasm. I have had sufficient experience in this direction to dare to say without misleading you that such research laboratory undertaking in the university will meet with increasing professional support. Possibly in their own non-busy times, professional architects could return as graduate students in that research and development. This would make it possible for the students to participate with men of experience, who could say, "The hard facts of life are thus-and-so once you get out of here, and that's why I'm coming back."