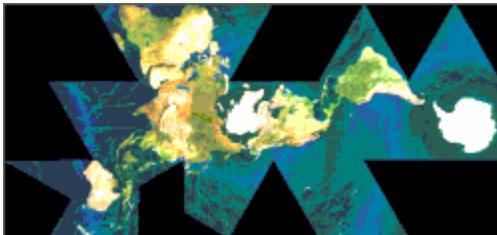


Comprehensive Anticipatory Design Science The Vision of R. Buckminster Fuller

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INTRODUCTION

The goals and tools (transform the marketplace and LEED) of the USGBC have many connections to the life work of R. Buckminster Fuller. In this brief presentation we focus on some highlights of Fuller's work, recall personal experiences with Bucky and encourage the reader to the Fuller bibliography, list of patents and web sites at the end of this paper and at www.bfi.org.



Fuller's Dymaxion Map showing all land masses without distortion.

PECKHAM RECALLS BUCKMINSTER FULLER

I first met Bucky Fuller in 1964 when he gave a talk at the Haight-Ashbury Free Clinic in San Francisco. At that time I was an architecture student at UC Berkeley. The talk began at 7 pm for a crowd of perhaps 80. Bucky talked about the "generalized principles that are operative in the universe" and "comprehensive anticipatory design science" and a wide range of topics. The talk lasted until breakfast the next morning. Six of us were left.

I was certain that Fuller was a man who made sense. Fullers WW I Navy experience was especially interesting since I was an officer in the US Merchant Marine.

This first encounter led to reading the books he had written. In 1965 I enrolled in the architecture program at the University of Pennsylvania, earned a degree and embarked on an internship in New York City and San Francisco. Occasionally I would read about Bucky or hear him speak. In 1972 I returned to Penn to earn an M. Arch. with Lou Kahn. By then the University of Pennsylvania had initiated the Ph.D. in Architecture and had hired Fuller as "World Fellow in Residence".

I asked Bucky to be my dissertation supervisor. This hour-long conversation was tape recorded for posterity. (10 years later my son needed a tape to record some punk music and used the Bucky tape!)

My dissertation topic was to investigate the possibility of creating new nations on the ocean. Bucky loved the idea and he compared it to his work in Tokyo Bay.

There was always the global vision; always the understanding we are all in this together; always the faith in technology and design; always the certainty that we are capable of solving humanity's physical problems: food, shelter, housing. But there was also the concern that without some equity in addressing basic human needs the we may not have the will or the spirit or the understanding to let everyone succeed.

In one of his last talks, on Integrity Day in 1983, organized by his grandson Jaime Snyder, Bucky observed, "The next fifty years will reveal if humanity is a failed experiment."

In 1974 the Bell Telephone Company gave Fuller a grant to videotape "Everything I Know". Before scheduling the videotaping he asked eight or ten of us to be an audience so that he would have an immediate sense of how well he was articulating his ideas and life work. You are encouraged to view this work. A funny story: during the taping we took a break to go to the toilet. We were standing next to each other at the urinals and I asked him a question. (He was travelling the world constantly and I took advantage of every moment together.) He said, "Nick, I can't talk and pee at the same time!"

The next week we had an appointment to have lunch. We were in a Philadelphia restaurant crowded with Penn faculty and students. Many said "Hello" to Bucky. He would nod but when he was talking with someone, in this case me, he gave his undivided attention, his unblinking gaze. I told him, "Bucky, I've been a college student for 12 of the last 16 years. I feel like I'm wasting my life." Without a pause he said, "Find a problem no one else is solving, and solve it. Then you will never have to worry about this again."

I walked back to the architecture department with two "problems" to solve. First was the observation that more than 95% of the architects were white males in a world that is half female and multi-racial. This led to teaching design at Stephens College, a woman's college in Columbia, Missouri. And second was being a member of a profession that did not fully embrace the relationship between the built and natural environments. This led directly to a number of green architecture projects in the 70's and 80's and to the USGBC.

BERKEBILE RECALLS BUCKMINSTER FULLER

Of all the professors I was exposed to in college the one individual that had the greatest impact on me then and now, was Bucky Fuller. I had previously read John Muir and others who pointed out that

everything is connected to everything. So I knew about interdependence but Bucky helped me EXPERIENCE it, to KNOW it and integrate it into my design work and life. For me this was a huge change. He taught me to look at nature differently, to see the invisible, to think holistically - always on the lookout for systems, links, relationships and patterns. It was he who introduced me to the concept of thinking globally and acting locally. It was Bucky who taught me to embrace failure as a unique learning experience, when the first tensegrity 100 foot diameter working model (which we had spent four months designing and building) collapsed.

Integrity was the most important thing in his life. And I discovered during my first day with Bucky that integrity was much more than I had learned before encountering his refreshing mind. For him, integrity was a way of thinking, a process of discovery, a way of life. Human beings have an important destiny - to see and discover the truth. And he believed that much of our capacity for understanding relationships has been dramatically reduced by our education.



Students building a "Tensegrity Sphere".

"We were all born geniuses but we are gradually de-geniused by our parents and our teachers." For example, the concept of 'up and down' should have become obsolete when Magellan discovered the world was a sphere, there is only in and out, convergence and divergence. Since Copernicus the sun is not setting, it is being eclipsed by our rotation; the wind is not blowing from the SW, it is sucking from the NE. It was integrity that motivated him to create the dymaxion world map, to eliminate the distortion present in the Mercator projection.

Integrity requires the courage and self-discipline to seek and work only for the truth. He would advise us not to work for a living. "You must decide whether you want to make sense or make money".

So if Bucky were with us today what would he say?

I think he might say to USGBC, 'LEED is a nice start. Now that you have raised the issue of thinking more holistically about the built environment, its time to begin to the real work. Expand the definition of LEED to acknowledge that we are part of a living system with bioregions that must inform our designs for living.' He would probably suggest that 'Any decision making tool must help us see the truth, the larger reality, the invisible forces that will define our future.' To the world community he might suggest that 'Its time to create a better word than sustainability- something that suggests the need for restoration and adding vitality to the larger system-spaceship earth.' I think he would suggest we focus on changing people and he did say, "The only way to make significant change is to make the thing you are trying to change (in this case human behavior) obsolete." Bucky was a very optimistic person but at the same time he believed that if we are unable to demonstrate integrity the human experiment has failed and the universe is no longer needed. I think he might be urging us to begin thinking in terms of changing our behavior and human strategies to increase our capacity to design for the restoration of community and regional systems (social, economic and environmental).

FULLER AND LEED

The connections between LEED and fuller's work are numerous

Sustainable Sites - when Bucky coined the term 'Spaceship Earth' he was telling us that, "all the ship's supplies are already here. No more are coming. Do not soil the earth.

Water Efficiency - always thinking at the largest scale, Fuller spoke of the 2/3rds of planets surface being ocean, and all but 1% of the fresh water being frozen in the ice caps. He often spoke about water and about the hydraulic principles that allow trees to sway in the breeze. He knew water was the basis of life.

Energy and Atmosphere - much of Fuller's work was about the inefficient energy devices people continue to make in the name of profit. Automobiles were a particular offender, and all his buildings were about energy conservation.

Materials and Resources - throughout his 56 year experiment Bucky championed recycling and minimum energy use. He would often ask, "How much does your building weigh?"

Indoor Air Quality - the health of living things was a lifelong concern, perhaps made stronger because of poor eyesight undetected until he was 5. The

natural ventilation of the Dymaxion House and the internal air movement in a Geodesic dome respond to IAC.

Innovation and Design Process – this is what Buckminster Fuller's life was about.

COMPREHENSIVE ANTICIPATORY DESIGN SCIENCE



From "Everything I Know," 42 Hours with Buckminster Fuller

"I find that I have to use the words "Comprehensive Anticipatory Design Science." Science sets in order the facts of experience. Design as against that which is happening to you: it is that which you do deliberately. Using principles, then, employing order, we try to anticipate the needs of humanity, anticipate the needs of nature in general, try to anticipate the accommodation of the total intercomplementarity, using those principles then to actually begin to participate in the evolutionary formulations of nature, so we don't just have to wait and take it for granted that someone else is going to provide this thing for us, and leave it up to them. Each one of us then, has an increasing intuition and an obligation to employ these principles in an effective manner on behalf of all humanity, and on behalf of the Total Integrity of Universe Itself - in its eternal regeneration."

In 1927, while teaching at MIT, Fuller outlined Comprehensive Anticipatory Design Science as follows:

Subject 1: Strategy of Formulation From the comprehensive to the particular.

Experimental proofs of the validity of SYNERGY: The behavior of wholes unpredicted by the behavior of parts.

Definition of "principle" as regenerative behavior patterning.

Definition of "Universe" as the aggregate of all men's teleologically translated experience. Definition of "teleology" as the subjective to objective, intermittent, only-spontaneous, borderline-conscious and within self communicating system that distills equitable principles - from our pluralities of matching experiences and re-integrates

selections from those net generalized principles into unique experimental control patterns.

Definition of a "system" as zonal subdivision of Universe itself subdividing the microcosmic within-ness from the macrocosmic withoutness.

Definition of "precession" as the effect of one motion system on another motion system which results in a plurality of complementary transformation accommodations.

Subject 2: Strategy of Mathematical Structuring History of an exploration and discovery of a comprehensive synergetic-energetic co-ordinate system employed by nature. Disclosure of an omnirational, reciprocal functioning of co-evolutionary design accommodations in nature. Exposition of the comprehensively rational integrity of Synergetic-Energetic Geometry.

Subject 3: Strategy of Geographical Reconnaissance

Assumption in 1927 of an accelerated realization of a comprehensive Airocean World traffic-patterning, Reorientation to most economical aerodynamic integrations. Ascendency to economic primacy of Airocean World transport service and equipment industry."

Subject 4: Strategy of Communication Assumption in 1927 of a comprehensive, approximately instantaneous, electromagnetic-wave-oceanworld. Adoption in 1927 of an accelerated realization of a wireless, aural-optical, omni-scrutability of comprehensive, evolutionary patterning of economic geography, world industrialization network, technological evolution and scientific penetration.

Subject 5: Strategy of Priority Ranking Governing World and History's Progressive Resource Reinvestments

The comprehensively packaged advancement of the world-around high-standards-of-living of all men adopted as the number one priority of focus of the swiftly multiplying scientific effectiveness in management of the world-around industrial network.

Subject 6: Strategy of Economics Fundamental economic recourse to the comprehensive world-around chemical resource and to the all-history technical experience resources. Comprehensive recirculation of chemical elements. Progressive waves of comprehensive design replacement phases as evolutionary re-circulatory, regenerative resource processing. Accelerating replacement of humans by machines in all muscle, reflex, regenerative feed-back, integrative calculation, infra- and ultra sensorial exploratory inventorying.

Subject 7: Strategy of Education Progressive transfer of population from physical production and distribution functions to a

fundamental preoccupation with education, experiment, search, research, development, prototyping, tooling, tool-to-make-tooling-instrument-to-make-instrument-regenerative-step-up-transformation of technical man-advantage over a priori environmental patterning.

Subject 8: Strategy of Design
Comprehensive integration of the factors of Strategies 1 through 7 in formulation of INDUSTRIALLY REALIZABLE COMPREHENSIVE, ANTICIPATORY DESIGN SCIENCE in evolutionary waves scientifically synchronized with progressive rate of augmentable step-up of the comprehensive performance effectiveness of the progressively available resource inventory in the obsoleting zone of out-performed design in such a manner as to ever avoid impairment of latest and most advanced comprehensive effectiveness of the going "processes." Designed pull-up of the bottom vs. austere pull-down of the top.

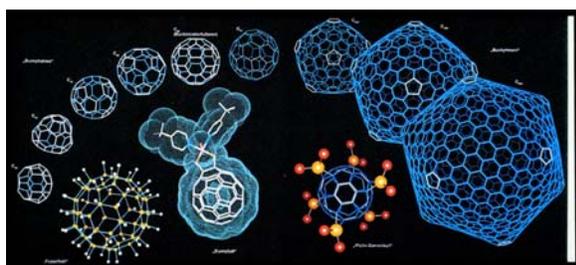
MATH & SCIENCE

Synergetics is the name of two books by Fuller, and the name for the geometry he advanced based on the patterns of energy that he saw in nature.

Fuller approached geometry as a laboratory science based on physical models that were with him at most lectures. His students made models of the closest packing of spheres.

Every talk included an explanation of the triangle as the fundamental structure and the most economical relationship between events.

He treated lines as vectors of energy. The triangle is the stable form in two dimensions. In three dimensions this becomes the tetrahedron. The icosahedron model led Bucky to the vector equilibrium. In *Synergetics I* and *II* Geometry is metaphysical. These books are, "Explorations in the Geometry of Thinking."



The Buckminster Fullerene

In 1985 a new allotrope of carbon (C_{60}) was discovered. Sixty carbon atoms form the shape of a ball like a football with a carbon atom at each of the corners of the hexagons and pentagons. Each carbon atom has three bonds. These are not called giant molecules because there are only sixty atoms. A large number of these molecules can fit together to form a transparent yellow solid called fullerite. This form of carbon was named after R. Buckminster Fuller, who was famous for designing a large geodesic dome which was similar to the molecular structure of C_{60} . Many other balls of carbon called fullerenes have since been made,

including C_{70} , C_{76} , and C_{84} . The molecules have become fondly known as "buckyballs".

George Olah of the University of Southern California won the 1994 Nobel Prize in chemistry "for revolutionizing the study of hydrocarbons and uncovering new ways to use them in the petroleum industry." Much of his late work was on cage molecules, particularly fullerenes.

R. BUCKMINSTER FULLER'S GRAND STRATEGY FOR SOLVING GLOBAL PROBLEMS

◆ "Throughout the history of man there has never been enough to go around for everyone---there has always been scarcity. Therefore, the basic problem was: who gets what? Who survives and who doesn't? Every society has had a different system for deciding that question, and which group survived was usually decided by war!"

◆ "But just because it has always been that way doesn't mean that it always has to be that way in the future. Just because there was scarcity in the past, does that mean that there has to be scarcity in the future?"

◆ "No! Mankind now has enough knowledge to be able to invent our way into a future of plenty. We are just not aware of the fact that we now have that possibility. According to the engineers, the world's industrial system is now operating at only about four percent efficiency, but it could easily be improved to an average of twelve percent. In other words, all we have to do is start using already existing inventions and stop being so wasteful!"

◆ "Ok. That sounds great, but having two or three times as much wealth would not do much good if the world's population keeps growing. Luckily, it just so happens that as industrialization increases, the global birth rate decreases. As the amount of energy per person increases, the birth rate decreases, so that if the world is completely industrialized by about the year 2010, the total population should peak at about 6 billion & then start declining."

◆ "Therefore, if we only double the average efficiency we could easily take care of the world's present one billion poor (the other four billion are already "making it" now). And if we triple the efficiency we could not only take care of any future population growth, but dramatically raise everyone's standard of living."

◆ "(The figures that I have used are very conservative. The efficiency could probably be raised much higher, complete industrialization could be achieved much faster, and population growth slowed down much faster. It is better to understate than overstate.)"

◆ "So, we are not on a treadmill; there is a way out. There is a practical strategy. How, specifically, can we raise the efficiency? How can we get more

energy, use less material, & use less time to provide for our basic needs? What do we need?"

◆ "Lots of renewable energy, plenty of food, decent inexpensive housing, medical care, education, transportation, and communication, to name the basics."

◆ "Energy first: We need to develop about a dozen types of renewable sources of energy and we need to develop ways of distributing that energy."



◆ "We now have the know-how to connect together all the world's electrical generating plants. That one project would almost double the amount of energy available in the world because right now most generating plants run at about half capacity & use the other half for peak demand only. By interconnecting they could all swap power (especially between the light & dark sides of the earth) and therefore be run at almost peak capacity most of the time--without building any new generating plants."

◆ "We must also phase in all the various types of renewable energy as the fossil fuels start to run out. There are plenty of alternatives to choose from: solar, wind, hydroelectric, biomass, alcohol, geothermal, tides, photovoltaic, hydrogen, waves, etc."

◆ "All these alternatives, when fully developed, would not only replace the non-renewable, polluting, and dangerous sources, but also give us three times as much energy as we have now (not counting the gains through interconnecting)."

◆ "So, we can have plenty of energy if we want it. There is no energy shortage! There is just a shortage of awareness of what is now possible. The crisis is a crisis of ignorance!"

◆ "Now, what is the story for food? Much the same. We produce more than enough food for everyone, but much of it rots or is eaten by rodents because we don't have the means of storing, preserving, and transporting it. But, with adequate energy we could grow, preserve, and distribute plenty of food for everyone. In fact, if needed, we could probably grow two or three times as much as we do now."

◆ "And so, if we solve the energy & food problems, how do we provide good, inexpensive housing for everyone? Simple. Shelter people in mass-produced, self-contained, surplus-energy-producing, geodesic dome homes that would be helicopter-delivered to anywhere for a tenth the cost of conventional houses."

◆ "A geodesic sphere is the lightest, strongest, and cheapest way of enclosing space ever invented. Domes can not only house individual families, but they could cover whole cities---and even float in the air or be anchored on or under the oceans. Domed cities use about 1/90th the energy of uncovered cities, and have perfect climates all year round---no matter what the outside climate."

◆ "So, if people have adequate food, energy, shelter, etc., they are bound to be healthier. The easiest way to control disease is to eliminate its causes, such as malnutrition, bad water, exposure, vermin, etc."

◆ "As far as transportation is concerned, we need to mass-produce already-invented ducted-fan air cars that can go on roads or rise vertically on jets of air. This would allow personal transportation just about anywhere without roads."



◆ "Also, we need to develop personal, modular transportation pods which could go on roads, be hooked together in groups, be loaded onto trucks, trains and boats, or put into airplanes for transport anywhere, with the whole global system scheduled by computer."

◆ "Development of wireless, satellite relayed, two-way communication systems will enable great numbers of people to work at home, wherever that may be in the world, thus cutting down on the expense of commuting to the office."

◆ “Also, education will return to the home because students will have two-way multimedia access (the Internet) to all the information banks of the world. They will be able to call up the best and latest information presented by the best teachers in the world. Two-way voice, data and fax will also be transmitted by satellite, thus cutting down on the use of energy and materials and speeding up the exchange of ideas and information.”

◆ “All this vast increase in wealth and decrease in waste (time, energy, materials) will make it possible to have a minimum level of guaranteed annual income for all which should gradually increase with time. People will have to work less and less and will have more and more time to do whatever they want---study, fish, travel, think, etc.”

◆ “Also, the fear of not having the basic necessities of life will be gone, and that should eliminate a lot of worry, stress-caused illnesses, and crime.

◆ “But most of all, if people no longer have to fight each other over limited resources, then the basic reason for war will be gone and war will become obsolete. The oldest dreams of mankind--peace, prosperity--will have come true.”

◆ “People living now, for the first time in history, have the opportunity, privilege, and responsibility to help to make all these things come true. All of humanity has struggled, dreamed, hoped, worked, and prayed for this moment in history. It is up to us to help make it happen.”

INTEGRITY: “What can I do?”

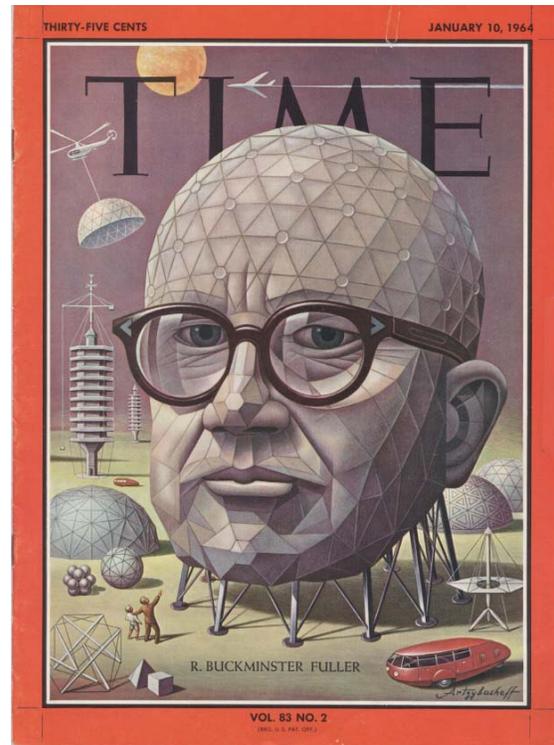
When Fuller was 27 years old he had been thrown out of Harvard (twice), failed at several businesses, he and Anne had lost their daughter to infant illness, he was broke, and he had decided to commit suicide by swimming past the point of exhaustion into Lake Michigan.

Before Jumping in he reviewed his life and rather than end it he committed the remainder of his life to addressing the question, “What can a single individual do for the benefit of all humankind?”

R. Buckminster Fuller demonstrated with his life work that individuals can do many wonderful and necessary things. He disdained solutions that would ‘come from the government or large corporations’ and he always favored teamwork.

Were he still alive he would be 108 and he would have been the featured keynote speaker at this GreenBuild 2003. And after his talk was done, each of us would be changed for the better so there would be hope for a positive response to his question, “Is humanity a failed experiment?”

“You never change things by fighting the existing reality. To change something, build a new model that makes the existing model obsolete”
-R. Buckminster Fuller



WEBSITES

The Buckminster Fuller Institute www.bfi.org has 1,000’s of pages of information and additional links. A list of Fuller’s patents and books can be found there.

Nick Peckham, Bob Berkebile and others are continuing the global vision at www.Critical-Path.org Current firm practice can be found on their firm’s sites www.PWArchitects.com and www.BNIM.com.

“Above all, I am motivated by the most mysterious drive we ever experience-- that of love...I don't think there's any influence on my life that compares with love. ”
-R. Buckminster Fuller