

December 22, 1958

Mr. Stuart Campbell
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Dear Mr. Campbell:

I regret my delay in answering your letters, which has been due to constant travel in the U. S.A. since my return from Europe.

I now answer your questions in the order of asking.

I do not have the financial means to bring you to the U.S.A. nor to employ you, should you come at your own expense. I have had students, from time to time, who have traveled about with me on their own initiative and financial arrangements. I do not have time for tutorial instruction of the latter and they learn by accepting various responsibilities from me and particularly from repeated participation in my university visits.

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 Flys' Eyes, geodesic structuring is true invention. The Radiolaria collapse when taken out of water. Flys' 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 one 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" with formulas thereby derived, but this does not provide theory but only special knowledge concerning this particular case rather than any general knowledge. For this reason, 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. I enclose a list of my university and college engagements but I do not have at hand a list of the professional societies visited, which is equivalent in its world coverage.

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 world-wide 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 now 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 assymetrical 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 integritability in respect to their two prime domains.

If you feel yourself inundated by this response, it is because I have taken this occasion of answering your letter to also answer others with similar questions. A comprehensive answer seemed appropriate.

In order to avoid frustration of any individual's enthusiasm for the extension of the geodesic principles at the academic research level, I have developed a non-exclusive, non-transferable, single edition, student license which permits the individual employment of the principle, with royalty only voluntary and only if the licensee should judge that the circumstances so warrant. Commercial license, covering any and all reproductions of prototypes, are available, on a non-exclusive basis, issuable to any reputable individual or corporation at a reasonable royalty rate but without payment of advance royalty. Inasmuch as there are now over one hundred large corporations, many of them competitors of one another, operating under my patent license, any possibility of monopolistic hinderance to trade has been avoided.

Regarding your diagram of what we call the four frequency alternate geodesic structure (see Ford Motor Co. 93' diameter dome of 1953) - the failure of all your vertices to fall in one spherical surface of unit radius, is probably occasioned by your mathematical error in, or lack of employment of, the pertinent spherical trigonometry. The number of different lengths of members, in all our "regular" or "alternate" frequency geodesic structures, is the same as the number of the frequency itself. In the alternate four frequency, we have the spherical icosahedron's main triangle with the triangle edges divided into four identical modules (a modular

frequency of four). If we letter each vertex along these edges, starting at the corners, as A B C B A and if we will connect great circles between the mid-edge points, C, C, C, of the three sides of the main triangle and then take the mid-point D of the three great circles C, C, C respectively and interconnect all the vertices of the big triangle, we will have the sixteen triangles symmetrically subdividing the big triangle A, A, A. In this relationship, the following table gives the lengths of the great circle chords of the total triangular patterning where the length of the radius of the sphere equals the number one. If you are working in inches or feet then multiply these numbers by the radius of your geodesic dome as stated in the inches or feet respectively.

I am enclosing two copies of the student license. If you will sign both copies and return both to me, I will sign both and return one to you. This will give you the legal right to produce an experimental structure at your university but not to re-license others. If you wish to build another dome I will issue another license, on your application.

Regarding your remarks on Conrad Wachsmann's philosophy and research, if it is similar to mine, it must be a matter of recent adoption. When he was at the Institute of Design of the Illinois Institute of Technology his technical explorations in structure were in directions other than geodesic though he did, toward the end of his Chicago visit, explore the use of my octahedron-tetrahedron truss in connection with the roof of his Air Force hangar. Though I am warmly sympathetic with Conrad Wachsmann's exploratory urges and technical strategies and I have heard him express enthusiasm for my work, it was clear that his explanations of his undertakings had not developed from any specific realization of my philosophy.

As the scope of my letter must indicate, I am grateful for your earnest interest and support. I feel confident that many of your negative reactions to historical preoccupations of man can be converted into positive initiatives and worthwhile results if not discoveries. I am certain that the positive contributions of sensitive lives must, however, wait upon a tolerant understanding of the dilemmas into which men have innocently entered and often reflexed in superficial offensive manner. I send you my good wishes.

Faithfully yours,

R. Buckminster Fuller