GEODESICS INC.
3013 HILLSBORO STREET
RALEIGH, NORTH CAROLINA

January 8, 1955

Dean Buford Pickens
School of Architecture
Washington University
St. Louis, Missouri

Dear Buford:

Happy New Year!

Thank you for your thoughtful statements in your letter of December 28. I assure you that we enjoyed our visit to Washington University to the utmost.

Here are the answers to your Questions Nos. 1, 2, and 3:

On Questions 1 and 2 regarding the proposed Swedish Dome and Sources of Dies for extruding the appropriate sections. The answers will be supplied to you by Mr. David Sides of Geodesics, Inc., 3013 Hillsboro Street, Raleigh, North Carolina, who will from now on take over as Liaison Designer-Engineer. We have gone over the matter here at Raleigh in great detail and he has already made a full-size aluminum tetrahedron unit. Mr. Sides is especially well prepared in the matter of sources for dies, joint technology, already-in-production parts, etc. He will soon give you the best section for the strut and the fundamental hinge treatment for which that section is suited. The section may be tubular as this gives the most strength for the least material weight.

Regarding your Question No. 3. For both yourself and Mr. Sides I will now state everything I can think of, but before giving my digest of the project I would like to point out that its scheduling at Washington University should be, in many ways, affected by perspective gained on the project just closed. However, to gain such perspective it will first be necessary that all of the documenting and reporting departments of the just-closed project will have to package up their work and present copies to:

Dean Buford Pickens
R. Buckminster Fuller
David Sides
To Accompany Swedish Dome, for Exhibition Purposes
New Thesis Group
Washington University Library

The report should include not only the Secretary's comprehensive statement of the project and its diary, but also the Purchasing Department reports, the Treasurer's report, together with the economic studies in regard to the parts, chemical and price analyses, and all other possible statistical information. The Mathematics Department should make its report and then the Drafting Department should hand in all of its work on uniform size 24 x 36 drawings.

Then there should be the photographic documentation of all of the Research Department's joint and strut studies and strength tests of components and subassemblies, and there should be the Engineering calculations report on the structural analysis of the Dome's system-behavior and joint and strut strengths, and working parts specifications and dimensions.

In the preparation of such report the problems of the Swedish Dome will come into vigorous preview and will modify anything which I now may be able to say as far as departmentalizing, priority scheduling, etc., for the final Swedish-Dome phase of our joint project.

Professor James Fitzgibbon, whom you already well know, and who now heads Geodesics, Inc., has agreed to the assignment of Mr. Sides of his staff to this special liaison task, and has promised the guidance of the whole Geodesics, Inc. staff. He understands that it is of great importance that your students work out the calculations and strategy wherever appropriate and that this is the reason that they are undertaking the work, and that your scheduling it as a school project is in order that they may acquire knowledge in the most profitable manner which, of course, is that acquired by real challenge and responsive experiment.

It must be remembered, however, that misconception is readily developed in respect to my projects, borne of my effort to give the student the maximum opportunity of direct realistic challenge. It must be remembered that the Dome was manufactured and erected in St. Louis within one week only because I had an experience fertilized teleologic design backlog and therefore could make extemporaneous exposure of this design. I designed the project comprehensively and thus eliminated any chance of decision vacillating delay in its tightly designed fulfillment, beyond close of the exquisitely short period available.

My strategy of operation with university projects is an inverted corrolary of the proposition that if a man draws a small triangle he is inadvertently drawing a large triangle upon the system drawn upon. In my university projects I pre-draw the big triangle on the world industrial network system by my total life work and sharpen the lines of that embracing large triangle as the defined limits of the problems presented to the students, thereby establishing the small triangle's specific design by synergetic inherence. Another way in which I often state this is that: "A Problem Adequately Stated is a Problem thereby Solved." But the little design inherently effected by the big design is as focus-invisible to the university student as is his inherent construction of a big triangle whenever he constructs a little one. Therefore, it is necessary that I now call this to the student's attention as part of the original adequate teleological statement of the problem.

This meant that student decisions fell within my designed limits of their responsibilities as, for instance, in selections from available material stocks and best application of that material to my strut dimensions, and as ingenuity of organizing high-speed procedures for

test solving any moot point as, for instance, the best type of vertexial interaction, or in production jigging ingenuity, comprehensive foresight and scheduling, processes of high-speed dissemination of all gained information through frequent total and divisional meetings. In order to give everyone satisfaction that he was really participating in a unique design prototyping experience and not forced to do so from a completely fresh start, where none of them knew about geodesic structures and aircraft industry technology and economics, and where few of them even knew spherical trigonometry, it meant that I had to forego any spontaneously precipitant preconceptioning of the design until I took up for live conscious consideration in their actual presence, when by thinking out loud I could review in effect everything pertinent I knew and all those of my experiences which integrated logically at that moment, into that unique next design experiment within my over-all strategy of exploration for tactical design functions which when solved would fill gaps in the over-all integrating network of commonwealth advantage.

It meant that I must review vigorously and clearly all my experience developed thought tools of these years. It meant that I must then bring the problem of meeting with them at this moment in history and in this particular place, into gear with a clearly conceivable real world task which could be translated into true value to society. This all lead to my strict defining of the required performance characteristics of that unique design implicit to my statement of the problem and my strict statement of what the prevailing limits of its realization under the present circumstances were.

It then meant that I must so rapidly and effectively process and integrate all the foregoing factors before the students that the students could feel by induction and thought process momemtum, as if in a theater, that they had lived all of those experiences and had acquired all those tactical tools themselves, so that as I then presented the actual structural design itself they would feel spontaneously that this was indeed their declared design. It is to be noted that in giving them their aircraft industry departmentalization for the high-speed teleologic realization of our project I very specifically called to their attention that there was no design department, that those who went to drawing boards would be making documentary record of the design which I was giving them, and that the satisfactory freshness of my design to them lay in the fact that it had never been realized before. Therefore, it must be seen in review of these facts that what we will call design ingenuity of the individuals was perforce demonstrated in the matter of carrying out the logical sub-complex patterning. This sub-patterning is also true design for all design is subservient to the great design of universe and its sets of comprehensive permitted reciprocal behaviors. It is true that every student was responsible for some phase of original design conceptioning, but none of them must make the mistake of thinking, to their own disadvantage, that they have been responsible for teleologic processes as yet beyond the limits of their experience and capacity. Unfortunately, I have known many students who have fooled themselves into thinking that their participation

in these projects and their exciting results warranted their self-deception that they had mastered the organization of such comprehensive teleologic design functioning within all the going ramifications of science, industry, and economics, history and philosophy. There is no lesson so difficult to learn as that which tells us how little we know without at the same time destroying that little and our confident though meager competence in converting this little teleologically to the advantage account of all.

In the same way it must be remembered that I have, of necessity, also designed the Dome we will send to Sweden and for which the representatives of Halsingborg had asked me. And, therefore, the thesis students, in order to be effective within the limited time allotted, will have again to act as a team in designing the sub-complex forwarding requirements of my preconceived comprehensive solution. My design involved not only the jig built, folded for shipping and site articulatable magnesium Dome which we will send to Sweden, but my teleologic concept of what was appropriate to send to Sweden in relation to the present historical events in which North America, with seven percent of world population, finds itself on trial before the balance of the world and my concept as to how effectively, resolutely, consciously and directly we may meet the challenge of upping the performances per pounds of those functions of the world-wide industrial network, of whose majority portion in physical resources the United States at present, despite its small percentage of population, is the major custodian.

My design, then, as stated to the students on December 7th and as since processed, involves a potent sample capsule of the brand of technological responsibility toward upping world living standards which we in the U. S. A. are preparing to furnish in a major way, dispatched from the center of the United States to Sweden, a country able to rebroadcast its findings in regard to the United States, to the great majority of world peoples. This the Swedish people can do in an authoritative manner because they themselves are noted world-wide for their design efficiencey, general competence, and intuitive cleanliness of economic solution. Our jointly realized design involves, then, the integration of all such experience as, in due course, brought me to St. Louis. It involves my shoot-the-works investment of all such teleologic-design-ability credit as may have accrued to me in general, as well as that which I may specifically have with the students of Washington University and with the citizens of St. Louis, and with the industrial organizations whose products and services are appropriate to our sending to Sweden of a message that may be obviously and spontaneously worth rebroadcasting by the Swedish people to the majority of peoples of the earth.

In response to the Swedish request for a Dome which they stated in their letter would be "A Great Asset" to the success of their exposition, our design is, then, to send to the Halsingborg Exposition a 5/8 spherical structure of unprecedentedly high cubage per weight of structure, so designed that it may be flown to Sweden on an historical date, that is, May 22 (Anniversary of the Lindbergh Flight--a name of Swedish origin and identified epochally with St. Louis by the name of Lindbergh's Plane "The Spirit of St. Louis").

It is an historical fact, that might be purposefully recalled in this instance, that it was less than a year after Lindbergh's notable flight of May 22, 1927 that a large portion of St. Louis houses consisting of the heavy brick and masonry variety were utterly demolished by a tornado, the ignorant concept of excessive weight and width for greatest stability having proved false. It was also demonstrated that such building design concept had failed to make it a basic working assumption that such major stresses might be applied to St. Louis houses. The structure we send as "The Follow-Through Spirit of St. Louis" must, with 1/200th the weight of an equivalently cubaged 1927 dwelling, be of such precalculated strength as to insure its immunity to tornado and hurricane forces.

Now within only 28 years following Lindbergh's "Spirit of St. Louis" Flight of 1927 more people have come to cross annually the world's major oceans by airship than by water ship. It would therefore be good news if it is seen that the now realized world integrating tool of flight can carry a capsuled package of comprehensive enclosure and facilities for high standard living flown from the very center of the mass-production complex of the United States over the North Pole to be installed ready for instant use in Europe, - a flown distance that could have landed it in Asia as well.

At no time should this general picture of the comprehensive responsibility of our project be lost sight of by any who take part in it--students, university staff, or executives and employees of industrial establishments who may be brought into the successful realization of our undertaking.

Beyond the above comprehensive strategy comes the desire to provide this particular structure with evolutionary and newsworthy advances over any previous geodesic structuring.

There is no question that such a newsworthy degree of evolutionary design advance may be realized through inclusion of the self-opening function whereby a completely preassembled and skinned Dome of 42 feet in diameter, weighing less than six hundred (600) pounds, can as do nature's biological designs be long-distance air lifted in compact seed form and at landing, upon receipt of appropriate exterior signal, open itself to full bloom. This advance design feature is not one which remains as a hopeful challenge but is one which we know how to organize.

The ability to solve the self-articulating problem with comparative ease lies in the minor dimensional variation to be accomplished at the tetrahedronal vertex masts by tightening the three outward radial tension members of the respective identical tetrahedra from a closed parallel condition to an open radial condition. This differential is in the order of two or three inches local radial tension and the tightening, which in turn opens the whole Dome, can be accomplished by thirty (30) locked coil springs which on folding the Dome into "Seed" shipability, are easily pressured into the alert, high-potential condition by the long leverage advantage afforded by the tripod legs, so that all that is necessary for the opening of the Dome, on arrival at site, is some means of simultaneous unleashing of the spring pressures so that the whole Dome may spring into open condition. It may be that we will learn by model experiment that the opening could occur

as a chain reaction, by releasing the spring of one outer tetrahedronal unit, which would then by velocity of release tend to unlock the next spring and then the next springs, etc. If the whole Dome were mounted at a 30-ft. height on a mast at the time the chain reaction occurred the Dome could open in free space unfrustrated by ground contact, or the whole "Seed" bundle could be hung from a crane arm for this free motion purpose.

Inasmuch as the time schedule imposed by the June First opening necessitates that the structural strut section be determined by calculations and the strut extrusions be ordered immediately from stock dies, it is in turn necessary that we employ the advance engineering knowledge of the Geodesics, Inc. staff, which is the exclusive and authorized proprietor of the accumulated information developed for this very kind of task over a twenty-seven year period.

It will be quite possible for the students to verify for their own account and experience that this section was well chosen under the time and inventory limitations. The best section itself will impose certain further limitations on the conformation of the most effective terminal treatment and will, therefore, induce further dimensioning and metallurgical limitations upon the hinging mechanisms.

This section of strut engineering is sequitor and subservient, however, to the larger problem challenging the ingenuity of your thesis students. The large problem which does first challenge them is that of developing the "final" general assembly design through tests of models and through experiments with local full-size sub-assemblies. These experiments will determine what the best means will be of hinging, springing, folding, packaging, installing, and detonating the whole structure are. Your students will have to manufacture the tent Dome assembly, but I am sure that we will be able to arrange to have the fabric for the project donated by the suppliers. I have been to see Dupont at Wilmington, Delaware, regarding this and they indicate approval, but will have to confirm.

We have, in Geodesics, Inc., a well developed experience in the making of such tents but have never had the problem of combining those tents with a structure to be exploded into full installation condition. This "chain reaction" opening will involve great competence to insure that the tenting remains undamaged throughout all of the phases of collapse, shipping, and sudden explosion.

These articulation problems are customarily of such magnitude as to be solved by industry only, over a period of years. Let there be no sense of student inferiority developed regarding the magnitude of the challenge with which they are confronted, - despite the thoroughly well glimpsed over-all scheme.

If the "Follow-Through Spirit of St. Louis" is to carry the message of greatest comfort and welcome to the most people in the world, it should also be accompanied by a compact, light-weight package containing a complete energy exchange system which would provide heat, light, refrigeration, pure water processing, water condensation

from the atmosphere, compressed air, etc., adequate to supply this generously cubaged dwelling space with all the customary standards of atmospheric, olfactoral, tactile, audible, and optical environment most favorable to human habitation, its sanitation, and the provision of means of stabilized shunting and conversion of the energy increments from the comprehensive universe environment into the preferred metabolic process patterns suitable to the occupants.

A student now candidate for his Master's at the University of Michigan, Department of Architecture, named Ronald Goodfellow, has conducted his Master's thesis in the development of such an energy exchange package for an autonomous dwelling facility as a valved unitary mechanism. Ronald Goodfellow has greatly forwarded the autonomous dwelling package problem, which I started in 1927 and which has since then passed through a 27-year series of team research processions. In recent years the autonomous energy exchange unit has been greatly forwarded by a team of students at the Institute of Design in Chicago in 1949, and thereafter by one of the leaders of that group in his Master's research work at Massachusetts Institute of Technology in 1951, and thereafter by a thesis group of six students at Yale in 1952 and 1953.

I would suggest that the Washington University Department of Architecture get in touch with Mr. Goodfellow and, if possible, arrange to retain him throughout the period of the Swedish Dome development as a research associate, and if the latter is unfeasible that they arrange, if Mr. Goodfellow is willing, to take advantage of his extraordinarily able work in actually assembling as much of the energy exchange apparatus as is feasible under all the circumstances and under the willingness of the appropriate industries and merchants. All of Goodfellow's apparatus is commercially available.

If Mr. Goodfellow is unable to help you I would then have your students put together a package of their own search and devising which would incorporate, for instance, an onan, aircraft type, aluminum diesel or gasoline motor generating set, together with calrod heating elements, refrigerating elements, etc., all of whose energy processing should turn all by-product towards the most effective processing and valving of the atmospheric conditions.

Research teams from amongst your thesis student group should be set toward competent solution of the interior and exterior aerodynamic valvings, also of preferred accoustical and lighting solutions. Other team problems not hithertc discussed should center in provision of high-speed, light-weight, high-performance furniture for a family of six. Other team members should be concerned with most effective and economical means of arriving at local optical, oral, olfactoral, tactile, and psychological privacies without wasteful partitioning.

Other team problems should relate to the most economical means of insulating the occupants from unfavorable conditions obtaining to proximity to the earth while at the same time allowing for maximum use of the earth for garden and primary support purposes. Team members should be concerned with light-weight octet trussing

to provide island-sky platforms within the Dome, hanging balconies, etc., where these would seem desirable. None of the above team research and designed integration should result in anything other than simple, economical, packagable, flyable, high-speed installable physical phenomena. Great discretion must be continuously exercised in the elimination of the irrelevant.

This, for the moment, is all that I can remember as having been essentially concerned with in respect to our undertaking.

I am having this letter dittoed so that copies may be sent to whoever may be concerned. I myself will send copies directly to Mr. Ronald Goodfellow and to Mr. Ellis of the Dow Chemical Company, and to Mr. Robert Fuller of E. I. duPont deNemours Company in Wilmington, Delaware, Synthetic Fabrics Department, who I am hoping may be able to be of assistance. I am also sending a copy to Mr. Donehower of the Dupont Company, In Charge of Development of Dupont's "Mylar" Program.

Faithfully Yours,

RBF/JB

R. Buckminster Fuller
President