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Brigadier General Harold E. Watson, USAF  
Commander, Air Technical Intelligence Center  
Wright-Patterson Air Force Base, Ohio

Dear Hal:

Enclosed are two copies of the Dymaxion Airocean World Map together with their explanatory supplements. I send these because of an item in NEWSWEEK, April 11, page 25, which reads as follows:

DAYTON, OHIO - The Air Force has developed an extraordinary new precision system for mapping the world for future guided-missiles of bombing operations. It's called "Hiran", short for high-precision, short-range navigation. It uses electronic instruments for accurately measuring distances from known points.

I hope that you may be willing to forward my Airocean Maps and their supplements together with a copy of this letter and other enclosures to the Commander of the "Hiran" operation.

Certain of the information contained in the supplement is directly pertinent to "Hiran". The second column from the left-hand edge of the supplement is particularly pertinent, but columns one and three - which latter contains illustrations - also are of direct mathematical applicability and hold potential technical advantage to be developed in respect to the reference Air Force Project.

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You may recall that, in May 1952, with the assistance of Cornell students, I designed and built a 20' Miniature Earth on the roof of Cornell University's Electrical Engineering building at Ithaca, New York. (See enclosed cover of The GENTRY Magazine reprint.) In the course of that project I confirmed my earlier conviction that a direct linkage with basic long-distance remote flight control systems could be developed through fundamental coordination of world triangulation with a large, triangulated, Geodesic globe.

I am now launched upon a similar project, but eight-fold more ambitious, which is a three year program - inaugurated in November 1954 - at the University of Minnesota's Department of Architecture, in

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association with approximately thirty students coordinated by Mr. George Ah Tou under the supervision of Professor Walter Vivrette.

This project will produce and install on the University of Minnesota's Minneapolis campus a One Millionth full size Earth. A one millionth ratio was chosen because it is the scale long since selected by a world-around convention of geographers as the international standard for detailing local areas in a coordinated plan to map the entire world.

The Minnesota Geodesic sphere will be approximately 50 feet in diameter - having a surface area of 7,854 square feet and a circumference of 157 feet. It will consist of a triangulated twelve frequency great circle grid - with edges of triangles measuring approximately thirty-two inches. Each triangular facet of the sphere will contain approximately  $3\frac{1}{2}$  square feet. Its appearance will be similar to the pattern shown on page one of my Patent No. 2,682,235 for structures, enclosed herewith. The twelve frequency, thirty-two inch module was chosen for two reasons. First is that it makes the structure comfortable and easy to climb - either through or around - like a "jungle-gym"; the sphere is therefore self-scaffolding. Secondly, the thirty-two inch module assures that the structure's basic subassembly components will go through stock doorways en route from shop to sphere.

In the Minnesota One Millionth Earth - herewith nicknamed "Minni-Earth" - each of the 2160 exterior, triangular openings of the spherical frame structure will receive a triangularly sectioned, tapered, box-kite-like, slide-frame insert. This insertable, triangular "box-kite" will consist of an open framework with a triangular base which "box-kite" is - geometrically - a truncated tetrahedron. The omitted apex section of the truncated tetrahedron would have reached - if not truncated - to the theoretical center of the 50' sphere.

Each of the truncated tetrahedra frames acts like a triangularly sectioned phantom file-case drawer, and is designed to slide into, or out from, its "corkable" position in the 50' sphere.

This particular mechanical property of the construction will permit the students to insert and remove at will each or all of the truncated tetrahedral phantom file-case drawers of the sphere. Each of these featherweight truncated zonal frames when extracted will have a triangular base measuring approximately 31 inches per edge, while the radial edges of the sphere's truncated tetra each measure five feet long.

When all the triangular phantom file drawer frames are locked into place in the sphere, the spherical structure thus totally resulting will have an

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exterior spherical zone everywhere five feet deep. Therefore, the sphere - 50' in exterior diameter - will have an interior spherical diameter of 40', which is approximately the size of the One Millionth Earth.

The five foot deep truss of the sphere's framing performs all primary structural functions. This permits the students to introduce delicate secondary structural components within each of their truncated-tetra file drawer frames, which secondary structural elements will - when totally assembled - present the World's geographical configurations, viewable either from the center of the sphere or from outside of the sphere, as an open lace-like pattern. The openings through this pattern will permit an approximately uninterrupted view of the stars at night from the center of Minni-Earth.

The coordinate triangular gridding and sinus orientation of the Dymaxion Airocean World Map - which I have enclosed with this letter - corresponds to the triangular gridding and orientation of Minni-Earth. Both map and Minni-Earth are identically oriented in respect to the geographical "features" of the real Earth - as these occur upon their respective grids of triangular coordination.

I enclose an additional copy of the Dymaxion Airocean World with its major triangular faces - corresponding to the spherical icosahedron - subdivided by twelve frequency grid, wherefor each of the 2160 little triangles of the twelve frequency grid - thus produced - corresponds exactly with the 2160, -31 inch-edged, -triangles of Minni-Earth. And the geographical data contained within each of the 2160 little triangles on the Airocean World Map corresponds to the same data to be featured by the featherweight secondary structuring installed within each of the truncated tetras' insertable, box-kite, phantom file drawers.

The lace-like network of the exterior five foot zone structure of Minni-Earth when fully assembled will contain at its inner twenty foot radius a pattern of the Earth's geographical surface data dimensioned at 1:1,000,000 scale. At this scale Greater New York City, for instance, will be visible as a three inch diameter, cross-hatched spiderweb. Continents and islands will be outlined in silhouettes by lines of various thicknesses and colors, as appropriate to quick recognition. The data and pattern will be readable from inside or outside the sphere - with varying synergetic effects in respect to far and near viewing.

The outer five foot zonal depth of Minni-Earth will be appropriately subdivided (like an onion) by concentric spheres, with the radius magnitude of each sphere exaggerated to render clearly visible the separate strata of the Minni-Earth's complex exterior. At inner sphere level will appear the ocean's

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bottom conformations. Outward of this will appear continental shelves and sea level contours. The basic oceanographic stream data will be shown. Outward of this will occur successively the sky's graded spheres each readably codified in respect to chemical, thermal, electric magnetic, and pressure limits. In the outer atmosphere will be shown the jetstream's thin doughnut shaped ranging and its west-to-east 300-400 M.P.H. rotation.

When installed at one of the University of Minnesota's buildings, Minni-Earth will be mounted well outward of the roof with an access stairway to its center - leading in through the "lonely vastness" of its 500 square foot Indian Ocean. The stairway will lead to an observation platform at approximate center of Minni-Earth. Upon the platform will be mounted simple instruments for accurate positioning of the observer's eye at true center of Minni-Earth. This follows the operating precedent successfully established in the 1952, 20' Miniature Earth of Cornell University.

The Minnesota One Millionth Earth will be rigidly fixed in its orientation in respect to the real Earth. All its axii of reference - rotational, antipodal, and precessional - will be aligned in parallel with the respective axii of Parent Earth. Because it is to be installed at Minneapolis, the antipodes of Minneapolis on Minni-Earth - which occurs in the Indian Ocean - will be oriented towards the center of Parent Earth in a straight line which continues on through Earth to emerge in the real Indian Ocean, - only  $1/23$  of a light-second distant from Minni-Earth.

Because the center's of Minni-Earth and Parent Earth respectively will be but 4,000 miles apart, while the nearest star is 92,000,000 miles away, the distance between centers - of Minni-Earth and Parent Earth - is astronomically negligible and therefore truly "invisible". Observations from the center of Minni-Earth - in every direction not blocked by its giant neighbor Parent Earth - will appear identical in every detail to our own next observations if we were to jump from Minni-Earth's center to Parent Earth's center and be given X-ray vision, operative without diffraction through the surrounding Earth mass - with the exception of the continental outlines - thus to view directly the comprehensive celestial pattern through the pattern of Earth's continental features as for any moment oriented within the great Cosmic system, and thus verify the remarkable agreement of observational relationships as taken from either Minni-Earth's or Parent Earth's centers.

Just as a lifeboat upon the davits of the "Queen Mary" is rigidly fixed and aligned in parallel with the "Queen Mary's" lines - athwartships, fore-and aft, and in rake of mast (its vertical and precessional axis), so, too, will Minni-Earth be rigidly fixed and aligned in relation to its

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Parent Earth's lines (axii).

As the "Queen Mary" rolls and pitches and changes course upon the sea, so, in perfect coordination, does the lifeboat fixed upon its davits roll, pitch, and change course, not only in respect to the very same sea and its shores, but also in respect to the very same Earth and its surrounding star theater.

In consequence of its identically fixed alignment with Parent Earth, Minni-Earth - like the lifeboat - must move about within the depths of the celestial ocean theater precisely in every respect as does Parent Earth move within the very same cosmic ocean, or star theater.

As the Parent Earth revolves about its own north-south axis, so, too - with negligible (4000 mile) celestial eccentricity - does Minni-Earth revolve about its own north-south axis which also points ever truly, as does Parent Earth's polar axis, toward the North Star - Polaris. As Parent Earth rotates, orbits and precesses in the Solar System, so exactly does Minni-Earth rotate, orbit and precess in the very same real Solar System.

If, because of phenomenal "June booking" of passengers, the "Queen Mary's" navigator was temporarily quartered in one of the topside lifeboats together with his sextant and other instruments, he could "navigate" his lifeboat by angular observation sights of the sun and stars in respect to the Earth's horizon, entirely from within the gunwales of his lifeboat, as though the "Queen Mary" did not exist. He could thereafter relay the processed navigational information and resulting course corrections to the "Queen Mary's" helmsman to be executed simultaneously for both the big and little craft.

In many ways Minni-Earth has inherent cosmic navigation advantages not possessed by Parent Earth. For instance, when - to the observer with eye at center of Minni-Earth - a star appears in zenith outwardly of any visibly identifiable point on Minni-Earth's surface, that star will always be in true zenith over the same point on Parent Earth. This you will note is in marked contrast to sky and star viewing from big Earth's surface which, for instance, falsely persuades the viewer that all the stars near the eastern horizon are not in zenith to another part of the world, but are seemingly "rising" toward the viewer's exclusively existent zenith.

However, we have been learning realistically that, as seen from the center of Minni-Earth (to which Parent Earth is but a neighboring sphere - ever in zenith outwardly of the Indian Ocean - and hogging the view), all heavenly bodies are always in zenith, wherefore to Minni-Earth inhabitants

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no stars or planets ever have occasion seemingly to "rise" and "sink", i.e., go "up" and "down" - which is pure nonsense, as there are no directions of "up" and "down" in Universe.

Furthermore, you can't measure by eye the angular relationship of stars to your position on Parent Earth, but from center of Minni-Earth the surface grid's known module of  $5\frac{1}{4}$  degrees of arc, makes astronomical observation and approximate calculation possible without any other instruments than Minni-Earth herself.

From the center of Minni-Earth, see for yourself a star in zenith over Minni-London, Minni-England, quickly telephone long-distance to London, England, and you will learn by personable testimony of an observer there that the very same, very real star is truly in zenith over big London - readably a quarter of the way around big Earth from Minni-Earth.

Thus by a succession of similar informative experiences will you as observer in Minni-Earth become confident of the reliability of your continuing observations and resulting sense of cosmic orientation and celestial behavior to a degree you had never before seemed able to be on Parent Earth.

Many a youngster says today: "I wonder what it would feel like to be rocketing through Universe in a Space Ship?" The answer is: "What does it feel like? That's what you are doing now and have always been doing, but, of course like a flea, deep in the carpet of an enormous outside 'decking' of your Space Ship and therefore with a very limited, "flea-eyed" view. Minnie-Earth can, if experienced and studied, give you "feel" - as well as "know" - of your passaging through Universe just as you would see and know from inside your windowed Space Ship."

You will learn to feel that Minni-Earth is truly a very small - but very real - Siamese-twin planet of Parent Earth behaving in the very real Universe exactly as does its giant twin, but there is a difference: the inhabitants at center of Minni-Earth have rational vision of celestial phenomena, regarding which the inhabitants of big Earth are partially blind.

Minni-Earth will thus come to constitute what might be classified - both scientifically and popularly - as a True Planetarium.

As seen from the center of Minni-Earth, the North Star stays in zenith over the center of the Arctic Ocean all night long and, if looked at through a very long metal tube, all day long as well. This fixity of Minni-Earth in the cosmic scheme draws spontaneous attention to the changes continually taking place

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in respect to Minni-Earth's equatorial lands observed in black shadow seemingly moving at creep-rate against the luminosity of the comprehensive star pattern and easily persuades the senses of the viewer that Minni-Earth and - by induction also - big Earth - are now rotating in unison around their respective polar axii in the vast star theater.

Just so is it sensed realistically by our navigator, now huddled low within the "Queen Mary's" lifeboat, that a sudden parade - almost overhead - first of New York's Skyline, and then a vigorous rotation between his ship's masts and that New York Skyline - are both relative motions, - jointly caused: firstly by entry into the Port of New York and secondly by the "swinging" of the lifeboat and the "Queen Mary" around their respective vertical axii in respect to New York during the docking maneuvers. The navigator - through momentum of his experienced observations of his ship in motion in respect to celestial fixes - does not yield to the error of "seeing" the event as New York City's Manhattan Island "probably" steaming out into the Atlantic and racing around the "Queen Mary" and her lifeboat, which would be the same brand of nonsense which now persuades Earthians to "see" the Sun, rising out of "the East" and zooming "over" the Earth.

And whereas Man has long held a rigorous intellectual grasp of these motions of the Earth, the actual sensing of the motions seemed hopelessly beyond him. Because of Minni-Earth he will now see that this frustration of his astronomical motion-sensing is not caused by innate blockage, but is due alone to his confinement to the - seemingly fixed - surface of a deceptively large sphere.

Now, also the whole sense of such "coupled" - and thus visible gyrations - becomes as natural to his working senses as do his coupled rotations in respect to waltzing, in which case - if he is not dizzy with rum or love - he will see himself and his partner (irrespective of changing axial eccentricities from respective center's of boy-girl gyration) as turning mutually in respect to the ballroom, though if either of their separate motion patterns alone were traced, each of the separate paths would correspond to the common pattern of their mutual gyrations in relation to the walls.

The Cornell 1952 twenty foot Miniature Earth provided the observer with his first emancipation from "Sun-sets". Minnesota's Minni-Earth will greatly augment the process of general emancipation from a plethora of pre-Copernican non-sense, which as yet practically debilitates the "everyday" thinking of the world - and even in a marked way the practical thoughts of advanced scientists.

It is relatively unimportant that Minni-Earth may be, for the moment,

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the largest spherical representation of real Earth. What is truly unique in regard to both the University of Minnesota's Minni-Earth - to be - and Cornell University's Minniature Earth - that was - is the transparency of its exterior pattern and the ability to both go through and look through it from many viewpoints. There are several solid, or opaquely skinned giant "globes" in existence - most of them mounted on revolving axii - firstly to "imitate" an only theoretically rotating Earth on a "seemingly" fixed real Earth base, and secondly, to revolve otherwise unreadable portions of the imitation Earth's surface before the standing observer. These giant globes are constructed with the mistaken notion that the bigger the globe the better the information. The fact is that a greater percentage of the surface of a twelve inch diameter hand globe is visible to the observer, at any one time, than may be seen by him - within data reading range - at any one time on any giant globe. If bigger were truly better - to an observer isolated either outside or inside of a "solidly" skinned globe - then real Earth itself would be the best giant globe of all. But the fact is that to a solidly isolated observer, the bigger the observed object in respect to the viewer, the less of the whole pattern - and significance of the relationship of that whole pattern - that may be apprehended at any one time by the observer. And the worst "globe" for quick comprehensive survey is the Earth. That's where comprehensive "blindness" and "dizziness" thrives.

Solid globes viewed from Inward may not be viewed through the back of the head, so even these frustrate comprehensive inspection. Maps are better for detailed comprehension of real Earth's local patterns, than are any giant globes which tend to approach relative flatness and lose the significance or the relationships they fallaciously attempt to capture.

In contradistinction to these solid globes, Minni-Earth may be seen all the way through, and its comparative intra-antipodal relationships apprehended while orienting those relationships truly to true Universe.

The Minni-Earth's centrally observable - and triangularly identifiable celestial "fixes", and their direct locus readability in respect to true triangular coordinates - makes possible installation of automatic animations relayed from remote, simultaneous, three-way focused, photoelectric cell observations of various sky motion phenomena. It is also possible to have mechanically scanned upon the inner surface of Minni-Earth a relayed, radar-tracing of either controlled-away or watched-in missiles, or any other flights beyond or within horizon's rim. All remote sky observations could be locally identified and traced in amplified and readable magnitude by miniature electric lamp animations in Minni-Earth's local sky and thus made simultaneously readable upon the starscape and upon Minni-Earth's triangularly-coordinated, geographical pattern, as the latter rotates in progressive zenith registrations with the celestial pattern.



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Minni-Earth is being developed with the vigorous hope that it also may prove of tactical - if not strategic - value in our maintenance of an earned - and therefore true - world leadership as the most reliable and swift translators of scientific advances into every-day commonwealth advantages through means of our mastery of the principles of industrialization. Accepted responsibility in maintenance of our world lead-initiative in respect to such realization of scientific potentials for world-around people, demands an at first unpopular program of plowed-back increments of technical advantage in the tools-to-make-tools principle governing regenerative step-up transformation of industrial distributive potentials - thereby, however, bringing about at earliest possible date an industrially mass-produced, and world adequate crop of comprehensive technical advantages inducing acceleratingly higher standards of common and individual living and goodwill.

It is hoped that Minni-Earth's regenerative effect will be to induce integrated deposit of fundamental information accruing from the whole gamut of original world resource reporting and subsequently digested by governments, universities, pure science and industrial laboratories alike. Minni-Earth could greatly augment the development by the United States of a foreign policy so wise and so effective that none on Earth could doubt either our integrity nor our ability to blaze the shortest trail to the most world satisfaction in the shortest time, while ever commanding in all ways the degree of respect essential to our accomplishment of that trail blazing under peaceful world conditions.

Minni-Earth could be one of those visible respect-breeders as well as a practical tool for assimilating vast information, - governing those fundamental controls. It is all very well to have machines integrating details, but only humans may comprehend the significance to humans of the unprecedented, emergent, integrating, synergetic patterns and only humans may initiate the comprehensive new strategies appropriate to forwarding human welfaring processes.

It is hoped that this notice to you - and the Air Force through you - of Minni-Earth's development will be of direct interest and receive the direct support of the Air Force and other Departments of the Defense.

If the Air Force officials of "Hiran" are in agreement with my thought, I would be glad to arrange a licensing agreement to them for employment of the Dymaxion cartographic transformation patent, either in projection or control relays for processing the data subjectively or objectively. My Geodesic structures patent also falls into direct functioning in the solution of technical problems that arise in respect to automation of the translating process of geographical data into controlled systems. (Enclosed are copies of patents referred to: Geodesic structures Patent No. 2,682,235; and the Cartographical Patent No. 2,393,676 is bound within the Fluid Geography Essay.

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Both my funds and those of the University of Minnesota's Department of Architecture are inadequate to the kind of job that can be done. We do have enough money, however, to start the work and insure the fabrication of the structural sphere and the triangular drawer frames. How far we will be able to go in techniques of effective around-the-clock, day-night, and animated display of the data will depend entirely upon how much financial help and student work support we receive.

If adequate funds become available the geographical "features" data could be presented by various dimensions of neon gas-filled tubes and so wired that call-up relays could be actuated hand-wise or mechanically to call into view comprehensive, integrated variable and constant informations of extraordinary importance and interest.

The local removability of the triangular zonal frames makes possible not only remote preparation of original work by the students either in their school shops or own homes, but it also permits a constant reworking of the data, or even substitution of preferred local data arrangements - by production of alternate spare insert frames.

Of interest and possibly great importance to world flight controls is the fact that it would eventually be feasible to wire and light Minni-Earth in such a manner as to make visible the continuous and comprehensive pattern transformations of meteorologic, atmospheric, and oceanographic phenomena by radar-radio, world-around relayed, reporting.

Such a Minni-Earth project might readily induce a series of identical or larger inter-wired repeaters in other major centers, with interchangeable local frames.

The importance of such a tool to instruction of air and sea navigation is obvious, but its educational advantage at the highest levels of comprehensive thinking and planning is startling to contemplate. For example, such questions as the following could be asked and visibly answered:

"Where, proportionally, as of today, is the world's petroleum and how does it flow?"

and on go the lights showing world-around reserves, productions, pipelines, and shipflows, etc., or:

"Where are the world's active military divisions?"

on go another set of lights, or:

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"Where are the world's ships at this moment?"

and there "They" are - printed circuits - I.B.M. cards actuating an animatable, omni-directional, wave-strataed point system.

I am returning with gratitude "The Geography of the Air". We have communicated with Mr. Possony in regard to obtaining the document and he replied that it is soon to be published in The Annals. (The Annals of the American Academy of Political and Social Science, May 1955, special issue "Air Power and National Security".)

I send you this letter because of your long demonstrated interest and support of my geographical and my structural explorations alike which have now become unexpectedly married in Minni-Earth.

Faithfully yours,

R. Buckminster Fuller

Enclosures