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PUBLIC RELATIONS DEPARTMENT

HOW TO MAKE A UNISPHERE

Remarks by

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During an earlier meeting, you gave us a little homework to do. I am pleased to report today that this homework now is completed. We believe the answers are correct.

Briefly, here is the work assignment you gave us to solve:

Problem: For purposes of monumental beauty only, complete a feasible design for a stainless steel structure 12 stories high, the sole function of which is not to help perform any human work but, rather, by its appearance only, to inspire mankind the world over for ages to come. To make the structure beautiful on both the inside and outside and as viewed from any direction. To make it generate breathtaking awe from any height, when viewed from the level of its base or from the cabin of an airplane above. To make its interior complement its exterior so that each blends, always with the other.

To make it graceful yet grand, light yet massive, solid yet transparent, bright yet diffused. To make it pleasing to see at any hour from dawn to dusk, in shadows or sunlight, rain or snow. And at night, to make it appear with the same beauty under floodlights.

Further: Make it a spherical structure detailing the continents of the earth; where each line, committed centuries ago to a predetermined place, must perform the work of holding it together; where it must be unsymmetrical; where its base must be small yet strong, airy yet solid to keep winds from upsetting it; where basic conditions of esthetic design -- determined by nature eons ago -- must be met within the laws of engineering science; where all pieces of the structure either fall in toward each other or fall away from each other; and around which three three-ton, stainless steel orbital rings must be placed without any discernible means of fastening them.

And finally. Make the structure appear effortless, as if creating and building it were of no consequence at all.

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This then was our homework: Complete a feasible design for the Unisphere.

We are pleased that you entrusted to us the solution of this difficult problem. For there are aspects to this mental exercise that make the Unisphere unique in the history of monumental architecture.

First is the design itself. Symbolic monumental architecture, of course, is not new. The Great Pyramids, the Eiffel Tower and the Washington Monument, for instance, each reflect esthetic characteristics of their respective ages that were arbitrarily chosen. In this sense, no predetermined design and esthetic restrictions were imposed, and their creators could do pretty much as they pleased, within the laws of engineering.

The Unisphere departs from this free-flowing, unrestricted use of art. The die -- esthetically speaking -- was cast right from the start, when the decision was made that a model of the Earth be the symbol of the 1964-65 New York World's Fair.

Doubtless, other symbols could have been selected to allow for greater freedom of esthetics -- no one of which ever would have completely satisfied everyone, since tastes do change from generation to generation. The more timeless the design, the more esthetically enduring it is. It is, therefore, no great shock to me that you selected the most timeless design of all, The Earth, as your symbol.

This leads to another intriguing aspect. In a sense, the traditional roles of engineering, design and esthetics in construction have been virtually reversed. Usually engineering feasibility is determined first. But in this instance, the ground rules for basic esthetics were determined first. The structure was to be a sphere with predetermined lines of support -- the meridian and parallels; with its surfaces -- the land masses -- also predetermined by location and configuration. These fixed esthetic requirements had to be met with sound engineering and good design.

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Still another aspect of the Unisphere adds to the weight of the problem. Peter Muller-Munk and his team of industrial designers, who worked with us, put it this way:

"The Unisphere cannot be treated as a building or other traditional monumental structure, for in reality it is a piece of open sculpture. This is perhaps the most demanding form of art. For it must exist from all sides, with no one texture, surface or line out of harmony with another."

So, its inside surfaces must be as appealing as the outside, requiring methods to fasten it together so that bolts, welds and other fastening devices do not mar its beauty.

The engineering and design problems surrounding the Unisphere, we believe, are among the most complex found anywhere.

Since the design specifies an "open" or Armillary Sphere -- to symbolize our ties to the past -- no bracing can be used between the meridian and parallel members. This called for a rigid frame design, strong enough not only to support the sphere but also to resist transverse wind loads. And these members still had to look light and slender. The sphere, also, is required to sit with its axis tilted 23½ degrees to correspond with the way the Earth revolves, which makes an unsymmetrical design.

This meant that over 1,500 unknown forces had to be solved co determine unit stresses so that steel could be used to its maximum! These problems were so complex that they were broken into three separate sections, the largest of which involved solving 670 simultaneous equations! By comparison let me point out that, as a general rule, not more than 30 to 40 such simultaneous equations are needed in analyzing some of the more complex modern structures!

Gentlemen, that is a lot of algebra!

For us to have calculated these 1,500 problems manually might have taken perhaps as long as ten years! But fortunately America's ingenuity and technical

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genius paved the way for us. We were able to solve our simultaneous equations through the miracle of electronics. We had the use of some of the most advanced electronic equipment anywhere in the world, which belongs to the Electric Boat Company at Groton, Conn., and which is used to solve the detailed problems of building our atomic submarines. As a result, we solved our problems in only a few weeks!

It is safe to say that a few years ago this particular design of the Unisphere would have been too impractical to calculate. For many safety factors would necessarily have been designed into the sphere, obviously making its steel members heavier and, therefore, less appealing. So, it was the pride of perfection that challenged us to achieve the best design by using the properties of stainless fully, so that each structural member, in turn, achieves a light, fine line appeal. We wanted the Unisphere to reflect the best of what can be done in steel -- even when basic esthetics are predetermined. And it can only be done in steel, I might add.

Which brings me to another aspect. It was necessary for the industrial design profession to work side by side with the engineering profession right from scratch.

Our American Bridge Division's structural engineers tell me that right from the start Peter Muller-Munk and his industrial design associates were on the scene. The complexities of the problem were such that neither the engineering side nor the design side made a move without consulting each other. It was a case of mutual effort and teamwork of the highest caliber. Certainly this speaks well of the progress of design and engineering in this country.

Engineering a final esthetically appealing design for the Unisphere is somewhat different from designing a hood ornament or an exotic park fountain. For one thing, mock-ups can be built close enough to scale so that over-all visual effects of the end product can be predicted.

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But knowing ahead of time exactly how an open sphere, 120 feet in diameter, will look is another matter. A two-foot model of the structure is seen in an entirely different perspective than if you or I were standing at the base of the real 12-story article -- the point from which most people will view the Unisphere.

Thus the key problem in design -- except for the unit stresses -- was one of "visual mixture," a kind of optical illusion where something viewed up close looks different when seen farther away. It was this bogy that required a constant interchange of ideas between our American Bridge people and the Peter Muller-Munk designers.

Their first detailed consideration, of course, was the base. When we view a two-foot model of the world from the top side, the base is of relatively little importance. But when people view the Unisphere, the base will be the structure immediately in front of them -- rising 20 feet above the reflection pool. Esthetics here is obviously important, and so Peter Muller-Munk created the design for a 70-ton open sculptured base to convey lightness, grace and simplicity and yet kept it engineeringly sound to support a 250-ton sphere. The base also had to hold the sphere steady against wind load over three times as great as the dead load. In fact, we even conducted wind tunnel tests on a model of the Unisphere to be certain of our calculations.

The problem was not too unlike fastening a beach ball to a golf tee -- a slight exaggeration, perhaps, but it does convey the idea that we had some real design problems.

Next on the list was the choice of structural members for the sphere, itself. Here again, engineering was used only as a means to an esthetic end. What kind of structural members should be used for the slender meridians and parallels? Should they be round tubes or hollow rectangles? What about their

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surfaces -- highly reflective or dull? What about joining problems -- welding, bolting or what? How could sections doing most of the support work be built up or thickened without appearing out of proportion with the rest of the meridians and parallels?

Ultimately the answers came. For the most part meridians will be eight inches wide and 12 inches deep except at support areas. They will be curved rectangular stainless hollow shapes, highly polished on the outside surface and dull finished on the other three surfaces. The parallels will be curved stainless tubing, six to ten inches in diameter, with a dull finish. The members will be butt welded together.

But the land masses constituted the biggest "visual mixture" problem. Here we had to design representations to a staggering scale. Also, since everything has to fit the curvature of the Earth, nothing could be square in any plane.

First we thought of heavy stainless mesh that could be formed into land configurations. But investigations revealed that the mesh virtually disappears when held against the daylight. So we built a full-sized land section of expanded stainless metal, shipped it to the Unisphere site here at Flushing and hauled it into the air at exactly the spot it would appear on the sphere. Placed that far from the eye, the metal was too transparent and too directional in pattern. The bogy, "visual mixture," again.

Next, we tried various existing patterns of formed or rigidized stainless sheets to diffuse the light, but the patterns also were too prominent.. By that time we had learned, too, that the surfaces would have to be of dull finish and also be rigidized in some way. Surfaces of a sphere curve away from the human eye; therefore, a bright metal under floodlights at night would make the land areas "turn black," since only pinpoints of light would be reflected back to the eye.

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We finally out-foxed the demons of optical illusion, by creating a special, free style pattern of rigidized stainless steel sheets. The pattern is so designed that light is properly diffused. Also, it eliminates matching and fabrication problems that would have existed in joining stainless steel sheets with a more directional pattern. Here, "visual mixture" works in our favor!

The land masses will be built up "layer-cake" style, like huge contour maps, to conform with topographical highlights of each continent. It was necessary to distort the scale of these contours by exaggerating them 44 times as great as they actually appear on the surface of the Earth. Otherwise they would have appeared too inconsequential on the Unisphere to be particularly noticeable. Using this exaggerated scale, each land mass layer will be five inches high, each representing a change in elevation of 1,000 meters or 3,280 feet.

Land masses will be fabricated in sections roughly ten feet wide and 35 feet long and fastened with hidden bolts to meridians and parallels.

Even the skeleton framework, between the meridians and parallels and behind the land masses, has been designed to blend with all other lines in the Unisphere. These will appear to the human eye as slim lines, which are mileage markers between the meridians.

Finally, there are the three three-ton stainless orbits circling the Unisphere. We struggled with that one quite a while, and we had to go back to the bicycle to solve how they would be kept in place. They will be held the same way the rim of a bicycle wheel is held to its hub -- by taut high strength stainless steel wires, 1/8 inch in diameter, radiating from the Unisphere to the orbits. They, of course, will be too small to conflict with the rest of the sphere.

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And there you have it -- a close look at what it took to complete what we are convinced is the best design of the Unisphere.

While perhaps the birth of this structure is not as exotic as problems connected with space explorations, the Unisphere, nonetheless, does represent a delicate, intricate exercise in design and engineering skills.

It will, therefore, stand -- not only as a symbol of the World past and of the future -- but it will stand, too, as a symbol of what American technology and art can achieve when teamed together.

In this day of ideological warfare -- when fears and doubts plague free men everywhere -- may all who view this piece of open sculpture know that America as a nation has the will, the strength, the patience and the skills to do its homework very well indeed!