DEVELOPMENT OF MEMBRANE STRUCTURES FOR LEISURE AND RECREATION APPLICATION IN JAPAN AND NORTH AMERICA

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Convention 88

Membrane Structures
Architecture for Leisure and Recreation

Membrane Structures Association of Australasia

Today, I would like to introduce to you a few of our company's projects in the field of leisure and recreation.

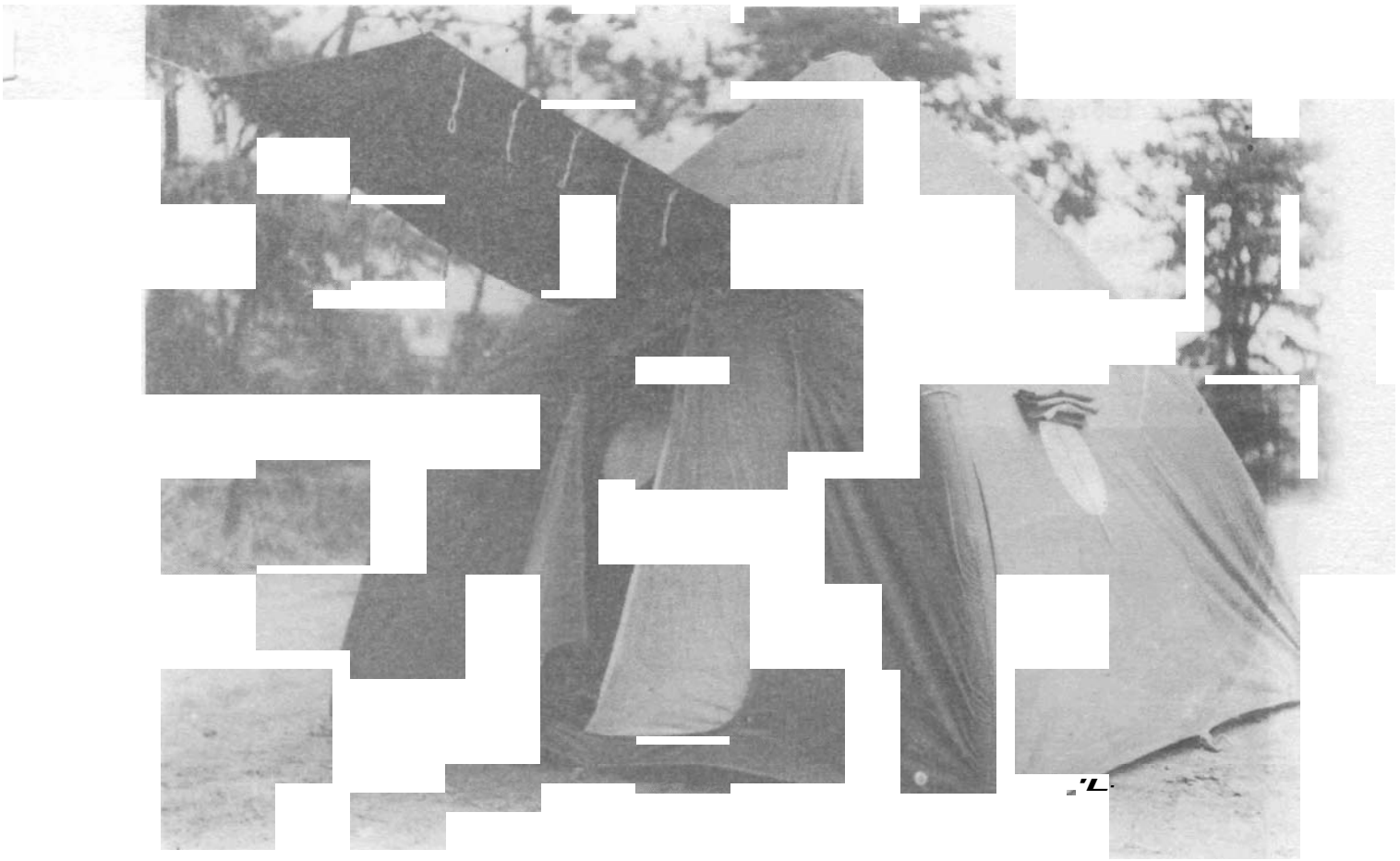
First allow me to present a brief background of our company. Taiyo Kogyo Corporation was originally established in 1922 by my grand-father. In 1945, during World War II, the company's facilities were completely destroyed. In 1946 the company was rebuilt by my father, Ryotaro Nohmura, the current Chairman of the Board and Chief Executive Officer.

Since the company started, Taiyo Kogyo has continued to develop products which utilize membrane technology and as evidenced by the remarkable growth of our company we have been highly successful. The development of membrane structures has been a significant factor in our success.

Presently Taiyo Kogyo employs 900 people with 1988 revenue projected to be 300 million U.S. dollars ($370 million Aus. dollars) Taiyo Kogyo has, additionally, 25 subsidiaries with a total employment of approximately 1400 with total revenues for this year projected at 420 million U.S. dollars ($515 million Aus. dollars).

Helios Industries became a 100% subsidiary of Taiyo Kogyo in 1975, promoting membrane structures not only in North America, but world wide, except for Japan. I will present several projects of Helios Industries, later.

Looking at the history of Taiyo Kogyo's involvement with membrane structures, I believe this photograph will be of interest:

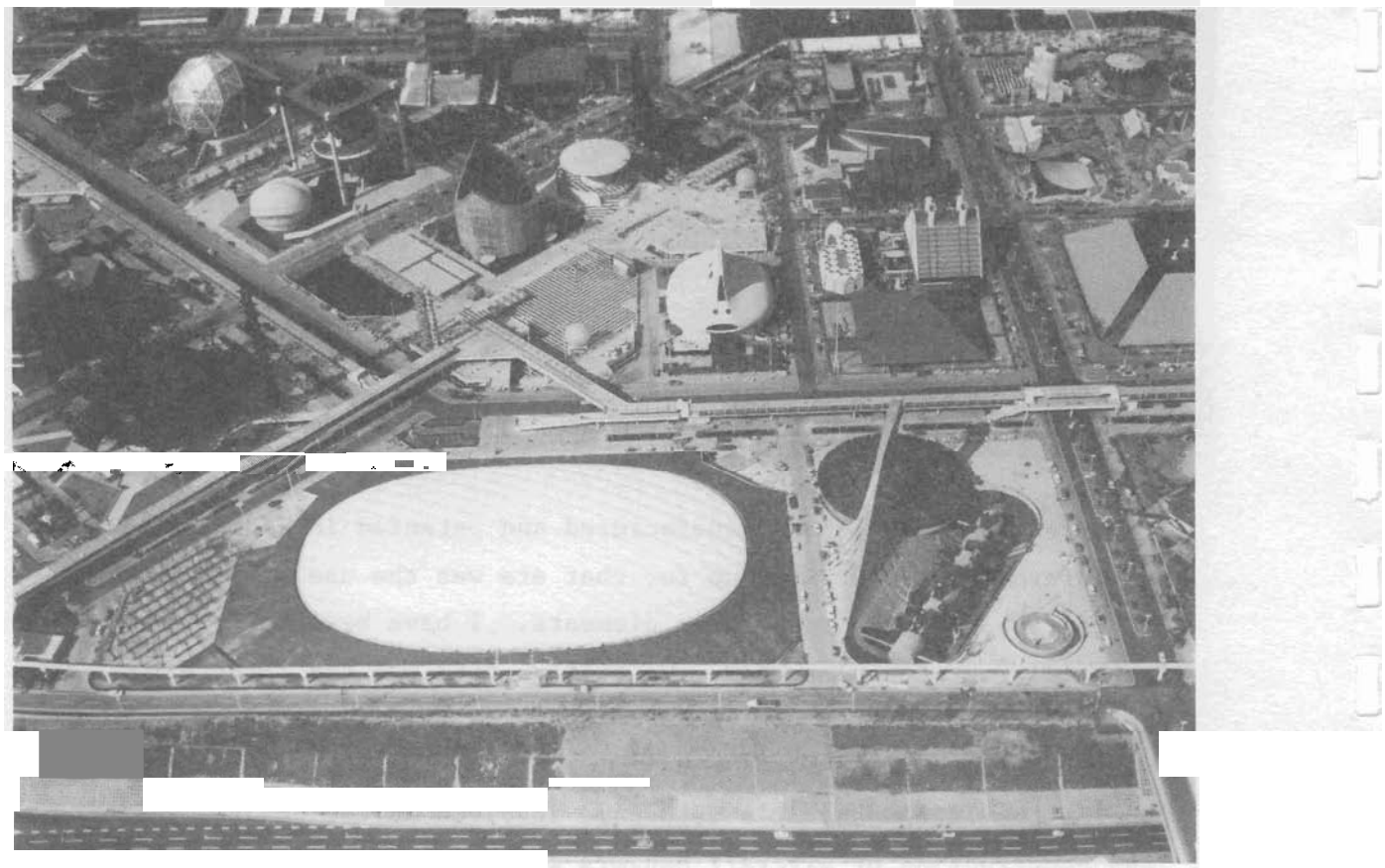


This tent was developed, manufactured and patented in Japan by my grandfather in 1930. Unique for that era was the use of air inflated tubes as the supporting elements. I have been told the tube material. was natural rubber. We believe this was the first air inflatable structure. It is unfortunate that the patent has expired.

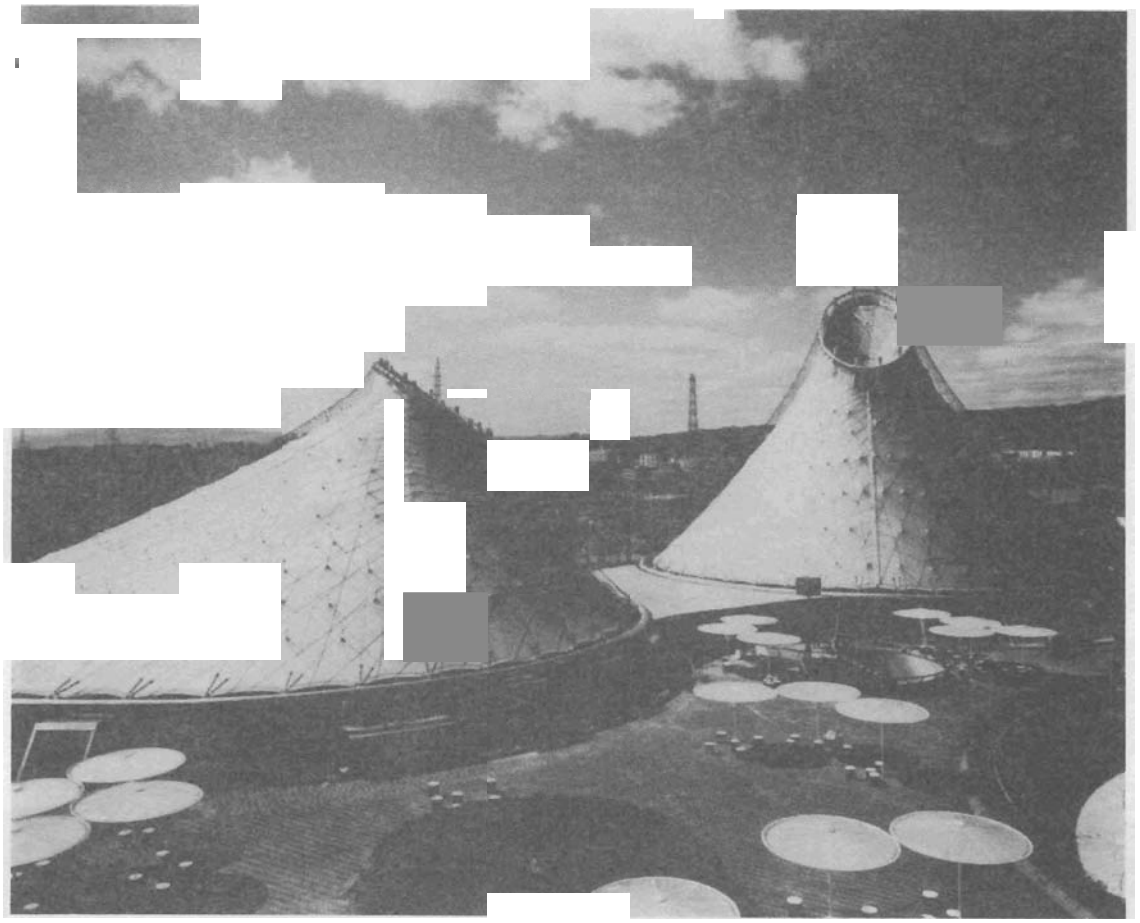
During the 1920's and 30's we became involved in the design, engineering and construction of aircraft hangers which I believe can be defined as large scale structures. These structures were required to be engineered to withstand the Typhoon force winds which all too frequently impact Japan.

"Festivals" are one of Japan's main leisure and recreation time activities. For many years the Japanese have celebrated harvest time each fall, the new year, weddings, religious festivals, etc, etc. It is no exaggeration to say that these festive events have influenced and stimulated the development of membrane structures in Japan. I am sure all of the people at this convention agree that membrane structures produce a most suitable atmosphere wherever people gather together.

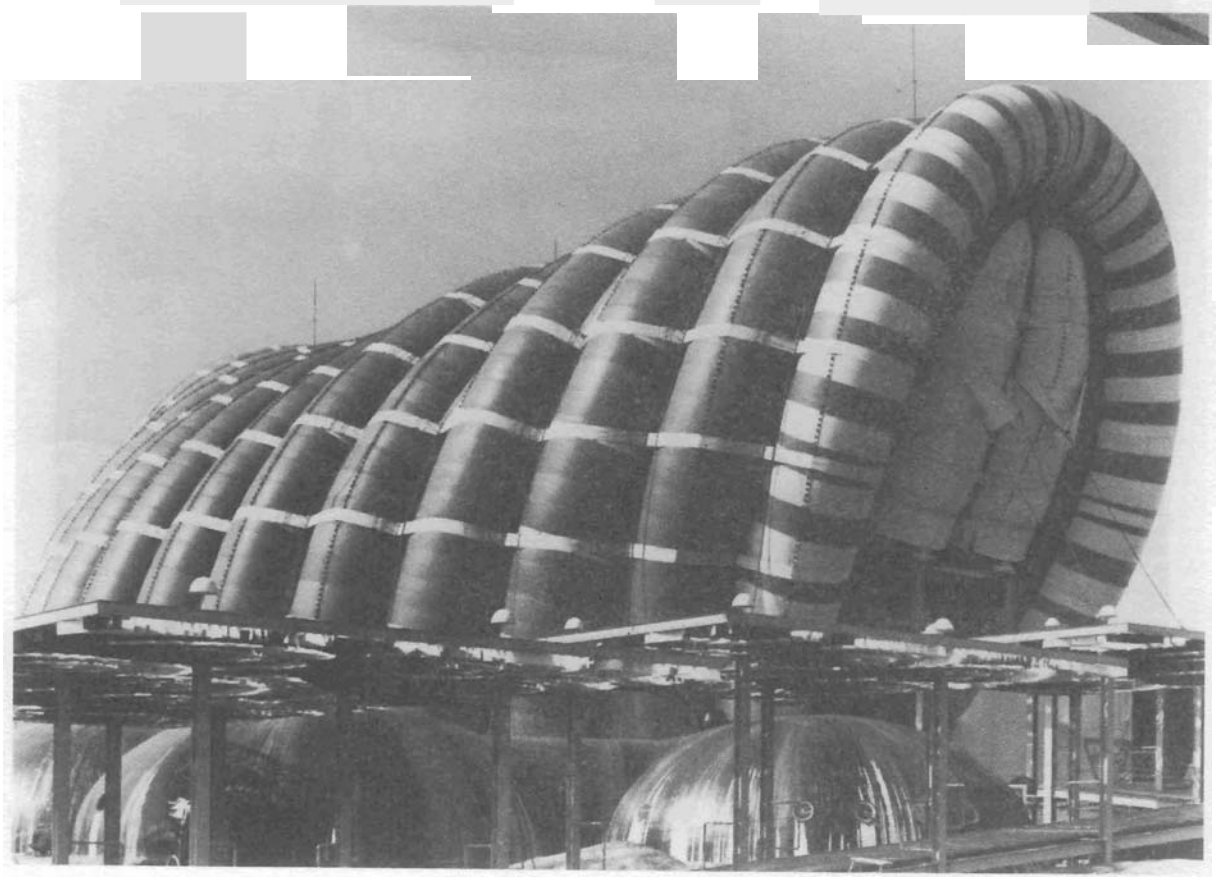
In the history of Japanese festivals and world's fairs, I believe the most impressive use of membrane structures was at Expo 70, Osaka. Taiyo Kogyo designed, engineered and constructed the greatest number and variety of membrane structures the world had seen up to that time. I would like to show you some of the exciting structures from that exposition:



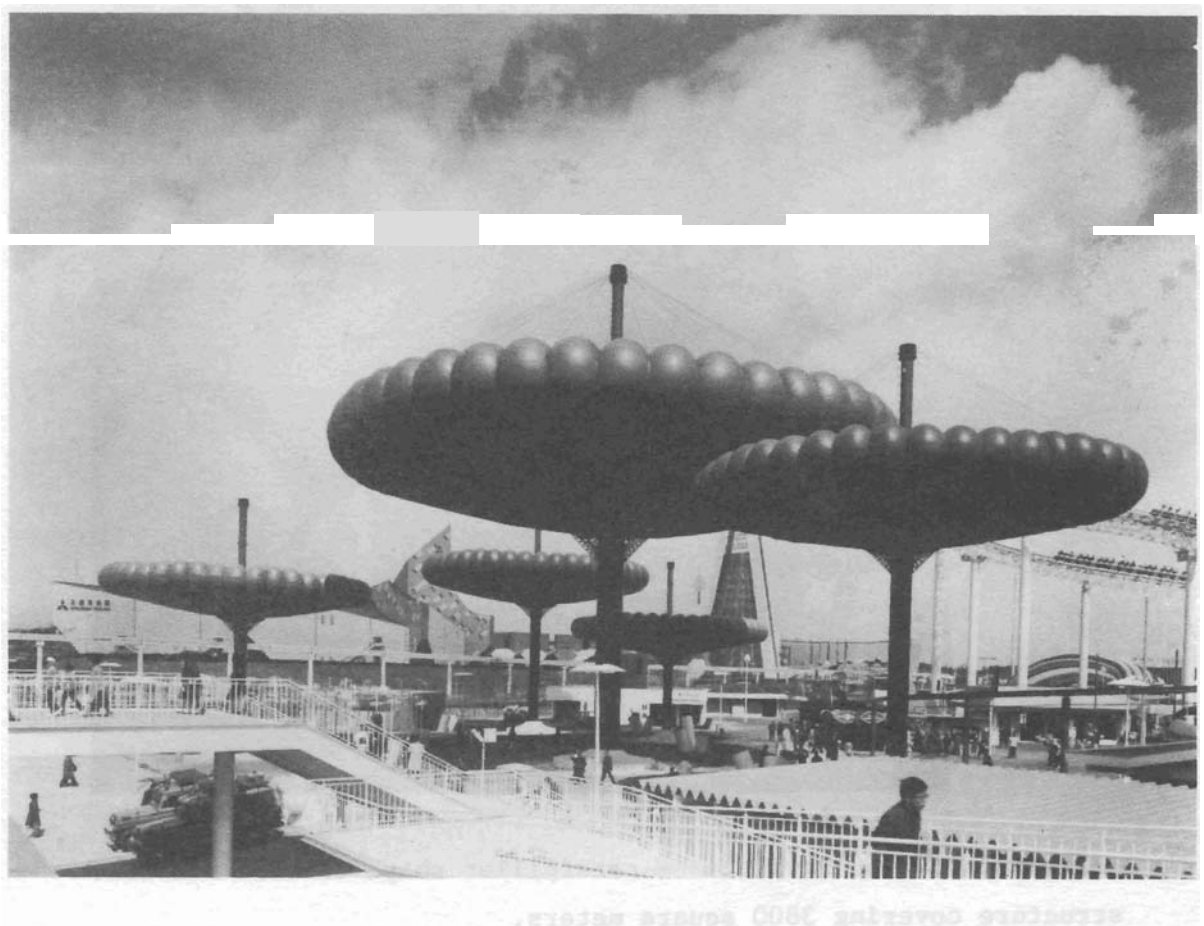
The United States Pavilion had a covered area of 10,000 square meters. This was the first low profile air supported cable restrained fabric roof structure. Because of government regulations and their structural requirements of in-depth engineering evaluation, it took us 17 years from the time of Expo 70 to get approval and construct a permanent roof stadium similar in design to the membrane roof of this pavilion.



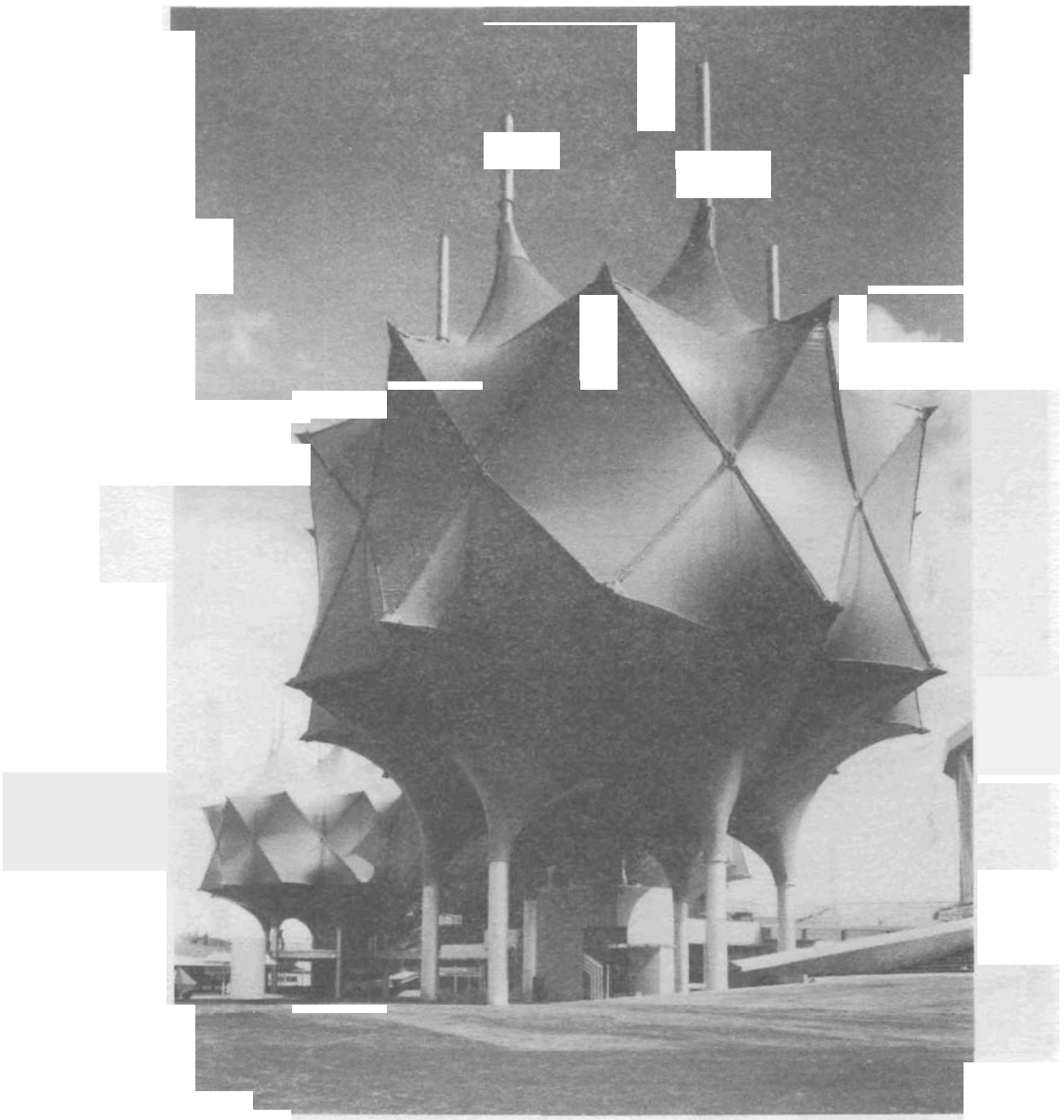
Automobile Pavilion – cable net supported tension membrane structure– 45 meters in diameter.



Fuji Group Pavilion . – An air inflated tube structure. Each of 16 tubes are 4 meters in diameter and 78 meters long.

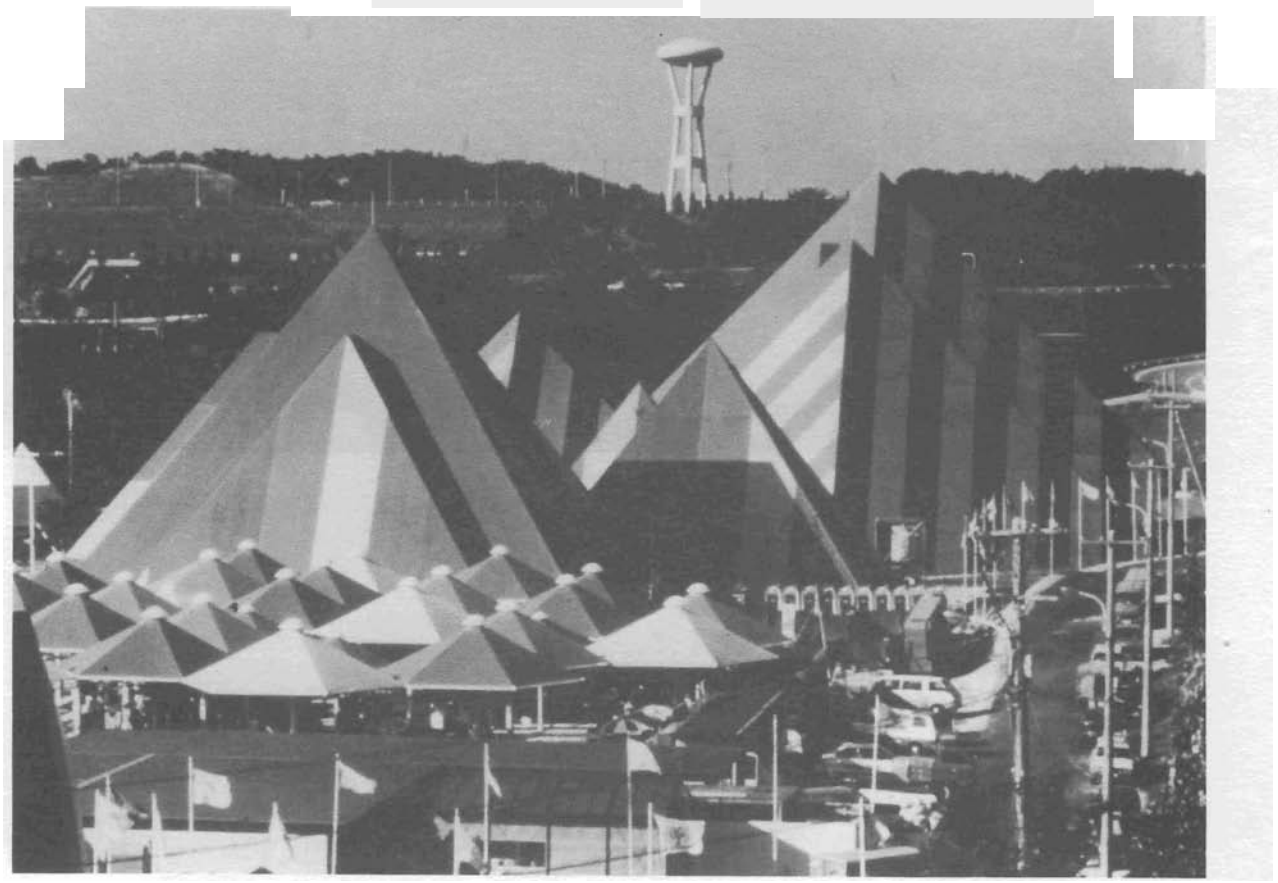


Mush Balloon - 30 meters diameter, air inflatable structures that open and close.

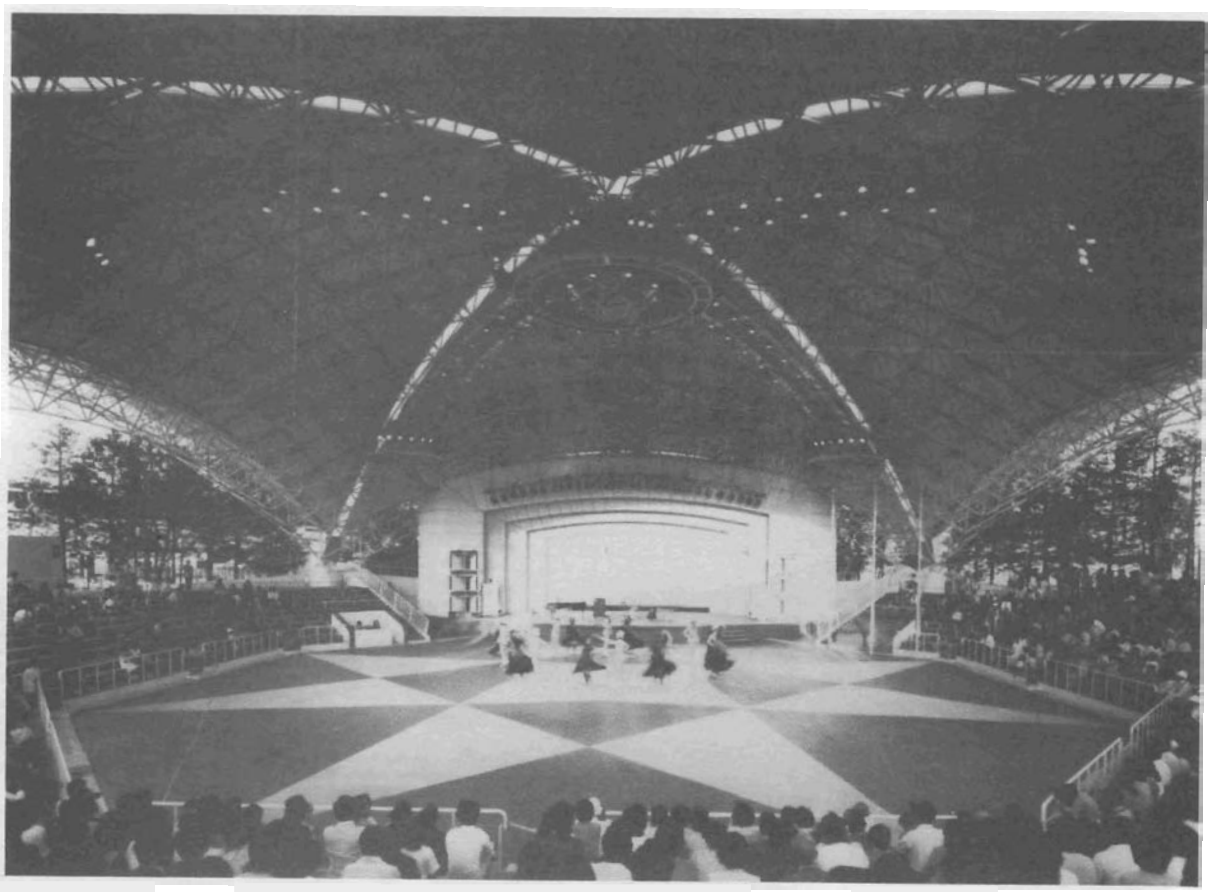


Telecommunication Pavilion – caterpillar shape tension membrane structure covering 3800 square meters.

Expo 70 presented us with the tremendous opportunity to develop new membrane structure technology. Since Expo 70, we have con-sfructed many structures for expositions and recreational facilities.



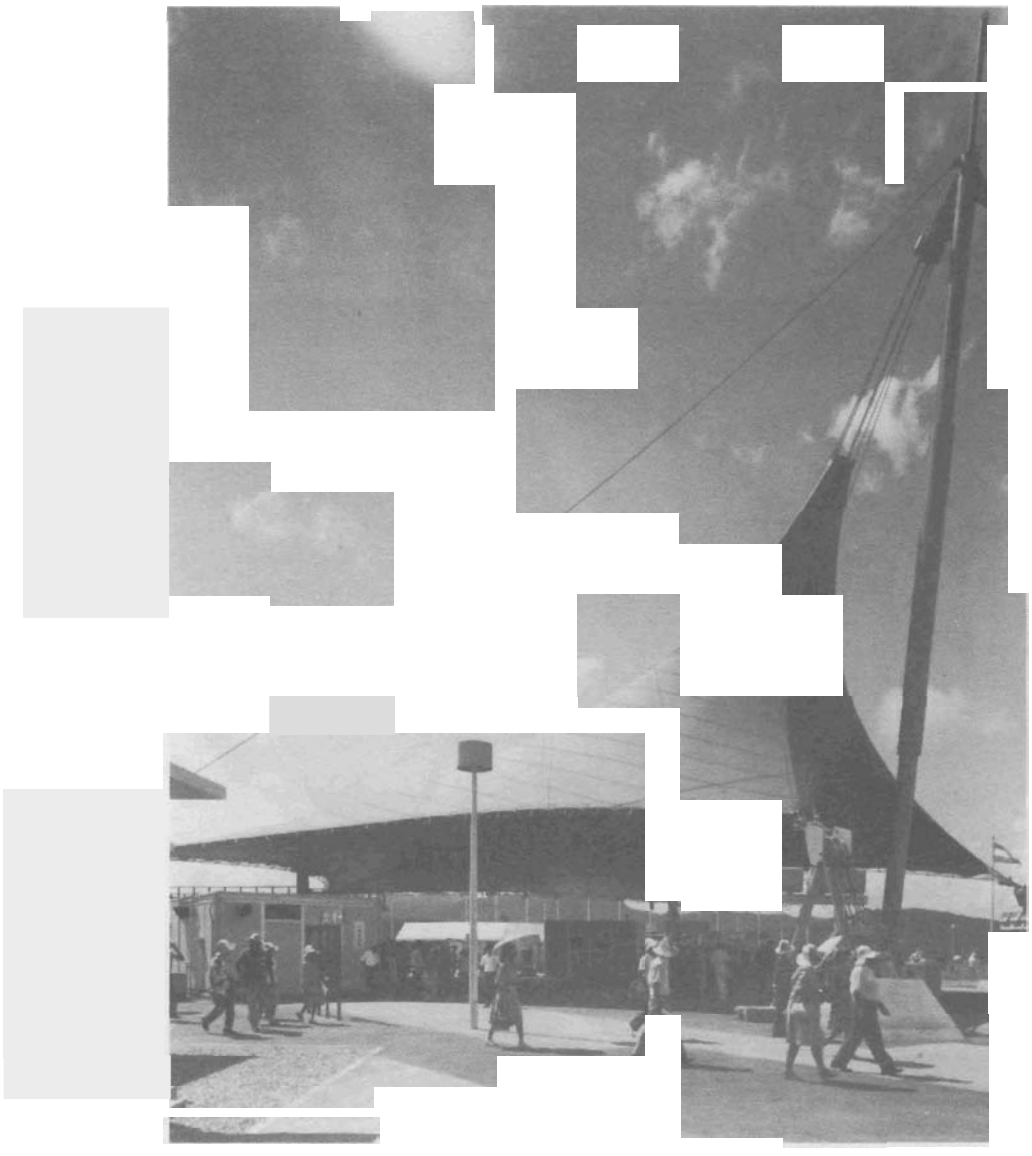
Childrens Exposition using space frames and fabric structures.



Portopia Exposition in Kobe

Winter season ice skating rink cover

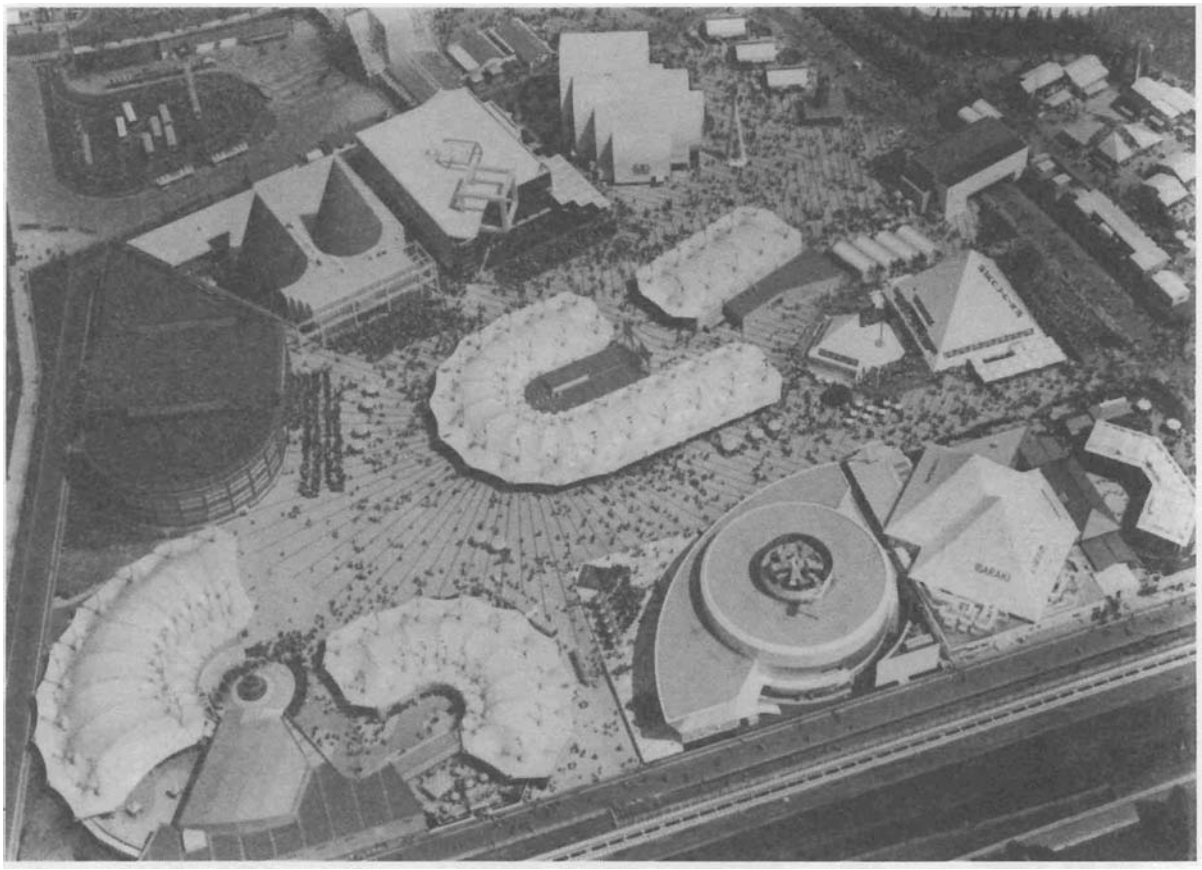
Outdoor **Amphitheater**



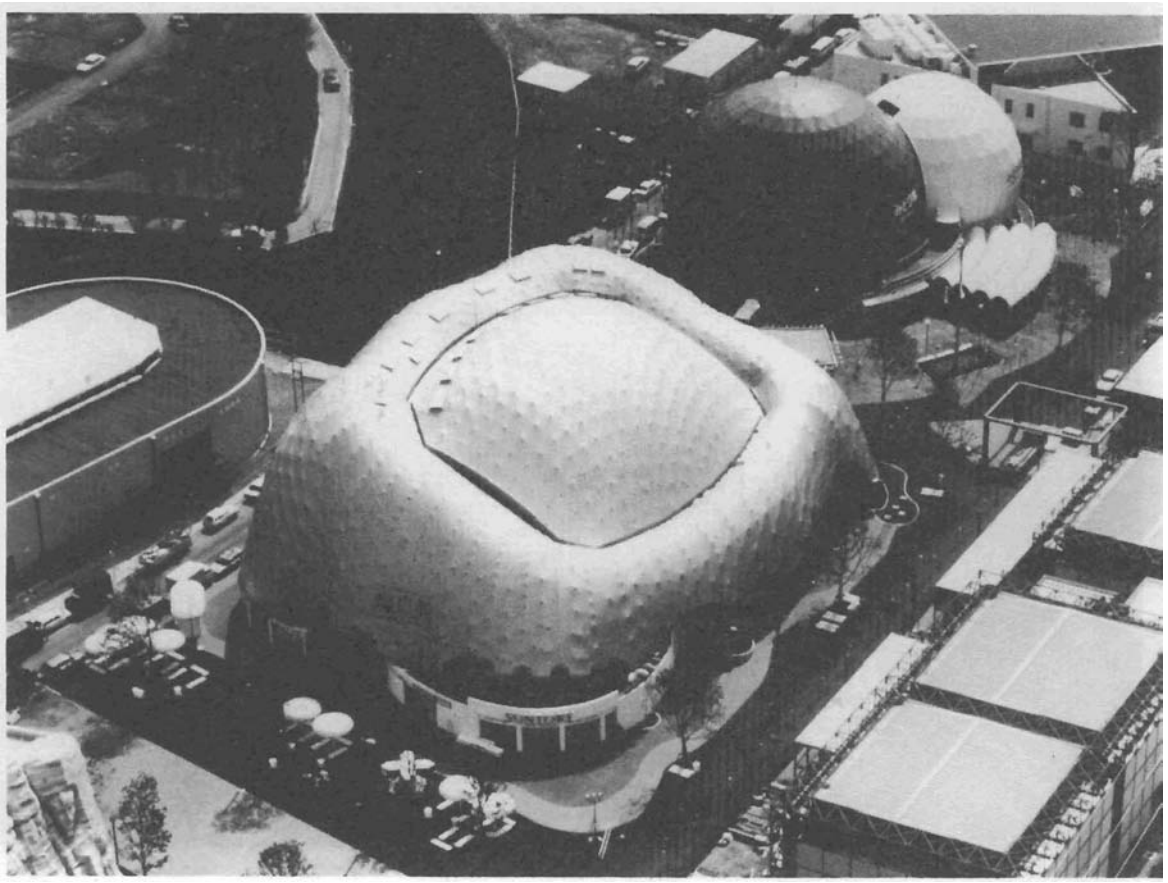
Main gate structure for Okinawa Expo 75

At the world fair in Tsukuba, Expo 85, we successfully constructed 95% of the fabric structures. Here are examples. of our products:

Electric Power Pavilion



Overall view of International Pavilion at Expo 85

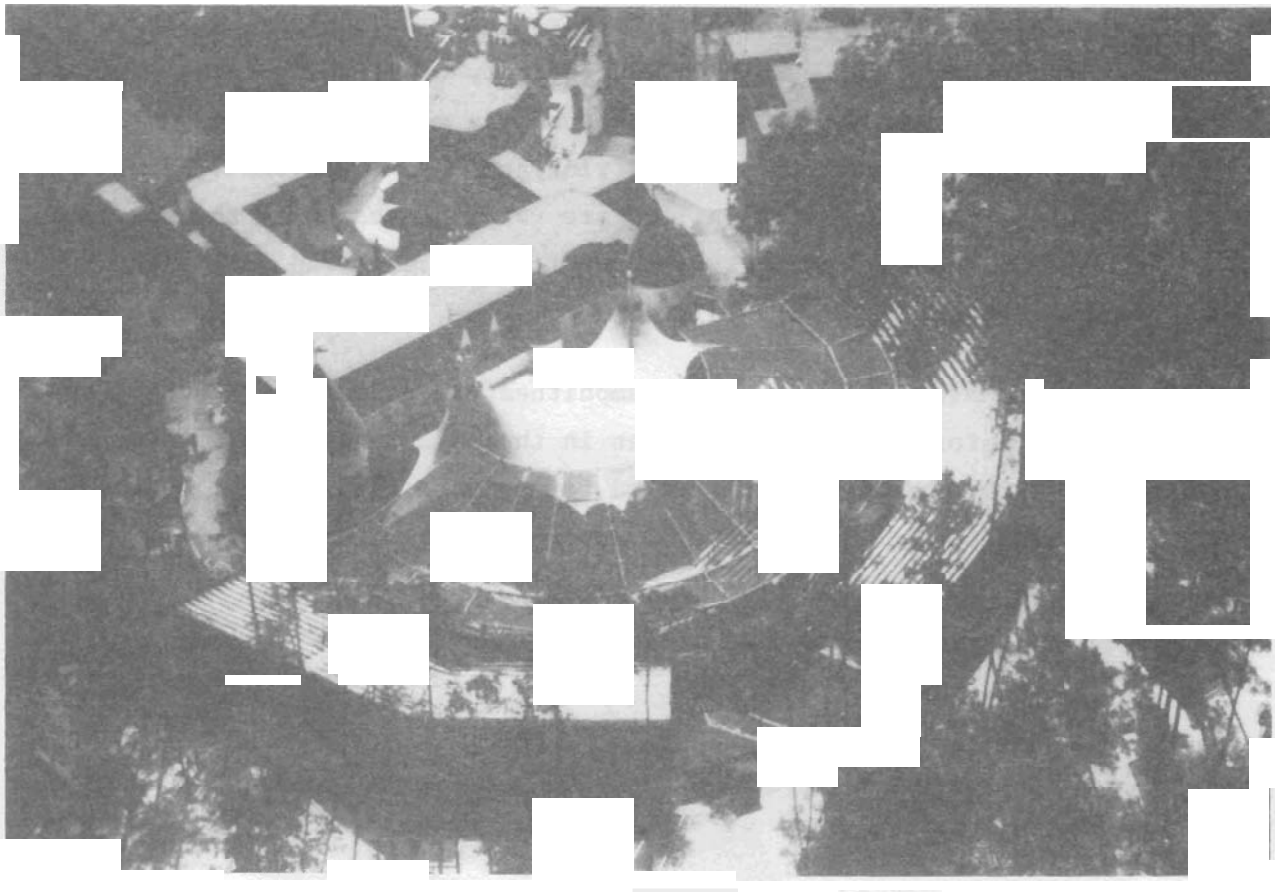


Suntory Pavilion

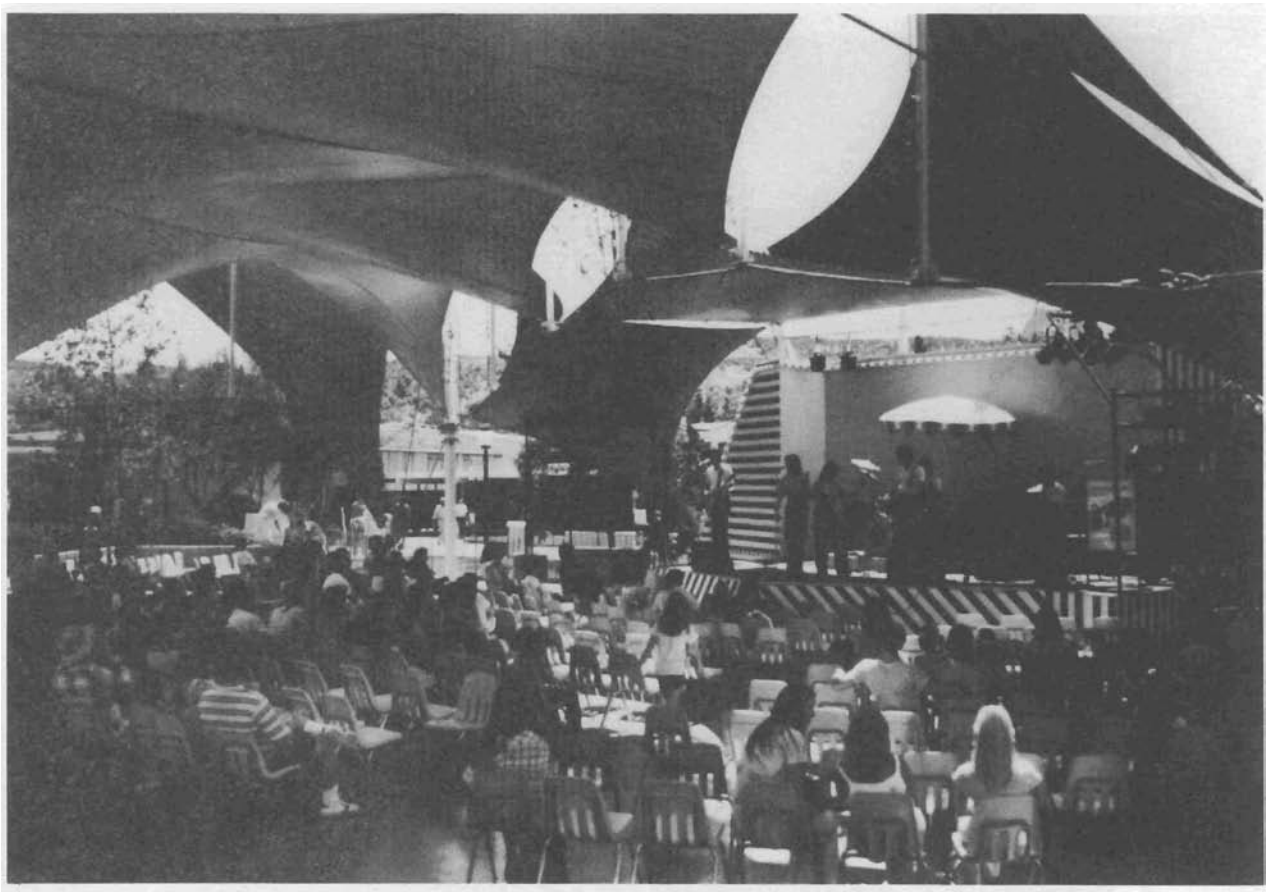
I present, now, some of the projects of Helios Industries that have been constructed in North America. In 1975 Helios Industries started to promote membrane structures world wide. At our California facility we have the full capability to design, engineer and manufacture air and tension membrane structures. As previously stated, Helios Industries represents Taiyo Kogyo Corporation internationally for membrane structures. We have successfully completed projects not only in North America but in other areas of the world including Central and South America, Southeast Asia, Africa and the Middle East. You notice I did not mention Australia. We are very interested in the Australian market and we are currently looking for an Australian firm with whom we can develop a working relationship.

Today, I have selected outdoor amphitheaters as one of the major applications for membrane structures in the leisure and recreation market. These structures were constructed for private theme parks, municipalities and county, state and U.S. government agencies.

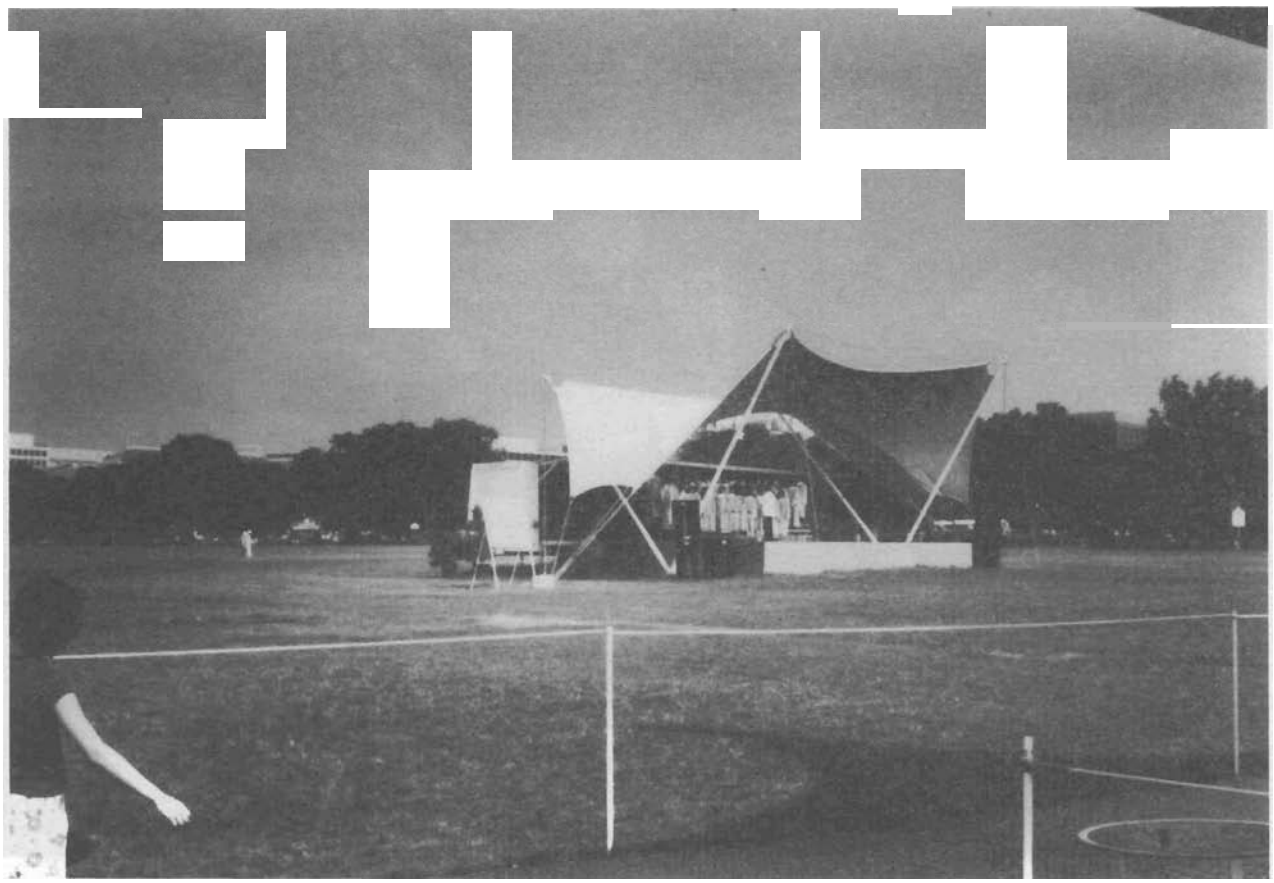
Tampa State Fairgrounds



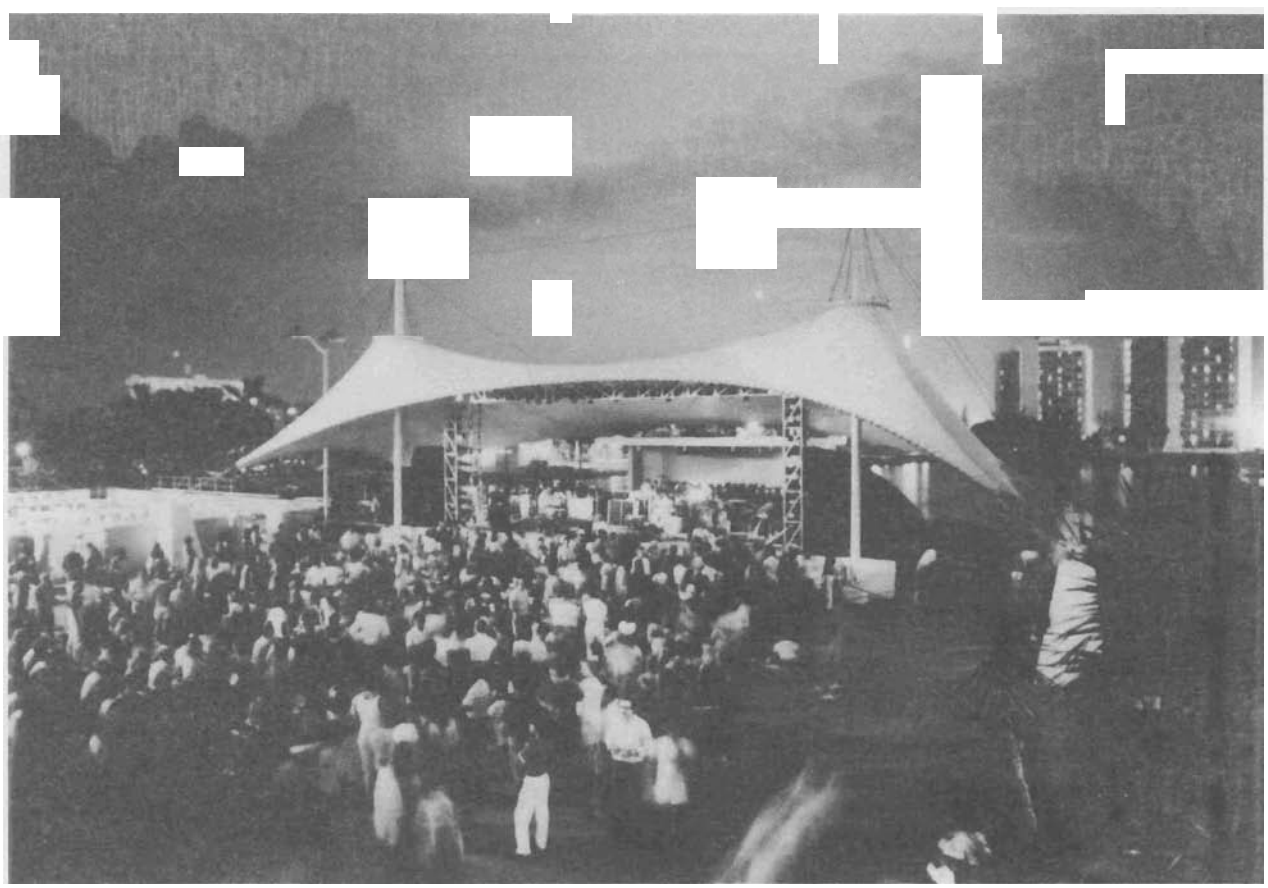
Busch Gardens, Williamsburg, Virginia



Magic Mountain Theme Park in California

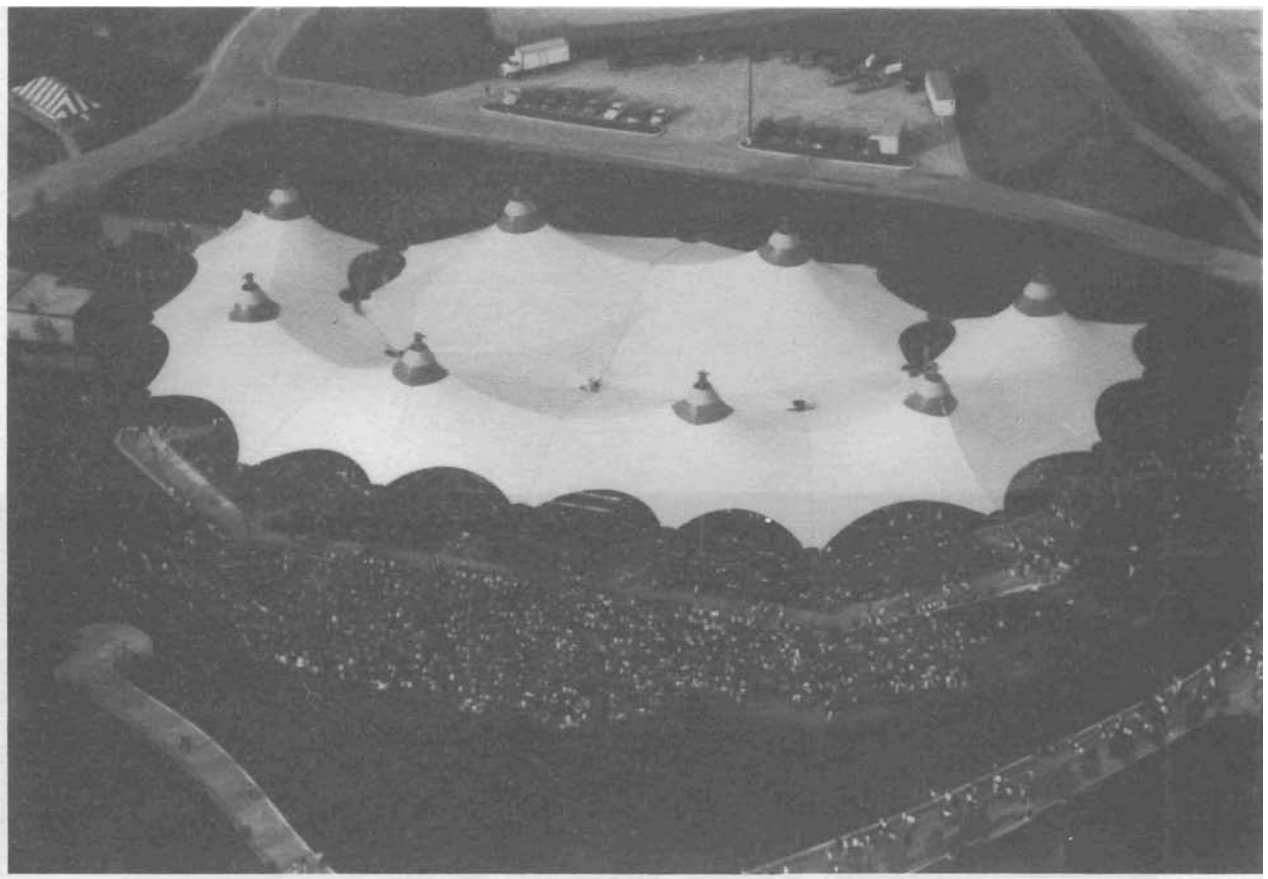


Washington, D. C.



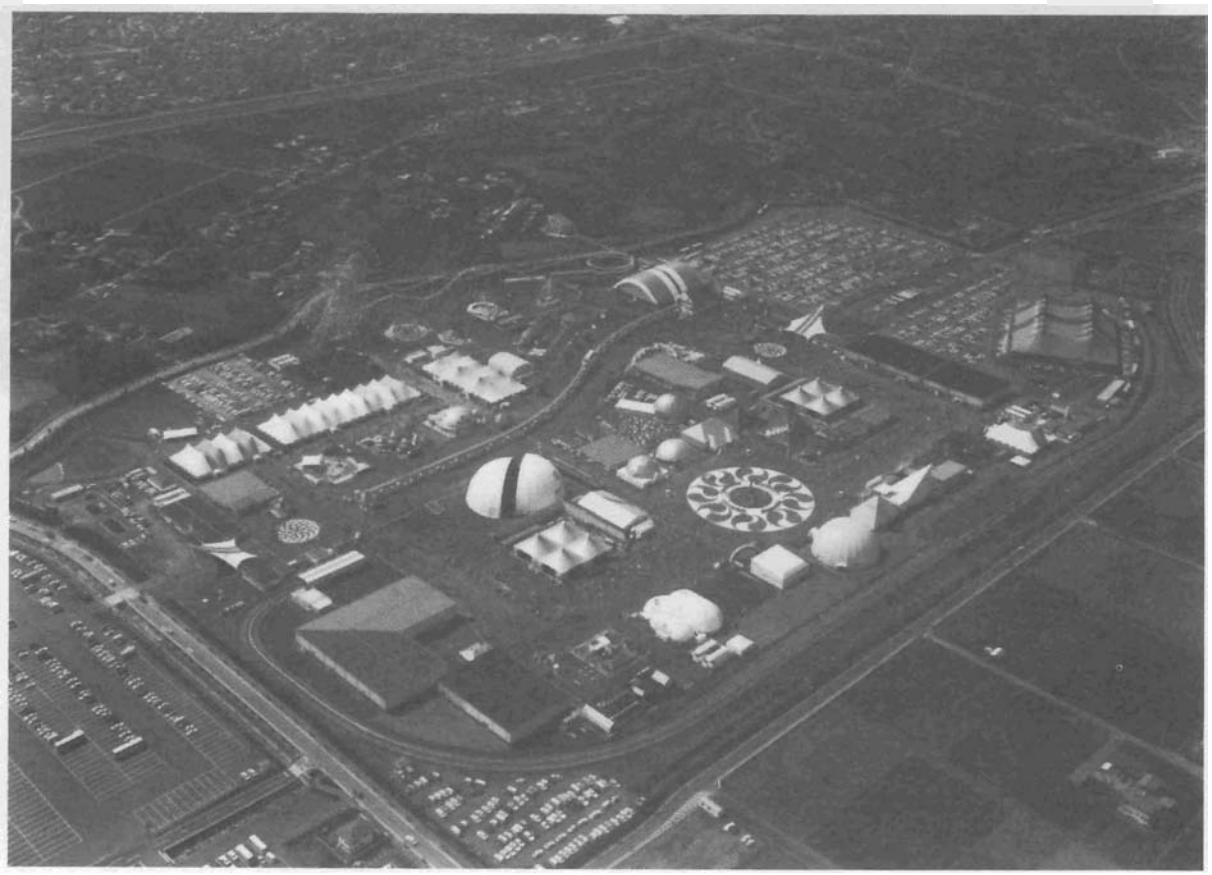
University of **Miami, Florida**

City of Tulsa, Oklahoma

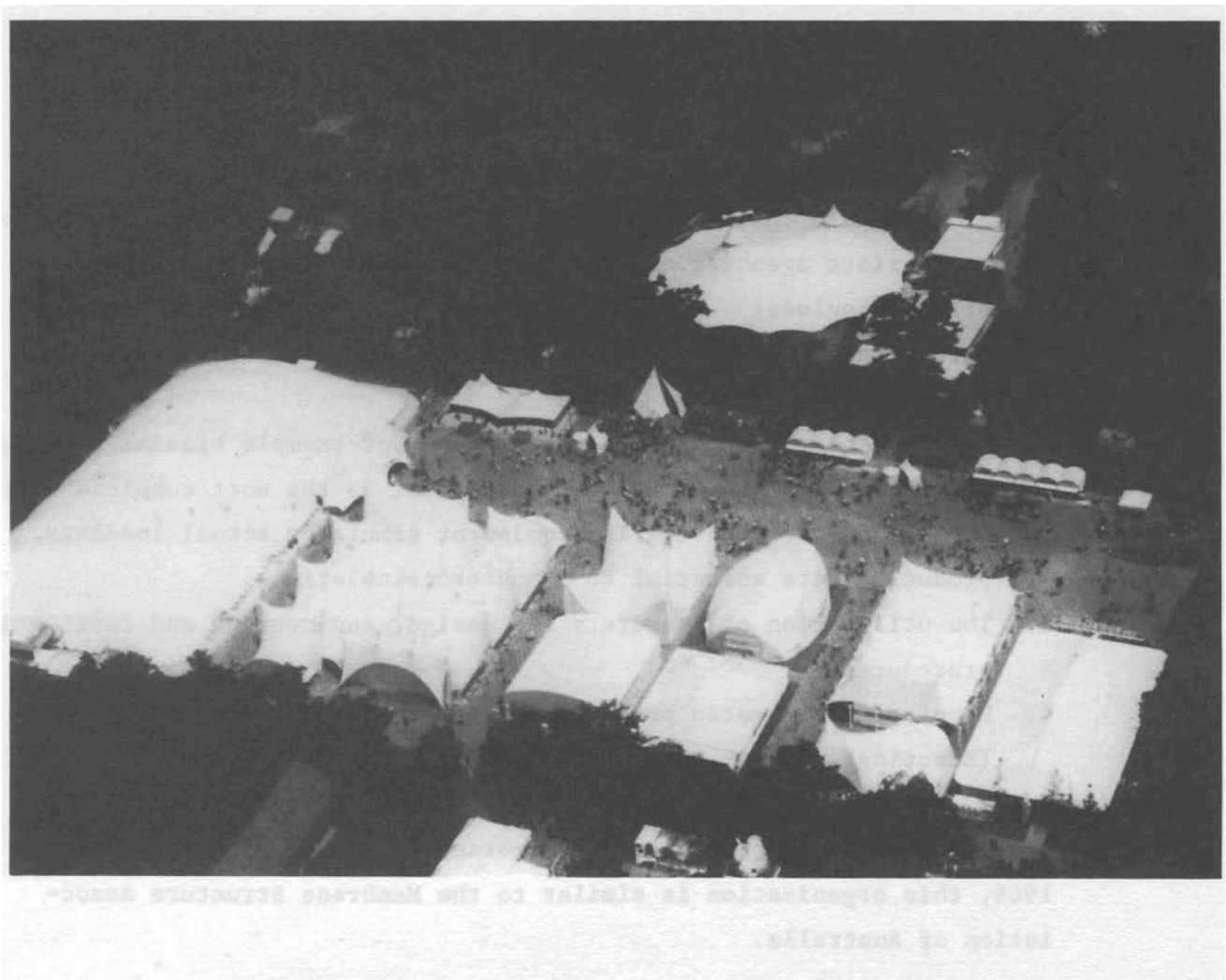


Toronto, Canada

Each country has a different way to enjoy leisure and recreation. Fortunately, through Japanese culture, Japan has developed into a society that loves to celebrate festivals. Our capability is not only to design, engineer and construct structures, we now handle the complete design of an exposition and, at times, the operation of the entire event. Here is an example of the most recent local expositions in which we were involved with the master design. These expositions are currently open in Japan



Saitama Exposition



Nara **Silk Road Exposition**

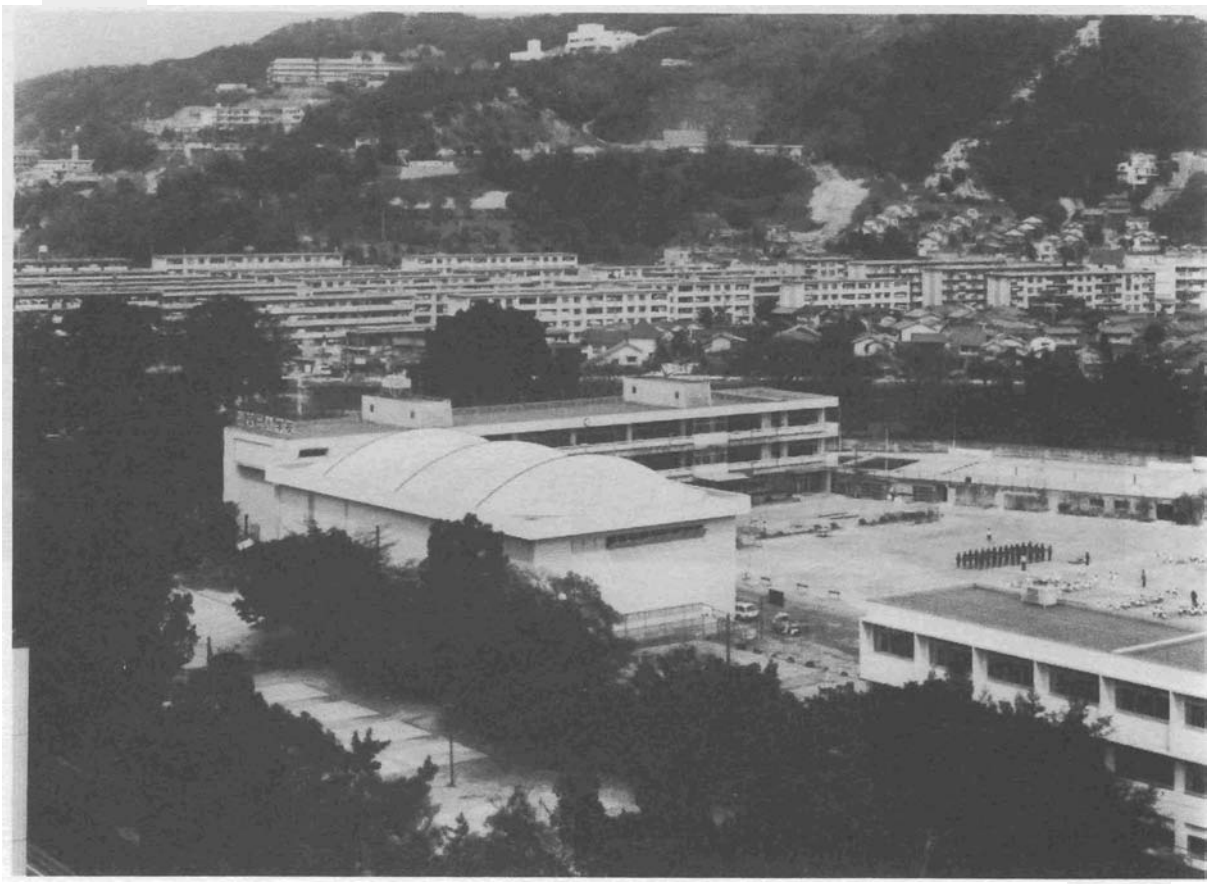
As is no doubt true in all countries, there are restrictions placed on the construction industry in the form of building codes or laws enforced by a Construction Ministry or other government agencies. I believe we all feel that controls are necessary in the interest of life safety. However, I am sure we have all experienced the frustrations of working through various bureaucratic government agencies for either acceptance of new building concepts or approval of new building materials. Japan is no exception and to that end Taiyo Kogyo is devoting a total effort to develop, through advanced technology, a verifiable set of guidelines for membrane structures and their component materials that will justify the approval of these structures by the appropriate agencies.

Our efforts include:

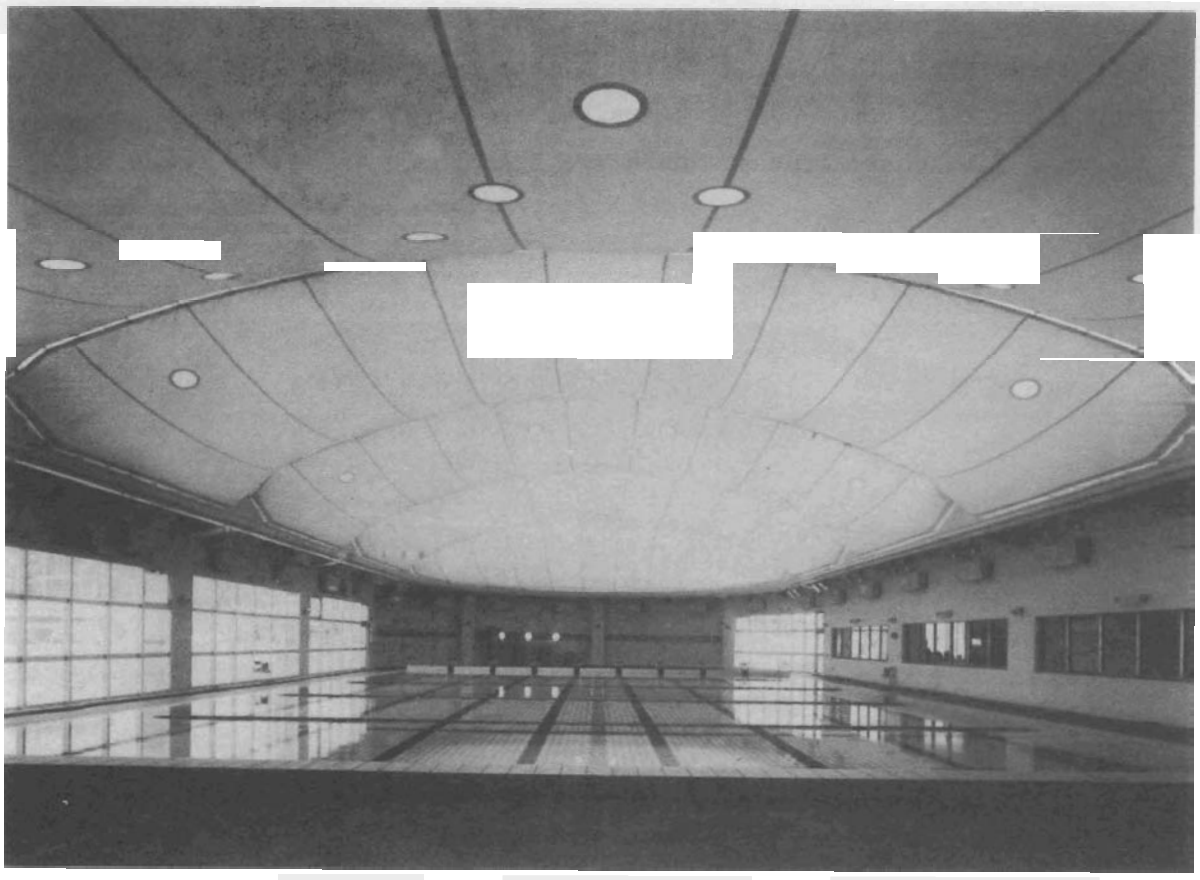
1. Establishment of testing procedures for membrane structure fabrics.
2. Development of the testing equipment. For example biaxial testing machines. Our biaxial testing equipment is the most complete in the industry. Advanced testing equipment simulates actual loadings, producing data essential to computer calculations.
3. The utilization of computers for design, engineering and fabrication procedures.
4. Developing automated production technologies and equipment (Robotics).

We also established the Japanese Membrane Structure Association in 1966, this organization is similar to the Membrane Structure Association of Australia.

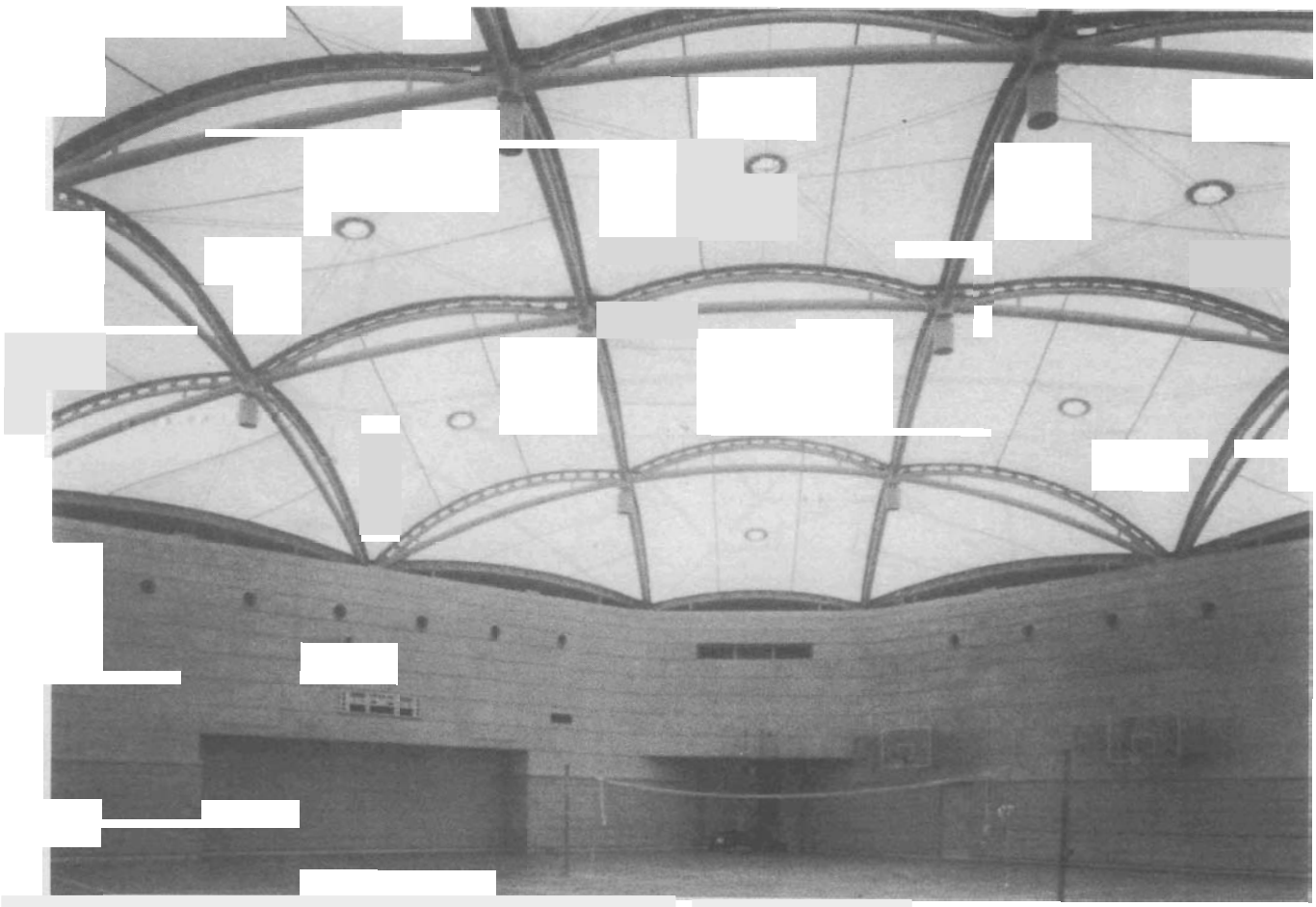
In 1971 Teflon coated fiberglas was introduced in the United States as a fabric for permanent architectural structures. However, in Japan, we had to wait almost 15 years before obtaining approval to use this material for permanent structures. It was in 1986 that Teflon coated fiberglas was finally authorized as a non-flammable material by the Ministry of Construction. The era of Teflon membrane structures has finally arrived in Japan. Over the past 2 years, we have constructed more than 30 Teflon ated fabric structures. Here are examples of a few of these projects:



School gymnasium enclosure

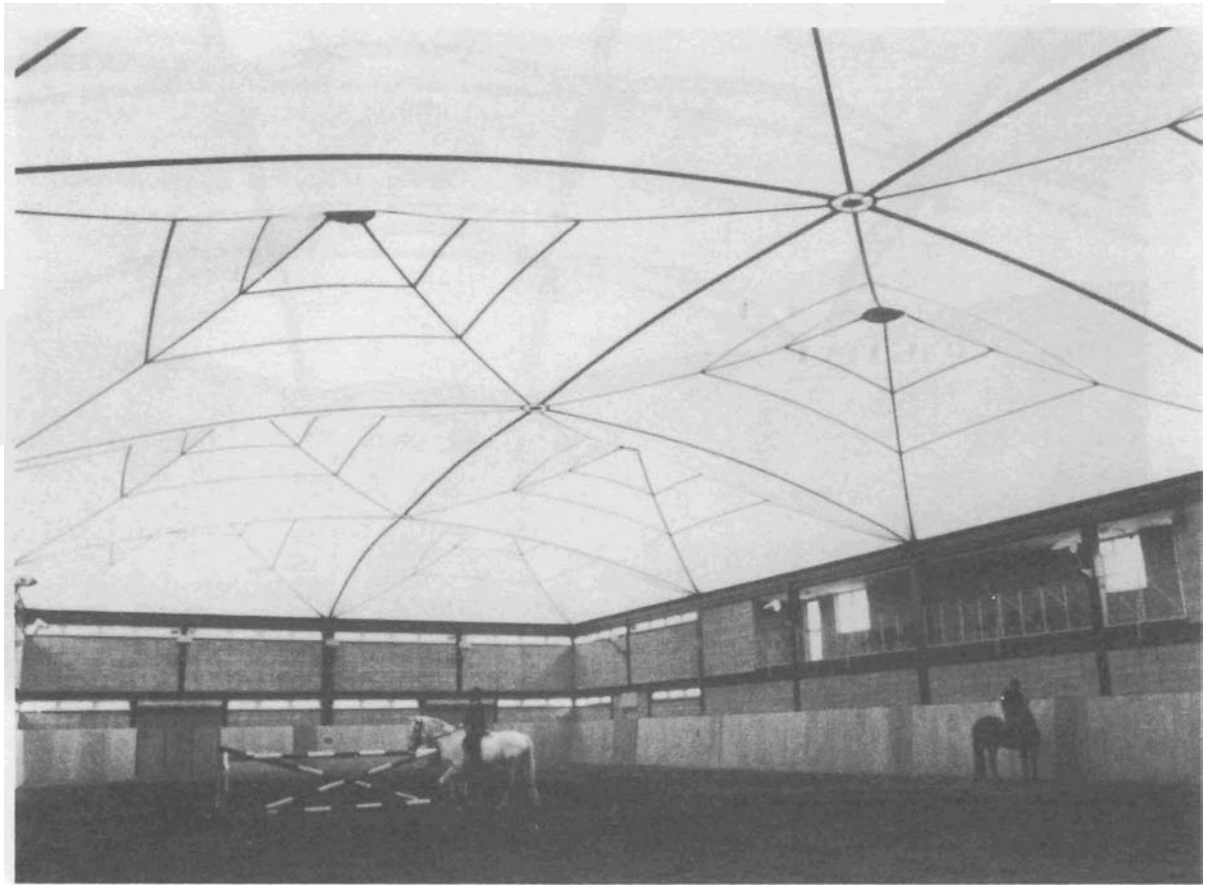


Swimming pool enclosure



School gymnasium

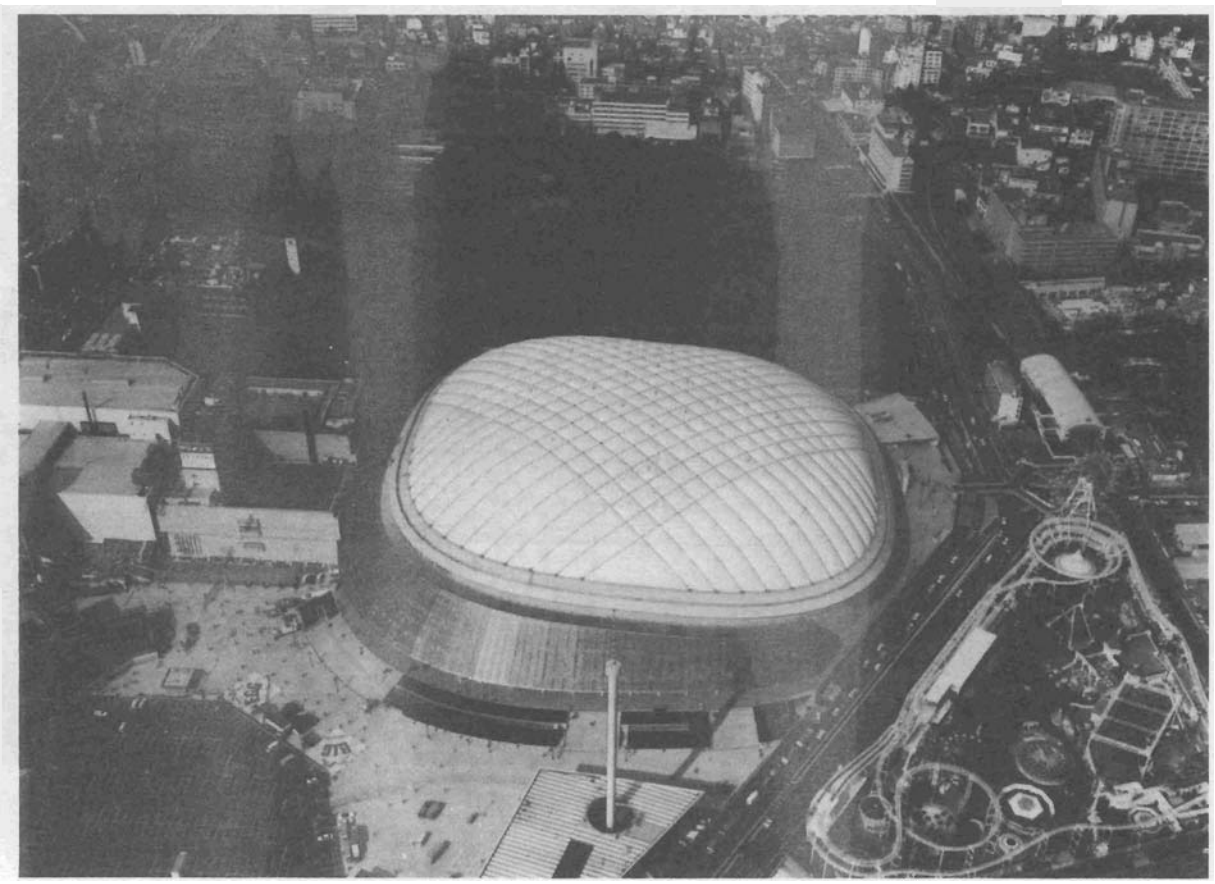
Beginning in 1976 we became heavily involved with space frame structures. Here are examples of the combination of space frames and Teflon coated fiberglas:



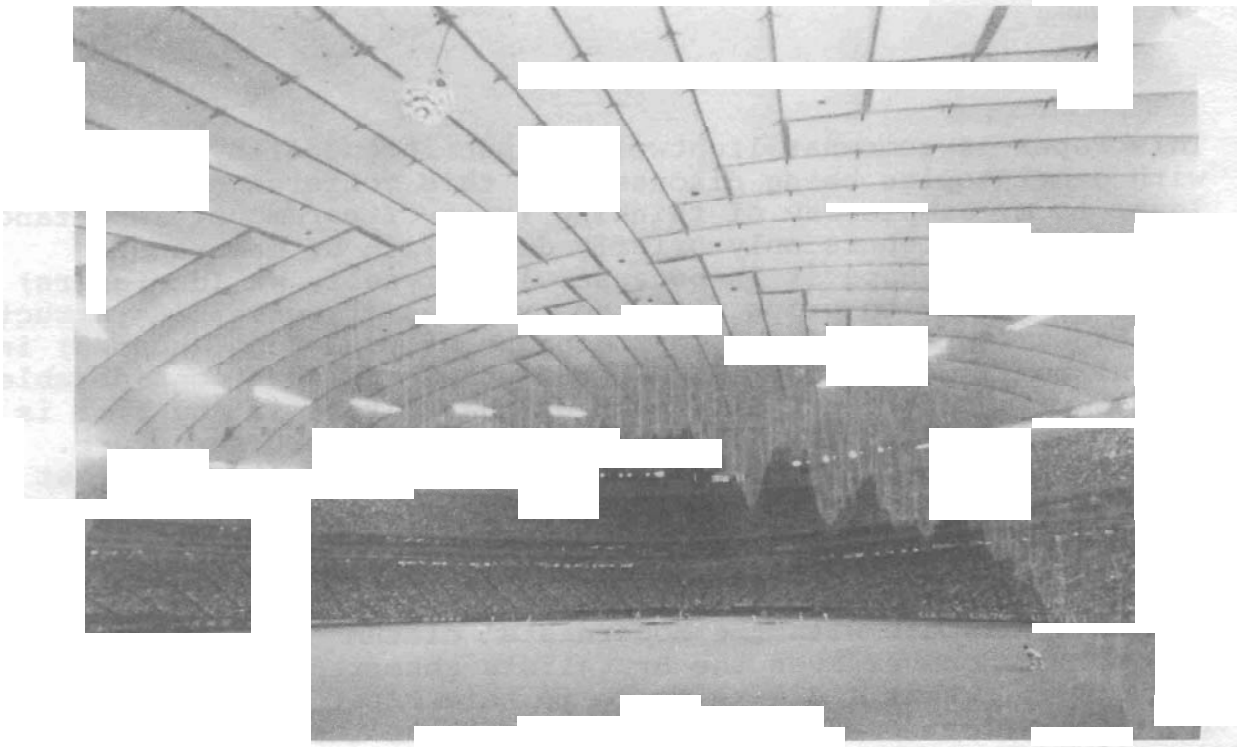
Horse riding arena

Permanent Exposition Plaza in Osaka covering 4,000 square meters.

This year, we completed Japan's first air supported Baseball Stadium with Teflon membrane in Tokyo.



Exterior of Tokyo Dome



Interior of Tokyo Dome

Creating a new civilization with membrane structures, this is our aspiration.