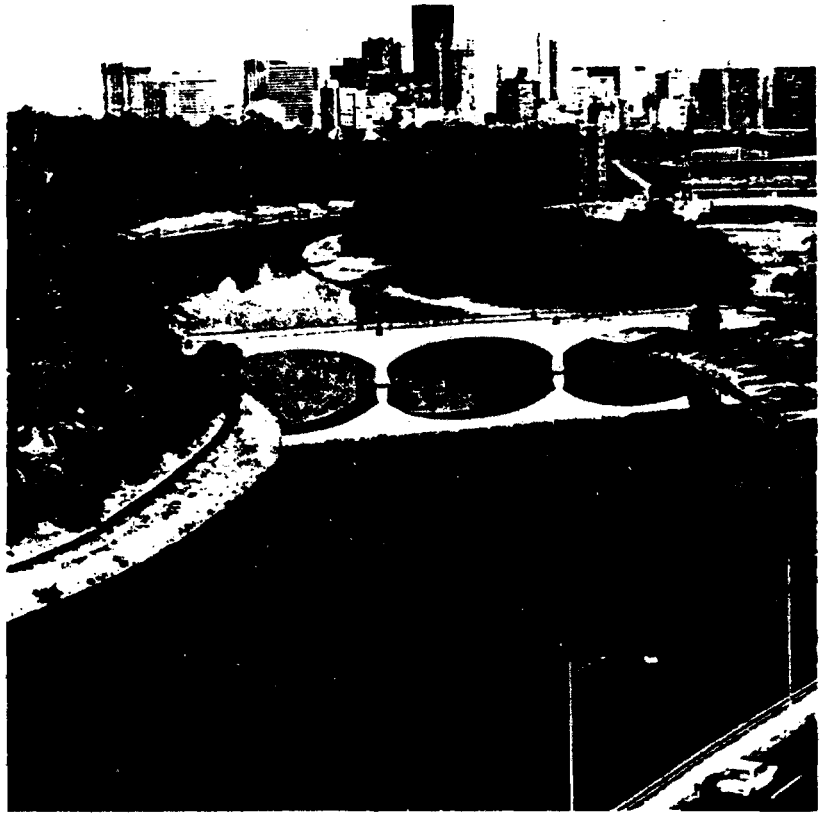
LSAA / MSAA 1983 Proceedings

MEMBRANE STRUCTURES ASSOCIATION
OF AUSTRALASIA

1983 CONVENTION

Membrane Structures in Sport and Recreation

MELBOURNE – 3RD JUNE, 1983



Ansett.

THE MEMBRANE STRUCTURES ASSOCIATION OF AUSTRALASIA

The Association is an autonomous, inter-disciplinary group of interested parties comprising Members from the Professions (Architects, Engineers, Researchers), from Industry (Material Suppliers, Fabricators, Contractors) and Government actively involved in the field of membrane structures with the basic aim of promoting the proper application of membrane structures and their design, fabrication, construction and materials, and the further development of these and other aspects particular to membrane structures.

MSAA was founded in 1981 being the first such organisation worldwide dedicated to all types of membrane structures and comprising representation from all aspects in the field.

The 1983 Convention is the third event since its recent foundation which provides an opportunity for all those interested in this new and exciting field of construction to meet and to exchange information with those actively involved in the design, analysis, fabrication, construction and application of membrane structures.

The preceding meetings were: The First Australian Seminar on 'Membrane Structures: Design, Analysis and Construction and the Second Seminar on 'Practical Membrane Structures', both held at the University of New South Wales in 1981 and 1982. (Combined proceedings of these events are available.)

THEME

The impact of membrane structures on the construction of Sports and Recreation Facilities Overseas has been considerable.

In view of Government policies encouraging future growth of these facilities the timing was deemed to be appropriate to dedicate the proceedings of this Convention to this particular 'field of application.

The speakers, each being an outstanding expert in his field, are representative of various levels of Sports and Recreation Facility Planning: policy implementation, planning, design and construction of major facilities, major sporting users and membrane structures design and research.

This meeting is expected to provide important highlights into this rapidly growing field of potential application for membrane structures.

It is supplemented by a state of the art report on recent projects, the activities of the Association and finally the Annual General Meeting. The Convention culminates in the first time presentation of the MSAA Design Awards during Dinner.

PROGRAMME

THURSDAY, ZND JUNE, 1983

1800.1900	Registration
1900-2000	Informal Cocktail Hour

FRIDAY, 3RD JUNE, 1983

Proceedings

0830-0930	Registration
0930	Welcome by the President
0945	Laurie Jackson: 'Government Involvement in the Development of Sporting Facilities'
1030	Morning Tea
1100	Philip Cox: 'Buildings for Sport and Recreation'
1145	'Membrane Structures in Sport and Recreation' Vinzenz Sedlak: 'International Examples and Design Criteria' Jack Sanders: 'Critical Appraisal of Swimming Complex Planning'
1245	Lunch
1400	Open Discussion, Presentation of New Projects and Activities Reports of MSAA Committees
1530	Afternoon Tea
1600	Annual General Meeting of MSAA
1730	Approximate Close

Dinner and Awards Presentation

1930	Dnnks
2000	Dinner and Presentation of the 1983 MSAA Design Awards
2400	Approximate Close

Notr: Members' Spouses and Participants intending to attend the Evening Function only (Dinner and Awards Presentation) will be able to book for these separately.

Copies of invited papers will be available at registration.

VENUE

The Convention will be held in the President Motor Inn, 63 Queens Road, Melbourne, 3000. Telephone (03) 51 8411. Close to the G.P.O.

ACCOMMODATION

Has been arranged at the President Motor Inn at the following rates:

2nd June	Single or Double $50	Twin $53
3rd, 4th June	Single or Double $40*	

Presidential Suites are available at a daily rate of $75

* Special weekend rate

AIR TRAVEL

Ansett Airlines of Australia have been appointed official carrier. Flight bookings should be made directly with your nearest Ansett travel consultant. Accommodation and rental car bookings may also be made through Ansett.

SPEAKERS

Philip Cox (Architect, Philip Cox & Partners Pty. Ltd.)
Major projects include Bruce Stadium and National Indoor Sports Centre, Canberra, Yulara Tourist Resort Project, N T. Numerous RAIA Merit Awards for both public buildings and prtvate houses. Guest lecturer at Sydney, Melbourne and New South Wales Universities. Member of Architecture and Design Board. Visual Arts Board. Past Chairman of the RAIA Historic Buildings Committee. Author and Co-Author of various books on historic Australian buildings.

Laurie Jackson (Department of Home Affairs and Environment, Sport and Recreation Branch, Canberra)
Employed in prtvate enterprise 1961-71. Since 1971 in Public Servtce National Fitness Section 1971-73. Department of Sport and Recreation and various Sections (1974-79). Sport and Recreation Division of the Department of the Capital Territory (1979-81). Since 1981 Project Officer, Sports and Recreation Branch. Department of Home Affairs and Environment.

John Sanders (Consulting Engineer, North Ryde)
Past Secretary/Treasurer MSAA. Specialist in Swimming Pool Complex Design. President of the N.S.W. Amateur Diving Association. Secretary of the Australian Diving Association. Member of the International Diving Committee since 1972. Member of the International Technical Committee responsible for establishing international requirements for swimming. diving, water polo and synchronised swimming since 1975. Construction advisor to the International Swimming Federation.

Vinzenz Sedlak (Senior Lecturer and Director Lightweight Structures Research Unit, University of N.S.W.)
Principal, Surface and Spatial Structures, Membrane and Lightweight Structures Consultants, Randwick, N.S.W.; President, MSAA. Lightweight Structures research since 1969: University of Stuttgart, West Germany, with Frei Otto, Space Structures Research Centre, Universitv of Surrey, U.K., since 1976 University of New South Wales. Author of numerous publications, Editor-LS Publication Series 'Lightweight Structures in Architecture'.

CAR RENTAL

Avis allows a 20% discount on daily rates for participants. Arrangements should be made either directly to Avis or through Ansett by quoting this Convention.

TRADE DISPLAY SPACE

Display Board spaces are available at moderate rates. Enquiries should be directed to Brian O'Flaherty Telephone (03) 520 0722.

REGISTRATION

Advance Registration should be made by returning the enclosed slip together with the appropriate payment before 20th May, 1983 to:

Mr. Brian O'Flaherty,
Hoechst Australia Limited,
G.P.O. Box 4300,
Melbourne, Victoria, 3001
Telephone: (03) 520 0722

1983 MSAA CONVENTION
MEMBRANE STRUCTURES IN SPORT
AND RECREATION'

REGISTRATION FORM

Detach and forward before **20th May 1983** to:.

Mr. Brian O'Flaherty,
Hoechst Australia Limited.
G.P.O. Box 4300,
Melbourne, Victoria, 3001

Please make the following registration **bookings**:

Company/Organisation . . . .

. . . .

Mailing Address. . . . .

. . . .

. . . . **Postcode** . . . .

Telephone No. . . . .

Given **Name** Family Name

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REGISTRATION FEES:

Members Convention and Evening Function . . . . **$75 per person**

Member & **Member's** Spouses Evening Function Only . . . . $30 per **person**

Non-Members Conwntion and Ewning Function . . . . **$90 per person**

Non-Members Ewning Function Only . . . . $35 per **person**

I ENCLOSE A CHEQUE PAYABLE TO THE 1983 MSAA CONVENTION AMOUNTING TO $ . . . .

1983 MSAA DESIGN AWARDS

The MSAA Design Awards will be awarded at the Convention for the first time. Awards will be in 3 categories:

1. Large membrane structures in excess of 300m^2 ground cover.
2. Small membrane structures less than 200m^2 ground cover.
3. Special applications:
   (a) permanent buildings and other structures
   (b) temporary, demountable buildings and other structures.

Awards are open to membrane structures constructed during the last 24 months which must have been designed and fabricated in Australasia.

An Award of Merit will be available for projects of predominantly Australasian design which were fabricated overseas.

Submissions are invited and must be received by 25th April, 1983 at the address given below.

The Members of the Judging Panel will meet shortly thereafter in order to consider submissions
Vinzenz Sedlak, President MSAA. Chairman.
Philip Cox, Architect, Philip Cox & Partners
Richard Dexter, Material Suppliers, Brella
David Goodearl, Fabricator, Goodearl & Bailey – President, CGMA.
Richard Kell, Consulting Engineer, McMillon Britton & Kell, President Concrete Institute (N.S.W Chapter).

REGISTRATION FORMS AND SUBMISSION GUIDELINES have been circulated to Members. Non-Members intending to submit projects should obtain them from.

MSAA Design Awards.
C/o Richard Dexter,
Brella (N.S.W.) Pty. Ltd.,
P.O. Box 79,
Milperra, N.S.W., 2214
Telephone: (02) 771 3011

All enquiries relating to the Design Awards should be addressed to Richard Dexter, Chairman Promotions Sub-committee.

Laurie Jackson

Department of Home Affairs and Environment, Sport and Recreation Branch, Canberra

GOVERNMENT INVOLVEMENT IN THE DEVELOPMENT OF SPORTING FACILITIES

Paper presented at:

1983 Convention
'Membrane Structures in Sport & Recreation'
Melbourne - 3rd June, 1983.

Membrane Structures Association of Australasia

MEMBRANE STRUCTURES ASSOCIATION OF AUSTRALIA
1983 CONVENTION

MELBOURNE, 3 JUNE 1983

"Commonwealth Government involvement in the development of 'sporting facilities".

Laurie Jackson, Assistant Director,
Events and Facilities Section
Department of Sport, Recreation and Tourism

I would like to congratulate the Membrane Structures Association for convening this seminar on the important topic of provision of sport and recreation facilities.

In this short address I would like to broadly outline the extent to which the Commonwealth Government is involved in this area and make some personal observations which may provide some insight into the problems Government officers working in this field encounter. I have based this presentation on the experience I have obtained in the administration of the Australian Government's International Standard Sports Facilities (ISSF) Program (since 1981) and my participation in the development of facilities at the National Sports Centre in Canberra prior to that.

To help me provide the broadest possible view of Government involvement I have asked some colleagues from the NSW, VIC, and SA State Departments of Sport and Recreation to join me here to answer any questions you may have which relate specifically to the policies and programs of their respective Governments

Present Programs

Over recent times the Australian Government has been involved in four major areas of facility development:

(i) the International Standard Sport Facilities (ISSF) Program;

(ii) the funding of sport and recreation facilities in the ACT under the National Capital Development Commission's Works Program;

(iii) the develpment of facilities in educational institutions and Defence establishments such as Duntroon and the Australian Defence Forces Academy, and;

(iv) special grants for the development of facilities for special events, particularly the 1982 Commonwealth Games.

Through these programs there has been a marked increase in the range and quality of facilities throughout Australia, particularly in those which cater for national and international competition.

(i) ISSF Program

Under this Program administered by the Department of Sport, Recreation and Tourism, the Australian Government provided $25m for commitment in tne 1980/81-1982/83 triennium on a dollar for dollar basis with the States and Territories for development of sporting facilities of international standard. Funds are allocated for those facilities rated the highest priority by the respective State/Territory Governments. The $25m has been allocated to the State/Territories, although some projects are still to be submitted for approval.

Some of the projects being developed under this Program include:

indoor sports centres at Homebush Bay in Sydney and Darwin;

a hockey field, equestrian centre and the upgrading of the No 1 Ground at Olympic Park in Melbourne;

an aquatic centre in Adelaide;

a baseball centre at Belmont in Western Australa and at Kingborough in Tasmania;

a rowing centre at Lake Barrington (Tasmania) and an inaoor velodrome in Launceston.

Although the Australian Government has set guidelines tor the Program which are designed to ensure that international standards are met tor the respective sports being catered for in each facility, access tor the disabled is provided and adequate planning has been made tor managing the tacility, it is the responsibility of the State Government and/or local government to co-ordinate and approve all aspects of the projects including the brief, final design and selection of materials and equipment.

Should any one be interested in ascertaining more information about specific projects I, and I'm sure the State Governments represent'atives would be happy to talk with you later.

(ii) Facility Development in the ACT

The responsibility for the planning, development and management of facilities in the ACT rests with the Department of Territories and Local Government and the National Capital Development Commission. However, as the Minister for Sport, Recreation and Tourism carries responsibility for the Australian Institute of Sport his Department and the Institute also participate in the planning of facilities at the National Sports Centre where the Institute is based. Facilities at the National Sports Centre include:

- the National Athletics Stadium;
- the National Indoor Sports Centre which includes an adjacent specialist gymnastics/warm up hall;
- indoor swimming complex
- indoor/outdoor netball courts
- outdoor netball courts
- specialist throwing area for field athletes

Construction has commenced on an integrated training tacility which will comprise:

a five court hall for basketball and netball;
a theatrette for weightlifting competition, seminars films etc.;
a weightlifting training centre and associated conditioning gymnasium;
synthetic indoor and outdoor playing surfaces for soccer and hockey, and;
two outdoor grass soccer pitches.

All of these facilities are used by athletes attending the. Institute on a full-time basis and by those athletes participating in the National Training Centre Program. The Centre is also used by sporting organistions for major championships and community use is encouraged when time is available.

The National Capital Development Commission is also responsible for the provision of facilities for the ACT ranging from basic recreational facilities such as ovals and tennis courts to swimming pools, indoor centres and sports facilities associated with schools.

(iii) Other Federally Funded Facilities

Federal Funds are also provided tor a wide range of facilities in establishments such as educational institutions and defence bases throughout the country. Generally, these are co-ordinated through the Department of Housing and Construction. As my Department has no responsibility in this area, I am unable to make any comments on the policies related to the provision of these facilities. However, the Department if Housing and Construction has regional offices in the States, and I'm sure they would be able to answer any enquiries.

(iv) Special Grants

Funds were provided to the Queensland Government to assist with the development of facilities for the 1982 Commonwealth Games. As with the ISSF Program the State Government and the Brisbane City Council were responsible

for the planning and construction of these facilities. Another special grant was made to Western Australia for it sesquicentenary in 1979 to develop the Commonwealth Hockey Stadium which incorporated the first synthetic hockey pitch in Australia.

PLANNING

An Important project that the Australian and the State/ Territory Governments and national sporting organisations have been working on for a number of years is the preparation of an inventory of international standard sports facilities in Australia. This has been a difficult task, particularly ascertaining the standards for each sport and then identifying the facilities accordingly. The major purpose of this exercise was to find out what facilities we have in Australia and what they provide. When completed this document will be used to assist all levels of Government plan for the future development of facilities of international standard.

FUTURE DIRECTIONS

Over recent years the Commonwealth Government's priority in assisting the development of facilities has been in the specialist and elitist facilities area. The present Government's election policy has, however, referred to:

.the provision of direct grants to local government bodies for basic sporting and passive recreation facilities such as tennis courts, picnic grounds, football grounds and netball courts;

funding on a dollar for dollar basis to local and State Governments for the building of family leisure centres, and;

the maintenance of funds made available to the States on a dollar for dollar basis for the provision of competitive facilities of international standard.

It is not yet known how soon these new programs will be introduced. However, guidelines and administrative arrangements are presently being developed to allow their early implementation subject to the prevailing economic climate.

I would now like to make some comments on my experiences in the facility development field.

I think it is important for you to bear in mind that many officers in Government Departments involved in this area are laymen. It is therefore essential they are given every opportunity to improve their understanding of technical requirements and trends in design so that they can make reasonably informed decisions.

During the planning of the National Indoor Sports Centre for instance an officer of the National Capital Development Commission and myself were faced with writing a brief for the first multi purpose specialist sporting venue in Australia. We discovered that the various sporting bodies were unclear about many of the detailed technical requirements for their respective sports. This is probably explained by the fact that they were only familiar with facilities which were not of international standard and were not up to date on the trends and expectations of their overseas counterparts.

Additionally, there were no accepted Australian based standards for aspects such as sports floors and lighting and, most importantly, there was no centralised core of detailed information, either Australian or from overseas available on this subject.

To overcome these difficulties it was necessary tor the architect and representatives of the client Department to work very closely throughout the project researching basic requirements and checking these with the prospective users. In many cases our research resulted in last minute changes being made to what was previously considered the correct course.

Despite these difficulties the Indoor Sports Centre was completed on time ana, apart from the inevitable minor problems is a magnificent asset to Australian sport. However, the whole exercise would have been easier if a detailed management plan had been developed for the Centre and we had been able to write a comprehensive brief from the outset, based on internationally accepted and proven standards.

It is therefore important that professional groups such as yours, firms marketing products, authorities managing recreational and sporting facilities and user groups such as sporting bodies keep each other and Governments abreast of developments/problems in their particular area.

In these times of economic restraint organisations concerned with the provision of facilities are obviously keen to get the best value for dollar while still ensuring the minimum requirements of the users are met. Accordingly there will often be a need to compromise between state of the art technology and economy. It is therefore important that designers, manufacturers and builders ensure that their products are efficient and reliable. Because of the high cost of maintenance and the operational cost of facilities care needs to be taken by all those involved to ensure the final design takes cognisance of this. For example, it would seem pointle'ss to install an expensive timber floor and surround it by untreated concrete, which will result in cleaning problems and probable damage to the floor.

As many aspects of facility design and more particularly equipment are advancing quickly with new technology, it is important that all people involved are aware of the latest trends so that facilities are not obsolete before the planning stage is completed.

As you will understand a well informed client whether a sporting association or government organisation can prepare a much more detailed and accurate brief which should ensure a more usable facility in the end.

To help overcome the problems associated with a paucity of information in this field the Commonwealth has asked the Footscray Institute of Technoloyy to prepare a report on the need for an information and documentation service for the design of recreation facilities in Australia. The report, prepared by Mr Alan L Bundy, is still being considered.

With the recent development of international standard facilities in Australia there are increasing opportunities for an exchange of ideas between people involved in the area. I am continually ringing my counterparts in the States (and vice versa) and I am aware that this is also happening in other circles. I trust that this positive attitude will continue to grow so that the facilities which are developed are the most efficient and effective we can provide. I would encourage professionals to submit papers to the respective journals outlining their experiences and achievements.

In summary I would stress the importance of continuing to improve our knowledge in all aspects related to the development of sport and recreation facilities. It there is a commitment by all involved in the field together with better communication and consultation I am sure all Australians will benefit through the quality of facilities that are provided.

In closing I would like to thank Mr Sedlak and Mr Sanders for for inviting me here today. I am very keen to learn more about developments in your field as they apply to the sport and recreation area, and I trust that the overview I have given will help your understanding of the Australian Government's role in this area.

Philip Cox

Philip Cox & Partners, Architects

ARCHITECTURAL ASPECTS OF LIGHTWEIGHT AND MEMBRANE STRUCTURES IN SPORT AND RECREATION

Paper presented at:

1983 Convention
'Membrane Structures in Sport & Recreation'
Melbourne - 3rd June, 1983.

Membrane Structures Association of Australasia

Australia is proceeding (if somewhat sluggishly) during the last quarter of this century on the development of buildings which have hitherto been considered' as luxury. Although the United Kingdom, Europe and America have developed since world war II a lively sophisticated network of sport and recreation buildings and national sports centre, Australia has not. Australia has tended to rely upon its relative sunny disposition, its equitable climate and long suffering educationists and utilize nature's own sports hall - the open field.

It has been a long tradition .in the Australian imagery of dusty ovals or cricket pitches somewhere located in the outback and the never never with hot piercing sun. Some quaint figures are to be seen playing on the field, sometimes in their whites observed by a lazy dog and a few bedraggled bystanders dressed in moleskins and slouch hats.

The same scene was familiar for swimming. A fenced off section of Sydney Harbour was adequate for any national event and most swimming centres were tidal. I believe that 'Boy' Charlton broke world records in such a situation at Woolloomooloo Bay, no doubt lowering himself down on one of those incredible gantries which coped with tidal fluctuations and gave swimmers a relative easy dive into the murky brink.

Indoor sports were generally unheard of 30 years ago. Basket ball, badminton, indoor tennis, gymnastics, volley ball were relatively rare and not particularly encouraged 'because of the lack of facilities. If these sports were played in any organised way they were generally relegated to convenient outdoor spaces such as a disused tennis court or car parking allotment.

The ancestor of the indoor sports hall was the scout hall, the local parish church hall or the Masonic Temple Hall - all of which were particularly gloomy affairs and particularly unsuitable for the production or the promotion of any indoor sports activities. At the same time women's yoga classes or health clubs or the odd gymnast class for youngsters which was sometimes misappropriately confused with the term Ballet were conducted in these halls. Let us give them credit they were genuinely multi-purpose.

In 1960 squash became popular and this sport increased dramatically in popularity due to the enterprising efforts of local operators who saw a 'quick quid' in the office workers obtaining 'instant' exercise and those who could not participate in more organized sport. Such was the scene in which I grew up.

Now all that has changed due to a change in the ethics of our community which previously had put work as the principal focus of life and the main provider of satisfaction and within the community.

Leisure and not work has become more significant in our life and well may be considered vital to the development of an individual's identity and self-realisation than work. As people become more disenchanted with more opportunity and work satisfaction so leisure assumes a greater and more creative role. As the sports council for Great Britain stated 'Any concept of leisure planning should therefore be concerned with the totality of lifes satisfactions: more specifically with considering how the provision of facilities in sport, recreation, arts, education, tourism and recreation generally can better serve human needs'.

With this background in mind, that we as architects need to address the problem of design and the various problems which we face in the selection of structures suitable for the housing of sport and recreation purpose and the design of sensitive and useful buildings.

Australia is therefore becoming aware of the need for indoor sports facilities, they have finally recognised that although they are living in the 'lucky' country, the Australian climate is generally as hostile as the landscape itself. Therefore separate provision have to be made.

Over the last ten years there has been an enormous development in indoor sports. This has resulted in the same important buildings being built which are capable of catering for a large number of activities. The main concentration has been on badminton, squash, basketball and the martial arts, while some other sports like tennis and indoor hockey have emerged as being capable of being played within these building types as a corollary. Gymnasts facilities have followed.

In all pioneering countries the first and major buildings to be built are the essential.

Apart from some limited buildings such as a swimming centre built for the Olympic games in Melbourne in 1956 and some other minor buildings in other capital cities. Australia has been bereft of any major indoor sporting facilities. Each capital city has constructed a cricket ground surrounded by an 'ad hoc' selection of grand stands. Sydney is typical of this situation and instead of possessing and taking pride in a uniform group of grand stands and facilities has an unco-ordinated relatively undisciplined, visually haphazard collection of grand stands. Unfortunately the Australian vernacular approach of "adding on the lean to" does not exactly work in these circumstances, the forces are far too great and the scale of these structures too vast for the inexperienced.

In 1976 things changed. Canberra wanted symbols, oventures of good will and intention to sport within the Nation.

Philip Cox and Partners were commissioned to design the first of these symbols - an athletics stadium for the hosting of the Pacific Conference Games. This was followed by the construction of the Indoor Sports Complex in 1978 and the National Specialist Gymnast facility in 1981.

We are here to talk about light weight and membrane structures, however, I think the exercise we went through with the National Capital Development Commission important as it may give the members of this conference some clues as to why fabric structures were not selected and why a tensile structure using more traditional materials was selected.

The site chosen for the National Sports Complex was Bruce, Canberra. The site is on a valley floor surrounded by the foot hills of Black Mountain. The site has a subtlety which we believed deserved special landscape response which unfortunately has been ignored by other architects who followed the three initial buildings completed by us.

All types of structures were examined in the case of the stand. These included, traditional truss type cantilever structures, portal cantilevers, suspension structures and membrane structure. Schemes were produced on all these types and cost analysis were made. These were evaluated and we were advised by our Quantity Surveyors and Cost Planners that a tensile structure the most economical.

An evaluation of the structures was concurrently made in terms of life structure, durability, maintenance, guarantees of performance, erection time, erection ease, extendability, thermal transmission, acoustic performance etc. Although our learnings were visually and architecturally towards the use of a membrane structure, we were generally persuaded to adopt a tensile structure rather than membrane.

With regard to the major sports hall, the choice of structure was more difficult. Again the shopping list of structures was examined in this case truss, space frame, portal, tensile, membrane. The selection criteria was as follows:

	Truss	Portal	Space Frame	Tensile Fabric	Pneumatic
Thermal External	Good	Good (metal roof coverings)	Good	Poor	Poor
Thermal Internal	Good	Good (roof insulation)	Good	Poor	Fair
Acoustic	Controllable	Controllable	Controllable	Poor	Poor
Aesthetics	Poor	Poor	Good	Excellent	Excellent
Flexibility	Fair	Good	Good	Good	Poor
Expandability	Easy	Easy	Difficult	Note easily expanded	Not easily expanded
Fire Risk	Truss space needs sprinkling	Good	Good	High	High
Cost $/m^2	385.00	245.00-305.00	400.00	250.00-350.00	350.00-500.00

In terms of maintenance, longevity, durability, acoustic, thermal, day light interference etc. further assessment of the structural type was made. The selection again was a cable, light weight structure using a precast panel ceiling which formed an effective acoustic and thermal barrier.

With regard to the Specialist Gymnastic Facility the same analytic process was entered into and the selection was a two way truss system.

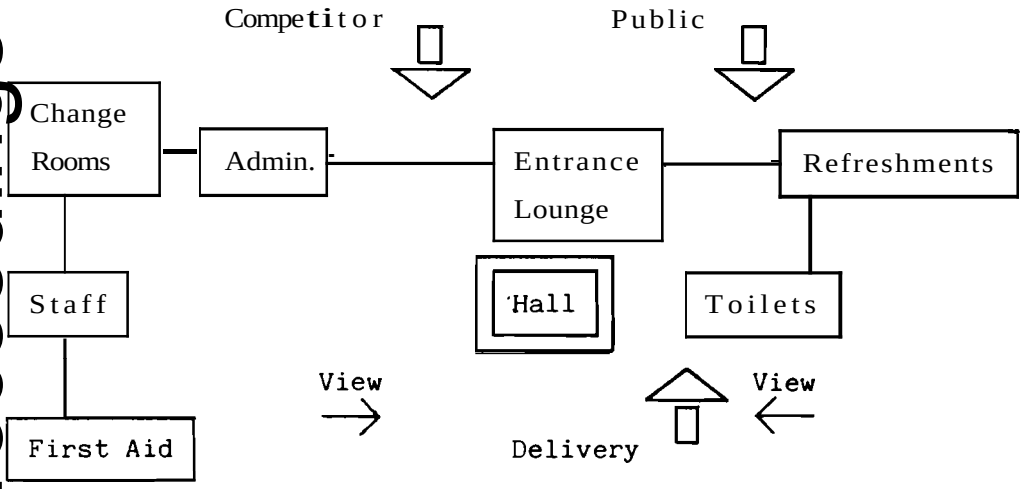
However, in other projects such as the Northern Suburbs Sports Centre at Baulkham Hills we have proposed a tensile structure with fabric and this (funds permitting) should be an exciting structure. The light weight structural solution satisfies the two way nature of the viewing within the stand and gives a great freedom of architectural expression.

At Yulara, the new town at Ayers Rock in the Northern Territory, although not sport and strictly recreation, major areas such as outdoor interpretative centres have employed purely hyperbolic forms secured to masts. The fabric in these spaces is P.V.C. Because of the intense sunlight shading of streets has been achieved by the use of P.V.C. fabric stretched simply on frames. In the major resort a double membrane system has been used using a common structural support. The principal behind this development is precisely the same as the tradition tent with tent fly. The outer hyperbolic membrane, shades the lower barrel vault which is stretched on hoops supported on a common gutter section. The main problem in this resort was heat tranference and the importance of shade. I believe this is one of the first occasions where this old age principal has been applied to a major structure.

One of the architectural and social reasons for using this structural type was the imagery that one has of the desert and the practicality of the tent when used under these circumstances. Obviously kitchen and service areas are not within the tent. These have been designed as separate units in traditional masonry construction.

Design principles which may be of assistance to those in the industry.

In general terms for medium size developments, the following arrangements are considered desirable:



For Australian conditions the following facilities may be considered necessary in the selection of function with the necessary selection of structure, light weight tensile or membrane.

The table (refer Table A) published by the Sports Council of UK in Handbook of Sports and Recreation Building, is a most useful guide in the selection of building size when related to the standard of operation for National, Clubs, Recreation Standards.

Further the selection of hall size and the subdivision of the hall needs to be carefully worked out to give the greatest flexibility of operation in accordance with Table C.

The subdivision of the hall is further required to ensure flexibility (refer Table B).

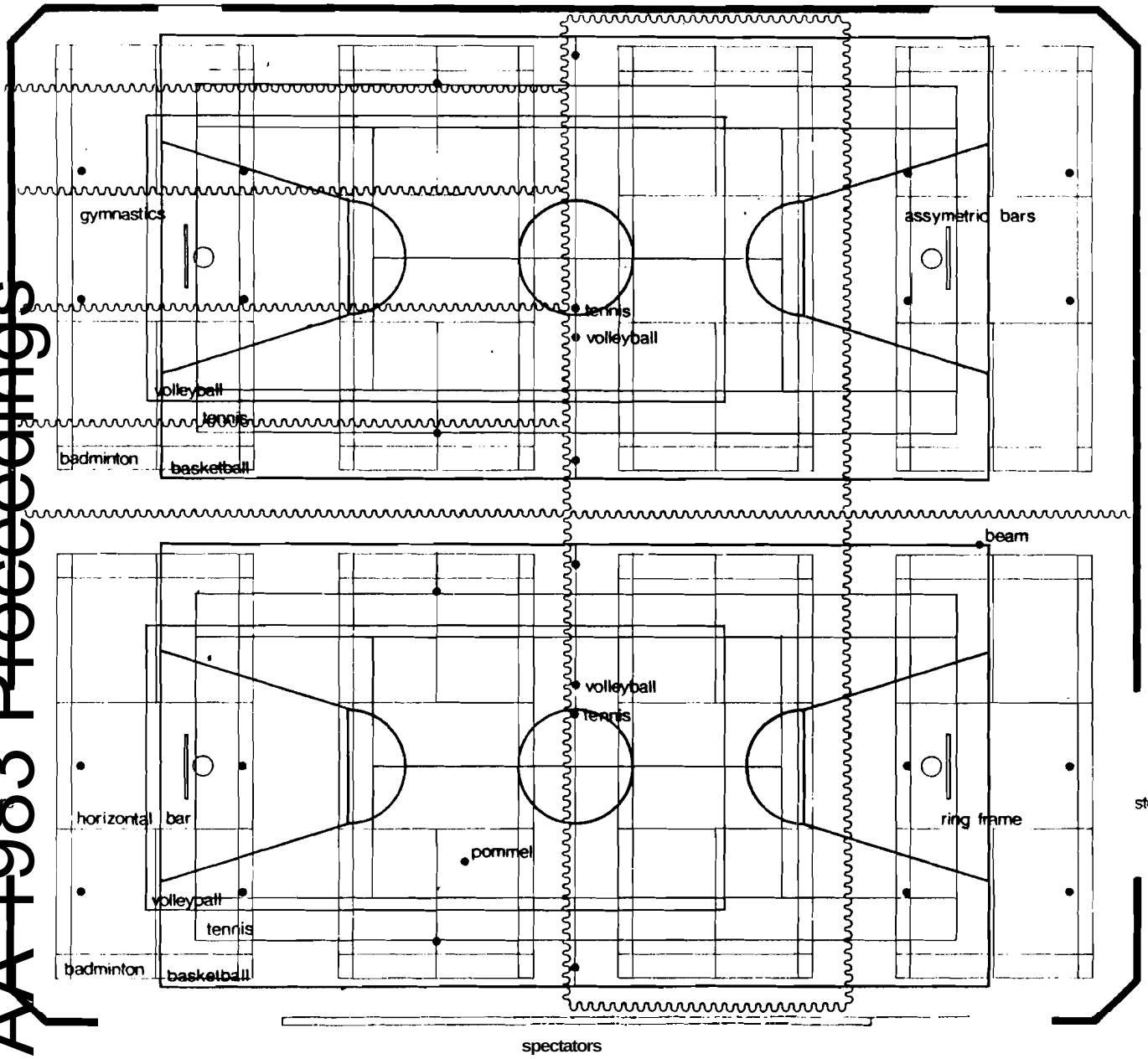
This relates directly back into the selection of the structural system whether the structure is prestressed or non-prestressed, whether point supported or line cable supported or surface supported as in the form of a pneumatic structure.

Table A Building Features

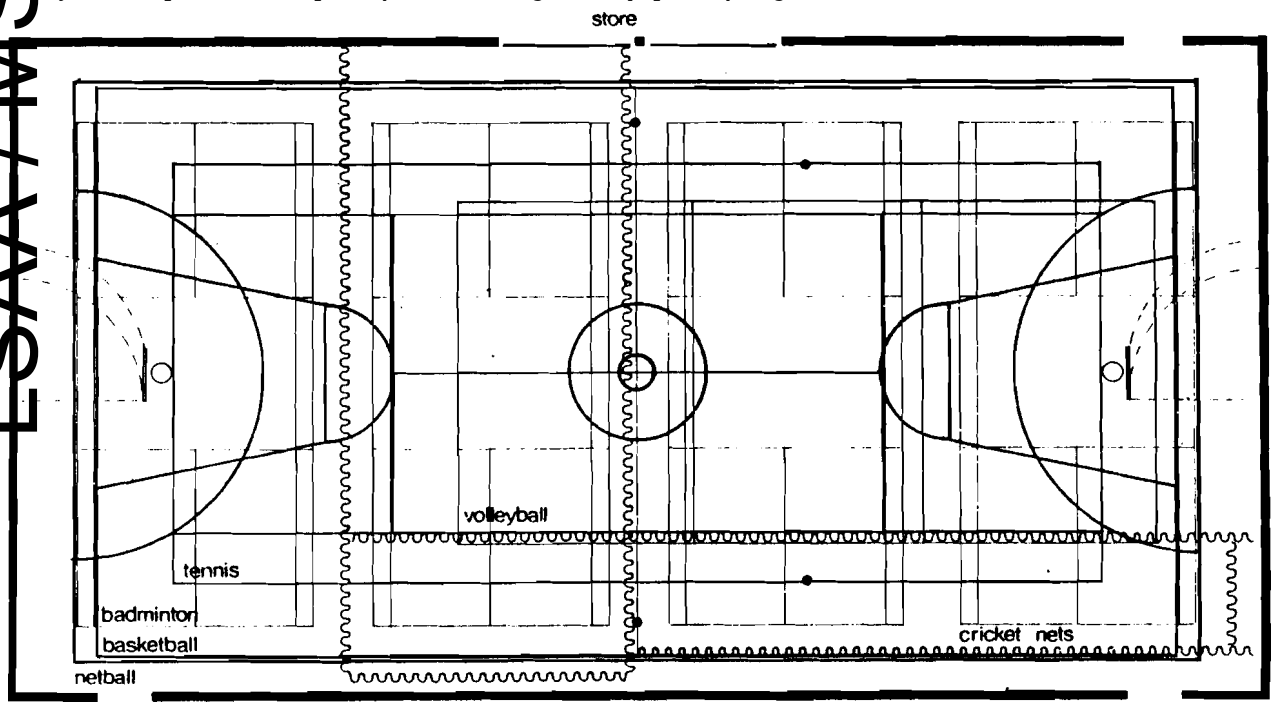
	Large scale sports centre	Medium scale wet and dry sports/rec centre	Small sports centre	Small community provision
Pocls	● ●	● ●		
50 metre	o			
25 metre	●	o		
20 metre		o		
Learner Pool	●	o		
Diving	●	o		
Sports Hall(s)	● ●	● ●	● ●	● ●
Large hall	●	o		
Medium hall		●		
Small hall	o		●	
Small community hall				●
Ancillary indoor sports accommodation	- -	● ●	o	
Practice hall	-	●	o	
Weight training/ conditioning room	-	o		
Projectile hall	o	o		
Squash courts	-	●	●	●
Climbing wall	o	o		
Indoor bowls	-			
Billiards/snooker	o			
Ice rink	o			
Theatre/multi-purpose hall	o			
Ancillary accommodation	- -	● ●	● ●	● ●
Changing	- -	● ●	● ●	● ●
Spectator seating				
fixed	o			
occasional	-	●		
Information viewing	-	●	●	●
Club meeting room(s)	o			o
First aid room	- -	● ●		
First aid equipment	●	● ●	● ●	● ●
Creche (separate store)	-	o		
Creche facilities (alt. use, sep. store)		o		
Sauna suite	o			
Refreshments	● ●	● ●	●	●
Cafeteria	●	●	o	
Bar	●	●	o	o
Vending machine	o	o	●	●
Staff and management				
Reception	● ●	● ●	● ●	● ●
Office(s)	● ●	● ●	●	●
Staff rest room	● ●	o		
Staff changing	●	o		

	Large scale sports centre	Medium scale wet and dry sports/rec centre	Small sports centre	Small community provision
Outdoor assoc. facilities				
Grass pitches	o	o		
Hard porous/synthetic pitches	o	o		
Floodlit pitches	o	o		
Tennis courts	o	o		

Key: ● ● **Essential**
o **Possible**
● Typical/desirable



Wycombe Sports Centre: plan of court markings and equipment fixings



Tamworth sports centre: plan of court markings and equipment fixings

TABLE C

Table 11 Indicative or preferred maximum number of courts related to standards of play and sizes of sports/community halls

Indoor sports	Large halls* 36·5 × 32 × 9·1m 1168m²		Medium halls* 32 × 26 × 7·6–9·1m 832m²		29 × 26 × 7·6–9·1m 754m²		32 × 23 × 7·6–9·1m 736m²		Small halls 32 × 17 × 6·7–7·6m 544m²		29·5 × 16·5 × 6·7–7·6m 486·75m²		26 × 16·5 × 6·7–7·6m 429m²		22·5 × 16·5 × 6·7–7·6m 371·25m²		Community halls 17·0–20·0 × 15·0 × 6·7m 265·2–321m²		17·0 × 8·5 × 6·1–6·7m 144·5m²	
	No.	Standard	No.	Standard	No.	Standard	No.	Standard	No.	Standard	No.	Standard	No.	Standard	No.	Standard	No.	Standard	No	Standard
Aikido	4 6	N C	4 —	N —	4 —	N —	2 +1(1*)	C R	2 1(1*)	N R	2 —	N —	2 —	N —	1 1	N R	1 —	N —	— —	— —
Archery (length of shoot)	— — — —	50m 25m 18m 20yds	— — — —	— S25m 18m 20yds	— — — —	— — 18m 20yds	— — — —	— S25m 18m 20 yds	— — — —	— S25m 18m 20yds	— — — —	— — 18m 20yds	— — — —	— — 18m 15yds	— — — —	— — 18m 15yds	— — — —	— — — —	— — — —	— — — —
Badminton†	4 — 8	N — C/R	3 5 6(2*)	N† C R	3 4 5(4*)	N† C R	3 4 6	N† C R*	4 — —	C** — —	3 — 4	C** — R*	3 — —	C** — —	3 — —	R — —	2 — —	R — —	1 — —	R — —
Basketball	2 —	N —	1 2	N C*/R	1 2	N R*	1 —	N —	1 —	C** —	1 —	C** —	1 —	C** —	1 1	R* Mini BB	— 1	— Mini BB	— —	— —
Bowls (indoor non-competitive rinks)††	7	R	5	R	5	R*	4	R	3	R	3	R*	—	—	—	—	—	—	—	—
Boxing (training only)	9 12	N R	6 12	N R	4 9	N R	6 8	N R	3 6	C R	3 8	C R	1 8	C R	1 4	C R	1 4	C R	1 —	R —
Cricket nets & 6-aside cricket	1 2	N C	1 —	C —	1 —	R —	1 —	C —	1 —	R —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —
Cricket	8	N	6	N	6	C	5	N	4	C	4	C	4	R	—	—	—	—	—	—
Fencing (pistes)	12 14	N C	8(3*) 9	N C	7 8	N C	6 8	N C	3/4 2/3	N/C R*	3/4* +2	N/C R*	3/4* +1	N/C R	3 4	N C*	3 —	C —	1 —	R —
Five-a-side Football	1 2	N R*	1 2	C R*	1 —	R* —	1 —	C —	1 —	R* —	1 —	R* —	1 —	R* —	1 —	R* —	1 —	R* —	— —	— —
Gymnastics (Olympic)	—	N	—	C	—	P	—	C	—	P	—	P	—	P	—	P	—	P	—	—
Handball & Mini Handball	1 —	N* —	1 —	C —	1 —	R* —	1 —	C —	1 —	R —	1 1	R* C	— 1	— C	— 1	— C	— 1	— R*	— 1	— R*
Hockey	1	C*	1	R	1	R	1	R	1	R	1	R	1	R	1	R	—	—	—	—
Judo	4 6	N R	2 4	N R	2 4	C R	2 4	N R	2 3	C R*	2 —	C —	1 2	C R	1 2	C R*	1 —	C —	— —	— —
Karate	4 12	N R	4 6	N R	2 4/6	N C/R	2 6	N R	2 6	N R*	2 3	N R	1/2 3	N/C R*	1 2	N R	1 2	N R	2 —	R* —
Keep Fit, Movement and Dance, Yoga		✓		✓		✓		✓		✓		✓		✓		✓		✓		✓
Kendo	4 6	N R	2 4	N R	1 4	N R	2 4	N R	2 —	N —	2 —	N —	1 2	N R	1 2	N R*	1 —	N —	— —	— —
Lacrosse	1	N	1	C*	1	R	1	C*	1	C*	1	R	—	P	—	P	—	—	—	—
Lawn Tennis	1 2	N* R	1 —	R* —	— —	— —	1 —	R* —	1 —	R* —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —
Micro Kurfball	1	C	1	C*	1	R	1	C*	1	R	—	—	—	—	—	—	—	—	—	—
Netball	1 1	N C*/R	1 —	C*/R —	— —	— —	1 —	C*/R —	1 —	C*/R —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —
Table tennis C/C	11 15/21	N C/C	10 10/15	N C/C	8 10/12	N C/C	6 10/12	N C/C	7/9 14	C/C 1	7 11	C/C 1	6/7 10	C/C R	4 8	C/C R	3–6 6–8	C/C R	4	R*
Trampolining	11 15	N R	8 10	N† R	4 6	N† R	6 8	N† R*	5 —	C** —	4 —	C** —	4 —	C** —	3 4	C** R*	1 —	1 —	1	R —
Tug of War	—		N	—		RC	—–	C	—	C	—	R	—	—	—	—	—	—	—	—
Volleyball	2 3	N R*	1 2	N† C	1 1	N† R	1 1	N† C*	1 —	C** —	1 —	C** —	1 —	C** —	1 —	C** —	1 1*	R* —	— —	— —
Weight Lifting contests	—	N	—	N	—	N	—	N	—	C	—	C	—	C	—	C	—	C	—	—
Wrestling	4/6 9	N/C R	4 6	N R	6 4	N a	4 6	N* R	1 3	N R	2 3	N R*	1 —	N —	1 2	N R	1 2	N R	— —	P —

Key
N National/international standard
C County/Club standard
R Recreational standard
P Practice areas only
c/c For table tennis there are two grades of maximum space allowances for inter-county/inter-club standards of play. See Volume 4, sports data sheet 19.
‡ Playing dimensions and maximum compartment volumes should be checked. Halls of 7000m³ or over need a DOE waiver.
* 'Volume' can include an open structural roof space.
§ Area beyond shooting line is below safety standard recommended, see Volume 4. Acceptable space can be provided with a lengthening of the hall, or existing spaces may be used for practice purposes.

b National court standards are required for County standards. Where badminton umpire chairs are required the number of courts reduces to no less than given for N.
* Below minimum space standard recommended by the governing body concerned, but capable of providing purposeful and enjoyable activity. See Volume 4.
** Recreational standard where the hall is less than 7·6m clear height for Badminton and Trampolining, or less than 7·0m for Basketball and Volleyball. 6·7m height is sensible for Mini Basketball and Mini Volleyball. See sports data sheets in Volume 4.
† County/Club standard where the hall is less than 9·0m clear height. Check minimum heights for required standards given on respective sports sheets in Volume 4.
†† There is also a short mat game of bowling played in Ireland and Wales.

Notes

The numbers of spaces given for each sport is the optimum that will fit into an undivided hall space for the three standards of play, N: international and national, C: County and Club. R: Recreational. The required minimum space allowed for each takes into account not only the actual playing area, but also:

- The necessary run-out or safety margins, team bench and officials' space around the playing space, which together amount to the *Overall Areas* used for this reassessment.
- Where practical, a degree of overlap of the margin between parallel individual courts of the same kind.
- Critical heights, which in some cases degrades the standard for which otherwise there is adequate floor space, eg volleyball in 32 × 17 × 6·7m halls: see also Footnotes.
- The need for some additional free circulation space inside the hall entrance.

For most sports it is possible to provide spaces for a mix of the three standards at a time. In some cases this can be a more economical way to use otherwise surplus space. Two example are Aikido and Fencing, where N or C *plus* R is given on the second line entry. (Otherwise a second line entry is an alternative to the first line provision.)

In practice a variable number of different activities may be programmed at a time. The sub-division of halls into such zones are shown in 2–13 on pp 48–49.

The table does not list the 'centre-court' or island ring situations, where obviously one only playing space is required, surrounded (at least on two sides) with spectator seating.

When more than one competition space is required, eg wrestling, these have been taken into account in the Table entries. Detailed overall dimensions are given on the sports data sheets Volume 4.

	Truss	Portal	Space Frame	Tensile Fabric	Pneumatic
Span Maximum	18-19 m	30-35 m	40-170 m	unlimited	unlimited
Maximum depth Structure	3 m	-	3 m	unlimited	unlimited
Roofing	Metal	Metal	Metal	Fabric	Fabric
Wall Treatment	Glazing or Solid	Glazing or Solid	Glazing or Solid	Glazing	Integral
Erection	Very Slow	Slow	Slow	Speedy	Very Fast
Maintenance	Good	Good	Good	Intensive	Intensive
Gaurantee of Durability	15	15	10	10	5
Lighting Natural	Poor	Poor	Poor	Excellent	Excellent
Lighting Artificial	Good	Good	Good	Gantry Required	Gantry Required

Every architect will be asked to examine the structure. He has chosen and evaluated in general terms its performance. I have listed five typical structures in a selection matrix which may be of assistance. Obviously not every point is equally weighted and environmental, visual and special conditions will play an overriding matter of choice. In some areas cost may not be as a vital issue as it generally is. The information collected on ccst issues is from a professional quantity survey.

It can therefore be appreciated that the selection of structural type is not easy. Particularly if the architect has a difficult and disconcerning client who is conservative by nature and wants to be convinced on all matters technical and aesthetic.

We believe that membrane and light weight structures have a tremendous future in Australia, particularly in their appreciation in the more remote areas of this country where the high cost of transporting more traditional materials can be offset against the apparent cost loadings presently being experienced, particularly the glass fibre cloths. As research advances the quality of these cloths will improve and the longevity of the materials proven to enable these materials to be used with greater confidence within the building industry and by client bodies such as Sport and Recreational organizations.

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MEMBRANE STRUCTURES INTERNATIONAL EXAMPLES AND DESIGN CRITERIA

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1983 Convention
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Membrane Structures Association of Australasia

INTRODUCTION

As the preceeding speakers have outlined we, in Australia, are at a very early stage of development in planning and constructing sport and recreation facilities when compared to other industrialised societies in Europe (W Germany, France, U.K.), North America and Japan. As I have learnt even some of our immediate pacific neighbours place greater emphasis on forward planning of leisure time facilities.

Australia's particular situation is that of a pioneering country which, within a very short period of time must take the leap into a sophisticated, established. twentieth century society. By their very nature Australians are more orientated towards individual activities in the outdoor than to community activities in-doors. Although indoor activities are often misunderstood and replaced by what has so aptly been presented on recent television commercials on the national campaign 'Life - Be In It', namely Norm sitting in front of his television set with the familiar beer can in his hand and watching the cricket or rugby league match.

As the Australian society becomes more closely knit by necessity, following the developments in the other industralised countries which indicate that leisure time activities will increase considerably over the next decade, the need for adequate research and co-ordinated planning of facilities which allow the communities in which they are erected to spend their leisure time creatively and actively has become urgent.

Not only in the larger cities where people live in close contact and unit-living as against living in individual houses in becoming more and more acceptable to a wider range of people, but also in the remote areas, in the outback, mining settlements etc. properly planned and constructed all year round facilities which allow individuals a choice to exercise, play and relax in a versatile recreational setup are needed.

The somewhat traditional excuse for lack of planning by looking towards overseas expertise and duplication of planning methods and construction techniques is bound to fail, because of its inherent lack of consideration of the particular needs that are formulated by the unique character of the Australian and the unique society combined with the unique character of the land.

In order to plan for our specific needs our own particular requirements must be recognised and problems must be solved based on our own, Australian, resources.

In this context my talk which will predominantly show examples of overseas facilities which could be considered as a stimulus to an Australian based development program.

Membrane structures because of their very nature have an important role to play in the planning and construction of such facilities. I will outline in the following reasons why membrane structures are a form of construction which is particularly suited to meeting our specific needs.

Because of'Australia's particular sociological. and climatic situation as well as the contrast between sparsely and extremely densely populated areas in a vast continent innovative approaches must be sought and developed.

As an ongoing study at the University of Melbourne emphasises, (Mr. Tah Wen Chu, project leader on that study will make his own comments later on), some of the alternatives are as follows:

1. Relocatable service units to be used in outback situations.
2. Adaptable modular units which allow the setup of temporary facilities where a specific need exists.
3. Economical low cost but visually attractive structural solutions and envelopes such as membrane structures in order to provide communities with even small populations with adequate facilities.
4. Foldable or removeable roofs or walls over facilities according to climatic conditions leading to a dual purpose use indoor/outdoor.
5. Environmental filters for outdoor activities in harsh climates through large scale shade nets utilising membrane structures.

The particular advantageous characteristics of membrane structures when related to sport and recreational facilities are:

Relatively low initial cost,
Speed of erection,
Large spans are possible and economical which in conventional construction would lead to a rapid increase in cost,
Variable and adaptable spaces,
Removable, reaplicable and expandable,
Adaptable to temporary function,

Maximum utilisation of daylight illumination through inherent translucency,
Possibility of colour and shading influencing the quality of the interior as well as exerting psychological influence due to colour experiences (e.g. orange colour relaxes),
Indoor/outdoor transition can be soft and not hard in contrast as in conventional construction:
Landscaping can be carried from outdoor into indoors, indoor landscaping and gardening is possible because natural light facilitates plant growth.

As against these advantages of membrane structures there are disadvantages which are:
Limited life span,
Fire risk,
Poor thermal and acoustic performance,
Ongoing maintenance,
Susceptibility to vandalism,

The first three of these disadvantages can be overcome or at least eased with present day developments in membrane materials and thermal and acoustic design which is specifically tailored to lightweight construction techniques.

In this context I would like to point out that LSRU has been studying environmental control in lightweight structures with a view of providing future guidelines for the environmental design of membrane and other lightweight structures.

I would now like to show a series of examples of membrane structures used for sport and recreational facilities here and, in particular, overseas.

EXAMPLES

The examples shown fall into three different categories:.
Firstly, seasonal covers which provide an originally open air facility like tennis courts or swimming pools with cover and enclosure during the colder months. These applications are essentially temporary by nature, however, as experience shows, facilities which were originally planned as temporary may become permanent after the users discovered the benefits of a sheltered environment which makes its full time utilisation possible regardless of weather/or time of day.

The second group are facilities which have been designed as permanent in the first place. They are open integral leisure facilities providing for a range of activities for the entire family, for supervised play for children and for sport, sauna, food and drink outlets, relaxation and general entertainment for the adults.

A third type of facility caters exclusively for spectator sport and is not accessible to the community at large, outside staged events.

The majority of recent sports facilities constructed in Australia fall into the latter category.

SEASONAL FACILITIES

The majority of applications are seasonal covers for swimming pools, tennis courts and ice-rinks and those which may be used as swimming pools in summer and ice-rinks in winter.

Air Supported Membrane Structures

Standard air-halls with or without minor modifications have been used in order to cover swimming pools, tennis courts, ice-rinks etc. at low cost. Pools of all sizes can be covered. Australian examples include the North Sydney Olympic Pool as well as at a school swimming pool in Bundoora, Melbourne. LSRU designed a proposal for the seasonal enclosure of Andrew Charltan Olympic pool, Woolloomooloo Bay, Domain, Sydney utilising a low profile, cable stabilised air supported roof which could be removed in summer and stored.

Prestressed Membrane Structures

Prestressed membranes, due to their special anchorage requirements are rarely used for seasonal enclosures. If seasonal enclosure is sought it is usually provided in form of convertible prestressed membrane structures which allow the membrane to be retracted in summer and in good weather so that the facility underneath is open air providing cover within minutes, when needed, in bad weather or during the winter months. Several convertible membrane structures have been constructed predominantly in Europe (W. Germany, France) thereby providing one single pool instead of the customary indoor and outdoor pool found in these countries. Examples have been constructed at Boulevard Carnot, Paris at Lyon and at two other locations in France as well as in Duesseldorf and in Regensburg,

W. Germany. In this case a membrane is suspended from a radiating net of cables which are supported from one inclined mast which is guyed to the ground. So called cable tractors which are electronically controlled move along the radiating cables with the membrane attached to points underneath; typical opening and closing times are 8 - 10 mins.

Convertible prestressed membrane structures which cover ice-rinks during the winter months and swimming pools during the summer are the ice-rink in Villars, Switzerland which has a convertible roof which can be moved to one side, the membrane sliding in a concentina fashion along a series of parallel cables, and the ice-rink at Conflans St. Honorine, France which consists of a series of radiatinq arches from which a membrane is suspended along a number of points which then slide along the arches when the roof is opened or closed.

PERMANENT FACILITIES

A number of Australian examples, where membrane structures have been proposed for part of full enclosure of facilities, are either under construction or consideration.. Examples are the gallery roof for Homebush Bay Stadium, NSW a swimming pool complex in Adelaide and the shade roofs for Yulara Tourist Resort.

Prestressed Membrane Structures

The indoor and outdoor swimming pool complex Schoellbronn near Karlsruhe, W. Qrmany uses an aggregrate of similar, point supported membrane shapes for covering an array of differently sized areas for a variety of usages. The structure surrounds one side of a large circular outdoor swimming pool complex, it covers the two indoor swimming pools, changing rooms, toilets, kiosk and a dance floor. The result is a membrane structure which has been readily adapted to a rather unusual and difficult floor plan.

Norlane Recreational Centre in the Shire of Corio, Victoria upgraded its facilities in 1980 by constructing a proprietary imported arch-supported prestressed membrdne structure over it's existing 50m pool enclosing an area of approximately 2,300m^2 and providing additional facilities such as sauna bath, spa-solarium, gymnasium as well as an outdoor diving pool and fitness loop. A liner membrane was suspended from the arch framework for heat control. The membrane structure was chosen for it's cost economy. When priced against a compatible conventional solution the costs for the membrane structure were substantially less. During the summer months the side walls can be opened providing an uninterupted transition between indoor and outdoor.

A small community required a multi-purpose indoor facility for meetings, carnivals, shows, spectator sports, activities, music groups etc. The multi-purpose hall at Rheinstetten, Moersch close to Karlsruhe, W. Germany obtained its architectural landmark at economical costs in form of a prestressed tent structure covering 1200m^2 and supported by internal high and low point supports. It caters for 1,200. visitors and its unusual and aesthetically pleasing nature has made it into an attractive focal point for the surrounding community.

In 1972 the first Teflon coated fibreglass membrane structure was constructed in La Verne, a small community close to Los Angeles, California. The complex consists of two buildings one consisting of four intersecting conical membranes supported from central masts and clamped to circular edge boundaries on top of conventional concrete walls. The second one, a smaller conical shaped membrane with a single mast support and similar boundary, houses the drama laboratory and a 215 seat theatre. The larger campus centre covers an area of approx. 5,000m^2 and includes a two storeyed rectangular core which serves as a field house, the upper level accomodating basket-ball court, the lower level accomodating offices, dressing rooms, snack bar etc. Radiating cables from the mast top which are secured to the concrete boundary provide additional support and reinforcement to the membrane. The membrane is fully insulated and a sprinkler system is attached to the underside.. This facility has been in use for more than ten years and has operated satisfactorily.

Air Supported Structures

In the cooler climates of Europe and North America air supported structures have provided an appropriate, very economical solution for major sport and recreational facilities. Their validity for the Australian climate requires further investigation. Assessment must be made depending on the location of the proposed facility.

The following examples show almost exclusively integral leisure centres which provide a variety of facilities for family activities, usually centred around a swimming pool complex. These leisure centres have proved to be very successful and attract a large number of visitors annually.

The leisure centre Alpamare in Bad Toelz, near Munich, W. Germany provides approximately 1,250m^2 covered area containing an indoor surf pool and medical baths as well as health spa, sauna, solarium and restaurant facilities. Six

radiating cables stabilise a single membrane air structure.

The leisure centre 'Miramar' close to Mannheim, W. Germany encloses 5,000m^2 containing a 50m surf pool with non slip surface which is heated to 28-30^o. This enclosure is covered with a single skin air structure stabilised by parallel cables which are anchored to perimeter concrete beams. A second building covered by a single dome shaped air structure houses a massage and spa pool 250m^2 which is provided with a water lock leading into an outdoor heated spa which can be used all year around.

The complex contains two saunas, rest hall and solarium, outdoor nudist facilities, a spa bath, coffee house restaurant, a public bar and self service restaurant as well as an ice cream parlour. The complex is close to a natural lake which has been provided with a sandy beach.

The leisure centre 'Cuppamare', near Karlsruhe, W. Germany uses a cable stabilised central indoor pool facility covering 1,300m^2. The air supported membrane is anchored to 10 reinforced concrete arched glassed windowframes and is provided with a five layer membrane roof which enables environmental control of the interior at low cost.

The inner membrane layer enables recycling of air from the interior, the three intermediate layers provide an airpocket of non-circulating air, for insulation and temperature balance between inside and out. One layer is utilised for recirculating to the conditioning unit: when heating or cooling is required and energy consumption is not required for other purposes (e.g. heating of water, shower water etc.) air movement is located between the inner most layers. When the sun shines and heat energy is required air movement occurs between the outer most layers collecting radiant heat from the underside of the outside structural membrane layer, which thus acts as a huge solar collector. The warm air is then used to pre-heat the water in the showers, the pool or is used to heat the fresh air drawn into the interior during cool days.

The facility includes saunas, medical baths, rest rooms, solariums, cosmetic facilities, a restaurant and bar, and a game room.' It is open all the year around from 9am - 10pm daily.

The outdoor facilities includes an 1,100m^2 surf pool which is heated and fitted with flood lights for night swimming, a diving pool and children's pool, grass

rest areas 30,000m^2, playfields for ball games, tennis courts, table tennis, barbeque and fitness loops.

The leisure centre 'Ruelzheim', W. Germany uses two buildings which are covered and enclosed by double membrane air cushioned structures. The 50m indoor pool is covered by a single cushion roof suspending from masts with convertible double membrane side walls. The side walls can be deflated and rolled up, giving free access to the indoor pool. The structure covers a floor area of over 2,000m^2.

The adjacent leisure facility provides refreshments, playrooms, and houses a disco and meeting place for youth organisations, sporting activities as well as music and dances. It is covered by a double skinned air cushion which can be raised off it's support thus allowing the interior space to be opened around the walls. The entire complex contains a camping area with caravan park as well as an artificial lake with sandy beach facilities close to large wooded area, which provides for walks and fitness paths.

The student activity centre and pool of the University of Sta Clara, close to San Francisco, California is an economical example of a large cable stabilised single membrane air structure. The complex houses a large indoor gymnasium and two auxiliary recreation spaces, in the main structure covering 7,400m^2, which is enclosed with a Teflon coated fibreglass fabric membrane. The second, adjacent building houses a swimming pool and is covered by a single membrane, PVC/Polyester membrane cable stabilised air structure. Earth berms with concrete ring beam provide economical anchorage for membranes and cables, a steel frame work inside the main structure carries artificial lighting and provides safety support in case of deflation.

The physical education complex for Dalhousie University in Halifax, Nova Scotia, Canada utiliser an innovative structure. The 100 x 80m clear span air supported structure uses a stainless steel sheet membrane which is anchored to a concrete ring beam. Because of height restrictions applied to this project on planning grounds and excavation into the rock to provide sufficient height was necessary, a conventional truss roof proved to be excessively costly; a low profile metal membrane air supported structure was chosen. The membrane is fully insulated on the underside and was made in sections similar to cake slices, brought to the site like rolls of carpet and welded to expansion jointsections, radiating from the centre section to the perimeter. The roof is designed so that if the air pressure

LSAA / MSAA 1983 Proceedings

drops, the roof, because of its shallow curvature, can deflect safely to a concave shape.

Conclusion

This paper has provided an outline of the status quo of recreation facility planning and a number of Australian and international examples demonstrating the overseas response to the need of a leisure orientated society.

I would like to close with a quotation from the above mentioned study at Melbourne University which assumes that:

"Change expectations and demands in the community will exert a pressure towards the provision of improved and more varied indoor facilities for sport and community recreation,

Government is committed to promote the provision of sport and recreation opportunity for all,

Sport and physical recreation as leisure activities have intrinsic value for personal development and,

The development of varied facilities for sport and recreation is a dynamic and continuous process demanding the support of appropriate information systems and technical expertise."

As has been shown membrane structures provide an appropriate and economical construction method and are eminently suited for sport and recreation facilities.

Their rapid growth aver 'the past years overseas (USA 1383 prediction 10% above 1392) will assure a key position in the construction field.

A comprehensive planning policy for the creation and further development of sport and recreation facilities in Australia needs to be developed forming a basis for organised provision of the Australian community with adequate leisure time facilities.

An important prerogative is the conduct of research into sport and recreation facilities and their various aspects. In order for this research to be effective it needs to be conducted independently from ongoing construction programs by independent organisations, scch as Universities, which are well equipped in terms of knowledge and facilities for such research programs to be undertaken.

Membrane structures and their various aspects need to be integrated in funded research and development programs if their full potential and economy is to be utilised in practical applications. Australia is in a fortunate position in possessing a developing industry which is capable of designing and constructing membrane structures to the highest standards. The present dependance on overseas fabrication with long life durable fabrics as Teflon coated fibreglass may soon be reversed when silicone coated fibreglass fabrics make their inroads into the market. For the market to develop for the benefit of the Australian community it is essential that local industry and expertise is being supported.

This pledge should be noted in particular in Government induced developments utilising public funding provided by Australian taxpayers.

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RESEARCH FOR SPORT AND RECREATION FACILITY PLANNING IN AUSTRALIA - A DILEMMA?

Paper presented at:

1983 Convention
'Membrane Structures in Sport & Recreation'
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Membrane Structures Association of Australasia

'We all agree with the answers,
but what is the question?"

Anyone ever caught in a situation implied by this question knows the uncomfortable feeling. I have a suspicion for those of us who profess an interest in the development of sport and recreational facilities in Australia, this situation arises more frequently than we care to admit.

The causes of mismatch in intentions and outcome in any situation are often varied and complex. What I would like to bring to focus in this short paper is the role of research, and in particular the development, co-ordination and dissemination of relevant information in the field of planning and design of sports and recreational facilities in Australia.

For the time being I would just like to ask you to cast aside any suspicion you may have on the notion of research. Let us just agree that certain amount of research activity is unavoidable in every developmental endeavour. The planning and design of sport and recreational facilities in the 80's as a develomental endeavour is certainly no exception. It is important to realise that in Australia these developmental endeavours, remarkable as they are in recent years, have not been supported by a concern for the most rudimentary form of research effort - the development of a relevant information resource in Planning and Design for Australian conditions.

In case you are tempted to jump up in defence of the many useful things individuals and government departments, have initiated and completed in Australia I would like to point out that compared with the Federal Republic of Germany, the Netherland and the United Kingdom, we have really not yet scratched the surface.

As an indication of the degree of isolation we choose to shelter ourselves in this part of the world, I can recall the deep sense of amazement in 1982 when I attended the U.K. Sports Council sponsored FIRST international Conference "Sport and People" in London that only myself, together with a lady Principal of a Tasmanian Sports Clinic were the two originally registered delegates from Australia. There may be many reasons for this unusual lack of interest at the time but this lack of interest is certainly not shared by other countries in this part of the world.

Indian sent her director of National Institute of Sports. Malaysia her director General of National Sports Council and Korea her director general of the ministry of sports. Delegates came from Sweden to Swaziland, from Uganda to Bermuda. I need say no more.

Research in the Built facilities of any type has never been an area of strength in the professional activities of Architects. Have you ever heard of an institute of church design? yet look how many churches we built? The reasons are quite understandable. At the. risk of being abused by my fellow architects I would like to put forward some of the obvious ones.

(1) Architects, by nature of their traditional training are operationally oriented
- this often makes him tending to rely on the research of the multitude of disciplines which affects their work rather than undertake basic research and development.

(2) There is insufficient, if any, return in investing time and effort in research unrelated to the task at hand
- if my perception is correct he is just too busy at the moment making a living to even think of research.

(3) The pace of change is such that the rate of developing absolescence makes research unrewarding.

(4) The need of safeguarding in-house information against competitors in the practice of planning and design.

If this is the situation, and given that architects and designers are still the essential link in the delivery system of built faciltiies for sport and recreation can we in Australia afford to ignore the need to develop a relevant independent information resource to support the planning and design activities of the professionals?

If your answer is 'yes' your argument may run something like this:

We are too small a country in terms of population with a limited market to undertake original research in this area. We have always relied on overseas materials and have comfortably managed to cope with all the problems based on overseas precedents. There is no reason why we should not continue to do so.

It is not difficult to refute this sort of argument.

My refutations can be grouped under the following headings.

(1) The changed hetrogeneous composition of the Australian population tends to render the adoption of ready made overseas (usually British) solutions less likely to fit our real needs.

(2) The uniqueness of the Australian social, physical and climatic environments demand to be creatively accommodated and not ignored.

(3) The pace of change in user expectations, social values and technological innovation must be faced with imaginative strategies.

(4) There is a huge market in our part of the world eager to learn from Australian experience if we care to develop systematically.

In saying this I am not claiming that just by developing a good information resource all the wonderful things will automatically follow. Far from it, but I do believe that for all the wonderful things that can happen basic effort in doing some research is indispensable. The development of membrane structures in Australia is a case in point. Without the L.S.R.U. at the University of New South Wales the development of membrane structures in Australia would not achieve the degree of co-ordination we have today.

For designers and planners of recreational facilities the work of the H.S.A.A. is vitally important. But there are equally pressing needs for other relevant information to support not only designers of facilities but policy makers as well.

Let me just cite three obvious examples:

1. "What is the place of wave making technology in the designs of leisure pools in Australia?"
2. "What is the potential use of retractable membrane roof structure in Australia?"
3. "What is the feasible use of large scale shade fabric covers in tropical recreational locations in Australia?"

Until architects and designers are given a specific project by someone I doubt anyone in Australia will know any more than what we might read about or visit as spectators. By the time we get around to doing that I suggest we are followers rather than innovators. In a situation where change is the only constant we cannot afford the luxury of wait and see.

Lastly I would like to mention the connection between policy making and relevant planning and design information. I have had some modest experience in trying to develop a relevant information framework related to the planning and design of facilities in Victoria. I can stress that the lack of communication between researchers and policy makers, is the most critical problem to be overcome. With lack of communication, or even perceived lack of communication, a deep attitude of suspicion is prevalent. This is dangerous and counter-productive.

With insufficient funding and no established structure for funding research it is difficult to speak of improving communication as the main cause of this problem. Alas, I am venturing too far afield.

What I really want to say to those who may concern is that basic research in the development of a relevant information resource in planning and design is of paramount importance in Australia now. Architecture departments in Universities are the most logical focus for this work because of their assumed independence and continuity.

A modest start has been made at Melbourne University Department of Architecture and Building and further work will be developed. The example of the L.S.R.U. and M.S.A.A. are encouraging to us and we hope we can follow in their footsteps.

In conclusion may I say that in the planning and design of recreational facilities we must strive to achieve 3 basic aims:

1. Questions of facts must be supported with the best possible and up to date information.
2. Questions of preference must be given the best channels of communication between users, providers, policy makers and researchers.
3. Questions of policy must be considered with due regard to the maximun efficiency our political environment permits.

I submit to you that without these aims the planning and design of recreational facilities will always be in a situation of action by reaction.