

STRUCTURAL EXPRESSION IN ARCHITECTURE

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Abstract

A personal view of how structure can be employed to create exciting and memorable buildings. Commencing with the English 'Hi Tech' architects, the influence of Philip Cox and work at Creative Spaces the address will illustrate with the aid of slides how structural concepts, their expression and how they are detailed can generate a vibrant interesting architecture.

Introduction

Expressing the structure in buildings, making it evident how they stand up, has been a legitimate, although perhaps not always intentional, form of architectural expression since time immemorial. There can be no doubt about how the roof of the **Parthenon** on the acropolis was held up. This was probably not the designer's main motivation when considering the buildings aesthetics, nor indeed the primary motivation of many others over the centuries. Nevertheless the structure is there for us to appreciate in this and in many other examples.

The English Experience

My own understanding of this was slow in dawning, but following my formal training and during my O.E. I was attracted to the exciting architecture of the English architects of the 70's where structural expression was a key ingredient of the so-called "Hi Tech" aesthetic. The most memorable buildings of this period included:

The **Centre Pompidou** where everything is expressed, nothing hidden, all in its right place and very ordered through the use of strong colour

The **Willis Faber Dumas** building in Ipswich is a far less exuberant example of the style. Nevertheless the relatively conventional concrete structure of round columns and waffle slab is plainly evident. But what holds the glass up? It is all breathtakingly suspended from the roof (glass in tension) and held together with stainless steel bolts and silicone.

The **Sainsbury Centre** at the University of East Anglia is a very sophisticated "shed" used to house a significant art collection. The simple trussed structure is clearly expressed on the end elevations separated from the sophisticated lightweight cladding system, which wraps right over the building, waterproofed with the longest neoprene gaskets in the world. Norman Foster, the architect, had previously done a very simple "shed" in Thamesmead – so a healthy budget is not a prerequisite.

A New Land – A New Architecture

In the early 1980's I worked in Australia in the office of Philip Cox. Here an awareness of structure was developed and fostered by Philip Cox himself along with the opportunity to work with engineers from the Sydney office of Ove Arup. This awareness was prompted through some of Cox's early projects at Bruce in the ACT.

An example is **The Bruce Stadium**. This is a thoroughly Australian building, which acknowledges the landscape and harsh sunlight. It clearly expresses its parts: concrete stand and lightweight steel roof lightly suspended from masts tied back to the ground.

The Darling Harbour Exhibition Halls designed in 1985 is a clearly articulated cable stayed roof which continues a tradition of structurally innovative exhibition centres.

The National Tennis Centre designed in 1985 had for the time a very innovative retractable roof – the forerunner of many retractable roofs currently being built. The steel 'hoop' trusses are the most memorable features of this building.

The Sydney Football Stadium, also designed in 1985 was the first opportunity to experience first hand the excitement derived from working on a large span lightweight structure. This was very much a team effort involving architect, engineer and contractor, underpinned by a desire to create an exciting and memorable building. It was a privilege to work with two very talented people: Ed Obiala from Civil and Civic who had a very clear understanding of how he wanted to erect the roof and Tristram Carfrae from Ove Arup who very quickly seized the opportunity to create a unique cantilevered structure that is instantly recognisable. The distinctive steel pyramidal frames were a direct response to how it was proposed to erect the roof, and were first sketched by Ed. In the end the roof was not erected quite the way Ed had envisaged but the structural form remained.

The New Zealand Context

By 1991 I had returned to New Zealand and had established, with my partners, Creative Spaces. There was still a recession in the construction industry at this time but we were fortunate to win competitions for two distinctly different buildings:

The Tourism Rotorua Centre

The Unitec Centre for Sport and Recreation

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The Unitec Centre was designed to a very strict budget – its cost measured in dollars/m² never again being equalled. It is in reality a very simple building comprising:

- ❑ concrete slab substructure
- ❑ structural steel superstructure
- ❑ lightweight insulated panel cladding
- ❑ relatively conventional skillion roof construction

The structure is expressed on the outside of the building in a series of major and minor frames creating a rhythm which gives an appropriate scale to an otherwise large "box".

In other words the exposed structure makes the building "Legible" when viewed from a distance.



MSAA/LSAA Conf Proceedings

Figure 5. The Unitec Centre for Sport and Recreation

The New Zealand context
In 1991 I was invited to New Zealand and had a meeting with my partner Creative Spaces. There was still a
tension in the construction industry at the time but we were fortunate to win competitions for two industry
projects in Auckland.
The Unitec Centre
The Unitec Centre for Sport and Recreation

The North Harbour Stadium presented an opportunity to re-establish contact with Tristram Cafræ. Here the problem was to provide effective cover to the optimum number of seats. The roof geometry had been determined following consideration of environmental factors: wind, sun and rain; and a requirement to reduce the apparent bulk of a large building in a green fields site of gently rolling hills and bush covered escarpments. Tristram prepared three structural options for consideration:

- Cantilever Structure
- Cable Stayed Structure
- Inclined Arch Structure

The options satisfied the covered seat requirement to a greater or lesser but the selected option was the best in this regard. The structural solution comprises a 900mm diameter spiral wound pipe arch spanning 180m from one end of the ground to the other, leaning over and propped off the stand structure. The roof in turn is suspended beneath this arch and held down against uplift. The "trident" configuration of struts creates a rhythm to the structure. The result is a building, which is instantly recognisable, images of which have been used in advertising by North Shore City, Nike and Sky Sport.

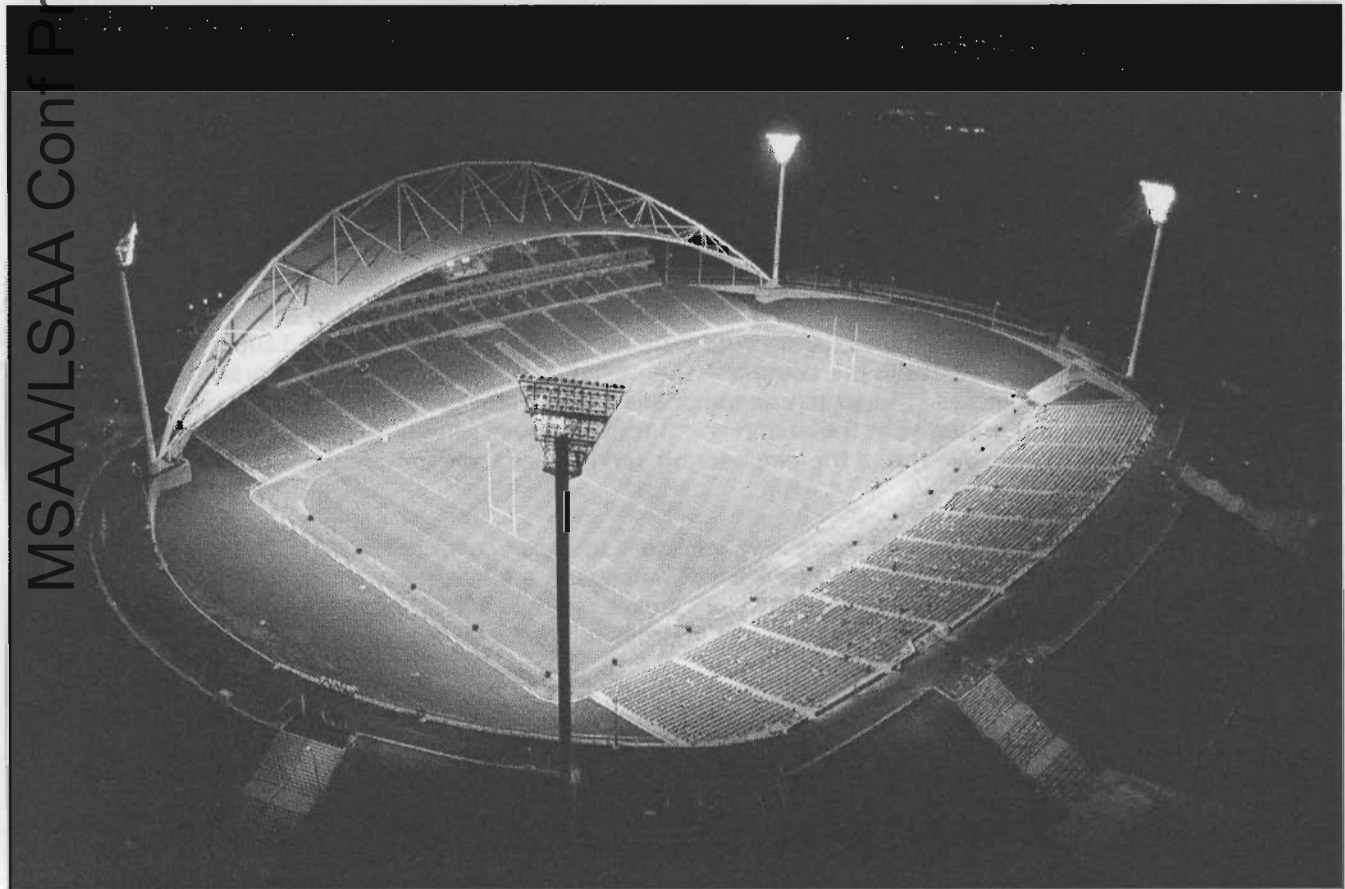


Figure 1. The North Harbour Stadium

The Tinley Street Gatehouse for the Ports of Auckland Fergusson Terminal responds to the obvious nautical imagery of ships derricks. The original concept was for a fabric roof but in the end this was felt to be impractical by POA. The structural expression here is very clear: the roof is held up by the big steel tubes and tied down against uplift by thin rods.

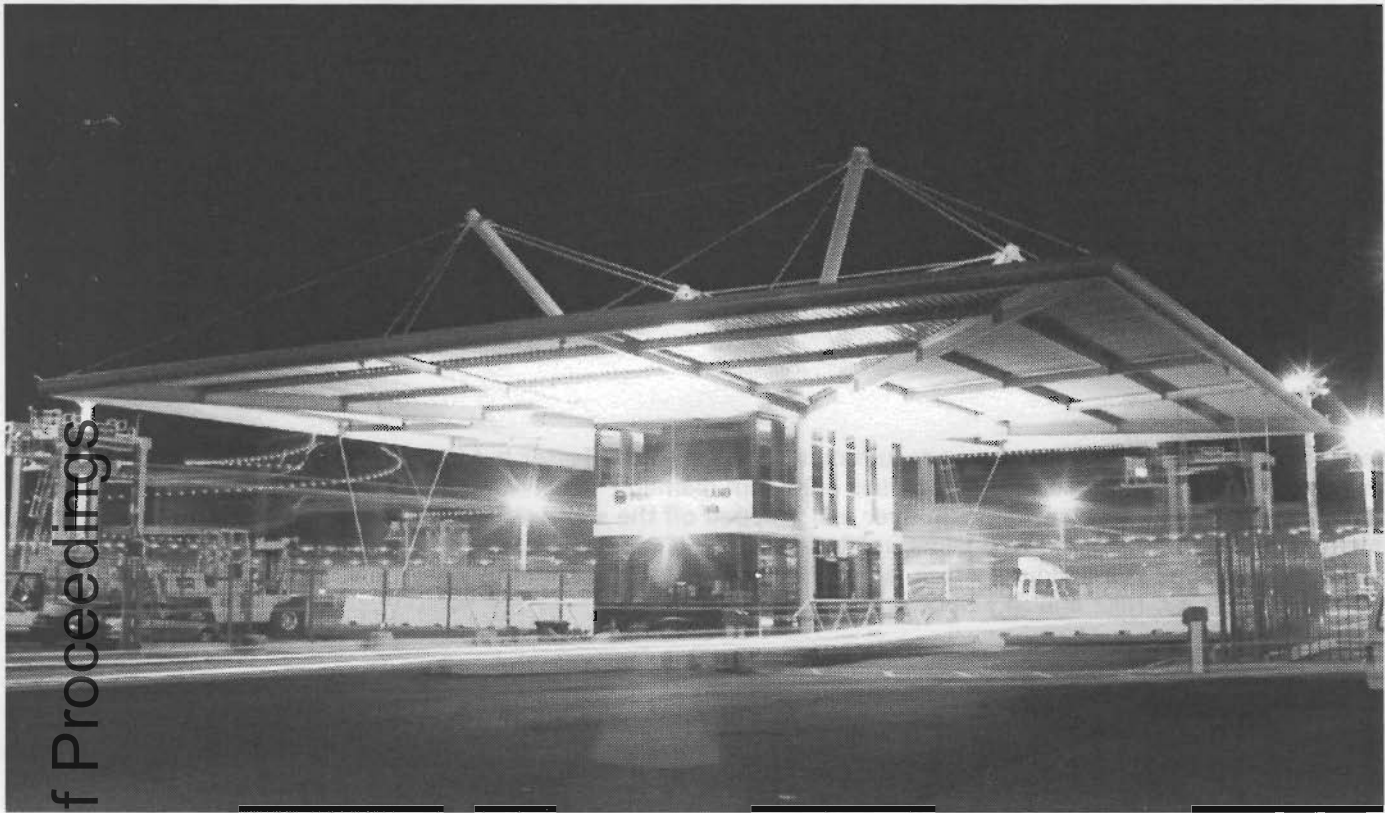


Figure 3. The Ports of Auckland Gatehouse

The Taupo Centre for Sport and Recreation (now known as the Taupo Events Centre) is a multi-purpose community recreation centre attached to an existing outdoor pool complex. The brief from Taupo District Council was "to create the best recreation centre in the country!" The design was developed in collaboration with Ove Arup structural and services engineers. The structure comprises a cable-stayed roof supported from masts along the perimeter. It is carefully integrated with the architectural form (derived largely from the volumetric requirements of the sports to be played) and the engineering services systems (where passive design principles played a big role).

At the outset the intention was to create an expressive structure to break down the scale of a large building on a highly visible site. The primary support is thus the "A frame" masts on a 12m grid. Cables pick up cantilevered laminated timber rafters, which in turn support lightweight trusses in the central raised monitor zone. As at Unitec a series of major and minor frames is established in order to create an appropriate scale for a large building.

It is worth considering here a number of detail design issues, which contribute to the coherence of the imagery:

- The structure is highlighted through its juxtaposition with other building elements e.g. cladding or glazing
- detailing of fabricated elements is carefully considered
- suspension and bracing rods create a fine tracery which adds texture to the image
- bolt connections are carefully considered
- pin connections are expressed
- the way the structural steel elements touch the ground is carefully considered
- the finish of the steel becomes an architectural finish as much as a protective coating



Figure 4. The Taupo Centre for Sport and Recreation

In this instance the steel structure becomes the "architecture" and as such requires as much consideration as any other architectural element. The references an architect uses in preparing a design can be many and varied. He or she will draw on his/her own experiences, that of others and wide range of other reference material. In this, (Pacific) our latest project, we are seeking to create a complex of iconic buildings expressive of Manukau City's multi-cultural population, but with a more lyrical, less "overtly" structural expression. This project also represents a renewal of the relationship with Philip Cox who has provided significant input to the concept design.

In seeking a "Pacific" imagery a number of sources were identified:

- Polynesian arts and crafts
- Polynesian buildings
- Polynesian sailing craft

Methods of building were also researched: for example the braced structures of outrigger canoes and the prefabricated "lightweight" roof structures of meeting houses. It was thus hoped to establish a new typology, which would lead to the iconic buildings sought for the complex.

The most significant buildings of the complex are:

- The Outdoor Arena characterised by its "claw sail" roof forms suspended from the "V" shaped masts
- The Indoor Arena characterised by its outrigger canoe plan and roof forms reminiscent of the frangipani motif of Tapa cloths
- Detailing will emphasise joints and junctions and make the structure explicit in a manner, which expresses some of the traditional crafts of building.

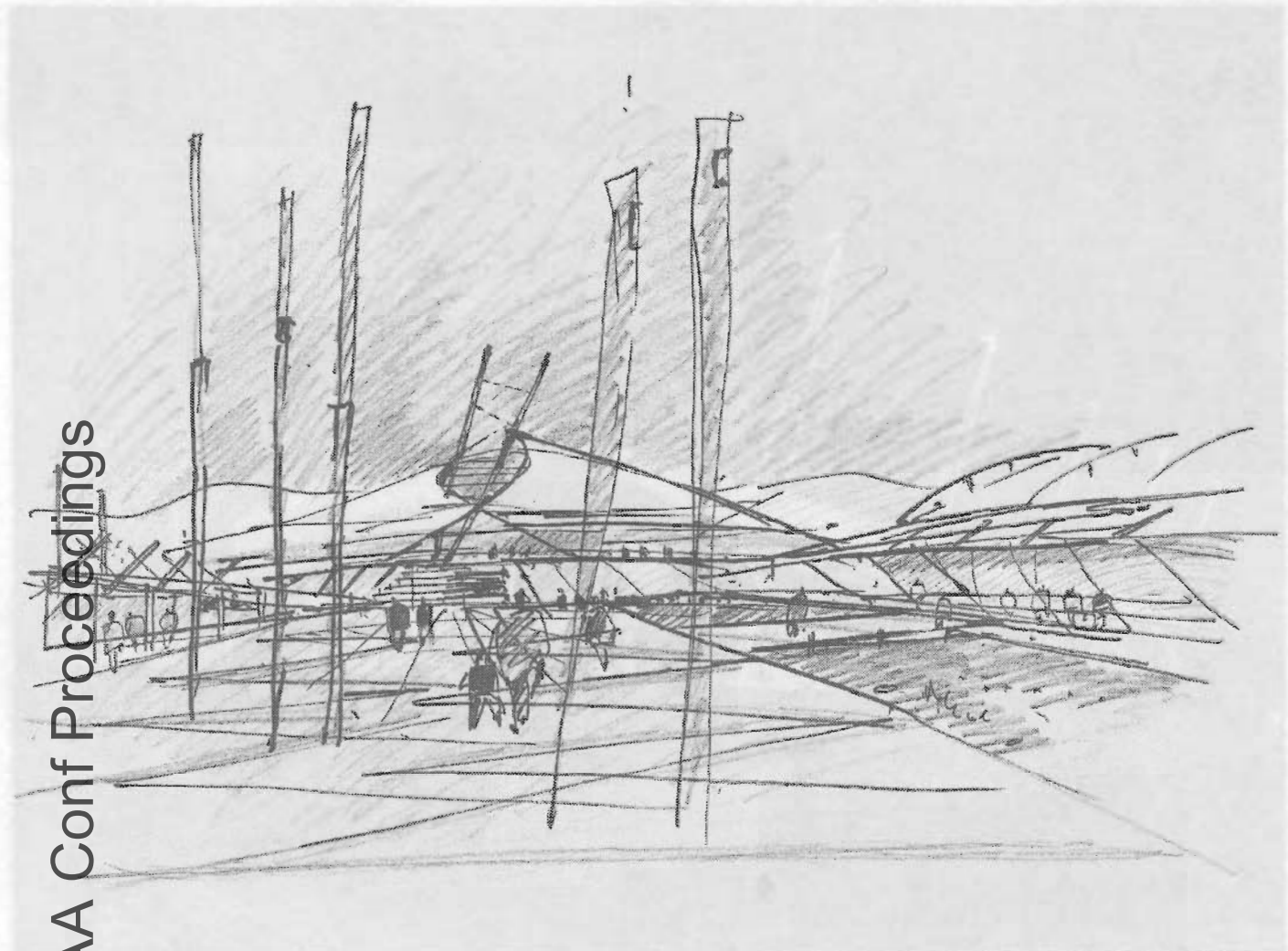


Figure 2. Pacific Plaza

Conclusion

The ideas and images presented here represent a personal approach to the creation of architecture and although it is not the only approach it is one shared by many architects around the world. What is important is that this approach makes apparent the enjoyment architects and builders alike gain from putting buildings together – and it inevitably assists in creating buildings that are enjoyable to be in and for that reason memorable