KEYNOTE ADDRESS

Chris Bosse
Director Visionary Architects
Formerley with PTW

Born in 1971 in Stuttgart, Chris Bosse was educated in Germany and Switzerland and worked in several European architecture firms. His postgraduate degree at the University of Stuttgart dealt with the implication of virtual worlds into architecture. With www.smoarchitektur.com (Mad Oreyzi) he developed the Bubble–Highrise for Berlin in 2002 (a+u 05:01). Since 2003 he has been working with PTW Architects in Sydney on many high–profile projects in China, Vietnam and Middle East. PTW has recently started a number of projects in various parts of Japan. The project for the National Swimming Center for Beijing 2008, called the Watercube, received the Atmosphere Award at the 9th Venice Biennale and is under construction since 2004. The MOËT Marquee in Melbourne explored his interest in unusual structures in a freeform interior based on the physics of champagne bubbles and minimal surfaces. The work is widely published and Chris guest–lectures at various universities.

He has recently left PTW and started his own office with branches in Sydney and Dubai.

Learning from Nature

The ”trend” of learning from nature has always been there. It currently experiences a renaissance through new computer–technologies. We have to differentiate between mimicking nature and learning from nature. Learning from the intelligence of nature, means lighter buildings, less waste of materials, more energy–efficiency and more natural environments. These happen to be naturally more beautiful, too.

People like Antonio Gaudi and later Frei Otto have initiated an intelligent approach in learning from nature for their architecture. We continue this today with digital means.

The Watercube

The so–called WATERCUBE associates water as a structural and thematical ”leitmotiv” with the square, the primal shape of the house in Chinese tradition and mythology.

The entire structure of the Watercube is based on a unique lightweight–construction, developed by PTW with ARUP, and derived from the structure of water in the state of aggregation of FOAM.

Behind the totally randomized appearance hides a strict geometry as can be found in natural systems like crystals, cells and molecular structures – (the most efficient subdivision of 3dimensional space with equally sized cells.)

By applying this novel material and technology the transparency and the appearing randomness is transposed into the inner and outer skins of ETFE cushions.

Unlike traditional stadium structures with gigantic columns and beams, cables and backspans, to which a facade system is applied, in the Watercube design, the architectural space, structure and facade are one and the same element.

Conceptually the square box and the interior spaces are carved out of an undefined cluster of foam bubbles, symbolizing a condition of nature that is transformed into a condition of culture.

The appearance of the aquatic centre is therefore a ”cube of water molecules” – the WATERCUBE.

In combination with the main Olympic stadium, a duality between fire and water, male and female, Yin and Yang is being created with all its associated tensions/attractions.

Water and visual appearance

One of the most interesting design elements of the Watercube project is its visual appearance. This is a building all about water. Water becomes a profound ’building material’ that de–materializes the building in a meaningful way. That is the molecular structure of water in its foam state is magnified into the structure of the building.

The structure of water softens and dissolves all the boundaries, and gives the sophisticated ’micro’ details to the monolithic totality. The sophistication and fun–ness of the components and the simplicity and monumentally of the whole gives the building an interesting duality.

In an inland city like Beijing, water becomes so precious and being with water such a luxury in people’s life. To us the Swimming Centre transcends its functionality as just an Olympic venue, it is also a paradise in Beijing’s heart that bring to people the endless happiness, joy and all kinds of fantasies of being with water.

The juxtaposition of the seemingly soft, curved, cushiony bubbles with the sharp rectangular form of its floor plan provides another point of interest.

ESD–principles

The National Swimming Centre Beijing is a very sustainable building:

1. The design allows lots of natural daylight to stream into the buildings interior, which allows it to passively heat the spaces as well as the pool water.

2. The high–tech ETFE cladding system acts in the same manner as a very efficient insulated greenhouse would, absorbing solar radiation and avoiding heat loss. The double skin façade of bubbles is so well insulated that it has the potential to achieve an annual net heat gain. The principle is to capture the solar radiation in the area of the building where it is most needed around the pool and keep it there. Thermal mass of the concrete and the water will absorb and re–radiate this heat at night when it is most required.

To achieve the right balance, the façade of the building has three modes of operation to respond to the climate summer, winter and mid season. The clear and translucent facades will allow high levels of natural daylight, which removes the requirement to artificially light the pool during the day. A core feature in the design of ETFE skin is the variable shading control system.

By modifying the pressures in the cavity, the internal foils can be either 'open' or 'closed'. This allows the light levels to be controlled to create a dappled effect, similar to the light under a tree or deep under water. The light can be controlled to only fall on areas that do not suffer from glaring reflections, alternatively the entire roof and wall can be turned 'off' to achieve optimal lighting conditions for television cameras.

At night the building will glow to highlight the activities within.

3. Swimming centres generally consume large amounts of water for various purposes, therefore the water cycle has also been carefully considered. Used water from the basins and showers will be recycled to reduce wastage. The grey water will then be re–used for flushing of the wc's, any architectural water features and irrigation systems. The rain will also be collected from the roof and stored in underground tanks before being filtered and treated for re–use.

Context

PTW Architects aimed to design a building that was compatible in its language to the new Olympic stadium being built in the near proximity, as well as a building sensitive to its proposed urban environment, that of the junction of the axes of the Forbidden City and the Fourth Ring Road in north Beijing.

We believe the National Swimming Centre should support the National Stadium. It should show wisdom and beauty without exhibiting a big gesture that competes or overpowers the National Stadium.

As a counterpoint to the exciting, energy–giving, masculine, totemic image of the National Stadium, the Water Cube appears as serene, emotion–engaging, ethereal and poetic, with changing moods that directly respond to people, events and changing seasons.

The sense of serenity and the potential for changing moods are considered the key features, ensuring our NSC provides that important supporting role.

ETFE

The finishing material used in the design of the building is a Teflon cladding system called the ETFE. This system was introduced to China through this project. The ETFE is lightweight and transparent. It is also a more cost effective solution that some of the more traditional materials. Because of the inherent surface properties of the ETFE, the exterior appearance of the building can be altered using different lighting and computer image projections.

The Landscape around the building

A cube is dropped into water; water splashes out on the earth as scattering drops with ripples spreading away. This is the theory behind the design of the landscape of National Swimming Centre. The 'water drops' become water pounds with vegetations, sculptures, fountains or other water features. Just as the ancient square Chinese city, such as the Forbidden City, that guarded by a river, the NSC building is separated from the land around by a lineal moat at the perimeter. Bridges are the only way to lead into the building. A consistent water wall runs above the moat to lift up the space frame system from the ground. At the entrance area the water wall becomes full height with a glass curtain wall on the back to allow the 'water filtered' day light into the lobby. People experience a walk through a water–screened space at entry every time they go into the building.

Structural concept

The structure of the National Swimming Centre is based on the most efficient subdivision of three–dimensional space. This pattern is extremely common in nature being the fundamental arrangement of organic cells, the crystalline structure found in minerals, and the natural formation for soap bubbles.

In the late 19th Century, Lord Kelvin posed a problem:

"If we try and subdivide three dimensional space into multiple compartments, each of equal volume, what shape would they be when the subdividing surfaces are of minimum area?"

This is an interesting problem, not only as a theoretical exercise, but also because such shapes are prevalent in nature.

The study of soap bubbles is probably a good place to start when considering Lord Kelvin's challenge. Plateau had already observed, in 1873, that when soap films come together, they always meet as three surfaces coming together at 120 degrees to form at edge. And these edges always meet, four to a corner, at the tetrahedral angle of approximately109.47 degrees.

In 1887, Lord Kelvin proposed a solution to his own problem based on a 14 sided figure made of 8 regular hexagons and 6 squares. This figure can be constructed by cutting off the corners of a regular octahedron.

However the corner angle of a square is 90 degrees and a hexagon, 120 degrees. Both of which are some distance away from Plateau's observed ideal of 109.47 degrees. A regular pentagon has a corner angle of 108 degrees, but dodecahedra (the twelve sided figure made from regular pentagons) cannot be joined together to tile space – they leave gaps between them.

It was supposed for some time that figures comprising some combination of pentagons and hexagons would be more efficient than Kelvin's Foam. But it was not until 1993 that two Irish Professors, Weaire and Phelan constructed foam of two different cells, one of 14 sides (two hexagons and 12 pentagons) and one of 12 sides (all pentagons) that used less surface area than Kelvin's foam.

The Weaire–Phelan foam remains today, the optimal subdivision of three–dimensional space and we have used it as the basis of the structure for the Beijing National Swimming Centre.

Despite its apparent complexity and organic form it is in fact based on a high degree of repetition. It uses only three different faces, four different edges and three different corners or nodes. So the Beijing NSC can readily be constructed using a highly repetitive, organic space frame based on one a solution of one of the world's greatest mathematical challenges which is also common throughout nature – a social, technical and green solution.

PTW Architects + CSCEC+design + ARUP

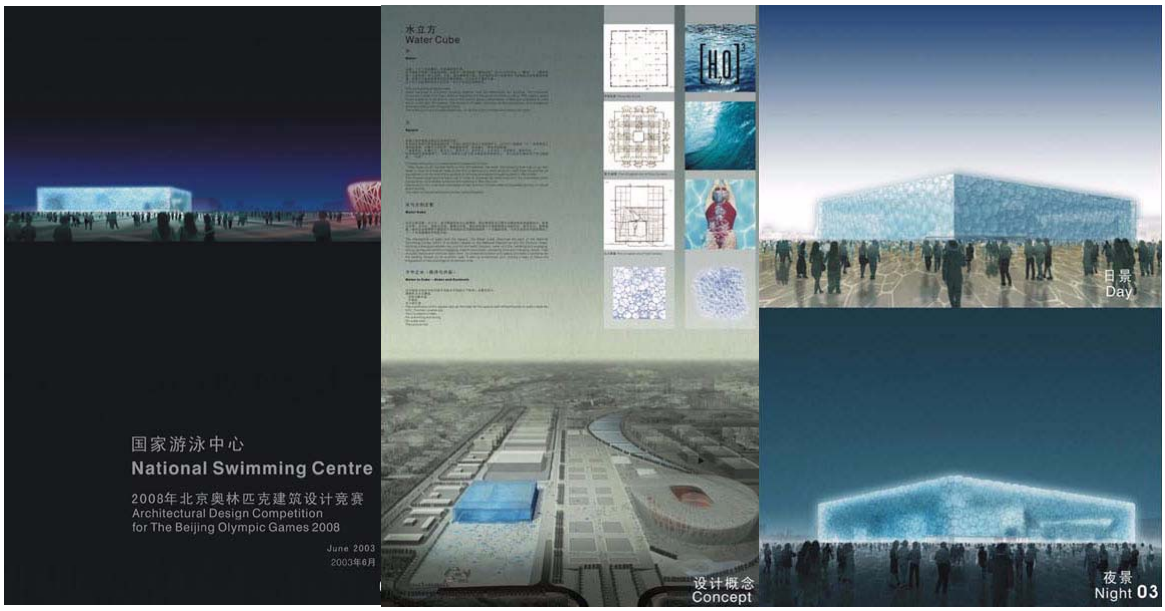
National Swimming Center Beijing, China 2003–2007

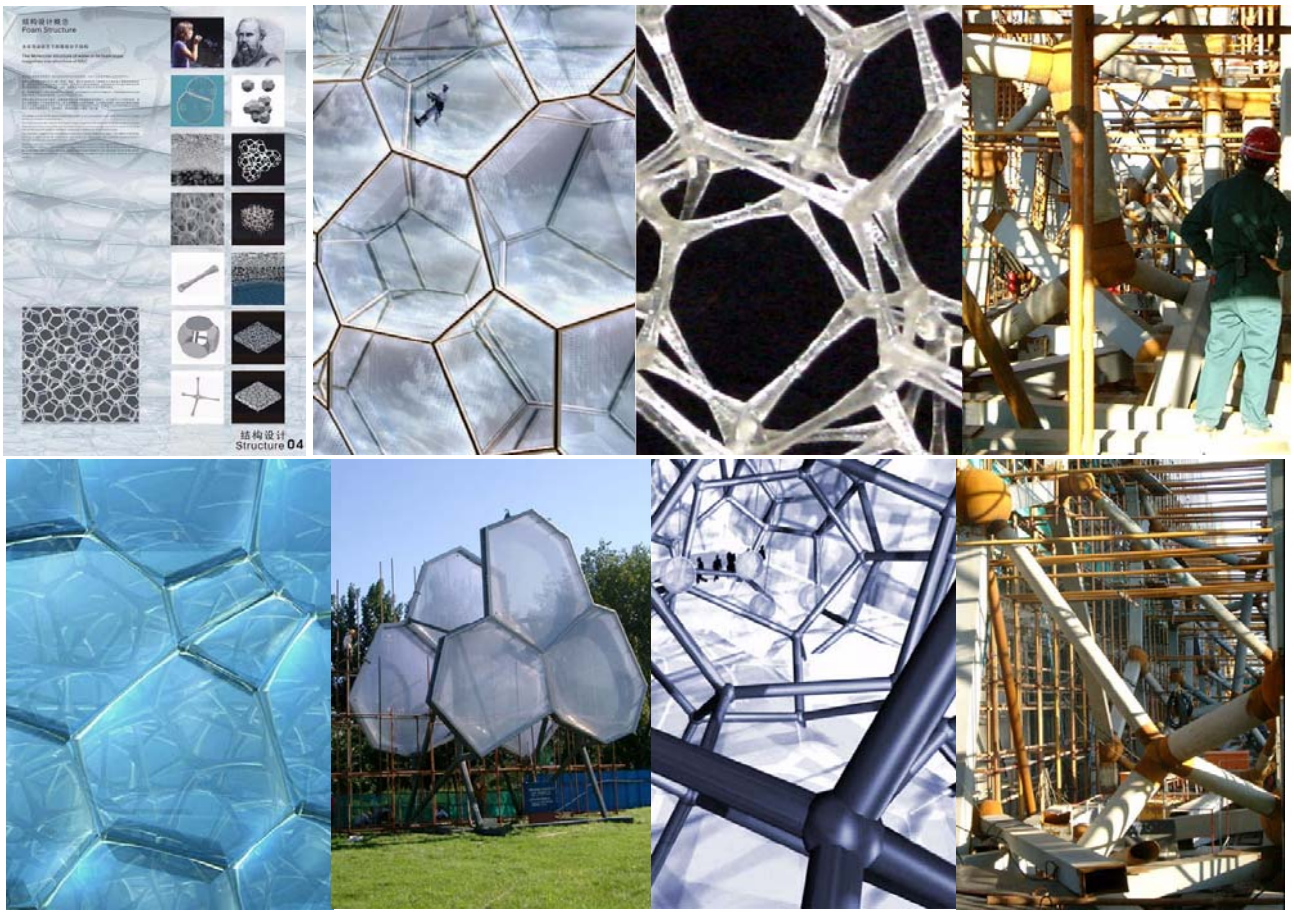
Credits and Data

Project title: Watercube, National Swimming Center, Beijing
Client: People's Government of Beijing Municipality, Beijing State–owned Assets Management Co., Ltd
Competition management: Three Gorges International Tendering Co., Ltd.
Design consortium: PTW Architects, CSCEC+design, ARUP

PTW design team: Director: John Bilmon; Mark Butler, Chris Bosse,

CSCEC+design team leaders: Zhao Xiaojun, Wang Min, Shang Hong
ARUP: Tristram Carfrae (engineering team leader), Peter Macdonald (structure), Kenneth Ma (building services), Haico Schepers (building physics), Ken Conway (environmental), Mark Lewis (communications), Steve Pennell and Stuart Bull (3–DCAD)




Foam Structure
结构设计
Structure 04

The Moet Marquee:

PTW architects Chris Bosse

Espace Lumiere, Space made out of Light.

Introduction

PTW architects designed the MOET Chandon Marquee for the Melbourne Cup 2005, the biggest annual horse racing event in Australia, together with Amanda Henderson from Gloss Creative.

The Architects used latest digital technologies from concept–sketch to realization, to create a sparkling and surreal atmosphere in the name of the ”**Bubble–ism**”.

Through the use of daylight and a tensioned Taiyo–Lycra material that is digitally patterned and custom–tailored for the space, a 10x10 ”off the shelf” marquee was transformed into a space that the press describes as an ”avant–garde environment not of this earth”

Structure and Space

The project renounces on the application of a structure in the traditional sense. Instead, the space is filled with a 3–dimensional lightweight–sculpture, solely based on minimal surface tension, freely stretching between wall and ceiling and floor.

Building Materials

Specially treated Lycra and daylight

Innovation and Digital Workflow:

The product shows a new way of digital workflow, enabling the generation of space out of a lightweight material in an extremely short time. The computer–model, based on the simulation of complexity in naturally evolving systems, feeds directly into a production–line of sail–making–software and digital manufacturing.

Transport and Sustainability

The pavilion (weight: 35 kg) is transportable in a sports–bag to any place in the world; can be assembled in less than one hour, and is fully reusable. While appearing solid, the structure is soft and flexible and creates highly unusual spaces which come to life with projection and lighting. Projects of any scale and purpose can be realized in a short amount of time.

Minimal Surfaces

(–any surface that has a mean curvature of zero. – for a given boundary a minimal surface cannot be changed without increasing the area of the surface–).

The lightweight–fabric–construction of the pavilion follows the lines and surface–tension of soap films, stretching between ground and sky.

These natural curves of bubbles are translated into an organic 3–dimensional space. Since the early seventies, with Frei Otto‘s soap–bubble experiments for the Munich Olympic Stadium, naturally evolving systems haven’t lost their fascination in the field of new building typologies and structures.

Derived from Nature / Design by Optimization

The shape of the pavilion is not explicitly ”designed”, it is rather the result of the most efficient subdivision of three–dimensional space, found in nature, such as organic cells, mineral crystals and the natural formation of soap bubbles . This concept was achieved with a flexible material that follows the forces of gravity, tension and growth, similar to a spider web or a coral reef.

Light

By partially letting sunlight penetrate ”through” the fabric structure, the pavilion comes to life as a ephemeral and surreal bubble experience. The perforated ceiling filters natural light and directs it onto and through the Lycra fabric, creating the depth and translucency of the space, the ephemeral quality. The light changes constantly during the day with moving clouds and changing atmospheric conditions.

Credits:

Project title: MOËT Marquee / Espace lumiere,

Client: Moët & Chandon Australia
Location: Spring racing Carnival, VRC, Melbourne, Australia
Completion: November 2005

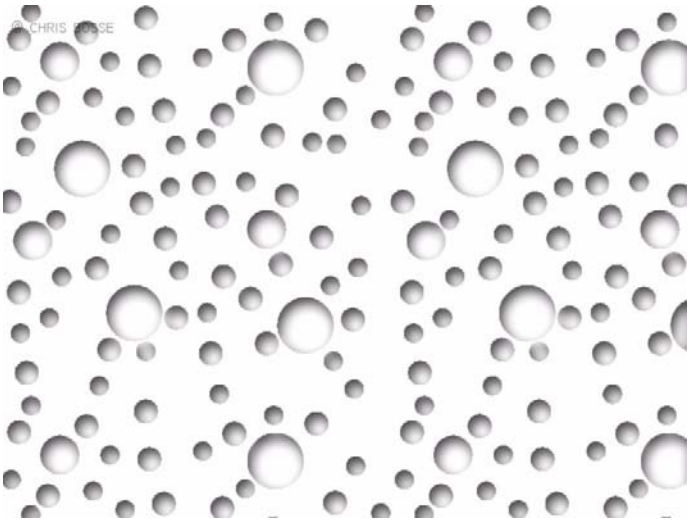
Project team: PTW Architects, Sydney, Australia
Managing director: John Bilmon
Associate director: Mark Butler
Project architect: Chris Bosse

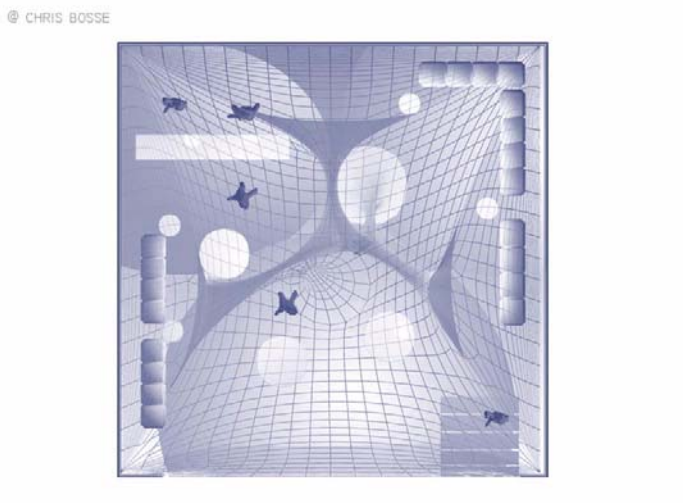
Styling + project management: Amanda Henderson / creative director Gloss Creative, Melbourne, Australia

Soft furnishings: Cameron Comer / Comer & King, Melbourne, Australia
Image and concept graphics: Round, Melbourne, Australia

Membrane, engineering and patterning: Taiyo Membrane Corporation, a division of the Taiyo Kogyo Group

Photography: Dianna Snape and others.

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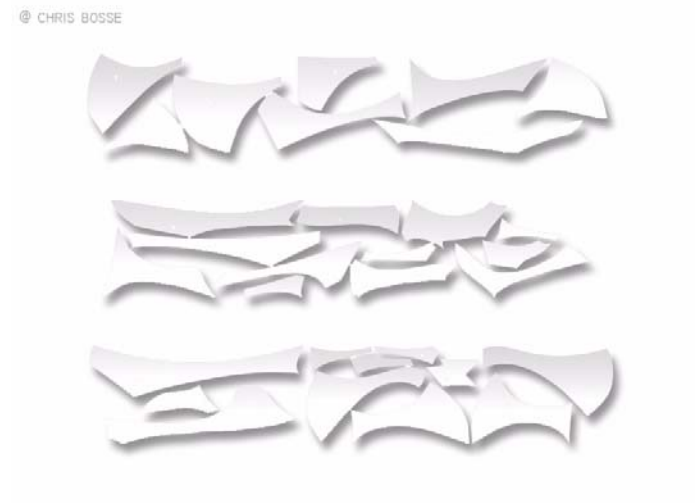
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