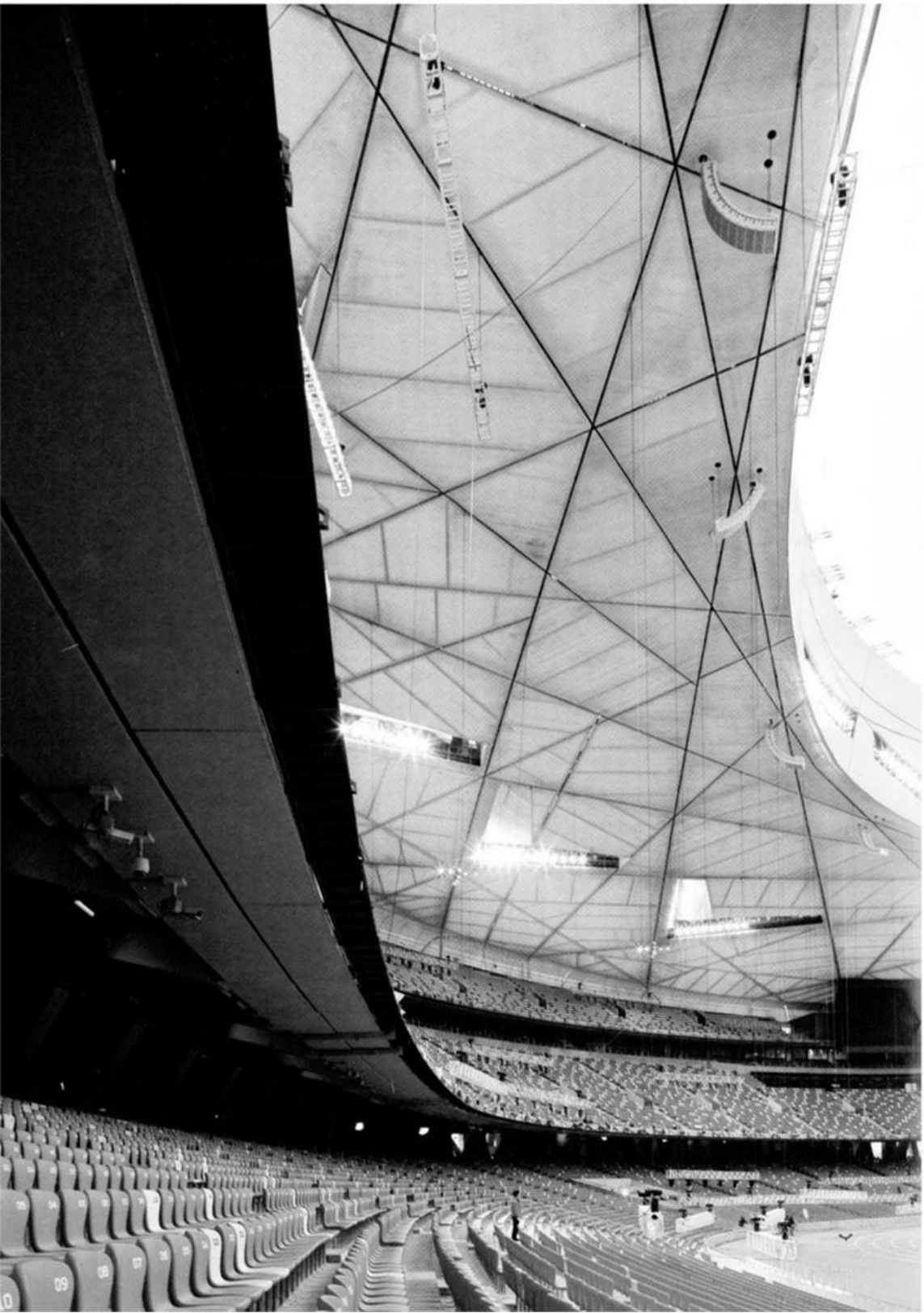
University of
Portsmouth

HISTORY AND THEORY RESEARCH PROJECT

BEIJING NATIONAL STADIUM



UNIT 320

HISTORY AND THEORY RESEARCH PROJECT BA3

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Table of Contents

	Page
List of Figures	1
1.0 Introduction	3
2.0 Research Method	5
3.0 Research Development	6
The background of the Olympic architecture	
International design competition of the national stadium	
The architectural design	
4.0 Conclusion	14
5.0 Bibliography	16
6.0 Research Folder	17+

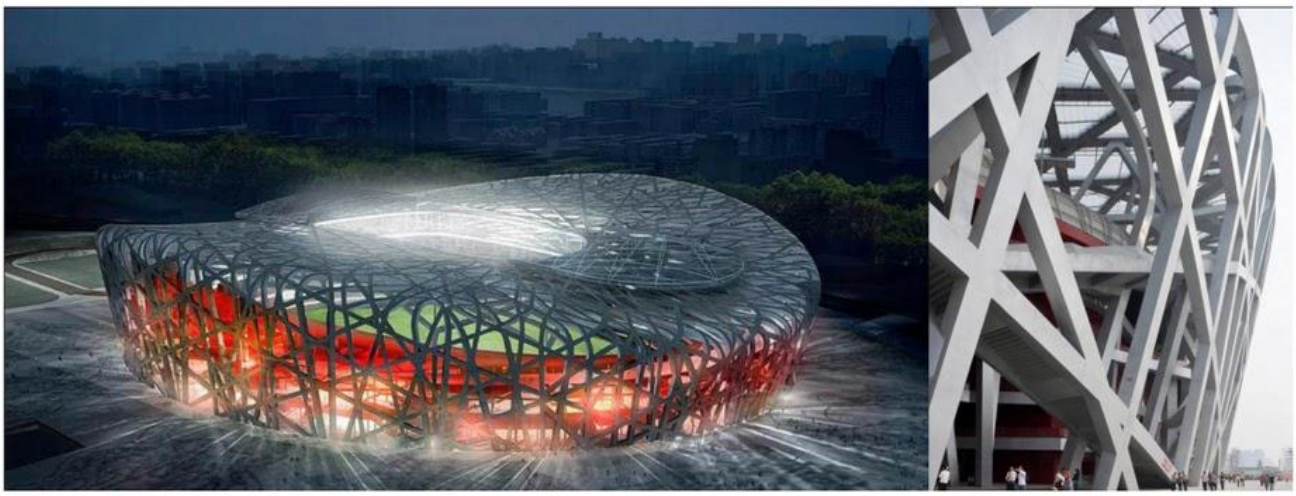
List of Figures

Figure1	Rendering of exterior view of Beijing National Stadium: Bird's Nest / The façade of the stadium
Figure2	The portrait of Herzog & de Meuron
Figure3	Tate Modern, London Herzog & de Meurons' project
Figure4	A bird's eye view of the national stadium / A night shot
Figure5	The primary and secondary structure of the roof
Figure6	Proposal: the "bird's nest"
Figure7	Main project actors of the Bird's Nest project
Figure8	The position of Olympic Stadium / The position of Olympic Stadium2
Figure9	Site plan
Figure10	Beijing crackle glazed pottery: the original inspiration for the Stadium roof.
Figure11	"Bird's Nest"
Figure12	"I was there" moments- the interior view of the stadium
Figure13	The bowl's concept
Figure14	Section1
Figure15	Section2
Figure16	Single-layer ETFE membranes
Figure17	Lower corridor
Figure18	Night view of the stadium
Figure19	The timetable of the stadium

We didn't design it to be Chinese. It's an object for the world.
-Ai weiwei: Artist consultant

We wanted to do something hierarchal, to make not a big gesture you'd expect in a political system like that but something for 100,000 people on a human side without being oppressive. It's about disorder and order. It seems random, chaotic, but there's a very clear structural rationale.
- Herzog: Architect

Viewed from a distance, the contrast between its bent steel columns and its bulging elliptical form give the stadium a surreal, moody appearance, as if it was straining to contain the forces that are pushing and pulling it this way and that… A secondary pattern of irregular crisscrossing beam is woven through this frame, creating the illusion of a gigantic web of rubber bands straining to hold the building in place…
The crisscrossing columns create a...world of dark corners and odd leftover spaces—an effect that intensifies as you ascend through the structure. Light filters through the translucent roof panels...The feverish play of light and shadows is reminiscent of a German Expressionist film.
- Nicolai Ouroussoff: New York Times architecture critic



Beijing National Stadium (Photo: Iwan Baan)

1.0 Introduction

Beijing National Stadium is located at north 4th ring of Beijing city, the south part of Beijing Olympic Green. Due to the structure of this stadium which is similar to a huge steel-made bird's nest when overlook from afar, it is commonly known as *Bird's Nest* by the local people. It is a stunning landmark building designed by the Pritzer-Prize-winning Swiss architects Jacques Herzog and Piere de Meuron.

For this report I have decided to concentrate my studies on the design of this building, the 2008 Olympic Games' most striking structure, recognised all over the world. This design beat out 13 other finalists in the international design competition for the National Stadium, and won the inaugural Design of the Year for Architecture Award in 2009,[1] just one year after Beijing Olympic Game. At the same time, it is a great architecture which was criticized for such a long time by cultural identity, budget, structure, etc. As it has been often mentioned by mass media"…The building has received both praise and criticism for its unconventional and potentially risky design—over 70% of the building's weight hangs over the audience's head…" (*China-travel*, 2008)

This article traces back to Beijing's bid and preparations for the Olympics and analyses the architectural and the structure design of this flagship architectural project, it is divided into three sections: The first section studies on the background of the Olympic architectural projects, the nature of the Beijing Olympics as a national event instead of a city event explains the rationale behind central and city government officials' decisions to choose the best global architecture for the stadium.

The second section discusses the International design competition of the national stadium, with an unusually exposed structure that mimics a bird's nest, the design delivered the most shocking visual impact among all the proposals, capturing the votes of both the international architects and Chinese politicians.

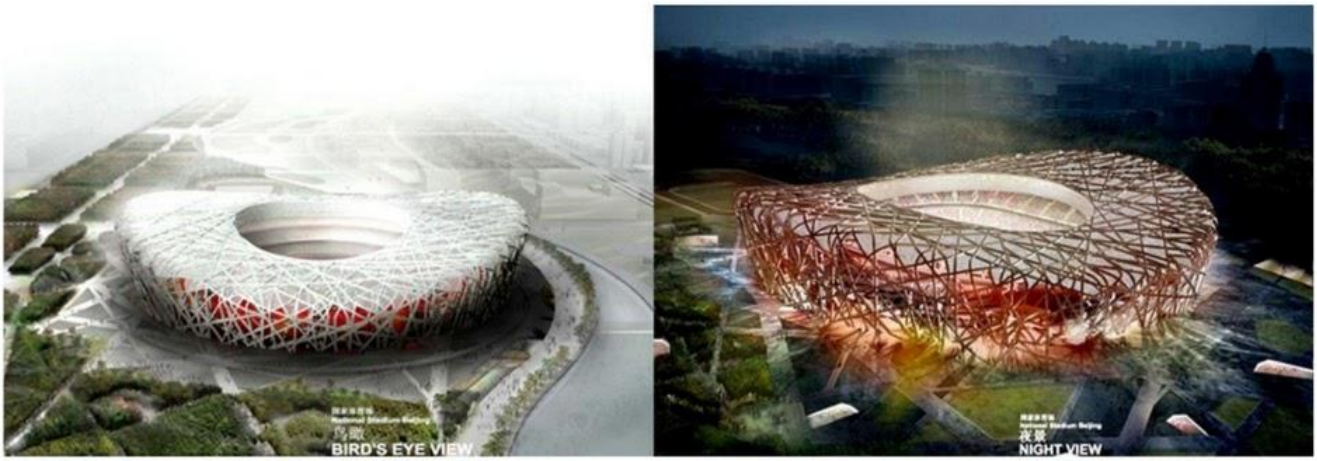
The third section analyzes the four aspects of this remarkable piece of architecture, from site plan to the bowl design, from the façade/roof structure to the green features. Especially in construction part, the designers didn't do any redundant disposals to the look of the stadium, they just exposed the steel structures entirely and let them become the most natural appearance. ("National Stadium (Bird's Nest)", 2010) From my point of view, that is the most extraordinary feature of Bird's Nest: the perfect combination between the architectural and structural design.

1,Lubetkin Prize: The Lubetkin Prize is named in honour of the Georgia-born architect, who worked in Paris before coming to London in the 1930s to establish the influential Tecton Group. The RIBA Lubetkin Prize 2009 winner is The National Stadium Beijing by Herzog & de Meuron with China Architectural Design & Research Group and Arup Sport for National Stadium Company.

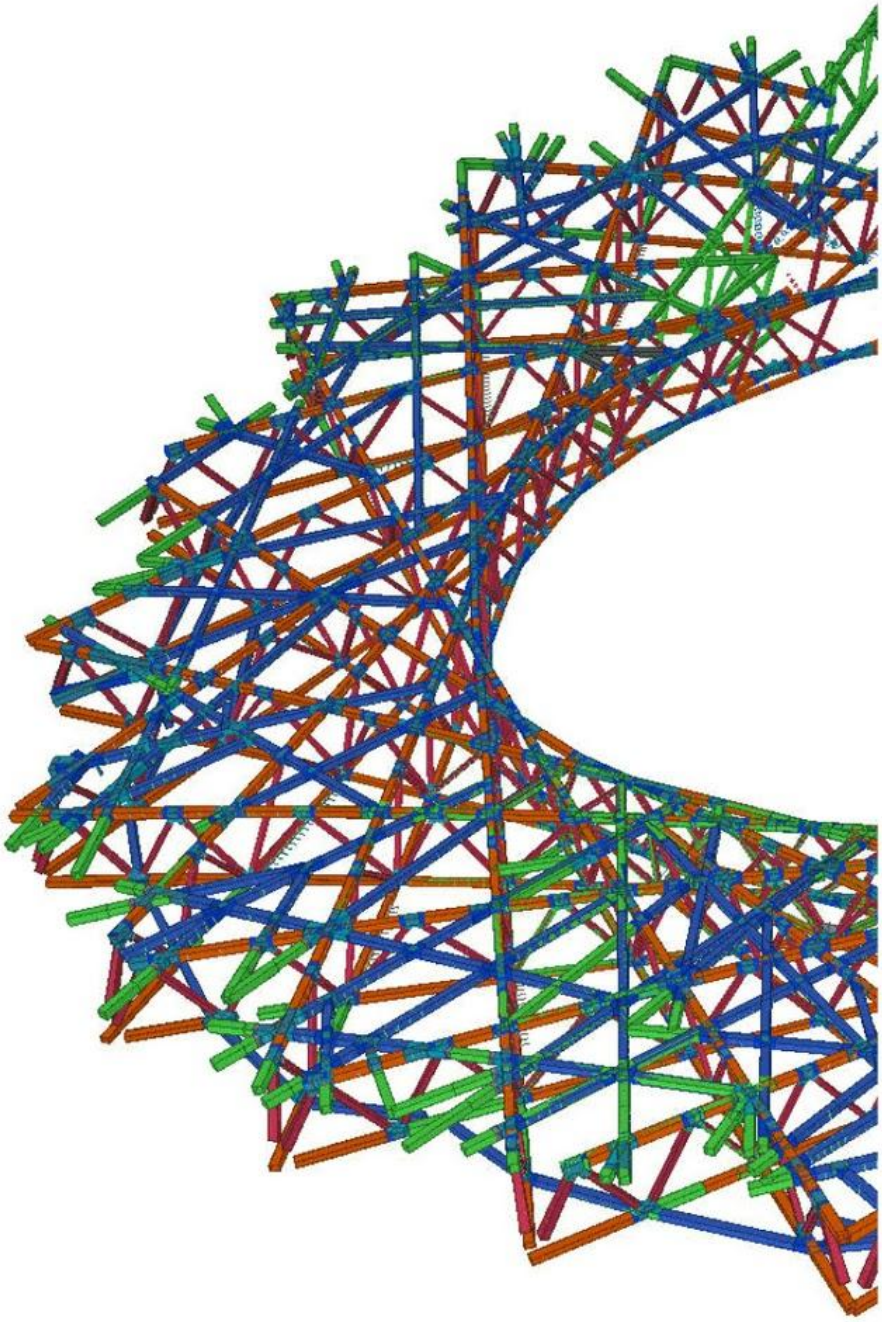
Herzog & de Meuron Architekten, BSA/SIA/ETH (HdM) founded and headquartered in Basel, Switzerland in 1978. In 2001, Herzog & de Meuron were awarded the Pritzker Prize, the highest of honors in architecture. In 2009, they were awarded the Lubetkin Prize for the Beijing National Stadium. They became famous when they converted London's dour Bankside Power Station into London's Tate Modern museum.

Tate Modern, London

Tate Modern was created in the year 2000 to display the national collection of international modern art (defined as art since 1900).



A bird's eye view of the national stadium / A night shot



The primary and secondary structure of the roof

2.0 Research Method

It was secondary sources that contributed to my research: books and journal articles that explained the original inspiration of Beijing national stadium as well as the architectural and structural design of this building. My initial intention was simply to study the connection between the Chinese traditional culture and the concept of the stadium, but, later my research triggered a change in direction, after referencing more related materials, I hope to make an overall analysis on the National Stadium covering original inspiration to final design.

This research project has encouraged me to combine architecture and structure, particularly during my design work. The fact that the research will influence my decisions as a student and as a future architect, shows how successful the project has been in opening up a whole new area of knowledge and direction for my work to take.

3.0 Research Development

The background of the Olympic architecture

According to "Bids for the 2008 Summer Olympics", ten cities submitted bids to host the 2008 Summer Olympics and Paralympics that were recognized by the International Olympic Committee (IOC) in 2000, five of which made the IOC Executive Committee's shortlist. Beijing was one of them.

It is well known that Beijing's bid and preparations for the Olympics involved 'higher stakes'. For this bid, Beijing promised the IOC that they would provide world-class stadiums for the Games. Since then, hundreds of local architects and planners drafted designs for 32 Olympic venues. In Beijing's Olympic Candidature File, 235 out of the 596 pages are devoted to explanations of stadium design and construction. (Xuefei R, 2008,pages 175–190)

And in the next year, on July 13, 2001, the IOC president Juan Antonio Samaranch announced that the host city of the 2008 Olympic Games was Beijing. That was a big moment to China, "Hosting an Olympic Games has been a century-old dream for the Chinese nation. For seven years, the hearts of 1.3 billion Chinese people have been pulsating in unison with the Olympic Movement," President Liu said when making a speech at the opening ceremony of the Beijing Olympic Games. (Liu Qi, president of the Beijing Organizing Committee of the 29th Olympic Games).

It is well known that the 2008 Olympics was no longer a sports event or even an urban regeneration effort, it was a national event and a symbolic showcase through which the central government of China would intend to demonstrate to the world the country's economic achievements over the past two decades. As china daily stated, Hosting a successful Olympics carried great weight for Beijing and China as a whole. Through various strategic plans, Beijing would be gradually building up the momentum for Beijing 2008. It is in this context that the international design competition for the National Stadium took place.

International design competition of the national stadium

In 2002, the Beijing Municipal Planning Commission held an international competition for the design of the main stadium for the 29th Olympic Games. As the building would host the opening and closing ceremonies, as well as the track and field events, the original competition program included the following main criteria (Beijing Organizing Committee for the Games of the XXIX Olympiad. 2002)

- A stadium capacity of approximately 100 000 people during the games (to be reduced to approximately 80 000 afterwards),

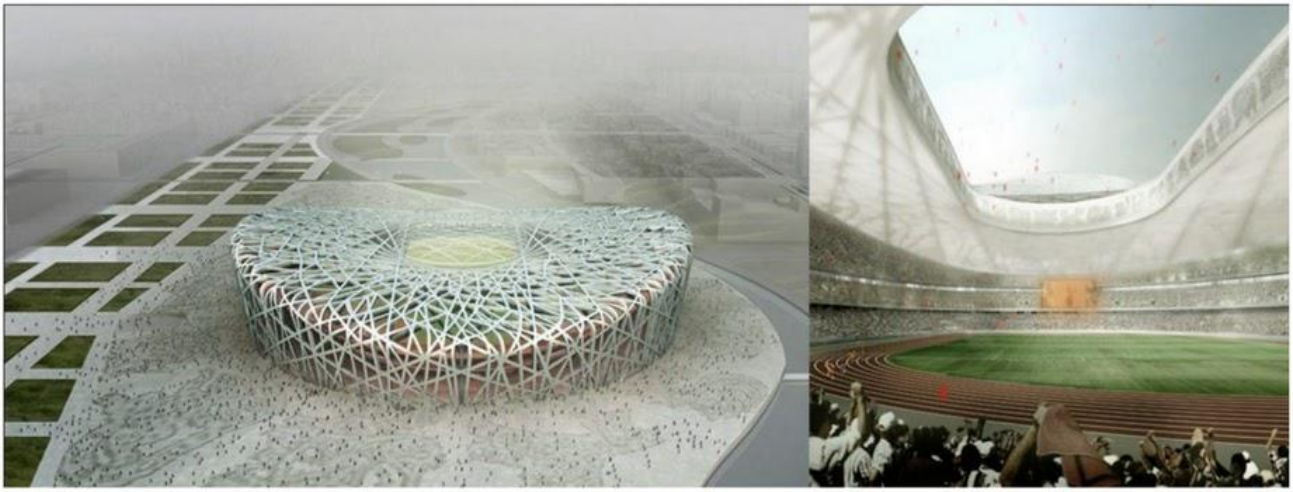
- A retractable roof,

- A multi-functional design, to efficiently incorporate a range of uses in the future,

- An emphasis on green building and advanced technology.

The overwhelming number of international design teams and jury members reflected the globalizing tendency of the political elites in the BOCOG and BMPC. The BMPC specified a set of prequalification requirements, such as prior experience in designing large-scale stadiums, so that only those established international firms and a few large domestic design institutes qualified to compete. As a result, the invited design firms included eight foreign firms, three joint ventures, and only two Chinese design institutes in the end (Xuefei R, 2008,pages 175–190).

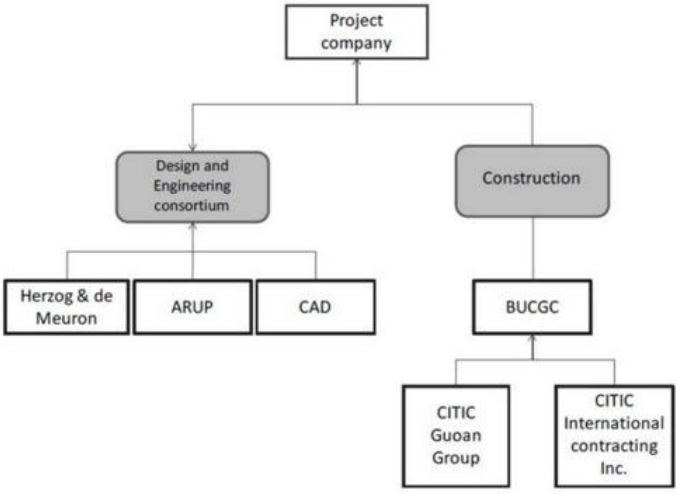
Proposal for Beijing Olympic Stadium competition: this design creates an image of a floating water lily, surrounded by petals and blossoms, emerging in a gently undulating pond.



At the presentation, the "bird's nest" revealed to everyone an unprecedented architectural form, with steel twigs interwoven together like branches of trees. Compared with the other designs, in which the focus was more on the roof, the "bird's nest" attracted everyone due to its irregular yet beautiful form.

All 13 competition schemes were displayed at the Beijing Exhibition Centre in March 2003, attracting thousands of visitors, and alongside the deliberations of the international jury panel, votes by the general public were also taken into account. By the end of March 2003, it was announced that the "Bird's Nest" scheme was selected as the winner, both by the jury panel and by public voting (Tony C, 2009, P5-P8). From my point of view, this design emphasized the pure shape of the stadium, furthermore, these interwoven grid-like structures producing a dramatic effect at the same time. The design delivered the most shocking visual impact among all the proposals, capturing the vote of both the international architects and Chinese politicians, The BMPC praised the design highly, commenting that "the pure, simple and powerful building shape blends all into a harmonious whole" and the entire building gives a strong sense of dynamics and vigor." (Beijing Municipal Planning Commission, 2004)

This winning stadium has a gross volume of three million cubic metres and is considered to be the world's largest enclosed space, stated in Arup journal, it is also the world's largest steel structure with 26km of unwrapped steel used. At the time the architectural competition for the Beijing National Stadium was announced, Herzog & de Meuron and ArupSport (Arup's multidisciplinary practice specialising in sports architecture) were already working together on the Allianz Arena in Munich. This successful creative partnership was based on a shared desire to innovate: Herzog & de Meuron in creating unique buildings with strong local cultural context, and Arup in designing stadiums that would perform ever better for spectators, athletes, and operators, for the Beijing competition the two practices joined forces with one of the leading Chinese Design Institutes, CAD. Major contractor and subcontractors were members of the CITIC consortium: Beijing Urban Construction Group Corporation, CITIC Group, and CITIC International Contracting Inc. Figure behind shows the main actors in Bird Nest project.



Main project actors of the Bird's Nest project

(Cheryl S.F. Chi, Inkeri Ruuska, Raymond Levitt, Tuomas Ahola, Karlos Artto,2011)

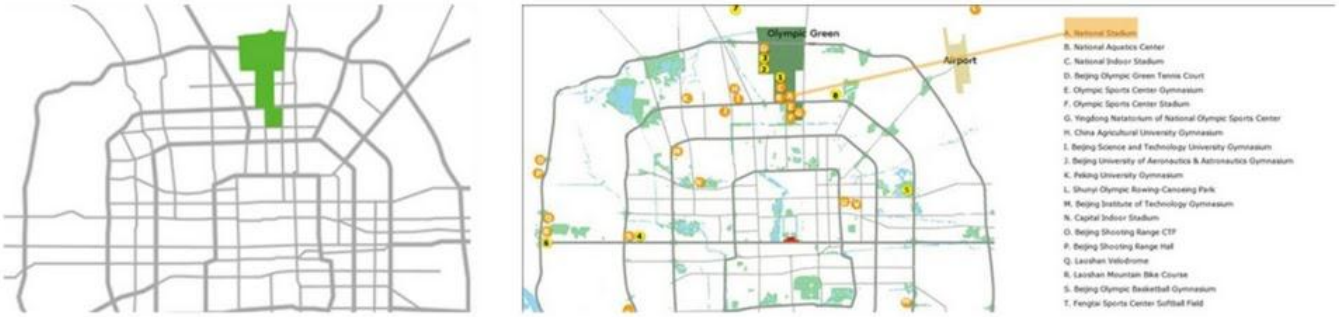
The architectural design

Site principle

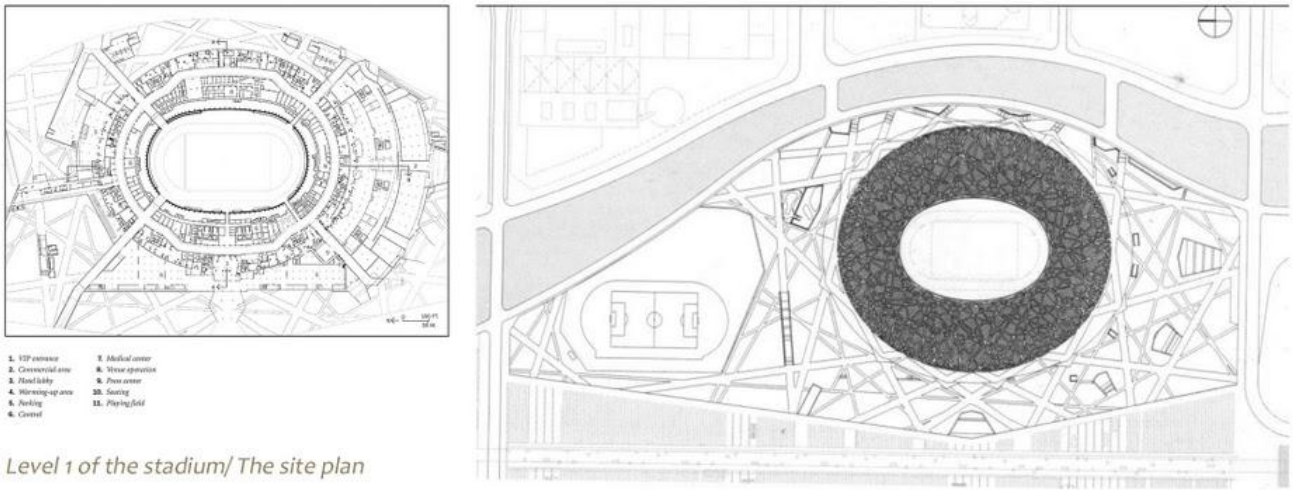
The National Stadium is located in the southern part of the Olympic Green, which was masterplanned by Sasaki Associates and covers an area of 1135 on the north side of Beijing, close to the city's central axis.

"To understand just how important the Beijing Olympics are to China, you have only to look at where the Olympic Green has been built. As Beijing began its first major expansions as a city, six hundred years before this current era, the city was laid out symmetrically on either side of a north-south axis. Similar to Paris and Washington, DC, Beijing's most symbolically important structures have fallen along the main axis. " (Architectural Influence, 2009)

The Stadium is the centrepiece venue of the Olympic Green, on an irregular quadrangle approximately 20.4ha in extent. As the Aurp Journal stated, the terrain is relatively flat, with ground elevations ranging from 42m to 47m, highest at the south-west corner and lowest at the north-east corner. The position was chosen so that there would be a gradual rise in level from the city roads in the north-east, forming a gentle slope up to the Stadium plinth, about 5.3m higher. The plinth connects to the main concourse, level 1 of the Stadium. (The Aurp Journal, 2009)



The position of Olympic Green / The position of Olympic Stadium



Level 1 of the stadium/ The site plan

Original inspiration

Though the Beijing National Stadium is often known as "Bird's Nest", the original inspiration was actually from a combination of local Chinese art forms - the crackle glazed pottery that is local to Beijing, and the heavily veined Chinese "scholar stones". However when the artist Ai WeiWei first saw the proposal he quickly drew a bird in a tree. The panelised approach gave way to infinite lines of structure and the name "Bird's Nest" quickly became synonymous with the project.

Beijing crackle glazed pottery: the original inspiration for the Stadium roof. (google)

Its appearance, inspired by local crackle-glazed pottery and veined scholar stones, defies structural logic. It is an amazing display of architectural, engineering and construction innovation. Local people affectionately nicknamed the Stadium the "Bird's Nest" while the initial competition entries were on display in Beijing.

The bowl design

Like most modern stadia, the "Bird's Nest" was designed inside out, beginning with the competitive field in the centre and seating stands around it for total 91,000 spectators, is designed to promote an exciting atmosphere which will spur all the athletes on to deliver top performances. The tiered seating is arranged with as few gaps as possible to preserve a homogeneous impression. The distinctive lines of the underside of the roof are concealed behind acoustic panels let the spectators concentrate entirely on the event taking place down in the competitive field.

"Every game has its own thrilling "I was there" moments, when athletes perform miracles and new records are set. The team wanted to create a stadium that would harness and amplify this excitement in the way the world's best loved venues do." (J Parrish, 2009, p8-p10) The architects' ambition was to create not only an instantly recognizable symbol of China's cultural, but also the most exciting stadium in Olympic history.

The form of the bowl and the distribution of seating types largely determine all other aspects of a stadium, including the shape and structure of the roof, the levels and locations of the concourses and premium facilities, and the amount of natural light and ventilation reaching the playing area. J Parrish (2009) stated that the team worked closely with the international Olympic and local organising committees to streamline and rationalise the on-field facilities. The result is a more compact bowl with less distance between the spectators and the track.

Bird Nest is designed to be a huge crowd of vessels, whether near or overlooking, all seem to leave a distinctive and indelible impression on the mind. Inside the Bird Nest, bowl-shaped structure of this uniform body will be able to mobilize the excitement of the audience, and to make athletes feel more exciting. Create a consistent appearance, seats to be controlled to a minimum of interference, acoustic ceiling will cover the structure and the site makes the audience become the focus of attention on the activities. In a word, the crowd formed a building.

-- http://beijing-birdsnest.com/

"I was there" moments (google)

The bowl's concept (google)

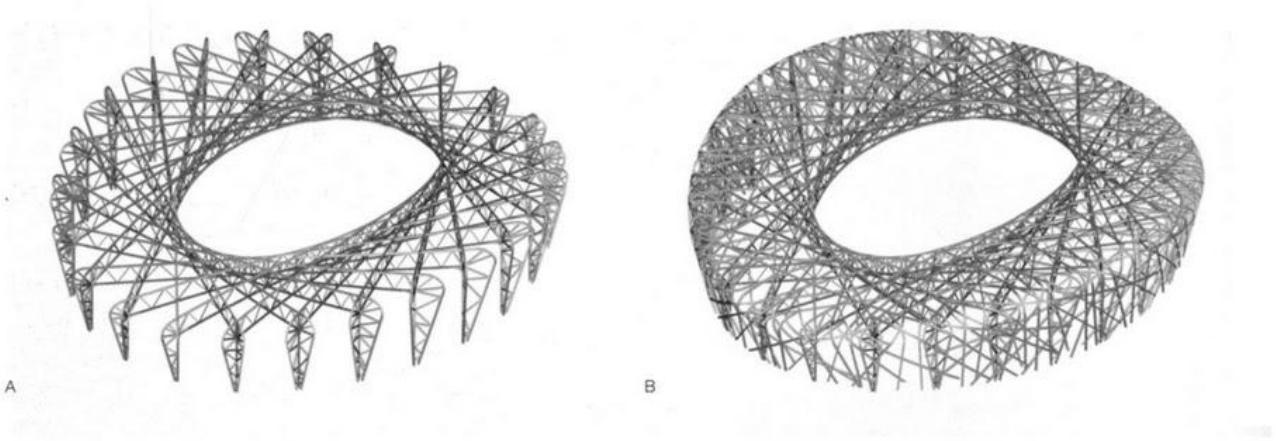
A skillful balancing of several key criteria is involved in this project and has been transformed in recent years by parametric relationship modelling. Most importantly, spectators want to be as close as possible to the action and to have a good view of the field, while the stadium developer needs to accommodate a certain number of seats within a defined budget. These requirements often conflict, and as Parrish said, "Even a tiny adjustment to the configuration of the seats can have a huge impact on the overall design and cost of the building". By using powerful computer software, designers can quickly generate the initial form of a stadium within defined parameters such as geometric constraints, environmental factors, and the limitations of construction materials.

Having produced the initial concept, the architect can quickly explore and test options by adjusting variables such as the height of a row of seats. It is well known that creating a stadium that will be both an athletic and a soccer venue is always a challenge, for the National Stadium, "Athletics fields are bigger than football pitches, which means that spectators in the

stands are further away from the action. Consequently, people in the upper tiers may not be able to see the ball on the pitch, and the atmosphere – which is so important to a soccer crowd – may be seriously diluted." Architects used its own specialist parametric modelling software to develop a bowl geometry optimised for Olympic athletics that would also work well for soccer in legacy mode. The team produced 33 versions of the design to fine-tune the form of the bowl.

The team decided that this landmark Stadium should have the same distinctive external form in both Olympic and legacy modes, and so the temporary additional seating needed to be accommodated within the main envelope. The temporary seats, which are mainly to the rear of the top tier, have the least-favourable views in the Stadium and are located in zones that can be converted to other revenue- generating use.

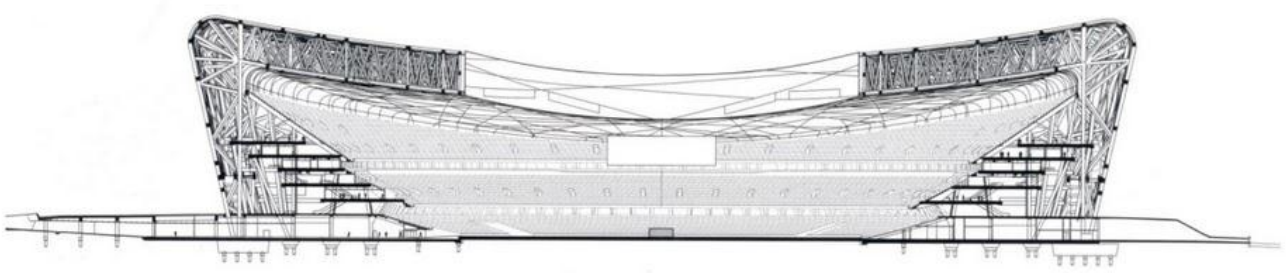
The façade/roof structure



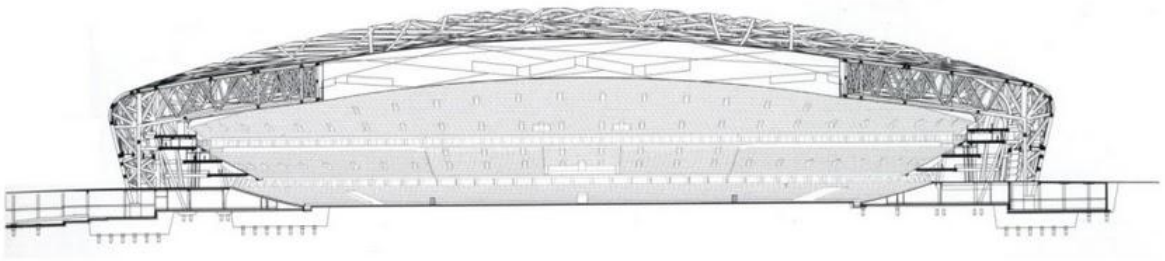
A primary structure with portal girders/ B primary and secondary structure (Detail)

The bowl and external form of the Stadium were developed in parallel, with Herzog & de Meuron working on the façade and roof while Arup defined the size of the bowl and proposed an optimised roof structure. "The load- bearing frame for the stadium looks chaotic without any hierarchy of structure, but none of these girders are unnecessary or purely decorative, there is indeed a very rigorous organization behind it." From the figure A we can recognize that 24 portal girders aligned in a very regular pattern. This primary structure is divided at irregular intervals by secondary girders and braced (figure b). "All the girders with outer dimensions of 1.2*1.2m lie in the same plane. The different loadings are taken up by different sheet thicknesses." (National Stadium in Beijing, 2008, p7-p9)

We can find a clear explanation in Arup journal (1/2009): the seemingly accidental arrangement of steel members that forms the envelope makes it almost impossible to distinguish between the primary structural elements supporting the roof, the secondary staircase structures, and the tertiary elements that add to the random effect. Each of the façade's steel members retains a 1.2m wide external profile as it twists and bends to follow the saddle-shaped geometry of the Stadium.

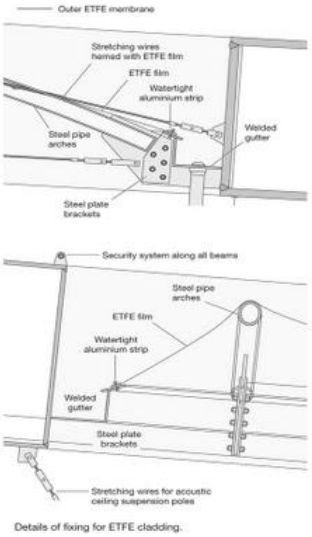


Section A

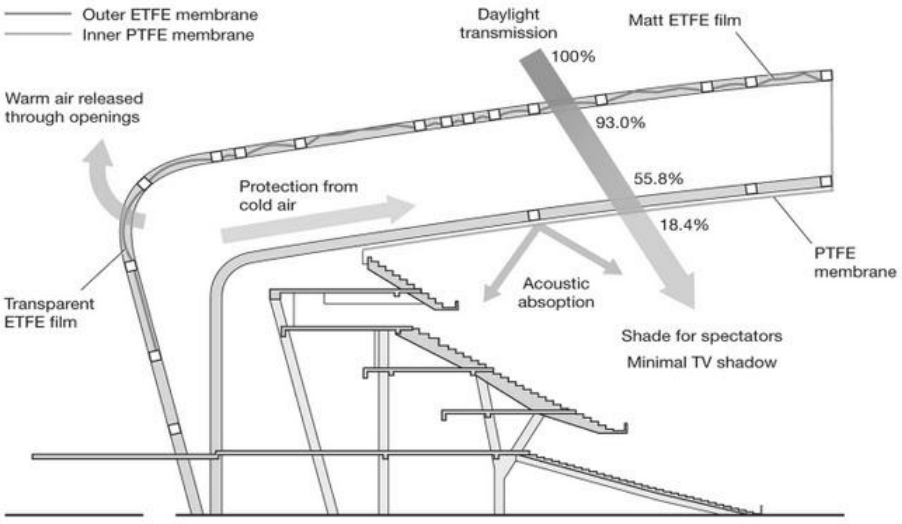


The roof structure spans a 313m x 266m space, closely enveloping the bowl and concourses to form both façade and roof. The façade incorporates the Stadium's main staircases. The result is a compact and sinuous external form uninterrupted by masts, arches, or stair cores. While the façade is open, a roof covering made of single-layer ETFE membranes stretched between the steelwork sections protects the spectators from wind and rain.

Single-layer ETFE membranes stretched between the steelwork sections protects the spectators from wind and rain.(google)



Details of fixing for ETFE cladding.



Section through Stadium showing locations of ETFE and PTFE cladding. **(The Arup Journal)**

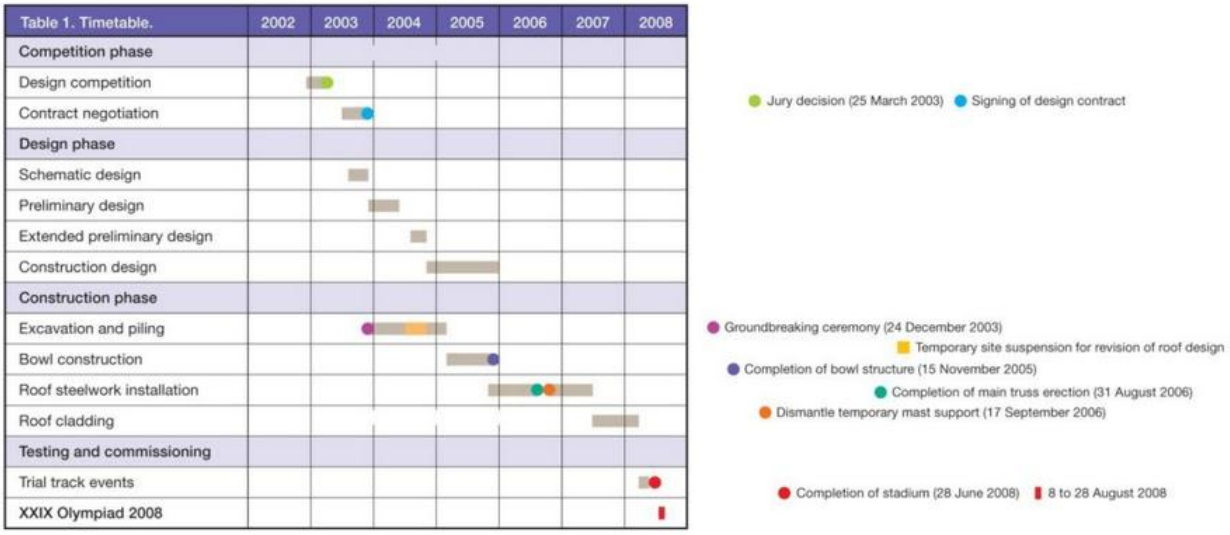
The steel structure is painted light grey, contrasting with the red-painted external concrete wall of the bowl, which is clearly visible through the façade. This could create a variety of impressive effects, particularly when lit at night.

The night view of the stadium(google)

Green features

Some of the new and innovative green features of this stadium are a rainwater collection system, a roof that is completely translucent so natural sunlight can come in, and a natural passive ventilation system that forces breezes and winds throughout the stadium. With all this technology you would think it would be a warehouse of waste but with these new innovations integrated into the stadium it is quite self-sufficient. The most unique of these is a series of cushions that have the stadium surrounded that help to regulate the sunlight, wind and water flowing into it. They fill gaps to prevent water leaks and fill air holes to make sure no air is lost or no old air is recirculate it is quite the technical marvel.

4.0 Conclusion



The timetable of the stadium (The Arup Jounral)

Through the former three sections, I have gained an overall understanding of Beijing National Stadium through the background of the Olympic architecture, the International design competition of the national stadium, as well as the architectural design. This design winning in the end of the competition is not only due to the background of the architects, but the competitive inspiration as well. The dynamic form and vast scale of this building create a new icon for the city of Beijing. Described by the Times of London as “the world’s most iconic building in this decade of iconic buildings”.

The national stadium is both a monument for enjoying the great performance of athletes and a great civil building for the local citizens to enjoy this public space in the following years after Beijing 2008 Olympics. As Herzog once mentioned in an interview, “For us, this stadium is more than just a building. It's a part of a city. Vision is always such a big word, but our vision was to create a public space, a space for the public, where social life is possible, where something can happen.”

Last but not least, I reckon that considering the long-term use of the building is essential, we need a stadium that could accept other civic, cultural, recreational and commercial uses, and hope that the place would become a major destination after the event. On the eve of Olympic year of 2012, we could foresee the influence of London National Stadium on the fabric of the city through reflection of Beijing National Stadium.

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