Engineering China's Skylines

Dasui Wang

Interviewee

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Dasui Wang is one of China's foremost thought leaders on the design and implementation of supertall buildings, with experience in both structural engineering and architecture. Wang graduated from Tongji University in 1964. As a Design Master of China and a consultant for ECADI, he is renowned in the field of engineering design. Currently, he holds the position of Deputy Director of the High-Rise Building Committee of the Architectural Society of China. He is a member of the Ministry of Construction High-Rise Building Review Committee and an adjunct professor at Tongji University. He has participated in writing and reviewing a number of national design specifications and codes.

Dasui Wang, China Design Master and chief structural engineer for East China Architectural Design Institute (ECADI), is the recipient of the inaugural CITAB - CTBUH China Tall Building Outstanding Achievement Award. Wang has committed his life's work to designing the structural engineering solutions behind some of China's and the world's outstanding tall buildings. His long list of projects includes the Oriental Pearl TV Tower, CCTV New Headquarters, Tianjin International Financial Center, Shanghai World Financial Center, and Shanghai Tower. Wang sat with CTBUH Journal Editor Daniel Safarik to talk about his 52-year career and the tremendous amount of change he has seen during this time.

What do you consider to be your greatest accomplishment?
I don't know that I can say I have a single great accomplishment, but I think of myself as walking along with the development of China. Specifically, the last 30 years have been a golden period of time in China's development. I have been working at ECADI for 37 years, since 1979. In this period, my colleagues and I really did something for our country. We were lucky to have participated in building most of the important tall buildings in China. That is a source of great pride for me.

One of your groundbreaking works was the Oriental Pearl TV Tower in Shanghai (see Figure 1). Can you talk a little about how that project came to be?
The project is a truly original one for China. ECADI did all of the work independent of the transmission technology. We got the project in 1989, when I was the lead structural engineer. During that period, there were few communications with overseas professional architects. And we had never seen foreign TV towers to use as a reference. There were several TV towers under construction at Tianjin, Liaoning, Wuhan, and Beijing, but they were all smaller than the Oriental Pearl Tower.

So this was an unprecedented structure, meant to be not only a TV tower but a symbol and an observation tower. What accounted for the tripod-like, ball-and-stick design for which it is famous?
Originally it was created for broadcasting purposes. There was no cable TV back then; only high-frequency transmissions, which required height to cover all of the city's territory. The location chosen was the geographic center of Shanghai.

The architects proposed the initial formal concept of "Oriental Pearl," which was based

> "Since the economic opening, China has benefited from foreign architecture techniques, and has closed the gap with the world. Now that we have the confidence to execute complex projects, we need to focus on originality in design and innovation."

Figure 1. Oriental Pearl TV Tower, Shanghai.
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on Shanghai's central position on China's coastline and its role as the brightest city of eastern China. You can see the tower has six balls, which the Chinese call *mingzhu* (pearls). There is an ancient Chinese poem that refers to "big and small pearls falling into a jade plate." We structural engineers made great efforts to realize this concept. In conclusion, the achievement of the Oriental Pearl Tower is owed to several architects and structural engineers, rather than the work of one person.

There were many proposals, and ECADI presented several of them. The former President Jiang Zemin, who was mayor of Shanghai in 1989, chose this proposal after consulting with the relevant experts' opinions.

There is a painting in the China Art Museum, which features what appears to be Deng Xiaoping looking admiringly out a window at Oriental Pearl Tower. What is the story behind that?

Jiang showed Deng Xiaoping a model of the Oriental Pearl, which was highly praised by Deng.

It is impressive that this was at a time when Chinese architecture was not as open to international expertise as it is now. How was a feasible concept realized?

Most of the tall TV towers around the world consist of one single tube with cable-stayed supports. The Chinese don't like the cable-stayed style. They like self-supporting towers. Since the design called for a big ball to be put up to 300 meters' height to accommodate tourism needs, a single tube would not be strong enough to support it. To support the three vertical tubes and the ball, the inclined, triangulated tubes composed a stable structure. The structural concept is very clear.

It must be satisfying to see the tower remains popular to this day.

At the same time, considering that there are a large number of visitors – about five million a year – we need six elevators in those three tubes. Recently, the owner has requested more elevators to increase capacity, which is not easy. We are working on developing a feasible plan for them.

What do you think are the greatest challenges that you have overcome?

I think this is best answered in the context of the development progress of China in tall buildings over three decades. In the 1920s and 1930s, Shanghai had some tall buildings constructed, like the Park Hotel, and it looked like a small Manhattan. But because of World War II and the Chinese Civil War, it all stopped, and most of the work in engineering was in industry. After the 1970s, as the population increased, we had to consider high-rise residential development. At that time, China was a closed-off country without foreign communication. Chinese engineers had to do their own research and development. Before 1986, nearly all of the engineering work was done domestically.

The important projects I was involved in at that time were the Huating Hotel, 1982–1985, and the Huadong Diandi (East China Electrical Power Distribution) building in 1989 – both in Shanghai. From about 1986, foreign architects and engineers began to be involved in Chinese projects, firstly in Shanghai, including the Jinjiang Hotel on Huaihai Road. Since 1990, when Pudong opened to development, more high-level foreign architecture companies have been involved.

What was different about working with those firms?

The government set relevant policies at that time, which welcomed foreign architects to be involved. But another policy was that foreign designers could only be involved up to the concept period. Before the construction drawing stage, the foreign architects and engineers were more involved. And Chinese architects and engineers got more involved in the later stages. We had these policies in effect for a long time, which I think was the right decision.

The two groups of architects paid attention to different stages but kept in constant contact, which was good for Chinese architectural development. We were exposed to new technology and new expression methods, both architectural and structural.

Figure 2. Shanghai World Financial Center, Shanghai. © Mori Building

There is still, it seems, a lot of responsibility that rests with the Chinese design institutes, more so than in the West, where the design architects often insist on being involved all the way through the projects. Do you think the projects have achieved a higher level of quality through this more rigid separation of duties?

Before 1990, we did not have many tall buildings in Pudong's Lujiazui District. Then, Lujiazui became a showcase of China's "opening up," with a great number of excellent tall buildings. These buildings, which combined foreign technology and Chinese engineers' skills, are our pride.

Two projects, in particular, impressed me deeply. One is the Jin Mao Tower. You can see that there are some Chinese elements in the design. From the structural standpoint, I find that an efficient outrigger system was used.

The other is Shanghai World Financial Center (see Figure 2). The structural engineer was Leslie Robertson, who is really a genius. He was an electrician on an aircraft carrier in World War II. After the war, he came to university and finally became an excellent engineer.

Since the opening up, China has benefited from foreign architecture techniques. Nowadays, we don't have a big gap with high-level architecture around the world. We can design all kinds of buildings. Now that we have the confidence to do that, we need to focus on originality in design and innovation.

What interested you in structural engineering?
In my teenage period, unlike the students of today, I was happy in my pursuits without thinking of the pressure of college entrance examinations. I studied what interested me. I enjoyed doing sports and making models. I also studied engineering because of the demand for it China. They did not separate tall buildings out of building construction as a subject at that time. There was no distinction.

How did your career develop after university?
I worked on industrial buildings before I committed to structural design. The Socialist industrialization of China meant that most building tasks were factories. I gained experience in prefabricated structures at that time. I have been involved in tall buildings since 1980 or 1981.

The sheer volume of tall buildings in China is overwhelming. There is much creativity and much monotony. How do you balance the need for creativity and productivity/accommodation?
We have cooperated with foreign architects for many important tall buildings in China. In the process of cooperation, we not only transfer the concepts and master plan to construction drawings, but we also optimize and deepen the design in consideration of the situation in China.

Now the process seems more interwoven, which has to be good.
As a good example of this, Tianjin World Financial Center (see Figure 3), in which ECADI collaborated with SOM, is the world's tallest building to be constructed of steel-plate shear walls. With such thin plates, we had to consider the tendency of steel to buckle as well as the need to deal with multi-directional forces. But it was a very flexible and efficient method, so the overall fitness of the design was increased. We worked on this with Tsinghua University and did some tests on the issues between shear wall stability and gravity load. That was in 2008. When the tower was ultimately built, SOM and ECADI presented our design on the annual conference of the American Society of Structural and Civil Engineers (ASCE). This project received the structural category Award of Excellence.


Figure 3. Tianjin World Financial Center, Tianjin. © SOM/Tim Griffith

What would you want to pass on to the next generation of structural engineers?
I don't think much of the elaborate division of the subjects in higher education. Architectural structure or road and bridge engineering could be integrated into one area of civil engineering because of the same basic knowledge of mathematics, mechanics, geotechnics, and seismic forces.

You would encourage the disciplines to interact more, and not to over-specialize?
Schooling should emphasize big concepts. You can choose different aspects to pursue when entering your career. And anyway, people of high capability could do both at the same time. My role model – Professor Lin Tung Yen – who was a well-known bridge and high-rise building structural engineer, is an excellent example.

What is the biggest change you have seen over your career, how has that affected the shape of the skyline, and how do you feel about it?
My working platform is ECADI, which means I am not alone when facing those challenges. For something like the CCTV New Headquarters, I couldn't evaluate it from an architectural aspect. But, it really brought great challenges in structural design. Two of my major assistants helped me with this, and they gained important experience from it. For particularly important projects, it is very helpful that the government ask experts to peer-review the project.

For this project, OMA, the architect, and Arup, the lead engineer, made a lot of contributions. However, there were still many practical problems for us to solve. For example, the huge eccentricity in the structure, the huge cantilever, and how to keep the floor flat when the cantilever was completed, how to manage the high-steel-ratio columns. It was an unforgettable accomplishment that we finally managed to complete the building within reasonable cost while ensuring safety. We felt very pleased.

While we are on the subject of extraordinary buildings like this, what do you think is "weird" architecture? How do you think discouraging it will affect the industry?
Since 1957, China has set up a development policy that emphasized appropriateness for use, low cost, and beauty when applicable. I agreed with this policy, since it helped show a way out of China's economic backwardness. Of course, things have changed now.

When Rem Koolhaas spoke at the 2013 CTBUH Awards, accepting for CCTV as Best Tall Building Worldwide, he said, "This is a building that could only have been thought of in Europe and only built in China."
As China's development has arrived at a certain stage, there is an awareness of the need to pursue aesthetics. However, some people would consider "strangeness" as "beauty," even when the aesthetic level is not that high. This situation may depend on the preference of local leaders or developers sometimes. There was a period of time in which many "strange" or even ugly buildings were built. But, I think that time has passed, and China has come to a more rational stage. The aesthetic level of our nation has improved now that developers and the government think it is not appropriate to spend too much to build those strange buildings. Now, China has come out with a modified development policy – "appropriate for use, low cost, green, and beautiful." I would say that architectural development in China took a short detour before. But now, it is on the right path. ■