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Authors: Scott Duncan, Partner, Skidmore, Owings & Merrill LLP
Yue Zhu, Associate Director, Skidmore, Owings & Merrill LLP

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SOM and China: Evolving Skyscraper Design Amid Rapid Urban Growth



Scott Duncan



Yue Zhu

Authors

Scott Duncan, Partner
Yue Zhu, Associate Director
Skidmore, Owings & Merrill
224 South Michigan Avenue
Chicago, IL 60604
United States
t: +1 312 360 4157
f: +1 312 460 4545
e: yue.zhu@som.com
www.som.com

Scott Duncan

Throughout his 16-year tenure at SOM, Scott Duncan has developed a body of work recognized by The American Institute of Architects, MIPIM Asia, World Architecture Festival, The Municipal Art Society of New York, and The Chicago Athenaeum. He offers extensive experience in the design and implementation of complex projects around the world – including large-scale mixed-use, transportation, commercial, hospitality, and residential developments in Asia. Duncan's most recent large-scale project, the Pertamina Energy Tower in Jakarta, is the world's first supertall tower for which energy is the primary design driver.

Yue Zhu

As a Senior Technical Designer and Associate Director in the Chicago office of SOM, Yue Zhu has experience in architectural design, technical expertise, urban design, and sustainable design. He has participated in the design and construction of commercial and civic buildings in North America, Europe, and Asia and he has extensive experience and expertise in Chinese projects, including many high profile high-rise buildings and multi-use urban development projects in China.

China's rapid urban and economic growth has challenged designers, engineers, and planners to innovate and collaborate to meet the needs of a changing country. Skidmore, Owings & Merrill (SOM) has been practicing in China for more than two decades, working with residents and policymakers to shape urban environments. The firm's integrated, interdisciplinary approach has produced work at all scales that addresses the challenges of urbanization and gives form to the aspirations of the country. Through a survey of notable projects in China, this case study expresses how practices have evolved to help Chinese cities become more vibrant and compelling.

Introduction

The largest-ever human migration – the movement of people from rural to urban China that began in the 1980s – has created burgeoning, vibrant cities across the country. The question of how best to build cities for prosperity, social cohesion, and a healthy environment demands an integrated approach that considers how people can live well, both now and in the future.

SOM was founded as an interdisciplinary practice and brings together design, technical design, structural engineering, urban planning, MEP, interiors, and project management practitioners to create buildings and cities that are sustainable, well-executed, and enduring. An integrated way of working enables the firm to meet the challenges posed by rapid urbanization and to develop and utilize research that can make urban living greener and more enjoyable.

After three decades of working in China, SOM's projects in the country have become some of the firm's most iconic and innovative, joining a global portfolio that includes the Burj Khalifa in Dubai, the Willis Tower in Chicago, One World Trade Center in New York, and the Canary Wharf master plan in London. Though global in scope and experience, solutions are sought that are responsive to site, context, culture, and history. The firm's past and ongoing work in China speaks to how an integrated approach can help answer pressing questions of urbanization, environmental sustainability, and livability by

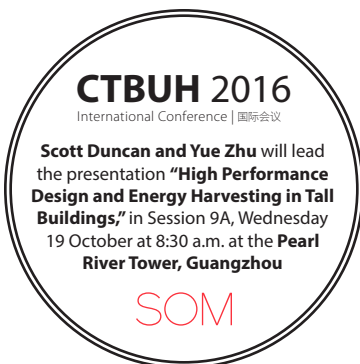
focusing on practical, sensitive, and lasting design solutions.

China in the 1980s

Economic liberalization and rapid population growth of major urban centers in the 1980s initiated a massive construction boom. Urban growth required dedicated master planning and intensive land redevelopment: Beijing, Shanghai, and Guangzhou were among the first cities to implement new strategic master plans amid surging demand for the construction of complex buildings and capital infrastructure projects. The rapid pace of construction raised questions about the technical constraints of existing methods and introduced a dialogue about how architecture can meet the needs and aspirations of a rapidly changing society.

SOM Arrives in China Amidst its Transition to a Market Economy

Chinese cities boomed in the 1990s, as did demand for design, structural, and planning services. SOM established its presence in the country through monumental projects that clearly demonstrated a deep sensitivity to China's cultural history and market needs. The most notable projects during this phase were the Industrial and Commercial Bank of China (ICBC) Headquarters in Beijing and the Jin Mao Tower in Shanghai (see Figure 1).



The ICBC Headquarters on Chang'an Street in Beijing was completed in 1999 – its stone base, structural steel frame, and glass façade with a monumental roof inspired by historical forms creatively incorporated traditional Chinese elements into a modern architectural expression. Technical innovation was also inherent to the building: the steel frame structure was the first of its kind in China, heralding the growth of the steel construction industry.

In the same year, the 88-story Jin Mao Tower was completed in Shanghai. Jin Mao was a monumental success for China and it became a symbol of the country's ambitions. The building embodied a way of working that interprets local cultural inputs into a modern supertall architectural expression. This cultural sensitivity was carefully integrated with the numerous technical complexities of supertall design by including a performative exterior wall that uses delicately textured shading elements against the unitized glass curtain wall as well as the first megacolumn and outrigger truss system in China. Jin Mao was a soaring demonstration of how architecture could synthesize sensitivity to history and local culture with structural and design excellence.

Both ICBC and Jin Mao demonstrated how thoughtful design resulted in substantially improved buildings and, in turn, more vibrant cities.

SOM's China Practice Evolves

Entering the new century, SOM's practice in China stepped forward with the evolution of the firm's principles, paralleling China's own achievements. The Poly Corporation Headquarters in Beijing demonstrated a deliberate consideration of the relationship between architectural form, context, and environmental responsibility (see Figure 2). An L-shaped layout with a large atrium connects the floors, increasing the feeling of community in the building, while the world's largest suspension-cable curtain wall system and lightweight structural members welcome natural daylight into the atrium



Figure 1. Jin Mao Tower, Shanghai, 1999. © Hedrich Blessing

“The rapid pace of construction in China raised questions about the technical constraints of existing methods and introduced a dialogue about how architecture can meet the needs and aspirations of a rapidly changing society.”



Figure 2. Poly Corporation Headquarters, Beijing, 2006. © Tim Griffith



Figure 3. Poly Corporation Headquarters - interior rocker and wall. © Tim Griffith



Figure 4. Poly Real Estate Headquarters, Guangzhou, 2007.



Figure 5. Zifeng Tower, Nanjing, 2010. © Liu Qihua



Figure 6. Zifeng Tower - façade detail. © Liu Qihua



Figure 7. China World Tower, Beijing, 2010. © Tim Griffith

and connect the building to its context (see Figure 3).

During the same period, the Poly Real Estate Headquarters in Guangzhou integrated structure, thermal and visual performance, and efficient space planning (see Figure 4). The site, alongside the Pearl River, strongly influenced the orientation of the buildings to take advantage of the views. Offset cores and external diagonal structural bracing provided uninterrupted open office floor plans, shading along the southern façades, and wide views to the north towards the Pearl River. Natural ventilation and outdoor green roofs were also integrated to achieve a high degree of sustainability.

The Chemsunny Plaza in Beijing, completed in 2008, is a further expression of attention to culture and context. This dynamic, 15-story commercial building uses a highly articulated glass and steel façade and comprises three parallel bars connected by atria and bridges – a composition inspired by a Chinese puzzle and its interlocking parts. Chemsunny Plaza's design also provides dynamic interior spaces for communication and collaboration, resulting in an active intermediary zone between the city and the building.

After the 2008 Beijing Olympics, a new national focus on spurring economic growth and development in the Yangtze River Delta

“Awareness of, and demand for, environmental protection is now widespread around the world, including in China. As a result, higher requirements for the performance and impact of architecture became a central design issue for SOM tall building projects.”

resulted in a wave of construction in the second tier of Chinese cities. Zifeng Tower (2009), an iconic supertall project in the ancient capital city of Nanjing, showcases innovations in craft and takes advantage of existing regional strengths in design and construction (see Figure 5). The dynamic, stepping vertical form, and highly articulated façade consists of a saw-tooth curtain wall that provides a memorable visual impression of a dragon, while also providing natural ventilation (see Figure 6).

Progressive improvements in construction quality brought about the possibility of increased sophistication, thus allowing for new tower designs to emphasize simplicity without compromising rigor. In 2010, the soaring China World Tower became the tallest building in Beijing and the centerpiece of the Central Business District (see Figure 7).

Embodying quiet, purposeful elegance, the mixed-use building stands in contrast to the clutter of new buildings in the fast-growing area. The tower's base is folded seamlessly into this hectic urban fabric and visually anchors the elegantly tapering spire. Within the simple form, the intricate detailing of the curtain wall demonstrates the full range of design considerations. The fritted glass and metal fins on the tower's façades mitigate solar heat gain while maximizing daylighting – features that helped the project earn LEED Gold certification. This textured surface reads as a waterfall of light and detail. This approach – to combine an elegant, simple form with efficient and sustainable thinking through fine detail – quickly became a new standard. In Tianjin, the approach was used on the Global Financial Center, with its simple tapering form and a finely articulated exterior wall (see Figures 8 and 9).



Figure 8. Global Financial Center, Tianjin, 2011.



Figure 9. Global Financial Center – façade detail. © Tim Griffith

Awareness of, and demand for, environmental protection is now widespread around the world, including in China. As a result, higher requirements for the performance and impact of architecture became a central design issue for new tall building projects. China Merchants Tower in Shenzhen reflects an intentional emphasis on incorporating sustainable strategies in the fundamental nature of the design (see Figure 10). A bowed and tapered form increases the building's aspect ratio and allows lower floors to slope away from the sun, which decreased the solar radiation received by the exterior wall. The shape also allows for the distribution of exterior notches that support balconies, giving tenants access to the outdoors on each level. The building features low-e unitized glass curtain walls, clad in a repetitive system of horizontal glass fins and vertical aluminum struts. The fins are closely spaced together, reducing solar gain. Aesthetically, the fins give the façade a fine-grained texture, balancing against the slenderness generated by the tower's verticality. The fins also refract light at night and work in conjunction with the top of the tower – its signature element – to illuminate the form to allow it to be read as a beacon across Shenzhen.

In Guangzhou, SOM completed one of the most energy-efficient supertall buildings ever constructed, and the first LEED Platinum tower in China, setting a new paradigm for green design interventions. The Pearl River Tower (2013) redefined what is possible in sustainable tall building design by incorporating the latest green technology and engineering advancements (see Figure 11). The sculpted body directs wind to a pair

of openings at its mechanical floors, where turbines generate energy for the building. Other integrated sustainable elements include solar panels, a double-skin curtain wall, a chilled ceiling system, underfloor ventilation, and daylight harvesting, all of which contribute to the building's energy efficiency.

The Kingtown International Center in Nanjing (2014) utilizes a double-skin curtain wall that enables the building to respond to the city's extreme heat during summer months (see Figure 12). The cavity between the two walls is ventilated to the outside and serves as a thermal insulating buffer zone around air-conditioned spaces. Benefits of the double-layer envelope include improved HVAC system performance, lower operational costs, and increased comfort for occupants. Contained within the cavity are diagonal structural braces that wrap the tower from base to top. Deploying this system reduced the use of structural materials by approximately 20%.

With the rapid advancement of computer technology, information and parametric technology have also been widely used in the development of SOM projects in China. The Nanchang Greenland Parcel A project (2015) depended on computer-aided design to achieve a more optimized form, rationalizing building surfaces (see Figure 13). This technique contributed to the reduction of the number of required wall panel types and sizes, while pioneering the use of cold-bent glass in a tall building of this scale. The maturing computational platforms allowed for the exploration of forms that were refined and shaped rationally, thus responding more specifically to site and economic constraints.

These collective experiences in China, and others from around the world, further validated the potential of an integrated multi-disciplinary approach to design. The Poly International Plaza in the Dawangjing district of Beijing (complete in 2016) is an exemplary project integrating the architectural and engineering disciplines (see Figure 14). Throughout the process, it was proven that highly integrated building systems are inherent to exceptional architectural form. Poly's long-span structural design strategically opens up interior spaces and employs a sustainable approach to addressing the climatic and air quality issues specific to Beijing. A faceted, diagrid exoskeleton system forms an outer thermal envelope around the office spaces enclosed within a second glazed interior envelope, creating day-lit communal areas in between. These areas not only accommodate meetings and foster social interaction, but also allow circulation and visual connectivity between floors.

Similarly, the design of Shenzhen Rural Commercial Bank Headquarters (2016) provided an integrated, externally braced structural system that facilitated flexible use of internal space, while also offering unencumbered views to the adjacent park (see Figure 15). Other notable examples of an integrated approach to architecture and engineering include the Shum Yip Upperhills mixed-use development, which utilized only eight megacolumns, resulting in an expansive and open typical office floor, as well as the Shenzhen CITIC Financial Center, with its innovative topology optimized, externally expressed megastructure system.

In the process of developing projects with a multi-disciplinary approach, a deeper appreciation of the relationship between architecture and nature was found. Through processes of intensive analysis, calculation, and modeling, natural forces were quantified into generative inputs that heavily influenced resultant building forms. The 96-story Tianjin Chow Tai Fook Binhai Centre, designed in 2013 and now under construction, is a distinct example (see Figures 16 and 17). The curvilinear and tapering tower was methodically sculpted to its final form

“The Poly International Plaza's long-span structural design strategically opens up interior spaces and employs a sustainable approach to addressing the climatic and air quality issues specific to Beijing.”



Figure 10. China Merchants Tower, Shenzhen, 2013.
© Tim Griffith



Figure 11. Pearl River Tower, Shenzhen, 2013.
© Tim Griffith



Figure 12. Kingtown International Center, Nanjing, 2014.
© Tim Griffith



Figure 13. Nanchang Greenland Parcel A, Nanchang, 2015.
© Lv Hengzhong



Figure 14. Poly International Plaza, Beijing, 2016.
© Bruce Damonte



Figure 15. Shenzhen Rural Commercial Bank Headquarters, 2016.
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Figure 16. Chow Tai Fook Binhai Centre, Tianjin, 2018.

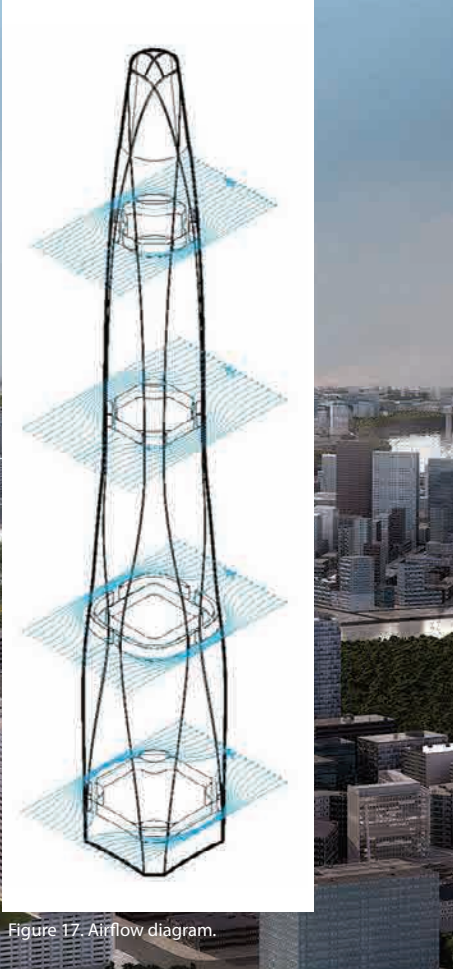


Figure 17. Airflow diagram.

through deep structural load analysis. The gently curving glass façade conceals eight sloping columns tracking the primary curves of the vertical form. Integral to resolving gravity and lateral loads, these sloping columns increase the structure's stiffness in response to seismic concerns. Strategically placed, multi-story wind vents, combined with the aerodynamic shape of the tower, dramatically reduce wind loads by cutting vortex shedding.

Vision for the Future

To date, SOM has completed nearly 120 projects in China, 47 of which are included in the CTBUH Skyscraper Center database and have a combined height of 8,868 meters, longer than Shanghai's Yangpu Bridge (see Figure 18). This substantial contribution clearly illustrates the large footprint of SOM's architecture, engineering, and planning design work over the past 20 years in China. The combined effect is felt in the development of the country's economy, in noteworthy improvements to the livability of urban centers, and in paradigm-setting designs and approaches, which have been widely embraced throughout the country.

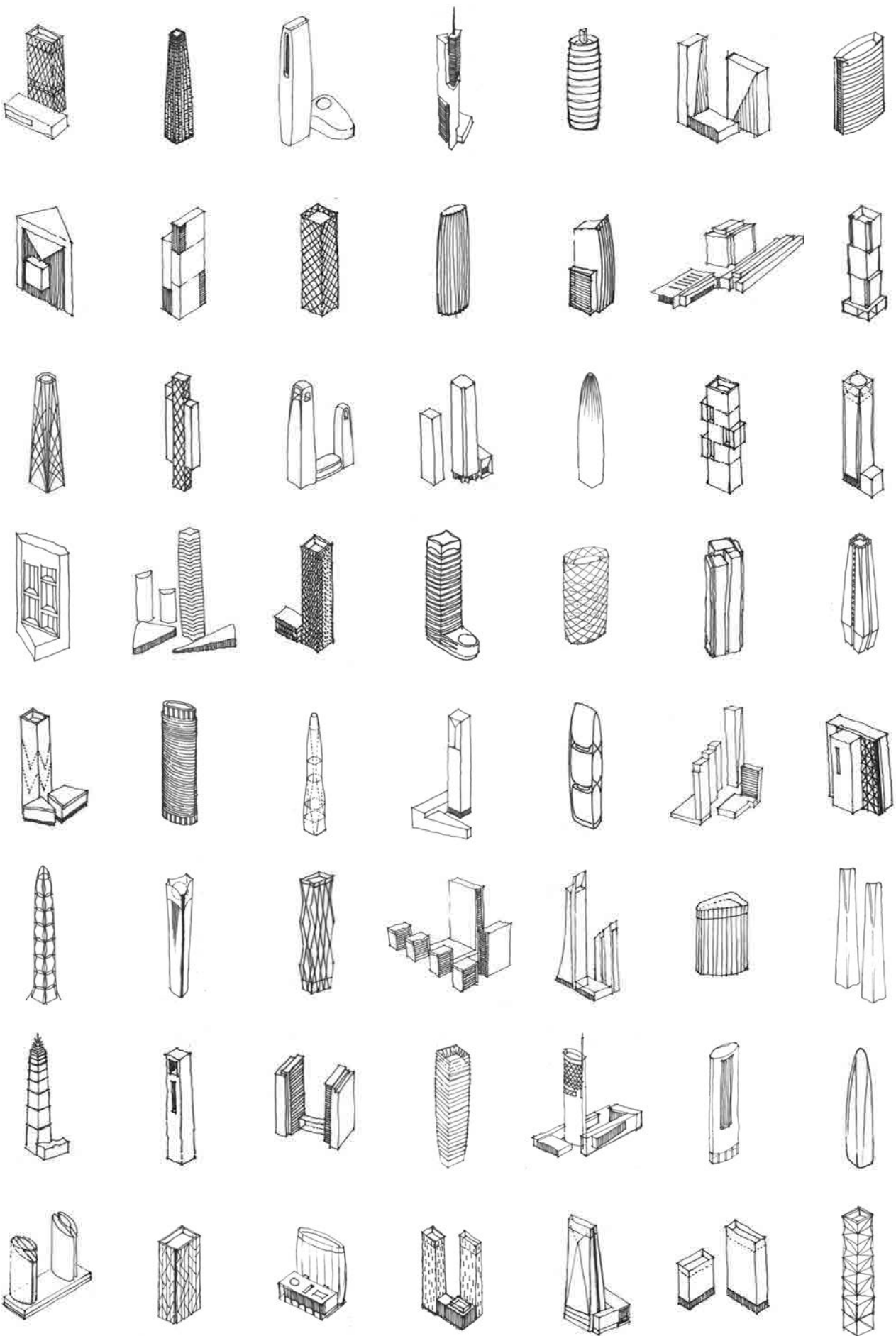
Building on its experience, the firm continues to address pressing needs in China, and will further refine its approach to solve new and evolving challenges. An emphasis is placed on constantly rethinking the nature of architecture as it relates to, defines, and affects urban areas in China. It's essential to continue thinking critically about how to work with residents of Chinese cities to shape growing cities in ways that become inviting green communities. This task is especially pertinent as some recent projects are building entirely new urban areas. One such example is the World Trade Center in Guiyang. The project will ultimately consist of 21 new structures, covering a land area of over 160,000 square meters with a diverse variety of program, building types, and urban spaces. Guiyang World Trade Center will become a dense new urban environment, surrounded by lush parkways and landscapes.

Today, through the rapid development of public transportation systems including high-speed rail, distances between China's cities have been bridged. These improvements have blurred and broken traditional barriers, which in turn have resulted in the creation of large-scale and highly interconnected megacities and megaregions.

In Tianjin's Binhai area, a new high-speed rail station forms the heart of walkable, green district that is deeply integrated into the larger Beijing-Tianjin-Hebei region. Balancing global and regional connectivity with a sensitive approach to livability and intimate urban environments, the SOM master plan speaks to an approach that addresses the challenges of urbanization at all scales with a considered, interdisciplinary method. In this way, SOM's work in Tianjin and beyond seeks to help residents shape cities that are prosperous, attuned to the needs of individuals, and environmentally sensitive. Looking ahead, SOM aspires to build on its experience in China to continue pursuing collaborative, integrated design thinking in architecture, engineering, and planning to elevate urban livability, promote sustainable growth, and foster a sense of belonging and place for current and future generations. ■

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► Figure 18. Sketches of selected SOM tall building projects in China.



About the Council

The Council on Tall Buildings and Urban Habitat is the world's leading resource for professionals focused on the inception, design, construction, and operation of tall buildings and future cities. A not-for-profit organization, founded in 1969 and based at the Illinois Institute of Technology, Chicago, CTBUH has an Asia office at Tongji University, Shanghai, and a research office at Iuav University, Venice, Italy. CTBUH facilitates the exchange of the latest knowledge available on tall buildings around the world through publications, research, events, working groups, web resources, and its extensive network of international representatives. The Council's research department is spearheading the investigation of the next generation of tall buildings by aiding original research on sustainability and key development issues. The Council's free database on tall buildings, The Skyscraper Center, is updated daily with detailed information, images, data, and news. The CTBUH also developed the international standards for measuring tall building height and is recognized as the arbiter for bestowing such designations as "The World's Tallest Building."



CTBUH Headquarters

104 South Michigan Avenue, Suite 620
Chicago, IL 60603, USA
Phone: +1 (312) 283-5599
Email: info@ctbuh.org
www.ctbuh.org
www.skyscrapercenter.com

CTBUH Asia Headquarters

College of Architecture and Urban Planning (CAUP)
Tongji University
1239 Si Ping Road, Yangpu District
Shanghai 200092, China
Phone: +86 21 65982972
Email: china@ctbuh.org

CTBUH Research Office

Iuav University of Venice
Dorsoduro 2006
30123 Venice, Italy
Phone: +39 041 257 1276
Email: research@ctbuh.org

CTBUH Academic Office

S. R. Crown Hall
Illinois Institute of Technology
3360 South State Street
Chicago, IL 60616
Phone: +1 (312) 567 3487
Email: academic@ctbuh.org

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