Title:	**From Jin Mao to Kingdom: Search for an Asian Supertall Vernacular**
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Subjects:	Architectural/Design Building Case Study Sustainability/Green/Energy
Keywords:	Design Process Supertall Wind
Publication Date:	2012
Original Publication:	CTBUH 2012 9th World Congress, Shanghai
Paper Type:	1. Book chapter/Part chapter 2. Journal paper 3. **Conference proceeding** 4. Unpublished conference paper 5. Magazine article 6. Unpublished

From Jin Mao to Kingdom: Search for an Asian Supertall Vernacular

从金茂大厦到吉达王国大厦：追寻亚洲超高层的本土性

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Adrian Smith, FAIA, RIBA, has been a practicing architect for 45 years. Adrian's body of work includes four of the world's current 12 tallest buildings, including Burj Khalifa in Dubai, the world's tallest building; Jin Mao Tower in Shanghai; Trump International Hotel & Tower in Chicago; and Zifeng Tower in Nanjing, China. Recently, Adrian's portfolio has expanded to include Kingdom Tower, to be the world's tallest building when completed in 2017 in Jeddah, Saudi Arabia; and Wuhan Greenland Center, to be the world's fourth-tallest building when completed the same year in Wuhan, China.

艾德里安-史密斯，美国建筑师协会会员，英国皇家建筑师学会会员，从事建筑实践已有四十五年，史密斯先生的作品包括了现今世界上最高的十二座建筑中的四座，它们分别是世界第一高塔迪拜哈利法塔、上海金茂大厦、芝加哥川普国际酒店大厦和中国南京紫峰大厦。近来，史密斯先生又有了新的作品，包括沙特阿拉伯吉达市的王国塔，2017年建成后高度将是世界第一，还有中国武汉绿地中心，2017年建成后高度将是世界第四。

Abstract

The paper traces the evolution of Mr. Smith's career as a designer of supertall buildings, the Jin Mao Tower (1999) to Kingdom Tower, to be the world's tallest building when completed in 2017. He discusses his contextual approach to design, which seeks to engage the history, culture, indigenous architecture and natural environments of the locations his buildings serve. His work was the first to recognize the relationship between a tall tower's exterior form and the resultant wind resistance's effects on the tower's movement and the comfort of its occupants. This has led to a methodology in the design of high-performance supertall towers that mitigates the acceleration of movement caused by wind vortices, "confusing" the wind by shaping, manipulating or opening the buildings' form. This method, verified by wind-tunnel testing in the early stages of design, is now widely emulated and influential within the profession.

Keywords: Supertall. Design. Jin Mao. Burj Khalifa. Kingdom Tower.

摘要

本论文回顾了史密斯先生从事超高层建筑的设计生涯，从1999年完成的上海金茂大厦，一直到即将成为世界第一高楼的沙特阿拉伯吉达市的王国塔。他讨论了他的文脉主义的设计方法，即将当地历史、文化、乡土建筑和自然环境融为一体的设计方法，他的设计首先认识到了高塔的外形和它产生的风阻效应对建筑摇动及使用者舒适度的关系，由此产生了高效能超高层建筑的设计方法，即通过操纵建筑的体型可以减少风涡产生的建筑摇动的加速度，这种设计方法，正如设计早期的风洞试验所证实的那样，今天已经在建筑行业内被广泛效法，影响深远。

关键词：超高层，设计，金茂大厦，哈利法塔，王国塔

Introduction

I am often asked: How did you get interested in designing supertall buildings? When I was a young man and a student, I recall a moment in 1966 when I was driving into Chicago for the first time and I saw this mountain of buildings looming out of the horizon. It was a magnificent sight, all man-made, majestic and alive. It was that moment that I knew that I wanted to be a part of the world of supertall building design.

A year later I was hired by Skidmore, Owings and Merrill, and one of the first projects I worked on was the John Hancock Building, detailing the entries to the observatory, at the basement level. I went on to help design a very tight mechanical system for the second floor mezzanine space. That was a long way from where I wanted to be, professional speaking, but it was a start.

It would be 25 more years before I had the opportunity to design Jin Mao Tower, my first supertall, where we are today (see Figure 1). This was done via a competition process; the stipend was equivalent to $10,000 for a very complete schematic design effort, which wasn't much money. But this was during the

引言

人们经常问我：你是如何对超高层建筑设计感兴趣的？回想起来，那是1966年，我还是个年轻学生，第一次开车进入芝加哥，我看到一大片建筑浮现在地平线上，那场面真壮观， 雄伟，生机勃勃。 就在那一刻我意识到我想要成为超高层建筑设计世界的一员。

一年以后我被SOM建筑设计事务所（Skidmore, Owings and Merrill）雇用，我最早参与的项目之一是芝加哥汉考克大厦，为位于地下室的通往观景台的入口设计细部，后来我又帮助设计了二楼夹层中空间紧张的机械系统。这些工作离我想要做的相差很远，但从专业上说，这的确已经是个开始。

25年后我才有机会设计我的第一幢超高层建筑，就是我们现在所在的上海金茂大厦（图1），这个项目是通过竞赛得来的，完成一套完整的初步设计方案我们的报酬是1万美元，钱不多，但因为当时正处在1993年的经济衰退中，所以我们接了这个项目。这同时是个诱人的项目，因为421米的高度注定将成为当时中国的第一高楼，世界第三高楼，今天，金茂大厦的高度是世界第12位。

recession of 1993, so I took it on. It was tempting, also, because at 421 meters it was destined to be China's tallest building and the world's third-tallest; today it's the world's twelfth tallest.

By 1993, I had developed my philosophy of contextualism—the idea that buildings should engage the history, art, landscape, climate, vernacular architecture and indigenous materials of where it's located, and to interpret and honor the cultures they serve—and the Jin Mao competition offered an opportunity to apply this philosophy on a grand scale.

That year, a delegation from the client visited us in Chicago and made clear, early on, that they wanted an 88-story building. My first question was: Why? Why not two buildings on the site, say a 50-story office and a 38-story hotel, instead of a tall mixed-use building? After all, it would be cheaper and would be constructed much faster. They said it had to be 88 stories because Deng Xiaoping, the Chinese leader, was 88 when he stood on this very site and declared that it would be the new financial center of China. This happened in the eighth month of 1988. Later, at lunch at a restaurant in Chicago's Chinatown, after we had eaten and the fortune cookies were handed out, the client's chairman, Mr. Zhang, opened his and found the numbers 8, 16, 24, 32 and 40 on his fortune. Very excited, he showed it to all of us and quickly put it in his wallet. I then looked around the table and noted that there were eight of us, and that this was March 24: 3 x 8 = 24. I understood the significance of the number 8 to the client and to Chinese culture in general, and I knew right there that I would design this building around it.

We didn't base all of our design decisions around the number 8, of course, but it became intriguing to weave elements of it into the design. The elements of the building that worked best in conjunction with the number 8 came very naturally, such as the octagonal core, the eight main super-frame columns and the eight-sided exterior at the top. The setbacks of the building were also examined with eight-floor increments in mind. And very early on, we looked at the setbacks as mathematical increments of eight by doubling it, as in the form of the first setback (2 x 8 + 16 floors). We reduced the number of floors in each setback zone by one-eighth until we reached the hotel (16, 14, 12 and 10). At each eight-floor zone, the pace of setbacks was changed to single-floor increments at the hotel, or one-eighth of eight (8, 7, 6, 5, 4, 3, 2, and 1). The final combination of floors totaled 88.

The other major cultural influence I drew upon for Jin Mao was China's 5,000-year history of building pagodas, one of the precursors of the manmade skyscraper. Jin Mao is of course not a copy of a pagoda, but rather an analogy to the profile, in much the same way as the 1950s simple rectangular International style glass box forms were evocative of the towers at San Gimignano, Italy. The pagoda symbolized the center of gathering within villages and cities through ancient China, and as such, the analogy was fitting for the centerpiece of Shanghai's new Pudong Financial District.

In this sense, Jim Mao is uniquely Chinese in character and symbol. However, in its use of materials, building systems, the technology used to construct it, and the nature of its spaces and functions, it was a state-of-the-art, international building of the highest quality. And the pagoda-like form is also modern in other ways. The biaxial symmetry of Jin Mao responds to views from all directions, its gently stepping and undulating form ascending in a progressively rhythmic way, increasing the sense of height through the use of a forced perspective (see Figure 2). This also acts as a wind damper to diffuse the lateral wind forces on the mass, which can cause lateral movement in supertall towers that can be sensed by their occupants —a concern that I would also

Figure 1. Jin Mao Tower, Shanghai, China. Photo ©SOM. All rights reserved.
图1. 金茂大厦，上海，中国。SOM照片，版权所有。

Figure 2. Jin Mao Tower, Shanghai, China. Photo ©SOM. All rights reserved.
图2. 金茂大厦，上海，中国。SOM照片，版权所有。

到1993年，我已经形成了自己的主要的文脉主义的设计哲学，即建筑应融合当地的历史、艺术、景观、气候和乡土建筑形式与材料，并诠译和光大地方的文化，金茂大厦设计竞赛让我有机会在这样一个宏大的尺度上实践我的设计哲学。

那年，甲方的一个代表团来芝加哥访问我们，他们一上来就提出要一幢88层的大楼。我的第一个问题就是：为什么？为什么不在地段中建两幢建筑，比如一幢50层的办公建筑和一幢38层的酒店，而是选择建一幢高层混合功能的大楼？两幢建筑的方案造价低而且工期短。他们告诉我这必须是一幢88层的大楼，因为中国领导人邓小平当时就是站在这块地段上宣布了这里将是中国新的金融中心，邓小平那年88岁，那是1988年8月。后来，我们和甲方在芝加哥中国城吃午饭，饭后大家打开幸运饼，甲方主席张先生的幸运饼里的幸运数字是8.16.24.32和40，他十分兴奋，传给在座的每个人看，然后小心的收藏在钱包里。我环视餐桌，我们正好8个人，那天是3月24日， 3 x 8 = 24。我明白了8这个数字对于甲方，以致在整个中国文化中的重要意义。这顿饭后，我知道我要围绕8这个数字展开设计。

当然，不是所有设计决定都是围绕8这个数字定的，但是把8的因素融入设计非常耐人寻味，与8有关的建筑元素在设计中运用得天衣无缝，如八角形的建筑核心，八根主体框架结构的柱子以及建筑顶部外形呈八边形，在建筑体型的收分层数上我们也尝试了按8的倍数收分，从设计之初，我们就按8的倍数进行收分，如第一级收分在第16层（2x8=16），从这往上的收分按16的1/8（即2）逐级收分直到酒店层（各级收分分别是16，14，12和10层）

Figure 3. 7 S. Dearborn, Chicago, USA. Model photo ©SOM. All rights reserved.
图3. Dearborn南 大街7号，芝加哥，美国。 SOM模型照片，版权所有。

address on all my subsequent supertalls, although in very different ways.

Jin Mao received a great deal of attention internationally when it opened in 1999, and led to several new inquiries from clients looking to build supertalls. There were several failed efforts to win design competitions such as Central Station in Hong Kong and Kowloon Tower. There were also false starts like 7 S. Dearborn in Chicago and the Xiamen Post and Telecommunications Tower in China, both designed but never built. I learned a great deal from these efforts, including some of what could and could not be done in supertall building design, structurally and otherwise. I also learned that the existing knowledge base for supertall design was very limited. Each time a supertall design was started and got to the point at which wind-tunnel tests were conducted, the profession's knowledge of the typology was about 10% greater than before. One memorable leap was when we tested 7 S. Dearborn both with and without the slotted steps I had designed. We discovered a great advantage to the slotted structure that could greatly reduce the negative effects of wind vortices on the tower (see Figure 3).

Burj Khalifa

The opportunity to advance my experience in the supertall typology in a built project arrived in the form of a visit from representatives of Emaar Properties, a major developer in Dubai, which was interested in holding a competition to design the tallest building in the world, to be called Burj Dubai (see Figure 4). They had seen Jin Mao, which led to our being invited to participate in the competition in early 2003. We ultimately won with a scheme that was geometric in plan, starting with three branches and three pods. Setbacks occur at each programmatic element, decreasing the tower's mass as it rises toward the sky. At the tower's top, the central core emerges and is sculpted to form a finishing spire. Views of the Gulf and city are maximized throughout the building through the use of a Y-shaped floor plan inspired in part by certain early designs by Mies van der Rohe, Chicago's Lake Point Tower and my own design for Tower Palace III in Seoul, South Korea.

The setback pattern of Burj was both aesthetic and functional, particularly in terms of its function in response to the problem of wind vortices. By manipulating the architectural form of Burj, we were able to "confuse the wind" substantially, making the tower much more stable than any previous supertall building. We confirmed our findings by a series of wind tunnel tests, adjusting the concept until

，从酒店层开始，收分按8的1/8逐级收分（各级收分分别为8，7，6，5，4，3，2，1层），这样得出总共楼层为88层。

影响我设计金茂大厦的另一个文化因素是中国五千年的造塔历史，塔是摩天大楼的先驱，金茂当然不是原样复制一个塔，而是模仿了塔的轮廓，就像1950年代国际风格的简单玻璃方盒子建筑，让人联想起意大利圣吉米尼亚诺的高塔一样。塔在中国古代城市和村镇里象征聚集的中心，这个类比在金茂的设计中也非常适用，金茂是上海浦东新金融区的中心。

在文化意义上，金茂具有突出的中国特点和标志，但其建筑材料的选择、建筑系统、施工技术及建筑空间的性质和功能，都具有国际一流的品质和工艺。这种塔的造型在其他方面看也很现代，金茂双轴对称的平面呼应四面八方，平缓的收分和起伏，强化了透视感，增加了建筑的高度感，并使建筑体型充满上升的韵律。（图2）这种造型还是个减震器，分散了风作用在建筑实体上的横向力，从而减小了超高层建筑中使用者能够感受到的建筑摇动，这个问题我在接下来的其它超高层实例中还将讲述，以阐述其它的解决方法。

金茂大厦1999年落成时在国际引起很大关注，为我们带来了一些寻求建造超高层建筑的甲方。我们还参加了一些设计竞赛，但没有赢，如香港中央车站和九龙塔，另外还有一些项目完成了设计而没能够建成，如芝加哥的Dearborn南大街7号楼和厦门邮政通信大厦。通过这些设计我学到了很多东西，包括超高层建筑设计在结构和其它方面，什么能做，什么不能做，我也同时认识到现有的对于超高层建筑的知识是很有限的。每一个超高层设计从开始到进行风洞试验，我们对这种类型的建筑专业知识就比以前增长10%。记忆最深的飞跃发生在我们为Dearborn南大街7号楼做风洞试验时，我同时设计了有和没有沟槽退台的体型，我们发现有沟槽的结构在减小风涡对塔楼的负面影响方面，具有很大的优势（见图3）。

哈利法塔

埃玛尔地产（Emaar Properties）代表的来访，给了我在建成项目中扩展超高层建筑类型的设计经验的机会，埃玛尔地产是迪拜的重要开发商，他们想组织一个设计竞赛，做世界第一高楼，起名叫哈利法塔（Burj Dubai）（图4），他们见过金茂大厦，是金茂让我们在2003年初得到了竞赛邀请，我们最终赢了竞赛，我们采用几何形平面，基本形状像植物的三个分支加三个角果。

Figure 4. Burj Khalifa, Dubai, United Arab Emirates. Photo © Adrian Smith + Gordon Gill Architecture; photo by James Steinkamp.
图4. 哈利法塔，迪拜，阿拉伯联合酋长国。艾德里安-史密斯和戈登-吉尔建筑师事务所照片，版权所有。摄影:James Steinkamp.

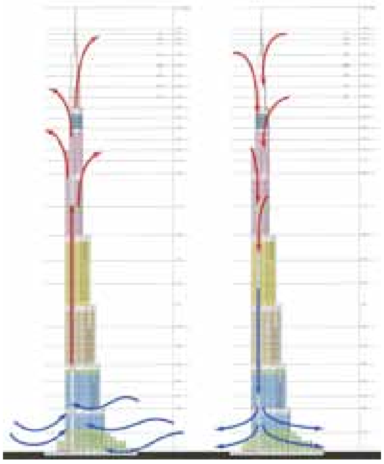

Figure 5. Burj Khalifa stack effect mitigation strategies. Diagram ©SOM. All rights reserved.
图5. 哈利法塔叠加收分示意图。SOM示意图，版权所有。

we got the stepping system to optimum performance and verifying that the building shape responded properly to the maximum winds expected on the site. We also took several steps to mitigate the stack effect, which in Burj means that, due to the height of the building and difference between the internal and external temperature, indoor air tries to travel downward and flow out of the bottom of the building (see Figure 5). To address this issue, we minimized the infiltration/exfiltration of the exterior wall.

But the problem of wind forces was far from the only issue I was confronting. As always, it was important to me for Burj to be culturally contextual, which led me to search for elements within the existing context and culture of the area to draw inspiration from. Within the Middle East and in Dubai, there are strong influences of onion domes and pointed arches, and patterns that are indigenous to the region, some of which are flower-like with three elements, some with six, and so on. You can see the flower image in the building in plan, or from the air, looking down from a plane or from the observatory. The reference to the Islamic dome structures can be seen when looking up at the legs or branches of the tower and looking at the plan of each section of the building's three legs. The pointed dome form in plan also became an ideal form for the development of bay-like windows from individual units to provide a more panoramic view of the city and the Gulf. Other influences include spiral imagery, and the philosophy embedded in Middle Eastern iconographic architecture and motifs. These forms helped inspire the overall composition of Burj, which is, finally, a vertical object reduced and transformed by spiral reduction of branch lengths until it reaches its central shaft, at which point the shaft peels away to reveal a triptych configuration that erodes in a spiral manner until a single spire remains (see Figure 6).

There were also proportional issues in the massing that had to be resolved, particularly in relation to the building's height. As I mentioned, Emaar was interested in having Burj be the tallest building in the world, but that standard could have been met with a building much shorter than the one we ended up designing. But I envisioned Burj as a very elegant, slender building, and to resolve the design in an appropriately proportional way required a great deal of height--quite a bit more than Emaar had originally expected. Fortunately, Emaar's chairman, Mohamed Alabbar, understood these issues, and gave me the freedom to design a building that was as tall as it needed to be. When the building opened in January of 2010 under its new name, Burj Khalifa, its official height was announced at 828 meters.

建筑随功能分区不同进行收分，越往上建筑体量越小，在建筑顶端，主体核心部分显露出来，体型塑造成顶端尖塔。得益于Y字形平面，整个建筑都最大程度的拥有海湾和城市景观，这个Y字形平面的灵感，一是来自于密斯·凡德罗设计的芝加哥湖景大楼（Lake Point Tower），二是来自我设计的韩国首尔的塔宫三期建筑。

哈利法塔的收分规律既是美学要求也是功能要求，特别是在功能上应对风涡问题，通过改变哈利法塔的体型，我们能够‘迷惑风的作用’，从而使哈利法塔比它之前设计的任何超高层建筑更为稳定。我们的这些发现在一系列的风洞试验中得到印证，通过调整建筑体型使建筑收分系统在当地最大风力是达到最高效能。我们还采取了几项措施减小建筑的烟筒效应，在哈利法塔中表现为由于建筑高度和室内外温度差，室内空气会向下流动，试图从建筑底部流出（图5），未解决这个问题，我们让空气通过外墙的渗入/渗出达到最小。

风力作用的问题还不是我们面临的唯一问题，和以往一样，我很关注哈利法塔的文化脉络，由此我努力寻找当地现存的文脉，以求从中得到设计灵感。在中东地区和迪拜，洋葱式穹顶和尖拱影响很大，还有很多具有地方特色的图案，如三元的，六元的和更多元的花的图案，从建筑平面里能看到花的图案，从空中或观景台上也能清楚看到。哈利法塔的三条腿从下往上看，或者观察每条腿的建筑平面，都能看到类似伊斯兰穹顶的结构。在平面上，尖拱的形式像是一系列飘窗，使每个单元都有更为开阔的城市和海湾景观。其它的文化影响还包括旋转的图形，和饱含中东哲学思想的影像和图案。在这些图案的启发下，哈利法塔的整体结构最终成为建筑分支在竖向围绕中心旋转，逐渐变短，直到主体核心露出来，主体核心再次三相旋转上升变小，最终成为塔尖(图6)。

哈利法塔还有体型比例的问题需要解决，特别是对于建筑 的高度问题。如我上面提到过的，埃玛尔要把哈利法塔建成世界第一高塔，要达到这个目标，我们完全可以做一幢比这个设计矮得多的楼。但是在我的想象中，哈利法塔应该是一幢优雅的、纤细高条的建筑，要使设计达到这样的比例，需要相当大的高度，远远高于埃玛尔先前预想的高度。幸运的是，埃玛尔的主席莫哈默德·阿拉巴（Mohamed Alabbar）先生完全理解这个问题，给了我们充分的自由，把建筑设计到理想的高度。当哈利法塔（后改名

Figure 6. Burj Khalifa, Dubai, United Arab Emirates. Photo © Adrian Smith + Gordon Gill Architecture; photo by Tim Griffith.
图6. 哈利法塔，迪拜，阿拉伯联合酋长国。艾德里安-史密斯和戈登-吉尔建筑师事务所照片，版权所有。摄影：Tim Griffith.

Figure 7. Zifeng Tower at Nanjing Greenland Financial Center, Nanjing, China. Photo © Adrian Smith + Gordon Gill Architecture; photo by James Steinkamp.
图7. 南京绿地金融中心紫峰大厦，南京，中国。艾德里安-史密斯和戈登-吉尔建筑师事务所照片，版权所有。摄影:James Steinkamp.

Figure 8. Pearl River Tower, Guangzhou, China. Photo © Adrian Smith + Gordon Gill Architecture.
图8. 珠江大厦，广州，中国。艾德里安-史密斯和戈登-吉尔建筑师事务所照片，版权所有。

Zifeng Tower

At the same time I was designing Burj, I was also working on another supertall: Zifeng Tower at Nanjing Greenland Financial Center (see Figure 7), which opened in 2010 in Nanjing, China, and at 450 meters is the world's seventh tallest completed building. Cultural context was prominent in my thinking here, with Zifeng Tower's form derived from three elements of life in Nanjing: the Yangtze River flowing through the city; the lush green landscape environment and garden city atmosphere; and the dragon and column iconography so prevalent in Chinese culture.

Zifeng Tower is shaped in a triangular form to relate to the shape and size of the building's site and to take maximum advantage of the views of the mountains, lake and historic buildings in Nanjing. The stepping of the tower relates to the functions within the building and the desire to shape the floor plates to achieve maximum efficiency. The tower's curved corners present a soft, continuous surface to the exterior. The vertical and horizontal clear glass seams separating the differentially textured glass surfaces of the tower are metaphorically analogous to the clear water of the Yangtze River separating two interlocking dragon forms. The exterior treatment changes direction from one major component to the other in an effort to more clearly identify the two dragon forms interlocked around the central core of the building. The exterior wall of this tower has a distinctive directional feature. Each pane of glass is angled at 7 degrees from the occupied space, and the module alternates or staggers by 0.75 meters from floor to floor to imbue the skin of the building with a scale-like quality that emphasizes the similarity of the building's components to those of China's mythical dragons.

Pearl River Tower

Late in my tenure at SOM, I worked with Gordon Gill on the design of another supertall, the 71-story Pearl River Tower (see Figure 8), which opened this year in Guangzhou, China. We designed this building to be very close to net-zero-energy and carbon-neutral on an annualized basis. We didn't get all the way to net zero, largely because the power grid in Guangzhou was unequipped to receive donated energy from individual buildings, but we're still very proud of Pearl River, which

为哈利法塔）2010年落成时，官方公布的高度是828米。

紫峰大厦

在我设计哈利法塔的同时，我还在做另一栋超高层建筑-南京绿地金融中心紫峰大厦（图7），它于2010年在中国南京落成，高度为450米，是世界上建成的高塔之中排名第七。在这个项目中追求文脉是我的重点，紫峰大厦的形式是从南京生活的三个主要的东西中衍生出来的，一是穿城而过的长江；二是广袤的绿地和花园城市的环境；三是中国文化中的蟠龙柱的图形。

紫峰大厦平面呈三角形，与地段的形状和大小相适应，并且最大程度地利用周围山、湖和南京古建筑的景观。建筑的退台和内部功能有关，用最理想的平面形式提高建筑的利用效率。大楼的曲线转角表现了柔软而连续的建筑外立面，竖向和横向的透明玻璃线条分割出大楼表面不同质感的玻璃，象征长江之水分隔开两条交错的神龙，建筑外墙的处理上，通过改变外墙主要部件的方向，使外墙两大部分十分明显，表现交错的龙紧紧着围绕建筑核心。紫峰大厦的外墙具有独特的方向感，每片玻璃都向外倾斜7度角，同时玻璃的模数与楼层之间的模数错开0.75米，这样，建筑的外表形成一种渐变的鳞状质感，突出了建筑表现两条中国神龙的主题。

珠江城

我在SOM工作的最后几年，我和戈登-吉尔合作设计了另一座超高层建筑，就是71层高的，于今年在中国广州落成的珠江城（图8）。我们的设计是要让建筑的年度指标非常接近净零能耗和碳中性，我们最终没有实现零能耗，是因为广州的市政电网没有接收单体建筑所贡献的电能，即便如此，我们仍然为珠江城感到骄傲，我们相信它是至今世界上最具可持续发展的超高层建筑。我们根据空气动力学原理设计的建筑体型和朝向，正对南面的主导风向，使风加速穿过建筑内置的涡轮机组。建筑的体型也有利于利用内置的光伏发电和提高结构性能，如涡轮机的孔洞减小了建筑结构的风压。

迪拜1号

2006年年底，戈登、罗伯特-佛鲁斯特和我离开SOM，在芝加哥成立了自己的公司，就是艾德里安-史密斯和戈登-吉尔建筑师事务所。仅在一年多以后，我们就赢得了一项重要的国际竞赛，在阿

we believe to be the world's most sustainable supertall. We designed an aerodynamic tower oriented and shaped specifically to harvest wind power by directly facing the prevailing winds from the south and funneling them into building-integrated turbines at accelerated speeds. The tower's shape also facilitates building-integrated photovoltaics and improves structural performance, as the wind-turbine apertures act as pressure release valves.

1 Dubai

In late 2006, Gordon, Robert Forest and I left SOM to form our own firm in Chicago, Adrian Smith + Gordon Gill Architecture. In just over a year, we won a major international competition to design three supertall structures in the United Arab Emirates, including 1 Dubai (see Figure 9), a trio of supertall towers of staggered heights (each at least 600 meters) joined near the base. A city within a city, this giant mixed-use project was envisioned as the centerpiece of Dubai's Jumeira Gardens development, now on hold due to economic conditions there. On its tripedal base, 1 Dubai rises over a canal that forms an oasis in the center. From there, viewers would look up through the great atrium-like space between the three towers. At night, we envision a giant beam of light lancing up through the atrium, creating a virtual fourth tower. On special occasions, the oasis would transform itself into a unique event and performance space, with a floating stage surrounded by barges doubling as seating banks. High above, a series of three-story skybridges connects the towers as they taper upward. The skybridges offer great views, help stabilize the towers structurally and facilitate interfloor circulation.

Kingdom Tower

That brings me to our latest supertall project, Kingdom Tower (see Figure 10), which at more than 1,000 meters will be the new world's tallest building when completed in 2017 in Jeddah, Saudi Arabia. Kingdom Tower will feature a Four Seasons hotel, serviced apartments, Class A office space, luxury condominiums and the world's highest observatory. Work on the site began Jan. 1 of this year.

The symbolism of the project is obviously important. Our vision for Kingdom Tower is one that represents the new spirit of Saudi Arabia. It

Figure 9. 1 Dubai, Dubai, United Arab Emirates. Rendering © Adrian Smith + Gordon Gill Architecture.
图9. 迪拜1号，迪拜，阿拉伯联合酋长国。艾德里安-史密斯和戈登-吉尔建筑师事务所渲染图，版权所有

Figure 10. Kingdom Tower, Jeddah, Saudi Arabia. Rendering © Jeddah Economic Company/Adrian Smith + Gordon Gill Architecture.
图1. 帝国大厦，吉达，沙特阿拉伯。吉达经济公司/艾德里安-史密斯和戈登-吉尔建筑师事务所渲染图，版权所有

拉伯联合酋长国设计三座超高层建筑，三座高度不同的超高层塔楼（每座高度都超过600米）在基部相连，迪拜1号是其中之一（图9）。这个超大综合体是一个城中城，目标是要成为迪拜Jumeirah花园开发的核心部分，但因为经济的原因，项目被暂时搁置。迪拜1号的三叉形底部从一条运河上升起，形成河中间的一块绿洲，三座高耸的塔楼中间形成一个高大的中庭空间，夜晚，我们设计了一条巨大的光柱穿过中庭射入夜空，虚拟成第四幢塔。在特殊节日，整个绿洲成为庆祝和演出的空间，水上舞台四周是驳船连成的观众席，空中，有一系列三层楼高的桥连接三座倾斜向上的塔楼，这些桥提供了绝妙的景观，同时也起到了稳定塔楼结构、联系塔楼楼层交通的作用。

王国塔

现在来讲我们最新设计的超高层-沙特阿拉伯吉达市王国塔（图10），它的高度超过1000米，2017年建成后将成为世界第一高塔，王国塔内部包括一座四季酒店、服务式出租宅、A级办公空间、豪华公寓和世界最高的观景台。今年1月1日正式开工。

王国塔的象征含义明显十分重要，我们想象它代表沙特阿拉伯王国的新精神，即引领世界金融和文化的新精神。它同时是新兴、高效科学技术打造的强有力的新偶像。像哈利法塔一样，王国塔的设计体现了高技术和全自然的特点，塔的体型高挑，稍稍不对称，像一捧向上的树叶，枝繁叶茂，生机勃勃。

三瓣形平面是十分理想住宅平面，向上收分的体型使建筑富于动感，同时也减小了风涡效应造成的结构负荷（我们的风洞试验证明，在减小风涡对结构的负荷方面，王国塔的向上收分体型和哈利法塔的退台体型一样有效，甚至可能做得更好.）王国塔高性能的外墙系统，通过减少热负荷，使建筑能耗达到最小。另外，国王塔的三面还设计了一系列凹槽，为建筑提供了深远的遮荫和宽阔的室外露台，从这里眺望，吉达市和红海的美景尽收眼底。

王国塔突出的高度需要最尖端的电梯系统与之配套，整个建筑共有59台电梯，包括54台单层电梯和5台首层电梯，还有12台自动扶梯。直达观景台的电梯双向运行的速度是每秒10米。另一个建筑特色是塔顶平台，直径大约30米（98英尺），位于第157层（图11），是顶层复式住宅单元的活动天台，它原先的设计是直升飞机起落坪，后来的研究表明这在功能上并不实用，但我们和甲方都深深的喜爱这个建筑元素，所有天台被保留下来，毫无疑问，在这里举行招待会，将会是举世无双的体验。

symbolizes the Kingdom as an important global business and cultural leader. It represents new growth and high-performance technology fused into one powerful iconic form. Like that of Burj, the design of Kingdom Tower is both technological and distinctly organic. With its slender, subtly asymmetrical massing, the tower evokes a bundle of leaves shooting up from the ground—a burst of new life that heralds more growth all around it.

The three-petal footprint is ideal for residential units, and the tapering wings produce an aerodynamic shape that helps reduce structural loading due to wind vortex shedding. (Our wind-tunnel testing indicates that Kingdom Tower's sloped shape will accomplish this just as well as the stepped setback pattern of Burj, and perhaps even better.) The project also features a high-performance exterior wall system that will minimize energy consumption by reducing thermal loads. In addition, each of Kingdom Tower's three sides features a series of notches that create pockets of shadow that shield areas of the building from the sun and provide outdoor terraces with remarkable views of Jeddah and the Red Sea.

The great height of the tower necessitates one of the world's most sophisticated elevator systems. The complex will contain 59 elevators, including 54 single-deck and five double-deck elevators, along with 12 escalators. Elevators serving the observatory will travel at a rate of 10 meters per second in both directions. Another unique feature of the design is a sky terrace, roughly 30 meters (98 feet) in diameter, at level 157 (see Figure 11). This is an outdoor amenity space intended for use by the penthouse floor. We originally designed it as a helicopter pad, but further research made that function appear impractical. By that time, however, we'd fallen in love with it as an architectural element, and so had the client. So it stays as part of the design, and no doubt will prove to be one of the world's most remarkable spaces in which to attend a reception.

New and future designs

Beyond Kingdom Tower, Gordon and I continue to examine the possibilities for what supertall buildings can be. In the process, we draw on the lessons of our past work. For example, our design for Wuhan Greenland Center (see Figure 12), now in the early stages of construction in China, advances some of my ideas from 7 S. Dearborn, particularly in its use of vents to improve structural performance. We have also worked on a speculative design for a mile-high tower, which, at least in the popular imagination, is the obvious next milestone in the evolution of the typology.

The biggest single limiting factor in creating a mile-high building is the elevator systems, which currently max out at about 575 meters in a single shaft. To get to the top of a mile-high structure, you'd have to transfer from one elevator to another at least three times, perhaps more—which is inconvenient, obviously, and time-consuming. For that reason, elevator system technology will have to advance considerably from its current state before a mile-high building will be practical. A second major limiting factor is the issue of area inside such a tall structure. To support its weight, the base of a mile-high building would probably have to be very large, creating a great deal of open space inside. What do you do with all that space, inside which occupants would be very far from windows and natural light? If it's an atrium, that's an extremely large atrium, and would that make economic sense? I'm not sure.

Of course, that won't keep us from working on the problem.

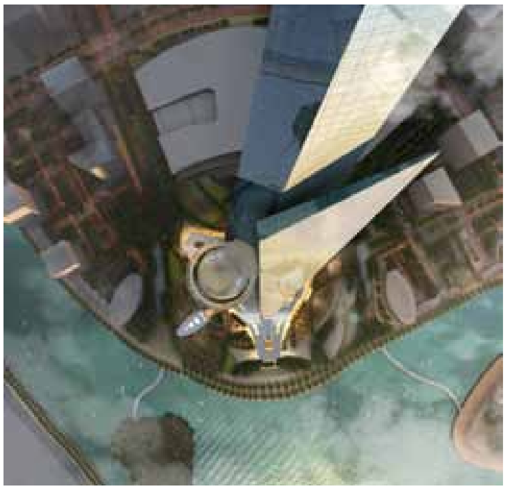

Figure 11. Kingdom Tower, Jeddah, Saudi Arabia. Rendering © Jeddah Economic Company/Adrian Smith + Gordon Gill Architecture.
图11. 帝国大厦，吉达，沙特阿拉伯。吉达经济公司/艾德里安-史密斯和戈登-吉尔建筑师事务所渲染图，版权所有

Figure 12. Wuhan Greenland Center, Wuhan, China. Rendering © Adrian Smith + Gordon Gill Architecture.
图12. 武汉绿地中心，武汉，中国。艾德里安-史密斯和戈登-吉尔建筑师事务所渲染图，版权所有

未来的新设计

继王国塔之后，戈登和我还会继续探索超高层建筑的各种设计可能性，在这过程中，我们会从过往项目的经验中不断学习提高。例如，正在施工中的武汉绿地中心（图12），我们在设计中进一步完善了我在Dearborn南大街7号楼的一些想法，特别是利用风道强化结构的理念。我们还做了一个虚拟的1英里(大约1600米)高的超高层方案，至少在大众眼里，将成为超高层建筑设计演化中的下一个里程碑。

限制超高层建筑高度的最大障碍是电梯系统，目前，单独电梯井能达到的最大高度是575米，要让建筑高度达到1英里（1600米），至少要转换3次电梯，也许更多，这非常不便而且费时。应此，只有在电梯技术大幅度提高之后，英里高超高层才能成为现实。另一个限制超高层建筑高度的障碍是建筑内部面积的利用问题，为支持建筑的重量，英里高超高层的底座必定相当巨大，产生巨大的室内空间，怎样利用这些空间是个问题，因为这些空间的很大部分都远离窗户和自然光。当然可以做成中庭，但将是非常巨大的中庭，这能有经济效益吗？这些我都不能肯定。

当然，所有这些都不能让我停止探索。