Asia Ascending

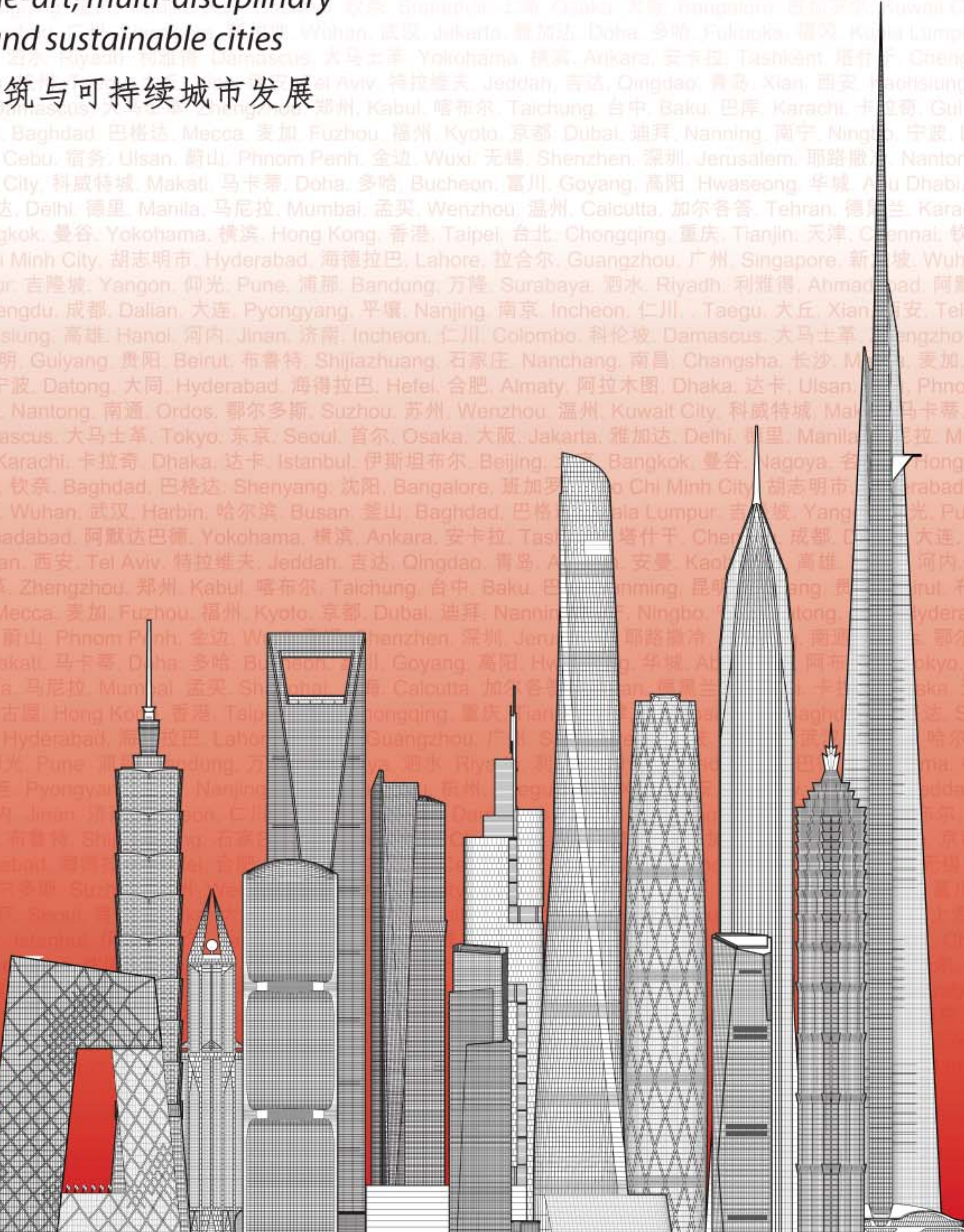
Age of the Sustainable Skyscraper City

崛起中的亚洲

可持续性摩天大楼城市的时代

A collection of state-of-the-art, multi-disciplinary papers on tall buildings and sustainable cities

多学科背景下的高层建筑与可持续城市发展最新成果汇总



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That the 21st Century will be the age of the Asian Skyscraper seems indisputable. Already, the past two decades have witnessed a **major shift** in tall buildings from west to east. Many of the major advances in the tall typology are now taking place in Asia, often with a collaboration of eastern and western expertise. With global urbanization approaching **200,000 people** every day, the need for a new or extended city of a million inhabitants every week is driving **massive growth** in hundreds of Asian cities simultaneously – from Mecca to Manila, Istanbul to Incheon, Karachi to Kunming.

At the same time, there is still **intense global debate** on whether the extrapolation of our cities vertically offers the best chance to combat global **climate change,** or whether a more sustainable pattern of life can be better achieved through other means. Tall buildings are not the only solution for achieving increased **urban density,** and the higher embodied energy of constructing and existing at greater heights may offset gains in land and infrastructure efficiency. The **impact on inhabitants** of future vertical cities must also be better understood. In all cities, infrastructure, long-term planning, and joined-up thinking are essential. The major issues are no longer focused on just individual buildings, but how these buildings fit into the larger **urban whole.**

In this publication the Council on Tall Buildings and Urban Habitat brings together a number of state-of-the-art, multi-disciplinary papers, initially presented at the CTBUH 2012 9th World Congress Shanghai, to examine these poignant issues. Is the skyscraper a sustainable building type? Can tall buildings truly reduce and harvest enough energy to become **carbon-neutral?** What is the full impact on the city and the lives of its inhabitants by developing skyward? And what support mechanisms and **urban infrastructure** are required for such growth?

In short, the publication asks the question: Does the vertical city offer the best chance for **human survival** in our rapidly-populating, urbanizing, consuming, and resource dwindling world?

二十一世纪，将毋庸置疑的成为亚洲摩天大楼高速发展的时代。在过去的这二十年我们目睹了高层建筑从西方向东方的**显著转移**。目前高层建筑的许多重大进展都发生在亚洲，将东西方技术完美的结合。在全球城市化以每天**20万人**的速度增长之际，每周都会发现一批能容纳一百万居民的新生城市或是扩张城市在以成倍数量**快速繁殖**——从麦加到马尼拉，从伊斯坦布尔到仁川，从卡拉奇到昆明，无一例外。

同时，一个**激烈的全球性的生活模式争论**一直存在着：垂直城市是否是我们与全球**气候变化**抗衡的最佳方式，或者是否可以通过其他方法获得一种更具可持续性的生活模式？高层建筑不是解决不断增长的**城市人口密度**的唯一途径，并且建设过程中不断增长的能源消耗和在不断增加的高度上的生活也会抵消掉基础设施的效率和我们在陆地上的收获。同样，我们必须更深入地了解其对未来垂直城市生活模式的**聚居者所造成的影响**。在所有城市和基础设施中，长远的规划和多角度结合的思考都是必不可少的。这些主要问题的焦点已不再聚集于单个的建筑物上，而是这些建筑物将如何被安置在**更大的城市空间**内。

在此出版物中世界高层都市建筑学会集合了众多在2012年第九届上海全球会议首次演讲的高水准、多学科论文来审视这些深刻的问题。摩天大楼是可持续性的建筑类型吗？高层建筑真的能降低能源消耗并得到足够的能源来达到**碳平衡**吗？建筑高度向天际发展时将给城市及其栖息生命带来的全面影响是什么？应对这样的增长有需要怎样的支撑机制和**都市的基础设施**的配合？

简言之，本出版物探求了：垂直城市在这个人口急速增长、城市化进程加速、高消耗和资源逐渐减少的世界中是否能为**人类的生存**提供最佳解决方案？

Note: The sections of this publication are organized according to track sessions presented at the CTBUH 9th World Congress Shanghai 2012, where **P** refers to Plenary session, **T** refers to general track session and **PO** refers to Poster Session. Please note that sections **T10** and **T26** have no content since these were congress panel discussions not substantiated with papers.

备注：本出版物内容将根据2012世界高层都市建筑学会上海全球会议分会演讲顺序进行排列，其中**P**表示全体大会，**T**表示普通分会，**PO**表示海报分会。请注意由于分会**T10**与**T26** 是座谈小组讨论，无实体论文，因此不包含在内。

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Introduction
引言

Recent Global Trends in Tall Buildings: Asia Ascending

Although there have been intense periods of tall building construction in concentrated geographic areas throughout history – late nineteenth century Chicago, Art Deco New York, or post-second world war Europe for example – the tall building boom of the past two decades has been unprecedented in that it has taken place across virtually the entire globe simultaneously – from Toronto to Tokyo, Rio to Riyadh, Brisbane to Beijing. The facts are staggering. By the end of 2012, it is predicted that 58 of the 100 tallest buildings in the world will have been completed in the past seven years, since the end of 2005.

In terms of supertall buildings (i.e., those in excess of 300 meters – or 984 feet – in height), there were only 13 supertall buildings in existence internationally in 1990. By the end of 2012 this number is expected to be around 70; a 538% increase in just two decades. A dozen or so supertalls are expected to complete in 2012 alone – more than any other year in history.

It is not just at the supertall end that tall buildings have been proliferating. As the graph on all tall buildings greater than 200 meters shows[1] (see Figure 1), the total number of buildings over 200 meters in existence globally (predicted to be around 780 by the end of 2012) has more than doubled in the last ten years. This year alone, 70–90 buildings over 200 meters are expected to be completed, compared with a typical 8–12 buildings of that height completing annually during the 1990s. And that is against the backdrop of most major western economies still recovering from the 2008–09 recession, and thus not actively building tall at all, currently.

What is perhaps not apparent from these overall statistics, however, is how the world of tall buildings has changed fundamentally over the past decade or two, with a number of trends now evident. These trends are in addition to the simple trends of more – and taller – tall buildings being constructed, and demonstrate fundamental shifts in the industry (see Figure 2).

The first of these trends is that the predominant location of the tallest buildings in the world has been changing rapidly. Whereas as recently as 1990, 80% of the World's 100 Tallest were located in North America, by the end of this year that figure is expected to be only 20%, with the shift occurring predominantly to Asia (42%, with 34% in China alone), and the Middle East (32%, with 21% in Dubai alone). If the Middle East is classed as being part of continental Asia (which, for the purposes of the CTBUH 9th World Congress Shanghai and these proceedings, it is), then by the end of this year, 74% of the World's 100 Tallest Buildings will be located in Asia, up from only 12% in 1990.

Perhaps more interesting than the number, height, and location statistics, is how the function and structural material of the tallest buildings has been changing, with major moves away from the steel

世界高层建筑发展的最新趋势：崛起中的亚洲

尽管在历史上高层建筑曾经在某些地区有过集中建造的时期——例如在十九世纪末的芝加哥、装饰艺术时期的纽约以及二战后的欧洲——但在过去的二十年里，高层建筑同时在世界各地获得了空前的发展——从多伦多到东京，里约热内卢到利雅得，布里斯班到北京。这一事实是惊人的。到2012年底，目前世界最高的100座建筑中，有58座是从2005年底到现在的七年中建成的。

就超高层建筑而言（即高度上超过300米——或984英尺），在1990年全球范围内仅有13座，而到了2012年底这一数字有望达到70左右，即在过去的二十年里增长了538%。单单在2012年就预计有十几座超高层建筑建成，为历史之最。

然而超高层建筑的迅速发展还未结束。正如图表中显示的所有高度超过200米[1]的高层建筑（见图1），全球现存的200米以上的高层建筑总数（预计在2012年底将达到约780座）在过去的十年里翻了一倍还多。单单在今年，预计有70-90座超过200米高的建筑建成，而在20世纪90年代基本上每年只有8-12座如此高的建筑建成。这还是在大多数西方主要经济体仍处于2008年-2009年经济衰退的恢复中发生的，因此他们目前的高层建设并不活跃。

然而这些总体的统计数据也许并没有明显地反映出高层建筑领域已经在过去的十年或二十年间是怎样发生了根本性的改变，这些改变伴随着的很多趋势如今也非常明显。除了简单地证明有更多更高的高层建筑正在兴建，这些趋势还体现了行业内的根本性转变（见图2）。

这些趋势中首先体现出的是拥有最高建筑的主导性地区已经迅速发生改变。近至1990年，世界最高的100座建筑中有80%位于北美，而到今年年底这一比例预计仅有20%，主导地区转向了亚洲（42%，仅中国就占34%）和中东地区（32%，仅迪拜就占21%）。如果中东地区可以被归为亚洲大陆的一部分（亚洲是在上海召开的CTBUH第九届全球会议和这本论文集的议题），那么到今年年底，亚洲拥有世界最高的100座建筑的数量将从1990年的12%增长到74%。

也许比数量、高度和地区统计更值得关注的是最高建筑的功能和结构材料已经发生改变，不再是那些主导最高建筑排名几十年的钢结构办公大厦了。我们现在看到的排名中具有居住和混合使用功能的建筑，在这个世纪之交从12%增长到53%。而在过去的十年里混凝土与复合结构的应用使得单一的钢结构建筑所占比例从39%下降到14%，而近至1970年这一比例高达90%。

有很多原因可以解释为什么高层建筑的功能转向了居住与混合使用，并非仅仅归因于一种“边缘投注”的商业性诱因，即根据市场对办公、居住、酒店等功能的波动性需求而将其都包含在建筑业态中。对于更加可持续的生活方式（详见下面的“城市可持续性的未来”）的需求以及对城市中心区能够保持长达24小时活力的渴望也起到了重要作用。另外，如果建得这么高的目标是有一个主导性功能，并且建造居住功能的高层建筑比办公更容易实现，那么这一转向也是合理的。住宅的楼板可以比办公建筑的楼

[1]The focus on buildings over 200 meters in height is driven by the need to ensure accuracy of data, rather than suggesting that this is the threshold for a tall building. Even projects over 200 meters in height can be difficult to stay abreast of, especially in rapidly developing markets such as China, thus accuracy of data would diminish at height thresholds less than this, though the trends would largely be the same. Readers should also be aware of the difficulties in predicting the number of skyscrapers to complete in a year at the halfway point of that year (as is the case while currently writing this), especially given the tendency of building developers and consultant teams to give rather optimistic completion predictions! This is even more evident when predicting completion figures for future years, based on the current status of projects under construction. For this reason our predicted completion numbers are listed as an expected range (see Figure 1), rather than a single definitive figure.

[1]聚焦高度超过200米的建筑是为确保数据的准确性，而并非表明这一高度是区分高层建筑的临界值，即使高度超过200米的项目已经很难准确统计，特别是在像中国这样迅速发展的市场。因此，如果将这一临界值设定在200米以下，数据的准确性会降低，即使趋势大致上是一样。读者还需要注意的是，在年中（正是我现在写这篇文章的时间），预测摩天大厦在全年的建成数量也是困难的，尤其是考虑到开发商和顾问团队乐观估计其项目完工进度的情况下！基于正在建造中的项目的当前状况，这一问题在预测未来几年的建成量时显得更加突出。出于这个原因，我们列出的项目预计建成数字只是一个预期范围（见图1），而非单一的确切数字。

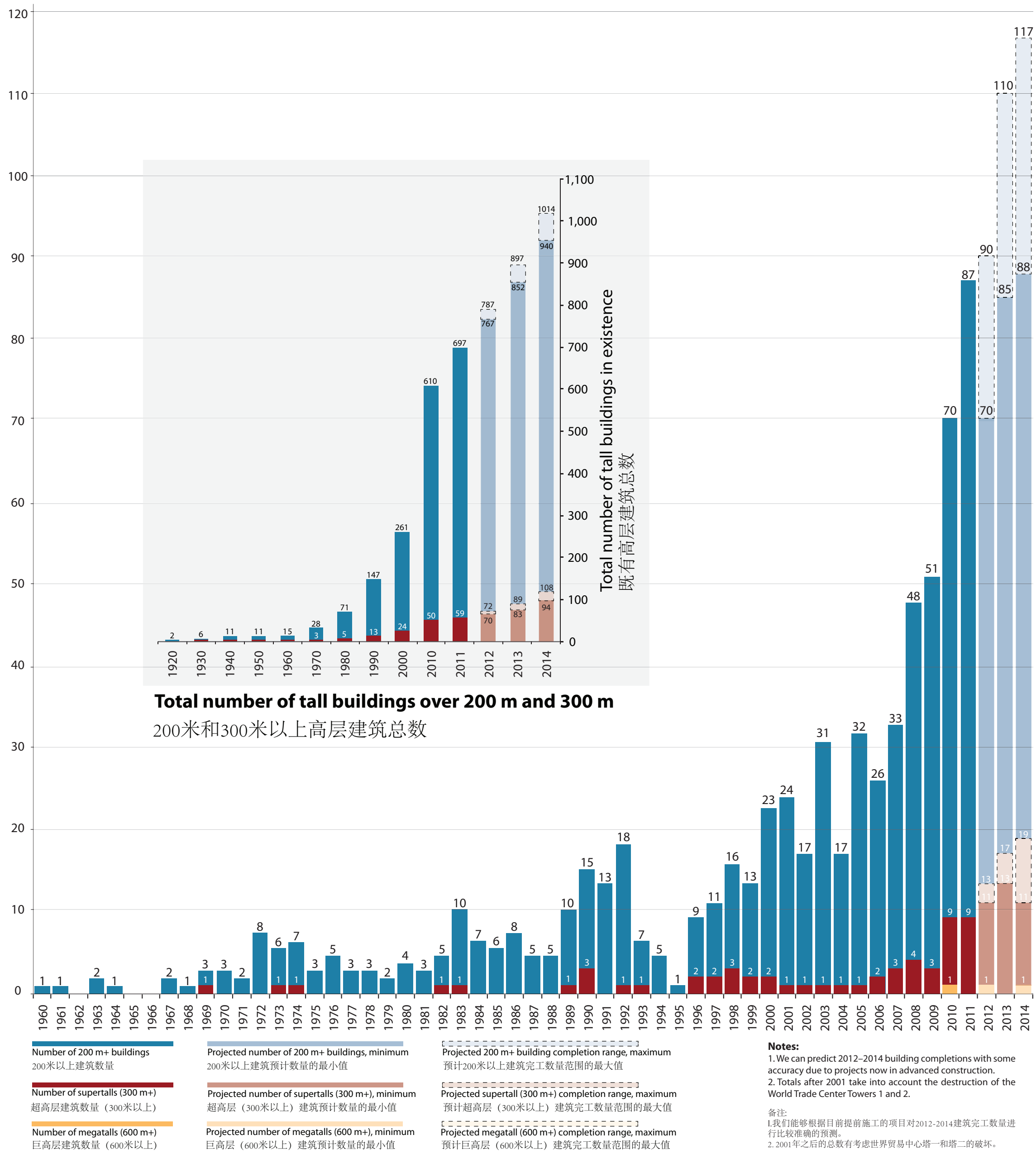


Figure 1. Tall buildings completed each year over 200 m, 300 m, and 600 m since 1960. Inset shows total numbers of completed buildings by decade, revealing exponential growth rates.

图1. 自1960年每年建成的200米，300米和600米以上高层建筑。插入的图表显示了每十年中高层建筑的建成量，可看出呈指数增长状态。

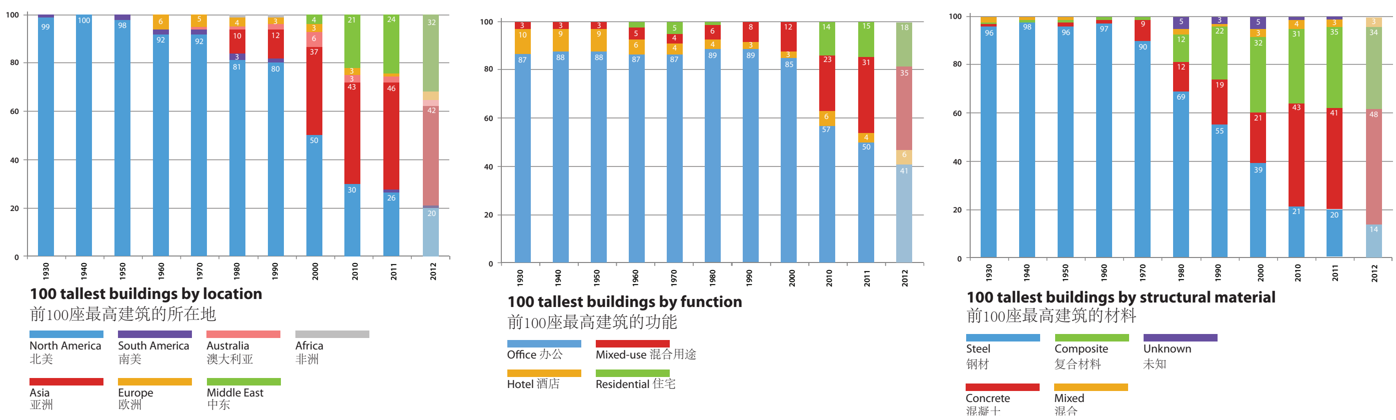


Figure 2. Graphs of Tallest 100 Buildings in the world each decade since 1930 – depicting trends in function, material, and location; mixed-use functions, concrete construction and locales in Asia have prevailed.

图2. 自1930年，每十年世界最高的100座建筑的功能、材料和地区的统计，显示了高层建筑的主导性特征：混合使用的功能、混凝土建筑、以及项目地点位于亚洲。

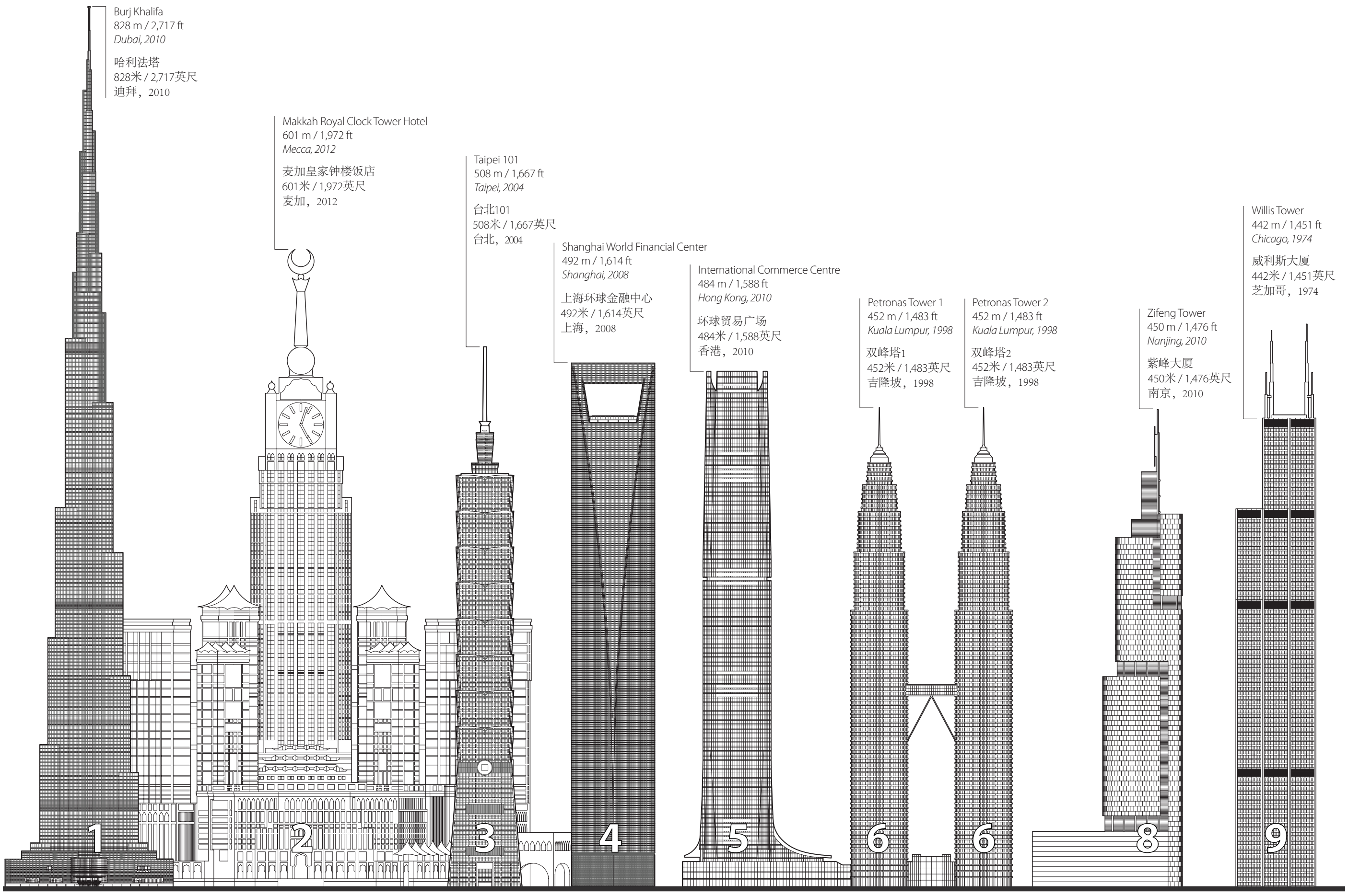


Figure 3. Diagram of the World's current tallest 20 buildings (as projected by the end of 2012) according to the CTBUH Height Criteria of "Height to Architectural Top." For more information on CTBUH's Height Criteria, see pages 898–901.
图3. 依据CTBUH高度评判标准中的“至建筑顶端的距离”的标准统计出的当前世界最高的20座建筑（预计到2012年底）。更多有关CTBUH建筑高度评判标准的信息，请见898—901页。

office buildings which have dominated the tallest lists for many decades. We are now seeing residential and mixed-use functions influence the list, up to 53% from 12% at the turn of the century, while solely steel buildings have dropped from 39% to 14% in favor of concrete and composite structure over the last decade, and from 90% as recently as 1970.

There are numerous reasons for the shift to residential and mixed-use, not least the commercial incentive to "edge bets" on fluctuating demand for office, residential, and hotel functions by including all in the building program. The need for more sustainable patterns of life (see "*The Future of Urban Sustainability*" on page 21), and the desire for more 24-hour vibrancy in our urban centers is also playing a large part. It also makes sense that if the objective of great height is a predominant one, then it is easier to achieve this with a residential rather than an office function. Residential floor plates tend to be much smaller than office floors – an advantage when subjecting materials to wind and other pressures high in the sky – and also require less floor-area-consuming elevators and other vertical services to support the function. In other words, if the creation of one of the "World's Tallest Buildings" is a primary motivator, then it is easier to do it with a function that will put less people in continual occupation at the top of the tower and thus reduce the size of the floors to house them and services to support them.

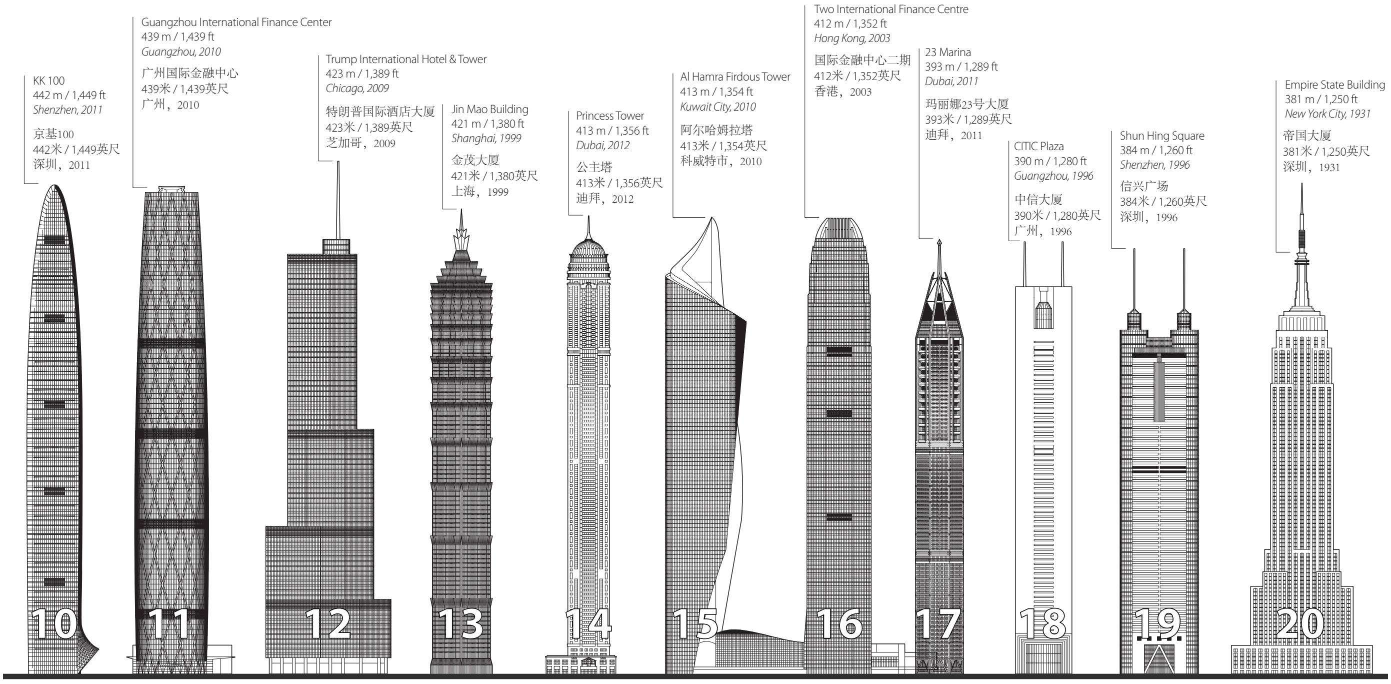
The reason for the trend towards concrete/composite structure in the world's tallest buildings is similarly multi-layered. This is partly a

板小很多——当建筑材料需要抵抗风力或者其他高空压力的时候，这是一项优势——同时支持居住功能的电梯和其他垂直向服务所需要的楼层面积也会减小。换句话说，如果建造“世界最高的建筑”是其主要动因，那么更容易实现的是设定一个功能，将更少的连续居住的人群安排在大厦的顶部楼层，因此就可以减少供这些人居住的楼层面积和为这些人服务的设备。

混凝土/复合结构应用在世界最高的建筑上，造成这一趋势的原因是多方面的。一部分原因是相对于钢铁，这些高层项目所在的发展中国家更可能拥有高效的混凝土技术专长。上面提到的向居住和混合使用功能的转变对此也是有影响的，因为居住对防火、声响和通话的要求使其本身更适合用混凝土建造，而不是通透开敞性强的钢铁材料。尽管行业内有这样一种看法是混凝土比钢铁更便宜（虽然从材料的整个生命周期的循环分析来看可能相反），但同时有很多人认为对于在高空中提升结构的性能——需通过阻尼运动与垂直荷载传递——钢铁和混凝土的混合使用会有更好的效果，而非采用单一的材料。

最高建筑的现在与未来：巨型高层建筑的时代

图3显示了当前世界最高的20座建筑，其中有17座位于亚洲大陆（包括了拥有5座最高建筑的中东地区）。美国只有3座，其中包括了仅排名第20位的帝国大厦，它属于世界最高的20座建筑已有81年（这一壮举在很长一段时间内很难被复制，如果真的有）。另外一个值得关注的现象是排名中住宅或者混合使用的建筑超过了半数以上，而不再是办公大厦占据主导；只有三座建筑是单纯



product of the developing countries where these projects are located – which are much more likely to have sufficient concrete technological expertise than steel. The aforementioned change towards residential and mixed-use functions is also influential, since the fire, acoustic, and cellular requirements of living lend themselves better to concrete construction rather than open-plan-enabling steel. While there is a perception in the industry that concrete is cheaper than steel (though considerations of the whole life cycle analysis of materials would likely change this equation), there are also many who believe that the increased performance required of the structure at great height – through the required damping of movement as well as the transfer of vertical loads – can be more adequately handled by steel and concrete acting together compositely, rather than one material alone.

The Current and Future Tallest: Age of the Megatall

Figure 3 shows the current tallest 20 buildings in the world, noting that 17 of these buildings are located in continental Asia (which embraces the Middle East region, where five are located). Only three are located in the United States, including the Empire State Building which stays on the list in 20th place, marking 81 years in the tallest 20 buildings in the world (a feat likely not to be repeated for a long time, if ever). Also of interest is that more than half the buildings are either residential or mixed-use buildings, rather than offices, and only three are constructed of pure steel, with the rest either concrete, composite, or mixed structures (see Figure 4).

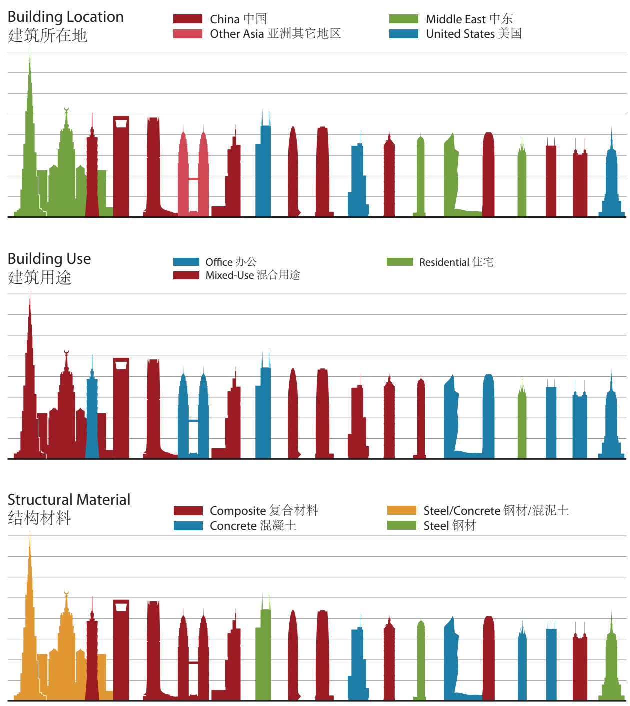


Figure 4. Statistical data on the current tallest 20 buildings in the world (as projected by the end of 2012). See Figure 3 for project details.
图4. 目前世界最高的20座建筑的统计数据（预计至2012年底）。项目详情请见图3。

Shanghai Tower: Re-Thinking the Vertical City

上海中心大厦：反思垂直城市

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Abstract

The construction of the Shanghai Tower breaks through conventional design methods and explores the possibilities of future supertall architectural approaches. These approaches bring the project to a new height of being "naturalistic, technological, and humane" in such aspects as form, functions, quality and management. Architectural forms transform into a harmonious community that focuses on relating to the city. Architectural functions transform into a multifunctional vertical community. Architectural quality transforms into a green community that can save energy and protect the environment. Building information transforms into a smart and forward-thinking community, and architectural culture transforms into an enjoyable and human community.

Keywords: Supertall Buildings, Shanghai Tower, Verticality, Green, Culture

摘要

上海中心的建造是突破传统，探索未来超高层建筑的理念，从形态、功能、品质、管理多方面赋予它"自然、科技、人文"的未来高度。建筑形态转向关注与城市关系的和谐社区；建筑功能转向多功能复合的垂直社区；建筑品质转向节能环保的绿色社区；建筑信息转向便捷的智慧社区；建筑文化转向人文享受的文化社区。

关键词：超高层、上海中心、垂直、绿色、智慧、文化

Supertall buildings are the products of global urbanization and economic development. "What is the developing trend for future supertall buildings?" should be the question considered at this moment in time. The Shanghai Tower reaches beyond traditional architectural concepts to explore the future of supertall buildings in the following five aspects: architectural form, function, quality, information, and culture.

1. Building Shape – transforming a traditional focus on the shape alone to emphasis on a harmonius relationship between the building and its context.

In the past, architecture has mainly focused on a building's shape. In the future, architecture should be responsible to society so as to meet social requirements and needs in a broader context and with deeper content. For Shanghai Tower, such considerations are given in three perspectives: architecture, context, and city.

From a city's perspective, the skyline of the city should be rich in view. Supertall buildings can easily change a city's existing skyline that has been forming for years. To preserve the original urban appearance

随着全球城市化和经济发展，超高层建筑将不可避免。未来超高层建筑的发展趋势是什么？这是现在必须思考的问题。上海中心超越传统建筑概念，从建筑形态、功能、品质、信息和文化五个方面探索未来超高层建筑：

一、建筑形态—从传统注重自身形态，转向关注与城市关系的和谐社区。

过去，在选择建筑方案时以自身为主。未来，必须以对社会负责的态度，从更大范围、更深内涵去思考才能满足社会需求。上海中心主要从建筑、区域、城市三个层面思考。

在城市层面，着重城市天际线的丰富。超高层建筑会改变一个城市多年形成的天际线，从保护城市面貌的角度，必须极其谨慎地确定。上海中心在研究高度时，把它放到与周边2栋超高层建筑的关系、与浦东和上海城市的关系上进行研究，最终采用3栋超高层建筑高度螺旋上升的方案（请见图1）。

在区域层面，着重小陆家嘴核心区功能完善，提升区域发展潜力。上海中心在规划阶段，特别关注区域交通建设，在B2层增加了连接周边建筑的地下通道，形成区域立体交通，减轻地面交通压力。在调查区域功能配套情况后，特别增加了较缺乏的

of a city, the building shape should be given serious consideration. When determining the height of the Shanghai Tower, considerations are made to its relationships to the two adjacent supertall buildings (the Jin Mao Tower and the Shanghai World Financial Center), to the Pudong area, and to the city of Shanghai as a whole. The final scheme was selected to reflect the ascending height of these three supertall buildings (see Figure 1).

From a regional perspective, the Shanghai Tower aims to improve functional programs of the Little Lujiazui Central Area and enhance its potential for better regional development. During the planning phase, the Shanghai Tower emphasized the regional transportation network where an underground tunnel has been added on the B2 Level to form a regional three-dimensional traffic system that will release ground traffic pressures. After regional service program investigations, additional supporting facilities were added for commercial services, cultural services, and white-collar service facilities.

From a construction perspective, the Shanghai Tower simply does not wish to make the building taller for the sake of it, but rather have a unique characteristic to its architecture and a distinct relationship to the city and the region. The Tower's main concerns are focused on the innovation of design and improvements of internal functions with more emphasis on naturalistic, humane, and technological elements.

2. Architectural Function – transforming from a traditional single function to a multi-functional vertical community

Vertical communities, in short, require the superimpositions of horizontal blocks in verticality in order to create a dynamic vertical community. The future of the vertical communities will have more comprehensive functions and pleasant spaces. The characteristics of the Shanghai Tower are:

Vertical function zones. The entire tower is divided into specific function areas, from downwards up, they are: public parking, public passageways, living areas, commercial and meeting areas, offices, hotels, sightseeing areas, and an observation deck (see Figure 2).

Separately zoned transportation and mechanical areas. There are zones that service vertical transportations. In each zone, people can go up directly to the respective zone from the ground and then take shuttle elevators to each floor. This can reduce the pressure of high population concentrations on the ground level. Every single zone has its own mechanical floor and refuge floor which establishes an independent system within the zone that can save energy and enhance the evacuation process of the whole building. The building is also connected to public transportation. For example, on Level B2, public passages are connected to adjacent buildings and two lines of the city's metro railway (see Figure 3). On the ground level, the tower is also connected to ground public transportation.

Street level plazas. There are various intersecting plazas in the Shanghai Tower which provide people with a diverse and social environment to mingle in. The 24 sky lobbies in the tower also make communication easier (see Figure 4). On the ground level, lobbies are distributed for commercial activities, social activities, and offices while each of them holds a unique independent plaza. On Level B1, there are two outdoor plazas through which people can enter and exit the building with ease.

Vertical green areas. Besides the exterior public green areas, there is also a green area on the balcony of the fifth floor of the podium.

配套商业、文化设施、白领服务设施。

在建筑层面，不是复制更高的建筑，而是增加建筑内涵。重点考虑建筑设计的创新、内在功能的完善以及增加自然、人文和科技的含量。

二、建筑功能—从传统单一功能，转向多功能复合的垂直社区。

垂直社区就是把原来水平街区叠加为垂直社区，未来垂直社区的功能更全面、生活更舒适、空间更宜人、使用更安全。上海中心的特点是：

垂直功能分区。整栋建筑自下而上分成地公共停车区、公共通道和生活区、商业和会务区、办公区、酒店区、观光区、和塔冠等不同功能的分区（请见图2）。

交通和机电分区供应。分区服务的垂直交通，每个区分别从地面直达分区转换层，再乘坐区间电梯到分区的每个楼层，减轻人流集中的压力。每个分区有各自的设备层和避难层，形成相对独立的小系统，节约能耗，提高大厦安全和疏散能力。与城市公共交通连接。在B2层，通过公共通道与周边多栋建筑相通，与城市两条地铁线相连（请见图3）。在地面1层，与城市公交衔接。

街区广场。上海中心在不同功能区设计了街区广场，形成不同群体的交流场所。塔楼部分有24个空中大堂（请见图4），提供了

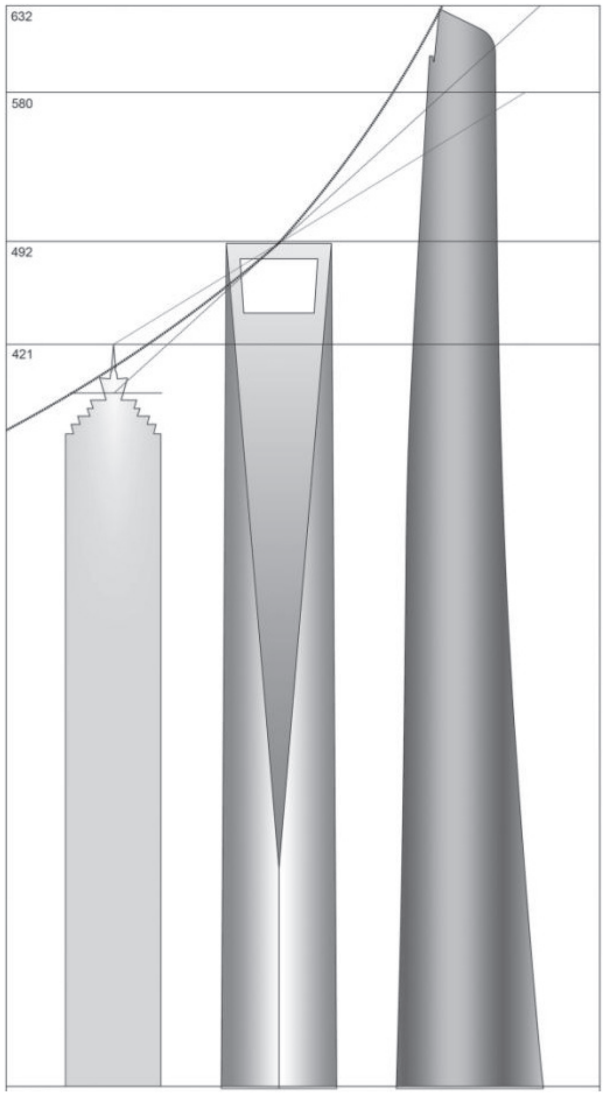

Figure 1. Jinmao Tower, Shanghai World Financial Center & Shanghai Tower (Source: Shanghai Tower Construction & Development Co., Ltd)
图1. 金茂大厦、上海环球金融中心、上海中心大厦（出自：上海中心大厦建设发展有限公司）

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。

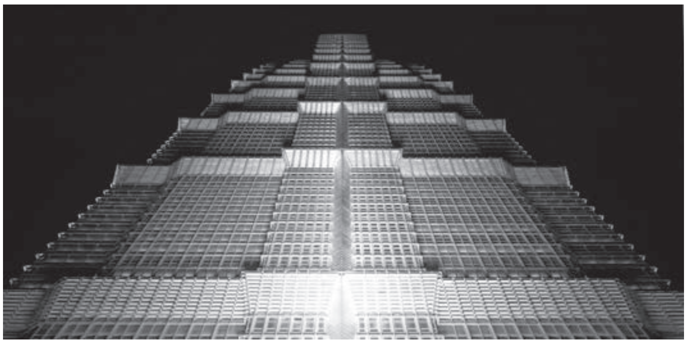

Figure 2. Jin Mao Tower, Shanghai, China. Photo ©SOM. All rights reserved.
图2. 金茂大厦，上海，中国。SOM照片，版权所有。

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）

Supertall Building Difficulties and Control Points
超高层综合体难点与管控要点

ZhaoHui Jia

Min Tang

Abstract

This paper takes the world's seventh supertall, Zifeng Tower, as an example and integrates the authors' management experiences in more than ten supertall buildings in order to analyze the difficulties of the entire construction process from the perspective of the architect and estate owner. This paper proposes specific ideas and methods to ensure quality during the whole process of arrangements in the early stages such as: design firm selections, designs, and construction processes.

Keywords: Zifeng Tower, Management experience, Design quality assurance

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ZhaoHui Jia graduated from Harbin Institute of Technology with a Master's degree in Architecture. He worked in the Shanghai branch of China CTDI Engineering Corporation and the P&T Group before joining the Greenland Group in September of 2003. He was the technical director responsible for the management and operations of all technical work for the world's seventh tallest high-rise, Zifeng Tower (450m) from August 2004 to August 2010. He started working in the technology management and product R & D department of the Greenland Group in August 2010. As general manager, he is now responsible for the Wuhan Greenland Center which is over 600 meters tall, the 300-meter Wujiang supertall component layers, Changchun super high-rise, the direct management of a couple other 300+ meters high supertall, and five star hotels as the technical management of eastern China.

贾朝晖：毕业于哈尔滨工业大学，建筑学硕士，曾在机械工业设计研究院上海分院、巴马丹拿（上海）咨询有限公司工作，2003年9月进入绿地集团，2004年8月-2010年8月作为技术总监负责世界第七高楼紫峰大厦（450米）全程技术管理工作，2010年8月开始在绿地集团技术管理与产品研发部工作，作为总经理助理目前负责600多米武汉绿地中心、300多米的吴江超高层、长春超高层等多个300米以上超高层技术直管和五星级酒店技术直管工作以及东部区域技术管理工作。曾参与中国第四届、第五届超高层峰会、重庆城市综合体与超高层论坛等多个论坛作为主讲嘉宾。

Min Tang graduated from Tongji University in March of 2007 with a Master's degree in Architecture. She joined the Greenland Group in April 2007 and served as a technical director in the technology management and product R & D department. She participated in the direct technical management of the over 600-meter high Wuhan Greenland Center, the 300-meter Wujiang supertall component layers, Changchun super high-rise, and other 300+ meters super high-rise developments within the group.

唐敏：2007年3月毕业于同济大学，建筑学硕士，2007年4月进入绿地集团，至今在绿地集团技术管理与产品研发部担任技术总监，负责参与600多米武汉绿地中心、300多米的吴江超高层、长春超高层等多个300米以上超高层技术直管工作以及集团内300米以上超高层项目的研发工作。曾代表绿地集团参与中国第四届、第五届超高层峰会、重庆城市综合体与超高层论坛等多个论坛，并作为主要嘉宾。

摘要

本文结合绿地集团已经建成的世界第七高楼紫峰大厦和在设计和建设过程中的十余幢超高层管理经验，从房地产业主建筑师角度对整个建设过程中的难点进行剖析，提出了在前期定位、设计单位选择，设计过程把控及建设过程中如何保证设计品质等具体思路与措施。

关键词：紫峰大厦、管理经验、设计品质保证

Introduction

Since supertall buildings are sought after by mankind as a medium to stretch the laws of physics, these supertall buildings have already gone far beyond conventional construction methods. Supertall buildings often carry the representational expectations of a city or a country. As the economy and development of related technologies continue to thrive in Asia, China has already become the main field of competition for supertall building construction. Currently, more than one-third of the one hundred tallest buildings and over half of the ten tallest buildings in the world are in China. China is entering the supertall building era at an unprecedented pace.

As one of the top five hundred companies in the world, Greenland Group is among the first few real estate companies in China to enter the supertall building field. Greenland Group has established working relationships with SOM, Adrian Smith + Gordon Gill, Thornton Tomasetti, ECADI, and many other famous design institutes. The Group has also been working with the Shanghai Construction Group, China State Construction Corporation, and many other large construction companies since 2004. Greenland Group has grown from a "freshman" to an experienced developer with

引言

超高层建筑作为人类高度追求的载体，在标志性方面已经超越常规建筑的意义，往往承载着一个国家或城市的期望，随着亚洲经济的腾飞与相关技术的日益成熟，中国已经成为超高层的主要战场，在已经建成最高的前一百座超高层中有超过三分之一在中国，在已建成的最高的十座超高层中有超过半数在中国，中国正以一种前所未有的步伐进入超高层时代。

绿地集团作为世界五百强企业，是中国最早进入超高层领域的房地产企业之一，二千零四年就进军超高层领域，在过程中同SOM、AS+GG、TT、华东院等著名设计单位，上海建工集团、中建总公司等特大型施工企业以及各个方面的资源建立良好的合作关系，绿地集团也从一个领域新兵逐渐成长为具有完善的超高层管理体系和丰富经验的开发商，超高层已经成为集团的核心竞争力之一，目前建成与建设中二百五十米以上的超高层超过十五幢（请见图1），其中包括已经建成运营的四百五十米的南京紫峰大厦（请见图2）和已经结构封顶即将交付使用的郑州千禧广场（请见图3）。在设计建设过程中著名的有超过六百米的武汉绿地中心、超过五百米的大连绿地中心等。

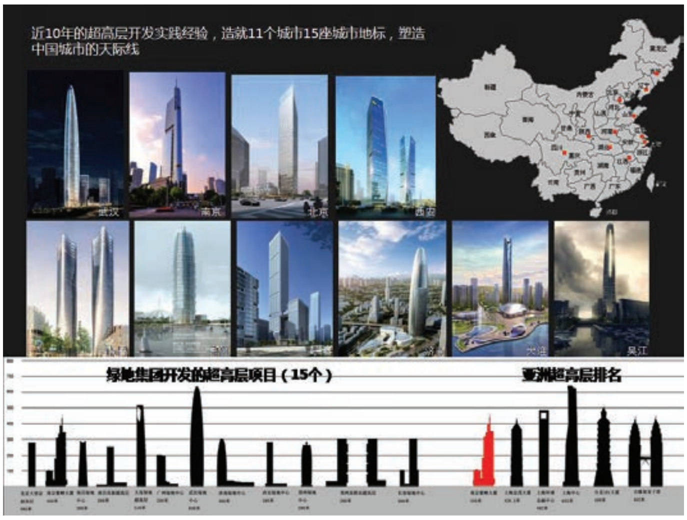


Figure 1. Supertall building practices of Greenland Group
图1. 绿地集团超高层实践

a well-established supertall building management system through this process. Supertall buildings have become one of the Group's core strong points. More than fifteen supertall buildings over 250 meters tall have already been completed or are currently under construction (see Figure 1); this includes the completed 450-meter Zifeng Tower, which has been put into operation (see Figure 2), and the Zhengzhou Qianxi Square which recently topped out and soon will be put into operation (see Figure 3). The 600+ meter-high Wuhan Greenland Center and the 500+ meter high Dalian Greenland Center are among some of the well-known under construction projects of the Greenland Group.

Architectural characteristics and difficulties of supertall buildings

Supertall buildings usually have enormous volumes, generally over 200,000 square meters, and complex functions, which usually include hotels, apartments, offices, business clubs, and tourist observatories.

These structures require large capital investments, easily over tens or hundreds of billions RMB and have long periods of return because only offices and apartments within the building are for sale. The rest of the building is only leased out for hotels, retail, and tourist functions. In earlier years, the majority of completed supertall buildings were all leased properties. Recently, some supertall buildings are beginning to sell part of their property such as the Burj Dubai, Hong Kong Finance Center, Zifeng Tower, and the World Financial Center.

It is also more difficult to operate and manage supertall buildings, and they have higher operating costs in comparison to regular projects,


Figure 2. Nanjing Greenland Square Zifeng Tower
图2. 绿地南京紫峰大厦

超高层建筑特点与难点

体量巨大，一般都超过二十万平方米。功能复杂，一般包括酒店、公寓、办公、商业、会所和观光功能等其中的几种。

资金投入大，动辄数十亿甚至上百亿，回报周期长，除部分办公、公寓可销售外，酒店、商业、观光等作为持有物业。从早期已建成的超高层来看，绝大部分作为持有物业来考虑， 近年来所建超高层则考虑部分销售，如哈利法塔、香港金融中心二期、紫峰大厦、环球金融中心等。

未来运营难度和管理难度大，其运营成本也比一般项目要大的多，年能源费用在数千万不等，由于超高层综合体功能复杂，除了大物业以外还有商业管理公司、酒店管理公司等专项管理物业，未来的运营整合比较复杂，尤其涉及持有和销售部分，后期运行管理难度就更大。

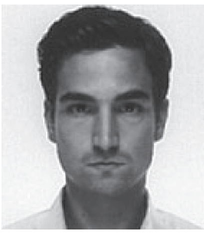
建设周期长，经济形势与政策调控对项目影响大。从目前已经建成的超高层来看，大部分建设周期都在5-8年，往往会经历至少一次的经济危机和政策调控。

设计与施工技术难度大，审批流程复杂。超高层综合体设计除了常规的建筑、结构、机电、专业外，还涉及深基坑维护设计、电梯流量设计、幕墙设计、灯光设计、声学设计、管线综合设计、钢结构设计等数十项专项设计。除常规审批外，消防、抗震设计


Figure 3. Zhengzhou Qianxi Square
图3. 郑州绿地千禧广场

The Design Process of Complex Architectural Façades
复杂的建筑外墙的设计过程


Bert van de Linde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Abstract

Facades form the identity and functionality of high-rise buildings. The "design process" for complex bespoke architectural high rise facades is an abstract term that in reality is not a single process but a simultaneous cross-disciplinary design processes. These include façade integration with the building environmental systems, holistic system performance, decision making tools and efficiency streamlining for production, procurement and installation. This paper outlines various cross-disciplinary integrated design processes with a particular emphasis on the need for specific customised design systems and tools that enable complex façade forms to be economically and efficiently realised.

Keywords: Design Process, Integrated Design, Holistic Design, Efficiency Streamlining

摘要

幕墙建立了高层建筑物的身份和功能性。对复杂定制建筑的高层建筑幕墙来说“设计过程”是一个抽象名词，但事实上，它不是一个单一的过程，而是同步进行的跨学科设计过程。该过程包括将幕墙与建筑环境系统，整体系统性能，决策工具和高效精简的生产，采购及安装流程相结合进行一体化整合。本文概述了各种跨学科一体化设计的过程，并重点强调对特殊定制设计系统和工具的需求从而能够经济且高效地实现复杂幕墙。

关键词：设计过程、一体化设计、整体综合设计、高效率精简流程

Rethinking The "Design Process"

"Design", particularly as it relates to building facades, is an abstract term often presumed as a linear process. Unlike other systems within the building which have distinct yet relatively independent functions, the façade must be designed to cope with numerous building system requirements including structural (building movements), thermal (solar irradiation, heat transmission), weather tightness (durability, water exclusion), comfort (acoustics, glare), security (blast, intrusion) and safety (fire, impact), whilst maintaining the desired architectural aesthetic.

In reality, "design" is a series of distinct concurrent multi-disciplinary processes that includes:

- Façade whole-building environmental system integration
- Holistic system performance
- Effective & reliable decision making
- Design Streamlining & Efficiency.

“设计过程”的反思

“设计”，尤其是当其与建筑幕墙相关联时，是一个抽象术语，通常被假定为一个单一线性过程。与建筑内部其它系统清晰独特且相对独立的功能不同，幕墙必须设计成能应付众多建筑系统要求包括结构（建筑位移），热工（太阳热辐射，热传递），水密性（耐久性，防水性），舒适度（声学，防眩光），防护措施（防爆，防侵扰）和安全（防火，抗冲击）等，同时还应保持想得到的建筑美感。

事实上，“设计”是一系列独特并行的多学科过程，包括：

- 幕墙与整体建筑环境系统的集成
- 整体系统性能
- 有效及可靠的决策
- 设计精简及高效率

幕墙与整体建筑环境系统集成

减少碳排放量的必要性已在全球各国建筑法规中有多次修订旨在减少能耗。幕墙系统必须被设计为用户提供舒适（眩光，自然采光，表面辐射效应等）之间及节能（太阳热辐射，热量传递，渗漏等）的动态元素。在建筑环境系统的设计中，幕墙性能常常被模拟为静态性能的属性。事实

Façade Whole-Building Environmental System Integration

The need for reductions in carbon emissions has seen many revisions in national building codes worldwide aimed at reducing energy. Façade systems must be designed as dynamic elements providing between comfort (glare, natural daylight transmission and radiant surface effects) and energy (solar heat gains, thermal transmission, leakage). In the design of building environmental systems, facade performance is often modelled using steady state performance properties. In reality, environmental conditions vary and the façade will invariably be dynamically regulated to achieve a balance of occupant comfort and energy efficiency. In order to be able to achieve energy reductions and improved comfort levels in buildings, the dynamic performance advantages of facades need to be accurately modelled as well as controlled and monitored with a high degree of confidence.

From an engineering viewpoint, the dynamic behaviour of the façade can be achieved using an advanced control system that includes blinds, HVAC, occupancy sensors and lighting.

A managerial constraint in achieving façade whole-building environmental system integration is primarily due to the time schedule which the environmental system and façade are procured, with the former usually carried out during the whole building design engineering process whilst the façade is usually procured at the specialist sub-contractor stage when major building design has been "completed". The possibility to use the specialist engineering experience of the façade contractor to integrate the façade and HVAC system is often too late in the main construction programme.

Permasteelisa & SOMFY have developed a BMS system utilizing software algorithms where blind controls have been integrated that interact with HVAC controls that dynamically regulate the façade for cooling demands, using the solar heat gains to condition the building before switching on heating as well as to interact with lighting and glare controls (see Figure 1).

Further optimisation is achieved using occupancy sensors. When the room or office is not occupied, the glare protection or comfort level has no priority setting so blinds can run in the energy mode.

After façade installation, either the façade contractor or blind manufacturer is responsible for all electrical connections from and to the façade. Thus a great deal of site work is required at generally higher costs compared to factory installation. With this technology it is possible to integrate blind controls into the façade. The major advantage being that a majority of electrical connections and programming is completed resulting in considerable time savings and less on-site failures. This integration is undertaken during façade production as well as testing and regulation of the blinds essentially eliminating failures.

Holistic System Performance

The application of advanced materials, particularly composites, in aerospace, automotive and defence industries is well established and gradually being embraced as an architectural material in tall building facades.Design standards relating to the use of innovative materials in building facades are not well established. In order to correctly design innovative materials into facades which have no standards for application or track record, an alternate design process is required that looks at a holistic system performance.

The standard design approach involves specialists in various performance disciplines including design, structural, materials, building

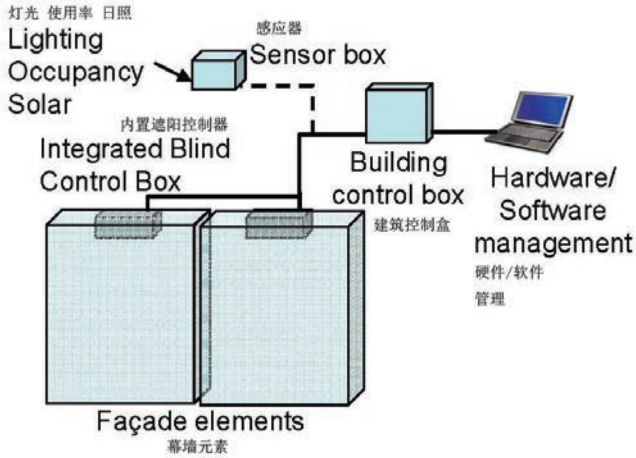

Figure 1. Schematic façade BMS integration (Source: Permasteelisa Group, 2012)
图1. 幕墙BMS集成示意图（来源：帕玛斯迪利沙集团，2012）

上，环境条件是不断变化的，因此幕墙必需动态地调控，以达到用户舒适性和节约能源之间的平衡。为实现建筑物的能耗减少和改善舒适度，需要有充分把握地对幕墙的动态性能优势进行精确模拟，调控及监测。

从工程角度来看，幕墙的动态特性可通过采用涵盖遮阳，HVAC（采暖，通风，制冷），空间占用感应器及照明的先进控制系统来实现。

在实现幕墙与建筑环境系统一体化中有管理上的限制，主要是因为环境系统和幕墙采办的时间安排。前者通常在整体建筑设计工程过程中实施，而幕墙通常则是在大部分建筑设计被“完成”的专业分包阶段采办。由于往往为时太晚，在主要施工程序上利用幕墙承包商的专业工程经验来将幕墙与制热、通风与空调控制（HVAC）系统一体化的可能性几乎微乎其微。

帕玛斯迪利沙与尚飞（SOMFY）联合开发的BMS系统采用与遮阳控制合整的软件算法和HVAC控制互动，从而按制冷负荷动态地调节幕墙，在开启供热前利用太阳辐射热增益来调控预备建筑物，同时与照明及眩光控制互动（图1）。

通过空间占用感应器可实现进一步的优化。当房间或办公室无人时，眩光保护或舒适度不再是首要设定，遮阳可以在节能模式下运行。

在幕墙安装后，则由幕墙承包商或遮阳制造商负责所有与幕墙之间的电子连接。与在工厂安装相比，这样大量的现场工作是通常需要较高成本的。通过这个技术可将遮阳控制合整置幕墙内。该技术的主要优势在于大部分电子连接和编程在幕墙安装之前完成，节省时间并减少工地现场出错。此一体化在幕墙制作及遮阳的测试和调节过程中进行，从而在本质上消除故障。

整体综合系统性能

先进材料，尤其是在航天、汽车和国防工业的复合材料应用已经成熟，并已逐渐被接受为高层建筑幕墙建材。但新材料应用于建筑幕墙的相关设计标准还不完善。在没有应用标准及先例记录的情况下，要正确的设计新材料置于幕墙中，就需要一个统观整体系统性能的交替设计过程。

常规的设计方法牵涉到各性能学科的专业人员，包括设计，结构，材料，建筑物理，声学，防火，表面处理，生产和现场安装，来对系统的需要进行审查并提出建议。

参见图2，此设计过程为会聚法，设计按顺序和不断被审查而产生影响逐步会聚成一个设计方案。此过程的主要限制在于，它不仅耗时，而且扼杀了创新思维， 因为各专业人员的知识往往局限制于其狭窄的领域， 故对设计的贡献有其局限性。

A Tale of Tier Two Cities

二级城市的传说

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Abstract

The migration of Chinese residents to cities presents great challenges and opportunities. Large developments near the city core represent the best solution to the challenges of this urban migration, but the superblock must be configured with a strong sense of place, and tall buildings are essential to making this possible. Tier 2 and Tier 3 cities pose additional challenges to creating developments that establish a sense of place both in the skyline and at street level: how can one achieve architectural sophistication with a simplicity of means? Three case studies designed by NBBJ for Eton Properties—located in Xiamen, Shenyang, and Dalian—are considered. The future of tall building design is the architectural expression of internal function.

Keywords: Tall Buildings, Superblocks, Simplicity, Tier 2

摘要

中国居民逐步的迁徙到城市展现着巨大的挑战与机遇。在城市中心附近的大型开发项目代表解决城市迁徙的最佳方案，但超级街区必须体现出强烈的场所感，高层建筑对于实现此目标至关重要。二级与三级城市提出了另一种挑战：打造一个在天际线和街道标高两方面均建立场所感的开发项目：如何以一种简约的手段达成建筑的经久不衰？ 三项由NBBJ为裕景兴业设计的案例—位于厦门、沈阳、和大连—在此探讨。未来高层建筑的设计是内部功能的建筑体现。

关键词：高层建筑，超级街区，简约，二级

In 2011, for the first time in history, a higher percentage of China's population lived in urban areas than in rural ones (Bloomberg, 2012). And though other regions are urbanizing at a faster rate than China, the United Nations estimates that 1 billion Chinese will live in urban areas by 2050—an increase of more than 300 million people (United Nations, 2012). This influx of urban residents presents great challenges and opportunities. And while much has been written about China's Tier 1 cities—Beijing and Shanghai, and typically Guangzhou and Shenzhen as well—most development in the next four decades will occur in the so-called Tier 2 and Tier 3 cities, in maturing and emerging markets throughout the country.

To accommodate this growth, Chinese cities must become increasingly dense. For instance, the three emerging cities under consideration here—Xiamen, Shenyang, and Dalian—contain, respectively, only 1,600 people per square kilometer, 2,200/km^2, and 2,400/km^2 (US Consulate, 2012a and 2012b; Xiamen). These cities are significantly less dense than Los Angeles (3,100/km^2), let alone Paris (20,000/km^2) or Manhattan (27,000/km^2), although they are expanding rapidly (US Census, 2012a and 2012b; United Nations, 2011).

在2011年，中国城市人口比例在历史上首次高于农村（彭博社，2012年）。并且尽管其他区域正在以比中国更快的速度城市化，联合国预计十亿的中国人将在2050年之前住在城市地区内——一个超过3亿人口的增长（ 联合国，2012年）。城市居民的这种集聚代表着巨大的挑战和机遇。而在中国一级城市—北京和上海，以及作为典型的广州和深圳被大量报道的同时—在接下去的40年内最多的开发项目将发生在所谓的2级和3级城市，遍布全国的成熟中的和新兴的市场。

为了顺应此增长，中国城市必须逐渐提高密度。譬如，在这里考量的三座新兴城市—厦门，沈阳和大连—每平方公里分别仅包含1,600人， 2,200人和2,400人（美国领事馆， 2012a和2012b；厦门）。这些城市尽管正在急速扩大，仍然远没有洛杉矶（3,100人/平方公里）密度高，更不用说巴黎（20,000/平方公里）或曼哈顿（27,000/平方公里）（美国人口普查，2012a和2012b）；联合国，2011）

由于传统的胡同巷弄和低层建筑将显不足，城市核心区域附近的大型的城市尺度开发项目代表了解决这座城市变迁所带来挑战的最佳方案。只有大型城市可以满足密度要求，创造一个连贯统一的空间体验，并包含点燃地区城市活力所需要的混合用是途规划项目的关键体量。当获得成

As traditional hutong streets and low-rise buildings will be insufficient, large urban-scale developments near the city core represent the best solution to the challenges of this urban migration. Only large sites can accommodate density, create a coherent spatial experience, and house the critical mass of mixed-use programming necessary to jump-start urban vitality in the area. When successful, these projects can then be leveraged to positively influence the surrounding area, increasing nearby land value and spurring additional high-quality development. We call this city building.

When poorly executed, however, large "superblock" developments have rightly received criticism for being out of scale, hostile to the pedestrian experience, or walled-off fortresses divorced from the city around them. To avoid these pitfalls while still achieving the benefits of large development—density, critical mass, mixed uses, a coherent environment, and urban vitality—the superblock must be configured with a strong sense of place, and tall buildings are essential to making this possible.

As China continues urbanizing, many planners and architects may ask—certainly many have asked us—why so many tall buildings? The reasons are many. For one, tall buildings enable greater density, even as they free other portions of the site for open spaces such as plazas, courtyards, and other public amenities which create a sense of place that enhances the overall value of the development and benefits the surrounding community. For their inhabitants, tall buildings provide outward views, daylight, and airflow around the exterior; while the large building site furnishes a convenient mix of uses and proximity to the CBD. Economists and planners have repeatedly proven that the kinds of social interactions that spur innovation and increase GDP thrive on the density that tall buildings can provide.

Finally, tall buildings play a crucial role in the image and psyche of the cities in which they are built. Most people associate a city with its tallest or most interesting buildings: New York has the Empire State Building, Hong Kong the Bank of China building, Shanghai the Oriental Pearl Tower. This is no exception in emerging cities, where prime sites challenge their designers to create sophisticated architecture that represents the city's aspirations.

These are the factors fuelling China's dramatic building boom, and some truly impressive architecture has resulted. However, Tier 2 and Tier 3 cities pose an additional challenge to creating a development that will establish a sense of place both in the skyline and at street level. That is, how can one achieve architectural sophistication with a simplicity of means? In developing markets, simplicity yields important benefits: ease of constructability can not only accommodate varying capabilities in the construction trades, but also speed the product to market, which may make all the difference in a rapidly urbanizing area.

Developer Eton Properties and architects NBBJ are currently collaborating on projects in three of China's rapidly developing Tier 2 cities: Xiamen, Shenyang, and Dalian. These projects, all of which feature large development sites and tall buildings (and all currently under construction), exemplify our approach to creating a sense of place using architecturally sophisticated simplicity.

Xiamen Eton Center

Xiamen, a southeastern coastal city located approximately halfway between Hong Kong and Shanghai, occupies a large island and surrounding mainland areas. The Eton Properties site—adjacent to the harbor, the CBD, and the main street leading from the water deep into the city—enjoys tremendous views of the sea and nearby historic

功时，这些项目可以用于对周边区域产生积极影响，增长周边土地价值并激励其他的高质量的开发项目。 我们称之为城市建筑 。

然而，当运作不佳，大型的“超级街区”开发项目立即被批评为规模过大，人性体验不友善或者构筑无城墙的城堡把它们周围的城市分隔开来。为了在取得大型开发项目优势—高密度，关键体量，综合用途，一个连贯统一的环境，和城市活力—的同时避免这些缺陷，超级街区必须被赋予强烈的场所感，而高层建筑对于实现此目标至关重要。

由于中国持续城市化，很多规划师和建筑师可能会问—至少我们已经被问过很多—为什么这么多的高层建筑？原因有很多，其中之一，高层建筑可以有更高的密度，更能将场地其它部分释放出来作为广场，庭院和公共设施等开放空间，这创造了提升开发项目的整体价值并使周边社区受益的场地感。对于它们的住户，高层建筑提供了向外的视野，日照和外部周围的空气流动 ；当大型建筑场地配以综合用途功能并邻近中心商务区时，它们也提供了极大的便利。经济学家和规划师已经反复证明了，高层建筑的高密度，将会提供这类社会交互活动激励创新和促进繁荣国民生产总值。

最后，高层建筑在城市的形象和灵魂方面扮演一个重要的角色。大多数人们通过最高或最有趣的建筑联想到一座城市； 纽约有帝国大厦，香港有中银大厦，上海有东方明珠电视塔。 这在新兴城市中也是不例外的，优质场地向设计师提出挑战来创造能代表城市愿景的经久不衰的建筑。

这些因素是促使中国戏剧化的高楼耸立，和产生一些真正令人印象深刻的建筑的缘由。然而，2级和3级城市提出了另一种挑战：打造一个在天际线和街道标高两方面均建立场所感的开发项目。即如何以一种简约的手段达成建筑的经久不衰？ 对于发展中市场， 简约产生重要的益处：容易施工性不仅可以顺应建筑行业中的不同变化的能力，也加速 产品推向市场，使其在快速城市化的地区中与众不同。

开发商裕景兴业和建筑设计方NBBJ目前正在就中国快速发展的2级城市：厦门，沈阳和大连的项目进行合作。这些项目， 都具备大型开发场地和高层建筑的特色（并且所有目前都在施工中）例证了我们利用建造经久不衰的简约性创造一种场地感的设计手法。

厦门裕景中心

厦门， 一个大约位于香港和上海中途的东南海岸城市，包含一座大岛屿和其周边的陆地。 裕景兴业基地—紧邻海港，中心商务区和从水域直插入市区的主干道 —享有无尽的海景和边临具有历史意义的鼓浪屿 。 项目包括一座5星级酒店和礼堂，SOHO（小办公室/家庭办公室）和商业配套。

第一步是理解场地如何与城市脉络产生联系，城市是一个带有狭窄街道的行人友善的地区。作为回应，用穿透性的商业裙楼界定了一个内嵌的中心庭院和场地内的公共广场，提供一个到达场所和公共交互活动。两个主要元素在上方竖向耸立：一座18层楼的酒店和一座40层楼，210米高的SOHO塔楼。 横向相称比例的滨海酒店最大化地展现海景；在地面层横跨着一条有盖顶的过道，它为酒店大堂打造了一个巨大的入口门户，并且也框定了远处的海景。 曲线型的SOHO塔楼，在内陆亭亭玉立，同时充分利用了绝佳的海景 （图1）。

把城市活力和场所感带入厦门裕景中心项目的最简单的表述不是仅仅建筑方面的：商业和酒店/礼堂规划项目在SOHO和酒店大厦之间被分隔开来， 通过人行天桥把它们连接起来 （图2）。这些连接鼓励在两幢大楼之间的互动，当购物者在穿越地面层的中心庭院时，以及酒店宾客从第4、第5层穿到SOHO大厦的礼堂和会议

Taipei 101 Striving to be a Sustainable Skyscraper
台北101：一座永续发展的超高层建筑

Harace Lin Hong-Ming

Yvonne Lin

Abstract

Taipei Financial Corporation (TFCC), similar to most super high-rise developers, has gone through its share of challenges throughout the relatively short span of the building's existence; from the early days of planning and design, through construction and subsequent management. But after only 13 years of successfully navigating numerous obstacles, the TAIPEI 101 project can already be considered to have achieved its original objective to be truly sustainable. Such sense of success could not be achieved without the integration and accomplishment of three critical aspects – Economical, Environmental, and Social.

Keywords: Sustainability; Tall Building; Skyscraper; Taipei; TAIPEI 101

摘要

台北金融大楼公司（TFCC）从规划设计初期、实际兴建一直到后续展开营运，在整体建物并不算长的存在时间中，与其他超高建筑物的开发者一样都经历了各种严峻的挑战。不过，度过了13年克服万难的岁月，台北101大楼已经达成了各面向主要目标，成为永续发展的成功个案。而成功的背后原因，是因为整合了以下三个重要的因素：经济因素、环境因素、社会责任。

关键词：可持续性，高层建筑，摩天大厦，台北，台北101

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Harace Lin Hong-Ming is the Chairman and President of Taipei Financial Center Corp., and is responsible for the investment, construction and management of TAIPEI 101. Mr. Lin has over 30 years of experience in real estate development. He is also the Vice Chairman of Hong Kuo Group, that is involved in businesses in real estate development, building construction, hotel development and operations in Taiwan and overseas. Mr. Lin has carried a personal mission to "build something that can be passed on", which leads him to practice sustainable real estate development and operation.

台北金融大楼股份有限公司董事长兼总经理林鸿明先生，从筹资、建设一直到营运管理，促成了台北101的诞生和营运获利。林先生个人具备超过30年的房地产开发经验，同时，他还担任宏国集团副董事长职务，其事业跨及台湾海内外的房地产开发、建筑规划、酒店营运发展。林先生背负着他个人的梦想与使命——"盖一栋可以流传给后世的建筑"。这也是使他能够实践"可持续房地产开发和运作"的重要关键。

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Yvonne Lin is an executive director in real estate development under the Hong Kuo Group. Yvonne was educated in the United States and further obtained her master degree in real estate from the University of Hong Kong. She is devoted to developing buildings sustainably, and is a member of the small LEED Accredited Professional community in Taiwan. As former assistant to the Chairman of Taipei Financial Center Corp., Yvonne has an extensive knowledge in TAIPEI 101's project planning, development, and operation.

林钰芳女士目前担任上胜开发有限公司执行董事，该企业为宏国集团旗下的房地产开发公司。 林女士在美国受教育，随后在香港大学取得硕士学位，专攻房地产研究。 她是台湾为数不多的取得美国绿色建筑协会专业认证(LEED AP)的建筑专业人士，并致力于可持续性房地产开发。作为前一任的台北金融大楼股份有限公司总经理特助，林女士对于台北101这栋摩天高楼专案的规划、开发、营运有着广泛的了解。

Introduction

TAIPEI 101 is a skyscraper situated in the XinYi Planned District , Taipei, Taiwan. The District, an urban development project initiated in the 1980s that covers 153 hectares, was planned to be the financial, retail, and entertainment hub of Taipei, showcasing the internationalization and vitalization of the city. (see Figure 1).

Formerly known as the Taipei International Financial Center, TAIPEI 101 is a Build-Operate-Transfer (BOT) project that was financed, developed and has been operated by Taipei Financial Center Corporation (TFCC) since 1997. The plot of land is zoned for commercial development and specifically designated as a location for multinational financial institutions, as Taipei aspired to be Asia's regional financial center. The development is comprised of a 101 floor office tower, a 5 level retail podium and 5 basement levels totaling approximately 398,000 square meters of world class floor space. TAIPEI 101 set a new benchmark of prestige and luxury to the businesses, consumers and tourists of Taipei. TAIPEI 101 Mall opened for business in November 2003, followed by the office tower one year later. TAIPEI 101 Observatory, on the 89th floor, welcomed its first visitor in January 2005.

引言

台北101这栋超高摩天大楼位在台湾台北市的信义规划区内。信义规划区最早开发于1980年代，占地面积153公顷，并将规划成为台北市的金融、零售与娱乐中心地点，展现台北这个大都市的的国际观与活力。（见图1）

台北101的旧称为台北国际金融中心，是一个系兴建-营运-移转为一体的个案，于1997年间由台北金融大楼股份有限公司投资、开发并营运。建筑基地位于在新兴商业区，且有鉴于台北市有成为亚洲区域金融中心之潜力，经市政府指定为跨国性金融机构的所在地。整体开发案包含一座101层高的办公塔楼及5层的商业裙楼和5层地下楼面，总平面面积达到39.8万平方米。对于台北市的游客、消费者及企业团体而言，台北101是一座崭新时尚、顶级精品的高档写字楼地标。2003年11月，台北101 购物中心正式营业，次年底写字楼启用，到了2005年1月间，位在89楼的台北101观景台也正式对外开放营业。

无论在设计或兴建阶段，台北101自始便怀抱著一个长期的目标：以建筑本身来展现当地文化与价值，成为世界与台北的桥梁。若要成为一个座永续存在的摩天大楼，台北101必须将以下三者予以完美整合：1）经济因素，2）环境因素，3）社会责任。

TAIPEI 101 was designed and built with a long-term goal in mind, wishing to demonstrate local culture and values, becoming the bridge between Taipei and the World. To be a sustainable skyscraper, it requires the integration of the following three aspects: 1) Economical, 2) Environmental, and 3) Social.

Financial Success

The "Curse of skyscrapers"

When it comes to the economics of super high-rise buildings, the "curse of skyscrapers" has become an inevitable topic of discussion since Andrew Lawrence coined the "Skyscraper Index" in 1999. The concept proposes that skyscrapers are indicators of impending economic downfall. This was succinctly summarized by,Thornton (2005, pp58) who said that "First, a period of 'easy money' leads to a rapid expansion of the economy and a boom in the stock market. In particular, the relatively easy availability of credit fuels a substantial increase in capital expenditures. Capital expenditures flow in the direction of new technologies, which in turn creates new industries and transforms some existing industries in terms of their structure and technology. This is when the world's tallest buildings are begun."

The investment in building a skyscraper is normally the result of confidence fuelled by excessive availability of credit, which occurs most prominently as major economic cycles reach their peak, after which contraction is a natural and unavoidable consequence. In that sense, the timing of the decision to build TAIPEI 101 to such an exceptional height can be argued to support this idea, however, the decision was made with the support of extensive business modeling and sophisticated financial planning.

Because of their exceptional scale and complexity relative to standard sized commercial buildings, the duration for planning and construction supertall buildings are relatively longer. This increases the risk that the construction phase must weather an economic down cycle which can severely impact the project in terms of project financing. In addition, it is even harder to predict the economic environment and market situation at the time the building comes on line, which creates a serious challenge to the subsequent successful operation of the building. The developer of a skyscraper must therefore take a very long term view in planning for financial success.

TAIPEI 101 was conceived at the height of Taiwan's technology-reliant market and broke ground in 1999, coinciding with the burst of the dotcom bubble, as construction proceeded through the 2001 global recession. Taiwan's economy didn't start to recover until 2002 (see Figure 2). Careful financial planning and a well thought out project development strategy allowed TAIPEI 101 to complete construction in 2004, though the management team dealt with a steep learning curve.

Market positioning

TFCC has planned the development into three operating units according to local market needs – TAIPEI 101 Mall, TAIPEI 101 Tower and TAIPEI 101 Observatory. Many question the exclusion of residential and hotel components from the development. The reasons for this omission are that residential development under local market practice requires strata title sale, which raises huge concern over safety, and effective management and high quality of operations that the project sought to deliver. In addition, due to zoning restrictions, it was not possible to include either residential or hotel space during the planning stage. Zoning restrictions were relaxed during the construction phase, but by then it was not feasible financially and operationally to include a hotel component to the project.

Figure 1. XinYi Planned District, Taipei, Taiwan (Source: Taipei Financial Center Corp)
图1. 台北市信义计划区（资料来源：台北101）

成功的投资案

"超高建筑魔咒"

自从1999年间学者安德鲁·劳伦斯（Andrew Lawrence）率先提出了"摩天大楼指数"以来，"超高建筑魔咒"便成为摩天大楼财务上不可避免的议题。"超高建筑魔咒"意指摩天大楼的兴建可能会成为社会经济衰退的预告指标。学者马克·索恩顿（Mark Thornton, 2005, p58）在2005年间延续劳伦斯的见解，精辟地指出："首先，一个时期的'热钱'将导致经济快速扩张、股市大旺，尤其是当信贷门槛过低时，会加速造成资金消费的大量增加。资金消费蜂拥汇入新科技，反过来又创造出新的产业，同时改变既有产业的结构与技术。就在此时，全球各地纷纷开始兴建超高型建筑。"

一般而论，景气循环来到高峰，资金供应过度带来了消费信心，这时就会见到超高层建筑开发案的出现。景气高峰之后是紧接着的经济衰退，这是不可避免的情况。从这一点来看，决定建设台北101的时间是符合上述情形的。但是，该项目的建设决策背后也有密集的营运模式考量与缜密的财务规划。

与一般的商业建筑开发案相比，超高型建筑的高度非比寻常，其规划、兴建阶段也跟着拉长，从而使得风险增加：在兴建阶段必须熬过外部经济环境的衰退，而经济环境的衰退很可能冲击到超高层建筑的财务预算。此外，超高层建筑竣工后必须面临的经济环境与市场情况也很难事先预测，从而使得后续的营运挑战更大。因此摩天大楼的投资者务必在财务安排上以长远眼光审慎规划。

Figure 2. Taiwan Economic Growth (Source : Taiwan Statistic Data Book, 2005)
图2. 台湾经济增长（资料来源 ：2005年台湾统计手册）

Burj Khalifa: Creating the World's Tallest Integrated "Vertical City"
哈利法塔：创造全球最高的复合性“垂直城市”

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Fred Durie, a U.K. civil engineer by training, has worked in Dubai since 1986, initially with the Dubai Municipality, before joining Emaar in 2001. In his role as Executive Director of Development he managed Emaar's major developments at Dubai Marina, Emirates Living, Arabian Ranches and most notably its flagship development at Downtown Dubai, which includes Burj Khalifa, currently the world's tallest building.

In 2008 he became CEO for Emaar JV companies in Saudi Arabia and, until late 2011, headed a team carrying out development services for Kingdom Holdings on projects in Riyadh and Jeddah. The project in Jeddah is planned around the Kingdom Tower which will be the future tallest building in the world.

Based in Dubai, he is now CEO for Emaar International working on developments in Egypt, Saudi Arabia, Morocco, Syria, Jordan, Lebanon, Turkey and Pakistan.

弗雷德•杜里是一位来自英国的土木工程师。他1986年去迪拜工作。先是服务于迪拜市政府，2001年加入了艾马尔公司。他在艾马尔公司任发展部执行主任一职，主要负责迪拜码头、阿联酋生活、阿拉伯农场和著名的迪拜市中心的旗舰发展项目。哈利法塔是该旗舰发展项目的一部分。哈利法塔是目前世界上最高的建筑。

2008年，杜里被任命为沙特阿拉伯的艾马尔JV公司的首席执行官（CEO）。至2011年下半年，由杜里领导的团队主要负责王国控股在利雅得和吉达的项目开发。在吉达的项目位于王国塔附近。 该项目将成为未来世界最高楼。

杜里现在任职总部设在迪拜的艾马尔国际公司的首席执行官。他们负责的开发项目遍及埃及、沙特阿拉伯、摩洛哥、叙利亚、约旦、黎巴嫩、土耳其和巴基斯坦。

Abstract

Burj Khalifa, the world's tallest building, is more than simply an icon for fast-growing Dubai. Emaar Properties created the world's most dramatic example of an integrated vertical city, combining residential space, a luxury hotel, restaurants, offices and retail space into one efficient tower, where people can live, work and play. The average daily occupancy of Burj Khalifa is more than 6,000 people. The 828-meter tower also serves as a centerpiece of Downtown Dubai, a $20 billion, 500-acre development which creates a new urban environment for the emirate. The increasing value of land and projects in the area due to the presence of the tower is now known as the "Burj Khalifa Effect." This paper discusses the challenges in designing and building the world's tallest building and making it a vertical community, while integrating the project with the surrounding development plan.

Keywords: Dubai, Burj Khalifa, Planning, Environment

摘要

哈利法塔作为世界上最高的建筑，不仅仅是快速发展中的迪拜的标志。艾马尔地产公司创造了世界上让人印象深刻的成功案例，一个综合性的垂直城市。哈利法塔包含了居住空间、豪华酒店、餐馆、办公室和零售空间。人们可以在那里生活、工作和娱乐。哈利法塔平均每天入住超过6000人。828米高的哈利法塔也是迪拜商业区的核心，该商业区耗资200亿，占地500英亩，将为首长国创造新的城市环境。由于哈利法塔的存在，该地区的土地和项目都有所增值，大家称之为“哈利法塔效应”。本文讨论了在设计和建造这座世界最高建筑，使其成为一个垂直社区，并同时结合周边发展项目过程中的挑战。

关键词：迪拜，哈利法塔，规划，环境

Introduction

The Burj Khalifa, unlike previous "World's Tallest" buildings, is a mixed use development accommodating the world's first Armani Hotel, hotel serviced apartments, residential apartments, restaurants and office space, and as such operates on a "round the clock" basis. The average daily occupancy of the building is in excess of 6,000 people (see Figure 1).

At 828 meters (2,716.5 ft) in height, Burj Khalifa features more than 1.85 million square feet of residential space and more than 300,000 square feet of prime business space, in addition to the Armani Hotel Dubai and private Armani Residences Dubai. It also includes four pools, clubs, an exclusive residents' lounge, health facilities and At.mosphere, a fine dining restaurant. In many ways, the tower represents a coherent set of ideas about technology, design, art and ambition. The scale is unprecedented: 330,000 cubic meters of concrete, 142,000 square meters of glass and 57 elevators.

But tall buildings in the 21st century do not stand alone. Alone they might come to be seen as little more than grandiose gestures. If they are to truly live, then they must be part of a greater scheme, and that greater scheme is the city. A city must build a social space, a

介绍

哈利法塔与以往的“世界最高”建筑不同。哈利法塔是一个综合性大楼，包含了世界上第一个阿玛尼酒店、酒店服务式公寓、住宅、餐馆和写字楼， 并为大楼内人员提供不间断的服务。哈利法塔平均每天入住超过6000人（见图2）。

哈利法塔高828米（2716.5英尺），内部设有超过185万平方英尺的住宅区和超过30万平方英尺的高级业务空间。塔内包括阿玛尼迪拜酒店和私人阿玛尼迪拜公寓。它还包括4个游泳池、会所、居民休息休闲区、医疗设施和名为At.mosphere的高级餐厅。在许多方面，哈利法塔的设计将高科技、设计、艺术和野心融为一体。哈利法塔的规模是空前的：33万立方米混凝土，142000平方米的玻璃幕墙和57台电梯。

21世纪的高楼大厦不是独立的。单独看这些建筑，他们可能显得很宏伟。如果真正实现这些建筑的价值，那么他们必须是城市规划的一部分。一个城市必须建立一个社会空间、商业空间、艺术、体育和文化空间，人们才可以在这一个城市工作、休息和娱乐。一个城市由建筑物组成，城市也需规划建筑物。

就像吉隆坡的双子塔一样，哈利法塔在城市规划中占有更重的分量。该塔是新迪拜“商业中心”的核心焦点。造价200亿

commercial space, a space for art and sport and culture, a place within which people can work, rest and play. Buildings make cities, but cities also make buildings.

Like Kuala Lumpur's Petronas Towers, Burj Khalifa is part of a much larger, greater scheme. The tower is the central focus of the new Dubai "downtown," a US$20 billion mixed use development covering 500 acres. Key elements include The Dubai Mall, one of the largest shopping and entertainment destinations in the world; The Dubai Fountain, the world tallest performing fountain, shooting water 500 feet high; and more than 1 million square feet of office space. Building and integrating these diverse elements to create a living, breathing city were just as complicated as building the world's tallest tower (see Figure 2).

Even as the project evolved, staying true to the original vision for Downtown Dubai was crucial. Typically in a project like this on a mass urban scale anywhere in the world, a wide variety of compromises are made, due to the involvement of different interests. It is compromised because a city planner wants to change something, or one mayor wants it this color, another mayor wants it that color. With this project, that wasn't the case. From the commencement of construction in 2004 until the inauguration in 2010, the building became part of the collective experience both of those who worked there and of those who admired it from afar.

Early Stages

Burj Khalifa was designed as the tallest structure ever built by man. The tower itself required great leaps forwards in tall building technology. Gravity load analysis, aerodynamic shaping and wind engineering played a major role in the architectural massing and design of the project. From the commencement of construction in 2004, the tower became part of the collective experience of everyone who worked on the project, as they sought to solve issues and create new approaches for the structure.

Emaar Properties PJSC, the developer, is best known for luxury master-planned developments. Founded in 1997, Emaar is a Dubai-based global property developer listed on the Dubai Financial Market. It has operations in several countries, in addition to the UAE, where it has also developed the Dubai Marina - a master-planned waterfront development with the "world's densest block," including several of the world's tallest residential towers.

The design of Burj Khalifa is based on the geometry of a desert flower and patterns found in Islamic architecture. The towering mass is organized around a central core with three wings. Each wing consists of four bays. At every seventh floor one outer bay ends as the structure spirals to the sky. The Y-shaped floor plans maximize views and add natural light to the interior spaces. The tower is built from reinforced concrete to level 156, and then structured steel to the pinnacle. As it grows taller, the tower grows thinner, reducing wind dynamic effects (see Figure 3).

The lateral load reducing system consists of reinforced concrete core walls, linked to the exterior columns through a series of shear wall panels at the mechanical levels. The core walls vary from 500 to 1,300 millimeters (19.69 inches to 51.18 inches), and are typically linked through a series of 800 to 1,100 millimeter reinforced concrete or composite link beams at every level (see Figure 4).

The exterior cladding is comprises reflective glazing with aluminum

Figure 1. Burj Khalifa standing among the buildings of the city. (Image: SOM, Nick Merrick Hedrich Blessing, 2010.)
图1. 哈利法塔耸立于城市的建筑物之间。（图片提供：SOM， Nick Merrick Hedrich Blessing， 2010）

美元，占地500英亩的商业区包含综合用途。其主要元素包括：世界上最大的购物和娱乐目的地之一迪拜购物中心；射水500英尺高，世界上最高的表演喷泉迪拜喷泉；和超过100万平方英尺的办公空间。建设和设计整合这些不同的元素，创造一个活生生的、会呼吸的城市，其复杂程度不亚于建造世界第一高楼（见图2）。

即使项目已经启动，保持迪拜市中心的城市特点是至关重要的。通常，无论这样一个大尺度的城市项目发生在世界的哪个地方，由于不同利益方的参与造成的各种各样的妥协和修改是难免的。比如，城市规划者想要改变一些东西，或者一个市长希望这个颜色，另一个市长希望不同的颜色。这个项目的情况并非如此。从2004年破土动工，直到在2010年的典礼，大楼的建设是基于在当地工作的人和远道而来的专家集体经验基础上的。

初期阶段

哈利法塔被设计为人类有史以来建造的最高建筑。在建造时，需要拥有高超的高层建筑技术。重力荷载分析、气动成型和风力工

Figure 2. The master plan for the Burj Khalifa development.
图2. 哈利法塔的总体规划

Kingdom Tower: A New Icon for Saudi Arabia
王国大厦：沙特阿拉伯新标志

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Talal Al Maiman is a member of the board and executive committee of Jeddah Economic Company, a corporation established in 2009 to develop Kingdom Tower in Jeddah, Saudi Arabia. Mr. Al Maiman is also Chairman and CEO of Kingdom Real Estate Development Company, based in Riyadh. KREDC is a division of Kingdom Holding Company, whose chairman is His Royal Highness Prince Alwaleed Bin Talal Bin Abdulaziz Alsaud, nephew of Saudi Arabia's King Abdullah.

Talal Al Maiman是吉达经纪公司董事会和执行会员会成员。创建于2009年的吉达经济公司开发了位于沙特利雅得的王国大厦。Al Maiman先生也是位于利雅得的王国房地产开发有限公司主席兼CEO。王国房地产开发有限公司是王国地产公司的一个子公司，公司主席是王子殿下Alwaleed Bin Talal Bin Abdulaziz Alsaud，他是沙特阿拉伯国王的侄子。

Abstract

This paper provides an introduction to, and overview, of Kingdom Tower - expected to be the world's tallest building, at over 1,000 meters, when completed in 2017 in Jeddah, Saudi Arabia. The paper outlines the project's history, including the competitive process that led to the selection of the design scheme; its architectural and structural designs by Adrian Smith + Gordon Gill Architecture and Thornton Tomasetti respectively; its sustainability features; and its construction schedule.

Keywords: Kingdom Tower, Talal Al Maiman, Jeddah Economic Company, Adrian Smith, Gordon Gill

摘要

本文介绍了位于沙特阿拉伯利雅得的王国大厦，其高度超过1000米，2017年竣工时有望成为世界第一高楼。文章概述了项目的历史（包括从竞赛阶段到设计方案的选择）、来自Adrian Smith + Gordon Gill建筑设计事务所和Thornton Tomasetti的建筑设计与结构设计、可持续性特点以及施工进度。

关键词：王国大厦 Talal Al Maiman 吉达经纪公司 Adrian Smith Gordon Gill

It has been the author's great pleasure to be involved in the planning of Kingdom Tower, which, at more than 1,000 meters, will be the world's tallest building when completed in 2017 in Jeddah, Saudi Arabia (see Figure 1). The intention of His Royal Highness Prince Alwaleed Bin Talal Bin Abdulaziz Alsaud and Jeddah Economic Company (JEC), on whose executive committee the author serves, is for this magnificent soaring structure to express the vitality, the aspirations and the greatness of our Kingdom and its people for generations to come.

At a total construction area of 550,000 square meters, Kingdom Tower will be the centerpiece and first construction phase of the 5.3 million-square meter Kingdom City development in north Jeddah, overlooking Obhur Creek and the Red Sea (see Figure 2).

Expected to be constructed at a cost of US$1.2 billion, Kingdom Tower will be a mixed-use building featuring a luxury hotel, office space, serviced apartments, luxury condominiums and the world's highest observatory. Kingdom Tower's height will be at least 173 meters taller than Burj Khalifa, the world's current tallest building (see Figure 3), which was designed by Adrian Smith while at Skidmore, Owings & Merrill.

作者一直非常高兴参与王国大厦的规划。王国大厦高度超过1000米，2017年竣工时将成为世界第一高楼（图1）。王子殿下Alwaleed Bin Talal Bin Abdulaziz Alsaud和作者作为执行委员会成员所在的吉达经纪公司决定建造这一宏壮美而直达云霄的建筑来表达王国以及世世代代人民的活力、雄心和伟大。

总建筑面积为55万平方米的王国大厦将成为吉达北边王国城530万平方米发展的核心和第一建设阶段。大厦可以俯瞰Obhur河以及红海（见图2）。

建造预算为12亿美金的王国大厦将成为涵盖豪华酒店、办公空间、酒店式公寓、豪华公寓和世界最高的观光厅的综合体项目。王国大厦将会至少现在的世界第一高楼比哈利法塔高173米（见图3）。哈利法塔由SOM建筑设计事务所设计。

由Adrian Smith + Gordon Gill建筑事务所设计的王国大厦既体现了高技术，同时也明显带有有机性。其纤细又略显不对称堆叠的形态让人联想起如同从地上突然生长的一束枝叶——预示着将激发出地上周围更多新的生活。

光滑并呈流线型的塔楼形式可以比作沙漠中茁壮成长的植物的折叠状叶状体。叶状体从地上以单一的形式向上冒出，然后在顶端开始彼此分离，这比喻新的增长伴随技术的融合。

Figure 1 : Kingdom Tower, Jeddah, Saudi Arabia. (Source: Jeddah Economic Company/AS+GG)
图1. 王国大厦，吉达，沙特（出自： 吉达经济公司/ AS+GG建筑事务所）

Figure 2 : Aerial view of the tower overlooking Obhur Creek. (Source: Jeddah Economic Company/AS+GG)
图2. 鸟瞰三瓣状的地面印记，王国大厦，吉达，沙特（出自： 吉达经济公司/ AS+GG建筑事务所

Figure 3 : Burj Khalifa, Dubai. (Source: AS+GG/ Tim Griffith)
图3. 哈利法塔，迪拜，阿拉伯联合酋长国（出自：AS+GG建筑事务所/ Tim Griffith摄影）

Adrian Smith + Gordon Gill Architecture's design for Kingdom Tower is both highly 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. This symbolizes the tower as a catalyst for increased development around it.

The sleek, streamlined form of the tower can be interpreted as a reference to the folded fronds of young desert plant growth. The way the fronds sprout upward from the ground as a single form, then start separating from each other at the top, is an analogy of new growth fused with technology.

While the design is contextual to Saudi Arabia, it also represents an evolution and a refinement of an architectural continuum of skyscraper design. The three-petal footprint (see Figure 2) is ideal for residential units, and the tapering wings produce an aerodynamic shape that helps reduce structural loading due to wind vortex shedding.

The result is an elegant, cost-efficient and highly constructible design that is at once grounded in built tradition and aggressively forward-looking, taking advantage of new and innovative thinking about technology, building materials, life-cycle considerations and energy conservation.

For example, the project will feature 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 (see Figure 4) with stunning views of Jeddah and the Red Sea.

The great height of Kingdom Tower necessitates one of the world's most sophisticated elevator systems. The Kingdom Tower complex will contain 59 elevators, including 54 single-deck, 3 double-deck, and 2 triple-deck elevators, along with 10 escalators. Elevators serving the observatory will travel at a rate of 10 meters per second in both directions.

尽管设计考虑沙特阿拉伯的地域性特征，但同时展现了超高层建筑设计进程中的不断进化与完善。三个花瓣状的地面印记（见图2）是居住单元的理想形态，尖细的侧翼呈现出空气动力学形态则有助于减少由风力漩涡脱落产生的结构荷载。

最后的结果呈现出一个优雅、高成本效益并具备高水准的构造设计，一经建成必将重塑传统同时体现前瞻性，并表达对于技术、建造材料、生命周期以及节能等方面的创新性思考的进步性。

例如，本项目独具特色的高性能外墙系统会通过减少热负荷最大限度地减少能量消耗。此外，王国大厦在其三个面上都独具特色地设置了一系列凹口从而创造出阴影区来遮蔽阳光，同时提供了室外露台（见图4）来欣赏吉达以及红海的壮丽景象。

超高的王国大厦需要世界上最先进的电梯系统。大厦有59个电梯，其中54个单轿厢电梯、3个双轿厢电梯以及2个三轿厢电梯，还有10个自动扶梯。直达观光厅的电梯双向都可保持每秒10米的速度运行。

设计上另外一个独具特色的部分是在157层有一个直径大约为30米高空露台（见图5），这是一个利用大厦顶部的阁楼而创造出的舒适的室外空间。值得注意的它最初被设计为直升机停机坪。之后经过设计团队的研究认定在这一高度，大厦四周的风力具有不可预知的运动性，因此设置直升机停机坪是无法实现的。然而在那个时候，设计团队和吉达经纪公司（JEC），特别是王子殿下Alwaleed已经喜欢上了这一独特的设计元素，所以决定保留它。

项目历史

王国大厦的规划过程大约在四年前在Alwaleed王子的授意下开始展开。Alwaleed王子一直设想在吉达建造超高层建筑作为王国的象征以及作为国际社会一份子的卓越地位。

为此，吉达经纪公司于2009年成立成为开发王国大厦的法人实体。吉达经纪公司（JEC）最初的合伙人是王国地产公司（KHC），其主席是Alwaleed王子和吉达杰出的 商人Samaual Bakhsh和Abdulrahman Hassan Sharbatly。2011年，沙特历史最悠久最富

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