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Mega Size Mixed-Use Projects: Redefining Vertical Urbanism

巨型多功能建筑：对纵向都市化的重新定义



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Abstract | 摘要

As the draw to urban centers increases drastically with financial growth and global influence, emerging markets seek to develop salient markers of success and hope. This paper explores the trend of defining an icon with a mixed-use development, and how designers cope with the scale and magnitude of these high-profile projects, especially in regions breaking ground for mega-size structures. Drawing comparison between the 300-meter development of New York's Hudson Yards, the 600-meter Ping An IFC in Shenzhen, and the 1,000-meter Jeddah Tower, a relationship is found between the desire for an icon and the practicality of such construction in nations of different cultural and economic background. What was once pushing the limits of construction technology has become achievable for new cities establishing global recognition while megacities still find stability and need for the tall, mixed-use development.

Keywords: Construction, Height, Mixed-Use, Planning, Structural Engineering, Vertical Urbanism

在经济增长和全球化的大背景下，都市中心的吸引力变得愈发巨大，新兴市场希望通过建造地标性建筑来构建他们成功与希望的象征。本文探讨了现今通过综合开发项目来定义地标性建筑的趋势，以及设计师们如何在那些巨型建筑鳞次栉比的地区协调与规划这些高知名度大规模项目。通过研究对比300米高的纽约哈德逊城市广场、600米高的深圳平安国际金融中心以及高达1000米的吉达王国塔后，不难发现对于城市地标的的需求和此类建筑在不同的文化与经济背景下的实用性之间存在着某种特殊的联系。在新兴城市运用着突破曾经建筑工艺局限的技术建立全球认知度的同时，特大型城市依旧稳固发展，两者对高层综合开发项目有着共同的需求，并持续增长。

关键词：施工、高度、混合用途、规划、结构工程、垂直城市化

Urbanism in Context

For designers, urbanism is an end goal, which culminates in an environment where the lines between live, work, and play are blurred. Working through the context of a single structure, designers modestly construct cities and set the urban habitat. As an individual, the expectations of a city are much higher; to attract occupants, consideration must be paid to comfort, beauty, and less obvious characteristics such as wind accelerations and vibration mitigation. Structures are expected to honor the local climate, taking into consideration history, building practice, and topography (Charter of the New Urbanism, 2001). Urbanism in the form of high-rises is manifested in the functionality of condensing a city into a vertical module. This is our concept of vertical urbanism. As the high-rise evolves, and trends establish themselves, we begin to see the purest form of vertical urbanism in mixed-use development. The combined mixed-use habitat emerges as a prime vessel for distilling the societal needs of living by one's work, easily reaching areas of relaxation, and thriving in a safe environment. As a trend, vertical urbanism is the development of these

都市化的定义

对于设计师来说都市化是人们生活、工作以及娱乐场所的交错与融合，也是设计师们的终极目标。从某种角度来说，设计师需要谨慎地建设规划城市，营造都市人居环境，因为就个体而言，人们对于城市的期许会很高。如2001年出版的《新城市主义宪章》所言“建筑的结构需要顺应当地的气候、也需考虑当地的历史情况、建筑习惯以及地形特点。”要想让城市变得更具人气，更具吸引力，我们就必须将一些如风速和振动这样需要降低的因素以及城市的舒适与美观纳入考量。都市化正以高楼林立的形式出现，体现了城市纵向化集合的功能。这同时也是我们对于纵向都市化的定义。随着高层建筑的演变，逐渐形成一种以综合开发项目为载体出现的纯粹的纵向都市化的趋势。混合的综合性人居环境作为一个能满足人们社会工作与生活需求、使人们拥有放松空间并能作为一个安全环境供人发展的重要载体而出现。纵向都市化是高层建筑的发展方向，作为一种发展趋势它将以人们几十年前所无法想象的形式不断出现。

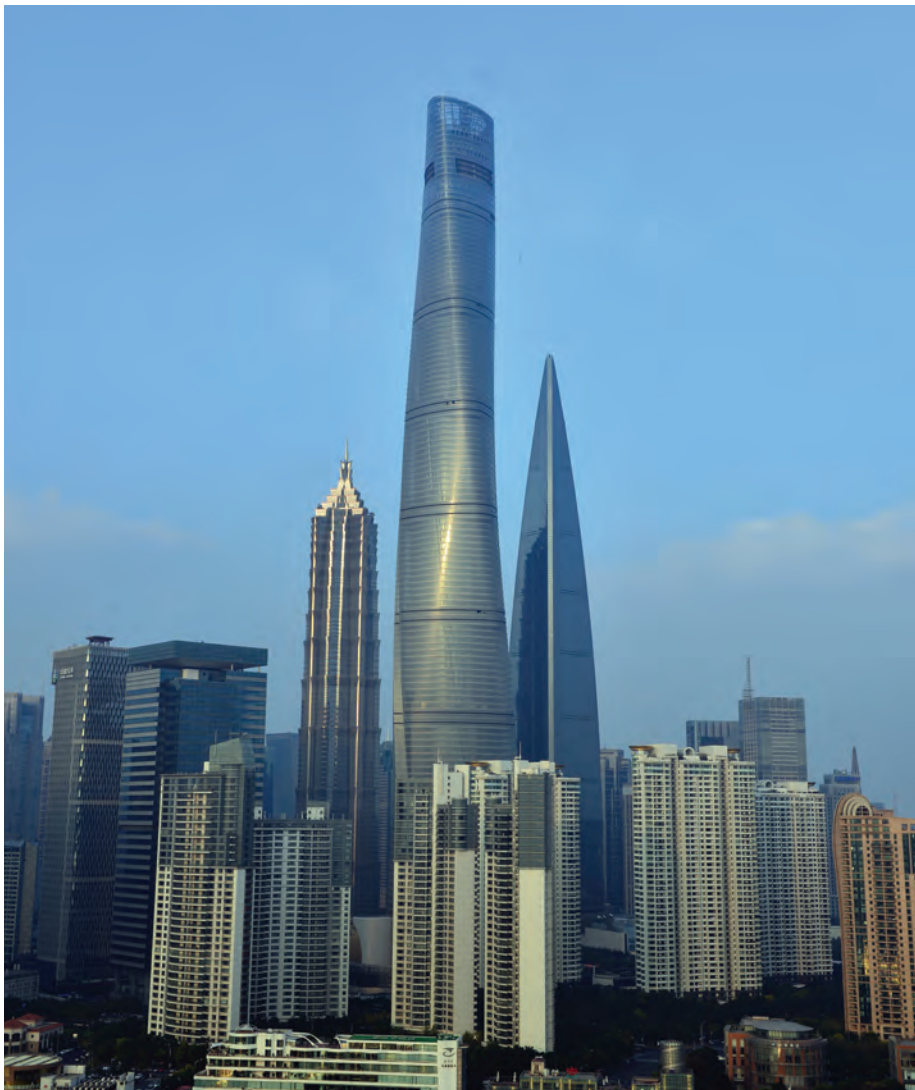


Figure 1. Shanghai Tower and Pudong skyline (Source: Shanghai Tower Construction and Development Company)
图1. 上海中心及浦东天际线（来源：上海中心大厦建设发展有限公司）

tall and supertall high-rises, which serve their occupants in forms unrealized decades before.

Defining an Icon

For an inhabitable structure, notoriety is often achieved by chance; a material flaw may lead the façade to grandstand, a developer scandal could place the structure in headlines, or the physical geometry could form a solar reflector. Practically, the designer is in control of the building's reputation at its conception. While architecture may be thought of as the sole means to develop an icon, scale and height also play a major role. The marriage of massing, enduring imagery, and efficient programming define an icon and ensure that society will find a use for future generations. For the three structures identified in this paper, their status as icons is without question for reasons beyond this project scope and magnitude. The attraction for end-users of these structures is undoubtedly swayed by the icons that they are in the regions that they stand in. The national symbols they become, such as Shanghai

Tower in Figure 1, serve to complete skylines and support the cities where they stand. As products of shared knowledge, societal wealth, and human ingenuity, the shared space these structures create play to the mixed-used nature of new construction. This unity both inside and out furthers the concept that urbanism grows skyward when cities have reached horizon's limits. As cities within cities, mixed-used towers stand as icons across the globe.

New York Hudson Yards – Completing the West Side

For the city of New York, untouched land is hard to come by. Air rights and land rights come at a price on top of the physical ground to be built upon, in addition to the nuances of protecting infrastructure and local structures on the site. Hudson Yards falls in a grey area: it is a site that is developed as a train yard, yet has the ability to rise skyward between the rails. In terms of programming and functionality, the neighborhood in which Manhattan's Hudson Yards is situated does not offer much to

构建地标

就一个居住型建筑而言，坏名声往往是不经意间得来的：材料的缺陷可能导致其金玉其外、开发商的丑闻也可能让这个建筑上头条亦或因为它的几何外形使得它成为了光污染的来源它就会臭名远扬。实际上设计师是能够在建筑的概念层面上进行声誉管理的。建筑可能被认为是设立地标、体现规模与高度的唯一方式。经久不衰的形象、建筑群以及高效规划的紧密结合是现今构成地标的重要因素，当然还需要确保它对于未来的人们是有用的。对于本文中所提及的三栋建筑，它们作为地标是毋庸置疑的，它们对于人们意义远超项目本身。这些建筑在当地的影响正是引起终端用户兴趣的重要原因。它们成为了国家的象征，就如同图1中的上海中心那样，它们为城市的天际线增光添彩，使得所在的城市熠熠生辉。作为知识共享、社会财富和人类独创性的产物，这些建筑的共享空间体现了新型建筑多功能的特点。当城市土地出现局限的时候，这种内外的统一拓宽了都市化的理念：向天“要地”。多功能综合性高层建筑就像是城中之城，它们作为地标在全世界范围内如雨后春笋般涌现。

纽约哈德逊城市广场——西城的最后一块拼图

对于像纽约这样的城市而言，土地已经拥挤得动弹不得。除去保护项目所在地的基础设施和局部结构的费用外，为获得项目所在地上空的使用权和其土地的使用权还需支付额外的费用。但哈德逊城市广场却是一个特例：它所处的位置是被开发作火车站使用的，而正是这些铁轨间的土地拥有着向天“要地”的可能性。在规划与功能方面，哈德逊城市广场周边除了基础设施连接以外没有任何可以提供给居住者的资源。对于综合开发项目而言这是再理想不过的了。哈德逊城市广场就像是一座浮于火车站之上的空岛，为人们提供了大规模的商业、居住、文化以及公共活动空间。然而要在纽约这么一个拥挤的城市里挤出一个如此大的空间是充满挑战的，即使现有的工程技术与规划能够使得这个项目得以实现，但它仍是困难重重。

哈德逊城市广场分为两部分开发：铁路西站场被开发作居住用，铁路东站场则以商业为主进行开发。西站场靠近哈德逊河，让人有种脱离城市喧嚣的感觉，而北站场临近市区因而开发作商业大楼规划以融入曼哈顿的天际线（图2）。这些模块的配套基础设施由与之相邻的北面的纽约地铁以及西面与南面的空中花园构成，它们将曼哈顿的大片区域连为一体。而遍布在这些建筑间的文化、零售和开放空间使得小小两个街区就能满足其中的居民和员工在一个城市中几乎所有的生活与工作需求。

residents aside from infrastructural connection. For a mixed-used development, this is ideal. Offering commercial, residential, cultural, and public open space, Hudson Yards stands as an island above the train yards, at a grand scale. The challenges of filling such a large void in a congested city are immense, though mountable with engineering knowledge and planning.

Logistically, Hudson Yards is split into two, staged developments: the western rail yard to be developed with a residential focus and the eastern rail yard under development with a commercial directive. For the western yard, proximity to the Hudson River allows for a reprieve from the city while the eastern yard rises to the height demands of a New York commercial tower (Figure 2). These modules attach to the infrastructure through a northern connection to the local subway service and as western and southern connections to an elevated park, which ties together a large swath of Manhattan. Cultural, retail, and open space break up the massing and allow residents and employees the functionality they demand in a large city, condensed into two blocks.

Structurally, designing a building to span and reach terra firma among existing rail tracks requires immense planning and consideration. In the case of 30 Hudson Yards, the steel commercial office tower reaching nearly 1,300 feet, structural system transferring must occur at the rail yard level. Physically, the constraints of the site define the massing that can rise from the footprint. For the remainder of the site spanning directly over the rail yard, a platform spans to carry any low-load column modules. Higher loaded columns are forced to walk, and the spanning retail structures are hung from upper trusses to distribute the load to terra firma between the rails below. The conventionally framed laterally is stabilized tower through a braced core with three levels of double-height outriggers. As New York is a wind governed region, and based on occupancy comfort, dampers are frequently utilized to reduce undesirable building accelerations.

For a tower exceeding 1,250 feet and achieving the supertall status, this mixed-use structure is iconic in form and composition. Users have the opportunity to work, live, and relax in a footprint of a city block rising vertically over four and a half blocks into the skyline. This verticality is the new standard in the urban context where planar space to grow becomes scarcer and scarcer.



Figure 2. Hudson Yards rendering (Source: Thornton Tomasetti)
图2：哈德逊城市广场概念图（来源：宋腾添玛沙帝）

从结构设计角度来看，设计一栋横跨现有铁轨的建筑需要极其繁复的规划与思考。以高1300英尺（约396米）的钢结构商业写字楼A为例，它的结构体系转换一定会出现在铁路层。从物理学角度来看，项目所在地的种种局限限制了该区域的承重能力。一个横跨的平台用于承载所有低负载柱形模块，建筑其余的部分则直接横跨过铁路站场。相对高负载的柱子错落而立，横跨其上的结构从上方的桁架悬挂而下，经由桁架卸力到铁路间的地面。传统框架结构塔横向上由一个由三层、两倍高度的支撑脚构成的支撑核心来稳定。考虑到使用的舒适度，像在纽约这样常受大风影响的地区，我们常常使用阻尼器来减少不必要的晃动（建筑加速度）。

对于一个超过1250英尺（约381米）的高楼而言，它超高层的形式以及多功能的综合架构使得它成为了地域标志。它也让人们有机会在一个占地仅4.5个街区的天空之城里工作、生活和娱乐。这种垂直化的发展是在土地资源越发稀缺的当下都市化概念的新标准。

深圳平安国际金融中心——浓缩的都市模块

当一座高楼突破600米大关，就会成为为数不多的巨型高层建筑家族的新成员，并作为新型区域地标闻名于世。平安国际金融中心，在占地3000平方米的区域里破土而出，其使用面积超过460,000平方米，约为深圳市区土地面积的0.02%。从深圳的天际线来看，平安国际金融中心的高度是独树一帜的（图3）。规划这样一个高占地高

使用面积的项目须要因地制宜。平安国际金融中心作为一个拥有综合零售、餐饮及旅游观光用途的多功能都市栖息地拔地而起，成为一座以商业为主要目的的垂直化城市。同时它作为一栋以尊重保护环境为前提建造的建筑，平安国际金融中心希望能够获得美国LEED-CS的金牌认证。它通过其高能效、拥有智能配水系统以及限制了挥发性有机化合物使用的建筑特色让用户能以一个高标准的状态生活在绿色环境中。高空自然通风进气冷却系统的主要部件、热回收系统、高性能幕墙、制冰蓄冰系统以及对用户照明的控制、对采光的考量、雨水的收集还有对冷却塔废水的回收这些设计都为保护周遭环境起到了积极的作用。对于中国而言要建造一栋环保、高能效的良心建筑意义重大，因此每一个细节，小到材料的选择（如材料的来源、材料的生产和运输等）我们都应高度重视。

从概念上说，都市与其商业模块的堆砌与垂直化的概念最为相近，平安国际金融中心就将这些建筑群从地面抬升到了天空之中，使得它成为了新的地域象征。在设计时考虑到安全因素与建筑寿命，深圳区域的地壳活动成了横向支撑系统设计的关键，同样设计师还需要将风荷载对于这类大型建筑的影响考虑在内。设计师们将抗震设防烈度设计为七度，经过对在多次反复地震、中度地震和严重地震三种情况下的建筑性能分析，通过非线性时程分析法优化了建筑的结构系统提高了建筑的安全系数。此外设计师亦对楼板的形状进行了优化以减少如漩涡脱落这样的动态风荷载影响，设计师们还减少了设计荷载、柱和核心筒的尺寸以及建筑自重，以使如此大型的建筑能够拥有一个相对较小的碳足迹。如同其他拥有类似高度与宽高比的建

Ping An International Finance Center – Densifying the Urban Module

For a tower of 600 meters, the realm of megatall is a small class with notoriety as the new regional landmark. Ping An, at over 460,000 m² accounts for 0.02% of the total urban land area of Shenzhen, rising vertically in a footprint of 3,000 m². In the context of the local skyline, this magnitude is unparalleled (Figure 3). Programming such a vast area of floor space followed the demands of the region. Ping An rises as a vertical city for business drawing on mixed-use urban habitats with combined retail, restaurants, and observation usages. As a structure that respects the environment in which it is constructed, it seeks to achieve a LEED certification of Gold for Core and Shell. Occupants in an energy efficient, water smart, and VOC limited structure are subjected to a higher standard of living with such a significant portion of one's day in a green environment. Major components of natural ventilation, such as altitude air intake chilling, heat recovery systems, high performance façade cladding, ice storage generation, occupant lighting controls, daylighting consideration, rain water collection, and recycled cooling tower bleed off, play an important role in the positive contribution of the tower to the surrounding environment. For China, creating an efficient and conscientious structure holds a high importance as care is taken, down to material selection, to minimize the environmental impact on the region from material extraction, manufacturing, and transportation.

Conceptually, the stacking of urban, commercial modules is the most direct analogy to achieving a vertical form; Ping An pulls this massing from the street level and brings it skyward to define itself as a new icon of the region. In the context of design considerations for safety and longevity, Shenzhen's seismic activity plays a large role in lateral system design, as does the wind loads imparted to a structure of such magnitude. A seismic fortification intensity of the seventh degree with three design considerations for building performance under frequent, medium, and severe earthquakes is analyzed through nonlinear time histories optimizing the structural system for safety. Additionally, floor plate geometry is optimized to reduce the effects of dynamic wind loading effects, such as vortex shedding, to reduce the design loading, column and core sizing, and building mass, which creates a smaller carbon footprint for a tower of such scale. As with any tower of this height and aspect ratio, a tuned mass damper is utilized to reduce the structural accelerations due to wind and achieve high

筑, 平安国际金融中心使用阻尼器来减少由风引起的结构加速度以保证在刮风情况下用户的高舒适度。

综合性巨型建筑在经济影响日益增长的区域不断涌现并扮演了回馈当地环境的重要角色。从社会经济角度来看, 这些项目刺激了从建筑市场过度到商业租户市场的就业, 为城市带来了繁荣与发展。正是平安国际金融中心这样有代表性的建筑构建了城市的垂直化发展, 它们就像是灯塔, 为社会的进步与都市化的发展指明方向。

吉达王国塔——沙漠里的都市化明珠

为了能够比较综合项目发展的驱动机制, 吉达王国塔将会作为一个完全的新区成为吉达经济城方圆2英里范围内开发的焦点。竣工后吉达王国塔将不仅仅成为世界第一高楼, 它还将成为人类所建造的第一栋超过1千米的建筑! 以周遭区域为背景, 图4展现了这座高楼为天际线所增添的光彩。作为人文与科技的共同成就, 吉达王国塔将永久地改写垂直都市化的现状。除了居住型酒店、酒店式公寓和住宅的规划外, 吉达王国塔还将拥有A级办公室和全球最高的观光层。在同一建筑中工作与生活的综合建筑的成型吹响了都市化变革的号角。吉达王国塔和吉达经济城将为满足社会需求提供一系列的服务, 从而以一塔成城。

吉达王国塔是人类世界高层建筑的未来, 是拓宽垂直都市环境边界的历史性一步。作为一个典型的承重墙系统, 吉达王国塔在楼板设计时选择使用纯钢筋混凝土的结构。对于将多个分散的区域规划其中的住宅楼而言这样的沉重墙构造是最为理想的。也正是这种基础结构为人们提供了触摸更高天空的有效方式, 并且再一次重新定义了人类的居住极限。核心筒采用了三角型布局并辅以过道与额外的翼缘墙作稳定器, 保证了塔的扭转稳定性。广义高质量与纯粹的锥状简明外形对超高层建筑而言是必要且有益的。

虽然在这个地区地震对建筑的威胁不如那些地震高发区, 但透过大气施加在建筑结构上的风荷载却是极为明显的。吉达王国塔的外形使得它拥有了抵御动态风的独特能力, 它减少了如辅助阻尼器设置这样的额外设计。正是像这样实用性驱动的设计使得我们步入了未曾设想过的发展前沿。在都市化的背景下, 社会范围的不断扩大以及由尖端科技重新定义的人类居住环境意味着我们将会以曾经只能幻想的居住形式生活在那些我们未曾幻想过的空间。

都市化前景

在人类社会对地球影响日益增大的当下, 全球范围内有33亿人居住在都市空间中,



Figure 3. Ping An International Finance Center nears completion (Source: Thornton Tomasetti)

图3. 平安国际金融中心完成图 (来源: 宋腾添玛沙帝)

levels of occupant comfort even under wind events.

Mixed-use towers of mega-sized proportions rising in regions of growing economic influence serve an important role in giving back to the environment they are born in. Financially, these projects become job engines for the construction market transitioning to the commercial tenants they house bringing prosperity and growth to the city. As beacons of progress and urbanism, symbolic structures such as Ping An shape the vertical growth of cities.

Jeddah Tower – Urbanism in a Desert

To contrast the driving mechanism of development for a mixed-use project, the Jeddah Tower will stand as the focal point of the two square mile Jeddah Economic City development, an entirely new district of Jeddah. When completed the Jeddah Tower will not only rise as the tallest building in the world, but also the first structure over one kilometer tall built by man. Considering the context of the surrounding region, Figure 4 displays the impact of such a tower entering the skyline. As an achievement both by humanity and technology, the state of vertical urbanism will be changed forever. Housing hotel programming, serviced apartments and condominiums, the tower will also contain Class A offices, and the world's highest observatory. The mixed-used achievement of living and working in the same structure and the abilities of this functionality stand as a testament to the evolution of urbanism. A city in its own right, Jeddah Tower and Jeddah Economic City will provide a host of services to society's needs.

Jeddah Tower stands as a step in history towards the continuing development of tall structures in the world and pushing the boundaries of the vertical urban environment. As a typical bearing wall system, the tower finds efficiency in floor planning with pure reinforced concrete construction. For residential towers, this bearing wall construction is ideal as discrete areas are defined among the residential plans. This base structural system proves an effective means to reach even higher and once again redefines the limits for human habitability. The natural layout of the core walls provides torsional stability for the tower using the triangular form with the assistance of corridor and additional fin wall stabilizers. The benefits of having a highly generalized mass coupled with the pure tapered form lend to a simplicity that is necessary for a building of such height.



Figure 4. Jeddah Tower rendering (Source: Jeddah Economic Company/Adrian Smith + Gordon Gill Architecture)
图4 吉达王国塔概念图（来源：吉达经纪公司/艾德里安史密斯和戈登吉尔建筑事务所）

人类寻求新的生活、工作与娱乐的空间和形式(Dociu, Dunarintu, 2012)。根据图5所描绘的都市人口增长趋势，我们不难看出全世界城市的发展和演变规律，而比较后就可以发现巨型多功能建筑的出现满足了这些区域与日俱增的需求。纵观全世界的建筑，如上文提到的哈德逊城市广场、平安国际金融中心和吉达王国塔，还有武汉绿地中心、台北101大厦、上海中心大厦、吉隆坡石油双子塔和雅加达标志塔

已经为它们的所在地带来了巨大的变化，它们还将持续为所在区域发光发热。作为在全球范围内扩大财富和影响力地区的地标，它们极大地改善了那些在其中生活与工作的人们的生活质量。随着社会的发展，这些大型项目将会演变成多功能综合性建筑，并用以前可望而不可及的方式来服务大众。在都市化的大背景下，城市发展的焦点将转移到天空之城、垂直运输创新、生态足迹和居住舒适度上。

While the seismic forces imparted by the region are less significant than those in areas of greater risk, the wind load imparted to a structure reaching through atmospheric layers is significant. The form has a unique ability to resist the dynamic wind effects that often govern acceleration phenomena which reduces the need for additional design considerations such as auxiliary damping. It is this practical driven design that allows for the limit to be pushed in developing frontiers we have not yet considered. In the context of urbanism, growing society's reach and redefining what it is to live on the cutting-edge of humanity's ability means living in spaces we once never conceived and bringing what was once concept to habitable form.

The Future of Urbanism

In the growing development of society's influence on the planet, and with 3.3 billion people living today in urban space, we seek new places and forms to live, work, and play (Dociu & Dunarintu, 2012). Cities grow and evolve – Figure 5 depicts the trend of urban population growth – and the comparison can be made of mega size mixed-use construction meeting the growth demands in these regions. Structures across the world, such as the aforementioned Hudson Yards, Ping An International Finance Center, and Jeddah Tower, as well as Wuhan Greenland Center, Taipei 101, Shanghai Tower, Petronas Tower, and Signature Tower Jakarta have drastically changed and are changing the regions in which they stand. Rising as landmarks in regions of expanding wealth and influence at a global scale, these icons serve communities by greatly improving the lives of those that work and live within them. As society evolves, these mega-scale projects develop into mixed used constructs, serving the masses in greater ways than previously imagined. In the context of urbanism, the focus shifts from the city as a whole to a skyward module, providing innovations in vertical transportation, the environmental foot print, and occupancy comfort.

For cities of existing density, supertall mixed-used towers pull occupants to new heights, while attracting economic growth to the region with a new icon. Once these mega size mixed-use structures are completed, cities experience periods of further growth, such as how the completion of the Petronas Towers in 1996 allowed for the continued urban development for the region in Figure 6. These towers rise in locations of high value and in turn unify areas across the urban landscape,

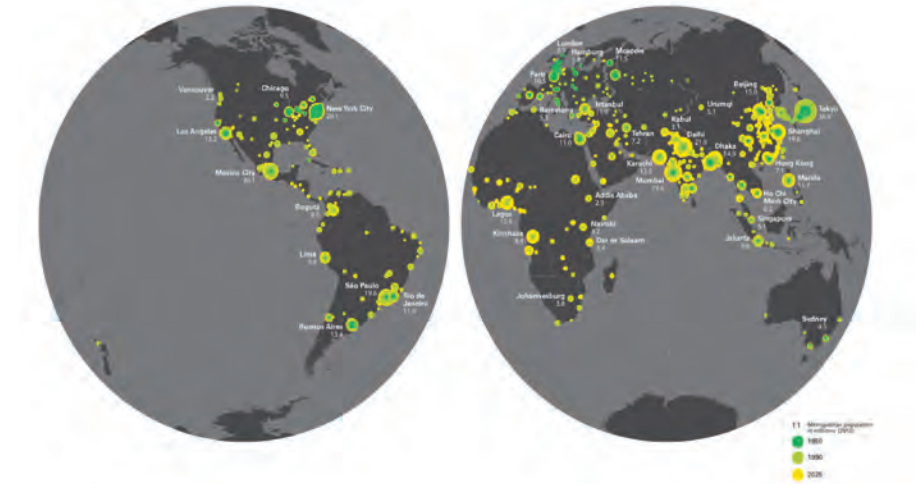


Figure 5. Where cities are growing (Source: LSE Cities, 2013)
图5. 城市增长分布 (来源: LSE Cities, 2013)

对于建筑密度难于调整的城市而言，超高层多功能建筑不仅将用户引领到了一个新的高度，它们还作为标志为所在地带来经济增长。一旦这些巨型多功能建筑建成，城市会进入一个持续增长阶段，就如图6所示，1996年吉隆坡双子塔的完工使城市持续发展了一个阶段。这些高楼在高价值的地点建造，不仅统一了城市景观，还缩短了国家内部、国与国间的乃至整个世界的距离(Graham, Marvin, 2001)。图7与图8展示了城市建筑密度与超高层建筑和大型综合开发项目的理想位置。对于发展中的城市来说，这些巨型项目巩固了经济，它们就像一个个成功的巨型标志矗立在城市中，数据显示每年约有6千万人会搬到城市中居住，社会需求的增长是极为显著的(Dociu, Dunarintu, 2012)。图9所展现的上海的急剧发展在短短的25年间得以实现，而图10的中央正是这影响全国的变化如火如荼发生的地方。与之相反，图11展现的是一个密集发展城市的变迁，纽约进行重建以适应人们日新月异的居住需求，同时市民能够在纽约的重建中寻找慰藉和统一。

为了实现这种快速的变革性的发展，建造这类巨型项目所面临的主要挑战是技术工

艺和材料科学的发展局限、垂直运输和侧向运动的难题以及荷载的传递。在不到一年的时间里，像质量调谐阻尼器、基础隔震结构、主动阻尼系统以及混凝土化学混合器这样技术的进步改写了人们对建筑的固有认知，新的建筑技术已得以全面实现并改变了全世界的天际线。如何快速高效地将人们传送至建筑物的高处？如何使人们能够快速融入高层的都市化？像这样如何将这些项目的交界面与区域内的基础设施的连接，将会成为这些建筑融入城市的最大障碍。为此地铁站、人行道以及马路这些配套都必须在这些高层建筑的底部重新规划，以服务这些高层的人流需求。

社会在世界范围内不断地扩张与发展，与此同时，全球数据共享正指数级地改变着世界进行大规模建设的方式。如图12所示，城市对于人们的吸引在全球范围内仍在不断地增长，城市的横向发展的限制恰恰为城市纵向化的发展提供了条件。那些被进步与发展的象征所吸引的人们在这些象征所伫立的地区放飞了新的希望。社会逐渐地统一，能将实现人们需求的所有设施压缩到一个仅一个街区大小但高耸入云的模块之中，都市化已然融入了我们的生

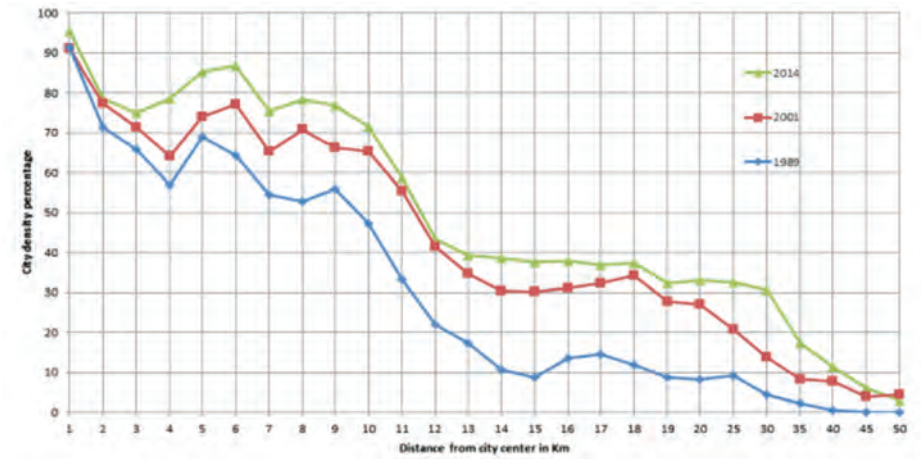


Figure 6. Kuala Lumpur city density compared to distance for 1989, 2001, and 2014 (Source: Boori, Netzband, Choudhary, Vozenilek, 2015)
图6. 1989、2001及2014年吉隆坡城市密度与距市中心距离对比图 (来源: Boori, Netzband, Choudhary, Vozenilek, 2015)

as well as across national, international, and global distances (Graham & Marvin, 2001). In Figures 7 and 8 the density of cities coincides with the most desirable locations for supertall and mega sized mixed-use developments. For developing cities these mega-projects solidify economies with tangible icons of success; as 60 million people move annually into urban environments, the demand grows in these regions specifically (Dociu & Dunarintu, 2012). The drastic development in Figure 9, which occurred in a period as short as two and a half decades for Shanghai, culminates in these developments of national significance at the center point in Figure 10. Conversely, the evolution of a densely developed city in Figure 11 provides for the changing needs of inhabitants as New York rebuilds and citizens search for solace and unity.

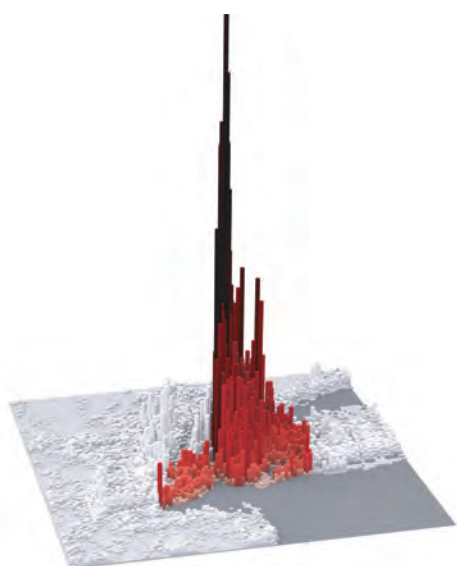


Figure 7. Ambient Density, New York (Source: LSE Cities, 2015)

图7. 纽约环境密度 (来源: LSE Cities, 2015)

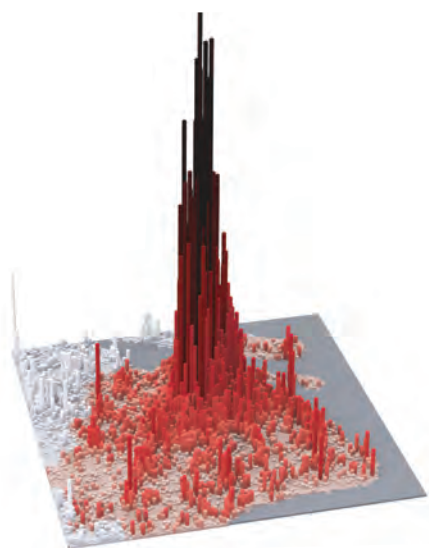


Figure 8. Ambient Density, Shanghai (Source: LSE Cities, 2015)

图8. 上海环境密度 (来源: LSE Cities, 2015)



Figure 9. Pudong skyline development (Source: Reuters/Stringer, Carlos Barria)

图9. 浦东天际线发展前后对比图 (来源: 路透社记者, Carlos Barria)



Figure 10. Urban footprint - Shanghai (Source: LSE Cities, 2009)

图10. 上海城市生态足迹 (来源: LSE Cities, 2009)



Figure 11. Lower Manhattan skyline development (Source: Lars Plougmann, 1991 / CC BY-SA)

图11. 曼哈顿下城天际线发展前后对比图 (来源: Lars Plougmann, 1991/CC BY-SA)

活。就一栋建筑而言，城市环境要求它能统一人性并满足所有的需求；而巨型综合开发项目不仅能够满足这点要求，它还作为一个关键的工具纵向定型了新都市的生活方式。

To allow for this rapid and evolving development, construction challenges facing mega size projects are elucidated by developments in technology and material science, solving problems of vertical transportation, lateral motion, and load transfer. In time spans of less than a decade, the use of new building technology has been fully implemented successfully, changing the skylines across the globe. Advancements such as tuned mass dampers, foundation isolation structures, active damping systems, and concrete chemical mixers forever change the way structures are conceived. Physically, the bonding and marriage of the project's interface to the region's infrastructure will prove the greatest hurdle: joining the urbanism of the tower to quickly and efficiently convey individuals to the structure's heights. The constructs of metro stations, sidewalks, and roadways must be redefined at the bases of such structures to facilitate the flow and demand of new towers.

Communities grow and expand across the globe while, simultaneously, the ability to share

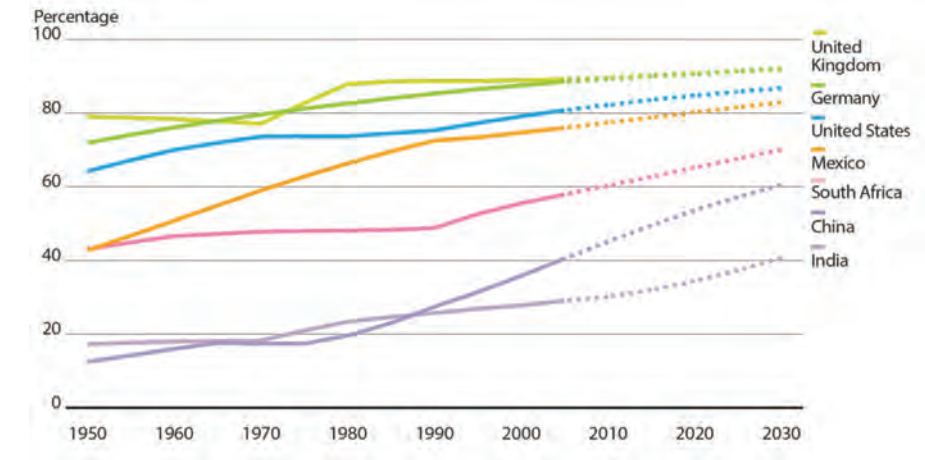


Figure 12. Urbanization by selected countries (Source: LSE Cities, 2007)
图12. 特定国家的都市化进程 (来源: LSE Cities, 2007)

data exponentially changes the ways in which the world is able to build at scale. The draw to cities continually increase across the globe in Figure 12, bolstering the needs for vertical expansion when lateral growth is impossible. Regions in which such salient markers of progress and growth rise inspire a new hope in the occupants they attract. Urbanism joins all of us, as communities unify and the ability to

fulfill one's occupations condense down into a module that is the size of a city block, but is as tall as the clouds. As a construct, the urban environment unifies humanity and meets needs required by all; by using a key tool of the mega-sized, mixed use development, urbanism is shaped vertically.

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