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Author: JianPing Gu, General Manager, Shanghai Tower Construction & Development

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Shanghai Tower: Re-Thinking the Vertical City

上海中心大厦：反思垂直城市



Jian Ping Gu

Jian Ping Gu

Shanghai Tower Construction & Development Co., Ltd.
No. 51 West Lu Jia Zui Road
Shanghai 200120
China

tel (电话): +86 21-33831136
fax (传真): +86 21-33831071
email (电子邮箱): gujianping@shanghaitower.com.cn
www.shanghaitower.com.cn

Jian Ping Gu, is the general manager and board member of the Shanghai Tower Construction and Development Co., Ltd., and an engineer. His previous work experiences include positions as the secretary of the deputy mayor of the Shanghai Government, the general manager of the China City Real Estate Investment Group and China City Property Investments, and as the trustee of the Shanghai World Expo Land Holding Co., Ltd.

顾建平，高级工程师。曾任上海市政府副市长秘书、上海城投房地产开发公司及上海城投置业发展有限公司总经理、上海世博土地控股有限公司董事。现任上海中心大厦建设发展有限公司董事、总经理。

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 harmonious 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

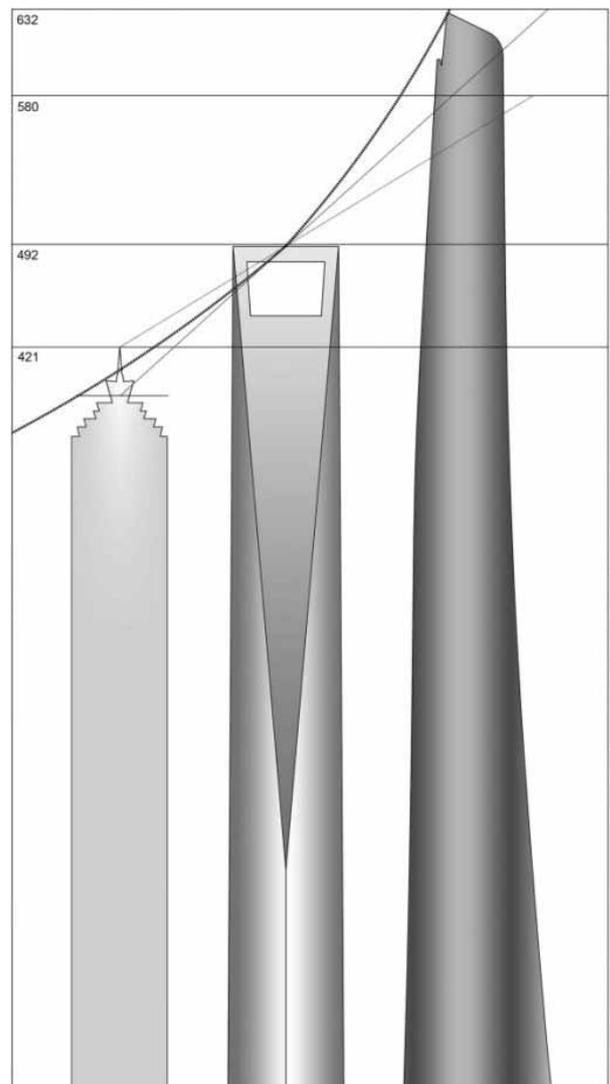


Figure 1. Jinmao Tower, Shanghai World Financial Center & Shanghai Tower (Source: Shanghai Tower Construction & Development Co., Ltd)

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）

In addition, vertical green spaces are distributed in eight sky lobbies throughout the tower.

A multifunctional community. A mature community should have diverse functions for business, culture, education, and services to meet various needs. The Shanghai Tower not only provides offices, hotels, sightseeing observatories, shopping, and recreational areas serving as its general services, it also holds museums, exhibitions, cultural performances as well as financial facilities such as banks, consulting firms, trading firms, etc., and at the same time, education, training, and lectures are also offered.

3. Architectural Quality – transforming from traditional energy-consuming buildings to a green community that is energy efficient and environmentally-friendly

When looking at the Shanghai Tower's project vision from the perspective of global development, environmental protection and energy conservation are the general trends and therefore, the project's green concept was solidified. In line with the USGBC LEED Gold Standard and China's Three Star Standard, a total of 43 technologies are implemented to save energy and resources as a way of reflecting the project's characteristics of being humane, energy efficient, intelligent, and convenient.

In efforts to conserve land resources, the Shanghai Tower does not take any fertile arable land, but rather it is built on used land. On a 30,000 square meters land, a building with an area of 575,000 square meters is being built which can save land resources for a city with a dense population and tense land resources, like Shanghai.

In efforts to conserve indirect energy source usage, the tower is making full use of recycled water and rainwater. The amount of recycled water that will be used every year is 210,000 cubic meters with 20,000 cubic meters of rain water to be used annually. The use of recycled water resources is up to 25%. Using water-saving devices and water-saving sanitary-wares helps the saving rate increase up to 60% compared to the usage of traditional sanitary-wares. Setting up a wind power system on the top of the building to make use of wind energy also provides the building with 300,000 kilowatt-hours per year of green electricity.

In respect to energy conservation, a double-skin façade with a shading system is utilized. Heat recycling devices are set up in the atrium which makes heat insulation, sound insulation, and energy conservation possible. By using the VAV air conditioning system, electricity consumption is reduced to 50%. By using a brightness sensor for lighting, energy is also saved for interior lighting. The overall energy conservation rate of the Shanghai Tower is 54.3%, which is 21% better than similar buildings.

In terms of material usages, 83% of high-strength concrete C50 is used while the use for high-strength steel bars is increased up to 74%. Local material usage accounts for 97% of the total weight of all materials used in the building and 70% of the materials were acquired within 800 kilometers of the vicinity. In the structural design, the building uses a 120° twist theme, which can reduce 25% of wind loads and save a great number of materials.

In terms of improving indoor environmental quality, if maximum natural lighting is utilized, then almost 90% of the main programmatic spaces can meet the requirement standards. In the basement, natural light is introduced through two descending sunken plazas on the east and west sides. For levels one and two below grade, the ratio

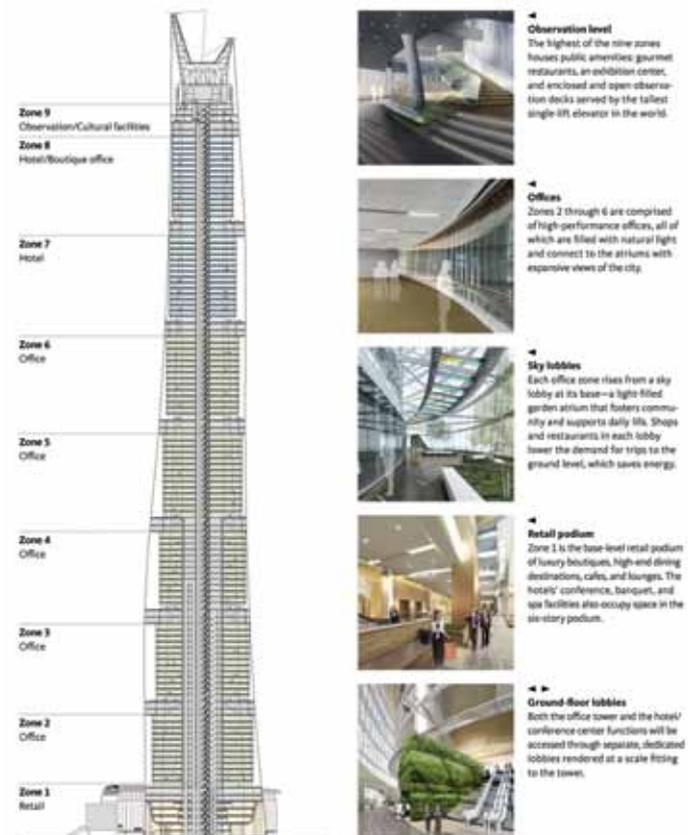


Figure 2. Function areas in Shanghai Tower (Source: Shanghai Tower Construction & Development Co., Ltd)

图2. 上海中心功能区分布图（出自：上海中心大厦建设发展有限公司）

交流的空间。在地面1层有商业、活动、办公、酒店等功能的大堂，形成各自独立的广场。在B1层，分别有2个连接室外的露天广场，便于市民直接进出。

立体绿化。除了室外地面公共绿地外，裙房五层平台有露天绿化，八个分区空中大堂有以自然形态为主题的立体室内绿化。

多功能复合。一个成熟社区具有经济、文化、教育、服务等多种功能，能够满足多种需求。上海中心不仅提供办公、酒店、观光、购物、休闲娱乐等经济活动，还提供博物馆、展览、演出等文化活动，提供银行、咨询、交易等金融活动，同时提供学习、培训、讲座等教育活动。

三、建筑品质—从传统的耗能建筑，转向节能环保的绿色社区。

上海中心在考虑项目远景时，从世界发展趋势判断，认为绿色、环保、节能必将是未来发展的方向，确定绿色建筑的方向。按照美国LEED金级和中国绿色三星标准，以“体现人文关怀，强化节资高效，保障智能便捷”为特色，从节约土地资源等方面共43项技术加以实施。

在节约土地资源方面，不占用耕地良田，而是利用已经使用过的土地。在3万m²的土地上，建造了57.5万m²的建筑，为上海这样人口密集、土地紧张的城市节约了可建设的土地资源。

在水资源和非传统能源利用方面，充分使用中水和雨水，中水年回用量约为21万立方米，雨水年利用量约2万立方米，非传统水源利用率超过总用水量的25%。使用节水设备和节水洁具，相比传统洁具节水率60%以上。利用风能，在建筑顶部采用风力发电，年供绿色电力约30万千瓦小时。

在节能方面，设计双层幕墙，加以遮阳系统，中庭设热能回收装

of area where the daylight factor is higher than 1% is 38% and 19%, respectively.

In terms of management operations, establishing a comprehensive metering and charging system and applying a CPMS Multi-Energy Management System should control the interior air quality.

In terms of executing green construction, key controls should be taken on noise, dust, and overexposure of light. Recycling and reusing wastes can increase the recycle rate up to 38%.

4. Building Information – transforming from a traditional smart building to a convenience-oriented and intelligent community

As information technology continues to develop with the concept of “intelligent city” continuously being raised, building construction and management in the future will require an advanced information technology to deliver unprecedented high-quality service, greater efficiency, less resource consumption, and a sustainable lifestyle. Components of the Shanghai Tower’s intelligent community include:

- Infrastructure with internet, fiber-optic cable, ICT, and RFID technology. An enormous amount of information is processed, filtered, and integrated with intelligence which builds a basic foundation for the intelligent community.
- BIM technology and property management. Shanghai Tower applies the use of BIM, a new advanced management technology in engineering for the building’s entire architectural life cycle from design, construction, and purchase to property management.
- Building a health monitoring system based on sensor technology. By using this technology, building changes in main structure, settlement, and curtain walls can be managed under the effects of earthquakes, wind pressures, and temperature changes. Thus, timely measures and corresponding solutions can be made according to the monitoring system and the safe operation of the building can be ensured (see Figure 5).
- Information technology based on a logistics network and a cloud computing center. The Shanghai Tower is a complex that combines multi-functional zones and multi-industry customers with multiple requirements. Different systems need to work together and share data and information while using the same comprehensive data and results which will require a powerful information processing center to make it happen. The Shanghai Tower implements a cloud computing center that is based on the internet, a logistics network, a high-speed fiber network, and a broadband wireless network which can all help build the intelligent community in support of the system’s safe operations.
- An information platform based on customer requirements. This will provide communication between communities, hotels, business services, sightseeing services, virtual offices, and activities platforms.

5. Architectural Culture – transforming from a simple traditional building to an enjoyable humane community

The Shanghai Tower exceeds traditional architectural design in the programming of space usage. The design is based upon a humanistic construction to enhance the cultural charm of the building. The

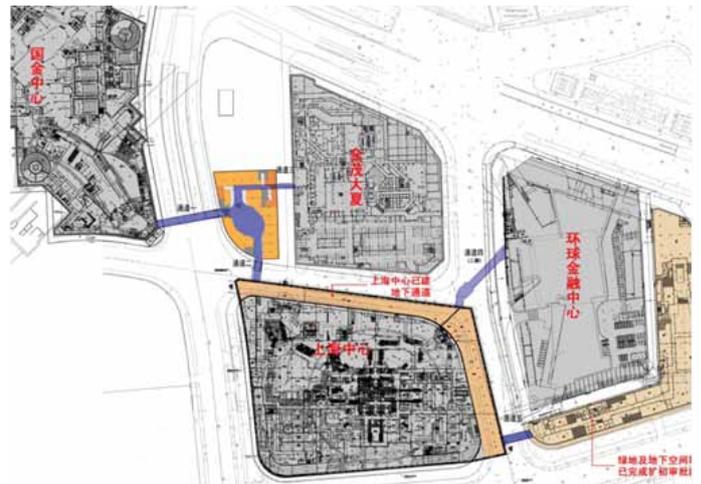


Figure 3. Underground passage layout (Source: Shanghai Tower Construction & Development Co., Ltd)
图3. 地下通道 (出自: 上海中心大厦建设发展有限公司)

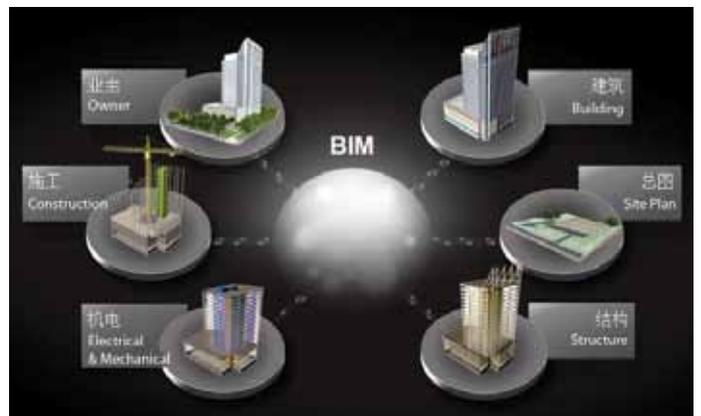


Figure 4. An operation of an entire life cycle in BIM (Source: Shanghai Tower Construction & Development Co., Ltd)
图4. BIM的全生命周期运用 (出自: 上海中心大厦建设发展有限公司)

置，达到隔热隔声节能的效果。采用变风量空调系统，降低风机电耗50%。使用灯光亮度传感器，节约室内灯光能耗。大厦综合节能率约为54.3%，与同类建筑相比，节能率高出约21个百分点。

在材料利用方面，C50以上高强度混凝土使用率达到83%，高强度钢筋使用率达到74%，本地材料使用率占材料总重量的97%。70%材料采购距离在800公里内。在结构设计中，外形采用旋转120°的方案，可降低风荷载25%，大大节约结构材料。

在提高室内环境质量方面，尽可能利用自然采光，近90%的主要功能空间满足标准。在地下室，通过东、西两个下沉式广场，引入自然光线，采光系数大于1%的面积比例：地下一层为38%，地下二层为19%。

在运营管理方面，建立全面计量收费系统，采用CPMS多能源管理系统，控制室内空气质量。

在绿色施工方面，重点控制施工过程中噪声、粉尘和光污染。回收和再利用废弃物，施工废弃物回收率达38%以上。

四、建筑信息—从传统的智能建筑，转向便捷的智慧社区。

随着信息技术不断成熟，智慧城市概念的提出，未来建筑建设和管理将更多运用信息技术，提供从未有的高品质服务、更高的效率、更低的资源消耗和可持续发展的生活。上海中心智慧社区组成主要有：

humanistic community aims to provide a cultural environment within and around the building for the users by bringing them a more pleasurable experience of cultural traditions. The principle of “oriental roots, creative future” guides the Shanghai Tower to an architectural and cultural community in various artistic ways as follows:

Spatial culture. The building form, public spatial arts, and garden art forms the building’s interior and exterior into a collective art. In respect to the exterior architectural forms, the Shanghai Tower’s triangular façade rotates 120° while tapering, forming a unique and streamlined shape. In the interior spaces, there are a total of 24 sky lobbies – with three sky lobbies in each zone ranging in height from 54 to 67 meters to form thematic art spaces. The building emphasizes the concept of “architecture in the garden” in the exterior garden components.

Image culture. Paintings, photographs, sculptures, and decorative artwork will be appropriately displayed and arranged in the public passages in the underground level two, offices, hotels, public lobbies, and sky lobbies. There will also be a new art museum on the 37th floor where visitors will have access to art culture.

Functional culture. The functional culture includes sightseeing, lighting shows, art galleries, bookstores, and multi-functional auditoriums. The sightseeing experience begins with purchasing tickets, continues with extensive vertical travel, and finally concludes with a feeling of having been up in the air. There will be three modes of lighting: normal mode for everyday usage; holiday mode which can illuminate special colors, patterns, and characters for holiday celebrations; while the third is an illumination performance of various lighting designs that is only on display a few days per year. An art gallery is provided at underground level five where a bookstore will also be installed in the future. The second floor annex will be a multi-functional room for high-end commercial activities and wedding ceremonies.



Figure 5. The rendering of the sky lobby (Source: Shanghai Tower Construction & Development Co., Ltd)

图5. 空中大堂效果图（出自：上海中心大厦建设发展有限公司）

- 基于网络、光纤、ICT和RFID技术的基础设施建设。形成处理海量信息和智能过滤、综合的能力，为智慧社区建设提供给基础条件。
- 基于BIM技术的建设和物业管理。BIM作为一项工程领域现代管理的新技术，上海中心把这项技术运用在建筑设计、施工、采购、物业管理等建筑全生命周期（请见图5）。
- 基于传感技术的建筑健康监测。通过该技术，掌握在地震、风压、温差作用下建筑主体结构、沉降、幕墙的变化，及时对变化的程度和趋势做出判断，采取对应措施，确保建筑安全运行。
- 基于物联网和云计算的信息化技术。上海中心是多功能区域、多行业客户、多应用需求组成的综合体，多个系统之间信息需要共享交互，不同系统需要共同使用相关综合数据和结果，繁复的系统需要强大的信息处理中心。上海中心正在实施基于互联网、物联网技术的云计算中心与高速光纤网络、无线宽带网络，构成支撑庞大系统安全运行的智慧社区。
- 基于客户需求的商务信息平台。将提供社区交流、酒店和商业、观光旅游服务、虚拟办公等互动的商务信息平台。

五、建筑文化—从传统的单纯建筑，转向人文享受的文化社区。

上海中心将突破传统建筑单纯提供使用空间，立足人文建设，提升建筑文化魅力。文化社区主要是满足使用者实际生活需要的文化，给使用者带来愉悦的文化。上海中心以“根植东方，创意未来”为核心，从多个艺术形式系统体现建筑文化社区：

空间文化。以建筑造型、公共空间艺术和园林艺术为主，形成建筑自身、室内和室外三位一体的空间艺术。在建筑造型上，上海中心三角形的外立面，层层收分，连续旋转120°，形成了独特的流线型建筑造型。在室内空间上，上海中心首创每个区外包3个、每个高约54—67 m、共24个空中大堂，这些空中大堂将形成主题性的空间艺术。在室外园林空间上，将突出“建筑在公园中”的设计理念。

形象文化。地下二层公共走廊、办公和酒店及商业的公共大堂、空中大堂设置合适的绘画、摄影、雕塑、装置艺术品，在37楼开设艺术品博物馆，提供艺术的享受。

功能文化。包括观光、灯光秀、艺术品藏库、书店、多功能厅。观光将会使游客从购票开始，形成等候、垂直上下和空中三部分连续的体验。灯光将以日常、节假日和灯光秀三种模式展现，日常模式以满足大厦正常使用的照明为主，节假日主要是在一些特殊的节日用色彩、图案、文字等形式予以表现，灯光秀则一年一次集中数天进行不同设计的表演。地下五层开设艺术品藏库，还将开设24小时服务的书店。裙房二楼建造一个满足高端商业、婚礼的多功能厅。