Consideration of Green Hospital Building Planning and Design in China
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Abstract
Applying theories to practice, the thesis studies green hospital building planning and design in China from the perspective of sustainable master planning, building configuration in consideration of climate characteristics, humanized facilities and energy saving.

Key words
master planning, green hospital building, energy saving

Hospital is a place for healthcare and recovery as well as a battlefield against diseases. Different from other kinds of building, hospital has three prominent features: First, in order to save lives, hospital needs to operate 24 hours a day, which leads to huge energy consumption. Second, the hospital has a complicated function. Its function has always been influenced by the evolution of medical technology and medical model. Third, hospital provides services to patients, healthy people in a specific physiological state (e.g. pregnant women, newborns) and people for body check. Different people have different demands for space and feeling of comfort.

The features mentioned above request the design of modern hospital to consider not only a reasonable and sustainable medical process, but also an energy saving construction and a humanized rehabilitation environment.

1. Sustainable master planning
Hospital building is a kind of important construction which protects people's health, so its lifespan usually reaches a hundred years. It means hospital building can hopefully be used for a very long time. However, with the constant update of medical treatments and equipments, it is inevitable to reconstruct or expand hospital building throughout its life cycle so as to meet demands for new space usage. Consequently, a reasonable master planning for construction is essential for green hospital buildings. Both owners and architects are requested to take a long-term view before phase one construction, and need to be aware that it is impossible to complete a hospital at once. Analysis on hospital status and function has to be done according to the national healthcare policies. On this basis, master planning makes its future development possible and flexible.

1.1 Satisfy the current needs and face the future.
Green hospital planning has to meet the current needs of healthcare in the region and consider the future development at the same time. A reasonable arrangement of medical functions provides flexibility for hospital's development. In the design competition of Xiaoyi Central Hospital in Shanxi Province, the requirements are general, which only define a piece of land about 20 hectares (300 acres) and a 1000 inpatient-bed scale. The hospital will construct 500 inpatient beds at first. For its abundant area, the design has given a well-conceived conception for the future development of the hospital according to the city's population, economic scale and the hospital's status. In view of variable factors in the reform of medical system, the design has not only arranged a complete medical function, but also reserved area for inpatient building on phased two construction and infection building and office on phased three construction, which makes it possible for the hospital to reach a 1000 inpatient-bed scale at last. What's more, the design reserves an area on the east for the unpredictable future development. The hospital could
either enlarge its scale as usual or develop related industries, such as rehabilitation center, nursing home and vocational training school. The reserved area is easy to exploit with independent entrances and convenient connection with the hospital. (Figure 1) Although the total area has been reduced to 65% for various reasons after the bid, and the hospital officials want lower buildings and more gardens in it, the further design keeps reservation on the ground we can control recently. (Figure 2)

1.2 Spatial framework design for future development

There are various ways to expand a hospital, but as an architect, more attention should be paid to using the land efficiently in the campus. It is significant to think about which site is suitable for reservation without interrupting medical flow lines and losing control of the form of buildings even after the future development.

1.2.1 Suitable site for phase one construction

Phase one construction of the hospital is foundational. It has a great impact on further development of the hospital's spatial framework. So the location and the size of it has to be clarified in total area of the land. It is common in our country that when a building has been done, there is no room left for any other buildings in the same place. John Weeks, a British architect, had ever said that "the planning of hospital is not for perfect, but for development." That is to say, architects should not only focus on graceful architectural configuration, but also consider the further improvement of hospital's function and space in order to make a spatial framework.

Take Longgang Maternal and Child Health Hospital in Shenzhen as an example. With the development of the hospital, the land for future construction is strained. However, the hospital has constructed a 400-beds inpatient building recently in the absence of a master planning. The inpatient building is located right in the center of the campus, which makes it hard to use rest of the land surrounded. After repeated consideration, design locates the health promotion building and the outpatient building to the south as far as possible while satisfying requirements of planning department and fire department. The north part of the ground is set aside as a leisure garden for patients and the staff, and it is also a place for reservation in the future. (Figure 3)

In order to prevent the occurrence of the above problem, we have done a lot in Linxia People's Hospital in Gansu Province. The land for construction is tight, while the hospital needs more inpatient beds to meet medical demands in the region. Design arranges the outpatient...
building, the medical technology building and the inpatient building intensively on phase one construction. Buildings are not located in the center of the site, but a little northwest without breaking the rules. So the hospital can develop on the east and the south part of reserved land later. (Figure 4)

1.2.2 Building form controlled by main street and modular layout.

Research of hospital spatial framework development dated from 1970s. It contains various theories such as Nucleus System, Main Street System and Meditex System. All of them are talking about expandability of construction with a few common features like fundamental grid, modular dimension and general space. It usually utilizes open ends of modular volumes to control building form and developing direction. (Figure 5)
1.2.3 Building form controlled by open space

Apart from open ends, spatial framework development can also be controlled by open space like garden and square. Longgang Central Hospital is a good sample. It was founded in 1952, which is the largest grade-three general hospital in East Shenzhen. The hospital has 900 inpatient beds now. It aims to become a regional healthcare center with a 1800 inpatient-beds scale by using existing land on the campus and surrounding land acquisition. Unfortunately, there was no master planning at all, so buildings that rose in different periods just go their own way. There are chaotic medical flow lines in the hospital, and no organic connection among buildings. The key of design is garden. On the basis of reframing medical flow lines, three sequent gardens separates the outpatient building, three inpatient buildings and existing buildings into groups. It shows a new architectural order and diversified spatial layers on the campus. (Figure 6)

1.2.4 Comprehensive way to control building form

There is also a comprehensive way to control building form, which combines the advantages of both sides mentioned above. In the design competition of Xiaoyi Central Hospital, the master planning is carried out relying on the central park in the core area. Medical functions are arranged on the west side, and the hospital can extend along the north-south main street through open ends. The east side is left for a long-term development. Building forms can be various according to the specific functions it will develop in the unforeseeable future, such as
medical functions or related industries. Because all the development surrounds the central park, open ends of the existing buildings are not necessary. So it is more flexible and keeps convenient flow lines. The entire campus of the hospital looks organic and coordinated. Besides, the central park provides a good view from wards and public area of outpatient building. No matter how the hospital will develop in the future, the central park always faces south, making it possible to organize natural ventilation for main buildings in transition seasons. (Figure 7)

2. Hospital design with local climate consideration

Hospital has a high energy consumption for its complicated functions and all-day operation. Hospital design adapts to the local climate on the purpose of reducing energy consumption.

2.1 Pattern planning with local climate consideration

On the basis of reasonable function arrangement and traffic flow lines, a hospital’s pattern planning with a consideration of local climate is tend to focus on thermal relationship between buildings. Energy saving can be achieved through a suitable micro-climate environment. There are some important factors like orientation, distance between buildings, architectural configuration, prevailing wind direction, solar radiation intensity and outdoor environment, etc.

Take a 800-inpatient-bed hospital design competition in Guangming new district of Shenzhen for example. Architectural thermal engineers participated in the project in pattern planning phrase. Various models were made for computer simulation, especially for the discussion of the connection between thermal environment and wind environment on the campus in summer. With comparison, it sets a large green square and a pool on the southeast of main buildings, which allows environment cooled summer prevailing wind to blow into the semi-open main street of the hospital. Buildings are stretch and well ventilated, and it is hard to find obvious vortex area of wind. Therefore, it creates a good microclimate environment and reduces energy consumption at the same time.

2.2 Indoor space pattern with the use of natural condition

Illumination and air condition are major parts of the energy consumption in the hospital. It is helpful to save energy by optimizing indoor space pattern, which improve the efficiency of natural lighting and natural ventilation. For instance, in the 800 inpatient-bed hospital design competition in Guangming new district of Shenzhen, the design makes main buildings in the campus face the same direction as the summer prevailing wind. It also has some means to
achieve natural lighting and ventilation in most frequently-used rooms, such as little gaps, deep shades and multi-level courtyards and patios, etc. In transition seasons, cooler wind from outdoor can completely comfort crowded departments. In addition, design also pays attention to the cold wind in winter and adjusts the location of building entrance. (Figure 8)

3. Energy saving design with humanization

Hospital is not only a functional building, but also a building which needs more humanization. After ensuring the special medical function, design should pay attention to patients' psychological requirements. It is beneficial for patients' recovery to create a comfortable environment accompanied by a convenient medical treatment process.

3.1 Humanized design in outpatient public space

Waiting takes up most of the time when people are in hospital. Natural lighting and ventilation in outpatient public space can not only reduce the use of air condition and indoor illumination, but also give patients good air quality, pleasant mood and lower anxiety caused by pain. (Figure 9)

The main street is a typical outpatient public space in hospital. There are usually natural lighting, natural ventilation, plenty landscape and convenient facilities. For example, Dresden Hospital in Germany divides the main street into two different areas with passageway on the one side and the rest area on the other. Bakery, self-help water dispenser and chairs are set behind plants in the rest area, which creates a private space in the large public main street. However, the main street of Pompidou Hospital in France seems more public. It is just like a walkway in the city with cafes, shops and other commercial facilities on both sides. (Figure 10)

In the collaborative design of Panyu Central Hospital in Guangzhou, design sets a water curtain and fresh air cooling system instead of central air-condition system on both sides of the glass ceiling of the main street. (Figure 11) It is a kind of natural ventilation mode with mechanical assist, which makes patients comfortable while saving energy.
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3.2 Departments with efficient use and resource sharing

Departments of hospital should pay attention to sharing resources in medical aspects, space.
and logistical support, so as to maximize the efficiency of medical service. Take Linxia People’s Hospital project as an example. Design puts departments with similar function together to share medical resources. Inpatient building has a layout of line style, which is simplest and most efficient. All the traffic space and auxiliary rooms face north, so offices and duty rooms for doctors can also be arranged to the south part on the condition of 50% inpatient beds facing south. Nurse stations of different nursing units are connected on the same floor. So they can help each other if necessary and work more efficiently.

4. Conclusion

The speed of Hospital construction is rapid in the last decade. Hospitals in China can neither be medical machines only nor develop without planning. It is the requirement of the society that architects and hospital managers to solve the problems of sustainable development, energy saving and humanization.

With the cases and design practices above, the author believes that it is necessary to clarify development direction of the hospital as early as at planning stage and set up framework to control its spatial development. Meanwhile, due attention should also be paid to climate characteristics in the region, which means to use natural condition in master planning and spatial configuration, so as to save energy and conform the service targets. Last but not least, it is important to optimize medical lines and facilitate patients and staff by humanizing indoor public space and functional department.

Figure Credit

Figures 1-8 come from Architectural Design Research Institute of SCUT.
Figures 9-11 are taken by the authors.

Reference


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