Hospital Architectural/Engineering Master Planning

a report by
Yasushi Nagasawa

Professor, Department of Architecture, University of Tokyo

Yasushi Nagasawa is a Professor in the Department of Architecture at the Graduate School of Engineering of the University of Tokyo. Professor Nagasawa is an eminent planner of hospitals and healthcare buildings in Japan and internationally. He is a consultant to the World Health Organization (WHO), President of the Japan Institute of Healthcare Architecture (JIHA), Vice President of the International Federation of Hospital Engineering (IFHE), Vice President of the Healthcare Engineering Association of Japan (HEAJ), Vice President of the Japan Association of Health Service Management Consultants (JAHC) and Secretary-General of Global University Programs in Healthcare Architecture (GUPHA).

Hospital planning evolved a great deal in terms of theory, technology and operation during the latter half of the 20th century. The inclusion of master planning in hospital development is essential, especially in the case of large-scale hospitals that require many years of planning and construction. It is worth investigating existing cases of master planning in order to try to discover the 'secret' of successful master planning and to explore the concept of hospital planning in the 21st century.

In the 1960s, John Weeks proposed the concept of 'indeterminate architecture' in order to cope with, and adapt to, the continual growth and change of hospital functions and physical requirements, which are the natural outcomes of constantly evolving hospital buildings. Weeks recognised that from the moment of completion at any stage, a hospital building immediately begins to become outdated on some level as a result of changing institutional need. Several eminent projects addressing growth and change in hospital function are described below.

The Chiba Cancer Centre, Chiba, Japan

The Chiba Cancer Centre (CCC) combined a hospital and research institute in order to accommodate clinical and research functions in the same complex. As future diagnostic and therapeutic techniques for cancer patients cannot be predicted, the master planning required particular consideration of how the complex would cope with future requirements.

A design team led by Professor Yasumi Yoshitake worked to develop as flexible as possible a configuration for the cancer centre. They proposed a 'multi-wing type' configuration. The building elements are arranged around one main artery street with clinical wings extending out in an 'open ended' shape. Patient/administration blocks accommodate vertical shafts for elevators and staircases connecting to the artery street.

This configuration was designed to cope with future growth for new functions. Since the team recognised that future change would likely require major adjustments in the clinical and research blocks rather than the nursing tower, all the clinical and research wings were designed to contain 'universal space', i.e. no columns and anti-seismic walls were placed inside these clinical wings. It was considered that in this way the range of activities, hospital functions and technical requirements that could be eventually accommodated would be maximised.

In addition, a couple of separate corridors for installing engineering ducts and pipes were placed running parallel to, and between two clinical wings. Seen in plan view, they act as seams joining the two wings. Ordinary corridors for patients were placed on the other side of these engineering corridors. This idea is an alternative design form of the interstitial space that is generally placed between two floors in a multi-story building. Rather than being placed between floors and seen as a line on a vertical plane, they are placed between wings and seen as a line on the horizontal plane.

One of the advantages of a multi-wing type configuration, as experienced at the CCC, is that it can be relatively compact in shape and thereby significantly contribute to reducing walking distance for patients and staff.

The complex of buildings was completed and began to be used in 1972. Changes since then include expansions to existing wings, and elsewhere new blocks or architectural elements were built as separate and independent units. In 1981, a computed tomography (CT) block was added in an independent building attached to the X-ray department. In 1990, substantial construction work was carried out in order to cope with an increasing number of in-patients and out-patients, as well as development of medical technologies. The radiological diagnostic wing and animal research wing were expanded, a magnetic resonance imaging (MRI) block was added, and the out-patient department wing was extended.

The McMaster Health Sciences Centre, Hamilton, Canada

The McMaster Health Sciences Centre (MHSC), combines accommodation for medical and health sciences and education and research with a 418-bed hospital and extensive facilities for out-patient treatment. The building was designed as a compact, four-level structure with a parking level below and the possibility of an additional fifth level in the future.

The MHSC was designed to provide an infinitely flexible space. Eberhard H. Zeidler designed a modular structure that separates each part of the building into permanent and non-permanent elements. He introduced the term 'servo system' to identify the permanent frame of the MHSC - an integration of the structure with the primary electrical and mechanical services, which various functions may be plugged into. Zeidler's approach was to incorporate interstitial spaces (ISs) throughout the entire complex. Besides organisational, structural and time-saving intentions, the idea was to reduce the adaptation costs that are often more excessive than the original cost of the building.

The other, most important, design principle was growth. All the building components of the MHSC were planned in advance for horizontal expansion and for vertical expansion of a fifth floor. The structure of the building was designed to support the extra weight, and mechanical and electrical systems were installed to support any function that would be located on the additional floor. Even the elevators and stairs were raised to the level of the fifth floor. In addition, as part of the construction and development process, some areas in the building were left unfinished to accommodate inward growth.

Despite Zeidler's efforts to design in advance for future expansion, the MHSC did not expand as he envisioned. Changing hospital administrations and political and economic conditions diluted and diverted the implementation of the original master plan. In 2002, McMaster University prepared a new campus master plan that redefined the boundaries for the MHSC site and limited its options for expansion. When additional space was needed, the Hamilton Health Sciences Corporation chose to invest in a new building, rather than to complete the MHSC's fifth floor.

Many changes to the MHSC's physical plant were the result of the advance of medicine over the years. For example, a short-stay unit was added in 1981 on the second floor, as advances in analgesia techniques facilitated day-case surgery and the building has since been renovated twice to support the development of new treatments.

Insel University Hospital, Bern, Switzerland

Insel University Hospital (INO) is the first known project to apply new principles rigorously in healthcare architecture. The INO is a hospital for intensive care, emergency and surgery. For several years, the facilities planning group of the Canton Bern Building Department (CBBD) tried to fix a programme of uses so that a design team could produce construction documents for a major addition. Each year, events prevented them from fixing the programme: new medical procedures were introduced; a new head of surgery was hired who had new staffing and equipment requirements; a paediatric facility was scheduled to be expanded, etc. As a result of these continual changes to the programme, the facilities group found it impossible to get the needed addition. To solve the problem, the group adopted an entirely new planning process recommended by architect Urs Hettich of the CBBD.

The client's demand for long-term utility value in the facility addition defined the most important aspect of the new design and decision process: the ability to optimise adaptability in the face of changes in technical, social or political circumstances. The traditional idea of delivering healthcare facilities has been that it is easier and more economical to optimise a construction project by comprehending the 'whole' with all its interdependencies. However, in complex buildings like hospitals, the hospital administration had learned that it is never possible to do this. Such facilities are too dynamic and cannot be planned and built as if they are programmatically static. Rather, the 'whole' emerges over time, incrementally. This means that large, complex buildings are never finished. In recognition of these realities, the INO project was split into three systems, organised and conceived by expected lifespan:

- primary system (nearly 100 years);
- secondary system (nearly 20 years); and
- tertiary system (five to ten years).

The primary system determines the whole structure of the hospital and establishes conditions for developing the systems to follow. The interfaces are exactly defined. The lower-level (secondary and tertiary) systems are as independent as possible.

Discussion

Length of Period

The CCC and MHSC case examples have been indicative of the number of years that architects can expect their best master plans to be effective. Most of the examples described here reveal that the master plan was developed and has been in effect for more than 30 years. Considering drastic changes in healthcare service delivery systems, medical technology developments, advances in construction and engineering technology and especially in information technology, 30 years of sustainable effectiveness is quite remarkable. That is not to say that the limit is 30 years, but rather that 30 years, from today's viewpoint, could quite reasonably be considered a minimum standard for future master plans.

Availability of Site

Inherently implied in the concept of growth and change in hospital configurations is the availability of space into which the growth and changes can occur. In fact, this was a partial starting point for the original notion of streets or arteries. By providing enough extension of these main design lines, and enough empty space between them, it is possible over time to fill the spaces. It is necessary then to understand, and it has been revealed in our studies, that a sufficient allocation of site for future development is a basis for sustainable effectiveness in master planning.

In terms of providing expansion possibilities, horizontal expansion is preferred to vertical expansion because it is more economical, although it requires large areas of land and consideration of walking distances. A concern for maximising flexibility continues to be achieved by modularity, full or partial interstitial spaces and the separation of functions.

Continuity of Daily Activities

In the case of the CCC, generally speaking, these periods of growth and change have been carried out, as might be expected, following from the principal concept of flexibility, which is inherent to a multi-wing type configuration. The master plan presupposed the characteristic of being able to accept extensions and renovations without disturbing daily hospital and research activities and ensured that the functioning of the complex was kept to a certain level without impedance.

Role of Key Individuals

The master planning approach remains a basic tool in planning for an unknown future, yet its success depends on the client's understanding of architectural ideas and the willingness of successive hospital authorities to honour the architect's original vision.

Thus, master plans need to have key individuals or teams of people that are present and supportive throughout the entire process. This is critical for ensuring consistency of purpose and provides invaluable oversight ensuring adherence to the most important parts of the master plan over time.

Master Planning for the 21st Century Healthcare Environment

The story of the INO project is worth recounting because it represents the decision of a large client and its facility planners to alter the methods it had been using for decades in order to obtain a new facility to meet the future with more assurance. This would imply that the skeleton-infill (SI) system can be suitably introduced to hospital planning.

The comparative typology of a hospital's development reveals the move from megastructure to more bounded facilities, the reduction in the construction of interstitial floors, the transformation of outdoor courtyards and esplanades to an interior atrium and the development of a circulation system from a closed-ring corridor to an open system of corridors surrounding and crossing the atrium.

Healthcare design has seen an evolution in approaches to planning for change in the form of master planning, expansion and design for flexibility. The notion of the machine hospital has been transformed into a healing healthcare campus; the technological approach has been exchanged for a holistic one; the megastructure has been reconstituted through a series of separate or confined structures; and the labyrinthine corridors and abandoned esplanades and courtyards have metamorphosed into an open, light, green atrium.

The current trend of creating a community setting in the public space of the hospital and a domestic atmosphere in the patient units has replaced the modernist goal of developing the high-tech functions of the hospital. This transformation is the shift from the modern machine hospital to the postmodern healthcare campus. The changing expectations of our society, which sees the hospital environment as a reflection of healthcare delivery, will continue to transform our conceptions of the hospital. ■