Chapter 1

Planning Hospitals of the Future

Richard Sprow, AIA

Over the last 60 years, there have been recurring trends in thinking about the planning and design of hospital facilities, which seem to go through cycles. Specialty hospitals, new standards for patient rooms, ideas for efficient nursing unit planning, and design for healing environments; all have been the subject of architectural thinking in the past and then interest has subsided – but all will certainly be back again. As planners in one of the world's largest healthcare design practices, we spend every day talking with hospital managers about future planning issues, which are often linked to marketing responsiveness, new technologies, and changing expectations about healthcare delivery.

Ten Ideas Driving New Hospital Planning

Rethinking patient flow in hospitals to improve the patient experience and make operations more efficient. With more digital information being shared around the hospital network, and the desire for a patient visit which is as seamless and direct as possible, hospitals are now looking beyond departmental borders to think about how patients make appointments, how they arrive at the right location for their visit, and how clinical and financial information is captured and processed. Instead of an older departmental organization, along the lines of the now-vanished large department store, hospitals are thinking about providing service concierges to direct patients, providing central registration points to capture basic information for the database only once, and using computer-assisted scheduling and management systems that track patient arrival times, length of wait, and final results. Having this information makes possible management analysis and responses to smooth the flow. The next step in this process may be like more advanced retail uses, where the information on arrival and wait time is displayed to customers and any response beyond the stated goal gets them an apology and a reward.

Integrating information technology is the other side of this operational point of view. From concerns only few years ago that clinical staff would never use a keyboard, we now see computers as an essential fixture at every point of patient contact, often as part of a wireless network linked to staff smart phones and communication systems. Old technology like the nurse call system can now be part of the network, linked to data collection and faster response. From a facility

point of view, the need is for more space – the "paperless" environment replaces clipboards and forms and rooms full of paper files with more computers, keyboards, server closets, printers, shredders, and fax machines, plus storage for all of their supplies.

Wayfinding is more than signs.

A stronger management concern for the patient experience, as part of a market share focus, means that old systems such as endless standard signs (and even worse, colored stripes on the floor) are being replaced by more information, more interactive systems. Electronic kiosks, computerized direction systems, and planning that is clear and modular, even without signs, are the new tools in helping patients and families navigate the hospital and to make it more accessible to them.

Dealing with flexibility and change – repeatedly. Hospitals are unique in being a building type with a long overall useful life but a very short lifetime for specific rooms. Unlike commercial or educational facilities, hospitals are routinely used for 50 years or more – but at the same time individual rooms may be changed or replaced after as few as seven years, as clinical methods and equipment change. The challenge is to plan for ease of use, good wayfinding, high technology and a healing environment, but without assuming that specific rooms will remain unchanged for very long. Hospitals are responding with an acceptance of more generic and modular space, much less likely to be customized to the needs of specific service or a particular donor's desires. Today's pediatric exam room may later be part of a geriatric cardiology unit, or a new imaging suite, or relocated office functions in only a few years. Often it is more flexible and efficient to build a smaller number of larger but standardized room.

Interior design standards and a systematic approach. The need to plan for and facilitate rapid change means that hospital interior design must also reflect a broader, more flexible approach, so that new and renovated and existing parts of one facility can co-exist and look like parts of one coordinated institution. Creating and maintaining design standards is an important tool in creating this unified look. Housekeeping staff is now often involved early in evaluating maintenance of materials and agreeing to choices that can be kept at a high standard over the long term. Hospitals are large facilities in constant evolution, so their interiors must be able to blend with the times and to deal with change in small increments. Unlike hotel or retail environments, a partial closure to allow one new look to be implemented is never an option, and the true 24 hour/7days a week /365 days a year healthcare environment puts special stress on furnishings and finishes not seen in other building types.

Fast response to new service needs is suddenly critical. As hospitals recruit key clinical staff and strengthen their areas of expertise in response to market conditions, hospitals are seeking truly fast track projects, to get high-revenue and highly visible services in place as quickly a possible. Hospitals with urgent needs for complex new imaging equipment or specialized services to support newly added staff are finding that the financial realties have made accelerated design and premium-time construction efforts essential. To deal with these situations the hospital needs the support of experience facility program managers and a systematized approach to design standards, interior design, and patient flow issues, since there is often little time to investigate options and develop a measured response. When each room may generate significant monthly revenue once it comes on line, every week becomes critical.

Upgrading to meet new technical standards is driving many hospital support services projects. Areas such as dialysis suites and pharmacies, which were constructed only recently, now need to meet more rigorous standards for patient and staff safety and infection control, which require more extensive construction than merely a facelift. Computerized order entry and tracking of supplies requires something more than a simple storeroom.

High-productivity planning for surgery. Hospitals with functional older facilities, often scattered on different floors or in different wings, are finding that it makes sense to invest in larger-scale surgery facilities which are more productive and more flexible. Some have created units with 20 or more generic operating theatres, directly adjacent to highly flexible peri-operative units which can function flexibly as pre-operative holding for ambulatory patients and recovery for ambulatory surgery and for inpatient. Rooms and recovery beds are grouped in clusters, so that staffing can follow peaks and valleys in the work load through the day. Surgical rooms are designed for multi-specialty use as needed, with very few dedicated rooms. Operating theatres are also being rebuilt to include facilities for minimal-access surgery and telemedicine, with more flexible ceiling-mounted utility booms, and new generation lights which integrate efficient and flexible LED lighting, video cameras and flat-screen technology. New hybrid operating theatres blur the distinction between surgical and imaging functions and design requirements.

Responding to Emergency Medicine volume with new care models is also driving major projects at many hospitals. Often the Emergency Department is the marketing front door and the starting point for a high percentage of patient admissions, and hospitals are very concerned about making it both more productive and more responsive to patient concerns. One common approach is the single-room treatment concept, which provides a large number of private treatment rooms so that each patient and their family are usually taken directly to one room for all of their treatment. Triage steps are minimized, and much of the admission process can be done directly in the room. The result is a patient experience of being seen and attended to almost immediately, rather than the typical story of being held in the waiting room for long periods of time. Satisfaction is much higher and flexible generic rooms can adapt easily to changes in utilization. Reducing the need for waiting room space allows for more functional space.

Opportunities for bold master planning are leading hospitals to look at their facility needs in new and different ways. Instead of the usual method of space programming and master planning with an incremental view of growth and space needs, typically resulting in the classic hospital of many wings, each 10 years apart in delivery, new planning considers ways to right-size facilities and change the delivery process. Older community hospitals are continuing the trend toward mergers and creating more-efficient, smaller facilities on a neutral site. Large urban teaching hospitals are looking at opportunities to replace inefficient older buildings, consolidate operations, and in some cases even replace the entire facility with a new, smaller one that incorporates higher efficiently and often lower staffing and operational costs.

Taking a Fresh Approach to Hospital Planning

Hospitals are unique among building planning and design projects for their high level of complexity, in terms of their complex circulation patterns and constant use as much as for their technical systems. By definition, a hospital is a place where healthcare services are delivered to patients who may stay in overnight accommodations or may visit briefly for specific care. The

hospital as a unique building type is less than 100 years old. In history, hospitals were generally charitable places where bed-ridden patients could be cared for and given simple treatments. At the start of the 20th century new advances in radiology, aseptic germ theory, anesthetic surgery, and later electronics and communications made the former nursing care facility into a highly specialized workshop for medical services. The hospital took on a new physical form, as a large dense building with many specialized parts.

The ability to provide extended 24 hour care with a high level of complexity of medical services differentiates a hospital from other healthcare facilities such as medical offices, clinics, ambulatory care centers, day surgery centers, skilled nursing and recovery centers, and specialized treatment facilities.

Successful hospital planning must be measured over a long term, not just as an inviting and attractive new building but as a structure that supports these intensive and demanding functions on a 24 hour/7 day basis over what is often more than a 50 year useful life.

Queens Hospital Center's Ambulatory Care Pavilion, New York. Corridor 1.
Image © Paul Rivera-Arch Photo. Courtesy: Perkins Eastman

Hospital Design Opportunities

Over this long period of use, a hospital is an intensely people-centered building type in which efficient circulation and the flexibility to meet unknown future challenges are critical factors in how well it supports these operations. Even a small hospital is often one of the largest employers in its community, with a staff of hundreds or thousands. A hospital has to comply with many overlapping regulatory requirements and voluntary accreditation standards and is forced to constantly upgrade its technology and its operational practices. With round-the-clock use and high occupancy, and the need for high capacity and redundant building systems,

a hospital is also a large energy consumer and a prime opportunity for the benefits of green and sustainable design.

Hospital Design Philosophy

As a place dedicated to health, a hospital building must first be a healing, life-affirming space that plays an active role in helping patients and their families return to health. Hospitals of the future will need to plan for higher patient acuity, shorter stays, and must deal with aging patients (and staff). Because of their long term operational costs and long life cycle, hospitals have to be designed for improved performance and work flow, and with a high degree of flexibility and adaptability for constant change.

The detailed architectural and interior design philosophy of the future hospital needs to start with this feeling of hospitality, and of providing a link to nature and the world beyond. The facility design has to provide a safe, comfortable environment, and reduce stress and confusion for patients, families, and staff. A successful design will recognize the dimensions of life as well as the needs of efficient operations and include art as well as technology. The design team needs from the outset to plan for sustainable design and reduced energy usage, which in a building that operates continuously is a major opportunity for lowering the carbon footprint of the service. To maintain a feeling of well being and positive support for the needs of people, the hospital must also have clear, intuitive way finding and an easily understood layout.

5 Key Hospital Design Goals

Clearing the decks for a new approach to the ideas of hospital planning begins by keeping five key goals firmly in mind:

Patient-centered care and family as part of the care process, since the patient is the hospital's reason for being

Efficient operations, clinical safety, optimal functional relationships, value for money, modern systems, low upkeep requirements

Flexibility for expansion and new technology in unexpected ways over long useful life

Sustainable design, reduced energy usage, intense 24 hr use and high occupancy

Healing environment to include art and hospitality, not just science and technology

Planning for Building Systems

Hospital circulation systems are critical not only to provide clear and intuitive way finding for families and patients, and to accommodate the many staff members and services, but also for infection control, carefully designed to separate and control public and private, clean and soiled traffic types. Planning is made more complex by the many functions which need specific adjacencies and short travel distances, while at the same time controlling and directing traffic flow. In planning the hospital, a logical and simple horizontal and vertical circulation system is the essential framework for more detailed planning.

The nature of healthcare services is that relatively small rooms need to be provided for very specific functions, kept closely adjacent to related services and well apart from other functions. A typical hospital may have only a few grand spaces, but thousands of small rooms and large amounts of circulation space. The space program which guides the development of a hospital is often a document detailing the room by room space needs, planning assumptions, projected activity volume, factors for efficiency and circulation, and detailed medical equipment needs. This schedule of accommodations required is based on all of these factors, not only on guidelines in terms of space per bed.

Hospital buildings also have extensive mechanical, electrical, plumbing and medical gas systems whose needs drive architectural

planning as well. Each of these services needs significant space for its equipment, and benefits from the shortest and most direct distribution while keeping building services out of sight and separate from the clinical and public areas. Structural design for future hospitals emphasizes a high degree of flexibility to accommodate planning requirements that change all through the design process and interior layouts which can be expected to change many times over the years. To deal with these systems, modular planning within a consistent structural grid can be established early in the planning process to lend order to the result.

Unlike other building types, such as schools and housing, which remain unchanged for most of their useful life, hospitals must be able to accommodate repeated waves of expansion and renovation as needs and technology change. Most hospital campuses see a series of new or renovated facilities every five or ten years, but with different services turning over at varying rates. From the beginning, the planning process must find ways to manage this need for change and to allow flexibility to meet new requirements.

Planning for Low Upkeep

A major challenge worldwide is to find the right balance between simple, easily maintained materials and building systems which can be used over a long project operating life and the need for open planning which allows flexibility and change in unpredictable ways over that long term. Floor and wall materials need to be durable and easily cleaned, yet the location of partitions and doors will almost certainly change in many areas of the buildings, so the construction method needs to accept that. Even simple hospitals will now have extensive data and web-based communication and control systems, yet the components have to be easily obtained and access to them needs to be simple and clear.

Some low upkeep choices go back to the idea of keeping the hospital as simple as possible- use of more natural ventilation when possible eliminates both ducted systems requiring upkeep and the suspended ceilings needed to conceal their systems. More use of daylight can reduce the number and complexity of light fixtures, and new types of fixtures such as LED lighting can have longer life and lower maintenance costs. Durable finishes simplify cleaning and replacement.

Five Types of Hospital Space

For all of these reasons, future hospital planning starts with information from the organizer about the proposed operational plan and numbers of procedures and services, projected forward into space needs and relationships. Planning also needs to consider the very different needs of the five key components of hospital space:

Inpatient Care: The word “hospital” brings to mind an immediate image of patient bedrooms and the nurses attending them, and while this is still a critical element recent changes in technology have meant that most healthcare services are delivered in other parts of the facility. Patient rooms and nursing units have been the subject of most research into hospital design, over the last 50 years, and new data has led to “evidence-based” design which is really a shared understanding of design elements which reinforce intuitive choices: patients in bed recover faster and feel better if they can have their family with them, have more private space and amenities, and have views of nature and the outdoors. Evidence has also shown that nurses work better if given decentralized work stations near the patients, which reduces their travel, and that single patient rooms where feasible offer more flexibility for levels of care and more privacy, while reducing patient transportation and transfers. Although patient length of stay is often less than it used to be, this is still a longer term occupancy whose use is measured in days, not in hours.

Hudson Valley Hospital Center – ICU Patient Room. Image © Sarah Mechling-Perkins Eastman; Courtesy: Perkins Eastman

flexibility to meet changing equipment needs, and the long term plan is that while these units will be periodically updated and refreshed they are not appropriate to be renovated for other uses due to their specialized layout. In subsidized healthcare systems, where two-bedded rooms or larger multi-bed patient wards are still the norm, there is still an expectation that patient and family centered care and a healing environment are still important goals.

The architectural form of the inpatient component reflects these functional needs: compact blocks of patient rooms or wards with associated decentralized nursing support, not the long corridors of traditional hospitals, and with a high amount of building perimeter to allow maximum patient room windows. Groups of patient units can share centralized support spaces, such as conference and staff facilities, but each unit needs close by space for medications, clean supply and soiled disposal rooms, staff charting work stations for physicians and non-nursing staff, and adequate storage for supplies and equipment. Because the patient rooms are continuously occupied, their orientation in terms of the sun and the environment is important.

New directions in patient ward design are driven as much by financing systems and cultural expectations as by medical practice. When the payment system supports more staff and more generous use of space, the current trends, and latest regulatory requirements, are moving toward larger private rooms which can be adapted from intermediate step down care to longer term care, with optimal infection control and with amenities such as private toilet and shower, entertainment and communications, and visitor accommodations. With larger private patient rooms, there is greater

Inpatient care areas are very specialized spaces, which are not easily used for other purposes, although they are often cosmetically renovated over the years of use. When the need for more beds to support the hospital's business plan is well developed, inpatient units usually expand in increments of the bed tower, usually several floors of new nursing units, often 10 or more years after the previous project.

Bed units are grouped by an efficient number of beds for most effective nurse staffing and shortest traffic flow for staff, usually from 24 to 40 beds. Patient rooms need to be located with views to nature and in consideration of climate and environmental needs, and of local codes. For example, some health codes require a high percentage of patient rooms in Northern Hemisphere countries to face generally south for maximum sun, while in hot climates the opposite may be required. Nursing units need to be separate from public areas, traffic restricted to staff and visitors, and no traffic through one unit to reach another. Within the unit separate visitor and staff/patient traffic needs to be considered, especially at elevators.

The layout of nursing units must provide clear and separate circulation for clean and soiled materials to support services such as food service, materials management, pharmacy and laundry. Since patient movement to and from other services is not frequent, close elevator connections are acceptable but critical care beds should be on the same level adjacent to Surgery to simplify transportation of these patients as quickly as possible. In the interest of greatest flexibility, it is generally better to locate all critical care unit types together on the same levels if possible, rather than trying to relate ICU bed types and related step down acute bed on the same levels. Inpatient units need fairly direct access to diagnostic and treatment services, efficient support services access, but should be separated from ambulatory care areas and back of house support areas.

***Ambulatory Care**:* As the opposite of inpatient care, care for walk-in ambulatory patients is the fastest area of growth in healthcare services. New technology and new diagnostic tools have made this much more than a traditional clinic facility. Ambulatory care is now the approach of choice, with inpatient admission only as necessary for continued care or diagnostic and treatment services. While patient and family-centered care is a growing trend, unlike inpatient care the length of stay for each encounter is a matter of an hour or two, not days, so efficient use and flexibility are very important. Even with these short contacts, an orientation to nature and a healing environment improve the experience, so whenever possible exposure to natural light and ventilation can provide an inviting human-scaled space.

With current trends toward new, less invasive methods of care and treatment, in most hospitals an increasing share of patient care is done on a walk-in, one day basis, rather than as an inpatient stay. Because these are short duration services and patient and family convenience is a big factor, ambulatory care functions need to be close to parking and a point of entry.

Since most ambulatory care services are delivered by one or two professionals, meeting with a patient and possibly a family member, the space need is for many small encounter rooms with low technology needs which can be fairly standardized. Efficient operations and patient flow are very important, so to maximize the efficient use of space the trend is to create modular groups of rooms for examination, consulting, and treatment which can be used by different services as needed from one session to the next. Each module typically has a reception and registration work area, nearby waiting for post-registration patients and their families, a block of identical exam and consulting rooms, and shared support for staff functions. A two-sided layout keeps patient traffic and staff traffic into the modules well apart and lets staff come and go without passing through patient areas. Each exam room is carefully worked out to balance patient privacy and efficient staff work areas, with needed supplies close at hand.

Examination Room, New York Congregational Nursing Center.
Image © Sarah Mechling-Perkins Eastman; Courtesy Perkins Eastman.

Evidence has shown that errors are minimized when facilities are similar, so in many current plans all exam and consultation rooms are identical, with same-handed layouts in which repeatable staff procedures are more important than backing up plumbing risers.

Ambulatory care modules are planned to provide light and views where people spend most of their time, in the waiting areas and in staff offices behind the patient contact area, not in the exam rooms as a first priority. To accommodate this modular approach to planning, large wide floor plates work better than narrow wings, so they often take the form of deep spaces with parallel front and back circulation systems to separate patient and staff traffic. Patients are often referred to other diagnostic services after their initial examination or treatment, so the ambulatory area needs to be closely adjacent to functions such as Diagnostic Imaging and Non-Invasive testing. Because this is a relatively fast turnover function, the ambulatory care entrance should be convenient to parking and patient arrivals and separate from other hospital public and visitor and inpatient areas.

In order to get maximum efficiency in the use of this space, the current best practice is to organize services in modular units, each of which has standardized waiting, reception, exam, consultation and office areas. Each unit has patient access from one end, and private staff circulation at the other, without having to pass through patient areas. Instead of being organized as separate clinics, each the territory of one service which may use them only part time, adjacent modules can be shared to accommodate peaks of usage by overflow into the next module, while from the patient perspective there is one point of reception and one waiting area for the service.

This modular layout works best with large blocks of flexible space, requiring windows at the public and staff ends but not for most exam rooms. Large programs of ambulatory care may have multiple floors or pods of similar modular space. Diagnostic services need to be accessible nearby, for referral of patients, but need not be directly adjacent. Ambulatory care needs convenient access to patient and public services, such as food services, registration, and amenities, but should be apart from inpatient areas and from back of house support.

Ambulatory care often grows by expansion with more modules, rather than by renovation, but this simple low-technology space can be fairly easily revised as needed later.

Diagnostic and Treatment Functions: In addition to the direct care of inpatients and ambulatory patients, hospitals routinely provide centralized technical services to assist in the diagnosis and treatment of patients, which need to be accessible easily to both types of patients without mixing the two. As in direct healthcare, the essence of the program requirement here is for relatively small, highly specific rooms in which specific services are performed.

Diagnostic functions, to help identify the cause of a disease or condition, often include Imaging (X-ray, CT Scan, MRI Scan, Ultra Sound, and Mammography), Clinical Laboratory services, and Non-Invasive testing (EEG, EKG, Stress Test, Nuclear Medicine). Treatment functions may be invasive (Surgery, Endoscopy, Interventional Radiology, Biopsy, all with patient preparation and recovery areas) or non-invasive services such as physical medicine and respiratory therapy. All of these services have similar program elements- patient registration, waiting, dressing or preparation, staff work areas, office space- and a similar pattern of separate patient and staff circulation.

A current planning trend to provide more flexibility and more efficiency of operations is to group related functions by type of use, cutting across departmental lines. For

Cath Lab: NYU Medical Center's Cardiac and Vascular Center.
Image © Sarah Mechling-Perkins Eastman; Courtesy: Perkins Eastman

Flexible construction and planning for future renovation are most important in these diagnostic and treatment areas, where changing equipment needs and the frequent addition of new technology and new services require very specialized rooms to be adapted to house extremely costly equipment. The overall structural envelope for these spaces needs to be optimized for flexibility, not specifically tailored to current practices which may change in unpredictable ways. One important approach is to plan for soft, non-technical space between highly technical areas, to provide a cushion to absorb future space needs. Mechanical and electrical systems in these areas also need to be highly flexible and adaptable. Some rooms, such as MRI and CT imaging rooms, require large and heavy pieces of equipment whose future removal and replacement needs to be accommodated. In almost all areas, a current trend is to utilize ceiling-mounted movable booms to provide electrical, medical gas, and equipment at the patient location, which requires a structural system which has the flexibility to support overhead equipment at almost any location and can be easily modified later.

example, patient holding and recovery functions can be located together, with the number of staffed observation beds able to expand and contract as needed during the day, to serve a variety of functions. Interventional services, which require sterile precautions and a restricted area with special HVAC and electrical services, such as Surgery, Endoscopy, Interventional Radiology, Interventional Cardiology, and Intra-Operative Imaging can all be part of one larger suite which shares specialized support functions such as staff locker rooms, Central Sterile Supply, clean supply and decontamination, rather than creating several similar suites.

Planning for diagnostic and treatment functions typically requires large blocks of space with multiple circulation paths to separate patients, staff, visitors, clean, and soiled traffic. While natural light is desirable in waiting, patient recovery, and staff areas, it is often not permitted in areas which require rooms with controlled lighting and special environments. In order to facilitate fast and easy access between related functions, for example Emergency, Imaging, and Surgery, vertical stacking may make sense as opposed to spread out horizontal areas.

The major services, such as Emergency, Surgery, Imaging and Lab are self-contained units which each have their own internal needs in terms of functional adjacency and circulation. In general, each has a public side, for ambulatory patients and their families, and patient circulation which need to be kept separate from inpatient traffic on stretchers and staff circulation.

Emergency needs a close horizontal connection to Diagnostic Imaging, and a secondary connection which is usually vertical to Surgery,

where patients are sometimes transferred after they have been stabilized. Imaging also needs to be accessible to ambulatory patients, but not usually with direct transfers from the ambulatory care area to imaging; this is seen more as two visits, which may or may not occur on the same day. Other interventional services such as Endoscopy and Catheterization Labs or Interventional Radiology are well located adjacent to Surgery, where they may be able to share patient preparation and recovery areas and staff facilities.

Non-invasive testing, such as EEG, EKG, Stress Test, Nuclear Medicine, and Biopsy, is well located near Imaging which also deals largely with ambulatory patients. Clinical lab patient contact functions, such as blood drawing and specimen collection, need to be accessible to ambulatory patients, but the analysis and processing functions of the laboratory, which are now often automated high volume services, are well located away from public access and linked by pneumatic tube or other systems. While access is needed for clean and soiled materials from support services, diagnostic and treatment areas should be located generally away from both public and back of house support areas.

Support Services: The fourth element of hospital services is the less-technical space which supports the other functions, with the ability to deal with the needs of patients, visitors, and staff members and traffic which vary over the 24 hour, 7 day cycle of hospital operations. Support services include staff facilities such as lockers, education and training, on-call rooms for on-site medical staff, lounges and staff rooms for employees who often cannot leave their work areas for breaks, and overall administration and office activities.

They also include back-of-house hotel type services such as dietary kitchens and services, materials management for clean supplies and equipment, pharmacy services, housekeeping, loading bays, waste management, and engineering and maintenance functions. Separation of circulation,

Radiology Procedure Rooms: Cardiac and Vascular Center, NYU Langone Medical Center. Image © Sarah Mechling-Perkins Eastman. Courtesy: Perkins Eastman

for clean and soiled materials, is an important consideration, and so is efficient distribution-staff time is the largest expense in the life cycle of a hospital, so inefficient distribution is a cost penalty which keeps increasing over time.

Many of these support functions, unlike the spaces where medical care is delivered, utilize larger rooms and large blocks of space, but no daylight is needed for most supply and support functions. These areas are usually a very low priority for later renovation and expansion, unless the overall scale of the hospital has changed dramatically.

Support functions need their own direct access from an industrial loading dock, well apart from visitor and patient traffic, with good vertical connections to inpatient and diagnostic and treatment areas. Often, staff facilities such as lockers, education and training, and employee health are part of this area but with their own entrance convenient to staff parking and public transportation.

Public Spaces: The fifth type of space is the cultural and emotional heart of the hospital, and the element of design which lifts it from being a technical clinical service to being a healing place. Public functions include

entrance lobbies, atriums, meeting places, visitor and family accommodations, food services, amenities such as shops and public services, and access to administration and registration functions. Public access is also needed for conference centers and health information and library services. Public access, from convenient parking and pick up and drop off areas, needs to be well separated from service functions and loading areas. Visible and clearly identifiable large volume spaces are needed for major public functions, and are typically one of the slower areas to be expanded or renovated as services increase.

The public portion of this service, such as lobbies, atriums, shops, conference center, café and food service, registration and finance, needs to be highly visible to arriving patients and visitors and close to parking and arrivals, with the flexibility to handle large numbers of people at peak times and for special events; natural light, a relationship to the outside world, and clear wayfinding are all important. Directly adjacent to these public spaces are the principal ambulatory care area, access to major diagnostic services such as Imaging and Noninvasive testing, and visitor access to inpatient nursing units. The public zone should be separated from major treatment functions such as Emergency and Surgery and from support services.

Relationship of Spaces

Whether it is a large academic medical center or a smaller community hospital or rural healthcare facility, the form of a hospital needs to derive from the functional relationships which are essential to the efficient operation of a very specific 24 hour/ 365 day service, with overlapping functional needs. Unlike some other building types, the

Atrium Winter Garden: St. Vincent's Medical Center's Cancer Center. Image © Chris Cooper. Courtesy Perkins Eastman

demanding functional needs of a hospital are best served by architecture which is planned from the inside out, rather than fitting program elements into an overall form. The room by room functional nature of healthcare services means starting with the necessary plan for one room type, with its equipment and relationships, then building that into functional planning modules, departmental zoning, and finally the overall stacking of the building mass where functional flow and architectural balance and design all need to coexist.

Modular Planning

Recent experience in medical planning by large healthcare organizations has shown the value of working within a standardized typical planning module to organize a flexible structure that can adapt to future needs. Hospitals of 50 years ago reflected the planning assumptions of the times, that

narrow wings of patient rooms were desirable to allow for natural ventilation, and that once planned the hospital's diagnostic, treatment, and support areas were relatively static. Current thinking is quite the opposite; while patient units take a form specific to their function, and are seldom modified for other functions later, the rest of the hospital needs to be easily adaptable and expandable without disruption to ongoing operations. The discipline of an overall planning module encourages these kinds of alternatives.

Worldwide, the trend is toward an overall hospital planning module that can accommodate either a large ward or pairs of patient rooms, groups of typical exam rooms, one large special purpose room such as an operating room, or groups of structured parking bays. For flexibility and economy, the module needs to be part of a simple and cost-effective structural system, and one which permits later changes and modifications easily.

One frequently used planning module that fits these criteria is a bay size of 9.2 M x 9.2M (30 ft) which neatly fits a cluster of 6 exam rooms with a 1.6M (5ft)corridor, or two patient rooms with a nominal width of 4M (13ft), or a group of 6 parking spaces. This size module also is within the capacity of a minimum depth flat slab concrete structure or a simple steel structure, without long spans.

Planning for Hospital Expansion

Expansion occurs in increments, whose size and typical frequency of change vary by type of function. Inpatient Space generally expands in multiples of typical nursing units, as the need for beds increases due to changes in population of services. Changes in the number of beds are a major change to all hospital services and to the business plan, and there is a logical cap on beds for most hospital sites; beyond a certain level it makes more sense to build a new inpatient hospital some distance away, rather than to create a very large number of beds on one site. Inpatient additions may occur in waves 10 years apart, even in times of fast growth, given the time needed to confirm demand, make business plans, and design, finance, and construct large expansion projects.

Ambulatory Care also expands as to meet an increasing volume of patient visits, but the change is seen more quickly than bed need and is easier to plan for. Expansion usually occurs as a multiple of clinic modules and even in times of fast growing volume may be on a 5 year span between additions, given the time to plan, design, and execute.

Diagnostic functions change more quickly, with frequent new and improved technology which requires smaller and faster incremental changes. Expansion or more likely renovation may happen almost continuously as projects are identified and funded, and diagnostic expansion is limited by functional distance relationships, not just site conditions. Projects are often small, involving a cluster of rooms or a change of technology in one existing room.

Treatment Functions expand more slowly. Changes in treatment services, such as Emergency, Surgery, or Cancer Therapy are major changes in the business case and need substantial advance planning before reaching the design stage. Expansion or renovation of these services is a major project which occurs in large blocks of space, where functional relationships need to be maintained and existing services must not be disrupted.

Support Services expansion is infrequent and even large increases in beds and services may not need similar changes in support services. Expansion occurs in medium size blocks of space for functions such as food service or supply services, if at all. Outsourcing of services may be considered to preserve space on site for critical functions.

Public Space expansion for major public spaces such as lobbies, atriums, and amenities is often the lowest priority for expansion other than cosmetic change. Revising and expanding public spaces is usually part of a major master plan and change in direction. Understanding these different ways in which hospitals grow and change is a basic first step toward planning for successful future expandability.

The future hospital: A Logical Planning Approach

Because a hospital is by definition all about people and movement, planning has to start with circulation systems as a basic framework for any concept:

- The main public entrance needs high visibility and easy access, leading to the main public space
- An outpatient entrance, also visible but separate from inpatient and visitor traffic, leads to ambulatory care clinics
- Emergency Medicine needs a separate away from public traffic, but convenient to outside access
- The service entrance and loading bays need to be easily accessible but out of public view
- Drop off and parking needs to be conveniently provided for all types of traffic
- Hospital staff parking, separate from patients, needs to be close to a 24 hour entry

As each of these layers of circulation is added to the plan, the logical form of the hospital begins to take shape, with different types of traffic approaching from different directions and vertical circulation finding its place as logical nodes along the circulation grid.

Provide Right-Sized Space for Hospital Functions

Hospital space needs are directly related to operational and business planning assumptions, and need to be based on projected activity volumes and basic elements (not just SM/per bed). For each type of space, this analysis depends on days of operation, time per activity, and the size of rooms and support space needed for the activity.

For example, if ambulatory care visits take an average of 1 hour, including time to turn over the room between patient visits, and if the program will operate 5 days per week, 50 weeks per year, with an 8 hour working day and 80 % utilization as a target for operations, one exam/consult room has a capacity of: 5 days x 50 weeks = 250 days; 8 hrs x 250 days =2000 hours available; 80% utilization =1,600 visits per room per year. If each exam/ consult room is typically 11 SM, and for each working room there needs to be an area of about 60% for support space and local hallways, the number of annual visits per SF for exam/consult module areas would be: 11 SM x 160% =18 SM to do 1,600 visits per year, or about 89 visits per year per SM. A business plan that assumes 85,000 annual visits (340 per day, on average) would need about 955 SM of exam/consult areas, plus waiting, reception, and other related functions.

Clearly, changing each of these assumptions changes the end result in a very transparent way. Similar analysis of procedures and the spaces needed for them can be done for almost all functions, from Surgery, Emergency, and Imaging to inpatient beds and support services. It is also possible to project future growth in services to provide at least space on the site for future expansion that seems probable, even if not constructed in Phase One.

With a Functional/ Space Program which summarizes all of these working assumptions, the design team can add functional blocks of space to the circulation framework, for each of the key types of space:

- Inpatient Care Units
- Outpatient care
- Diagnostic /Treatment
- Admin/ Support Services with loading bay
- Public space and lobby

Organizing Key Functional Relationships

Shaping quantities of space needed into a logical hospital starts with a modular planning grid which allows flexible uses and shifting of functions later, within a basic structural system. Decisions about the vertical stacking of the spaces, to fit the site and to make circulation more efficient, consider the basics of hospital organization:

- Provide ground level access for public, outpatients, ER
- Provide horizontal or vertical circulation between critical services
- Consider distribution of support services and separation of traffic types
- Even with a very large site available, efficient travel distances for patients, visitors, and staff often suggest a multi story plan for at least some services. Outpatient clinics, which share a common arrival point and patient services, but only a limited relation to each other, are often grouped into an ambulatory care building adjacent to but a bit separate from the rest of the hospital, possibly even with a simpler business- occupancy type of structure. Inpatient units are often stacked for the same, reason, since they have limited connections with each other but need very close and convenient access to diagnostic and treatment services. Emergency needs to be horizontally adjacent to Imaging, if possible, for easy patient movement, but can be vertically linked to Surgery and ICU which should be adjacent to each other.

Planning for Variable Speed Expansion

The key to a flexible and expandable hospital is to recognize it as an open system, in which each element has a place to grow at its own rate without disrupting others and without changing the efficiency of the overall hospital. This systems thinking will allow the hospital to adapt to a changing business case, as the need for services and the ways in which it addresses the market change in unexpected ways. The goal is a flexible and expandable facility which remains scaled to needs of people in a clear and hospitable way, even as it goes through changes over its long life time.

The short history of the hospital as a building type, over less than 100 years, has shown that it is not possible to set out a Master Plan for growth based on assumptions which will change in unknown ways. For example, hospitals of 1920, 1960, 1980 and 2008 each had a Radiology department, later better named as Diagnostic Imaging, with radically different sets of assumptions. A hospital of 1980 planned for specific growth in radiology imaging rooms would have missed the future revolution in technology such as CT scanners, MRI, PET CT, and digital imaging, which have had a major impact on the use of imaging services, the amount and type of space needed, and how those services interact with other hospital functions.

Hospitals planned with many beds, for a long length of stay, now find themselves needing to be radically downsized and in many cases reconstructed, as patients remain in the hospital for much shorter periods and the nature of hospital services changes. A hospital designed as a closed and perfected architectural object, exactly tailored to its program and initial planning assumptions, is generally obsolete by the time it is open, in some ways.

Allowing for variable speed expansion means opening the door to unexpected change but channeling it in controllable ways to preserve overall functional relationships. At the departmental level, planning for expansion means using soft spaces to create buffers between hard, technical, and costly to change functions, such as locating easily changed offices and storage areas between two complex imaging rooms, to allow for future change if needed but without investing now in shell space which in itself makes too many assumptions about future uses.

At the facility level, planning for expansion means not stacking functional areas too tightly and leaving some slack in the plan to allow change to happen, without spreading functions out inefficiently. At the site level, it means projecting possible future growth needs and creating flexible zones where unplanned things can occur, while managing the overall flow of activity on the site.

Expandability also recognizes that building systems will have to grow and change, and need to be accessible and have their own pathways for growth. Organizing vertical circulation and horizontal distribution of services in relation to the overall planning grid provides a planning discipline for the initial design and easily understood directions for future change.

Example: A 250-Bed Future Hospital

To test some of these ideas for a very flexible and expandable hospital, the authors started with a typical program for a new hospital in an expanding area, based on our work with many international hospitals. Unlike long range strategic planning and complex renovations of existing hospitals, a new hospital puts the focus on clear and creative thinking, rather than on dealing with the many variables of an existing facility. The basic functional/space program is typical for a hospital of this size, based on some key planning assumptions:

Gross building space was targeted at 35,000 SM, at 140 SM /bed. Space needs were estimated by type of space, plus provision of 50 indoor parking spaces for physicians and key staff:

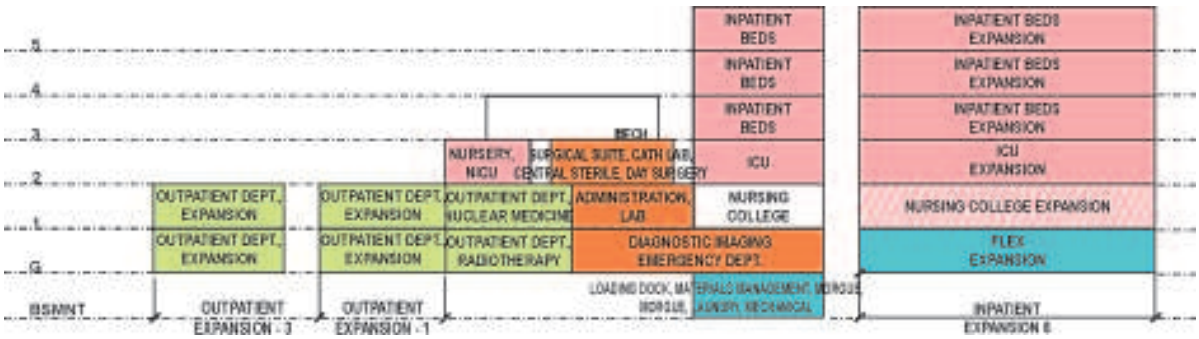
Emergency	60,000	visits/yr
Surgery	15,000	cases/yr
Imaging	50,000	procedures/yr
Outpatient	200,000	visits/yr
Inpatients	18,000 228 Beds 22 ICU Beds	admissions/yr, 5 day Avg. Length of Stay Medical, Surgical, OB/G, Peds, 6 units of 38 beds, 1, 2, 4 bed rooms Medical/Surgical/Cardiac ICU, all private rooms

Building Program Summary by Type (SM)

(assumed program)	**dept gross**	**% of gross**
Inpatient Nursing	7,000	26%
Outpatient	3,800	14%
Emergency	1,400	5%
Diagnostic/Treatment	2,200	8%
Surgery/ PACU/ICU	3,200	12%
Clinical Support Services	2,400	9%
Operational Support Services	4,000	15%
General Support Services	800	3%
Lobby, Public Amenity, Retail	800	3%
Training & Education	800	3%
Staff Welfare	600	2%
Net Floor Area (dept gross w/o factor)	**27,000**	100%
MEP Services	3,200	12%
Inter-Dept Circulation	4,100	15%
Total Dept Gross Area (w MEP and Circ)	**34,300**	**127%**
Total Building Gross Floor Area -GFA	**34,300**	GSM
Basement parking @ 50 SM/ Car	2,500	GSM
Number of cars	50	cars
Gross Floor Area per Bed including parking	147	GSM

Other design goals were a mix of private and subsidized ward types, with natural light and ventilation used in many patient areas and non-technical spaces. Outpatient clinics are scaled to projected volume, but can be easily adjusted for other assumptions. In order to provide flexibility of implementation, the goal was also for a flexible plan which would permit phased construction and expansion as needed, for example building the ambulatory care center in advance of the hospital itself, or building the 250 beds in two or more phases as needed.

Analysis of these amounts of space required, and a workable relationship between functions, suggested a concept for organizing the building, shown here as a stacking diagram which is just that, a diagram, not a design Planning for this proposed hospital starts with circulation; in terms of the number of daily users, the Outpatient Pavilion entry will be the one used by most of those who come to the hospital; the Main Lobby entrance serves inpatients being admitted, visitors to inpatients, and administrative visitors, so it needs to be separated from the higher volume outpatient entrance, yet be able to share some amenities and support services. Emergency patients need a point of arrival well away from other entrances, while staff and service functions need private access of their own.

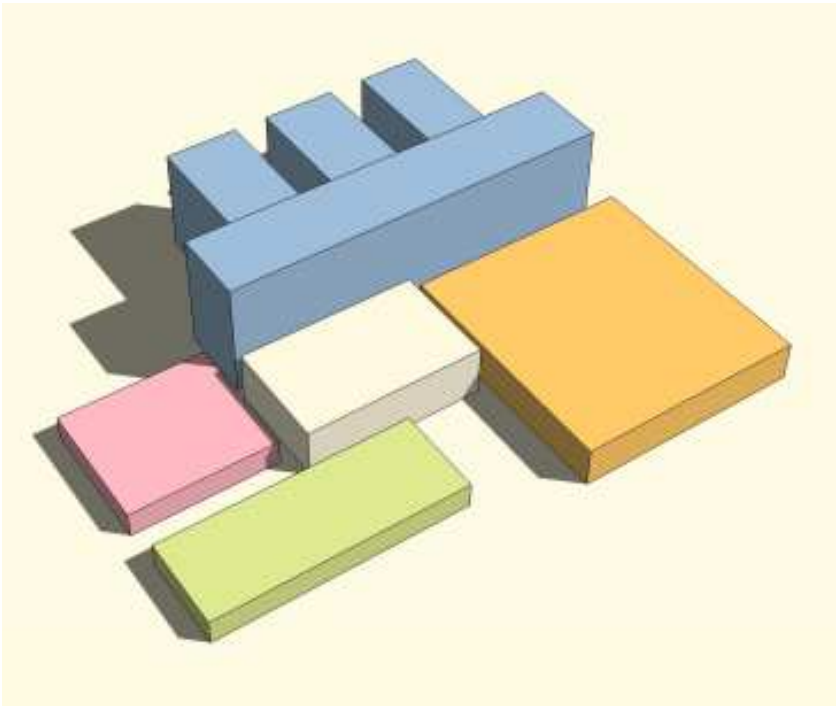


Stacking Diagram Section-250-bed Future Hospital. Courtesy: Perkins Eastman

The resulting concept is a four-sided plan, with each of these main entrances on its own side. Each entrance is also linked to vertical circulation: smaller, faster public elevators for outpatients and visitors, patient/staff service elevators for more private hospital functions with large capacity elevators.

The design concept stacks the major functional spaces by type, around a healing garden courtyard which is the visible center of the hospital. Outpatient services are in a three story block with a major entrance plaza facing the main street, and a building form which is articulated to allow natural light and ventilation to all of the exam/consult rooms in modular plan clinics. Dedicated elevators or escalators link the clinic floors to the large Outpatient Lobby and to a Medical Street with patient services on the ground floor.

Inpatient nursing units are stacked on the more private side of the hospital, further away from the street, but looking out onto the garden court and to green roof areas. Each nursing unit is served by groups of public and hospital elevators, organized for clear and simple planning. Nursing units would have a mix of room types as appropriate to the patient mix: isolation rooms, private rooms or suites, or 2 and 4 bed multi patient rooms, each with adjacent toilet/shower and space in the room for family use. Where the climate permits, many of these rooms can be naturally ventilated and the shallow width of the wings allows daylight in most patient spaces.



3-D Diagram -250-bed Future Hospital. Courtesy : Perkins Eastman

Diagnostic and treatment services are in a block spanning between the two bars of the inpatient and outpatient pavilions, accessible to both and able to expand as needed on its own. This block locates Emergency and Imaging together on the ground

floor, Surgery, PACU, and ICU together on the second floor, and on the third floor Labor/Delivery/ Recovery adjacent to Obstetrics/Gynecology, Nursery, and Pediatric beds.

Hospital services are in a basement, served by a loading dock accessed from the rear street, organized for separation of clean and soiled functions. A basement under the Outpatient Pavilion accommodates 50 parking spaces for physicians and senior staff with direct access up to the building.

This plan is designed for direct and intuitive way finding for each type of user, and is able to expand incrementally as needed: Outpatient clinic modules can be added, Diagnostic services can expand outwards, and one or more additional inpatient nursing towers can increase bed capacity. If necessary, the project could be developed in phases, with the Outpatient and/or the Diagnostic block built first, and inpatient beds and support services added later.

Massing Diagram-250-bed Future Hospital. Courtesy: Perkins Eastman

Massing Diagram - 250-bed Future Hospital. Courtesy: Perkins Eastman

Example: 600-Bed Urban Hospital

In a similar example, these concepts can be applied to the design a new 600-bed hospital for a developing area of a major city. The design concept focused on the high volume outpatient block as the main entrance, with a large public plaza at the street where patients wait for buses, taxis, and private cars. A major planning issue was a local code requirement for south-facing patient rooms in two nursing unit towers with future expansion as a third tower.

The proposed project located diagnostic/treatment services as flexible space between the inpatient and outpatient wings of the hospital, and created a garden court as the heart of the hospital which is visible from both the outpatient plaza and the Main Lobby inpatient area.

Total program area was 72,000 SM, with 90 basement parking spaces and support services in the basement. The architectural design features a contrast between, the low, curved outpatient pavilion fronting on the main street and the tall, brick-faced inpatient towers behind it.

Columbia-Presbyterian Medical Center Circa 1940

RenJi Hospital, Shanghai, China: Rendering (Aerial). Courtesy: Perkins Eastman

Example: 500-Bed Regional Hospital

In a similar test of the concept, similar ideas are the basis for a proposed large regional medical center, to be built in a semi-rural site. The design brief requires 500 beds, including VIP and ICU beds, expandable in future to up to 1,000 beds, plus a large scale ambulatory care service and a major emergency service.

Once again, planning began by recognizing the Outpatient block as the main entrance for most patients, located to be clearly visible to traffic entering the site. An iconic inpatient lobby, with a distinct sloped oval form, provides separate access for visitors and patients being admitted, linked to the large Healing Garden courtyard and elevators to patient units. The visitor lobby there overlooks a scenic river, toward which the gracefully curved nursing units are oriented for sun and views. The top floor of one patient tower houses a unit of VIP patient suites and ICU suites, which also share private elevator access to a VIP outpatient clinic and lobby at the ground floor.

A diagnostic/treatment block facing the outpatient pavilion across the garden accommodates Emergency, Imaging, Surgery, Recovery, ICU and Labor/Delivery and postpartum care. Its roofs step back to create a series of roof garden terraces, which are linked with sloped trellis planting walls to the main garden below.

Two basement levels house hospital services, receiving, and parking for 600 cars. Staff housing is provided on the site for a mix of senior consultants and clinical staff.

The hospital is planned for possible expansion up to 1,000 beds to serve this growing region; a second bed tower with two curving wings of rooms oriented toward the river can be built on the other side of the outpatient and diagnostic blocks, and each of those can be separately expanded toward the end as needed.

301 Peoples Liberation Army Hospital and Health Resort, Sanya, China, Rendering (Aerial). Courtesy : Perkins Eastman.

301 Peoples Liberation Army Hospital and Health Resort, Sanya, China.
Hotel Waterfront, Rendering. Courtesy: Perkins Eastman.

A Way Forward for Future Hospital Design

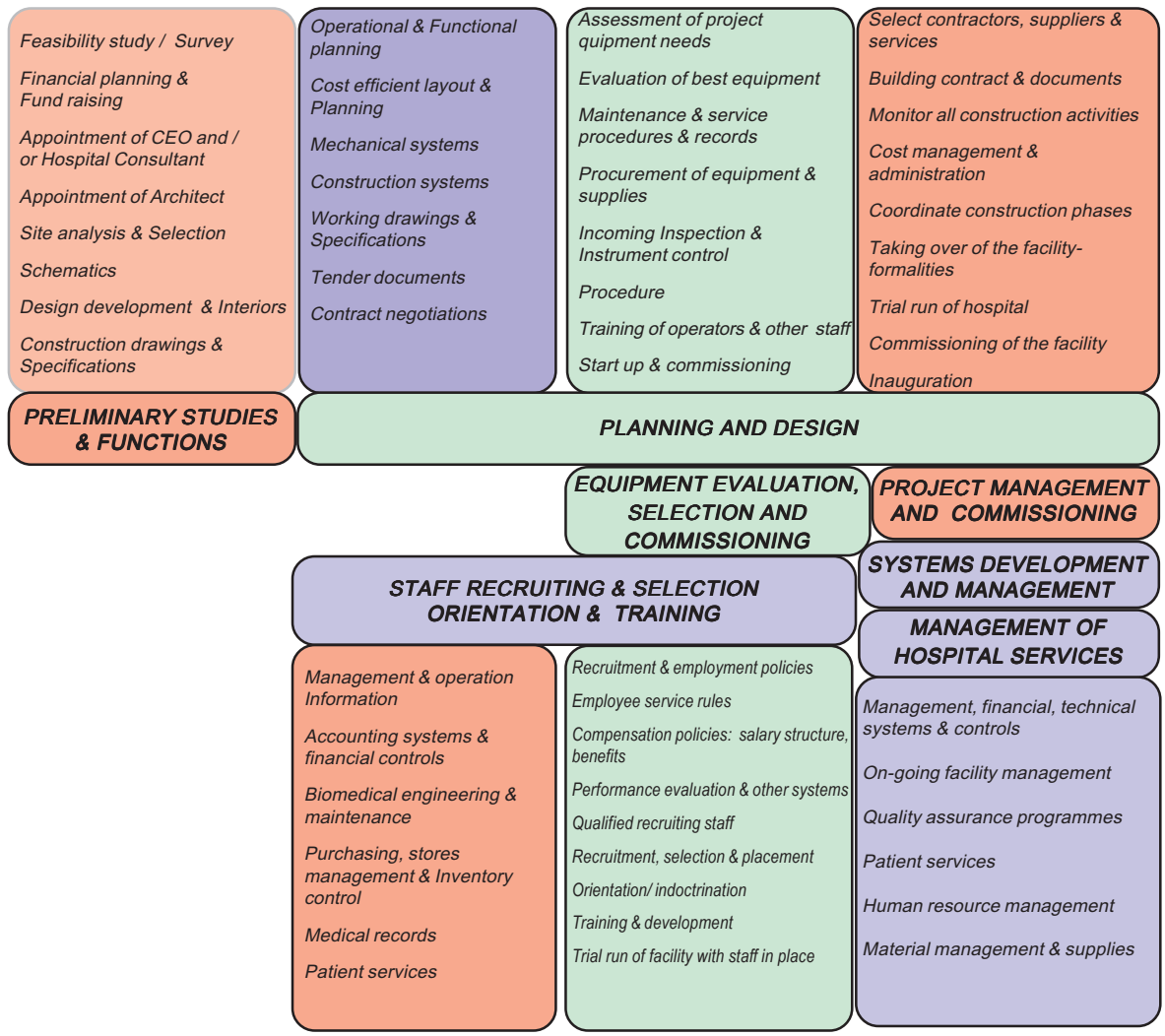
In developing these ideas, it was very important that this new concept should not be a recycled North American or European hospital plan type, but should focus on the basic ideas which need to drive hospital planning worldwide. The result is not a fixed design, but is an approach to planning which can be applied at different sites and in different sizes. What is most important is to focus on a planning process leading to form, not on designing an architectural idea first. It was also critical to think in terms of an open system of planning, in which variables such as required services, anticipated volume, operational and staffing assumptions, and building system decisions could all be adjusted and tuned as needed while keeping in mind the basic goal of a high quality, low upkeep, flexible and expandable hospital concept which can be an expression of a new hospital type for world use.

Chapter 2

Hospital Building Project

G. D. Kunders

Development Phases of a Hospital Building Project



Different Stages in the Construction of a Hospital Building

01 Commencement certificate
02 Demolition (if necessary)
03 Site preparation / grading
04 Layout and marking
05 Footings
06 Foundations
07 Structure
08 Floor and decks
09 Walls
10 Windows / Doors
11 Electrical work
12 Plumbing
13 Water supply and sanitation
14 HVAC
15 Fire detection and protection
16 False ceilings
17 Interior walls
18 Waterproofing
19 Hard interior
20 Floorings
21 Paint and Finish
22 Built-in (fixed) equipment
23 Depreciable equipment
24 External services
25 Landscaping
26 Testing and commissioning
27 Trial run
28 NOC / Certificate of occupancy
29 Takeover by the owners
30 Move in.

Building Project Time Schedule