HOSPITAL DESIGN GUIDE
How To Get Started

by
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Hospital Design Guide: How to get started: Contents

Hospital Design Guide: How to get started

Introduction: The Beginning

The art and science of designing a hospital anywhere is a complex affair. Beyond technical requirements that modern medicine demands and rigid functional relationships between different medical departments, the designer has to cope with a host of more subjective issues like the anxiety of the patient, the stressful work environment of the staff and the need to build a sustainable and healing building; Hippocrates' injunction to the medical community being, "First, do no harm."

This design guide will address pre-design programming and concept design, which in India are a much neglected but essential part of the process of designing a good hospital.

This guide is not a tome on the theory behind designing good hospitals. My colleagues in the first world would probably bemoan the scant attention paid here to the myriad statutory requirements that their code books specify for construction of healthcare facilities in their countries. There are very few codes applicable to hospital design in India; you could count them on the fingers of one hand.

The majority of my work experience has been with privately financed hospitals, a doctor, a group of doctors or a healthcare corporate entity being my client. Public sector hospitals present a substantially different design approach, I will write here only of private sector hospitals.

By means of this book I will try to enable you to come up with a "sketch" of a great hospital. I mean that figuratively but not literally. In my career so far I have always worked in horizontally aligned design offices', meaning that one person handles the beginning of all the projects, i.e. the pre-design programming, then takes them to concept design, schematic design and upon sign-off of that stage by the client, another larger team of professionals takes over to produce the tender documents and then "good for construction" drawings. As mentioned before, his volume only addresses the beginning of the design process. The sketch is but a stepping stone in that process.

So, welcome aboard! I hope the following pages will contribute to the betterment of hospital design in India and the rest of the emerging economies, but it is you who are the future, dear reader, you hold the key to the sentiment expressed above, and I hope to enthuse you to read this guide till the end and enable you to design much better hospitals then I ever did.

How to Get Started: What You Need: Management Consulting

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- **Market Survey**

Healthcare in India

Healthcare in India is in a developing stage and it needs a radical policy shift at government level to usher in the changes to face the challenges of the future. Under the umbrella of health care providers are outpatient set-ups, nursing homes, hospitals, medical colleges, health spas, diagnostic centers, ayurvedic and naturopathy centers, hospices, old age homes and more. Most of these institutions will have varied needs, which will differ vastly in terms of their planning needs. Health care provision in India is different in rural and semi urban settings where it is more unorganized to today's super specialty centers where it more institutionalized. The sector suffers from long years of neglect by the government in terms of priority funding despite being a basic need of the community. The mechanisms for funding are fast changing to the private sector involvement thereby pushing up the cost of both setting up hospitals as well as availing health care in these hospitals. The lowering of interest rates over the years has no doubt helped the cause of the private sector wherein more entrepreneurs are coming forward to set up hospitals as it has become affordable to take loans and repay them. The rapid growth of the insurance sector is equally helping the community to face the problem of spiraling health care costs.

Stakeholders

There are innumerable stakeholders in the health care delivery domain including the government, philanthropic trusts, educational institutions, corporate sector, insurance companies, bio-medical vendors, architects, construction companies, patients, relatives, the pharmaceutical industry, professionals like doctors and other para-medical staff, and the funding agencies. Given the wide spectrum of stakeholders, the industry growth will benefit many in the population.

The hospital ownership pattern can be basically three types:

i) Government owned - central / state / district / autonomous like army, railways etc
ii) Not For Profit – Managed by Trusts / Societies
iii) For Profit – Corporate Sector

The opening up of the economy has definitely helped the cause by brining in the accountability on various stakeholders. Even the government funding is now aided by multi-lateral agencies like the World Bank, UNICEF, European Commission, WHO etc wherein sustainability of the initial capital expenditure is the main concern. This is no doubt helping us to improve the delivery mechanisms. The private sector too is developing, aided by growth in health insurance and the industry per se is moving towards a market economy concept throwing up cafeteria choice for the consumer. Adding fuel to growth is the concept of medical tourism in which Indian hospitals are gearing up for the challenge of treating foreign patients. This needs a definite focus on hospital planning as we have to meet global standards, which by far exceed the ones followed until the recent past.

Project Conceptualization

The first step in hospital planning is to freeze the project concept in terms of:

- Identification of the market needs
- Finalization of the facility mix

- Deriving the appropriate size of the project
- Determining the possibility of getting skilled manpower

All the above factors have a bearing on the project cost and its viability in future. This process helps understand the need of the community that will be served by the hospital in the given location. For doing this, one needs to undertake a detailed Market Survey by collecting secondary data from various sources like the internet, libraries, media publications, news paper archives, ministry of health and district health departments records etc. Unfortunately India does not have a reliable mechanism for capturing health related data especially in the private sector. One also needs to undertake primary data search by conducting interviews with households, practicing doctors and visiting existing institutions. There can be three types of surveys required:

House Hold Survey: This is essentially done to understand the health care seeking behavior pattern of the community as a whole. Sampling techniques are used to map the statistically significant number of households. The basic information which should be collected and analyzed is as follows:

i. Demographic details of the family
ii. Education & Income details
iii. Disease profile in last three years
iv. Choice of health care provider for minor & major ailments with reasons
v. Method of payment for availing healthcare
vi. Their opinion on deficiency in health care market
vii. Critical success factor for the proposed project

Doctor's Survey: Medical professionals are normally the best judge of the deficiency in the health care market and need to be interviewed carefully to identify the project concept that would succeed in the geographic service area. The sample of doctors to be interviewed should include professionals from all possible faculties in medicine and surgery including those from diagnostic divisions like laboratories, imaging, physiotherapy etc. The basic information to be collected and analyzed from them would be:

- Personal details on specialty, qualification, experience etc
- Area of practice and hospital attachments
- Patients seen and their drainage area
- Referrals to other hospitals/diagnostic centers with reasons for referring
- Views on deficiency in health care market and solutions for same
- Patient's capability to pay
- Critical success factors for a hospital project in the service area

Institutional Survey: Getting a basic feedback on the competitors in the primary service area of say 5-10 km radius would be important to assess the strengths and weakness of major players. For national centers of excellence, however, the catchment area could be much larger, maybe the whole country, like Tata Memorial Hospital in Mumbai. One would also need to know the productivity, tariffs, salary structure etc which would help us in preparation of the feasibility report. The important information to be collected would be as under:

- Ownership with historical growth pattern
- Service Mix (diagnostic, therapeutic, medical, surgical, support services)
- Bed mix
- Productivity of major services
- Tariffs of major services
- Bed to manpower ratio
- Technology level

- Annual revenue/expense in last 2-3 years to understand growth pattern

Data Analysis

The data collected through secondary and primary sources is then analyzed to arrive at a facility mix for the proposed project. It will also determine the scale of the project in terms of its bed size. In case it identifies some atypical need like cancer treatment, it would perhaps need more research to understand the profitability of such capital intensive specialty. The end result should give definitive information on the following:

i) Specialties to be practiced in the proposed project
ii) Number of OPD rooms
iii) Bed mix with break up
iv) No of operation theatres
v) Diagnostic services
vi) Blood bank
vii) Support services

In case the project is to be developed in phases the facilities to be phased should be clearly identified as the engineering services and areas for the phased development will have to be accordingly planned.

- **Detailed Project Report / Financial Feasibility**

After finalizing the project concept in terms of its facilities and size, the next important step is to analyze its financial viability. This will also help the promoter in planning the means of financing the project based on its profitability and capability of servicing the debt proportion.

The first step of the feasibility process is to identify the cost of the project in a realistic manner. This is done by way of producing a detailed project report (DPR). Many projects have failed midway through construction process because it was identified that the cost overrun would be more than 50% of the estimated budget. Hospital buildings are very complex in terms of its engineering needs and hence specialized agencies are required to plan these and identify the cost. The cost of the project should be broken down under the following heads:

i) Civil Works including RCC, masonry, doors, windows, interior, and façade treatment

ii) Electrical Works

iii) Plumbing and fire fighting

iv) Air Conditioning

v) Landscape and site development

vi) Elevators

vii) Medical equipment broken down under departmental heads

viii) Non medical equipment like kitchen, laundry, computer hardware & software etc

ix) Hospital furniture and fixtures

x) Professional fees

xi) Pre Operative Expenses

xii) Municipal Taxes & deposits

xiii) Interest during construction

xiv) Contingency

The estimates for all the above should be compiled meticulously after detailed discussions with experts and undertaking adequate research. Financial institutions also required sufficient back up data to accept the costs before accepting the project for funding.

Income Assumptions:

After compiling the project cost, the next important step is to ascertain the income from the project from various heads. Whilst doing this, one would rely heavily on the institutional market research to understand the industry benchmarks for making assumptions. Income assumptions will need to be made for the following income heads:

i) Room rents for all categories of beds like general ward, twin/single rooms, ICU, NICU etc.

ii) Departmental income for diagnostic services

iii) OPD & IPD consultations

iv) Surgical operations (major and day care interventions)

v) Health check schemes

vi) Pharmacy

vii) Emergency

viii) Deliveries

ix) Blood Bank

x) Emergency

xi) Any specialty service like LINAEC, IVF, Angioplasty, Minimal Invasive Surgery, Organ Transplant etc. will need to be separately assessed

For calculating the income some important assumptions will need to be made with regards to the number of OPD/IPD days in a year, bed days available depending on the bed capacity, average length of stay (ALOS), number of admissions, number of operation theatres, number of OPD rooms etc. These assumptions form the important basis for assuming a realistic productivity for various departments which when multiplied with an average tariff rate will give the income on an annual basis. An example for assumption is given below:

Number of beds	-	100		
Number OPD days	-	300		
Number of IPD days	-	365		
Bed Days available	-	100 x 365	=	36,500
ALOS	-	5 days therefore no of admissions = 36500/5 = 7300/annum		
Number of theatres	-	4 No of surgeries / OT / day =4, therefore surgeries/annum = 4x4x 300		
Number of OPD	-	10, no of patients / OPD / hr =4, No of OPD/annum = 10x4x10 hrs= 400		
Number of X-ray	-	1 per admission for IPD and 10% of all OPD cases		

One has to assume such productivity for all departments by using sound logic and keep cross checking it with some industry benchmark. All income is calculated on 100% capacity utilization and then adjusted for year wise utilization as % in year 1, year 2, year 3, till year 10. (It needs to be qualified that if there are further capital investments in the course then that BEP cannot be generated accurately)

It is important to include all heads of income as may be possible.

Expense Assumptions:

The next important step is to compute all the important expenditure heads for the project operations. These heads would include the following:

i) Salaries and wages – these should be computed on a cost to company basis and should take into a staffing pattern inclusive of those for leaves, contract labors etc.

ii) Departmental expenses in terms of consumables. This could be arrived as percentage expense to the departmental income by taking industry benchmarks

iii) Professional fee payable to doctors for rendering clinical services. This would differ from assuming a flat salary to incentive based remuneration. Again industry benchmarks will have to be followed for same. Some hospitals have a mix of both the options

iv) Energy costs in terms of electricity, water, medical gases, generator

v) Food expenses for patients and staff

vi) Laundry & linen expenses for patients and staff

vii) Housekeeping expenses can be calculated on a per sq ft basis for the building

viii) Stationery expenses

ix) Telecommunication

x) Conveyance and car maintenance

xi) Marketing expenses

xii) Repairs and maintenance

xiii) Insurance, Legal and Audit charges

xiv) Miscellaneous expenses

xv) Depreciation

xvi) Interest cost for loans taken

xvii) Taxes for corporate hospital

Financial Statements:

After computing the income and expense statements as mentioned above, one arrives at the various financials such as Profit & Loss statement, Balance Sheet, Cash Flow, and Break Even Analysis. After computing these statements once can undertake sensitivity analysis by subjecting the project assumptions certain changes and evaluating the impact on profitability like:

- Change in debt to equity ratio

- Change in interest rates on the loan taken
- Change in capacity utilization over the five year period
- Effect of cost escalation

Such meticulous financial analysis will give the promoter confidence to decide on whether to undertake the project or not. This also helps them to arrive at a proper debt to equity ratio for the project.

The architect or the client will have to use the services provided by a Hospital Consultant, hopefully one with some experience in the field, to anticipate and avoid the many pitfalls in the above described process that await the unwary or inexperienced. These consultants have a Masters of Hospital Administration degree or a MBA in Health Sciences or better, both.

How to Get Started: What You Need : Architectural Consulting

- **Facility Mix**

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  The facility mix is a list of the various components of the proposed hospital and is derived from the Detailed Project Report. It will give the number and types of inpatient rooms and wards, thrust areas for the proposed hospital i.e. the departments or modalities that will form the cutting edge of the various services the hospital will offer, and a list of other departments and support services necessary.

  This facility list forms the input for the functional and space program, discussed next.

- **Functional & Space Programs**

Once you have agreement on a capital investment strategy and a facility mix (derived from the detailed project report), it is time to undertake programming. The detailed project report (DPR) may have been done for a long range planning strategy, a short-term need or maybe both. The functional program and the space program is to be prepared for the short-term project or for phases of a longer term project for which planning has already been done in totality, like a teaching hospital. It serves as a common policy document which outlines the parameters and vision of the project for all the members of the planning and design team. It should also contain all the necessary information for the architectural design team to commence conceptual and schematic design.

Architects and the designers among them in general are eager to put pencil to paper and are impatient with reading through long briefs. Many times in my experience I have received plans (or maybe even semi-constructed buildings) where the architect has "jumped the gun" so to speak and then paid a heavy price for that impatience. It is very difficult to extricate the project from this mess if it is semi-constructed, and it invariably results in a compromised design.

The method in which the functional and space programs are produced is very important to the healthcare facility design process. This is because in larger projects the initial capital costs very often exceed the long term operational of the facility in four to five years in India and in two to three years in the West. Quality thought being given to the initial planning will go a long way towards decreasing long term operational costs. Care should be taken to develop realistic workload projections in the DPR and distinguishing between actual area requirements and the "wish lists" of departmental heads occupied in building their own sub-kingdoms. Many times this kind of empire building will result in the provision of extra, unnecessary space with which nothing can be done later.

Traditionally, the space program (or area program as it is also referred to in India) was the only programming document prepared before the start of the design process. As of today, the functional program in combination with the space program is the way to go.

The components of the functional and space program for each department of the proposed healthcare facility could read as follows:

Listing of planning assumptions:

- An assessment of the situation on the ground (as existing)
- The planning objectives and a vision for the future
- Existing and proposed workloads
- Proposed time of operation
- Existing and proposed staffing
- Operational and support systems assumptions
- Equipment list for the proposed department
- Functional adjacencies and access requirements of the various departments

The space program consists of a list of the various spaces in the department in square feet and meters.

The space program provides a list of all rooms or areas required for each function and the total area required for the function.

The above approach flows from the functional requirements. We initiate a dialogue with the client representatives / stakeholders on what eventually becomes the functional program. This document defines the functional requirements of the project in keeping with the facility & services mix brief provided by the clients. These functional requirements are defined in terms of the following parameters:

- The services accommodated,
- The potential workload, &
- The key operational premises.

An example of a functional and space program is given below:

An elementary illustration of Functional Program:

Ambulatory Care Services	
Activity description	▪ Consultative clinics conducted by consultants and multi-disciplinary teams; ▪ Initial consultations, pre-surgery and pre-procedure assessments and short and long term follow-up visits; ▪ Minor procedures and treatments; ▪ Phlebotomy and Sample Collection;
Operational Assumptions	▪ Dedicated spaces assigned where special facilities / installed equipment is required e.g. Ophthalmology, Dentistry, ENT etc. ▪ Hours: working day / working week, aggregating 300 working days per annum.
Projected workload	▪ The planning premises are an eventual patient throughput of 1,200 – 1,300 patients / day. o 288,000 visits / annum (Generic rooms) – 960 / day o 9,600 visits / annum (Dentistry x 2) – 32 / day o 14,400 visits / annum (ENT, Ophthalmology) – 48 / day
Functional elements	▪ 40 x generic consultation / examination rooms ▪ 5 x atypical consultation / examination rooms; ▪ 10 x Treatment rooms / multi-purpose rooms (Injection / Dressing room, Immunization room, Ophthalmology filter clinic, Plaster room, Audio + Speech Therapy room, Nutrition + Diet counselling etc.); ▪ 2 x Sample collection rooms; ▪ Administrative control areas ▪ Staff accommodation areas ▪ Utility rooms
Functional Relationships	Diagnostics - Imaging Suite, Cardiology, Laboratory Suite, Medical Records Department; Adjacencies: Imaging Suite, Cardiology
Projected space	m^2 (departmental gross area)
Allocated Space	m^2

The purpose of the document, apart from defining the functional content based on the brief referred to, is to facilitate deliberation towards arriving at concurrence on the operational principles governing the delivery of clinical, diagnostic and support services. For these have an important bearing on the programming and hence, on the design.

An illustration of Space Program:

1 Emergency Care Services

Area in sq. m.

Departmental Gross Area		**717**
BUA factor, vertical core loaded	18%	717
Circulation loaded	30%	607
Total Net Area		467

					Area	Net area / unit	No of units	Total Net Area	Comments
		Administrative / Control						***36.0***	
1	1	Reception / registration	*2*	*places @*	*4.0*	8.0	1	8.0	excl. new appointments
1	2	Medical Officer				12.0	1	12.0	
1	3	Police Work Room				8.0	1	8.0	
1	4	Secured Holding Room				8.0	1	8.0	
		Patient Care						***380.2***	
1	5	Triage trolleys	*3*	*trolleys @*	*8.0*	24.0	1	24.0	
1	6	Resuscitation Bays	*2*	*places @*	*15.0*	30.0	1	30.0	
1	7	Plaster Room				12.0	1	12.0	
1	8	Surgical Suite				113.5	1	113.5	
	(	*Class A Operating Rooms*	*3*	*theatres @*	*25.0*	*75.0*	)		2 for endoscopy
	(	*Equipment Bay*	*1*	*place @*	*8.0*	*8.0*	)		
	(	*Scrub & Gown*	*1*	*place @*	*8.0*	*8.0*	)		
	(	*Change Rooms*	*2*	*places @*	*7.5*	*15.0*	)		
	(	*Scope Wash & Storage*	*1*	*place @*	*7.5*	*7.5*	)		
1	9	Patient Change & Lockers	*1*	*place @*	*7.5*	7.5	1	7.5	
1	10	Observation Bay	*16*	*places @*	*10.0*	160.0	1	160.0	in two modules, 10 + 6
1	11	Nurse Work Station				13.2	1	13.2	

		(Work Station with med prep counter 2 places @ 4.0 8.0)					
		(Control drug storage 1 place @ 1.4 1.4)					
		(Medicine carts, refrigerator 3 carts @ 0.8 2.4)					
		(Clean supplies/linen alcove 1 places @ 1.4 1.4)					
1	12	Nurse Staff Base	8.0	1	8.0	2nd observation bay
1	13	Toilet - Patient	6.0	2	12.0	incl. ante room
		Shared Support			***51.0***	
1	14	Clean Utility	8.0	1	8.0	
1	15	Dirty Utility	6.0	1	6.0	
1	16	Multi-purpose room	8.0	1	8.0	
1	17	AHU Room(s)	12.0	2	24.0	
1	18	Toilet - Staff	2.5	2	5.0	

- **Room Data Sheets**

The room data sheets are an extension of the space program. Usually confined to an A3 sheet, it can contain a plan of the room, minimum dimension of the space, a list major items of medical or other equipment to be housed within that space, and any unique temperature, humidity, lighting etc. conditions.

Without the plan, the same information can be given in an Excel sheet, and the plan can be added after schematic design is done to complete the sheet. At this stage the room data sheets could only be generic to help the non-healthcare architect plan the furniture, fixture and equipment plan (FFE). For the room data sheets to be of optimal use, they would need to be prepared after the FFE is in place.

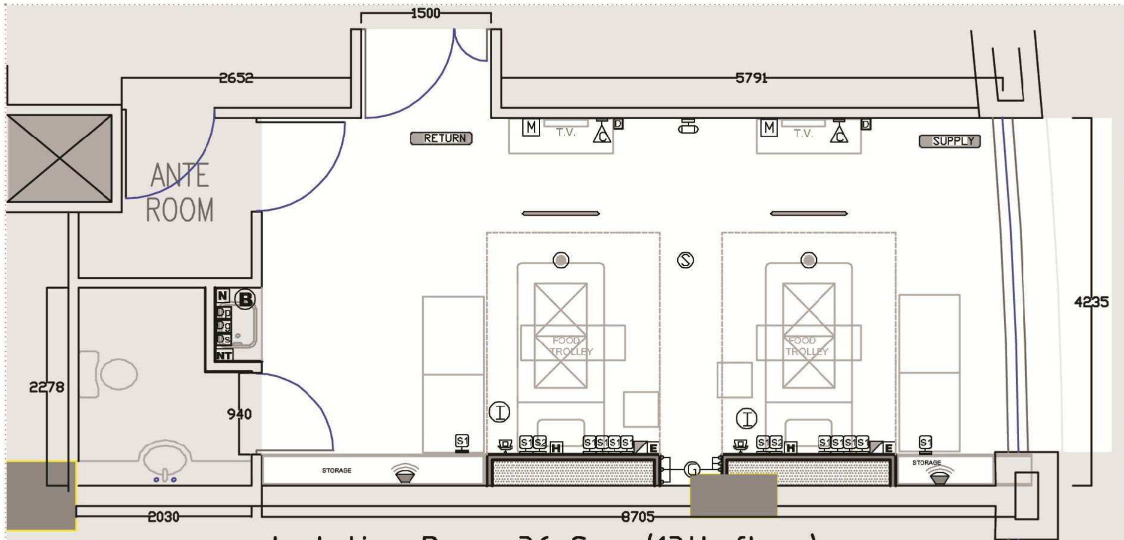
Below is an example of one type of room data sheet:

SpaceRequirements

Number of Rooms	TBC
Area	36 sq.m
Ceiling Height	2.7 m minimum
Security	

Enviormental Criteria

Natural Light	Preferred
Artificial Light	CFL
Design Temprature (degrees F/C)	75F (24C)
Relative Humidity	Max. 60%
Minimum Outdoor Air Changes / Hour	2
Minimum Total Air Changes / Hour	12
All Air Exhausted Directly to Outdoors	Yes
Recirculated by Means of Room Unit	No
Pressure relationship to adjacent areas	Negative pressure



Isolation Room 36 Sqm (13th floor)

FURNITURE AND FITTING

Category	Fitting	Qt.	Selection
Metalwork	Television bracket	2	
	Curtain tracks, bed	2	
Metalwork	Examination light : mobile	1	
Furniture/ Fitting	Dispenser : disposable gloves	1	near the entry
	Dispenser : paper towel	1	to basin
	Dispenser : soap antiseptic	1	to basin
Furniture/ Fitting	Cupboard : wardrobe	2	
	Shelf : laminate	1	for flowers

ROOM FINISHES

Floor finish	Vinyl	Standard slip resistant	Seamless, coved	-
Skirting	Vinyl	Pre finished	Floor vinyl coved 150mmHt.	-
Wall finish	Vinyl	Pre finished	splash back	to basin, tile also acceptable
Ceiling	Plaster board	Paint / washable	Flush set / suspended	-
Wall protection	Composite	Laminate / prefinished PVC	Bed protection wall panels/ corner guards to 900H	-
Door Protection	Composite	Prefinished PVC	Protection plate to 900mm AFFL	equal to acrovyn
Door Frame Prot.	Composite	Prefinished PVC	-	equal to acrovyn
Door (fitting)	Solid core	Paint	Double leaf, observation panel	1400 clear opening set
Observation	Alum / glass	Powder coat	Internal visual panel	to corridor side
Window screen	Synthetic	Washable	Roller blind	natural light & outlook essential

FIXTURES, EQUIPMENT AND ASSOCIATED SERVICES

Description	Qt.	Ele	CdW	WmW	Tap	Dns	Selection
Basin : scrub - Lab sink	1	-	Yes	Yes	Yes	Yes	Counter mount, long lever tap
Clock : Anolog	1	-	-	-	-	-	-
Xray viewing box	1	Yes	-	-	-	-	-
BP sphgmomanometer	1	-	-	-	-	-	-

SERVICES

Service Category	Description	Qt.	Remarks
Communications	Voice Point	2	
	Data Point	2	
	TV	2	
	Music system	2	Speaker / headphone
HVAC	Heating, Ventilation & Airconditioning		ASHRAE
Lighting	General : Ambient light	4	300 lux
	Special : reading	2	500 lux
	Special : night lights	2	
	Special : light connected to UPS		If possible
	Examination light	4	
Medical Gases	O2	2	to head bed panel
	Medical air	2	to head bed panel
	Vacuum	2	to head bed panel
Nurse Call	Nurse call system with all parameters	2	Indicator button & lights, 2 way communicator
	Nurse assist call		Indicator button & lights
	Emergency call (with code alarm)	2	Indicator button & lights
	Occupancy indicator	1	above the door
Electrical	5 Amp	8	head bed panel
	5 Amp	2	adjacent to patient
	15 Amp	2	head bed panel
	5 Amp emergency power	2	head bed panel
	Cleaner	1	
	Body protected		
	Special: for equipment	2	TV

LEGEND

- 1 No. Switch + Socket 5Amp.
- 1 No. Switch + Socket 15Amp.
- 1 No. Switch board
- Waste Bin
- Weighing Machine
- Ceiling Mounted Task Light
- Syringe Needle Distroyer
- Ceiling Mounted Light
- Examination Light Mobile
- Thermostat Control
- Nurse Call
- Emergency Call
- Telephone
- Data
- Cable Line
- Smoke Detector
- IV Track
- Sprinkler Head
- Music System
- Speakers
- Clock
- Medical Gas Supply
- A.C. Supply
- A.C. Return
- Head phone
- Indicator - parameters
- Drain
- Disposable gloves
- Paper towel
- Soap antiseptic

Staging -

Isolation-Room

17/8/2006	K D A H Mumbai	Revision 1	Scale 1:50	09a

- **Stack Plan**

A "stack" plan as the name suggests is not an architectural plan but an Excel spreadsheet which has the departments from your space program listed on the Y axis and the floors as in basement, ground, first etc. listed on the X axis. The idea is to distribute the areas of the departments on the various floors to get a handle on how much area each floor template is holding, and which departments too.

Now for this exercise to be productive and realistic, the designer needs to have conceived some sort of basic building form derived either from site restrictions along with height constraints, or maybe from a preliminary working of what kind of inpatient tower he/she has conceived of, in conjunction with then either a straight tower, a tower plus podium building form or any of the other various kinds of building forms possible. It could also be based on some formal conception of the building, which, however, would take a lot of experience and confidence.

At times the healthcare facility may comprise of several buildings on a healthcare campus. You could then replace the floor list with building numbers and prepare a so-called "stack plan" for various buildings on the campus instead of floors. Of course you would then need to prepare the regular stack plan for each building.

The designer may be tempted to hold all this information in his/her head, as they are usually notoriously shy of paperwork and in a rush, as I have mentioned before, to start the design process. A word of caution here, healthcare facility design are always much more complex than design of other building types that you might come across, and these documents will help you steer your way through the time-consuming and thus expensive pitfalls that you will face. By using an Excel spreadsheet it is easy and quick to examine various alternatives and fine tune the area distribution.

The stack plan forms an important part of the programming documents. An example of a stack plan is given below:

Proposed Hospital at Shillong (all areas are in sq. ft. and are carpet areas) **STACK PLAN**

Department	Basement	Lower Ground	Upper Ground	First	Second	Third	Fourth	Total
Public Areas			1152					1152
Casualty Department			1118					1118
Out-Patient Department				1313				1313
Radiology / Imaging & Diagnostics			1352					1352
Operation Theater Complex							2133	2133
Intensive Care Units							2444	2444
In-Patient Wing					6000	6000		12000
Central Sterilization & Processing Department							538	538
Clinical Laboratory				1287				1287
Kitchen & Dining			1269					1269
Administration				1356				1356
Building Services	6400		1100					7500
Parking		Parking						0
Sub-Total	6400	0	5991	3956	6000	6000	5115	33462
Add Vertical Circulation and BUA @25%	1600	0	1498	989	1500	1500	1279	8366
TOTAL	8000	0	7489	4945	7500	7500	6394	**41828**

Site Selection and Analysis: An Important Exercise

Hussain Varawalla

- **Factors for Site Selection – Shape and Attributes**

In our experience at Hosmac, clients usually (almost always) come to us with the map of a piece of land and the desire to build a healthcare facility. Many times we find the shape and size of the piece of land to be unsuitable for the healthcare facility desired. In urban areas in India the price of land is very high, especially so in Mumbai, where we are based. If only the client would come to us with the desire to build a hospital and a budget for the land, we could then evaluate various potential sites with regard to location, size, shape and orientation, in short, evaluate their suitability to house the proposed facility. In fact our second client, a cardiac surgeon, consulted us before buying the land and the project is till date our most outstanding success.

Among the above four factors, location, size, shape and orientation, for a proposed healthcare facility the most important is location. Whether it is in an urban area or not, the location of the facility will be an important determinant in its financial success. Corporate healthcare providers even study which city to base their facilities in based on various demographic conditions. I have had the opportunity to be an onlooker of one such analysis, but the details of how to go about it are beyond the scope of this book. Proximity to transportation hubs, good access roads, visibility, the location of competitor's hospitals with regard to the proposed facility all contribute to the suitability of the site.

The size of the piece of land is linked to its price and also to the Floor Space Index (FSI) of the site. This, taken along with the various statutory requirements of the piece of land determines how much built-up area the site will sustain. The FSI (similar to the Floor Area Ratio or FAR) is the ratio between the site area and how much area in square feet can be built upon it. Healthcare facilities command an increase in FSI over other usages even on adjacent or nearby plots, and with the right kinds of authorities being approached many times this FSI can be increased, which will substantially enhance the value of the plot. It is best if this is determined before purchasing the plot. Hospitals in India can possibly get an FSI of 2.0 all the way up to 5.0. A note of caution here; the size (area) of the plot and the FSI will not be the only determinants of how much area can be built. Other municipal regulations such as the open spaces to be left around the building (which are often related to its height) and the Ground Coverage, which is the percentage of the site the footprint of the proposed building can cover, will sometimes prevent you from using the full FSI. Thus you see that a careful analysis of the plot will go a long way to determine the efficiency and thus the cost-benefit advantages of its proposed usage. There may be a high tension electrical line running through the plot. It should be ascertained whether these can be shifted or how much it will disrupt planning if not. Many such pitfalls await the unwary.

While the municipal regulations that come hand in hand with every plot of land will permit the desired usage are a very important site attribute, they differ considerably from city to city, and even with in cities from site to site, and a detailed discussion on them is beyond the scope of this book. The National Building Code of India, however, specifies that the maximum height a hospital building can go up to is 30.00. This height is usually measured from the centerline of the access road to the site, i.e. the widest, major road.

We come to the third attribute, the shape of the site. This is usually a matter of common sense. As a thumb rule, we have found that given the area as a constant, for the smaller sites, a ratio of 1:1.5 between the two sides of a rectangle (approximately) works best. Usually you will find there is only one access road on the short side of the site. If it is on the long side you are luckier. I there are roads on two or more sides of the site you are even luckier and it has access roads on all four sides you are indeed blessed. Small sites with odd, jagged shapes are obviously unsuitable, large sites are a pleasure to work with, despite a few zigs and zags.

By orientation of a site I mean the orientation of the building(s) it will permit. In the smaller urban sites we have been discussing before, it is unlikely you will have any choice in the matter. As large parts of these hospitals are likely to be artificially lit and ventilated, the orientation is important as to the heat gain from sunlight. Techniques exist to calculate and minimize this with various building features and materials. On larger semi-urban and rural sites the opportunity exists to orient the buildings to make most use of natural light and ventilation. This is the subject matter of a science called Climatology and a detailed discussion is beyond the scope of this book. A lot of reading and reference material is available on this subject in this age of green architecture.

I would suggest to future clients that an inherited site or a site bought on the attractiveness of the asking price is not the most cost-beneficial way of going about planning a healthcare facility. Attention to the selection factors outlined above would go a long way to contributing to the success of the project.

- **Understanding the Scale of the Building(s)**

In this age of AutoCAD one of the greatest problems I have found with young architects who have grown up working largely on this software is their inability to conceptualize scale, both of drawings and buildings. Model making skills too seem to have suffered and there is a reluctance to build a lot of quick and dirty study models because of the time taken and the easiness with which the building views can be prepared in 3-D. The views are so much more seductive than our little dirty models of Styrofoam of yesteryear that I too stand guilty of being seduced by them, not to speak of the ultimate authority, the client. I leave it to you to decide which road is better. In our youth we had to baptize these models with drops of blood from accidentally cut fingers. As Bob Dylan sings (albeit nasally)…'the times they are a-changing'…

We move on to the conceptualization of the scale of buildings while designing on paper. I taught design in an architectural school briefly once, and the thing that most amazed me was that given a design assignment with the same site and the same brief the size of the buildings put down on paper by these students varied greatly! On probing a bit more I found there was no idea in their heads at this initial first cut of design of how big these buildings were. The way I approach the issue is to take the total footprint area of the building, punch it into my calculator and hit the square root button. Then you draw a square with that dimension to scale. After drawing this square you can very quickly using your eye alone modulate this square into various basic building forms of the same area.

This gives you a very quick idea about various footprints in plan. To get the third dimension scale I suggest axonometrics pulled up from these building shapes to the appropriate level with the floor heights to scale (in today's world I feel the need to mention this!) and the buildings will bulk out of the paper. More amazing is that they will stay the same size with respect to your body and you can see the whole site (and its surroundings!) all the time, unlike zooming in and out on the computer (which sometimes makes me dizzy...)

It is very important to understand the scale of your designs; simplistically put, you could say it is what architectural space is all about.

- **Zoning**

  Zoning of a site is a concept every architect is familiar with, so I will just give a brief description for the benefit of my healthcare professional readers.

  On a site that has multiple usages by which I mean buildings housing differing kinds of functions it is useful at the onset of design to block out appropriate areas that each usage will occupy. This is done by considering the following factors:

  - The functional and spatial relationships between the various buildings/usages.
  - The topography of the site.
  - The vehicular and pedestrian circulation connections between the buildings.
  - Any special site features such as trees, existing buildings, water bodies, HT lines etc.
  - Orientation of the buildings with respect to sunlight and prevailing winds.

The Design Team: The Importance of Consultants

Hussain Varawalla

In the conceptualization, design, construction and commissioning of any successfully run healthcare facility project, the services of some or all of the following types of consultants will be required:

1. Hospital Consultant/Facility Planner
2. Consulting Architect / Architect
3. Municipal Architect / Local Architect
4. Structural Consultant / MEP (Mechanical, Electrical, Plumbing) Consultants
5. Project Management Consultants
6. Lighting Consultant
7. Networking Consultant
8. Safety/Security Consultant
9. Fire Safety Consultant
10. Logistics Consultant
11. Acoustic Consultant
12. Quantity Surveyors
13. Public Health Engineering Consultant
14. Environment Clearance Consultant
15. Bio-Medical Waste Consultant
16. Infection Control Risk Assessor
17. Kitchen Design Consultant
18. Laundry Design Consultant
19. Audio-Visual Coordinator
20. Chartered Accountant
21. Geo-Technologist
22. Land Surveyor
23. Landscape Architect
24. Interior Design Consultant / Graphic Designer
25. Bio-Medical Engineer / Medical Equipment Consultant

In addition to these consultants, the design team would also include:

26. The Client / Client’s Representative
27. Hospital Administrator / CEO of Proposed Facility
28. User Groups

We thus have twenty-eight individuals / consulting firms or groups of people who would constitute the Design Team.

Their fields of expertise and thus scope of services would be as follows:

1) The Hospital Consultant/Facility Planner

At the start of the project, the hospital consultant’s role is to do a market survey and financial feasibility report to establish what should be the role of the proposed healthcare facility in the region it is to serve. The consultant’s recommendations focus on the total operational future of the facility, including the service area market financial future, proposed medical specialties and bed strength. His most important function is to provide an independent professional opinion and plan based on an unbiased look at the total operation. This consultant is usually retained to develop a long-range plan (also known as strategic plan.)

The facility planner would typically have domain knowledge of the subject of construction. And while the architect would know what it takes to design a building, the planner would typically advise on the functional content. He would advise on the facility mix – what are the services and the number of beds to be accommodated, what should be the sizing of the X-ray rooms, what should come next to the emergency care services, what are the minimum critical heights for the surgical floor etc. The planner may well be the bridge between the owners’ aspirations and the architect’s pencil, providing a brief that captures the essence of the owners’ requirements in a language that the architect understands. A good planner should have an understanding of finance, medical practice, architectural and engineering practices too.

The hospital consultant/facility planner’s role in design and construction is thus that of a programmer. The consulting architect will help him in this. Once the hospitals’ role in the community has been established, the operational and functional plans must be established. These can be done with the help of the consulting architect/architect.

This consultant/planner has a role to play towards the end of construction too. He can offer services relating to recruitment of staff, setting of tariffs, formulating operating procedures for the different medical departments, may offer consulting services on the evaluation of medical equipment to be purchased and may facilitate computerization of hospital functions. He may formulate marketing strategies and offer TQM / ISO 9000 solutions.

In an existing facility he may advise on turn around strategies, do operational audits, costing of services and systems study and redesign. He may advise on hospital waste management practice. He may also advise on equipment planning, and participate in the purchase of the equipment, if the client so desires.

Fees are not regulated, and will vary depending on the scope of services.

2) The Consulting Architect / Architect

Consulting Architects offer specialized healthcare programming and design services. They may offer these services on a national or international basis. The national firm may have either many offices throughout the country or a home base or a few regional offices. Its design expertise includes master planning, layout, and equipment from projects ranging from medical colleges to rural primary health care centers.

The Consulting Architect may also extend his scope of services to do conceptual planning and schematic layouts for individual hospital projects. This will then be then the input to the next consultant, the Architect.

If the Architect has the necessary expertise to design and produce construction drawings and documents for the hospital project himself, and if the scale of the project is within his design and production capabilities, the consulting architects' services are not needed for that project.

Selecting the consulting architect / architect can be a difficult and tiring process. The selection committee may sit through four presentations a day, hearing equally good demonstrations of expertise. The following tips may help narrow the choice:

a) Find out which member of the firm will handle the job and evaluate his or her responses. You will be working closely with this person for a long time, and this is the key to a firm's selection.
b) Study the proposed team and its organizations appearance. Ask about the teams' members' experience and request a reference of complete work.
c) Check the firm's references.
d) Explain your needs and the goals of your project, such as design excellence, mechanical systems and functional concerns, and ask questions as to how these can be met for your facility.
e) Relate the fee quoted to the larger costs, those of construction and efficient operation. Do not pick the lowest fee just because it is low. Once a fee is verbalized, it greatly influences a committee. However this fee amounts to only a small fraction of the total amount you will spend for construction, and an even smaller amount of the total project cost, including land and medical equipment. Money is not saved if the building does not operate efficiently. Every 3 to 5 years of operations will cost as much as the initial construction. The building will in all probability operate for around 50 years. It is important to *trust* in your selection.

3) Municipal Architect / Local Architect

The Municipal Architect is the consultant who will be responsible for obtaining all the requisite permissions / No Objection Certificates (NOC's) from the concerned regulatory authorities. This would include approval of the land use, the proposed built-up area, the open spaces around the building, the provision for parking, any recreational space / gardens that may need to be provided and the plans showing the individual rooms with sizes. He would also be responsible for obtaining clearance as to fire-fighting provisions and means of exit such as staircases.

If the hospital is being designed by an architectural firm that does not have representation in the city / town / rural area where it is proposed, a Local Architect may be appointed, who, as his designation suggests is based in the locality of the project. He may be the same as the Municipal Architect. He would then, in addition to the above-mentioned functions, supervise the day-to-day activities on site, reporting to the main architect. He could also provide information on locally available materials and local methods of construction. He could advise on the traditional architecture of the region, if the main architects desire to respond to it in their proposed aesthetic for the facility.

Both these architects are better selected by the Main Architect than the client, as the working relationship between all these architects needs to be based on mutual respect and hence cooperation. Many a project has come to grief over disputes or differences in outlook between different firms of architects working on the same project. Creative professionals can often be prima donnas, or behave like them.

4) Structural Consultants / MEP (Mechanical, Electrical, Plumbing) Consultants

Structural and MEP Consultants are engineers. Structural engineers are more generically called civil engineers.

Historically, engineers who worked on non-military projects became known as civil engineers. Three main divisions of civil engineering exist today:

a) Transportation Engineers
b) Structural Engineers
c) Sanitation Engineers

Civil Engineers contribute their talents to hospital construction in three areas:

i) Site Planning
ii) Structural Design
iii) Construction

Site planning: Site planning is the art and science of arranging the uses of land. Site planning is done professionally by architects, landscape architects and civil engineers. The civil engineer plays a role in readjusting the existing landform through designed grading and providing for proper drainage.

Structural Design: The structural engineers' role is that of providing the optimum support for the building. Structural work needs to be coordinated with the architect and the other engineering consultants; this coordination is absolutely essential in hospital projects. He will decide in consultation with the architect the structural system to be used.

It is in the preliminary stages of design that the structural engineer can effect the most savings. He must be appointed at the beginning of the project, and work with the architect even during conceptual design.

1. **Construction:** The civil engineer is responsible for inspection and testing of the materials used in construction, to make certain the owner gets the quality and quantity specified. He designs the columns, the beams (or how to work without them), the slabs, the retaining walls; in other words, he

designs the framework and the structure on the strength of which the edifice stands. He also happens to give you the structural stability certificate. His role is that of Construction Manager, dealt with in detail later on.

2. **Mechanical Engineers** study the conservation of energy and apply it in the most efficient and economical way. They design the heating / air-conditioning loads for the hospital, design the system and specify the necessary equipment. He will design the incorporation of the necessary filters into the air-conditioning system to produce the desired sterility conditions in that space. This consultant addresses the HVAC design, a very important aspect in healthcare facility. For one, it is a high energy guzzler, and thereon, design properly it can check infection, but not designed properly, it can become a source of infection.

3. **Electrical Engineers,** if you appoint one and all your electrical design requirements are taken care of. Wishful thinking! One just has to browse through the sub-trades to realize that this goes beyond the commonly perceived power design considerations – the sub-station, transformer, D G sets, L.T. panels, U.P.S., distribution boards, switch sockets and earth systems. They design the electrical systems of the hospital and calculate the electrical loads based on lighting and equipment loads. He should be aware of the public utility supply and rates to ensure economical power distribution and the required emergency supply. He will specify the equipment needed. He will design control and monitoring systems (Building Management Systems) and cater to communications and data processing requirements.

4. **Plumbing Engineers** are responsible for the processed water supply and liquid waste disposal throughout the building. They design the capacity of the water tanks (overhead and underground) required based on occupancy and applicable regulations. They design the fire-fighting systems required, the sewage treatment plant (if required) and water purification plants for the hospital. The plumbing consultant would also advise you on the choice of gravity water flow versus hydro-pneumatic system, the various technologies available for sewage treatment and what works best for you, the choice of an IBR boiler versus a non-IBR boiler, how to secure dry steam and quite probably, also the fire-fighting systems of hydrants and sprinklers.

In its engineering requirements, each hospital presents a unique problem. There is no universal solution to the selection of a system even after the problem is defined. There are many technical considerations depending on the medical equipment to be housed and the medical procedures to be performed within the proposed facility.

It is important that the MEP design team is hired as early on in the proceedings as possible, ideally at the start of the project, as they can advise on many decisions that are often taken without their involvement, presenting them later on with a de facto situation resulting in inefficient design and / or construction.

Coordination of the work of the engineering design team and the architectural design team is of crucial importance. A lot can go wrong if this is not rigorously done, especially in hospital design.

Very often, at the end of the project, a few of the consultants and sometimes the client too are not satisfied with the outcome. Too often the client is heard to say, "Well, it is not what I expected or what I wanted."

This condition of dissatisfaction can be avoided with value management. This performs the following functions:

i) Understanding the client's expectations
ii) Understanding the constraints on the clients
iii) Understanding the expectations and limitations of the architect, engineer and construction manager
iv) Helping the design team communicate their expectations and needs to one another
v) Helping the architect and engineer make changes and stay with schedule and budget
vi) Monitoring and reporting issues that seem likely to delay design or cause dissatisfaction among members of the design team.
vii) Preparing and conducting special problem solving sessions to clarify values and objectives, improve design, maintain or lower total cost, maintain or shorten schedule, improve life cycle costs and improve energy design and costs.
viii) Employing the methods and procedures of all problem-solving systems, including value engineering, value clarification, design-to-cost and Delphi.

Value engineering is a set of concepts and methods used to adjust designs to acquire the best total value. Using definition and analysis of function, value engineering is aimed at achieving the lowest total cost commensurate with design excellence. Specific methods include function analysis, brainstorming sessions, matrix comparisons and analysis of life-cycle costs.

5) Project Management Consultants

Project Management of hospital projects in the West began in the 1960's. By now, almost all projects include a project management consultant to save time, ensure quality and stay within the budget. The advantages of including a project manager early in the design phase can be great. For example, the project manager is familiar with:

- Current building systems that are available on the regional market at a competitive price.
- Current labor and industrial prices, enabling him to establish a proper estimate in the specific area.
- Sub-contracting trades that can advise on detail.
- Specification review.
- Cost consulting and scheduling.
- Management.
- Inspections.
- Insurance programming.
- Samples and Testing.
- Shop drawing and Coordination.

This knowledge, if applied in the design phase, can lead to cost improvements, time savings and fewer change orders. The expected contingencies now budgeted and used should be reducible. Many architect-engineer firms offer project management services.

The project manager performs a variety of functions, such as managing general conditions on site, including start-up and overall supervision. Towards the end of construction, the project manager is responsible for drawing up a certificate of substantial completion.

6) Lighting Consultant

The lighting consultant design lighting systems and selects fixtures throughout the hospital and the site. If only it were a matter of placing a couple of fixtures in a room! There are lighting standards that define the level of illumination, commonly measured in terms of lux, for all spaces. It does not help much that these are defined in a range, say, 100-150-250. One can't blame them though, since the variables are practical matters such as application (ambient or task lighting), the surface reflectance (depending on the finish proposed by the interior designer) and the age of the user, among others. While energy conservation is the buzz word, should it be FTLs or CFLs or LEDs? How should the metal halides be placed? Is the LPW for T5 better than T8? Are sodium vapor lamps a better option or should one consider photo voltaic lamps for external lighting? Will ingress protection level at IP 54 do, or is IP 56 required? These are some of the riddles that a trained lighting consultant helps resolve.

7) Networking Consultant

The networking consultant designs the data and communication networks. While we have D.I.D, we may also have ZIP phones and then the now ubiquitous mobile telephony boosters. Will their installation interfere with the readings on the monitor? Can I run the power and data cables in the same conduit? But what is the best infrastructure backbone – CAT 6 or fiber optics? How does one capture the endoscopy images and then transmit these real-time to the monitor on the consultant's desk? Should the cabling for central monitoring be done in parallel or in series? How best can I connect my outreach programs to the specialist at my referral centre – tele-medicine? Is core networking adequate or will there be applications which require wireless networking? How secure would these be? Bar coding! Smart cards! And we are not even contending with the choice of software, the servers and hardware as yet. These consultants are much more than mere electrical engineers.

Patient Communication Systems are another extension of the networking applications, these deal with Patient Call system, Nurse Call system, IPTV etc. Where should the nurse call from treadmill be annunciated at – emergency care or in the ICU? How is the Code Blue to be relayed – over phone by the nurse or by a dedicated paging system? How is the patient data charted – at the nurse station or on the move? With the introduction of tablets, patient administration has changed in ways previously unimaginable.

8) Safety/Security Consultant

The safety/security consultant is responsible for maintaining the safety and security of all those in the hospital, patients and staff. He is concerned with the following aspects of design:

a. Closed Circuit Television – PTZ cameras? Night vision cameras? Quadraplex monitors? Numbers & locations?
b. Radio-Frequency ID – equipment only, or should neonates & geriatric patients be covered too?
c. Public Address – should this be provided in the patient room? In the operating room? How does one plan for selective zone annunciation?
d. Fire safety –but that's a different field of specialization!

9) Fire Safety Consultant

The fire safety consultant, as his designation suggests, is responsible for maintaining fire safety throughout the hospital. How does one deal with fire safety in a public institution where the primary users are perhaps incapacitated? One has a network of smoke detectors and heat detectors to detect fire. But what if there is a fire? There are laws of the land and which are getting increasingly intricate. The some detection systems get linked to the HVAC system which has in turn to be drawn in keeping with the principles of fire zoning. In the event of a fire the HVAC system shuts down to prevent ingression of smoke into other zones. The fire doors, the planning of the refuge area, the planning of elevators as fire elevators, the linkage of alarm activation to the local fire station are subject matter of the fire safety expert. What if there is a break out in intensive care or worse, in an operation room? One cannot use the sprinklers, not foam or dry chemical powders (the patient could be cut open), not carbon dioxide (the patient and others could asphyxiate)…so what are the choices? This consultant would advise on the choices of agents that can be used in a gas based fire suppression system that would be safe to use.

10) Logistics Consultant

The logistics consultant advises on the vertical and horizontal movement of supplies. Elevators, escalators, pneumatic tubes, dumb waiters are some means of vertical communication. The sizes, numbers and speeds are determined by traffic analysis.

11) Acoustic Consultant

The acoustic consultant advises on the various techniques and materials to be used for sound insulation and noise control. This is yet to gain currency in India but is an important regulation and consideration in certain developed economies. The National Building Code too defines the permissible decibel levels. Also, the source of noise, the material considerations to attenuate the decibels etc. have become a specialized branch of design.

12) Quantity Surveyors

Quantity surveyors are the engineers who quantify; both the quantity and the price and are important to determination of the project budget early on and to bill certification and cost monitoring later on.

13) Public Health Engineering Consultant

Plumbing water supply and drainage, water treatment plants, effluent / sewage treatment plants etc. are the subject matter of the public health engineering consultant.

14) Environment Clearance Consultant

The Ministry of Environment & Forests requires an environmental clearance for projects above 20,000 sq m. Also, this resource facilitates complying with the documentation, submissions and presentation.

15) Biomedical Waste Consultant

This member on the team helps define the biomedical waste disposal policy and may advocate a hydroclave installation, as also articulate the storage and disposal of bio-medical waste policy and provisions.

16) Infection Control Risk Assessor

The infection control risk assessor is an important member of the team. His job is to determine the infection control measures and how these are to be factored into design. It is this consultant who also advises on types and numbers of isolation rooms.

17) Kitchen Design Consultant

The kitchen design consultant is responsible for the layout and equipment selection of the hospital kitchen and satellite pantries. He zones the kitchen in terms of material receipt area, bulk stores, day
stores, prep area, cooking area, wash area, cutlery store, tray setting area….the related automation and engineering too.

18) Laundry Design Consultant

As with kitchen, there are professional planners for laundry who advise on the equipment types, sizes and numbers. You may choose between a washing machine with hydro-extractor and a washer-extractor – and this consultant helps you choose.

19) Geo-technologist

The geo-technologist is responsible for soil investigations. Without a soil investigation survey and thereby determining the safe bearing capacity, the structural designer cannot calculate the optimal solution.

20) Land Surveyor

Before the architect starts profiling the building, the plot boundaries need to be known. If the plot is sloping a contour plan needs to be prepared. The trees, the underground utilities et al need to be marked. This is done by the surveyor.

21) Audio-Visual Coordinator

There are a lot of equipment that need to be decoded and coded for audio-visual transmission – say, between the catheterization lab and the counseling room, or the operating room and the auditorium, or for that matter, for AV to IP. These systems work on different technologies and it takes a coordinator to make this work, especially when the provisions have to be generic, as at the project stage, and then adapt to whatever technology is brought in.

22) Chartered Accountant

Quantity surveyors help generate and monitor the budget, but the chartered account monitors the means and the finances.

23) Landscape Architect

The landscape architect is responsible for the design of outdoor areas, around the hospital or the spaces in-between buildings on a campus. While the architect usually does the layouts of motorable roads, the landscape designer suggests the layout of pedestrian pathways, paved outdoor areas and plantation. He may also suggest water bodies, fountains, street furniture and lighting and provide detailed construction drawings for all these elements. He will work in close coordination with the main architect.

24) Interior Design Consultant / Graphic Designer

We are in an era in which interior architecture design has become an integral part of the architectural process; it begins with the earliest architectural concepts and ends with the client occupying the completed space. In the case of a hospital, it is best that the interior designer is able to work as a direct extension of the architect and is often hired directly by the architect to perform work included in the basic architectural contract. The architects firm may itself contain an interior design division. Such designers are best qualified to perform the total range of services needed to complete any medical facility including basic design and functional considerations, durability and maintenance of product, and control of costs.

Fees vary, based on scope of work. The earlier the consultant is retained, the better. Listed below in chronological order are some of the interior design services available:

i) Analysis of scope and architectural review.
ii) Interior design materials and color coordination.
iii) Programming based on social and behavioral factors.
iv) Operational programming for efficient use of space and furniture.
v) Inventory analysis and evaluation for existing furniture reuse.
vi) Preliminary budget.
vii) Space planning of detailed layouts.
viii) Lighting design, coordination and review.
ix) Furniture selection or design, budget and specifications.

"Corporate image" does not sound like a term that should be applied to the design and construction of hospitals, but it is an area of design that is of great importance. The overall concept of a hospital's image includes graphic art and design. The interior of a hospital should be tied to a graphics program and that requires the services of a **Graphic Designer.**

Two types of programs are of interest to the hospital designer. One is that of directional graphics, a signage program. A mass of information must be transmitted visually to the patients, visitors and staff so that time and motion are not wasted. The program develops a consistent lettering font and style and a directional program. The second is that of the corporate image of the hospital, the hospital logo and master program for all printed data. Graphic design should be thought through early in the design stage, allowing incorporation of the graphic design into the total design concept.

25) Bio-Medical Engineer / Medical Equipment Consultant

The responsibilities of the medical equipment consultant can be limited or quite broad. Basic equipment planning services might include:

a) Assisting the client in making equipment selections.
b) Establishing and tracking the equipment budget
c) Compiling an “equipment book” including manufacturer’s installation data and “cut sheets” (equipment specifications) and obtaining other relevant data from equipment vendors.
d) Developing room-by-room equipment lists and indicating the general location of equipment.
e) Obtaining from the vendor and forwarding to the architect (via the owner) installation data necessary to develop architectural and engineering components of the building.
f) Organizing and directing equipment user group meetings in which the specific equipment needs of facility users are identified.

Additional services, which may go beyond the scope of basic equipment planning services, may include

a) Assisting the owner in procuring and installing equipment and negotiating a purchase agreement with the vendor.
Although the equipment planner can be quite helpful in this area, many health care providers may be affiliated with some type of bulk purchasing service and can negotiate competitive prices themselves. The difference between an aggressively negotiated price and list price is considerable. Negotiated pricing also should include extended service contracts, which in themselves can eventually add up to a considerable sum.

b) Additional user group meetings.
Departmental user group meetings consist of a series of long, intense, interactive work sessions. In order for these meetings to be conducted in a time-efficient manner, each department user group should have a general idea about the equipment it is considering to purchase or reuse. The equipment planner can be an additional resource in describing some of the specific attributes and requirements of each unit, instead of having to begin with more basic issues. The equipment planner will bring a more objective viewpoint than the equipment vendor.

c) Coordinating tours to visit facilities where similar equipment is in operation and presentations by equipment vendors.
One good way to learn more about the equipment that currently is in use is to visit similar facilities that have recently opened. When conducting such a tour, it is best to select a facility that is similar in scope to the one being designed. It should also have been operational long enough for the staff to develop more than just first impressions, but not one that is so old that the equipment does not compare with what is currently on the market. Equipment vendors may also organize tours of their showrooms and current facilities showcasing their equipment. Such tours can be both educational and economical. However vendor organized tours tend to be less objective than those organized by the architect or equipment planner.

The bio-medical engineer also helps define the medical gas outlet distribution and the gas scavenging system in consultation with the doctor user group.

Trade shows are another good source for learning about current equipment as well as staffing, management and business issues relating to the operations of health care facilities. Many equipment vendors unveil their latest technology at such shows.

26) The Client / Client's Representative

As a client or his representative who intends building a new healthcare facility or adding to or renovating an existing facility, you will be working with the above-mentioned design team. Long before the first shovel hits dirt or hammer is swung, you will find yourself committed to many hours of planning meetings with professionals such as the above. You will be an integral part of the design team.

This is what Vincent Wang, Design Director, Stanhope Properties plc, has to say on the subject:

"Quality is a state of mind, not an optional extra. It cannot be bolted on. The lead must come from a strong and committed client and the pursuit of quality must form every strand of the process"

An essential function you will perform right at the beginning of the project will be to state the project goal/s, or 'Statement of Intention". This will form a reference point for policy decisions taken by the design team, which will need to be consistent with this formulation of project goals or intention. Keep it short and state it with clarity. Weigh each word that forms part of this statement.

The whole team will look to you to provide direction and purpose to the whole effort. If you falter or show signs of indecision this will communicate itself to the entire team, and if this goes on for an extended period of time, the whole group will come apart at the seams. You have to project, as Mr. Wang says above, strength and commitment, and lead from the front. If you are perceived as losing interest in the project, maybe you show the team that you are more concerned about your other business, then it is bad for morale. You must always communicate keen interest in the project. Make an effort to establish a rapport with the key members of the design team. Consultants work harder for clients they like as people; you can't always buy that kind of extra effort with money. (Of course, you can try, it won't do any harm!)

Maintain project momentum. If you drag out the process, all concerned will lose interest.

27) Hospital Administrator / CEO of Proposed Facility

It is a good move to appoint the CEO of the proposed hospital or the HOD of the additional department/s being added / renovated right from the design stage. If they are already working in the existing facility they need to get themselves a hardhat and take on a part-time job. They will be liaison and interpreter between their staff and the design team.

My advice to this CEO is:

a) You need to be an active member of the planning and design team as early on as possible.
b) Try to keep a copy of the most up-to-date plans. This way you can keep up with progress and revisions.
c) Keep a current plan located in a strategic location so staff and physicians can become familiar with the project.
d) Take your own project meeting notes. You can double check them with the architectural minutes to make sure you don't forget anything. You should be on the mailing list for project meeting notes.
e) Involve your staff. Invite key members of your department to architectural planning sessions.
f) Form a staff planning committee and meet regularly for feedback and plan reviews. Involve a cross section of staff from different shifts, those that embrace change and yes, those that are most resistant.
g) Create flow charts of critical work processes. Determine what your problems and issues are with your current plan. How will these processes be supported in the new plan? Examples of processes to

consider include chart flow within a department, supply flow and storage, soiled / clean linen flow and clean / soiled instrument / procedure tray pathways.

28) User Groups

As we have mentioned above, in an existing hospital addition or renovation, staff members of the concerned departments are invited to attend what are called “user group meetings” in which they, as the eventual users of the proposed facility comment on the plans prepared by the design team. Their comments can offer insights into the efficient operations of the proposed facility, helping the design team get in touch with reality. These could be meetings with physicians, nurses, support staff, anyone who would be using the proposed facility.

Even in a greenfield project, it is presumed the user knows best. One may test this theory, but these are the people who would eventually use the building and therefore constitute an important element of the design team. It is the rare doctor that can visualize spaces architecturally and more often than not, they want more of the same (that they have been accustomed to). And yet, these would be the team members that define the requirements.

Whew! That was the design team. Now come a slew of cooks to prepare the broth, the recipe for which has been collectively given by the 28 consultant cooks!

Enumerated below are the agencies who would be collectively involved in the construction of the hospital:

1. Excavation contractor:
2. Civil contractor
3. Plumbing
4. Fire-fighting
5. Electrical
6. HVAC
7. Elevator
8. MGPS
9. Pneumatic Tubes
10. Nurse Call
11. IBMS
12. Hard Flooring & Dado
13. Casework, millwork
14. False Ceiling
15. Painting
16. Wall coverings
17. Crash guards / corner guards
18. Doors
19. Windows
20. Loose furniture
21. Artworks
22. Façade works
23. Landscape
24. Signage
25. IV tracks, curtains

26. Steel storage
27. Medical furniture
28. Display screens
29. Equipment – medical, non-medical
30. Low voltage applications – access control, CCTV, RFID etc.

Putting Pencil to Paper: Starting Architectural Design

Hussain Varawalla

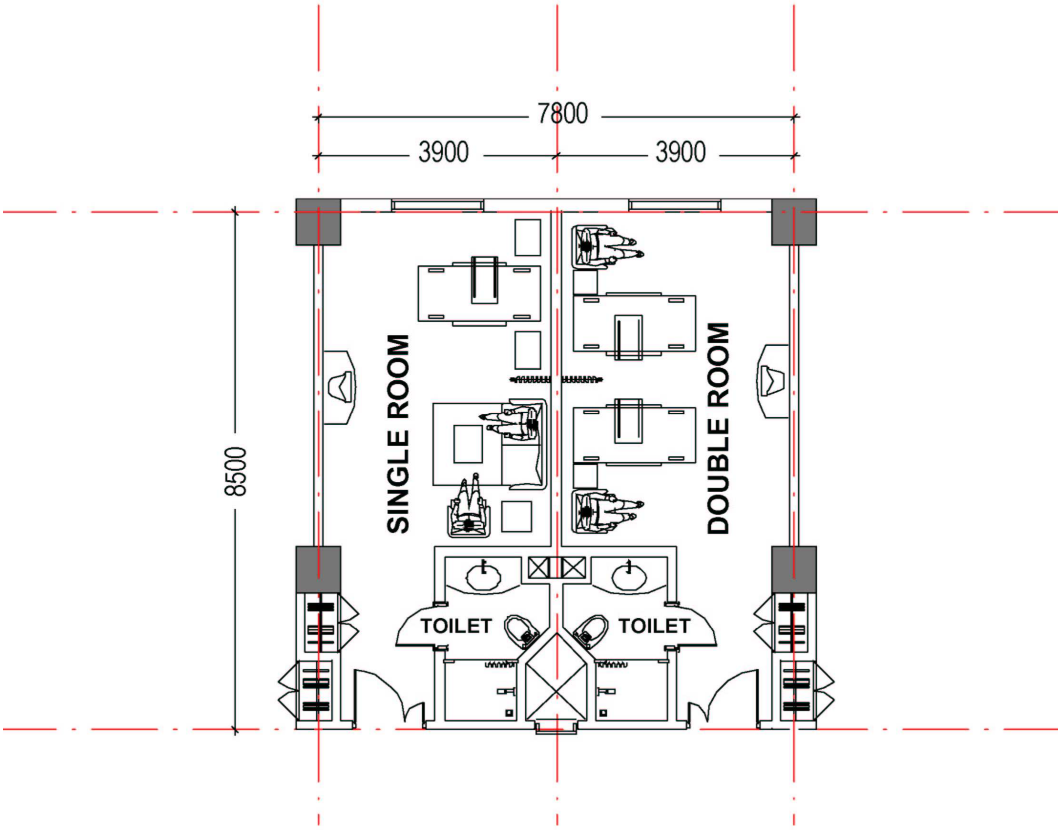
- **The Planning Grid: Creating a Framework for Design**

A Planning Grid is an overlay of lines usually represented by a 'long dash-dot-long dash-dot' (they need not necessarily be horizontal and vertical, but often are) and is a design tool used by us architects to create some kind of order on what is otherwise a (chaotic) blank white paper when they start to design a building.

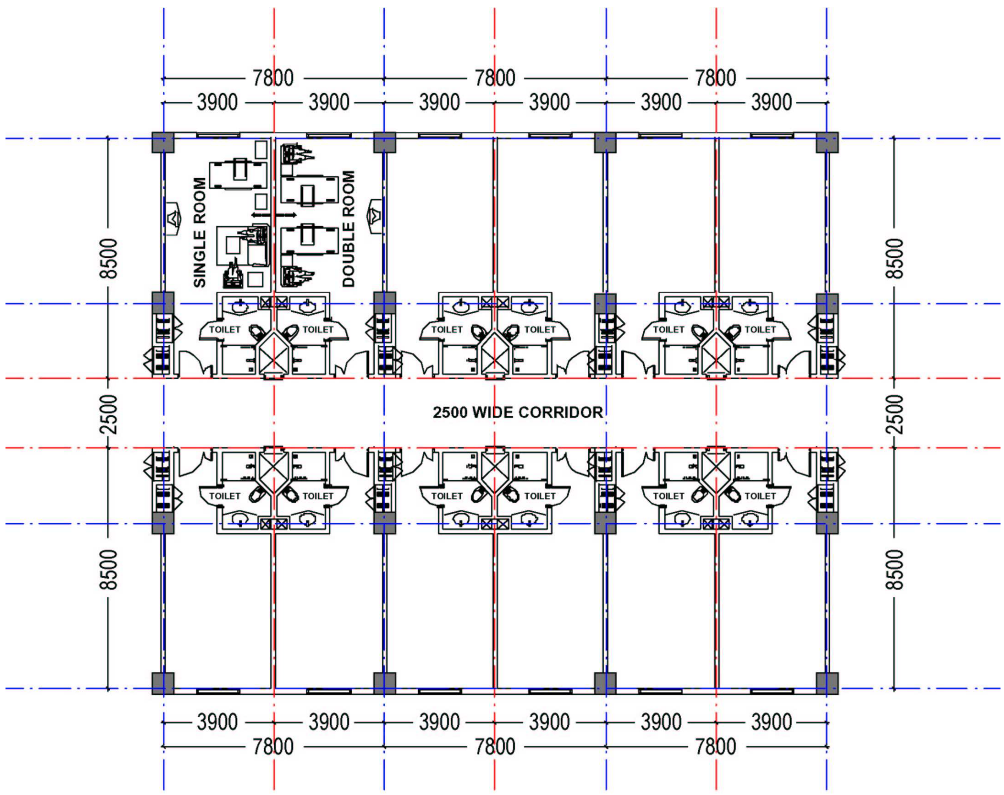
It kind of gives us a handle on which we can hang our hats before rolling up our sleeves, loosening our ties and getting down to some serious work.

Healthcare designers can derive their planning grids in one of the two following ways:

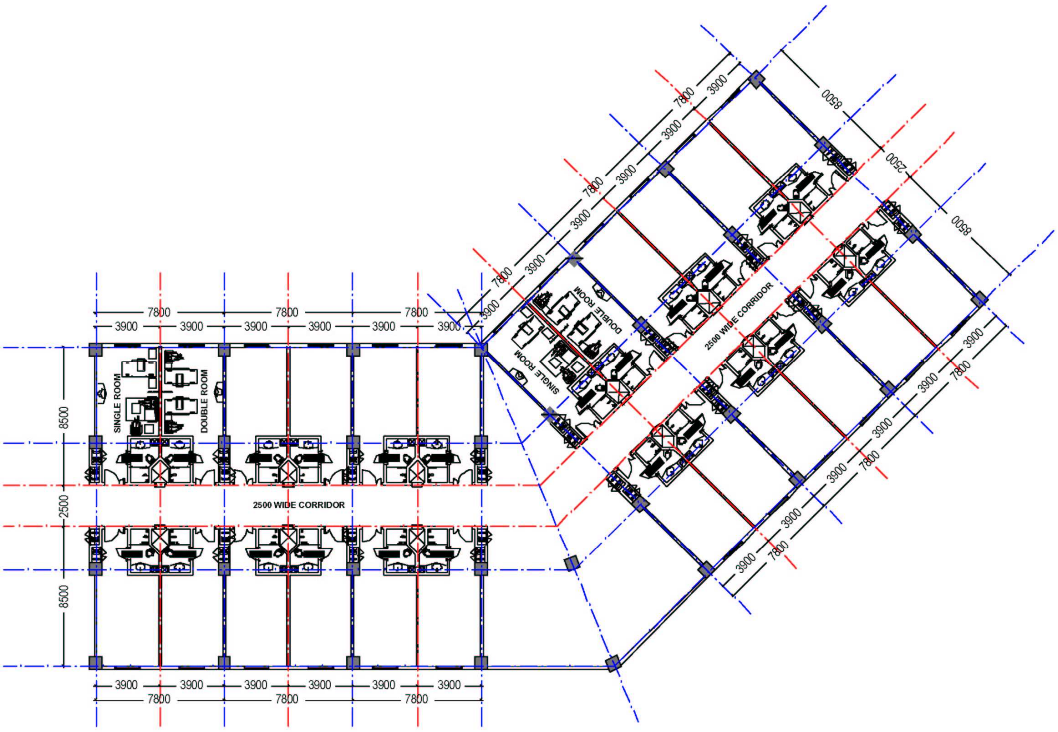
1. In urban situations, where the hospital takes the form of a vertical building comprising of a podium containing diagnostic / therapeutic and interventional services and a tower housing the inpatient facilities, the planning grid is largely determined by the layout of the inpatient tower. The module(s) used to determine the shape and size of this grid is the module(s) used to house the various kinds of inpatient facilities (rooms + toilets) conceptualized by the designer. In the example given below you can see how the planning grid modules (in red) of 3.90 M x 8.50 M is determined by the accommodation desired for a single bed patient room, a double bed patient room and their toilets. This room centerline of 3.90 M is a median between the lowest recommended room centerline of 3.75 M and the "best" and most spacious centerline of 4.00 M. In some of our Gulf projects we have even used 4.25 M.



Expanding on this with the addition of the access corridor and stringing the rooms out in a line, as in the plan below, we see how the planning grid starts taking form. Looking more closely at this plan we can see something important has been determined, namely, the positions of the columns that will support the building. We can thus see how the structural grid (in blue), the network of lines defining the location of columns, has been derived from the planning grid. The structural grid need not necessarily be the same as the planning grid, but is usually derived from it.



Coming to the next example, we can see that the designer has decided to twist the entire inpatient tower block at an angle to the horizontal / vertical one. This is just one example of how the planning grid could take almost any conceivable shape depending on what the designer wants to do with it. Having said that, we can still see how this twisted planning grid still serves its purpose of imposing order on a blank chaos, giving the designer a framework within which to design, even the rest of the hospital.



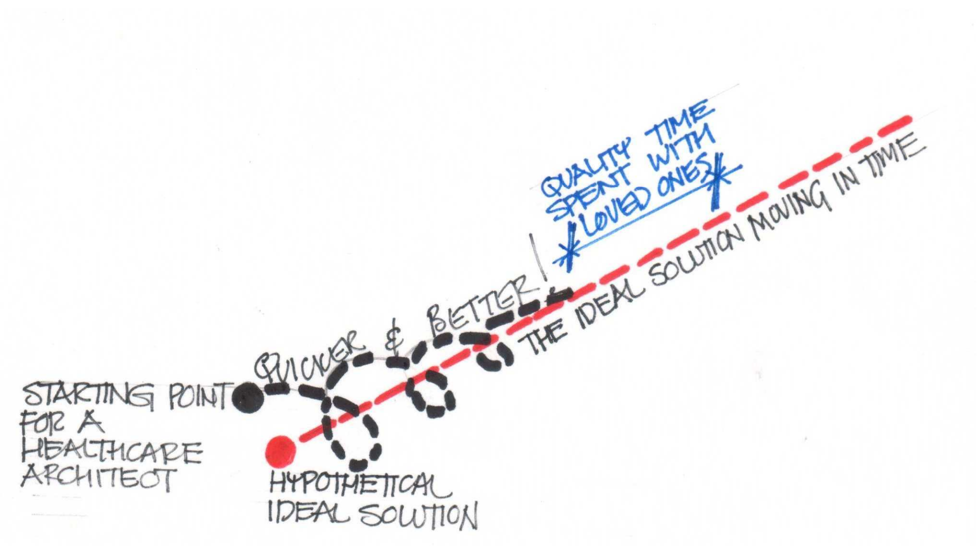
Maybe you don’t see that. Well, consider this. The positions of the structural columns determined by this planning grid, twisted or otherwise, will continue downwards through the rest of the hospital, through the lower floors (the podium mentioned above) till their respective foundations, where they will transfer their load to the ground below. Hence the lower floors (the podium), which will contain the Operation Theater Suite, the Radiology and Imaging Sciences Department, the Main Kitchen and the Mechanical Areas in the basement, to name just a few, will all need to be designed within the constraints of these column positions. Extrapolating from here, we can see how the façade of the hospital will need to be designed in harmony with the windows of the inpatient rooms above, which will be designed with the use of the planning grid. Even if the podium extends beyond the footprint of the tower above, it is almost certain that the positions of the additional columns required would be derived from the structural grid used for the tower, which has been derived from the planning grid determined by inpatient facility design.

In vertically organized healthcare facilities, we design from the top (inpatient tower) down (the diagnostic/therapeutic/interventional podium).

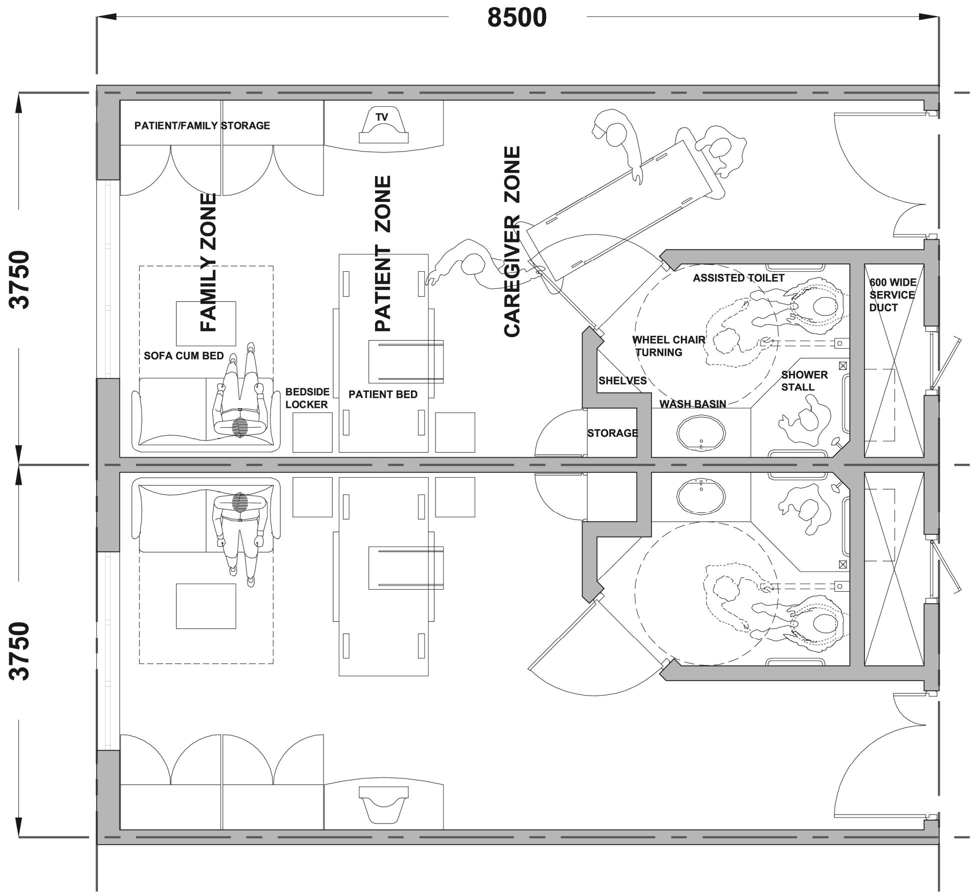
Not really. Actually we design in a kind of collapsing spiral with a time dimension. What I mean by this is illustrated in the sketch below.

The design process can be conceptualized as a process that begins at a point in time and space and endeavors to find for its particular problem definition and in its particular circumstances (real world time and money constraints) an (of course, illusory) ideal solution. In the sketch above, let us imagine that the red dot is this “ideal” solution and the black dot is the point in time and space that we begin our search for this solution. The blue dashed line represents our design path in the third ‘time’ dimension, and the red dashed line represents the movement of the ideal solution in this time dimension. We can see how the designer so to speak ‘circles’ the ideal solution, thinking about it in its entirety, always coming closer, but fated, however, never to reach that elusive ideal.

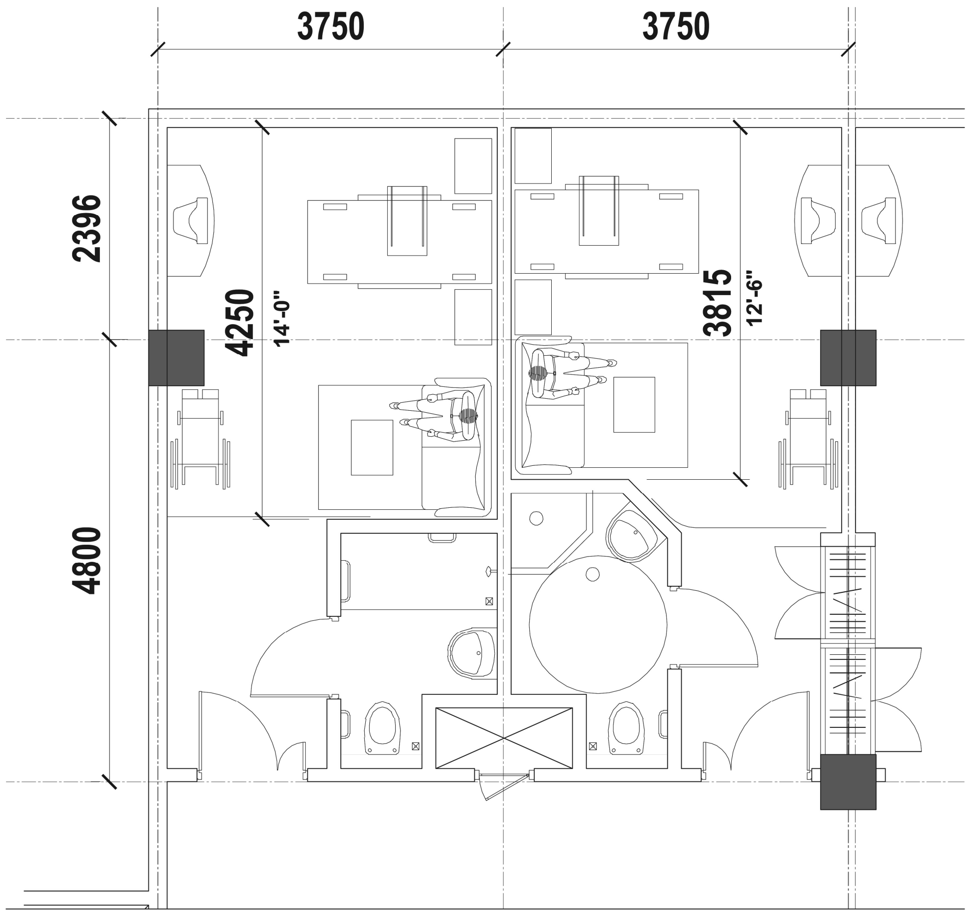
I hear the cry from my audience, “There are many correct solutions to any design problem! What is this talk of ideal solutions? Design blasphemy!” To this valid criticism I reply “Can we not imagine a cluster or range of “good” or even “acceptable” solutions grouped around this” ideal” one?” The diagram still describes how we search for them (or should, at least!) Let me give you an example. Let us assume the design search is on for a healthcare facility, and the above diagram represents the way you would search for it before you have read this guide. Let’s draw another diagram, as below, to describe the path you would take after you have read this guide. Can we see how you have started your search closer to the solution you are looking for and take less time to zero in on it? If we can see this by means of these two diagrams then they are surely representative of some aspects of the design process. I invite you to invent your own diagrams to illustrate other aspects and share them with us.



To get back from this design theory to some real life examples illustrating the importance of choosing the appropriate planning grid right from the start we have below a plan of an inpatient room designed for a children’s hospital. Providing space for the parents to stay overnight with the child is very desirable in such dedicated pediatric hospitals, and you can see how the planning grid is 8.50 meters which provides for a “family zone”, a “patient zone” and a “caregiver zone” (i.e. hospital staff). This longitudinal grid dimension also makes it possible to provide a slightly larger toilet than usual, which enables a wheelchair turning radius and an assisted toilet configuration. This is enabled despite providing a duct along the full face of the toilet along the corridor, that eases maintenance and repair considerably. However, it should be kept in mind that this large toilet only works with a single occupancy room, as shown.



Another example below shows how the provision of a handicapped access toilet within the same planning grid can significantly reduce the area available for the inpatient room. Also you can see how an 'S' shaped wardrobe along the entrance to the two rooms has been provided, making good use of this otherwise dead circulation space. This example also demonstrates how the inpatient room works within a grid of 7.30 meters in depth, as opposed to the 8.00 meter plus grid we have been using so far. The toilet duct gets impacted by this shrinking of the grid, and while this sort of duct can work, it is not the ideal configuration for a maintenance-friendly hospital.



Getting back to the business of planning grids in healthcare facility design, below we have the second way in which we can determine these planning grids.

2. In semi-urban or rural situations, where the land available is very likely to be larger with respect to the built-up area desired, determining the planning grid is another ballgame, one with much greater flexibility in the rules.

   In this situation, the planning grid will be determined by what designers call as their 'concept' for the hospital. This 'concept' is also an ordering tool, and will have been used to determine the form of the hospital in even the previous example of the urban site, but with less freedom. When there is a lot of land available, it gives the architect more elbowroom, and his hand is likely to move with more (hopefully graceful) abandon. This freedom enables many different types of building layout and form.

   Referring to the wisdom of Merriam-Webster Collegiate, my dictionary of choice for almost the past 25 years, we find concept defined as: "something conceived in the mind: THOUGHT, NOTION."

   This is not very helpful to us as architects have a lot of things in their minds and sifting through them will be a long and possibly not very informative experience.

   Another word designer's use for 'concept' is 'parti'. The closest Merriam-Webster gets to this is 'parting' which it defines as: "a place or point where a division or separation occurs."

   Actually, this definition may be of more use in understanding how 'concepts' and therefore our planning grids originate in these situations of design freedom that designers crave but rarely get. The thought process behind design can be described as a process of analysis and synthesis or divergent and convergent thinking, or as a 'parting' followed by a 'meeting' of thought within their minds. At the point of separation, the designer throws up a whole lot of different ways in which he could define an ordering principle that he would use to design the hospital. Suffice it to say for now that based on his / her chosen criteria the architect will (converge) select one or a combination of concepts to provide the ordering principle.

The focus of our discussion here, the 'planning grid', in this situation gets relegated to an almost incidental design tool, subject to great local variation if the structure is single storied, and might vary substantially even if the hospital is partially high rise and partially low rise, as the two forms of building could have planning grids independent of each other. Façade design might also vary greatly, there being less discipline to be followed.

Different parts of the hospital may have different planning grids derived from the functional planning requirements of the hospital departments they house.

(Now why couldn't I have told you this right at the beginning? Don't tell anyone, but I'm just a hack who gets paid by the word!)

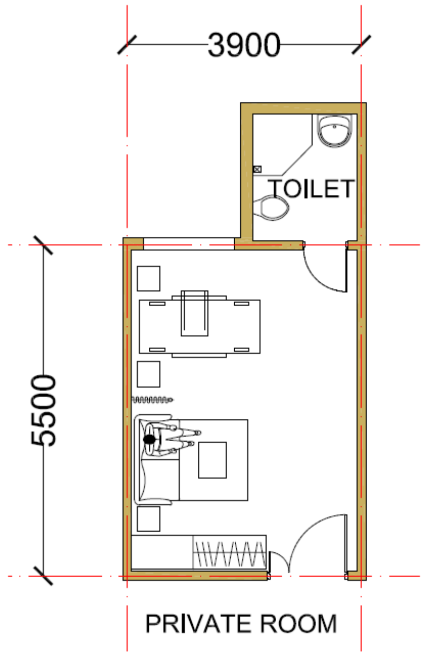
Of course, certain spaces in the hospital may be designed without using any geometrical planning grid at all. In practice, however, you will find such spaces are few among the totality of spaces that comprise the hospital, and are usually those in which the activities have little to do with the field of medical technology or do not house patients who are ill. These areas are usually ancillary facilities such as auditoriums, entrance lobbies or spaces in which patients are recuperating after treatment.

Healthcare facilities often present a complex and challenging proposition to designers engaged in other types of architectural design projects. Thus any means of imposing some "order on the problem" or limiting your options in a meaningful way is not to be sneezed at. The key word there was "meaningful". To impose arbitrary constraints is meaningless, though it will also make life easier for you. That is just avoiding the issue and moving the job along when it may well have stalled in the studio. It is better to collect all the design sketches, crumple them up and throw them away, send the staff home early, go home and put your feet up, listen to the music that turns you on till midnight, then crash out and get up in the morning to the beauty and awesome potential of the sun rising on a new day. It will be a beautiful day, you just have to live your life to its fullest, and the healthcare design solutions will flow.

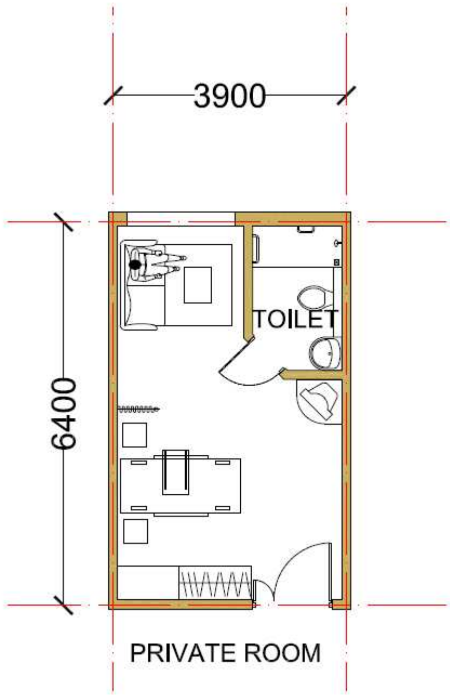
But finding good planning grids might help that flow along just a little bit. Don't knock it until you've tried it.

- **Room / Toilet Configurations**

  Well, above we saw an example of a planning grid derived from one particular room-toilet configuration. We can equally successfully derive planning grids from other room-toilet configurations, some examples of which follow:



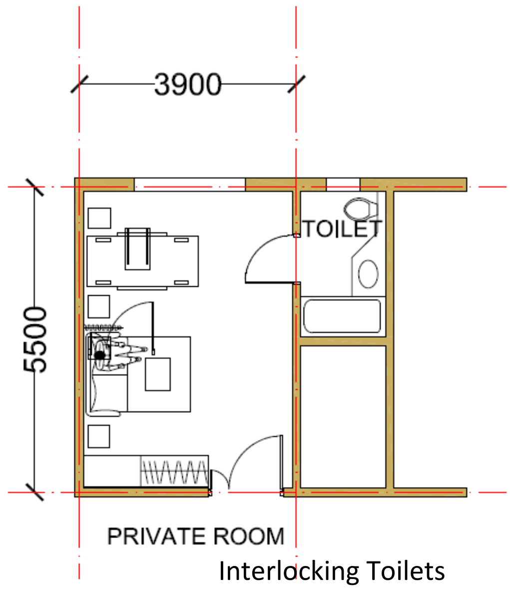
External Toilet 1



External Toilet 2

In the example "External Toilet 1", the toilet is outside the envelope of the inpatient room. This configuration enables good observation to and from the room. It can be used to minimize the room width, if so desired, for a still workable stretcher movement within the room. The toilet gets the advantage of natural light and ventilation, an advantage not to be sneezed at! Another advantage is that the toilet duct can be accessed externally. This type of toilet can be "bolted" on to an existing building. A major disadvantage is that it reduces the window area in the bedroom.

In the example "External Toilet 2", we again get good observation to and from the room. We get all the previous advantages and disadvantages as well, with one additional disadvantage, that it increases the floor area of the room, if the same feeling of spaciousness is to be provided.

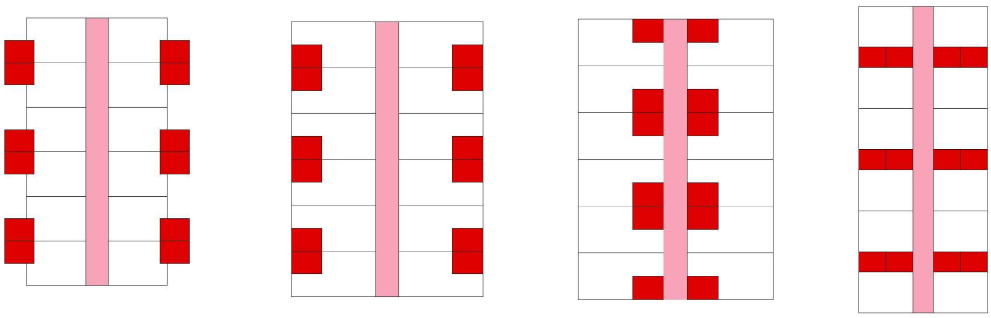


Interlocking Toilets

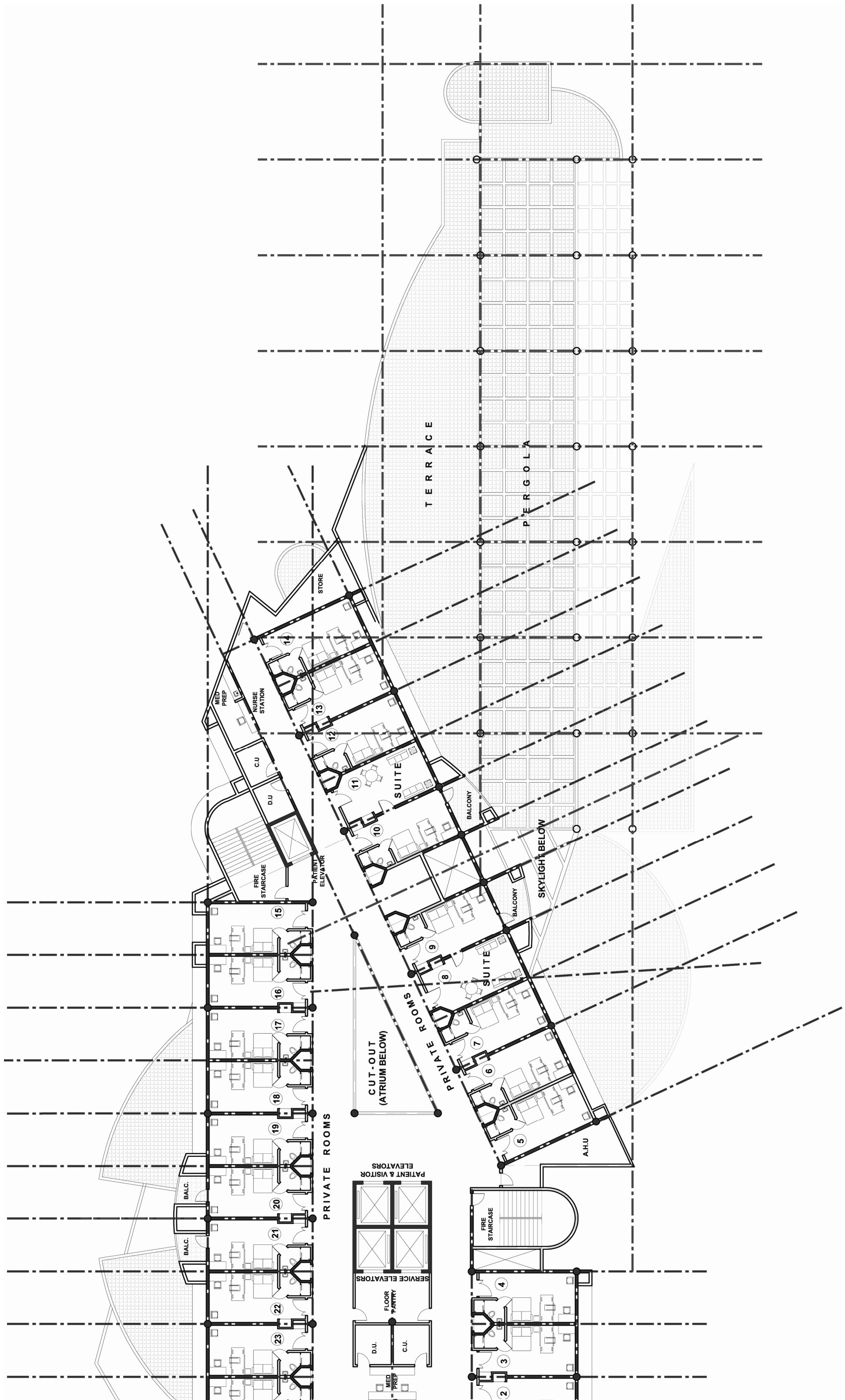
In the example "Interlocking Toilets", we again get the advantage of good observation to and from the room, this layout can be used to increase the overall width of the room, it maximizes window area in the bedroom and the bathroom service duct can be maintained from the corridor or the external face. The disadvantage is that we get one internal bathroom per two bedrooms, without natural light and ventilation. This toilet needs forced ventilation. Another major disadvantage is that this configuration increases the length of corridor needed to service each room, width remaining constant, thus increasing the area of the entire hospital, maybe even in the podium floors in some circumstances.

The example shown to you first, at the very beginning, could be called "Internal Toilet". This configuration has the disadvantage of reducing observation to and from the room. It also creates a kind of "dead" area or passage immediately behind the entrance to the room, thus increasing the area of unusable floor space. It has the advantage of maximizing the window area in the bedroom, and the toilet duct can be maintained from the corridor. This is, however, the only configuration that minimizes the approach passage area while maximizing the window area in the room. One factor is dear to the heart of the healthcare provider, and the other to the patient. I'll leave it to you to figure that one out. It is thus widely used, more so in the hospitality industry. The toilet needs continuous forced ventilation.

Depending on which of the above types (or your own type) of room-toilet configuration you use, you will generate different planning grids, and each type of configuration will necessitate or limit your options of building form, especially on the lower floors. In all but the "Internal Toilet" example it becomes difficult to extend the lower floors beyond the periphery of the inpatient tower, and believe you me, you would very much like to do that, for reasons obvious to any designer.



Plan of a Proposed Hospital in Mumbai (Bombay) below: See the complexity of the planning grids…



- **Alternative Building Forms & Massing: Pro's & Con's – Horizontal or Vertical**

In the developed West, designers are increasingly moving away from planning hospitals largely oriented around vertical circulation systems. Especially in the UK, where the Nightingale ward horizontally planned pavilion hospital never really died out. The usage of the Nucleus planning templates in the UK bears this out.

An in-built problem of vertical planned healthcare facilities and more so of an inpatient tower block, is that it can only expand vertically, not laterally. The substantial portion of the floor template taken up by the vertical circulation core and vertical service runs is not just wasteful and costly, it makes the template rigid and difficult to massage and limits its flexibility. The expansion of a vertically planned hospital usually takes the form of a collection of small buildings at the bottom of the tower, making for more and more difficult service runs and circulation paths. Vertical planned hospitals are less likely to have a workable master plan for expansion, especially for the lower floors. Alternatively, "shelled" (unfinished expansion space) or "soft" space (administration offices, waiting lounges which can be easily relocated) have to be planned.

Vertical hospitals will usually need more costly environment controls; they have large facades which are exposed to direct sunlight so they are less energy efficient, and have more difficulties of evacuation in case of fire than have horizontally planned ones, in which evacuation is through successive fire zones moving away from the location of the fire.

It is mooted that vertically organized hospitals can be built on smaller sites. This only holds true for centrally located urban hospitals. The most common type of vertical hospital, especially in America, is the "tower on podium" form, popularized by Gordon Friesen the designer of a series of mineworkers' hospitals, which were based on the principle of supplies feeding the wards from a basement service center. The podium of these hospitals will spread (in most cases) to have a footprint which is the same as those of compact horizontal hospitals. The inflexibility of such vertical hospitals is becoming more evident when across the world hospitals are becoming centers of mostly acute care and the ratio of inpatient wards to total built up area of the hospital is diminishing.

An argument could be sustained that modern hospitals, with their complex functional design requirements and unpredictable final form, are more suitable for the alternative much more organic school of modern architecture, as seen in the work of Frank Lloyd Wright, Aalvar Aalto and Hans Scharoun, than for the purist geometrical designs of Mies van der Rohe and his followers. On larger sites the concept of a "hospital street" with perpendicular outgrowths of building still holds appeal. But in India we are still fascinated by the phallocentric attractions of the glass and metal clad tower, no matter how unsuitable this building form and materials are in the prevailing circumstances.

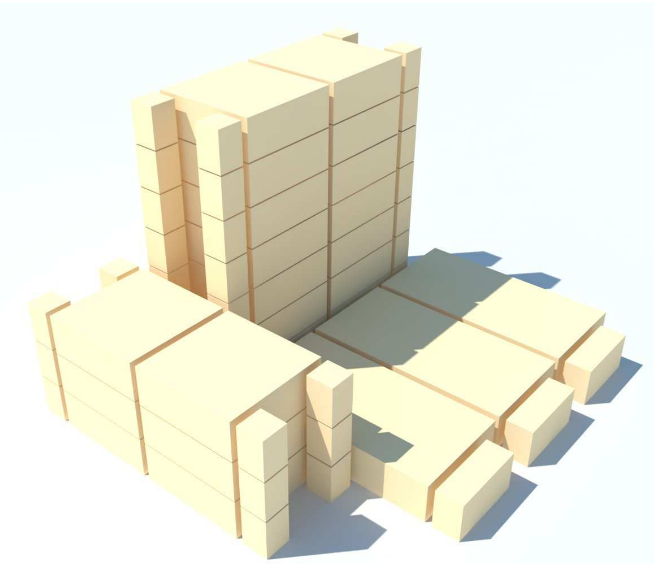
Many times, the building form and massing can mostly be determined by the climate prevalent in the hospitals location, that is, the designer's response to the environmental characteristics of the site. The amount of design time spent in placing and orienting a building on the site with respect to the open spaces and the path of the sun is time well spent. It may be the single most important decision you will make regarding the hospital with respect to its response to its environment and consequent energy savings.

With the building tentatively located on site, you have to then determine the approximate shape of the building before designing interior spaces. Buildings shaped without consideration for the sun-path require more energy to heat and cool. Huge amounts of energy are consumed in heating and cooling buildings worldwide. Even as energy resources diminish, many buildings today are still designed without considering the sun's impact on, and potential contribution to, space heating and cooling.

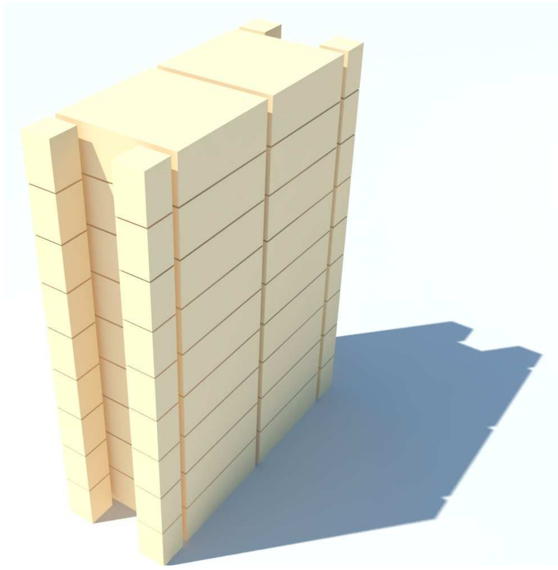
This design approach is made necessary and timely in an age of rapacious energy consumption. Today, more than ever before we need to design our buildings in a way that is strongly related to site, climate, local building materials and the sun. Inherent in this design approach is a special relationship to nature that offers the potential for an inexhaustible supply of energy. A lot of vernacular architecture has always shown a strong relationship to daily and seasonal climatic and solar variations.

Today the designer's approach to problem solving has been dominated by the use of technology to the exclusion of other approaches. In the buildings of today this approach shows itself in the materials we build with, such as plastics and synthetics. Especially in healthcare facility design, there is a dependence on the air-conditioning of indoor spaces rather than the usage of climatic and other natural processes to maintain the comfort conditions. In a way, we have become prisoners of complicated air-conditioning systems, since windows must be permanently closed and airtight in order for these systems to work. A minor power or equipment failure can make these buildings uninhabitable. Scant attention is given to the unique types of local climatic conditions and building materials. One can now see essentially the same types of recently built retail, commercial and institutional buildings across the country.

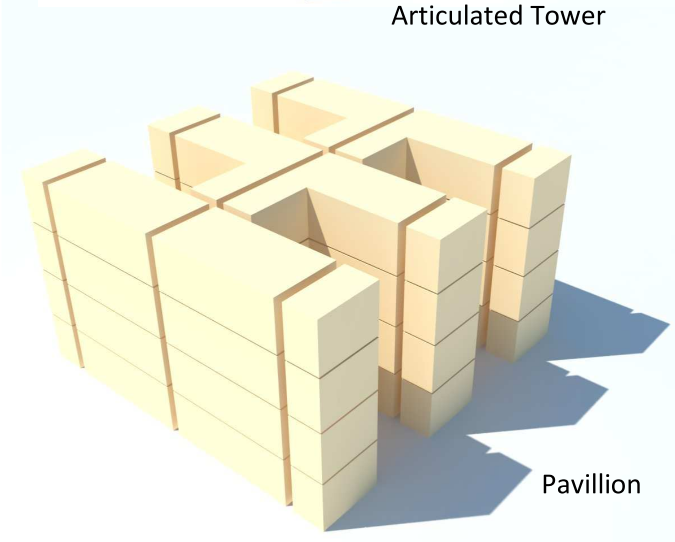
Shown below are various configurations of hospital built form:



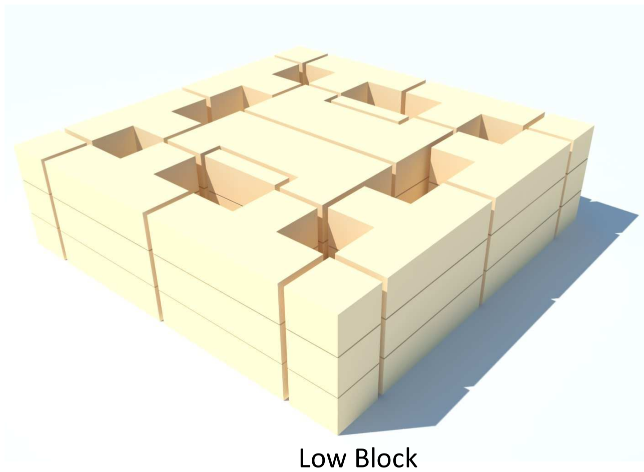
Articulated Tower



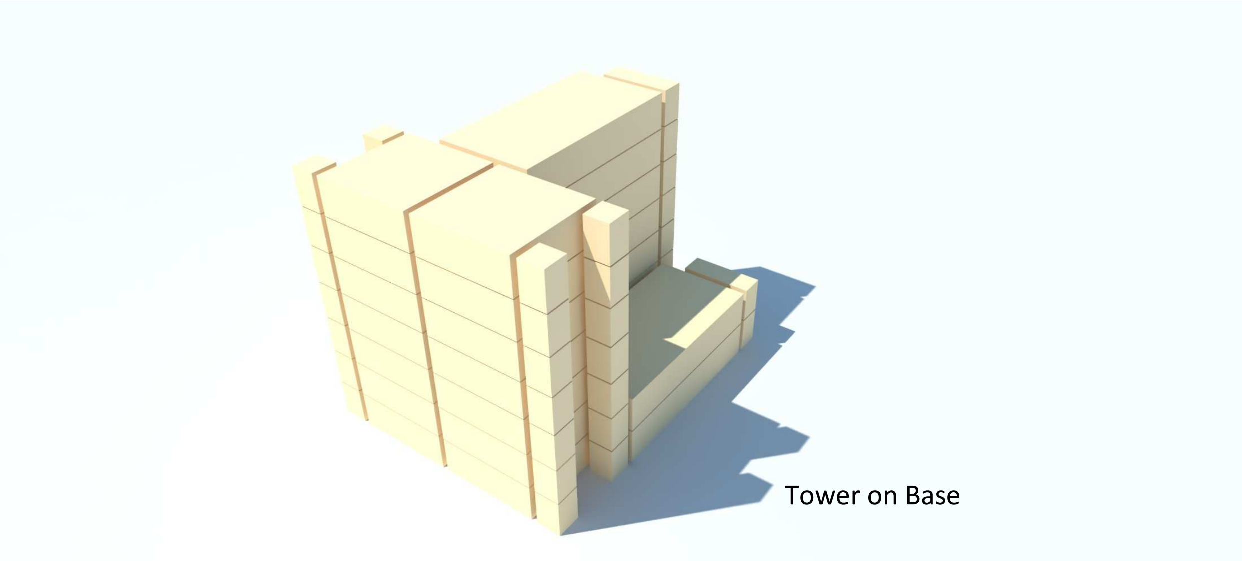
High Block



Pavillion



Low Block



Tower on Base

- **Circulation: A Critical Issue-Conceptual Clarity and Ease of Wayfinding**

'Circulation' is defined by our now familiar Merriam-Webster's collegiate dictionary as: "orderly movement through a circuit; esp: the movement of blood through the vessels of the body influenced by the pumping action of the heart."

So we have our medical analogy; though a hospital is often compared to a small city, I've never heard or read a comparison to the human body. We do, however speak of the 'pulse' of a city, and it's 'major arteries'. But we are wandering; let us get back on track.

In the above definition, 'orderly movement through a circuit', the word we should pick up and focus on is 'orderly'. It implies purpose, and purpose implies design. We are going to talk about the importance of the design of circulation in a healthcare facility.

Hospitals, like the small cities they are likened to, contain main circulation routes often described as hospital streets. The way in which the different parts of the hospital are assembled, as a coherent whole but with the parts differentiated, make for analogies with urban design; the way in which traffic moves, and the routes that are taken by mechanical and electrical services are fundamental generators of the plan.

In a vertically stacked hospital, which could also be called a functionally stratified hospital, almost always the inpatient areas are placed on the upper floors, to allow for a more pleasant, naturally lit environment. The planning grid is determined by the layout of these inpatient floors. Another important planning feature, the vertical circulation core, is also to some extent located within the building by the layout of the inpatient floors. We somewhat simplistically claimed in that earlier lecture that in vertically organized hospitals we design "from the top down." What we actually do is during the layout of the inpatient floors, we provisionally decide on a position for the vertical circulation core and other staircases that may be required, many times by the local building codes. This location, however, is to be checked for its design impact on the lower floors containing the diagnostic / therapeutic / interventional departments. This 'checking' process is described by the diagram of the spiral form of the design process presented earlier.

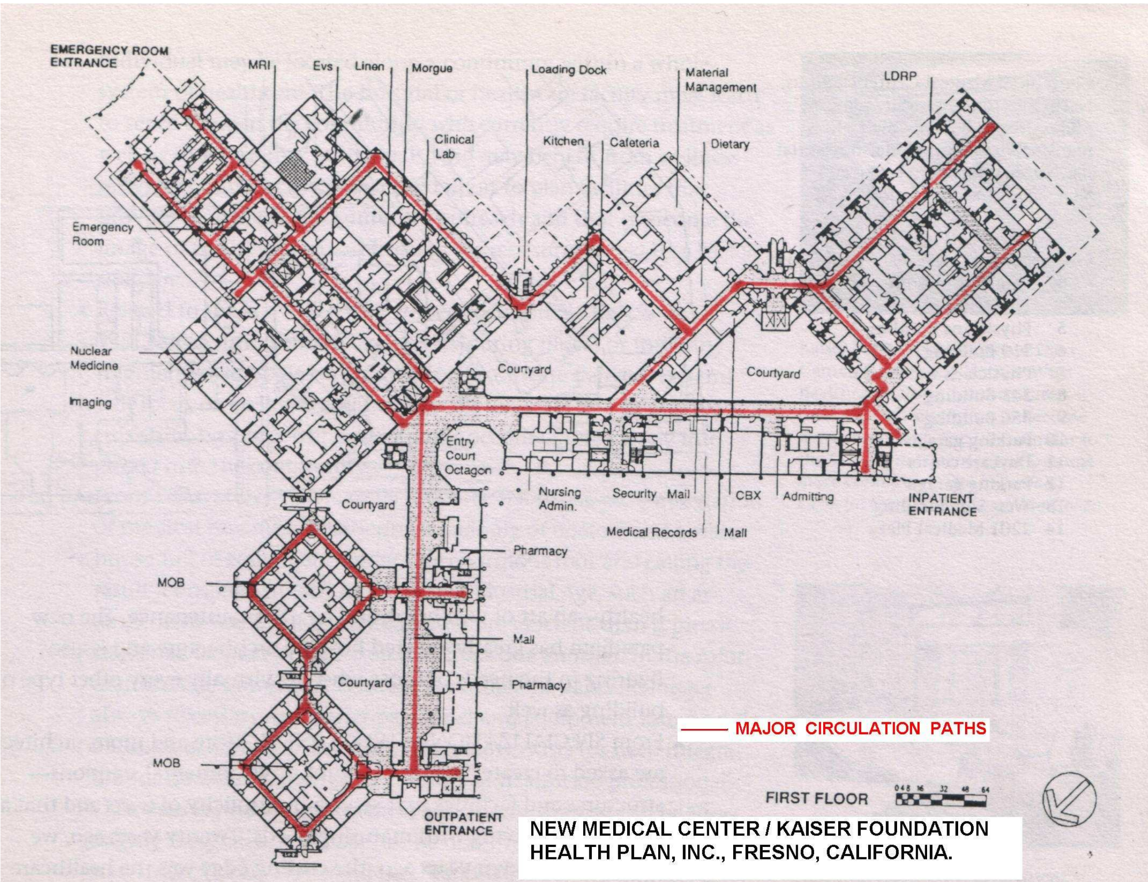
The pattern of circulation conceptualized for the hospital under design will be considerably impacted by the location(s) of the vertical circulation core(s).

It is something like all roads leading to Rome(s). The vertical circulation core is the focus of all the major circulation paths of the hospital. An attempt can be made through design to minimize vertical transportation by placing (for example) all surgical beds, operating theatres and the intensive care unit on the same floor. This design approach may be used as a justification to reduce the number of elevators, or the width of the staircases, but in no way does this mean that the core can be located more casually by the designer.

It is important that patients, visitors and staff be able to orient themselves while moving through the hospital by providing windows in corridors to enable them to look out and to allow natural light in, important in alleviating the tedium of long corridors. If the site enables them, courtyards are also an excellent means to this end.

As such there is no easily available prescription for the way the circulation pattern for a healthcare facility should be. The qualities it should possess, however, I will try to enumerate:

- It should have conceptual clarity. By this I mean it should be designed with purpose, and should not be leftover space or squeezed into the gaps between other areas. Geometry can be a recourse, but it should work with other planning imperatives, and junctions should be uniquely treated to avoid confusion over which corner of the hexagon (for example) you have reached.
- It should not be boring. Try to make walking from one place to another interesting, modulate those corridors, color them differently, and hang artwork along the way. Niches, outside views, courtyards, all these will help.
- It should enable wayfinding. In combination with well-designed signage and maybe super-graphics, people should be able to find their way to their destination with ease. Color-coding for floors or departments is sometimes used.
- They should be wide enough to handle anticipated traffic. Stretcher traffic needs 8’-0” width of corridor for easy movement (turning). 7’-0” will work, but use 8’-0” if you can. 8’-0” is an international standard for the width of hospital corridors. Corridors between Operation Theaters make sense even with 10’-0” width. There may be a lot of stuff parked along the sides, despite instructions to OT staff to the contrary.
- They should be indirectly lit. Patients on stretchers get to look at the ceilings. The sign put up by the traffic police at the end of Marine Drive in Mumbai says, “Drive carefully. Hospital ceilings are boring.” While not advocating rash driving, we would advocate making the ceilings interesting.



NEW MEDICAL CENTER / KAISER FOUNDATION HEALTH PLAN, INC., FRESNO, CALIFORNIA.

See the complexity of the circulation paths in the hospital plan given as example above.

Some of the hospitals currently existing in India have been provided with ramps in addition to the usual elevators and stairs. Power cuts are realities that have to be considered. But consider putting some (two) of the elevators on a generator, if this helps in avoiding the ramp, which is wasteful of space and difficult to use, as the gradient is often excessive. (With an acceptable gradient, the length becomes excessive, considering that the lower floors of hospitals are considerably higher than those of the usual non-hospital building.) However, ramps may be mandatory like in teaching hospitals, and required by code in many cities and towns across India.

When planning for the area occupied by this circulation space (corridors) in the architectural space plan, it can be provided for as a percentage of the department area (usable, built-up area). This percentage will vary depending on the department and may also vary if the architect has any special feature in mind for that department which is not explicitly provided for in the room-by-room area statement (such as semi-covered, landscaped waiting). The percentage can vary from 35% for an Operation Theater Suite (with 8’-0” corridors) to 20 – 25% for the Administration Department. In the Inpatient unit there may be singly loaded or doubly loaded corridors. For double loaded corridors we take 30%, for singly loaded it would be appropriately more.

On the Inpatient floors or even in the Outpatient Department, these corridors can be modulated by recessing pairs of doors that occur at regular intervals, and using an accent color in the niche so created. This helps relieve the boredom of walking through long, uninteresting corridors.

Very frequently the major circulation paths through the hospital are laid out even before the tentative space allocation for the hospital departments is done. Thus, the importance of conceptualizing these paths in a way that they contribute to the concept and functional layout of the hospital is not to be underestimated, the exercise should not be done casually.

Frequently the manner in which the healthcare architect conceptualizes the working (and therefore layout) of certain hospital departments, notably the Surgical Suite and the Radiology & Imaging Sciences Department will determine the circulation pattern through that department, and hence affect the layout of circulation paths in contiguous areas of the hospital.

Frequently you will find that in the areas below the footprint of the inpatient tower in the podium, you end up using the same corridors that you used in the inpatient floors. (At least I find myself doing this quite often. There must be a good reason for this, I hope there is! It beats me if I can think of it though. Maybe you can think of one.) (Taking the easy way out? Aaaaahh…let's keep it within the profession!)

The funda is:

Defining major circulation paths through the proposed and future buildings is a design decision that will considerably impact the form, layout and thus the eventual functioning of the healthcare facility being designed. Do it thoughtfully and with conceptual clarity.

- **Block Plans**

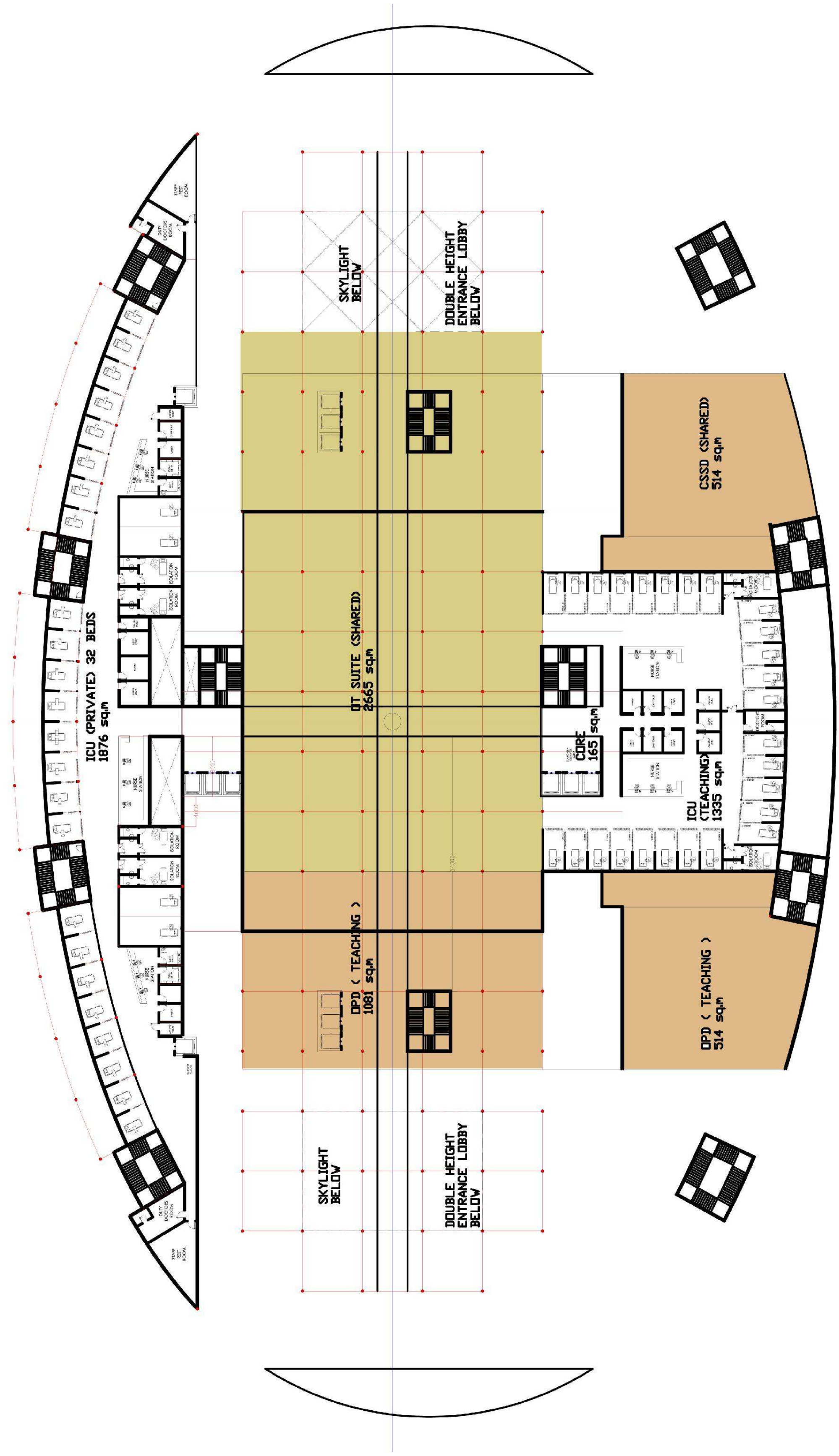
This is a book written primarily for architects and they have a good understanding of what I mean by "block plans". However, for the benefit of my healthcare professional readers I will give a brief description of what they are.

The space program that we spoke of earlier contains a list of rooms comprising a department, the area per room, the number of such rooms and the total area of that kind of room. After adding a percentage area for circulation within the department we get the total area of the department. This is the figure we use to prepare the block plan.

When we prepared the stack plan we allocated areas for each department and put them on the various floors of our tentatively conceptualized hospital. A block plan is an extension of the stack plan only this time the word plan is used in an architectural sense and we draw out a tentative template for each floor and locate within this template the major circulation routes and vertical circulation cores and other vertical elements like staircases and proposed vertical service runs. Then we mark out the area for each department on this template in different colors. This is done keeping in mind functional adjacencies for departments and the nature of the proportions of the space required for future good planning. For example, the Central Sterile Supply Department (CSSD) will work better in a space with a proportion of 1:2 and an Operating Theater Suite needs a "chunky" or "squarish" space, with a proportion of 1:1 to 1:1.5. Now this is something you will get the hang of only through experience.

The preparation of this block plan is important as it forms the content of what is usually the presentation of the first architectural plan to the client, and when you get a sign-off on this you can proceed to the next step, schematic design, or room by room planning of your hospital, which will be the subject of the next handbook in this series.

Below is an example of a block plan:



- **Concept Design**

In the preparation of the block plan I mentioned that you would need to lay out major circulation routes and vertical cores and staircases. This reads a lot easier than it is to do, how would you go about doing this in a meaningful manner? The block plan after all implies that some decision has been taken on the massing of the building.

The way I go about it is to first of all lay out the planning grid for the proposed hospital on the site. The process of establishing the planning grid has been described in detail earlier in this guide, under the heading "The Planning Grid – Creating a Framework for Design." There was another section about understanding the "scale" of the site, by this I mean understanding how big the site is in relation to a standard inpatient room or ward. So what I do is I draw the room/toilet configuration I have selected somewhere in the middle of the site and string it out for about eight rooms. If you then look at this plan with an experienced eye you can tell what kind of inpatient room/ward configuration will work on this site and after some trial and error has been done you will get a tentative configuration and number of floors for this inpatient lay out.

Don't forget that there is a 30.00 meter height restriction on the hospital. This will usually mean you cannot afford more than three or at the most four floors of inpatient facility at 3.30 (or even better 3.6) meters per floor. (You might think 3.00 meters is sufficient but there will be a lot of service runs in the corridor not to mention beams, and allowing for 3.30 or 3.6 meters height top of slab to top of slab would be prudent.)

There are many different types of inpatient unit configurations, and to describe all of them would be beyond the scope of this first volume of these Hospital Design Guides. They will be covered in detail in the second volume.

Earlier we discussed various different types of hospital built form. This will substantially influence the type of inpatient floor you choose for your particular site. While designing your inpatient floor you will also have to make decisions on the location and configuration of the vertical core (various kinds of elevators) and the staircases. You may have dedicated patient elevators for only inpatient movement (bed or stretcher elevators), visitor elevators and service elevators for movement of supplies and food service to the inpatient wards. It is a good idea to size all these elevators as bed elevators so that they can be used as such at a crunch. Also, while designing the inpatient floor you will have to locate nursing stations and nursing support facilities (clean utility, dirty utility and floor pantry). Such support services may also be shared between two nurse stations, in which case they have to be sized accordingly. The size of the floor pantry/satellite pantries will depend on the policy for food service, whether meals will be served plated or from bulk containers (bain-maries) and whether washing and storage of plates will be done at ward level or in the main kitchen. There are various pros and cons which are beyond the scope of this first guide.

The next section of your hospital you have to address are the (usually) lower diagnostic/ therapeutic/ interventional floors containing the various departments and whether there will be any basements containing any departments, building and hospital support services and parking. There is usually height available for three such floors (ground +2) and you will usually get statutory permission for a maximum of two basements. Between the inpatient ward floors and the lower diagnostic/ therapeutic/ interventional floors we usually provide a service floor with a maximum height of 2.40 meters (maybe free of FSI) which allows plumbing lines from the toilets of the inpatient floors to be gathered together and taken down in fewer, larger ducts and air-handling units (AHU's) for the

Operation Theaters (OT's) and various Intensive Care Units (ICU's) usually placed on the floor immediately below (the first or second floor, usually the second). We advocate that the OT floor be a minimum of 4.20 meters in height (preferably 4.50 meters or more) and the other lower floors at least 3.90 meters. This is necessary to ease design and construction of service runs. The greater the height you provide (maybe up to 5.1 meters), the better will be the layout of your service runs and their construction and maintenance will be easier.

Basements usually house the building support services, hospital support services and parking. If you are proposing two basements, first of all you have to decide which one will contain what. If you take parking on the first basement considerably less area and money is wasted on the ramp, as it only goes down one floor. We suggest you keep this parking floor at least 3.00 meters in height, as you will have to provide for an overhead forced exhaust system to prevent carbon monoxide build-up. With 3.60 meter height for parking spaces you could get 2-tier parking. When space is at a premium, this would be important. The basement that contains the building services mechanical and electrical equipment as well as the various kinds of underground water tanks should be at least 3.60 meters in height. If chillers that run on piped natural gas are used you will need a height of 4.50 meters for them. This is usually provided by taking the building services into the second basement and providing a cut-out in the slab of the parking basement. Keep in mind that basements cost 1.5 times more than superstructure, if you can provide parking on grade or in a parking structure it may be more cost-effective, and building services can also be provided on grade in a service structure.

Now that we have addressed the questions of the inpatient floor layout as well as a tentative configuration for the lower floors and basements, we have to address one more issue concerning the height of the hospital namely the type of structural system we will use. Our options are:

- Beam and Column
- Flat Slab
- Grid Slab
- Pre-stressed Slab

Conclusion: But Not the End

Hussain Varawalla – Healthcare Architect

In this first book an attempt has been made to explain what goes into the pre-design programming stage of a healthcare facility design and a description of how to kick-start the design process with a conceptual design. If you are reading these words I assume you found it useful to read this book, and dare to hope you found it interesting.

I hope to go on writing about further stages in healthcare facility design in the future.

If you have anything you would like to discuss after reading this book you can always reach me at hussain@heathcarearchitecture.in Constructive criticism and suggestions are more than welcome. I have always enjoyed hearing from my readers and will do my best to reply to all of you.

Bye for now and watch this space.

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