# "Inpatient unit design": An architectural Flexibility in healthcare infrastructure

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## ABSTRACT

***The pace & intensity of change are greater in hospitals than in other types of building. One of the challenges facing the architecture profession in 21st century therefore is how to design a flexible hospital to suit unpredictable needs. [1] Hospitals, like cities, are also never finished. In the best cases, architectural infrastructures retain value and maintain coherence over many decades of change the interior layouts mutate, evolve and alter in response to the dynamics of the health care field and additions are made to the original buildings. In the worst cases, architectural infrastructures fall out of favor, and are found incapable of accommodating varying cycles of change with the result that entire facilities, after several stages of functional downgrading, have to be demolished because they lack agility. [2] So every healthcare infrastructure should be flexible in terms of architectural design with respect to adaptability, convertibility, expandability with the time axis and this flexibility is only possible when the departments/ units inside the infrastructure are self sustain/ independent on itself for flexibility. Thus, this paper is based on architectural design strategies for a flexible inpatient unit in a healthcare infrastructure.***

**Keywords:** Healthcare infrastructure, Flexibility, Inpatient unit, Architectural design strategies

## 1. INTRODUCTION

Healthcare infrastructures (hospitals) are very complex & crucial. With respect to time, healthcare system experiences much advancement within its system such as advancement in services, advancement in medicine, equipments and diagnostic facilities with respect to operating rooms, ICUs, inpatients unit. These factors are highly unpredictable in nature and have been influencing the planning and designing of healthcare spaces. [4]

Flexibility, in general, can be viewed as flexibility to adapt, convert, or expand. Flexibility to adapt (or adaptability) can be defined as the ability to adapt the environment to new circumstances (such as changing workplace practices). Flexibility to convert (or convertibility) can be defined as the ability to convert the environment to new uses (such as changing to a different occupancy type). Finally, flexibility to expand (or expandability) can be defined as the ability to expand a space associated with a programmatic function. [5] So to cater the present situation needs as well as future the healthcare infrastructures need to be flexible in terms of design so that it can adapt the advancement within the system.

## 2. NEED OF THE STUDY

With evolution of time some driving forces have also evolved directing the changes in a healthcare infrastructure. They include advancement in medical science, technologies, changing care or treatment practices, evolving demographics and markets, reimbursement patterns, regulations and standards. [3] Thus this advance trends in healthcare are directing the changes and these changes are adaptable in a healthcare infrastructure if only flexibility is provided/ adapted in it. So, there is a need to study flexibility in a healthcare infrastructure to adapt the changes with time axis.

Normally we study in a macro scale (flexibility on overall hospital) but here this paper will showcase the flexibility study in a micro scale (particular space in healthcare infrastructure). Here we will be focusing on the flexibility study of an inpatient unit. Here we will study that how a inpatient unit is flexibly designed to adapt patient population at all levels of acuity, from acute care to step-down to intensive care. [5]

## 3. FLEXIBILITY & IT'S ASPECTS

### 3.1 Flexibility

"Flexibility" is a broader term with wide & multiple perspectives. When we talk about flexibility in inpatient unit in a hospital, it refers to patient view flexibility in terms of enhanced personalized care, whereas nursing staff view flexibility primarily in operational terms. Hospital administrators, managers view flexibility in terms of patient care management, staff management, resource allocation etc. Architects and engineers view flexibility in terms of functional spaces, its adjacencies to other spaces, structural grids, light & ventilation, patient comfort etc. [4]

Flexibility is not about only planning, designing, and execution of the project but also to adapt future demands without much physical changes of the spaces. Flexibility in inpatient unit must consider the expandability in terms of number of beds, services and adaptability in terms of adapting patients with different acuity level efficiently with minimum time without much renovation.

### 3.2 Aspects of flexibility

There are 3 types of aspects such as adaptability (flexibility), convertibility, expandability which can enhance the design;

#### 3.2.1 Adaptability

"Adaptability" is the ability of the health infrastructure to adapt changing needs of healthcare without making any change in the environment. It is also known as short term flexibility and should have the ability to adapt changing requirements of the hospital during its life time. [4]

For example; relocating the nurse station for easy visibility of patient to reduce risk of patient fall, accidents and to provide enhanced medical care to the patient as patient visibility is must in critical care/ intensive care units and inpatient unit.

#### 3.2.2 Convertibility

"Convertibility" is the ability of the health infrastructure to convert as per changing needs of the healthcare with moderate alteration to the existing structure in a moderate budget. [4]

For example; changing space with respect to the change in equipments due to technological advancement. This leads to change in floor space, material, finishes, loading pattern, particular type of indoor environment etc, for which existing spaces may need to convert according to the latest equipments.

#### 3.2.3 Expandability

"Expandability" is the ability of the health infrastructure to expand horizontally or vertically as per changing needs of the healthcare. Expandability is also known as long term flexibility in which major renovation work is required to be carried out. Where the hospital has been constructed in phases, the hospital infrastructure may expand horizontally as well as vertically. [4]

## 4. KEY ISSUES

So here we are talking about flexibility but why this flexibility is required? Are present spaces are incapable/ insufficient/ unjustified to the present functions, societies? If yes then what are the forces that are driving/ enhancing flexibility?

The forces that influence the need for flexibility are numerous and ever-evolving. They include advancement in medical science, technologies, changing care or treatment practices, evolving demographics and markets, reimbursement patterns, regulations and standards. [3]
These forces are impacting the healthcare infrastructure in different ways, ranging from the simple repurposing of existing spaces (as they are with minimal cosmetic renovation), to the wholesale gut renovation and/or expansion of departments, addition of service lines or the complete replacement of a given infrastructure. Changes in areas made up of repetitive cellular spaces, such as inpatient units and ambulatory care clinics, often occurs within their cellular

structure. For examples, this includes the conversion of semiprivate rooms to single-patient rooms, the addition of monitoring to convert an acute care room or unit into a step-down unit. [3]

## 5. EVOLUTION OF INPATIENT UNIT

Inpatient care since the mid 20th century has moved from multi-bedded wards, to semiprivate patient rooms to private patient rooms to deluxe patient rooms to super deluxe room. Toilets and showers in each room became the standard rather than the exception. Progressive patient care introduced intensive care units and step-down units. Birthing units evolved with LDR and LDRP rooms replacing the factory model of obstetrics that existed mid-century. Women's health anticipated a broader patient and family-centered care movement that has continued to transform the size and outfitting of inpatient rooms and other spaces throughout the hospital. Concepts of therapeutic environments have been rediscovered, widely adopted and have begun to be validated through an expanding body of research. The patient who was once a passive recipient of care is now more likely to be an engaged and educated consumer of care, with higher expectations both on the quality of care and the care experience. These forces have fundamentally transformed the design of hospitals and other settings. [3]

Changes in inpatient units typically resulted from the increasing acuity of patients and the need for acuity adaptability. The move to all-private patient rooms and providing accommodations for families were also reported as drivers for the renovation of patient rooms and inpatient units. [3]

So this kind of evolutions takes place due to increasing and changing monitoring technologies, acuity level of patient populations, accommodations for family members and changing guidelines.

## 6. STRATEGIES FOR FLEXIBLE INPATIENT UNIT

### 6.1 Structural grid

Structural grid is a systematic planning and arrangement of columns and beams to support the superstructure. It is evident that wider the column spacing, future flexibility will be more as functional spaces may be planned with minimum interruption of column in between the functional spaces. If the column spacing will be more, at one hand it is easier to plan spaces but at the other hand the structure will also be heavier, the depth of the beam will be more and the construction cost will also be more. And if the column spacing is less, the structure may be economical but at the same time future flexibility will be less as it is difficult to get bigger spaces without intermediate column. [4] Here this figure shows that how a grid can be flexible. For example, here a grid size of 7.2M X 7.2M is taken in which it can be converted into 3 functional spaces of different sizes such as 4M X 3.6M, 7.2M X 3.6M & 7.2M X 7.2M. So with proper grid flexibility can be achieved and if larger size grid is taken then it would be an advantage with initial increase in construction cost reducing the future renovation cost of a unit.

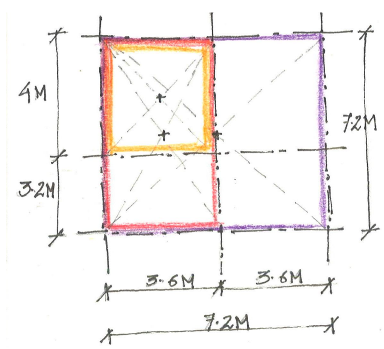


**Figure 1** Showing the flexibility in grid

### 6.2 Ceiling height.

Ceiling height is a very important criterion for future flexibility in healthcare buildings. Operating rooms, imaging rooms etc typically requires greater floor to ceiling height in comparison to other functional spaces of the hospital building. It has been observed in various healthcare buildings that typically 3.6 M floor to floor heights have been kept for all the spaces except operating rooms. This will reduce the scope of flexibility in future if another set of operating rooms are to be made at any other floor. To cope with the technological advancement in the field of medical and imaging equipments, which may require larger duct size, special provisions in the ceiling and/or floor etc for its installation and functioning, an increased floor to floor height is recommended. Considering the future flexibility option, floor to floor height of all the floors of hospital building shall not be less than 4.0 M to avoid any costly structural modification at later stage. [4]

### 6.3 Size and design MEP/IT systems for change with minimal disruption to patient care and operations

Provide accessible MEP and information technology (IT) pathways and systems with routing to avoid disruption of functional areas and other critical building services. Provide added capacity in the main plant, risers, trunk lines, electrical and IT closets to accommodate increased equipment loads and expanded demand.

### 6.4 Open building system

This system can be visualized into three basic levels; System Level 1 – base building; System Level 2 – tenant up fit or space plan; and System Level 3 – fixtures, furnishings and finishes. [7]

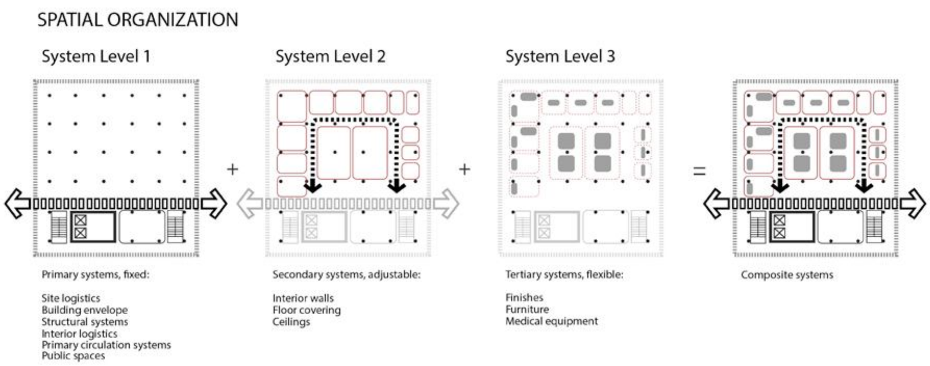


**Figure 2** Open Building Concept

### 6.5 False flooring/ Raised floor system

Access floor technology/ False floor/ Raised floor system brings the evolution of building design to the next level. Under floor air, wiring, and data cabling services combined with significant structural advantages offer incomparable first-build and long-term value and flexibility. Under floor air distribution reduces energy costs, improves indoor air quality, and enhances personnel productivity and comfort.

Raised Floor Systems (also referred to as Raised Access Floors) are Floor designs that provide an elevated structural floor above a solid substrate (often a concrete slab) to create a concealed void for the passage & accommodation of mechanical services (ducting for bldg. HVAC) and electrical services (cables & conduits).

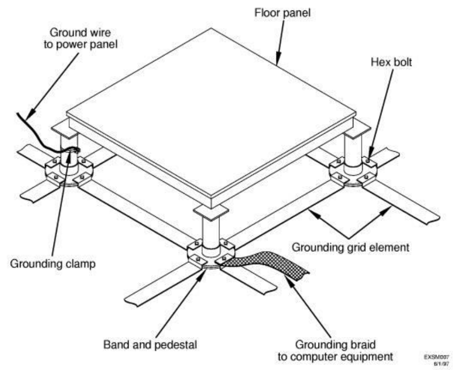


**Figure 3** Raised/ false flooring

### 6.6 Interstitial spaces

Interstitial space is walkthrough space provided between two regular consecutive floors. It is fully accessible space, created to accommodate different services of the hospital. By providing interstitial floors in the hospital especially in hospital laboratories, operating rooms, intensive care unit areas, the rearrangement of these facilities during their lifecycle is easier and hence lifecycle cost will be reduced. Interstitial space is also very helpful in maintenance of these services without disrupting the normal functioning of these critical facilities. Though the initial cost of constructing these extra floors is high, it is very useful in terms of uninterrupted functioning of the hospital and therefore considered as one of the modern concept in hospital planning. Vertical expansion of hospital is also very easy if hospital has interstitial floors, though the height of the building increases. [4]

### 6.7 Acuity adaptable

The Acuity Adaptable concept has evolved as a means of maintaining the patient in the same patient room or nursing unit from admission until discharge, regardless of the patient's level of acuity. The required level of care is brought to the patient instead of having the patient endure multiple transfers. Acuity adaptable beds minimize bottlenecks and delays in the patient flow because of the unavailability of the correct level of care. Utilizing this model of care delivery requires combining critical care staff with progressive or medical-surgical nursing staff to eliminate hand-offs and provide a more seamless comprehensive care practice. [6]

### 6.8 Universal patient room

The Universal Room concept shares similar characteristics to the Acuity Adaptable concept but operates in a traditional clinical manner with patients being transferred between units and levels of care. As the acuity and complexity of the entire inpatient population grows, hospitals that are remodeling or expanding have begun to task the design community to create patient rooms that are universal or flexible enough to accommodate the increasing patient acuity over time. Thus the Universal Room began to evolve as the concept of a flexible patient room design that could accommodate a variety of patient types and an increasingly higher acuity mix of patients over its extended life. [6]

## 7. DESIGN CHARACTERISTICS OF A FLEXIBLE INPATIENT UNIT

### 7.1 Privacy in inpatient unit

With overall large room size to accommodate the patient's critical care needs with space for equipment and procedures commonly performed at the bedside, and to provide unencumbered staff access to the patient, the room is divided into 3 types of zones—Patient Zone, Clinical Zone, and Family Zone.

A family zone includes seating, sleeping accommodations, and other amenities which further lead the family to be close to the patient. It is mostly observed that family centered/oriented rooms' helps in reducing patient falls and nurse per hour visit. It also reduces stress and improves patient health.

**7.2 Patient safety principles**

From studies it is observed that most falls occur in patient rooms particularly when the patient is alone and attempting to reach the toilet. So location of toilet matters a lot in patient room and should have direct access without any hindrance to avoid/ reduce patient fall. As we know that, visualization of the critically ill patient is very important so if placement of toilet is made outboard then there will be better visual observation of the patient from the corridors and easier entry for beds and equipment.

**7.3 Technology requirements**

An inpatient room should be always designed with a future perspective with respect to patient acuity levels so that an acute care patient room/ unit can be converted into a step down unit. There are some approaches through the headwall/ patient head panel to fulfill the technical requirements and they are as follows; [6]

**7.3.1. Fully loaded capacity**

The headwall is equipped with an intensive care level complement of medical gases, electrical outlets, and communication and data ports. In addition, a wall mounted patient monitor and other patient devices are incorporated into the headwall.

**7.3.2. Flexible capacity, "plug-N-play"**

The headwall is equipped with a moderate complement of gas outlets, but can be increased through the use of flexible hose outlets that can be installed at another time. The patient monitor may be rolled in on a computer on wheels, and other medical devices can be added to accessory tracks.

**7.3.4. Conceal and reveal**

Similar to the concept used in labor, delivery, recovery, postpartum, the headwall is designed to conceal the outlets and devices behind sliding panels or bifold doors. These are often intended to look like cabinetry or casework with attractive wood finishes presenting more of a "hospitality" look. When the patient requires advanced monitoring and intensive care services, the panels may remain open until the use of these services is discontinued.

**7.4 Decentralized nurse stations**

Decentralized nurse stations reduce nursing workload by minimizing the time spent travelling to multiple locations to gather supplies and medications. [6]

**7.5 Transfer issues and clinical outcomes**

Generally we find that patient depending on their acuity level shares rooms, such as patient with higher acuity level shares an ICU bed and other with lower acuity level shares beds in inpatient rooms or unit and this is a conventional practice. But during any emergency patient transfer into intensive area is required and this transfer create a stress on patient and enhance the level of anxiety. So if an inpatient unit is designed satisfying the needs of converting it into a step down unit during emergency then it will reduce the transfer issues leading to better patient health & clinical outcomes, patient satisfaction, staff satisfaction.

## 8. CONCLUSION

With time circulation healthcare system experiences lot of changes such as, growth in population (rise in everyday foot fall), technological advancement & globalization. This further leads to expansion of the system and only possible if planning & design is done with a perspective of future (flexible design). Flexibility is required in both macro (healthcare infrastructure) level & micro (a particular department) level. And according to this paper an inpatient unit should be designed with a scope of future needs that could be accommodated later such as; converting a unit into step down unit depending upon the emergency of the patient (acuity level of patient), or increasing number of beds. And simultaneously we need to focus on the services both clinical & non clinical that are supporting healthcare deliveries in an inpatient unit.

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