FLEXIBILITY AND ADAPTABILITY IN HOSPITAL DESIGNS (CREATING UNIVERSAL SPACES)

by

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Dedication

This material is dedicated to the Lord God, Most High; the one who was, and is, and is a king to come.

I also dedicate it to my parents whose support for me has been unparalleled.

Declaration

I hereby declare that this submission is my own work towards the M. Arch and that, to the best of my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made in the text.

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Student Name and ID	Signature	Date
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Supervisor's Name	Signature	Date
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Head of Department's Name	Signature	Date

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First of all, I am most grateful to the Lord God most high for grace, mercy, power, wisdom and might.

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God richly bless you all.

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PREFACE

Health care is learning from other sectors in which the design of environments is very important. For example, the hospitality industry has taught us that people form their impressions of quality very quickly upon arrival, often in the first few minutes. The experience of parking, entering a lobby and encountering a place that welcomes and reassures rather than intimidates and confuses is critical.

More so a space which applies itself to future changes and still works effectively is equally considered very important in today's hospital design.

KNUST proposed the construction of a 2500 bed capacity teaching hospital to complement the services of Komfo Anokye Teaching Hospital. The goal has been to come out with a design which does not repeat the errors of the past but optimizes lessons learnt from the past and incorporates new ideas into the design. This research compares the design of the gynaecology centre of the Komfo Anokye Teaching Hospital with the gynaecology centre of the proposed KNUST Teaching Hospital.

ABSTRACT

Over the years, there has been increasing demand on hospital facilities and this has called for a lot of expansion and change of use of space for most hospital buildings. Some of these changes and expansions have been found to be very expensive.

This thesis focuses on the overall adaptability of the hospital building by looking at properties that describe the physical and technical infrastructure, areas reserved, expansion possibilities and extra capacity of construction (load capacity, floor height) and technical supply. Here, we use the concept of adaptability to mean the building's capacity to handle changes; its flexibility and elasticity.

A series of case studies and review of other literature was carried out to find out in line with this study.

It has been observed that hospitals deal with changes more than any other category of buildings and this has necessitated a lot of renovations and additions to existing structures. It is difficult to add another structure to an existing structure in most hospitals today whiles renovations and change of use have been seen to be very expensive.

The essence of this thesis is to give the kind of actions which need to be taken in order to give birth to high physical adaptability and flexibility of the building structure, creating universal spaces which can easily adapt to technological, operational and diagnostic changes.

The author found out that due to this difficulty in construction coupled with the high cost of construction, several financiers have in times past and still now proposed the construction of an entirely new facility instead of renovating an old one. It is sad to say that an entirely new one is built only to realise after ten years or more that, it also needs a lot of changes due to

technological, operational and diagnostic changes.

The author also observed that the issue of adaptability and expansion is usually not high on the agenda during the design stages.

In order to arrest this problem, the author recommends that flexibility, adaptability and expansion should be given very high consideration during hospital designs.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

Medical facilities are very important to every group of people across the face of the earth. Adequate health facilities and services are regarded not only as the right of the people in a country but also as a condition for national wellbeing and security. In third world countries like Ghana, the essential need for medical facilities can not be over emphasized.

According to Neufert P and Neufert E, 1998, over the past decade, three major factors have been shaping the contemporary hospital:

- the introduction of public spaces within the hospital,
- the importance accorded to natural light,
- new medical practices.

It goes on to say that the combined effect of these three factors has introduced a horizontal and fragmented approach to hospital design, a radical departure from the most common hospital morphology of the 1970s and '80s: the tower-on-a podium concept or the "matchbox on the muffin", as it is sometimes called. The hospital is being "unbundled".

Services are grouped together in separate blocks according to their functional and clinical affinities: the diagnostic and treatment block, the ambulatory care block, the support services block. Inpatient units are no longer on top of the podium that previously housed all these

fixed backbone of mechanical, electrical and communication systems and a prime vertical and horizontal circulation network. The reason for this test design methods has been the issue of adaptability and change.

1.2 STATEMENT OF PROBLEM AND JUSTIFICATION

According to Neufert P and Neufert E, 1998, it has been established that, it takes eight to ten years for a hospital construction project to move from initial planning discussions to commissioning. This is equivalent to the time required for the development of a whole new medical technology, which puts the building at risk of being out of date when ready for use. Thus the need for adaptability and flexibility in the design of the hospital cannot be over emphasized.

With large numbers of patients being recorded in the hospitals in recent times vis a vis inadequate spaces to contain them, the issue has been how to make changes on the old structures in order to increase their capacity and still keep the facility operational even during the renovation process.

For instance, the picture in fig 1 below shows a congested ward in the gynaecology unit of the Komfo Anokye Teaching Hospital (KATH).

Fig 1: A picture showing a patient sleeping on a mattress put on the floor in one of the Gynaecology wards in KATH. (Source: Author, February 2008)

1.3 SCOPE OF STUDY

The study will include foreign and local case studies in order to know how the issue of flexible designs (adaptable/universal spaces) has been done in other parts of the world; its successes and failures and then how it can be incorporated into our local setting.

The study will look at the agents of change and how to address these during the design process.

1.4 AIMS

Through this research, the author seeks to:

- Find out the factors which really inhibit smooth change of use of a health care facility and
- Identify a blue print guideline for health care facilities that will support change of use and facilitate efficient delivery of service

1.5 OBJECTIVES

The main objectives of this work are to:

- Find out some of the successes and failures of healthcare facilities which have undergone change of use and expansion.
- Come out with principles for a hospital design which will be sufficiently flexible to allow for programmatic and technological change.
- Design of a facility employing the principle of universal rooms; that is adaptable design features and construction processes enabling:
    - adopting new and still unknown technology
    - avoid future obsolescence
    - able to accommodate a change model of care and expand capacity into future

1.6 RESEARCH QUESTIONS

In carrying out this research, these critical questions were asked by the author.

- Has the adaptability we need been defined and what growth do we need to anticipate?
- What is my own picture of what adaptable design optimally is?
- Must our planning and design standards be looked at again?
- Do the hospitals around have critical infrastructure and post disaster capability?
- Are the structures lasting enough to grow and accommodate undefined future change?

1.7 RESEARCH METHODOLOGY

The main data collection instruments that will be used for this research are case studies as well as author's personal observation and the world wide website through the internet.

The main analytical framework that will be used will be the use of a series of case studies both local and foreign to identify how their designs inhibit or aid change of use.

CHAPTER TWO

LITERATURE REVIEW

2.1 Flexibility and adaptability in hospital design

Flexibility has always been an elusive and frustrating goal in hospital design. Hospitals are heavily serviced and built to last, and yet they must constantly adapt to changing needs arising mainly from technological development and new medical practices.

Flexibility is related to the ability to change internally and to grow externally, and to replace parts that have become obsolete.

Adaptability refers to versatility, to the possibility of using the same space for multiple functions. (*www.healthcare designs/flexibility and adaptability, March 2008)*

Over the years, many solutions have been used to resolve the issue of flexibility. One of these has been fragmenting the hospital into separate blocks so that the blocks can grow at their own pace and can eventually be fully or partially replaced. But this has seen its own troubles as it eventually turns out that carrying out changes in the separate blocks is very difficult.

Vertical expansion has also been tried in the tower-on-a-podium concept, but is seldom used as it is associated with numerous problems such as vertical expansion of the podium and horizontal expansion of the tower.

According to Marberry S, 1977, the interstitial space hospital was conceived as a way to provide that ever elusive complete flexibility; an “equipotentiallity” that would allow any function to be located anywhere within the long-span structural frame by tapping into a

service backbone located within the interstitial floor. This approach found its purest expression in the McMaster Health Centre in Hamilton, designed by Zeidler Roberts Partnership Architects of Toronto (Canada). Briefly, the strategy is to separate the permanent from the temporary and to create a kind of universal framework that has an open plan.

2.2 Creating Architectural Spaces

An architectural design eventually ends with creating volumes and spaces for an activity to take place. However, the emphasis is the quality of the architectural space as it relates to the various elements that make up that space. An architectural space comprises discrete identifiable elements and spatial forms. The author has observed that a variety of interpretations can be given to an architectural space based on the elements that make up that space such as the surface finish, colour, texture, height, material etc. All these eventually go a long way to militate against or foster the use of a space and its subsequent change of use if the need arises.

In creating the healing space therefore, one has to identify the elements and patterns that comprise the basic constituents of the form and composition of the health facility in its totality. The relationship of the elements or the organization is often revealed through geometry and proportion.

Antoniades, A, 1980 also indicates that there are organizations based on plan typology. These types include symmetrical and bisymmetrical plans; linear and axial organizations; radial and centralized plans and plans that are a result of a repeated module, sometimes referred to as cluster plans. There are also grid organisations, free plans and fragmented organisations.

Humans primarily respond to their environment visually and spatially. The spatial emphasis of humans is due in part to the nature of our eyes. Our eyes are located in the front of our heads, giving us stereoscopic vision, and our eyes have separate mechanisms to gather light, identify an object, focus on it precisely and locate it in space. However, though most of our senses act in concert in experiencing our environment, the principal means through which we experience architecture is through sight and movement. The ease or difficulty of walking along the path and its surface and texture, the scale and distance of the entrance, the shifting views as we move along the route, inclines and steps, all form part of the experience of approaching and passing through architecture.

Thus, it can simply be said that if the principal means through which we enjoy architecture is by sight and movement, then a well designed facility should by proportion give a very aesthetically pleasing edifice whiles allowing for easy movement and functionality.

2.3 EMBRACING CHANGE (ADAPTIBILITY)

Design of hospitals and construction must allow for a variety of extension possibilities since hospitals are usually built in phases.

According to Neufert P and Neufert E, 1998, Hospital design does not follow architectural expressions only, but it is affected by diagnostic and therapeutic aspects. These change from time to time due to scientific advances of technology.

2.3 Standardization

Standardization has been documented as an important strategy in human factors design. It reduces reliance on short-term memory and allows those unfamiliar with a given process or design to use it safely and efficiency. Much of the work in human factors focuses on improving the human-system interface by designing better systems and processes. The standardization of the facility and room design—from the location of the outlets, to bed controls, to the cupboards in which the latex gloves are stored—all have an impact on human behavior. (*source: www.google.com/universal rooms standardisation/, May 2008*)

In the light of this, facility designs should be such that proper wiring/cabling is included in all areas where medication may be dispensed or delivered. In addition, a pneumatic tube system should be installed in all areas of the hospital where medication will be dispensed or ordered, minimizing hands off and maximizing timely delivery. Technology plans should include an integrated clinical system linking electronic medical records, decision support, bar code readers, and an automated pharmacy system to ensure accuracy in ordering and delivery, and minimize "human touches", therefore reducing errors.

2.4 Culture of safety

Reason J. (2008) defines "culture" as "shared values (what is important) and beliefs (how things work) that interact with an organization's structures and control systems to produce behavioural norms (the way we do things around here)." Reason's components of a safety culture include an informed culture (those who manage and operate the system have current knowledge about the factors that determine the safety of the system), a reporting culture

(people are prepared to report their errors and near-misses), a just culture (people are encouraged and even rewarded for providing safety-related information, but must be clear about what is acceptable and unacceptable behavior), and a learning culture (the willingness and know-how to draw the right conclusions from a safety-information system and to implement reforms). He believes that a safety culture can be engineered, not in the traditional sense of developing more sophisticated gadgeting, but through social engineering. The importance of a safety culture in creating a patient and staff safe health-care experience cannot be underestimated. If safety is important to an organization and if an organization does things with safety in mind, a safer experience will result for patients and staff. The systems of a hospital are highly influenced by its culture or are a reflection of its culture.

2.5 CASE STUDIES

A case study is a careful study of some social unit (as a corporation or division within a corporation) that attempts to determine what factors led to its success or failure. (*Source: www.google.com/case studies, April 2008*)

The following case studies are on three hospitals; two foreign ones and a local one which was carried out by the author.

The first case study does a comparative study of six hospitals in Norway and the second one is on the Intensive Care Unit of the Clarian West Hospital in Indianapolis which had to undergo change of use and expansion just two years after construction whiles the third is on the Obstetrics and Gynaecology unit of the Komfo Anokye Teaching Hospital, Ghana. The

case studies on the Intensive Care Unit of the Clarian West Hospital and the Gynaecology unit of the Komfo Anokye Teaching Hospital are discussed under the following headings:

- General design concept
- Standardization and zoning
- Future vertical and horizontal expansion

2.5.1 CASE STUDY ONE: A CASE STUDY OF SIX HOSPITALS IN NORWAY

Introduction

Valen, M. S. (2005), indicated that it was envisaged that Norwegian hospitals will face great challenges in the years to come that will influence the hospital management and facility management services. Significant periods of hospital developments in Norway have been in the 50's and the 70's with functionalism as the main building style. This way of designing buildings reflects the focus on efficiency and uniformity of how to operate the hospital.

Today's trend goes towards a greater focus on the patient as a customer of health care. This leads to a patient focused design concept that supports the patients and their needs rather than focusing on a way of organizing according to medical units (staff and discipline focused). This trend is also responsible for changes in existing hospitals.

Pilosof et al (2005) mentioned that the future remains unknown; planning for change is still, more than ever, one of the great challenges facing the hospital designer. He also mentioned that the more complex physical environment the more problematic it will become to modify.

He points out the *paradigm shift* taken place since the 70's until today: that the technological approach has been exchanged for a holistic one; like the labyrinthine corridors and the abandoned esplanade and courtyards have metamorphosed into an open, light, green atrium. One question he raises; can a hospital truly combine the technological with the human?

A study of some hospital projects (Bergsland et al, 2000, Valen et al, 2005), shows that one of the major challenges for the hospital is to adjust existing buildings to new demands and needs that mainly ends in reconstruction and sometimes extensive alteration in addition to new buildings. In order to handle changes in functionality, assignments and activities, the hospital buildings and infrastructure must be continuously updated with the hospitals tasks that are capable to adjust to the given limits of physical and technical design. Therefore, the healthcare campus, with a conglomerate of various buildings from different time periods and varying architecture will continuously be going through renewal through strategic removal of individual buildings.

The central questions were:

- How or whether existing hospitals can meet all these demands for changes?
- Do the buildings have necessary physical adaptability?
- What principles and physical solutions are profitable in order to increase the buildings ability to handle change?
- Which actions will give a positive effect on economy, efficiency and quality of the health production over time?

These questions were investigated by Valen et al by studying project reports, articles and hospital documents like a space plan, interviewing technical and management personnel of

the hospital, as well as consultants and architects involved in the planning process of the hospital.

By studying a selection of hospitals, looking at what kind of changes they have handled since completion and the causes for these changes, some solutions can hopefully be pointed out that can give a better and more efficient hospital as well as a longer functional life time. One question was how these hospital buildings were prepared for and handled the changes, technically and physically.

Key figures of the six hospitals located in the different Regional Health Authorities (RHA) are presented in Table 1.

Hospital	**No. of inhabitants**	**Bed capacity**	**No. of in-patients**	**No. of out-patients**	**Total space (BRA m2)**
St. Olav	645 700	1065	333 580	285 979	-
Rikshospitalet	895 388	585	78 000	173 000	228 263
Haukeland	948 479	~900	356 335	352 514	125 000
UNN	462 640	450	-	-	~78 000
Elverum	1 654 156	-	48 446	67 458	-
Levanger	645 700	-	130 772	96 282	63 000

Table 1. Key figures (2004) - bed capacity, operation cost, man labour year, no. of in-patients and out-patients, no. of inhabit. in their respectively health regions. (Source: Rikshospitalet Annual reports, 2004)

2.5.1.1 St Olavs Hospital - University Hospital in Trondheim (– to be finished in 2014)

The patient focused design concept was used in the planning of the new St. Olavs Hospital. It is organized by a central model, with link between the centers by communication bridges. Adaptability is highly focused in the planning process, with the intention of a robust concept to handle both organizational and physical adaptability over time. *(www.stolavs.no, May 2008)*

2.5.1.2 Rikshospitalet (RH) – A new university hospital in Oslo

The new university hospital, opened May 2000, is the hospital with the best and highest technology in Norway serving all the people of Norway. *(www.rikshospitalet.no, May 2008)*

The architectural design has focused on air and light, based on the idea of a humanistic hospital, where shape, colours and materials take care of the people and create a sense of safety and comfort. The building is low with direct visual contact with the nature outside. The hospital is built with the intention of physical adaptability and possibilities for continuous change in tasks and organisation. The "heaviest" functions regarding treatment and technical demands are located along the middle of the building structures. *(www.rikshospitalet.no, May 2008)*

2.5.1.3 University hospital of Northern Norway (UNN), Tromsø

UNN was opened in 1985, and according to the hospital director the first refurbishments started already the day after the opening ceremony. The hospital was planned as a rather traditional hospital without having much focus on adaptability issues. The building complex is adapted to the falling terrain, and consists of a central building structure with several wings on each side. The hospital site is large and has good possibilities for both extensions and

additions of buildings. *(Source: http://www.unn-tromso.no, March 2008)*

2.5.1.4 Haukeland University hospital in Bergen (HUS)

The central building (completed in 1983) is chosen as case. It is the compact and large building in Figure 3. It is characterized by a massive, large building structure in the lowest floors, with two "crosses" in the upper floors. The functions regarding treatment and technical demands are mainly located in the lower floors. *(Source: http://www.helse-bergen.no, March 2008)*

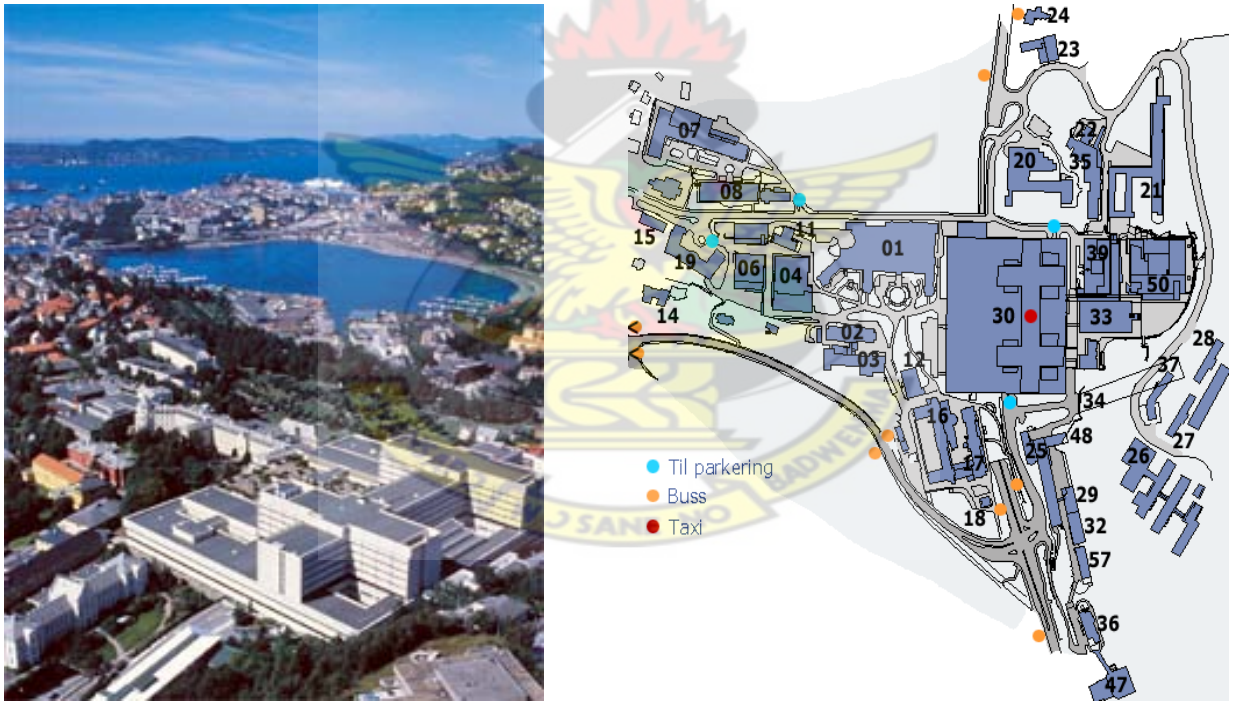

Figure 2 and 3. Haukeland University hospitals (HUS) in Bergen, (Source: http://www.helse-bergen.no, March 2008)

2.5.1.5 Sykehuset Innlandet HF – Elverum hospital, Elverum

Elverum hospital is a local hospital with buildings from different time periods, the oldest from 1925, the others from 60's, 70's and 80's. This hospital is, in that way, characteristic for many existing hospitals, with a conglomerate of buildings, built at different time periods, with various architecture and physical properties, without any specific concept or philosophy behind that ensures the totality of the structure. *(Source: http://www.sykehuset-elverum.no, March 2008)*

2.5.1.6 Levanger hospital

Levanger hospital is a local hospital with buildings built from 1916 till 2005 and in many ways similar to Elverum. Levanger also consists of a conglomerate of buildings, built at different periods with different architecture and physical properties, without any specific concept or philosophy behind the total structure. *(Source: http://www.levanger.no, March 2008)*

2.5.2 RESULTS FROM THE SIX HOSPITALS

Overall results for the six hospitals are presented and commented in this section. A summary of some results from the mapping of technical and physical properties relevant for physical adaptability per hospital building is presented in Table 2.

St. Olavs Hospital has focused on physical adaptability to meet future changes by using interstitial floors above the operation suites and image diagnostic area. Floor heights and load capacity are relatively high. The interior walls have no bearing loads or built-in technical

installations, which makes changes and refurbishments easier. The technical grid is 7.2x7.2m, which gives possibility for large open spaces, without columns. The hospital is planned with a high amount of standardized room sizes that prepares possible use for several functions. St. Olavs Hospital has also focused, especially, on clusters of bed wards with generic size and a short distance to functions and supplies (patient-focused). All centres have possibilities to expand into the neighbourhood (supports organisational flexibility). All the operational suites are connected between the centres with bridges at the second floor. A horizontal extension of the buildings is possible giving a total area reserve of 62,000 m^2 of day light area.

The *Rikshospitalet* project focused on adaptability, which is by using interstitial floors above high-tech functions, such as operation suites. The modularity gives room for relatively large open spaces. Floor heights are relatively high (3.5-4.0 m), and load capacity is high. Interior walls are not bearing load and have not built-in technical installations. The original rest capacity for technical installations is already used, and rest capacity is now limited. The hospital was planned with possibilities for horizontal expansions, and 5-6 years after the opening of the hospital the capacity of the site is fully used. It is still possible to add a floor on several parts of the building, but this will represent a break with the concept of the low building structure.

Haukeland has medium floor heights and good load capacities. However, possibilities for larger open spaces are limited, due to columns (limitations in modularity). Interior walls are not load bearing, but have to some extent built-in or crossing technical installations. There is no surplus capacity left on HVAC. It is possible with vertical extension of one floor, but

limited possibilities for horizontal expansions.

For UNN, floor heights are medium and load capacities are also good. Possibilities for larger open spaces are limited, due to columns (limitations in modularity). Interior walls are not load bearing, but have to some extent built-in or crossing technical installations. Surplus capacity of technical supplies is 30%. The rooms are not standardized. The hospital was built with possibilities for both vertical and horizontal extensions, as well as possibilities on the site for new buildings. Adaptability and the need for future changes were not given much attention during planning.

Elverum employs no interstitial floors with limited Load capacity. Floor height is low in some parts of the buildings, and relatively good in other places. There is high amount of heavy, load bearing interior walls that limits flexibility and so the possibilities for larger open spaces are limited. There are no possibilities for vertical extensions, but still some possibilities for horizontal expansion.

Levanger has no interstitial floors. The floor heights are low in some parts of the buildings, and load capacity is also limited. Just like Elverum, there is high amount of heavy, load bearing interior walls that limits flexibility and so possibilities for larger open spaces are limited.

Table 2 below gives a summary of the results above.

PERFORMANCE CRITERIA						
Hospitals	**St. Olav**	**RH**	**HUS**	**UNN**	**Elverum**	**Levanger**
Construction Year	2014	2000	1983	1985	1925/1965/ 1984	1972/1995
Area (m2 BTA)	222 971	228 263	~125 000	~78 000	10 988 3 345 16 690	12067
STRUCTURAL AND TECHNICAL FLEXIBILITY						
Interstitial floor	yes	yes	partly	partly	no	no
Floor-to-floor height	> 4 m	3,5 – 4 m	3,5 – 4 m	3,5 – 4 m	3,0 – 3,5 m 3,5 – 4 m 3,5 – 4 m	3,0 – 4 m
Floor loading capacity	4-5 kN/m2	> 5 kN/m2	4-5 kN/m2	4-5 kN/m2	<3 kN/m2	3 kN/m2
Possible open space (modularity)	Very open	Open	Less open	Less open	Less open	Less open
Corridor space	-	2,4 - 3,0 m	2,4 - 3,0 m	>3 m	2,4 - 3,0 m	-
Core space	Spacious/ Very Good	In exterior wall	Less Good	-	Spacious	-
Internal wall	Light no load	Light no load	Light* no load, some install.	Light no load, some install	Heavy, carries load	Heavy, carries load
OTHER FACTORS						
HVAC - surplus capacity	20-30 %	limited	0 % left	30 %	-	-
Horizontal addition - Site exploitation	Good 50 %	Limited	Limited	Good	Some	Some
Vertical addition - one or two floors	No addition (?)	one floor	one floor	two floors	No addition	No addition

Table 2. Structural and technical flexibility for technical and physical properties of the selected building, year of construction and area. (Source; informants and reports, Valen et al., 2005, Gulbrandsen and Andersen, 2005)

Figure 4 shows the frequency of changes per decade for each of the hospitals while Figure 5 shows the number of types of changes. The frequency has increased in the last three to four decades. It is interesting to register that the new Rikshospitalet, which was opened in 2000, already has been through 30 changes during the first 5 years it has been operating. With no surprise, most of the changes are refurbishments, relocation and changes in existing buildings.

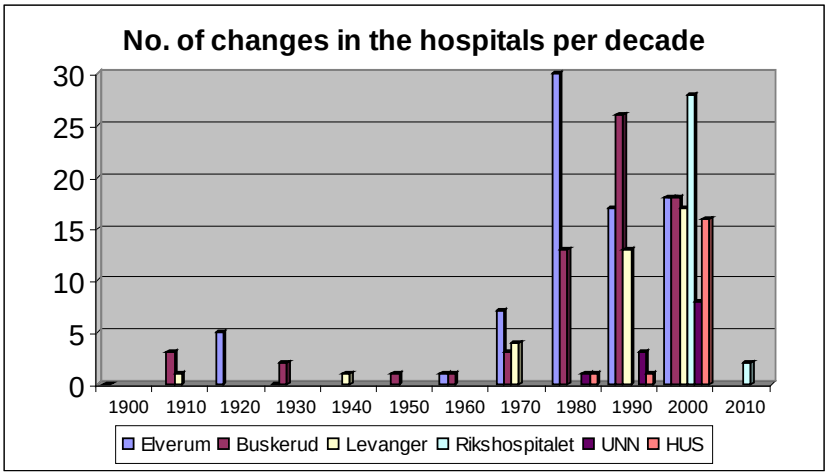

Figure 4. Frequency of changes over time per decade per hospital. (Source; informants and reports, Valen et al., 2005, Gulbrandsen and Andersen, 2005)

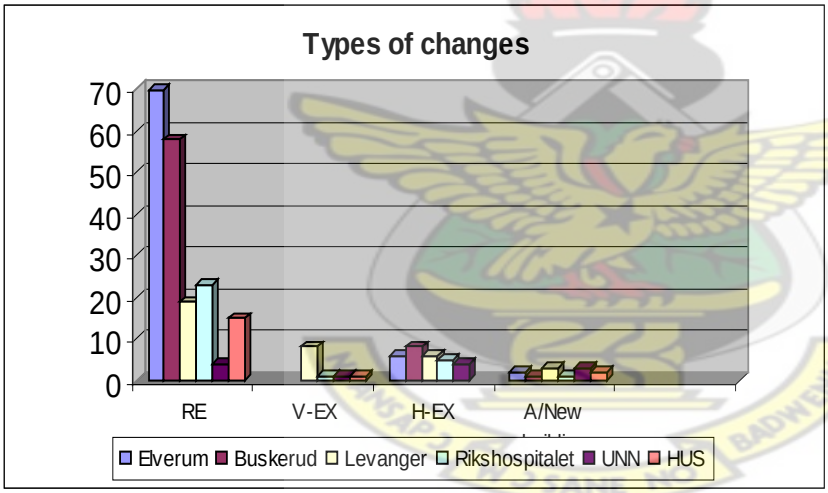

Figure 5. Number of changes per type of change per hospital, characterized as relocation and renovation of space (R), vertical and horizontal extension (V-ex and H-ex) and new buildings/addition (A). (Source; informants and reports, Valen et al., 2005, Gulbrandsen and Andersen, 2005)

Figure 6 presents the type of change versus the causes of changes per hospital. Obviously the main changes are categorized as relocation of new functions and refurbishments due to

organizational changes (O) and reasons and new demands (D).

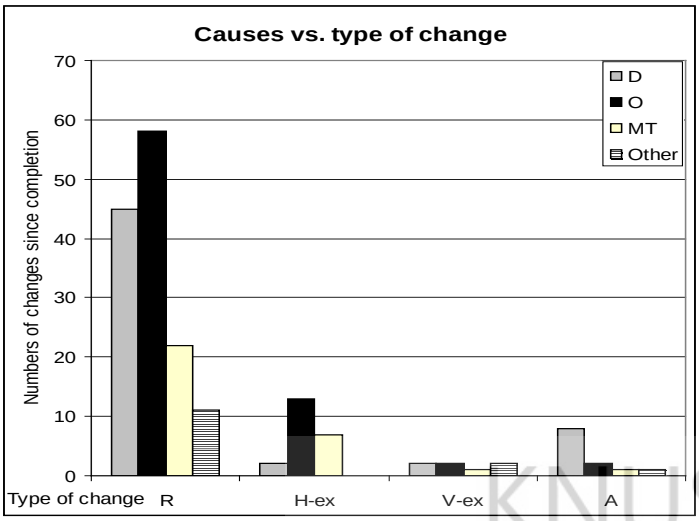

Figure 6. Total number of changes due to new demands (D), organizational changes (O), new medical technology (MT) or other reasons vs. types of changes (relocation, renovation or refurbishment (R), horizontal or vertical expansion (H-ex / V-ex) or addition (A) (Source; informants and reports, Valen et al., 2005, Gulbrandsen and Andersen, 2005)

2.5.3 HOW WELL THE CASE HOSPITALS HANDLED CHANGES?

The issue as raised in this study is how these case buildings were prepared for the changes, technically and physically, and how their ability to handle changes were due to new demands, new medical technology, organizational or development reasons. The purpose was to demonstrate what principles and solutions that have been obviously useful and profitable in the long run. Common for all the cases since completion is that the buildings have been through a huge amount of changes, mainly numerous relocations and refurbishments, but also several periods with additions and extensions. The main causes for change have been new demands, organizational changes, new medical technology and treatment methods.

The study also shows that the frequency of change has increased rapidly for the last 30 years

and for each decade. Changes are also painful and disturbing for the staff; it takes time and disturbs the production and the health service offered to the patient. In many cases production stops and reduced productivity during construction work costs even more than the refurbishment cost itself.

It was realised in the study that the concept of the University hospitals and Rikshospitalet so far has been a success considering handling changes due to area reserved for future changes. They confirm that preparing for expansions, especially horizontally but also vertically were profitable. All cases that were prepared for extensions (horizontal and vertical) have more or less been utilized. Others have not followed the design concept or a master plan, or they simply lack a holistic plan for the hospital. These hospitals have increased in space, resulting in a hospital with a conglomerate of buildings with various architecture and functionality, not to mention the challenge for the holistic logistics of the hospital. One of the cases reports problems to efficiently locate related functions within the same area because of limitations in the shape and structure of the building.

Summary

In general, flexibility of hospital buildings is a matter of:

1 The design concept and master plan allowing for changes of function or growth at adjacent area and possibility for vertical and horizontal extension.

2 Modularity that gives room for larger open spaces, sufficient load capacity to serve different functions and installations of equipment, sufficient floor height to serve several types of functions and equipment installations, more use of standardized room size and less variations in room size.

3 Flexible design that supports the possibility to make frequent changes in the interior plan, technical infrastructure and new equipment, such as flexible interior wall systems, sufficient floor heights and/or interstitial floors.

4 Surplus capacity of core space, technical installations (HVAC, wiring, ICT)

5 Enough corridors and core space

2.6.1 CASE STUDY TWO: CLARIAN WEST MEDICAL CENTRE - INDIANAPOLIS

Just two years after building their facility in Avon, Indianapolis, and the leadership of Clarian West Medical Center realized the hospital's intensive care unit (ICU) could be better positioned as indicated by Gatmaitan A, (2000).

Fig 7: A picture showing the main entrance of the Clarian West Medical Centre (Source: www.clarianwest.org/views - April 2008)

Design concept

The hospital was designed with flexibility as the concept. Adaptability was a major goal in the design of Clarian West, located in a growing suburb of Indianapolis. The building's layout enables the hospital's staff and administration to respond quickly both to changes in their patient population and the advancement of new health care delivery methods.

The goal as indicated by Morgan N. T. (2000) was also to create an environment that was not only responsive to change, but would also promote healing and be efficient to use and maintain. An oversized clinical pathway on the patient floors for instance adds to the building's adaptability, as well as making it easier and safer for patients and staff to use.

Double-leaf doors hang at the entrance to each patient room and bathroom. These facilitate the movement of patients in and out of rooms, even when surrounded by medical equipment. The door configuration also allows caregivers to walk beside patients, "as opposed to awkwardly being in front of or behind them," (Gatmaitan A. 2000)

The author observes that staff lounges include garden views. They are often hidden away in the least valuable space. Lounges without windows have access to the hospital's garden café and other garden areas. In addition to the lounges, which include typical amenities such as televisions and refrigerators, the architects also included staff retreats. These areas overlooking the rose garden give staff members a chance to relax in a more peaceful environment than the lounge.

The building also includes several features for physicians, such as a walkway that leads directly from the adjacent medical office building to the hospital surgery center. This allows

physicians to move quickly between their offices and the hospital without traveling through public spaces.

However, the author observes that carpeting may not be the best option as it makes pushing of carts difficult. Maintenance of carpets is also difficult, though can easily be replaced.

Soothing colours were selected for the same reason. The colour scheme extends even to the uniforms worn by hospital staff, providing a consistent look throughout the building. Complementary colours and styles lend variety to the design while keeping it flexible. "You could really take anything in that hospital and move it from one place to another, and I think it would fit in well," McFadden D. (1999)

Fig 8: A picture of the front view of the hospital (Source: www.clarianwest.org/views - April 2008)

The spaces above, that is the ward and the operating theatre can easily be converted to a different use with minimal challenges. Consider for instance the ward space being converted

into an office space, clearly, the day lighting and the French windows used become very advantageous to the work done in a hospital space.

Clarian West was designed with universal patient rooms. Every room is spacious enough to allow for programmatic and operational change. “The sizes of the rooms and the configuration can serve varying purposes; from medical-surgical to labor and delivery to intensive care” Gatmaitan A. (2000)

Fig 9: A picture of the operating theatre of the hospital l(Source: *www.clarianwest.org/views* - April 2008)

Standardization and Zoning

With standardized rooms, when the Intensive Care Unit needed to be moved down the hall, it was a simple matter of reassigning some medical-surgical beds as ICU beds. Such possible movements were all part of the hospital’s overall master plan. For instance, the obstetrics unit

can move up and down or even between two towers without difficulty due to the flexible nature of the design. *(Source: www.clarianwest.org/new icu - April 2008)*

The patient rooms vary somewhat depending on their location in the building, but they generally measure 14 feet by 21 feet. They are sized to provide distinct, abundant space for caregivers, patients and families. According to Gatmaitan A. (2000), the organization did not find the large rooms to be an extravagance, but rather an important safety feature. "If the rooms are not crowded, they are less likely to have tripping hazards, it's easier to see where you are walking, the lighting can be more focused, and it's certainly more accommodating" to all users.

The size of the caregiver, patient and family zones enabled the builders to install incandescent lighting and separate lighting controls for each zone. This has two benefits. First, the light quality is very close to natural light, so caregivers can assess patients more accurately. Second, incandescent lights are simple to dim, enabling all users to adjust the lighting in their zones without disrupting others in the room. Floor-to-ceiling windows in the patient rooms provide natural light and afford an unobstructed view of the hospital's gardens. When patients are in bed, they're not looking at a 36-inch windowsill. Daylight can be controlled through the use of window coverings that include both light-filtering and blackout shades. *(Source: www.clarianwest.org/new icu - April 2008)*

Future Vertical and horizontal expansion

Clarian West was constructed with the tendency for change and expansion in mind. Every room is spacious enough and has the appropriate medical gas access and nursing sight lines

for all acuity levels—from medical-surgical to labour and delivery to intensive care. Carpeting in the hallways of the patient units creates a softer, glare-free walking surface that is less likely to cause falls than a hard-surface floor. Hallways are carpeted with Low-maintenance sheet vinyl floors *(Source: www.clarianwest.org - April 2008)*

While the design of the patient rooms would allow any room on the unit to be used for any type of patient, hospital administrators have chosen to cluster acuity levels together, for staffing purposes. Thus as the hospital's census changes, rooms can effortlessly swing back and forth between acuity levels as necessary.

It is important to note that all health care facilities can benefit from this type of design, particularly as the amount of medical equipment at the bedside continues to increase. He encourages even those expecting a more typical, 10-year facility growth to conduct a cost-benefit analysis of adaptable design.

Fig 10: A picture of a patient room in the hospital (Source: www.clarianwest.org/views - April 2008)

Summary

The building's flexible nature is clearly advantageous to a hospital experiencing rapid growth. The highlights of the hospital's flexible design can be summed up as follows:

1. Standardized rooms through out the facility design allows for easy change of use.
2. Extra provision for hospital service ducts in patient rooms and surplus Heat, Ventilation and Air Conditioning (HVAC) capacity and wiring is always advantageous to future change of use and new technological requirements.
3. Double leaf doors at corridors makes movement easy and can easily serve as patient corridors, general corridors or service corridors.
4. It is important to plan for vertical and horizontal expansion as well as change of use right from the master plan design stage.

2.7.1 CASE STUDY THREE: OBSTETRICS AND GYNAECOLOGY UNIT OF THE KOMFO ANOKYE TEACHING HOSPITAL (KATH) – KUMASI, GHANA

Background Information

Komfo Anokye Teaching Hospital (KATH) is located in Kumasi, the Regional Capital of Ashanti Region with a total projected population of 3,204,609 (1998).

The geographical location of the 1000-bed Komfo Anokye Teaching Hospital, the road network of the country and commercial nature of Kumasi make the hospital accessible to all the areas that share boundaries with Ashanti Region and others that are further away. As

such, referrals are received from all the northern regions (namely, Northern, Upper East and Upper West Regions), Brong Ahafo, Central, Western, Eastern and parts of the Volta Regions.

Historical Background

In the 1940s, there was a hospital located on the hill over-looking Bantama Township designated African and European Hospitals. As their names implied, the African side treated Africans while the European side treated Europeans. However, on some rare occasions, high-ranking African government officials were given treatment in the European section.

By 1952, the need to construct a new hospital to cater for the fast increasing population in Kumasi and therefore Ashanti Region arose. The European Hospital was therefore transferred to the Kwadaso Military Quarters to make way for the new project to begin. In 1954/55 the new hospital complex was completed and named the Kumasi Central Hospital. The name was later changed to the Komfo Anokye Hospital in honour and memory of the powerful and legendary fetish priest, Komfo Anokye.

The hospital became a Teaching hospital in 1975 for the training of Medical Student in collaboration with the School of Medical Sciences of the Kwame Nkrumah University of Science and Technology, Kumasi

The hospital is also accredited for postgraduate training by the West African College of Surgeons in surgery, obstetrics and gynaecology, otorhinolaryingology, ophthalmology and radiology. The hospital currently has about 1000 beds, up from the initial 500 when first built.

The hospital has the following clinical and non-clinical directorates.

Clinical Directorates

- Anaesthesia and Intensive Care Unit (ICU)
- Child Health
- Dental, Eye, Ear, Nose and Throat (DEENT)
- Diagnostics
- Medicine
- Obstetrics & Gynaecology
- Oncology
- Polyclinic
- Surgery
- Accident and Emergency department

Non-Clinical Directorates

- Domestic Services
- Security
- Supply Chain Management
- Technical Services

Fig 11: A picture showing the main entrance to the wards at KATH (Source: Author, February 2008)

Fig 12: A picture showing the wards of the hospital (Source: Author, February 2008)

2.7.2 THE OBSTETRICS AND GYNAECOLOGY UNIT

The Obstetrics & Gynaecology directorate has six wards of which three are designated as Labour wards. The three Labour wards are general, official and high risk wards. The wards in the directorate have a bed capacity of 160. The average turnover per bed is 118. The average length of stay in the ward is 4 days with a bed occupancy rate of 132%.

Design concept

Generally, the design of the hospital embraces good functionality, efficiency and a working environment in some areas where as others just appear to be a haphazard evolution of the design. The hospital was designed with long corridors which go through the patient wards as the concept. In as much as this helps medical practitioners to easily monitor patients in bed as well as all visitors in the wards, it also affects privacy as a visitor wanting to visit two wards on the same floor has to use the other ward as a thoroughfare.

The nurse station is located right in the middle of the ward for easy monitoring. This inhibits privacy especially when the nurses have to give confidential information to a relative or relatives of in patients.

Lighting was a major concern right from the design stage. Thus the hospital uses extensive glazing all through the wards. In order to avoid glare in the wards, translucent tinted fixed glass was used, some coloured to reduce the sun's ingress into the wards. This however seemed to have failed at certain areas with a typical example being the labour ward. Fig 13 below shows the glare in the labour ward.

Fig 13: A figure showing the glare at the labour ward (Source: Author, February 2008)

Fig 14: A figure showing the extensive glazing of the wards (Source: Author, February 2008)

The construction system used is the post and beam construction. The hospital also employs the use of concrete barrel roofs with ducts running all the way to the ground floor into the main drains allows for services to be hidden in the roof space.

Also, open plan of the ward allows for easy movement and re-partitioning of the wards.

The room height of 2700mm also allows for services to be hidden in the ceiling space whiles the use of PVC tiles for the floors have proven to be very long lasting. The hospital also used polished terrazzo as the floor finish for its verandas and stairs. This has also proven to be an excellent decision as over the years it has withstood pressure over the years.

Fig 15: A figure showing the polished terrazzo finish of one of the stairs (Source: Author, February 2008)

Floor-to-ceiling windows in the wards provide natural light and afford an unobstructed view by nurses from the nurses' station. Glare has been controlled by the use of fixed tinted translucent glass with clear glass in the middle only that can also be opened.

Fig 16: A picture showing a bed with the tinted and clear glazing above it (Source: Author, February 2008)

However, exposed ducts in the wards are not pleasant. The nurses say that repair works on all those ducts affect operations in the wards which are already over crowded.

Fig 17: A pipe work in the gynaecology ward (Source: Author, February 2008)

Fig 18: An exposed electrical wire in the gynaecology ward (Source: Author, February 2008)

On unsightly scene in the hospital which will be a great hindrance to future change and redesign is the running of pipe works in the wards as can be seen above.

Standardization and Zoning

Patient wards are standardised. Interior areas employ conventional rectangular spaces and these are most suitable for current usage as well as future redesign or change of use without much difficulty in furniture and machinery placements.

Zoning at the Komfo Anokye Teaching Hospital is not clearly demarcated. The road network employs the grid system at certain points and uses a peripheral loop system with connecting branch lanes at another end of the hospital layout.

By the nature of the road network, internal vehicular movement, especially from one directorate to another directorate, is quite difficult. It does not appear that there was a conscious pedestrianisation of any zone of the hospital, since even the central part which barely has any roads there still experiences a lot of vehicular movement.

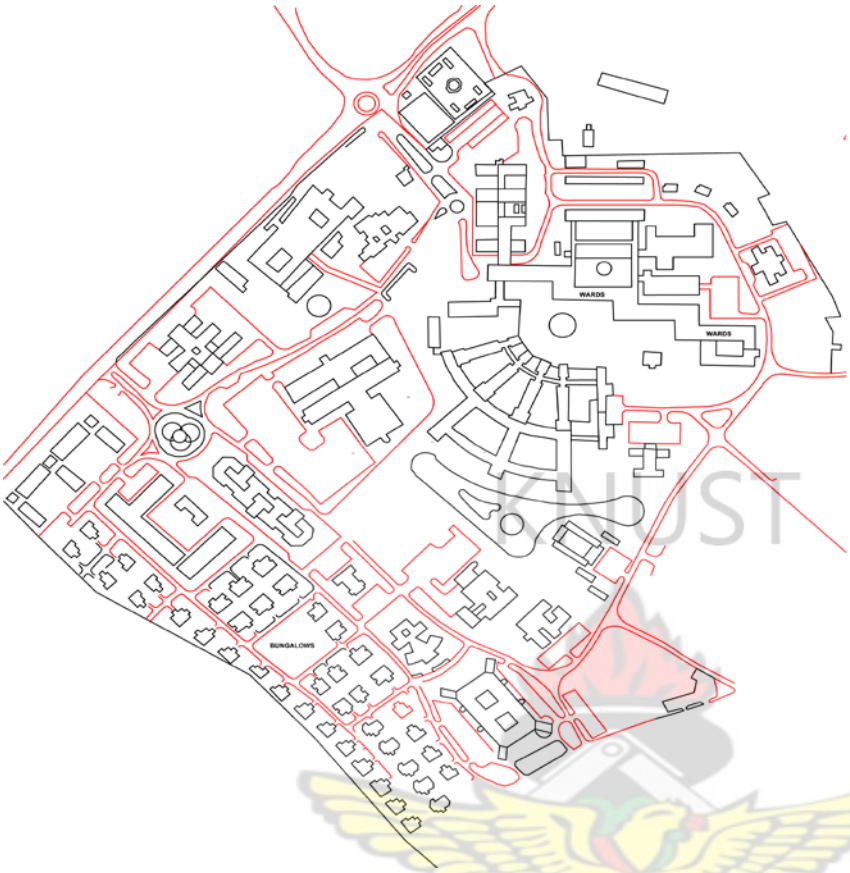

Fig 19: A figure showing the layout of the Komfo Anokye Teaching Hospital (Source: Komfo Anokye Teaching Hospital, Estate Department, February 2008)

Future Vertical and horizontal expansion

The planning of the hospital does not allow for easy cohesive vertical and horizontal expansion. The irregular road network for instance is a great hindrance to horizontal expansion and re-zoning. However, by the hospital's rectangular form, horizontal expansion may not be very difficult.

The author also observes that, surplus HVAC capacity was not made available and as such installation of additional air condition units will require breaking of some parts of the building. Also, extra duct for an additional hospital gas is not available in the unit.

Summary

A conscious effort was not made for future expansion in the design of the hospital especially within directorates. Limited and restricted spaces in between directorates and buildings with restrained movement does not only create ventilation problems but also lighting problems at certain places especially where a one storey building sits against a five storey building.

However, the hospitals open plan is very advantageous for change of use and redesign of floor spaces.

2.8 GENERAL SUMMARY

In general, from the three case studies, a building which is designed with flexibility, adaptability and expansion in mind requires a lot of detailing and sometimes the provision of extravagant spaces and services. Such a decision may be expensive at the initial stages but clearly highly advantageous in the long term.

The author also observes that there are four agents of change in hospital facilities. These are:

1. Discoveries about the rules and conditions of hygiene
2. Scientific and Medical discoveries (diagnostic and therapeutic reasons)
3. Technological discoveries in medical engineering and electromechanical services
4. Information revolution

Design of hospitals and construction must allow for a variety of extension possibilities since hospitals are usually built in phases. The design concept and master plan must allow for changes of function or growth at adjacent area and possibility for vertical and horizontal extension.

Modularity in hospital design as well as provision of larger open spaces is a necessity in

addition to sufficient load capacity to serve different functions and installations of equipment, sufficient floor height to serve several types of functions and equipment installations.

CHAPTER THREE

RESEARCH METHODOLOGY

In order to obtain substantial information for this study, both primary and secondary sources of data were collected.

3.1 PRIMARY DATA

The information used to write this thesis was acquired through the adoption of a number of tried and tested research methodologies. These research methods made the acquisition of information simple and they are explained below. The information gathered was carefully evaluated to ensure that only the one that would aid the execution of the task was collected. Literature reviews, taking of photographs, measurement of buildings, personal observations, photographic recordings, case study and the internet sites were the research methods employed.

3.1.1 OBSERVATION

Much of the information was obtained through personal observation. This offered me first hand information and also gave me the opportunity to experience the spaces. Information gathered on the place of study was scrutinized and documented and was also captured photographically. The photographs are completely devoid of any alteration what so ever.

3.1.2 INTERVIEWS

Both formal and informal interviews were carried out with various people including some medical practitioners at the Komfo Anokye Teaching Hospital, an architect and fellow students.

3.2 SECONDARY DATA

3.2.1 INTERNET

Several sites were browsed in search of more information on the subject matter. The World Wide Web of information (of the internet) was of immense benefit to the author during his research and information gathering. The information and pictures gathered in this particular sector of information source were also not altered. They were presented as obtained as much as possible.

3.2.2 PHOTOGRAPHS

Relevant photographs and drawings were taken in order to authenticate the issues raised.

3.2.3 BOOKS

Several books were used to expose me to so much information on the subject matter. These include books (as much as the author could lay his hands on) and authentic authorities on the subject of discussion

3.3 LIMITATION OF STUDY

There was difficulty in getting permission from the research and development unit of KATH in order to use their facility as a case study. Also even when the permission was given, delay in the release of data from the statistical unit of KATH also greatly affected the work.

CHAPTER FOUR

FINDINGS AND DISCUSSIONS

4.1 THE PROPOSED GYNAECOLOGY CENTRE FOR THE KNUST TEACHING HOSPITAL, KUMASI – GHANA

4.1.1 Background to The design

The essential need for purpose built and well resourced medical facilities are very important to all people. Adequate health facilities and services are regarded not only as the right of the people in a country but also as a condition for national wellbeing and security.

The author observed that in the whole of the Ashanti region, it was difficult to come by a purpose built Obstetrics and Gynaecology medical facility to address the reproductive health needs of women. The one at the Komfo Anokye Teaching Hospital (KATH) is a conversion of two of the floors of one of the five storey in-patient blocks to an obstetrics and gynaecology centre.

However, the author observes from the literature review that modern trends in health care are such that health facilities are built to address specific health issues, thus the architecture, the spatial arrangement, the colour, the forms, and so on are all designed having that target group in mind.

It is in the light of these problems and the increase in demand on KATH that the Kwame Nkrumah University of Science and Technology (KNUST) decided to build a teaching hospital to complement the services of KATH and the other satellite health facilities in the city whiles providing a place for its medical students to be trained.

Thus, KNUST has proposed a 2500 bed capacity purpose built teaching hospital to be built on their premises. As part of this proposal, there will be specialized centres to take care of special cases. One of these is an Obstetrics and Gynaecology centre.

Daily Graphic, Friday, February 1, 2

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI

REQUEST FOR PROPOSALS (RFPs)

DETAIL DESIGN OF 2,500 BEDS TEACHING HOSPITAL PROJECT AT KNUST

1. Kwame Nkrumah University of Science and Technology, Kumasi intends to apply part of its budgetary allocation to fund eligible payment for the procurement of healthcare consultancy for the

- DESIGN WORK - Phase 1:
  - Produce 1:500 site layout drawings.

- Similar jobs handled in the past 5 years.
- Recent experience in Ghana relating to major healthcare projects including design, construction and medical equipment

Fig 20: A picture showing the Daily Graphic's publication on the proposed KNUST Teaching Hospital (Source: Author's archives, February 2008)

4.1.2 Design Philosophy

The author observed that the hospital is a small city, with its own internal network of avenues, streets and back alleys. Services are organized along and between these arteries as in neighborhoods. As such an improper organisation of its internal network just as in a neighborhood creates disorderliness, congestion and difficulty in its use and also makes any expansion very difficult or haphazard.

4.1.3 Defining the adaptability we need

From the literature review, the author establishes that a hospital which has adaptability appraised right from the conception of the idea, through to the sketch design, master plan and construction stage evolves the design, construction and maintenance around these three areas.

1 Design concept

2 Standardization and zoning- modularity, generic rooms, less variation of room size

3 Future Vertical and horizontal expansion

These same areas were used in discussing the case studies on the Intensive Care Unit of the Clarian West Hospital and the Gynaecology unit of the Komfo Anokye Teaching Hospital.

4.2 DESIGN CONCEPT

The design sits right opposite the main administration block of the proposed KNUST Teaching Hospital. Entry to the facility is tapped from the main road in front of the administration block.

Fig 21: A picture showing the block plan of the proposed KNUST Teaching Hospital. (Source: Development Office of KNUST and Author's design thesis, May 2008)

Generally, the design by the author is not a sprawling development. Rather, the author took advantage of the good geology of the site to go up.

Thus the design is made up of structures carefully connected with walk ways with a geometrical form which opens up and allows for good green landscaping and good ventilation. Natural lighting was very much harnessed in the design, thus at day there will probably be no need to use much artificial lighting.

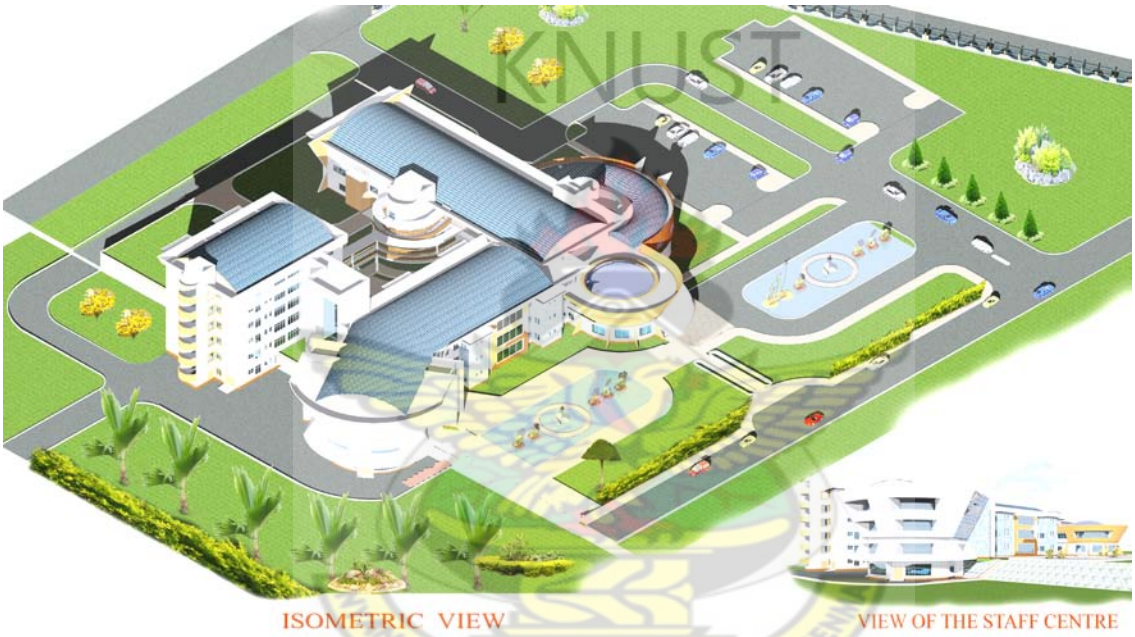

Fig 22: A picture showing an isometric view of the centre (Source: Author's design thesis, May 2008)

The facility allows for easy movement without crossing other activities taking place.

The facility with its parking space and streets cover about 40% of the site leaving a substantial amount of space around for air circulation, greenery and future development.

The open court in the middle helps to bring in light and air. Quite apart from that, the open court has a garden which will enhance views and relaxation. Seating has been provided in the open court to allow for relatives and friends who accompany patients to the hospital to relax

comfortably, whiles enjoying the greenery and other natural elements such as the fountain and the rock garden.

Due to the staggering of the plan, the facades are well shaded during the day. There is interplay of horizontal and vertical elements.

This is a truly unique physical environment with weather, views and sunlight that simply are not present elsewhere. It offers us the opportunity to bring these unique outdoor experiences inside and to make healing gardens, contemplative outdoor spaces and breathtaking views integral to what our patients, visitors, caregivers and staff will experience.

There are a good number of single-patient rooms, which have been shown not only to provide better infection control but impact a wide range of issues, from improved comfort and privacy for patients and families to reduced medical errors related to transferring patients between rooms during hospitalization.

Single-patient rooms are the new standard, and the potential for rooming in by family members is available in every room. The author's goal was to create hospital rooms that are as much like the home environment as possible. That means providing the same kind of information, communication and entertainment technology that are close to what people have in their homes. The author's design by the creation of private and general lounges allow for family-friendly, comfortable rooms that will also allow families at the hospitals to communicate with friends and relatives.

In other words, the building has been designed such that there is the ability to personalize your space and shape it to various purposes. You feel the space is really yours. The building is full of small micro-environments, each of which is different and each a creative space. Thus the building has a lot of personality.

Fig 23: A picture showing 3-dimensional impressions of the centre (Source: Author's design thesis, May 2008)

4.2.1 Access Accommodation

Pathways are made a little wider (3m wide) than usual and this adds to the building's adaptability, as well as making it easier and safer for patients and staff to use. These pathways are carpeted to allow to be replaced easily. It also allows the option of using them at another place when the need arises to make changes in those corridors or to convert them to another use. These carpets create a softer, glare-free walking surface that is less likely to cause falls than a hard-surface floor.

Double-leaf doors hang at the entrance to each patient room. These facilitate the movement of patients in and out of rooms, even when surrounded by medical equipment. The door configuration also allows caregivers to walk beside patients, “as opposed to awkwardly being in front of or behind them,”

The system of construction used is the post and beam with pre-fabricated self supporting barrel roofs. These pre-fabricated self supporting barrel roofs can easily be removed and re-located.

Noise reduction was achieved through single rooms and the use of special noise-absorbing ceiling tiles, structural systems designed to reduce vibrations, the elimination of overhead paging, and insulation between rooms.

There is also the provision of hospital gas such as oxygen and hydrogen. There is a reservoir cylinder behind the main theatre from which the pipes take their gas from before distributing to the consumption areas in the wards and the main theatre.

A third gas duct is provided so that incase of any new gas which must be distributed, that third duct can be used. Quite apart from that, this third duct is sometimes used as an overflow outlet duct.

4.2.2 Surplus Capacity

Surplus capacity on HVAC, wiring and ICT has been utilized maximally by providing extra ducts. Due to the increased room height of 3600mm, more services can be hidden within the suspended ceiling which drops 600mm. This will also allow for the introduction of service lines which might not have been anticipated as at the time of the design.

Standardized headwalls (the “plate” attached to the wall in which gases, electric, and other patient care resources are housed) in patient rooms and heightened ceilings will allow for more services—such as enhanced radiology procedures, endoscopy, or minor surgery—to be delivered in the patient room enhancing safety through flexibility and adaptability.

Fig 24: A private patient room. On top of the bed is a duct for hospital gas and other pipe work in future (Source: Author’s design thesis, May 2008)

4.3 STANDARDIZATION AND ZONING

All rooms were standardized in layout, including location of supplies, equipment, and furniture. A cabinet containing all supplies needed for patient care, are provided allowing the nurse to remain in the room with the patient, reducing fatigue and increasing time spent with the patient. Room height at the ground floor is 3750mm whiles the room height at the upper floors is 3600.

Fig 25: A picture showing a general ward with racks for holding moveable partitions (Source: Author's design thesis, May 2008)

As much as possible, crowding has been curtailed in the main wards by making provision for only seven beds to a ward with a nurses' station in the middle for easy monitoring. This concept has been repeated in all the general wards to allow for easy construction, re-design and change of use.

4.3.1 The patient room

Private patient rooms in the facility allow more space for staff to provide care and for family members who want to stay close to the patient to do so. A small charting alcove adjacent to the room allowed nurses to observe without disturbing the patient's rest, creating a better healing environment. The windows to all patient rooms are oversized, improving visibility of

patients while enhancing their view of natural surroundings. Light sources within rooms mimic natural light, yet allow for appropriate viewing of patients.

For added safety, patient rooms will be wired for the use of cameras, to assist with monitoring of high-risk patients. The cameras will connect directly to the nurses' station or another appropriate location, and will only be used with the consent of the patient. Lift infrastructures will be installed in every room so patients and staff risks during transfers are minimized.

Provision has been made for automatic lights that go on when the patient attempts to get out of bed so as to reduce the potential for patient falls. Beds lower to reduce the harm to patients falling and rubber flooring has been used in the design and this is safer than traditional hard flooring alternatives.

Bedside computers are planned to allow nurses or other staff to double-check medication or other scheduled treatment prior to administration. Patients will have access to their scheduled medication or other treatments prescribed, encouraging them to become more involved with their own care.

The patient room has capacity for expansion to accommodate new, advanced procedures and diagnostics.

The general patient rooms generally measure 10m by 7.5m for seven beds whiles the single patient rooms measure 3.9m by 3m. They are sized to provide distinct, abundant space for caregivers, patients and families. The author shares in the opinion of Gatmaitan below and that is the reason for the relatively large patient rooms.

According to Gatmaitan A, 2000, their organization did not find the large rooms to be an extravagance, but rather an important safety feature. “If the rooms are not crowded, they’re

less likely to have tripping hazards, it's easier to see where you're walking, the lighting can be more focused, and it's certainly more accommodating" to all users, he says.

Built-in decentralized nurses' stations, with computers and supply carts, stand between every two patient rooms. Windows looking into each room provide nurses with clear sight lines to all patients. The design of the patient rooms allow for easy change of use.

Fig 26: The archway in between two general wards with the nurse station in the middle for easy monitoring (Source: Author's design thesis, May 2008)

One important issue in the design is the personalization of spaces. As much as possible, spaces requiring different activities are screened so as to give that sense of enclosure.

Apart from the labour wards which have been located at the ground floor, all the other wards are located on the upper floors. The ground floor is devoted to out patient and diagnostic activities. Provision was also made for a staff centre which has rest rooms, internet café, lavatory facilities and offices. This staff centre allows for the staff to come together and share ideas.

4.4 FUTURE VERTICAL AND HORIZONTAL EXPANSION

As in the case of the six Norwegian hospitals changing plan due to refurbishment and relocation is likely to characterize this facility in the future.

However, the building's flexible layout will enable the hospital's staff and administration to respond quickly both to changes in their patient rooms and the advancement of new health care delivery methods.

Flexibility makes this design ideal for programmatic, technological and operational changes. Made to support heavy loads and of post and beam construction, it allows for increased floor levels in future.

The interior walls just like the Rikshospitalet hospital have no bearing loads or built-in technical installations, which makes changes and refurbishments easier. The technical grid of 7.5m by 10m, gives possibility for large open spaces. As against the Elverum Hospital in Norway, the load capacity was very high so as to make room for additional loads.

This hospital building when completed will have a better adaptability than other hospitals in the region. This is due to the fact that the building uses more load bearing external walls and larger spans instead of internal load bearing heavy walls, which give possibilities for more open space.

Having enough floor height makes it possible to easily change and access technical installations and gives fewer problems with suspension of medical equipment.

4.5 SUMMARY

As can be recalled from the summary of the six Norwegian hospitals, and the other case hospitals, certain principles which were employed were seen to be helpful whenever there

was the need for change of use or expansion. As such, the following were employed in the author's design.

1. The design concept and master plan allows for changes of function or growth at adjacent area and there is the possibility for vertical and horizontal extension.
2. Standardised grid gives room for larger open spaces, sufficient load capacity to serve different functions and installations of equipment, sufficient floor height to serve several types of functions and equipment installations, more use of standardized room size and less variations in room size.
3. The design is Flexible enough to support the possibility to make frequent changes in the interior plan, technical infrastructure and new equipment.
4. There is surplus capacity of core space, technical installations such as heat, ventilation and air condition (HVAC) systems as well as wiring and Information Communication Technology (ICT).
5. Provision of private rooms to provide personal privacy
6. Provision was made for improved technology, including electronic medical records (EMR), computerized physician order entry (CPOE), and advanced nurse call system (including wireless phones)
7. Close proximity between bed and bathroom to reduce the potential for patient falls
8. Ceiling heights and room size to allow for easy adaptability.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 RECOMMENDATIONS

- Our planning standards have to be looked at again
- Growth and change should be planned from the very beginning. Services most likely to grow are identified at the programming stage and future growth is planned either by allowing space on the side for expansion or internally by providing "soft space", space that is easily displaced, located next to services most likely to expand.
- Patient rooms should be truly standardized, including materials, gases and head wall designs
- Hospitals should have the capacity to easily accommodate, expand and adjust to changes in technology and work processes. It should be flexible enough to eliminate unsafe and outdated conditions with respect to ceiling height, wiring, tubing, conduiting, lighting, door and hall width, building materials, and locations to expand major services in future. This versatility is usually achieved through modularity and universality: patient rooms that can adapt to different levels of care; multipurpose exam consultation rooms and offices; modular clinics; operating rooms that can be adapted for various procedures; identical medical surgical units; and so on.
- Standardize location of equipment, supplies, room layout, and care processes should not be overlooked.
- Use an established checklist for current and future designs.
- Bring critical information for decision-making close to the patient.

- Use adaptive systems that will allow function in the future.
- Begin equipment planning on Day 1.

5.2 CONCLUSION

A good design concept which ensures good functionality, efficiency and a working environment where staff feel comfortable will also give good curing environment for the patients. However, it is also important that the building is designed for handling physical changes.

When planning new hospitals today physical adaptability of the buildings and a concept that support organisational flexibility should be in focus. However, the solutions chosen may differ from project to project.

Also some of the solutions such as standardized room sizes leads to increased area and also increased operation cost as well as construction cost. However, experience of several hospital projects show that the total construction cost corresponds to two or three years total operation cost. Failing to invest in adaptability can have dramatic negative consequences on the operation costs over time.

The importance of engaging architects, equipment planners, information systems leadership, contractors, hospital ownership representatives, executive management, and department heads also is critical to the success of a hospital design. Their support, expertise, and guidance is critical at brainstorming retreats and throughout the evolution of the planning and construction process.

APPENDIX

Architectural Drawings of the Gynaecology Centre for the Proposed KNUST Teaching Hospital

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