RICE UNIVERSITY

FOUNDATIONS OF HOSPITAL DESIGN

AN ANALYSIS OF THE EVOLUTION OF DETERMINANTS AND STRATEGIES OF HOSPITAL DESIGN

by

Henry T. Winkelman, Jr.

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Andrus Todd

Thesis Director

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ABSTRACT

FOUNDATIONS OF HOSPITAL DESIGN: an Analysis of the Evolution of Determinants and Strategies of Hospital Design

by Henry T. Winkelman, Jr.

This thesis examines the historical evolution of hospital design and attempts to identify the primary determinants which have shaped hospital design strategies. In order to facilitate a systematic study of this subject, a matrix has been constructed to organize historical information. The evolution of hospital design is structured into Five Time frames which mark distinct directions in hospital design. Within each Time Frame, the role of the hospital as an institution, the design strategies which developed for organizing space and activities within the hospital, and the technology and theory which supported design strategies are analyzed. From this historical inspection of the evolution of hospital design, conclusions are set forth as to the emerging directions in hospital design and their implications on architectural practice and as to the generalized implications of the unfolding nature of the hospital design problem on the organization of activities within the city.

A major theme in this thesis is the deep relationship of hospital design to the society in which it develops and the dynamic impact of the changing components in precipitating the restructuring of the design problem and stimulating new design strategies. It attempts to identify these mechanisms of change and to encourage a more dynamic fit of solutions to problems as they are perceived and the anticipation of directions and needs.

Design develops from needs, and the changing needs and changing approaches to meeting them marks the evolution of the hospital facility. The evolution of the hospital and its design is anchored to a fundamental precept which has formed the foundation of hospital design: the concept that the physical environment should assist in the recovery of the sick and injured. The definition of who is to be served
has expanded with the wider definition of illness and health. With the shift from the consideration of the individual as healthy until proven ill, to the concept of the individual assumed ill until proven healthy, the orientation of the hospital and design moves from the specific patient to society.

The definition of how the needs of this expanding group could best be met forms the second changing determinant of design. The orientation of design has shifted from the need to control infection which was restricted to serving the hospitalized patient to the need for the effective management of resources which can provide a wider delivery of services to society.

The hospital has shifted from a limited-use facility with its design determinants oriented to the specific nature of internal function to a mixed-use complex which generates design determinants from the broad framework of intermixed health care, educational, research, and social service systems. This reshaping of the hospital design problem has provided new opportunities for organizing activities to meet collective needs and is generating design strategies which allow the structuring of a more interdependent society.
<table>
<thead>
<tr>
<th>CONTENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRODUCTION</td>
</tr>
<tr>
<td>1-9</td>
</tr>
<tr>
<td>METHODOLOGY</td>
</tr>
<tr>
<td>SUMMARY OF TIME FRAMES</td>
</tr>
<tr>
<td>49-55</td>
</tr>
<tr>
<td>COMPONENTS OF THE HOSPITAL</td>
</tr>
<tr>
<td>56</td>
</tr>
<tr>
<td>RELATIONSHIP OF THE HOSPITAL TO THE CITY</td>
</tr>
<tr>
<td>57</td>
</tr>
<tr>
<td>FUNCTIONAL BASE</td>
</tr>
<tr>
<td>58</td>
</tr>
<tr>
<td>PROBLEM STATEMENTS</td>
</tr>
<tr>
<td>59</td>
</tr>
<tr>
<td>CONCEPTUAL STRATEGIES</td>
</tr>
<tr>
<td>60</td>
</tr>
<tr>
<td>DESIGN STRATEGIES FOR THE NURSING ENVIRONMENT</td>
</tr>
<tr>
<td>61</td>
</tr>
<tr>
<td>GOODS PROCESSING AND DISTRIBUTION</td>
</tr>
<tr>
<td>62</td>
</tr>
<tr>
<td>ORGANIZATION OF THE COMPLEX</td>
</tr>
<tr>
<td>63</td>
</tr>
<tr>
<td>TECHNOLOGICAL BASE</td>
</tr>
<tr>
<td>64</td>
</tr>
<tr>
<td>THEORETICAL BASE</td>
</tr>
<tr>
<td>65</td>
</tr>
<tr>
<td>LIMITATIONS OF DESIGN STRATEGIES</td>
</tr>
<tr>
<td>66</td>
</tr>
<tr>
<td>CONCLUSION</td>
</tr>
<tr>
<td>148-158</td>
</tr>
</tbody>
</table>
INTRODUCTION

My search has been for the foundations of hospital design, what they have been in the past, what they are presently, and what they should be; to recognize where old, and no longer applicable, foundations have been carried forward, and to attempt to define directions which will provide firm foundations for solving existing and emerging problems.

This study has developed from three intertwining bases: study of hospital function within St. Luke's and Texas Children's Hospitals and other components of the Texas Medical Center, historical research of the evolution of the hospital and the hospital facility, and concurrent work in the design of health facilities at CRS Design. Each of these activities had complemented the other, with the overriding perspective being from a design orientation—design not limited to hospital facilities but expanded to the larger problem of creating a benevolent, man-made environment.

Historical research was reinforced by studies conducted under John Duffy, professor of History of Medicine at Tulane University, who taught at Rice University during the spring, 1970. These historical studies focused on the design of hospital facilities in the eighteenth and nineteenth centuries and on the implications of the miasmic theory of disease on design. From these studies emerged an enlarged awareness of the impact of medical theories in shaping design concepts. The hospital design problem was restructured in the late eighteenth century by the general acceptance of the miasmic theory of disease as a base for new design determinants, and a new hospital design theory was forged out of the controversy these new approaches to hospital design precipitated.

The concurrent work at CRS Design was involved with the design of four health facilities; Norton–Children's Hospitals, in Louisville, Kentucky; Ross County
Medical Center, in Chillicothe, Ohio; Doctor's Hospital, in San Antonio, Texas; and Mount Sinai Medical Center, in Milwaukee, Wisconsin. These experiences provided an insight into the sociological, economic and political setting of the hospital and an introduction to the new approaches to organizing hospital services. Most significantly, these design experiences made visible the design implications of the new concepts of organizing hospital function.

The experiences at St. Luke's and Texas Children's Hospitals, Norton–Children's Hospitals, and Mount Sinai Medical Center have been most significant in reflecting the shifting structure of the health care system and the integration of research, education, and health care programs of various institutions into the common setting of the hospital. These insights stimulated investigation of design strategies responsive to the new requirements for the organization of activities within the health facility.

This thesis developed in three basic stages. The first stage consisted of studies of specific aspects of hospital function and historical research oriented to restricted subjects. These studies were constantly reworked with the gaining of new insights from the base of enlarging design experience and expanding research.

From this base of functional studies and historical research, a generalized framework was developed to allow the organization of historical information about the hospital and the design of the hospital facility. This framework was developed as a matrix, in which Time Frames were constructed along one coordinate and various aspects of the hospital or of the design of the hospital facility were constructed along the other coordinate. The development of the matrix formed the second, and most significant, stage in the development of this thesis.
This matrix allows the systematic display and analysis of information. Its organization allows an inspection of the interrelationships of various determinants within specific "Frames" of time and an inspection of specific aspects of hospital function and design as they evolved through several Time Frames. The open-ended organization of the matrix allows the growth and expansion of this study. The organization of this matrix is an attempt to illustrate the relationships of the design of the hospital facility to the technological, economic, philosophical, and political elements of the society in which it develops. These elements form specific problems and simultaneously provide design resources to deal with them. From this setting, conceptual ideas are developed to respond to the problem; and these ideas, referred to as design strategies, form the basis for the structuring of the physical environment.

The matrix attempts to illustrate the responsiveness of hospital design to its social setting, with the nature of the design problem constantly redefined by the changing role and function of the hospital and the development of design strategies constantly reshaped by the evolution of building technology and design theory. These major areas form specific determinants which are most significant in shaping the design of the hospital facility.

The matrix organization attempts to make visible the formal implications of an idea and to provide a perspective for the wholistic evaluation of design. It attempts to facilitate the identification of designs constructed on obsolete concepts, unresponsive to the shifting structure of the design problem, and limited in the use of the available technology to extend the dimension of the design solution. Specific hospitals designs can be evaluated against the background from which they developed; the problems which existed and the design resources which were
available. Each of the bases of design can be inspected independently: the accurate perception and organization of the full use of design resources, the generation of conceptual strategies valid within the framework of existing science and technology, and the direct and expressive translation of these ideas in design.

The foundations of design lie within the nature of the problem itself, and specific designs are a product of inputs from building technology, design theory and the specific problems set forth. The matrix is organized about the inspection of each as it has evolved and as it is presently emerging.

The third stage of this thesis has developed from this generalized organization of historical material. It attempts to synthesize from the historical research an understanding of the continuing process of emerging problems and to identify directions for the contemporary situation. This segment of the study has drawn deeply from perceptions gained in current design experience at CRS Design.

Forces within society are changing the role and function of the hospital. From the new nature of the hospital new design determinants are emerging which are stimulating the development of new design strategies for the creation of the hospital facilities. These design strategies suggest the restructuring of the design process and the creation of a new level of expertise oriented to designing comprehensively the micro-scale environment. These new directions in hospital design offer broad application to the design of other facilities and portend a new form of the city.

The changing nature of the hospital develops from the interaction of a broad spectrum of social forces: science, technology, economics, politics, and philosophy.
Concerns for the delivery of comprehensive and efficient health services are expanding the role of the hospital and stimulating the development of new programs and the reorganization of institutions and activities to conduct them.

New design determinants are emerging from the new role of the hospital as a health center. The industrialization of the hospital which followed World War II developed design determinants from the internal functional requirements for patient care and support services. The new role of the hospital as a health center generates new determinants upon the framework of the health care system. A basic concept of the evolving health care system is the intertwining of health care, education, research and community services.

The hospital is in transition from an independent, self-sufficient facility to a complex of mixed activities highly interdependent upon each other and upon other components of the city. The hospital facility becomes a common denominator in the integration and coordination of health related services and the new environment is structured about the requirements of these systems. Health care agencies and institutions formerly housed in separate facilities begin to be structured within the common physical environment of the hospital.

The new hospital becomes a microcosm of the city; its determinants develop from the broad needs of society and its organization of activities reflects a high level of interdependence. The new designs of the hospital will develop the physical implications for structuring a more interdependent society.

New design strategies are shaped by the framework of new determinants and by the limitations of previous design strategies. The new strategies are oriented to
the problems of the additive growth of new components of the health care system as well as the expansive growth of the traditional elements of the hospital. These strategies are directed to provisions for flexibility to allow the physical modification of the facility to changing needs.

The new design strategies separate the design problem into two components; one, the three-dimensional organization of spaces and circulation networks; and, the other, the internal development of highly specific micro environments. The solving of this latter problem is not limited to the initial design and construction, but can continue into the lifetime of the facilities.

This split of the design problem into two distinct components generates implications on architectural practice. These design strategies allow the separation of the highly complex and tightly integrated hospital design problem into several distinct design problems set within a defined and more manageable framework. This separation of the design problem into more specific design tasks suggests the restructuring of design teams for more effective and comprehensive solutions of each. The organization of new design teams about these distinctive design problems implies an extended dimension of professional services, both into the field of health care policy and the organization of health services, and into the more comprehensive design of the micro-scale environment. These new concentrations of design expertise would allow the creation of facilities more responsive to the needs of society and the individual.

In summary, two complementary forces have shaped the opportunity for the design of environments more responsive to the needs of man. Concerns for the more efficient and effective delivery of health services have generated new
relationships of institutions and activities about the hospital and allowed the organization of activities more appropriate to their collective needs. Secondly, the design strategies which have been generated to accommodate the structuring of these mixed activities facilitate the design of the micro-scale environment with greater focus on the needs of the inhabitants.

Several observations can be developed from the historical study of the evolution of the hospital and the design of the hospital facility. First, is the increasingly apparent shift of the hospital design problem from the periphery to the center of architectural practice. Second, is the potential application of the new hospital design strategies, and the new organization of design skills which they may stimulate in the design of other facilities. Third, are the implications arising from the new nature of hospitals on the structuring of activities and their environments within the city.

The expanded nature of the hospital design problem is serving to bring hospital architecture back into the mainstream of architectural practice. The hospital design problem shifted to a position on the periphery of architectural practice during the latter part of the nineteenth century under the implications of the miasmic theory. The miasmic theory explained the spread of infection by the movement of contaminated air through the hospital facility, and high rates of infection were linked to defects in design and construction. The miasmic theory established causal relationships between health and environment and generated specific design determinants for shaping the design of the hospital facility.

The design determinants which the miasmic theory identified were in sharp contrast to the fundamental orientations of the architectural profession. The highly
specific nature of these determinants, their base in the mysteries of medical science and the rituals of medical and nursing procedures, and their sacrifice of traditional aesthetic orientations served to separate the hospital design problem from the mainstream of architectural thought and practice.

The increased orientation to generalized vice specific problems shifts the hospital design problem from being monopolized by the few architects familiar with the details of hospital function to one that requires a more open design orientation.

The design strategies generated in response to the new nature of the hospital are both old and new. As concepts, they derive from city planning studies conducted in the early twentieth century which were zestfully developed in the early 1950's with the work of Team 10. These strategies are new in the sense that they are being employed in a setting in which a broad range of activities and determinants exist. The enlarged nature of the hospital with its intertwining of health care, education, research, and community service activities forms a demanding laboratory for the testing and evaluation of these strategies.

The successful application of these strategies to the hospital will influence the design of other facilities. The new role and function of the hospital requires the accommodation of most activities, and their environment, found within the city. The problem solving strategies and the skills assembled to deal with the complexity of hospital design can be applied to other areas.

The changing nature of the hospital to a mixed use activity node is reflected in the integration of activities on new scales within other institutions. The degree of change in the restructuring of health care activities is perhaps unique because
of the intense economic, political, and philosophical pressures which are focused on defining the health care system. These pressures on the health care system have interwoven traditionally separate institutions and linked profit and non-profit extensions of the system. By redefining the design problem they have extended the possibilities for the solution to better meet the collective needs of society.

Other institutions and service systems presently survive in a more loosely organized way within society, and the physical development of the city reflects the fragmented development of their facilities. The new structure of the hospital design problem, the invisible structure of interwoven service systems, provides the more comprehensive base for the physical development of the city. The metamorphosis which is reshaping the health facility is occurring in other elements of the city. The design strategies which are evolving in hospital design, and the new professional growth which they can foster, offer the potential for the development of the urban environment more appropriate for the needs of society.

The historical analysis of the hospital and its design reflects the development of these directions. The framework which has been established allows these parameters to be viewed as they have developed in time: one, the evolution of the hospital, its changing function and form; two, the changing orientation of needs and resultant design strategies; and three, the evolution of a design theory which formed the collective conscience of the hospital designer. It attempts to identify the determinants which have shaped hospital design through time.
METHODOLOGY

The search for foundations of hospital design has been approached in two directions: first, through the static analysis of specific designs and the historical study of the hospital as an institution and the cultural setting in which both the design and institution exist; and second, through the dynamic analysis of specific aspects of the hospital and the hospital facility as they have developed through time. The first approach holds time constant and examines a broad range of considerations to allow the study of their interrelationships. The second approach holds the subject constant and observes its changing nature through points in time and attempts to construct its presently emerging form.

The static analysis provides an understanding of the interrelationships between the cultural setting, the role and function of the institution, and specific aspects of the design of the hospital facility. Design can be viewed as the response to specific needs and problems structured by its milieu, and the static analysis of the hospital, its design, and its cultural setting, attempts to render these linkages visible.

The dynamic analysis of specific aspects of the hospital and its design as they have developed through time allows the perception of the nature of change, and its underlying forms, and illustrates the dynamic setting in which the design problem is structured.

This two-directional analysis is structured in a matrix in which Time Frames, for the analysis of the hospital and its design at points in time, are constructed along one coordinate and specific parameters are organized about the second coordinate. This structure allows a uniform and systematic analysis of the hospital through time and provides an open-ended framework for the growth of the study.
Two specific aspects require elaborations: the structure of the Time Frames and the definition and significance of the specific parameters considered. New parameters can be developed as they are recognized as being of significance in this study.

The parameters considered in this study are established for the analysis of the hospital as an institution, the design of the hospital facility, and the cultural setting in which they developed. The first attempts to provide a summary of the scientific, political, social, philosophical, economic and religious forces which were significant in structuring the role and function of the hospital and to describe the major design directions within each Time Frame.

The second section monitors various aspects of the role of the hospital in society and its internal function; the third section focuses on specific aspects of design, the various foundations upon which it developed, the influences in the development of design, and the feed-back implications of design on hospital function.
Inherent in this matrix organization is an abstract model representing the interaction of forces which structure design determinants, which in turn form the base for the development of design strategies which directly shape the physical environment. This abstract model structures a hierarchy of decision-making processes which develop the architectural solution as an artifact or output of a deterministic cause and effect mechanism.
The abstract design decision model moves from the construction of fundamental precepts to the generation of increasingly specific responses to the specific problem of the milieu as set within a framework of available resources. Several separate processes in the development of the design solution can be identified: the highest level, the establishment of fundamental precepts; second, the translation of these precepts into manageable problems defined by specific conditions of the milieu at each point in time; third, the generation of conceptual strategies responsive to these problems and developed within the framework of science and technology afforded by the milieu and; fourth, the generation of design strategies for the organization of spaces developed about these concepts and within specific limitations of site, program, budget, and the available building technology. Within the structure of design strategies minor variations or design tactics appear which reflect highly specific modifications of problem structure.

The highest levels of the abstract model depict the interaction of forces which structure the design problem and its priorities. These design priorities can be considered as determinants of design or as establishing needs to be fulfilled in the design solution. The forces structuring these design determinants develop from the broad cultural setting of the time period and provide a visible example of the web of relationships which tie architecture to its milieu.

The lower levels of the model describe a simplistic design methodology in the translation of needs into the organization of the physical environment. This section of the model attempts to focus on the specific steps in the generation of a design solution and to identify a framework of conditions and needs against which the design can be evaluated. The first section of the model attempts to illustrate the fit of the physical facility into the needs of the institution and its larger
cultural setting. The model attempts to depict and to organize the invisible web of relationships which establish the basis of design.

The technological, economic and political components of the milieu are the dynamic forces which constantly restructure the specific output on various levels, reshaping the problem and providing alternative solutions.

The advances of medical science, with their concomitant structuring of health care programs and the nature of medical procedures are the overriding generators of change of hospital function and design. Second, and becoming increasingly a stronger force for change, is the concern for the control of the cost of health care services. The pursuit of efficiency in hospital function is conducted against a backdrop of changing medical and nursing requirements, and is modified by an expanding technological base of support and communications systems and by the shifting organization and distribution of labor.

Thus, the design problem is in continual adjustment, reshaped primarily by the changing medical and nursing activities which are developed in response to the changing health needs of the population, the expanding base of medical science and the changing interests of physicians and surgeons. These changes are accelerated as the hospital becomes caught in the vicious pursuit of efficiency. The evolution of new technology precipitates the restructuring of procedures for the most effective and efficient performance of an expanding range of services.

The abstract model of the hospital design problem is intended to provide a general understanding of interaction of forces which structure and support specific designs while the matrix attempts to enhance a systematic identification and analysis of the problems which have formed the foundations of hospital design through time.
Six major Time Frames have been constructed to provide a framework for a comprehensive analysis of hospital designs at points in time. The structure of the Time Frames allows the examination of the hospital, its function and the forces which shaped it, and an analysis of the design strategies employed in the design of the hospital facility and the theoretical and technological base from which they developed. This structure enhances the identification of interrelationships which exist between design strategies, the nature of the specific problem and the broad cultural setting in which they exist. The scope of study is expanded from an examination of hospital designs in isolation to include the broad cultural setting in which they were generated.

Each major Time Frame defines a period in which the structure of the hospital design problem is rather consistent, and the design strategies employed in response to these problems are related. Science, technology, urbanization and social change are the primary forces which define the role of the hospital and form the nature of the design problem within each period; these forces are the mechanisms of change in the constant restructuring of the design problem.

Time Frame 6 is constructed about the gradual coherence of design concepts about concerns for environmental hygiene and sanitation and for the creation of a healthful environment for the recovery of the sick.

More significantly, Time Frame 6 marks the articulation of precepts of hospital design which established an ethical decision-making value base and formed the foundation of hospital design theory. The articulation and expression of these ideas accelerated in the eighteenth and nineteenth centuries with the emergence of modern science and the sweeps of social reform. The publication of Notes on Hospitals, by
Florence Nightingale in 1860, reflected the full cohenence and general acceptance of the new concepts of hospital design and marks the closing of Time Frame 6.

Time Frame 5 focuses on the evolution of design strategies oriented to control of infection and derived from implications of the miasmic theory of disease. These strategies were oriented to the separation of patients into small groups and to the effective ventilation of the hospital environment. Collectively, these strategies formed the pavilion system of hospital design. The explosive development of building technology in this period provided new design alternatives and the rapid advances in medical science reshaped medical practice and hospital function. The construction of Herbert Military Hospital at Woolwich in 1863, which incorporated ideas expressed by Florence Nightingale's Notes on Hospitals, marks the beginning of Time Frame 5 and the completion of Royal Victoria Hospital in Belfast in 1903 marks the closing. The design of Royal Victoria Hospital reflects the turning of design strategies from infection control to a new hierarchy of design determinants developed about patient comfort and economy of construction and operation. Time Frame 5 is not so much a period of major evolution of design determinants as it is of the constant development and testing of design tactics: the probing and experimental use of the new systems of mechanical ventilation which the strong advances in building technology made available, and the architectural manipulation of the components of the hospital within the framework of pseudo-scientific concepts of infection control. Time Frame 5 depicts the application of technology to architectural design with the concomitant expansion of design freedoms and marks the emergence of a new hospital architecture which embraces and exploits building technology to extend the dimensions of problem solving.

A significant overlap occurs between Time Frames 6 and 5: the continuing evolution of the pavilion system. It is tempting to extend it from the hospital for sick seamen
at Stonehouse, to Peter Brent Bringham Hospital, in Boston, which would cover a span of 158 years; but to do so would be focusing on artifacts and not on the growth and passing of ideas. The dominant intent is to structure Time Frames about significant and unique ideas and directions. Time Frame 6 is structured about the development of hospital design theory and to a lesser extent, the generalized design strategies which formed the pavilion system of hospital design. Time Frame 5 is structured about the development of highly specific design strategies within the framework of that theory, noting the specific application of emerging ventilation technology to support new design strategies.

It is easier to note the slow demise of Time Frame 5 than to identify a strong development which marks the initiation of new directions. Royal Victoria Hospital in Belfast, is a useful indicator of the declining priority of design strategies oriented to the control of infection and illustrates the acceptance of the germ theory and the application of new building technology to allow the structuring of facilities responsive to new considerations. It employs mechanical ventilation systems to achieve a compact design with a dense concentration of patients and nursing staff to enhance the economy of operation and to provide a closer relationship of the increasingly interactive diagnostic and treatment areas. The compaction of the hospital facility forms the basic characteristic of hospital design in Time Frame 4. Compaction was achieved principally through the vertical organization of the activities of the hospital and developed upon the skyscraper technology which had emerged at the turn of the nineteenth century. The integration of hospital into the fabric of medical practice and into the physical structure of the city was an indirect outgrowth of the previous decade of sweeping scientific advances, and acted as the primary determinant of new design strategies.

Time Frame 3 is structured about the strengthening focus on hospital function which followed World War II. A series of investigations initiated by newly developed
research foundations, and projects such as Gordon Friesen's mine workers hospitals in West Virginia, reflect the industrialization of the hospital and the attempt to apply engineering principles to plan hospital function. This new orientation of planning to the dynamic operational procedures of the hospital stood in contrast to the traditional quantitative planning of space and equipment. Design strategies were developed about new concepts of hospital function and drew upon industrial technology to allow new organizations of hospital activity.

Underlying much of the early work within Time Frame 3 are concepts of functional independence and reliability, perhaps transferred from the attitudes of military planning, which generated self-sufficient Utopian health care empires. These design strategies employed new communications, goods distribution, and air conditioning systems to structure new patterns of function. Stimulating this focus on hospital function are economic and political pressures for the control of the increasing costs of hospital care.

The publication in 1965, of "Hospitals for the 70's", by John Weeks, provided a clear statement of generalized conceptual strategies oriented to the problems of growth and change, and these strategies form the theme of Time Frame 2. These design strategies have been reflected most clearly in the design of McMaster Health Sciences Center, Hamilton, Ontario, and in recent VA hospitals in San Diego and San Antonio. The orientation of design strategies to problems of growth and change suggests their application in other areas of design. Time Frame 2 marks the shift of design strategies from an orientation to specific concepts of internal function to more generalized problems of growth and flexibility. These new design directions develop from the accelerated change in patterns and techniques of health care and from the increased pressures for organizing more comprehensive and efficient services through the restructuring of the fragmented agencies and institutions of the health
care system. Health care institutions are being physically integrated into the larger physical and functional systems of the medical center, and perhaps the new organization of activities within the medical center portends a model of the future restructuring of activities of the city itself.

Time Frame 1 is tomorrow. It exists as a reminder of open-ended nature of this study and as a stimulus to further work.
INTRODUCTION
COMPONENTS of the hospital

The types and amount of spaces required to provide for the activities of the hospital have constantly changed. The term hospital facility is very imprecise in describing a specific physical assemblage of spaces which comprise the hospital facility at specific points in time, their relative proportion of the whole, and the specific internal design determinants which they generate form basic determinants of the design problem.

The evolution of medical science, the shifting interest of physicians and surgeons and the changing health needs of the population are the primary forces which shape medical and nursing procedures. These activities develop requirements for the internal planning and equipping of spaces and for its organization within the total complex and is visible in steady development of the diagnostic and treatment departments. The steady accretion of new equipment and procedures within each department reflects on a smaller scale the glacial advance of medical science, and the gradual reshaping of the hospital facility.

New technology radically shifted basic techniques for the processing and distribution of goods and generated new space needs with strong requirements for the accommodation of equipment and the development of efficient work flows.

The continuing evolution of building technology has allowed the more penetrating focus on specific functional problems. The development of environmental control systems removed the basic architectural problem of organizing spaces to provide natural light and ventilation, and the development of new communications and automated goods distribution systems has minimized the problems of time and distance in the organization of activities. The development and economical feasibility of a new generation of goods distribution systems with automated horizontal and vertical movement will stimulate new organizations of activities and further reshape the hospital facility.
The design of the nursing environment has been reshaped by the steadily increasing needs for patient privacy and comfort and by the increasingly specialized functional needs which develop from new concepts of nursing care and new staffing patterns. The intertwining of educational and research activities into the hospital setting is expanding the nature of the design problem into a new dimension of organizational complexity.

Through the historical analysis of the hospital, several basic shifts can be observed: first, the general transition of the hospital from a dominant nursing environment to a mixed-use complex including a wide range of activities to the extent that the hospital design problem contains the basic spectrum of activities found within the city; and second, the increasing complexity of the design determinants generated by each of the components.
INTRODUCTION

RELATIONSHIP of hospital to the CITY

This section examines the relationships between the hospital and the city which have influenced the physical development of each other. These relationships can be structured into two major categories, the invisible linkages of the hospital to the service systems of the city, and the visible physical relationships of the hospital to other components of the city and its setting within the physical fabric of the city. This section is oriented to identifying the role and function of the hospital as determinants of urban development as well noting the determinants of hospital design which are imposed by the physical constraints of the city.

The historical evolution of the hospital depicts the expanding role of the hospital within the invisible service system; from the single-use ghetto for the isolation of the sick and dangerous from society; to an extension of the doctor's office to support new dimensions of health care services and the established base of medical education and research, to presently becoming the primary base for the delivery of health care services and intertwining new levels of educational and research programs. This shifting role of the hospital has generated new support components and developed new physical relationships between them. The changing role of the hospital within the service systems of the city has shifted the location of the hospital within the physical structure of the city. The integration of the hospital and the urban setting has stressed the ability of the hospital to acquire land and has shaped new determinants of hospital design. The expanded role of the hospital has generated new patterns of development about it which is reflected physically in the evolution of the medical center, and on this scale the hospital can be viewed as a primary force in the evolution of city form and land use.

The use of the hospital facility has shifted from the support of a narrow range of health services to the integration of a broad range of programs which extend from
various service systems of the city and from the public, private, non-profit, and private-for-profit sectors. This metamorphosis of the hospital from a single-use to a mixed use activity node within the city has transformed the hospital design problem from one which focuses primarily on internal function to an urban design problem which requires the close coordination with other institutions and agencies and the planning of a physical framework which allows the integration of programs and the development of shared services. The transformation of the hospital design problem suggests a new model of change which is reshaping other institutions, a shift which is distinguished by the intertwining of programs and the development of multiple-use facilities.
The design of the hospital facility has constantly changed with the shifting nature and scope of the health services programs conducted within the hospital. These programs have their base in medical science and in the socio-political setting in which the hospital exists in time. The specific programs conducted form a basic determinant of the design of the hospital facility.

The evolution of the functional base of the hospital is distinguished by the constantly expanding scope of services, a broadening orientation to more diverse spectrum of society, and a shift from an introverted and self-sufficient life style to a highly interactive and interdependent linkage to other institutions. These changes are reflected in the changing of public attitudes of the hospital, from being a place of despair to being a place of hope and, recently, of expectation. The changing nature of hospital function is further evident in the changing composition of the patient and employee population of the hospital. The type of patients, according to illness, age, and socio-economic background, the type and number of medical nursing staff required to deliver health services, and the type and size of student and support groups within the hospital serve as useful monitors of the functional programs conducted within the hospital at specific points in time.

The specific health care, educational, and research programs conducted within the hospital are shaped by the health needs of the population, the level of the development of medical science, and the interests of physicians and surgeons. The economic and philosophical base which has supported the service programs of the hospital has changed with a concomitant restructuring of responsibility and control of hospital function. The shift of the economic base of the hospital from the private contributions of a philanthropic mercantile elite to patient payment for hospital services, and more recently to payment by third party institutions such as insurance companies and
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**Analysis of the Hospital**

**Role of Hospital Within Society**
- Philosophical and Economic Base
  - Primary Sharing Forces
  - Economic Base
  - Population
  - Attitudes Toward Hospital
  - Relationship to City
  - Components
  - Problem Statements

| EXPANDING SOCIAL CONSCIOUSNESS AND NEEDS OF MEDICAL EDUCATION | ADVANCES IN MEDICAL SCIENCE | SOCIAL ATTITUDES TO HOSPITAL. | INCREASED PUBLIC EXPENSE OF HOSPITAL AND MEDICAL PRACTICE. EXPANSION IN MEDICAL SCIENCE. | PHILANTHROPIC FUNDING. Began in 1930s. FADs NEW FOUNDATION. |
| SUPPORT BY PHILANTHROPIC GIFT ON FOUNDATIONS OF CHARITY | INCREASED COST OF HEALTH SERVICES AT AN INFLATIONARY ECONOMIC BASE OF VOLUNTARY CONTRIBUTIONS | CONTRIBUTIONS AUGMENTED BY PATIENT PAYMENT TEMPORED BY ADORITY. JERK RICH SUPPORTING SICK POOR. | ALTRUISM COMPANIES, BEGAN IN 1930s. SHIFTS ECONOMIC BASE TO BOARD BASED PUBLIC INSTITUTIONS. | GOVERNMENT FUNDING. BEGAN IN 1960s. SHIFTS ECONOMIC BASE TO BOARD BASED PUBLIC INSTITUTIONS. |
| CHANGING INFLUX WITH TREATMENT DRUG ABUSE ATTENTION | ACUTE ILL PATIENTS INCREASED AT HOSPITAL BASE OF MEDICAL EDUCATION. WELL TRAINED NURSES. | ACHIEVE ILL PATIENTS INCREASED AT HOSPITAL BASE OF MEDICAL EDUCATION. WELL TRAINED NURSES. | DECREASE IN INFECTIOUS DISEASES - INCREASED PREVENTIVE SERVICES. NEW PARA-MEDICAL TECHNIQUES. | INCREDIBLY VERY TIDY AND CLEAN WITH MULTIPLE INNOCULATIONS. ADORNED WITH HOSPITALS AND ALLIED HEALTH SERVICES. |
| DESPAIR | DESTRUCTION | HOPE | EXPECTATION | DEMAND |
| GHETTO - SELF-SUFFICIENT COMUNITY TO WINDING ROAD PARK | EDUCATIONAL LINKAGE TO URBAN SERVICE SYSTEM. ATTENDED TO SUPPORT FOR ALL. | LINKAGE INTO HEALTH SERVICE SYSTEMS OF RICH AND HIGH INCOMING. URBAN STRATIFIED. | LINKAGE INTO ALL CLASSES. SELF-SUFFICIENT EMPIRE. | INTER-DEPENDENT URBAN HOSPITAL INTERACTING INTEGRAL WITH SERVICE SYSTEMS. |
| NURSING ENVIRONMENT. | GROWTH OF EDUCATION AND SUPPORT ELITES. | EVOLUTION OF DIAGNOSTIC TREATMENT - NATIONAL SECURITY. | HOSPITAL PRACTICE WITH COMPLETE RANGE OF SERVICES. | INTEGRATION OF RESEARCH AND EDUCATION - EXPANDING ON SERVICES. |
| FEAST ECONOMY OF SUPERVISION TO CONTROL OF INCREASING | MINIMIZE BUILDING COSTS. | EFFICIENT AND EFFECTIVE INTERNAL OPERATIONS. | RESPONSIVENESS TO GROWTH AND CHANGE | PROBLEM STATEMENTS |
INTRODUCTION
PROBLEM STATEMENTS

The conduct of health care, educational, and research programs by the hospital generates requirements on many levels for people, equipment, spaces, and for the specific organization of the functional areas. These needs can be categorized as a listing of the specific number and size of spaces, the desired affinities or relationships of spaces or departments to one another, and qualitative statements describing the specific ends which the unit or facility should serve and specific attributes which the design should provide. This process of defining the design problem is conducted on several levels; on the level of individual units or departments and on the collective level of total hospital complex. This investigation of the dimensions of the design problem can be conducted from varying perspectives, with often differing needs and priorities perceived by the medical staff, administration, nursing, and other groups. From these various and often conflicting viewpoints, problem statements can be constructed and organized in a hierarchy of importance which define the major purposes the new structure should serve. From this description of the design problem, concepts and strategies for the design of the new facility can be developed and evaluated.

These statements of the design problem are constantly reshaped and reorganized by the changing programs and interest of the hospital. This restructuring of priorities and redefinition of the design problem provides the base for the generation of new design strategies.

The historical analysis of the construction of problem statements depicts a broadening base and widening participation in the definition of the design problem. Time Frame 6 is distinguished by the new priority for a sanitary environment as set forth by physicians, surgeons, and nurses, and the decreased relative importance of economy of construction and operation. Time Frame 4 marks the increased focus
government, has stimulated more standardized and accurate accounting and has
developed a new base of influence which significantly shapes functional programs.
This shifting economic base of the hospital is reflected in the enlarged concept of
the client whom the architect is serving. The client has expanded from the board
of trustees of the hospital to include medical and nursing staff, special groups within
the social structure of the hospital and various agencies and review groups within
the health care system. The participation of this new client in shaping the design
solution directly and indirectly is visible in the increasing number of formal and
informal approvals required in the design process.

The nature of the changes in the functional programs of the hospital can be sum¬
marized as expanding in complexity and scope; the role of the hospital and the
conception of who is to be served has shifted from the nursing of the sick poor to
the organization of comprehensive health services for all groups within society.
The scope of programs has developed from a limited range of nursing and diagnostic/
treatment services to a broad range of programs which interweave with educational
and research activities. These changes transform the hospital complex into a mixed
use facility with design determinants structured from new perspectives.

The study of the hospital reveals the extremely large number of forces which are
constantly redefining the functional programs, and indirectly modifying the design
problem and the design of the hospital itself. These forces, although far removed
from architecture, become the dynamic forces of change which hasten obsolescence
and stimulate new design directions.
on patient needs for comfort, privacy, and dignity; and Time Frames 3 and 2 reflect the new priority to public demands for more efficient and comprehensive health services.

The definition of the design problem is of utmost importance in establishing a base against which proposed solutions can be evaluated. The responsibility for this task is at the overlap of the scope of professional services of the architect and the hospital consultant and is requiring an increasingly sensitive organization of often conflicting desires.

The structure and definition of the hospital design problem is constantly expanding and providing more comprehensive design problems which in turn are allowing the resultant design solutions to be more serviceable facilities and more responsive to social needs. Architecture is limited in its ability to serve by the performance criteria which are established for it, and the hospital design problem reflects the shift from the limited needs of a few to the broader needs of society.
The first step in the problem-solving design process is the generation of conceptual strategies in response to specific problem statements. These conceptual strategies are generally oriented to the organization of activities within the complex to the centralization and decentralization, the integration and separation of activities; to enhance the efficiency and effectiveness of services. These conceptual strategies develop from the field of administrative policy and from the functional requirements of the program and services of the institution and are formed within the framework of the scientific, technological, economic, and political setting of the institution.

These concepts form the basic direction in the development of design strategies and represent the abstract solution to the generalized problems, whereas design strategies are refinements of conceptual strategies and are developed within the set of special problems of site, budget, space program, and other specific constraints.
<table>
<thead>
<tr>
<th>Date</th>
<th>Summary of Time Frame</th>
<th>Problem Statements</th>
<th>Design Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>1860-1910</td>
<td>Control of Infection through Application of Ventilation Strategies and Exploration of Science and Technology</td>
<td>From Economy of Administration to Control of Infection and Establishment of Helpful Environment</td>
<td>Various configurations of wards and organization of space to enhance natural ventilation and separation with increasing use of mechanical ventilation systems</td>
</tr>
<tr>
<td>1910-1945</td>
<td>Extension into Third Dimension</td>
<td>Minimization of Building Costs - Initial Construction, Operation and Maintenance</td>
<td>Vertical organization using high-rise technology - Modification of Nursing Environment for Greater Privacy</td>
</tr>
<tr>
<td>1945-1965</td>
<td>INDUSTRIALIZATION OF THE HOSPITAL</td>
<td>EFFICIENT AND EFFECTIVE OPERATION AND ORGANIZATION OF SERVICES</td>
<td>CENTRALIZATION OF LIKE ACTIVITIES UTILIZING NEW COMMUNICATION AND AUTOMATED GOODS DISTRIBUTION SYSTEMS</td>
</tr>
<tr>
<td>1965-1972</td>
<td>DESIGN FOR GROWTH AND CHANGE</td>
<td>TIME AS DESIGN DETERMINANT</td>
<td>SEPARATION OF FIXED AND FLEXIBLE ELEMENTS IN PLAN AND SECTION</td>
</tr>
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**SUMMARY OF TIME FRAME**

**PROBLEM STATEMENTS**

**DESIGN STRATEGIES**
INTRODUCTION

NURSING ENVIRONMENT

As the nursing environment comprises a large proportion of the total hospital complex, the strategies for the design of the nursing environment are extremely significant in shaping the design of the total hospital complex. The nursing environment is shaped primarily by requirements derived from concepts of nursing staffing and by the need for the orientation of the patient environment to the exterior with windows or skylights.

The basic definition of the problems in the design of the nursing environment can be constructed abstractly and have remained almost constant since they were first comprehensively articulated by Florence Nightingale in Notes on Hospitals in 1860. Specific design determinants are constructed from conditions which exist at various points in time and are defined by the particular patient care programs which the institution conducts and the financial and technological resources which are available for supporting them.

In general, the determinants for the design of the nursing environment have developed about the concerns for the comfort, privacy, and care of the patient and for the economy of construction and operation. The concerns for control of construction costs focused in the additional floor area, plumbing, and other expenses which were required for the development of single rooms, which offered the inherent provisions for privacy and control of infection. The control of operational costs was primarily related to levels of nursing staffing required for adequate supervision and care of patients and was in conflict with the development of private rooms which increased distances between patients and created barriers to easy supervision.

The pursuit of operational economy is reflected in the evolution of the patient environment from the open ward, to the cubicle, to the semi-private room and the
private room depicts the constant search for patient privacy against the requirements for construction economy and efficient levels of nursing staffing.

Two distinct directions in the design of the nursing environment can be identified which have significantly influenced the design of the total facility. The first direction attempts to resolve the configuration of the nursing environment into a regular geometry in which other activities can be developed. The second direction is developed upon the idiosyncrasies of nursing patterns and generates distinct building configurations which are appropriate for a limited range of activities. The increasing specialization of nursing activities is developing a new complexity of design determinants and is supporting design strategies which provide a wide range of planning freedom in meeting these more specialized design needs.
<table>
<thead>
<tr>
<th>YEAR</th>
<th>DESCRIPTION</th>
<th>DETERMINANTS</th>
<th>PRIMARY DESIGN STRATEGIES</th>
<th>EXAMPLES</th>
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<tr>
<td>1750</td>
<td>Nursing of chronically ill patients by the three-day nurse</td>
<td>Separation of patients into small groups isolated from one another by fresh air for control of spread of infection, temporary division to prevent epidemic infections, organization of beds for plan of air flow within rooms, organization of wards for natural ventilation and supervision</td>
<td>Up-grade nursing unit to provide for warmth, privacy and comfort, organization of beds isolated to prevent spread of infection from wards to surgical patients, orientation of patient areas to provide for natural ventilation and breeze, study of nursing unit design for ideal climatization and maximum of rooms, increased double room against single, special units designed for new functions and observation, move toward economy to allow greater support from central services.</td>
<td>Block Hospital, Edinburgh, in 1730.</td>
</tr>
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INTRODUCTION
GOODS processing and distribution

Concepts of material handling have become increasingly significant determinants of hospital design with the increased concern for the efficient and effective operation of the hospital facility and with the increased utilization of materials within the hospital. The new concepts of goods handling have been structured upon the capabilities and design constraints inherent in the equipment which has developed for materials processing and distribution, and upon the increasingly sophisticated base of industrial management of work flow.

Concepts of materials processing and distribution were not significant in shaping hospital design until after 1900, when the vertical organization of the hospital required the restructuring of hospital function and provided the elevator, the dumbwaiter and gravity chutes to assist in organizing more efficient supply systems.

The design of the supply system about concepts of task responsibility and the capabilities of support equipment was stimulated following World War II by the heightened concerns for efficiency which had been developed by the experiences with the Depression and wartime rationing, and were supported by the new profession of work flow and efficiency experts. This period focused on the consolidation of the sub-systems within the sum total materials processing system – and is marked by the centralization of materials reprocessing and sterilization functions. Concepts of materials processing and distribution became significant shapers of design strategies and the designs reflected the organization of components about materials distribution hardware.

The first generation of automated materials distribution hardware was capable of vertical movement only and the limitations which these systems imposed reinforced
the vertical organization of the hospital facility. The integration of the separate materials processing and distribution functions of dietary, sterile supply, bulk supplies, pharmacy, into a fully coordinated and interfaced supply system generated new sets of design determinants for the organization of the components of the complex. The centralization of receiving, storage, and distribution for all materials processing activities was facilitated by the horizontal organization of these functions and the use of the second generation of materials distribution systems which allowed automated horizontal and vertical movement. These systems allowed centralized distribution and breakdown functions and the automated movement of goods to several destinations on the same level and complemented design strategies which developed large horizontal organizations of nursing and diagnostic/treatment functions.

The pursuit of efficiency in materials handling is reflected in the shifting scales on which specific activities are performed. These shifts reflect the implications of new technologies for supporting materials handling activities and the changing requirements for support services generated by hospital function. The historical analysis of materials handling concepts reflects the increasing scope and complexity of supply requirements and the shifting organization of activities to provide more comprehensive response to individual or departmental needs while maintaining or increasing efficiency. The evolution of the dietary system perhaps best reflects the constant restructuring or a system to provide more personalized service while increasing efficiency.
Several shifts can be observed historically. The first is the almost cyclic centralization, then decentralization of materials processing activities with the development of new technologies. The second is the gradual coordination of materials handling processes into a total materials management system. The third is the increasing dependence on components outside the direct control of the hospital for support and supply functions. This is visible in the development of shared facilities and in the increased reliance upon suppliers and manufacturers.
strategies for the ORGANIZATION of components

The configuration and form of the hospital complex is a product of design strategies for the organization of the basic components. These strategies are oriented to the solution of specific functional problems and are developed with a framework of restrictions which derive from the cultural setting in which the design exists and from specific limitations imposed by the site, program, and other local influences.

Design strategies have historically been oriented to the overriding needs of the institution at various points in time and have expanded from the need to separate patients for the control of infection, to the need to provide an efficient materials distribution system, to the present requirements for the organization of activities for effective and comprehensive health services.

The scientific knowledge and technology which exist at specific points in time establish the basic range of resources which can be employed in the development of design strategies. The scientific concepts of disease and infection control formed the basic framework within which design strategies were developed from the mid 1700's until the list of the nineteenth century. The development of new building technology and the emergence of new industrial skills provide the primary framework within which design strategies have evolved since 1900.

The evolution of new technology has operated on two scales to reshape hospital design strategies; the first scale can be considered as the development of architectural building technology which has expanded alternatives for the design of the physical facility and extended its serviceability; the second scale can be considered as the development of functional support technology which has allowed new organizations of activity.
The development of the skyscraper technology and the evolution of environmental control systems, such as air conditioning, have provided the basic architectural resources upon which new design strategies have been constructed. The expanding technology of communication systems and materials processing and distribution systems have provided the basic tools for restructuring the activities of the hospital.

The historical analysis of strategies for the organization of the components of the hospital identifies five basic approaches:

One, the horizontal organization of components for the control of infection.

Two, the compaction of the facility and vertical organization of components about a core of goods and people movement systems.

Three, the organization of the components into categories which require like types of space, and the stacking of these like types of space.

Four, the horizontal organization of like activities of the functional sub-systems.

Five, the search for the module of universal space which can allow a wide range of alternatives and which can facilitate the integration of dissimilar activities.

The requirements for the separation of the components of the hospital for the control of infection emerged in the mid 1700's and stimulated the horizontal organization of the hospital complex. The linkage of the components to enhance functional interaction was considered subservient to the need for separation. The strategies for separation produced formal configurations of the complex which are reappearing in recent projects, but which are now developed from strategies for growth and for linkage of the expanding number of components for the hospital.
The shift of the hospital into the urban setting in the early 1900's, and the development of the skyscraper building technology stimulated the compaction of the hospital complex and the vertical organization of activities. Design strategies emerged which attempted to exploit the control and economy of vertical movement which the elevator provided and to allow the economical construction and operation of the complex by minimizing the number of roofs, walls and foundations and developing compact building configurations.

The vertical organization of the components of the hospital imposed restrictions on the planning and growth of departments on each floor by the pattern of fixed elements of structure, shafts, and mechanical chases which threaded vertically through the facility and by the limitations of the configuration of each floor by the requirements on floors above and below, these restrictions stimulated the concept of separating the components of the hospital into categories which required like types of space, and developed the design strategy of stacking like types of spaces. This strategy allowed building economies through the concentration of like types of construction and equipment, and more importantly allowed greater responsiveness in the design to the requirements of the specific departments. The strategy of stacking like spaces must be viewed as an architectural solution to an architectural design problem, but it was reinforced by the structure of medical specialties which organized diagnostic/treatment and nursing activities of each specialty on the same level. This approach enhanced relationships for medical education and research within the specialty, but frustrated more efficient organization of space and equipment, and personnel, and restricted the interaction of medical specialties, which was being developed by the complexities of medical science.
New strategies, oriented to the horizontal organization of like activities, emerged with centralization of like activities and with the recognition of the value of horizontal relationships of activities in promoting the interaction of staff and enhancing health care, educational, and administrative functions. These strategies are primarily an administrative solution to functional problems, and are employed in the work of Sheila Clibborn and in Le Corbusier's project for the hospital in Venice.

In both of these projects, like types of activity are organized horizontally with the design of the nursing environment generating unique configurations derived from the requirements for the orientation of the patient area to the exterior and from the internal determinants for the organization of patients about nursing patterns.

This design strategy encounters many of the same problems met earlier in the vertical organization of components. The problem of coordinating design provisions for structure and mechanical shafts to the varying needs on each level is somewhat minimized by the use of more sophisticated structural and mechanical systems.

The strategy for the horizontal organization of like activities identifies the design of the environment for nursing activities as requiring a unique configuration developed from requirements for light to patient rooms and the organization of patients about nursing staffing patterns.

This approach enforces a separation of nursing and diagnostic/treatment activities which becomes increasingly difficult to achieve with the emergence of increasingly specialized nursing care programs and with the steady integration of research and educational activities into the patient care setting.

The need for greater flexibility in the organization of activities within the total complex developed the concept of universal space, which attempts to develop a basic building block of space which can be organized in a variety of configurations.
to meet the highly unique needs of the nursing activities or to provide an environment for a broad range of diagnostic, treatment, research, and educational activities. It attempts to develop a basic system of building components with which the total hospital complex can be constructed, thus providing an aesthetic unity of the whole as well as a long-term flexibility in structuring activities. With this design approach, space requirements need not be rigidly defined early within the design process, nor must harsh distinctions between nursing and treatment environments be constructed. These design strategies focus on the generalized development of circulation systems and the three-dimensional zoning of flexible loft spaces, with the emphasis on provisions for growth and linkage, to other facilities, and to the circulation systems of the city. This strategy is oriented to the accommodation of mixed activities, and it allows the restructuring of architectural practice to develop a new dimension of problem-solving expertise, oriented to the more traditional problems of internal function.
1757-1910
ORGANIZATION
IN PLAN TO
PRIMARILY SEPARATE
ALL COMPONENTS
PAVILLION
SYSTEM

1910-1959
ORGANIZATION
IN SECTION
AND PLAN ON
APPLICATION OF
SATISFYING
TECHNOLOGY

1965-1971
THREE
DIRECTIONAL
OPEN-ENDED
CIRCULATION
SYSTEMS

NETWORK FOR
INTEGRATING NEW
COMPONENTS INTO
SYSTEM.
The level of development of building technology forms a critical foundation in the evolution of design strategies for the hospital. The base of building technology available with each Time Frame serves to define the range of design alternatives. The advancements in building technology have allowed greater design freedoms and an increasingly specific response to the needs of the user. Simultaneously, the application of new technology to design has generated new design restrictions for the accommodation and organization of the physical hardware for the efficient and effective operation of the system.

The application of building technology in hospital design within specific Time Frames is a function of the support systems available and economically justifiable.

The orientation of hospital design in the early eighteenth century to the problems of the adequate ventilation of the hospital environment stimulated the cautious application of developing thermal extraction and propulsion ventilating systems. Ventilation systems provided the base for the development of hospital designs within the Time Frame 5, and the hospital became the locus of perhaps the most advanced and experimental ventilation systems employed within any building type until the early 1900's. The general acceptance of the germ theory diminished the role of ventilation as a significant strategy for the control of infection and weakened the rationale for the application of such advanced systems.

The shift of the hospital into the general practice of medicine and into the physical fabric of the city which accelerated after 1900, stimulated the vertical organization of the activities of the hospital and the development of design strategies utilizing the new building technologies which had developed in the last quarter of the nineteenth century for skyscraper construction - the elevator and fire-proofed skeletal steel construction.
The gradual application of mechanical ventilation and air conditioning systems to the components of the hospital, which increased during the post war period, allowed the development of new design strategies. The design problem was restructured from the requirements for the organization of spaces along the exterior for natural light and ventilation to a deeper orientation to the functional requirements of the users. Air conditioning extended design freedoms; it allowed the concentration of staff, patients and equipment and promoted the development of new organizations of activities which can be most clearly seen in the planning of surgical suites and radiology departments. The influence of technology in shaping design strategies was clearly reflected in the use of new automated goods distributing systems and the dominant vertical organization of the hospital which the use of these systems required.

The increased requirements for mechanical, electrical and other support services produced a technological overload of the traditionally designed and constructed facility and limited the responsiveness of the building to changing requirements. New design strategies emerged in the mid 1960's oriented to providing a more responsive environment, and are best reflected in the concept of interstitial space. This concept attempts to organize the building systems; structural, mechanical and other utility systems in a coordinated system which can establish unobstructed loft spaces for the planning of hospital activities and support these activities with a wide range of services. It is interesting that this approach is not so much a product of new technology, but a new understanding and organization of now familiar tools to reach new solutions.
INTRODUCTION
THEORETICAL BASE

Design is developed about a value base. That value base may or may not be identified, and the value base may be double, the one which the architect articulates in his writings, and another which he employs in actual design.

The design of hospital facilities is unique in that a clearly defined value base has served to guide the development of hospital design. This value base was articulated by Florence Nightingale in *Notes on Hospitals*, and it identified the purposes of hospital architecture as "to do the sick no harm", and stated positively, to contribute to the care and the recovery of the sick.

The foundation of this design theory was the linkage established by the miasmic theory of disease between qualities of the design of the hospital facility and the recovery of the sick. The miasmic theory attributed high rates of infection to defects in design and provided principles for the design and construction of a healthful environment.

The enduring significance of the miasmic theory is that it established a clear necessity for the orientation of design to the specific needs of the user, and within the life and death setting of the hospital design problem, forced the restructuring of design priorities.

The concept that hospital architecture should be oriented to the care of the sick has provided the framework for the evolution of hospital design theory. The definition of the patient for whom the design is oriented has expanded from the hospitalized patient to the patient within society. The concepts of the manner in which architecture should assist in the care of the sick has shifted from the control of infection to the management of resources and the organization of comprehensive
services. The specific understanding of who is to be served and the specific method of how to assist in the recovery of sick through design forms basic determinants of the design of health facilities.
The physical environment is organized to meet human needs, it enhances some activities and restricts others; it allows rapid responses to some problems and frustrates responsiveness to others. As the negative implications of the hospital environment come to the foreground, new design strategies emerge and attempt to overcome previous defects in design. It is curious that the positive roles which architecture can provide – aesthetic, psychological, functional are so difficult to define and communicate, whereas, the negative aspects of design become so acutely obvious.

Design strategies for the hospital have built-in limitations. As the nature of the design problem has changed through the advances of medical science and the expanding role of the hospital, the positive benefits of specific design strategies have diminished and the limitations have become increasingly intolerable. Obsolete design strategies become the seeds for change.

The breakdown of design strategies under the stress of change illustrates the "trade-offs" inherent in the design process and underscores the necessity for clearly defining and evaluating the disadvantages inherent in specific design solutions during the design process. The historical analysis of hospital design depicts the development of new design strategies out of the limitations of its predecessors.
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<tr>
<td><strong>Design Strategies</strong></td>
<td><strong>Limitations</strong></td>
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<tr>
<td>COMPOSITION FOR EASE OF NURSING AND ADMINISTRATION.</td>
<td>LARGE SITE REQUIREMENTS INCREASINGLY DIFFICULT TO MEET WITH CLINIC IN HOSPITAL. TOO EXPENSIVE TO KEEP MAINTAINED AND CONSTRUCTED.</td>
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<tr>
<td>SEPARATION OF PATIENTS IN SMALL GROUPS SEPARATE FROM THE OUTSIDE BY FRESH AIR.</td>
<td>LACK OF FLEXIBILITY IN PLANNING OF AREAS, LACK OF RESPONSIBILITIES TO GROWTH AND CHANGE.</td>
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<tr>
<td><strong>OPERATIONAL EFFICIENCY THROUGH USE OF TECHNOLOGY CENTRALIZATION OF LIKE ACTIVITIES.</strong></td>
<td><strong>TECHNICAL OVERLOAD OF THE HOSPITAL WITH BUILDING SUPPORT SYSTEMS OF AIR CONDITIONING, MEDICAL GAS CYCLES, ETC., PLUS AUTOMATED FOOD DISTRIBUTION AND ETC. MINIMALIST EQUIPMENT, LOSS OF RESPONSIBILITIES TO CHANGE.</strong></td>
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<tr>
<td>GROWTH AND CHANGE, DURING AND AFTER DESIGN AND CONSTRUCTION.</td>
<td>(NOT FUT OPPOSING, BUT POSSIBLY NOT ALLOWING SPECIFIC SOLUTIONS.)</td>
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Design strategies for the hospital developed from three basic considerations; the formal influences inherited from the church, which nurtured the hospital as an institution; the functional needs for the aggregation of the sick for ease of supervision and administration; and concerns for hygiene, environmental sanitation and the creation of a healthful environment for the recovery of the sick. The evolution of the latter as a significant design consideration stimulated the articulation of the precepts of hospital design theory and formed the base for the development of specific design strategies. The evolution of design strategies oriented to establishing a healing, healthful environment forms the theme of Time Frame 6.

Concepts of hygiene and environmental sanitation in hospital design had been incorporated in the designs of Santo Spirito, in Rome, in the late 15th century; in Ospedale Maggiore, in Milan, in 1456; and many other early hospitals, but as the demand for hospital services by the sick poor increased with the rapid urbanization produced by industrialization in the early 1700's, the principles of environmental sanitation were neglected. Facilities were designed with the principal objective the aggregation of as many sick as possible under one roof for the ease and economy of administration. The concentration of patients, the septic nursing and surgical techniques, the lack of adequate lighting, ventilation and sanitation combined to form an environment in which infection was rampant and mortality high.

Concerns for problems of infection emerged with the shift of medical education to the hospital setting and as the primary interest of medicine shifted away from the diagnosis and classification of diseases to therapeutics and patient care. Infection became a significant menace, not only to medical education and research, but to the establishment of reputations by hospitals and physicians for the effectiveness of their services and to the securing of the economic benefits such reputations enjoyed.
Two distinct periods can be identified within Time Frame 6. The first period extends up to 1780 and marks the gradual but limited and inconsistent use of hospital design strategies oriented to creation of a sanitary, healthful environment. This period can be traced back to some of the earliest hospital designs, but is significantly noted by the increased writings of physicians and surgeons in the early 1700's setting forth principles of hospital design. Proposals were advanced for the separation of patients in small groups and for provisions for the liberal ventilation of the hospital environment. These concepts were reflected in the design of the hospital for sick seamen at Stonehouse, in 1757, by the architect Rovehead. This hospital served as a model of these principles and greatly influenced the subsequent development of hospital design.

The second period is defined in time by two major public scandals, the investigation of conditions in Hotel Dieu in Paris, which developed around 1780, and the investigation of conditions in Scutari Military Hospital following the Crimean War and carrying up to 1860. This period marks the organization of principles of hospital design into more comprehensive proposals, and the weaving of these design principles into the larger social movement for the reform of the hospital which blossomed in the late eighteenth century from the expanding social consciousness. This period is punctuated by political and social reform, the rising public concern for hospitals, and the increased inquiry into sound principles of design.

Several publications were significant in expanding public awareness of conditions in hospitals. Foremost were the writings of John Howard, which depicted conditions in hospitals and prisons in England and Europe during the 1780's and later the writings of Paul Tenon, describing conditions in Hotel Dieu, in Paris, which were published in 1784.
The most significant events shaping hospital reform were a series of public scandals which instigated detailed investigation of principles of hospital design and focused public attention on their conclusions. The controversy over conditions in Hotel Dieu, precipitated the investigation of the hospital in 1874 by a committee of the Royal Academie des Sciences and the preparation of recommendations for hospital design. This report, prepared by a distinguished group, including such esteemed scientists and thinkers as Lavoisier, Tenon and Coulomb, was developed from visits to other hospitals including Stonehouse, and articulately set forth principles of hospital design. These recommendations which were widely published and later incorporated in architectural handbooks, established the base for the development of hospitals in France into the mid-nineteenth century. La Roquette, designed in 1785, but not constructed; St. Andre, in Bordeaux, completed in 1829; and Lariboisiere, in Paris, constructed in 1854, can be directly traced to this report.

The second major public controversy erupted in England following the Crimean War. It derived from the scandalous conditions which had existed in the military hospital at Scutari, and was inflamed by the design for the proposed hospital at Netley. From this controversy and the series of investigations which it sparked emerged a series of writings, most significantly, Notes on Hospitals, by Florence Nightingale, which constructed pseudo-scientific evidence to support hospital design reform and to illustrate the defects of traditional design strategies. Most importantly, Notes on Hospitals questioned the very rationale for hospital construction and set forth fundamental precepts of design which structured the design decision-making process.

This later controversy was most significant in shifting the nature of the hospital design problem from the traditional framework of architecture to a highly unique
and foreign structure subversive to fundamental precepts of the architectural profession. Hospital design traditionally was oriented to the creation of permanent and monumental facilities, reflecting the power and generosity of the benefactors, and the aesthetic skill of the architect. The traditional functional design determinants were oriented to the aggregation of the sick for economy of supervision.

New strategies for hospital design, which had developed from fundamental concerns for sanitation and hygiene, were now structured about the design implications of the psuedo-scientific miasmic theory of disease.

The miasmic theory based the causes of disease on hypothetical substances contained in the vapors and gases which purportedly emanated from the decay of organic matter in the soil, sewers, and drains, and from the exhalation and perspiration from the bodies of the sick. This contaminated and poisonous air provided the mechanism for the conduction of disease causing substances. Fresh air supplied in quantity became the key to a healthful environment.

As an outgrowth of the miasmic theory and the concept of the aerial conduction of disease, the spread of infection within the hospitals was attributed to defects in the hospital environment and site selection. The siting of the hospital down-wind from swamps and cemeteries or adjacent to similar environmental hazards was considered a prime cause of disease within the hospitals. Most significantly, infection was attributed to the dense concentrations of the sick within hospitals with its concomitant concentrations of contaminated air rising from the bodies of the sick; to inadequate ventilation of the hospital environment; to defective design and construction which, through corridors, stairs, ducts, and chases, allowed the communication of poisonous vapors through the hospital or the movement of contaminated air currents over the
bodies of the sick; and to the saturation of the surfaces of the hospital with poisonous matter which no amount of cleaning could remove.

The significance of the miasmic theory on hospital design and the design process derives from these definitive if erroneous relationships which it established between the design of the hospital environment and the health and recovery of its inhabitants. These relationships expanded the responsibility of the architect to include the well-being of the inhabitants, and clearly defined the purposes and priorities of hospital architecture. The linkage of health to environmental conditions which the miasmic theory established required the design of the hospital within a specific framework which subordinated traditional aesthetic considerations to functional concepts which possessed significant formal design implications. The miasmic theory not only reshaped design strategies, but it developed a visible, rational design methodology. It shifted the design process from an intuitive, and somewhat arbitrary decision-making process to one with a highly structured basis for design decision-making on all scales, from site selection to detailing. As a consequence of this changing nature of the hospital design problem and the highly restrictive nature of the design approaches, the hospital design problem begins to drift from the general practice of architecture to a limited group of hospital "specialists".

The hospital design problem emerged in 1860, highly structured in its philosophical foundations and equipped with a scientific rationale about which design decisions were to be constructed.

The philosophical revolution in redefining the hospital design problem and structuring a design theory on which to construct design decisions can be viewed as a forerunner to the ideological examination of the purposes of architecture, the role of the
architect, and the value base for design which emerged following World War II, and which was most significantly reflected in the writings of the European architectural protagonists, the Team 10, and briefly associated with the architecture of the "New Brutalist". The hospital design problem evolved a design theory which almost a century later developed within the broader framework of architectural practice.
Nucleus of fashion: strategy
Based on principles of hygiene and sanitation.

Settings
Inspection evident
In hospitals -
Threat to life and
development of medical science

Ideas
Writings of physicians and surgeons on principles for healthy environment
For care of sick:
Pringle 1753
Van Swieten 1760
Murphy 1764
Brooksby 1769
James 1772
Rush

Designs
Physical expression of these concepts in design of
Hospital for sick
Settlement at Stonehouse, near
Plymouth, 1757
by Stovehead.

Articulation of design strategies
Setting
Scandal of Hôtel Dieu
In 1789 with
Investigation by Committee of
Académie des Sciences

Writings of John Norwood explore
Social consciousness

Public confrontation with larger social issue of reform
Scientific proof through statistics.

Setting
Scandal of Southwark
Following Crimean War, 1854.

Investigations by
Commission on barracks
Expanded controversy
Over proposed design
Of Netley

Ideas
Expressions of principles in
Hospital construction
Set forth following extensive investigation
Including: Visit to
Stonehouse:
Report never published

Designs
La Rochette 1787
By Pojet, not constructed
But published
St. Andre at Bordeaux
1829
Lazarets, Paris
1853
All developed from
Principles set forth in
Report

Ideas
Florence Nightingale
Famous for
"Notes on Hospitals"

Anuran Hoggart
and George Godwin
Contribute to
Hospital design literature

Designs
Blackburn and
East Lancashire
Infirmary, 1856
Herbert Military
Hospital.
The hospital primarily a nursing environment, with minimal support spaces for materials processing, treatment, and administration.

Nursing facilities comprise a dominant percentage of the total complex.
WITH THE DEVELOPMENT OF THE CHRISTIAN ETHIC OF CHARITY, THE ROLE OF THE HOSPITAL IS EXPANDED TO PROVIDE NURSING CARE FOR THE SICK POOR.

HOSPITALS USED FOR THE PROTECTION OF SOCIETY FROM THE INSANE AND FROM THOSE SICK WITH INFECTIOUS DISEASES.

HOSPITAL ISOLATED FROM THE FABRIC OF THE CITY.
HOSPITAL DEVELOPED FOR THE PROTECTION OF SOCIETY FROM THE INSANE AND DISORDERLY AND FROM THOSE SICK WITH INFECTIOUS DISEASES.

HOSPITAL BECOMES A WELFARE INSTITUTION FOR THE CARE OF THE SICK POOR. DEVELOPED UPON THE SPIRIT OF SOCIAL CONSCIOUSNESS AND THE CHRISTIAN ETHIC OF HUMANITARIANISM AND CHARITY.

ECONOMIC SUPPORT OF THE HOSPITAL BY PHILANTHROPIC ELITE.

HOSPITAL PROVIDES SHELTER AND NURSING CARE OF THE CHRONICALLY SICK POOR AND CLINICAL EXPERIENCE FOR MEDICAL EDUCATION AND RESEARCH. NURSING CARE BY THE POORLY TRAINED AND THE "THREE-DAY DRUNK".

PRIMARY DELIVERY OF HEALTH CARE IN THE PHYSICIAN'S OFFICE AND THE PATIENT'S RESIDENCE, SUPPLEMENTED BY A FEW SPECIAL NURSING HOMES FOR THE WEALTHY.
FUNCTIONAL NEEDS
OF PROVIDERS.

ORGANIZATION OF PATIENTS FOR EASE AND ECONOMY OF SUPERVISION.

MONUMENTAL EXPRESSION TO REFLECT THE POWER AND GENEROSITY OF THE BENEFACtors.
EARLY DESIGNS ORIENTED TO REFLECT THE FORMS AND RITUALS OF THE CHURCH.

FUNCTIONAL NEEDS
OF USERS.

GRADUAL SHIFT OF DESIGN PRIORITIES TO CONCERNs FOR THE CREATION OF SANITARY AND HEALTHFUL ENVIRONMENTS AND THE CONTROL OF INFECTION.

SYMBOLIC FUNCTION.
STRATEGIES FOR THE CONCENTRATION OF PATIENTS AND COMPACTION OF THE ELEMENTS OF THE HOSPITAL SLOWLY ABANDONED.

NEW STRATEGIES ORIENTED TO THE CREATION OF A SANITARY, HEALTHFUL ENVIRONMENT THROUGH DESIGN PROVISIONS FOR ADEQUATE SUNLIGHT AND VENTILATION AND THE SEPARATION OF PATIENTS FROM ONE ANOTHER BY FRESH AIR.
NURSING ENVIRONMENT

**PHASE ONE**

CONCENTRATION OF PATIENTS FOR EASE OF SUPERVISION. DENSE CONCENTRATIONS OF PATIENTS REFLECTED IN BLOCK HOSPITALS.

**PHASE TWO**

SEPARATE INTO SMALL GROUPS

GROUP LIKE TYPES OF ILLNESSES.

DEPACATED AND TRAINED NURSES

EFFECTIVE NURSING SERVICES

UNTRAINED "3 DAY DRUNK"

CUSTODIAL CARE OF SICK

EVOLUTION OF NURSING PROFESSION SHAPES HOSPITAL FUNCTIONS

GRADUAL RECOGNITION OF THE NEED TO SEPARATE PATIENTS INTO SMALL GROUPS TO CONTROL INFECTION. THE VALUE OF FRESH AIR AND SUNLIGHT WITHIN THE HOSPITAL ENVIRONMENT GIVEN INCREASED IMPORTANCE.

GOODS processing and distribution

MINIMUM MATERIALS PROCESSING WITHIN THE HOSPITAL. PATIENT BRINGS BASIC SUPPLIES. PHARMACY PLAYS SIGNIFICANT ROLE IN PATIENT CARE.

MINIMAL USE OF MATERIALS IN THE HOSPITAL FOR PATIENT CARE.
strategies for the ORGANIZATION of components

EARLY STRATEGIES ORIENTED TO THE COMBAC-
TION OF THE COMPONENTS OF THE HOSPITAL
INTO THE BLOCK STRUCTURE.

GRADUAL SEPARATION OF THE COMPONENTS.
TO CONTROL INFECTION AND ORIENTATION
OF THE FACILITY FOR OPTIMAL EXPOSURE FOR
SUNLIGHT AND VENTILATION.

GRADUAL SHIFT FROM THE VERTICAL LAYERING
OF ACTIVITIES WITHIN THE BLOCK HOSPITAL
TO THE HORIZONTAL ORGANIZATION OF
SEPARATE, SINGLE STORY COMPONENTS.
MASSIVE, LOAD-BEARING STRUCTURAL SYSTEMS
RESTRICTED DESIGN ALTERNATIVES.

GRADUAL DEVELOPMENT OF VENTILATION TECHNOLOGY, MARKED BY A SERIES OF PUBLICATIONS ON THE USE OF FLUES AND VENTILATORS, EARLY APPLICATION OF THERMAL AND PROPULSION VENTILATION SYSTEMS TO HOSPITALS.

LIMITED WALL PENETRATIONS

EVOLUTION OF ENVIRONMENTAL CONTROL SYSTEMS.
- GAS LIGHTING
- FANS AND VENTILATORS
- VENTILATING FIES
GROWING SOCIAL CONSCIENTIOUSNESS OF CONDITIONS WITHIN HOSPITALS DEVELOPS IN LATE 1700'S.

SANITARY REFORM MOVEMENT ESTABLISHED NEW PRINCIPLES OF DESIGN, BUT LACKED THE SPECIFIC IMPETUS AND RATIONALE TO CHALLENGE TRADITIONAL PRIORITIES.

MIASMIC THEORY ESTABLISHED RELATIONSHIPS BETWEEN HEALTH AND THE ENVIRONMENT. IT LINKED HIGH RATES OF INFECTION TO DEFECTS IN DESIGN AND GENERATED PRINCIPLES OF DESIGN FOR A HEALTHFUL ENVIRONMENT.

THROUGH THE LINKAGES OF ENVIRONMENT TO HEALTH, THE CONCEPT EMERGED OF AN ARCHITECTURE ORIENTED TO THE NEEDS OF THE PATIENT AND WHICH CONTRIBUTED TO THE RECOVERY OF THE SICK.

DESIGN ORIENTED TO NEEDS OF THE HOSPITALIZED PATIENT - CONTROL OF INFECTION. SOLUTIONS DEVELOPED WITHIN THE FRAMEWORK OF MIASMIC THEORY OF DISEASE.
CONCENTRATION OF PATIENTS PRODUCED CONDITIONS IN WHICH INFECTION AND MORTALITY WERE HIGH. HOSPITAL BECOMES AN OBSTACLE TO PATIENT CARE AND THE PHYSICIAN MUST CURE THE ENVIRONMENT BEFORE THE TREATMENT OF THE PATIENT CAN BE SUCCESSFUL.

THE CONCEPT OF NATURAL VENTILATION AT ODDS WITH DEVELOPING TECHNOLOGY FOR MORE EFFICIENT AND EFFECTIVE HEATING AND VENTILATION SYSTEMS WHICH COULD PROVIDE GREATER PATIENT COMFORT.
1860 - 1910: DESIGN FOR CONTROL OF INFECTION

The design of Herbert Military Hospital, at Woolwich, responded to the complete spectrum of design determinants established by Florence Nightingale in Notes on Hospitals. Woolwich became a prototype of the pavilion system in its purest expression, not only as a formal configuration as had Lariboisiere in Paris, ten years earlier; but as a complete expression in its every detail of an adherence to a decision-making base developed from the miasmic theory of disease. Time Frame 5 centers on the design implications of the miasmic theory of disease and on the design strategies which developed for the control of infection. It depicts the advances of medical science and building technology and the new problems which they directly and indirectly formed and focuses on the restructuring of design strategies which these changes precipitated.

Three distinct architectural design concepts were derived from the miasmic theory of disease; one, the separation of patients into small groups isolated from one another and potential sources of contamination by fresh air; two, the provision for adequate ventilation to insure the rapid and continuous changes of air with consideration of air flow to avoid the spread of infection; and three, the planned obsolescence of the hospital structure with its destruction and replacement when its surfaces became saturated with infection and disease endemic.

The concept of separating patients into small groups established the basic organizational form of the hospital within Time Frame 5 and was intertwined with design strategies for enhancing natural ventilation. Various formal configurations developed for the organization of the components of hospital responsive to a broad range of considerations: optimal orientation to the sun and to the prevailing breezes, constraints of site, provisions for future growth, formal composition of the total complex, and the organizational relationships derived from the affinity of elements and the optimal flow of staff, patients, and goods.
The components of the hospital were organized horizontally to achieve the greatest possible separation, with the vertical organization of activities limited to a maximum of three levels, and ideally held to a single story, the need for linkage of the components was subservient to needs for separation to provide control of infection.

The concept of the temporary hospital represents the extreme pursuit of the design implications of the miasmic theory and the orientation of design strategies to the issue of infection control at the exclusion of broader parameters of patient care. The temporary hospital is perhaps an accurate monitor of the strength of the miasmic theory as a design determinant. As a concept the temporary hospital was most vulnerable to the implications of the germ theory and the new techniques for the control of infection which it provided. The control of infection shifted from being primarily an architectural problem to being a problem of medical and nursing techniques.

The incorporation of improved heating and ventilation systems in the hospital increased the construction costs of the facility and sealed the demise of the temporary hospital except as a response to problems of wars and emergencies. No longer was it economically feasible nor medically necessary to destroy the facility to prevent disease from becoming endemic within the hospital facility.

The dominant theme in Time Frame 5 is ventilation, a theme established by the implications of the miasmic theory of disease and carried to a new dimension by the development of artificial ventilation systems which technological advances made possible. The requirements for the adequate ventilation of the hospital had been well established, but the means by which ventilation should be achieved became the subject of intense debate. The fundamental issue became the use of artificial versus natural ventilation systems.
These new systems afforded the environmental comforts of warmth and ventilation, and provided more economical heating and greater control of filtration and air change. Time Frame 5 reflects the cautious application of ventilation technology to the hospital and the gradual evolution of design strategies to exploit the new design freedoms which these systems allowed.

Two separate artificial ventilation systems were employed in Lariboisiere and Paris in 1854, to allow the comparative evaluation of the different systems. The higher rates of infection which existed in Lariboisiere were attributed to defects in the artificial ventilation systems. This experience provided the main arguments against the use of artificial ventilation systems in hospitals into the 1880's. With the gradual discard of the miasmic theory and the general acceptance of the germ theory, the spread of infection was attributed mainly to the septic nursing and surgical techniques. Simultaneously the development of the more efficient and transportable power sources of steam and electricity and the advancement of engineering and manufacturing skills provided more effective and reliable artificial ventilation systems for use in the hospital.

For the first time in the history of architectural design invisible systems hidden in walls, attics, and floors were utilized to solve problems formerly dealt with through the organization of space. These "hidden" technological support systems imposed new constraints on design for the physical accommodation of their hardware and for its organization to allow the efficient function of the systems. The plan no longer provides an adequate descriptive analysis of designs, and the section, with its indication of equipment above the ceiling and below the floor is necessary to allow a comprehensive understanding of the design strategies employed.
Time Frame 5 portrays a great explosion of science and technology which was reshaping all aspects of society. Advancements in medical science, particularly in the fields of anesthesiology, surgery and bacteriology began to reshape the practice of medicine and the role and function of hospitals. With the integration of the hospital into the mainstream of medical practice for the diagnostic and treatment resources of people and facilities which it offered, the hospital was drawn from the periphery of the city and into the urban fabric. The pavilion system, with its need for extensive sites to accommodate the horizontal development of the hospital complex became increasingly unsuited to the new position of the hospital within society.

Time Frame 5 depicts the slow rejection of infection control as the primary determinant of design and the increasing significance of economics as a design determinant.
SLOW SPECIALIZATION OF THE DESIGN OF THE NURSING ENvironments FOR SPECIFIC ILLnesses SUCH AS INFEcTIous DISEASES, ADDS A NEW DIMENSION OF COMPLEXITY.

SURGERY, AUTOPSY, AND OUTPATIENT CLINIC BECOME INCREASINGLY IMPORTANT SPACES FOR MEDICAL CARE AND EDUCATION. THESE SPACES GENERATE UNIQUE INTERNAL DESIGN DETERMINANTS.

DEVELOPMENT OF THE MATERIALS HANDLING ELEMENTS OF THE KITCHEN AND THE LAUNDRY HEAVILY INFLUENCED BY THE TECHNOLOGICAL IMPROVEMENTS OF STOVES, BOILERS, AND OTHER APPLIANCES.
RELATIONSHIP of hospital to the CITY

HOSPITAL BECOMES MAJOR BASE OF MEDICAL EDUCATION. LINKAGE ESTABLISHED INTO THE INVISIBLE EDUCATIONAL SYSTEM OF THE CITY WITH NEW RELATIONSHIPS TO UNIVERSITIES.

ADVANCES IN MEDICAL SCIENCE, PARTICULARLY IN SURGERY BEGIN TO SHIFT THE HOSPITAL FROM BEING PREDOMINANTLY A NURSING ENVIRONMENT FOR THE ACUTELY SICK POOR TO FUNCTIONING AS A DIAGNOSTIC AND TREATMENT CENTER FOR ALL GROUPS WITHIN SOCIETY.
HOSPITAL BECOMES PRIVILEGED LOCUS OF EDUCATIONAL PROGRAMS JEALOUSLY GUARDED BY PROFESSIONAL GROUPS. SHIFT FROM CHRONIC TO ACUTE ILLNESSES OF PATIENTS REFLECTS INTERESTS AND NEEDS OF MEDICAL EDUCATION AND RESEARCH.

RAPID INCREASE IN SURGICAL PATIENTS WITH DEVELOPMENT OF ANESTHESIA AND THE USE OF ANTISEPTIC, AND LATER ASEPTIC, SURGICAL TECHNIQUES. SURGERY SHIFTS FROM PATIENT'S RESIDENCE OR DOCTOR'S OFFICE TO HOSPITAL.
INFECTION IN HOSPITALS BECOMES A THREAT TO THE DEVELOPMENT OF MEDICAL SCIENCE AND A SOCIAL DISGRACE.

PRIMARY NEED FOR THE CONTROL OF INFECTION - WITH THE DESIGN RESPONSE DEVELOPED WITHIN THE FRAMEWORK OF THE MIASMIC THEORY OF DISEASE.
SEPARATE PATIENTS INTO SMALL GROUPS ISOLATED FROM ONE ANOTHER WITH FRESH AIR.

VENTILATE THE HOSPITAL ENVIRONMENT WITH ATTENTION TO THE MOVEMENT PATTERNS OF AIR TO MINIMIZE THE SPREAD OF INFECTION, PREVENT THE COMMUNICATION OF AIR THROUGH CORRIDORS AND SHAFTS TO OTHER AREAS.

DESTROY THE HOSPITAL ENVIRONMENT WHEN ITS SURFACES BECOME PERMEATED WITH POISONOUS MATTER. CONSTRUCT THE HOSPITAL WITH INEXPENSIVE MATERIALS TO ALLOW ITS FREQUENT REPLACEMENT.
GROUP PATIENTS BY TYPE OF ILLNESSES. SEPARATE PATIENTS INTO SMALL GROUPS ISOLATED ONE FROM ANOTHER WITH FRESH AIR. ORGANIZE BEDS AND NURSING WARDS TO OBTAIN MAXIMUM LIGHT AND VENTILATION AND TO AVOID THE SPREAD OF DISEASE BY THE FLOW OF AIR OVER SUCCESSIVE PATIENTS. CHARACTERISTIC NIGHTINGALE WARD A PRODUCT OF THESE DETERMINANTS.

CIRCULAR AND OCTAGONAL WARDS DEVELOPED FOR IMPROVED VENTILATION. INCREASED USE OF ARTIFICIAL VENTILATION SYSTEMS TO SUPPLEMENT NATURAL VENTILATION. SINGLE STORY FACILITIES EVOLVE BASED ON CONCEPTS OF INFECTION CONTROL. ORGANIZATION OF TOILETS AND SERVICE SPACES DISTINCT FROM WARDS TO MINIMIZE THE FLOW OF CONTAMINATED AIR INTO PATIENT AREAS.

ORGANIZATION OF NURSING UNITS AND SUPPORT SERVICES BASED ON CONCEPTS OF NURSING ECONOMY AND EFFECTIVENESS. SIGNIFICANT INFLUENCE OF FLORENCE NIGHTINGALE ON HOSPITAL DESIGN AND ON THE DEVELOPMENT OF NURSING SCHOOL.
GOODS processing and distribution

FOOD PRODUCTION RESHAPED BY NEW RECOGNITION OF THE RELATIONSHIPS OF DIET TO HEALTH AND BY NEW TECHNOLOGY FOR THE PREPARATION, STORAGE, AND DISTRIBUTION OF MEALS.

ZONING OF KITCHEN AND LAUNDRY BASED PRIMARILY ON CONCEPTS OF SEPARATION FOR CONTROL OF INFECTION WITH CONSIDERATIONS OF ECONOMY OF MATERIALS DISTRIBUTION SECONDARY.

EXTREME HORIZONTAL DISTANCES IN PAVILION SYSTEM FRUSTRATE MORE EFFICIENT OPERATION.

PRIMITIVE "RAILROADS" FOR MOVING PATIENTS AND SUPPLIES DEVELOPED IN LARGE MILITARY HOSPITALS. LOWER LEVEL GOODS DISTRIBUTION CORRIDORS FREQUENTLY DEVELOPED.
strategies for the ORGANIZATION of components

PRIMARY STRATEGY ORIENTED TO THE SEPARATION OF THE COMPONENTS OF THE COMPLEX, WITH LINKAGE SECONDARY, OFTEN BY A GROUND LEVEL ARCADE.

ORGANIZATIONAL STRATEGIES DEVELOP FROM VARIOUS CONSIDERATIONS: ORIENTATION TO SUN AND BREEZE, CONFIGURATIONS OF THE SITE, AESTHETIC COMPOSITION OF THE COMPLEX, ECONOMY OF OPERATION DEVELOPED FROM THE AFFINITY OF ELEMENTS AND THE FLOW OF GOODS, STAFF, AND PATIENTS.
RAPID DEVELOPMENT OF THERMAL AND PROPULSION VENTILATION SYSTEMS WITH THE ATTEMPT TO EMPLOY THERMAL VENTILATION SYSTEMS TO STERILIZE THE AIR EXHAUSTED FROM THE HOSPITAL.

IMPROVEMENTS IN BOILER TECHNOLOGY PROVIDE NEW HOT WATER HEATING SYSTEMS AND ALLOW DEVELOPMENT OF LOW VELOCITY FORCED AIR HEATING SYSTEMS.

PREFABRICATION OF COMPONENTS FOR MILITARY HOSPITALS. USE OF CAST IRON COMPONENTS AND GLASS PARTITIONS FOR EASY CLEANING IN FEVER HOSPITALS.
ORIENTATION TO THE CONTROL OF INFECTION WITH THE PHYSICAL EXPRESSION THROUGH THE DESIGN IMPLICATIONS OF THE MIASMIC THEORY OF DISEASE, WHICH WAS REFLECTED IN ALL ASPECTS OF THE DESIGN, FROM THE LARGE SCALE STRATEGIES FOR SEPARATION AND VENTILATION TO THE ORIENTATION OF BEDS AND PLANNING OF TOILETS.

HOSPITAL AESTHETIC SHAPED BY THE ZESTFUL EXPRESSION OF THE DESIGN DETERMINANTS WHICH DEVELOPED FROM THE MIASMIC THEORY - AESTHETIC SOLUTION WAS NOT SUPERIMPOSED FROM EXTERNAL CONSIDERATIONS.

ARCHITECTURE CONSIDERED AS A MEANS TOWARD PATIENT CARE AND THE RECOGNITION THAT THE CONSTRUCTION COSTS OF THE FACILITY MUST BE EVALUATED AGAINST ENDS SERVED. THE ADDITIONAL PREMIUM OF THE PAVILION SYSTEM WAS CONSIDERED NECESSARY TO ASSIST IN RECOVERY OF THE SICK.

UNNECESSARY ARCHITECTURE, EXTRAVAGANCE, ORNAMENTATION AND RICH INTERIOR DESIGN CONSIDERED AS WASTEFUL. DEVELOPMENT OF THE CONCEPT OF ARCHITECTURE AS AN EXTENSION OF THE SERVICE SYSTEM RATHER THAN AN ARTIFACT.
EXTENSIVE SITES REQUIRED FOR THE HORIZONTAL DEVELOPMENT OF FACILITIES INCREASINGLY DIFFICULT TO ACQUIRE WITHIN URBAN AREAS AND INCREASINGLY EXPENSIVE.

DISTANCES BETWEEN ELEMENTS FOR CONTROL OF INFECTION PRODUCES INEFFECTIVENESS OF OPERATION AND HINDERS MEDICAL STAFF INTERACTION.

CONSTRUCTION AND MAINTENANCE OF NUMERous SEPARATE STRUCTURES, EACH WITH FOUNDATIONS, ATTICS, ROOFS, AND CONNECTING CORRIDORS, BECOMES INCREASINGLY EXPENSIVE.

APPLICATION OF IMPROVED HEATING AND VENTILATION SYSTEMS WITHIN THE PAVILION SYSTEM IS EXPENSIVE AND INEFFECTIVE OPERATIONALLY.

PATIENT COMFORT NOT PROVIDED IN THE NIGHTINGALE WARD WITH ITS LACK OF PRIVACY, ITS ORIENTATION OF THE PATIENT TO THE GLARE OF WINDOWS, AND THE LACK OF ADEQUATE HEATING INHERENT WITH NATURAL VENTILATION.
1910 - 1945: EXTENSION INTO THE THIRD DIMENSION

The dramatic advances of medical science in the last half of the 19th century significantly reshaped the hospital from an institution for the nursing of the sick poor to a major diagnostic and treatment center for the sick and the injured of all socio-economic classes. The advances in medical science removed the hospital from a position on the periphery of the health care system and intertwined the hospital into the general fabric of medical practice.

Externally, the hospital became increasingly an urban institution, facing the traditional problems of the scarcity and high costs of land. Internally, the hospital shifted from a static nursing center to a dynamic multi-faceted complex with increased needs for the direct and efficient organization of movement patterns. Control of costs, both initial construction cost and operating expenses became increasingly important. To these problems the pavilion strategy of hospital design was unresponsive and in conflict. The primary determinant of the pavilion strategy - the miasmic theory of disease, had been supplanted by the general acceptance of the germ theory. Needs for ventilation could now be met through the use of mechanical systems which provided additional benefits of filtration and control of temperature and humidity. It is curious to observe that the inertia of the pavilion system carried significantly into the middle of this period, although the determinants upon which the system was structured had long been eroded by science and technology.

Early in the 1900's, writings appeared challenging the pavilion system, primarily on the basis of the high costs of land required to accommodate the extensive horizontal development. Secondary were considerations of the high costs of construction and maintenance of the large number of separate structures with large amounts of foundations, basements, attics, roofs, and connecting corridors. The separations
inherent in the pavilion organization for control of infection now restricted the movement of patients, staff, and goods, and the interaction of emerging medical specialties. The adoption of the skyscraper technology, which had developed in the last quarter of the nineteenth century, was proposed as a response to the need to control construction and maintenance costs and to the reality of the limited sites within urban areas. The design alternatives for the organization of the components of the hospital were expanded into the third dimension, and the building section, not exclusively the plan, becomes increasingly important in understanding the organization of activities within the hospital facility.

The vertical organization of the hospital can be observed as primarily a response to the limited sites available within urban areas and to the shifting of priorities of the hospital design problem which accompanied the demise of the miasmic theory. The pavilion system with its large, expensive sites and its separation of the components of the hospital, was no longer an unquestionable pre-condition in the establishment of an environment for the recovery of the sick. The causes and major controls of infection now lay outside the primary framework of design and strategies for infection control shifted from the major organization of space, which marked the pavilion system, to internal provisions for equipment - lavatories, autoclaves, later high filtration air handling systems.

The fundamental pressure shaping hospital design became the needs for the compaction of the hospital facility and the primary design response became a vertical organization of the components of the hospital. The limited ability for horizontal relationships between components within the high-rise structure restricted traditional patterns of function and stimulated new concepts of function utilizing the potential of the elevator and the dumbwaiter. The elevator allowed the rapid distribution of
goods from centralized processing areas directly to points of use, and facilitated the functional integration of activities by establishing a common nervous system on which all activities could develop.

Time Frame 4 depicts the increasing complexity of the hospital as a design problem. The advances in surgery, the laboratory sciences, and radiology generated new space needs and highly specific design determinants for the planning and equipping of these internal areas. The design problem of the hospital developed a new dimension of complexity with the addition of these new sets of design determinants to those already generated by the traditional nursing, administrative, and support components.

With the use of the hospital by a broader spectrum of society, new attitudes and new standards of the hospital environment emerged. These social pressures for the up-grading of the hospital were reflected in the evolution of the nursing environment from open wards to cubicles and private rooms and were balanced against traditional requirements for ease and economy of nursing supervision and the rising problem of costs of hospital construction.

The vertical organization of the hospital imposed severe constraints on hospital planning and function, and it is curious that it took so long for these limitations to manifest themselves and precipitate new strategies. In addition to the traditional design constraints imposed by the requirements for natural light and ventilation to each room within the hospital facility, the configuration of floors above and below and the necessary vertical penetrations for structure, stairs and mechanical shafts inherent in the vertical organization of activities further restricted initial planning, growth, and flexibility. The horizontal organization of the pavilion system
had allowed the design of each component to respond to its own internal requirements and had minimized the imposition of planning restrictions by the design solution for one problem on other areas. With the vertical organization of the hospital, the internal planning of the components now became restricted by the limitations generated by the solution itself.

The development of design strategies within Time Frame 4 reflects an increasing sensitivity to the planning restrictions imposed by the vertical organization of the components of the hospital and by the restrictions generated by the needs for natural light and ventilation. New design strategies developed which attempted to allow greater responsiveness to the increasing priority of the internal planning determinants generated by the components of the complex, such as nursing, radiology, and surgery. Design strategies shifted from the attempt to stuff the activities of the hospital into a unified building shell in which hospital functions were by necessity 'cut to fit', to design strategies which allowed the subdivision of the hospital design problem into a number of smaller and similar problems which would facilitate the design of environments responsive to needs of each problem set and minimize transferring constraints from one area to another. The new design strategies are oriented to the organization of the whole hospital complex in such a manner as to maximize the design freedoms in solving the microscale functional problems. These design strategies are characterized by the vertical stacking of "like types of space" and the horizontal organization of distinct space defining structures responsive to the needs of like sets of problems.

The structure of the hospital design problem and the decision-making value base underwent a radical shift. With the demise of the miasmic theory, the primary
mechanism for the translation of fundamental precepts into design strategies was removed and design determinants were nebulously defined. With the increasing costs of health services, the increasing demand by a broader spectrum of society for hospital services, and with the limitations of hospital construction imposed by the Depression, a new mechanism began to operate on the periphery of the design process, the emergence of a morality of resource allocation to provide optimum services to the broadest spectrums of society. This morality is primarily visible in the planning of hospital facilities and programming of spaces within the hospital. The new morality of resource conservation acts as a new base for decision-making and provides a fundamental anchor to hold the hospital design problem within its distinct framework apart from the mainstream of architecture.

Time Frame 4 reflects the shift of leadership in hospital design from Europe to the United States. Perhaps because of the more fluid and less developed society within the United States and its shortage of facilities in contrast with the large number of pavilion hospitals in Europe, the United States became the setting for the evolution of this and the next generation of hospital design strategies. These designs reflect the emerging health care system within the United States and are constructed upon the expanding technological and economic resources which were available.
COMPONENTS of the hospital

UP-GRADING OF THE NURSING ENVIRONMENT TO PROVIDE FOR INCREASED PRIVACY AND COMFORT. TRANSITION FROM OPEN WARDS TO CUBICLES.

INCREASED REQUIREMENTS FOR SPECIALIZED DIAGNOSTIC AND TREATMENT PROCEDURES WITH NEW ADVANCES IN MEDICAL SCIENCE, GROWTH OF SURGERY, LABORATORY SCIENCES AND RADIOLOGY.

ADDITION OF NURSING SCHOOLS AND OTHER COMPONENTS TO THE TOTAL COMPLEX.
HOSPITAL INTERTWINED WITHIN FABRIC OF MEDICAL PRACTICE FOLLOWING DECADE OF SPECTACULAR ADVANCES IN MEDICAL SCIENCE. LOCUS OF MEDICAL PRACTICE SHIFTED FROM PHYSICIAN'S OFFICE AND PATIENT'S RESIDENCE TO THE HOSPITAL WITH ITS CONCENTRATION OF EXPERTISE AND DIAGNOSTIC AND TREATMENT FACILITIES.

HOSPITAL PULLED FROM THE PERIPHERY OF THE CITY WHERE IT HAD BEEN RELEGATED AS A NUISANCE AND AN ENVIRONMENTAL THREAT AND INTEGRATED INTO THE URBAN FABRIC FOR ACCESSIBILITY TO PATIENTS AND PHYSICIANS.

FLEXNER REPORT STRENGTHENS THE HOSPITAL'S ROLE AS AN EDUCATIONAL BASE AND DEVELOPS CLOSER RELATIONSHIPS TO UNIVERSITIES.
THE RAPID ADVANCES IN MEDICAL SCIENCE CONTINUE TO DEVELOP THE HOSPITAL AS A MAJOR DIAGNOSTIC AND TREATMENT FACILITY AND INTERTWINES THE HOSPITAL WITHIN THE GENERAL PRACTICE OF MEDICINE.

THE USE OF THE HOSPITAL BY ALL SOCIO-ECONOMIC GROUPS. SEPARATION OF PATIENTS INTO PRIVATE AND SERVICE PATIENT CATEGORIES.

REVENUE BASE OF THE HOSPITAL SHIFTS FROM A PRIMARY ORIENTATION TO VOLUNTARY CONTRIBUTIONS BY PHILANTHROPIC ELITE TO PATIENT PAYMENT FOR HOSPITAL SERVICES TEMPERED BY THE ABILITY TO PAY.

GRADUAL EMERGENCE OF THIRD PARTY INSURANCE GROUPS TO EXTEND HOSPITAL SERVICES TO BROAD SEGMENTS OF THE POPULATION.
INTEGRATE THE HOSPITAL INTO THE URBAN SETTING AND THE WEB OF MEDICAL PRACTICE.

CONTROL COSTS FOR LAND ACQUISITION, BUILDING CONSTRUCTION, MAINTENANCE, AND OPERATION.

UP-GRADE THE HOSPITAL TO ACCOMMODATE INCREASED RANGE OF ACTIVITIES GENERATED BY NEW DIAGNOSTIC AND TREATMENT MODALITIES AND TO CREATE AN ENVIRONMENT RESPONSIVE TO NEW SOCIAL ATTITUDES AND VALUES.
COMPACT THE DEVELOPMENT OF THE HOSPITAL COMPLEX TO REDUCE SITE REQUIREMENTS AND CONSTRUCTION COSTS.
CONCERNS FOR WARMTH, PRIVACY, AND ENVIRONMENTAL COMFORTS BECOME MORE IMPORTANT WITH THE USE OF THE HOSPITAL BY A BROADER SPECTRUM OF SOCIETY.

ADVANCES IN MEDICAL SCIENCE DEMONSTRATED THE CONTROL OF INFECTION THROUGH PROPER NURSING TECHNIQUES AND THE USE OF DISINFECTANTS. THE IMPORTANCE OF NATURAL VENTILATION WAS DIMINISHED BY THE ACCEPTANCE OF THE GERM THEORY.

THE DEVELOPMENT OF SEMI-PRIVATE CUBICLES WITH THE BEDS ORIENTED PARALLEL TO THE WALL TO AVOID THE GLARE FROM WINDOWS AND TO ENHANCE PRIVACY (FIRST DEVELOPED AT RIGGS HOSPITAL, COPENHAGEN). FULL ACCEPTANCE OF ARTIFICIAL HEATING SYSTEMS.

INCREASED COST FOR CONSTRUCTION OF CUBICLES VERSUS THE OPEN WARDS. NEW PATTERNS OF NURSING STAFFING Evolve WITH THE SHIFT FROM THE OPEN WARD ENVIRONMENT AND THE NEW PROBLEMS OF PATIENT OBSERVATION.

THE DESIGN OF NURSING UNITS WAS SIGNIFICANTLY BASED ON THE ORIENTATION OF ROOMS TO LIGHT AND BREEZE WITH CONCEPTS OF NURSING STAFFING PATTERNS AND TRAVEL DISTANCES SECONDARY CONSIDERATIONS.
GOODS processing and distribution

MATERIALS HANDLING ACTIVITIES FRAGMENTED ON MANY LEVELS WITHIN THE HOSPITAL WITH LITTLE COORDINATION OF SUPPLY ACTIVITIES.

MAJOR DEPARTMENTS OF THE HOSPITAL SUCH AS SURGERY AND EACH NURSING UNIT EXIST AS SELF-SUFFICIENT MATERIALS STORAGE AND REPROCESSING UNITS.

FOOD PRODUCTION BEGINS SHIFTS FROM DECENTRALIZED FLOOR KITCHENS TO CENTRALIZED FACILITIES UTILIZING NEW AUTOMATED DISTRIBUTION TECHNOLOGY.

ELEVATOR ALLOWS SEPARATE AND SEMI-AUTOMATED GOOD DISTRIBUTION AND FACILITATES THE CENTRALIZATION OF PROCESSING ACTIVITIES BY ALLOWING RAPID DISTRIBUTION TO NUMEROUS POINTS OF USE.

GRAVITY LINEN AND TRASH CHUTES AND DUMB WAITER FURTHER REINFORCE VERTICAL ORGANIZATION OF ACTIVITIES ABOUT A CORE OF SERVICE SHAFTS.
strategies for the ORGANIZATION of components


VERTICAL ORGANIZATION OF THE COMPONENTS OF THE HOSPITAL ABOUT THE ELEVATOR CORE, USE OF THE ELEVATOR ALLOWS DIRECT LINKAGE OF COMPONENTS WITHIN SMALL INCREMENTS OF TIME.

LIMITED USE OF MECHANICAL VENTILATION SYSTEMS. PLANNING OF INTERIOR SPACES RESTRICTED BY REQUIREMENTS FOR NATURAL LIGHT AND VENTILATION.

EVOLUTION OF DESIGN STRATEGIES WHICH ALLOWED GREATER RESPONSIVENESS IN THE PLANNING OF SPECIFIC DEPARTMENTS REFLECTED IN THE SHIFT FROM THE MONO-BLOCK TO THE STACKING OF LIKE SPACES.
THE ELEVATOR, FIRE-PROOFED SKELETAL STEEL CONSTRUCTION AND NEW FOUNDATION TECHNOLOGY, WHICH HAD DEVELOPED DURING THE LAST HALF OF NINETEENTH CENTURY WERE EMPLOYED TO SUPPORT NEW DESIGN STRATEGIES.

SOPHISTICATED HEATING AND VENTILATION STRATEGIES WHICH HAD BEEN EMPLOYED WITHIN THE FRAMEWORK OF MIASMIC THEORY WERE ABANDONED. THE USE OF BASIC VENTILATION SYSTEMS REQUIRED THE ORIENTATION OF ROOMS TO THE EXTERIOR AND GENERATED NARROW BUILDING WHICH RESTRICTED PLANNING.

VERTICAL ORGANIZATION SUPPORTED BY PRIMITIVE MATERIALS DISTRIBUTION TECHNOLOGY. GRAVITY LINEN AND TRASH CHUTES, DUMB WAITERS.
THE DEMISE OF THE MIASMIC THEORY OF DISEASE ELIMINATED THE PRIMARY SOURCE OF DESIGN DETERMINANTS ORIENTED TO THE CARE OF THE SICK. INFECTION CONTROL WAS NO LONGER A SIGNIFICANT DETERMINANT OF DESIGN.


LACK OF FLEXIBILITY IN THE PLANNING OF DEPARTMENTS DUE TO THE CONSTRAINTS OF STRUCTURE AND THE CONFIGURATION OF THE FLOORS ABOVE AND BELOW.

LACK OF FLEXIBILITY IN PLANNING DIAGNOSTIC AND TREATMENT AREAS PRODUCED BY THE NEED TO ORIENT SPACES TO THE EXTERIOR FOR LIGHT AND NATURAL VENTILATION.

FRAGMENTED RELATIONSHIPS BETWEEN COMPONENTS OF THE HOSPITAL PROVIDED BY THE VERTICAL ORGANIZATION OF ACTIVITIES WHICH BEGINS TO RESTRICT INTERACTION OF MEDICAL SPECIALTIES AND PATIENT CARE.
The post war period provided a new setting for the hospital design problem. There was an urgent need for hospital construction generated by the increased utilization of hospitals, and by the long period of minor construction activity due to the Depression and World War II. There was an expanded interest in efficient planning and operation of hospitals as the costs of health care increased and as the economic base shifted from the patient to third party providers, insurance companies and government. There was an expanded base of information, technology, and professionals to support a comprehensive focus on the design and function of health facilities. There was the emergence of the hospital into the public view, out of the graveyard and into the lifestream of society, with new attitudes and expectations. Finally, there was an attitude, a trust in the promises of planning, and a belief that, through careful analysis and planning, the utopian hospital facility might be structured. The post war era depicts the industrialization of the hospital, the design of hospital function, the application of new management and industrial technology, and development of design strategies about new concepts of hospital function.

The expanded interest in efficiency derived in part from the vigorous concern for the most effective use of resources which had developed with the Depression and World War II. From the wartime experience emerged a new group of professionals, the management and efficiency experts oriented to the application of engineering and management principles to achieve a more efficient and effective operation. This orientation to hospital function was reinforced by the simultaneous development of research units to provide background information, to conduct studies, and to stimulate the exchange of ideas and experiences.

The application of planning processes to provide improved health services developed on two major scales; one, the detailed planning of the internal function of the
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The application of planning processes to provide improved health services developed on two major scales; one, the detailed planning of the internal function of the
hospital facility; and the other, the regional planning of facilities, institutions and agencies which together comprised the health care system. The effectiveness of the latter was severely limited by the lack of definition, and acceptance of that definition of the total health care system; by the lack of political and economic controls to influence the large scale development of facilities; and by the broad resistance to such a rigidly structured system for fear of the controls which it necessarily establishes. The intertwining of the hospital with the political, economic, and philosophical structure of society can be clearly seen. Due to the resistance to planning on the regional level and the broad scale organization of Health Services, the most visible and dramatic implications of planning to surface were developed about the concerns for more efficient and effective function within the hospital facility.

The most significant aspect of this new planning effort was its focus on the processes of how a hospital should function vice the traditional orientation to the physical environment and the quantitative description of the rooms and equipment and their organization.

The new planning efforts were oriented to the definition of the dynamic processes of hospital function, to the development of more efficient and effective procedures of medical and nursing care and support services. Space, equipment and personnel needs were structured about functional systems which then formed the basis for the development of design strategies.

The primary directions in the planning of internal function were the centralization of likes types of activity and the specialization of tasks commensurate to training and experience of personnel to allow more efficient and effective use of people
and equipment. These directions were supported by a new management and technological base. New communications and materials distribution systems allowed the centralization of processing activities and the rapid response to users at remote points. Sophisticated management systems facilitated the reorganization of tasks and the monitoring and evaluation of new processes. The hospital became increasingly oriented to the movement of patients, staff and goods to and from centralized activity areas with a concomitant stressing of the horizontal and vertical movement systems of the hospital. With the centralization of activities, the hospital internally began to operate on a new collective level, and new levels of interdependence of the components to one another were established.

Design strategies developed about new organizational relationships created through the centralization of like activities and about the goods and information movement systems which supported them. From the experience with the limitations of the vertical organization of the components of the hospital which developed in Time Frame 3, new strategies emerged. These strategies were oriented to enhancing the responsiveness of the design to satisfy the expanding web of interrelationships which the new organization of functions produced and to respond to pressures of growth and change stimulated by advances in science and technology.

The traditional design constraints imposed by the requirements for natural light and ventilation were reshaped by the application of air conditioning to the hospital. Air conditioning allowed and encouraged the development of windowless rooms, which in turn allowed the development of wider structures. The development of "deep planning" strategies extended new freedoms in the planning of departments and the organization of activities and movement systems. With the development of spaces along the exterior for natural light and ventilation no longer a mandatory
design determinant, more dense concentration of activities could be structured and is reflected particularly in new designs for surgery and radiology. Deep planning allowed new organizations of circulation systems for the separation of the increasing in-patients, staff, goods, and public movement within the hospital and allowed more activities to be organized contiguous with one another to induce or promote functional interaction.

The centralization of like activities reinforced the design strategy for grouping like types of spaces; i.e., nursing, diagnostic-treatment, and building services. This strategy develops distinct "space defining structures" from the generalized requirements of each set of related or "like" problems. This approach allows the hospital design problem to be subdivided into more manageable problems and the design of the environments more responsive to the internal planning determinants. The stacking of "like types of space" contributed to the control of building costs by concentrating like types of construction and equipment. With this design approach of grouping like spaces the elements of the hospital emerged from the mono-block into distinct structures, each shaped by their own sets of formal determinants.

The materials distribution systems became the dominant framework for the organization of the components of the hospital. The dumbwaiter, the pneumatic tube, the trayveyor, and other automated systems were applied to the hospital to facilitate the centralization of like activities and to meet the rising problem of the high cost and shortage of labor. This first generation of hospital automation is distinguished by the vertical constraints which the use of these goods distribution systems imposed. These systems, and their vertical structure became the framework on which the components of the hospital were organized.
Time Frame 3 reflects the major interweaving of new technological support systems within the traditionally designed and constructed facility. The hospital structure becomes a support system for technology which in turn serves the inhabitants. Materials distribution and communication systems; increasingly complex support systems for medical and nursing needs – gases, electrical, and communications systems; and the complex requirements for air conditioning are in shafts, walls, and ceiling spaces. Costs and time of hospital construction increase, and more significantly, the responsiveness of the hospital environment to the changing needs of its inhabitants is restricted. The hospital, as traditionally designed, approached technological overload.

The first period of industrialization of the hospital focused on an analysis, design and optimization of the parts rather than the whole. The lack of a well established understanding of hospital function restricted the focus to specific aspects of function, and the solutions which these studies generated were often oriented to narrow considerations. It represents a design of sub-systems, but not their coordination and resolution into the total balanced system. It produced fragmented approaches heavily oriented to restricted ends.

The pursuit of efficiency and effectiveness of hospital function through application of technology and the organization of tasks became in itself an accelerator of change and obsolescence. The structure of the problem was constantly redefined with the evolution of medical and nursing procedures and the most effective or efficient response was modified with the developments of new support technology and with new concepts for the organization of tasks.
COMPONENTS of the hospital

The number and complexity of the components increases with the specialization of medical practice.

Centralization of functions generates new components.

Nursing environment shifts from cubicles to semi-private rooms. Increased design orientation to nursing patterns. Emergence of highly specialized nursing environments, such as intensive care, burn units, etc.

Expansion of diagnostic and treatment facilities—surgery, laboratories, radiology. Emerging medical specialties such as cardiology develop new space requirements.

Materials processing components consolidated. Shift of supply areas from within various elements of the complex to the new central supply department.

Development of specialty hospitals oriented to limited range of patient care programs which increasingly frustrates the more efficient and comprehensive delivery of care.

Specialty hospitals reflect the increasing complexity of the health care system.
RELATIONSHIP of hospital to the CITY

HOSPITAL FUNCTIONS AS A SELF-SUFFICIENT EMPIRE WITH MINIMAL DEPENDENCY ON THE CITY FOR SUPPORT SERVICES. MINIMAL USE OF DISPOSABLE AND EMPHASIS ON REPROCESSING OF LINENS AND MEDICAL SUPPLIES.

HOSPITAL SUPPORTED SCHOOL OF NURSING TO PROVIDE CAPTURED LABOR POOL. FRAGMENTED HEALTH CARE SYSTEMS PRODUCED BY THE DEVELOPMENT OF INDEPENDENT AND SEPARATE SPECIALTY HOSPITALS.

USE OF THE HOSPITAL BY A BROADER SPECTRUM OF SOCIETY AND FOR A WIDER VARIETY OF SERVICES—GREATER USE OF THE HOSPITAL REFLECTED IN INCREASED MATERNITY SERVICE.

DEVELOPMENT OF INSURANCE PROGRAMS MAKES HOSPITAL CARE AVAILABLE TO A LARGER SEGMENT OF THE MIDDLE CLASS POPULATION.
Hospitals often oriented to the treatment of specific illnesses or defects—polio hospital, TB hospital, etc., gradual shift of services into common facilities to allow more comprehensive and efficient care.

Role of the hospital enlarges from the care of the acutely ill to the delivery of preventive services and is marked by an increased use of hospital facilities by outpatients.

Increased spectrum of paramedical specialties—x-ray, lab tech, physical therapist and others expand hospital population.

Increased government participation in the construction of hospitals with the enactment of Hill-Burton program. Establishment of new federal guidelines and standards to control hospital construction and the organization of health services. Enactment of Medi-Care expands government support of hospital services.

Increased use of emergency rooms for routine medical services reflects the new image of the hospital as a community health center.
Problem:

INCREASED NEED FOR HOSPITAL CONSTRUCTION FOLLOWING THE LONG PERIOD OF INACTIVITY IN CONSTRUCTION DUE TO THE DEPRESSION AND WORLD WAR II.

INCREASED CONCERNS FOR THE COST OF HOSPITAL SERVICES. HOSPITAL LABOR BASE SHIFTS FROM THE DEDICATED WORKERS WITH PAYMENT IN SERVICES TO THE COMPETITIVE LABOR MARKET.

LIMITED FUNDS AND RESOURCES FOR CONSTRUCTION AND LIMITED MANPOWER STIMULATES SEARCH FOR MORE EFFICIENT AND EFFECTIVE FUNCTIONAL PROCEDURES.

GROWTH OF MEDICAL SPECIALTIES GENERATES NEW REQUIREMENTS FOR THE INTEGRATION OF ACTIVITIES.
INCREASING POLITICAL AND ECONOMIC CONTROLS SUCH AS HILL-BURTON PLANNING GROUPS ALLOW THE PLANNING OF FACILITIES WITHIN A MORE RATIONAL STRUCTURE.

DESIGN OF FUNCTIONAL PROCESSES OF THE HOSPITAL AS A BASIS FOR THE DEVELOPMENT OF THE DESIGN OF THE FACILITY.

CENTRALIZATION OF LIKE ACTIVITIES TO ALLOW EFFICIENT CONTROL OF MATERIALS AND MORE EFFECTIVE USE OF EQUIPMENT AND PEOPLE.

USE OF NEW AUTOMATED GOODS DISTRIBUTION SYSTEMS AND NEW COMMUNICATIONS SYSTEMS TO ALLOW CENTRALIZATION OF ACTIVITIES FORMERLY FRAGMENTED WITHIN THE COMPLEX.

CENTRALIZATION WITHIN TIME FRAME 3 WAS PRIMARILY WITHIN THE SUB-SYSTEMS, I.E., FOOD PREPARATION FUNCTIONS SHIFTED FROM FLOOR KITCHENS TO CENTRAL KITCHEN AND REPROCESSING AND STERILIZATION FUNCTIONS SHIFTED FROM INDIVIDUAL NURSING UNITS AND DEPARTMENTS TO A CENTRAL DEPARTMENT.
SHIFT FROM CUBICLES AND SIX TO EIGHT BEDWARDS TO SEMI-PRIVATE ROOMS.

DEVELOPMENT OF NEW CONCEPTS FOR GROUPING PATIENTS FOR MORE EFFECTIVE SERVICES SEEN IN DEVELOPMENT OF INTENSIVE CARE UNITS AND INTRODUCTION OF PROGRESSIVE PATIENT CARE SYSTEM.

FUNCTIONAL STUDIES OF NURSING UNIT DESIGN BY NUFFIELD TRUST IN ENGLAND, AND IN THE DESIGN OF ROCHESTER METHODIST HOSPITAL TYPIFIED THE DESIGN STRATEGIES DEVELOPED ABOUT NURSING STAFFING PATTERNS, TRAVEL DISTANCES, AND THE OBSERVATION OF PATIENTS.

NEW MATERIALS DISTRIBUTION SYSTEMS REMOVE REPROCESSING FUNCTIONS FROM THE NURSING UNIT. NEW COMMUNICATIONS SYSTEMS AND BUILT-IN MEDICAL GASES DISTRIBUTION SYSTEMS INCORPORATED IN NEW CONSTRUCTION.
AUTOMATED VERTICAL GOODS DISTRIBUTION SYSTEMS, NEW COMMUNICATIONS TECHNOLOGY, AND INDUSTRIAL MANAGEMENT TECHNIQUES EMPLOYED IN ORDER TO CENTRALIZE SUPPLY AND PROCESSING ACTIVITIES TO REDUCE INVENTORY AND TO MAKE MORE EFFECTIVE USE OF PERSONNEL.

MATERIALS REPROCESSING AND STERILIZATION ACTIVITIES SHIFTED FROM MAJOR AREAS SUCH AS SURGERY AND NURSING UNITS TO A CENTRAL AREA FOR GREATER CONTROL AND EFFICIENCY. DEVELOPMENT OF THE CENTRAL SUPPLY OR STERILE REPROCESSING UNIT.

SLOW INTRODUCTION OF THE PRE-PACKAGED DISPOSABLE ITEM INTO HOSPITAL USE, WHICH SLOWLY SHIFTS THE CENTRAL REPROCESSING AND STERILIZATION DEPARTMENT FROM A REPROCESSING ORIENTATION TO A READY STORAGE AND DISTRIBUTION FUNCTION AND DEVELOPS NEW LINKAGES TO THE PURCHASING DEPARTMENT.

CENTRALIZATION OF FOOD PREPARATION ACTIVITIES FROM FLOOR KITCHENS TO CENTRAL KITCHENS MADE POSSIBLE BY THE NEW DISTRIBUTION SYSTEMS AND BY THE NEW FOOD SERVICE SYSTEMS - THE PELLET SYSTEM AND THE HOT/COLD FOOD CART.
strategies for the ORGANIZATION of components

ORGANIZATION OF COMPONENTS OF THE HOSPITAL ABOUT AUTOMATED DISTRIBUTION SYSTEMS.

EMPLOYMENT OF ELEVATOR, DUMBWAITER, TRAY-VEYOR, PNEUMATIC TUBE, ETC., TO ACHIEVE OPERATIONAL ECONOMIES.

APPLICATION OF AIR CONDITIONING TO ALLOW DEVELOPMENT OF WINDOWLESS ROOMS, AND TO EXTEND FREEDOM IN PLANNING DEPARTMENTS OF THE HOSPITAL. PLANNING DETERMINANTS SHIFT FROM THE ORIENTATION OF SPACES TO THE EXTERIOR FOR LIGHT AND AIR TO THE INTERNAL FUNCTIONAL REQUIREMENTS OF DEPARTMENTS. NEW DESIGNS FOR SURGERY AND RADIOLOGY DEVELOP WHICH SEPARATE HORIZONTAL MOVEMENT OF PATIENTS, GOODS AND STAFF.

ZONING OF LIKE SPACES A PRODUCT OF INDUSTRIAL ENGINEERING TO CENTRALIZE LIKE ACTIVITIES FOR GREAT EFFICIENCY AND EFFECTIVENESS OF OPERATION AND AN ARCHITECTURAL RESPONSE FOR GREATER PLANNING FLEXIBILITY.

ZONING OF LIKE SPACES DEVELOPS FROM THE CENTRALIZATION OF LIKE ACTIVITIES AND PRODUCES DISTINCT STRUCTURES TO MEET DESIGN DETERMINANTS OF EACH PROBLEM SET.

VERTICAL ORGANIZATION OF "LIKE SPACES" ALLOWS CONCENTRATION OF LIKE TYPES OF CONSTRUCTION AND PROVIDES BUILDING ECONOMIES.
BUILDING TECHNOLOGY

MAJOR APPLICATION OF MECHANICAL VENTILATION AND AIR CONDITIONING WITHIN DIAGNOSTIC/TREATMENT, ADMINISTRATIVE, AND MATERIALS PROCESSING AREAS ALLOWS NEW PLANNING FREEDOMS, GREATER CONTROL OF INFECTION, AND INCREASED COMFORT.

DEVELOPMENT AND EXTENSIVE USE OF AUTOMATED GOODS DISTRIBUTION SYSTEMS SUCH AS THE DUMBWAITER, TRAY-VEYOR, AND PNEUMATIC TUBE.

SHIFT FROM PORTABLE SERVICES TO ASSIST PATIENT CARE-OXYGEN, SUCTION, ETC., TO BUILT-IN SYSTEMS.
NEW DESIGN STRATEGIES DEVELOPED FOR CONTROL OF INFECTION, PARTICULARLY IN SURGICAL SUITE, USING THE SEPARATION OF MOVEMENT SYSTEMS AFFORDED BY AIR CONDITIONING.

STRUCTURING OF ACTIVITIES FOR THE INCREASED INTERACTION OF MEDICAL AND NURSING STAFF-

EARLY ATTEMPTS TO DEFINE THE HEALTH SYSTEM AND DEVELOP FACILITIES WITHIN THE FRAMEWORK OF LARGER NEEDS REFLECTED IN EARLY WORK OF PUBLIC HEALTH STUDIES AND HILL-BURTON PLANNING PROGRAMS.

FOCUS ON PLANNING OF FUNCTION TO PROVIDE EFFECTIVE AND EFFICIENT SERVICES, CONCERNS FOR THE PROPER PROGRAMMING OF SPACES AND EQUIPMENT TO ALLOW THE MOST BALANCED UTILIZATION OF THE FACILITY REFLECT THE ETHIC OF RESOURCE CONSERVATION AND THE ORIENTATION NOT ONLY TO THE HOSPITALIZED PATIENT, BUT THE NEEDS OF SOCIETY.

FOCUS ON EFFICIENT OPERATION GENERATES A LARGE NUMBER OF DESIRED RELATIONSHIPS WITH LITTLE HARD DATA TO SUPPORT SPECIFIC DECISIONS.
LIMITATIONS

TECHNICAL OVERLOAD OF THE BUILDING STRUCTURE WITH INCREASINGLY COMPLEX SUPPORT SERVICES AND THE RIGIDITY OF THESE SERVICES TO THE INCREASING NEED FOR FLEXIBILITY.

STRESSING OF MOVEMENT AND COMMUNICATION SYSTEMS BY THE INCREASED VOLUME AND CRITICALITY OF MOVEMENT PATTERNS GENERATED BY CENTRALIZATION OF LIKE ACTIVITIES.


RAPID OBSOLESCENCE OF DESIGNS DEVELOPED ABOUT HIGHLY SPECIFIC FUNCTION CONCEPTS PRODUCED BY THE RAPID DEVELOPMENT OF NEW SUPPORT SYSTEMS AND BY THE CHANGING NEEDS.

DYNAMICS OF MEDICAL SCIENCE FRUSTRATE PLANNING PROJECTIONS AND SHIFT DESIGN PRIORITIES FROM THE FIT TO SPECIFIC PROBLEMS TO THE FLEXIBILITY TO MEET MANY.
1965 - 1971: STRATEGIES FOR GROWTH AND CHANGE

An undercurrent begins to appear in hospital design thought which can be seen gathering increased attention and expression. It is a reaction to the increased problems of growth, change, and obsolescence in hospitals; to the increased complexity of servicing hospitals with technology; and to the frustrations of the lengthening process of planning. It develops from an enlarged understanding of efficiency in the management of resources, and from a growing architectural interest in an aesthetic derived from an expression of building technology and the formal determinants inherent within the design problem. These directions shift design strategies from an orientation about highly specific concepts of function to a focus on more generalized concepts for the creation of more flexible and responsive environments. The philosophical base for these strategies is reflected in the writings of John Weeks and the physical expression is developed in the separation of the fixed and flexible elements of the hospital facility and the creation of open-ended structures.

The changing approach to hospital design developed from the changing nature of the hospital as an institution. Advances in medical science and building technology reshaped the internal function of the hospital and the steady evolution of the political, economic and philosophical base of the health care system served to redefine the role and function of the hospital in society and to knit together the fragmented components of the health care system. These changes enlarge the hospital design problem and mark the development of the more complex health facility and medical center design problem. Increasing economic and political pressures for more comprehensive, effective and efficient health services generated new organizational relationships of institutions and activities. As the orientations of medicine expanded from illness to health, new needs and responsibilities emerged which required increased support services and the integration of health care programs which often were scattered among several institutions and agencies. These new
pressures precipitated the restructuring of highly specialized health care institutions such as TB, polio, and orthopedic hospitals which had developed with little control in the previous decade, and forced the accommodation of an enlarged spectrum of activities and space needs within the hospital environment. The increasing costs of health care, the growing role of insurance companies and government as the economic base of hospital services, and the increasing political cry for control of costs and organization of health services developed a new base of political and economic influence which begins to structure directly and indirectly the organization of health services.

The physical restructuring of the health care system is visible in the first stage of this transition as the clustering of health care institutions and agencies within a common area; the second stage becomes the weaving of programs among these and other institutions and the development of shared services; the emerging third stage becomes the structuring of programs of various institutions within a common physical framework. The design determinants of this new environment develop from the larger spectrum of needs of various intertwined service systems of society.

This new structure expands the determinants of hospital design from a focus on internal function to an external orientation to the broad needs of society, and extends beyond health services to include educational and community service roles. The pressure for growth in the hospital facility is not limited to the expansive growth of the traditional components. The needs emerge for the additive growth of new components to the hospital complex, for the accommodation of new activities and institutions and the integration of political components of the pluralistic society into a framework which preserves identity and autonomy but which enhances the integration of services. The new invisible structure of the
design problem develops from the needs of the interfacing systems of health care, education, research and community service.

Internally, the functional nature of the hospital was reshaped by expanding medical science and technology which restructured medical and nursing procedures and which generated new demands on the hospital environment to support patient care. These new pressures are most visibly reflected in the increasingly sophisticated and specialized care programs such as the diagnosis and treatment of cardiovascular diseases, with their complex requirements for support equipment, staff and specialized nursing care.

Similarly, the emergence of new technologies for the efficient and effective support of nursing and medical procedures reshaped traditional patterns of function and generated new design alternatives. These new technologies include the evolution of the second generation of goods distribution systems which provided automated horizontal as well as vertical movement and the development of new concepts of materials processes and food preparation.

The emerging nature of the hospital function reflects the attempt to develop the hospital internally as a balanced system, to coordinate the various subsystems and to structure activities on levels most appropriate to their own determinants. These efforts were supported by the total "systems" orientation of the Time Frame and by the significant success of such approaches in the space program.

These systems investigations began to identify an increased priority for the horizontal relationship of like elements of functional subsystems and began to shift the organizational structure of the hospital from a more rigid definition of independent nodes, often physically organized vertically, to a highly interactive molecule.
comprised of numerous elements and held together by their overlapping bonds. This new orientation to the horizontal organization of like activities began to challenge the previous design strategies for stacking like spaces and precipitated the evolution of new design strategies. The horizontal structuring of subsystems produced three distinct layers of activity, the materials processing level, the diagnostic and treatment level, and the enlarged nursing level, and is reflected in the work of Sheila Clibbon, Le Corbusier's hospital for Venice, and in most of the major projects of the Time Frame.

The design of the nursing unit reflects the restructuring of activities on new and overlapping scales to allow specific tasks to be performed on the level at which they are most efficient and effective. The larger horizontal organization of the nursing environment establishes a broad range of scales which allow greater administrative flexibility in the shifting organization of patient care and support services.

The development of design strategies structured about the comprehensive planning of hospital function was discouraged by several factors. The limitations of design strategies oriented to highly specific functional processes, which built in early obsolescence, were reorganized. These strategies had developed facilities upon highly specific concepts of function and employed specific sets of goods distribution hardware, which were both made comparatively inefficient or ineffective by the rapid emergence of new technology and changing needs. The highly specific nature of these designs proved to be unresponsive to the shifting organization of activities within the hospital. The tailor-made facility could not adapt to changing needs.
Planning became less significant in controlling costs with the acceleration of change in hospital function, and with the rapid inflation in the national economy, the speed of design and construction became increasingly important in providing cost savings. With increasing frustrations due to the lengthening planning process, time became an increasingly significant design determinant and reinforced design strategies which allowed an overlap in the planning, design, and construction processes.

With the increased value of time, the evaluation of efficiency in hospital design extended beyond the static evaluation of first costs into the dynamic consideration of operating costs. The development of design decisions based on long-range considerations was made possible by the accumulation of data through research studies initiated earlier in Time Frame 3. The hospital design problem increasingly became colored by the total economic setting of the Time Frame and the hospital moved from its formerly independent financial base into a competitive market similar to that on which other building types develop.

The increasingly complex needs generated by health care and research activities for support systems such as special air handling systems, communications, and goods movement systems, make the hospital increasingly difficult to design and construct, and increasingly unresponsive to modifications in the face of needs for flexibility and responsiveness stimulated the development of new design strategies.

Growth and change are processes observable in most building types, but in the hospital these forces took a new dimension and priority. The nature of the activities within the hospital require the adaptation of the environment to the
to the needs of the activities and allow a narrow range of variation to meet the constraints of the environment. The management or control of change was made exceedingly difficult by the diverse background of scientific and technological advances and political and economic pressures from which it was developed. Against these needs for flexibility the hospital stood rigid and inflexible, with the responsiveness in extreme disproportion to the need.

From this new orientation to growth and change, the hospital design problem formed a complex architectural design challenge. The hospital design problem was reoriented from highly specific functional requirements developed about medical and nursing procedures to the more traditional architectural problem for the organization of building components to the general requirements of flexibility. This change in the nature of the design problem began to push the hospital design problem within the larger scope of architectural practice and into the forefront of design challenges.

A number of developments converge within the emerging structure of hospital design problem and become mutually reinforcing; the development of generalized design strategies oriented to growth and change, the need for design strategies allowing a more manageable subdivision of design tasks, the mounting interests in the development of building systems, the conception of a dynamic aesthetic generated by the requirements of the users within a broadly established design framework, and the emergence of new groups oriented to the development of specific aspects of interior planning.

From the expanding nature of the hospital design problem emerges the conception of the hospital as a microcosm of the city. The hospital brings together both
mechanistic and humanistic design determinants. It requires the organization of activities for efficient and effective flow of people, goods, and information, and integrates these needs with environmental requirements for the reflection of human dignity and the support of health. The hospital reflects various characteristics of the city; both share similar problems of the organization and control of movement patterns and both are distinguished by the interweaving of diverse social, political and economic considerations. The design methodologies, design strategies, and aesthetics of the city and the hospital intertwine. The hospital becomes an omni-structure, containing a broad range of the diverse activities of the city, and supplants the skyscraper as the vibrant architectural design problem. From a position behind the wings of architecture, cloaked in special dogmas, rules, and rigid design determinants which made it highly specialized, unexciting and formally limiting, the hospital has moved to a central position in the development of architectural theory and design.

This shift of the hospital from a closed, tightly structured, and inwardly oriented design problem on the periphery of architectural practice to a more open, externally oriented, and generalized problem was reinforced by the convergence of the fundamental tenets of hospital design theory with new design attitudes and approaches emerging from the mainstream of architectural thought.

Hospital design theory had oriented design to the creation of environments which assist the care and recovery of the sick, with first the miasmic theory, and later a morality of resource conservation as the mechanism for translating this generalized precept into specific design decisions. The aesthetic of hospital design, in theory, if not in practice, was the direct expression of the determinants which shaped the design solution.
From the general mainstream of architectural practice emerged the concept of an aesthetic derived from the expression of the internal determinants of the problem and the search for a design approach more purposefully oriented to the needs of the inhabitants. These directions are reflected in the writings and work of architectural protagonists such as Team 10, the Metabolists, and later the Archigram group. Design strategies which these groups advocated had evolved from early concepts of city planning and were oriented to solving urban problems as they emerged in the postwar era. These strategies were oriented to the generalized problem of growth and change and were distinguished by their organization of movement systems. These strategies provided a stimulus for the development of new hospital design strategies. These new strategies were a continuation of the earlier attempts to separate the hospital design problem into smaller and more manageable components and were oriented to the separation of fixed and flexible elements of the facility and to the organization of open-ended circulation systems. These concepts can be seen evolving in the organization of "served and servant spaces" by the Architect, Louis Kahn, in the organization of circulation networks exemplified in the design of the University of Free Berlin by Candilis, Josic, Woods, and in the fundamental utilization of plug-in technology.

To enhance flexibility for growth and change, both during and after the design process, design strategies emerged for splitting the hospital facility into "fixed and flexible" elements, the fixed supporting infrastructure of structure and servicing networks and the flexible human activity areas. The design of the infrastructure was oriented to the organization of people and the goods movement networks and the utilities and energy servicing systems and can be compared to the establishment of transportation networks of the city, or the nervous and circulatory systems of the human body.
The separation of fixed and flexible elements can be seen in plan and section and can be interpreted generally as a separation between the fixed "space defining" elements and the more changing "place defining" elements. In plan, the separation of fixed and flexible element is most clearly seen as the establishment of fixed horizontal and movement elements and flexible loft space areas in which a broad range of activities can be developed. In section, the building or space defining elements of structure and the mechanical and other servicing systems are established as a separate, fixed organization of hardware which is independent of the more flexible place defining elements of partitions, ceilings, and equipment which are organized to support specific activities. This latter vertical separation of fixed building servicing systems from the people plane developed as the concept of the inter-mechanical floor or "interstitial space".

The fundamental basis of this strategy was the recognition of two independent life spans of buildings; on one hand, the life span of the building components, the structure, the mechanical systems, the utility and power networks; and on the other, the life span of human activities for which these materials were organized and assembled.

When the rate of change of human activities was slower or in its nature less demanding on the environment for support, obsolescence was a simultaneous product of changing human needs, the degeneration of the support system, primarily the mechanical system, and the amortization of the financial investment in the facility. With the more rapid change of human needs as well as their more complex demands on the architectural environment, the life span of the architectural artifact became increasingly out-of-phase with the activities for which they were
being assembled. Obsolescence of expensive facilities aggravated the financial burdens of the institution and generated new barriers to change.

Strategies for separating the fixed supporting systems of structure, utility distribution, and environment controls from the flexible human activity plane were reinforced by an increased orientation of the design profession to the "integration of building systems", in which the structural system, mechanical, electrical, and plumbing system, and ceiling, partition, and exterior wall systems were designed and organized to allow the creation of more economical, flexible, and serviceable environments.

The basic characteristics of the new building system in hospital design are the use of long span structural systems to reduce the restraints imposed in the planning of the flexible people space and the design of the structural components to allow the integration of mechanical and utility distribution systems within the greater depth of the structural members which is required for the greater span.

These new approaches to the design of building systems were developed about the expanded understanding of efficiency in the organization of building components and of the long-term evaluation of operational benefits provided by investments for future growth and change. Flexibility in design requires a large measure of "over design" to allow tolerance for future modifications and adjustments. Flexibility was limited in previous design approach which optimized the design of the individual components to the minimum initial requirements, i.e., the smallest column size, smallest duct size, etc., to produce the lowest possible building cost. The new approaches in the design of building systems reflect the transition of attitudes seen in hospital planning, from the optimization of subsystems to the optimization of the whole.
The new strategies of hospital design are reflected in their extreme form in the concept of universal space. This module of flexible loft space, of approximately 10,000 square feet, forms a common structural, mechanical and exit module and establishes the basic module of planning and the smallest increment of growth. It forms a platform, serviced above and below with supporting utilities, one which a broad range of undefined activities can be structured. This concept, which is employed in the design of McMaster Health Sciences Center and in the New York State Medical Center bear a notable similarity to the design concepts for the University of Free Berlin by Candilis, Josic, Woods and to Yona Friedmann's plan for the redevelopment of Paris. The concept of universal space structures a utopian grid of space, the three-dimensional zoning of land, and its use by other components of the city is suggested in the nature of the concept.

With design strategies which allow a separate focus on the internal functional problems of the hospital, architecture reaches a fork in its development. The problem of hospital design does not disappear, it only shifts to another arena. The problem of the size and the nature of patient grouping; the type, number, relationships of diagnostic and treatment services; the concepts of materials processing and distribution to be employed all remain, but the resolution of these problems becomes an increasingly less significant determinant of architectural design. Architecture becomes more the organization of circulation systems and the volumetric organization of spaces and support services as derived from general rather than specific parameters.

These problems are far from the internal problems of hospital function; their resolution merely forms the base, the stage, from which a number of solutions
to the interior design of the micro-environment may develop as required through time. The total strategy is reflected in the theater, a grid of support systems which services changing human drama and settings. If one can design a theater without the script of the play, can one design a hospital without a narrative of how it will function?

The problems of developing the specific interior environment, defined in all its dimensions and qualities remains. The base for the solution is established, the stage is constructed; needed are the set designers.
NURSING FUNCTIONS CONTINUE INCREASING SPECIALIZATION BY TYPE AND DEGREE OF CARE, FROM SELF CARE UNIT TO INTENSIVE AND CARDIAC CARE UNITS.

DEVELOPMENT OF HIGHLY SPECIALIZED DIAGNOSTIC AND TREATMENT COMPONENTS SUCH AS NUCLEAR MEDICINE AND URIDYNAMICS.

INTEGRATION OF PHYSICIANS' OFFICES INTO THE HOSPITAL FACILITY. EXPANSION OF AMBULATORY CARE SERVICES AND INTRODUCTION OF NEW MULTI-PHASE SCREENING UNITS TO PROVIDE MORE COMPREHENSIVE SERVICES.

INCREASED EDUCATIONAL AND RESEARCH PROGRAMS STRUCTURED WITHIN THE HOSPITAL, GENERATING NEW REQUIREMENTS FOR SPACE AND SPECIFIC RELATIONSHIPS TO OTHER ACTIVITIES.
HOSPITAL EXTENDS ITS DEPENDENCY ON THE CITY FOR A BROAD RANGE OF EDUCATIONAL AND SUPPORT SERVICES.

DEVELOPMENT OF SHARED OR JOINT FACILITIES FOR MATERIALS PURCHASING, STORAGE, AND LAUNDRY.


THE USE OF SHARED COMPUTERS AND OTHER ADMINISTRATIVE AND ACCOUNTING SYSTEMS FURTHER REFLECTS THE INTERFACING OF THE ACTIVITIES OF THE HOSPITAL WITH BROADER SYSTEMS OF THE CITY.

THE INTERTWINING OF THE HOSPITAL AND MEDICAL PRACTICE CONTINUES, SHIFTING FROM THE DOCTOR'S WORKSHOP TO BECOME THE BASE FOR THE DOCTOR'S OFFICE AND THE ORGANIZER OF CARE PROGRAMS.

THE INTEGRATION OF SERVICE PROGRAMS WITH OTHER INSTITUTIONS REFLECTED IN GROWING NUMBER OF AFFILIATIONS. HOSPITAL-BASED NURSING SCHOOLS PHASED OUT AND COORDINATION WITH JUNIOR COLLEGE AND UNIVERSITY FOR A BROAD RANGE OF HEALTH MANPOWER NEEDS.
Patient population shifts in composition to the extremes in ages—the very young with developmental disorders and the very old with degenerative disorders.

Patients with multiple defects precipitate the structuring of a broad spectrum of specialists and supporting services to provide comprehensive and continuing care.

Medi-Care and Medic-Aid programs expand government participation in the health care system. The economic base of the hospital continues to shift to government and insurance companies, establishing new procedures and standards and reshaping directly and indirectly the health care system.

Hospital population becomes increasingly diverse, including a broadening range of employees and students.
ALLOW RAPID PROJECT DELIVERY BY RESHAPING TRADITIONAL PROCESSES. THE ESCALATION OF CONSTRUCTION COSTS AND THE LENGTHENING OF PLANNING DESIGN AND CONSTRUCTION PROCESS STIMULATE MORE RAPID DESIGN PROCESSES.

PROVIDE FLEXIBILITY FOR PHYSICAL CHANGE--AS THE RATE OF CHANGE OF HEALTH CARE PROCESSES INCREASES THE FLEXIBILITY OF THE FACILITY BECOMES ITS WEAPON AGAINST OBSOLESCEENCE.

ACCOMMODATE THE PHYSICAL RESTRUCTURING OF COMPONENTS OF THE HEALTH CARE SYSTEM TO PROVIDE MORE COMPREHENSIVE AND EFFICIENT SERVICES.
THE SEPARATION OF FIXED AND FLEXIBLE ELEMENTS OF THE BUILDING STRUCTURE TO FACILITATE CHANGE AND EXTEND FLEXIBILITY.

THE ORGANIZATION OF OPEN-ENDED MOVEMENT SYSTEMS TO PROMOTE GROWTH OF THE COMPLEX.

THE HORIZONTAL ORGANIZATION OF LIKE ACTIVITIES TO ALLOW MORE INTEGRATION AND COORDINATION OF ACTIVITIES.

INCREASE THE BUILDING BUDGET TO ALLOW FOR THE NECESSARY PROVISIONS FOR GROWTH AND FLEXIBILITY.
INCREASING SPECIALIZATION OF NURSING UNITS (METABOLIC, RENAL DIALYSIS, INTENSIVE CARE, ETC.) WITH SPECIAL DESIGN REQUIREMENTS.

SHIFT FROM SEMI-PRIVATE TO PRIVATE ROOMS. DEVELOPMENT OF NEW CONFIGURATIONS TO ALLOW DENSE CLUSTERING OF PRIVATE ROOM MODULES ABOUT NURSING PATTERNS. EXPLORATIONS OF THE MINIMUM PRIVATE ROOM. NEW CONSIDERATIONS FOR THE ROOM-IN PARENT OR RELATIVE.

RESTRUCTURING OF NURSING ACTIVITIES WITH NEW CONCEPTS OF TEAM NURSING AND INTEGRATION OF PARAMEDICAL AND SUPPORT PERSONNEL. INTRODUCTION OF WARD CLERKS AND UNIT MANAGERS REFLECTS NEW NURSING MANAGEMENT CONCEPTS.

DEVELOPMENT OF LARGE NURSING FLOORS (120 TO 150 BEDS) TO ALLOW THE ORGANIZATION OF NURSING AND SUPPORT ACTIVITIES ON THE SCALE ON WHICH EACH IS MOST EFFICIENT, DECENTRALIZATION OF SUPPORT ACTIVITIES SUCH AS PHARMACY SUPPLY, DIETARY AND SOCIAL WORK TO THIS LARGER NURSING FLOOR FOR MORE COMPREHENSIVE SERVICES.

NEW ORGANIZATION REFLECTS INTERDEPENDENCY ON OTHER COMPONENTS AND REQUIRES INCREASED COMMUNICATION AND COORDINATION.
CENTRALIZATION OF ALL MAJOR MATERIALS MANAGEMENT FUNCTIONS—RECEIVING, STORAGE, DISTRIBUTION, AND DECONTAMINATION. INTEGRATION OF ALL MATERIALS DISTRIBUTION SUBSYSTEMS—PHARMACY, DIETARY, CLEAN SUPPLIES, WASTES—INTO A COMMON SYSTEM.

UTILIZATION OF NEW GOODS DISTRIBUTION SYSTEMS CAPABLE OF AUTOMATED HORIZONTAL AND VERTICAL MOVEMENT (TELELIFT—CYBERAIL—AMSCAR—ETC.) THESE NEW SYSTEMS SUPPORT DESIGN STRATEGIES WHICH DEVELOP LARGE HORIZONTAL ORGANIZATIONS OF ACTIVITIES.

INCREASED DEPENDENCE ON FACILITIES OUTSIDE THE HOSPITAL—JOINT LAUNDRY, PURCHASING, ETC., USE OF DISPOSABLES AND CONVENIENCE FOODS, INCREASES RELIANCE ON THE SUPPLIER FOR IMMEDIATE DELIVERY.

FOOD PREPARATION SHIFTS TO THE NURSING FLOOR WITH THE INTRODUCTION OF CONVENIENCE FOODS. SATELLITE PHARMACY WITH UNIT DOSE DISTRIBUTION REFLECTS SHIFTING ORGANIZATION OF ACTIVITIES AND THEIR INCREASING INTERWEAVING WITH CLINICAL PATIENT CARE PROGRAMS.

WARD CLERK REPRESENTS THE EXTENSION OF THE MATERIALS MANAGEMENT SYSTEM OUT OF THE PHYSICAL CONFINES OF THE CENTRAL SERVICE UNIT TO WORK IN PARALLEL WITH NURSING.

MOVEMENT AND DISPOSAL OF WASTE BECOME MORE SIGNIFICANT PROBLEMS WITH INCREASED USE OF DISPOSABLES. NEW WASTE TRANSPORT SYSTEMS DEVELOPED—(PNEUMATIC LINEN AND TRASH CHUTE SYSTEMS FOR AUTOMATED HORIZONTAL AND VERTICAL MOVEMENT OF WASTES) WHICH COMPLEMENT DESIGN STRATEGIES FOR LARGE NURSING AND DIAGNOSTIC/TREATMENT LEVELS.
strategies for the ORGANIZATION of components

SEPARATION OF FIXED HORIZONTAL AND VERTICAL MOVEMENT SYSTEMS FROM FLEXIBLE LOFT SPACE AREAS. ORGANIZATION OF OPEN-ENDED CIRCULATION NETWORKS TO FACILITATE THE ADDITIVE GROWTH OF THE COMPLEX.

ACTIVITY CENTERS AS FLEXIBLE SPACES WHICH PLUG INTO THE FIXED MOVEMENT SYSTEMS.

VERTICAL SEPARATION OF DISTINCT MOVEMENT SYSTEMS DEVELOPED FROM CONCEPTS OF URBAN MOVEMENTS SYSTEMS (MULTI-LEVEL CITY).

THREE-DIMENSIONAL GRID OF SPACES AND CIRCULATION NETWORK ORGANIZED FROM GENERALIZED PARAMETERS OF ACCESS, GROWTH, LINKAGE, AND LIGHT.

SEPARATION OF FLEXIBLE PEOPLE ZONE FROM SUPPORTING NETWORK OF SERVICES DEVELOPED AS THE CONCEPT OF INTERSTITIAL SPACE TO EXTEND FLEXIBILITY FOR PHYSICAL CHANGE.

DESIGN SEARCH FOR THE MODULE OR UNIVERSAL SPACE IN WHICH THE ACTIVITIES OF THE MEGA-CENTER--FROM NURSING TO SPECIALIZED RESEARCH AND TREATMENT ACTIVITIES--CAN BE DEVELOPED.

HORIZONTAL ORGANIZATION OF LIKE ACTIVITIES TO ALLOW GREATER COORDINATION AND FLEXIBILITY.
ARCHITECTURAL INVESTIGATIONS IN THE INTEGRATION OF BUILDING SYSTEMS TO PROVIDE INCREASED PERFORMANCE AND LOWER COSTS. (SCSD - VA STUDIES)

USE OF LONG SPAN STRUCTURAL SYSTEMS TO MINIMIZE PLANNING RESTRICTIONS AND INCREASE LONG-TERM FLEXIBILITY.

SEPARATION OF BUILDING SUPPORT SYSTEMS FROM ELEMENTS WHICH FORM ENVIRONMENTS FOR PEOPLE ACTIVITIES SEEN IN THE CONCEPT OF INTERSTITIAL SPACE AND FORMS.

"SERVED" AND "SERVANT" SPACES IN PLAN AND SECTION.

VERTICAL DIMENSION IN THE CEILING SANDWICH INCREASED TO MINIMIZE CRITICAL COORDINATION IN MECHANICAL SYSTEMS AND TO ALLOW DAILY MAINTENANCE AND UP-GRADING OF SYSTEMS WITHOUT DISRUPTION OF HOSPITAL ACTIVITIES.

DEVELOPMENT OF PRE-FABRICATED COMPONENTS, SUCH AS THE PLUG-IN BATHROOM, PATIENT HEAD-WALL UNITS (AND WITH THE BOX CONSTRUCTION SYSTEM, THE PATIENT ROOM ITSELF) WHICH MODIFIES THE DESIGN PROCESS TO THE SELECTION AND INTEGRATION OF PRE-DESIGNED PACKAGES INTO A BASIC FRAMEWORK.

ADVANCED AIR FILTRATION AND DISTRIBUTION SYSTEMS WHICH DEVELOPED FROM NEEDS OF THE SPACE PROGRAM PROVIDE NEW DIMENSIONS OF INFECTION CONTROL.

SECOND GENERATION OF GOODS DISTRIBUTION SYSTEMS DEVELOPED WHICH PROVIDE AUTOMATED HORIZONTAL AND VERTICAL MOVEMENT.
DESIGN TO ASSIST IN THE RECOVERY OF THE SICK THROUGH THE ORGANIZATION OF THE ACTIVITIES OF THE COMPLEX TO CONCENTRATE PEOPLE AND EQUIPMENT ABOUT THE MOST CRITICALLY ILL. PATIENT ASSUMED ILL AND REQUIRING THE MOST COMPREHENSIVE SERVICE UNTIL PROVEN OTHERWISE.

INCREASED ATTENTION TO THE CONCEPT OF HABITABILITY AND TO STUDIES IN PSYCHOLOGY AND IN MENTAL HOSPITALS OF THE ROLE OF THE ARCHITECTURE IN THE DEVELOPMENT OF A SENSE OF WELL-BEING AND IN FOSTERING SOCIAL DEVELOPMENT.

THE CONCEPT OF INDETERMINATE ARCHITECTURE DEVELOPS AS A DYNAMIC EXPRESSION OF USER NEEDS AND AN AESTHETIC OF GROWTH AND CHANGE.

MORE EFFECTIVE USE OF FINANCIAL AND MANPOWER RESOURCES THROUGH THE COORDINATION OF SERVICE PROGRAMS AND DEVELOPMENT OF SHARED FACILITIES.

FOCUS ON THE BROAD FRAMEWORK OF THE HEALTH CARE SYSTEM FOR THE RESTRUCTURING OF INSTITUTIONS AND AGENCIES.
THE ORIENTATION TO GENERALIZED PROBLEMS MAY CREATE AN ENVIRONMENT UNRESPONSIVE TO THE UNIQUE REQUIREMENTS GENERATED BY HEALTH CARE PROCESSES. THE MODULE OF UNIVERSAL SPACE CAN BECOME A THROWBACK TO THE BLOCK HOSPITAL.

THE PREMIUM FOR FLEXIBILITY MAY PROVE UNJUSTIFIED. THE MAJOR MODIFICATIONS MAY BE ITS GRADUAL UP-GRADING THROUGH NEW EQUIPMENT. (THE EXACT NATURE OF PHYSICAL CHANGE IN HOSPITALS NEEDS MORE THOROUGH STUDY).

MAJOR CHANGES IN THE ENVIRONMENT MAY BE BETTER MET WITH THE CONCEPT OF THE DISPOSABLE BUILDING.
CONCLUSION

Four basic developments can be identified which offer the possibility of extending the problem-solving dimensions of architecture, and allowing the new form of the health facility to develop.

First, the redefinition of the design problem by the reorganization of activities within the framework of the larger service systems of society.

Second, the reshaping of attitudes toward identity, autonomy, and financing to allow new design alternatives.

Third, evolution of new design strategies for accommodating and organizing the mixed activities of the expanded design problem.

Fourth, extension of new design dimensions to more sensitively organize activities and more comprehensively develop the interior settings in which these activities unfold.

The evolution of these major areas can be seen in the present and emerging nature of the hospital design problem.

The hospital is in transition from an inward orientation to problems of internal function to an external orientation to the evolving system of health care. This metamorphosis of the hospital suggests a new organization of the hospital environment; it generates new design determinants and stimulates new design strategies.

From the nature of the new hospital design problem, with its increased scope and scale, new loft space design strategies have emerged, oriented to the generalized problems of growth and change. These strategies themselves begin to reshape
the design process and suggest new patterns of architectural practice. The metamorphosis of the hospital design problem begins to suggest a new model of change which is restructuring the activities and form of the city.

The orientation of design to problems of growth and change generated strategies which attempted to minimize planning restrictions through the separation of fixed and flexible elements of the facility both in plan and in section. These strategies structure two distinct design problems; the first, the organization of fixed movement systems and the three dimensional zoning of loft spaces and their network of servicing systems which together form the infrastructure; and second, the finishing of loft space areas and the definition of specific micro-scale environments about the activities and needs of the users.

This subdivision of the design problem suggests a separation of the design process into two distinct activities and the emergence of a new design team equipped with new professional skills and oriented to the increasingly complex task of creating the micro-scale environment.

This split of the design problem can be seen in the design of office buildings, shopping centers, and factories. The design and construction of the structural and servicing systems forms a distinct problem, often handled by one firm, and the finishing of the interior to the needs of specific tenants becomes a separate responsibility, handled by an emerging new profession of environmentalists, which is reflected in the field of "office landscaping". In health facility design it suggests the structuring of a new team embracing a broad range of skills and
equipped with specific training to coordinate functional programs and design the interior environment. The role of the architect in the creation and maintenance of the "built" environment now extends in time beyond the concept of first use. The interior team can service the environment through its lifetime, diagnosing new needs, responding to changing activities, and adjusting the setting to more appropriately meet the needs of the user.

The interior design team would pull together the basic perspectives and skills of architecture, interior design, psychology and industrial engineering. The composition of this team would attempt to provide a more comprehensive base of skills for the creation of the micro-scale environment. From industrial engineering it would draw the technology for the analysis of work flow and the management of space and equipment on a cost/benefit basis. It would attempt to draw from observations in the behavioral sciences on the role of the environment and the organization of spaces in fostering patterns of social development and communication. It would attempt to apply a new understanding of the mechanisms of perception and the role of the environment in creating a "state of well-being" which has developed from recent studies in psychology. The purpose of this team is to consolidate skills which have traditionally been fragmented and to allow a more penetrating focus and response to the needs of the users. Because of the broad scope of activities structured within the hospital, the skills of such a team are not limited to health facilities and possess implications on the practice of architecture.

Such a team must operate from an enlarged base. The ability to develop comprehensive understanding of hospital function and the environmental needs of
its users is severely limited within the existing structure of architectural practice. Architectural practice is remote from the problem in time and space. The time which separates the design of specific solutions from their use, and evaluation delays the feedback evaluation of design decisions. The fundamental framework of architectural practice is solution oriented and not problem oriented, and the role of the architect as an "expert" hinders a clear understanding of new problems. A new threshold, a new doorstep, must be developed to allow the meeting of architectural practice and the user of health facilities freer communication and more rapid and detailed analysis of problems and solutions. Such a forum would provide an expanded dimension of architectural education. The next generation of breakthroughs in design is more likely to emerge from the reorganization of existing and developing design skills than from the evolution of new building technology.

Several pre-conditions for the success of this new approach to hospital design can be identified; one, client acceptance of a new process, with new expectations of design and architecture at points in its development; two, a valid framework within which the interior environment is developed; and three, the capability, depth and strength of the internal design group to offer more than can be presently achieved.

Of these pre-conditions, the validity of the infrastructure poses the most serious problem, for the history of hospital design is the orientation to the idiosyncrasies of function, to the uncompromising requirements of health care. The possible breakdown of the infrastructure system can develop on two major levels, in the
design restrictions inherent in the basic module of universal space or the building system, and in the organizational structure of spaces and circulation networks.

The determinants for the organization of the infrastructure expand with the metamorphosis of the hospital from the more limited concerns for the internal functional systems of patient care and its support. The evolving health care system begins to provide the invisible structure upon which the programs of the hospital are developed. Moreover, it begins to intertwine with other service systems of society, educational and social, to structure new patterns of activity, with their concomitant physical needs of space, equipment, and affinity to other elements.

This restructuring of activities of society upon the framework of intertwined service systems becomes increasingly significant in reshaping the physical environment. Health care institutions and agencies which formally existed apart from the hospital require an increasingly closer relationship—for the convenience of staff and patients, to achieve operational economies through the sharing of services and to provide more comprehensive and specialized services. Activities which formerly were housed within separate facilities begin to merge into the common physical setting of the hospital.

Specialized agencies begin to seek the umbrella of the hospital to more effectively deliver their services and, similarly, hospitals begin to actively seek affiliations which complement their programs. Educational, service and research activities of various institutions and corporations become interwoven within the hospital.
with the concomitant enhancement of patient care programs and the symbiotic
development of the total spectrum of activities.

The forces motivating this restructuring of activities are primarily the economic
concerns for the control of the rising costs of health care and the moral concerns
for the structuring of more comprehensive and balanced services. The emergence
of federal legislation supporting health care planning groups stimulates this
restructuring of activities, but more significant, however, are federal programs
which reinforce self-structuring through financial grants and incentives.

The expansion of health care services generated new manpower requirements
which in turn stimulated new educational programs. The hospital became a signifi-
cant base for a larger range of educational programs and these programs developed
new space needs and new physical affinities between the components of the hos-
pital facility.

The term hospital becomes increasingly imprecise and misleading as the range
widens between the comparatively simple hospital and the increasingly complex
health facility. As the hospital design problem evolves into the medical center
design problem, the new sets of design strategies assume a new appropriateness.

The evolution of the medical center design problem reflects the physical impli-
cations generated by the evolving health and educational systems. The medical
center has evolved from a weakly related clustering of health care institutions
into an increasingly interdependent structure of institutions often developed
within a tightly controlled and planned area in order to enhance the coordination of programs, the development of new scales of shared services, and the interweaving of other educational and research institutions. This increasing functional interaction and interdependence of institutions and their tightening physical relationships, is reflected in the development of other areas of the city, particularly in the shopping center and commercial complexes. These reflect the emergence of the new scale of organization and development, one which requires an open-ended structure for the physical accommodation of new activities and linkages.

The traditional restrictions which shaped the physical development of the medical center environment are political and economic in nature. The political concept of a building as the basis for identity and autonomy has continued the development
of separate, independent facilities for each institution. This pattern of development is reinforced by traditional financing practices which required the development of separate structures which can be acquired in the event of foreclosure.

These political restrictions begin to give under the pressures for the reorganization of activities within the framework of emerging service systems. The problem of identity becomes increasingly less important to the user and subservient to the needs for the convenience and comprehensiveness of services. Mechanisms for preserving autonomy through the control of space exist through leasing and its variations and are expanded further by the concepts of the condominium development. Furthermore, these new mechanisms allow financial flexibilities which make them increasingly attractive alternatives to traditional forms of ownership. With these new attitudes toward identity and ownership, new physical settings for the delivery of services could be considered and the range of design alternatives expanded.

The new hospital design strategies oriented to growth and change are tailored to a rental society. The ability and interest of various institutions or departments to pay high rental costs for relationships within the circulation network provides a gaming mechanism by which activities of the whole can be organized; rent becomes the measure of propensity with which activities exist within the system; it becomes the dynamic monitor and balancing force.
The new medical center becomes less the organization of political empires and more the structuring of programs of health care, education, research and community service for the optimization of the larger service systems of society. The design problem expands from the traditional organization of building components and volumetric organization of space to include the design and organization of programs and activities. The opportunities for the significant improvement of the quality of life are expanded by the enlarged scope and comprehensiveness of the design problem. Architecture shifts its orientation from design for the problem to the design of the problem. The design of service systems portends new frontiers within which the architectural profession can make significant contributions.

The nature of the restructuring of activities which has evolved the medical center has had two components: the more visible shift of activities and institutions formerly within the larger and more loosely structured framework of society into the physical setting of the medical center for the increased interfacing of programs; and the less visible decentralization of activities and services into the fabric of the city.

This process of redistributing activities within society transforms the medical center into an urban node of reinforcing activities of a particular scale, scope, and character. The medical center becomes a gigantic institutional complex and its physical structure increasingly will be shaped by functional requirements derived from the invisible determinants of the service systems and less by political and social needs for the identity and autonomy of separate institutions.
The integration of health care, educational, research and social services transforms the medical center into a multi-faceted institutional complex. The composition of such a complex could be projected in Houston, with the physical and functional synthesis of Rice University, the Texas Medical Center, and the surrounding institutions, into a new physical environment in which activities were reorganized to be more responsive to their collective needs.

On the opposite scale, the services of the hospital are being restructured into the community and into the patterns of everyday life. Perhaps the hospital as we know it today will continue to be the "illness center", and the delivery of ambulatory and preventive health services will be restructured within new environments.

The intertwining of service systems which is reflected in the medical center will continue on the community scale. Perhaps the components of the educational system will emerge as the magnets and provide the physical setting for these new health care services. The school begins to expand its role from the education of a selected segment of the community, with limited periods of use, and like the medical center, assume mixed activities. The school may become the "health center" in its larger concept, conducting educational, recreational and health care programs on a new scale, oriented to the total community, not a narrow band of its population.

A new form of the city emerges, a clustering of activities not by type or by political or economic base, but by the common scale on which they function, the common spectrum of society which they serve, the common integration and support which they provide. The city becomes a hierarchy of service centers which integrate the functions of life into common settings.
The organizational design problems of this environment will be similar to those within the hospital as they are emerging today. The metamorphosis of the hospital is reflected in all facets of society and the same design strategies, the same framework of determinants and the same design methodology offers applications on the mega-scale.

"Building" and "institution" are no longer synonymous, a congruent political and physical module. The hospital becomes a pattern of loft space with activities structured about the requirements for access, linkage, light, growth, and affinity to other elements. This new hospital development houses a community of institutions and its physical environment is developed from the larger understanding of the functional interaction of its components. It becomes a microcosm of the city and the prototype of new urban environment derived from a new understanding of the physical design implications of an interdependent society.


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**Time Frame**

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