NBS BUILDING SCIENCE SERIES 54

U.S. DEPARTMENT OF COMMERCE / National Bureau of Standards

Health and Medical Facilities Design

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Health and Medical Facilities Design

Proceedings of the
First Federal Agency Workshop

Held at the
National Bureau of Standards
Gaithersburg, Maryland
December 5, 1972

Edited by

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Washington, D.C. 20234

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NATIONAL BUREAU OF STANDARDS, Richard W. Roberts, *Director*

Issued July 1974

Library of Congress Cataloging in Publication Data

Federal Agency Workshop on Health and Medical Facilities
Design, 1st, National Bureau of Standards, 1972.
Health and Medical Facilities Design.

(National Bureau of Standards Building Science Series, 54)
Supt. of Docs. No.: C13.29/2:54.

1. Health facilities—Design and construction—Congresses. I. Kapsch, Robert J., ed. II. United States. National Bureau of Standards. III. Title. IV. Series: United States. National Bureau of Standards. Building Science Series, 54. [DNLM: 1. Facility design and construction—Congresses. 2. Health facility planning—Congresses. 3. Hospital design and construction—Congresses. W3FE253 1972p/WX140 F293 1972p]

TA435.U58 No. 54 [RA967] 690'.08s [725'.5] 74-10561

National Bureau of Standards Building Science Series 54

Nat. Bur. Stand. (U.S.), Bldg. Sci. Ser. 54, 87 pages (July 1974)
CODEN: BSSNBV

U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON: 1974

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402
(Order by SD Catalog No. C1 29/2:54). Price $1.25.

FOREWORD

Dr. James R. Wright
Director, Center for Building Technology, IAT
National Bureau of Standards
Department of Commerce

Building research at the National Bureau of Standards is over fifty years old. However, it has only been recently that we have been sponsoring monthly meetings for Federal agencies interested in the planning, design and construction of buildings. This Federal Agency Workshop, on Health and Medical Facilities Design, is an example of these meetings held by the Center. In addition to our Federal Agency Workshop Program, the Center for Building Technology seeks to disseminate building research results from other countries through formal agreements, translations, and exchange of technical teams. In addition, the Center sponsors interdisciplinary research efforts from our 220 professionals and 40 disciplines for other Federal agencies on topics such as housing, energy conservation, office buildings, physical security and many others. It is through these efforts that we at the Center hope to aid professionals engaged in providing improved housing and places of work for Americans through building research and the effective dissemination of research results.

PREFACE

Samuel Kramer
Chief, Office of Federal Building Technology
Center for Building Technology, IAT
National Bureau of Standards
Department of Commerce

The Program of Federal Agency Workshops in building research was established at the National Bureau of Standards by a request from the Office of Management and Budget over four years ago. This program was established to coordinate the construction activities of the various Federal agencies, to provide a means for the reporting of recent building research results and to provide a forum for the Federal agencies to discuss their common building related problems. By all measures, this program has proved to be a success. This publication contains the proceedings of one of our workshops, on Health and Medical Facilities Design. The presentations made in this workshop were primarily given by representatives of other Federal agencies, such as Department of Defense, Veterans' Administration, Department of Health, Education and Welfare. The scope of these agencies research into the planning, design and construction of health and medical facilities is certainly extensive. Based on the comments that we received after this workshop, it was decided that the Center for Building Technology would have a regular workshop program in the area of medical facility planning, design and construction.

ABSTRACT

The Federal agencies have a large involvement in the area of Medical Facility Design; both in directly operated Federal facilities and indirectly through grant, loan and funding programs. Because of the impact of technology and because of the very large cost for new medical facilities; the last few years there has been the rise of a field best described as medical facility research. These papers, presented at a National Bureau of Standards Federal Agency Workshop, describe the latest medical facility research efforts by the Federal agencies including the Department of Defense, Department of Health, Education and Welfare, the Veterans' Administration and the National Bureau of Standards.

Keywords: Architecture; design; hospital design; medical facilities; medical facility research.

NATIONAL BUREAU OF STANDARDS BUILDING SCIENCE SERIES 54, Proceedings of the First Federal Agency Workshop, December 5, 1972, Gaithersburg, Md. (Issued July 1974)

INTRODUCTION

Robert J. Kapsch
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Department of Commerce

The Federal agencies have a large involvement in the area of Medical Facilities Design. Over 400 hospitals in the United States, representing over 160,000 hospital beds, are directly operated by Federal agencies, including the Department of Health, Education and Welfare (HEW), the Department of Defense (DoD), and the Veterans' Administration (VA). Besides hospitals and other medical care facilities which are directly operated, Federal agencies effect the design of non-Federal hospitals and other medical care facilities through programs such as the Hill-Burton Program of HEW for construction loans, medical facility standards and technical advice; Federal Housing Administrations' (HUD) program for loan guarantees, Medicare/Medicaid reimbursement for health care providers; National Institute of Health's grants for medical research facilities and others.

In the last ten years medical facilities have become much more complex. Sophisticated equipment such as electronic physiological monitors, automated laboratory testing devices have been introduced into many American hospitals. There has also been an increasing use of electronic data processing techniques and automated material handling systems.

Along with the increased level of complexity has come an increase in cost in constructing new medical facilities. Once new medical facilities, although never inexpensive, cost relatively modest amounts of money to plan, design and construct. Now however, under the impact of the application of technology, there are several new medical facilities either under design or construction whose costs exceed $100 million.

Because of the impact of technology on medical facilities and because of the cost of new medical facilities in the last few years we have seen the rise of a field of study that can be best described as medical facility research. In the past, medical facility planners and designers have engaged in some limited research efforts. However, these efforts usually engaged no more than one, two or three professionals. The medical facility research projects that have been undertaken in the last few years are of a much different nature. These efforts have been of a large scale, some taking years to complete.

Whereas the traditional medical facility research has been accomplished by one or two individuals within the organization responsible for designing the facility, these new medical facility research efforts typically call for the assistance of several external organizations. Finally, where traditional medical facility research has used one and perhaps two disciplines, these new medical facility research efforts have been truly multidisciplinary.

The rise of medical facility research is not a phenomenon unique to the United States. Rather, it is a worldwide trend in those countries which are facing the impact of technology in medical facilities and the great increase in cost of medical facilities. For example, the Ministry of Health in Great Britain for the last few years has been sponsoring Project HARNESS, a medical facility research project to optimize the design and construction of new hospitals. Sweden is another country engaged in such a program. The Institute for the Planning and Rationalization of Health Services and Social Welfare (SPRI) was established in 1968 to conduct these investigations. One of SPRI's primary missions has been to improve the planning, design and construction of medical facilities in Sweden through research.

The papers given in this workshop illustrate the growth of medical facility research in the United States in the last few years. Mr. Sigmund Gerber describes a major Department of Defense development effort to generate a New Generation of Military Hospitals, by incorporating the latest available technology. John Reese of the Hill-Burton Program, a program which has been actively engaged in medical facility research for many years, presents the latest standards for medical facilities developed by that organization. Howard Fogarty and Bruce Keane describe the extensive use by the VA of computers to aid in the planning and programming of new medical facilities. In the area of building systems, John Cook describes the VA's extensive medical facility research project, "The VA Hospital Building System." Donald Boyle and Joseph Russo discuss HEW's use of new management concepts for the planning, design and construction of new medical facilities. Finally, Robert Wehrli describes the National Bureau of Standards' own work in this area, an evaluation methodology for nursing units.

These papers summarize efforts which represent millions of dollars spent on medical facility research by the Federal agencies. It is through efforts such as these that we hope to improve the comfort and care of the patient, enhance the effectiveness and efficiency of the medical staff, and provide medical facilities at a cost the Nation can afford.

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NATIONAL BUREAU OF STANDARDS BUILDING SCIENCE SERIES 54, Proceedings of the First Federal Agency Workshop, December 5, 1972, Gaithersburg, Md. (Issued July 1974)

The New Generation Hospital

Sigmund I. Gerber
Director of Construction Standards and Design
Office of the Secretary of Defense
Department of Defense

ABSTRACT The Department of Defense has some 240 major hospitals and 460 dispensaries serving over 10 million people and employing about one quarter of a million medical and allied personnel. In 1968, a new project was initiated; A New Generation of Military Hospitals. The objectives of this project were to provide a more efficient health care delivery system through the extensive use of technology. The project consisted of two phases; Phase I was the systems analysis study of military and civilian hospitals and Phase II was the design and construction of a test bed military hospital. A number of recommendations resulted from Phase I, including use of a completely computerized hospital, convenience food system, light care nursing, out-patient surgery and others. Travis Air Force Base in California was selected as the site for implementation of Phase II. The organization and the planning of this project are discussed. The beneficial occupancy of the Phase II, Travis Hospital is scheduled for 1977.

Keywords: Architecture; design; hospital design; medical facilities; military construction; new generation military hospital; system design.

The Department of Defense (DoD) and the Military Departments, from time to time, do make contributions to the welfare of the Nation in the way of spin-offs from our own R&D efforts in the development of things for our own requirements. For example, we have been responsible for the development of:

Fire retardent paints - fiberglass screening - infrared photography - and even the caterpillar earth movers are patterned after Army tanks.

In recent years - starting with Secretary of Defense McNamara's prodding, the Department of Defense has been involved in developments which not only would have benefit to the Defense Department, but to the Nation as a whole on a social basis. Recent examples have been in the field of industrialized housing. Additionally, we have invited industry to use our vast housing and building inventory as a test bed for trying new products or to dramatize items to convince building authorities of their merit.

The discussion item of today is in the same view. Worldwide, Defense has some 240 major hospitals and 460 dispensaries serving over 10 million people and employing about one quarter of a million medical and allied personnel. This medical logistical set up costs about $1½ billion annually to operate, plus $60 to $100 million more for the annual capital investment of new construction, alterations and installed equipment.

So, it was natural that we take some initiative in this area to make it both responsive efficient and cost effective.

The Department of Defense, along with the entire medical profession, has been greatly concerned with the increasing cost of medical care, both with the in-house and ambulatory beneficiaries.

The Surgeons General are reasonably satisfied with the high quality of care that the beneficiaries are receiving. But realizing that everything is subject to improvement, late in 1968 Secretary Clark Clifford announced that we would take a leadership role via a new investigative project, entitled A New Generation of Military Hospitals with a number of objectives in view:

The first of these was to develop a health care delivery system that would be more efficient, diminish operating costs, and at the same time not only maintain, but, hopefully, improve the quality of care of the recipients. To satisfy this objective, it was envisioned that a significantly changed hospital model would evolve, and include all of the features embodied in a hospital of advanced design with particular emphasis on the exciting assistance offered through electronics -- both with computer techniques and communications.

The medical departments of the Army, Navy and Air Force have already been pioneering in the field of automation in various areas -- some concentrating on the laboratory phase of automation with multichanneled devices, some concentrating on the business management end and the cost disbursement area, others have experimented in communications, transport of material, flexible facility design and construction -- and the development of centralized or regional registries.

In essence, then, what we are doing is not absolutely new -- But, it does represent the first effort of this scale to combine and assimilate in an orderly fashion, in one operating medical facility, as many of these existing, proven, practices which can be cost-effectively married.

The Office of the Assistant Secretary of Defense (Health and Environment) prepared a formal project proposal calling for a two-phase effort as follows:

Phase I: This was to be a systems analysis study of hospitals, military and civilian, with a view toward reducing life-cycle costs at no reduction in the quality level of patient care. Primary responsibility for this phase would be the Office of the Director of Defense Research and Engineering (DDR&E).

Phase II: This would consist of the design and construction of a test bed military hospital for the purpose of incorporating and evaluating the recommendations emanating from Phase I. Primary responsibility for this phase would rest with the Office of the Assistant Secretary of Defense for Installations and Logistics (in which I work).

In early 1969, Secretary of Defense Laird (you see, there were a lot of players in the act -- first McNamara, then Clifford, and now Laird -- but all with the same objective) gave approval to the project, and work was begun on Phase I. A request for proposals went out to industry and 28 consortiums, representing just about everyone well-known in the systems analysis and medical planning business, responded. From this group, 7 firms were selected for interviews and, finally, contracts were signed with two consortia -- one headed up by the Westinghouse Electric Corporation of Pittsburg with the architectural firm of RTKL from Baltimore, and medical consultants from Johns Hopkins University; and the other group was headed by Arthur D. Little (ADL), Incorporated of Cambridge, Massachusetts with Lester Gorsline Associates - SRS Consultants and the architectural firm of Campbell, Aldrich and Nultry from Boston. It was intended by DDR&E to sign up as many as three separate firms in order to get divergent views on the subject, for about a total of $1½ million. However, the available funds would permit only two contracts -- actually these two contracts cost about $1.7 million ($780,000 + $900,000).

Over the year in which the contractors conducted their studies, regular progress reviews were held by a multidisciplinary panel with representatives from various parts of the Office of the Secretary of Defense, including Research and Engineering, Health and Environment, Installations and Logistics, Systems Analysis, the Comptroller, the Military Departments, and representatives from Health, Education and Welfare, and the Veterans Administration.

The two contractors finished their work and submitted their reports by May 1971. At that time, a Tri-Service panel with both medical and engineering members, reviewed the studies and extracted all of the recommendations. These came to 259 items. However, after further screening and consolidation of items, a net list of some 80 major recommendations evolved to be included in the new facility. There were, of course, other recommendations -- some which were appropriate for immediate application to retrofit situations; some which required policy decisions, such as extended (evening and/or weekend) hours for the outpatient clinics; and still others which will require continued R&D effort.

Among the more prominent recommendations accepted were:

1. Develop a completely computerized hospital system, drawing from the many existing fragmentary systems now in use at certain military and civilian hospitals.

2. Utilize the convenience food system and provide in-house preparation of the convenience food stock.

3. Develop light care nursing facilities, primarily for the category of patients who are not seriously ill, but are not well enough to go back to duty -- and those who have been admitted but are ambulatory and need not be confined to bed. I will discuss this light care aspect in more depth a little later, because of its magnitude and potential impact on costs.

4. Develop outpatient surgery to achieve savings in the number of beds required. This, as most of you know, is becoming increasingly popular throughout the private medical sector.

5. Develop physician assistants program to achieve a higher utilization of scarce professional staff. Such programs are underway -- but should be intensified.

6. Use multiphasic testing.

7. Extend the use of high cost clinical and operating facilities for more efficient utilization. (Longer hours - not a problem with the professionals, they can be directed, but there is a problem with administrative and clerical staffs).

8. Use the demand model, a computerized method of developing and predicting the specific requirements for medical facilities. A proper demand model cannot be downplayed in its importance, it will give you the specificity of current and expected demands in each area of required health services.

9. Design the physical plant so that it is susceptible to both expansion and/or alteration with little or no adverse impact to its daily operations. The two contractors had vastly differing ideas of how to accomplish this.

Lester Gorsline (working with ADL), as most of you know, is an interstitial space man -- RTKL (working with Westinghouse) seemed to combine the best of several functional designs we have been exposed to recently -- limited use of interstitial space, emphasis on vertical utility cores, and a minimal number of structural components reused in a very repetitive manner.

10. Establish an Evaluation Board of authorities with expertise in both hospital management and facility design to evaluate the merit of the end product.

The Department of Defense Medical Planning Review Board, which annually updates the Military Departments' Five-Year Construction Plan, in April 1971 designated the Travis Air Force Base Hospital, proposed for fiscal year 1975 funding, as the test bed hospital for Phase II development. Travis AFB was selected over the other candidate projects proposed because:

- Of the inpatient bed requirement of about 600 beds.
- (Actually there is an additional requirement of another 160 beds as a staging facility in support of Air Force's air evacuation program.)
- There is an outpatient load of approximately one-half million visits per year.
- It is near the Davis Campus of the University of California, which has a medical school, so there is teaching capability.
- And the proposed Travis hospital, which is actually a replacement facility, is of high enough priority to insure that it will be included in the annual legislative program.

Deputy Secretary of Defense, David Packard, at that time made the further determination that this phase should be handled under the Defense Systems Acquisition Review Council model of management. Under this system, a single manager is designated and tasked to carry out the total effort, and he, in turn, reports to a high level council composed of three Assistant Secretaries of Defense, namely that for Installations and Logistics, Health and Environment, and the Comptroller. I have been designated to serve as the Executive Secretary of the Council.

The Air Force, as owner of the Travis AFB hospital, has been designated to assume the Program Manager responsibility. Deputy Assistant Secretary of the Air Force for Installations, Lewis E. Turner, was named by the Air Force to be the Program Manager. Under his direction, Colonel Roy Lemons has been designated as Special Projects Officer. (See Figure 1.)

The Program Manager is presently administering three sub-tasks as follows:

1. By contract with Westinghouse Electric Corporation, an analysis of the beneficial population to be served, a quantification of the medical missions, and a documentation of the total project scope and cost. The end product is referred to as the Demand Model. We are also planning to enter into a supplemental contract with Westinghouse to have them develop a handbook -- a step by step guide for the development of a Demand Model for the general use by the Military Departments and any other interested Federal agencies.

2. A second contract is with Benham-Blair, an architectural firm from Oklahoma City with much expertise in the design of medical facilities, for a review of existing DoD medical facility criteria, a review of the Phase I study recommendations, and the development of a total design guidance package. This includes a review and recommended changes to the Class A & B equipment lists. With the recent demise of Office of Management and Budget (OMB) Circular A-57, an extra responsibility has been placed on those Federal agencies involved in the design of medical facilities or for the issuance of design criteria covering the design. Of import also, is the currency of the equipment lists; that is, what is to be contractor furnished and what is to be Government furnished and contractor installed. As many of you know, as soon as a contractor is given the award, he shops around for his equipment to install. The warranty starts upon delivery -- and it may not be put in use for two years or more. Additionally, certain items are undergoing design advancements -- and if they are purchased 2 or 3 years later, a more advanced model becomes available.

3. The third task being undertaken by Air Force is an in-house analysis of medical facility computer software, available to both the military and to the private sector -- worldwide -- including a compilation of state-of-the-art components and development goals for use at the Travis AFB test bed hospital.

The first two tasks, the Westinghouse Demand Model and the Benham-Blair study, are approaching completion at this time, and the software program is a continuing effort with no fixed termination.

At this point, permit me to elaborate on the Demand Model and its findings. A careful analysis indicated that Travis serves a geographic area with a radius of about 25 miles. This includes active duty personnel, their dependents, military retirees and their dependents. Bed demand was based on an 80% occupancy rate and clinical visits based on actual count (excluding immunizations). The data were broken down to the speciality distribution and resource requirements. Be mindful that we are addressing all kinds of services from pediatrics to geriatrics. The base data reflected 1972 -- and these were then projected for 1975, 1980 and 1985. Projections were based on known population growth patterns and the historical, recent experience in type of specialities being served and the trends of each. The bed requirement for 1972 was 594, for 1975 - 617, for 1980 - 648, and for 1985 - 668. Because of the 20% factor of

PHASE II
MANAGEMENT STRUCTURE
NEW GENERATION MILITARY HOSPITAL PROJECT

ACQUISITION REVIEW COUNCIL - OSD

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ASD(H&E) - Dr. Wilbur
ASD(C) - Mr. Moot

Executive Secretary (I&H) - Mr. Gerber

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Navy	Navy
AF	AF

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Hospital Planning Subcommittee
Dr. Kenneth B. Babcock
Dr. James E. McCormack

AF PROGRAM MANAGEMENT COMMITTEE

SAFILI - Mr. Turner, Chairman
AFSG - Lt. Gen. Patterson
AFPRE - Maj. Gen. Reilly
SAFMRP - Mr. Goode

AF SPECIAL PROJECT OFFICE

AFPRE - Col. Lemons, Project Officer
Staff - Medical Officer - Engineer Officer
Others as Required

DESIGN & CONSTRUCTION AGENCY - NAVFAC

Design Operation Group - Hq NavFac
Constr Contract Office - WestDiv, NavFac

FIGURE 1

NORMAL MEDICAL FACILITY DEVELOPMENT PROCEDURE

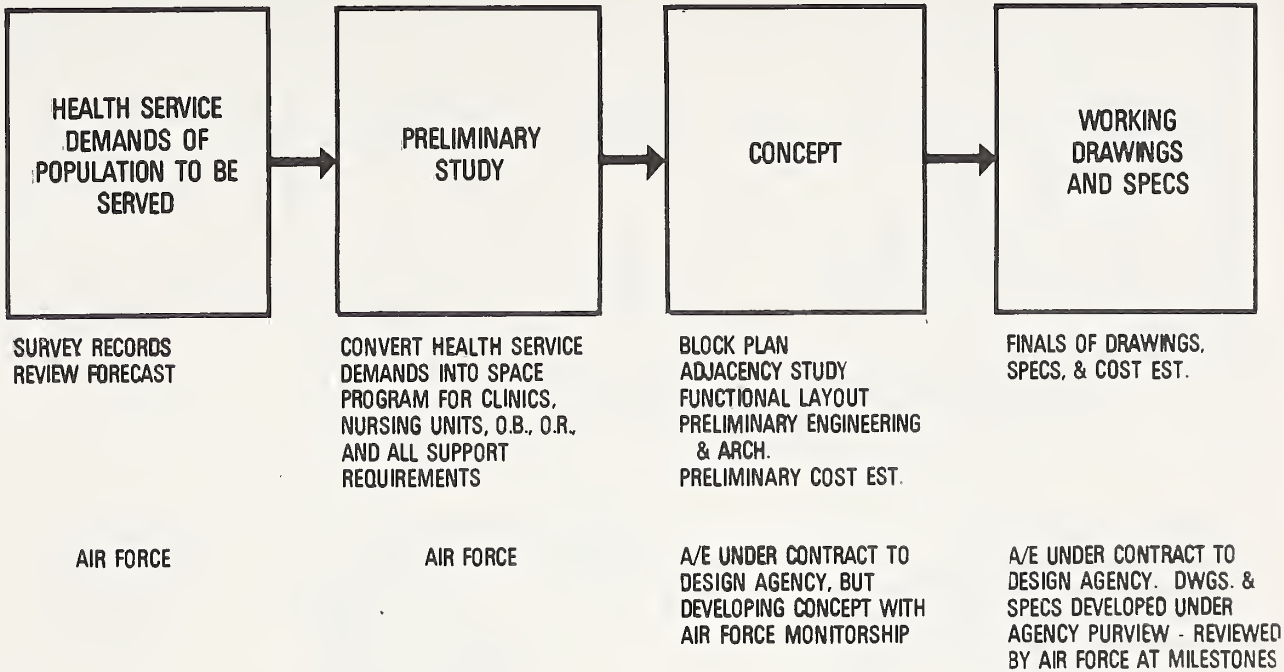


Figure 2

occupancy rate and because the physical plant is to be susceptible to alteration and/or expansion, it was determined that the bed size should be 600. Broken down by level of care:

Intensive Care	10	1.7%	
Heavy	105	17.5%	(includes 12 CCU)
Moderate	268	44.7%	
Light	217	36.1%	
	600 Beds	100%	

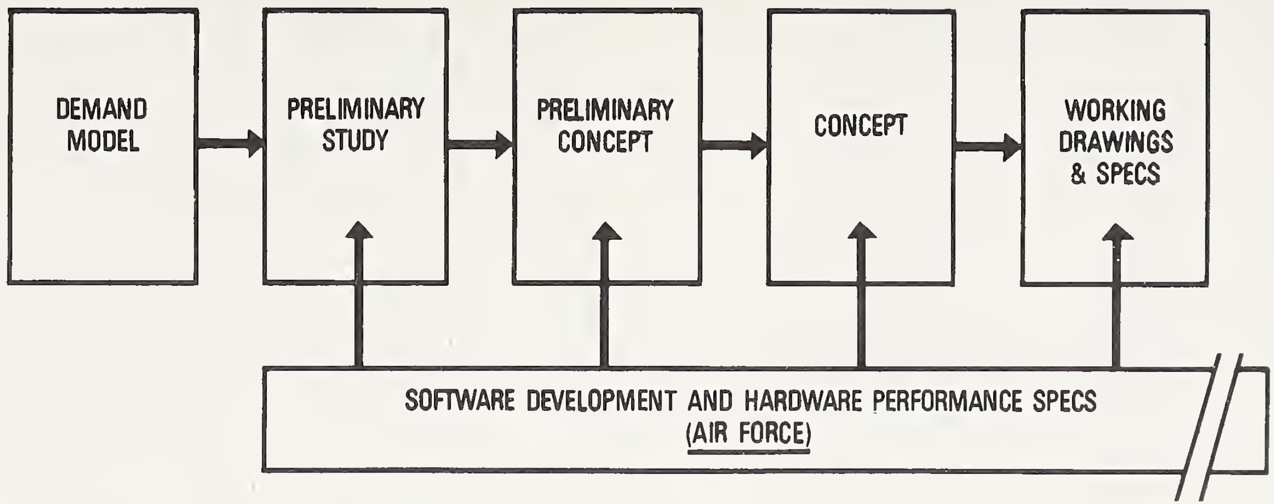
I wish to highlight the light care demand -- 217 beds or 36.1% of the total. Because this hospital serves the military, the flexibility requirement to accommodate emergencies is basic -- but to what degree should this be accomplished? In other words, to what degree should light care rooms actually be designed and equipped as moderate care nursing units? Certain die-hard military medics say it should be 100%, the overwhelming majority, however, say "maybe as much as 50% in this range of magnitude." Fifty percent of 217 beds is approximately 100 -- of 20% of the total 600 bed requirement -- which need only housing accommodations, maybe something like a hotel or motel room -- and maybe not even a nurses' station. This potential represents hard, life-long savings. The final decision on this aspect has not yet been made.

The design development is underway with the Westinghouse and Benham-Blair efforts being the initial phases, but the methodology is not in the usual mode for the development of military medical facilities. The normal development is in four stages - see Figure 2. The design normally evolves from the Demand Data; this data is translated into space requirements; the spaces are then configured into a Block Plan or an Adjacency Model (from which the preliminary or budget estimate is made); and then all this is developed into working drawings and contract specifications. The important things to note are that 1) the Demand Data are usually limited to a review of records and a rather unsophisticated forecast of future requirements, and 2) the conversion of the Demand Data to a Space Program is a rather mechanical process of using tables and criteria published in Defense Instructions which implemented OMB Circular A-57. Additionally, there is a current limitation that the gross area, for circulation and the plus dimensions to make the individual spaces fit into a workable mass, cannot exceed the net space criteria of the individual area by more than 15%.

The development of the New Generation Military Hospital at Travis is being handled differently -- and for obvious reasons. The chore of validation and getting all the necessary blessings at each milestone as we go downstream in each phase, has become an acute exercise in critical path scheduling (See Figure 3). The Demand Model is much more sophisticated in its survey techniques and projections; then instead of translating each of the requirements of the Demand Model into space requirements from existing criteria - each listed space in existing criteria was questioned as to its currency and appropriateness in the context of the New Generation effort. Of course, any changes to existing criteria have to be concurred in by both the Air Force Surgeon General and Defense, with Defense taking its action after consideration by the Technical Advisory Panels. This critique of existing criteria is being referred to as the Preliminary Study. Once the Preliminary Study is completed, then it is converted into a Block or Adjacency Plan solely for the purpose of developing a Budget Estimate. This space study is being called the Preliminary Concept.

Concurrently with these aforementioned studies, the Air Force's Task Group at Gunter Air Force Base has been working on the software developement and feeding in its

PROPOSED NGMH DEVELOPMENT PROCEDURE



WESTINGHOUSE
DEMAND MODEL

AIR FORCE

AIR FORCE W/A-E ASSISTANCE

SAME - EXCEPT BY DIRECTION OF THE PLANNING DCP, AF IS TO CRITIQUE EXISTING CRITERIA & RECOMMEND CHANGES THERETO IN THE LIGHT OF PHASE I RECOMMENDATIONS

BLOCK PLAN AND BUDGET ESTIMATE

NO CHANGE

EXCEPT CONCEPT DEVELOPMENT WOULD NOT BE DISCIPLINED BY BLOCK PLAN DEVELOPED UNDER THE PRELIMINARY CONCEPT. THE BLOCK PLAN IS TO BE USED FOR BUDGET COST ESTIMATE PURPOSES ONLY.

Figure 3

findings and recommendations as to space and power requirements to Benham-Blair so that the Block Plan and Budget Estimate can reflect the hardware requirements. Hopefully, these latter requirements will be sufficiently locked-in before Final Concepts are started.

All the work to this point is under the direct purview of the Air Force. With the completion of the Preliminary Concept and Budget Estimates, the development of the Final Concept and the working drawings and specifications become the responsibility of the Naval Facilities Engineering Command (NavFac). Within the framework of the management structure I spoke about earlier NavFac is the Design and Construction agent.

At the present time, NavFac is involved in the selection process for the Architect-Engineer (A-E) firm, or combine, which will develop the Final Concept and the contract working drawings and specifications. The Selection Board is working within certain guidelines in their considerations. The objective is, of course, to select the "best qualified" whether or not that firm has had previous experience with the Military Departments. The considerations, or guidelines, include the following: (See Figure 4)

The firm's demonstrated experience and expertise in --

- Medical and health care planning
- General hospital design
- Teaching hospital design
- Workload, existing and projected
- Adequacy of staff and in-house capability
- Management, including success in cost estimating
- Seismic design experience

And of course --

- The type of organization in this particular venture; whether it be an A-E firm with consultants, or a joint venture, and
- Previous experience with Federal projects.

NavFac started out with a list and files on about 250 A-E firms who had either expressed interest in the project, or were known to have some expertise in the matter. The initial screening reduced the list to something over 60 firms. A second screening further narrowed the list to some 23 firms -- and then further evaluations were made to a final list of 10. These 10 firms will be very carefully considered, their offices may be visited, and some may be requested to make presentations. The final selection will name the top 3 firms in priority order -- and after approval of this selection by the management structure, fee negotiations will take place with the number one firm.

Final building plans are scheduled for completion in late 1974, and beneficial occupancy of the hospital is scheduled for early 1977. FY 1975 military construction funding is proposed.

A word about the cost estimate -- that is, as of this time. Original ball-park estimates put the project at about $65 million:

$40 to $45 million for the physical plant and site development;
and $15 to $20 million for the electronic hardware.

The current cost estimate, reflecting the Westinghouse and Benham-Blair studies point to $100 to $105 million:

$70 to $75 million for the plant and site development;

ARCHITECT-ENGINEER QUALIFICATIONS

The following items will be considered in selection of an architect-engineer firm for the design of the New Generation of Military Hospitals (NGMH) Project, Travis Air Force Base, California:

Medical and Health Care Planning

Hospital Design
- Significant Projects of Similar Scope to NGMH
- Percent of Total Effort In this Area
- Awards and Recognition for Hospital Designs
- Availability of Consultants

Workload, Existing and Projected

Adequacy of Staff and In-House Capability

Management
- Experience with Fast Tracking Construction Management
- Experience in Incremental Design
- Success in Cost Estimating

Organization
- Type of Organization
- Previous Accomplishments of Joint Venture (if applicable)
- Integration of Architectural and ECapability

Seismic Design Capability

Previous Experience with U. S. Government Projects and $25 to $30 million for the electronic hardware.

In summary, the difficulties and risks associated with this project arise not so much from the fact that it is a direct attack on and utilization of the state-of-the-art health care delivery systems, but rather that it entails the ultimate integration of a number of state-of-the-art functional systems into a single cohesive system that not only satisfies the medical requirements of the Travis Medical Center, but also provides a flexible test bed for the accomplishment of follow-on-systems, procedures, and methodologies. But it is exciting and challenging -- and, hopefully, it will have manifold returns to the taxpayers for the investment involved.

NATIONAL BUREAU OF STANDARDS BUILDING SCIENCE SERIES 54, Proceedings of the First Federal Agency Workshop, December 5, 1972, Gaithersburg, Md. (Issued July 1974)

Rationale for Change--The Hill-Burton Program

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ABSTRACT The Hill-Burton Program was established in 1946 for the financing of needed health facilities in the United States. An important function of the Hill-Burton Program is the continual updating of minimum construction requirements with which Hill-Burton projects must comply. Many States, architects, and engineers use these requirements for all health facility construction. Some of the newly proposed changes described include modification of Fire Safety requirements to make them compatible with other government agencies; improved parking facilities; increased emphasis on making health facilities accessible to the physically handicapped; a new section for intensive and coronary care units, and a new section dealing with natural disasters. Government building regulations will continue to change, probably in the direction of making the environment more livable and in the increased concern for conserving human resources.

Keywords: Architecture; building regulations; construction standards; design; Hill-Burton; hospital design; medical facilities.

RATIONALE FOR CHANGE--THE HILL-BURTON PROGRAM

The National Bureau of Standards is to be complimented for sponsoring these Federal Workshop Seminars where different agencies concerned with similar programs can communicate. Understanding each other is the first step in coordinating efforts and eliminating conflicts.

I. What is Hill-Burton?

For those of you not familiar with the Hill-Burton program I have passed out a "Fact Sheet" (See Attachment). This outlines the impact that this legislation has had in obtaining needed health facilities throughout the United States since its inception in 1946. The Health Care Facilities Service, a unit within the organizational structure of the Department of Health, Education and Welfare (DHEW), is responsible for administering the program. The Office of Architecture and Engineering has the major responsibility for developing minimum construction requirements for Hill-Burton projects. Since this audience represents Federal construction programs in the health field, I want to outline the proposed changes in these requirements and the rationale for these changes. Community hospital problems, of course, differ in several respects from those confronting Federal facilities. For example:

A. Most Federal hospitals exceed 500 beds while most Hill-Burton hospitals fall in the 50 to 200 bed range.

B. Most of the personnel in Federal facilities are drawn from the military establishment while personnel in Hill-Burton facilities are hired at market prices.

C. Federal facilities are regionally oriented while Hill-Burton facilities serve local communities.

Despite these and other differences, you may find that our requirements can be applied to your hospitals in many ways.

II. Who uses Hill-Burton requirements?

State and regional Hill-Burton personnel as well as Regional Offices of Facilities Engineering and Construction Agency (ROFEC) which oversees Hill-Burton projects. Architects and engineers find they serve as guidelines in designing all kinds of health facilities -- regardless of whether they received Hill-Burton assistance. Many States have adopted these requirements as the State regulations governing all health facility construction.

III. Why do we need these requirements?

First and foremost, they serve as an educational tool and are considered an invaluable aid by hospital architects and engineers. Unfortunately, there are some hospital sponsors who are willing to let the dollar dictate design regardless of the inefficiencies of operation or hazards to the patient. The requirements then become a club to enforce adequate facilities. As many of you know, variations are permitted when the program or design assures us that the intent is not being violated.

IV. Who is responsible for keeping the regulations up-to-date?

This is the responsibility of the Health Care Facilities Service with the focal point being the Office of Architecture and Engineering. However, representatives of many different disciplines and organizations give us their recommendations on each item. These consultants include private practicing architects, engineers, physicians, hospital consultants, plus representatives from the American Hospital Association, State Hill-Burton agencies, and ROFEC.

V. What other Government agencies are consulted?

Representatives of various other Government programs attend meetings to give advice to bring about better coordination with their agencies. These include the Facilities Engineering and Construction Agency (FECA), the Department of Housing and Urban Development, and the Social and Rehabilitation Services. Unofficially, we obtain ongoing input and communication from the Bureau of Radiological Health, the National Bureau of Standards, the Veterans' Administration, the National Institutes of Health, the National Center for Health Statistics, and the National Center for Health Services Research and Development.

After proposed updating has been reviewed and revised, we send copies to all State agencies, regional offices, and many practicing architects and engineers involved in medical facility construction. All comments are evaluated for inclusion in the final document.

VI. Why are changes needed?

A. One reason for updating our requirements is to accommodate the Nation's changing emphasis in the delivery of health care. Today the emphasis is on outpatient services, preventive medicine, and sharing concepts rather than on facilities for inpatient care. For example, during fiscal year 1972, nearly half (47 percent) of the 191 projects approved for Hill-Burton grants were for construction or modernization of public health centers, outpatient facilities, and rehabilitation facilities. This compares with 37 percent in 1971, 29 percent in 1970, and 24 percent in 1969.

Sharing of resources by health facilities continued to be encouraged through the incentives provided in the 1970 legislation and through the Joint Project Support concept developed with other health programs. Maximum flexibility in the use of construction support funds was furthered by giving higher priority to projects which relate to other DHEW programs such as those concerned with health maintenance organizations, comprehensive health care, neighborhood health centers, maternal and child health, family planning, drug abuse prevention and care, and alcoholic rehabilitation. These priorities are reflected in our new requirements.

B. The second reason is the advancement of new programs and procedures, either dictated by Congress, required by the medical profession, or demanded by patients. Minimum requirements for the construction of intensive care units are but one example.

C. The third reason for change is to keep abreast of new technology, equipment, and concepts. New electronic devices, new safety equipment, and new concepts such as outpatient surgery and combining obstetrics with operating suites are several examples.

VII. What are the major changes?

The major changes in our proposed regulations may be grouped under four headings:

A. Fire Safety. Our fire safety standards have been changed so that they are now compatible with those of other Government agencies. We propose that construction shall be in accordance with the requirements of section 10-132 of the latest National Fire Protection Association (NFPA) Standard 101. Interior finish materials shall comply with the flame spread limitations for walls and ceilings in exitways, storage rooms, and areas of unusual fire hazards according to American Society for Testing and Materials (ASTM)-E84 Standards of 0-25; in other areas 0-75. Floors shall have a rating of 4 or less and comply with Underwriters' Laboratories (UL) Standard 992. Smoke production for wall and ceiling finishes shall not exceed a 350 rating as established by the ASTM-E84 Standard. Smoke production for floor materials shall be 350 or less by E94 or 450 or less by the National Bureau of Standards' smoke chamber.

B. Parking for hospitals and other health facilities. Each facility shall have adequate parking to satisfy the minimum needs of patients, employees, staff, visitors, and emergency and delivery vehicles. In the absence of a formal parking study, each facility shall provide not less than one space for each day shift staff member and employee plus one space for each patient bed. This ratio may be reduced in an area that is convenient to a public transportation system or to public parking facilities if proper justification is included in the narrative program, and provided that approval of any reduction is obtained from the State Hill-Burton agency. Additional parking may be required to accommodate outpatient services and other services when so specified in the narrative program.

Parking requirements for long-term care facilities would be the same as for hospitals except that not less than one space should be provided for each day shift staff member and employee plus one space for each five patient beds.

Vehicle parking for outpatient facilities shall be provided at the ratio of two spaces for each treatment and each examination room plus one space for each staff member.

For rehabilitation facilities, parking capacity shall be provided at the ratio of three spaces for each professional staff member. The same escape clauses as indicated for hospitals are also included.

C. Special design considerations for the handicapped (patients, staff, and visitors).

As set forth in Public Law 90-480, "Design and Construction of Public Buildings Financed with Federal Funds to be Accessible to the Physically Handicapped," such design considerations are required for all public buildings which receive any part of their funding through Federal grants or loans. The following items are listed to augment, clarify, or emphasize some of these special design elements:

1. Walkways and curbs shall be planned to facilitate travel by people in wheelchairs or on crutches.
2. Signals, such as elevator calls, shall be both audible and visible. Elevator control buttons shall be accessible to wheelchair occupants.
3. Not less than one percent of all parking spaces provided for the project (with a minimum of two spaces) shall be planned and set aside for the handicapped.
4. Design shall consider the needs of the user having physical impairments with special attention given to the shielding of sharp projections, moving parts, and heated surfaces.
5. Facilities such as drinking fountains, toilets, and handwashing shall be available on each public floor and designed to be accessible to the public and staff as well as patients who are physically handicapped.
6. Minimum requirements not otherwise noted in these standards shall be those set forth in American National Standards Institute (ANSI) Publication No. A-117.1.

D. Shared services: Obstetrics and Operating Room (OB - OR). Services shall be arranged to avoid traffic between the surgery and delivery rooms. OB service areas may be shared with and organized as part of the surgical facilities if the approved program reflects the sharing concept, except for the following:

> Sterilizing and scrub facilities located in either or both departments will not be shared with the other. Soiled work or holding room(s) shall not be shared. A janitor's closet -- a closet containing a floor receptor or service sink and storage space for housekeeping supplies and equipment -- shall be provided for the exclusive use of the obstetrical suite and another for surgery.

VIII. Major additions to the requirements include:

A. Freestanding outpatient facilities, for the first time, are being regarded as office buildings insofar as fire safety regulations are concerned. These facilities therefore are removed from the institutional classification where they have always been. They now conform to the NFPA definition for noninstitutional occupancy.

B. A special section of the requirements relates to the design of intensive and coronary care units. Although not a particularly new concept, the rate at which they are being incorporated into hospitals dictated this addition.

C. From the new section on natural disasters, I will quote directly since most of you are also re-evaluating your criteria:

"1. Earthquakes. In regions where local experience shows loss of life or damage to buildings resulting from earthquakes, buildings or structures shall be designed to withstand the assumed force by conforming with criteria set forth in the latest issue of the Uniform Building Code (UBC).

In buildings which are subdivided into separate structural units by seismic joints, each unit shall be provided with an exit stairway to permit evacuation from the building without need for traversing the seismic joints.

Special care shall be taken to anchor fixed equipment, suspended ceilings, light fixtures, and similar items to minimize hazard to occupants and damage to the equipment and building during an earthquake. Storage shelves and racks holding breakable or fragile supplies shall be designed to retain their contents when subjected to the lateral forces of an earthquake.

"2. Hurricanes, tornadoes, and floods. Special provisions shall be made in the design of buildings in regions where local experience shows loss of life or damage to buildings resulting from hurricanes, tornadoes, or floods.

"3. Communications. An emergency radio communication system shall be provided in each facility. This system shall be self-sufficient in time of emergency and capable of operation without reliance on the building service or emergency electric power supply. It shall also be linked with the available community or State emergency communication network, including connections with police and fire systems."

IX. What of the future?

In spite of what we think we know about medical facilities, the only thing we know for certain is that they will change. They must change as the systems for health delivery and the needs of people change. To be sure, the metamorphosis will be slow but I see signs of changes already upon us. One in which Government regulations are just getting their feet wet is the environmental impact statement. Ways must be found -- and soon -- to slow man in his efforts to destroy the livable qualities of this spaceship earth.

The other thing I see in the immediate future is the grouping of buildings and programs which deal with human resources. Let me give you an example:

In South Dade County this year I viewed a group of temporary buildings which housed various types of services for the area's migrant workers. The director told me this story: A worker came in one day and reported that he was too ill to work. A medical examination in the clinic revealed that insecticides had infected the man's respiratory system.

Upon questioning by the director, it was found that the farmer did not provide the workers with masks while they were spraying. Although the farmer promised to change the job of the worker under treatment and provide masks, the worker reported to the clinic the next day to say he was out of a job. The director went next door to the welfare agency to provide him with money to live on, then took him next door to the Public Health Clinic for immunization shots. Furthermore, he contacted the State official responsible for enforcing State laws dealing with the use of poisons and insecticides to force the farmer to provide the proper safeguards. Lastly, the director treated this migrant worker until he was again able to return to work (with the help of the employment agency).

I mention this story to illustrate a few of the many services necessary to enable a person to operate at his optimum capacity--physically and mentally. When these services are scattered all over the city, it not only prevents coordination but reduces their availability to the very people needing them most.

While we in Hill-Burton are proud of the program's long list of accomplishments, we are the first to admit that solutions to most health problems (particularly those with related socio-economic overtones) contain the seeds of many others. It is the program's flexibility that has enabled it to come up with new solutions to keep pace with the times. This flexibility may be the particular attribute which inspired the author of an article in the September 1970 issue of the American Journal of Public Health to write:

> "When the history of health legislation in the 20th Century is written, the place of honor as the most significant single piece of Federal legislation may well be accorded to the Hill-Burton Hospital Survey and Construction Act of 1946, at least until the era of a national health care program arrives."

ATTACHMENT

November 1972

FACT SHEET

THE HILL-BURTON PROGRAM

HILL-BURTON OBJECTIVES

Better patient care for all the people through the provision of appropriately designed health care facilities has been a major objective of the Hill-Burton Program since its inception in 1946. Some prime functions have included:

(1) the development of better planning methods to aid communities assess their overall needs and determine areas requiring greatest priority;

(2) the elevation of standards of design, construction, and operation of facilities through the provision of consultation services which includes the development of guide materials widely used not only in this country but by health facility planners around the world;

(3) financial assistance for the construction and modernization of various types of public and private nonprofit community health facilities. In addition to its long-standing grant program, Hill-Burton also provides loan guarantees with interest subsidies to nonprofit hospitals and direct loans to public hospitals.

PROGRAM SUMMARY

Keeping abreast of the Nation's fast changing health needs so that new directions could be instituted as needed has characterized Hill-Burton over the years. As a pacesetter, the program has scored many "firsts" and continues to look for better ways to help resolve the Nation's many health delivery problems.

Examples of innovations introduced by Hill-Burton include: Statewide planning which identifies needs on a priority basis; establishment of areawide planning agencies which ultimately led to comprehensive planning; establishment of minimum standards for construction, maintenance, and operation of health facilities which are continually updated; development of guide materials in functional programming, equipment, design, and hospital environment; and providing impetus to the sharing concept through grant incentives.

Amid ever-increasing changes in the health delivery system, the Hill-Burton program was redirected by new and significant legislation to meet the demands of the 1970s. The 1970 legislation extended the grant program and incorporated a number of innovations including provisions for loans and loan guarantees to provide greater flexibility in assisting the States to meet their community health needs.

The legislation also took cognizance of the need to emphasize out-patient facilities to lessen demand for more expensive inpatient facilities and to hold down the cost of health care to the patient. Thus, the current major thrust of Hill-Burton activities is aimed at the expansion and improvement of outpatient care. The annual authorization for outpatient facilities was increased from $20 million to $70 million, and for the first time Hill-Burton funds became available for the construction of freestanding outpatient facilities such as neighborhood health centers. Priority must be given to outpatient facilities for poverty areas, and the Federal share may be increased to 90 percent of the project cost for projects in such areas.

Other projects which may receive up to 90 percent of the cost in Hill-Burton funds are those involving facilities which offer potential for reducing health care costs through (1) shared services among health care facilities or (2) interfacility cooperation.

Other special priority categories include projects which will provide comprehensive health care, training in health or allied health professions, and treatment for alcoholism. Also, at the option of the State, priority may be assigned to projects serving rural communities. Other new provisions include:

1. That a hospital project approved for Federal assistance must make arrangements to provide extended care services.

2. That health professions education or training facilities operated in connection with a hospital are eligible for assistance.

3. That Federal assistance is available for purchasing equipment for existing health facilities if the equipment will provide a service not previously provided in the community.

HOW THE PROGRAM IS ADMINISTERED

State Hill-Burton agencies administer the program at the State level, while the Health Care Facilities Service has administrative responsibility for the overall National program. HCFS staff in the 10 HEW Regional Offices have project approval authority and work with State agencies and Central Office to assure that Federal requirements are met.

The State administering agency is the initial point of contact by those seeking Federal financial aid and consultation services.

HILL-BURTON GRANTS

As of July 1972, more than 10,900 projects had been approved for the construction or modernization of over 6,300 public and voluntary nonprofit facilities serving 3,800 communities throughout the country. Some 477,000 inpatient beds were provided for hospitals and nursing homes. The total cost of these projects was $13.2 billion, of which the Hill-Burton funds were $3.8 billion. The matching funds of $9.4 billion were provided by State and local sources.

HILL-BURTON LOAN AND LOAN GUARANTEES

The new Hill-Burton loan and loan guarantee programs, for which final regulations went into effect in January 1972, have made loan agreements and tentative allocations totaling $241.2 million with facilities in 95 communities during its first six months of operation. Actions under these new programs include two endorsements for a total of $5.2 million; 28 commitments totaling approximately $83 million; and 81 tentative allocations totaling approximately $153 million.

Loan guarantees with interest subsidies may be made to provide nonprofit agencies and direct loans to public agencies to aid in modernizing or constructing health care facilities. The legislative authorization provides that loans totaling $500 million may be guaranteed annually, or a total of $1.5 billion over the 3-year period covered by the statute.

Loan authorizations are allotted to the States on the basis of relative (1) financial need, (2) population, and (3) need for additional or modernized health facilities. The loan, or a combined grant and loan, may not exceed 90 percent of the cost of the modernization or construction project.

CONSULTATIVE AND TECHNICAL SERVICES

An important feature of the Hill-Burton program since its inception has been the consultative and technical services provided on the State and Federal levels. Consultation is provided in such areas as architecture, engineering, equipment planning, nursing, dietetics, pharmacy, central service, health education, and environmental health and microbiology.

Over the years, consultation has been provided by letter, telephone, personal visits, lectures, and participation in conferences and workshops. In addition, guidelines are published on many phases of design, construction, equipment, and operation of health facilities.

The program also conducts conferences on environmental health and infection control, dietary facilities, nursing service administration, medication distribution, central service, preventive maintenance, functional programing, and equipment planning in various parts of the country to supplement individual consultation and speeches on a variety of topics.

NATIONAL BUREAU OF STANDARDS BUILDING SCIENCE SERIES 54, Proceedings of the First Federal Agency Workshop, December 5, 1972, Gaithersburg, Md. (Issued July 1974)

INTRODUCTION - Application of Advanced Technologies to Hospital Design in the Veterans' Administration

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ABSTRACT The Veterans' Administration operates 168 hospitals, valued at five billion dollars, containing approximately 100,000 beds and employing 153,000 people. To meet the planning and construction requirements of such a health care delivery system requires the application of advanced technologies.

Keywords: Design, hospital design; medical facilities; planning; technology; Veterans' Administration.

The topic, Application of Advanced Technologies to Hospital Design", was selected for todays Federal Workshop in order to give you an overview of the Veterans' Administration' (VA) hospital system, and some idea of planning and design concepts. To do this, in the short time available, I will present some background data and then different members of our staff will discuss (1) "Space Planning Criteria", the basis for establishing detail requirements; (2) "Use of the Computer in Planning Hospitals", a real application of work-load data being combined with computer capability to produce planning documents, and (3) "VA Hospital Building Systems", a description of the research study recently conducted and its application to projects presently being designed.

To give you a general idea of the scope of the health care system managed by the VA let me cite a few facts. We operate 168 hospitals throughout the United States. Their real property value is approximately five billion dollars. The cost of maintaining these facilities is about $70,000,000 annually. There are approximately 100,000 operating beds in these hospitals, which support an average daily patient census of about 87,000. We employ 153,000 people in our Department of Medicine & Surgery and have an annual appropriation of approximately $2.5 billion for this activity. We also conduct major Research and Education programs in most of our hospital facilities, particularly those affiliated with Medical Schools. These programs and affiliation requirements contribute to the mirad of details to be related in planning and modifying the physical plants. The next part of this presentation will explain how these requirements evolve and are controlled in project development.

NATIONAL BUREAU OF STANDARDS BUILDING SCIENCE SERIES 54, Proceedings of the First Federal Agency Workshop, December 5, 1972, Gaithersburg, Md. (Issued July 1974)

Space Planning and Equipment Requirements-
Application of Advanced Technologies
to Hospital Design in the Veterans' Administration

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ABSTRACT Prior to 1958, the Veterans' Administration (VA) used a 500 bed prototype as the basis of all design and construction. This proved undesirable since almost all new VA hospitals were to be teaching facilites with widely varying requirements not well suited to any single prototype. At the end of the 1950's the Bureau of the Budget issued the Federal Space Planning Criteria. The VA expanded and refined this criteria and has been successfully applying it for over ten years.

Keywords: Criteria; hospital planning; medical facilities; planning; Veterans' Administration.

The Veterans' Administration (VA) operates the largest Health Care Delivery System in the nation consisting of 168 hospitals and a number of outpatient facilities physically located both within and outside the hospitals. Since World War II we have constructed many new and replacement facilities and modernized a number of our older facilities. Prior to 1958, VA hospitals were designed on the basis of a 500 bed prototype criteria. However, this approach was unsatisfactory since almost all of our new and replacement facilities were to be teaching hospitals affiliated with medical schools usually located adjacent to the university campus. We believe this trend for medical school affiliation will continue in the future. The 500 bed configuration did not meet the needs for these projects. The wide variation in program requirements in the teaching hospitals made prototyping undesirable. At about that point in time, Federal space planning criteria, which was prepared in the Bureau of the Budget with interagency staff support, was published. Although it involved only major functional areas, Federal criteria covered about 80% of the hospital space. Thereafter the VA expanded upon Federal criteria, refined it, and developed new criteria for those functional areas not originally included. These criteria are published as VA Manual M-7. They have been used for more than a decade as a guide for planning all VA Health Care Facilities construction projects. The Office of Management and Budget has delegated the space planning criteria to the individual agencies when the Federal Space Criteria, BoB circular A-57, was recently rescinded.

At any point in time we will have approximately 300 major and minor construction projects underway at various stages from preliminary planning through construction. Many of these are projects involving space ranging from complete master plans for new hospitals or major hospital modernization to space plans for small projects such as construction of intensive care unts. In fiscal year 73, $180,993,000 was appropriated for construction. To make the program more effective, funds for new and replacement hospital construction are now being incremented in successive fiscal years; e.g., design, one year, foundations and site another, building construction the following year.

The primary purpose of criteria is to serve as a tool for those who develop construction projects at all levels in our organization. They provide an established formula for determining the net space requirements for each functional area of the hospital. Their application, utilizing such data as projected staffing and workload, result in a space program or master plan dedicated to specific program needs as opposed to prototyping. Applied criteria also serves as a budget tool by defining the scope of the project in net square feet which in turn is converted to gross area. A current cost index and escalation factor are applied and a total construction cost estimate is developed. The project master plan or space program also serves as the basic guide document for the design of the hospital.

Master planning for a major hospital project is a tedious, involved, time consuming process which may extend 6 months to a year into the project planning schedule. In order to shorten the time span and to relieve the project planner of numerous manually accomplished computations, data research, and clerical tasks, considerable work has been done in the past few years to utilize computer technology.

At this time I would like to introduce Mr. Bruce Keane of the Space Planning Criteria staff, Health Care Facilities Service, Department of Medicine and Surgery, who will tell you about this effort.

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Use of the Computer in Planning Hospitals-Application of Advanced Technologies to Hospital Design in the Veterans' Administration

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ABSTRACT In 1965, the Veterans' Administration (VA) began developing the facilities Planning and Construction Requirements System to aid the VA in planning new facilities. This system is presently in use today. This computerized system utilizes files containing medical statistics, staffing, criteria and other information necessary for hospital planning. This system produces a master plan. This master plan provides a listing of medical functions, projected staffing, space requirements and other information. After review and approval of this master plan, it is used by architects and engineers for the design of VA hospitals. Future work on this system will include provisions for equipment, addition of special environmental factors and extension of the system to field station management.

Keywords: Computer-aided planning; design; electronic data processing; hospital planning; medical facilities; planning; Veterans' Administration.

Some of you, I am sure, have heard speakers say they really had three speeches to deliver:

One they had planned, the one they gave, and the one they wish they had given.

It is possible that your questions, if any, at the end of this talk will make number four - the one you wished I had given.

I have listened to four or five detail men that had been recently asked to talk about their product. After telling us what we already knew, they would conclude by saying, "We have the answer to the problem - I thank you."

We haven't a product so much as a service for our agency. It's an exciting project and fraught with problems because of the complexity of the Veterans Administration Health Care Delivery system.

The Facilities Planning and Construction Requirements system has resulted from studies evaluating the use of the computer as support to management activities.

The system was designed to provide a master plan, listing the staffing, the amount of space, and an abbreviated functional statement for each division or service in the hospital.

The system was originally designed for planning new facilities, although we have tried to stretch it to plan modernization projects. We soon found that it required from 75 to 850 units of information to provide a complete plan. This information was already available in other computer systems and we found a tie could have been made to interface with other going systems.

After our limited beginning in 1965, we launched on what is called the "Expanded System" in 1969. (Short for we goofed and needed to start over). Early users of the original system were disillusioned and unhappy with the results. After three years of trial and error, and one year studying the feasibility in changing the system, we started to correct the deficiencies of our original system which would provide the planning tools necessary for developing projects.

Our toughest problem in developing a viable system was that of language. Believe me, computer-types and hospital-planner types do not speak the same language, and an interpreter has been necessary.

Our system incorporates the use of the Automated Medical Information System (AMIS) and the information included in Manual M-7 "Planning Criteria for Medical Facilities." In addition we have developed and are conducting a space survey of all of our Health Care Facilities to provide a profile of our agency's space utilization.

Also, we have a master equipment list; however, incorporating this list into our system will have to await phase two of the project scheduled to start in October of 1973.

As I alluded to earlier, the language barrier created many of our problems in planning the sytem. To preclude this from happening here I would like to expain four terms:

File - An organized accumulation of records stored in a manner compatible with the system. We have five files: factor, function, profile, AMIS and control.

Function - Is a service, such as surgical, or supply service.

Module - The program for one function.

Field - The specific room, space, or workload factor within a modu

Our system is a marriage of workload to planning specifications. We have accumulated three working files: the AMIS file, the function file, and the profile file; and at a later date we will add an equipment file.

Planning our medical facilities falls into three categories: new hospitals, modernization or relocation of a hospital, and minor projects. New hospitals must be given all workload factors necessary to establish the whole project. We can use peer hospitals to extract workload automatically from accumulated files, where appropriate.

Modernization or relocation hospitals use the AMIS data to provide the workload and for some functions, we use a three-year accumulation to provide projections for future planning.

Minor projects, as with modernization, uses workload data for the existing hospital to develop the space requirements for those functions included in the project.

The initial output we request from the computer consists of a project plan, profile plan and control records; which we use to review, modify, and update the appropriate fields. A significant deficiency in our planning is staffing and providing for the number of students to be assigned to a given project. When planning facilities, the student population is determined by the training programs with affiliated schools and not directly by a predictable workload pattern. Medical program staffing guidelines are available; however, program emphasis at a particular hospital creates variables of the number of staff involved in specific functions.

It is then the responsibility of the planner to determine the projected staffing, including the student population, and update the appropriate staff fields. When the planner is satisfied that he has listed all the variables and provided for the special programs, he will then request a master plan. This plan provides a listing of functions with the projected staffing and space requirements, together with a narrative on some special environmental considerations. This plan is then reviewed by estimators and other members of management. After its approval, it can be submitted to an architect-engineer, or to the VA's own preliminary planning service for further graphic development.

If the project is a modernization, the master plan will provide a comparison between actual space as assigned and as it should be in accordance with current space criteria. Obviously, the space profile must be designed to allow for changes and updates to assure that current data is used.

As previously noted, we are involved in a survey of all of our hospitals and clinics. The survey is to be complete in April 1973, and each field location will receive a listing of space as assigned by function. This list will include data specifically programmed to be used by the engineering service in their maintenance and repair program.

Our system only uses data from the profile that is necessary for comparing functional space requirements in manual M-7, or net square footage in each facility by assignment. This information is displayed on a profile sheet for comparative purposes during the planning process, as well as being inserted for comparative purposes in a master plan.

This profile will give us the ability to review space assignments in ten or twenty surgical services including their comparative workloads. From this, the space criteria in manual M-7 can be modified when necessary.

The system has a built-in factor update file, allowing overnight changes in space allotments when criteria changes are approved.

The most important achievement is the cross-index of all of our functions allowing for automatic adjustment when changes of workload occur. This feature retains the interrelationships of the total hospital program so all functions can change if any element of the workload changes. For example: adding 20 beds to a project will effect support facilities from dietetics to the fiscal division. Our system will respond to this change and upgrade all functions to provide for the additional load.

Planning hospitals without the computer, or manually, often causes support services to fall through the cracks, so to speak. In one 1000 bed hospital 200 beds had been added without sufficient change in supporting facilities due to the pressure in planning deadlines. This caused many modifications of programs and a modernization project within 5 years.

The ultimate in building a master plan by computer will be the inclusion of special environmental factors for all functions. To date, we only have included narrative functional statements to a limited number of functions.

At a later date we anticipate this planning tool will be available to all field station management, as well as central office planners, thereby providing a readily accessible device for project development. We must realize that humans have the initial input and responsibility for maintaining a current file and the system will be only as good as the criteria, workload data, and profile information imbedded in these files.

When we talk of AMIS workload and profile input, we are talking about hundreds of thousands of bits of information used to complete the necessary records to accomplish our goal of a computer-planned hospital. The advantage of the computer is its ability to utilize these bits of information rapidly and provide a fast, dependable answer.

NATIONAL BUREAU OF STANDARDS BUILDING SCIENCE SERIES 54, Proceedings of the First Federal Agency Workshop, December 5, 1972, Gaithersburg, Md. (Issued July 1974)

Veterans' Administration Hospital Building System-Application of Advanced Technologies to Hospital Design in the Veterans' Administration

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ABSTRACT The Veterans' Administration (VA) Hospital Building System was begun to provide new VA Hospitals with improved cost control, improved performance, increased adaptability, a reduction in the time to go from planning to beneficial occupancy and to provide a system that could be continuously updated. The Building System is composed of three parts; the data base, the planning modules and the building subsystems. The data base contains the "user needs" necessary to determine functional and performance requirements for new VA Hospitals. The planning modules are areas of space large enough to accomodate a wide variety of hospital activities. Four types of planning modules are used; a structural bay with a constant width of 22.5 feet (6.86 meters); a service module of from 5000 square feet (464.5 square meters) to 15,000 square feet (1393.5 square meters); a space module, which is a sub-unit of the service module and a fire section not to exceed 20,000 square feet (1858.0 square meters). The building subsystems are the components of the VA Hospital Building System. Six subsystems have been developed in detail; structure; partitions; ceiling; heating-ventilating-cooling; plumbing distribution; and electrical distribution. Advantages of the application of the VA Hospital Building System include better response to the medical program, more accurate estimate and control of costs, improved performance, better functioning of the building and increased adaptability.

Keywords: Architecture; building systems; design; hospital design; medical facilities; modular design; performance; Veterans' Administration.

I. Objectives

The objectives of the Veterans Administration (VA) study on Systems Integration--to develop a new and improved method for the design and construction of VA Hospitals--were five in number:

1) Cost Control - Reduction of costs was an ultimate goal but in this age of constantly increasing costs, control of costs by knowing more positively at an earlier point in the overall development of a project what the various costs were, and identifying how they might be adjusted, seemed to be a more feasible objective.

2) Improved Performance - It was desired to make it possible for the hospital building to be more easily maintained. This meant a building that would give the maintenance personnel the ability to maintain and repair equipment in an economical way while also providing easy access to equipment and piping.

3) Adaptability - This was one of the most important objectives. Hospital medical technology and the resultant medical facility needs, were and still are changing so rapidly that buildings just had to be more responsive to these needs for change. Ability to "change and revise" the facility, therefore, was a very important criteria--and to be able to accomplish these changes within reasonable costs and with as little disruption to the functioning hospital as possible.

4) Time Reduction - Traditionally, VA Hospitals have been taking from five to seven years to complete--this is from the time of project approval through program planning, design and construction. Throughout all this time, not only were medical needs changing, but costs were also increasing--so success in time reduction would also assist cost control.

5) Progressive Development - If any developed System would be outdated and outmoded after its first application, it would be of very limited value. Therefore, the objective was to develop a system that could be continuously updated to accept new technological and medical advances without completely revising the system.

II. Scope

There were also certain rules that were laid down for the Consultant to follow--the Project Scope:

1) There were six subsystems to be developed in detail: structure, partitions, ceiling, heating-ventilating-cooling (HVC), plumbing distribution and electrical distribution. Other systems throughout the hospital; such as transportation, communications, etc. were to be considered to the extent they affected or were affected by the six subsystems developed in detail.

2) The resultant Building System must be buildable using available components and products. The VA did not have the authority to commit itself to any kind of guaranteed market needed to stimulate new product development (such as the SCSD project).

3) The System was to apply to new construction only. Remodeling has many problems peculiar only to that type of work and would, therefore, place unnecessary restraints on the System.

4) The System must be applicable nationwide. The VA operates hospitals in all the continental states and any future new hospital could be located anywhere in the country.

5) The System must be procurable within current laws and regulations. It was the desire of the VA to be able to apply the Building System without any delay that could be caused by the necessity of revising laws or regulations in order for the System to be legally procurable.

III. VA Systems Theory

The VA Hospital Building System is more a system of "planning and organization" than a system of "hardware". It is not dependent on any particular component or product but provides a means for using conventional products and materials within established modular disciplines--provided they also meet certain performance criteria which have been established.

The System provides a general solution to the general problem of hospital design. The approach, therefore, has been one of developing strategies for planning and construction which establish a basic compatability, while at the same time, allowing wide latitude for different project requirements, different siting conditions and different materials most suitable to the specific problem.

The Building System is essentially composed of three parts: Data Base--Planning Modules--Building Subsystems.

1) Data Base - The Data Base states the "User Needs" in the form of functional, environmental, psychological and esthetic needs. These needs are subsequently interpreted as functional and performance requirements which determine space allocation, arrangement and environmental characteristics for the Building System.

2) Planning Modules - Planning Modules are areas of space with an assured capacity to accommodate a wide variety of hospital activities. The modules have certain common characteristics which permit their assembly into hospitals of widely different size, program, siting and esthetic treatment.

3) Building Subsystems - The Building Subsystems are the components of the VA Hospital Building System--- the parts which transform the building from planning to construction. Although the Subsystems could be thought of as the "hardware" of the System, they are described in a general nature with a requirement to meet established performance criteria--the System, therefore, is not dependent on any specific material or component.

IV. Planning Modules

Let us now look more closely at the Planning Modules and Building Subsystems--first the Planning Modules.

There are four types of Planning Modules: structural bay, service module, space module and fire section. (Figure 1)

1) Structural Bay - The Structural Bay is the basic unit of which all other planning modules are composed. It establishes the basic dimensional disciplines for the Building System and was developed through an in-depth evaluation of the "User Needs" or minimum requirements for nursing units. Analysis had indicated that the nursing unit was the most repetitive and most stable functional unit in the hospital. The dimensions were then tested out for compatability with space requirements in other functional areas and final dimensions were established. Structural bay widths are a constant 22.5 feet (6.86 meters) throughout the hospital. Bay depths (beam spans) may vary from a minimum of 40.5 feet (12.34 meters) to a maximum 58.5 feet (17.83 meters) in 4.5 feet (1.37 meters) increments. Where required, an 18 foot (5.49 meters) cantilever is also available for use. These beam spans are about twice what the VA has most often been using in its hospital design. Through analysis of the complete building as a "system" it was determined that longer spans were unnecessary and uneconomical. The dimensions established, therefore, were determined to be the most compatible to all the requirements they must satisfy--both from a standpoint of space planning and structural design.

2) Service Module - The Service Module is the basic Planning Module for the Building System. It will be one of the most important "tools" used by the Architect/Engineer (A/E) in developing his hospital plan and building configuration. In size it may vary from 5,000 square feet (464.5 square meters) to 15,000 square feet (1393.5 square meters) the final determination being made after a comparison with space module sizes (which we will talk about in a moment) and overall medical program space requirements.

The Service Module consists of a service bay, service zone and functional zone (Figure 2). The Service Bay provides shaft space for all the vertical ductwork, piping, electrical conduit, busduct, etc. serving that portion of the building. It also provides space for air conditioning (A/C) and HVC units, pumps, electrical panels and other equipment supplying the service module. Space is also allotted for exit stairways. This allows each Service Module area of the building to be mechanically independent. This independence of the service module permits one unit to undergo alterations without affecting other areas of the hospital still in operation.

Services are fed out of the service bay into the service zone which carries all the horizontal service distribution of the service module. Within the service zone, all service runs are organized on the basis of reserved subzones to simplify design and installation, minimize cross-over problems and to preserve right-of-ways for future service runs.

Primary subzones (Figure 3) are horizontal layers of the service zone that define the direction of travel of the services. The main service distribution lines enter from the service bay immediately below the beams and run parallel to the main girder to the end of the service zone. Branches run at right angles to the mains and are located on the layers immediately above and below. Plumbing and drains occupy the upper layer between the beams. HVC and electrical occupy the lower layer. Laterals run at right angles to the branches and parallel to the ceiling system strongbacks immediately above the ceiling.

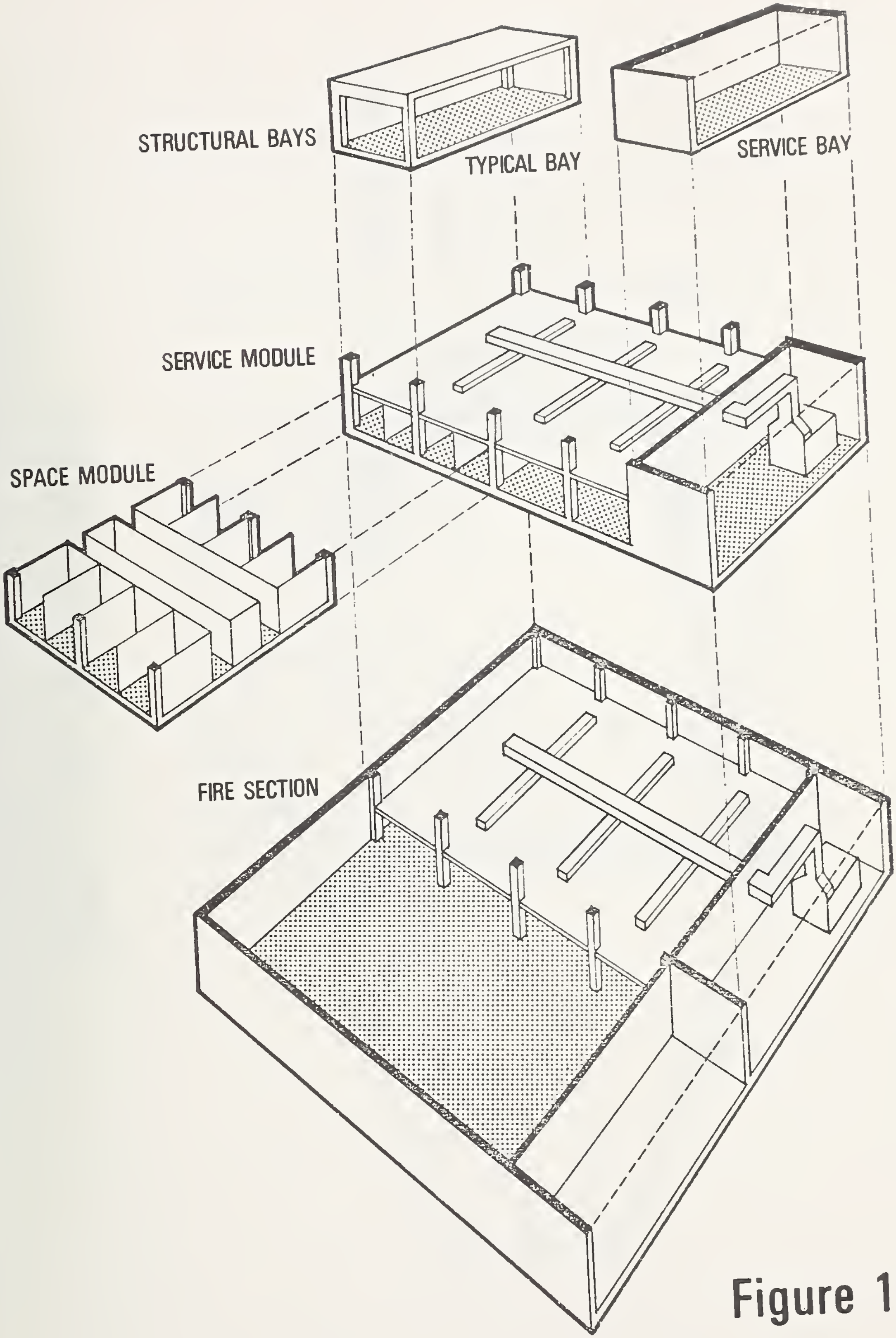
STRUCTURAL BAYS
TYPICAL BAY
SERVICE BAY
SERVICE MODULE
SPACE MODULE
FIRE SECTION

Figure 1

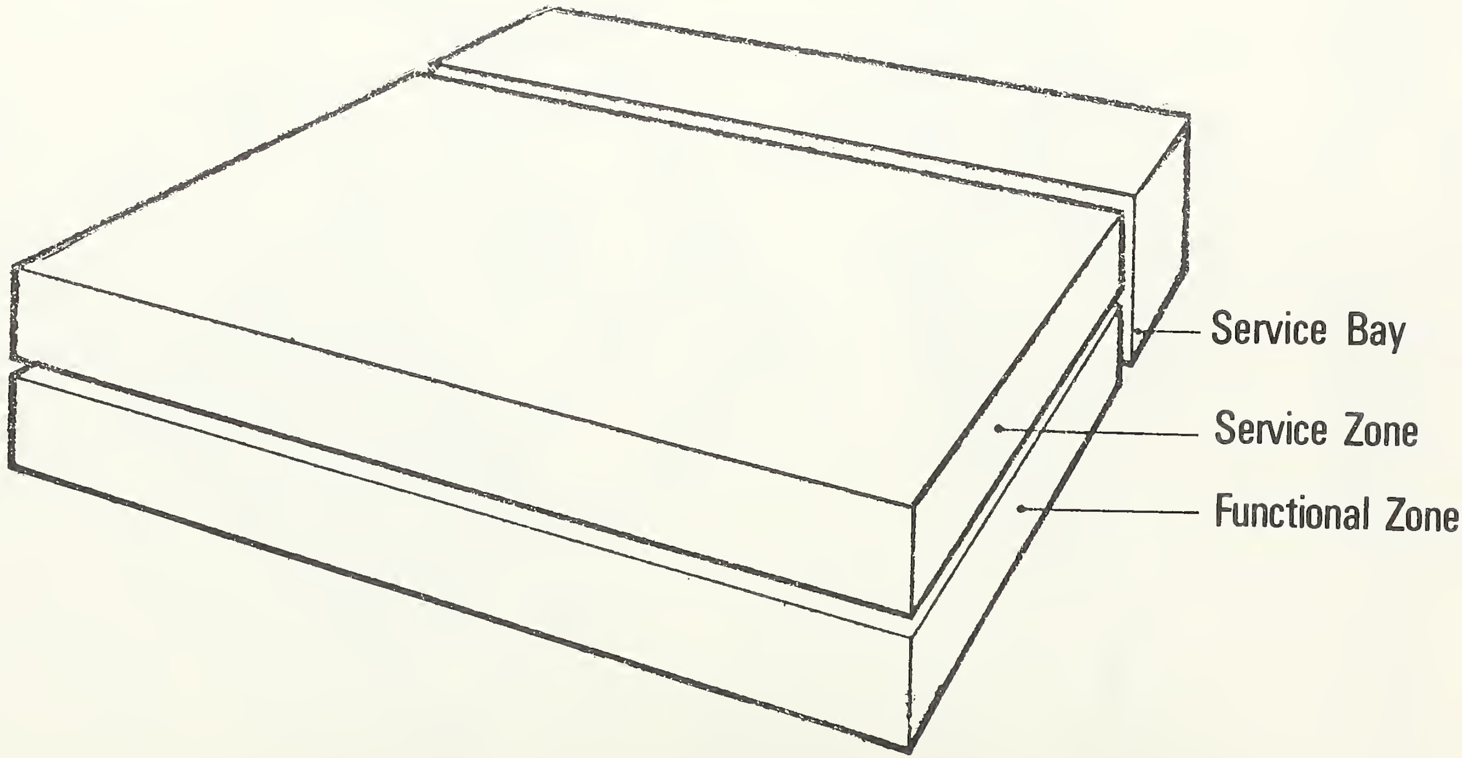

Figure 2. THE SERVICE MODULE

All dimensions are nominal.

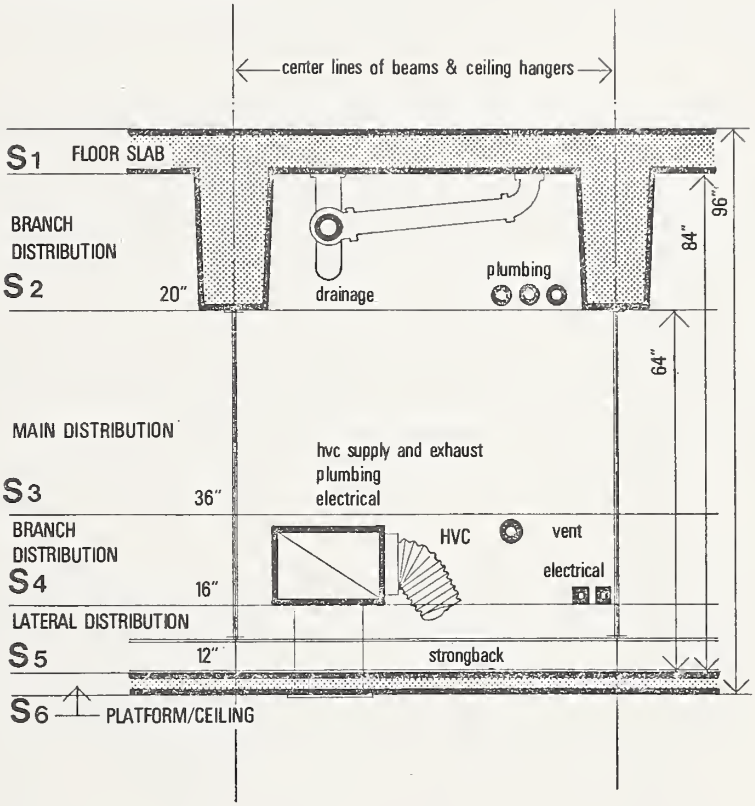

Figure 3

The direction and depth of beams, girders and ceiling strongbacks visually locate the respective layers and provide physical references in the service zone both for the initial location of services and for later revisions of the layout.

Secondary subzones are vertical divisions of the main distribution primary zone for particular services and are defined by the ceiling hanger spacing.

The functional zone portion of the service module houses the functional areas of the hospital, and can be internally organized in various ways to accommodate different functions. All services downfeed into the functional zone from the service zone above with the exception of the gravity drains which drop to the service zone below.

3) Space Module - The Space Module is a sub-unit of the service module and is the planning module used in the patient care areas--or Nursing Unit. The internal organization is more precisely detailed than the service module, taking into account the special requirements of these areas such as exterior exposure at the building perimeter. There are a total of eleven modules available which vary in size from a minimum of approximately 3,000 square feet (278.7 square meters) to a maximum of about 10,500 square feet (975.5 square meters). Each has been tested and determined to provide the required space for a nursing unit and its related functions relative to different medical program requirements. They have also been tested for other specialized functions such as Psychiatric Nursing Units, Research Lab's and Intensive Care Units (ICU's). Final selection of the space module to be utilized in a design problem is made after relating the medical program space requirements for the hospital under design to the space modules. A cross-comparison is also made with service module sizes to determine their suitability to satisfy the requirements of the remaining portions of the hospital. When a satisfactory correlation has been achieved, both the space module and service module size are set.

In utilizing space modules for the planning of Nursing Units, the A/E may sometimes find he does not have sufficient space to accommodate all the services that are necessary to the Units being planned. When this happens, the A/E can add "Additional Space" to the space modules in increments of one bay width (22.5 feet - 6.86 meters). In effect, this area becomes a "connector" between space modules or service modules. Consideration of the need for this space is made, of course, during the analysis of service modules and space modules just discussed--and if it is determined the space is needed it then becomes an "extension" of the space module and a "part" of the service module. In discussion this may sound crude and one might say from the standpoint of size there are really no space modules or service modules--but what this feature really does is permit the designer to "custom fit" the System to the specific space requirements of the design problem and it becomes, therefore, a tremendous design asset.

What happens in actual practice, then, is the A/E analyzes the building space requirements relative to the available sizes of space modules, service modules and additional space and selects for use in his design the one, or ones, which best satisfy all the requirements.

4) Fire Section - There is one additional rule the designer must keep in mind while determining the service module size. Code requirements do not allow hospital buildings to have areas larger than 20,000 square feet (1858.0 square meters) without suitable two-hour fire separation. Just as the space module is a sub-unit of the service module-likewise the service module is a sub-unit of a Fire Section. The goal, therefore, is to

have the boundaries of one or two service modules coincide with the boundary of a fire section; keeping in mind the code limitation of 20,000 square feet (1858.0 square meters).

As any penetration of a two-hour fire wall must be properly protected, the coincidence of service module and Fire Section boundaries greatly minimizes the number and complexity of service penetrations. With the two-hour fire walls also being the only partitions which are installed slab-to-slab, it can be seen that a complete "box" is formed which is both an independent fire section and (mechanical) service module within the total building. Operationally, it is like many little buildings placed together to form the total building and it is hoped the System will provide fire sections of a much more regular shape and outline than in the past.

V. Building Subsystems

We have discussed the Planning Modules used to develop the building plan--now let us look at the Building Subsystems which go together to create the form of the building.

The Subsystems are divided into two categories; shell and service (Figures 4 and 5). The shell subsystems are composed of structure, ceiling and partitions; service subsystems are composed of the HVC system, plumbing distribution system and electrical distribution system.

Each subsystem is developed as a general solution to a general design problem; that is it provides a range of options for appropriate selection and application to a specific design problem, each option having different space, performance or cost characteristics. Within this context, specific materials are not dictated by the System, only their performance. The project A/E will then select the materials best suited for the particular job and location.

1) Structure - The basic structural system is a column, girder and beam assembly with shear walls or braced frames assuming lateral loads. A three inch (7.62 centimeters) topping slab completes the system and allows for flexibility and adaptability of floor finish application. Material options are steel, precast or poured-in-place concrete. The organization of the structural components remains the same regardless of the material used. The top of the perimeter girder is level with the top of the beams. The top of interior girders, however, are flush with the bottom of the beams. This permits the passage of plumbing utility lines over the girders between the beams. Beam spacing is modular throughout the building but it will vary depending on material used--if the material is concrete the spacing is 4 feet - 6 inches (1.37 meters); for steel the spacing is 5 feet - 7½ inches (1.71 meters). Both of these dimensions are compatible with the 22 feet - 6 inch (6.86 meters) standard bay width.

There are two uniform loadings considered throughout the building--75 pounds per square foot (366.2 kilograms/square meter) in the patient (Nursing Unit) areas of the hospital and 115 pounds per square foot (561.4 kilograms/square meter) in the support areas of the hospital. Beam, girder and column dimensions are not set but minimums and maximums are established which are compatible with other system rules and are sufficient to carry the established loadings.

2) Ceiling - The ceiling system is probably the most unique of all the subsystems developed within the Building System. It is a load-bearing walk-on platform which serves as a working platform for the service zone (interstitial space) with the finish

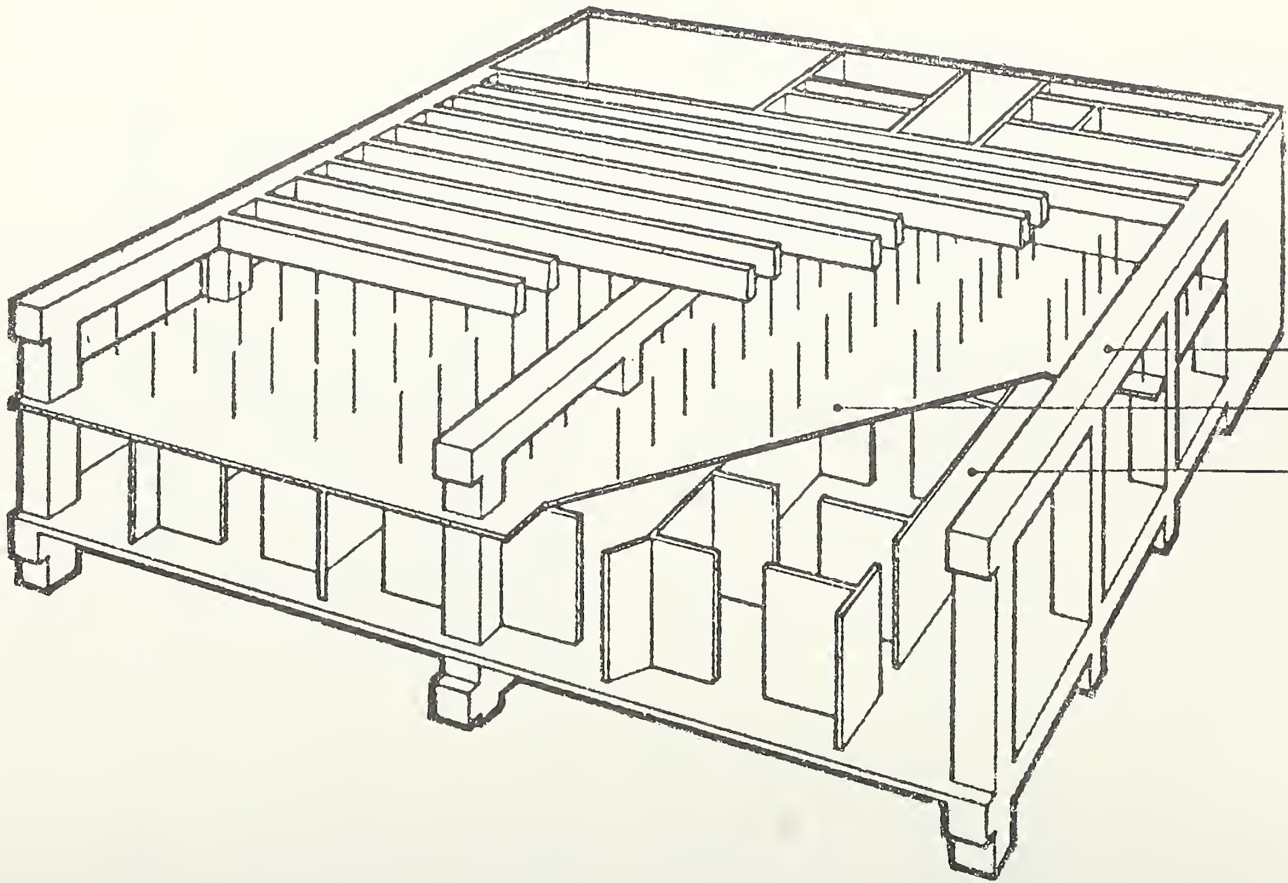

Figure 4. THE SHELL SUBSYSTEMS

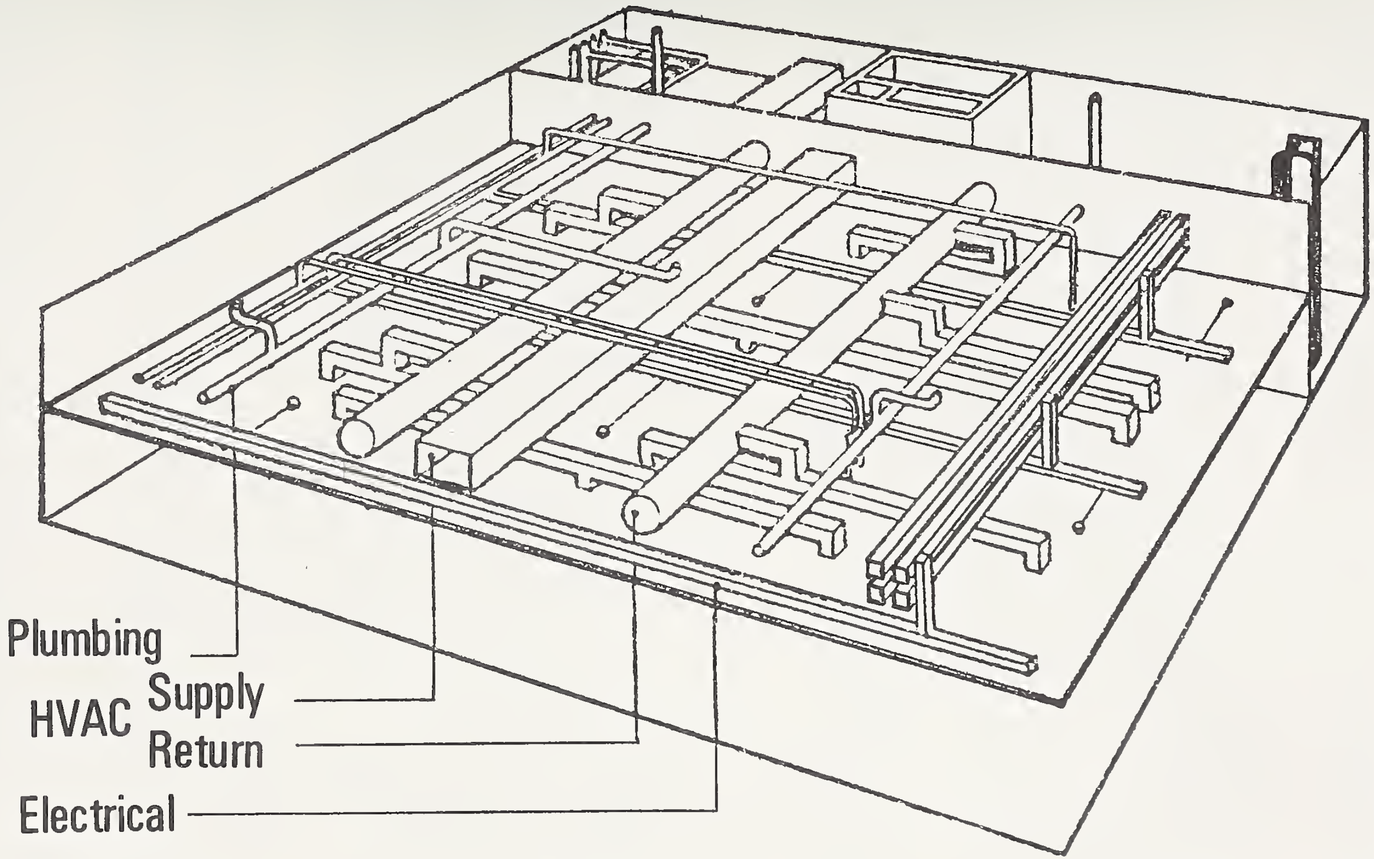

Figure 5. THE SERVICE SUBSYSTEMS

ceiling treatment applied to the underside of the platform. It provides support for and is the terminus for partitions as well as contributing to fire safety. As previously mentioned, the only partitions that extend from slab to slab and penetrate the ceiling are fire walls. The ceiling also acts as an acoustic, thermal and aseptic barrier between the functional and service zones.

The ceiling platform may be constructed from any acceptable material that will provide for the required 40 pounds per square foot (195.3 kilograms/square meter) live loading. The platform is supported by a framework hung from the structural system above by adjustable hanger rods, giving it the capability of fine level adjustment for installation of the ceiling finish to the underside surface. Surface mounted lighting is utilized to limit penetration of the platform--if recessed lighting is required in some area, however, provision is made for suspended ceilings. The Building System is not dependent on a fire rating for the ceiling assembly--fire rating reqirements will be determined for each individual project. At this time there are no available ceiling assemblies with established fire ratings. However, the VA Hospital Building System was applied to a private community hospital in California by the consultants who developed the System for the VA--in this project a poured-in-place gypsum deck was used for the ceiling platform material and when the assembly was tested, it exceeded the requirements for the two-hour test.

3) Partitions - Partitions are basically divided into two categories; rated and non-rated. Rated partitions are the two-hour fire partitions which extend from slab to slab and serve to enclose fire sections. Non-rated partitions include the one-hour smoke tight corridor partitions and partitions separating rooms. Materials and finishes may be those best suited to the functional area where located and the most cost effective for the geographical location of the project--the main criteria being that they meet the performance requirements established and are easily relocatable.

Partitions are uniform in height for any service module and generally are 9 feet (2.74 meters) high in nursing unit areas and 10 feet (3.05 meters) high in support service areas of the hospital. With all partitions (except fire walls) stopping at the ceiling, a tremendous advantage is gained in the service zone with no partitions or studs to interfere with the service lines. It also greatly simplifies the fire stopping problem as well as allowing establishment of uniform methods of attachment and lateral support and for acoustical seal around the partition perimeter.

It is recommended that, wherever possible, all services remain outside the partition and be contained in service containers. This feature, along with the fact that there is a complete separation between the functional and service zones, allows for simultaneous installation of partitions and services. It should also greatly simplify future maintenance and remodeling.

4) Heating-Ventilating-Cooling (HVC) - The first service subsystem we will discuss is the heating-ventilating-cooling system; many times referred to simply as the HVC system. The basic design offers two alternatives, a low-or-medium-pressure terminal reheat system or a dual-duct mixing-box system, and must be capable of providing from 25 to 100 percent outside air.

Fan units, pumps, etc. are located in the service bay along with all vertical ducts. Heating and cooling generating equipment may be remotely located or complete package units may be located in the service bay. Ductwork feeds out from the equipment into the service zone where distribution is made to the functional zone below in the organized fashion as previously discussed--with one of the main points to remember that each time a service line changes direction, it also changes elevation.

5) Plumbing Distribution - The general organizational pattern for the plumbing distribution system is the same as for the HVC system--all vertical risers and any necessary equipment are located in the service bay with horizontal distribution occurring in the service zone and then downfed to the functional zone below. The one exception to this is the gravity drains which drop into the service zone from the functional zone above.

Conventional materials and assembly procedures are used but it is expected that a greater quantity of material will be required. This will be offset by the easier accessibility for maintenance purposes, which makes it more economical, and an expected lesser cost for remodeling changes.

6) Electrical Distribution - As with the HVC and plumbing distribution systems, electrical distribution is also accomplished by the same highly organized pattern of distribution layout. All necessary transformers, electric panels, etc. for a service module are located in an electrical closet in the service bay with electric feeders going out into the service zone for distribution down to the functional zone below.

There is one additional characteristic of the building subsystems--certain of the components are designated "permanent" and others "adaptable". The components which are labeled permanent are considered, theoretically, to never require change throughout the life of the building; in other words their modification or removal would require major building reconstruction. Components falling into this category are all the structural system except for the topping slab, all the ceiling system except the ceiling finish, the two-hour fire wall partitions of the partition system and all the main trunk ducts and main service lines of the HVC, plumbing and electrical distribution systems. All other components are considered adaptable and are assumed to be subject to change and alteration on a random basis throughout the life of the building--they can be relocated, altered, added or deleted without major building reconstruction.

VI. Conclusion

It is felt there can be many advantages in using the Building System:

1) A better response to medical program requirements is possible. With the possibility of overall project time reduction and the capability to analyze many functional relationships through use of the planning modules; medical program response should be better.

2) The Planning Modules and Building Subsystems should allow for a more accurate estimate and control of costs.

3) Building performance should be improved by the highly organized layout of service distribution and easier accessibility to mechanical equipment and piping.

4) Function of the building should also be improved through the planning capabilities available from the planning module concept of design.

5) Last--and probably most important--the adaptability potential of the building should be vastly increased. Division of the building into independent service modules each containing its own service bay, the service distribution concept, a load-bearing ceiling completely separating functional and service zones, partitions which stop at the ceiling and contain only a minimum of utilities, and the permanent and adaptable components concept--all are characteristics which should increase the adaptability capabilities of VA Hospitals when designed by application of the VA Hospital Building System.

NATIONAL BUREAU OF STANDARDS BUILDING SCIENCE SERIES 54, Proceedings of the First Federal Agency Workshop, December 5, 1972, Gaithersburg, Md. (Issued July 1974)

INTRODUCTION - Current Issues in Health Care Facility Delivery

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ABSTRACT Some of the issues of concern to Health Care Facility Delivery are better planning, better prediction of facility needs, improved sensitivity to the need for responsive facilities, containment of parochial attitudes, restatement of the emphasis in planning and design and improvement of the management process. Failures in this area include lack of consideration of life cycle cost, non-utilization of available management and procedural skills and the numerous Federal, regional, State and local building and life safety codes that hamper technological advances. In a recent report to Congress, the General Accounting Office (GAO) identified these items and others and provided detailed recommendations. The Facilities Engineering and Construction Agency (FECA) presently has three projects dealing with these issues and problems. These projects include the investigation of the design process, the construction of three office buildings to performance specifications and using new management concepts and the third is the construction of five Indian Health Service hospitals using a sophisticated management plan.

Keywords: Architecture; construction; design; hospital design; management; medical facilities; performance specifications.

I was much impressed by the two previous presentations by DoD and the VA. We will follow the applications of those concepts with great interest, and it is reassuring to see so much effort expended in improving design and construction methods and techniques.

We should remind ourselves frequently, however--say every morning--that there is a fundamental issue behind all this, which is to plan and design with more responsiveness and sensitivity to the needs of both the patient and the practitioner.

There is a pot pourri of issues--we could take a sounding and probably not get the top 20 in the same order on any two people's lists, but these are some of the issues which concern me, and which I believe concern many of us, at this point in time:

- o To plan better so that facilities are on line when needed.
- o To predict facility needs five to ten years ahead to permit intelligent development efforts.
- o To improve our sensitivity to the need for facilities which can respond to the inevitable changes in health care delivery.
- o To contain parochial attitudes--we all enjoy a few--which are not consistent with our common cause.
- o To re-state the emphasis in planning and design of facilities so that the needs and the facility responses to those needs are much more rigorously tested during the conceptual effort.
- o To improve the management process on facilities procurement.

Perhaps at this moment the other side of the coin would be worth exploring, the negative side.

It gives us a feeling for the magnitude of our problems when we recognize that, even with the impressive advances which have been made, we still are not responding adequately, across the broad spectrum of health facilities, to the environment in which we work.

It's a tough environment:

- o Simultaneous escalation and tight funding;
- o Changing needs;
- o Split responsibilities and conflicting requirements for similar work; and
- o A downward trend in staffing.

We can't wrestle with all of our problems here, but let me touch on three:

1) Our failure, our long-standing failure, to consider facilities cost in true perspective--that is, in the light of the total life cost of the facility and all that goes on within it. We have the understanding and the skills to do so, but we have a lot of inertia to overcome.

Why is it so important? Because the early decisions--those which define the concept--shape the building--determine the response to the functional requirements--can have a dramatic effect on the total life cost--operations, alterations, and so on. But we persist, even today, for the most part, in viewing a construction job as an entity unto itself.

2) Our failure to utilize the management and procedural skills available to us--this costs us money--and it costs us time. When time and expenses go up on a given project and within a given budget--quality has no place to go but down.

Technologically, I have no argument with anyone. As needs are perceived, designers, fabricators, manufacturers, and builders respond beautifully. What then am I talking about?

The Tools

- o Phased design and construction;
- o Pre-bidding;
- o Performance specifications;
- o Others.

Certainly there are constraints to the use of these tools.

- o The law, in some cases;
- o Funding patterns, sometimes;
- o Regulations, on occasion;
- o Habit.

Whatever the constraint, there are ways to overcome it, including, when necessary, proposing corrective legislation.

Constraints or no, time marches on, and at this point we have only two choices:

Lead the march;

or

Watch it walk over us.

This may sound like a pretty harsh indictment of the Federal camp. Perhaps we deserve a harsh indictment.

3) As problems go, the quagmire of Federal, regional, State, and local building and life saftey codes and regulations certainly hold an important place in terms of hampering our ability to take advantage of technological advances.

Despite these three problems, I do not mean to imply that we have not made progress on the issues which I outlined earlier. However, I do suggest that we have been progressing at a snail's pace. How could we afford such a luxury?

Nobody had ever put the monkey on our backs!

Sombody just did!

The General Accounting Office (GAO) report to the Congress of November 20, 1972, on their "Study of Health Facilities Construction Costs" did just that.

For those of you who haven't yet studied the GAO report, I will paraphrase six recommendations which relate to this topic. There are many others, all of great interest.

GAO Recommendations (Paraphrased)

- o That the Department of Health, Education and Welfare (DHEW), assisted by the American Institute of Architects and the American Association of Hospital Consultants, publish essential factors to consider in the functional planning process--and the methodology to be used.
- o That DHEW explore reuse of designs from one facility to another and, if appropriate, establish the criteria under which designs, or elements of designs, could be reused.
- o That DHEW adopt a common set of requirements for new construction under Hill-Burton, Medicaid, Medicare.
- o That DHEW work with the National Bureau of Standards (NBS) to develop a scientific base of knowledge on lifefire safety. We see this as $500,000 per year for 5 years--we would hope for full participation by many Federal agencies. A relatively small effort is already underway.

- That DHEW participate heavily with NBS and others to improve our health facilities construction requirements and cooperate with model code groups and states.
- That DHEW issue policy guidance on the use of both phased design and construction and the total concept approach. In addition, that their use be considered on all projects assisted under the Public Health Service Act.

We have presented some of the critical issues of today, some related problems, and some very important recommendations by the GAO.

Now I should like to mention three on-going projects in which FECA is a participant and which come to grips with some of those issues and problems.

The first is a contract with a joint venture--Perkins and Will; Cresap, McCormick and Paget; and McKee, Berger and Mansueto, to evaluate the processes through which health facilities are procured under the grant and loan programs of DHEW. The contract will be completed in February. In the course of evaluation, these are the basic thrusts:

- To improve on the process itself; the interfaces, the timing, consistency between programs, elimination of unnecessary constraints, and faster testing and assimilation of new concepts, both technical and managerial.
- To improve on the gathering and use of data, and on the concepts and procedures contributing to life cost analysis and related decision making.

The second is a project with General Services Administration (GSA) and Social Security Administration (SSA) to build three Social Security Administration Payment Centers in three cities. That is approximately $100 million in construction having nothing to do with health facilities. However, these facilities bear watching, since they provide an excellent test bed for three of the tools which we can use in health facilities construction:

- The Executive Architect/Engineer (A/E) function;
- The Construction Manager concept, and;
- Performance specifications.

The third project takes full cognizance of the fact that it is during the planning and conceptual development that we can have the greatest impact. In that period the decisions are made which pretty well determine how well the project is going to respond to the user's needs.

Joseph Russo has been guiding a project through that stage of development. He will tell you now about how that project demonstrates a somewhat sophisticated management plan and uses the tools which we have mentioned earlier. The project will procure for the Indian Health Service, five hospitals across the Southwest.

NATIONAL BUREAU OF STANDARDS BUILDING SCIENCE SERIES 54, Proceedings of the First Federal Agency Workshop, December 5, 1972, Gaithersburg, Md. (Issued July 1974)

Application - Current Issues in Health Care Facility Design

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ABSTRACT The Facilities Engineering and Construction Agency (FECA) is presently accomplishing a project for the delivery of five health facilities. Unlike conventional projects, FECA commissioned an Executive Architect/Engineer (A/E) to review the programs of requirements, develop a functional definitive design kit upon which schematics would be based and to oversee the work of five regional A/E's who would be responsible for final design. Other unique aspects of this project include the use of a flexible management system, the use of a functional definitive design kit, the requirement for a guaranteed maximum price early in the design process from the construction manager and other innovations. Benefits include better quality Health Facilities delivered in shorter time and at a lower cost than through traditional means and the basis for continuous improvements of future health care facilities.

Keywords: Architecture; building systems; construction management; design; hospital design; medical facilities; performance; planning; programming.

You have heard Mr. Boyle discuss the issues with which we are concerned in the overall business of delivery of health care facilities. I should like to point out that, depending on the particular point in the building process, the issues have different degrees of influence. In Figure 1 is indicated the degree of influence of decision-making at various points along the project path. If the chart were continued, we would probably work our way up to the highest levels of government. In other words, the chart represents the big picture. It's in these earlier stages where the degree of influence is the greatest and where most of the work needs to be done. Whether we call these stages "comprehensive health planning" (for definitions see Appendix A) or call them "improvement of a national health care delivery system" (including social, physical, economic, and management planning), they represent all the decision making which happens earlier and impacts on the delivery of health care facilities.

As important and interesting as these earlier issues may be, they will not constitute the theme of my talk. As an architect, my area of involvement tends to start during the programming stages of the process. Consequently, I should like to focus on a specific project during the facilities delivery stage which addresses the issues and incorporates the tools or management concepts mentioned by Mr. Boyle.

It happens that this project was well along when the General Accounting Office (GAO) study was undertaken and we are delighted that their recommendations reinforce the thrust of our project.

The name of the project is: IHS/FECA Management System Health Facilities Project. This project is being accomplished for the Indian Health Service (IHS) by FECA.

The total project will involve the design and construction of five health facilities to meet the health needs of the Indian communities and to provide adequate resources for provision of a comprehensive, curative, and preventive health care program.

Very early in the programming stages of the project it was decided to design a management system to serve as the conceptual framework or backbone upon which we could build over a period of time.

The general management system involves a Government team and a builder team. The builder team consists of an Executive Architect/Engineer (A/E), Regional A/E's and Regional Construction Managers (C/M's). The Government will furnish, to the Executive A/E, five program of requirement documents which define the scope, health care programs, staffing patterns, workloads, budget, and other data for the five health facilities projects. These program of requirement documents are intended to serve as user requirement material for the project. The Executive A/E will review these five documents and may propose changes to the technical requirements. Based on these five program of requirement documents and contact with the users of each facility, the Executive A/E will then develop five separate study drawings. After approval of these drawings has been given a functional definitive design kit will then be developed from the drawings, as well as an analysis of the common requirements of the five health facilities (i.e., architectural, structural, mechanical, electrical, functional relationships, modularity requirements, building mass, etc.).

In addition to basing the functional definitive design kit on an analysis of the five design criteria documents and the five study drawings, the Executive A/E must consider and reflect the five-year IHS hospital construction program, IHS national health care delivery system, and IHS medical philosophies. Such program information will be provided to the Executive A/E by means of a one- or two-day seminar which will

THE COST OF WRONG DECISIONS

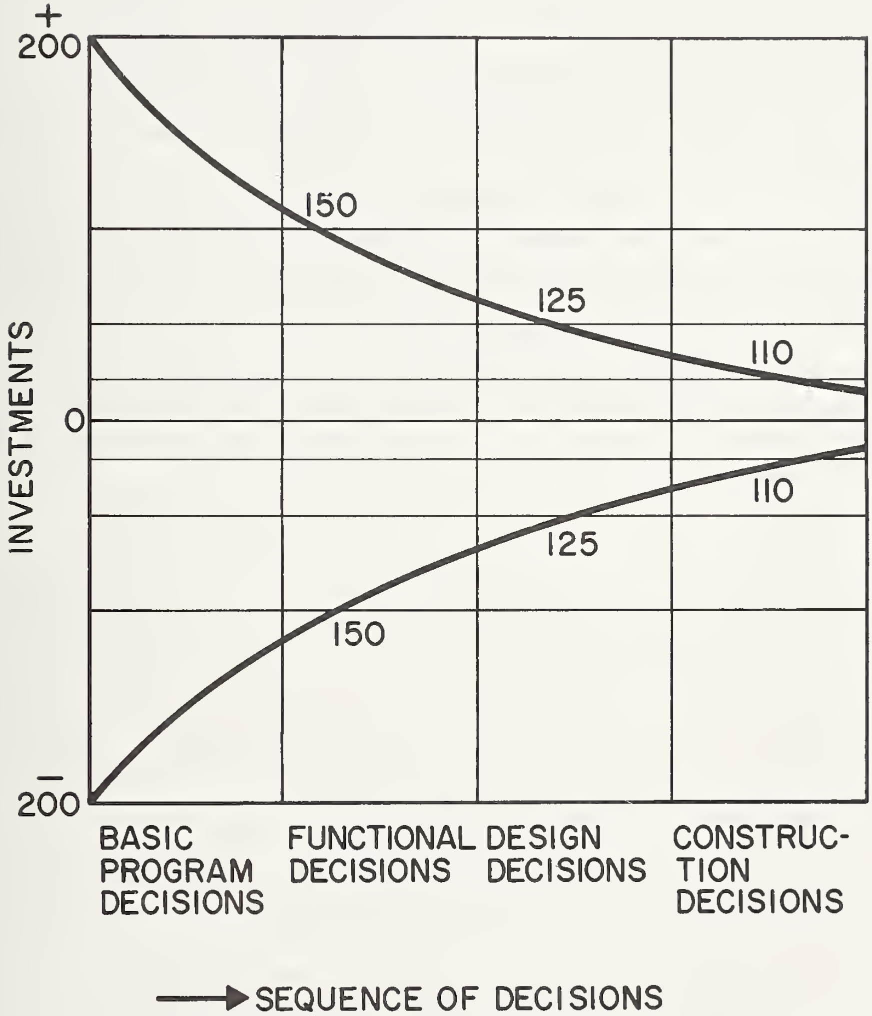


Figure 1

include handout material. The functional definitive design kit will serve as the main input into the Executive A/E's further development of schematic documents for the five facilities, with local conditions finally determining each schematic. The study and schematic documents will then be made available to Regional A/E's for further development.

The Executive A/E services will be performed under the direction of the Government's Project Manager (PM). The Executive A/E will also be retained during the regional design and construction phases to coordinate the total design effort and to assist the Government where necessary to resolve problems that may arise. As a means of insuring accountability of the Executive A/E's effort, the Executive A/E will serve as Regional A/E for one of the five projects. In this dual capacity, he will obviously program his total work in a manner which minimizes overlap of effort and maximizes the quality of effort.

The Regional A/E's will each be responsible for the completion of a specific project, utilizing the study and schematic documents provided by the Executive A/E. The Regional A/E services will be performed under the conceptual guidance of the Executive A/E.

The project contains several management concepts that have been tried on an individual basis elsewhere, however, it is one of the few projects whose sponsors have consciously attempted to incorporate the advanced state-of-the-art in building technology.

Such an attempt has resulted in the integration of all of the following management concepts in one package:

1. Executive A/E
2. Regional A/E's
3. Regional C/M's
4. Phased Design and Construction
5. Construction Management
6. Building Systems
7. Bulk Buying
8. Value Engineering and Life-Cycle Costing
9. Performance Specifications

An additional ingredient in the project is the use of a functional definitive design kit. In fact, we hope the kit will be the avenue by which we will incorporate the other management concepts.

In summary, the project utilizes a management system which emphasizes flexibility in management. This approach is a counterpart to the idea of flexibility in building hardware. In short, keep all options open and don't make a decision until you have to; but when it's needed, make it and make it expeditiously.

An outline of my talk is as follows:

1. Why the project?
2. Objectives
3. Management-System
4. Documentation
5. Benefits to Indian community, IHS, and FECA
6. Benefits to the Department of Health, Education and Welfare (DWEW)

1. Why the project?
   a. Health Facilities are needed.
   b. To respond to the President's message to Congress and follow-up attitude of House and Senate.

2. Objectives

   The objectives of this project are as follows:
   a. To provide health facilities which respond to the health needs of American Indians.
   b. To maintain or improve facility quality.
   c. To reduce project time.
   d. To reduce project cost.

3. Management-System

   To best meet the objectives noted above, we decided to develop the management system mentioned earlier which is primarily concerned with the total design and construction process. The first task prescribed is to identify, isolate and take advantage of the common denominators in each project. We feel our approach can provide better supervision of projects. Also it can provide lower expenditure of Government manpower resources by having a single A/E coordinate the work of several additional A/E's.

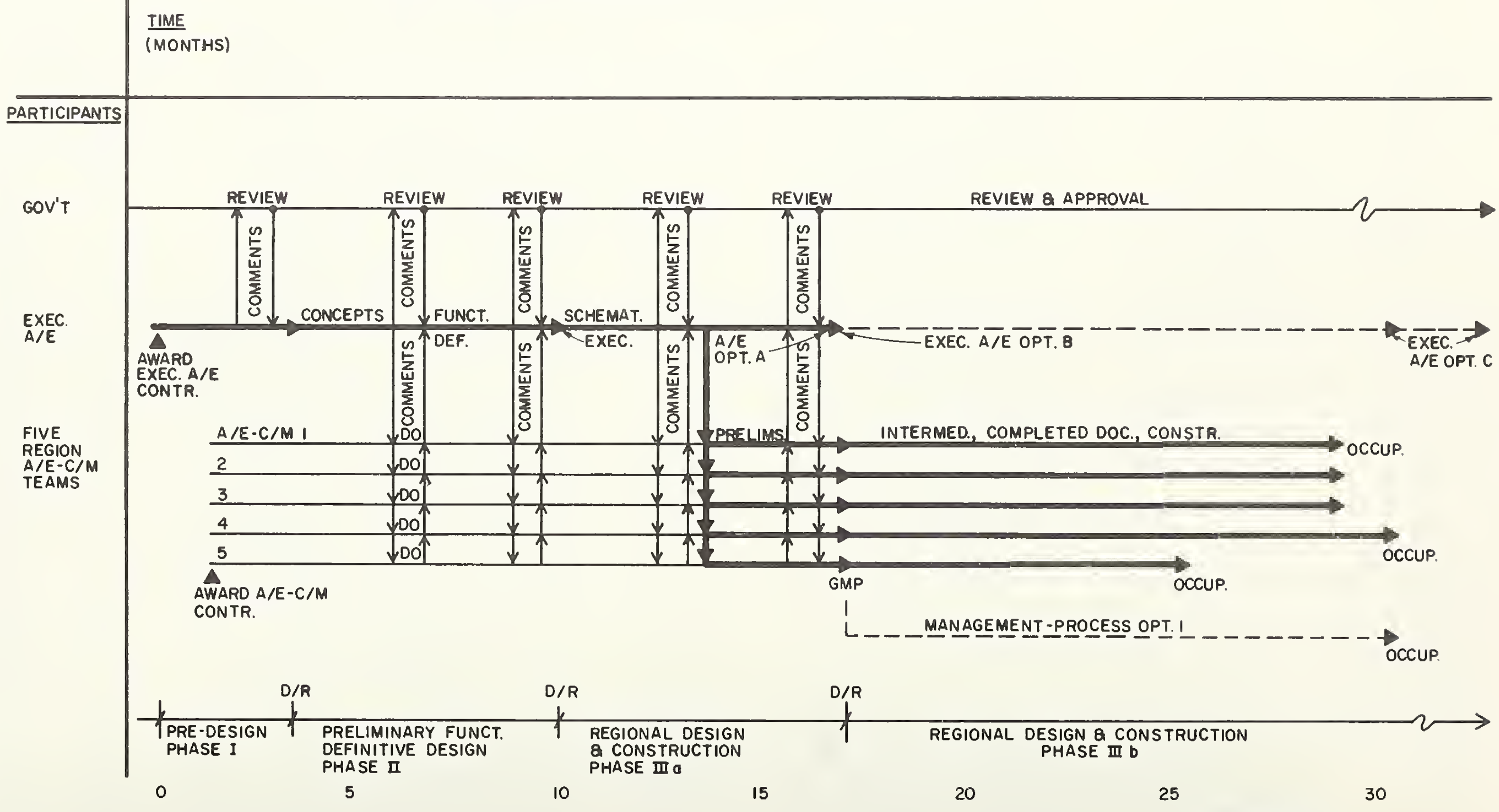
   Figure 2 represents the conceptual framework for the project. It's essentially a generalized process diagram indicating the activities of each participant over time.

   In addition to the most obvious elements of the management system, some of the more hidden elements include the use of concepts inherent in the ABS project, and the Florida SSP projects and the use of post evaluation and feedback. The point in the process to request a guaranteed maximum price (GMP) is a variable deserving of much evaluation as the project develops. In some situations, the GMP can be solicited early, while in other situations the GMP must be solicited later. The prudent project manager should allow a contingency fund in his fiscal spending plan to "buy more design" if the situation demands it. On one project the correct time might be at the end of preliminaries, while in another case that stage may be too soon; therefore, the GMP solicitation should be postponed to the end of intermediates or later stages.

   Figure 3 shows, in general terms, how the Executive A/E might approach the issue of common users' requirements for each project.

   Figure 4 summarizes the various management concepts which form a part of the project and indicates in which phase of work each concept is to be applied.

MANAGEMENT-SYSTEM FOR FIVE PROJECTS



ABBREVIATIONS
D/R = DECISION/REVIEW
FUNCT. DEF. = FUNCTIONAL DEFINITIVE

Figure 2

TASKS / PARTICIPANTS	TASKS: CONVENTIONAL PROCESS	TASKS: IHS/FECA MANAGEMENT-SYSTEM
EXECUTIVE A/E	Executive Architect/Engineer (A/E) Does Not Exist	Architectural, Structural, Mechanical, Electrical and Other Requirements; Functional Relationships; Massing and Module Requirements and Others
REGIONAL A/E-C/M TEAM 1	Architectural, Structural, Mechanical, Electrical and Other Requirements; Functional Relationships; Massing and Module Requirements and Others Program of Activities and Cultural Requirements	Program of Activity Requirements (e.g. surgery, radiology, etc.), Cultural Requirements
REGIONAL A/E-C/M TEAM 2		
REGIONAL A/E-C/M TEAM 3		
REGIONAL A/E-C/M TEAM 4		
REGIONAL A/E-C/M TEAM 5		

Figure 3

SUMMARY

APPLIED / CONCEPTS	I	II	III a 'A'	III b 'B'	III b 'C'
EXEC. A/E, R. A/E, R. C/M	✓	✓	/	✓	
FUNCT. DEF. DESIGN KIT		✓	✓	✓	
PHASED D/C			✓	✓	
C/M		✓	✓	✓	
B'LDG. SYST.		✓	✓	✓	
BULK BUY.			✓		
VAL. ENG. & L.C.C.		✓	✓	✓	
PERF. SPEC.	✓	✓	✓	✓	

Figure 4

Figure 5 represents a traditional functional definitive and can be found in use in many offices. While this type of definitive may have merit, it is not what we are looking for. We are seeking a functional definitive design kit as shown in Figure 6, a kit possessing the capability of achieving all of the characteristics of the traditional functional definitive. The outstanding feature of the kit will be its flexible and adaptable building block elements. We feel that these flexible and adaptable elements will permit the designers to deal with the different external site-related forces and internal building-related forces, both of which generally shape the building layout.

The final ingredient necessary to make the project work is a total team communication system as shown in Figure 7.

4. Documentation

The following documentation is necessary for this project:

a. Preliminary analysis of common features of five health facilities.
b. Government management plan.
c. Executive A/E contract.
d. Regional A/E contract.
e. Five Program of Requirements documents.
f. Project spending plan.

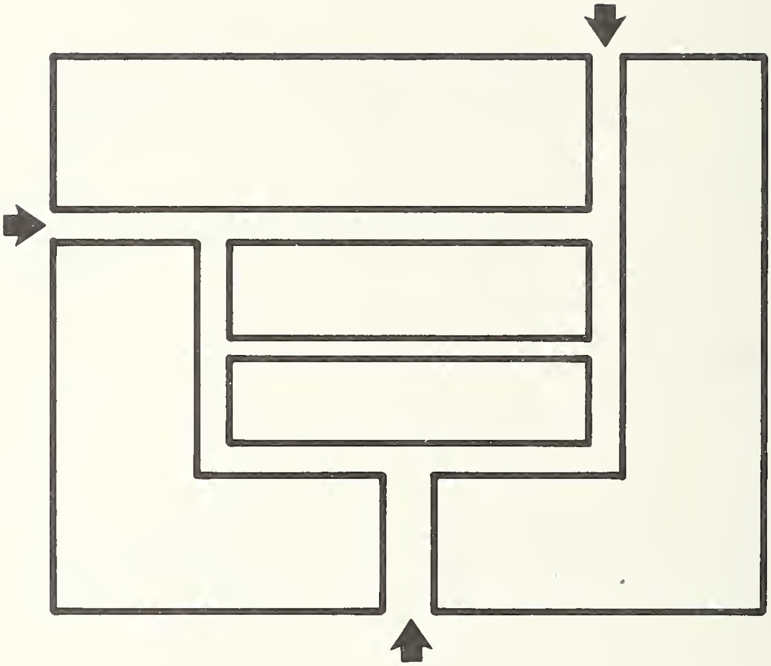
5. Benefits to Indian Community, IHS, and FECA

The benefits to the Indian Community, IHS and to FECA will include:

a. The management system will deliver five hospitals of better quality, in shorter time, and at lower cost than can be delivered by the traditional one-by=one approach.
b. It will provide a model for IHS, both for delivery of projects and for obtaining funding.
c. It will provide a basis for continued improvement of future facilities.

6. Benefits to DHEW

Finally, the results will be available for application to other DHEW Federally assisted programs.

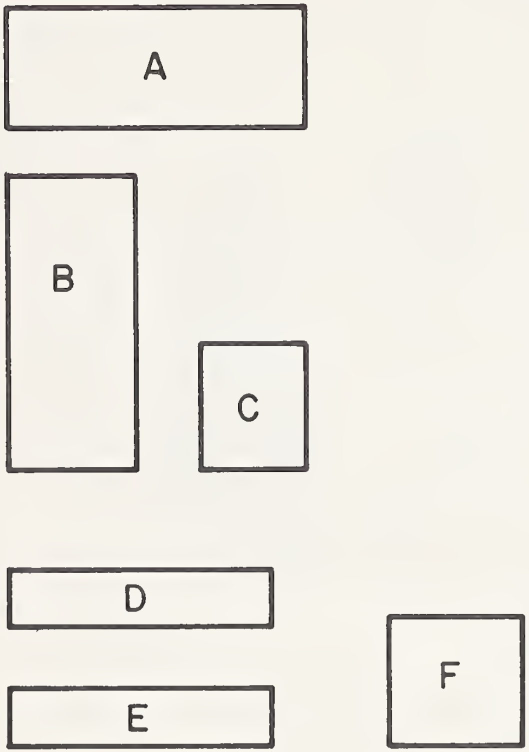


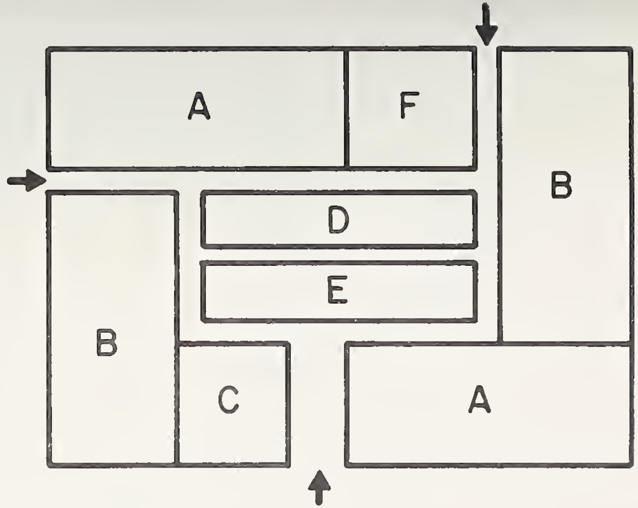
TRADITIONAL FUNCTIONAL
DEFINITIVE (SCHEMATIC)

Figure 5

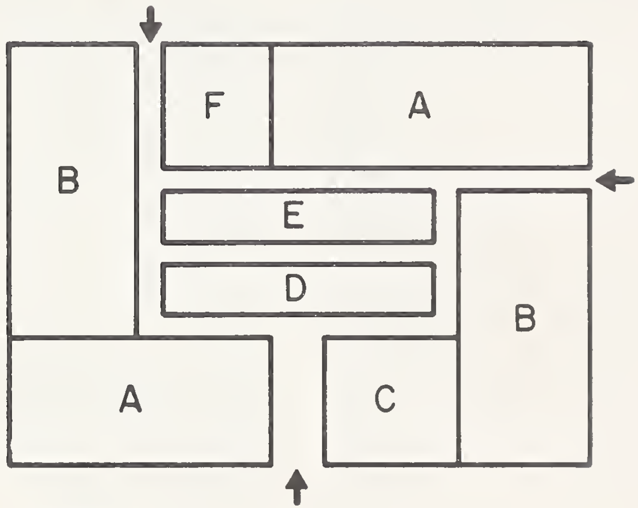
FUNCTIONAL DEFINITIVE DESIGN KIT:

1. DESIGN ELEMENTS
2. RULES GOVERNING THEIR USE





SCHEME 1



SCHEME 2

Figure 7

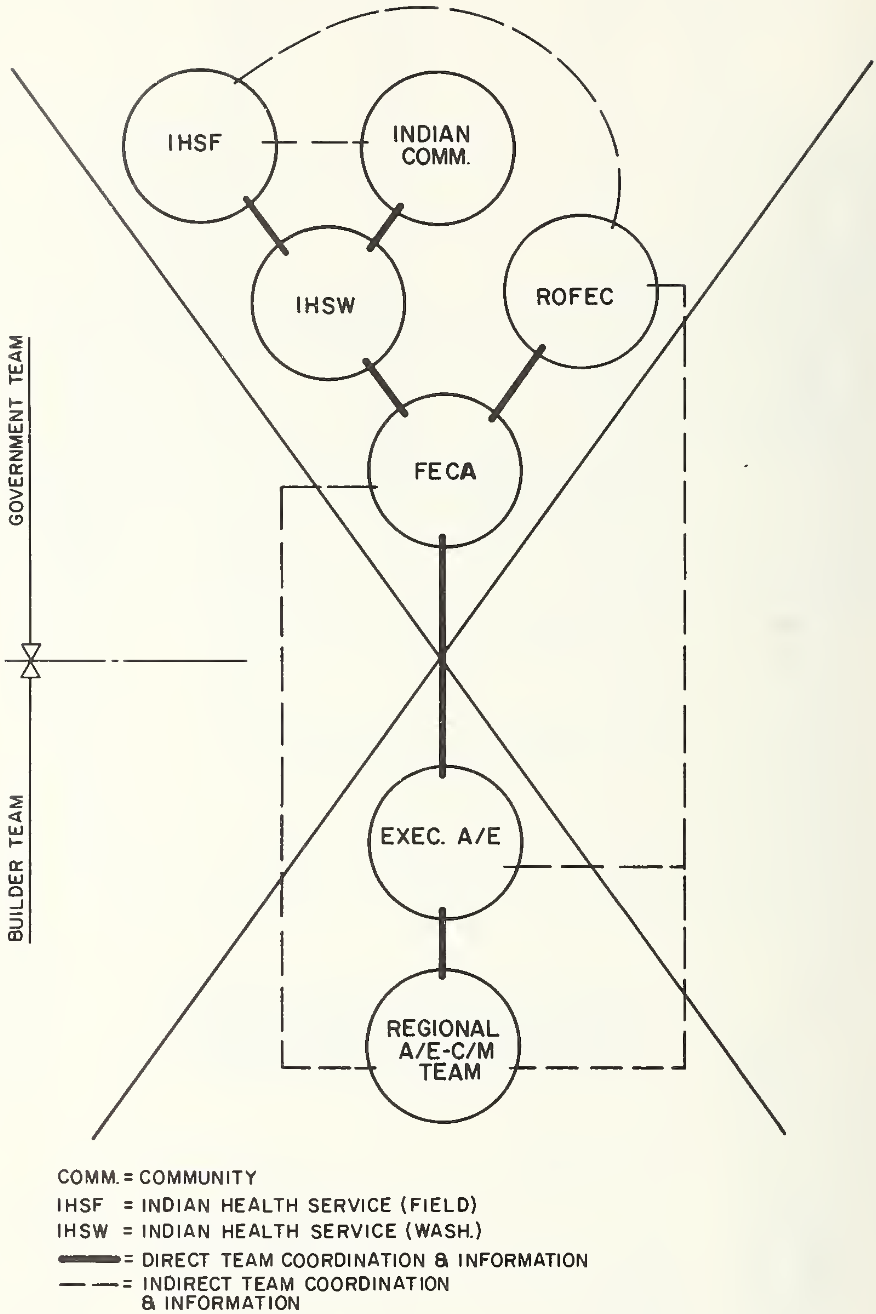

IHSF
INDIAN COMM.
IHSW
ROFEC
FECA
EXEC. A/E
REGIONAL A/E-C/M TEAM
GOVERNMENT TEAM
BUILDER TEAM
COMM. = COMMUNITY
IHSF = INDIAN HEALTH SERVICE (FIELD)
IHSW = INDIAN HEALTH SERVICE (WASH.)
= DIRECT TEAM COORDINATION & INFORMATION
= INDIRECT TEAM COORDINATION & INFORMATION

Figure 7

Appendix A

DEFINITIONS

1. <u>Building System</u>

Refers to building "parts," with rules governing their manner of composition to achieve some needed level of performance. An example of a building system would be Habitat at Expo '67.

2. <u>Comprehensive Planning</u>

Overall pre-design planning (including social, physical, economic and management planning) to accommodate the short and long-range objectives of a particular health care, educational, or welfare program, with emphasis on integrating the program within the community it is intended to serve. Inherent in comprehensive planning is a systematic approach to obtaining optimum consideration of broad user needs and thus providing facilities responsive to these needs.

3. <u>Functional Definitive Design Kit</u>

A kit including design elements with rules governing each element's use. Each element could involve one room or more or up to one department or more. The design kit must have the capability of achieving all of the above characteristics noted in the traditional functional definitive. The design kit differs from the traditional functional definitive in that it is made up of flexible and adaptable elements.

4. <u>Guaranteed Maximum Price</u> (GMP)

A price offered to the Government prior to the start of construction for completion of the project. Guaranteed maximum priced contracts guarantee that the reimbursement for the cost of the work, as set forth in the contract documents, will not exceed a stipulated sum. The Construction Manager (C/M) shall provide performance and payment bonds each in the amount of 100 percent of the Guaranteed Maximum Price. In the event that the cost of work as set forth exceeds the stipulated sum, the Construction Manager agrees to complete the work at no additional cost to the Owner. The ultimate cost of work to the Owner shall be calculated on the basis of the summation of all contracts awarded, the cost of materials purchased and the cost of reimbursable items authorized by the Owner in executing the work. Any savings realized through the reduction in the cost of the work below the stipulated Guaranteed Maximum Price accrues to the Owner.

5. Life-Cycle Costing

A concept of considering total costs which include:

a. initial costs;
b. program costs during project delivery;
c. program operations cost after project delivery;
d. financing costs;
e. building operations costs;
f. maintenance and repair costs and
g. alterations and replacement costs.

In addition, the salvageability or final value should also be taken into account when considering total costs.

6. Program of Requirements

A document which defines the project in terms of people, programs, and facility related needs. Also, the interrelationships among these needs. It is the result of information developed during the comprehensive planning phase. Site selection and site utilization analysis reports, user needs, health care services, space allocations, special relationships, staffing patterns, etc. are included. A well prepared document enables an architect to design a building or group of buildings with minimal additional guidance. The document serves as a deterrent to unnecessary modifications or increases in the scope of a project.

7. Post Evaluation

The critical investigation and measure of response of the facility to its intended and/or present use. Closely related to evaluation is the feeding back of the results in the loop of information which controls decision making.

8. Regional Construction Manager (C/M)

The individual who is generally responsible for providing a construction concept during the design stages and a guaranteed maximum price, and later is responsible for implementing construction. In the early stages of the project, his expertise will be primarily provided to the Executive A/E. After approval of schematics, the Regional C/M's expertise will shift emphasis and be primarily directed to the Regional A/E.

9. Systems Building

The "how" of project delivery.

10. Traditional Functional Definitive

A single line drawing generally considered to be a schematic and showing or enabling the following:

o plans, elevations, sections, etc.
o square foot allocations for various functions
o configuration of building with structural system
o pricing of facility
o utility requirements (e.g., power, water, heat, A/C, etc.)
o equipment layouts
o special considerations (minimum head room, critical dimensions, etc.)

NATIONAL BUREAU OF STANDARDS BUILDING SCIENCE SERIES 54, Proceedings of the First Federal Agency Workshop, December 5, 1972, Gaithersburg, Md. (Issued July 1974)

An Evaluation Methodology for Hospital Nursing Units

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ABSTRACT Hospital planners and designers are facing the twin trends of greater construction costs and greater demand to access to the health care delivery systems. Because of these twin trends, these planners and designers must become increasingly aware of the various requirements involved in nursing units. One method of achieving this is through evaluation. The evaluation methodology that was developed by the Architectural Research Section relies on the research aids of architectural psychology, building systems and the performance approach. In this methodology, requirements are systematically identified and schematic drawings of nursing units are weighted and rated based on these requirements. When allied with costs, this methodology permits a comparison of various schemes on a performance-cost basis. It also aids the designer in improving his design of nursing units.

Keywords: Architecture; design; evaluation; hospitals; medical facilities; nursing units.

BACKGROUND

Today we are faced with rapidly increasing costs of hospital construction, the primary facility in the health care system. In today's presentations, we have heard of several Federal hospitals either under design or construction that will cost in excess of one hundred million dollars. Concurrent with this trend of more expensive hospital construction is the trend of more people wanting increased access to the health care delivery system. With the twin trends of increasing cost and increasing citizen demand for access, hospital planners and designers must become increasingly aware of the various requirements that they must satisfy in any new medical facility. It is only through an increasing awareness of these various requirements, that improved, more effective, more efficient hospitals can result. One step toward developing such an awareness is through the design methodology which permits the evaluation of alternative design schemes in meeting these requirements prior to hospital construction. The Architectural Research Section has recently developed such an evaluation methodology for the Health Services and Mental Health Administration of the Department of Health, Education and Welfare. This evaluation methodology can be used for the evaluation of hospital nursing units.

Hospital nursing units tend to be quite complex organizations for the planner and the designer. In designing these units, they must take into account and design for such requirements as safety, security, convenience, and efficiency. Many of these requirements are in conflict among themselves and with others, resulting in the need for trade-offs among alternative requirements. Finally, the planning and design functions must usually be accomplished within an extremely tight budget. To develop an evaluation methodology which reflects this complex situation, it is useful to employ three research approaches; architectural psychology; building systems and the performance approach. These three are discussed as follows:

> Architectural psychology is a relatively new discipline. A mixture of behavioral sciences and architecture, it allows us to apply the results from behavioral science research to such rooms and spaces as nursing units. Because of the reliance on behavioral science studies, architectural psychology allows us to focus on the psychological, physiological and social needs of the patients and staff. The results of these behavioral studies provide us with a rigorous aid in approaching the problem of nursing unit evaluation by focusing on the needs of the patients and staff.
>
> The second research approach utilized was the building systems concept. The building systems concept provides a mechanism for considering a given building, such as a hospital, as a system which can be analyzed into a number of subsystems. A list of hospital subsystems would include site, structure, enclosure, space use, transport systems, environmental systems, power distribution systems, communications systems, and equipment. The building systems concept also allows us to categorize the great number of requirements that the planner and designer must deal with by means of performance attributes. A performance attribute can best be described as a collection of requirements associated with a building, or a nursing unit. A list of performance attributes would include fire safety, physical safety, chemical-biological-radiological safety, electrical safety, internal convenience and efficiency, external convenience and efficiency, anthropometric fit, physiological, social and psychological comfort, durability, reliability,

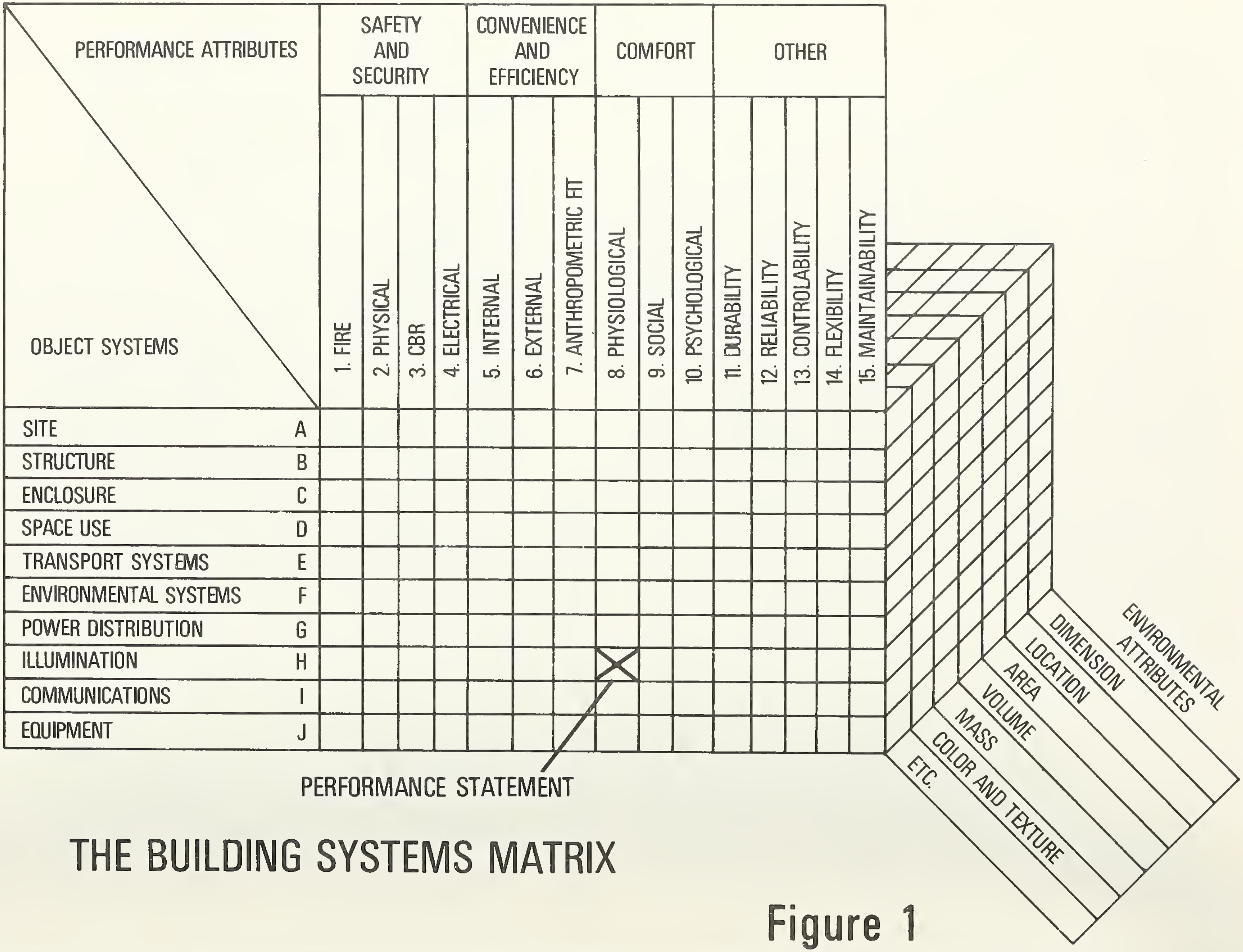
fit, physiological, social and psychological comfort, durability, reliability, controlability, flexibility, and maintainability. The building systems concept also allows us to list those properties that can be measured. Such a list would include dimension, location, area, volume, mass, surface color, texture and others. The utility of these categories, or lists, lies in their value for the systemmatic development and consideration of requirements for hospital nursing units, as will be shown in later pages.

The final technique utilized in developing the evaluation methodology was the performance approach. The performance approach is an emerging technique for developing and stating building requirements. It emphasizes the need for rigorous and detailed studies of user requirements in buildings. In stating building requirements, the performance approach consists of the translation of user needs into performance statements that are non-specifying in nature. That is, a performance statement is worded so that materials, dimensions, and specific design solutions are not included. To do this, a performance statement has three essential parts; the requirement, the criterion and the test. The requirement is the qualitative portion and the criterion the quantitative portion of the performance statement. In the case of illumination, for example, the requirement would state, "Adequate illumination will be provided...," the criterion would state, "Fifty foot candles of light will..." The third part of the performance statement is the test. The test gives the details on how a given specimen will be tested to see if it meets the stated criterion. For our example of illumination, a test would state, "IES Handbook test number..."

DEVELOPMENT OF THE EVALUATION METHODOLOGY

These three research approaches, architectural psychology, building systems and the performance approach, have been successfully used in building research before. For example, architectural psychology has been used for determining space arrangements, building systems have been used in the planning, design and construction of schools and other building types, and the performance approach has been successfully applied to the specifications for housing and office buildings. However, the three have never been collectively utilized for the purposes of building evaluation. In developing an evaluation methodology for hospital nursing units we employed these approaches in the following manner.

First, from building systems we adopted the previously mentioned list of building subsystems. Since we were concerned primarily with the hospital nursing unit, a portion of the overall building, we deleted the building subsystem "site" as extraneous to our immediate evaluation needs. Likewise, we also deleted the building subsystem "structure" as this subsystem is of primary interest in the evalution of the building as a whole rather than one department of that building. From building systems, we also adopted the list of performance attributes; that is, the list of what we think a building ought to do. We then arranged these two lists of building subsystems and performance attributes at right angles to form the matrix shown in Figure 1.



THE BUILDING SYSTEMS MATRIX

Figure 1

This matrix provides us with a number of advantages in the evaluation of nursing units, which have a very large number of requirements. The matrix shown in Figure 1 aids us in breaking down this big pool of requirements into smaller groups that are easier to analyze and evaluate. This point will be developed later. Another advantage of the matrix is that subdividing the large pool of requirements allows researchers to examine small portions of the pool, thereby making possible the close scrutiny required. This analytic method will become evident as we continue this approach to nursing unit evaluation. Finally, the matrix allows us to index a great amount of information and data in a reasonable and orderly manner. For example, we can use this matrix to organize the extensive literature concerning the planning and design of nursing units.

After establishing the matrix, performance requirements for nursing units were developed by examining each intercept of the matrix. For example, in the intercept of the building subsystem, "Environmental System", and the performance attribute, "Physiological Comfort", the need for such performance requirements as "Provide conditioned air," "Provide appropriate levels of temperature and humidity," and others became readily apparent. The initial list or pool of performance requirements were developed by a physiologist who brought to this task, experience in interdisciplinary research from similar projects. This initial list of performance requirements was reviewed and revised by a physician, an architect, an architect/engineer, an architectural psychologist and a medical systems analyst. The first three individuals were hospital consultants with numerous years of private practice in the planning, design and construction of medical facilities. The other specialists brought the perspective of the user to bear on the problem.

The final list of performance requirements was very large, over 150 such requirements being so identified. This well illustrates the designers dilemma in actually designing a hospital nursing unit, a difficulty which applies equally to other building types. However, not all requirements are equally important. Besides the problem of establishing priorities, as noted earlier some requirements actually conflict with others requiring trade-offs. In actual practice, the designer has several means to help him in coping with these numerous requirements. First, there are the building codes and regulations dealing with those requirements associated with safety. Second, the designer can rely on books, articles, and other published materials. And third, the designer can utilize the expert opinion provided by consultants, physicians, nurses, administrators and others.

The prime purpose of our evaluation methodology was for evaluating schematic drawings of different nursing unit designs. This purpose, which involved many levels of comparison, required the development of our own means for handling the numerous performance requirements. We did this by means of a nursing unit schematic drawing scorecard. The scorecard is shown in Figure 2.

Reading down the left hand of this scorecard are the letters A, B, C, and D. These letters designate the different schematic drawings of nursing units to be evaluated. Thus, a total of four different nursing unit designs can be evaluated through the use of this scorecard.

The column marked "x/o" identifies only those requirements that can be evaluated from schematic drawings. For each performance requirement that can be evaluated by using schematics, an "x" is entered into this column. For those that can't be evaluated from schematics, such as our earlier examples of "Provide conditioned air," and "Provide appropriate levels of temperature and humidity," an "o" is entered into this

1.B. SPACE USE	COLUMN X/O	COLUMN d/e	COLUMN W	COLUMN R1	COLUMN S1	COLUMN R2	COLUMN S2
	CAN BE EVALUATED FROM SCHEMATIC (X) / CAN NOT BE EVALUATED FROM SCHEMATIC (O)	DESIREABLE (d) / ESSENTIAL (e)	WEIGHT (W)	FIRST RATING (R1)	FIRST SCORE (WxR1=S1)	SECOND RATING (R2)	SECOND SCORE (WxR2=S2)
PROVIDE . . . ADEQUATE ACCESS TO EXITS AND/OR "AREAS OF REFUGE"							
SCHEME A	X	e	9	4	36	4	36
SCHEME B	X	e	9	5	45	5	45
SCHEME C	X	e	9	5	45	5	45

THE SCORECARD FORMAT

Figure 2

column. However, a schematic drawing is essentially a model of a completed nursing unit. Like all models, the schematic drawing emphasizes certain features of the completed nursing unit and ignores others. Because of this lack of comprehensiveness in schematics, not all performance requirements can be evaluated on the basis of the schematic drawing. In our evaluation of nursing units based on schematic drawings, those requirements marked with an "o" are thus ignored and not evaluated. If the evaluation was based on an existing nursing unit, such as would be the case in feedback studies, those requirements marked "o" would, of course, be included.

Reading from left to right on the scorecard, the next column is marked "d/e". In "real life," the designer does not have perfect freedom in design but must meet a certain number of legal requirements contained in building codes, regulations and other documents. The failure to meet these requirements usually would result in disapproval of his design. Column "d/e" reflects this reality. Each requirement was reviewed to see if it was usually required in building codes, regulations or other documents. If a requirement was usually legally required or could seriously affect operations, an "e" was entered representing a desirable requirement.

The next column to the right is marked "W", representing weight. Not all requirements, whether considered desirable or essential, are of equal importance. Each requirement was reviewed by a team of consultants experienced in the planning, design, and construction of medical facilities. For those requirements judged of extreme importance, a weight of 9 was entered into column "W"; for those requirements of very little importance, a weight of 1 was entered into column "W." Requirements considered between these two extremes were appropriately weighted.

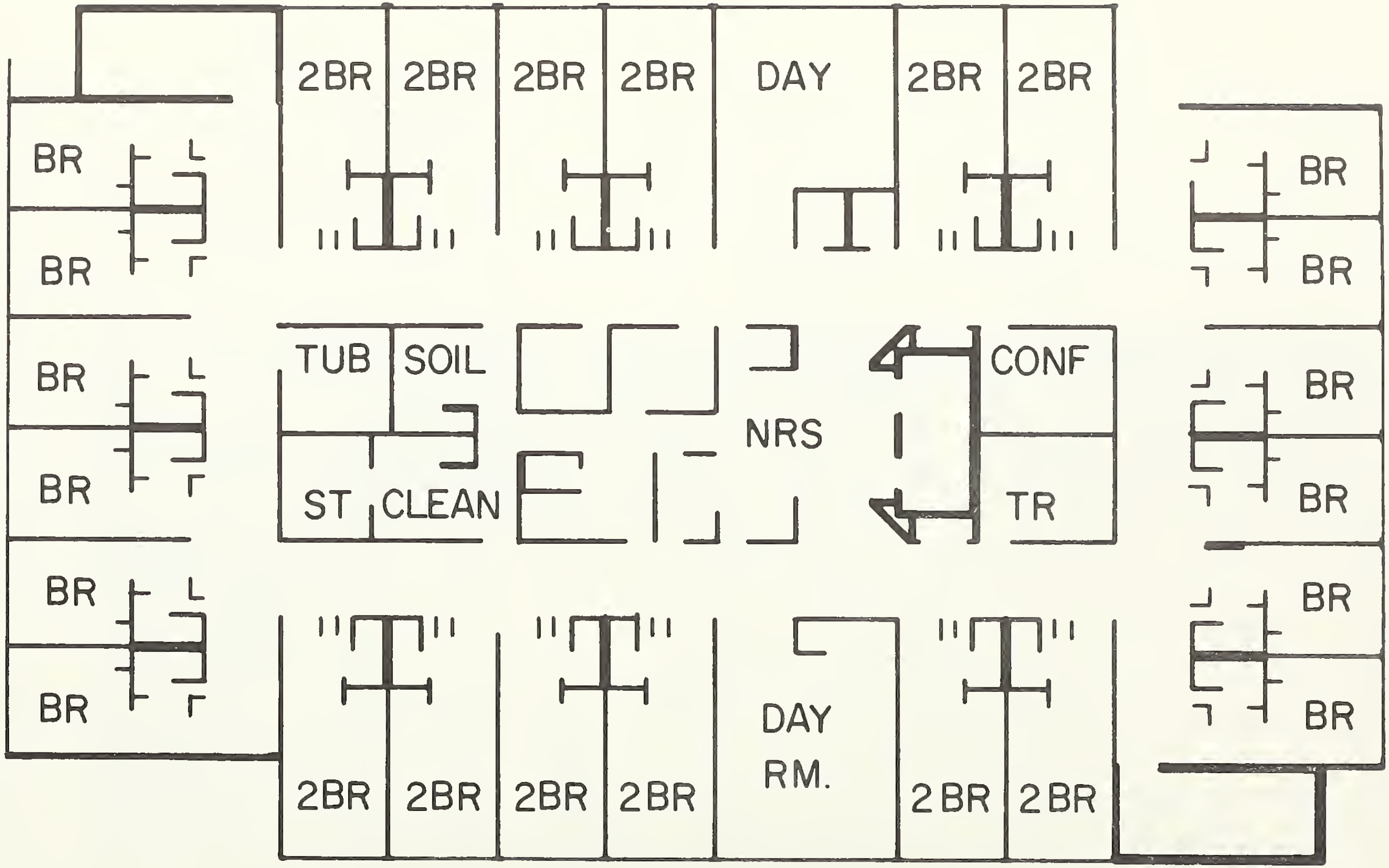
This concluded our initial preparation for the evaluation of the nursing units. The remaining columns shown on the scorecard will be explained in the following description of our evaluation procedure.

USE OF THE EVALUATION METHODOLOGY

Following the development of the methodology, we evaluated three schematic drawings of different nursing units. These three drawings were designed to our specifications by a private hospital consulting firm. Each of the three designed nursing units had twelve (12) double bedrooms, twelve (12) single bedrooms and similar support spaces such as nurses station, clean supply, treatment room, etc. The differences between these three nursing units' drawings was of the arrangement of spaces. Scheme A was arranged into two double loaded corridors, sometimes called the racetrack design. Scheme B was arranged into one long double loaded corridor. Scheme C was a square radial, that is, a square nursing unit with the nurses station found in the center with good circulation to all patient bedrooms located along the perimeter of the square. These are illustrated in Figures 3, 4, and 5.

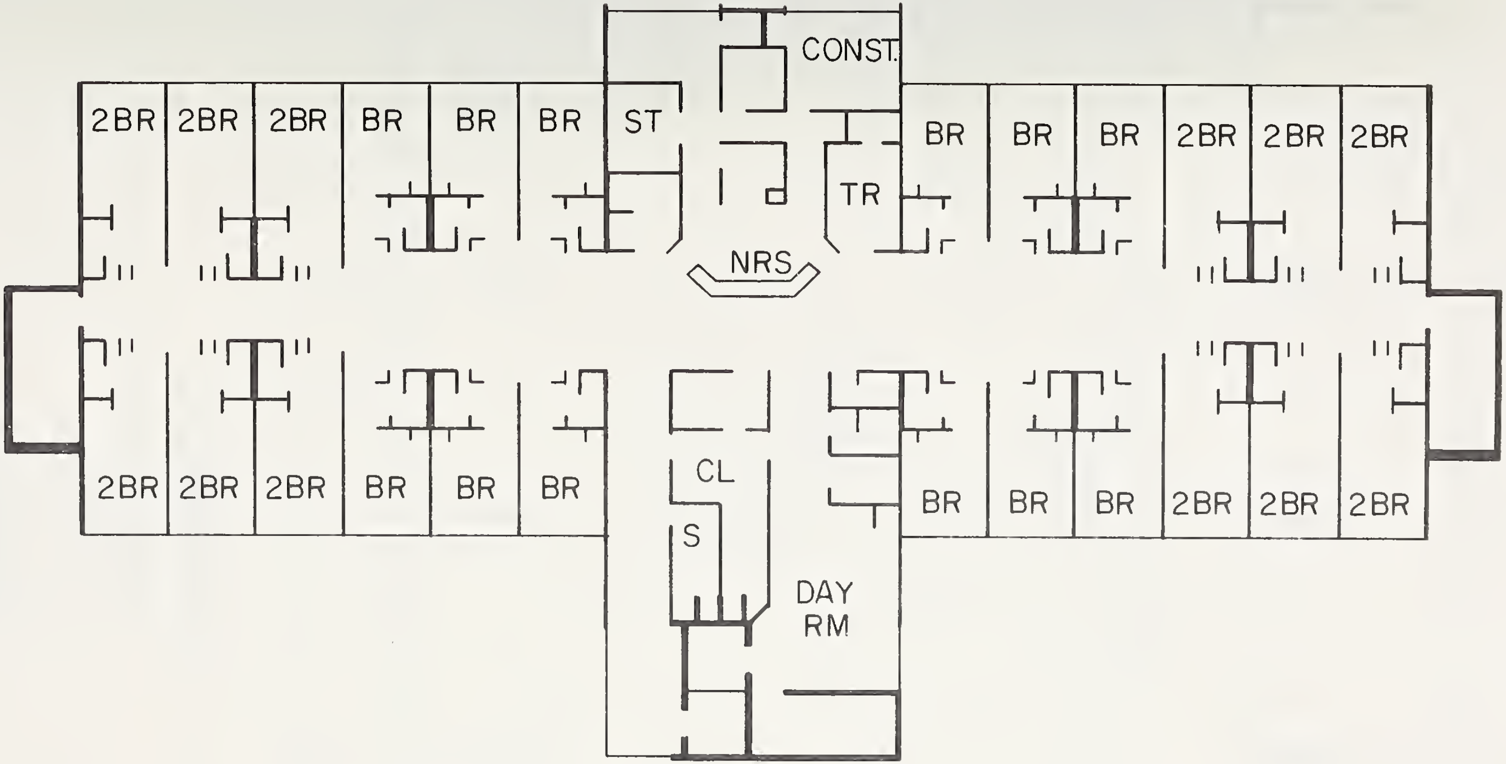
Thus, these three specially designed nursing units represented the situation of alternative designs being developed from the same architectural program, or design specifications.

After the schematics of Schemes A, B, and C were developed, a physician and an architect from a hospital consulting firm examined these designs against the previously described scorecard. For each requirement that had been marked "e" for essential, the three schemes were examined independently by this physician and architect to insure that



SCHEME A
12,400 SQ. FT.
36 BEDS

Figure 3

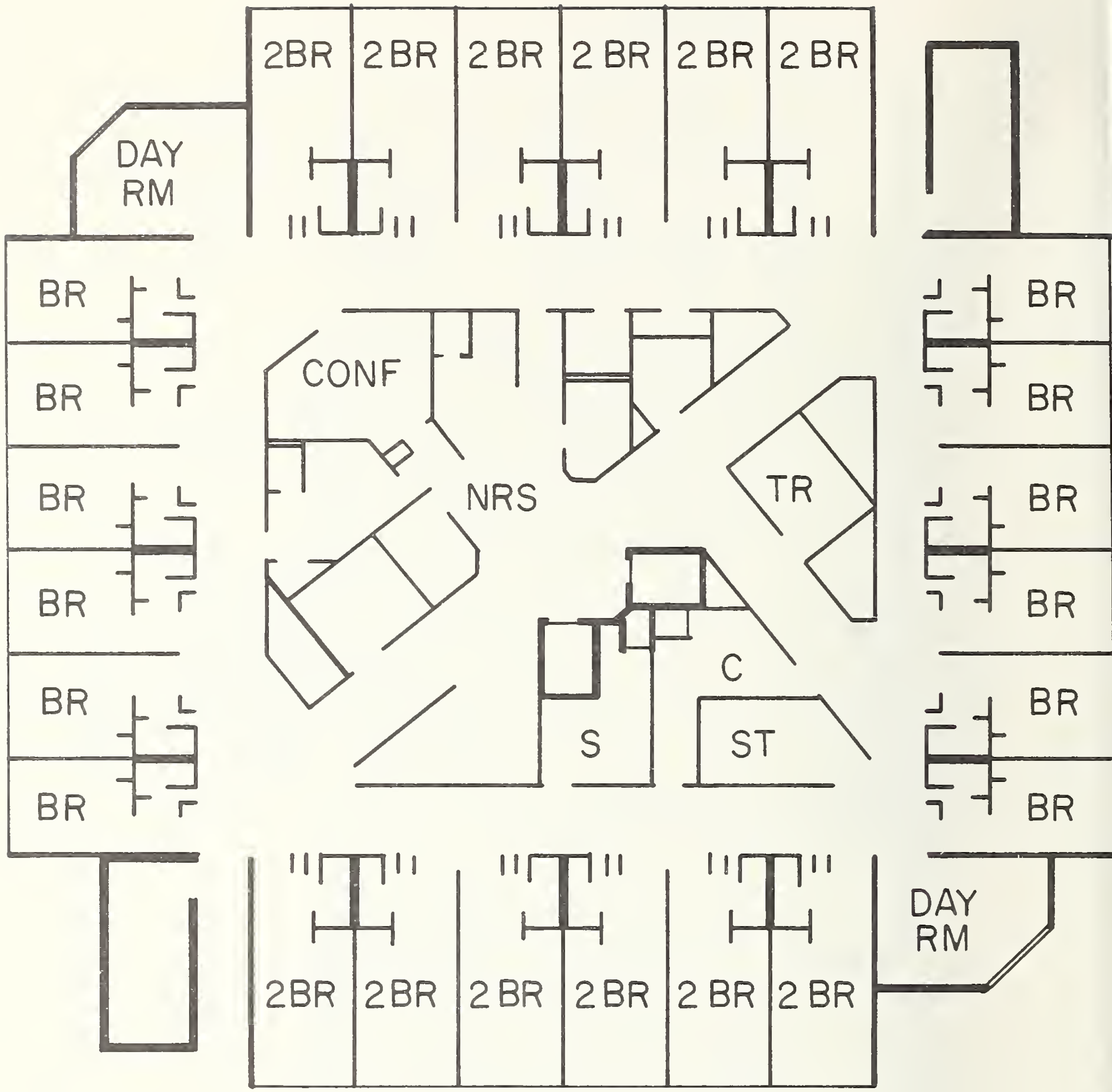


SCHEME B

11,600 SQ. FT.

36 BED

Figure 4



SCHEME C

13,400 SQ. FT.

36 BEDS

Figure 5

the three designs had some provision for each of these requirements. It was found that each of the three designs met those requirements marked "essential" to some degree or other. If it had been found otherwise, i.e., that one scheme did not make provision for one or more requirements marked "essential," then that scheme would have been disqualified from further evaluation. This procedure thus provides a check on design practice. That is, designs not meeting codes, regulations or other requirements or designs containing obvious dysfunctions to normal operations, are easily identifiable and can be discarded.

Following the analysis for "essential" requirements, the physician and architect independently rated each requirement that could be evaluated based on schematic drawings. This was done by entering a "5" in the column marked R_1 on the scorecard for those plans that met the requirement excellently and by entering a "1" in the same column for those schemes that only provide for the requirement minimally. Between these two extremes, ratings were entered based on the judgment of the evaluator. After all the requirements were rated in the above manner, the rating (column R_1) was multiplied against the weight (column W) to give the score, then entered into column S_1, the individual scores for each of the three nursing unit plans.

After this first evaluation, the two evaluators went through the ratings for each requirement a second time and entered their ratings in column R_2. As in the first evaluation, a score for each requirement was developed by multiplying the second rating (column R_2) times the weight (column W) and entering the result into column S_2. Also like the first evaluation, the scores of the individual requirements were summed to give a total performance score for each of the three nursing unit schemes.

These two evaluations provided us with a total of four performance scores for each nursing unit design, two from the physician and two from the architect who had performed these evaluations. We then averaged these four scores for each nursing unit to provide an overall average score for each nursing unit. The overall average score for each of the three schemes is shown below.

	Overall Average
Scheme A Two Double Loaded Corridors (Racetrack)	1522
Scheme B One Double Loaded Corridor	1699
Scheme C Radial	1576

What do such overall average scores tell us? First, it can identify for the designer the areas that can be improved in his designs. Using the scorecards, the designer can develop a list, through low performance scores by going through the scorecards and extracting all requirements that did not receive a perfect score. He can then arrange these in a priority-rated list with the first requirement being that one which had the greatest difference between its actual score and its perfect score. Through this method the designer can then achieve positive feedback on his designs prior to construction. Through the use of this positive feedback, the designer can improve his designs for the nursing units.

A second advantage is that these overall scores can aid us in making a decision on what schematic plan should be used in the new hospital under consideration. To make such a choice however, we can not consider the overall average scores alone. Rather, we must add the cost factor. To provide such a cost measure, we made the simplifying assumption that construction costs are a function of floor area. That is, we can calculate the construction cost for each of the three plans by multiplying the gross square feet in each plan by a dollar per square foot factor. This method of cost estimation is commonly used during planning of new hospitals. Of course it does not provide the accuracy of a cost estimate based on a quantity take-off. The factor we used to do this was $45 per square foot ($484.4 per square meter). Our estimated construction costs for each of the three schemes was as follows:

	Construction Costs
Scheme A Two Double Loaded Corridors (Racetrack)	$558,000
Scheme B One Double Loaded Corridor	$522,000
Scheme C Radial	$603,000

So we now have an estimated construction cost for each of the three schemes and an overall average score of performance for each of the three schemes. Borrowing from the methodology of benefit-cost analysis, we can now compare these three schemes on a diagram as shown in Figure 6. In this diagram the x axis is the overall average score of performance or predicted performance since our evaluation was based on appraising and comparing schematic drawings. The y axis is the costs. The line of maximum. performance is the total possible score that can be achieved. The boundary shown at the right side of the diagram is a theoretical line that represents the concept that the more money spent the closer you will come to maximum performance. On this diagram are plotted our three nursing schemes A, B and C. On this diagram, the most desirable solutions are those that fall to the bottom right of the diagram. That is, those solutions in the bottom right provide the least cost and the most performance. In our evaluation there was only one such scheme to fall in this area, Scheme B. From this diagram, it can be seen that Scheme B offers the advantages of the least cost and the most performance and therefore is superior to Schemes A and C.

In our particular evaluation, as stated, it so happened that only one scheme fell in the lower right hand region. Probably this would be unusual in most evaluations of this type. Rather than a single point in this area, probably the more usual occurrence would be two choices--one scheme having lower performance but costing less and the other offering higher performance but costing more. In this case the decision maker is faced with no easy decision but one of value; i.e., is it worth it to pay more money for more performance? Although there is no easy resolution to this question, the above described evaluation methodology can provide information on what areas of improved performance will be bought for the additional cash outlays required.

The development of our evaluation methodology for nursing units, how it works and how it can be used have been discussed. However, it is also necessary to discuss the future enhancements of this methodology that we intend to address.

FUTURE ENHANCEMENTS OF THE METHODOLOGY

First, requirements should be generated using more people than the few employed in the initial investigation. This procedure would be valuable because this initial "pool" of performance requirements can probably be enhanced through the use of many more experts in this field. A Delphi technique might be used to accomplish this result. In addition, the initial development of the performance requirements relied heavily on expert opinion. Ideally we would like to generate such requirements through architectural psychology studies of nursing units, studies that are now very few in number.

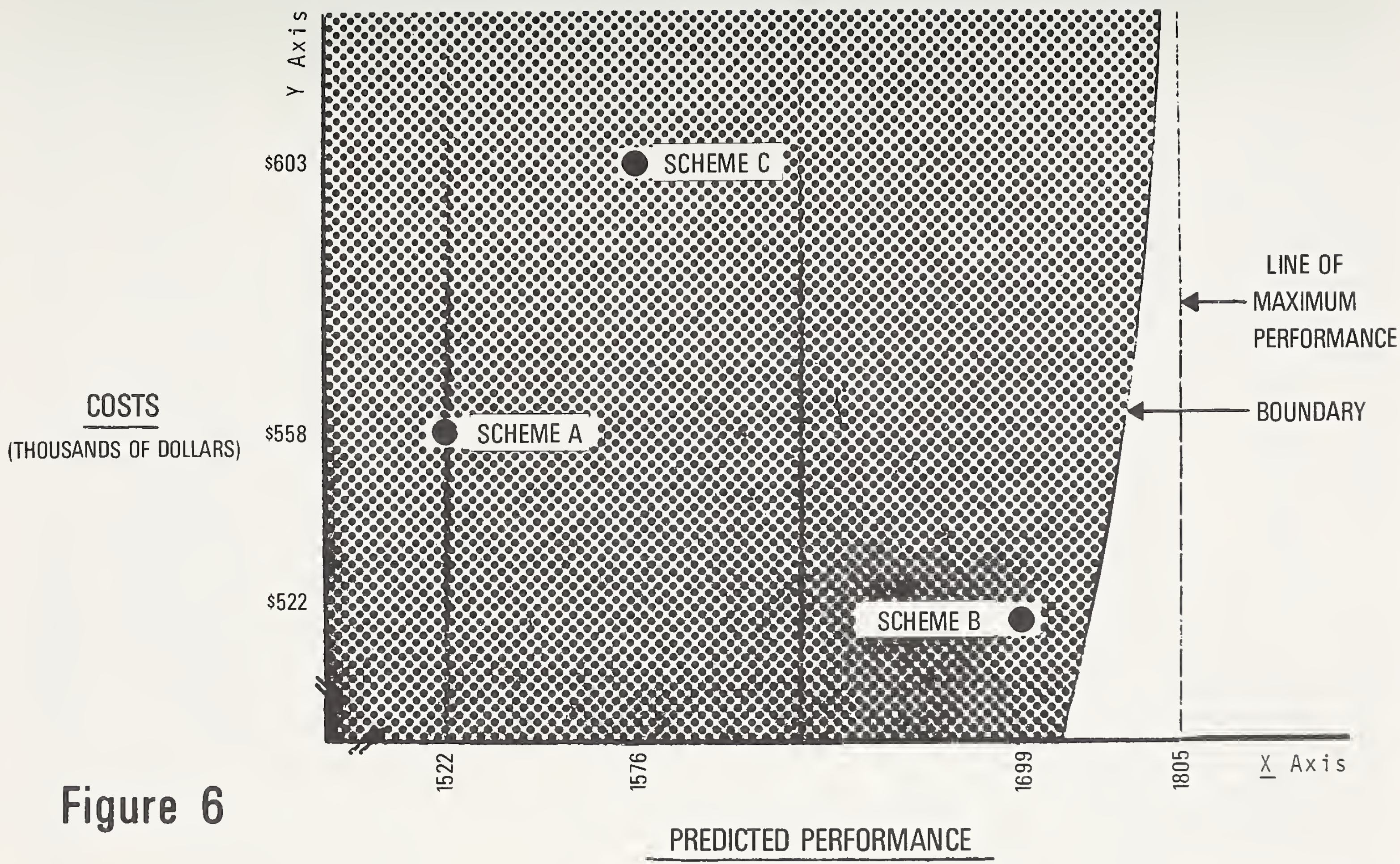

Y Axis
$603
$558
$522
SCHEME C
SCHEME A
SCHEME B
LINE OF MAXIMUM PERFORMANCE
BOUNDARY
1522
1576
1699
1805
X Axis
COSTS
(THOUSANDS OF DOLLARS)
PREDICTED PERFORMANCE

Figure 6

Second, rating system and weightings were likewise based on the results of few subjects. Like the generation of requirements, this data base can be improved by increasing the number of individuals involved, through techniques such as Delphi. In our study this was not attempted due to time and budgetary limitations. Beyond expert opinion, improvements may also be possible by utilizing psychological ranking systems such as Abraham Maslow's "Hierarchy of Needs" to develop an objective system, a study we would like to undertake.

Third, only the qualitative portion, the requirement, was used in the evaluation methodology described. It would be much more desirable to include the quantitative portion, the criterion, in this methodology to enable evaluators to have an objective basis for ratings. The development of criterion associated with the performance requirements would also allow the development of performance specifications, to be used in the planning, design and construction of new medical facilities.

Fourth, our method of calculating costs, i.e., by cost per square foot times gross square feet, represents a simplifying assumption. Actually, initial construction costs are a function of many variables such as the area of the perimeter wall, length of runs of utilities, etc. The use of such techniques as regression analysis could provide an improved method of estimating initial construction costs. However, detailed and accurate cost data upon which to base techniques such as regression analysis are generally lacking. Hopefully, this situation will improve in the future.

Fifth, and finally, we used initial construction costs in our evaluation methodology. It would represent great improvement in this methodology if we were able to use expected life cycle costs rather than initial construction costs. However, even to a greater degree that initial construction costs, data on life cycle costs are almost entirely lacking. This is a problem that many building research organizations are addressing. As data on life cycle costs are collected, analyzed and disseminated in the future; we will be able to incorporate expected life cycle costs in this evaluation methodology.

SUMMARY

As mentioned, we are presently faced with a trend toward greater costs in our new medical facilities at the same time that more Americans are seeking a greater access to our health care delivery systems. The burden of these twin trends fall most heavily on the hospital planners and designers. Because of these trends, these planners and designers must become increasingly aware of the multitude of requirements and their associated trade-offs, must be satisfied. The evaluation methodology that has been discussed today is one method of enhancing this awareness and of aiding these planners and designers to produce more effective and efficient hospitals.

We have only discussed this methodology in the context of the evaluation of schematic drawings of different nursing units. However, this same methodology can also be used to aid medical facility planners, to aid in the generation of facility requirements, to use in checking design drawings prior to advertising and for other uses in the planning--design--construction process. This is possible because the evaluation methodology described can ultimately provide a complete and comprehensive framework for our work in medical facilities.

S-114A (REV. 7-73)

U.S. DEPT. OF COMM. BIBLIOGRAPHIC DATA SHEET	1. PUBLICATION OR REPORT NO. NBS-BSS-54	2. Gov't Accession No.	3. Recipient's Accession No.
TITLE AND SUBTITLE Proceedings of the First Federal Agency Workshop on Health and Medical Facilities Design			5. Publication Date July 1974
			6. Performing Organization Code
AUTHOR(S) Robert J. Kapsch, Editor			8. Performing Organ. Report No.
PERFORMING ORGANIZATION NAME AND ADDRESS NATIONAL BUREAU OF STANDARDS DEPARTMENT OF COMMERCE WASHINGTON, D.C. 20234			10. Project/Task/Work Unit No.
			11. Contract/Grant No.
Sponsoring Organization Name and Complete Address *(Street, City, State, ZIP)* Same as Number 9.			13. Type of Report & Period Covered N/A
			14. Sponsoring Agency Code

SUPPLEMENTARY NOTES

Library of Congress Catalog Card Number: 74-10561

ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

The Federal Agencies have a large involvement in this area of Medical Facility Design; both in directly operated Federal facilities and indirectly through grant, loan and funding programs. Because of the impact of technology and because of the very large cost for new medical facilities; in the last few years there has been the rise of a field best described as medical facility research. These papers, presented at a National Bureau of Standards' Federal Agency Workshop, describe the latest medical facility research efforts by the Federal Agencies including, the Department of Defense, Department of Health, Education and Welfare, the Veterans' Administration and the National Bureau of Standards.

KEY WORDS *(six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons)*

Architecture; design; hospital design; medical facilities; medical facility research.

AVAILABILITY	19. SECURITY CLASS (THIS REPORT)	21. NO. OF PAGES
[X] Unlimited		
[ ] For Official Distribution. Do Not Release to NTIS	UNCLASSIFIED	87
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USCOMM-DC 29042-P74

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