Healthcare Facilities Design For Flexibility: A Report On Research For The National Institute of Building Sciences

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Abstract

The United States government has several primary agencies acquiring and operating healthcare facilities. Two of the largest are the Department of Veterans Affairs and the Department of Defense.

In 1972, the US Department of Veterans Affairs launched the VAHBS (Veterans Administration Hospital Building System). It was their vision for acquiring flexible hospitals, and used a tightly scripted "building system" employing an interstitial floor for mechanical systems. A highly detailed 800-page book of requirements is used to assure compliance of the architecture and engineering firms hired to design each project. Thirty such hospitals were built. Some have been demolished, but many more remain in use and have been or are being renovated. More are under construction.

In 2010, the US Department of Defense Military Health System (MHS), which invests $3B annually on its world-wide asset portfolio – medical centers, hospitals, clinics and research facilities – partnered with the National Institute of Building Sciences to conduct a study of "Healthcare Facilities Design for Flexibility." The MHS initiated this work to inform and clarify its own flexibility criteria, and validate its investment and management practices. By initiating this research, the MHS has taken a leadership role in the industry in defining and refining flexibility as it applies to the built environment.

A research team (the three principle authors of this paper) was invited to undertake the research and to address several subtasks:

1. Identify and define the use of the term "flexibility" as it relates to the design and construction of healthcare facilities.
2. Identify current Military Health System (MHS) approaches to flexible design.
3. Identify industry best practices to flexibility in healthcare design.
4. Identify any associated cost premiums in initial capital costs and lifecycle return on investment (ROI) implications.
5. Assist the MHS in defining a policy for flexible design standards relating to Facility Lifecycle Management (FLCM).

The research was conducted between January and July 31, 2012. This paper reports on the research, and reflects on the findings and their wider relevance beyond the MHS.

Key Words: Flexibility; healthcare facility design; United States Government

BACKGROUND

Flexibility has been a term in currency in the field of architecture, engineering and construction for at least 60 years around the world. The dream of flexible buildings has long been dominated by a focus on technology and has often been associated with the concept of "systems building" and "performance standards." This is not surprising, given the very strong 20th century belief in technological solutions to problems – not only in architecture and construction but in all segments of society. While new technology and techniques are certainly important, the research team began the research with the hypothesis that a too-narrow focus on technology - without considering control of decision-making processes - would fall short of the goal of providing clients with the tools needed to acquire and manage building with long and useful lives in the 21st century. Many of the findings here apply equally to the private sector.

Approach

The research drew upon insights and data gained from:

1. Identifying and interviewing subject matter experts in the private and public sectors;
2. Conducting a literature search of over 70 contemporary sources;
3. Conducting a structured survey of healthcare organizations, architects and engineers, consultants, equipment planners and construction companies;
4. Seeking "best practice" examples of flexible facilities in the public and private sectors;
5. Conducting a cost modeling workshop with both public sector and private sector experts to examine a method for analyzing the relationship between cost and flexibility; and
6. Conducting a policy seminar of both public sector (Military Health System + Department of Veterans Affairs) and private sector experts.

Key Issues in Healthcare Facilities Flexibility

Responsibility for setting criteria lies with the MHS (or any client) as the owner

The MHS leadership needs a strong case to continue its efforts to acquire flexible facilities. There is currently an absence of explicit requirements, metrics for assessment and benchmarks of success (or failure) to assert that past flexibility practices have paid off, even though facilities with some flexibility characteristics continue to be acquired. Little in the way of evidence exists on the basis of which to recalibrate the approach to flexibility in future acquisitions, or in the management and improvement of the existing asset base. The absence of this evidence makes it difficult to quantify the efforts required to develop and systematically apply rigorous flexibility strategies across the entire facility portfolio.

If the MHS mission were static, flexible buildings would not be needed. But the reality is different. Missions (therefore functional requirements) change. Change happens at varying time cycles (short, middle and long term) and at various levels – from replacing equipment, renovating and expanding departments, completely changing uses in a given building, to expanding and sometimes contracting facilities or campuses.

Change is driven by a complex mix of business and technical challenges (e.g. parts become obsolete), evolution in mission, changes in medical practices and hierarchical organizational patterns (who controls what, when). The key for the MHS to be able to handle change and to acquire and effectively use flexible buildings is to understand these "force fields" and their interdependencies.

To be effective, it is incumbent upon an owner (MHS in this case) to set the standards for flexible decision-making and flexible facilities at all stages and at all levels of the owner's organization and its business practices. Equally important is continuous training in and vigilance over the process within the owner's organization. While high-quality services of architectural and engineering, construction and management experts in delivering flexible facilities are critical, the owner's responsibility for maintaining a culture in which flexibility requirements are clear and continually improved cannot be delegated. The same would be true in any client organization.

Past and current efforts to acquire flexible facilities

With only a few exceptions, past and current strategies for acquiring flexible healthcare facilities – both in public and private owners, in practice and as found in the literature, both domestic and international - focus on technical / architectural solutions. The results in practice are uneven at best, and in all cases lack evidence that flexibility pays off in improved delivery of healthcare services or in the operational economics of facility management.

At the same time, a separate literature exists in the fields of decision-making and organizational management flexibility. But little in this literature - or the methods in practice – directly addresses flexible physical facilities. These two fields of study and action are not well linked – in fact few examples could be found in the literature or in practice in which technical and decision-making flexibility are explicitly interwoven in respect to procuring healthcare facilities – or built facilities of any kind.

While "flexibility" is widely used by service providers and clients alike, there is little consistency in definition – no "controlled vocabulary" - and therefore little clarity in understanding or assessing flexible facilities. There are, in other words, no accepted benchmarks available to guide decision-making, funding or innovation specifically focused on flexibility. At the time this research effort was initiated, no policy or consistent requirements existed in the MHS (or in the industry in general) for acquiring flexible healthcare facilities, although the term is mentioned in the world-class facilities website.(https://facilities.health.mil/home/knowledge-center/mhs-guiding-principles/)

Concurrently, investment in "flexible" buildings is conventional in the commercial office and retail markets. Developers ask architects to design buildings with capacity (flexibility) to accommodate a variety of changing occupants, and contractors specialized in building such "base buildings" construct them quickly, to be ready for still other designers and builders to "fit-out" the empty spaces inside for occupants that change or rearrange their spaces at cycles of 5-10 years or longer. The same phenomenon occurs in the reactivation of the old "flexible" building stock – repurposed for new functions. Similarly, the Federal Highway system and most utilities invest in "flexible" infrastructure assets, assessed and managed according to their capacity (flexibility) to accommodate varying and changing "service loads" over time.

Technical Innovation is more rapid in the building / medical equipment category, rather than in real estate assets per se.

In a seminal essay written in 1982 (Ventre: Building in eclipse, architecture in secession, *Progressive Architecture* 12:82) U.S. government statistical evidence was presented showing that investments in buildings and architectural services had been declining over the past decade, while investments in equipment – including office equipment, furnishings, fixtures, computers used in buildings and so on, were increasing. This research has not been updated nor has similar research been conducted for the healthcare sector per se. Yet all anecdotal evidence points to an acceleration of this trend, perhaps to a larger extent in the healthcare sector than other sectors because of the extent to which "functions" (medical procedures) drive reimbursements and because function is increasingly tied to equipment, not the building.

In the private sector, CFO's find advantage in increasing the investment in things that the tax laws define as "equipment" (allowing depreciation in 7 years) while reducing the investment in "capital assets" (allowing depreciation in 30 years). This has resulted in a building stock with increasing emphasis on and investment in the "tenant work" or "fit-out" as well as the "FF&E" (fixtures, furnishings and equipment) both in new construction and in reactivating the existing building stock.

This priority on the demand side has pulled the industry – from architects and engineers, contractors and product manufacturers – to innovate in the "equipment" category as something distinct from (but inevitably coupled to and dependent on) the "base building." This does not mean that innovation is not taking place in the category of "base buildings." But even in that part of the whole, it is façade systems – easily uncoupled from the structural frame – that are seeing the most aggressive innovation in response to demands for higher building performance in respect to energy

issues, natural illumination, shading, and so on.

In the healthcare sector, this shift of emphasis to an expanded "equipment" domain can be seen in the increased product offerings of companies such as Steelcase and Herman Miller, Hill Rom and others. It is also evident in the development of, for example, sophisticated telemetry supported by infrastructure backbones; new "plug-in" headwalls; new "fast-junction" electric and low-voltage systems; new partition systems integrating some of the piping and wiring; decentralized air-handling systems and controls for improved local indoor climate control; improved devices for modulating the quality and amount of natural light from inside the space; and new combined toilet/sink units for intensive care units which are "owner purchased" and thus separated from the building acquisition as such.

Acquisition and use of flexible healthcare facilities requires clear organizational synergy in developing management criteria, technical planning and implementation over the life of facilities

While "lifecycle assessment and management" have been terms in currency for many decades, there has been insufficient use of the available methods. One reason is that the variable life cycles of healthcare facilities have been explained in largely technical terms. The tendency has been to use a strict technical definition of change of parts in flexibility strategies, too often leading to the specification of expensive ceiling or partition systems, or heating and cooling systems and their individual components leading to excessive first costs. The other reason is that fragmented organizational responsibilities for decisions about operations, finance and facility support – especially in healthcare – have inhibited the use of formal lifecycle assessment methods.

The equally important issue – and demand for - sequential and distributed decision-making over cycles of change has remained largely tacit at best.

A major barrier to a better understanding and implementation of flexibility in the health care sector is the deep cultural orientation toward the short-term. It is a well-known fact that healthcare facilities are never finished – they continue to be adapted, part-by-part, and are often incrementally expanded before eventually being demolished. Yet little evidence was found that any tracking of facility behavior behavior over time has or is being done, either in the public (VA or MHS) or private sector. As a result, there is inadequate evidence for judging if one or another flexibility strategy has a suitable return on investment or positive impact on the mission. This is especially true in the private sector, but the public sector is not immune from this short-term perspective.

Finally, the mandate in law to provide a sustainable infrastructure has the principles of flexibility at its core – capacity for expansion (or contraction), reuse, and adaptation. The new UFC (Uniform Facility Criteria) 4-510-01 Design: Medical Military Facilities, and the UFC 1-200-02 High Performance Buildings – which is currently in draft form – must be explicitly coupled, to tightly link flexibility to sustainable and high performance buildings. When this is accomplished, it will set a strong precedent for the private sector to follow.

The most pressing problem this research identified is that the domain knowledge and practice of flexibility are almost exclusively technical, and as such are not well translated between planners, designers, builders and owners. The result is that knowledge of and action congruent with DISTRIBUTION OF RESPONSIBILITY FOR CYCLES OF CHANGE are inadequate to the challenges at hand for the MHS, along with the private sector.

THE RECOMMENDED ALTERNATIVE FLEXIBILTY STRATEGY

The timeline from initial development of requirements, planning, approval, programming, design and facility construction can take many years. Meanwhile, changes in the practice of medicine, research, technology and mission continue. No effective single solution will slow these inevitable changes, but a flexible acquisition process that defers decision to the latest possible stage can help retain owner control over necessary responses to changes outside the owner's control.

Conversely, relying on the A/E team's design process to assure a flexible facility takes control of change-management away from the owner and places it under the restrictions of design contract cost and time management, and the uneven knowledge in A/E teams of facility flexibility and how to deliver it.

An alternative acquisition methodology should be tested, on the basis of which the MHS can assess its current method of facility acquisition. As suggested in items 9) and 10) in the performance requirements recommendations later in this paper, we recommend that the MHS implement and monitor a specific alternative acquisition process, described below in more detail.

It is important to note that current practice in the MHS has evolved from an "all-at-once" process to a process in which the totality of a functioning medical facility has been separated into three basic "levels of investment intervention" or contract opportunities, following requirements development and planning, and investment approval:

a) Acquisition (design and construction) of the facility;
b) Initial Outfitting and Transition (IO&T);
c) Operations and maintenance.

We recognize this evolution to separated contracts as a response to a number of drivers, including rapid improvements in the field of medical practice and equipment and the reality of funding types. The result of these uncertainties is the necessity to defer IO&T decisions and contracts as an activity adjunct to construction, the better to maintain nimbleness in responding to timing of outfitting, new technology, fiscal programming realities and the transition from construction to operational readiness.

This three-part procurement typology has been accomplished in the formalization of the current practice by decoupling the decisions about medical functionality (increasingly embedded in equipment) from the building requirements. In this process, the facility is "fixed" while the equipment is "variable" (still to be specified somewhat independently). That is, decisions about the variable and general types of function (thus equipment) inform the design of the building, while specification and purchase activities are not on the critical path during design and construction. That is, the building offers spatial and technical capacity to accommodate a range of functions (equipment and outfitting decisions), decisions that can be deferred without risk of suboptimal whole-facility performance when the facility comes on-line, or over time.

The content of the IO&T is variable, per project, but generally includes what has been called elsewhere in this report the **"Tertiary"** system, or what is termed "FF&E" in the commercial real estate market (fixtures, finishes and equipment). In some instances, IO&T includes internal non-loadbearing walls and ceilings, and MEP systems (low voltage and premise wiring, medical gasses and so on) placed in such walls or hidden above the ceilings. Making this uncoupling or separation clarifies what was already happening on an ad-hoc basis but is now formalized and systematized, adding an important capability to foster innovation in technical systems.

Taking this policy one step further, we suggest that the conventional one-step or "all-at-once" process of acquiring the facility be further segmented based on the same logic that supported the separation of IO&T contract from the building contract. There is precedent for this in the commercial office and retail sectors. This two-step process separates the **"primary system"** (often called "core and shell" or "base building" - building structure, façade, building geometry, egress systems and pathways for and perhaps the main MEP systems) from the "**secondary system"** (often called tenant work or Fit-Out – including the MEP systems specific to floor plan layout, internal non-loadbearing walls, etc.). The exact demarcation of what parts and spaces are assigned to the "primary system" and which to the "secondary system" is made for each project. This way of working produces a "THREE-STEP" acquisition process of three "systems".

An illustration of this further delineation or separation is indicated in the diagram below, as a progression from the former procurement through the recently adopted method:

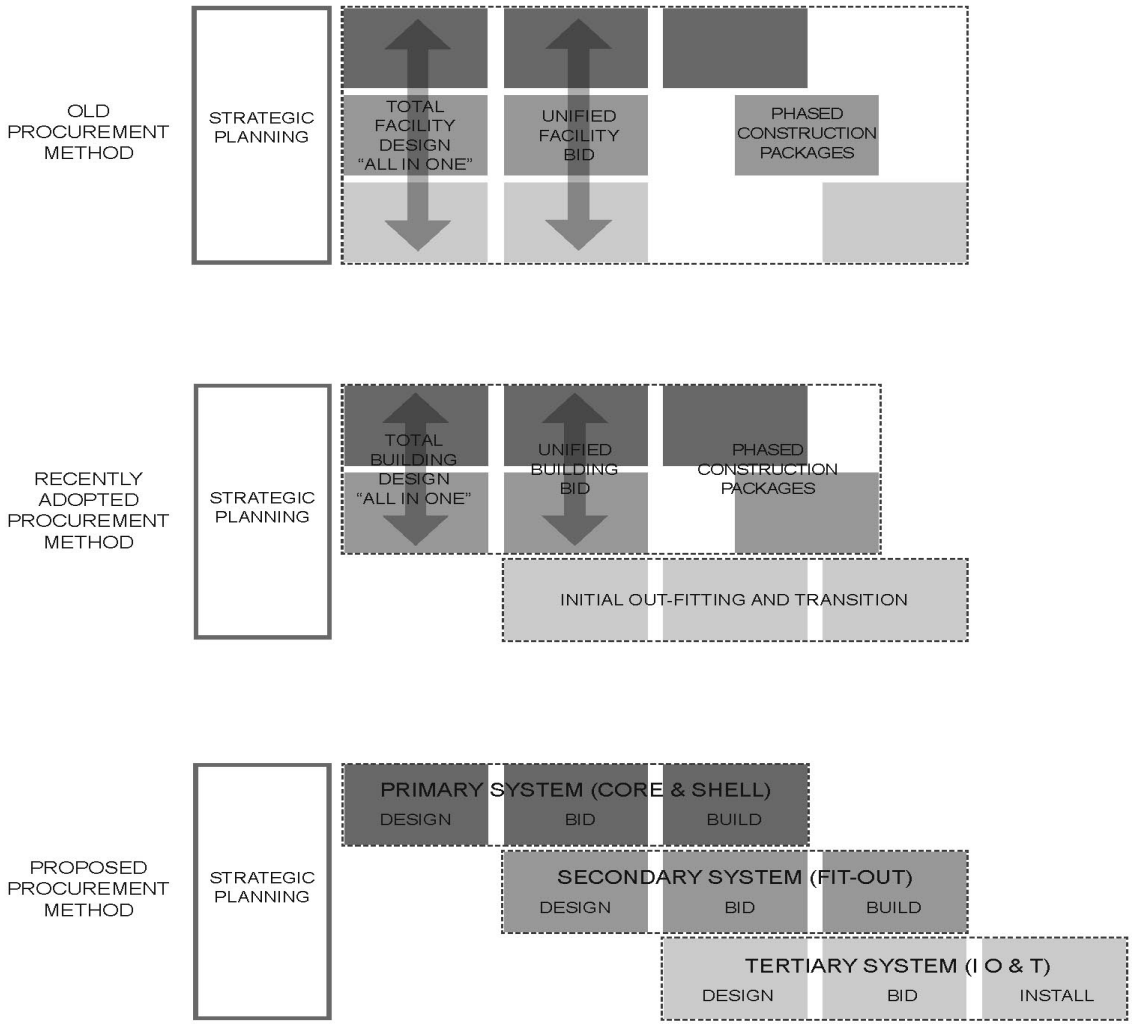

Figure 1: Proposed evolution of acquisition methods

Replacement of the "all-at-once" process with the "proposed procurement method" (Figure 1) reduces the owner's dependency on unevenly prepared design firms to assure that facilities perform according to required flexibility criteria. This gives clients (e.g. MHS) more control, assuring optimal timing and maximum flexibility of decisions and technical solutions, initially and over the facility's life. The result is greater consistency in flexible facility performance across the MHS portfolio. (The horizontal time-scale may vary from project-to-project while the three-step process remains the same)

Flexibility Lexicon

This report proposes a new lexicon of requirements – or a set of criteria for determining if a project is flexible. Adoption by the MHS will facilitate evaluation of proposals for and the acquisition of new healthcare facilities and the renovation of the existing stock of healthcare facilities congruent with its evolving mission. This lexicon focuses primarily on the requirements for long-term capital asset acquisition, and less so on the more rapidly evolving requirements for spaces and equipment specifically tied to medical functions.

1. **Horizontal building expansion** (or contraction) is enabled by disciplined site and infrastructure capacity planning methods
2. **Vertical building expansion** is enabled by a disciplined structural and MEP systems' design process
3. **Minimal internal structural walls** offer unimpeded space for functional arrangement and reconfiguration, and capacity of the building to be expanded
4. **Floor-to-floor height** of at least 16'-0"
5. **Building geometry** enables a variety of uses to be accommodated inside a buildings' footprint
6. **Floor structural loading capacity** enables alternative uses and related equipment
7. **Shell space** is set-aside for future assignment of use(s) as needs evolve
8. **A % of building floor area is fixed and held** for future vertical MEP and egress shafts
9. **Systems Separation -** Technical systems are designed to enable building elements with short-use value to be changed without disturbing those with long use-value

Cost of flexibility

Based on interviews, literature research, the questionnaire, the cost modeling workshop and the policy seminar, the research found that

a) The relation between first cost and return on investment for flexibility investments is poorly understood in the AEC industry or by owners;
b) The relation between the cost of flexibility strategies (architectural and decision making) and operational costs of healthcare facilities is not well understood in the industry or by owners;
c) There is a model of comparison of flexible vs. non-flexible infrastructure that can be applied with real economics in order to do the financial tradeoff analysis. This will aid decision makers in gaining deeper insights and evaluating trade-offs.

The report made five recommendations:

Recommendation 1

FLEXIBILITY must be included as a tenet in the Medical Uniform Facilities Criteria (the primary tool to guide architects and engineers designing facilities for the Military Health System), with language linking technical and project planning principles. Specifically, we recommend the following **FLEXIBILITY TENET:**

Flexibility is a principle for responding to uncertainty and risk in the lifecycle management of facilities that are part of the MHS portfolio. The goal is a portfolio of facilities capable of sustained usefulness in executing the MHS mission. Decision-making and management structures should correspond to the principles of flexibility and sustainability, and are critical to all aspects of planning, programming, design, construction, adaptation, conversion and operations. Flexibility, supported by scenario planning and cost modeling tools, should be considered throughout the life of each facility, and is important in both new construction and in re-use of existing facilities. Three high level tenets of flexibility shall be used throughout the planning and design process:

1. *Select sites and plan infrastructure with capacity for expansion (horizontal and or vertical) or contraction.*
2. *Facilities shall have the capacity for adaptation and for possible conversion to alternative use.*
3. *Ensure continuous high performance facilities by separating building components and systems for maintenance, according to their expected technical or utility lifespan.*

Recommendation 2

Our second recommendation is to incorporate specific performance requirements to be followed in the acquisition and long-term management, adaptation and conversion of facilities in the MHS portfolio. Specifically:

1. **Site capacity.** The site plan / master plan must consider future facility demands, including the necessity for either vertical (as in very dense urban sites) or horizontal expansion; or a combination of the two.
2. **Geometry of the structural system and floor plate(s).** This is a question to be answered by the design team and client when scenario planning and capacity analysis is conducted. Capacity analysis is the process used to evaluate proposed building plan / structural system geometry to assure that at least one serious conversion to another use and functional adaptations are possible over time.
3. **Floor-to-floor height requirement.** This is a decision to be made by the client and the design team. It is important to advocate added height - not less than 16 feet finish-floor-to-finish floor level.
4. **Loading capacity of the floors.** This is a decision to be made by the client and the design team. Building loads in current facilities should be studied; it then may be advisable to add load capacity after analyzing future use (capacity) and equipment scenarios and their load requirements.
5. **Minimal internal structural walls.** No structural walls should be the rule, except as needed for seismic requirements.
6. **Opportunity for vertical mechanical equipment shafts in the future.** Fix a % of total surface area for future vertical mechanical shafts and hold that requirement during project implementation. Slab penetrations at regular intervals provide for future use.
7. **Daylight provisions.** This question is for the design team and client to answer when considering the capacity of the primary system to accommodate future scenarios of use.
8. **Facades.** Facades will often not have the same long-term durability of the structural system. The façade ideally should be replaceable in the future when energy performance requirements increase.
9. **Separation of the Primary (Base Building), Secondary (Fit-Out), and Tertiary systems (FF&E).** Technical and procurement separation of systems is a question for the design team and the client. Decisions about medical and other "equipment" (tertiary system) should be de-coupled from decisions about the secondary system and decisions about functional layout and departmental adjacencies (secondary system) should be decoupled from decisions about the primary system to the greatest extent possible, while closely attending to interfaces. Among other things, this must result in a building enabling work on one floor (reconfiguration, change of spatial layout, change of equipment and fixtures) to be accomplished with no or minimal disturbance to activities on other floors.
10. **Management and decision-making structures will correspond to the principle of separating systems – both programmatically and technically.** The system of strategic and project management, from programming and budgeting to project design and acquisition to outfitting and transition must correspond to the principles of flexibility. This means a staged rather than an "all-at-once" decision-making process. The key is well-organized programmatic decision deferment, to enable timely acquisition of the most current technology and design knowledge – not before it is really needed. For initial budget authorization and sequenced appropriations, whole building budgets can be established based on accurate estimates of the Primary System, while cost estimates for the Secondary and Tertiary systems – to be specified and acquired in later stages - can be based on benchmarked estimates. In other words, flexibility must be an established criterion as part of decision-making in all phases of the life cycle and specifically in planning, programming, design, acquisition, construction-quality control and in

operation. Approaching project planning this way enables control over smaller and more executable scopes of work, resulting in more flexibility in programming and budgeting. Decision-making control rests with the owner or owner representative for the purpose of just-in-time decision making.

Recommendation 3

Recommendation three is to explicitly link requirements for flexible facilities with requirements for sustainable / high performance buildings. Current mandates (laws) for high performance infrastructure are interdependent with flexibility requirements.

Recommendation 4

Recommendation four is to develop and implement systematic tracking of facility behavior over time. Include the development of a policy and related performance metrics that identify characteristics of change accommodation.

Facility management or assessment software should be structured to enable collection and reporting of this data for the purpose of validating flexibility strategies and measuring return on investment.

We also recommend a pilot study be conducted to compare performance or behavior over time, of a facility in the Veterans Administration portfolio, a facility in the MHS portfolio, and a private sector facility.

Recommendation 5

Implement [and monitor] an alternative planning and acquisition process the goal of which is to better accommodate change management decision-making during the long facility planning, design and acquisition cycle of MHS facilities.

The timeline from initial development of requirements, planning, approval, programming, design and construction can take many years. Meanwhile, changes in the practice of medicine, research, technology and mission continue. No effective single solution will slow these inevitable changes, but a flexible acquisition process that defers decision to the latest possible stage can help retain owner control over necessary responses to changes outside the control of the owner. Conversely, relying on the A/E team's design process to assure a flexible facility takes control of change-management away from the owner and places it under the restrictions of design contract cost and time management.

In order for the owner to retain flexible decision-making control, an alternative acquisition methodology should be tested. As suggested in items 9) and 10) in the performance requirements recommendations (above), we recommend that the MHS implement and monitor a specific alternative acquisition process that essentially mirrors conventional practice in the private sector commercial real estate sector, where a distinct separation is made to allow organized decision-deferment and flexibility, between the "base building," "tenant fit-out," and "FF&E."

It is important to note that current practice in the MHS has evolved to a process in which the totality of a functioning medical facility has already been separated into two basic "levels of investment intervention" or contracts, following requirements development and planning and investment approval.

In summary, we recommend:

1. Further development of the cost model used in the cost-modeling workshop should be undertaken.
2. Decoupling selected secondary systems from the primary system and tertiary system should be carefully evaluated by a study of actual facility change. This will enable a determination of where the most impactful flexibility construct can and should be applied.
3. Further in-situ study should be made of real DOD assets to collect data showing what kinds and how much change occurred, and what change was desired but cost-prohibitive to complete.
4. Cost and change data should be collected as a mandatory part of facility management practices, as part of the effort needed to demonstrate return on investment of flexibility strategies.

One of the arguments against flexibility has been that it costs more. This depends on how costs are accounted for. Accepting that the highest priority should be placed on reducing first costs as much as possible, the research

found that the argument that flexible buildings have inherently higher first costs has never been substantiated. The research (policy seminar, cost modeling workshop, questionnaire, literature research) was not able to find evidence of analysis of return-on-investment of flexibility strategies in US government agencies with hospital portfolios (the VA and GSA), or in the private sector.

Demonstrating the economic value of flexibility by comparing systems designs is not a trivial task (de Neufville et al, 2008). However, the cost modeling tool used in the cost modeling workshop the research team conducted as part of this research (see full report for details) showed that by a) defining flexibility attributes and b) using evidence from a systematic study of a large sample of healthcare facilities, it is possible to generate useful data to support decision-makers in selecting flexibility strategies in respect to return-on-investment.

Conclusions

The research identified three realities of MHS facilities and the decision processes, recognition of which will enable lessons learned from them to be translated into practice.

1. MHS healthcare facilities (like all healthcare facilities) are never finished. While attributes of flexible infrastructure practice exist, the MHS currently lacks sufficiently clear management and design processes for planning, specifying, obtaining, managing and monitoring the performance of its stock of buildings.
2. The MHS management acquisition practice called IO&T (Initial Outfitting and Transition) establishes a structured decision-deferral strategy that separates a somewhat variable "bundle" of decisions from the acquisition of the facility. This is the basis for examining a further step in disentangling decisions in acquiring flexible facilities. The next step – recommended in the research report and summarized in this paper - can be considered an evolution of rather than a departure from current practice.
3. MHS (like any client) is responsible for developing a vigilant business culture dedicated to acquiring and managing flexible facilities.

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