Healthcare Facilities Designed For Flexibility
The Challenge of Culture Change in a Large U.S. Public Agency

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Abstract

The US Department of Defense Health Agency (DHA) has an international network of healthcare facilities to serve personnel serving in the armed forces. The DHA has a budget approximating $3 billion per year for the acquisition of new facilities and the maintenance and upgrading of existing facilities. Recently, the DHA – driven by a US government-wide mandate - has made a commitment to a policy of sustainable facilities. DHA leadership recognized that a key element of a sustainable asset portfolio is that the facilities must be flexible – planned for the likelihood of expansion, contraction, alteration or change of function or a combination of these – and thus capable of meeting the challenges of changing missions, patient demographics, medical practices, and medical technology.

This paper discusses the work being done to introduce flexibility as a high level principle in the DHA policies, practices and criteria. The paper discusses the recommendations being made to implement flexibility by the insertion of flexibility requirements in the key guidance documents used by architects and engineers in designing new and renovating existing DHA facilities. Because many of these are recommended to be mandatory (not simply incentives), their adoption is expected to require a change in the culture of DHA and in the entire decision-making chain for the acquisition and management of DHA healthcare facilities.

This paper reports on the recommended flexibility requirements and the culture change required for their full implementation.

Keywords: Healthcare facilities, flexibility, whole-life performance, sustainability, open building

HEALTHCARE FACILITIES DESIGNED FOR FLEXIBILITY
THE CHALLENGE OF CULTURE CHANGE IN A LARGE U.S. PUBLIC AGENCY

INTRODUCTION

This paper reports on the second of two research contracts with the National Institute of Building Sciences one of whose clients - the United States Department of Defense Health Agency (DHA) – asked for a.) Recommendations on introducing flexibility as a high level principle in their policy documents; b.) Assistance in writing flexibility requirements in acquiring healthcare facilities; and c.) Recommendations for tracking how their facilities transform over time for the purpose of assessing the merits of mandated flexibility requirements. DHA's goal is to assure the long-term value of their facilities portfolio and to assure the wise investment of approximately $3 billion per year expended in acquiring new and maintaining and renovating existing facilities worldwide.

The recommendations recognize that the DHA has already adopted measures that lead positively toward a more flexible portfolio. The effort reported on here has therefore been aimed at several things:

a. Defining the term flexibility as having both technical and decision-making dimensions;
b. Clarification of current developments within the DHA and in the building industry at large toward flexibility, with particular reference to newly adopted patterns of decision-making;
c. Formulating and describing these developments in a larger conceptual framework (Open Building), and
d. Making recommendations of mandatory flexibility requirements in the acquisition and management of the DHA facilities portfolio with the goal of high performance under conditions of change in medical practices, demographics and building technology.

The recommendations in this (and the first report) are based on four fundamental premises:

• DHA facility design for flexibility in the short, middle and long term (both new construction and upgrading existing facilities) is best accomplished by the systematic decoupling of decisions according to life-cycle principles, and by implementation of serial decision-making in acquisition, facilities upgrading and management processes;
• Acquisition teams should explicitly document capacity for change in submittal documents for each decision level (Primary, Secondary, Tertiary) supported by scenario planning and cost modeling tools;
• DHA is responsible for monitoring and holding acquisition teams accountable for compliance with flexibility requirements and to monitor and assess the return-on-investment of implemented flexibility requirements;
• Implementation of these principles requires a paradigm shift in the DHA towards a life-cycle management culture, the outcome of which should be improved facility performance and improved healthcare outcomes.

The Phase II research - undertaken between August 2013 and April 2014 - drew upon insights and data gained from:

1. The Phase I FLEX report included a literature survey of 70+ books, reports and technical papers covering more than 30 years; an extensive questionnaire of DHA,

Department of Veterans Affairs and private sector healthcare facilities subject-matter-experts. That report proposed a definition of flexibility and a recommendation for introduction of a classification and implementation scheme for implementing flexibility in DHA decision-making. (http://facilities.health.mil/repository/getFile/10796)

2. A systematic audit of key DHA requirements documents and the World Class Facilities Check List to identify and critique existing flexibility criteria;
3. Examination of literature on performance requirements in the building industry;
4. Examination of relevant literature on flexibility requirements;
5. Meetings with key DHA leadership and personnel;
6. Developing new and augmenting existing flexibility requirements in the Uniform Facilities Criteria for Medical Facilities and in the World Class Check List

FUNDAMENTAL PRINCIPLE FOR ACHIEVING FLEXIBILITY

Acquisition of assets expected to have a long use-value can only come out of decision-making processes based on a recognition that the built environment is never finished, and that continuous transformation must be recognized and planned for. Use-value itself is not only a technical term when associated with health care facilities: the concepts of use and value exist in a social body that understands that the value of the physical environment is not a static phenomenon but is evolving on the time axis.

Flexibility – like sustainability - is fundamental to a facilities life-cycle (whole-building life) agenda. Even though flexibility is not an industry standard, it should be a DHA requirement, like LEED and building codes, and should appear in all design guidance documents, cutting across lines of authority and decision-making.

BACKGROUND

Too often, the term flexibility is used to describe only technical performance or physical characteristics, such as added floor-to-floor height; or standardization of spaces to enable multiple uses of the same space; and so on. While technical solutions can be helpful to assure long-lasting (flexible and sustainable) assets, our studies demonstrate that technical matters alone are insufficient to achieving a flexible building stock, and sometimes actually thwart long-term utility of facilities if poorly employed. If clients retain decision-making patterns that result in physical facilities that lack the capacity to adapt, improved technical solutions offered by product manufacturers, architects and engineers will prove to be insufficient remedies.

Even before commissioning is complete, healthcare facilities are being adjusted and continue to be transformed in small and large ways, over many years, because of changing priorities, practices and policies. The concept of "continuum of care" therefore applies not only to people whose health these facilities are designed to recover and enhance, but to facilities themselves. This suggests that the current focus on near-term planning, budgeting, funding, design, construction, commissioning and outfitting of facilities must be supplanted by a longer view of continuous transformation. This long view must be supported by scenario planning and cost modeling (as outlined in the Phase I Flexibility Report – pgs. 153-174 - http://facilities.health.mil/repository/getFile/10796) and by data collection necessary for evaluating the return on investment of flexibility strategies. "Facilities maintenance" may not be an adequate concept or term of reference for the realities facing MHS assets. More "open ended" and "continuous improvement" attitudes and methods of accounting and management are needed, if the DHA expects its facilities to be sustainable and to provide continuous world-class operational and physical performance.

To support the flexibility principle outlined above, the Phase I Flexibility report recommended adoption of a serial decision-making model for managing uncertainty and change. Adoption of this model will enable greater transparency and more effective and rapid corrective policy and acquisition measures. This model is based on the principle of decoupling parts of a facility having long term utility from the parts having shorter-term utility (System Separation). This model is partly in use in the DHA with the Initial Outfitting and Transition contract (IO&T) as a separate acquisition activity, and with the use of "incremental funding waivers" in fast-track projects, allowing, for example, funding for an early "foundation package" before design of the rest of the building in detail is completed.

The model is conventional in the commercial real estate markets in the United States and internationally. This may seem unusual because commercial real estate decision-makers are considered to have very short-term interests: quick profits and turn-around and aversion to risk. Perhaps because of these tendencies investors have learned to be very "agile" (another word for flexible). The principle of decoupling is also evident in large infrastructure planning and operations, such as highways (highways are decoupled from the vehicles using them) and utility systems (electrical power transmission lines are designed with the capacity to accommodate a range of (changing) downstream user demands controlled by independent agents). The serial model has three "system levels:"

• **PRIMARY SYSTEM** (Base Building - an "open building:" structure, skin and primary mechanical, electrical and plumbing systems)
• **SECONDARY SYSTEM** (Fit-out – all components and spaces directly supporting functionality, including the parts of the overall mechanical, electrical and plumbing systems specific to a given program of functions)
• **TERTIARY SYSTEM** (Furnishings, fixtures and equipment – short-term investments such as equipment, furnishings, consumables)

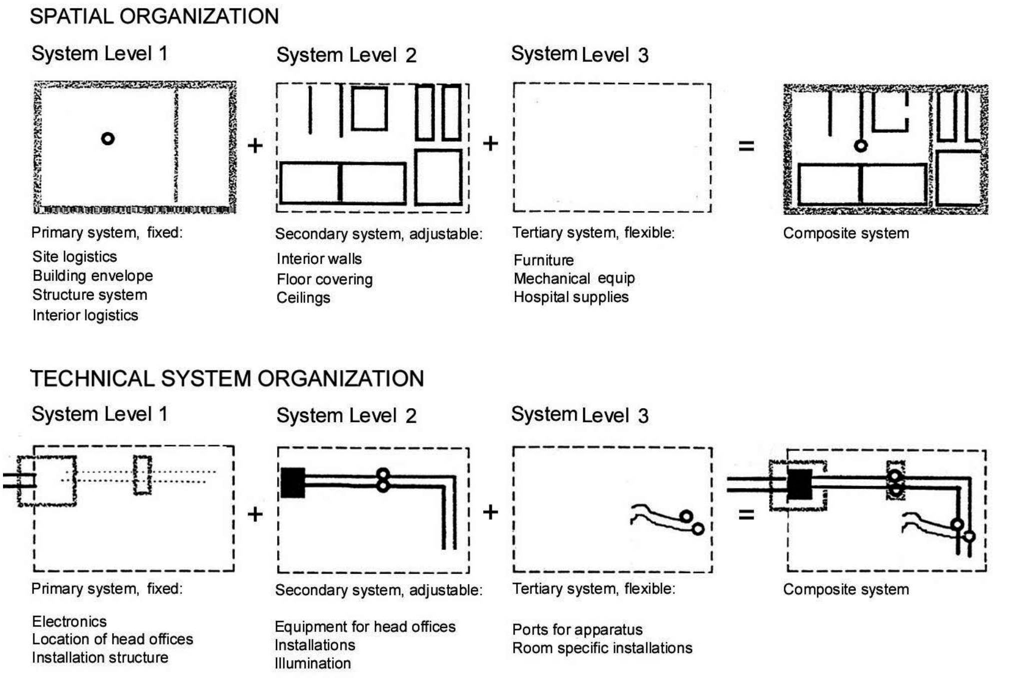


Figure 1*: (source: Office of Properties and Buildings, Canton Bern, Switzerland)*

Translating the principle in *FIGURE 1* into an acquisition-sequencing model, the recommended sequence (bottom sequence Figure 2 below) is actually an evolution from the recently implemented separation of IO&T (Initial Outfitting and Transition) contracts (as shown in the middle diagram in Figure 2 below).

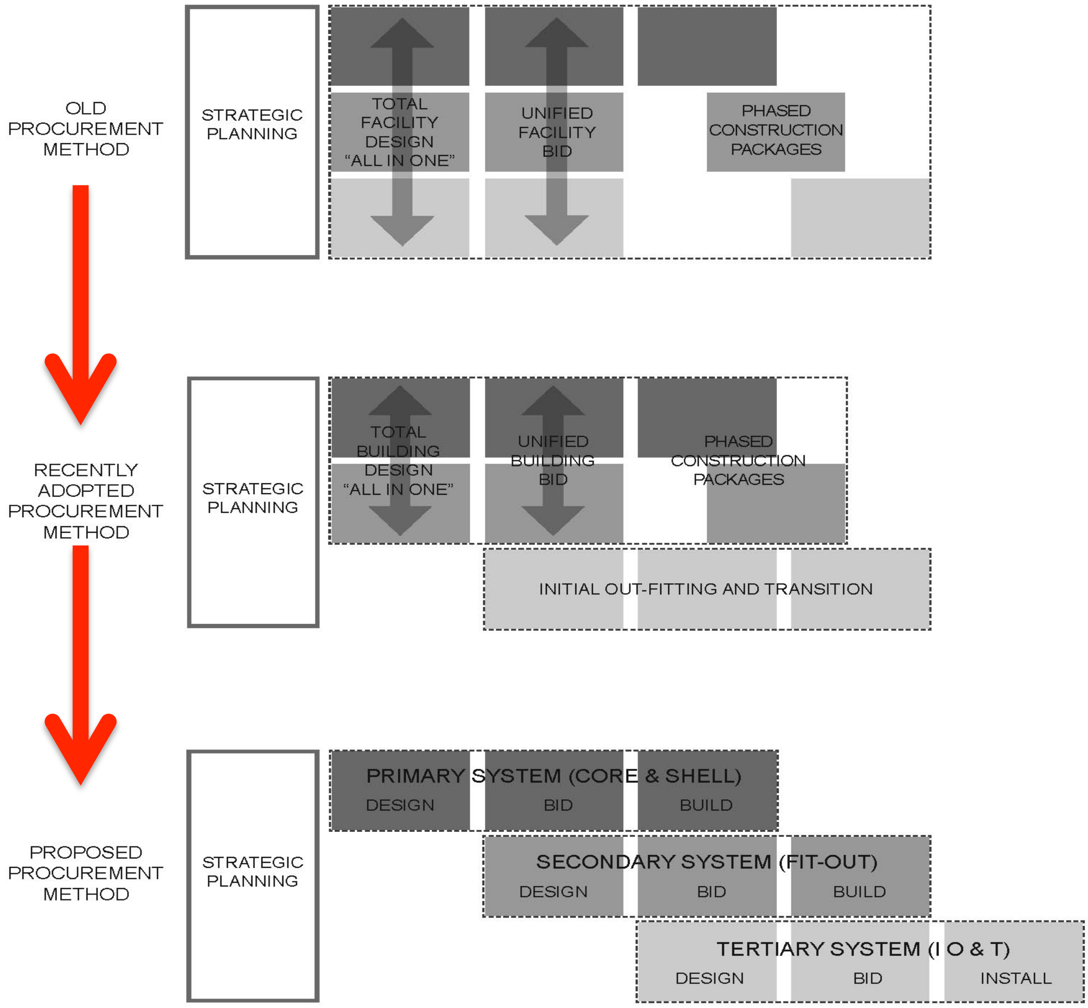


Figure 2*: Evolution from a parallel to a serial decision-making process. The "old" procurement model may be suitable for simple projects. But the greater the project size and complexity, the longer the critical path to realization is, and the greater the chance that the investment will undergo significant transformation later, the more important decoupling and sequencing of decisions becomes.*

The principle understanding embodied in this decision-making sequence (for new construction and for comprehensive reactivation of existing facilities) is that all facts and requirements cannot be known at once - at the beginning of a many-decades-long process from decision-to-build/renovate, through appropriations, commissioning, move-in and later adaptation to new requirements. Decisions are inescapably made sequentially during initial acquisition and then continuously over the life of the facility. How could it be otherwise?

Design decision-making for facilities should be decoupled based on the expected lifecycle (use-value) of the system “level” concerned. That is, the tertiary system can change without excessive disruption of the secondary system; and the secondary system (representing evolving DHA mission, functional and space requirements) can change with minimal disruption of the primary system, an investment designed to be useful over a long period of time.

ANALYZING DHA DOCUMENTS IN PREPARATION FOR WRITING NEW FLEXIBILITY REQUIREMENTS

Two DHA documents were analyzed in preparation for making recommendations for flexibility requirements. First was the UFC 4-510-01 (Uniform Facilities Criteria for Medical Facilities). Hundreds of pages long, it is periodically updated and has been the principle vehicle by which facility design requirements are promulgated. The second was the World Class Facilities Check-list, a public access website which undergoes continuous updating. UFC 4-510-01 requirements were analyzed and an assessment made as to how pertinent existing requirements are to flexibility. An Excel chart was used to:

1) Indicate relevance of existing requirements to flexibility by assigning them numbers 1, 2 and 3: 1 means no relevance; 2 means moderate relevance and 3 means high relevance;

2) Introduce the distinction between Primary, Secondary and Tertiary systems, and with an "X" depict the relevance of the UFC paragraph to one or more of these levels.

This analysis led to recommendations to augment the text of current UFC Flexibility Requirements.

ANALYZING THE UFC DESIGN SUBMITTALS

The Design Submittals contained in the UFC 4-510-01 are instrumental because they instruct architects and engineers in the preparation of drawings and specifications at each mandated design submission: Conceptual, Schematic, Design Development and so on. Because implementing flexibility necessities that architects and engineers explicitly demonstrate how they are complying with the requirements, and the client must monitor compliance, the Design Submittal requirements are – and will be – an essential instrument in implementing flexibility.

Because a direct relationship exists between the thirteen recommended UFC flexibility requirements (discussed later) and the UFC Appendix C Design Submittals requirements, it is important to make an explicit link between these as well.

If flexibility is to be implemented successfully across the DHA portfolio, the Design Submittals required of architects and engineers must be periodically assessed and revised. The client (DHA) must develop the methods, skills and culture to update these requirements as experience is gained and maintain vigilance of compliance over time in.

The work of adjusting the Design Submittals was not part of the research contract and is therefore not reported on in this paper but is recommended for further study. However, the full analysis on the basis of which such development can be done was included in the final report.

THIRTEEN RECOMMENDED AMENDMENTS AND ADDITIONS TO THE FLEXIBILITY REQUIREMENTS IN THE WORLD CLASS CHECK LIST

A comprehensive examination of the World Class Facilities checklist revealed several flexibility requirements, indicated in ***BOLD/ITALICS*** in the full list of recommendations below.

- Site Capacity
- ***BUILDING EXPANSION FLEXIBILITY***
- ***GEOMETRY OF THE STRUCTURAL SYSTEM***
- ***NATURAL LIGHT***
- Floor-to-Floor Height Requirement
- Loading Capacity of Floors
- Minimal Internal Structural Walls
- Flexible Facades
- Separate Systems
- Layout and MEP flexibility for the Secondary System
- Opportunity for Vertical Mechanical Equipment in the Future
- ***MULTIFUNCTIONAL USE OF ROOMS***
- Capacity for Variable Inpatient Bedroom Sizes

Based on extensive review of best practices in the industry worldwide, and following the principles enunciated in the official report, the existing requirements (***BOLD***) were augmented and additional requirements were added, as listed above. All of these were provided in the final report, following the World Class Facilities Check-List format.

Because of the importance placed on System Separation in implementing sequential decision-making, one of the World Class Flexibility Requirements focuses on and offers examples for architects and engineers in adhering to the principle of System Separation. This is given below.

SYSTEM SEPARATION

Strategy information

Technical separation of systems (Primary, Secondary, Tertiary) is a question for the design team and the client. In general, decisions about Tertiary system elements (i.e. IO&T) 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. Among other capabilities, this must result in a building enabling work on one floor (reconfiguration, change of spatial layout, change of equipment and fixtures) to be accomplished rapidly with no or minimal disturbance to activities on other floors.

MHS GUIDING PRINCIPLES	CORE DIMENSIONS
4 Improve Operational Effectiveness 6 Provide high value and be good stewards of taxpayer money 8 Design for maximum flexibility, standardization and growth	16 Adaptability, Flexibility and Future Planning 17 Building System Performance and Maintainability 20 Cost effectiveness and reduction

RESEARCH SUMMARY [+]

This flexibility strategy calls for adoption of a basic management and decision-making principle corresponding to the reality that healthcare facilities, once built and commissioned, inevitably face physical transformation over time to allow them to maintain value.

The key to the acquisition of assets with long-term value is decoupling decisions based on three "systems:" Primary System (75 year asset value); Secondary System (20 year asset value) and Tertiary System (3-10 year asset value).

To assure that the Primary system is not dependent on the Secondary system, and the Secondary system is not dependent on the Tertiary system (i.e. IO&T), the implementation of a serial decision-making process is recommended, replacing the "decide everything-at-once" decision-making process that is fast being replaced by smart clients around the world who value a long-term, life-cycle ROI.

This is a fundamental principle of any built environment that lasts; that continues to transform over time. The key is well-organized decision deferment, to enable timely decisions about and acquisition of the most current functional layout, medical technology and design knowledge – but not before it is needed.

For budget authorization, 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 - are based on benchmarked estimates.

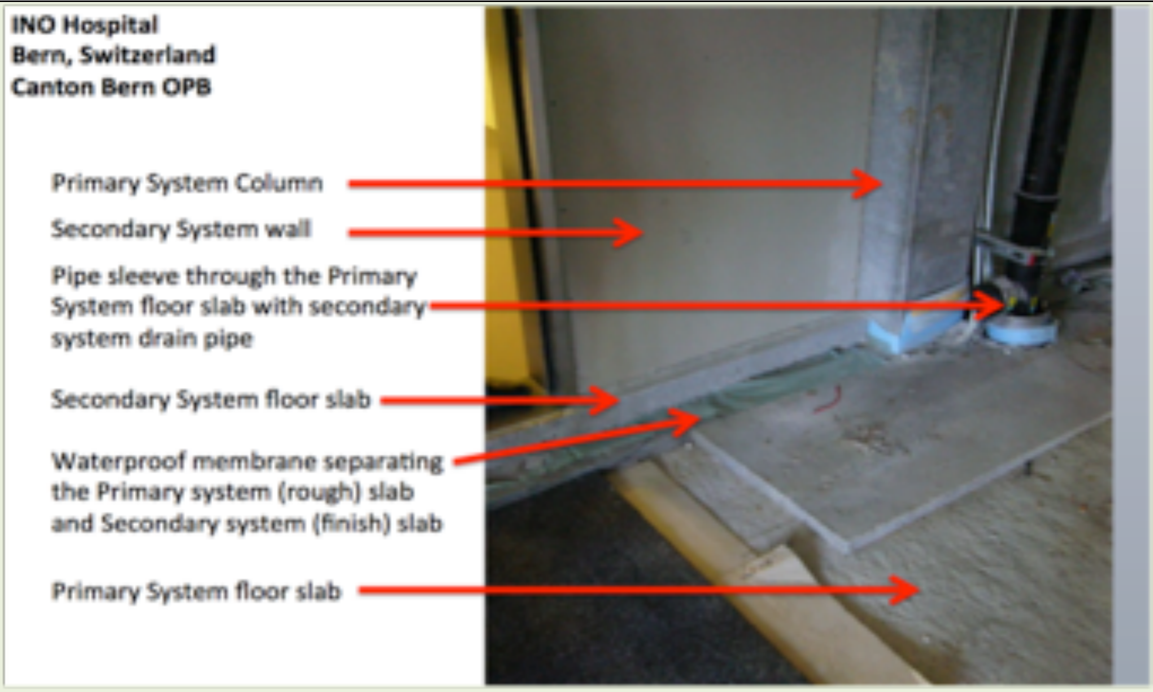
Flexibility must be an established criterion as part of decision-making in all phases of the life cycle and specifically in planning, programming, design, acquisition, construction quality control and in operation. Approaching project planning this way enables control over smaller and more executable scopes of work, resulting in more flexibility (and accountability) in programming and budgeting.

The same principle should guide the partial or total renovation of older facilities to "reset them" for a long and useful ROI.

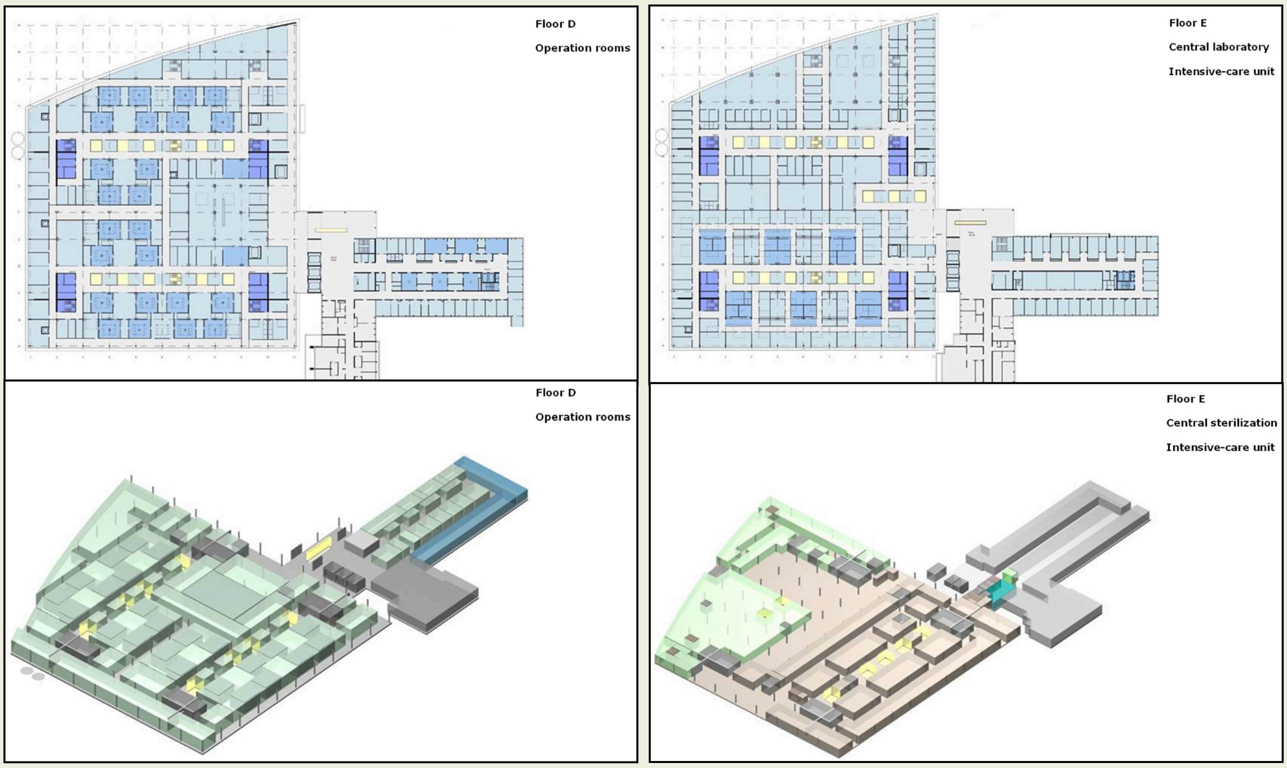
DESIGN IMPLICATIONS [+]

Primary System: Known as the "base building" or "core and shell" in the commercial market, this decision level consists of physical and spatial elements with the longest utility value (75+ years) for the project at hand. Generally, this includes building access; the building structure (possibly planned for vertical and/or horizontal expansion); the building facade; primary vertical MEP shafts and sleeves and set-asides for future MEP shafts, and primary vertical egress stairs and elevator shafts (or shafts for their eventual installation). The decision of what part of the total MEP systems are in the Primary System is decided for each project, but in general, facility flexibility necessitates that most of the MEP elements are in the Secondary System, while space is assured for them in the Primary System design. This decision, like other Primary System decisions, is finalized after completing the capacity analysis (called "test fits" in the commercial market) and cost modeling / cost trade-off exercises. In general, flexibility requires that MEP systems serving a given space be accessible to and from that space, to reduce disturbing other primary functions when changes are made. The most difficult is drainage piping which is usually positioned in the ceiling plenum of the space below the space served. Not only does this add complexity to the plenum space but it is a violation of the basic principle of flexibility. Therefore, every effort should be made to avoid floor penetrations for drainage piping except at locations planned-in to the Primary System. The principle goal is to assure that the Primary System can accommodate a variety of floor plan and equipment layouts over time for a given function (e.g. cluster or linear surgical suite layouts, not just one or the other), as well as changes of function (surgery to laboratory). Thus, the Primary System (like a highway) is not dependent on the secondary system (like the design of the highway is not dependent on any specific vehicle), but offers space for variable and changing secondary systems.
Secondary System: Known as "tenant work" or "fit-out" in the commercial market (with their associated depreciation schedule), this decision level consists of physical and spatial elements tied directly to functional requirements. Detailed programming for the secondary system is undertaken after the Primary System is under construction, within the constraints of the Primary System (understood as the fixed 'site' of the first or subsequently installed secondary systems, on one or severall floors). Generally, this decision level includes partitioning, ceilings, floor layer, and all MEP components supporting the secondary system being installed. (see design implications) Special attention must be paid to the provision of secondary system components that can be rapidly removed, repositioned or replaced with minimal disruption to the primary processes in adjacent areas (beside, or above or below). It is also critical that the secondary system design demonstrate that when changes are made to the tertiary system (e.g. medical equipment), the replacement or upgrading of the equipment can be done with minimum disturbance to the Secondary System.
Tertiary System: Known as FF&E (fixtures, furnishings and equipment) in the commercial market or, generally, the IO&T (Initial Outfitting and Transition) in DHA contracts, this decision level consists of "movable" components that have no permanent connection to the building's primary or secondary systems or their utilities. NOTE: the boundary between Secondary and Tertiary Systems is evolving. Some companies combine Secondary and Tertiary system components in one proprietary "product line;" others deliver "open" systems that are combinations of components from a variety of manufacturers. Therefore, decisions regarding the separation of Secondary and Tertiary Systems are to a great extent project specific, and depend on cost, service provider value and long-term return-on-investment. This issue is projected to be one of the most significant in reducing cost of healthcare facilities, in reducing "down-time," and in improving healthcare facility operations in the future.

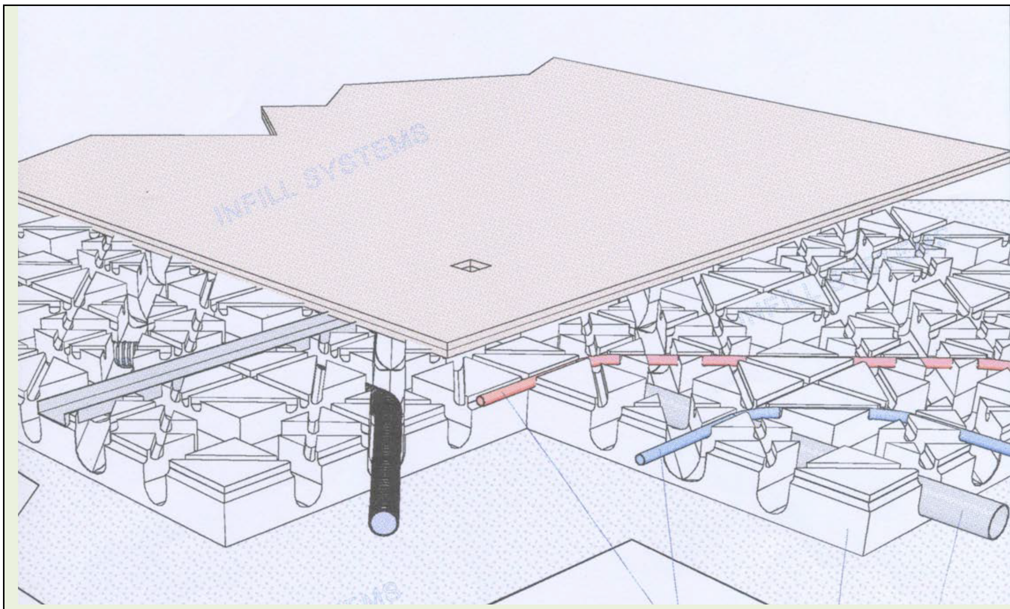
IMAGES [+]



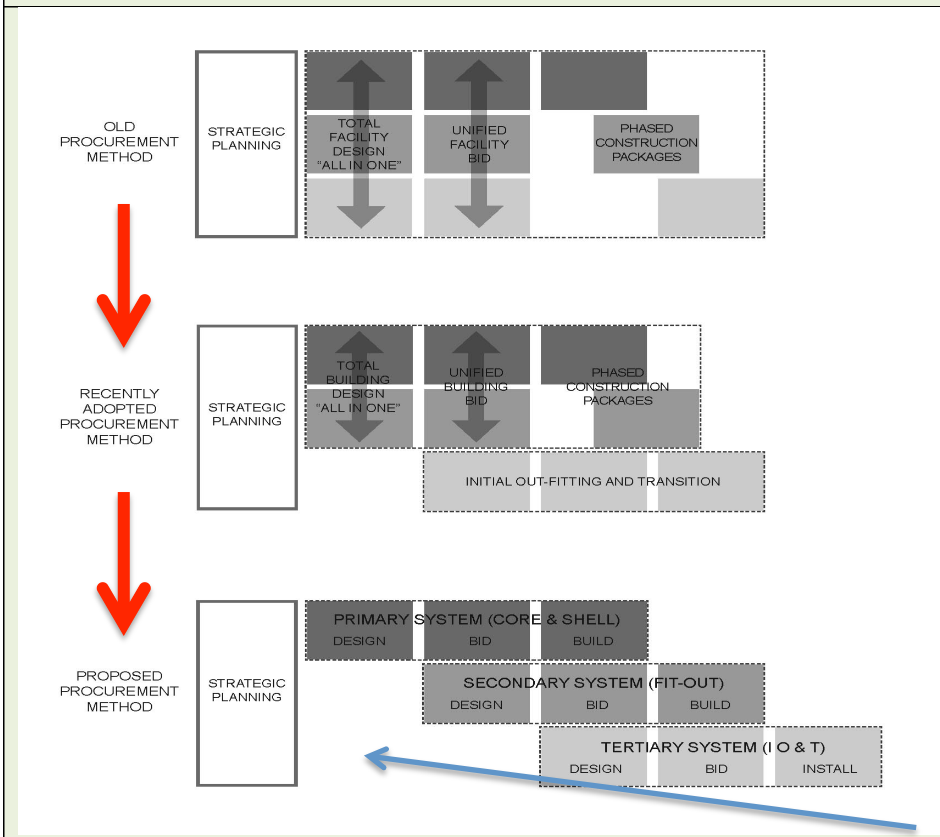
Primary



Primary System Capacity for variable Secondary System layouts (e.g. Surgery, Labs, Intensive Care

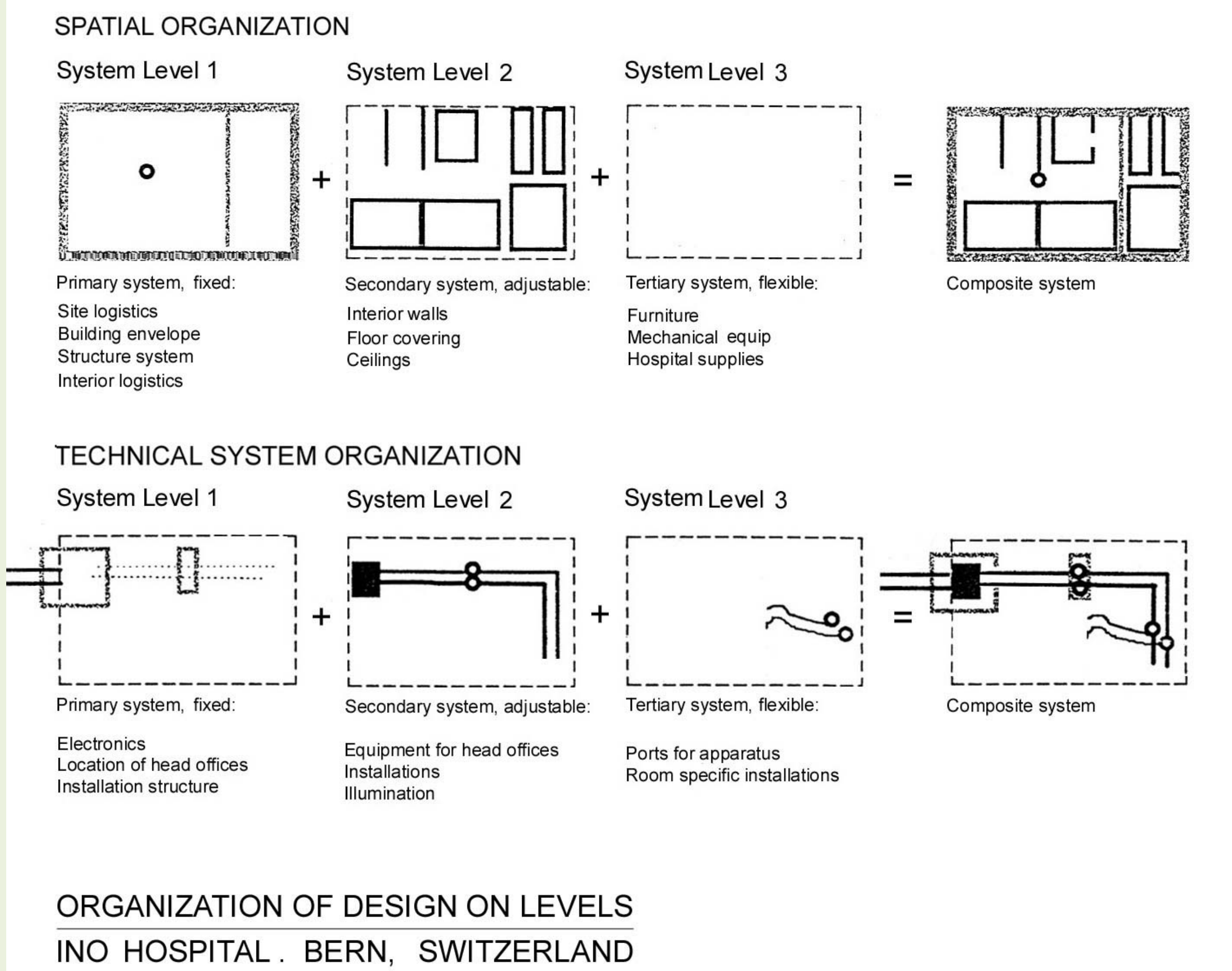


The MATRIX TILE is a solid material (e.g. medium density polystyrene) applied on top of the leveled base building floor. The tile thickness is approximately 4” (four inches). Grooves of various sizes and located in several horizontal “zones” allow the secure placement, without interference, of lines or conduits for various services, such as hot and cold water lines, gray-water drain lines (0-slope), hydronic heating pipes to radiators, floor heating, flat ventilation ducts, gas pipes and so on. This “tile” is covered by a 1” (one inch thick) fireproof floor layer, after lines and conduits are installed. Metal stud partitions are erected on this floor covering and any finish floor covering can be installed.

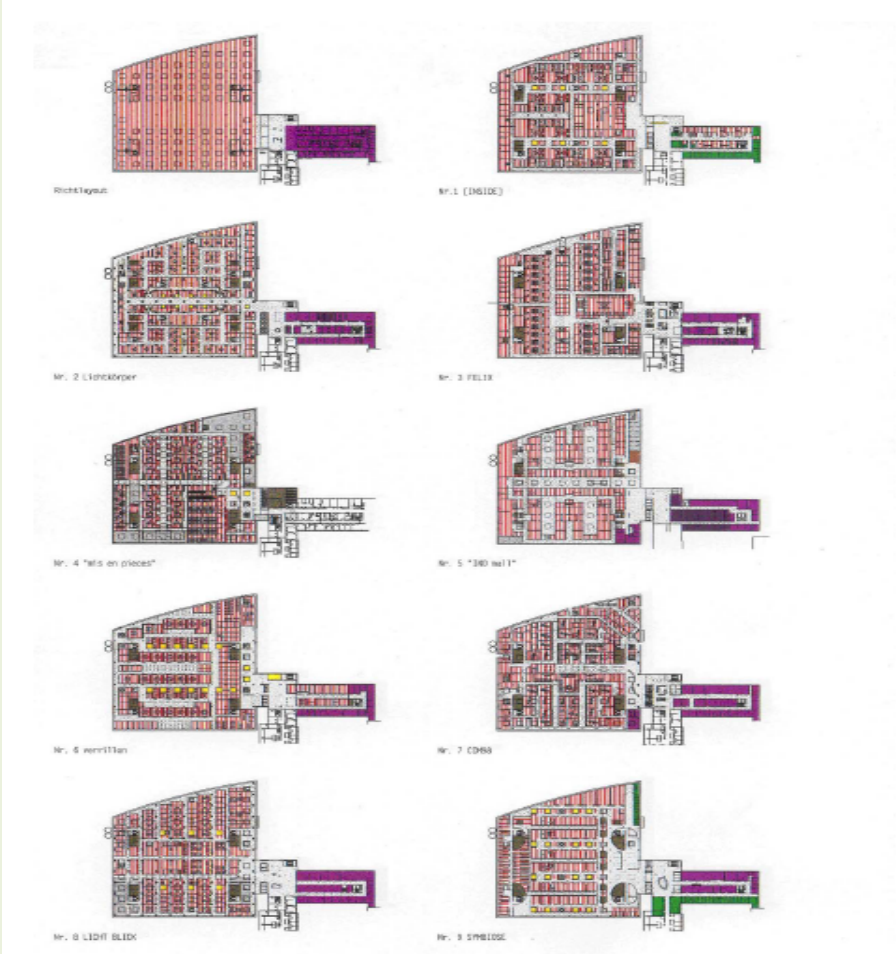


Just-in-Time planning

SERIAL DECISION MAKING: Transitioning from a process that produces rigid buildings to a process that sets up a facility for sustainable and inevitable change.



Primary/secondary/tertiary Systems



A given floor of the Primary System has the capacity for many secondary system layouts

METRICS [+]

1: ROI Evaluation (Potential costs, Cost savings, & ROI)	Few published studies exist on the ROI of system separation. The Canton Bern Office of Properties and Buildings in Switzerland (a public agency) has implemented more than 20 "system separation" projects. In the UK, a healthcare facility at the University of Bath hospital using system separation principles (under construction April-Sept 2014) is projected to cut costs by 15% and construction time by 30%.
2. Design Review Considerations:	Design review considerations for system separation are significant. Design submittals by the A/E service provider must include drawings up to (if not beyond) 10% completion demonstrating that the Primary System can accommodate a variety of Secondary System solutions - including MEP drawings showing capacity/alternatives. These must be based on client-driven scenario planning. Similar demonstration of capacity is necessary also for the Secondary System (showing capacity to accommodate changing equipment over time with minimum disturbance to the primary activities of the facility).

3. Potential Mockup/Prototype/Simulations:	Simulations can be useful, as long as it is understood that the point is not to choose ONE alternative but to design at each system level for a variety of changing configurations at the next lower level. Leading companies already provide mock-up and prototype capability, particularly for secondary/tertiary system solutions.
4. Post Occupancy Information Collections:	POE studies have not yet incorporated medium to long- term studies of how buildings change, but perhaps they could do so.
5. Focused Research Options:	DHA should have a research unit or should outsource continuing research into the long-term efficacy of specific flexibility strategies, and to draw lessons from work in other sectors and other countries.

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RECOMMENDED AMENDMENT TO CURRENT TEXT IN THE UFC 1-200-01 – HIGH PERFORMANCE AND SUSTAINABILITY REQUIREMENTS

The DHA asked for recommendations in linking flexibility to the existing principle mandated across all Federal Government agencies of achieving High Performance and Sustainable infrastructure and facilities.

Our report recommended the following language:

"Achieving high performance and sustainable – i.e. long lasting – installations and facilities necessitates their continued optimum functionality over time – that is, they must be flexible. This extends UFC 1-200-01's mandate to include the economic benefits and human satisfaction needed for long-lasting facilities. The tenet of flexibility in the UFC 4-510-01 and the flexibility requirements recommended for inclusion in the World Class Facilities Check List must be met for all DHA installations and facilities, newly constructed or acquired, or already in service. Installations and facilities constructed prior to the introduction of current and recommended high performance, sustainable and flexibility criteria must undergo strategic, systemic upgrades, preparing them for long-term value under conditions of change."

It should be noted that the LEED v4 for Building Design and Construction (Leadership in Energy and Environmental Design) includes a section pertaining to "design for flexibility" applied to healthcare facilities with the following intent: *"Conserve resources associated with the construction and management of buildings by designing for flexibility and ease of future adaptation and for the service life of components and assemblies."* (*http://www.usgbc.org/sites/default/files/LEED%20v4%20ballot%20version%20(BDC)%20-%2013%2011%2013.pdf*). V4 also includes LEED BD+C: Core and Shell, which is equivalent generally speaking to Primary System.

LINKING FLEXIBILITY TO PRINCIPLES OF RESILIENCY AND ADAPTATION TO CLIMATE CHANGE

We were also asked to link flexibility to the principles of resiliency. Discussions with leading experts and by reviewing recent literature lead to the following assessment. Both resiliency – the ability to withstand and recover from extreme natural and human-caused events – and capacity to adapt to climate change relate strongly to flexibility. While the causes of facility change differ (evolving functional and satisfaction factors over time drive the need for flexibility) the required facility performance common to all has to do with reducing the ripple effects of change in one part of a facility to all parts of that facility or installation.

In decision-making for flexibility, an economic and political (social/organizational/behavioral) assessment is required to evaluate the efficacy and return on investment of implementing a given flexibility strategy from a portfolio of candidate strategies. The same assessment is needed in preparing a facility for resiliency and capacity to adapt to climate change.

That is, if flexibility is achieved, resilience and capacity to adapt to climate change are easier to achieve. That said, some of the recommended flexibility strategies are demonstrably more relevant in achieving resiliency and climate change adaptability than others. **A thorough analysis of and elaboration of these points of convergence is needed.**

As an example, Cambridge University and Loughborough University in the UK are engaged in developing strategies for upgrading existing healthcare facilities to accommodate climate change (e.g. rising ambient temperature), focusing on energy systems upgrades that will not increase energy budgets. A flexible building implementing several of the strategies we recommend would go a long way to supporting such upgrading.

LINKING FLEXIBILITY AND SUSTAINABLE BUILDINGS – MOVING BEYOND TECHNIQUE

Up to now, the discourse on high performance and sustainable buildings - in published technical reports, academic and industry conferences, in client organizations and among service providers - has been largely devoid of a fundamental rethinking of decision-making patterns. The discourse has focused on technique, not control (who decides what, when). Discussion about technique is preferred because of its presumed objectivity and purported grounding in technical rationality.

Discussions about control, on the other hand, inevitably encounter questions of the distribution of control (no single person can control everything), for which there are no "right" answers that can be justified by technical rationality. The literature also calls this "task partitioning." Organizations steeped in the culture of technical rationality, but who also must inescapably operate in complex patterns of distributed control, do not have good theory on which to establish policy and practices linking technique and control: thus the avoidance of systematic restructuring of decision-making. This difficulty is particularly evident in a large governmental organization such as the DHA which have grown larger over time and which accumulate patterns of decision making with few opportunities for a thorough overhaul.

Based on the above observation, a high-level tenet is important to include in the introduction section of the newly published UFC 1-200-01 (Uniform Facilities Criteria High Performance and Sustainable Building Requirements). In the interim, these principles can be implemented in the medical facilities infrastructure by including them in the UFC 4-510-01and in the World Class Checklist.

CONCLUSIONS: ADJUSTMENTS IN THE CLIENT ORGANIZATIONAL CULTURE

To successfully implant a flexible (and high performance and sustainable) facility methodology as a normal way of doing business, DHA must develop the needed expertise and tools, as well as clear requirements to monitor and enforce a key principle: facility changes should have minimal consequences for the primary processes of the facility in adjacent areas, or above or below the affected floor area of the facility. This principle is relevant for new construction and for the reactivation or renovation of existing buildings.

Therefore, building elements and spaces with an expected long life should be strictly and explicitly decoupled from building elements and spaces with shorter expected use lives. This decoupling must be implemented in all phases including the planning, budgeting, design and construction (and renovation) processes.

The reason for decoupling is to assure that the change of a building element with a short life (e.g. an element serving a specific function) does not require disruption or change (or only minimal change quickly accomplished) of an element with an expected long life (i.e. an element or configuration that supports many building functions). For example, changing a wall with an expected short life should not require demolishing the structure; changing an electrical outlet should not require demolishing the wall it follows.

Within each of the three "systems levels" (Primary, Secondary, Tertiary), it is possible to find "fixed" and "variable" parts. For instance, the façade is assigned to the primary system. But within the "façade" category, some parts may need to be replaced or upgraded more frequently than other parts (e.g. windows may need to be replaced before the entire building cladding comes due for replacement; in that case, the building envelope as such is "fixed" and the windows are "variable").

There is no precise or scientific basis for decoupling or for deciding what should have a long asset life and what should have a short (or shorter) useful life. Part of the reasoning is certainly technical. But an equally if not more important set of criteria has to do with what could be called "interests." Decentralized interests may not be as easily discernable in a top-down organization such as DHA or other large, centralized organizations, as compared to large private healthcare systems with many geographically disbursed, semi-autonomous facilities such as, for example, Sutter, St. Joseph or Ascension Health Care Systems.

What is common across these cases is that a hierarchy of interests exists. At the highest level are interests in the long-term survival and maintenance of the asset base. In the case of the DHA, it is the US Congress. They are in the game for the very long haul. On the other end of the hierarchy of interests are the doctors and other caregivers. They are the direct service providers and are ethically and professionally committed to offering the best care with the best medicine, technology and personnel. A model may explain, in which system levels are paired with "interests":

PRIMARY SYSTEM	⟷	Central Organization (Agency, Governing Board)
SECONDARY SYSTEM	⟷	Local Healthcare Facility Management Group
TERTIARY SYSTEM	⟷	Doctors and Nurses

Needless to say, this practice of linking physical systems with "interests" has become conventional best practice in the bulk of commercial property development in much of the world and is increasingly found in other use types such as laboratories, institutional and multi-family residential properties. This model, when adopted for use in DHA facilities, will enable not only a positive return on investment, but also a more effective and fluid transfer of knowledge, experience and innovation between the private sector and the DHA, despite inevitable and important differences.

IT IS OF THE UTMOST IMPORTANCE TO GET THE PRIMARY SYSTEM RIGHT

This imperative is not unlike the necessary importance placed on getting the urban transportation and public space structure "right," because it sets the stage for 100+ years of evolution of the urban fabric. In that case, the street corridors and public parks together constitute a "fixed" configuration, while the public utilities that circulate in or under these public spaces, and the various and changing uses of these spaces, are "variable."

For similar reasons, the greatest emphasis must be placed on primary system longevity (and energy efficiency) in the face of inevitable functional and operational evolution in healthcare. The primary system should be built to offer long-term utility value to society, the client and the character of the urban fabric it is part of. This means that the primary system planning cannot be allowed to be dependent only on current knowledge, preferences and data.

This is the first and most important decoupling and is the most difficult to implement in an organizational culture used to operating with a model of unified top-down control in which all parts are equally dependent on all other parts. Therefore, most of the recommended flexibility requirements focus on getting the primary system "right," and getting it decoupled from the secondary system.

FLUIDITY OF THE SECONDARY AND TERTIARY SYSTEMS

International research shows that the state-of-the-art in secondary systems (mirroring evolving functional requirements, medical practices, etc.) and tertiary systems (constituting the movable equipment now undergoing the most rapid evolution and miniaturization) for medical facilities is already well on its way to the needed flexibility (decoupling). For example, comprehensive healthcare "systems" offered by large vendors such as Herman Miller and Steelcase (to name just two) illustrate the extent to which the boundary between secondary and tertiary systems is being blurred: walls, equipment and some MEP systems components are being bundled, with interfaces resolved within the "product" of one provider – often patent protected. These interfaces are not as well understood, when different companies deliver and install elements of attempted "integrated" solutions.

In the "open market," the interfaces between secondary and tertiary systems that must be solved on-site are very much in flux, as evidenced by a careful reading of IO&T contracts (Initial Outfitting and Transition – equivalent in large measure to the Tertiary System). In these contracts, interdependencies between these two levels are repeatedly indicated and are repeatedly the source of problems: quality control, re-work, and litigation over the locus of responsibility.

Further work is needed to develop smart flexibility requirements for the secondary and tertiary systems. This will also require further consideration of interfaces "on" and "between" system levels in products and components offered in the "open" market (now international).

An example of an interface "on" a level is the interface between electrical cable distribution and walls "on" the secondary system level is quite problematic and needs work. New solutions are available but their introduction can be disruptive to conventional arrangements between stakeholders who do not want to change their habits or supply chain relationships.

An example of an interface "between" levels is the electrical cabling at the primary system level and the secondary system, and between secondary system (walls) and tertiary system (equipment).

The development of performance-based flexibility requirements for such interfaces (and there are many) requires a separate research effort.

A SHIFT OF PERSPECTIVE IS REQUIRED

FROM	TO
•Assets understood as static	*•Assets understood as subject to transformation*
•Decision making focused on the initial acquisition of an asset	*•Decision making over time (assets will be transformed over time)*
•Flexibility focused on technology	*•Flexibility focused on sequenced decision-making over the life of the facility*
•Flexibility separated from sustainability	*•Flexibility ENABLING sustainability*
•Flexibility as an option	*•Flexibility as a requirement*

CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER ACTIONS

The recommendations made in the final report subject to review by the client organization along with a number of recommendations for further action, outlined here.

1. **AUDIT and REVISE EXISTING CRITERIA: (to de-conflict and improve the** workability of existing and improved criteria)

1.1 REVIEW EXISTING DOCUMENTS: Complete a thorough review of all existing criteria documents (UFC's, WCC, MDI, SEPS, 1691, etc.), to identify and if needed delete, synchronize and/or augment existing flexibility requirements in those documents.

1.2 UPDATE SUBMISSION REQUIREMENTS: Review and revise the Design Submission requirements in Appendix C of the UFC 5-410-01 to align with new flexibility requirements, and develop a compliance check list.

1.3 **DEVELOP METHODS TO PRICE AND ACQUIRE SECONDARY AND TERTIARY SYSTEMS**. Implementation of serial decision-making as recommended in this report necessitates development of pricing (e.g. benchmarking) and acquisition methods for the Secondary and Tertiary systems, separated from the Primary System. This is necessary to establish total budget requests for appropriation purposes.

2. **FLEXIBILITY OF EXISTING FACILITIES (Demonstrating efficacy of implemented flexibility strategies and developing criteria for improving the performance of existing buildings)**

2.1 AUDIT EXISTING ASSETS: Conduct an analysis of several existing DHA facilities in which flexibility strategies were implemented, and to which additions and/or adjustments have been made, to assess the extent to which the additions and/or adjustments diverged from implemented flexibility strategies. For example, we recommend an analysis of several DOD Integrated Building System or other so-called flexible projects and their additions and/or adjustments.

2.2 DEVELOP AUDIT METHODS AND CRITERIA FOR UPGRADING EXISTING FACILITIES FOR LIFE-CYCLE PERFORMANCE: Flexibility requirements for EXISTING FACILITIES should be developed and inserted into the UFC and WC Check-list. This is critical to the DHA asset portfolio in the coming decades as more resources are applied to upgrading the existing building stock to meet changing requirements. Such criteria should include measures such as “selective surgery” and installation of “strategic implants” to set up existing facilities for future flexible performance. This could be called “Activation of Existing Assets” and may be part of DODI 6015.17.

2.3 DEVELOP A PERFORMANCE-BASED METRIC FOR CHANGE OF FUNCTIONS OVER TIME: This system should set performance criteria for implemented flexibility STRATEGIES, defining the time allowed for several kinds of facility adjustments/upgrades. This includes a matrix of hospital functions and defines three classes of transformation – e.g. change of function (more to less complexity), setting out performance requirements based on the time needed to implement them.

3. METHODS FOR TRACKING FACILITY TRANSFORMATION

3.1 DEVELOP A SCENARIO PLANNING TEMPLATE BASED ON USE: Such a TEMPLATE should be part of all DHA facilities processes, to be used by architect/engineering teams, working with clients in planning facility upgrades, additions or alterations. The goals are: 1) to assure that facility planning avoids use of only one “program of requirements” as the basis for its design; and 2) to assure appropriate uniformity of assumptions and criteria across the portfolio.

3.2 CREATE AN INFORMATION COLLECTION AND TRACKING TOOL: Given current efforts on DMLSS, “BUILDER” (i.e. Medical BUILDER), should be augmented or a new procedure developed to track the facility upgrades, additions or alterations and the impact of the already implemented flexibility measures in that buildings.

4. **INITIATE A PERIODIC SHARED LEARNING FORUM:** Establish an industry forum to engage the private sector in improving acquisition (design and construction) and long-term asset management (adaptation and facility renewal) methods and tools. An example is the Strategic Roadmap Webinar Series conducted in 2012-2013)

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