Healthcare Facility Design for Flexibility

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1. Executive Summary

The MHS has made a commitment to conduct research on healthcare facilities design for flexibility, with the goal of identifying methods to improve the process of acquiring healthcare facilities to assure that they produce long-term value and continue to serve the evolving MHS core mission.

1.1 Recommendations

This report makes a number of recommendations in support of that goal:

1. Include FLEXIBILITY as a tenet in the Medical Uniform Facilities Criteria;
2. Include performance requirements (10 are proposed) for implementing flexibility as part of an Appendix to the Medical UFC, and in the interim, as part of the MHS World Class Criteria and/or the Medical Design Instructions (MDI);
3. Explicitly link flexibility with sustainability / high performance buildings, especially as the Medical UFC relates to the new DOD UFC 1-200-02 – High Performance Buildings;
4. 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. As part of facility management practices, this could be a metric that can be used to assure proper protection of investments, especially those designed as high performance facilities.
5. Implement [and monitor] an alternative planning and acquisition process to better accommodate change management and deferred decision-making during the long facility planning, design and acquisition cycle of MHS facilities.

1.2 Conclusions

This research concludes that three realities of MHS healthcare facilities and the current processes used to acquire and manage them must be recognized, so that the lessons learned from them can be successfully translated into policy and criteria.

1. MHS healthcare facilities are never finished. Even though some attributes of a flexible infrastructure practice exist, the MHS currently lacks sufficiently clear management and design processes for the purpose of planning, specifying, obtaining, managing and monitoring the performance of a stock of flexible buildings.
2. The recently implemented MHS management practice that separates the IO&T from the acquisition of the facility is the basis for taking the next step in acquiring flexible facilities. The next step can therefore be considered an evolution of rather than a departure from current practice.
3. MHS is responsible for developing the vigilant business culture dedicated to acquiring and managing flexible facilities, and is well positioned to take the needed steps to meet this challenge.

2. Overview of the Task Order: Healthcare facilities design for flexibility

2.1 Background

The Department of Defense Military Health System has been and remains committed to policies and practices that produce long-term value of and continuous improvement in its worldwide healthcare, research and support facilities portfolio. As part of that commitment, improvement of management methods for acquiring and utilizing a portfolio of flexible facilities - both new construction and renovated existing facilities - has been identified as critical to the MHS core mission of delivering world-class healthcare services. To further this goal, a task order was created resulting in this research report.

2.2 Approach

This report summarizes research undertaken between January and July 2012, under a subcontract to the National Institute of Building Science. The research and drew upon insights and data gained from:

1. Identifying and interviewing key subject matter experts in both 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 both the public and private sector
5. Conducting a cost modeling workshop with both public sector (Military Health System + Corps of Engineers) 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.

3. Key Issues in Healthcare Facilities Flexibility

3.1 Responsibility for setting criteria lies with the MHS as the owner

The MHS leadership needs a strong case to continue its efforts to acquire flexible facilities. There is 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 quality 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 (i.e. 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 the owner (MHS) 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. Recent work completed to codify the four major areas of business in life cycle facilities management in the DODI 6015.17 requires that each have its own policies and practices, if flexibility (and as a result sustainability) are to be effective. Equally important is continuous training in and vigilance over the process within the owner's organization. While the 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 recommendations in this report make specific suggestions about how to address these challenges.

3.2 Past and current efforts to acquire flexible facilities

With only a few exceptions, past and current strategies for acquiring flexible healthcare facilities – both in practice and as found in the literature, both domestic and international - focus on technical / architectural solutions. Although there is some evidence of such solutions (see Appendix 8.3), the results in practice are uneven at best, and in all cases lack proof 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.
The term flexibility has appeared for more than 60 years in the architecture and engineering literature – and in that context is often associated with "systems" buildings and "performance requirements." While "flexibility" is widely used by service providers and clients alike, there is little consistency in definition 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.

The Veterans Administration has developed and applied the Veterans Administration Hospital Building System (VAHBS) as its primary approach to flexibility for more than 30 years - albeit a technical solution based primarily on the building as a solution. The VA has not kept sufficient records of change as the basis for documenting its value and therefore has no hard evidence that it has paid off. The US General Services Administration has made occasional efforts – including the GSA/PBS "Peach Book" procurement method (see appendix) – to systematically improve the process of facility acquisition in respect to cost control and flexibility, but none have been monitored to assess long-term return on investment. The same can be said of the field of educational facilities.

At the time this research effort was initiated, no policy or consistent requirements existed in the MHS for acquiring flexible healthcare facilities, although the term is mentioned vaguely 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 “loads” over time.

3.3 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 was declining, 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” (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 allow 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 connected to and dependent on) the “base building.” This does not mean that innovation is not taking place in the category of “base building.” 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, as well as smaller companies such as 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 ICU’s which are “owner purchased” and thus separated from the building acquisition as such.

Studies of flexible facility acquisition and behavior over time, as outlined in recommendation 1.4 below, will begin to provide useful data for understanding:

a. **Where innovative products and processes have paid off;**
b. **Where opportunities for product innovation lie; and**
c. **How the roles of the various stakeholders are shifting in response to an increasing and varied array of products and services that support the goal of flexible facilities.**

3.4 Acquisition and use of flexible [healthcare] facilities requires clear organizational synergy in management criteria development, 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 differing 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 question of sequential and distributed decision-making of cycles of change has remained largely tacit at best.

A major barrier to a deeper 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 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 elements of this viewpoint are evident also in the public sector.

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 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, high performance buildings.

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.

4. Recommendations

4.1 FIRST RECOMMENDATION: Include Flexibility as a tenet in the Medical Uniform Facilities Criteria

Our first recommendation is that FLEXIBILITY be included as a tenet in the Medical Uniform Facilities Criteria, with language linking technical and project planning principles. We recommend that procedures for program definition to portfolio management be established as a business practice in the MHS and be embedded in policy guidance, training, fiscal management, performance metrics and measurement, and acquisition strategies. Specifically, we recommend the following **FLEXIBILITY TENET:**

Flexibility is a principle for responding to uncertainty and risk in the lifecycle management of facilities which 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.***

4.2 SECOND RECOMMENDATION: Include performance requirements for implementing flexibility principles as part of an Appendix to the Medical UFC, and in the interim as part of the MHS World Class Criteria and/or the Medical Design Instructions (MDI)

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.** It is critical that the site plan / master plan take into consideration future facility demands, including the necessity for either vertical (as in very dense urban sites) or horizontal expansion; or a combination of the two. This priority may come into conflict with current zoning and building regulations.

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 the client 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 15 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 those needed for seismic requirements.

6. **Opportunity for vertical mechanical equipment shafts in the future.** It is very important to fix the % of total surface area for future vertical mechanical shafts and to hold that requirement during project implementation, when there is always pressure to fill every part of the available floor surface area with “functional” spaces.

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. In general, occupied spaces should have natural illumination.

8. **Facades.** The facades in many cases will not have the same long-term durability of the structural system. Nevertheless, the facades should meet current and anticipated energy conservation standards. The façade ideally should be replaceable in the future when energy performance requirements will presumably increase and higher performing and less expensive facades are available.

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 equipment 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 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 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.

    Accomplishing these goals can be facilitated by matching the recommended flexibility criteria and associated policies with the DODI 6015.17, as the chart below shows.

DODI 6015.17 Process	Flexible Characteristic	Action Required
Corporate Strategic Facilities Portfolio Management	• Additional funds authority for new construction • Ability to move funds between appropriations,	• UFC • Policies • Criteria • Performance Metrics
Requirements Planning	• Capacity allowance for future expansion • Sites planned for growth • Sustainable outcomes • Business Investments	• UFC • Outcome based on return on investment • Validation Policy
Design and Construction	• Sufficient, proven and cost effective technical criteria • Alternate Acquisition Methods • Capable acquisition and management workforce • Trained consultants, designers and builders	• UFC • World Class Criteria • Guideplates • QA/QC programs • Workforce Training • Validation
Activation and Operation	• Sustainable platforms	• Operational Policies • Meaningful and reportable performance and measurement criteria • Trained Workforce • Investment re-validation and re-evaluation

4.3 THIRD RECOMMENDATION: Explicitly link flexibility with sustainability/high performance buildings, especially as the Medical UFC relates to the new DOD UFC 1-200-02 – High Performance Buildings

Our third recommendation 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.

a. A flexible site plan incorporating planning mechanisms that address long-term site utilization criteria will reduce resource waste, decrease operational disruptions and suboptimal use of permanent infrastructure investments (footnote UFC for Master Planning – https://portan.navfac.navy.mil/portal/page/portal/navfac/navfac_ww_pp/navfac_hq_pp/navfac_bdd_pp/au_criteriamgmt)
b. Flexible facilities will reduce barriers to the delivery of evolving world-class healthcare, and thus reduce barriers to continuing high performance.
c. Flexible facilities will deliver optimal performance when the design of parts with long-lasting utility value (e.g. building structure and geometry) is independent of the design of parts with shorter-term utility value (e.g. functional / departmental layouts and equipment; or mechanical, electrical and plumbing systems).

4.4 FOURTH RECOMMENDATION: 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. As part of facility management practices, this could be a metric that can be used to assure proper protection of investments, especially those designed as high performance facilities.

This tracking could become a valuable metric that illustrates the phenomenon of growth or change, and how the asset behaves over time. DMLSS or other 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. Such studies have been planned in the past, including the VAHBS, and the GSA/PBS "systems building" initiative (see appendix), but such studies – nor tracking facility behavior over time - have never been implemented.

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. The design of the study should focus on the technical response to growth and change over time and include the performance characteristics of the physical asset, how its parts change, how much it costs to make the changes, all compared against the mission migration of the institutions.

4.5 FIFTH RECOMMENDATION: 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 flexibility decision-making control, an alternative acquisition methodology should be tested. As suggested in items 9) and 10) in the performance requirements recommendations (section 3.2 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 conventionally 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 been separated into two basic "levels of investment intervention" or contracts, following requirements development and planning and investment approval (CIDM):

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

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 readyness.

This procurement typology has been accomplished in the now-current practice (implemented only within the past two years) by decoupling the decisions about medical functionality (embedded in equipment) from the building requirements. In this process, the facility is seen as "fixed" (given) while the equipment is "variable" (still to be specified). That is, decisions about equipment do not drive the design of the building. Instead, the building offers spatial and technical capacity to accommodate a range of 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) buried in such walls or hidden above the ceilings. Making this 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 current one-step "all-at-once" process of acquiring the building 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 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, egress systems, 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 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:

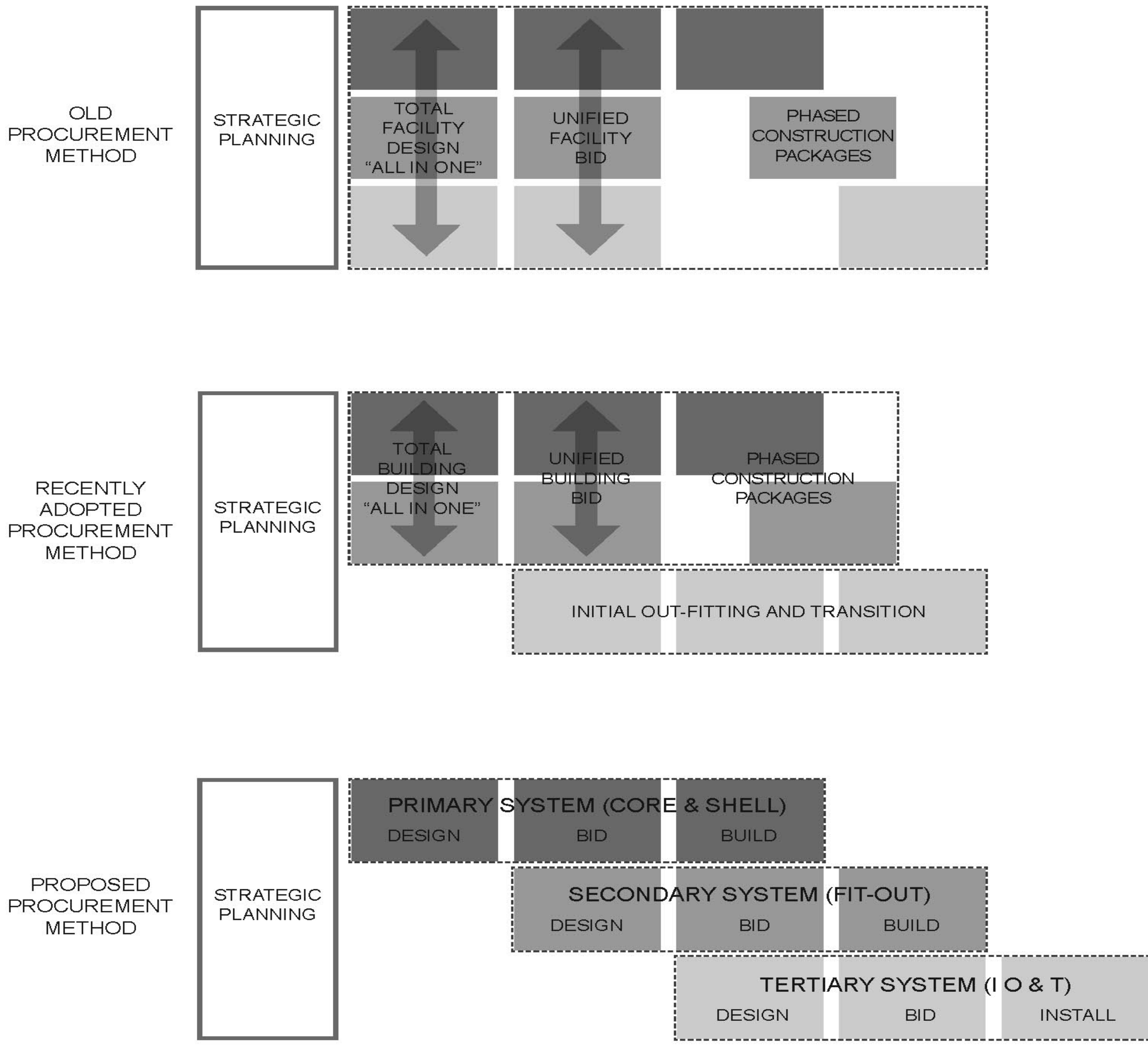

Figure 1: Proposed evolution of acquisition methods

Figure 1 is based on a design – bid – build approach, but the use of a design-build approach is also possible (and is indicated by a dashed line surrounding the design-bid-build boxes). An example of this acquisition process is already in use in the Canton Bern (Switzerland) office of Properties and Buildings (and presented at the June 20 Policy Seminar):

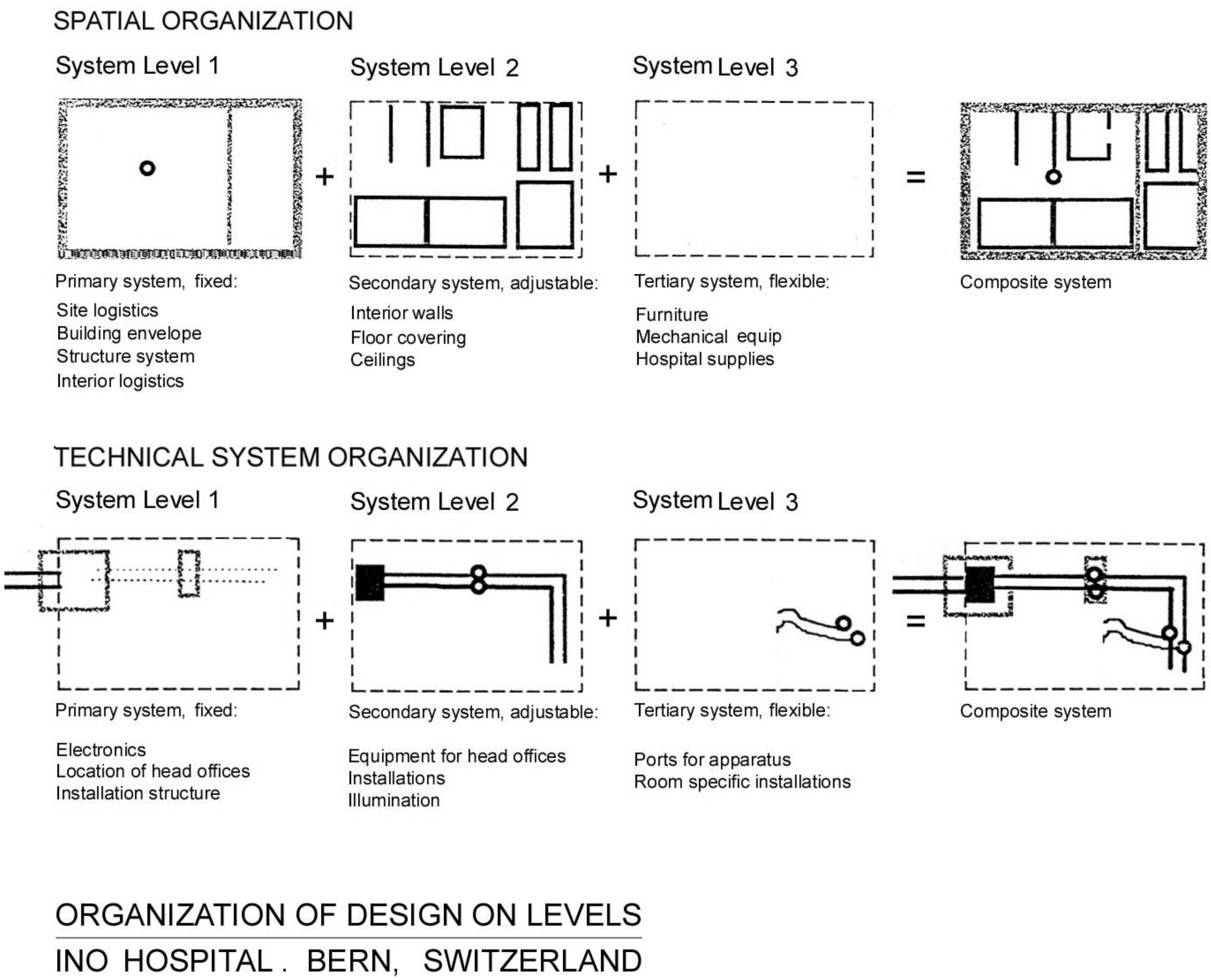

Figure 2: SYSTEM SEPARATION - Courtesy Canton Bern Office of Properties and Buildings.
System Separation is used in the acquisition of all buildings in the Canton Bern portfolio, and is applied in new construction and the renovation of existing buildings. It is also being extended to apply to the master planning of large complexes of buildings such as university and hospital campuses.

Replacement of the "all-at-once" process by the MHS and their acquisition agents – the Corps of Engineers and NAVFAC – reduces the dependency of the owner on unevenly prepared A/E service providers to assure that the facility will perform according to the required flexibility criteria. The organization of facility acquisition as described in Figures 1 and 2 would give MHS more control. It would assure optimal timing and maximum flexibility of decisions and technical solutions, during the acquisition period and over the life of the facility. The result of adopting this process will be greater consistency in flexible facility performance across the MHS portfolio.

5 Defining flexibility

5.2 Introduction and overview: Key findings from the questionnaire, literature review and Policy Seminar

Findings include:

a) Flexibility has been a goal for at least 60 years;
b) The most basic definition of flexibility for buildings suggests that buildings should be prepared for change;
c) The kinds and frequency of change, responsibilities for and causes of change remain ill defined with no shared data, metrics or accounting.

Webster's defines flexibility: "characterized by a ready capability to adapt to new, different, or changing requirements."

The term "flexibility" is a term in currency today in the healthcare sector – and has been for at least 60 years. For at least this long, both healthcare organizations and technical service providers have attempted to describe and frame solutions to the widely experienced problem that evolving practices of healing and healthcare are not well matched by correspondingly evolving healthcare facilities and decision-making processes. Despite the lack of a common definition, most facilities housing healing and healthcare functions face difficulties in adapting, too often producing a mismatch between the requirements for caregiving and the physical asset in which these functions are performed.

Based on the literature research (see appendix), interviews with key thought and practice leaders (see list in the appendix) and a survey of healthcare organizations, architects and engineers, consultants and medical equipment planners - public and private - all with substantial expertise in the field (see appendix), the research found that the term "flexibility" has no sufficiently focused definition. Congressional appropriators, MHS and TMA management, the architects and engineers who are asked to design healthcare facilities, and the facilities managers who must guide facilities through various cycles of transformation and adaptation use ad-hoc definitions. Further, "flexibility" has focused on technical or "hardware" solutions. While important, such solutions - if too narrowly construed - may push to the background the broader, and ultimately more important problems having to do with decision-making and design processes addressing uncertainty, and ways of acquiring and operating capital assets over time under conditions of highly disaggregated patterns of control.

5.2 Sample of definitions from major sources

1. Hattis, David B. The performance concept and health facilities 1973
   Flexibility is defined as "the ability to adapt to changing and often presently unknown needs over the life of the building". (Page 4)

2. Documentation and Assessment of the GSA/PBS Building Systems Program: Background and Research Plan (NBSIR 83-2662). Office of Design and Construction Public Building Service General Service Administration, February 1983.
   Flexibility is considered an "amorphous term" that means "relocate-ability of functions, or their expandability". (Page B-7)

3. Kurmel, Thomas David, Projecting building technology for hospitals: a study of growth and change in diagnostic imaging, Harvard University Graduate School of Design Dr. Des. Dissertation, 1991.
   Flexibility means: " to accommodate unforeseen change, growth, and new technology."

4. National Research Council. *Fourth Dimension in Building: Strategies for Avoiding Obsolescence*. Washington, DC: The National Academies Press, 1993.
   Flexibility is defined as the ability to readily accommodate changed uses, more intense uses, and new service systems (Page 40-41)

5. Battisto Dina, Hospital Clinical Laboratories are in a Constant State of Change", Clinical Leadership & Management Review, March/April 2004.
   Flexibility is intended as the ability to support evolving technological processes. (Page 96)

6. Barlow, James and Köberle-Gaiser, Martina, *Adaptability and innovation in healthcare facilities*, The Howard Goodman Fellow Report, The Health and Care Infrastructure Research and Innovation Center (HaCIRIC), 2007
   Flexibility is defined as the potential to accommodate future changing needs.

7. Latimer, H. Scott, *Analysis of Hospital Facility Growth: Are We Super-Sizing Healthcare?* HERD Health Environments Research & Design Journal, Summer 2008, Vol 1, No. 4,
   Design for flexibility is defined as improving space's capabilities or functionality by increasing the size.

8. De Neufville; Richard, Lee Yun S.; Scholtes Stefan, *Flexibility in Hospital Infrastructure Design*, IEEE Conference on Infrastructure Systems, Rotterdam, November 10-12, 2008. Flexibility means adaptability to unpredictable changing circumstances. The authors suggest a categorization of flexibility as strategic, tactical and operational. Strategic level of flexibility allows altering the size or usage of a building. Tactical level of flexibility is characterized by flexible design of footprints and operating theatres. Operational level of flexibility allows a daily or weekly basis usage, and can quickly adapt the infrastructure usage to deal with short-term volatility.

9. National Institute of Building Sciences, *Report of the Task Group for innovative future building environments for VA healthcare delivery*. United States Department of Veterans Affairs. Washington DC, December 5, 2008. Flexible refers to the ability to accommodate changing needs, programs and uses over time. (Page 6)

10. MHS website (last accessed June 2011)
    …Flexible building systems and utilities infrastructure to easily adapt spaces to accommodate new and emerging technologies, medical practices or surge capacity needs.
    https://www.mhsworldclassfacilities.org/home/knowledge-center/mhs-guiding-principles/

    Flexibility: to accommodate future changes
    http://www.wbdg.org/ccb/DOD/UFC/ufc_4_510_01.pdf (Page 17)

    https://www.mhsworldclassfacilities.org/home/Criteria?page_id=396
    http://www.tricare.mil/ocfo/_docs/20100902%20World-Class%20Lifecycle%20Report%20-%20Objective%20Oriented.pdf

5.3 Flexibility Lexicon

This report proposes a new lexicon of requirements – or 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 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

6 Current approaches and best practices

6.1 Findings

Based on interviews, literature research and the questionnaire, the research findings in respect to "best practices" in both the public and private sector include the following points:

a) Architectural strategies for flexibility are applied in some cases, but generally are not applied as "standard best practice solutions;"
b) Decision making strategies and financing models for flexibility are not well understood or applied;
c) Discussion about flexible healthcare facilities is insufficiently linked to the practice or policy debates about sustainability;
d) Exemplary projects exist (in the opinion of the research team), but are poorly documented and lack a theoretical framework for discussion/assessment;
e) Little is known about how healthcare facilities behave over time; There is no evidence that any public or private healthcare facilities in the US have undergone longitudinal cost or change assessment; the research could find no empirical evidence that healthcare facilities with so-called flexibility characteristics actually support the delivery of higher quality services than facilities that do not have these flexibility features.
f) The only exception we could find was a Dutch study that found that the cost of spatial adjustment of the analyzed hospitals after 20 years was an amount in the order of half of the original investment (see appendix)

6.2 Request for information

The research team requested from a number of high-profile architecture firms and healthcare organizations the following information on healthcare facilities projects that they deemed to be "flexible" and that have or are anticipating some level of change:

1. Site plan showing current buildings and site logistics, circulation, MEP spines, and planned expansion zones
2. Several illustrative floor plans (which complement the requested diagrams (5 below) showing how the building is prepared for future change)
3. Cost as constructed (total + breakdown by
    a. a) Core and shell;
    b. b) Fit-out including fit-out related MEP systems;
    c. c) Medical equipment and other fixtures not included in the fit-out;

4. Cost of renovations/alterations/expansions at any of the four levels of work noted below in item 5;
5. Diagrams of “flexibility strategies” at the following planning levels:
    a. **Site** (indicating “zones” of expansion, vertical and/or horizontal)
    b. **Core and shell or base building** (including structure, envelope, main MEP risers, primary vertical/horizontal circulation, etc);
    c. **Fit-out** including departmental layouts, main corridors, MEP flexibility strategy going with the specific layouts;
    d. **Equipment** flexibility (e.g. how an acuity adaptable room can accommodate various equipment; or how a surgery suite can accommodate new equipment as it comes available without changing the room itself).

6.3 Matrix of Best Practice Cases of Flexible Healthcare Facilities

Appendix 8.3 includes selected best practice cases of flexible healthcare facilities - in both the public and private sectors, in the United States and Europe. Only some of the information requested was received; thus the cases shown in the appendix are not exhaustively presented.

INO (Kamm Architects + Canton Bern OPB)
Martini (NL – Burger Gunstra Architects)
Dartmouth – Hitchcock Medical Center (Shepley Bulfinch)
Mayo - Gonda (Elerbe Becket)
Banner Estrella (NBBJ)
Spring Hill Baptist Health Medical Center (HKS)
Denver VAMC Project Eagle (SOM) (under construction)
Universal Grid Theory (Cannon Design)

	Horizontal expansion (or contraction)	Vertical expansion	internal structural walls	Floor-to-floor height	Building geometry	Floor loading capacity	Shell space	% set-aside	System Separation
INO	yes	yes	yes	yes	yes	yes	yes	yes	yes
Martini	yes	NA	yes	yes	yes	NA	NA	NA	yes
Dartmouth-Hitchcock Medical Center	yes	no	yes	yes	no	no	no	no	NA
Mayo Gonda	no	yes	yes	yes	yes	yes	yes	no	yes
Banner Estrella	yes	yes	yes	yes	yes	NA	yes	no	yes
Spring Hill Baptist Health Medical Center	yes	yes	yes	yes	no	NA	NA	no	yes
Denver VAMC Project Eagle	yes	no	yes	yes	no	yes	NA	NA	yes
Universal Grid Theory	yes	yes	yes	yes	yes	yes	NA	NA	yes

7 Cost of flexibility

7.1 Findings

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;
b) The relation between the cost of flexibility strategies (architectural and decision making) and operational costs of healthcare facilities is not well understood;
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.

We recommend, as noted above:
1. **Further development of the cost model 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.

7.2 The cost of flexibility

One of the arguments against flexibility is that it costs more, which depends entirely 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 building designs have inherently higher first costs has never been substantiated, nor has the counter argument.

Because there is no standard way of defining flexibility, there is no way of demonstrating the economic value of flexibility in comparing systems designs. (de Neufville et al, 2008) Other governmental agencies (the VA and the GSA) have no record of analysis of the return-on-investment of flexibility strategies they have put into place.

While there is a growing body of research (now known as “evidence based design”) to track the behavior of human subjects over time to understand the effects of various diseases and medical interventions, the same is not the case with the facilities in which these medical interventions are performed.

A key finding is that preoccupation with cost control, rather than delivery of value, may inhibit the acquisition of flexible healthcare facilities. If “value” is defined as a benefit-cost ratio, then current practices that focus on minimizing cost will not address well the maximization of benefits. (de Neufville, et al, 2008) In order to fully understand how the MHS investment for flexible buildings has “paid off,” a study should be initiated as recommended in order to track changes, then study the value of the investment. The MHS owns and operates several so-called “flexible” buildings that could be studied, including Madigan, Norfolk, Fort Bragg, Fort Sill, and Fort Sam Houston.

7.3 Cost Modeling Workshop

On May 31-June 1, a two-day cost modeling workshop was conducted at the NIBS office. It was led by Karel Dekker, KD Consulting, Voorburg, The Netherlands. **A full report on the Cost Modeling tool is included in Appendix 9.4.**

Attendees

Karel Dekker, Workshop Leader
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8 Conclusions

This research concludes that three realities of MHS healthcare facilities and the current processes used to acquire and manage them must be recognized, so that the lessons learned from them can be successfully translated into new policy and criteria.

1. MHS healthcare facilities are never finished, are almost always acquired with the expectation of a long useful life, but lack enabling management and design processes for the purpose of specifying and obtaining flexible (sustainable) facilities congruent with this reality. In other words, the MHS is unable to prove that it got what it paid for. The MHS also lacks organizational clarity about flexible asset or infrastructure performance either in policy or practice. The inability to validate the value of investments in general is a barrier to the development of the business culture that a high performance asset management team needs, to extract the most value from its investments and in turn to gain value from the processes used to acquire and manage them.

2. The recently implemented MHS management practice that separates the IO&T from the acquisition of the facility is the basis for taking the next step in acquiring flexible facilities. A further two-part delineation of decision-making, representing two basic lifecycle stages of a building (as is current practice in the commercial real estate market) would enable better control of the planning, acquisition and outcome of flexible facilities. Implementing this two-step process would also allow the possibility to revalidate the intent of the original statement of need developed early in the planning phase. This deliberate built-in revalidation step would also enable a separation of acquisition funds into more defendable and therefore executable appropriations, provide more specialized contractors for each stage of work, and give the DOD the opportunity to adjust the requirements "on-the-fly." The next step is therefore an evolution of rather than a departure from current practice.

3. MHS is responsible for developing the vigilant business culture dedicated to acquiring and managing flexible facilities, and is well positioned to take the needed steps to meet this challenge. The means to accomplish this are clear: MHS must assume the responsibility and the leadership of articulating a clear set of flexibility criteria, management and cost modeling tools that enable MHS personnel to properly management design and construction service providers in bringing on-line facilities designed according to the cycles of change – short (1-3 year), middle (15-25 year) and long-term (50 – 75 year) – that are intrinsic to MHS facilities.

9 Appendices

9.1 Annotated literature review
9.2 Questionnaire, list of recipients and results
9.3 Best Practice Cases of Flexible Healthcare Facilities
9.4 Cost Modeling Workshop
9.5 Policy Seminar Summary
9.6 GSA/PBS Peach Book review

9.1 Annotated Bibliography

Books

1. Giedion Siegfried, *Mechanization Takes Command*, Oxford University Press, New York, 1947
The author had inquired what mechanization is doing to man, and in particular the timeline evolution of it from different points of view: means used in agriculture, furniture, mechanization in household, the mechanization of the bath. *Flexibility, based on its mechanical connotation referred to interconnection, is defined as the capacity of one member in motion to set the whole system in motion.*
2. Habraken, N.J.Supports: *An Alternative to Mass Housing*. Second English Edition, edited by JonathanTeicher. Dutch edition, Scheltema & Holkema, 1961; First English edition, Architectural Press, London, 1972, U.K. Urban International Press, 2011.
This book, first published in Dutch in 1961, and in English in 1972, was the first to declare that the conventional attitudes and methods of professionals about the design of environment were wrong. By ignoring change and the user's evolving preferences, professional methods were producing rigid environments that soon become dis-functional and worse. *The book lays out a critique of traditionally technical concepts of flexibility, arguing that the question of who controls what is more central.* The book challenged professionals – architects, managers, financers, regulators – to rethink decision-making, production, and the relationship between all the parties involved in producing built environment.
3. Schon, Donald A. *Technology and Change.* New York: Delacorte Press, 1967.
The author analyzed the technological change, presented as a form of progress, in American Industry and its impact on American society. The book introduces some concepts that might be things to ponder and to relate to the concept of flexibility. In chapter two, *Innovation, Uncertainty and Risk,* he speaks about marketing and costs. He suggests that it is necessary to have info about the clients' culture and attitudes to create a successful product. *Relating this to flexibility, is a product flexible if it is adaptable to the different culture of people? The cost of innovation chart has an S shape, what is the shape of cost of flexibility?* Additionally the author introduces the process of planning.
4. Propst Robert, *The office: a facility based on change*, The Business Press, Elmhurst, Illinois, USA 1968.
The author introduces in this work his thoughts on what the office should and could be. Propst began by studying what happens in the office and how it evolved. He found that offices had become "wasters of effectiveness, vitality, health and motivation," according to Propst, largely because of their inability to handle change. In this book he suggests new rules for the office. Primarily he suggests a "forgiving behavior" in facility design to face the complexity of organizations and the environments in which they operate, and the unpredictable course of future directions. Secondly he proposes the idea of "grace with change". One of the opposition to change is the disturbance it brings to our life. He wrote we should to change with ease and to achieve a well-selected and determined solution. The last rule is about planning. He realize the increasing diffusion of the phenomenon of obsolescence: "the phenomenon of our age is that almost everything planned for our use is obsolete in capacity or function before it reaches our hands." He suggest to plan to "reach implementation early enough to serve the original needs." Finally he recommends two factors to stabilize the effect of change: modularity and commodity.

5. Russell Louise B, *Technology in Hospitals: Medical Advances and Their Diffusion*, Washington, DC: The Brookings Institution, 1979.

   This study has examined seven hospital technologies that have wrought major changes in hospital practice starting from the 60's. Each technology has been studied in detail, combining a case study of its use and cost with statistical analysis about the distribution and benefits. Overall, the book shows when new equipment was adopted and how fast they evolved.

6. Toland Drexel, Strong Susan. *Hospital-Based Medical Office Buildings*, Chicago, American Hospital Association, 1981

   Since 1950 a major trend in medical practice has been to cluster physicians' offices around hospitals and to create hospital-based medical office buildings. Many of these buildings have been sponsored by hospitals themselves. Not since 1959, when Rosen's monograph Physicians' Private Offices was published and it was addressing this subject specifically. Toland's book is mainly concerned with medical office buildings operated under the control of a hospital, with the needs of the hospital, medical staff and community in mind, in contrast to those developed primarily as commercial real estate ventures. According to Drexel the concept of flexibility of space utilization is strongly related to the ownership. He wrote: "other forms of ownership provide varying degrees of flexibility". He brought the example of a condominium as the poorest level of flexibility due to its rigid ownership structure. While hospitals could maintain flexibility almost equal to that provided by hospital ownership, but at a slightly higher price, through a lase-back agreement with a partnership or third-party owner.

7. Russell Barry, *Building Systems, Industrialization, and Architecture*, London, Wiley, 1981

   The central thread of this study is the method of industrialized mass production to the building process. This book offers some explanation for the recurring efforts to create building systems. Some of the possibilities suggested by the increasing body of knowledge around the general system theory itself are here examined but only in so far as they offer a proper context for the ideas being discussed. It argued that building systems have often developed in contradiction to the central notion surrounding systems theory. This phenomenon is not confined to architecture but can also be seen in system engineering: indeed it is more to this latter field that architecture appears to have looked for its model.
   Flexible system is not "interpreted as the ability to make frequent or rapid changes within the building envelope but much more it was seen as removing one of the main obstacles to planning freedom and allowing each building to be individually tailored to its site".

8. Ranko Bon. *Building as an Economic Process: An Introduction to Building Economics,* Englewood Cliffs, New Jersey: Prentice-Hall, 1989.

   The key issues of building economics in the context of the theory of capital and the theory of economic fluctuations or business cycles are explored in this book. The author suggests to shift from an old focus on the building economics that emphasized the building investment, to a new focus on building utilization and operation. The author argues that one of the reasons to adopt this change is that the "share of so-called maintenance and repair construction, including rebuilding in all its forms, is increasing". The author is facing the concepts of maintenance, replacement of building components (technical change) and obsolescence. He affirms that architect and engineers designers should "provide for future decoupling of building components needing replacement" by avoiding to affect the building utilization and operation. In doing this they should consider both physical and economic implication of building component decoupling. By referring to Habraken's approach to building design, Ban wrote "the expected life cycle of a building component, together with its interaction with life cycles of related building components, is therefore one of the most important consideration in its design or selection".

9. National Research Council. *Fourth Dimension in Building: Strategies for Minimizing Obsolescence*. Washington, DC: The National Academies Press, 1993.

   The book deals with the concept of obsolescence. It try to reply to the questions: what obsolescence means, when and why obsolescence occurs, and how to minimizing obsolescence. According to the book, if obsolete, the property value of a building may decline; additionally the environment might become unsafe. Hence it suggests to anticipating and accommodating changes.

10. Brand Steward, *How Buildings Learn: What Happens After They're Built*, Chapter 11 - The scenario-buffered Building, Viking Press 1994.

    The author defines the future as "unpredictable" and "perverse". He suggests to adopt a scenario planning based on strategy and not on prediction. The scenario planning starts with programming. In this phase architects figure out different scenarios (variables: driving forces, numbers of occupants, needs, etc.). The main idea is to avoid a plan, but adopt an adaptive strategy. The author intends flexibility as a combination or division of cellular elements or unit.

11. Miller Richard, Swensson Earl. *Hospital and Healthcare Facility Design*, New York City, W.W. Norton & Company, 1995.

    The authors recognize and document in this work the new directions in hospital and healthcare facility designs. They provide an historical prospective about hospitals and their design in the past. Through the observation and discussion of these trends they come out with reasonable inferences. A section in the third chapter is dedicated to the concept of flexibility. Here the authors define flexible design ("creating facilities that can be quickly, economically, and repeatedly retrofitted and reconfigured") and recognize in the concept of flexibility both a technological meaning and a space meaning. Indeed they state "the need for flexibility is further intensified by the technological nature of the healthcare industry" and " facilities must anticipate the physical demands new technologies may make" then they add "the need for flexibility in design, for spaces that can be expanded, or shrunk as needed".

12. Dilani Alan, *Design and Care in Hospital Planning*, Stockholm, Karolinska Institutet, 1999.

    This work analyzes the strategies, criteria and basic idea that are applied in hospital planning in the late 90's. The thesis has three level of analysis. The first focuses on the architectural development of the hospital from an overall historical perspective. The second is the analysis of nine nursing wards with an emphasis on the aspects of local environment. The third is an analysis of the planning of the University Hospital in Trondheim, RIT 2000, as case study of a contemporary hospital planning. The author's goal is to illustrate the problems involved in the planning and production of a large hospital when dealing with it from a holistic approach. The concept of flexibility with the meaning of rebuild-ability is used as criteria to analyze the design of the ward.. A flexible ward is "planned and built with consideration to future change in activity, and it should be possible to make alterations without major rebuilding operation".

13. Verderber Stephen, *Healthcare Architecture in an Era of Radical Transformation.* New Haven and London: Yale University Press, 2000.

    This book explores the transformation through the centuries of acute care hospitals, psychiatric facilities, retirement communities, and community clinics. The author identified six periods in the history of health architecture: the ancient, the medieval, the renaissance, the nightingale, the minimalist mega-hospital, and virtual healthcare. Verderber introduces the concept of flexibility as a way to manage the unpredictability and the facility's obsolescence when describe the "interstitialism." Several hospitals designed by adopting this system are cited and described. According to Verderber the plan of a hospital is flexible if it is adaptable to change and free to grow in the future.

14. Miller Richard, Swensson Earl. *Hospital and Healthcare Facility Design*, New York City, W.W. Norton & Company, 2002.

    This new edition of the book expands coverage of the timely and important topics covered in the previous edition, such as women's and children's healthcare and care for the elderly. New case studies and updated text show the evolving world of healthcare. The same words are used to define flexible design.

15. Verderber Stephen, *Compassion in Architecture: Evidence-based Design for Health*. Lafayette: Center for Louisiana Studies, 2005

    The book introduces the findings of an evidence-based research focus in Louisiana, the first state in United State to adopt an evidence-based facility improvement strategy for its public healthcare network. Eight case studies are presented. It also proposes a set of recommendations, graphically explained, to lead design decisions.The word flexibility is used by referring to the change of technical aspects and to the room size. Verderber speaks about "flexivity" alluding to a transformable "partì" able to take on any number of alternative shapes, from linear to curvilinear, re-configurability" (P.155). He describes the meaning of "flexivity" as "intake, each office provide space for transactions that occur between the patient, and the intake clerk. Walls are demountable and re-deployable, as needs dictate. Examination Rooms similarly are adaptable to seminar rooms for up to ten person, convertible with the aid of mechanical activated, moveable acoustic/visual screens" (P.159). *He states: "flexible space are required to support changing uses in light of the range of new programs"* (P.234).

16. Ellingham Ian, Fawcett William, *New Generation whole-life costing: Property and construction decision-making under uncertainty*, New York, Taylor & Francis. 2006

    New Generation Whole-Life Costing presents an approach to decision-making and risk management for construction and real estate. It applies the options-based approach that has revolutionized the management of uncertainty in the business world. This work introduces the idea of "lifecycle options". The idea of whole-life costing is spread, but take-up levels have been low. The authors indicate as problem the traditional techniques that fail to take account of future uncertainty. In contrast, the new options-based approach considers a diversity of possible futures, and favors flexible strategies that incorporate lifecycle options. This approach leads to more cost-effective and sustainable decisions, minimizing the risk of under- or over-investment. This book presents case studies that demonstrate the major use of lifecycle options. *The word flexibility is here used with the meaning of adaptability (referred to the layout of machinery and storage, and demountable partition and their different configuration), and it is related to the concept of obsolescence. Additionally the rise the question " How much is it worth paying for flexibility which may never be used?" without suggestion any quantifiable cost because it is not clear how to justify the costs for flexibility*.

17. *The transformation of healthcare*, TNO, 2009

    This book reviews the competition commissioned by the founded Dutch Center for Healthcare Assets in 2009. The competition is meant to be part of an ongoing debate on the theme of transformation of healthcare and hospital sites in central and Eastern Europe. Themes that were specifically addressed in the assignment were: urban integration, patient environment, logistics, flexibility, environment and economical feasibility. Each group gave its own interpretation to the concept of flexibility. In one case the program could be transformed by the flexibility of the structural frame inspired by the open plan, one group faced the flexibility by designing for future expansion, another group designed "flexible space-structure in the long run".

18. Verderber Stephen, *Innovations in Hospital Architecture*. London: Routledge /Taylor & Francis, 2010.

The idea behind the book is a retrospection of the events that characterized the first decade of the new century. The book is divided in three parts: background, design, and case studies. In the first part the author introduce the evolution of the hospital building type then he focus on the patient room. The second part is an analysis of the schematic design. Here he mentions the concept of adaptability, but never flexibility – except as referring to "the interstitial movement." In the third part the author analyses case studies in relation to a five-part architectural typology: autonomous community-based, children's care centers, rehabilitation and elderly care centers, regional medical campuses, prognostications.

Technical Reports

1. Hattis, David B. The performance concept and health facilities 1973

Hattis in his work inquired and defined the concept of performance, that is generically defined as the concept which approaches systems as any kind by considering their inputs, context and output. Hattis consider the concept of flexibility an important aspect to consider as input into the building process to improve the quality, hence the performance. Flexibility is defined as "the ability to adapt to changing and often presently unknown needs over the life of the building".

2. Fleming Harold P., Hollander Gerald M., *The cost of interstitial space - Internal VA report,* Washington D.C., April 1981.

This study shows that there is no premium cost for a well-designed systems integrated hospital with interstitial space.

3. Carrington D., *White paper: study of VA Design and Construction Requirements to Reduce the Cost of Facilities*, Internal VA technical report, January 1988.

This report is an overview of the study conducted by Smith, Kroach, Hayet and Haynie. They performed a critical review, analysis, and evaluation of the VA's policy documents governing the design and construction of its facilities. Carrington in its report focuses on the key observations and conclusions about VA hospitals, VA nursing homes and cemeteries.

4. Hughes John, *William M Keck Science Building Post-Occupancy Evaluation,* Stanford University, January 1988

The author wrote this report for three purposes. The first was to document what was reported by occupants of the building, the staff that service and maintain it, and the project team that worked with the consultants to design and built it. The Second was to summarize for senior officers the overall success of the project. The third was to educate those working on facilities projects by describing in some detail the performance of the building in functional and human terms and strengths and pitfalls of the fast-track design building process.

5. Smith W. Mason, Nothnagel Frederick W., *Case study: Dartmouth Hitchcock Medical Center, Lebanon, New Hampshire,* (Undated technical report)

This report informs about the people involved in the project, project schedule, gross square ft, technical information and construction cost. The program planning and schematic design phase are described.

6. Ott Guy, *FHCRC Board of directors steering committee*, NIH National Institute of Health, Washington D.C., May 1990

This report explain what an interstitial building is and why it seems useful, the initial capital cost and the cost implication associated with development of an interstitial building, and how these costs are mitigated during the construction phase.

7. McKenzie Margaret, Building cross-section study of interstitial hospitals constructed by the VA 1976-1995, Washington D.C., 1996.

   Eighteen of VA interstitial hospitals showing the schematic building cross-section, indicating vertical dimensions, construction system, the architect and year of construction.

8. Kendall Stephen, A Research Program to Document Change in Hospitals, Ball State University (unpublished study) 2002-2005.

   This document suggests open buildings as a systematic approach to design change-ready hospitals and some methods to document how hospitals change. Flexibility and long-term capacity for change are intended as principles of "open building".

9. Creating Change – Ready Hospitals. Think tank summary report. Boston, MA. April 7-8 2008 (unpublished report)

   This repost mainly focus on design for changes by anticipating them. Flexibility is intended as "change ready". Additionally several concepts related to flexibility are mentioned: obsolescence, building life cycle, cost, adaptability, evidence-based design. According to Stephen Tarnoki (University of Chicago): design for flexibility is possible by designing more " generic in order to hedge against any shift in strategy or market dynamic".

10. AIA/ACSA Council on Architectural Research – Health Facilities Research Program, Reducing the Cost of Health Care Delivery Through Improved Facility Design, Robert Wood Johnson Foundation, Princeton, New Jersey. (undated)

    This report is a proposal for a phase 1 of a multi-year program of research on reducing the cost of healthcare delivery through improved facilities design. The goal is an economics-based methodology for making investment decision affecting the design, construction and/or renovation healthcare facilities. The phase 1 is establishing the proof-of –concept for the methodology, assembling the data base to be used in subsequent phases, and develop a comprehensive, detailed plan for research activities in these future phases.

Thesis dissertation/scholarly papers

1. Wiedemann, Gregory C. Design for Flexibility, Adaptability and Growth. Report on Frederick Sheldon Traveling Fellowship. Harvard Graduate School of Design, 1978.

   In his thesis, Wiedemann evaluates the design strategies of two UK hospitals based on a detailed study of patterns of change in each hospital. Specific design strategies are linked to each type of change outlined in the first section. An attempt was made to generalize design strategies that would be appropriate to the patterns of change evident in many building types.

2. Kurmel Thomas D., Madigan Army Medical Center Design and Construction: a case study in Building Technology, Laboratory for Construction Technology, Graduate School of Design, Harvard University, Cambridge, Massachussetts. 1990.

   The case provides some background on the concept of integration of building components in order to provide a flexible system for change. It also describes one form of integration and its use in the design and construction of a major medical center complex.

3. Kurmel Thomas D., Projecting Building Technology for Hospitals: A Study of Growth and Change in Diagnostic Imaging, Doctoral Thesis, Graduate School of Design, Harvard University, Cambridge, Massachussetts, 1991.

This thesis examined one aspect of the medical-building technology gap by comparing 90 years of development of medical and building technologies in the diagnostic imaging departments of three Harvard teaching hospitals. Design for flexibility means “accommodate unforeseen change, growth, and new technology”.

4. Rab Shahid, An Investigative Study of the Veterans Administration Hospital Building System (VAHBS), The Catholic University of America, Washington D.C. 1993.

   This work in part cover a lack of a comprehensive and comparative analysis of the hospital designed by using VAHBS. He considered as case studies 10 hospitals built between 1974 and 1988. The evaluation criteria were: cost control, coordination, adaptability, time reduction, long-range development, avoidance of interruption, and modularity. The results show that the VAHBS gave impressive cost performance and the ability to accommodate new developments in medical and building technologies.

Conference proceeding

1. Kendall, Stephen (ed). *System Separation: Open Building in the Inselspital Bern, INO Project. A Symposium focused on the INO Hospital Project New Center for intensive care, emergency and surgery*. Office of Properties and Buildings, Canton Bern, Switzerland, July 11-12, 2006.

   This monograph offers a compilation of information, commentary and recommendations gained during the symposium, organized to discuss the “System Separation” approach to facility design, a process developed and implemented by the Office of Properties and Buildings of the Canton of Berne (OPB). During the Symposium, comparisons about hospital design and procurement processes were made across national borders. It was inevitable that a variety of building cultures would be revealed. These differences and similarities also had to do with the kinds of organization participants represented, having different time horizons governing decision-making. In conclusion there was near unanimous agreement that the System Separation approach was noteworthy in its precision, rigorous in its systematic organization, innovative in its complete transformation of practice, and valuable for its potentiality to achieve long-term value in built environment.

2. Neufville Richard, Lee Yun S., Scholtes Stefan, *Flexibility in Hospital Infrastructure Design*, November 2008

   The authors state that flexibility is a significant value for hospital infrastructure due to the unforeseen-ability of healthcare demand on the infrastructure and show this through a case study (Addenbrooke’s Hospital, Cambridge University). It’s authors opinion that an hospital infrastructure is flexible if it is able “to allow effective adaptation to unpredictability changing circumstances”. Then they suggest a categorization of flexibility as strategic, tactical and operational. Strategic level of flexibility allows altering the size or usage of a building. Tactical level of flexibility is characterized by flexible design of footprints and operating theatres. Operational level of flexibility allows a daily or weekly basis usage, and can quickly adapt the infrastructure usage to deal with short-term volatility.

3. *Report of the Task Group for innovative future building environments for VA healthcare delivery*. United States Department of Veterans Affairs. December 2008

   This report briefly present the finding of the investigation, made by the task group, about the state of practice and art for high-performance, sustainable and flexible environment for healing. The task group suggests in this report a list of conclusions and specific recommendation including adaptability and care optimization (“provide more building environments that can flexibly accommodate and adapt to more optimized functional process and procedures”).

4. *The 100-Year flood: the economic crisis meet healthcare reform*. The American Institute of Architects, Kaufman, Hall & Associates, Chicago, 2009.
   The presentation is raising several questions about healthcare reforms in an economic situation of crisis. It suggests that it is a good momentum to approve them. So some of the questions are: what are the principles that drive the reforms? What are the fix and the variables key points? What are the consequences?
5. Hamilton Kirk, Design for Critical Care Facilities, Building for healthcare in 21th Century, http://muhc-healing.mcgill.ca/english/Speakers/hamilton_p1.html
   In this paper Hamilton focuses on the patient room, on its design and specialization. He discusses the unit size, geometry and the various type of life support systems currently in use. In his paper he define "adaptive flexibility" as "the ability to accommodate change without a physical change in the room or unit.".
6. Ginn Gregory O., and Ruby P. Lee. "Community Orientation, Strategic Flexibility, and Financial Performance in Hospitals." *Journal Of Healthcare Management* 51, no. 2 (March 2006): 111-121. *Academic Search Premier*, EBSCO*host* (accessed March 21, 2012)
   This paper observes how community orientation and strategic flexibility influence accounting measures of financial performance in acute care hospitals. The findings showed that the community orientation of a hospital had a negative impact on its financial performance. However, the strategic flexibility of a hospital with regard to structure and resources was significantly and positively associated with hospital performance. They define "strategic flexibility" as " the ability of an organization to respond proactively to changing competitive conditions and thereby develop or maintain competitive advantage".

Government documents

1. Building System Development, and Stone, Maraccini and Patterson. *Feasibility Study - VA Hospital Building System: Integration of Mechanical, Electrical, Structural and Architectural System in VA Hospital Facilities.* Project Number 99-R003, United States Veterans Administration Office of Construction, Washington, D.C., October 1968.
   This report consists of three parts. The first volume, Summary, includes a summary of the findings, alternative, approaches for program continuation, and a description of the nature, history and methodology of building system development. The second volume, Feasibility, includes the major areas of investigation that affected feasibility determination. The third volume, Sample Studies, is a collection of sample studies illustrating User Requirements, Contract Documents, and Performance Specifications.

2. Documentation and Assessment of the GSA/PBS Building Systems Program: Background and Research Plan (NBSIR 83-2662). Office of Design and Construction Public Building Service General Service Administration, February 1983.
   The report documents the origins and conduct of the General Services Administration/Public Building Service (GSA/PBS) Building Systems Program (BSP) undertaken during the 1970s and recommends a research plan for assessing the effectiveness of the BSP. This report is divided in two parts: a documentation section that is largely a historical narrative and an assessment section addressing issues of research method. During the BSP (1970s) flexibility " was understood to mean the rearrangement or re-subdivision of the large and undifferentiated volume of the typical office floors erected in the program". While in 1983,

according to this report, flexibility is considered an amorphous term that means "relocate-ability of functions, or their expandability".

3. Building System Development, and Stone, Maraccini and Patterson, *Application of the Principles of System Integration to the Design of the "Nursing Tower" Portion of a VA Hospital Facility (Phase 2),* Project Number 99-R042, United States Veterans Administration Office of Construction, Washington, D.C., February 1971

   This report presents the principles of the System Integration applied to design a nursing tower. The report is divided in three volumes. The Volume One, the Narrative Report, provides the background and history of the project, states its objectives and procedures, and presents conclusions and recommendations. The Volume two, the Design Manual, discusses the principles of system prototype design. The volumes three, the Appendices, presents the design rationale, cost and time analysis, and a discussion of building trade unions and industrialization. In the glossary "flexibility" is deemed a synonym of "adaptability" and defines as "the capability of a limited range of building components to be arranged additively to produce any overall dimension above a specified minimum on a specified module". "Adaptability" is defined as "the ability to respond to, or be readily adjusted to, changing conditions".

4. Building System Development, and Stone, Maraccini and Patterson, *VA Hospital Building System: Application of the Principles of System Integration to the Design of a VA Hospital Facility,* Project Number 99-R047, United States Veterans Administration Office of Construction, Washington, D.C., January 1972

   This report presents the principles of the Veterans Affairs Hospital Building System. It is divided in three volumes. The Volume One, the Design Manual, consists of a description of the Building System Prototype Design and suggests a general design procedure to utilize in a building project. Volume two, the Data Base, contains information on user needs, functional requirements, costs of existing hospitals, labor unions, and laws and regulations. Volume three, the Project Report, provides a summary, conclusions, recommendations, and diverse appendices (design rationale, example designs and service module, cast and time analysis, special procedures). The Veterans Administration in the late 60's was experiencing a set of problems such as rising costs, lengthy periods between programming and occupancy, accelerating obsolescence and inadequate building performance. To response of these problems the building system was developed. Flexibility is considered a synonym of adaptability and having alternatives. Adaptability is defined as "the ability to respond to, or be readily adjusted to, changing conditions.

5. Supplement to VA Hospital Building System, Department of Veterans Affaires, Offices of Facilities Management, June 2006.

   This supplement was edited 30 years after the publication of Research Study Report (Red Book) with the purpose to address the effects that the changes in technology, construction practices, and health care models brought on the VA Hospital Building System concept.

6. United States Government Accountability Office (GAO-07-408), *VA Health Care: VA Should Better Monitor Implementation and Impact of Capital Asset Alignment Decisions*, Report to the Ranking Minority Member, Committee on Veterans' Affairs, House of Representatives. March 2007

   This report show the extent to which the Department of Veterans Affairs' (VA) Capital Asset Realignment for Enhanced Services (CARES) process has been implemented and how it has contributed to its mission of providing health care services to veterans. In particular this work focus on how CARES contributes to Veterans Health Administration's (VHA) capital planning process, the extent to which the CARES process took in consideration alignment options, and the extent to which VA has implemented CARES decisions and how this implementation has helped VA carry out its mission.

7. United States Government Accountability Office (GAO-08-495R), VA and DOD Collaboration on Veterans' Care, April 2008

   This report describe the extent to which the Department of Veterans Affairs' (VA) and the Department of Defense (DOD) have implemented the recommendations of the 2003 President's Task Force to Improve Health Care for the United States' Veterans related to collaboration and coordination.

Research center reports

1. Griffin Charles William, *Systems an approach to school construction*, Educational Facilities Laboratories, New York 1972

   This report is describes some programs that attempt to improve the quality-cost ratio in school buildings. Educational changes have required new sets of spaces in schoolhouses, whose specifications, according to the author, could be met by changes in building technology and in construction management. Five successful cases of school construction using the systems approach are presented with the advantages of systems applications.

2. *Re-Envisioning the Acute Care Enterprise toward the Health System of the Future,* Innovation Center, DoD Health Facility Executive Steering Committee Meeting, The Advisory Board Company, Washington D.C. 2003.

   The report inquiries the trend of wards' growth (different or increase use, new technology adoption) to forecast facility investment required. Additionally it searches the perfect unit layout, by considering different concepts and blueprint and keeping in mind future growth. The report raises a list of questions about facility flexibility. The question are mainly about cost, growth, and how often changes are required.

3. *Future Proofing buildings for healthcare,* The NHS Confederation, Issue 9, June 2005

   This report explains the importance of planning for uncertainty and the spatial layout as a means to design flexible buildings.

4. *Building Differentiation of Hospitals: Layers Approach*, Netherland Board for Healthcare Institutions, Report Number 611. 2007

   In this report the Netherland Board for Healthcare Institutions (the NBHI of "Board") introduces the "layers approach" for considering investment decision for hospital. This approach is based on categorization of functions setting similar requirements for the building environment, for the purpose of optimizing the property.

5. *Adaptability and innovation in healthcare facilities: lessons from the past for future developments.* The Howard Goodman Fellowship report. The Health and Care Infrastructure Research and Innovation Centre *(HaCIRIC), 2008*

   The overall aim of the research is to explore the relationship between the Private Finance Initiative (PFI) delivery mechanism for healthcare infrastructure and the potential to accommodate future changing needs, especially through flexibility and adaptability in the built form. "Adaptability" was defined as the facility to accommodate changes of use or function, which result in the need to alter the building and its services physically or organizationally. The term "flexibility" is used as synonym of "adaptability".

6. Rechel Bernd, Erskine Jonathan, Dowdeswell Barrie, Wright Stephen, Mc Kee Martin *Capital Investment for Health: case studies from Europe*, European Observatory on Health Systems and Policies, Observatory Studies Series n°18. 2009

   This volume comprises 11 case studies from across Europe illustrating different aspects of capital investment. It offers policy-makers, planners, architects, financers and managers practical illustrations of how health services can be translated into capital asset solutions. Design for flexibility is intended as the design of the overall program that will facilitate "change in capacity, models of care, practice and technology, as well as optimizing the benefits of the initial capital investment over a long life".

7. Rechel Bernd, Wright Stephen, Edwards Nigel, Dowdeswell Barrie, Mc Kee Martin, *Investing in Hospital of the Future*, European Observatory on Health Systems and Policies, Observatory Studies Series n°16. 2009

   The purpose of this book is to suggest how to get the optimal results from capital investments in the health sector. Their strategy consists of bringing together the existing knowledge about key dimensions of capital investment in the health sector. By recognizing the limitations of the evidence, they identified critical lessons that might increase the changes that capital projects would be successful. These include a variety of approaches for "ensuring future flexibility of building, taking a whole systems perspective, building on systematized care, considering the life-cycle of health facilities, and ensuring the environmental and other sustainability of new buildings". Flexibility is defined as the capacity to accommodate changes that are likely to occur over the building lifetime. It is opinion of the author that for a sustainable approach this flexibility is essential to deal with the changing needs of providing healthcare, and to diminish the need for additional construction.

Journal articles

1. (Author: unknown), *William M Keck Science Building*, Integrated Building Systems: a case study, Cost Engineering: The Journal of Cost Estimating, Cost Control and Project Management, Vol 28/No. 11, November 1986.

   The article presents the case study of the William M Keck Science Building, designed by McLellan & Chopenhagen through the integrated building system (IBS) approach. The author describes the IBS approach, the comparison of the hospital construction cost between the use of the Building System Design and the Conventional Design, and the breakdown of the cost for the lab surge building.

2. Walker D. H. T., & Shen Y. J. (2002). Project understanding, planning, flexibility of management action and construction time performance: Two Australian case studies. *Construction Management and Economics*, 20 (1), pp. 31-44.

3. Capitanucci Maria Vittoria, *New Versilia Hospital*, Abitare, July/August 2003

   While there is a tendency with large-scale hospitals to go on building large multipurpose containers untroubled by issues like urban transformation or the terms of the current architecture and technology debate, paradoxically it is in the small scale, or rather ultra-specialized hospital design that Italy's establishment vision of the postwar hospital. In "New Versilia Hospital" flexibility in intended as internal spatial adaptability though the use of partitions.

4. Battisto Dina, Hospital Clinical Laboratories are in a Constant State of Change", Clinical Leadership & Management Review, March/April 2004.

The author recognizes that to respond to the accelerating changes in health-care field, there has been great concentration in flexible design and furnishing in hospital laboratories. Nevertheless, Dina Battisto states that the hypothesis that flexibility was necessary in hospital laboratories has never been tested. Hence, this study investigates the range of typical and non-typical changes and how often these change take place in clinical laboratories located in community-based hospitals. She concludes highlighting the interdependency between activities, the technological processes and the physical environment. She provides four strategies for addressing flexibility in future hospital laboratory construction and renovation projects: to organize the clinical laboratory in zones (highly flexible zone, semi flexible zone, least flexible zone), to design the highly automated area as the most flexible, to include plug-and play systems particularly in the highly automated areas, and to use modular furniture.

5. Trigeorgis, Lenos*, Making Use Of Real Options Simple: An Overview And Applications In Flexible/Modular Decision Making.* Engineering Economist; 2005, Vol. 50 Issue 1, p25-53. The goal of this study is to inquiry how made simpler the use of real options through a flexible decision making process. The authors suggest modular problem structuring approach that allows simplifying of complex real option problems by decomposing them into a few basic building-block option types (reviewed) connected by some basic decision operators.
6. Kendall Stephen*, Open Building: A New Paradigm in Hospital Architecture*, The American Institute of Architect, 2006

   This paper discusses a significant and innovative medical facility constructed in Bern, Switzerland. The 500,000 square foot project, an addition to the Insel University Hospital called INO, is being managed by the Canton bern Building Department. The INO is the first known project to apply a new process based on a “System Separation” in healthcare architecture. It therefore sets a new standard for adaptable medical facilities. The owner and the management team realized that it is impossible to design a project based on a fixed program of requirements because the program inevitably change in response to new medical procedures, new regulations, and new market and insurance conditions. Recognizing these dynamics led to a decision to adopt an entirely new process for procuring the facility based on three distinct “levels”. The primary level is intended to last 100 years and is expected to provide capacity for a changing mix of functions. The secondary level is intended to be useful for 20-plus years and the tertiary level for 5 to 10 years
7. HERD Health Environments Research & Design Journal, Summer 2008, Vol. 1, No. 4, Analysis of Hospital Facility Growth: Are We Super-Sizing Healthcare?

   During the last 30 years, hospital rooms, departments, and overall buildings programmed for healthcare industry have grown in size. Indeed, design for flexibility is defined as improve space’s capabilities or functionality by increasing the size.
8. Pati D., Harvey T., & Cason C. (2008). Inpatient unit flexibility design characteristics of a successful flexible unit. Environment and Behavior, 40 (2), 205-232.
9. Lam, KC. Planning the Inherent Growth or Change of a Hospital. *Hospital Engineering and Facilities Management,* Hong Kong Polytechnic University, pp. 42-43. 2009 New and innovative technologies (communication technologies, biotechnology, bionics, mechanical and electrical components in the human body, computerized systems, etc.) are being developed on a daily basis to improve the quality of life and longevity of patients. Therefore, healthcare in every country is undergoing enormous and continuing change, be it as a result of an increase in medical technology application, evolving healthcare services or clinical innovation. All new technologies are beginning to influence the medical practice patterns and the design of a

sustainable healthcare building and its layout and size. New hospital infrastructure is being designed and built with a 30–60-year lifespan, and this will need to be flexible to accommodate the aforementioned changes otherwise the healthcare facility will become functionally obsolete even when its physical life is not yet exhausted. Obviously, even those currently in development will need to be refreshed as they come into use. So, how can we ensure that the facility planning carried out this year or next year will produce the right hospital building that is responsive to the needs of patients/users and payers in 2010, 2020 and beyond?

10. HERD Health Environments Research & Design Journal, Spring 2009, Vol. 2, No. 3.
    This numbers of Health Environments Research & Design is mainly dedicated to the Evidence-Based Design.
11. Battisto Dina, *Change in Clinical Labs in Hospitals*, in “Implications” Vol. 03 Issue 2009. www.informedesign.umn.edu
    Dina Battisto suggests in this article a new strategy to design clinical laboratory in response to accelerating changes in the healthcare filed. She proposes to organize the clinical labs into three flexibility zones (Highly flexible, semi-flexible, least flexible) that correspond to technological requirements.
12. Nils O. E. Olsson and Andres Brevik Hansen. *Identification of Critical Factors Affecting Flexibility in Hospital Construction Projects*, HERD - Health Environments Research & Design Journal 2010 Winter; 3(2):30-47. This paper analyzes the dynamics relating to flexibility in a hospital project context. Three research questions are addressed: (1) When is flexibility used in the life cycle of a project? (2) What are the stakeholders' perspectives on project flexibility? And (3) What is the nature of the interaction between flexibility in the process of a project and flexibility in terms of the characteristics of a building?

9.2 The Survey questionnaire, list of recipients and results

Consultants:
• 12 questionnaires sent / 8 responses received
Architects and Engineers:
• 69 questionnaires sent / 22 responses received
Healthcare organizations:
• 57 questionnaires sent / 30 responses received
Equipment and equipment planners:
• 9 questionnaires sent / 2 responses received
Construction Companies:
• 14 questionnaires sent / 1 response received

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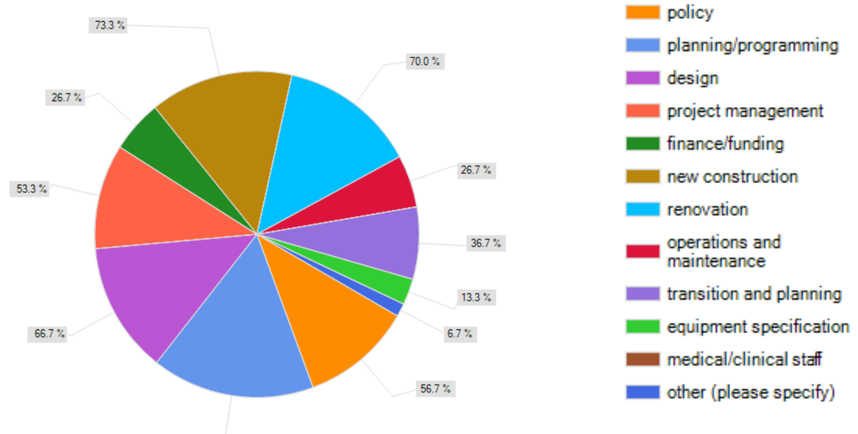
Questionnaire – Healthcare Organization

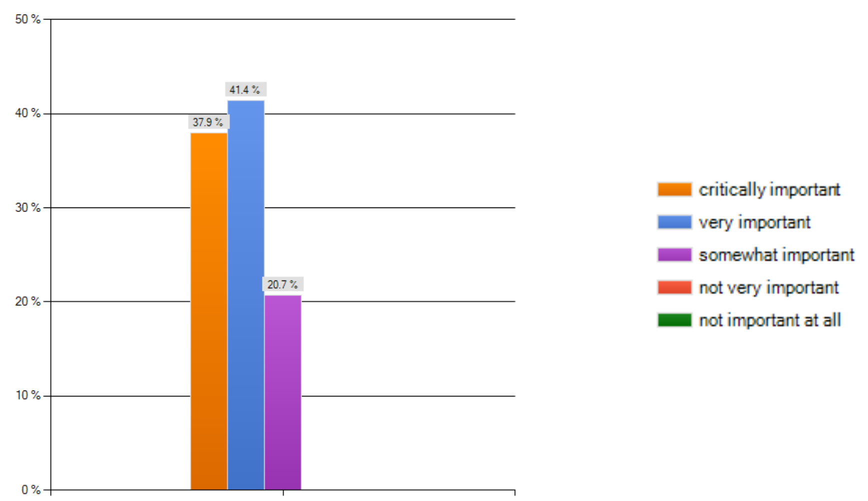
Personal Information

1. Please identify your NAME (optional)
2. Please identify your TITLE
3. Please identify your ORGANIZATION
4. How long you have been in this position?
5. Please identify your role in acquiring healthcare facilities in your organization



Flexibility As A Value Proposition

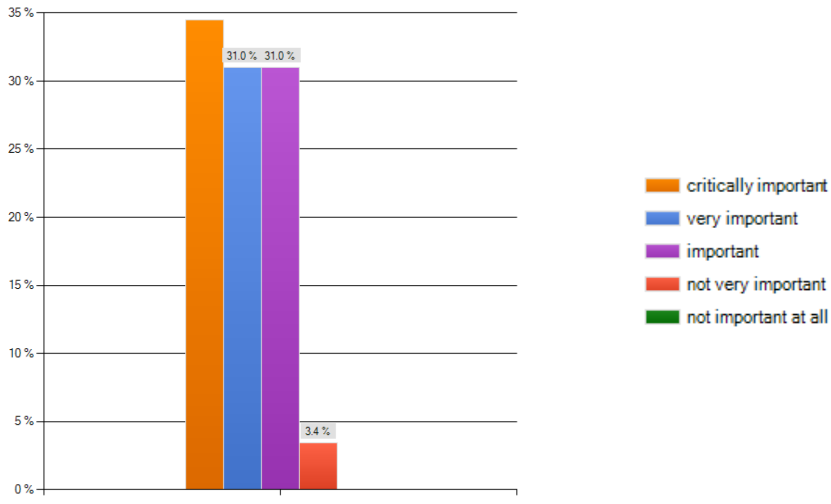
6. Is “flexibility” an important goal for public sector healthcare facilities?



7. If the answer to #6 above is somewhat important to critically important, please briefly explain why?
   - Spaces need to be designed in such a way that they can economically & readily adapt to changes in health care operations. The predominance of our work is performed in an ambulatory clinic environment. Offices, exam rooms, triage space, etc should be on a modular or multiple of a module so economical renovations can be made to reconform when required. Poor planning and anticipation of required flexibility leads to specialized designs which lock in space configuration for the problem of today.

- Our markets and DoD strategy change frequently. Healthcare, in general, is too dynamic to produce healthcare facilities that will provide functionality throughout their useful life.
- To minimize cost and disruption to adapt to changes in health care delivery practices and methods. To minimize cost and disruption to make changes because of changes in workload. To minimize cost and disruption to incorporate changes in technology and to incorporate code changes.
- Medical technology and military/Gov't missions change frequently and facilities need to as well.
- flexibility creates less need for future renovation costs and disruption.
- Replacing our facilities on a 50 plus year life cycle requires utmost flexibility be built in in year one
- things change quicker than we can build, so the ability to rework the built environment is critical. The challenge knowing where flexibility is needed vs. where we think it might be needed only to find out that the expense of flexibility measures were invested in the wrong place. Sometimes tearing things out and redoing it is the best ROI vs the cost of making something infinitely flexible for future unknowns.
- Churn and evolution of health care requirements.
- Healthcare facilities are expected to be in use for 50 years or more. During that span of time, health care practices and technology will change significantly. The facility must be flexible enough to accommodate this change.
- Our facilities are often used beyond their planned life cycle due to funding being at the mercy of the political climate. A flexible building solution reduces the dollars spent on renovations and/or modernizations to meet new modalities of health care delivery over the life of a facility
- Healthcare is changing and will revolve several times within a building life
- Life cycle management - optimization of newly constructed infrastructure.
- One has to balance current requirements and limited funds with designing for the future which is largely unknown.
- California regulatory environment discourages flexibility as defined for this survey. For us, flexibility is limited to adequate bay geometry
- enables reconfiguration of the environment of care to reflect changes in clinical practice and technologies
- Requirement change and facilities need to adapt to new situations
- Medical practice is expected to change dramatically in the next few years and the facility must support the delivery of care.
- Because changes are frequent and expensive
- Extending the life of major owned facilities is very important because capital funding is scarce. Flexibility allows more technological advances to be incorporated into existing buildings.
- Constant change in disease, technology, and care
- Flexibility is a belief that a facility can more easily make changes to a structure to support new healthcare concepts or modalities.
- Need to be able to switch functions quickly and inexpensively
- While we can anticipate future needs, it is impossible to know with certainty. With healthcare reform uncertainty and increasingly capital available for facilities, it is essential for flexibility
- Long lifecycle of public buildings (50-100 years) must be "flexible" to adapt to changing technology and modalities. (2) Must have an agile facility to adapt with changes in healthcare
- Changes in technology, equipment, capital and operating costs and clinical care drive creating flexible buildings.

8. Is “flexibility” an important goal for private sector healthcare facilities or systems?

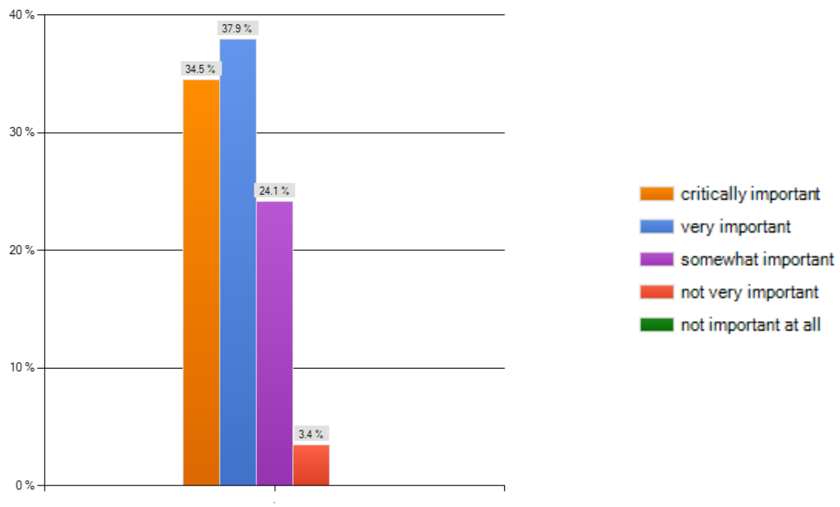


9. If the answer to #8 above is somewhat important to critically important, please briefly explain why?

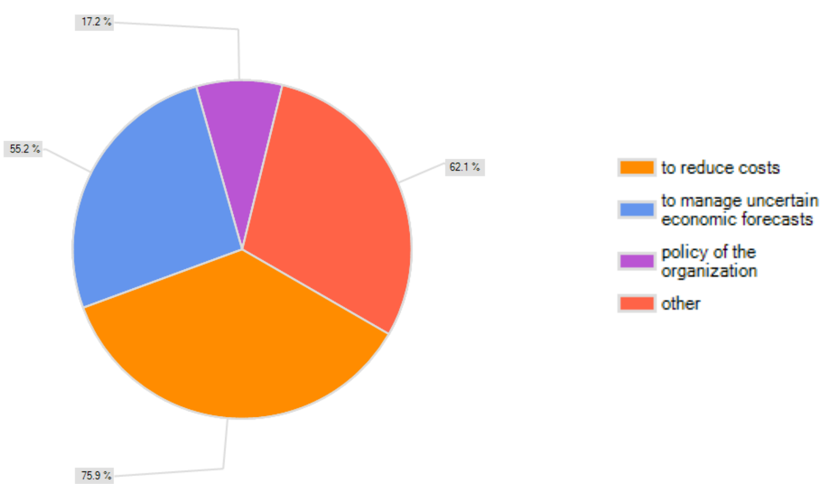
- I can't speak for private sector facilities but assume they must also deal with a rapidly changing healthcare environment. The big difference is their revenue is typically tied to a business plan investment which includes the space required (or facility).
- Same as answer to Question 7.
- Private organizations must be current with the latest medical technology and facilities must be state of the art to compete for market share.
- Flexibility creates less need for future renovation costs and disruption.
- Private sector hospitals are operating on a much shorter life cycle to continue to attract patient population and return profit to the bottom line. Flexibility is less important because they are building it in more frequently than public sector hospitals (DOD)
- I represent the public sector in healthcare, so I did not want to answer this for the private sector. Although my experience in the private sector is that flexibility is just as important, but the private sector is more able to prioritize and determine based on ROI's what they are willing spend money on to provide flexibility
- Same as above.
- Please see the response to question #7 above. Also, the rate of technology change is roughly 6-18 months. This rapid rate of change is only likely to increase. The acuity of all patients is increasing significantly as we are able to treat more and more conditions in other than inpatient facilities. Consequently, the inpatient facilities must be maximally flexible and adaptable.
- Same as public facilities except risk of error is private not public
- Need to be able to rapidly adjust to market requirements.
- If an owner plans to keep the facility then its more important than an owner who plans to sell the asset.
- Again, California restricts flexible usage
- As above #7
- Healthcare continues to undergo advancements in technology and healthcare delivery
- Same answer as for public with added twist of profit motive.
- Same as #7
- Flexibility allows more technological advances to be incorporated into existing buildings.
- As above
- Less so than public sector because they rebuild/replace more frequently.
- Same as #7, need to be able to switch functions quickly and inexpensively

- While we can anticipate future needs, it is impossible to know with certainty. With healthcare reform uncertainty and increasingly capital available for facilities, it is essential for flexibility
- Very important for same reasons as public sector, but private sector has more flexibility in business models and capital investment strategies. i.e. freedom to more easily relocate/ shorter lifecycle considerations.
- Changes in technology, equipment, capital and operating costs and clinical care drive creating flexible buildings.

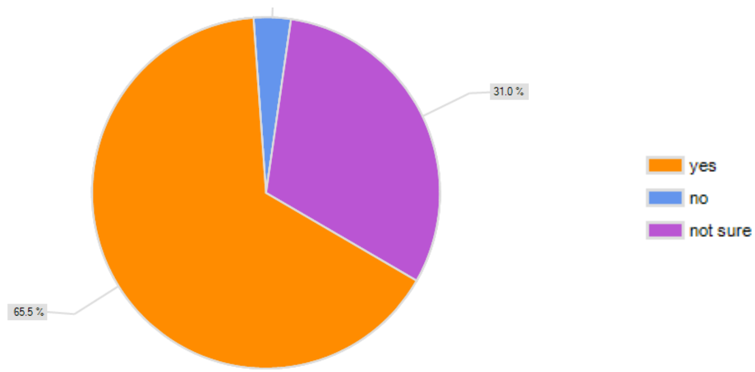
10. How important is “flexibility” as a goal for your organization?



11. Assuming “facility flexibility” has become an important priority for your organization or system, please briefly explain why. (answer as many as apply)



12. Should “flexibility” be an intrinsic part of the larger “sustainability” agenda, with its own metrics?



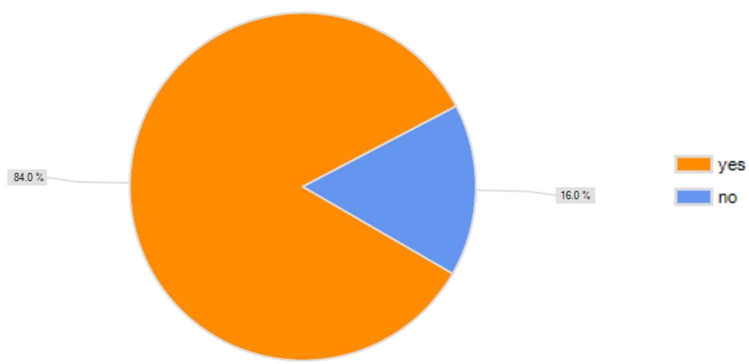
Defining And Assessing Flexibility

13. What is your current definition of healthcare design for flexibility?

- I do not know of one in the DoD MHS
- Design is one aspect of a flexible healthcare facility. The key driver is the clinical concept of operations and understanding how it will morph for each product line. More importantly, the clinical staff who operate that product line must understand how to leverage the flexibility of the facility as they change their business to meet evolving healthcare markets.
- The ability of a building to absorb new capabilities without major disruptions to on-going care.
- Consistent space standards throughout the organization (not just individual building centric), non-compartmentalized programs, size standards that can flex within themselves (e.g. 120 s.f. for an office, consult room, exam room).
- Design to 80% of defined current clinical requirement, preserve 20% future flexibility/facility adaptation
- The ability for the facility to respond to functional changes in the organizations operations that drive the need for the space to support either (1) a wide variety of activities or (2) more economically respond to a readaptation of the space for another activity than it was originally designed to support.
- Allow for change.
- The facility must have an organizational structure that allows both small scale and large scale change. The infrastructure must be robust and adaptable and must be able to be renewed or replaced roughly every 30 years.
- Standardization of spaces to enable reuse as different function
- Varies with different areas. Future capacity for radiology and ORs. Adaptability for rooms and clinics. Plug and play for equipment
- Robust infrastructure (power, chilled water, structure), large floor plates, careful selection of column grid, carful placement of verticle cores, generous floor-to-floor heights
- The ability to proling the life of existing infrastructure, through cost effective adaptation to meet emerging requirements.
- I don't know that we have a clear definition. But to me it means a facility that can be easily modified to a changing health care requirement.
- Ability of a space (department, unit, etc) to be used for more than one program's patients.
- To meet needs of users with minimum costs and inconvenience to adapt to changing requirements
- The organization struggles with this concept. We have a whole building design guide that envisions flexibility from the ability to reconfigure a suite or rooms by employing interstitial space. My definition is a move to more standardized templates that allow clinics to share exam room that we have common waiting space and a health IT backbone to allow for new technologies.
- Acuity adaptable rooms; evidence based design; staff ease of use; ability to reconfigure space from patient care to administrative space and return to patient care with minor renovation
- Don't have one

- The VA Hospital Building System includes many features that provide future flexibility: Interstitial floors when possible, high flr to flr heights, high LLs, stacked mech & elect service bays, wide wings, standardized bays, crawl spaces, defined zones or channels for services etc,
- Easy change
- Vague. Require expansion consideration in the design of a facility. Infrasture items-electrical, plumbing, etc should be designed for an additional 25% of space. Some concept of modular design in space criteria to look at greater flexibility in room usage-ex offices and exam rooms at 120nsf. Use of "soft" space close to high tech areas that have a good potential for future expansion needs, i.e. radiology.
- Creating space that is not excessive (aka supersized) yet adaptable and flexible to change over time with limited constraints
- Modular integration of structure and functional layout which easily adapts to different concepts of operations.
- Flexibility is taking the long view.

14. Have you tried to build a flexible facility in the past?



15. If so, please name the project or projects
- The steady adjustment of DoD space planning criteria has provided the basis for flexible facilities. Medical malls, templated exam/office space, sink stubs in offices, and other facets have allowed for clinical operations to shift capacity in outpatient clinics.
- BAMC and Madigan using interstitial spaces to run utilities. Korea and Belvoir hospitals with site placement of outpatient and ancillary services for future building expansion projects.
- Clinical Care Center West Campus Pavilion for Women Feigin Research Center Neurological Research Institute
- Ft Belvoir Community Hospital
- DoD MHS projects that include interstitial spaces. DoD projects that include modular wall construction or modular furniture arrangements in an open office layout. Examples include every hospital and clinic we have built over the last 10 years at least -- we use modular furniture outfitting in all of them. In many of our research laboratories we build in modular wall components (e.g. AFIP, etc.) Many of our hospitals have some level of interstitial space (but not all). Most of our new hospitals have site flexibility for about 20% expansion capacity built in -- either vertically or horizontally.
- All Army medical projects seek to provide flexible solutions.
- Kaiser tries to build flexibility and adaptability into all of its inpatient and outpatient projects. We are currently designing and building about $4 B a year in capital projects. Wherever possible, we are designing in flexibility.
- Ft Belvoir Community Hospital, Ft Bliss Soldier Family Care Center, Ft Riley Soldier Family Care Center
- Shands Cancer Hospital
- Most of our facilities built in the last decade have followed these principles.
- Walter Reed, Brooke Army Medical Center, Madigan Army Medical Center, Walter Reed Army Institute of Research. Each included interstitial floors. Every DoD facility includes "standard" rooms that are, theoretically, flexible.

- Sutter Medical Center Castro Valley uses a "Universal Care Unit" that was intended to serve patients observation patients from ED, Level II recovery and other patients of an equivalent acuity, with patient ebb & flow across the unit based on volume and time of day (observation late, Level II midday for example. State would not allow without setting up boundaries between the uses.
- Ft Hood (under construction) and Ft Bliss (in design)
- We say we do but the result is really customized space.
- All VA Hospital Building System projects incorporate many features that allow future flexibility.
- too many to recount
- All Veterans Affairs major construction projects that include new construction.
- Fort Belvoir Community Hospital USAMRIID/USAMRICD Laboratories
- May Ambulatory Clinical Building

16. What criteria do you or would you use to declare that a project (your project or other projects) is “flexible?” That is, what are the criteria for evaluating a facility for flexibility, both technical (A/E) or process-oriented?.

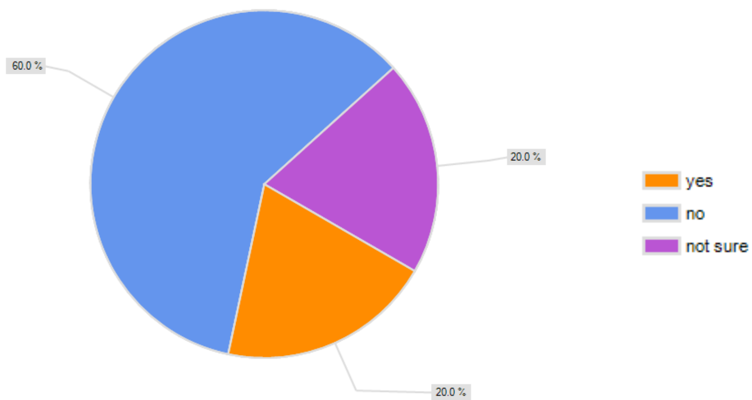
- Depends on organizational goals. For a cancer hospital it has to transform to other services as oncology becomes outpatient
- See answer to question no. 13. Also we try to not have facilities "customized" to specific and unique user preferences.
- Some ratio of time/cost, relative to required change.
- Spaces that can be repurposed without shutting down complete departments.
- Acuity-similar uses/similar patient functions across silos (Universal Care Unit as described in #15, shared waiting, changing, similar uses between departments instead of soloed replication California mandates.
- Can only really tell through POE process
- My criteria would center on the ability to shift the mission from primary care to specialty clinic with MINIMAL effort. That we have planned for a significant increase in IT traffic and can adapt new technology without a rebuild or ugly retrofit.
- Acuity adaptability, EBD
- I suppose when change occurs in the future, the building and the process can adapt more easily than if flexibility had not been considered in design.
- In general use of the VA Hospital Building System results in a "flexible" building. To my knowledge, we do not have criteria specifically for measuring flexibility.
- Easy change
- A/E designs must show how a building could be expanded in the future. Design reviews should evaluate "soft" spaces located next to areas of potential future growth. Design include infrastructure capacity to handle greater space requirements.
- Prior to design, completing full assessment of strategy, financials, community, and operations. Balancing first and ongoing costs, do not overbuild but allow for soft and expansion zones that promote ease of access. Do not focus on only acute continuum of care elements, including pre- and post-acute
- Ability to interchange departments
- How easily can you change the use, i.e. inpatient to outpatient facility, changes in practive, changes in technology. Also placement of fixed elements should be considered in the design, i.e. stairwells, elevators, utility shafts. These elements are usually fixed and financially infeasible to move.

17. What factors/constraints/drivers do you consider in discussing or implementing “flexibility” with your staff, your board, funders, agents, A/E service providers?

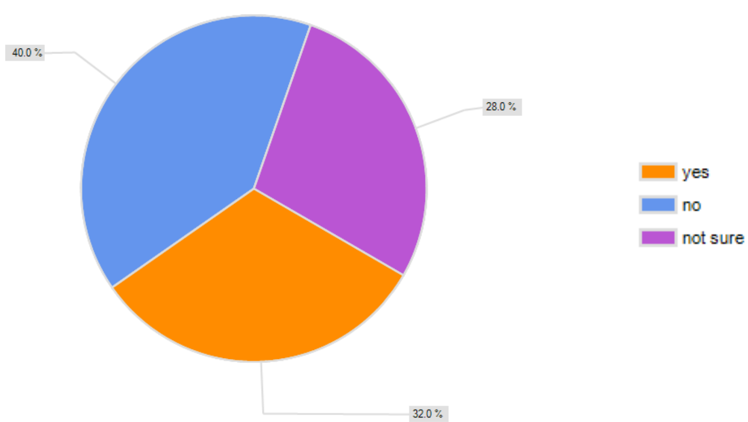
- Much the same as in Q 16
- Risk management. Identify the healthcare requirements 'x' years out and determine the risk in the design based on a set deviation from those requirements.
- See 16.
- Facility standards (from space allocation to paint colors) are set and approved at the highest level - Board of Trustees - to be able to implement consistency with all team members (A/E/C teams, users, clinicians, etc.)

- Patient Centered Medical Home, Mechanical Electrical and Plumbing flexibility to support future medical technology requirements
- Available capital currently and future, objectives of the proposed flexibility measure being proposed, any quantifiable evidence that the proposed flexibility is (1) probably to occur, (2) likely to manifest itself in the way the flexibility measure is being proposed to support, (3) has some defendable ROI that any additional initial capital cost would actually offset in the future.
- Initial and life cycle cost, expandability, size and volume of spaces (grid, modules, rooms, slab to slab), system capabilities, materials, furnishings.
- Flexibility is about good planning and thoughtful design. It also can be an issue of added cost as well. It is hard to make the argument if the constituents are solely focused on initial costs. The real payoff for flexible buildings is the total cost of ownership.
- No comment
- Capacity Planning horizon Easy to expand vs fixed systems Risk of change for individual systems and care patterns
- See answers to questions 13 and 16.
- First cost. Constraint.
- In the current Federal funding environment, Congress is only interesting in meeting current minimum requirements. Flexibility maybe viewed as going above minimum requirements. Even if flexibility is life cycle cost effective, additional up front costs are a hard sell.
- The state.
- Cost, ability to meet mission, functionality, world class
- No significant conversations.
- Cost
- We don't - yet
- For the big projects, all of the above.
- Understanding of life cycle cost
- The factors would be trying to identify those areas that have a higher potential for future growth. Energy plant extra capacity would not be cost effective at this stage but the ability to add equipment to the plant would be critical.
- The above
- Cost & Schedule (first costs). Selling point is adaptability and reduced life cycle costs. Demonstrating that the facility will readily accommodate the latest technology/equipment.
- Embraced in our organization even if first cost are higher. We take the on view since we build buildings with a 50+ year life.

18. The distinction between “equipment” and “real estate asset” provides one way to define “flexibility” in the sense that building equipment can be depreciated over 3-7 years while “interiors” can be depreciated in 15-20 years and “core and shell” in 30-year cycles. Given this, do you attempt to increase the investment in “non-core and shell” as a way to increase flexibility?

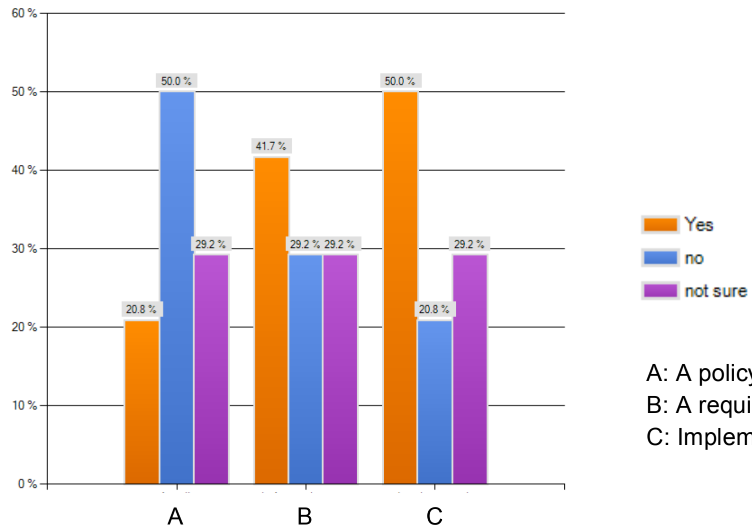


19. In your experience in the healthcare sector, has an expansion of the category of things called “equipment” – to include more and more parts of the total healthcare facility – made achieving a “flexible” facility more within your organizations’ grasp?



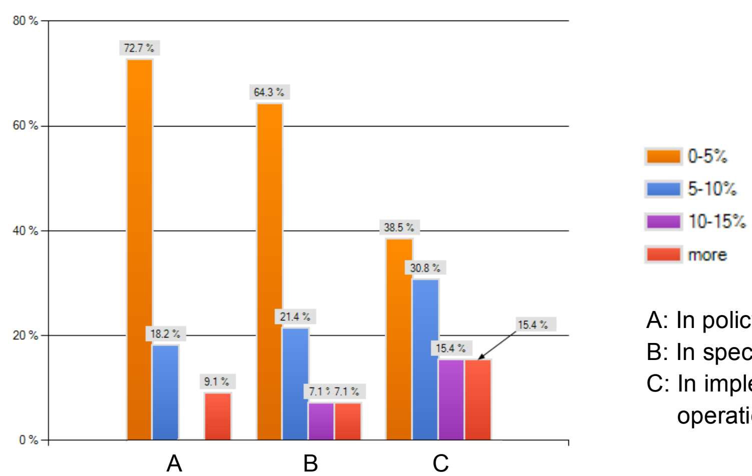
Cost Trade Off

20. Is there a cost premium to initial acquisition associated with adopting a “flexibility” strategy in any of the following?



A: A policy
B: A requirement
C: Implementation

21. If you indicated that there is a cost premium, would you say the premium for adopting a “flexibility” strategy in each of the above is:



A: In policy documents
B: In specifying requirements
C: In implementation (i.e. construction or operations/maintenance of…)

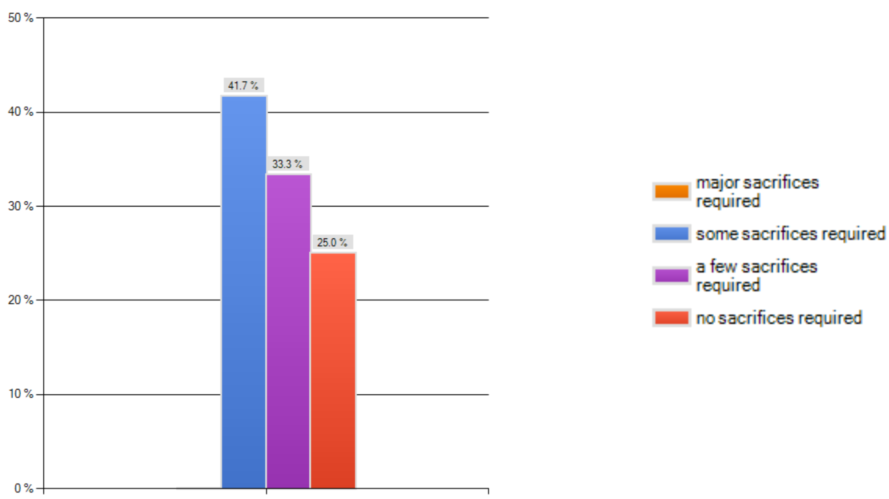
22. Give examples of initial cost premiums.

- IBS adds about 10 percent to the capital costs of a new facility.
- Increased time (translates to cost) to convince reviewers that flexibility is important and precise requirement specifications are counterproductive to designing and building a flexible hospital
- A requirement drives the need. If it is a consistent need it drives a policy. Policy drives potential additional requirements above the current status quo in the implementation of a project, so that is where it drives a cost premium. While the time involved in a policy is there it is the cost that results from the requirements a policy forces on implementation across the board. For example modular casework in a lab might cost 2-3 times that of no modular, however if you know you are going to rework casework in labs with a frequency of lets say changing out elements (say 40% of the casework in 75% of the labs every 2 years because of changing protocols) the ROI on is fairly high and the payback period is

less than 5 years in many cases. Interstitial space is a little tricker, because we don't have good data, hower our general basis is that the perceived cost of maintenance for the PM in those spaces + the cost of perceived change and limiting the down time for the function in the space out way the cost of the interstitial space for initial capital. Another more challenging discussion for our organization is building rooms larger than perhaps needed to allow the space to either serve multi-functional use or be easily readapted in the future. The cost for this is generally known up front, as we know our $/gross square foot both initial capital investment and lifecycle O&M.

- Increased systems sizing to support growth.
- This is tough to tease out the way the questionnaire is written. The more one can migrate away from built in solutions and the more one can invest in equipment and furnishings, the better. Flexibility need not cost more if one is replacing, say, built in case work with mobile equipment or furnishings.
- More system capacity. More wire etc
- Including more infrastructure than initially required
- It is unclear to me what the terms "policy/requirement/implementation" are intended to mean.
- Providing additional bed head wall units, air filtration, rough in plumbing for future sinks, structural systems that increase the bay size, construction shell space (most expensive)
- I have been told that there is but have not seen enough data to confirm assumptions
- Room for expansion built in, cable racks, wireless, repeaters and rooms with reconfigurable utilities.
- I do not understand the two questions above. Requiring interstitial floors would obviously add initial cost while stacking service bays would not normally add costs.
- Infrastructure items (electrical capacity, plumbing) are sized to support an addition 25% of space.
- Optimization for the known cost less than optimization for the unknown. (2) Redundancy and 'extra' capacities to enable multiple configurations within fixed building systems
- Plumbing in exam walls on the corridor wall rather than back to back. First costs initially somewhat higher but lower costs when you change use in the future.

23. To what extent do you have to sacrifice other priorities if you push hard to get a “flexible” project?



Comments:

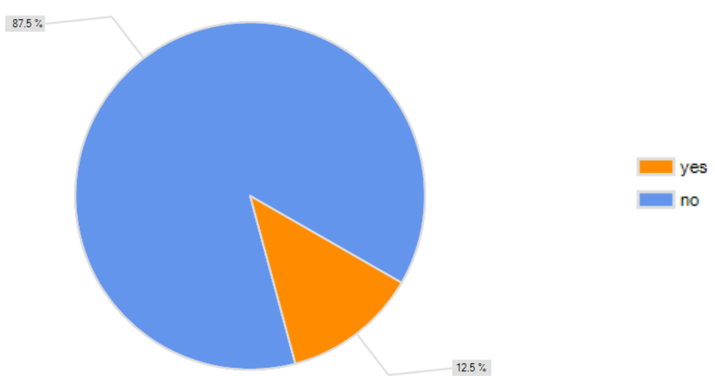
- By default we build flexible facilities since the lock-in of requirements leads the actual construction by 6-8 years.
- If you have a collaborative culture, the implementation is easier than if you first have to build that culture.
- Very much depends what flexibility strategy you're talking about

24. What other priorities are typically in conflict with “flexibility?”

- Personal ones.

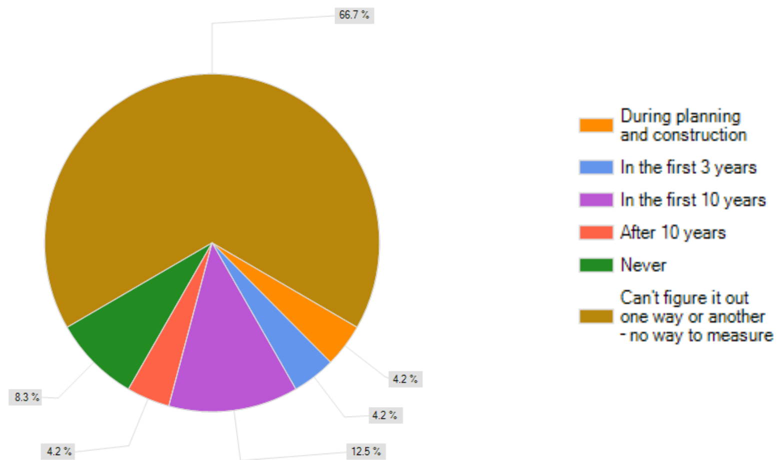
- Flash to bang between planning/ programming and execution.
- Perceived higher costs.
- Basis of physician or staff recruitment (i.e. promises). Unique clinical or research programs that just don't allow for a flexible solution (ISO labs, highly technical equipment like microscopes or radioactive environments)
- "I want it like this....period" mentality by design reviewers including providers
- NSF and quality of materials / equipment.
- Opportunity cost of funds not available for other project investments.
- Initial budget is the most powerful driver in the quest for flexibility. When the client is insistent on the lowest possible initial cost, often, the discussion regarding flexibility has to be dropped. With clients who take the longer view, adding in soft space, shell space, reconfigurable/moveable walls, an "empty square" for building or department renewal is not a hard sell.
- Can't think of any except budget
- Not sure
- Cost
- Perception we're building more than our current requirement - that space will be underutilized.
- The state
- May be locked into backward looking criteria and methods and not having the full benefit of the most innovative thinking
- Practitioners who only see one way to perform services or organize a facility. Large amounts of customized space that cannot accommodate other functions.
- Cost, adjacencies.
- Productivity?
- Cost, desire for more windows (wider wings enclose more area)
- Preciseness
- A/E understanding of the requirements. Adjacency requirements that might displace "soft" space locations used for future expansion.
- Limited capital
- Lowest cost. Minimum scope (optimized for singular functionality and concept of operations)
- Disagreements over the building infrastructure equipment.

25. Do you currently have a method of assessing the incremental cost premium of adopting “flexibility” measures?

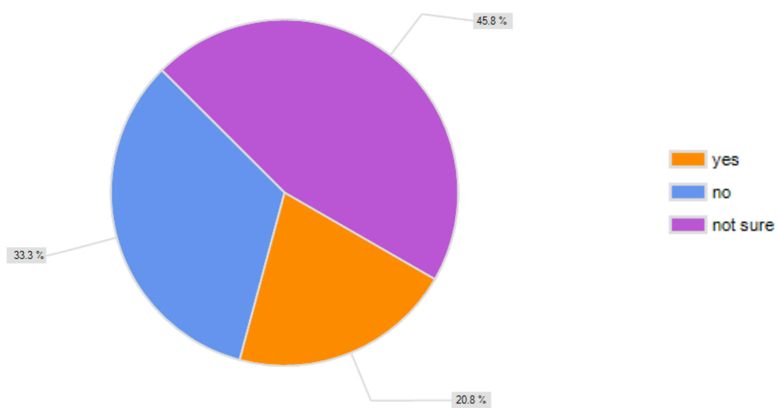


Other:
Comprehensive cost modeling, cost/schedule risk analysis, and rigorous scope management

26. Did a return on investment of your flexibility strategy (applied in your recent facility acquisition) come back to you?



27. Would you be willing to share cost details related to the above information that can be included in a final report associated with this questionnaire?

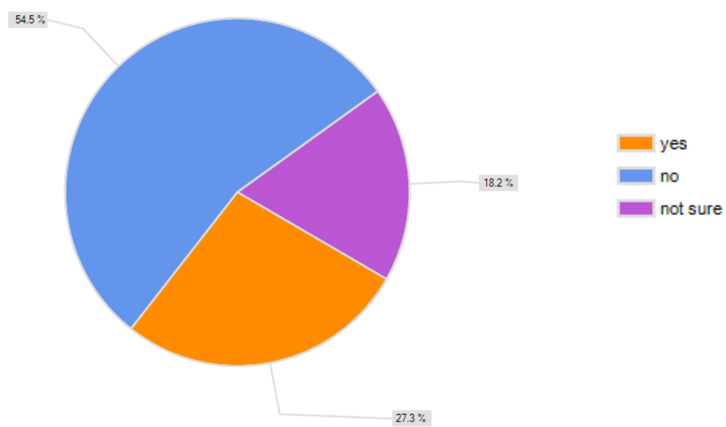


Barriers To Flexibility

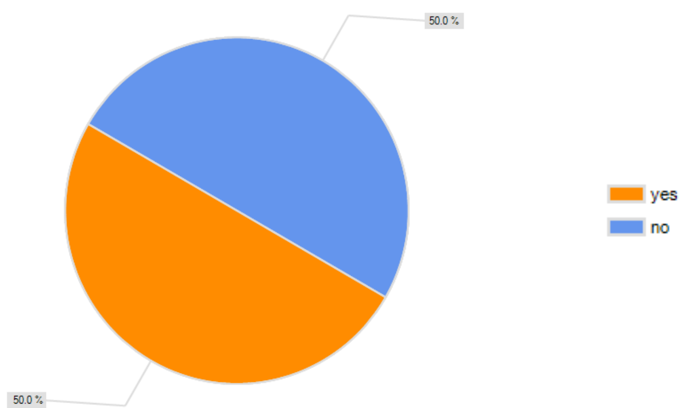
28. Assuming that your organization adopts short-term strategic plans, to what extent does this present a barrier to achieving a flexible facility?

- We already have projects too far down the funding process to redesign, Congressional timing
- As mentioned you lock in the requirement well in advance of construction completion opening the window for changes in the market and demand.
- Flexibility has become part of our culture for the last 10 to 15 years.
- Not sure -
- Don't know - DISREGUARD MY RESPONSE ABOVE - I had to select something

29. Are your current fiscal and planning/programming processes designed to achieve a flexible facility?



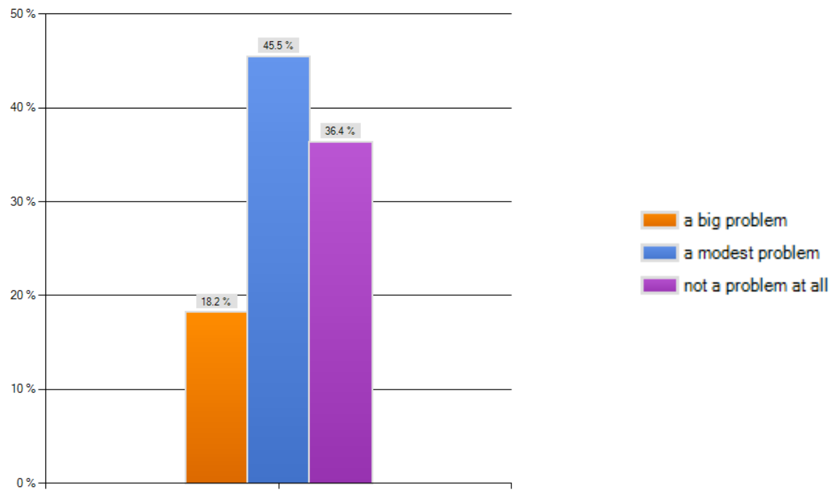
30. If not, have you considered adjusting your processes to enable you to acquire flexible facilities?



31. If the answer to #30 above is YES, please briefly describe these processes.

- Not yet. Needs to be done
- #29 answer is partially. As mentioned DoD criteria lends itself to a level of flexibility but the programming of funds and execution does not allow flexibility.
- We are putting in additional cost factors to build world class facilities which include consideration of flexibility, but it is too generic at this current point to identify specific ROI decisions.
- Not sure
- Current DoD Congressional budgeting processes do not allow building "flexible", "shell space" or any significant level of increased capacity.
- More focus on life cycle manage rather than just project /construction costs
- Not yet.
- Huh? We'd make it a part of our approach to design.
- A/E design requirements.
- Lots of consideration... little action

32. To what extent do current priorities and attitudes among your medical / clinical / administrative and support staff make achieving a flexible facility difficult?



33. Please explain briefly how current priorities, metrics and attitudes are barriers or enablers to your ability to acquire a flexible facility.

- Flexibility needs to be driven from the top. Too many decisions are made by the current staff on site. By the time a facility is constructed 2 or more changes in staffing has taken place.
- The current programming process requires a lock down on very specific requirements 6-8 years out from construction completion. The barrier is a direct function of the level of DoD scrutiny and accountability to design the building based on the specific requirements.
- Justify long-term benefits versus short term capital costs.
- Flexibility has become part of our culture for the last 10 to 15 years, so we don't' experience many barriers. New staff/clinicians tend to be the biggest barriers if they've come from a facility that allowed them to do whatever they wanted. Having documented facility standards and a process by which to vary from them are the best enablers to achieve flexibility.
- Current preference is to "build" a clinic or hospital to EXACT current requirement with no view toward the future/flexibility. Current practices/missions tend to be very well defined (written) where flexible facility design objectives are not written or well defined
- If we lock in funding before the flexibility issues are worked out we are stuck robbing peter to pay paul during execution to include flexibility measures. The current funding approach for DoD and federal government has a lot of pressure to do more with less that hinders the ability to argue more initial capital to save more long term.
- Enablers: UFC requires an expansion plan and expansion capability built into all building systems. Inhibitors: No option to build shell space though Cleveland Clinic demonstrated value added.
- Typically, the caregivers understand the need for flexibility and adaptability. On the other hand, they may insist on customization to a given individual's way of delivering care rather than a more "generic" approach that is more flexible. Limitations on total project cost and clients taking the short view are two of the most formidable barriers to flexible facility design.
- Staff is generally ignorant of a flexibility program. They have 1 year goals only
- Most clinical staff have limited experience with different facilities, therefore they tend to biase to the one they are most familiar with.
- These staffs would embrace a flexible facility.
- The US Congress only will fund to current requirement.

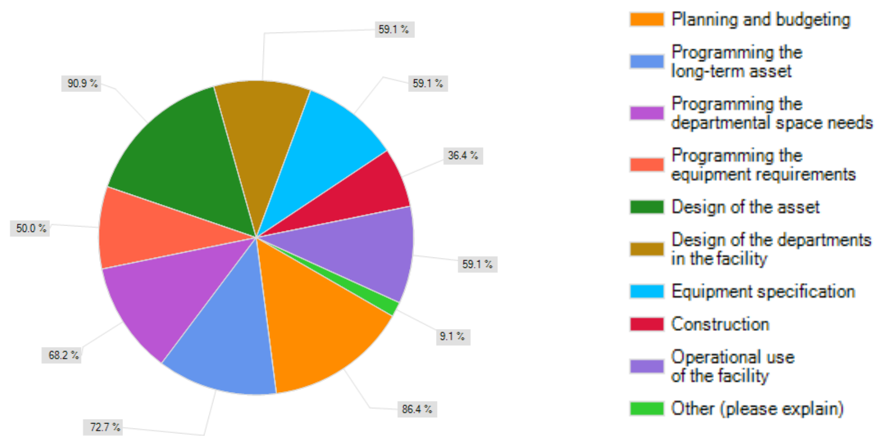
- The state is the barrier; practitioners are so accustom to state barriers that no one even discusses flexibility
- Thinking aligned. Just need the information to make informed decisions
- Central control of practice is weak. This leaves local practioners the ability to customize space and set it up for only the current use.
- The sheer number of stakeholders, combined with an inability to exceed specific departmental goals, plus an inability to build a larger facility for future growth, make flexible space design nearly impossible.
- Not measured.
- Cheapest and fastest
- Current policy supports the concept.
- Lack of an integrated project delivery process. Process is program centric where cost and scope are locked-in without regard to the benefit of integrated interaction between design and construction agents, effectively minimizing creative/innovative ability to maximize value.
- Institution embraces the long view, therefore this is not an issue.

34. What forces outside your organization's control act as the main constraints to your ability to acquire flexible healthcare facilities?

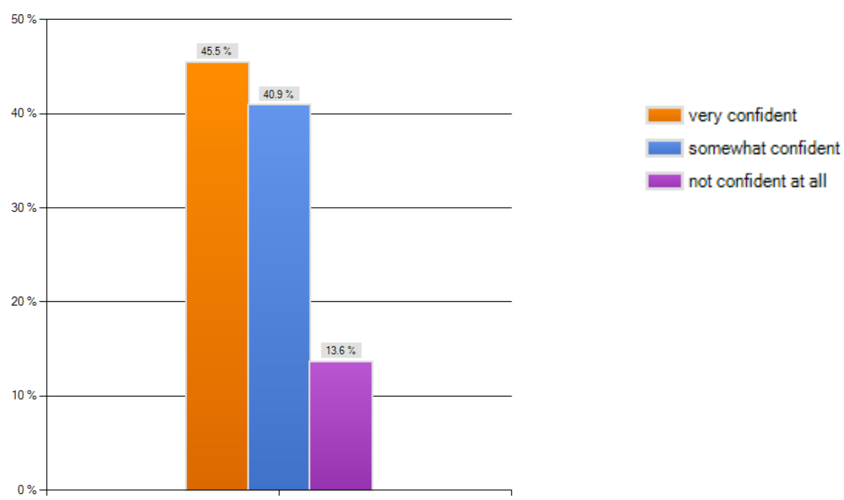
- Should not be any outside of the MHS
- Congressional and DoD scrutiny. A more challenging fiscal environment causes greater scrutiny based on criteria that may not directly correlate to the mission of the facility.
- Bean counters at OSD.
- None that I can think of.
- Absence of clear (HQ Driven) direction or policy on flexible design
- The economy of the US, political elections and the AEC industry's (which we are a part of) general in ability to effectively measure promises made during planning and design for "flexibility" measures.
- Fiscal policy/constraints.
- The most common outside factors are the small size of lease space available, the small size of a piece of land for purchase, or limits on the building FAR coming from the local planning department.
- Cost constraints. Sometimes codes
- Codes, licensing authorities
- DoD budgetary constraints.
- The US Congress only will fund to current requirement.
- The state
- Federal Gov. many issues to deal with although broad commitment to world class.......even though we have worked to define world class there are still questions about what it means and how to get there.
- There is not a clear driver that is preventing flexible facilities.
- Departmental policy; number of stakeholders
- None?
- Financial persons
- Cost comparisons to private sector construction costs.
- USC (public law)
- None

Planning Processes And Methods

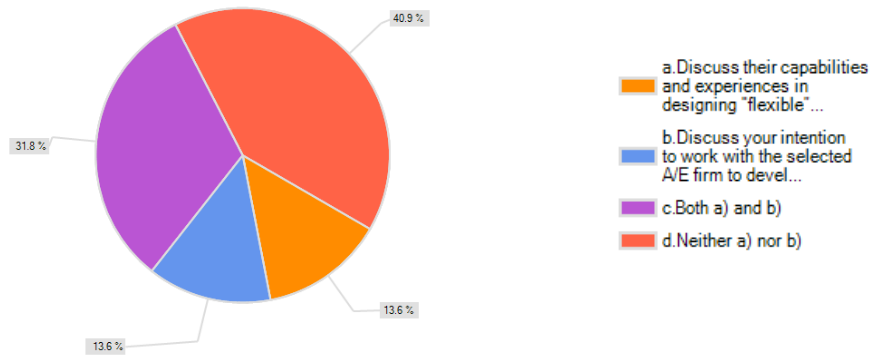
35. At what stage is a mandate for “flexibility” a critical success factor in achieving such a facility? (check all that apply)



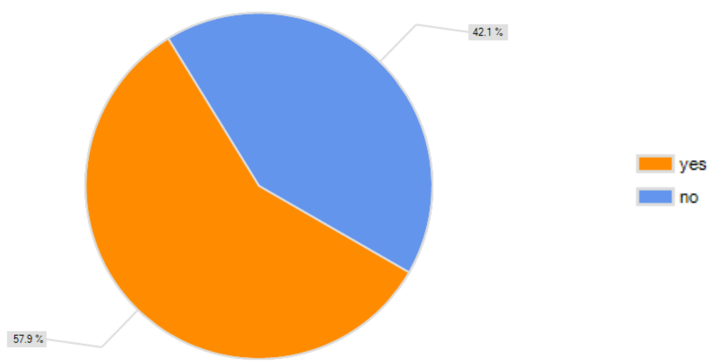
36. What is your level of confidence (assuming you want to achieve a flexible facility) that you can find an A/E team that can deliver a “flexible” facility?



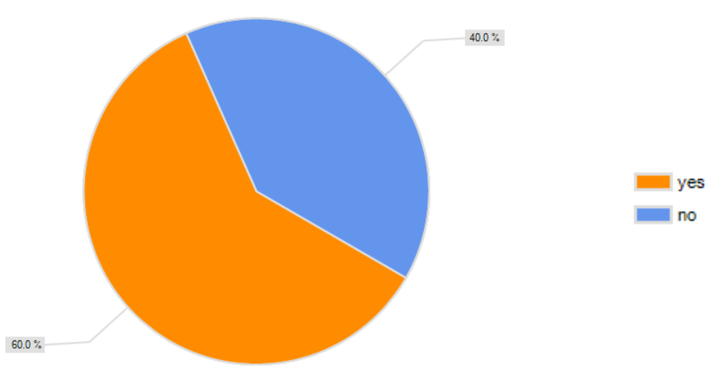
37. During negotiations with your A/E prior to final selection, did you 38. Did the A/E team discuss their method of eliciting alternative functional scenarios with your team's participation, in their interview or marketing?



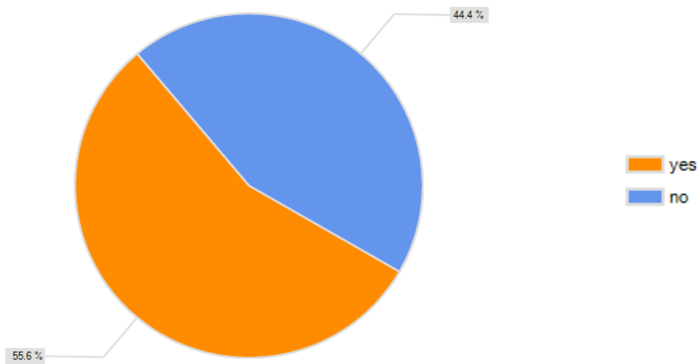
38. Did the A/E team discuss their method of eliciting alternative functional scenarios with your team's participation, in their interview or marketing?



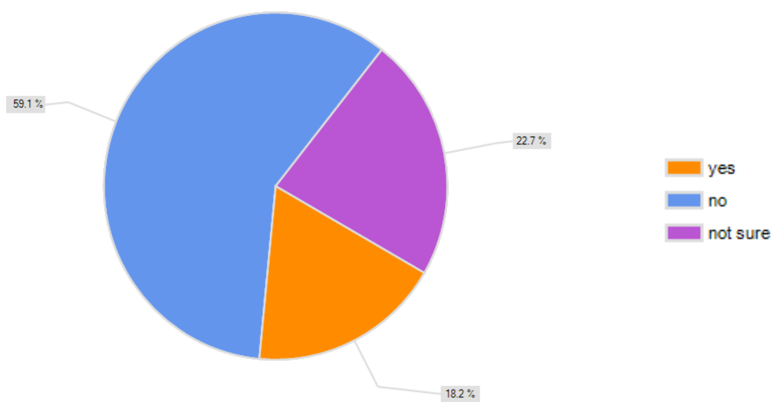
39. If the A/E team did not offer these services at their initiative, did you require the A/E team to show alternative scenarios anyway?



40. If you required the above, did you stipulate in the contract for services that these alternative scenarios would be shown (schematically, in architectural and MEP drawings) with no additional fee?



41. Do you budget for a “flexible” facility differently than you would if you were not aiming for a flexible facility?



42. If the answer to #41 was yes, please explain the differences in budgeting processes.

- Again we have a factor for World Class facilities which includes many things not just flexibility. Interstitial facilities generally have a factor for that applied at some level in our programming effort, although not consistent.
- Pricing for MEP includes mandated increases capacities.
- Not sure
- Some level of premium required, in either sf, or cost/sf. Interstitial costs called out specifically on funding documents.
- Obvious

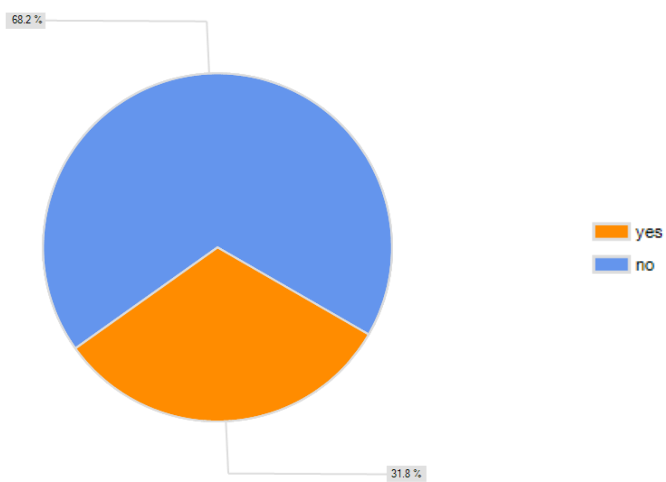
43. Please give a few examples of how your policy or planning documents explicitly explain how you will organize decision-making to achieve your goal of a flexible facility.

- none available
- it doesn't.
- We look at evidence based design criteria.
- No present written guidance on planning flexibility into our projects that I'm aware of
- Developing a project organization structure with roles and responsibilities for decision-making versus feedback for each party, from the Board of Trustess, Steering Committees, Executive leadership to the user groups, was absolutely instrumental in achieving success. For instance, user groups were the functional feedback point, clinical steering group was the functional approvers, and neither was an aesthetics feedback or approver. Aesthetics were approved through a Board appointed Design Subcommittee.

- Please read the UFC 4-510-01 on submittal requirements for schematics where alternatives need to be explored. Additionally search document for references on flexibility and adaptive design. That is our policy to date. I would also encourage you to review the world-class checklist and search for flexibility and review those strategies.
- Drawing must show expansion plan. Early design and follow up systems design must include capacity to support increased demand.
- Rather than policy, we depend on our planning and design tools to help our consultants understand what they will need to do when addressing flexibility in the project design. We typically work closely with our design consultants to make sure the design stays on message throughout the process.
- Managed in team meetings. Did not specify in contract.
- This survey is becoming excessive
- Economic analyses required
- Not sure
- N/A
- Core inclusion
- We do not address flexibility
- Don't exist.
- Cannot
- Our A/E submission requirements stipulate review submittals.
- At best the scope addresses future expansion and/or adaptable space. Narrow interpretation of congressional authorization limits scope considerations to "current requirement".

Precedents

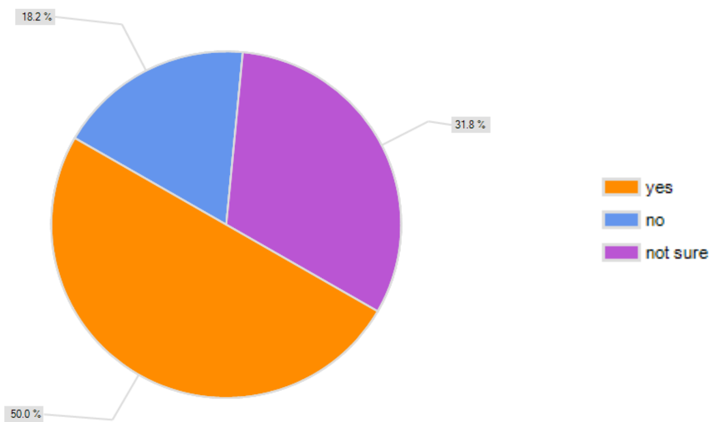
44. Have you examined other policies, requirements and/or projects that you consider “flexible” to see if you want to aim for a similar standard?



45. Please identify those policies, requirements and/or projects here.

- We conducted a deep dive into local, national and international facility space standards to assess where ours fell and if we needed to change our standards. We found we were competitive in standard provisions and application of them and did not need to substantially change anything.
- Broad overview of what the VA does and then other individual private sector projects (like Kaiser)
- Really?
- Loma Linda...a long time ago
- World class materials
- Many examples of IPD where the project delivery team had great flexibility of/in process to adapt midstream. Many private sector projects build "shell space" for future development (can't do this public)
- Consult with other institutions

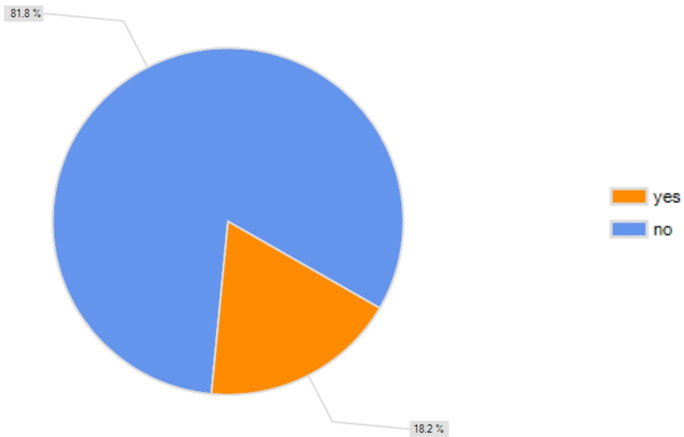
46. Does the commercial office markets' distinction of base building, fit-out and FF&E (furnishings, fixtures and equipment) apply to healthcare facilities design for flexibility. In such projects, detailed programming is done after the design of the base building (core and shell) so functional areas can change without disturbing other areas of the building



47. If the answer to #46 is yes, please explain why you think so and how it applies.

- As mentioned, integrated systems furniture, headwalls, nursing stations, etc. should be used whenever possible rather than hard walls, counters, and utilities.
- I do not see any comparisons between the two markets (office and healthcare). I believe DOD space planning criteria attempts to address "churn" in administrative areas by planning "open office landscape" where ever possible. Healthcare has unique requirements (different to office/business) that drive us toward hard office spaces in the embedded administrative areas supporting healthcare
- The need to shorten the time from strategic planning to use of a facility creates the need to fast track the design and construction process, so the need for the core and shell to be flexible for build-out allows the base building construction to start while the interiors are being designed. In addition, healthcare is ever changing, so a flexible base building is critical AND a flexible interior design reduces future renovation costs.
- It does only if we approach it this way. While we generally don't approach the project in this way in a pure sense, we do sometimes get into similar approaches with DB or ECI (CM@R) projects. Leasing if we did it in any uniform manner would also put us in this approach style.
- Helps w te but generally budgets and AHJ prohibit building shell space
- We are finding that, for uses such as medical office buildings, a leasehold building can be quite suitable. Much depends on the structural bay sizes and the base building capacity for growth and change. We have changed many of our room templates to make sure that they and the departments work in a standard lease office building.
- Hospital tend to be to operationally specific to follow an office building model
- See your description in #46 answered the question.
- I believe it applies, we "don't do it that way."
- Obvious
- MEDCOM makes great use of modular systems furniture and casework to allow adaptable facilities.
- Every building should be flexible, to what level should be established when setting budgets.

48. Do you look to overseas examples of “flexible” policies, requirements and / or projects?



49. If the answer to #48 is yes, please identify them.

- To the extent we try to ensure the same level of flexibility overseas (OCONUS) that we do in CONUS (continental US). We also try to see if local approaches have any new information or technology that would facilitate flexibility, although that is not an extensive local market investigation (it is usually more by happenstance or local designer/builder knowledge).
- Several hospitals in Germany and UK.
- No
- Expect agents and A/Es to bring best practices to the table from what ever source
- Too many

Tracking Flexibility

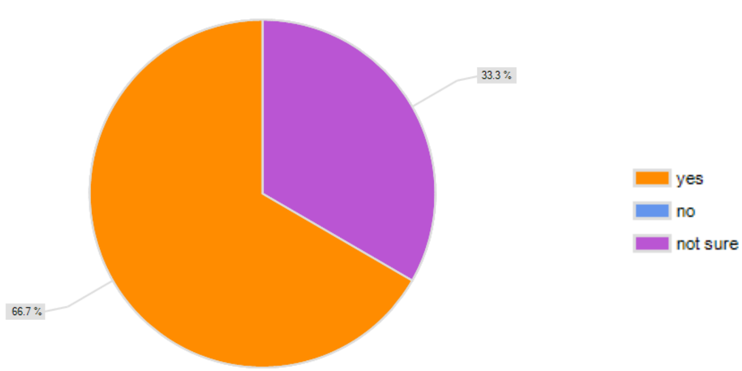
50. If you had resources to track the behavior of your facilities over a period of years, what patterns of change would you look for – situations or instances of change that, if you could document them, would be most beneficial to know about - patterns or situations of change that would yield results in planning future “flexible” facilities?

- Changing clinical space to admin
- Does the staff leverage the flexibility in the buildings’ design to maximize their effectiveness and efficiency?
- Cost savings on repair projects and major upgrades. Savings on clinical care for not shutting down services.
- I'd track embedded administration (Patient Administration, third party building, records storage areas) to determine if a medical office administrative structure (MOB) wouldn't be more cost effective than building it to the standards of Healthcare Occupancy. Same for Logistics or any other support function that does not lay hands on a patient daily.
- Renovations to various facility areas the need for them and the related costs. Renovations to specific department areas, the reason for them and the related costs. Infrastructure repairs and the need for replacement. Past technology investments and future planning for such, reason for them and related costs.
- Overall Expenditures of SRM/square foot on buildings that had flexibility outlays of initial capital. Amount of total individual Sustainment, Restoration or Modernization per gross square foot of building space over time for facility. Amount of RVU/gross square foot over time compared to RM component of the space over time.
- Care practice Technology Market demand
- Space demand, operational changes, systems demand, equipment sizing, cycle of renovation/capital investment, longevity of materials and finishes, cost/impact of modifications, acceptability of compromises due to facility limitations, patient and staff satisfaction.
- I would want to know about staffing changes, workflow changes, technology changes, how often we were forced to do work around because the building could not be easily changes, or how often we remolded a building that was easy or easier to change.
- Not sure
- How often certain room types/their use and/or outfitting actually got modified.

- Frequency of renovation, equipment recapitalization cycles, shifts in patient workload by product line
- POE process
- Not sure
- Number of rooms changed from patient care to administrative space within 5 years of project completion. Cost and line items of MEP replaced within 5 years of project completion.
- Cost and time of renovation
- Don't know
- What renovation projects took place and where they took place? What market conditions/workload changes caused the renovations? What technology changes happened?
- Capture cost avoidance due to flexibility.

51. What are the barriers to developing a systematic methodology to track how facilities change?
- No standard business in the MHS. Each SG and MTF commander does as they please.
- Consistent collection of information.
- Time and manpower.
- Current origin and tracking of funds to build and maintain usage category code 500 and other CATCODEs spaces.
- Disconnected or siloed organizational departments between facility planning, facility operations, equipment tracking, technology design, technology operations.
- Actually tracking the data effectively.
- Resources and provable outcomes
- Time, funding, record keeping tool.
- Kaiser is a huge system with about 1200 buildings of all sorts. The real estate portfolio is so large that we do not have sufficient staff or systems to track how facilities change.
- Reasonable metrics
- Resources/differing opinions on what/how to measure.
- Not sure
- POE process initiated
- Have not really thought about it.
- Facilities do not report the information, unless the cost requires additional MILCON outlay.
- Resources - time, attention and people
- Staff shortages
- Cost and staff. Large time lag from planning and design to actual construction.
- Long-term commitment. This cannot be assessed in short term.

52. Would you be willing to work with other clients and/or A/E service providers or universities to develop a systematic methodology to study how healthcare facilities change, and make the evidence available in the public domain?



53. If the answer to #52 is yes, what entity is best suited to fund, lead and promulgate such a method?
- Policy makers and resource managers.

- A group effort of a COO and a facility planner.
- It would be depend on the extent of what is trying to be achieved. Universities are problematic if a discernible and applicable product is the end state goal being funded. If concepts to help focus future applied solutions are needed it is better to fund an organization and then the funder make the information public. Universities contrary to the sales pitch do a horrible job at sharing data. They generally produce summation reports, but fail to create maintainable venues for data sources to be shared and built upon. Instead universities hard data and use it as basis defend future funding.
- Maybe a Management engineering project for a large university
- Not sure at this point. It depends on the cost of the work and what sort of manpower commitment was required.
- Not sure
- DoD/NIBS
- DoD is doing it as a component of healthcare mission
- We as an owner could possible fund some effort. I think organizations such as ASHE, CII and NIBS could also lead the effort and secure funding from healthcare owners
- NGOs
- Don't' know
- Government funding first then collaboration among A/E firms and universities.
- Probably a public sector entity due to long life-cycle facilities, institutional culture which may be shaped outside the external influences of changes in private ownership, market volatility, profit motive, etc.

54. If you are willing and interested to be contacted for follow-up questions and/or discussions, please indicate and provide information about how to contact you

Other Thoughts And Comments

55. Other thoughts and comments

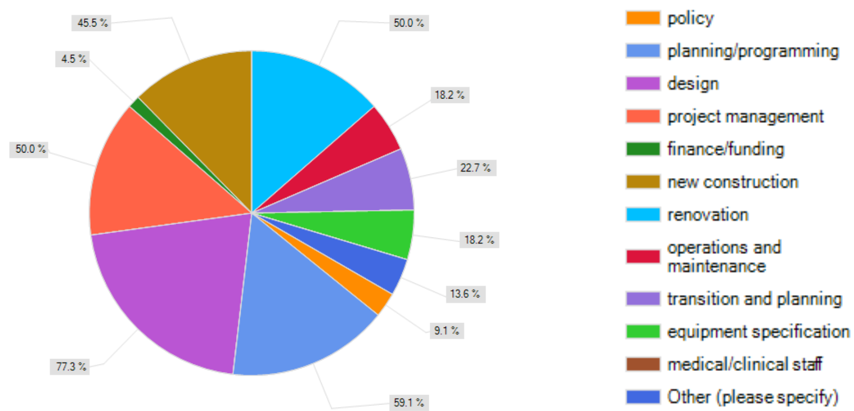
- We have an opportunity to reduce future costs and provide a better system of health care with flexible facilities.
- Please tell us how many questions are on the survey. I almost exited without completing it.
- Good thought provoking questions! Helped me with strategic planning considerations.
- Your comments on depreciation assume the public depreciates the facility as an asset. At least for the federal government we do not do that. The facility is generally considered a liability, not an access. There is no tax benefit for us in classifying the building elements by depreciation association.
- Long questionnaire! But an important topic.
- I had a bit of trouble with some of the questions--I do not think I always answered the question in a way that was intended. This will be a great conversation after you have had a chance to look at the responses. I think there will be great richness in the follow up conversation.
- Your survey could use some work
- Many of these questions are hard to understand and therefore the response may be lacking.
- Good topic. Should be part of the front end planning and programming.

Questionnaire – Architect/Engineers

Personal Information

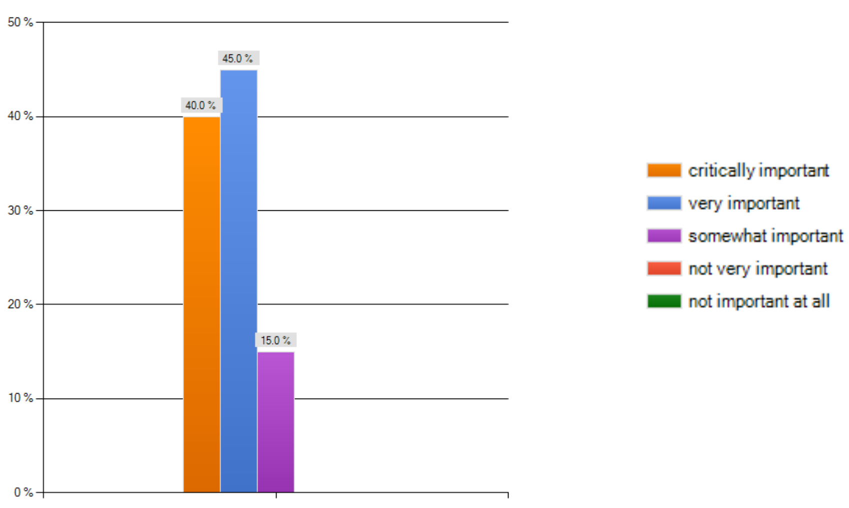
1. Please identify your NAME (optional)
2. Please identify your TITLE
3. Please identify your ORGANIZATION
4. How long you have been in this position?

5. Please Identify Your Role In Acquiring Healthcare Facilities In Your Organization



Flexibility As A Value Proposition

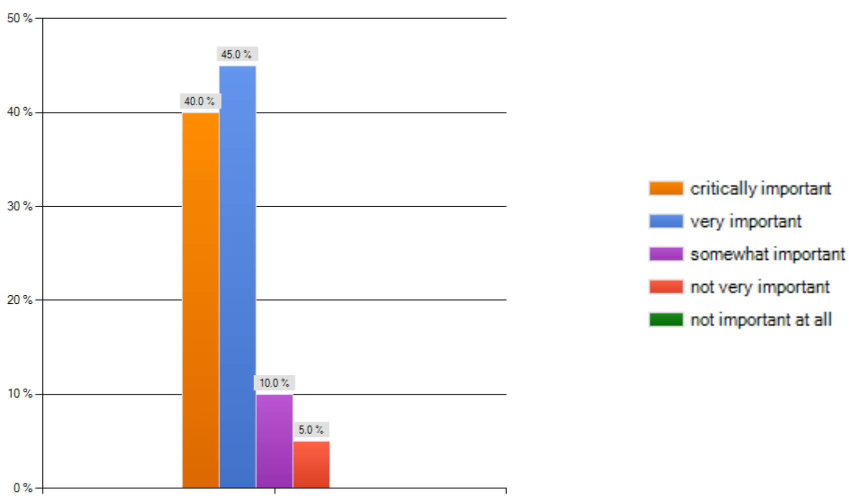
6. Is "flexibility" an important goal for public sector healthcare facilities?



7. If the answer to #6 above is somewhat important to critically important, please briefly explain why?
   - Changes in systems are so rapid, that they require functions to change within the building.
   - Change is inevitable
   - The changes that are developing in healthcare means that there will be significant changes in the delivery of healthcare over the next 10 years. Facilities should be designed and constructed with this flexibility in mind.
   - The future of healthcare and impact on facilities isn't predictable
   - All healthcare facilities need to readily accommodate change - daily, periodically, over time.

- Buildings are the static hardware in a continuously changing software environment.
- the ability to change overtime as equipment and clinical practices evolve rather than build new again
- Changing healthcare delivery will require facilities that change also. The disruption and cost of new or highly modified facilities ultimately impact the patient.
- I am taking this question as what most public clients express, not what i think it should be. Most public sector healthcare clients tend to emphasize flexibility less than private health care providers. Part of this is that flexibility has some cost and also takes creativity. Sadly, most public clients are short on both. The U.S. Army and increasingly now, the VA do emphasize flexibility.
- Healthcare facilities must be sustainable over years as they address changing technology, process and policy.
- The delivery of health services is critical to our social and economic success and will be taxed ever more in the upcoming decades. Both population-based and technology pressures will dictate changes in delivery models that, hopefully, our next generation facilities will be designed/constructed to respond to.
- Healthcare facilities needs are constantly changing and the rate of change is increasing
- Healthcare incentives, practice patterns and technologies continually change, and at a faster rate than can be accommodated by conventional buildings and construction techniques, leading to a lag in meeting the facility needs of healthcare, and in excessive costs for conversion.
- Healthcare facilities change constantly. the cost of change and its consequential impact to then current and future operations should be anticipated and controlled.
- There is a constant need for healthcare facilities to evolve over time to meet the changing needs of staffing, technology and population.
- Rapid changes in healthcare delivery and technology dictate it. Public facilities built for longer term heightening the need for flexibility.
- Life cycle cost savings
- Medical acuities are changing rapidly as are our evidence-based approach. Our building's need designs that can react to this easily A public hospital has to cater to all demographics and therefore flexibility is required

8. Is “flexibility” an important goal for private sector healthcare facilities or systems?

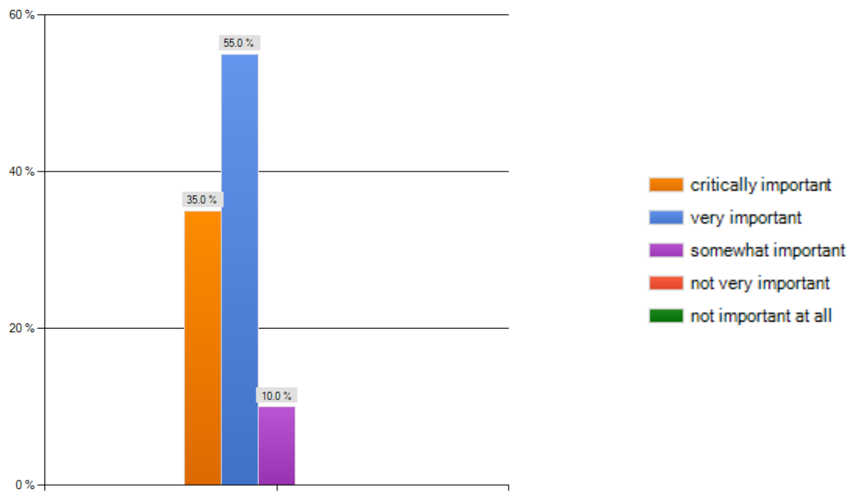


9. If the answer to #8 above is somewhat important to critically important, please briefly explain why?

- Changes in systems are so rapid, that they require functions to change within the building.
- Change is inevitable
- Flexibility is significant in order for them to stay competitive in a changing market.
- Same as question 7
- All healthcare facilities need to readily accommodate change - daily, periodically, over time.

- Same as 7
- The ability to change overtime as equipment and clinical practices evolve rather than have to build new again
- Don't know. Don't do private healthcare
- For the same reasons but to less of a degree. The reason; public healthcare may be restricted more than private to make the required changes. Here the patient will be impacted by not having the correct facility or equipment. The need for flexibility as a concept remains the same as written in #7.
- As noted above, private side is more aggressive about improvements to process and flow and therefore willing to invest time and money to be flexible so that future changes are achievable.
- Same reason - to remain viable in a changing environment of care.
- Lifecycle cost effectiveness is critical to privately funded/managed health/research enterprises.
- Healthcare facilities needs are constantly changing and the rate of change is increasing. It is no better or worse because a facilities is ranked "public or private"
- Same as 7.
- SAME
- There is a constant need for healthcare facilities to evolve over time to meet the changing needs of staffing, technology and population.
- Same as first sentence above. Shorter term building usage lessens the need somewhat.
- Similar to above, but a private hospital ca focus on certain centers of excellence that can minimize the need for flexibility

10. How important is “flexible healthcare facilities” as a goal for your organization’s expertise and value proposition?

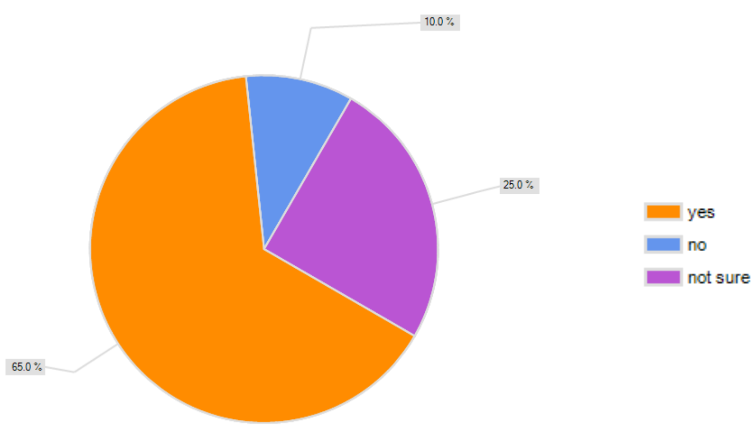


11. Assuming flexibility has become an important priority for your consultancy work, please briefly explain why – for example, is it a core corporate value or because clients ask for it?

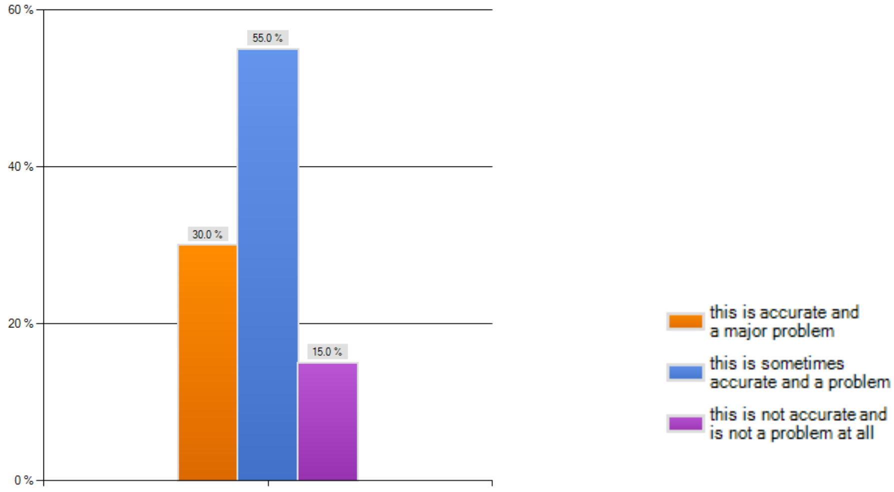
- It is a core corporate value that we have held for over 20 years. It is only one of many priorities and must always be balanced against short-term cost and operational cost increases.
- Core corporate value based on ever changing needs of clients and facilities
- We would not be acting on behalf of our clients if we did not explain to them the importance of flexibility within the design process.
- For the past 10 years we have be designing healthcare facilities based on a Universal Grid planning theory to build in flexibility anticipating unknown changes.
- Clients ask for it, thus it is a core value to HKS designers
- It is common sense to get the most, and that means over time, out of very extensive Capex
- This is a true need within our client's enterprise. They are seeking solutions that bring a high ROI for their new buildings

- Both
- The need for flexibility within our design and planning is a fundamental approach to how we offer services to our client. We strive to have "clients for life", meaning long-term clients and facilities in which we work within for decades. Often we are modifying buildings we originally designed and with the flexibility come successful retrofits or improvements for new technologies or healthcare methods.
- We think it is right thing to do, we often end up remodeling our own designs so want to make our lives easier in the future, :-) and it is the best value for our clients, whether they always know it or not.
- We are entrusted with designing a building that meets the clients' goals, mission and vision. We must provide a building that will meet their current needs and to minimize costly change in the future.
- It is mainly driven by what our clients are asking for. Flexibility is a common theme they want to see addressed.
- We believe planning for facilities flexibility or adaptability is a core responsibility of a HC architect and one that we take very seriously.
- While many claim to make flexible facilities, it is a poorly met need in the marketplace, and could be a competitive advantage if done well.
- it is a core value and a topic of specific research.
- Flexibility is seen more frequently in the research environment rather than the patient care environment. Investments in space tend to be to a longer time frame in patient care. Research needs must adapt more quickly to funding changes, whereas patient D&T spaces are more dependent on longer change cycles of staffing.
- Primarily a core corporate value recognizing the long-term value to flexibility.
- Client asks for it
- We suggest and recommend it to clients as part of our design and planning services

12. Should “flexibility” be an intrinsic part of the larger “sustainability” agenda, with its own metrics?



13. To what extent to you think that owners want flexible healthcare facilities but cannot define flexibility in specific performance criteria, making it impossible to assign a value (cost or otherwise) and making the design of flexible facilities impossible?

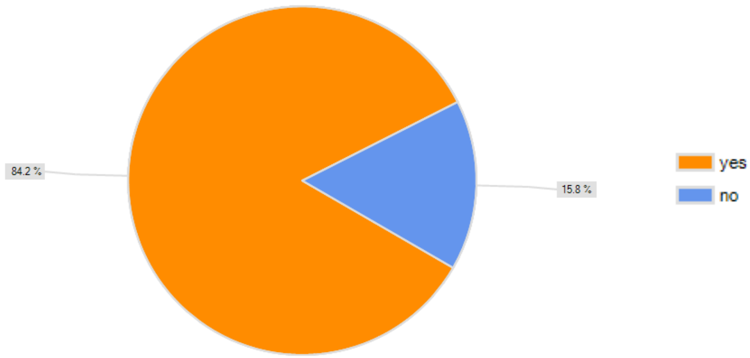


Defining And Assessing Flexibility

14. What is your current definition of healthcare design for flexibility?

- The ability to change and expand on a campus level, the ability to accommodate the most feasible options for modalities in a space today and in the future.
- Our Universal Grid Theory
- To ensure that new facilities can be adapted to accommodate the anticipated changes in healthcare delivery within the time frame of the building.
- A planned strategy that is adaptable to change ie modular systems of all types allowing incremental change without overall system change- plug and play
- Ability to accommodate change without construction, adapt for change with light or heavy renovation construction, or expand to grow through new construction with circulation infrastructure and way-finding remaining clear and strongly supportive to efficient and convenient use.
- The ability to accommodate changes in mission over an extended period of time, decades
- One that can adapt for future change and minimize downtime
- FLEXIBLE - to accommodate continuous programmatic change
- The ability to adapt a facility to future needs of the patients and caregivers
- No set definition, but i know it when i see it!
- There are many different levels of flexibility and each has a budget impact. The right level of flexibility must meet the client's budget. Flexibility means a footprint - free of vertical risers - that can be reconfigured in the future. The platform may have additional structural, mechanical, power and data capacity.
- Facility design that makes intelligent decisions to address future changes in program.
- Healthcare design for flexibility is defined at many levels. What is normally referred-to as flexibility is actually adaptability. That is the ability to accommodate, even embrace change. Change happens at many levels so adaptability must be accommodated at many levels.
- The ability of the facility to accommodate change in incentives, practice patterns or technology with minimized cost, schedule and disruption.
- ONE THAT IS RADICALLY ADAPTABLE TO BOTH SMALL SCALE AND LARGE SCALE CHANGE THAT IS A FUNCTION OF CAPACITY, TECHNOLOGY, PROGRAM, OPERATIONS OR PURPOSE.
- The best model for flexibility in healthcare is the acuity adaptable patient room or the "generic" outpatient clinic.
- Building systems that are integrated in a manner to minimize disruption and to have minimal impact on ongoing operations.
- Ability to serve differing acuities and medical protocols as the need of society and our physiologies dictate

15. Have you been asked by clients specifically to provide consulting services for a flexible healthcare facility?



16. If so, please name the project or projects

- Every client asks for flexibility.
- King Faisal, KAS; KOC, Istanbul
- Banner Health
- ALL OF THEM!
- Confidential
- MGH, NYU, BWH
- Virtually all projects want flexibility but are reluctant to pay for real flexibility.
- To some degree, all projects and all clients have asked for this. An example is many clients hold-off on medical equipment selections and we are required to maintain a level of flexibility until the actual equipment is purchased.
- US Army Fort Campbell Blanchfield Mental Health Facility Providence St. Vincent Surgery Expansion, Portland OR Legacy Salmon Creek Hospital, Vancouver WA Kaiser Orchards Medical Offices, Orchards WA National Institutes of Health Replacement Hospital, Bethesda MD Seattle Children's Hospital New Patient Building, Seattle Wav
- Mayo Clinic, University of Kentucky, Group Health Bellevue WA, University Hospital Dubai for Harvard Medical Center, Sanford Medical Center, Park Nicolett Health System, Mercy Health Partners OH.
- Victoria Comprehensive Cancer Centre, Melbourne. Common requirement for science park projects.
- Banner Health System. St. Joseph Health System, Veterans Affairs System, many university healthcare systems.
- All of them.
- Department of Defense Texas Health Resources Intermountain Healthcare
- Cannot w/out clients permission

17. What criteria do you or would you use to declare that a project (your project or other projects) is “flexible?” That is, what are the criteria for evaluating a facility for flexibility, both technical and process/policy-oriented?

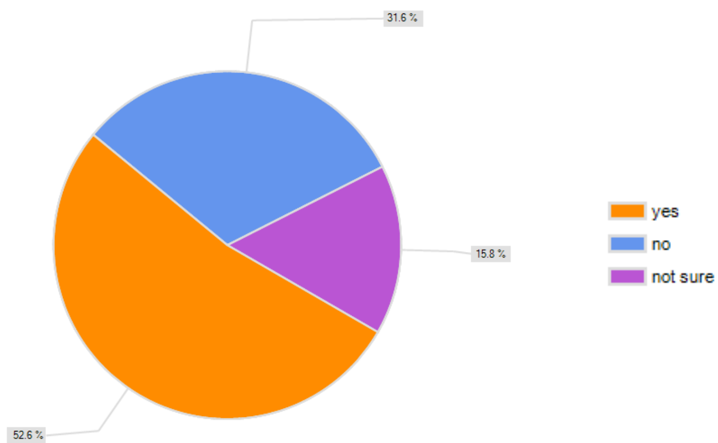
- It has mostly to do with infrastructure, adequate structural grid and modifiable construction materials.
- Universal Grid theory and implementation
- Can it grow beds, can it shrink beds. 2. Are the "types" of function clearly defined 3. Are areas interchangeable 4. Are the construction materials and form adaptable 5. Is there facility isolation to ensure adaption
- The major physical criteria would include the design of building components, systems and elements to have the ability to be moved and modified with minimum waste and time.
- Open-ended circulation pathways for public and service 2. Major departments positioned for easy expansion in the future without major renovation 3. Inherent soft space of departments that can be relocated to grow harder departments in place. 4. Standardization of rooms 5. Application of modular design where appropriate 6. Creation of areas for swing use of space during periods of opposing volume levels
- See 14 above

- Structural planning; floor to floor height investing in main MEP lines for future growth; determining the likelihood of growth/change for that particular institution and focusing on what it requires; accessibility for change while occupied; consideration for pre-fab that can easily be changed; first cost/operational savings analysis; Relationship to operational staffing; flexibility re: movable equipment and furniture; stacked services
- Flexibility requires configurationally flexibility (movable walls etc) and expandability.
- The initial criteria would be; the facility was able to adjust to the new technologies and new types of healthcare methods from the time the building was first designed to the first day of occupancy. Beyond that initial occupancy, the flexibility success would be a result of how the facility was able to continue evolving through the years, easily adapting to change in a cost effective and minimally disruptive way.
- Test includes open plan, simple grid, grouping of vertical elements and fixed "monuments" so that a variety of programs and room types can be laid out. Also extra capacity or means to add capacity of systems w/o major disruption
- Universal room modules - ED, Surgery, Inpatient; Interventional Platform that blends Imaging and open procedures; designated infrastructure zones; on-stage/ off-stage circulation
- Change/adaptability is incorporated into the program of requirements. Design options analysis includes growth/change models.
- A facilities ability to change at the micro level and the macro level
- No consistent metrics.
- Simple and modular geometries; structural systems and bay spacing; floor to floor height; core locations; systems distributions.
- Again, I think that the term "flexible" is very difficult to apply to healthcare space. It is very rare for a department or specialty to be relocated without some type of space customization to suit the staffing and efficiency model of the operation. Based on an institution's behavioral and organizational structure there are few static factors.
- Use of modularity. Open-ended growth potential Location of "soft space" close to high growth departments Establishment of structural, MEP, communications systems and medical equipment selections that accommodate the than inhibit process changes.
- as an engineer I focus on the MEP systems and their ability to meet the code needs of differing treatment levels

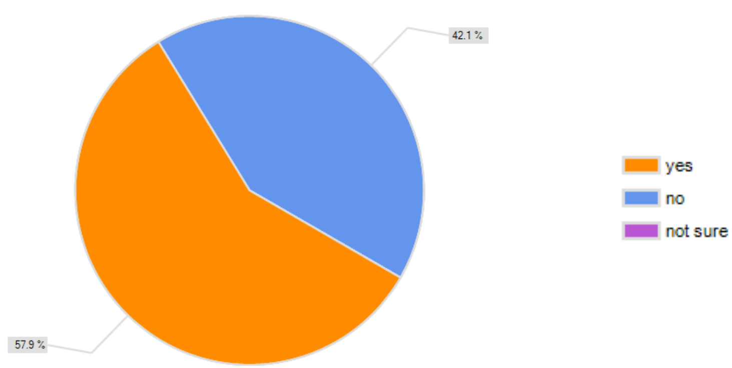
18. What factors/constraints/drivers do you consider in discussing “flexibility” with your staff?
    - First cost, available space, technology, likelihood of change, operational cost, ROI
    - Same as above
    - 1) Whole life costing must be a client driver 2) Future clinical needs must be appreciated 3) Forward-looking clinical leadership must be in place.
    - Degree of first cost for higher modular and movability compared with life cost
    - Items listed above in 17.
    - See 14 above
    - Same as 17 except making sure they highlight this as a goal and helps to shape the focus and decisions
    - All factors.
    - Ability to adjust healthcare staffing, type of care, medical equipment, maintenance, the patient and staff environment, future expansion, level of patient supervision, partial occupancy (ability to close-down parts of the building), security, accessibility, aesthetics and environmental conditions (light, heat, humidity, noise).
    - For one, I point out a local Skidmore Owings Merrill design done in 1970 for St. Vincent Medical Center. We have added on and remodeled millions of SF there and their design is soooo flexible to allow for clear expansion and for renovation for all sorts of program changes, we use it as a case study.
    - Universal room modules - ED, Surgery, Inpatient; Interventional Platform that blends Imaging and open procedures; designated infrastructure zones; on-stage/ off-stage circulation
    - Separation of systems with different lifecycles (new). Determination of additional engineering services capacity Systems redundancy models Modular design concepts
    - It is a way of life in our culture and constantly reinforced. Considering flexibility goes beyond the program and the immediate design solution. We build it into every HC project.

- While there is great interest in 'flexibility', it is rare that flexibility is considered more important than the additional capital cost, or reduced revenue, that flexibility seems to require.
- Capital expense; prototypical room types; speed to market; materials implications; design latitude; scale; net to gross ratios; program compliance.
- The difference in up-front cost for the infrastructure to support "flexibility" or "adaptability" is paramount. What must also factor into the discussion is the likely hood for change - a public or government facility is much more likely to experience a 20 to 30 year cycle between renovations that a private client.
- Budget Decision maker attitudes Lack of quantifiable and comparable operating data between more traditional and more flexible facilities.
- Space conditions and budget

19. The distinction between “equipment” and “real estate asset” provides one way to define “flexibility” in the sense that building equipment can be depreciated over 3-7 years while “interiors” can be depreciated in 15-20 years and “core and shell” in 30-year cycles. Given this, do you attempt to increase the investment in “non-core and shell” as a way to increase flexibility?

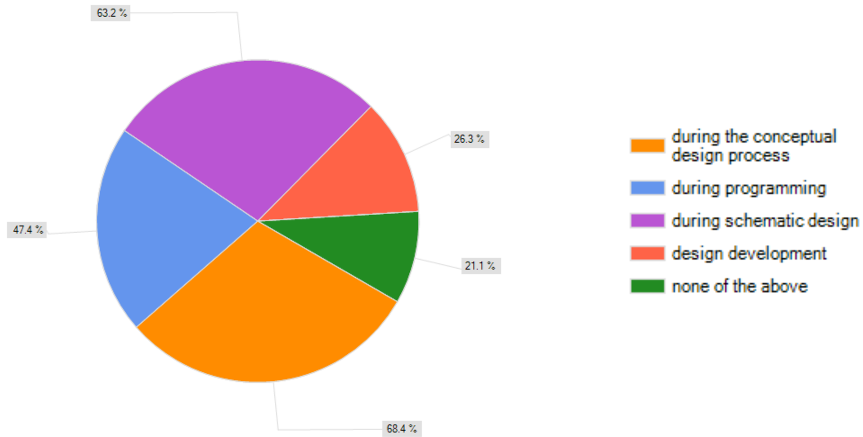


20. In your experience in the healthcare sector, has an expansion of the category of things called “equipment” – to include more and more parts of the total healthcare facility – made achieving a “flexible” facility for your client easier?

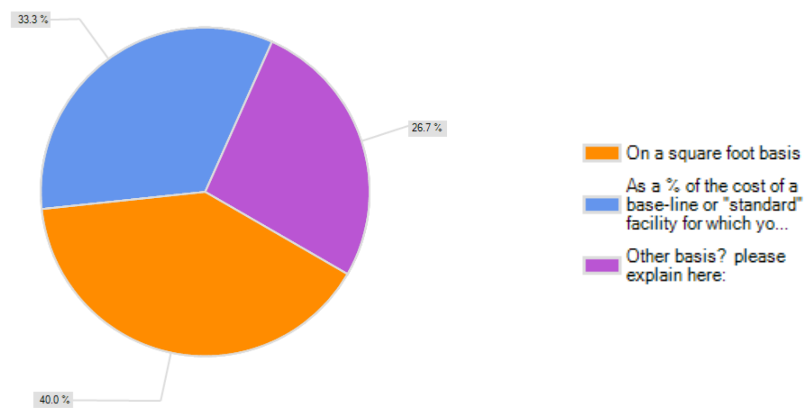


Cost Trade Off

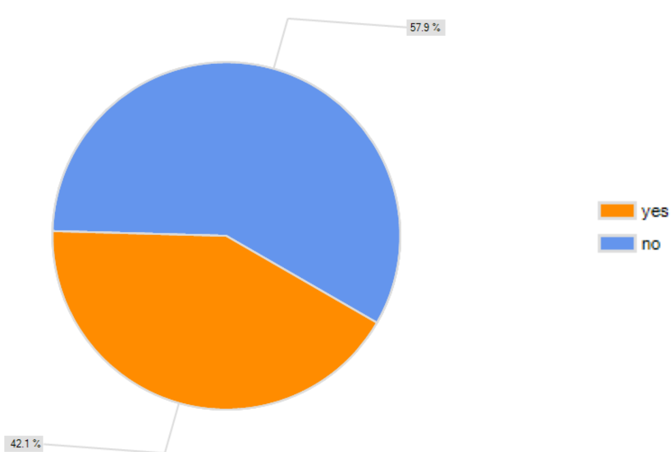
21. Do you provide cost estimates for alternative "flexibility" strategies? (check all that apply)



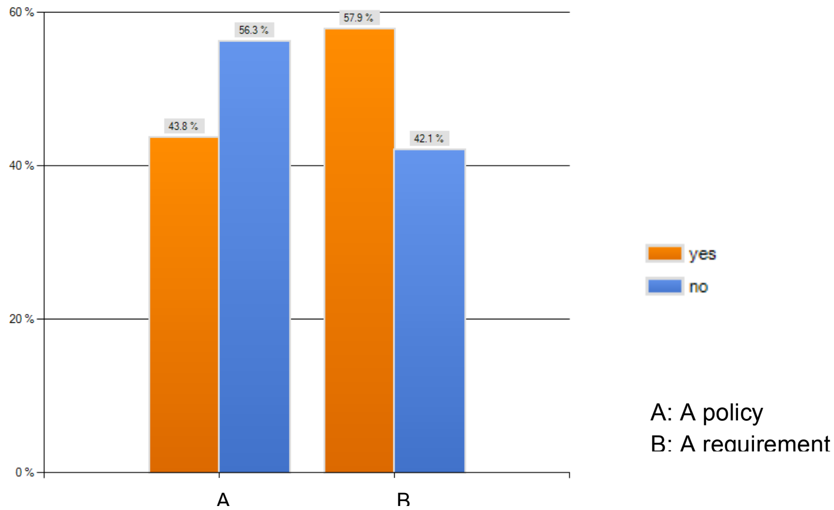
22. If the answer to the question #21 above is YES, on what basis do you offer such estimates?



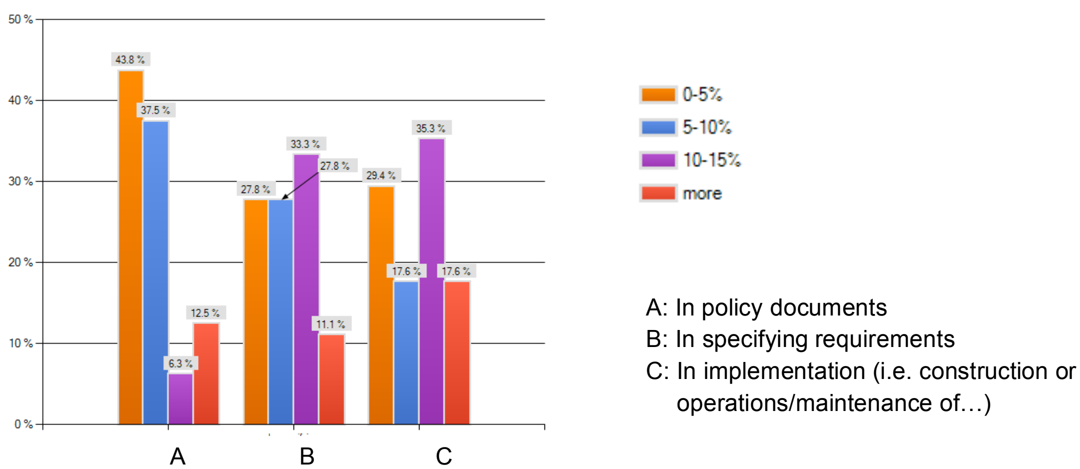
23. Do you have a methodology to estimate the added cost of making a facility flexible?



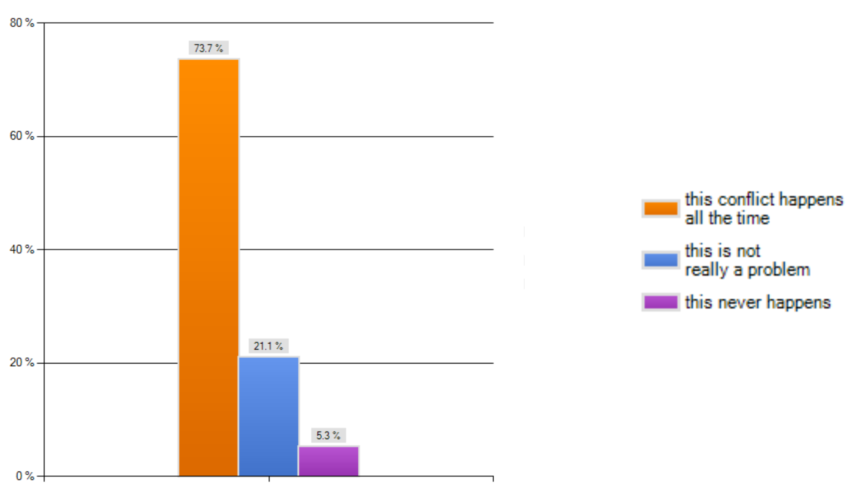
24. When a cost premium exists, to what can you attribute it?



25. Assuming that you know there is a cost premium, and assuming you can monetize it, would you say the premium for adopting a "flexibility" strategy occurs:



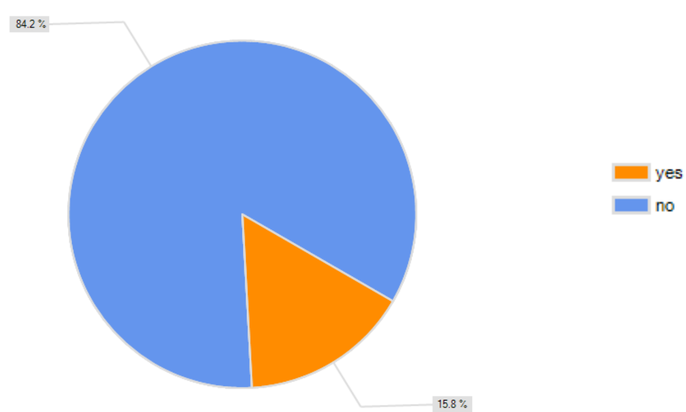
26. To what extent does a “flexible” project come into conflict with other priorities?



27. Please give a few examples of these conflicts.

- First cost, HVAC, space premium
- In laboratory design the cost of adjustable counters/bench, movable modular casework, etc
- Capex versus Opex
- Cost savings for VE specific requests by critical clinical leaders vs. a more Flexibile solution specific needs for specific departments.... neuro vs. cardiac for instance for 1st and 2nd use
- Cost and planning overall planning efficiency. Question 25 very confusing by the way. Please disregard answer.
- The conflict begins with the need to design to minimum standards. Anything beyond the minimum is often seen as wasteful or indefensible.
- I don't like the limited choices above in 25, (where i don't have the information) or 26, sometimes there is no cost if provided for early in process, (i.e. the right grid and building width) or CAN EVEN REDUCE COST! But an increased floor height often adds cost and within reason, improves flexibility is an example. Extra HVAC, I.T. and electrical capacity has cost too. I assume we are discussing first costs. If operational and long-term costs are mixed in, it is a whole new formula. The issue is that there are often fixed capital budgets and scope and no matter what the long-term savings, short term prevails. The DoD limits by law the ability to provide for that extra capacity also as do some other public agencies. Not sharing in Q 28 as it is usually informal and most clients don't ask for summary of documentation. Maybe able to find examples if needed.
- Physicians are used to working in their own "silo". Designing flexible, multi-disciplinary exam modules sometimes causes anxiety for physicians who want to maintain control over their clinic. Flexibility may require duplication of medical equipment.
- In conflict with first (construction) cost without ability to also factor ongoing life-cycle costs because they are from a separate budget. In conflict with design fees and the project schedule ("no time/fee to do lengthy studies).
- First cost, loss of revenue, demands of the program, lack of lifecycle data.
- Reducing area to reduce cost. Reducing floor to floor to reduce cost.
- A concern about initial costs. Often a low bottom line mentality from construction companies.
- Usually budget based

28. Would you be willing to share cost details related to the above information that can be included in a final report associated with this questionnaire?



Barriers To Flexibility

29. What are the one or two most powerful barriers to getting healthcare facilities designed for flexibility?

- Money and space
- One is the application of our Universal Grid planning theory both plan and more importantly the floor to floor-height (18feet) which will allow flexibility for future use change. The higher floor-to-floor heights are always challenged on a first cost basis due to envelope and volume cost.
- Site, zoning or existing conditions

- Adopting a future view of the likely clinical changes and then the cost of adopting the required differences.
- Building and department grossing factors infrastructure costs - providing lowest first cost sometimes conflicts with flexibility goals
- First cost
- Addressing it early in the process client's understanding/agreement of return for initial $ investment
- Cost and data about rate and cost of change.
- Cost and deviating from standards
- The issue is that there are often fixed capital budgets and scope and no matter what the long term savings, short term prevails. The DoD limits by law the ability to provide for that extra capacity also as do some other public agencies
- Cost Physician buy-in
- Stakeholders agreeing on the future requirements. Project budgets that acknowledge a premium.
- Lack of agreement on what 'flexibility' means, first cost, loss of revenue-generating space, lack of lifecycle costing data.
- There is an overwhelming pressure to customize a new facility to meet the needs of its immediate users. With budgets and available space often very overcommitted, it is long-term flexibility that most often suffers first.
- First cost pressures. Lack of understanding of what makes a facility flexible
- Cost and maintenance considerations

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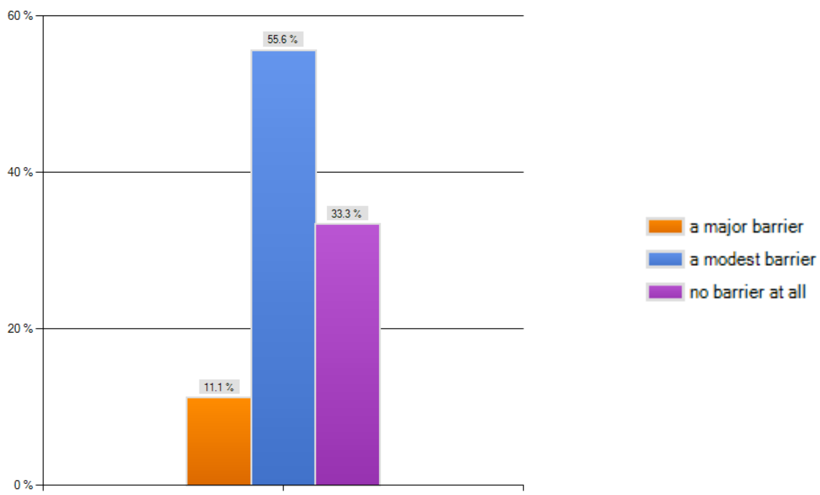
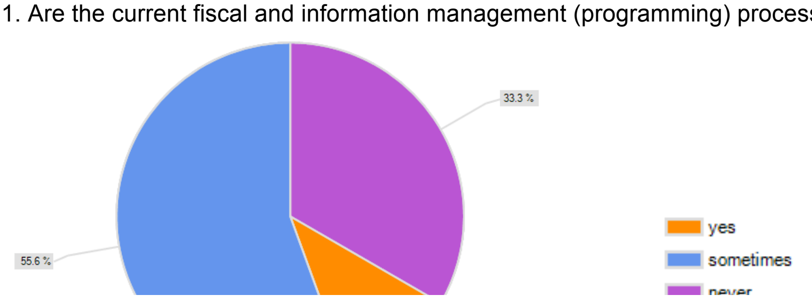
30. Assuming that your organization adopts short-term strategic plans, to what extent does this present a barrier to achieving a flexible facility?

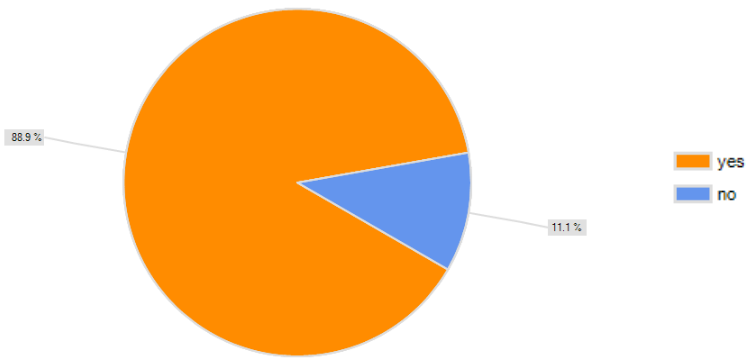


31. Are the current fiscal and information management (programming) processes used by your clients who expressly ask you

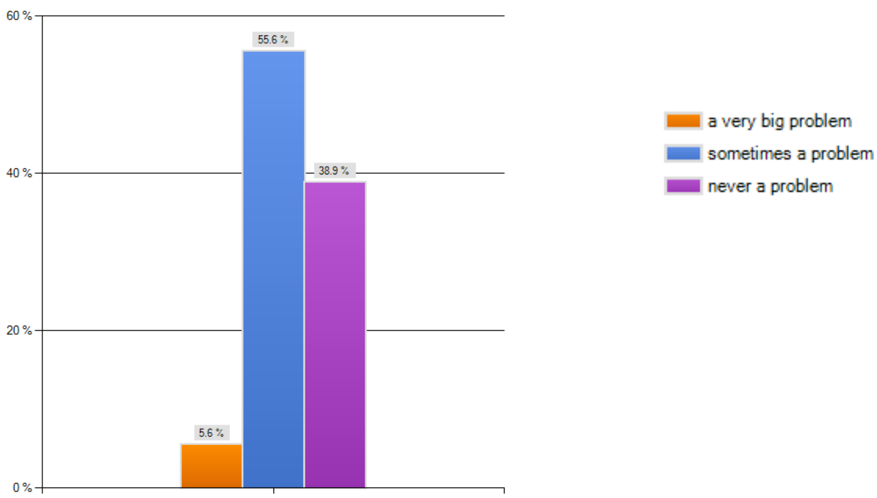


to help them acquire a flexible facility designed to support that goal?

32. If not, have you recommended to your clients that they adjust their processes to enable you support their planning efforts to acquire a flexible facility?



33. To what extent do your in-house priorities, metrics and attitudes make achieving a flexible facility difficult?



34. Please explain briefly how these priorities, metrics and attitudes are barriers or enablers to your ability to design a flexible facility.

- It's all about multipliers and space, which equals money and construction cost. This is a challenge, given a fixed budget.
- As previously noted we have practiced with a long-term futures/flexibility perspective. It is called Universal Grid Planning Theory. These issues are at the top of the agenda and a design driver in all our health and science projects.
- Our clients understand Universal Grid Theory as a long term, flexible and sustainable benefit.
- We do not have internal barriers to developing flexible designs. Our clients have the barriers in their organizations.
- Application of the principles cited in #17 to our designs
- The traditional sequential linear design process, often spread over many years, is not conducive to optimizing decisions. Our system, based on the chip design industry, introduces a circular process where no decision is final until all decisions are final resulting in optimized trade-offs.

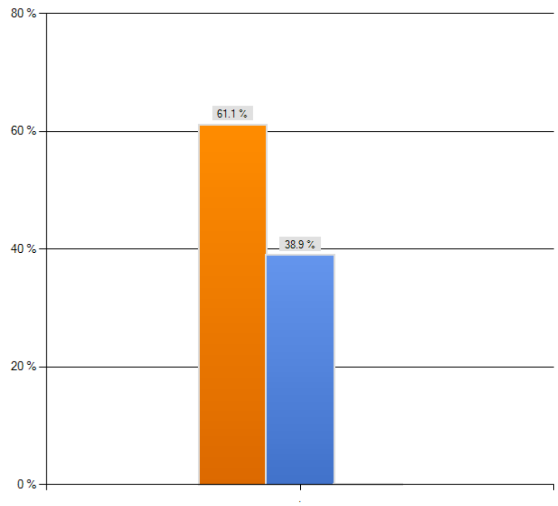
- if a team is not unified on the guiding principles regarding flexibility early on, a project can lose flexibility during the design process
- Concerns about cost prevent implementation of some flexibility strategies. We do things as an integrated design firm to optimize flexibility within budgets.
- Many are comfortable and confident with refining what they are familiar with. Flexibility requires a break from this and the ability to forecast changes.
- No comment
- One of our primary goals in providing flexibility and sustainability on all projects.
- For the most part, if fees and schedules are set address the additional design analysis, there would be little resistance and a lot of creative energy put into the process.
- The priorities for flexibility are no more or no less than any other priority because the costs are not significant.
- Healthcare needs change rapidly, and major healthcare facilities are generally designed and built within a very short range of future knowledge (i.e. <5 years). Growth demands almost always lag provision of adequate facilities, and therefore there is almost always an oversubscription for space, as well as the demand for a 'tight fit', as opposed to a 'loose fit' with a greater opportunity for adjustments to accommodate changing demands. With healthcare reform, and the demands of other capital-intensive elements of healthcare, equipment, renovations and IS, there is a similar pressure on minimizing cost. Both are barriers to providing more flexible facilities.
- A comprehensive attitude to incorporating long-term expansion and flexibility, along with the use of modular design components, are rarely barriers to good design.
- A certain amount of flexibility can be incorporated into any project. The barriers come to play when initial cost considerations take priority over highly flexible options; ie, Interstitial space, demountable partitions, flexible electrical connections and so forth. On the other hand an increasing acceptance of prefabricated elements is contributing to the ability to design flexible facilities.
- There are neither....it is usually a case by case basis

Planning Processes And Methods

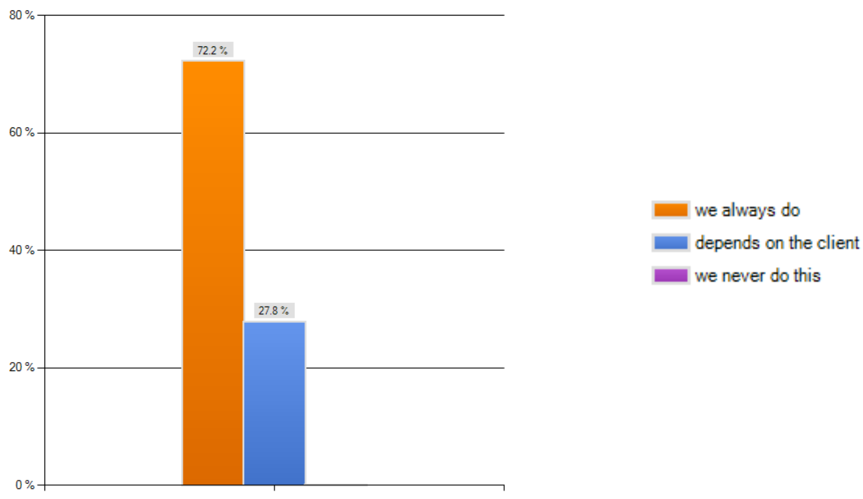
35. What are key critical success factors in a design process that you use to help you design a “flexible” facility?

- Imagining scenarios for expansion and change
- Planning grid/structural bay, floor to floor height, modularity of map systems, etc
- Adherence to Universal Grid Theory which adapts all programs needs current and future for HC facilities
- Reflecting on the past project solution and recognizing how flexible they had become over time.
- Noting to our clients why we recommend certain programming and design concepts and configurations
- See 34
- Guiding principles for flexibility early on Consultants who are on board with flexibility educating the client
- Client satisfaction.
- Having time to consider the future needs and a client who values this exploration
- Supportive client, flexibility is a stated project goal
- Reuse of the building or area for another function over time.
- Universal design concepts. Modular planning. System servicing/change out planning (operability).
- Simply explaining the importance of flexibly
- Lifecycle costing, developing the concept of standards and 'generic' space, loose fit.
- A successful space is able to meet the needs of multiple use typologies over time without severe limiting factors. That said, technology is always evolving and best-practice judgment must be applied to anticipate change.
- Post Occupancy Assessments that prove out the advantages of flexibility
- Education of the user groups demonstrating early on the benefits and cost implications

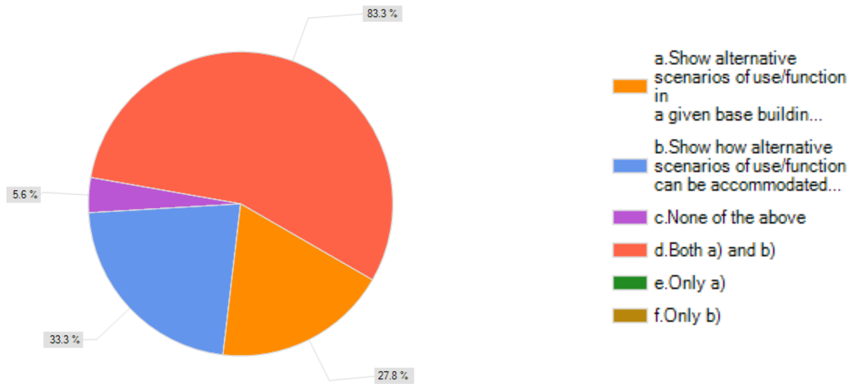
36. How frequently do clients ask for “flexible” healthcare facilities?



37. To what extent do you market your services as providing “flexible” healthcare facility solutions?



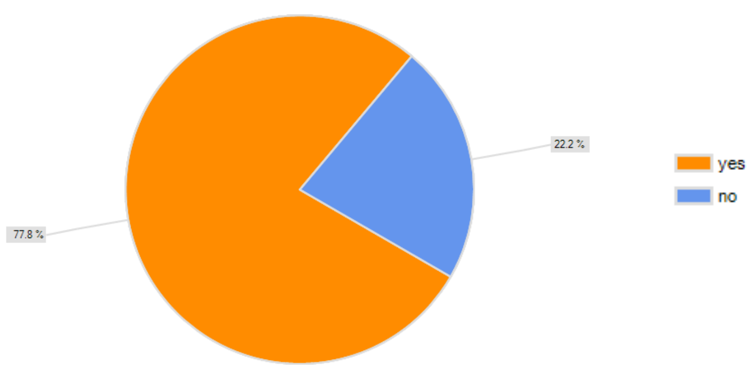
38. How do you demonstrate that the facility you are designing will be “flexible?” (Check all that apply and add comments if appropriate.)



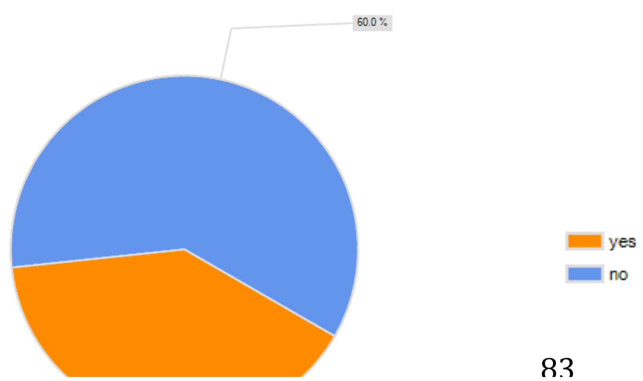
Comments:

- In the early design phases there will always be alternative solutions for plan form, elevations and systems. One range of options can be explained through "flexibility".
- Like other asks, all clients may ask for flexibility, but 50% of time, it falls by wayside due to budget or other priorities.

39. Does your firm invest in developing new methods and strategies for healthcare facility design for flexibility?



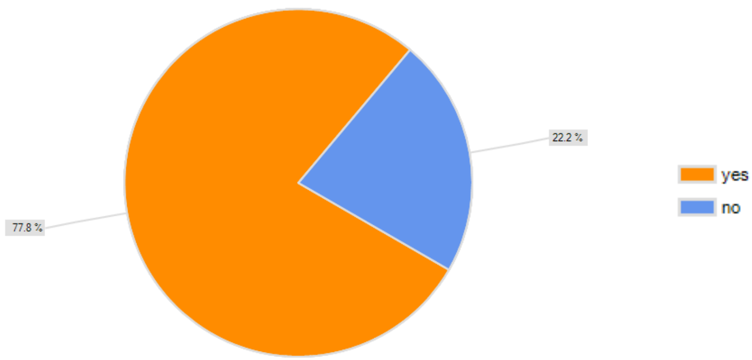
40. If the answer to #39 is YES, do you have a specific business plan or research team for developing and implementing



flexibility strategies?

Precedents

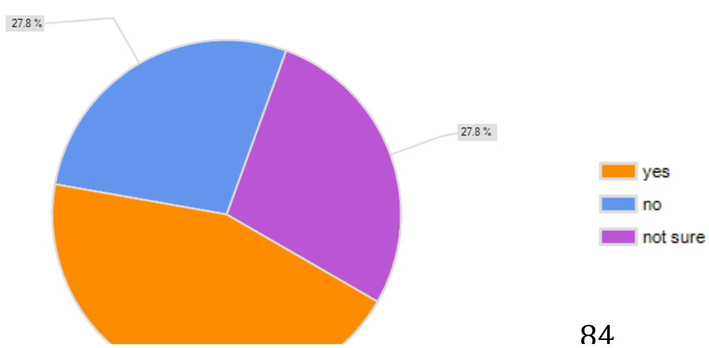
41. Have you examined other policies, requirements and/or projects (health care or non-healthcare) that you consider “flexible” to see if you want to aim for a similar standard?



42. Please identify those policies, requirements and/or projects here.

- We are currently working with Novartis on their Lab of the Future where every decision from equipment, systems, technology, furniture and planning is vetted for flexibility. The fixed infrastructure in being reduceds the moveable components considered for every possible decision.
- Not sure
- Commercial and retail facilities are usually the favorite targets.
- We look into other industries ini oru research efforts to see what is being doen outside of healthcare
- DOD, ARQH, NHS, VA,
- In manufacturing, commercial buildings, office environments and construction
- Lots of projects, but most impressed by recent projects in the Netherlands, including Martini and Orbis.
- Workspace, corporate and govt. offices, research labs
- We are constantly researching other means to provide flexibility in healthcare facilities.
- Science park design.
- There is something to be learned from other project types that have application to HC and many around flexibility.
- Various international healthcare projects.
- As our practice also includes academic education and research, we are constantly looking to them for inspiration.
- VA Red Book DOD Integrated Building System Criteria Flexible School Design Publications

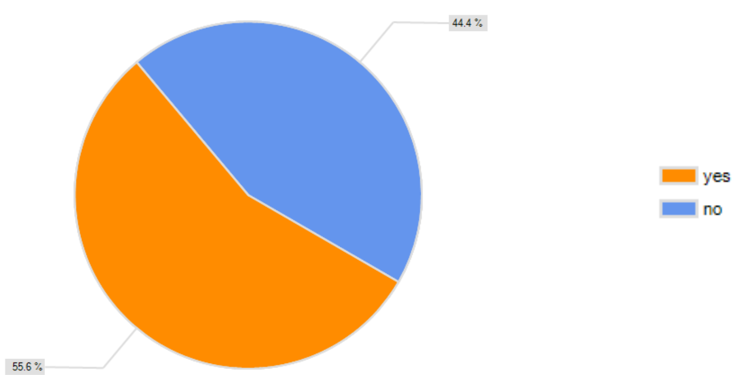
43. Does the commercial office markets’ distinction of base building, fit-out and FF&E (furnishings, fixtures and equipment) apply to healthcare facilities design for flexibility. (In such projects, detailed programming is done after the design of the base building (core and shell) so functional areas can change without disturbing other areas of the building)



44. If the answer to #43 is yes, please explain why you think so and how it applies.

- Simply the change and churning of office use is now seen as a very appropriate model for current and future unknown changes in healthcare spatial needs.
- Commercial office market in many cases sustains multiple change and fit up scenarios
- Separation of hardware and software applies in healthcare design as it does in chip architecture
- Our hospital clients are fixated on functionality, which they need assurance of in the design stage in order to proceed with the work.
- A facility designed as "core and shell" with separate fit-out packages is inherently flexible. The platform for department layout is free of risers and shafts in program areas.
- Occupants and functions are endlessly changing. Programs move in and out, especially in the expanding field of clinical research.
- Planning modules and plan layouts are just as important in other building types as they are in Hc.
- Commercial office needs are unsophisticated relative to more intensive healthcare facility needs, healthcare programs more demanding, and the operational determinates, from both clinical and infrastructure demands, on healthcare functions appear to demand a greater integration of the interior and exterior.
- A large share of healthcare work is in renovating existing facilities where the "shell-core" approach is the base condition. New facilities for ambulatory care are also being called for in this model.

45. Do you look to overseas examples of “flexible” policies, requirements and / or projects?

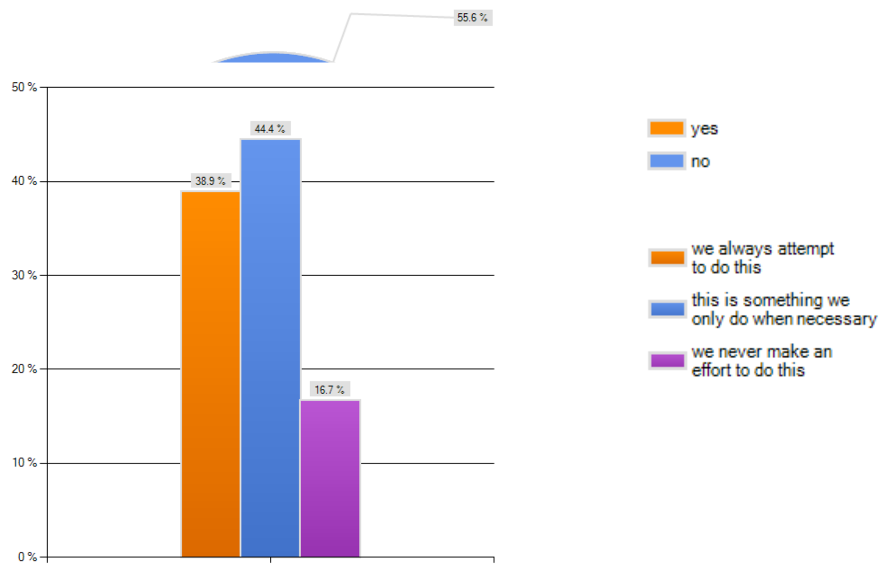


46. If the answer to #45 is yes, please identify them.

- Open Building history has its roots in Europe
- Other European Architects
- There are no exemplar cases that I have identified.
- Other healthcare facilities and health systems with whom we work
- UK, Canada, Australia, Holland,
- Depends...some are but have different regulatory codes than the US- but there is always something to learn.

- See 42 above
- H.C. in Europe has some elements of flexibility, but some that limit flexibility.
- INO Bern, Hospital du Luz Lisbon, British PPP policies.
- It is very difficult to look to European or Asian examples because the healthcare delivery system is radically different (staffing, reimbursements, length of stay, etc.)

47. Do you advocate to your clients that achieving "flexibility" requires that detailed decisions about spatial organization and equipment NOT be made up front or allowed to dominate the architectural infrastructure of the facility?



48. To what extent do you currently uncouple detailed programming for departments and equipment from the base building decisions, to avoid the details from determining the overall asset quality/value?

Tracking Flexibility

49. If you had resources to track the behavior of facilities over a period of years, what patterns of change would you look for – situations or instances of change that, if you could document them, would be most beneficial to know about? Patterns or situations of change that would yield results in planning future "flexible" facilities?

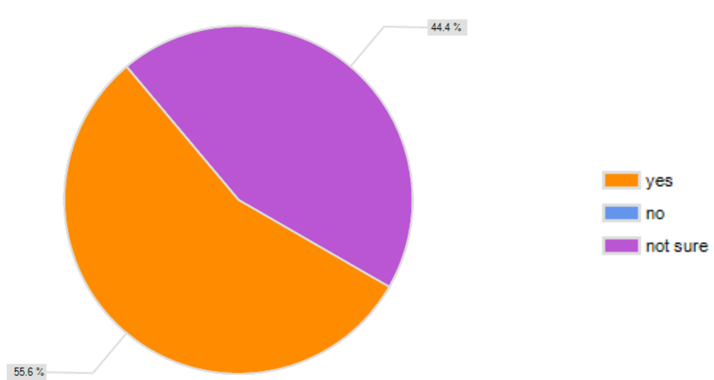
- Changes in use i.e. inpatient to office, diagnostic and treatment
- Change in use, change in function, change in technology, change in regulation, change in reimbursement, etc
- Technology and innovation outcomes both in terms of policy, practice and procedure
- Post occupancy evaluation is a missing component in identifying the success or failure of whether flexibility worked or not. These are rarely carried out and hence we have little
- CHANGES IN FUNCTIONAL PERFORMANCE, INCLUDING STAFFING PATTERNS, MATERIAL MANAGMENT, PATIENT SAFETY INCIDENTS AND FAMILY ACCOMMODATION
- Changes that impact MEP, dept layout, technical equip changes. Also changes that should have been made but were not because of the difficulty or cost involved.
- We do POEs and this is one thing we track- from the micro - how a person changed their work space, to a macro- how were they able to change a whole department or add onto the facility
- Data on change of all types, configuration, function, capacity would be enormously useful.
- Patient satisfaction and staff turnover rates
- Multiple use of spaces whether over long period of time, over a week or in a day. Degree of difficulty in renovations and how renovation planning is uncompromised, or is compromised.
- Operational/ nursing model changes technology changes

- Use change and elemental system cost e.g. change/adaptation.
- Is the building "easy" to add too? Can incremental change take place without serious interruption?
- Rate and extent of change required, cost, disruption, schedule.
- I believe that we would look at many things: staffing ratios - the amount of space and number of people; the amount of staff support space; the infrastructure requirements to support equipment; the size of patients and their companion groups; the size and number of patient amenities.
- Frequency of change Kinds of change Ease of change Cost of change
- The design of energy efficient buildings w/ iconic architecture to promote wellness also inherently promote flexibility

50. More generally, why, in your view, has no one yet developed a systematic methodology to track how facilities change?

- it's really complicated, and it's not clear that the results will help predict future change
- In general the concern while important is relatively recent. We have built a number of health and science buildings based on Universal Grid Theory over the last 5-10 years and will revisit but the "changes" haven't happened yet.
- Not sure
- Flexibility is a whole lifetime issue, construction budget is a 12 month accounting issue. The time lines are not complementary.
- We don't get paid for it. We don't get paid enough for the design effort to begin with.
- I do not know
- It is tough because all are so different. I think it would have to focus on specific issues...like mechanical systems for instance, changing medical equipment or OR use change.
- Lack of funding for research and the longitudinal nature of the study.
- Possibly the data is too random
- We are trying to get the work done in front of us on limited fees. Most clients, right or wrong, don't want to document such a system or won't pay for it. Kaiser Permanente is an exception in some cases.
- It's seems very complicated and somewhat specific to a healthcare organization - all of them may be different.
- This has not up until now been a "discipline" and hence no disciplined approach has been proposed. the market has not demanded such a view, as the measures of success and economic incentives were all short term.
- There has been some attempt to do this with POE's (post occupancy evaluations) but sometimes institutions become less interested our less disciplined in tracking such things.
- Too complex, too rapidly changing.
- I think that this is a difficult question to answer because the baseline is always shifting as healthcare delivery adapts over time. More outpatient space, more amenity space, single patient rooms, smaller staffing ratios, etc. have all dramatically changed over the past 25 years. It is not quite a chicken-and-egg scenario but it makes developing meaningful bench line data more challenging.
- It requires staff and cost to accomplish and assessments are probably sporadic rather than continual.
- We need organizations to track this and unify the design and medical communities committed to this (conferences, symposiums etc)

51. Would you be willing to work with other clients and/or A/E service providers to develop and apply a systematic methodology to study how healthcare facilities change, and make the evidence available in the public domain?



52. If the answer to #51 is yes, what entity is best suited to lead such an effort?

- A combination of a research based A/E firm and a University research team
- Our Director of Research
- The proposed new DoD MHS center for facility innovation and research, now in business planning stage.
- Not sure. Facilities Guidelines Institute?
- Smart clients with money to research. Look at the same group setting up BIM standards as they have lots of facilities and can benefit from ongoing improvements (compared to smaller organizations who build only occasionally) The BIM group includes U Texas, U Cal, VA, DoD, Kaiser and others.
- An academic group
- Not sure. First thought is a strategic facility management expert. Architects are best trained at open-ended thinking but probably can't lead the process.
- The architect with the approval and endorsement of the institutions "C" suite
- Perhaps the academics: I think this is more a policy and lifecycle costing exercise than a search for technological solutions.
- Some form of research entity that is sufficiently funded
- ASHE, or a building institute type organization

53. If you are willing and interested to be contacted for follow-up questions and/or discussions, please indicate and provide information about how to contact you.

Other Thoughts And Comments

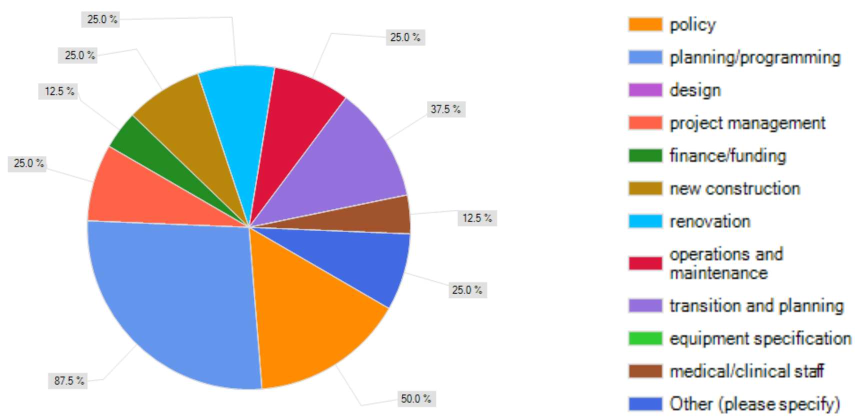
51. Other thoughts and comments

- Thanks for the opportunity to share my thoughts.
- GOOD DIRECTION!
- An important topic with a rich history going back to the NHS post WW2 in the UK
- The survey was a little challenging. Several questions didn't allow a 'no' or 'NA' response when they needed one. I would have liked more multiple-choice questions and fewer text response questions, as they require very thoughtful and time-consuming responses. Great need for research and data here.
- The same flexibility questions asked here can apply to research facilities, classrooms and kitchens. As Architects we enjoy flexible facilities, especially when the client or caretaker is creative and will assist in the successful evolution of the building over time.
- Survey done well, but please give us opt out when answers don't apply. Also helpful to have those bars saying "percent complete" sorry if misspellings and typos, in a hurry! Look forward to hearing results!

Questionnaire – Consultants

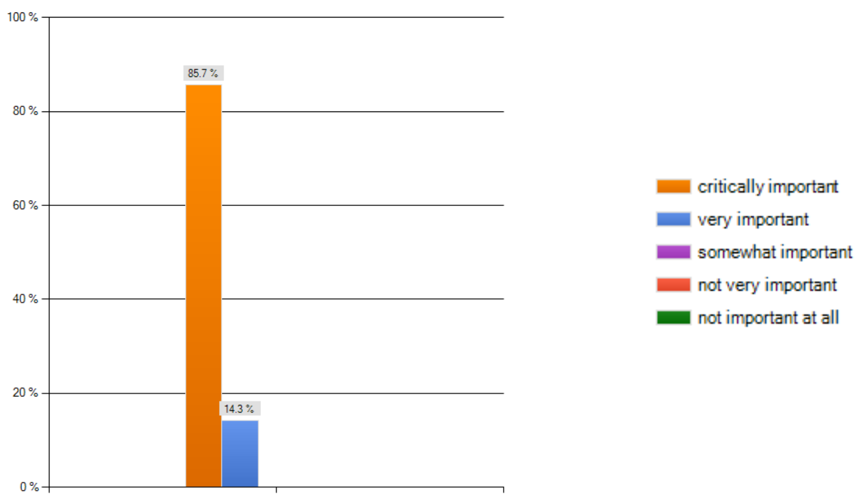
Personal Information

1. Please identify your NAME (optional)
2. Please identify your TITLE
3. Please identify your ORGANIZATION
4. How long you have been in this position?
5. Please identify your role in acquiring healthcare facilities in your organization



Flexibility As A Value Proposition

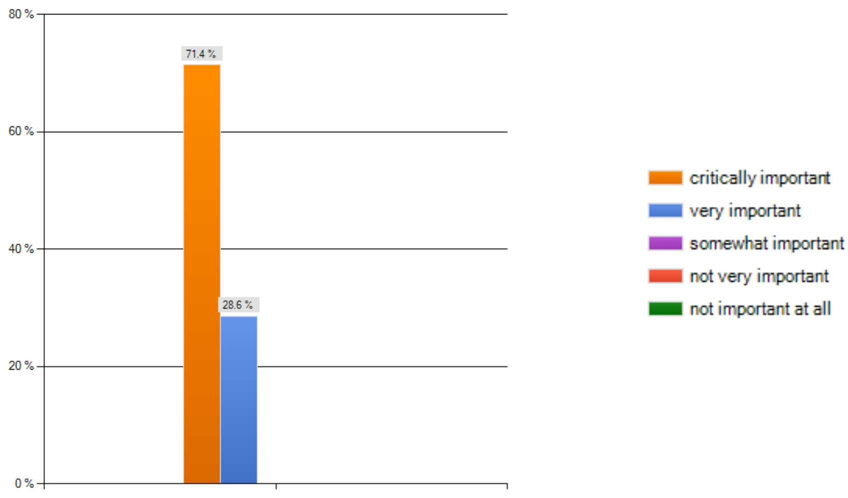
6. Is "flexibility" an important goal for public sector healthcare facilities?



7. If the answer to #6 above is somewhat important to critically important, please briefly explain why?

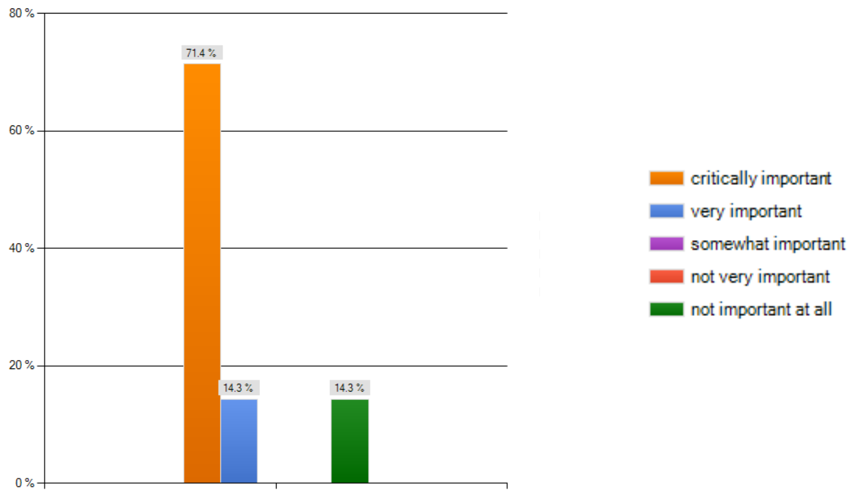
- Healthcare model is currently not sustainable. Relationship of costs to value is not balanced. Flexibility is critically important to not wasting the dollars spent on redefining more effective work-flows and being able to implement those flows without major encumbrances from the space they happen in.
- Rapid development of new healthcare procedures and processes, changing patient demographics, shifting organizational processes (mergers, etc.), new healthcare policies and public funding
- Health care is constantly changing and rigid structures and processes prevent needed change
- Need to accommodate changing functions at the least cost and disruption. In addition, to extend the useful life of healthcare buildings.
- No one can afford to keep building them. Must re-use and re-purpose existing structures.
- As an owner, the government can't have a choice over who it chooses to design or build their facilities. Building in the particular aspects of flexibility in the program, in design and in construction techniques and practices are essential to avoid building in obsolescence. The process from idea to turn of key can take many years. Flexibility in each step needs to be articulated and planned for.

8. Is “flexibility” an important goal for private sector healthcare facilities or systems?



9. If the answer to #8 above is somewhat important to critically important, please briefly explain why?
- Healthcare model is currently not sustainable. Relationship of costs to value is not balanced. Flexibility is critically important to not wasting the dollars spent on redefining more effective workflows and being able to implement those flows without major encumbrances from the space they happen in.
- Rapid development of new healthcare procedures and processes, changing patient demographics, shifting organizational processes (mergers, etc.), new reimbursement regulations
- Health care is constantly changing and rigid structures and processes prevent needed change
- Same as # 7 above. I see no difference.
- No one can afford to keep building them. Must re-use an re-purpose existing structures.
- The business of healthcare changes, as should the platform from which it is delivered. The private sector can depreciate investments and either re-use, re-purpose or refit investments much quicker than the fed. Being able to unplug from a facility and plug in a new one is essential but not as critical as making the investment pay-off.

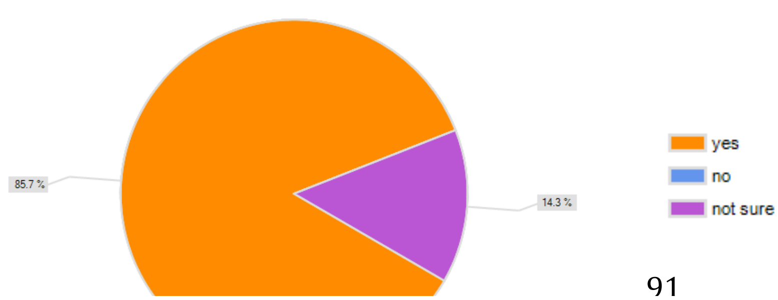
10. How important is "flexible healthcare facilities" as a goal for your organization's expertise and value proposition?



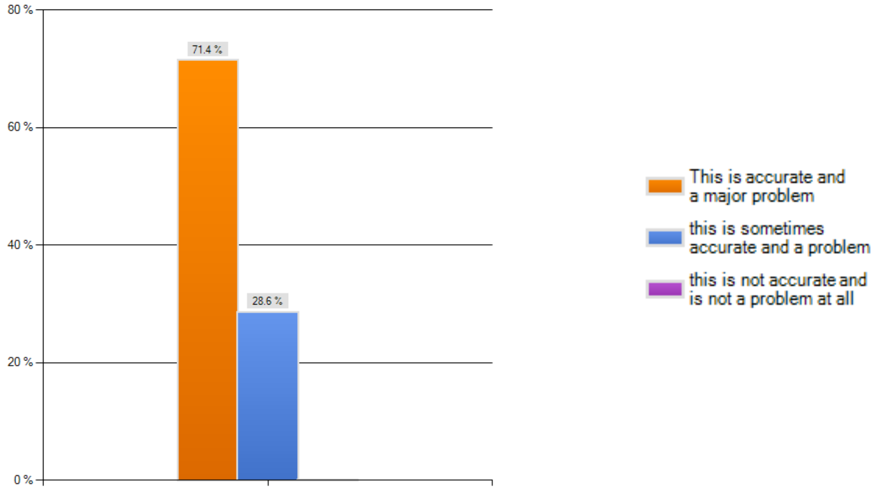
11. Assuming flexibility has become an important priority for your consultancy work, please briefly explain why – for example, is it a core corporate value or because clients ask for it?

- Many organizations are attempting to move from a "push" model of care delivery to a "pull" model. This transition is complex and deeply encumbered by facility limitations designed to perpetuate "push" inefficiencies. The push model (I also describe this as a "randomized assembly line" is characterized by very dedicated spaces to very limited tasks at each station, which in turn causes inherent lack of flexibility and constant pressure to revise space due to changes in care and technology. The "pull" transformation (many call this lean) is at the very heart of the work we are evolving to do and is an essential value in our work.
- Not part of BEC mission
- Only way to plan for and facilitate an uncertain future, knowing there will be dramatic mind shifts in the delivery of health care
- Clients do not understand what adaptability or flexibility means. They must be educated. They also do not have a "long view" of their facility and its future.
- No one can afford to keep building them. Must re-use an re-purpose existing structures.
- It's not about the building as it is about accommodating the changing practice of medicine and the ever increasing demand for technology services as part of modern acute medicine. The hospital can really be viewed as a machine with components that wear out as soon as a new technology is discovered.

12. Should "flexibility" be an intrinsic part of the larger "sustainability" agenda, with its own metrics?



13. To what extent to you think that owners want flexible healthcare facilities but cannot define flexibility in specific performance criteria, making it impossible to assign a value (cost or otherwise) and making the design of flexible facilities impossible?

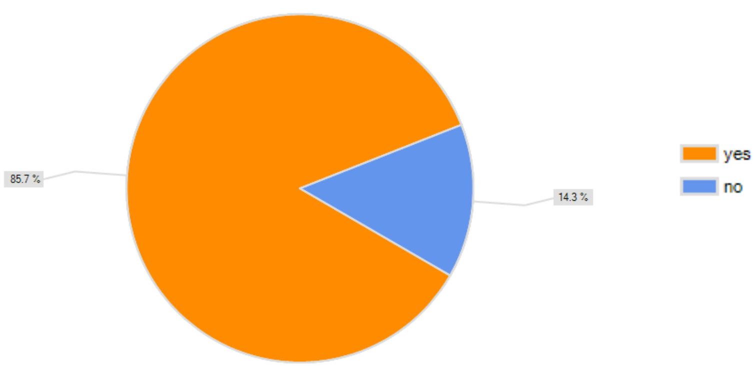


Defining And Assessing Flexibility

14. What is your current definition of healthcare design for flexibility?

- In a pull model, it is standardized clinical spaces (very little variability) developed to promote standardized work and clear outcomes with minimal patient and staff movement.
- Ability to quickly, easily, and cost effectively respond to changes over time in function, performance, and obsolescence
- Facilities that can be easily altered as care demand, care processes, information technology and new equipment change
- Ability to accommodate and facilitate change with minimum disruption and reduced cost over a buildings' lifespan.
- Potential for rapid reassignment and fictional re-use.
- Providing a chassis that can functionally and technologically accommodate change with very little disruption to the operation.

15. Have you been asked by clients specifically to provide consulting services for a flexible healthcare facility?



16. If so, please name the project or projects

- All Sutter Health projects based on the 2007 Prototype Hospital Initiative...(This includes Castro Valley, Santa Rosa and Elk Grove); UW Health System, Madison, WI; and several health regions throughout the province of Saskatchewan, Canada - I am involved personally with Five Hills Health Region replacing a regional acute care center in Moose Jaw, Saskatchewan and Cypress Health Region, planning a new facility in Leader, Saskatchewan.

- Long ago when I was on active duty as a medical center commander undergoing major new construction
- Too many to mention. Both in the VA and in the private sector.
- New inpatient buildings and backfill of vacated facilities at UCSF & MGH
- Not project specific, only the concept of providing components of flexibility across a program.

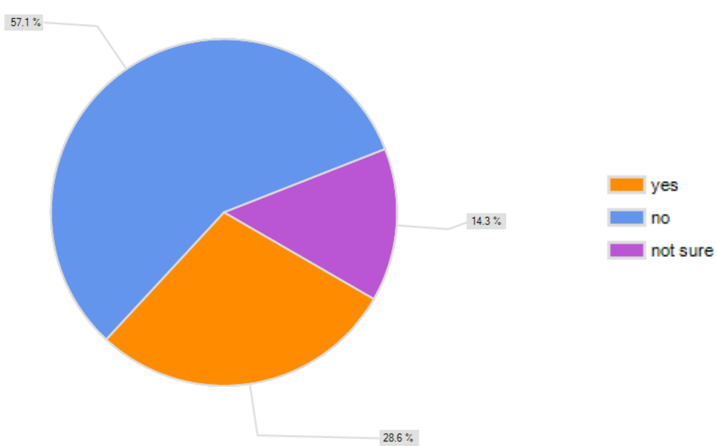
17. What criteria do you or would you use to declare that your consultancy work supports the acquisition of a "flexible healthcare facility?" That is, what are the criteria for evaluating a flexible facility, at any level, both technically and in terms of processes and policies?

- Standardized clinical zones (we define three - rapid throughput (sub 24 hour) services, procedural, and long stay (acute) All rooms in the rapid throughput and long stay zones are fully standardized based on a wide range of envisioned services. The procedural zone is based on standardized modules, allowing conversion from one procedural room type to another in support of demand. The module in this zone is approximately 622 square feet.
- Cost-benefit analysis of ability to accommodate change, including initial design/construction costs, downtime, O&M, compliance costs, patient and staff health and safety
- I start with getting people to think about the future - how the world is changing and therefore how health care may change. With this I challenge their thinking about what will be needed and then how to make flexible facilities.
- I would look first the MEP systems, the biggest inhibitor to change. Also the planning and its provisions for accommodating growth and change.
- Low cost and rapid renovation potential. Acceptance & functionality by multiple users.
- Plug and play space, structure, electrics, mechanical, and communications.

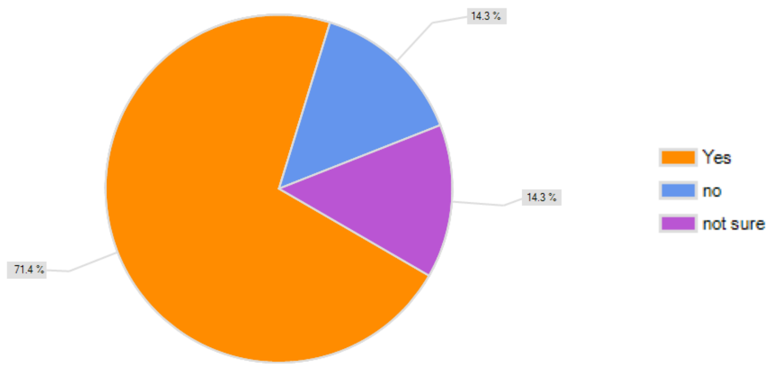
18. What factors/constraints/drivers do you consider in discussing "flexibility" with your staff?

- Pull concepts of workflow based on minimizing patient movement; standardized work; in general - lean principles of care delivery.
- Technical (functional and spatial interdependence of components, subsystems and systems), Organizational, Legal/Regulatory, Financial
- Resistance to change: Hard to imagine fundamental changes in health care; to imagine ways to change facility design; look at costs over a long cycle of time.
- Biggest constraint is first cost and the compartmentalization of first cost and long term operating costs.
- Cost, ability to anticipate and adapt for new technologies and practice patterns. Also location of facilities in the community.
- Always a tradeoff of perceived higher first cost vs. lifetime maintenance and operations and refit.

19. The distinction between "equipment" and "real estate asset" provides one way to define "flexibility" in the sense that building equipment can be depreciated over 3-7 years while "interiors" can be depreciated in 15-20 years and "core and shell" in 30-year cycles. Given this, do you attempt to increase the investment in "non-core and shell" as a way to increase flexibility?

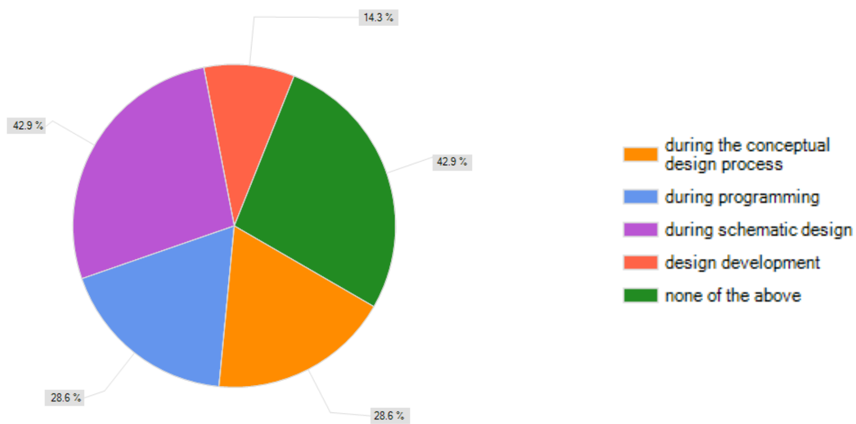


20. In your experience in the healthcare sector, has an expansion of the category of things called “equipment” – to include more and more parts of the total healthcare facility – made achieving a “flexible” facility for your client easier?

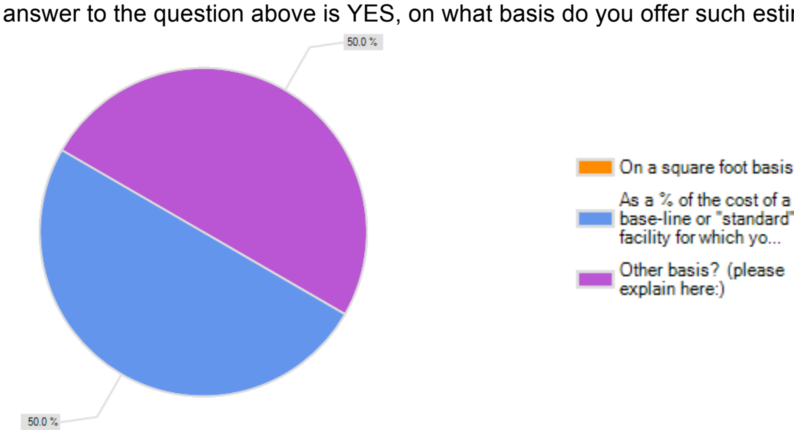


Cost Trade Off

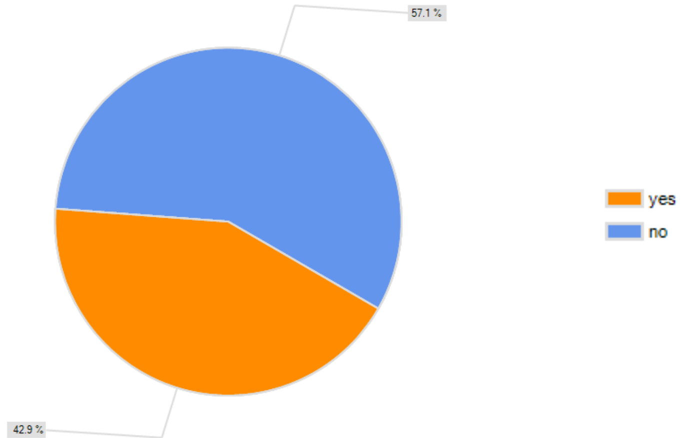
21. Do you provide cost estimates for alternative “flexibility” strategies? (check all that apply)



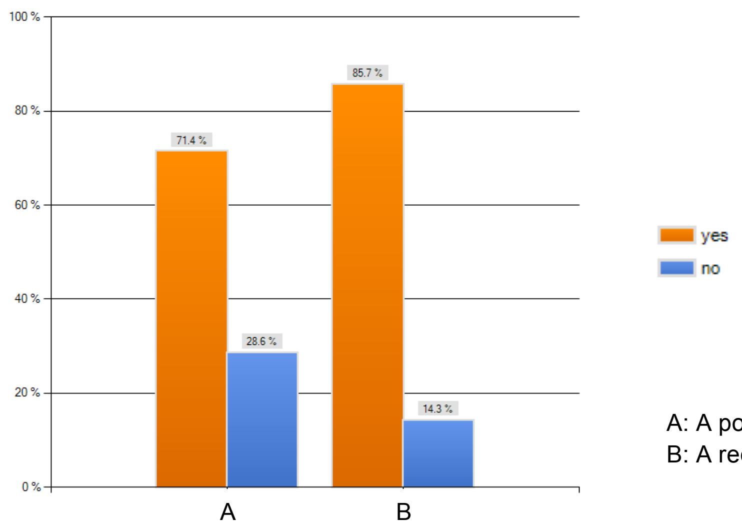
22. If the answer to the question above is YES, on what basis do you offer such estimates?



23. Do you have a methodology to estimate the added cost of making a facility flexible?



24. When a cost premium exists, to what can you attribute it?

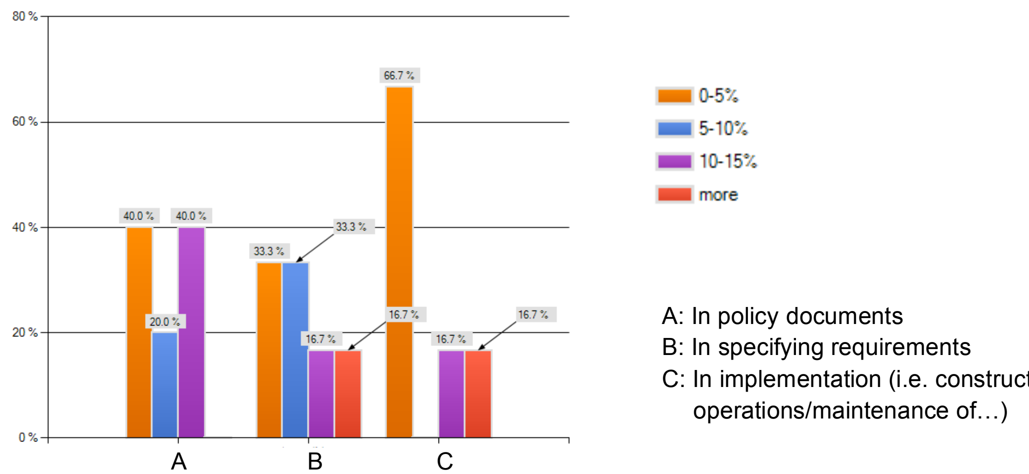


A: A policy
B: A requirement

Something else (Please explain)

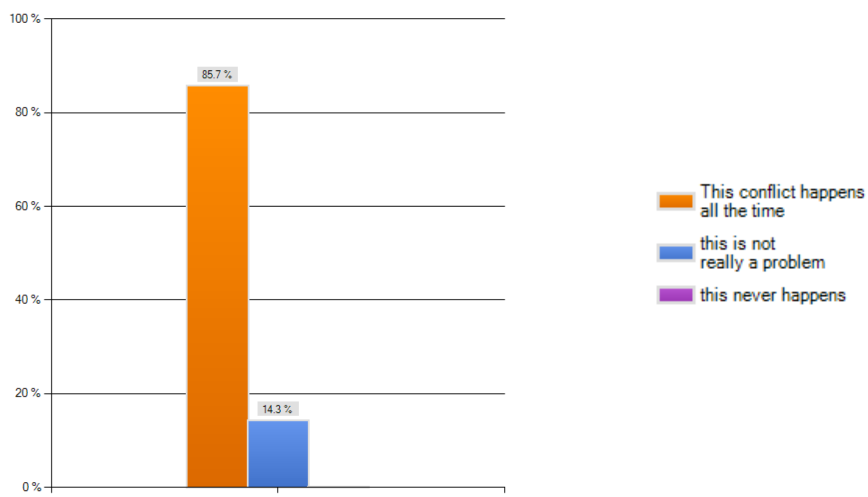
- Flexible facilities based on pull are inevitably smaller (the least expensive square foot is the one we don't need to build)
- The cost premiums are associated with adding value in terms of sustainable systems, equipment or perceived value (as defined by the owner)
- Certain things can cost more for the provision of future accommodation and certain things cost less. Need to take it on a case-by-case basis.
- Unknowns at the time of design. Potential additions or other functions that could be added to the facility.

25. Assuming that you know there is a cost premium, and assuming you can monetize it, would you say the premium for adopting a "flexibility" strategy occurs:



A: In policy documents
B: In specifying requirements
C: In implementation (i.e. construction or operations/maintenance of…)

26. To what extent does a “flexible” project come into conflict with other priorities?

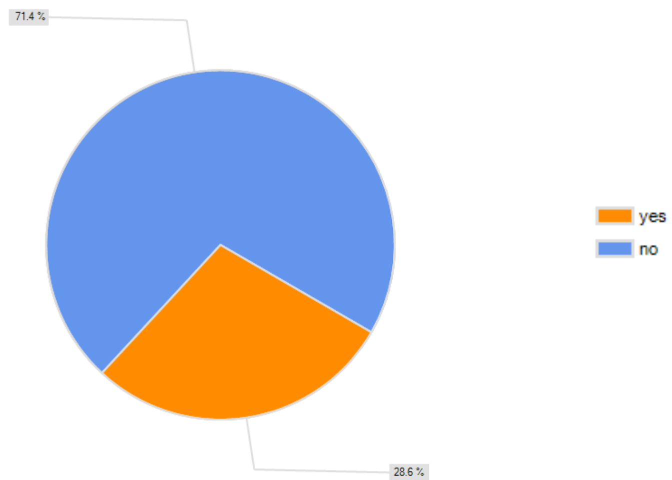


27. Please give a few examples of these conflicts.

- The schism between executive strategic planning and executive understanding of the operations-facility connection creates incorrect assumptions of the building as "overhead only" rather than a means for transforming the way work happens. Because of this schism, flexibility may be seen as another cost rather than an unparalleled opportunity to increase quality while decreasing costs. This gap in understanding is closing, but it has become an encumbering factor in making value decisions rather than merely cost decisions in many healthcare systems. All projects that are developed by owners who base their thinking first on cost rather than value are based on the assumption that the building is just an expensive place to work and the only "value" is that it provides sufficient capacity for that work to occur.
- NA
- Conventional thinking, conventional standards, fear of taking too long and too much money
- Floor to floor height when attaching to an existing building. Tight budgets vs. the desire to obtain flexibility.
- User objections to flexible aspects (not what they "want"). User inability to conceptualize need.

- Again, perceived importance of first cost vs operational savings. No good way to measure the opportunity cost lost for not having a flexible structure.

28. Would you be willing to share cost details related to the above information that can be included in a final report associated with this questionnaire?

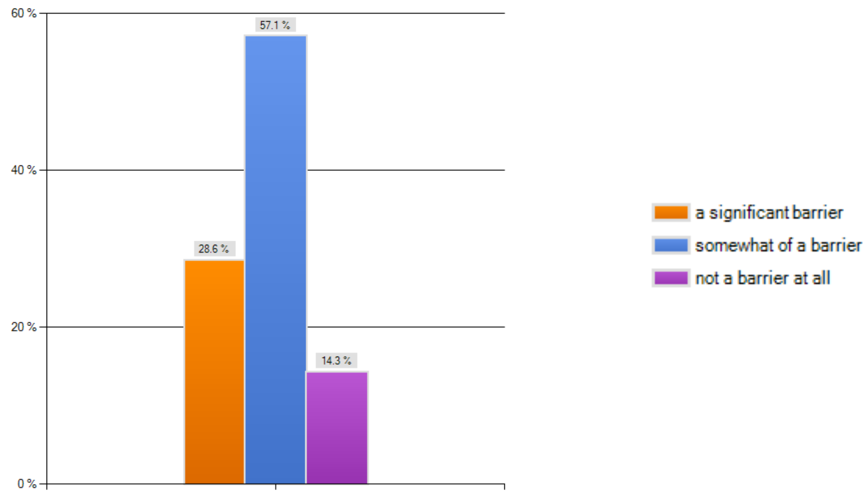


Barriers To Flexibility

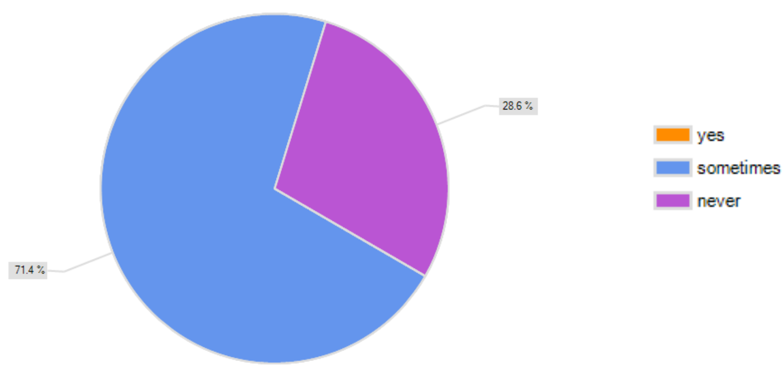
29. What are the one or two most powerful barriers to getting healthcare facilities designed for flexibility?

- A clear understanding of what it is (definition). A clear understanding of the value it offers (especially in terms of clinical operations quality and cost)
- Developing credible future scenarios that delineate the nature of potential changes and means to respond to those emerging requirements
- Biases of facilities planners and construction industry Biases of leadership and health professionals who want to create the past
- Compartmentalization of first cost and long term costs. Lack of knowledge on the part of the design and construction team. Short-term focus of many health providers.
- Cost. User rejection of concepts.
- Lack of proper definition of where and how to define and specify flexibility. Lack of discipline in the programming, planning, design and construction of investments.

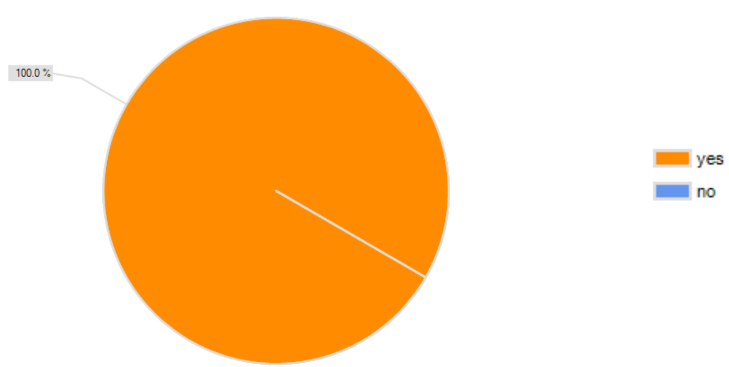
30. Does the tendency for some clients to use a short-term focus (3-5 year) in their strategic planning process present a barrier to achieving the goal of a flexible facility?



31. Are the current fiscal and information management (programming) processes used by your clients who expressly ask you to help them acquire a flexible facility designed to support that goal?



32. If not, have you recommended to your clients that they adjust their processes to enable you support their planning efforts to acquire a flexible facility?

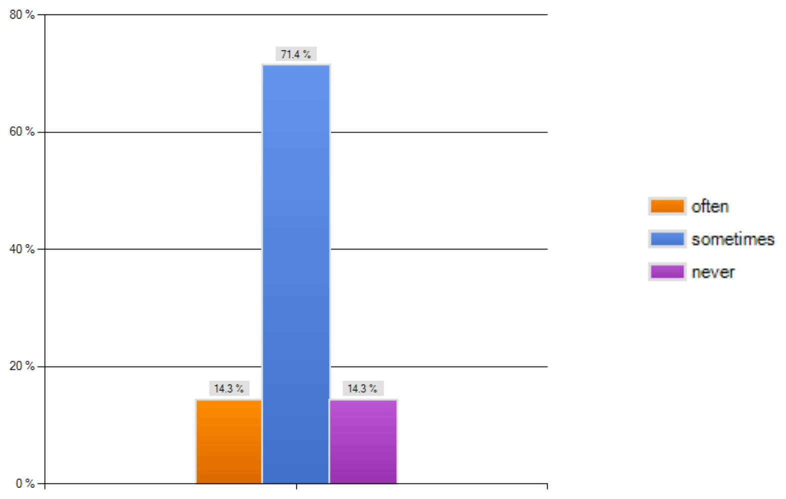


Planning Processes And Methods

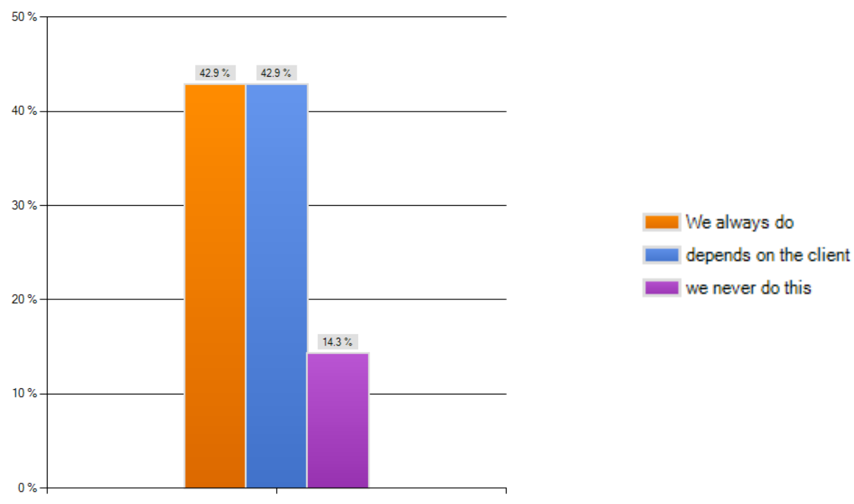
33. What are critical success factors in acquiring a "flexible" facility?

- Key measures of performance related specifically to outcomes: Cycle times (aggregated); Staffing resource allocation/utilization (aggregated per outcome); Handoffs; distance traveled (patients and staff); Area (square feet) required to support outcomes
- Setting the overall organizational objectives, developing organizational capacity within the client as well as the design/construction and facilities management teams to develop, implement, and use the flexible design characteristics to provide highest value
- Rapid adaptability of the physical plant to new services, processes, technology
- A client and a design team that are on the same page and have the knowledge to achieve success.
- User understanding and cost
- A corporate philosophy and standards. Programmed components (soft space, shelled space, extra structure loading capacity, disciplined MEP)

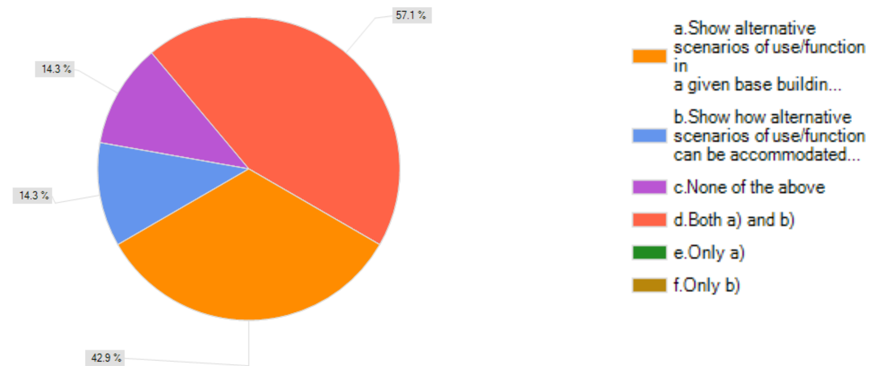
34. How frequently do clients ask for "flexible" healthcare consulting support?



35. To what extent do you market your services as providing "flexible" healthcare facility consulting?



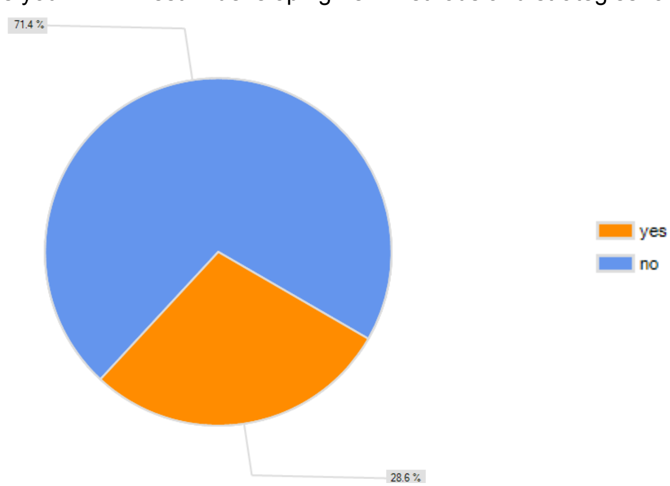
36. How do you demonstrate that the consulting advice you are offering will support a “flexibility” agenda?



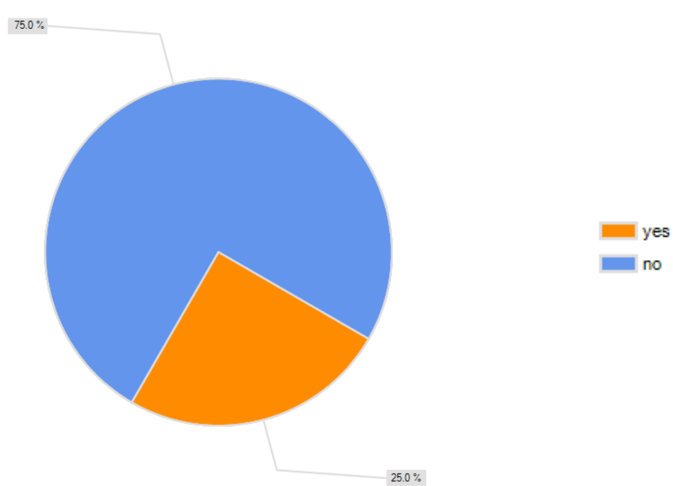
Comments:

- If we envision a scope of activity in a space, we can solve the space effectively.
- Field trips to examples of flexible solutions

37. Does your firm invest in developing new methods and strategies for healthcare facility design for flexibility?

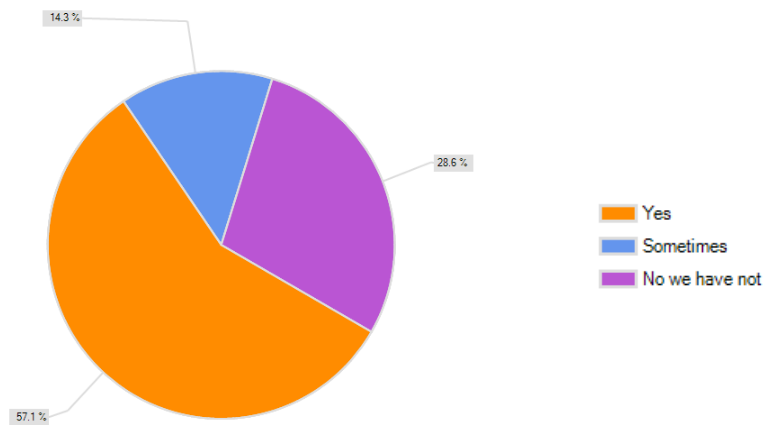


38. If the answer to # 37 is YES, do you have a specific business plan or research team for developing and implementing flexibility strategies?



Precedents

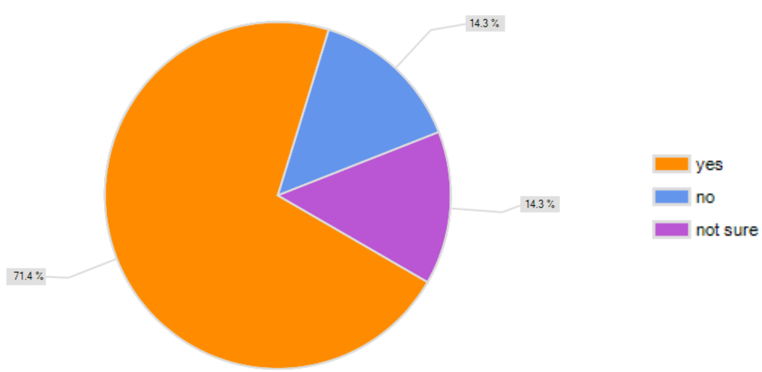
39. Have you examined policies or requirements that are claimed to lead to "flexible" facilities, and/or "flexible" projects, to see if you can make use of them in your own consulting?



40. Please identify those policies, requirements and/or projects here.

- Training related to Hoshin Kanri, 3P and Kaizen leads to effective understanding of flexibility ideas and value
- After 40 years of almost continuous application, the Integrated Building System remains the most outstanding example of a successful flexibility solution.
- Contractual approaches

41. Does the commercial office markets' distinction of base building, fit-out and FF&E (furnishings, fixtures and equipment) apply to healthcare facilities design for flexibility. (In such projects, detailed programming is done after the design of the base building (core and shell) so functional areas can change without disturbing other areas of the building)

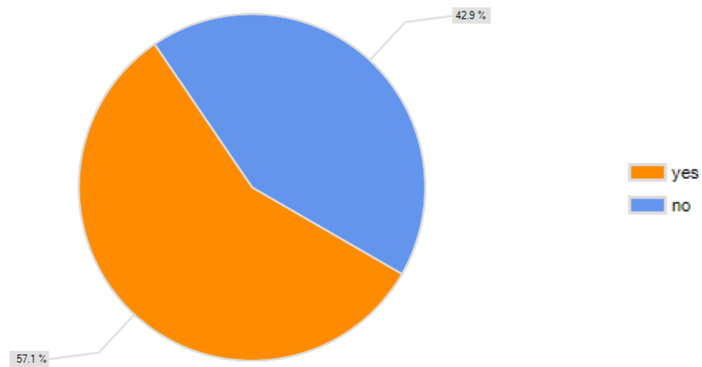


42. If the answer to #41 is yes, please explain why you think so and how it applies.

- In a 3P workshop, care givers are given the "shell" as a parameter and as a team, they are engaged to model the operations leading to a full scale partial unit mockup of space where they are able to game and learn collaborative teaming behaviors which they then can implement in the new facility. This gaming is based on a core and shell existing within which they envision a tenant fit out to support optimized flows.
- Different medical departments occupy specific portions of the medical campus over time - these shifts are similar to tenant turnover in commercial office buildings
- This applies to some limited extent.
- Low-tech and office areas in healthcare facilities apply to commercial FF&E

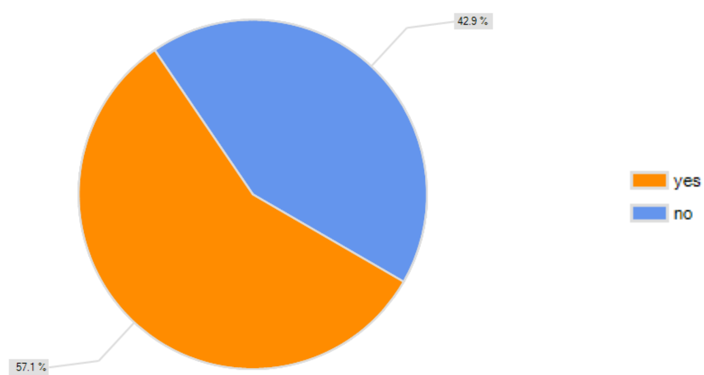
- You can wait until the last minute to acquire the latest technology and have it delivered and installed by experts, not by construction companies. It helps also in customizing spaces that have changed since initial programming or design. It allows more control over the end user interface and their use of the space, it allows better fiscal control but may result in lack of coordination for utilities etc.

43. Do you look to overseas examples of “flexible” policies, requirements and / or projects?



44. If the answer to #43 is yes, please identify them.
- For construction in the realm of modularity, we have studied hospitals in the Netherlands/Sweden. They are quick to build and quality facilities.
- Finland, Switzerland
- Work being done in England primarily.

45. Do you advocate to your clients that achieving “flexibility” requires that detailed decisions about spatial organization and equipment NOT be made up front or allowed to dominate the architectural infrastructure of the facility?



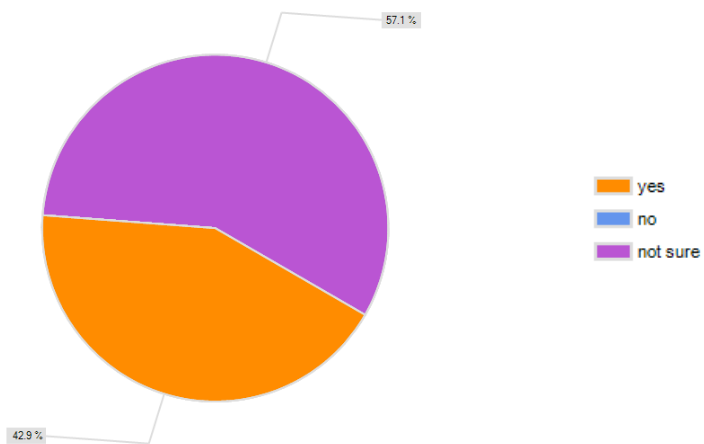
Tracking Flexibility

46. If you had resources to track the behavior of facilities over a period of years, what patterns of change would you look for situations or instances of change that, if you could document them, would be most beneficial to know about? Patterns or situations of change that would yield results in planning future “flexible” facilities?
- Frequency of renovations. additions or replacements of facilities. Worked hours per outcome and ongoing trends related to this and finally quality measures for those outcomes - specifically defect such as HAI, med errors, patient falls 30 day readmission rates etc. and the trends for those measures

- Overall performance (patient well-being and healing time, staff well-being) with respect to physical building attributes in specific locations over time
- Changes in size and function of clinical services Changes in technology and information systems Changes in how care is delivered and where
- Too complicated to answer here. There is a crying need to do more evaluations of buildings designed to change.
- Frequency of change to accommodate new technology and program growth.
- Churn, technology upgrade, mission change, business practice changes.

47. Why, in your view, has no one yet developed a systematic methodology to track how facilities change?
- This is fundamentally due to the gap between owner's attitudes about their facilities and consultants' views about those same facilities.
- Little current research on the relationship between healthcare provision outcomes and built facility attributes
- Time and money to do it well. Don't see near term ROI
- Unreimbursed cost for this and the complexities of evaluation methodology.
- Cost plus great variation among facilities and health care organizations. Also definitional problems and AE firm disinterest.
- Not an ingrained or well-understood concept, too vague, too building component centric. Typically not a corporate philosophy, and if it is its vaguely defined. My opinion is that good architecture and planning should start out flexible and be built in to professional practice. The design should reflect the program need for flexibility and be detailed enough to allow for a disciplined construction process that is mandated by the MEP designer.

48. Would you be willing to work with clients and/or A/E service providers to develop and apply a systematic methodology to study how healthcare facilities change, and make the evidence available in the public domain?



49. If the answer to #48 is yes, what entity is best suited to lead such an effort?
- I don't know if I have the time - this would need to be an independent organization with credibility in both the consultant and owner domains - possibly the Healthcare Advisory Board.
- Research organization working with empirical data provided by clients and service providers (including facilities management as well as A/E/C)
- The Department of Health and Human Services. Or NIBS under contract with a governmental agency.
- Likely the big public or commercial health systems including Britain and Canada.

50. If you are willing and interested to be contacted for follow-up questions and/or discussions, please indicate and provide information about how to contact you.

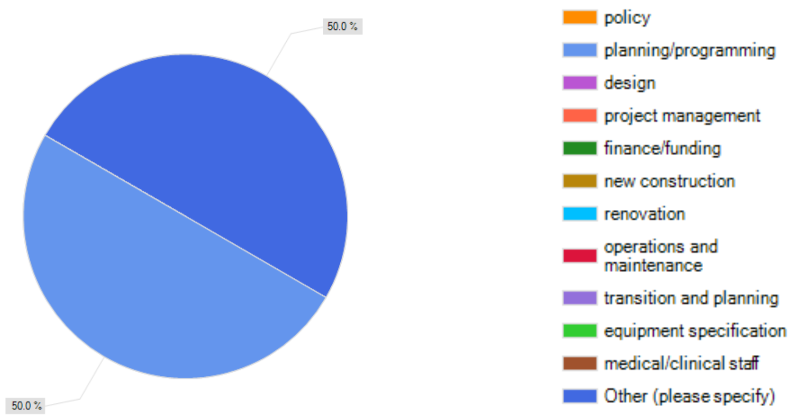
Other Thoughts And Comments

51. Other thoughts and comments
    - I think I have said enough for now.
    - As you can see I am not intimately involved in facility design or construction. I focus my effort on getting people to think about the future and its implications on health - "What is your vision of a future worth creating?"
    - This is a critical subject for the 21st century. A national program to promote flexibility in our healthcare buildings could help to substantially reduce the cost of healthcare delivery.

Questionnaire — Equipment And Equipment Planners

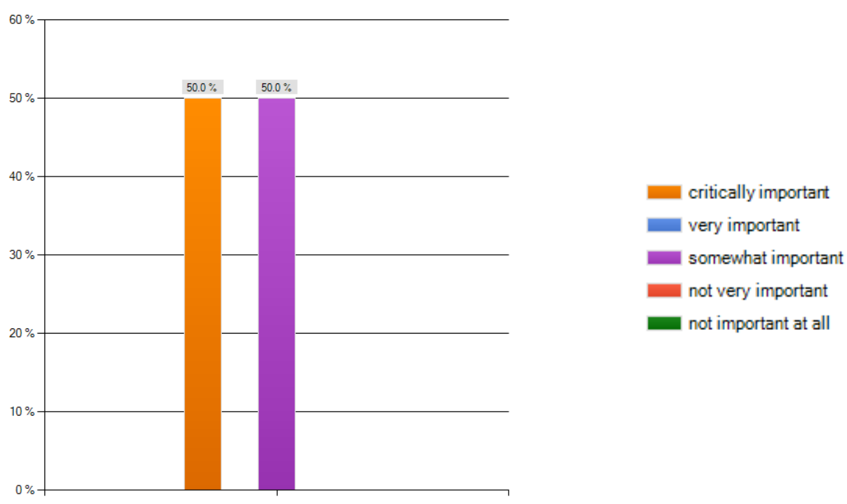
Personal Information

1. Please identify your NAME (optional)
2. Please identify your TITLE
3. Please identify your ORGANIZATION
4. How long you have been in this position?
5. Please identify your role in acquiring healthcare facilities in your organization



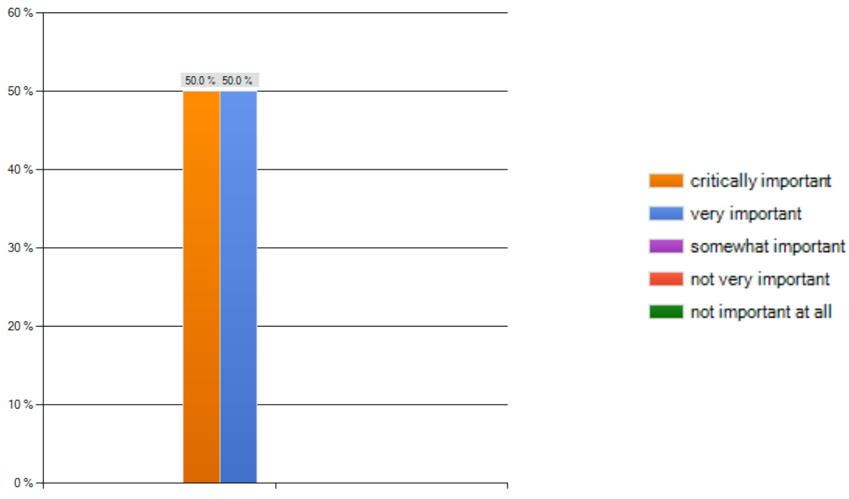
Flexibility As A Value Proposition

6. Is “flexibility” an important goal for public sector healthcare facilities?



7. If the answer to #6 above is somewhat important to critically important, please briefly explain why?
   - Uncertainty in program need and service demand has increased the risk of investing capital in facilities that won't work for unknown future requirements. In addition, public facilities take longer to deliver.
   - Facilities need to be able to upgrade to new care processes and technologies

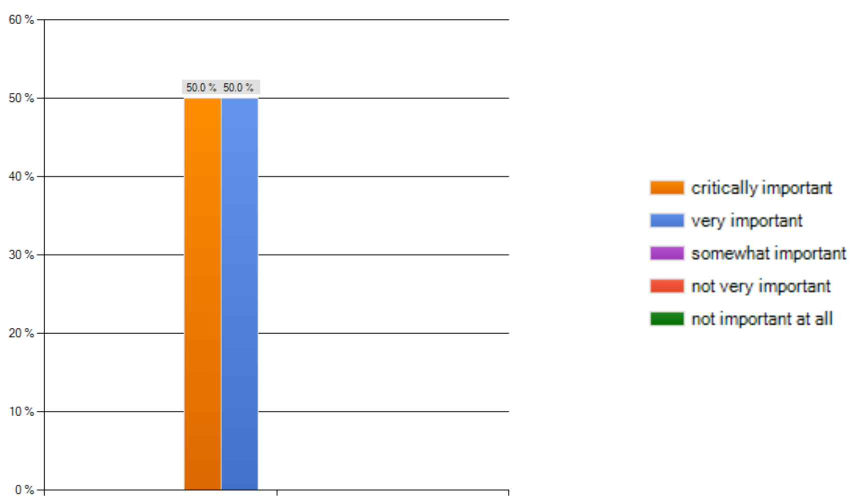
8. Is “flexibility” an important goal for private sector healthcare facilities or systems?



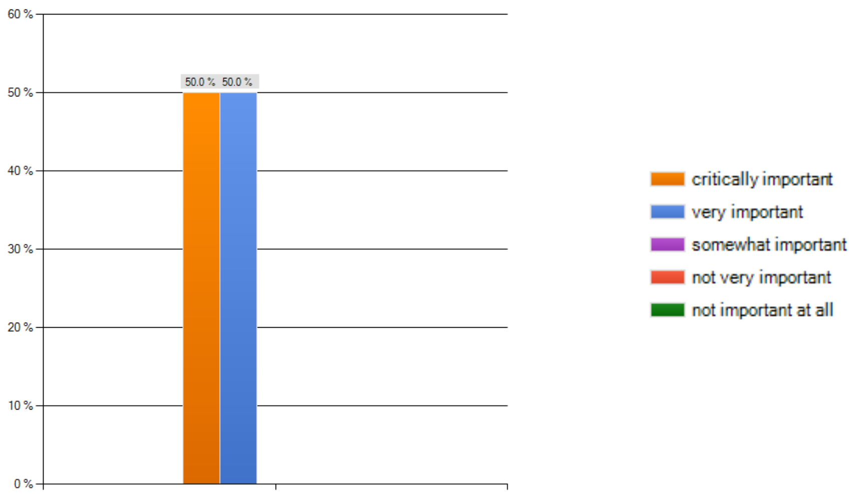
9. If the answer to #8 above is somewhat important to critically important, please briefly explain why?

- Same as 7.
- Private sector must compete for customers. Therefore, they must be able to offer the latest in medical care, technology and services.

10. How important is “flexible healthcare facilities” as a goal for your organization’s expertise and value proposition?



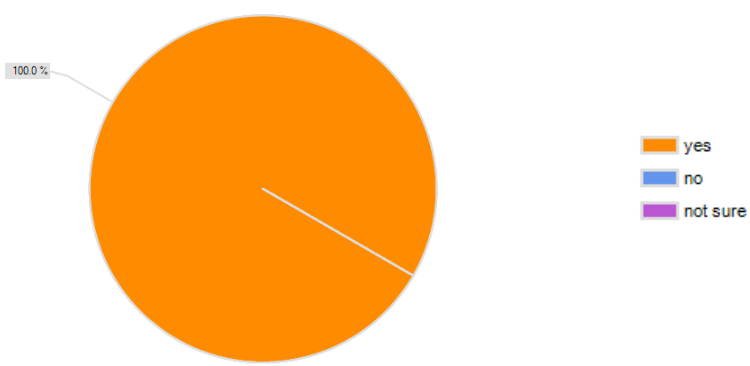
11. How important is "flexible healthcare facilities" as a goal for your organization's expertise and value proposition?



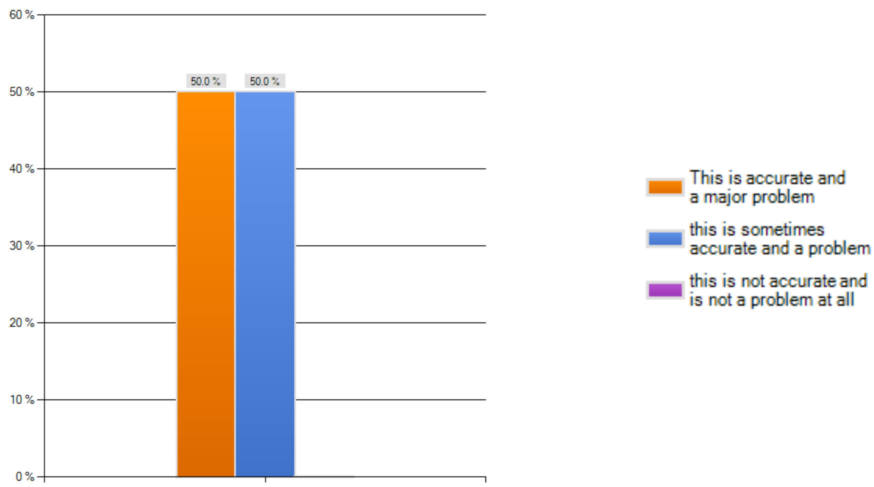
12. Assuming flexibility has become an important priority for your organization, please briefly explain why – for example, is it a core corporate value or because clients ask for it?

- Strategically, we want facilities and capital investments that can be easily and quickly repurposed with minimal additional capital and down time.
- Clients ask for it

13. Should "flexibility" be an intrinsic part of the larger "sustainability" agenda, with its own metrics?



14. To what extend to you think that owners want flexible healthcare facilities but cannot define flexibility in specific performance criteria, making it impossible to assign a value (cost or otherwise) and making the design of flexible facilities impossible?

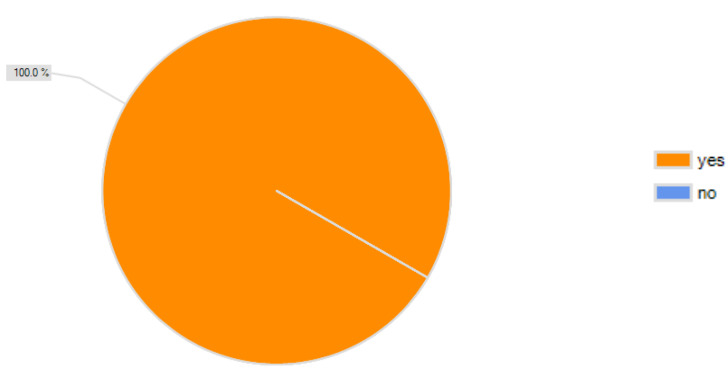


Defining And Assessing Flexibility

15. What is your current definition of healthcare design for flexibility?

- Flexibility should accommodate both major changes that may happen in longer time frames (e.g. annually) and daily small changes in operations that are necessary for continuous improvement to happen.
- The capability to "flex-up" todays patient care environment to accommodate tomorrow's higher acuity, more critical care like patients.

16. Have you been asked by clients specifically to specify equipment or other FF&E for a flexible healthcare facility?



17. If so, please name the project or projects

- Duke, Spectrum Health, Parkland, UHS Temecula, Virginia Mason Medical Center, Seattle Children's, and many more.
- Palomar Pomerado Health

18. What criteria do you or would you use to declare that your equipment or FF&E package is “flexible?” That is, what are the criteria for evaluating equipment or FF&E for flexibility, both technical and process/policy-oriented?

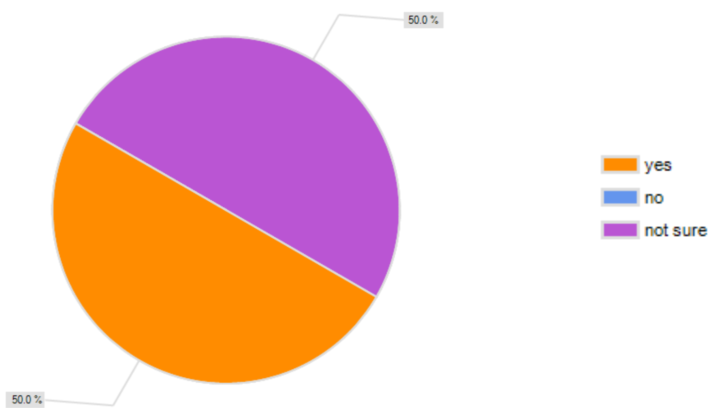
- Ease of change, % that can be repurposed without modification, durability to normal abuse, availability of compatible components over time, broad range of compatible components, limited number of parts, readily available, can be updated with minimal time, effort or capital, ability to accommodate changing technology, adjustable for ergonomic requirements

- Modular, Plug and Play, upgradeable

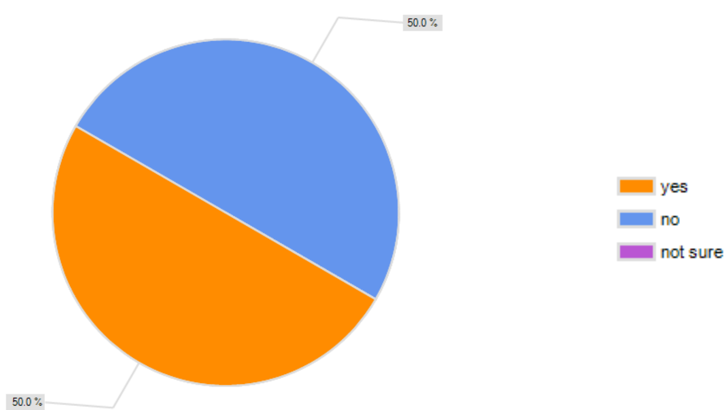
19. What factors/constraints/drivers do you consider in discussing "flexibility" with your staff?

- Design discipline to focus on broad functionality, not idiosyncratic, one-of-a kind solutions.
- Need to understand or become knowledgeable about emerging trends, new regulations and disruptive technologies that drive the need for change & flexibility

20. The distinction between "equipment" and "real estate asset" provides one way to define "flexibility" in the sense that building equipment can be depreciated over 3-7 years while "interiors" can be depreciated in 15-20 years and "core and shell" in 30-year cycles. Given this, do you attempt to increase the investment in "non-core and shell" as a way to increase flexibility?

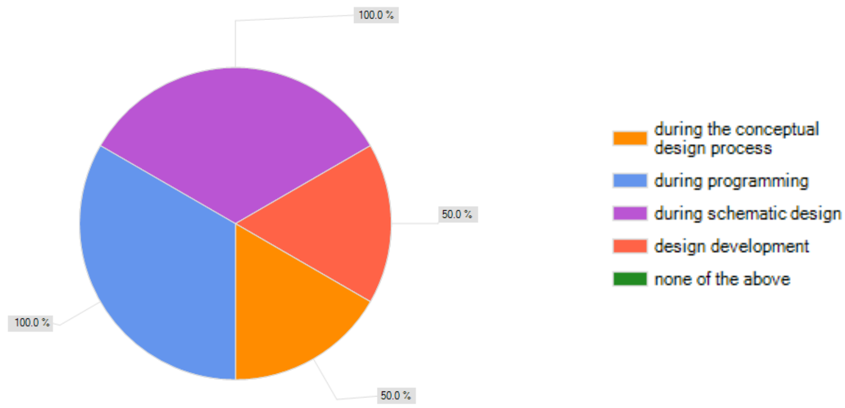


21. In your experience in the healthcare sector, has an expansion of the category of things called "equipment" – to include more and more parts of the total healthcare facility – made achieving a "flexible" facility for your client easier?

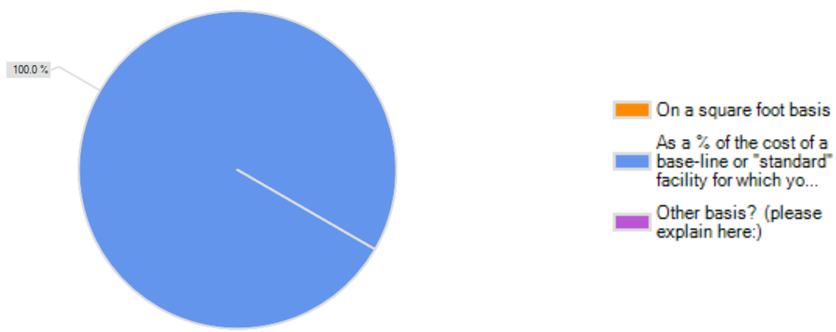


Cost Trade Off

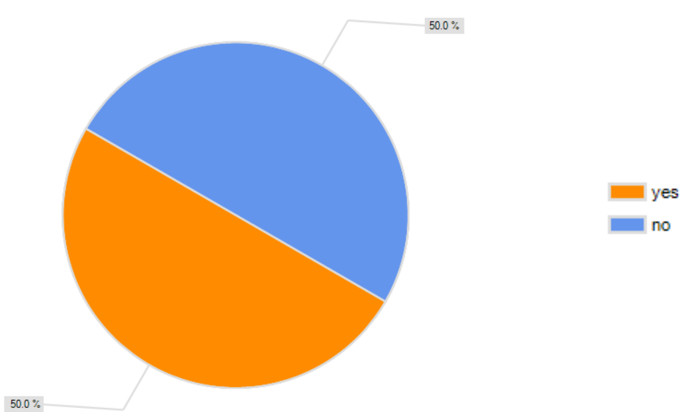
22. Do you provide cost estimates for alternative "flexibility" strategies? (Check all that apply)



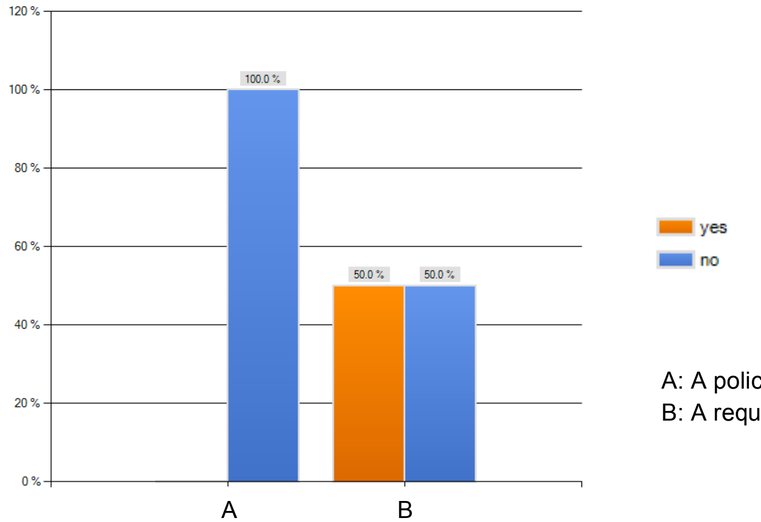
23. If the answer to the question above is YES, on what basis do you offer such estimates?



24. Do you have a methodology to estimate the added cost of making a facility flexible?



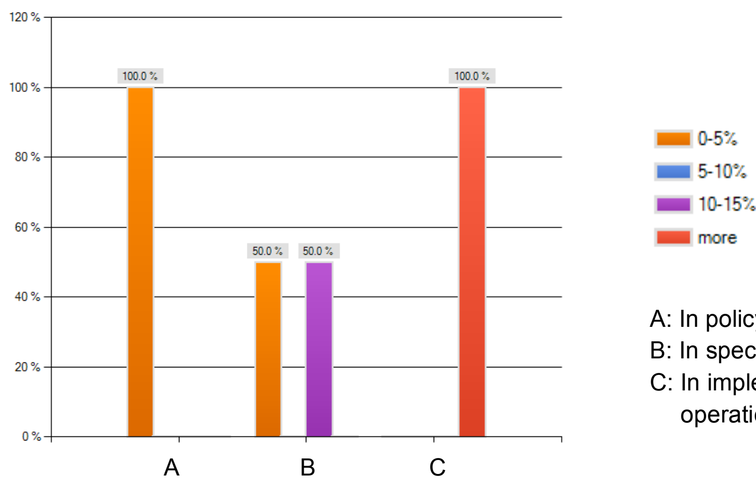
25. When a cost premium exists, to what can you attribute it?



A: A policy
B: A requirement

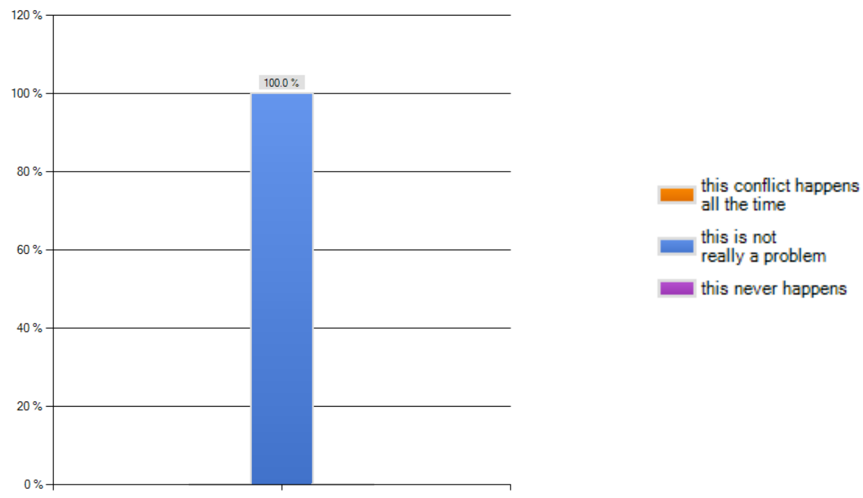
- There is not always a cost premium for flexibility so don't assume that is the case. When it does, the issue usually involves comparing apples to oranges and basing the comparison solely on initial costs, not life cycle costs.
- It could be a market differentiator - like a Starbucks in the lobby, or free Wi-Fi for visitors

26. Assuming that you know there is a cost premium, and assuming you can monetize it, would you say the premium for adopting a "flexibility" strategy occurs:



A: In policy documents
B: In specifying requirements
C: In implementation (i.e. construction or operations/maintenance of…)

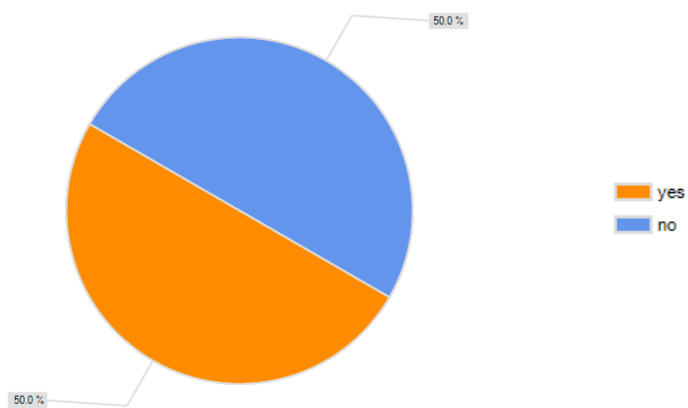
27. To what extent does a “flexible” project come into conflict with other priorities having to do with equipment and FF&E?



28. Please give a few examples of these conflicts.

- A desire to get competitive bids from multiple sources may end up in comparing solutions with dissimilar capabilities.
- When budget constraints challenge the need for flexibility or are traded off to stay in budget. The benefits of flexibility may not be realized during the tenure of the budget stakeholder

29. Would you be willing to share cost details related to the above information that can be included in a final report associated with this questionnaire?

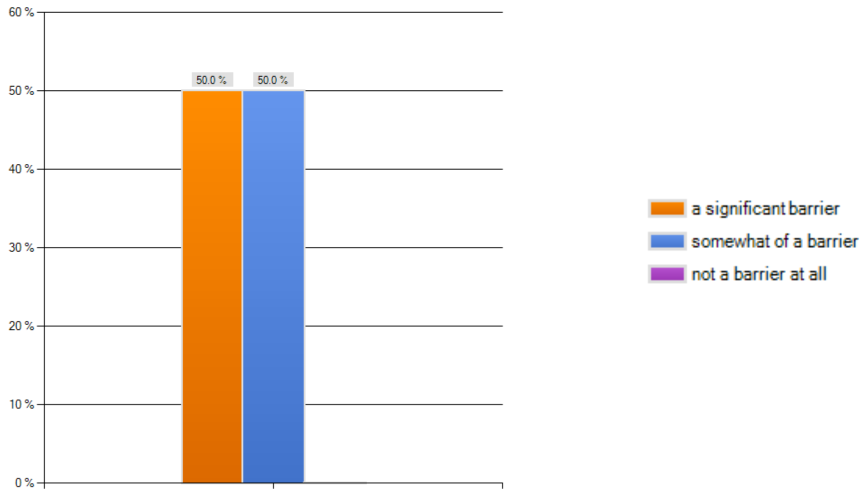


Barriers To Flexibility

30. What are the one or two most powerful barriers to getting healthcare facilities designed for flexibility?

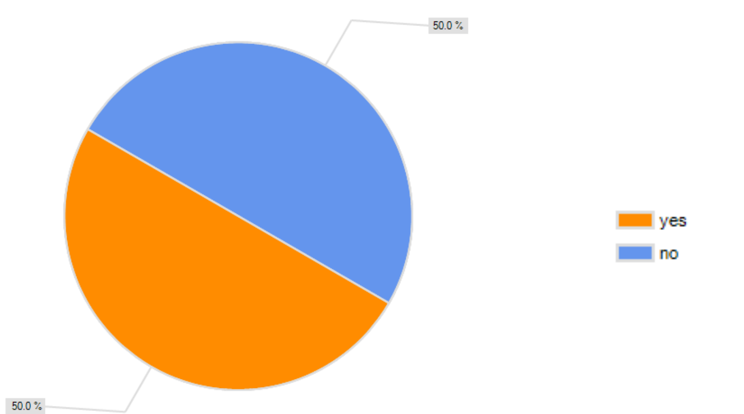
- Traditional architectural or interior design practices that don't fully comprehend the operational needs of healthcare over time.
- Selling the value / benefits during tight economic times

31. Does the tendency for some clients to use a short-term focus (3-5 year) in their strategic planning process present a barrier to achieving the goal of a flexible facility?



32. Are the current fiscal and information management (programming) processes used by your clients who expressly ask you to help them acquire a flexible facility designed to support that goal?

33. If not, have you recommended to your clients that they adjust their processes to enable you to provide a flexible facility?

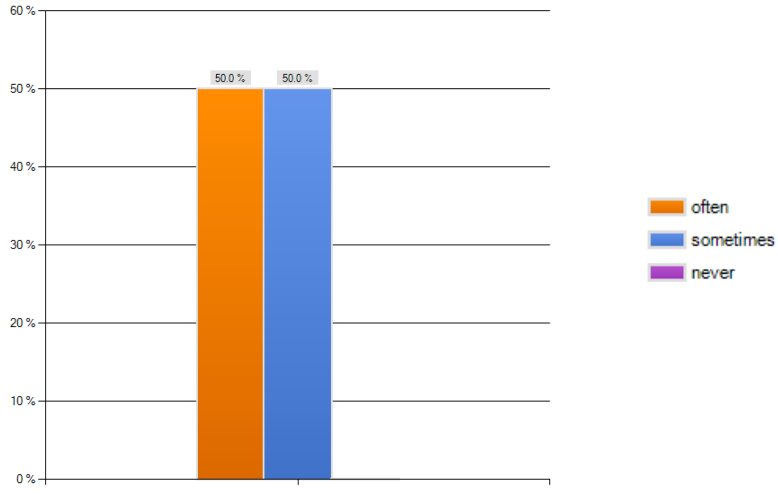


Planning Processes And Methods

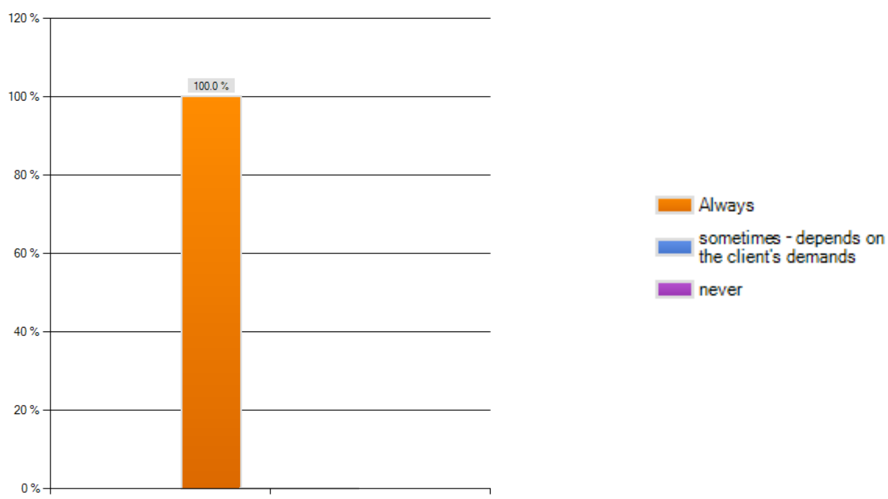
34. What are critical success factors in an equipment or furnishings, finishes and equipment specification process to help you design a “flexible” facility?

- Understanding that there are different rates of change. Color/material/finish trends change much faster than other parts of the facility. Technology changes much faster than anything else and can have an immense impact on facility operations.
- Presenting total "Life cycle costs" or cost of ownership

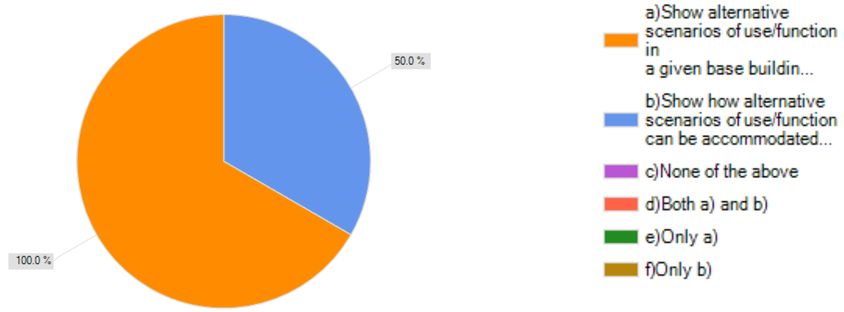
35. How frequently do clients ask for “flexible” healthcare equipment and other FF&E?



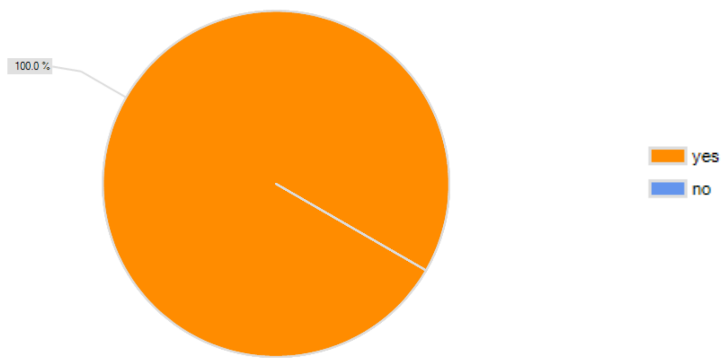
36. To what extent do you market your services as providing “flexible” healthcare facility solutions?



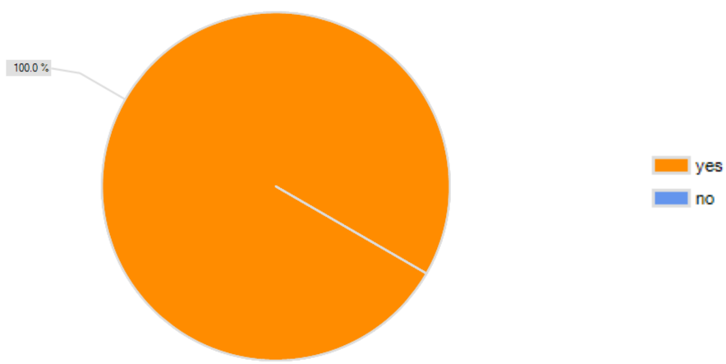
37. How do you demonstrate that the equipment and FF&E you are specifying will support a “flexibility” agenda? (Check all that apply and add comments if appropriate.)



38. Does your firm invest in developing new methods and strategies for healthcare facility design for flexibility?

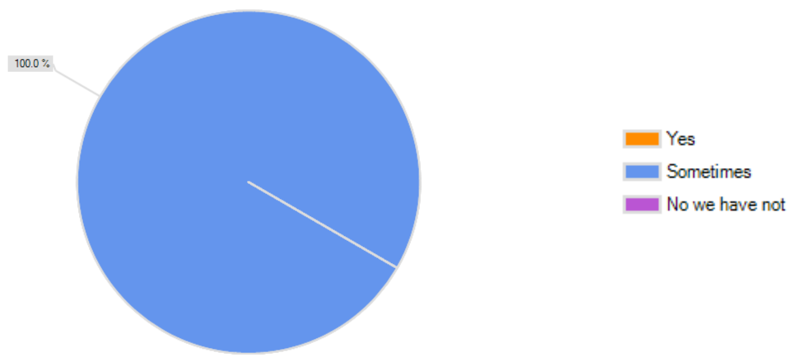


39. If the answer to #38 is YES, do you have a specific business plan or research team for developing and implementing flexibility strategies?



Precedents

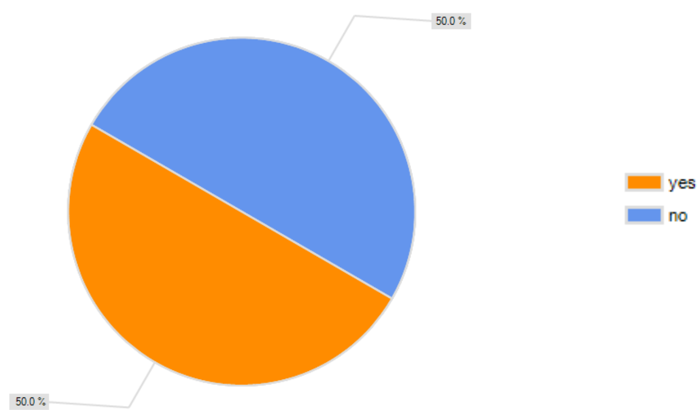
40. Have you examined policies or requirements that are claimed to lead to "flexible" facilities, and/or "flexible" projects, to see if you can make use of them in your own consulting?



41. Please identify those policies, requirements and/or projects here.

- Provide information of flexible patient room headwalls and nurse call systems

42. Does the commercial office markets' distinction of base building, fit-out and FF&E (furnishings, fixtures and equipment) apply to healthcare facilities design for flexibility. In such projects, detailed programming is done after the design of the base building (core and shell) so functional areas can change without disturbing other areas of the building?



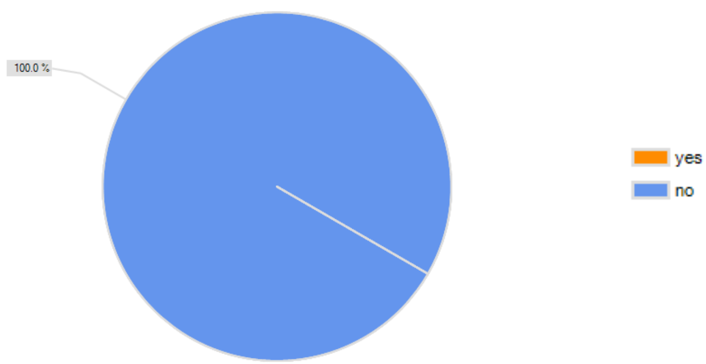
43. If the answer to #42 is yes, please explain why you think so and how it applies.

- Only partially. MEP and clearance needs for major equipment drive a lot of unique requirements.

44. Do you look to overseas examples of “flexible” policies, requirements and / or projects?

45. If the answer to #44 is yes, please identify them.

46. Do you advocate to your clients that achieving “flexibility” requires that detailed decisions about spatial organization and equipment NOT be made up front or allowed to dominate the architectural infrastructure of the facility?



Tracking Flexibility

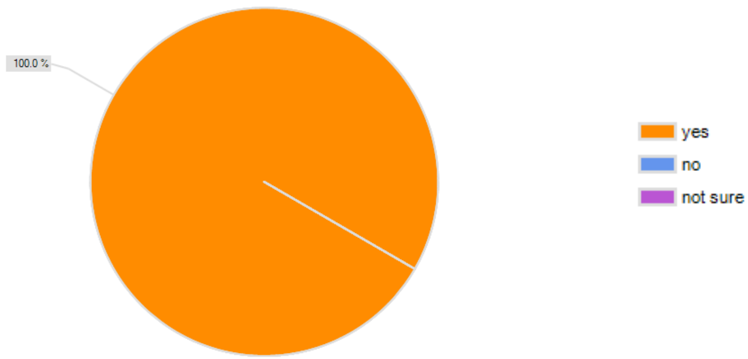
47. If you had resources to track the behavior of your facilities over a period of years, what patterns of change would you look for – situations or instances of change that, if you could document them, would be most beneficial to know about - patterns or situations of change that would yield results in planning future “flexible” facilities?

- We track what drives the change (technology, staffing, patient demand, etc.) and the percentage of reconfiguration.
- Changing patient acuity in medical-surgical driving patient room changes

48. Why, in your view, has no one yet developed a systematic methodology to track how facilities change?

- There is a disconnect between capital budgets (for construction) and operational budgets that get left holding the bag of making changes.
- it would require a detailed research of data spanning many years; difficult to collect the data and analyze.

49. Would you be willing to work with other clients and/or A/E service providers or universities to develop a systematic methodology to study how healthcare facilities change, and make the evidence available in the public domain?



50. If the answer to #49 is yes, what entity is best suited to lead such an effort?

- Facility managers who have operational responsibilities.
- not sure

51. If you are willing and interested to be contacted for follow-up questions and/or discussions, please indicate and provide information about how to contact you

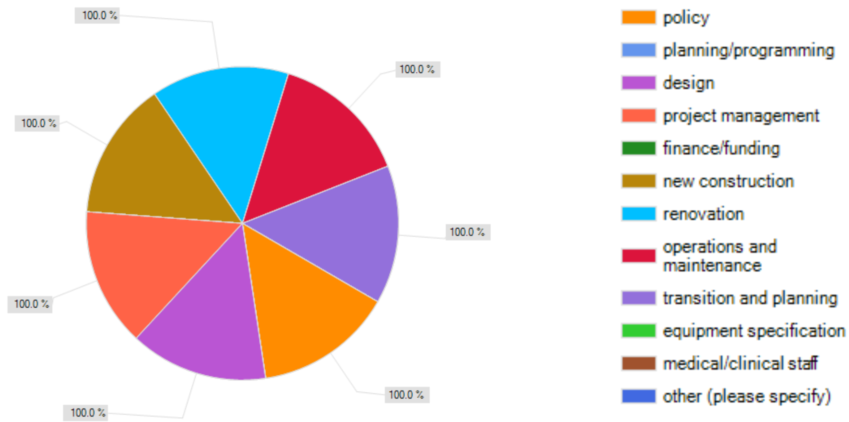
Other Thoughts And Comments

52. Other thoughts and comments

Questionnaire – Construction Companies

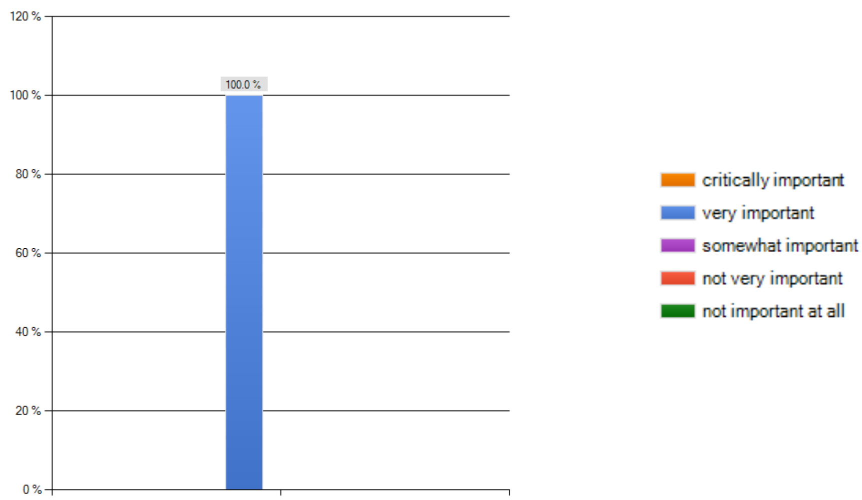
Personal Information

1. Please identify your NAME (optional)
2. Please identify your TITLE
3. Please identify your ORGANIZATION
4. How long you have been in this position?
5. Please identify your role in acquiring healthcare facilities in your organization



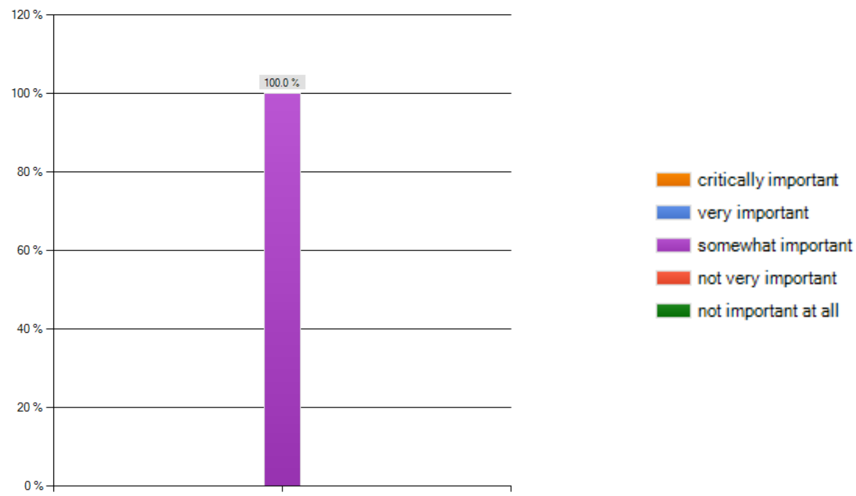
Flexibility As A Value Proposition

6. Is "flexibility" an important goal for public sector healthcare facilities?



7. If the answer to #6 above is somewhat important to critically important, please briefly explain why?
   - Military medical facilities, due to the nature of military missions, are constantly changing. What is an office today, is an exam room next year; a wing of exam rooms this year, could become a dental treatment wing or mental health clinic in the future; many other scenarios, including changes due to the ever rapidly changing medical technology.

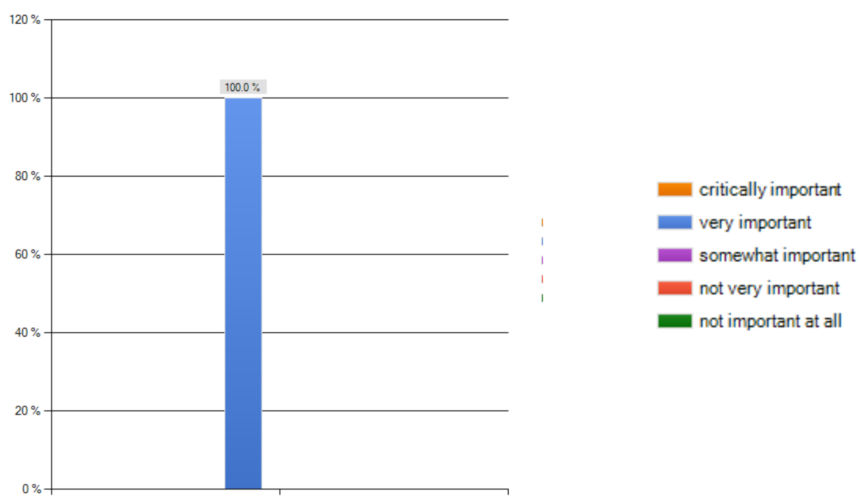
8. Is "flexibility" an important goal for private sector healthcare facilities or systems?



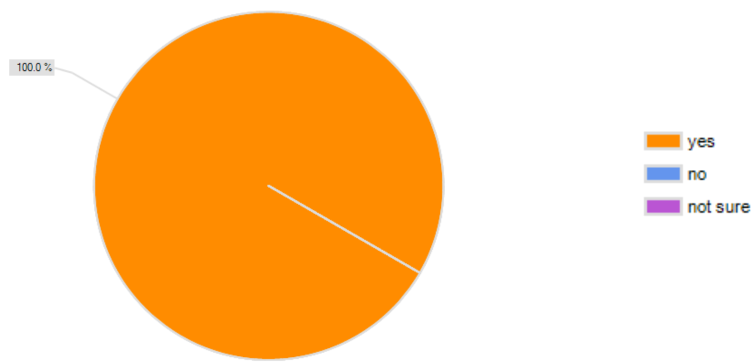
9. If the answer to #8 above is somewhat important to critically important, please briefly explain why?

- While not as volatile as in the military environment, private sector medical facilities also change due to changes in technology or emphasis on product lines.

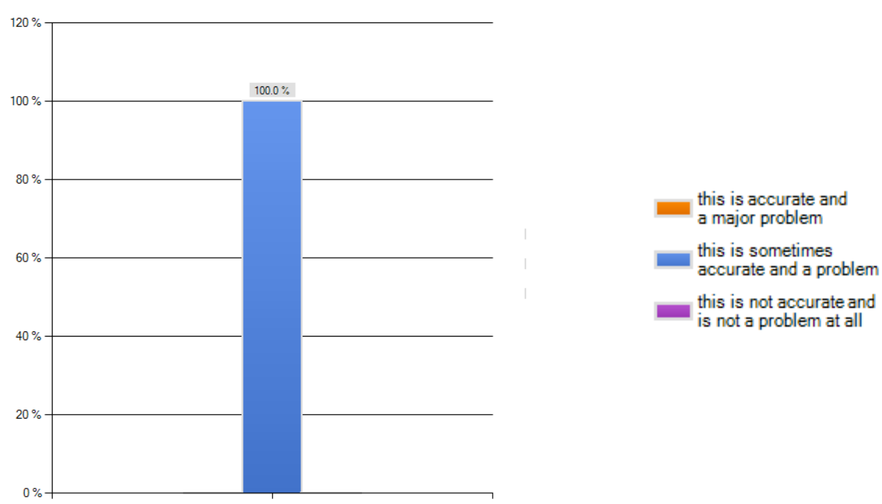
10. How important is "flexible healthcare facilities" as a goal for your organization's expertise and value proposition?



11. Assuming flexibility has become an important priority for your organization, please briefly explain why – for example, is it a core corporate value or because clients ask for it? (Open) Should “flexibility” be an intrinsic part of the larger “sustainability” agenda, with its own metrics?



12. To what extend to you think that owners want flexible healthcare facilities but cannot define flexibility in specific performance criteria, making it impossible to assign a value (cost or otherwise) and making the design of flexible facilities impossible?

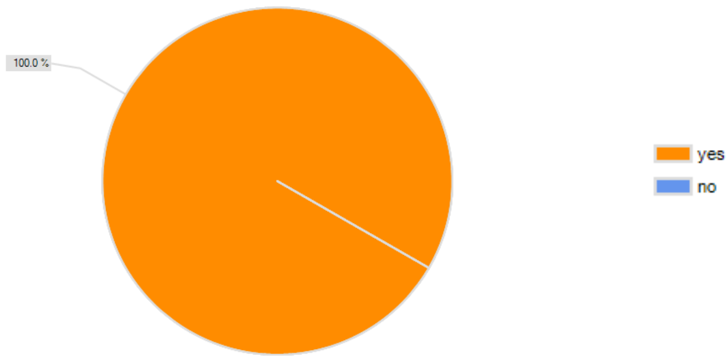


Defining And Assessing Flexibility

13. What is your current definition of healthcare design for flexibility?

- Flexibility is defined as laying out structural, partitioning, and utility systems such that they can be adapted to a new function without a major disruption of the immediate and surrounding building space, and at a reasonable cost. A secondary definition is to plan the facilities' operations to conceptualize changing the functional space (for example, acuity adaptable patient rooms).

14. Have you been asked by clients specifically to construct a flexible healthcare facility?



15. If so, please name the project or projects
  - All recent (past 5 years) DoD medical facilities.

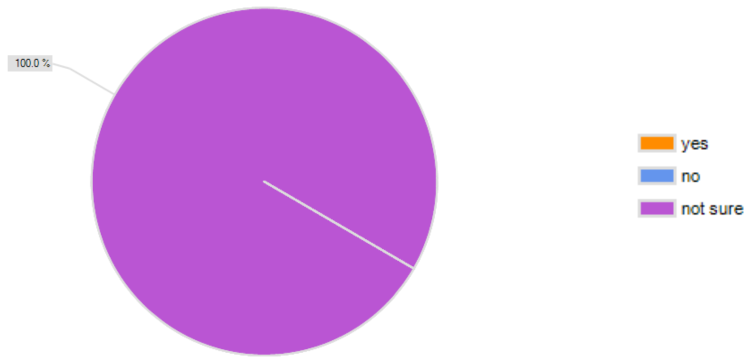
16. Have you been asked by clients specifically to renovate a flexible healthcare facility?

17. If so, please name the project or projects
  - Not yet!

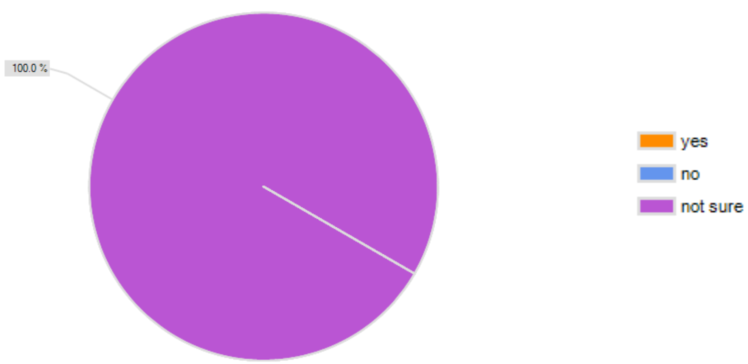
18. What criteria do you or would you use to declare that a project (your project or other projects) is “flexible?” That is, what are the criteria for evaluating a facility for flexibility, both technical and process/policy-oriented?
  - Outside of broad, conceptual notions of "flexibility" for a given project developed by the team during the programming or charrette process, I am not aware of written criteria that drives flexibility.

19. What factors/constraints/drivers do you consider in discussing “flexibility” with your staff?
  - Examples I cited above. The notions of flexibility for a given project are balanced against the cost and benefit of doing so.

20. The distinction between "equipment" and "real estate asset" provides one way to define "flexibility" in the sense that building equipment can be depreciated over 3-7 years while "interiors" can be depreciated in 15-20 years and "core and shell" in 30-year cycles. Given this, do you attempt to increase the investment in "non-core and shell" as a way to increase flexibility?

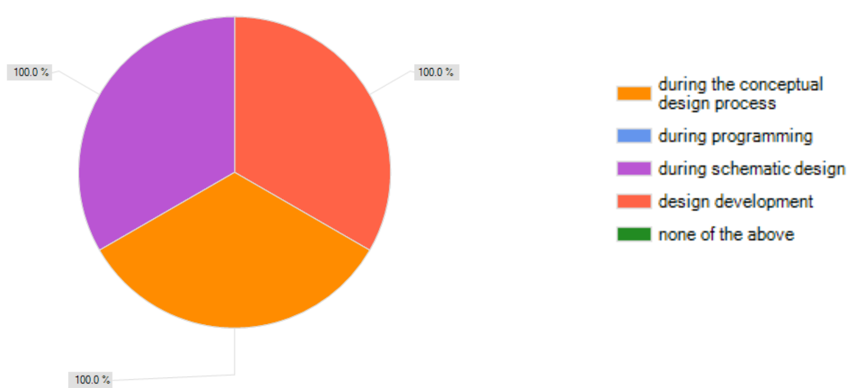


21. In your experience in the healthcare sector, has an expansion of the category of things called "equipment" – to include more and more parts of the total healthcare facility – made achieving a "flexible" facility for your client easier?

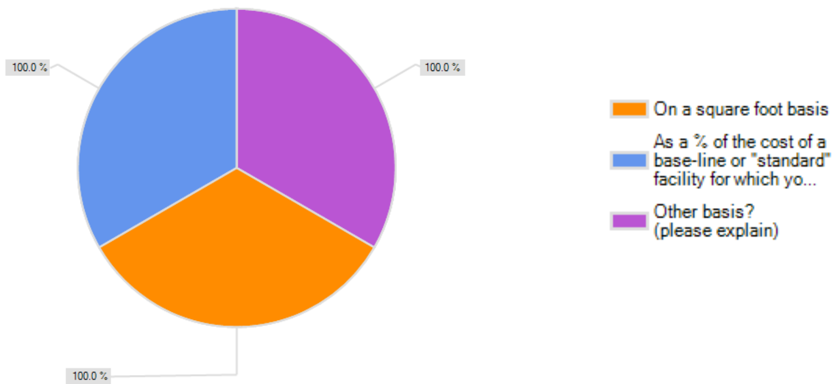


Cost Trade Off

22. Working with the A/E team do you provide cost estimates for alternative "flexibility" strategies? (check all that apply)



23. If the answer to the question above is YES, on what basis do you offer such estimates?

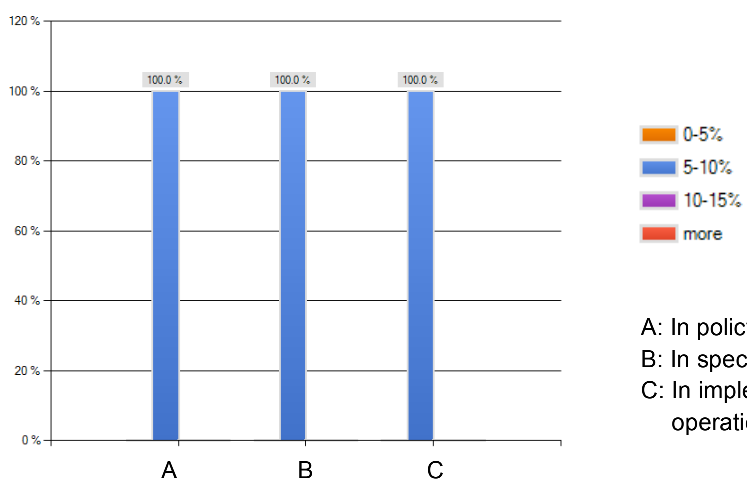


24. Do you have a methodology to estimate the added cost of making a facility flexible?

25. When a cost premium exists, to what can you attribute it?

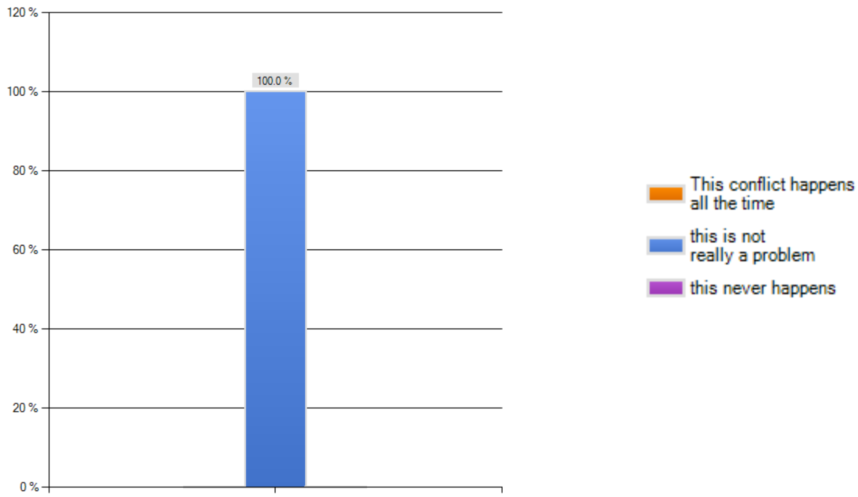
- Both policies and requirements for flexibility can create cost premiums, but must be balanced against the likelihood and importance of flexibility in a given building's life cycle.

26. Assuming that you know there is a cost premium, and assuming you can monetize it, would you say the premium for adopting a "flexibility" strategy occurs:



A: In policy documents
B: In specifying requirements
C: In implementation (i.e. construction or operations/maintenance of a facility)

27. To what extent does a “flexible” project come into conflict with other priorities?



28. Please give a few examples of these conflicts.

- Building in flexibility has not been a significant problem to date. Depending on the level of flexibility desired, there could be either little cost premium (in the case of building an office so it can become an exam room) to major, where a huge interstitial or utility space is created not only to ease maintenance, but also "in case" a major portion of the facility might become something else in the future. From my point of view, our teams do a good job balancing the requirements with the costs.

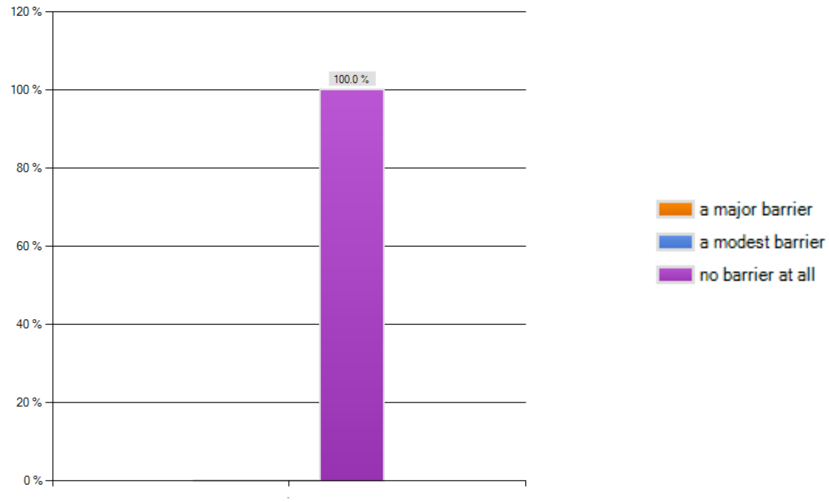
29. Would you be willing to share cost details related to the above information that can be included in a final report associated with this questionnaire?

Barriers To Flexibility

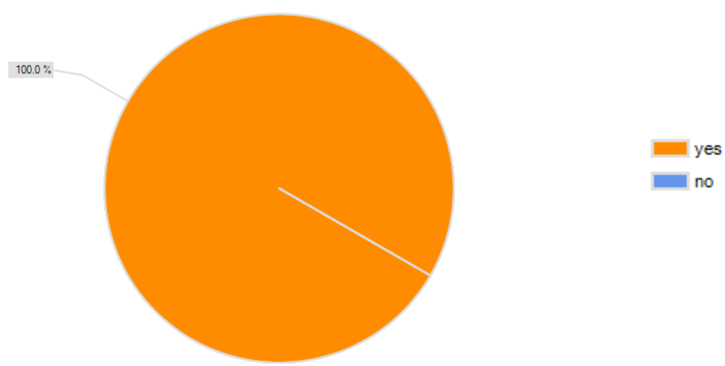
30. What are the one or two most powerful barriers to getting healthcare facilities designed for flexibility?

- I am not aware of any major barriers to flexibility (beyond possible additional cost).

31. Assuming that your organization adopts short-term strategic plans, to what extent does this present a barrier to achieving a flexible facility?



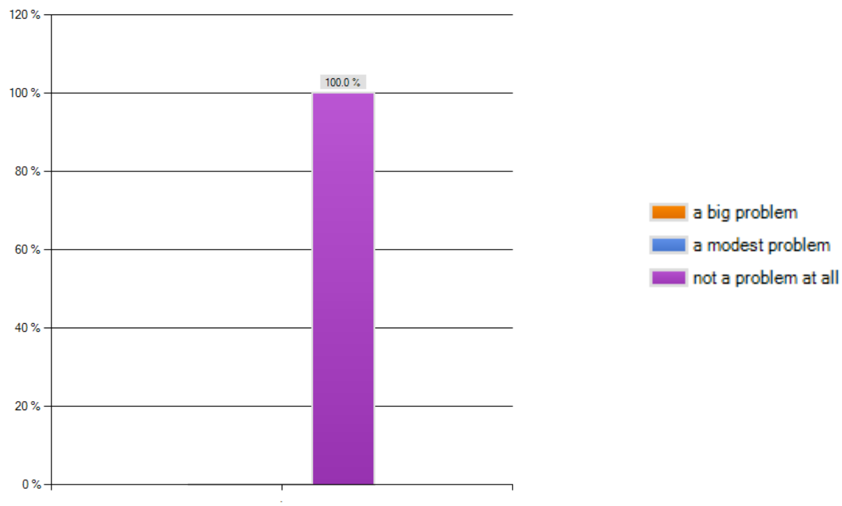
32. Are the current fiscal and information management (programming) processes used by your clients designed to achieve a flexible facility?



33. If not, have you recommended to your clients that they adjust their processes to enable you to construct a flexible facility?

34. If not, have you recommended to your clients that they adjust their processes to enable you to renovate an existing facility?

35. To what extent do your in-house priorities, metrics and attitudes make constructing a flexible facility difficult?



36. Please explain briefly how these priorities, metrics and attitudes are barriers or enablers to your ability to design a flexible facility.

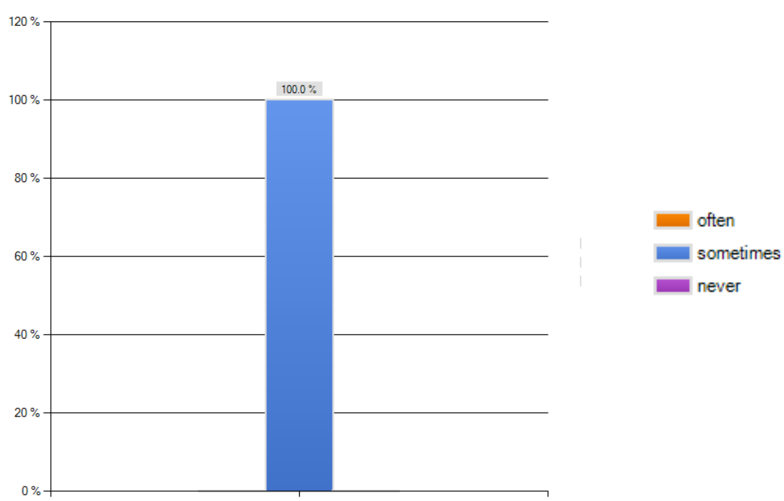
- We are at the execution end of the process. If the customer is able to determine what flexibility means to them, and the project is programmed to absorb the potential costs, flexibility is not an issue.

Planning Processes And Methods

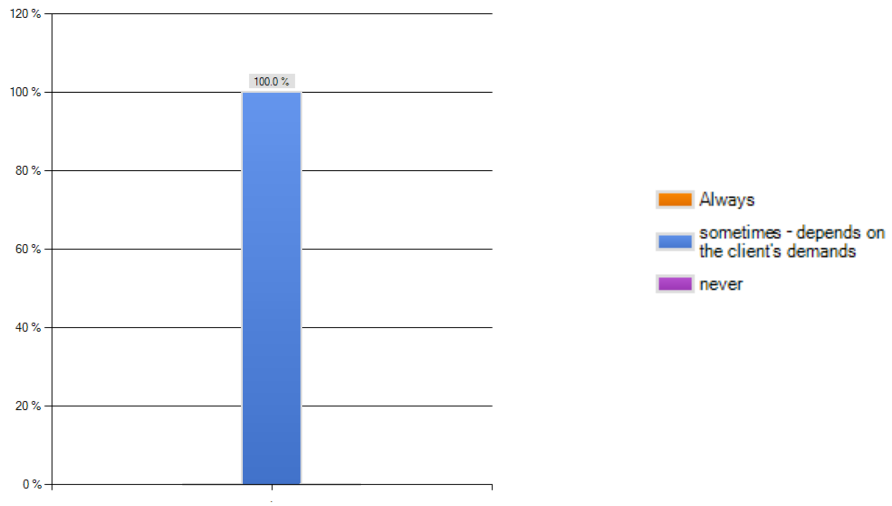
37. What are key critical factors that you consider critical to help you successfully construct a flexible healthcare facility or renovate an existing facility to make it more flexible?

- Having someone define the flexibility component so we can design and build it; programming (funding and space) to the desired level of flexibility; agreeing that once the flexibility decision is made, decisions are not reversed during late level design and construction.

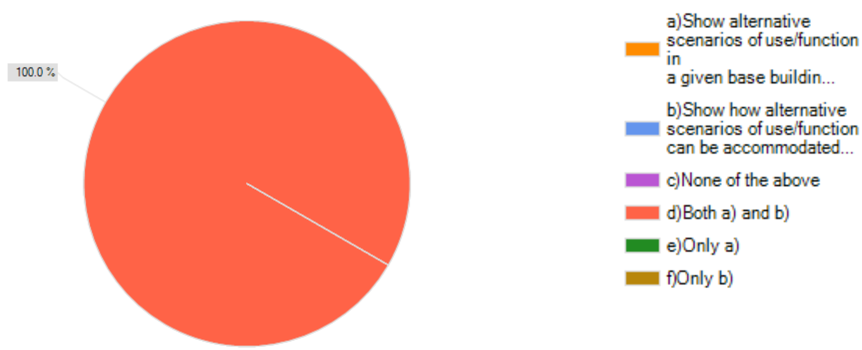
38. How frequently do clients ask for "flexible" healthcare facilities?



39. To what extent do you market your services as providing "flexible" healthcare facility solutions?



40. How do you demonstrate that the facility you are constructing or renovating will be "flexible?" (Check all that apply and add comments if appropriate.)



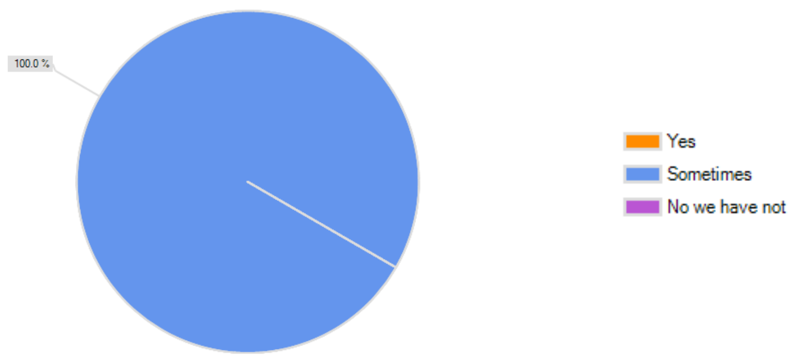
- As noted in the previous comments.

41. Does your firm invest in developing new methods and strategies for healthcare facility construction for flexibility?

42. If the answer to # 41 is YES, do you have a specific business plan or research team for developing and implementing flexibility strategies?

Precedents

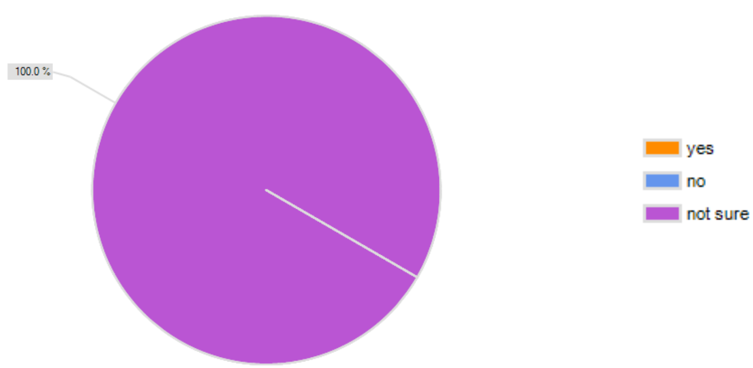
43. Have you examined policies or requirements that are claimed to lead to "flexible" facilities, and/or "flexible" projects, to see if you can make use of them in your own consulting?



44. Please identify those policies, requirements and/or projects.

- Various DoD reports and industry references on the subject.

45. Does the commercial office markets' distinction of base building, fit-out and FF&E (furnishings, fixtures and equipment) apply to healthcare facilities design for flexibility. (In such projects, detailed programming is done after the design of the base building (core and shell) so functional areas can change without disturbing other areas of the building)



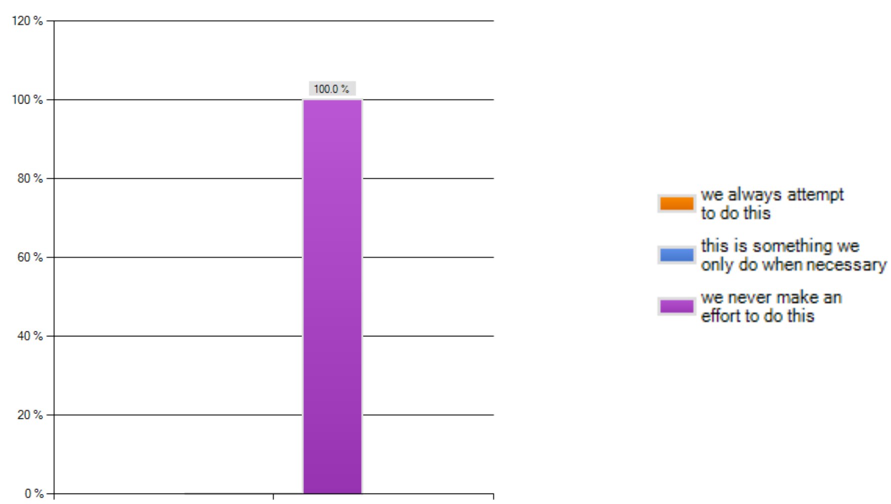
46. If the answer to #45 is yes, please explain why you think so and how it applies.

47. Do you look to overseas examples of “flexible” policies, requirements and / or projects?

48. If the answer to #47 is yes, please identify them.

49. Do you advocate to your clients that achieving “flexibility” requires that detailed decisions about spatial organization and equipment NOT be made up front or allowed to dominate the architectural infrastructure of the facility?

50. To what extent do you currently uncouple construction logistics and planning for departments and equipment from the base building decisions, to avoid the details from determining the overall asset quality/value?



Tracking Flexibility

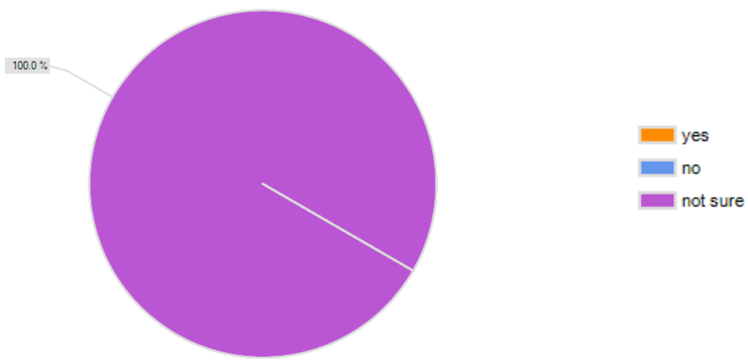
51. If you were asked to be part of a team to track the behavior of facilities you construct or renovate, over a period of years, what patterns of change would you look for – situations or instances of change that, if you could document them, would be most beneficial to know about? Patterns or situations of change that would yield results in constructing future "flexible" facilities?

- *How the space had been utilized and changed over a given period; what equipment had changed; what effort was necessary to make the changes, and at what cost.*

52. More generally, why, in your view, has no one yet developed a systematic methodology to track how facilities change?

- From my point of view, everyone is so busy concentrating on the matter at hand, or on the close horizon, that we don't take a good look BACK. Funding for such an effort is always an issue in government administration.

53. Would you be willing to work with clients and/or A/E service providers to develop and apply a systematic methodology to study how healthcare facilities change, and make the evidence available in the public domain?



54. If the answer to #53 is yes, what entity is best suited to lead such an effort?

- I didn't answer yes, because we are not funded for such a study. I believe a university or major medical system is most suited to lead such a study with support from the architect-engineering community and government (DoD including the individual Military Services medical departments, VA)

55. If you are willing and interested to be contacted for follow-up questions and/or discussions, please indicate and provide information about how to contact you.

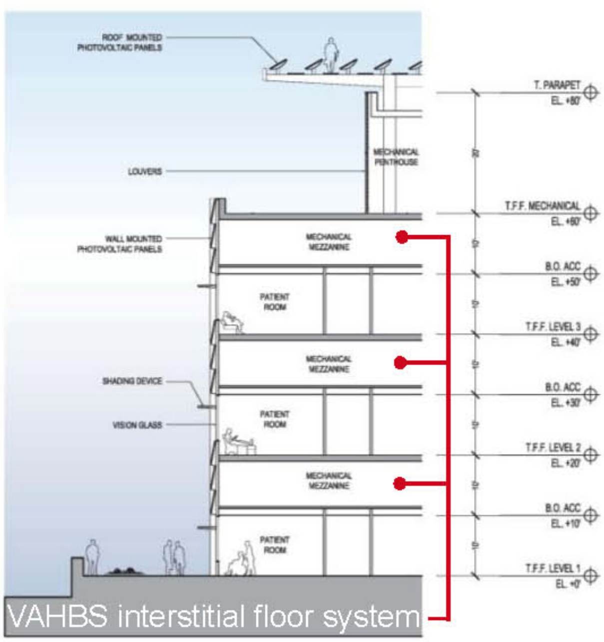
Other Thoughts And Comments

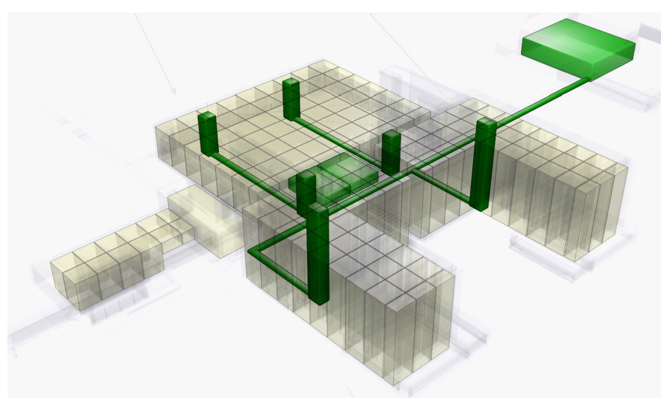
56. Other thoughts and comments

- Thanks for the opportunity to respond. We are only just starting our participation in this interesting field of flexibility and I look forward to observing, and possibly participating as I learn more

9.3 Best practice cases of flexible healthcare facilities


INO "Primary System" at the Inselspital Hospital, Bern, Switzerland





Veterans Administration Replacement facility in Denver

Banner Estrella Hospital, Phoenix

The research team requested information on “best practice flexible healthcare facilities” from a number of high-profile architecture firms and healthcare organizations. The body of the report contains the summative findings, in Section 4.3.

This appendix provides more detailed information about the facilities that are believed by the architects and healthcare organizations to be flexible. To assist, we employ a flexibility matrix using the FLEXIBILITY LEXICON presented in Section 4.3, to indicate which facility demonstrates which flexibility characteristics. NOTE: some of this information is speculative on our part, in the cases when sufficiently detailed information was not available at the time this report was submitted.

	Horizontal expansion (or contraction)	Vertical expansion	internal structural walls	Floor-to-floor height	Building geometry	Floor loading capacity	Shell space	% set-aside	System Separation
INO	yes	yes	yes	yes	yes	yes	yes	yes	yes
Martini	yes	NA	yes	yes	yes	NA	NA	NA	yes
Dartmouth-Hitchcock Medical Center	yes	no	yes	yes	no	no	no	no	NA
Mayo Gonda	no	yes	yes	yes	yes	yes	yes	no	yes
Banner Estrella	yes	yes	yes	yes	yes	NA	yes	no	yes
Spring Hill Baptist Health Medical Center	yes	yes	yes	yes	no	NA	NA	no	yes
Denver VAMC Project Eagle	yes	no	yes	yes	no	yes	NA	NA	yes
Universal Grid Theory	yes	yes	yes	yes	yes	yes	NA	NA	yes

Request for Data

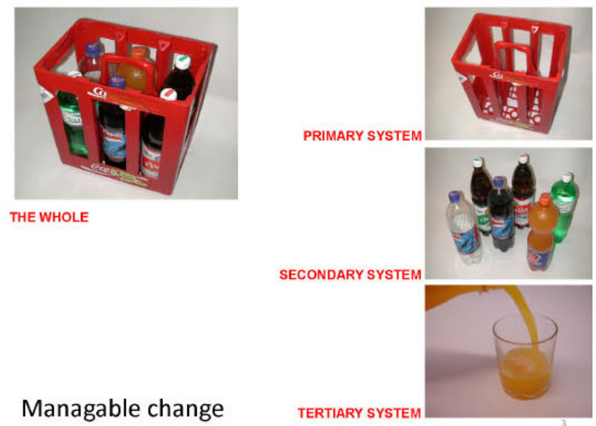
We asked for data on specific healthcare facilities projects that are deemed to be "flexible" and that have or are anticipating some level of change.

Desired information for each project included:

1 Site plan showing current buildings and site logistics, circulation, MEP spines, and planned expansion zones;
2 Several illustrative floor plans (which complement the requested diagrams (5 below) showing how the building is prepared for future change)
3 Cost as constructed (total + breakdown by
   a. Core and shell;
   b. Fit-out including fit-out related MEP systems;
   c. Medical equipment and other fixtures not included in the fit-out;
4 Cost of renovations/alterations/expansions at any of the four levels of work noted below in item 5;
5 Diagrams of "flexibility strategies" at the following planning levels:
   a. **Site** (indicating "zones" of expansion, vertical and/or horizontal)
   b. **Core and shell or base building** (including structure, envelope, main MEP risers, primary vertical/horizontal circulation, etc);
   c. **Fit-out** including departmental layouts, main corridors, MEP flexibility strategy going with the specific layouts;
   d. **Equipment** flexibility (e.g. how an acuity adaptable room can accommodate various equipment; or how a surgery suite can accommodate new equipment as it comes available without changing the room itself).

1. **Horizontal building expansion** (or contraction) is enabled by site and infrastructure planning
2. **Vertical building expansion** is enabled by structural and MEP systems' design
3. **Minimal internal structural walls** offer unimpeded internal spatial arrangement capacity
4. **Floor-to-floor height** of at least 15'-0"
5. **Building geometry** enables a variety of uses to be accommodated inside a buildings' footprint
6. **Floor 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

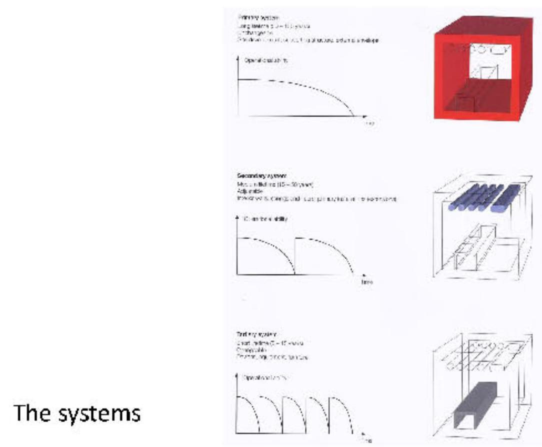
INO – Inselspital Bern (replacement for Emergency, Imaging, Surgery, Intensive Care, Pharmacy) – Office of Properties and Buildings, Canton Bern, Switzerland



Architect:
  Primary System: Peter Kamm
  Secondary System: Itten & Brechtbuehl AG
  Tertiary System: HWP Planungsgesellschaft mbH

Occupancy: Phase 1: 2009 / Phase 2: 2012

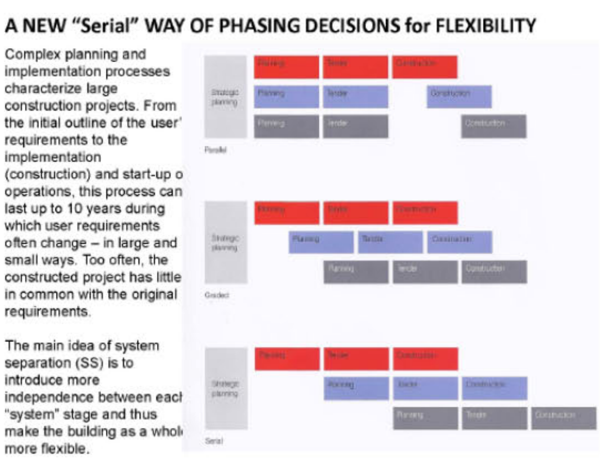
	Horizontal expansion (or contraction)	Vertical expansion	Internal structural walls	Floor-to-floor height	Building geometry	Floor loading capacity	Shell space	% set-aside	System Separation
INO	yes	yes	yes	yes	yes	yes	yes	yes	yes

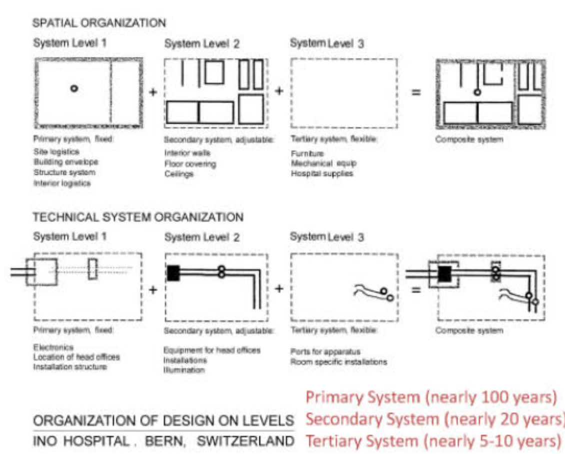


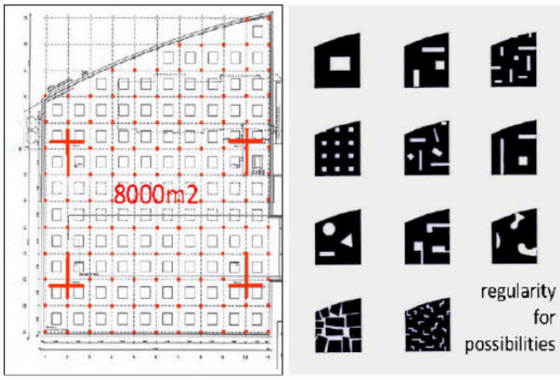
The INO project for intensive care, emergency, surgery and pharmacy at the INSELSPITAL Hospital in Bern, Switzerland used a new way for a client to acquire public buildings – System Separation. The Office of Properties and Buildings took the initiative to introduce this method. System Separation leads a client to make decisions at several points to get buildings with a high utility value, and by that – in combination with other requirements such as those concerned with ecological and energy – to realize sustainable buildings.

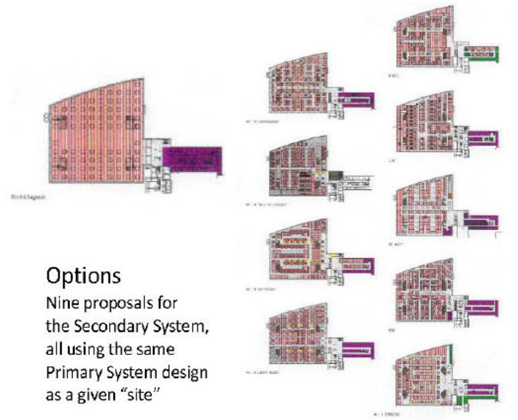
Three Systems Separation Principles:

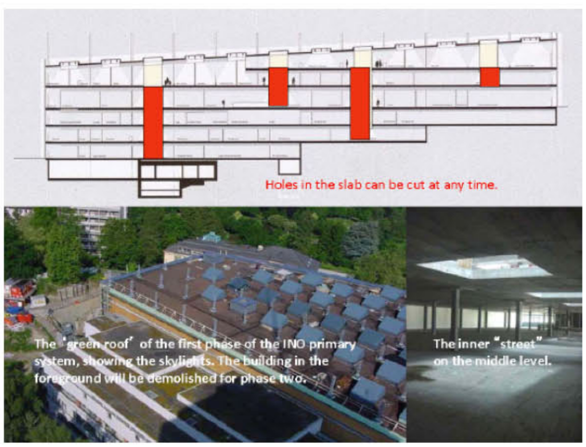
- Separation of building elements and spatial orders according to life- cycle and a corresponding management system;
- Building capacity (adaptability within a use category; convertibility to another use categories);
- Site capacity to accommodate expansion (horizontal and vertical), adaptability within a use category and convertibility to another usecategory.

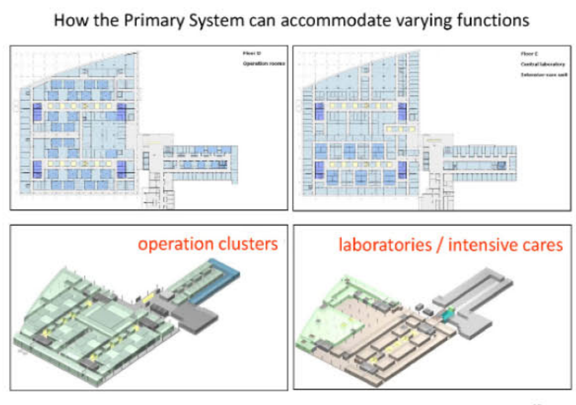













Open Primary System

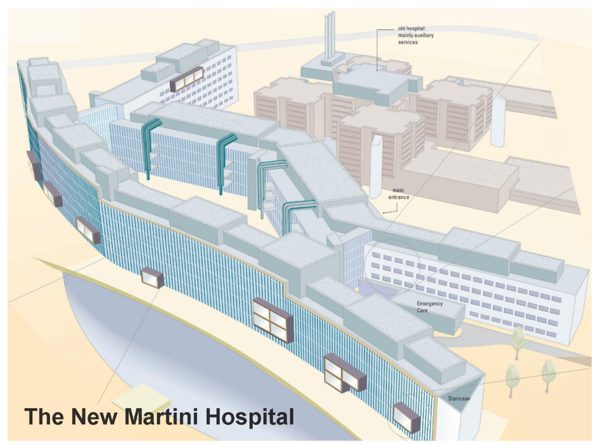
Martini Teaching Hospital Groningen, the Netherlands

Architect: Burger Grunstra Architects and Consultants, Alkmaar, NL

Occupancy: 2007

	Horizontal expansion (or contraction)	Vertical expansion	internal structural walls	Floor-to-floor height	Building geometry	Floor loading capacity	Shell space	% set-aside	System Separation
Martini	yes	NA	yes	yes	yes	NA	NA	NA	yes

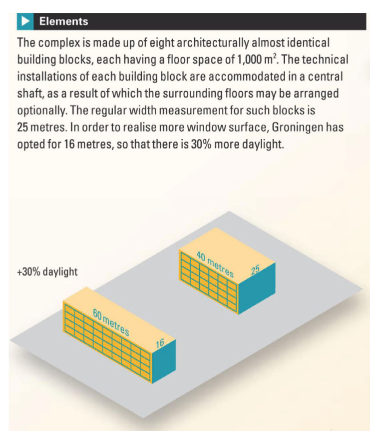
The new Martini Teaching Hospital will be built according to the ‘IFD’ principle: Industrial, Flexible and Demountable. In other words: ‘building in an operational, innovative and future-focused way’. Or just: ‘building in a smart way’. An innovative and future-focused hospital with a flexible lay-out that can respond to the demands made on a building by patients and professionals. Besides, it must become a building in which one feels good: a so-called ‘healing environment’, in which daylight, color and design are in such harmony that a friendly atmosphere is created.



The Martini Teaching Hospital hereby functions as an IFD demonstration project and it has, therefore, received a national demonstration status from the Ministry for Housing, Regional Development and the Environment.

The industrial building concept is based on standardization. Both the building skeleton, which is made up of uniform building blocks, and the façade panels and system walls are completely prefabricated. The rooms in the outpatient departments have standard measurements, suitable for various specialties. Pipe shafts have also been standardized. Only the high-tech departments, such as the X-ray and surgery wards, will have broader building blocks.

The building concept leads to flexibility at all levels. Extensions of 2.40 by 7.20 meters may be added as a ‘drawer’ to the building. This offers the possibility to increase the floor space of the entire building by approximately ten percent. The building has even been designed and functionally arranged in such a way, that in twenty years’ time, it may also accommodate non-hospital functions. In the new building, a nursing ward may easily be converted into an outpatient department or an office space. The partition walls and finishing floors are demountable so that a room may be adjusted to a changed function.

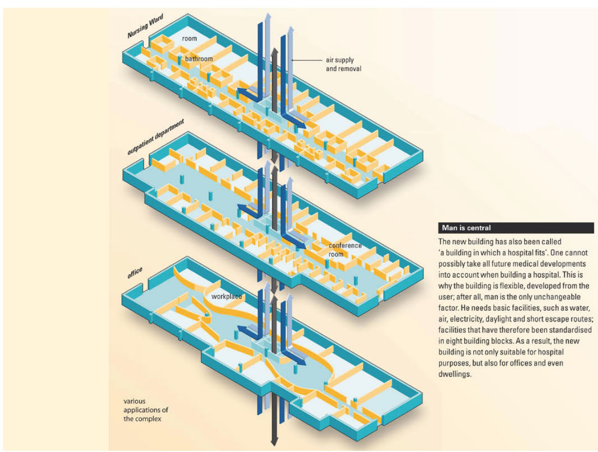


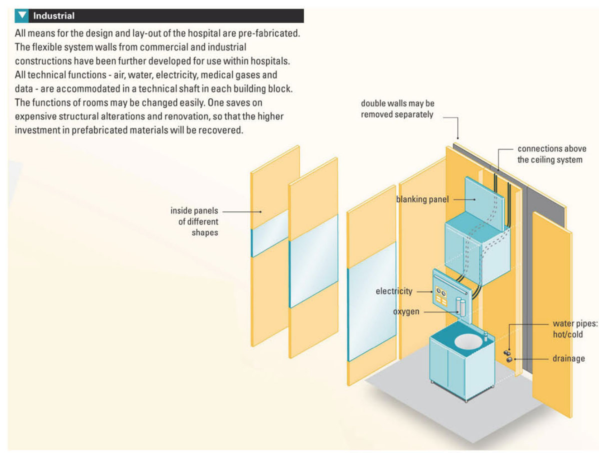
The plan of the new building takes the age difference of the old and the new building into account. The end of the life span of the old building (in approximately fifteen years’ time) will coincide with half the life span of the new building. The use of the lot indicates a proper long-term accommodation plan that will ensure that new developments may structurally take place on the premises in a so-called triple jump in the next forty years. Both the location and the building will provide new possibilities all the time. With the present dimensions
(16 x 60 meters) and the size of the building modules (1,000 m2), the building will be very suitable for office or residential functions in the future.

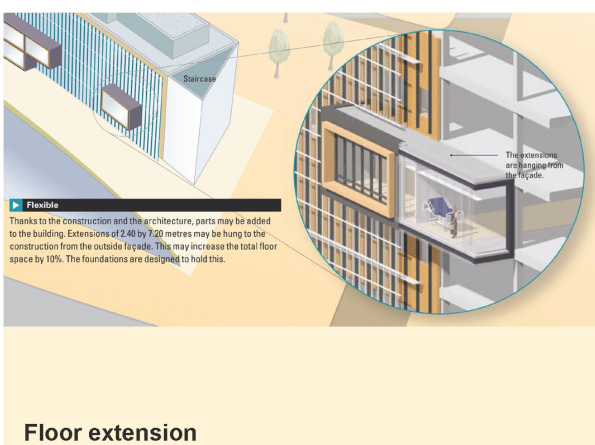
The new building has also been called ‘a building in which a hospital fits’. One cannot possibly take all future medical developments into account when building a hospital. This is why the building is flexible, developed from the user; after all, man is the only unchangeable factor. He needs basic facilities, such as water, air, electricity, daylight and short escape routes; facilities that have therefore been standardized in eight building blocks. As a result, the new building is not only suitable for hospital purposes, but also for offices and even dwellings.

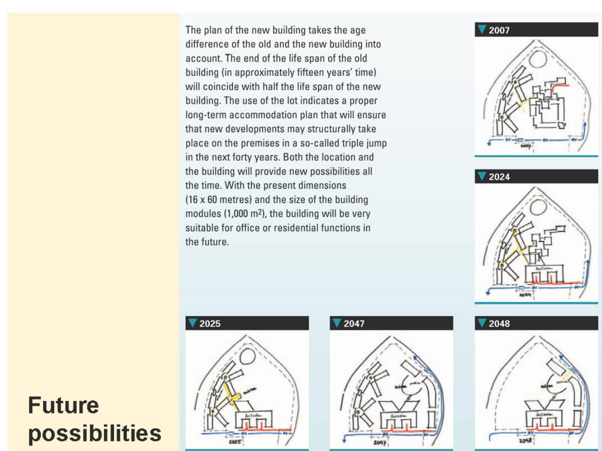

Nursing department
Outpatients department
Office space
Three proposals


Interior with four types of façade elements
Walkable cavity wall of 80 cm
Glass exterior
Windows of various dimensions
Demountable
The façade is a so-called double-layer façade. The exterior of the double-layer façade is completely made of glass and has, among other things, a sound-absorbing function. The entire inside of the façade is made up of movable, demountable façade elements. Thus, the building can be easily adjusted to the rear part of the department.
Demountable facade


Nursing Ward
room
bathroom
air supply and removal
outpatient department
conference room
office
workplace
various applications of the complex
Man is central
The new building has also been called 'a building in which a hospital fits'. One cannot possibly take all future medical developments into account when building a hospital. This is why the building is flexible, developed from the user; after all, man is the only unchangeable factor. He needs basic facilities, such as water, air, electricity, daylight and short escape routes; facilities that have therefore been standardised in eight building blocks. As a result, the new building is not only suitable for hospital purposes, but also for offices and even dwellings.


Industrial
All means for the design and lay-out of the hospital are pre-fabricated. The flexible system walls from commercial and industrial constructions have been further developed for use within hospitals. All technical functions - air, water, electricity, medical gases and data - are accommodated in a technical shaft in each building block. The functions of rooms may be changed easily. One saves on expensive structural alterations and renovation, so that the higher investment in prefabricated materials will be recovered.
double walls may be removed separately
connections above the ceiling system
inside panels of different shapes
blanking panel
electricity
oxygen
water pipes: hot/cold
drainage


Staircase
The extensions are hanging from the façade.
Flexible
Thanks to the construction and the architecture, parts may be added to the building. Extensions of 2.40 by 7.20 metres may be hung to the construction from the outside façade. This may increase the total floor space by 10%. The foundations are designed to hold this.
Floor extension


The plan of the new building takes the age difference of the old and the new building into account. The end of the life span of the old building (in approximately fifteen years' time) will coincide with half the life span of the new building. The use of the lot indicates a proper long-term accommodation plan that will ensure that new developments may structurally take place on the premises in a so-called triple jump in the next forty years. Both the location and the building will provide new possibilities all the time. With the present dimensions (16 x 60 metres) and the size of the building modules (1,000 m2), the building will be very suitable for office or residential functions in the future.
2007
2024
2025
2047
2048
Future possibilities

Dartmouth Hitchcock Medical Center, Lebanon, New Hampshire

Architect: Shepley Bulfinch Richardson and Abbott

Occupancy: 1992 (with subsequent renovations and expansions)

	Horizontal expansion (or contraction)	Vertical expansion	internal structural walls	Floor-to-floor height	Building geometry	Floor loading capacity	Shell space	% set-aside	System Separation
Dartmouth-Hitchcock Medical Center	yes	no	yes	yes	no	no	no	no	NA

The overall objective of the new Dartmouth Hitchcock Medical Center was to create a physically integrated and market responsive set of clinical and academic facilities. Five distinct institutions operate under the umbrella of the DHMC, including the Veterans Administration.

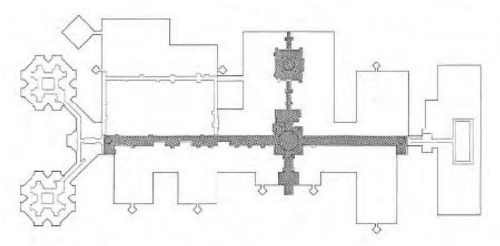
The facility is organized in five buildings along a central, sky-lit mall. The concept was to make it easy to add to or cut back if the budget required. Each component of the entire facility was planned to be able to expand independently of the others. The five components were:

1. An Inpatient Care Building
2. A Diagnostic and Treatment Facility
3. The Hitchcock Clinic
4. The Medical School
5. The Research Building (designed to be highly flexible and generic)

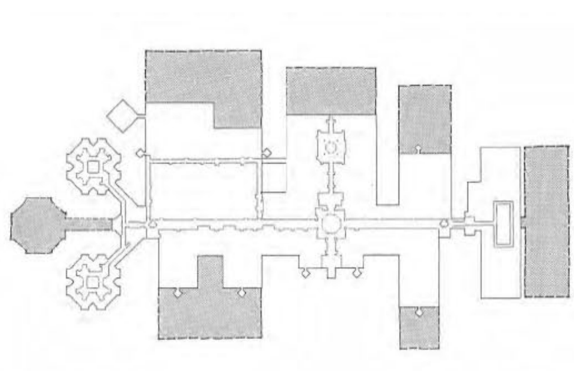
By this strategy, the designers avoided having to design each part of the structure with the flexibility and systems capable of handling different users.

The site and building were planned to accommodate future growth, by locating the power plant as far away as possible; the sectors of the hospital were located so that lateral development of each could be accomplished independent of the other sectors. The Inpatient and Research buildings grow by building additional pods or cells, while the other buildings are designed in an open-ended manner to permit easy future additions.

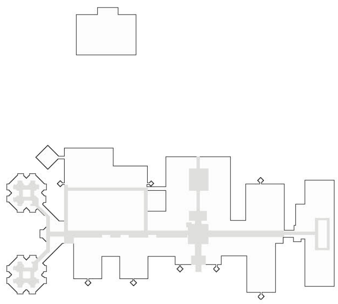
All the buildings were given generous floor-to-floor heights of 15 feet, and except for the specific structure used in the Inpatient Building, all other buildings have large and regular structural bays. Cable trays were used to accommodate anticipated need for computer and communications cabling in the future.



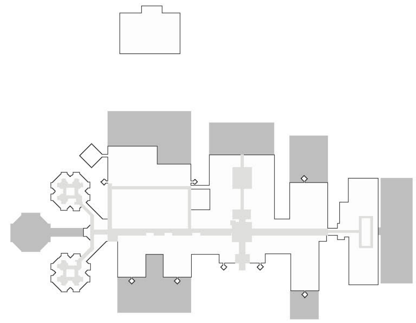
Proposed plan



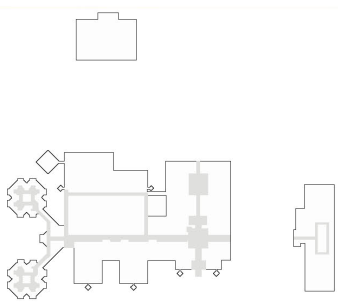
Proposed expantion plan



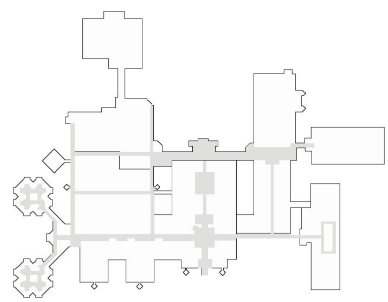
Proposed plan - 1987



Proposed extention plan - 1987

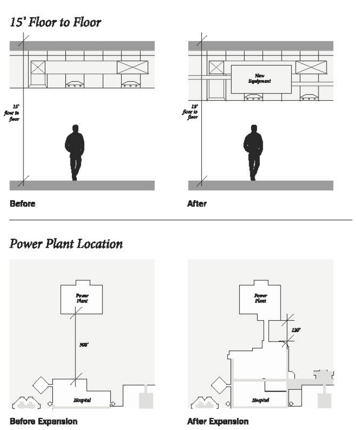


Plan as Built - 1992



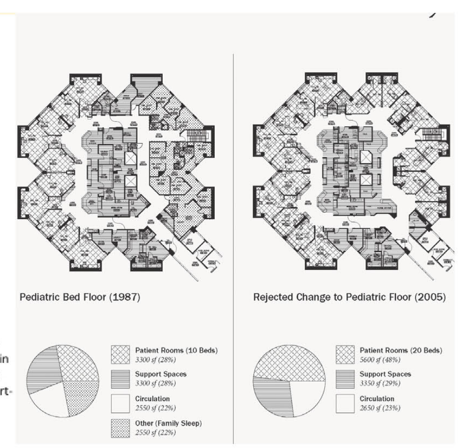
Expansion as Completed - Present

Flexibility measures



Limited bed floor flexibility

Because of a constricting floor plate, the bed floors cannot be efficiently altered. An increase in the number of beds decreases the support-to-bed ratio to an unrealitic level.



Mayo Foundation Clinic, Rochester, Minnesota

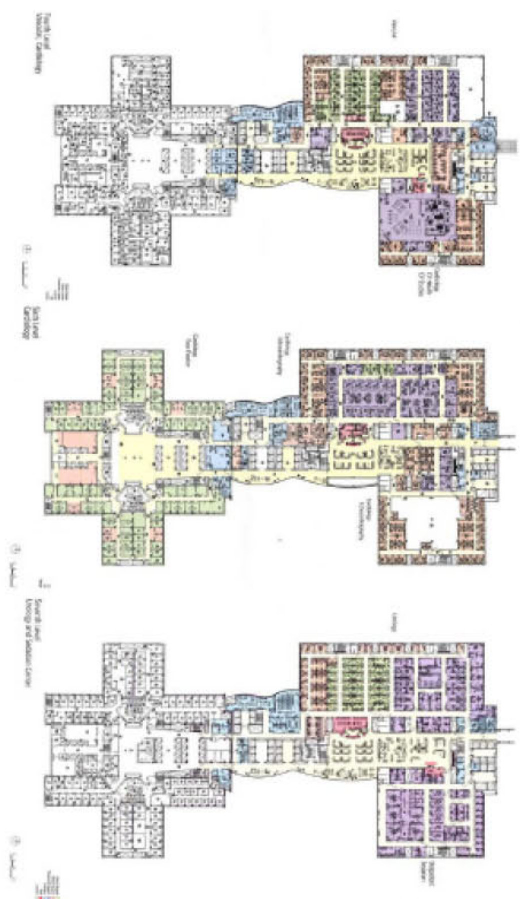
Architect: Ellerbe Becket, Inc. with Cesar Pelli (collaborating design architect)

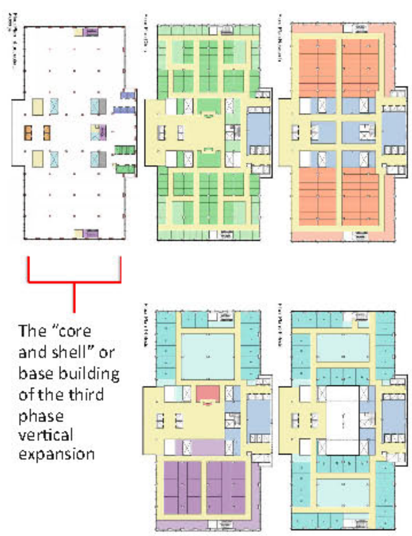
Date of substantial completion (Phase One): 2003

	Horizontal expansion (or contraction)	Vertical expansion	internal structural walls	Floor-to-floor height	Building geometry	Floor loading capacity	Shell space	% set-aside	System Separation
Mayo Gonda	no	yes	yes	yes	yes	yes	yes	no	yes

The expansion

The Gonda Building at the Mayo Clinic is a highly flexible, state-of-the-art building that allows for expansion, redesign, and accommodation of evolving technologies and biomedical discoveries, making the facilities ready to support the next 100 years of medical advances. The building's infrastructure – including HVAC, electrical and communication services, materials handling and vertical circulation – provides a shell that allows for diverse programs throughout each floor. The support zones are located outside the functional areas, to increase flexibility and allow for changes in medical practice. Excess capacity allows for building space to be maximally used for clinical exam and supporting activities, education needs, clinical research space, procedural activities, and contiguous hospital and non-hospital space. Future remodeling will be able to accommodate change in a very cost-effective manner. The building's structural systems will accommodate growth via a vertical expansion of ten floors.

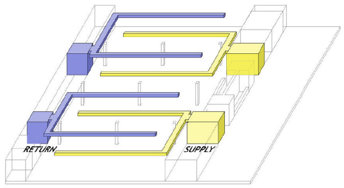




Each floor of the third phase vertical expansion can accommodate different functions

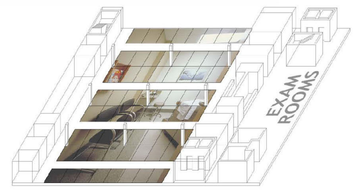
Flexible Model - applied on different floors

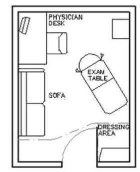
- HVAC layout to allow for a variety of functional layouts
  - Imaging
  - Outpatient Surgery
  - Labs
- Capacity for any use
  - Physician Office (50
- Future capacity



Planning Model-
Infrastructure: Mechanical Zones of Support

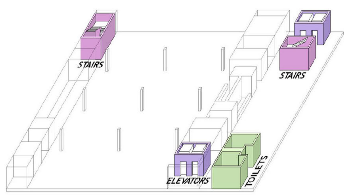
- 10' x 13' common module
  - Exams
  - Offices
  - Treatment
- Supervision
  - Staff Efficiency/Teaming
- Remodeling flexibility





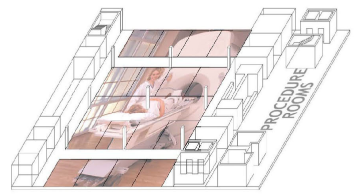
Conceptual Model-
Clinical Module

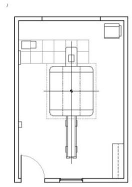
- Vertical Cores that allow for all potential tenant types and needs
  - Ambulatory patients
  - Occasional stretcher patient
  - Service
- Cores Include:
  - Elevators and Stairs
  - Public Toilets
  - Housekeeping
  - Data / Communication Risers
- Considers future capacity



Flexible Model-
Infrastructure: Vertical Circulation and Public Spaces

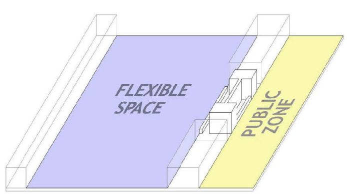
- Common module
  - Support
  - Reading Rooms
  - Technical space
- Staff Efficiency





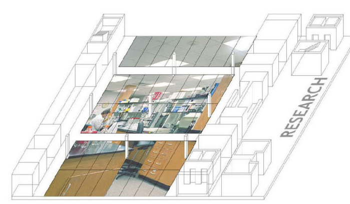
Conceptual Model-
Procedure / Diagnostic Module

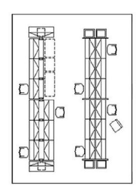
- HVAC layout to allow for a variety of functional layouts
  - Imaging
  - Clinic
  - Office
  - Labs
- Capacity for any use
  - Physician Office (50
- Future capacity



Flexible Model-
Maximize Tenant Usable Area

- 10' x 13' common module
  - Offices
  - Labs
- Supervision
  - Staff Efficiency/Teaming
  - Remodeling flexibility





Conceptual Model-
Research Module

Banner Estrella, Banner Health System, Phoenix, Arizona

Architect: NBBJ

Occupancy: 2008

	Horizontal expansion (or contraction)	Vertical expansion	internal structural walls	Floor-to-floor height	Building geometry	Floor loading capacity	Shell space	% set-aside	System Separation
Banner Estrella	yes	yes	yes	yes	yes	NA	yes	no	yes

BANNER ESTRELLA: THE HOSPITAL OF THE FUTURE

The hospital for the future is designed to adapt to unknown futures – to facilitate change and growth, while contributing to healing, being affordable at first cost, and remaining effective in the long term.
As the frequency of change continues to increase, each change cycle becomes a fraction of a building's life. We are aware that some things have a greater sense of permanence and follow slower cycles of change, such as the human need for clarity and the distribution of energy. Other things, such as care delivery methods and medical technology, are more temporal with more rapid cycles of change.

Given this perspective, we have developed a framework for design that enables a facility to self-create by establishing a rational system for growth. It organizes a building into permanent zones for integrated circulation and infrastructure, and temporal zones for rapid change with minimal disruption and cost. By keeping permanent infrastructure out of the spaces that allow for change, the redevelopment of these areas is significantly less costly and disruptive.

An important element of this framework is the scalability of the concept – from the entire site down to individual rooms. The strategic components of this integrated strategy include:

FLEXIBILITY STRATEGIES

Integrated Circulation and Infrastructure Systems – the three-dimensional framework which organizes and integrates the structural skeleton with the pathways for the distribution of building systems (heating, cooling, ventilation, plumbing, medical gasses, electrical, communications) and the major circulation systems (both vertical and horizontal system of movement of supplies, patients, staff, visitors)

Universal Functional Zones – modular "space fields" which create universal, multi-level blocks of space, adaptable to a wide variety of user types

Universal Building Modules – a modular system which provides uniform, adaptable increments of space, bounded by three-dimensional structural systems (the skeleton created by floor plates and columns)

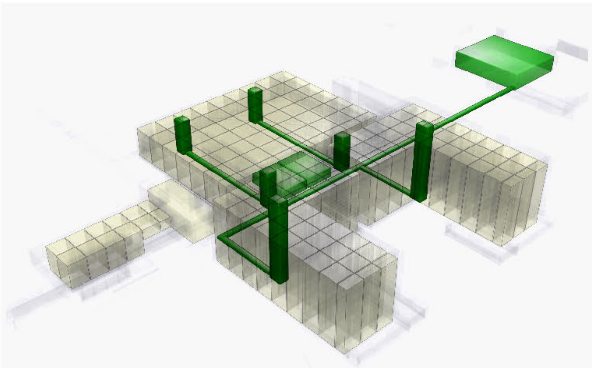
Universal Rooms – rooms configured to accommodate a variety of compatible uses without requiring permanent and costly physical changes

Modular Systems – integrated modular building components (ceilings, floors, walls) and modular casework and furniture systems

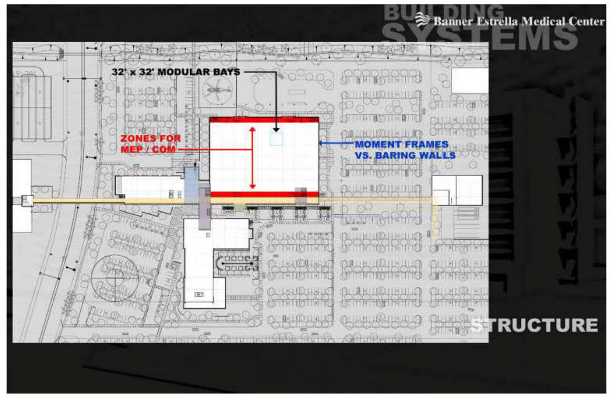
Environmental Components – standardized room elements to support the process, energize the care team, enable the patient, and engage the learner

Adaptability Patterns – planning strategies that create an orderly framework for growth and change.

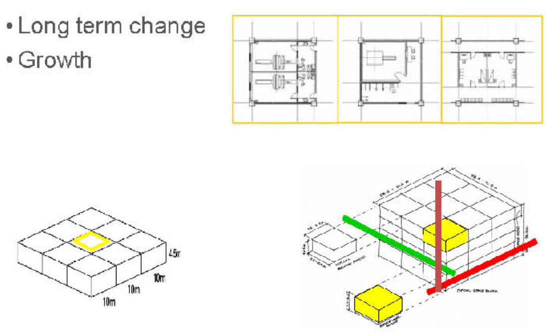
The open-ended infrastructure and materials flow spine becomes a primary organizing element of the site to which the adaptable, universal space fields attach. This attribute enables expansion without disruption. The space fields, unencumbered by major infrastructure penetrations, are set up for rapid change as the healthcare needs of the population change over time.



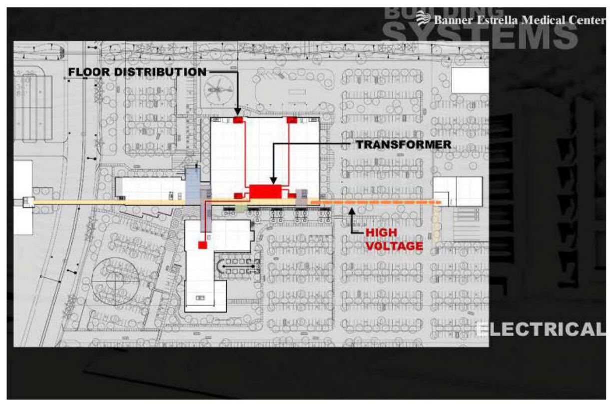
Systems Approach to Design
Permanent & Temporal Zones - Space



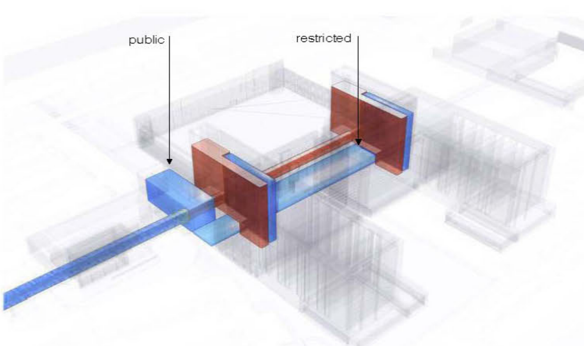
Structure



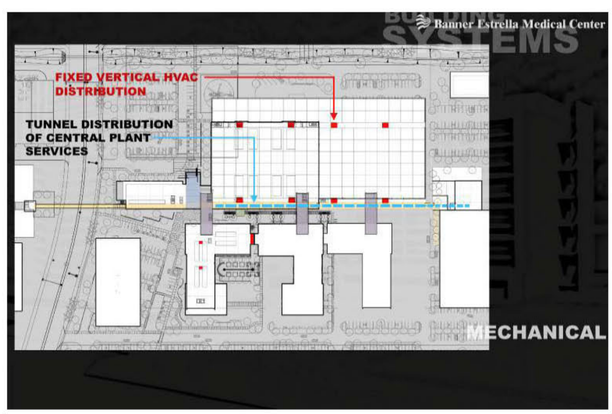
Adapting To Change



Electrical



Relationship of public to private/restricted circulation



Mechanical

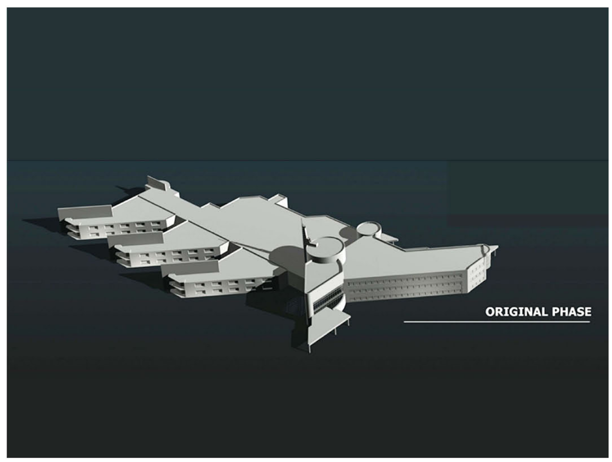
Baptist Health Medical Center, Little Rock, Arkansas

Architect: HKS

Completion Date: Phase 1 (1998) Phase 2 – 3rd floor expansion (2002)

	Horizontal expansion (or contraction)	Vertical expansion	internal structural walls	Floor-to-floor height	Building geometry	Floor loading capacity	Shell space	% set-aside	System Separation
Spring Hill Baptist Health Medical Center	yes	yes	yes	yes	no	NA	NA	no	yes

The guiding vision established by the design team for Baptist health Medical Center – North Little Rock was to create a patient-focused medical village that fosters health and recovery in a pastoral healing environment. The 321,500-square-foot building is designed primarily as an outpatient oriented facility with an inpatient component integrated into the patient flow. It's initial 120-bed capacity has since been expanded to 186 beds and is master planned to accommodate future growth to 400 beds. A 4-story main lobby atrium provides visitor orientation to all of the service facilities. It also provides a dramatic sense of place while giving the facility identity to the local community.



Phasing Strategy

A straight-forward circulation system delineates a separation between public and service traffic while providing a chassis for future incremental growth spurts. These systems are open-ended and growth-oriented with their origins at the 4-story main lobby atrium, provided visitor orientation to all of the service facilities.

The building components that attach onto the service and circulation chassis have two distinct personalities. To the south are specialized functions housing inpatient rooms and intake clinics. To the north is a flexible "warehouse" of space that can be adjusted or manipulated as treatment needs arise and change.

Unique and creative solutions developed:

• Organized in a unique way that facilitates patient/physician access, while preserving options for expansion.

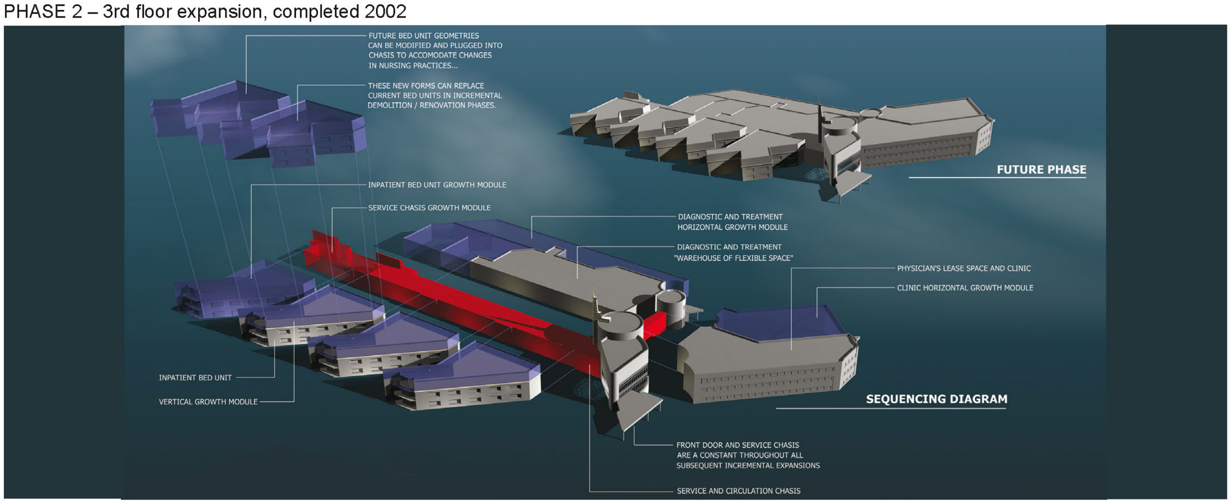
• Addresses the dilemma of future inpatient capacity by open-ended growth chassis for horizontal expansion.

• The nursing wing was designed for simple and rapid vertical expansion which was implemented in 2002.

• All departments are planned for future growth.

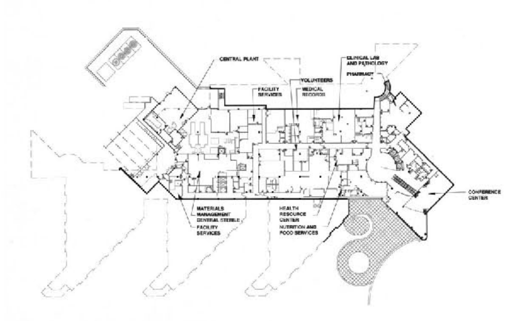
PHASE 1 complete 1998

PHASE 2 – 3rd floor expansion, completed 2002

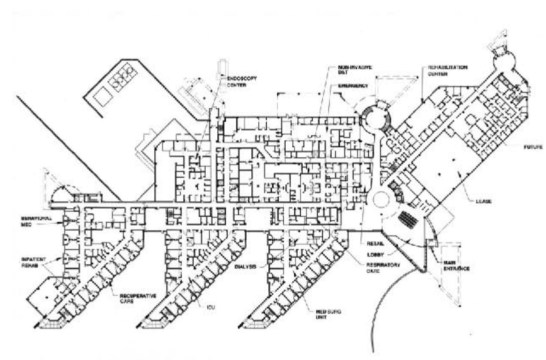


Phase 1

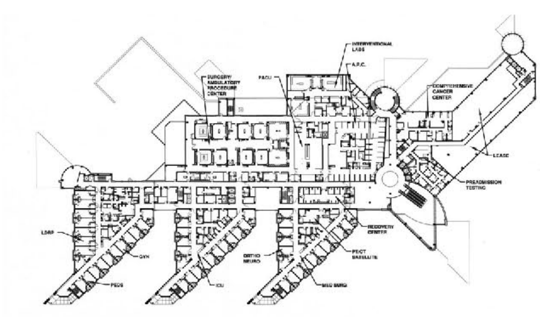
Phase 2



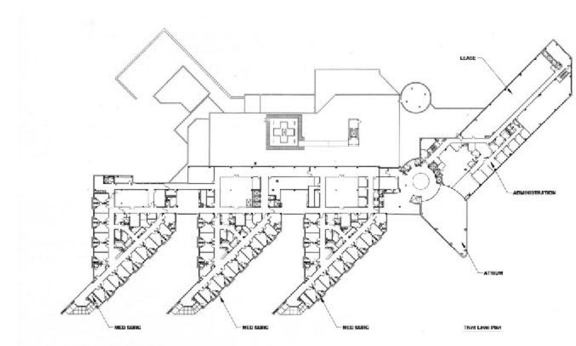
Garden floor



First floor



Second floor



Third floor - Phase 2 (2002)

REPLACEMENT MEDICAL CENTER FACILITY, Fitzsimons Medical Campus Veterans Administration Medical Center, DENVER, CO

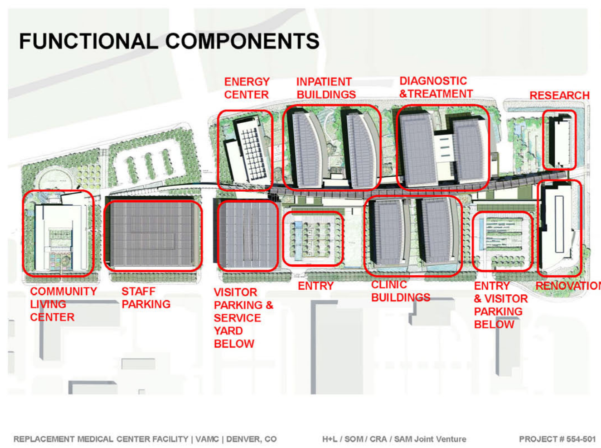
Architects: H+L / SOM / CRA / SAM Joint Venture

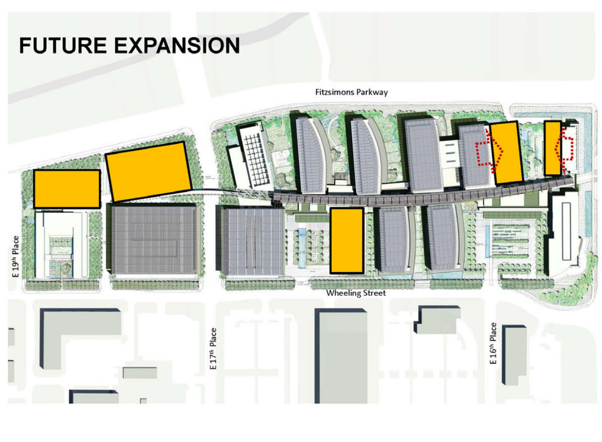
Under Construction (2011 -)

	Horizontal expansion (or contraction)	Vertical expansion	internal structural walls	Floor-to-floor height	Building geometry	Floor loading capacity	Shell space	% set-aside	System Separation
Denver VAMC Project Eagle	yes	no	yes	yes	no	yes	NA	NA	yes

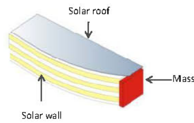
1. Horizontal building expansion (or contraction) is enabled by site and infrastructure planning ***Yes***
2. Vertical building expansion is enabled by structural and MEP systems' design ***No***
3. Minimal internal structural walls offer unimpeded internal spatial arrangement capacity ***Yes, especially by removing many core elements to the concourse***
4. Floor-to-floor height of at least 15'-0" ***F-F ht 20'-0" throughout***
5. Building geometry enables a variety of uses to be accommodated inside a buildings' footprint ***Geometries optimized for functional groupings – within the Diagnostic and treatment fingers there is great flexibility. However it is not set up to convert between bed units and D&T***
6. Floor loading capacity enables alternative uses and equipment ***Yes***
7. Shell space is set-aside for future assignment of use(s) as needs evolve ***On the concourse level only***
8. A % of building floor area is fixed and held for future vertical MEP and egress shafts S***ervices are fed from the central spine in a "plug and play" fashion.***
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. ***Per the use of the Interstitial floor and the VA Hospital Building System (VAHBS) this system separation is automatic.***

- Full Interstitial floors are used throughout so that MEP changes can be made in a remodeling without disruption to neighboring departments on adjacent floors;
- Public circulation including elevators are pulled into the central concourse so the functional spaces are less encumbered by vertical elements;
- The design concept is "unbundled" so that Inpatient beds are separate from and not over Diagnostic and treatment spaces so that services for one do not encroach or limit the other. The same is true for outpatient and research functional groupings;
- Each "finger" that attaches to the central spine/core has structural systems and spacing optimized for its type of function: larger structural bays are used in diagnostic and treatment, for instance, because they are not encumbered by the geometry of the inpatient bed floor.
- Expansion is enabled though new "fingers" plugged into the central concourse / service spine;
- Efficient incremental renovation is possible due to the interstitial floors;
- In the Clinics, adaptive reuse is planned for through the standardization of clinical units;
- Standardization of the inpatient room (with the exception of Spinal Cord) allows for conversion from one medical service to another and relatively simple accommodation of higher or lower acuity levels;
- Expansion locations and configurations are shown on the drawings, but no drawings or cost analysis were prepared to demonstrate how the VAHBS could accommodate internal reconfiguration of space;

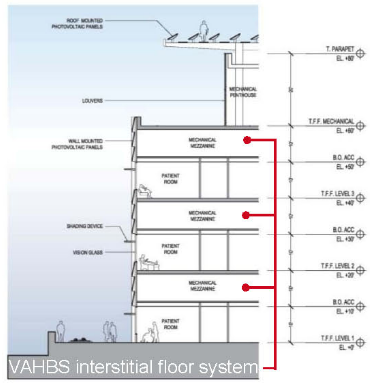


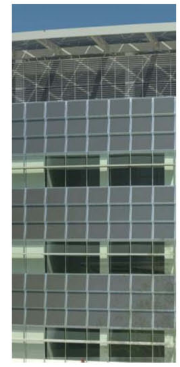


D+T BUILDING
LEVEL 1

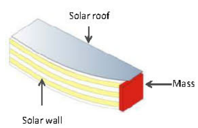


INPATIENT BUILDING- System Diagram

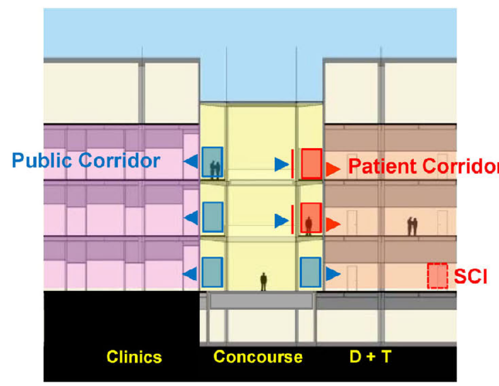




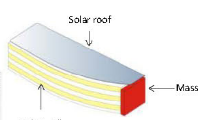
D+T BUILDING
LEVEL 2



SECTION LOOKING NORTH



D+T BUILDING
LEVEL 3



Universal Grid Theory

Architect: Cannon Design

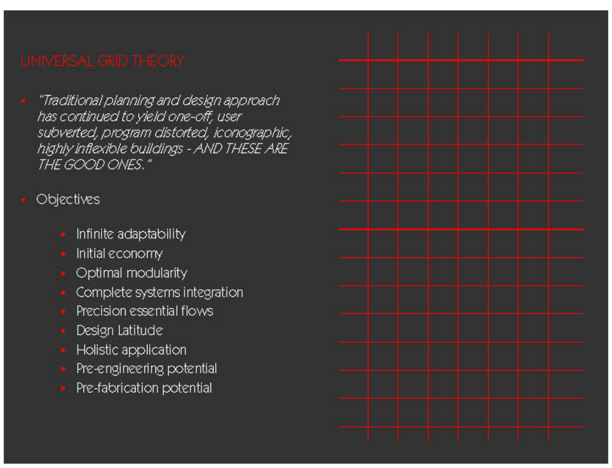
Occupancy: 6 projects realized between 2008-2012

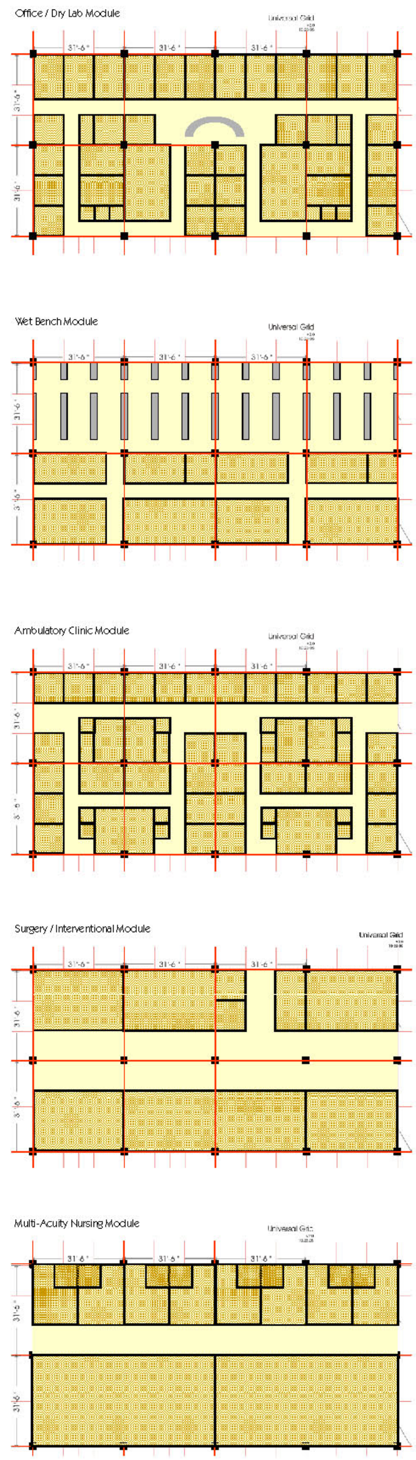
	Horizontal expansion (or contraction)	Vertical expansion	Internal structural walls	Floor-to-floor height	Building geometry	Floor loading capacity	Shell space	% set-aside	System Separation
Universal Grid Theory	yes	yes	yes	yes	yes	yes	NA	NA	yes

The Universal Grid Theory is responsive to inevitable change at all levels of healthcare facilities. It offers an alternative to the usual one-off design of healthcare facilities, offering:

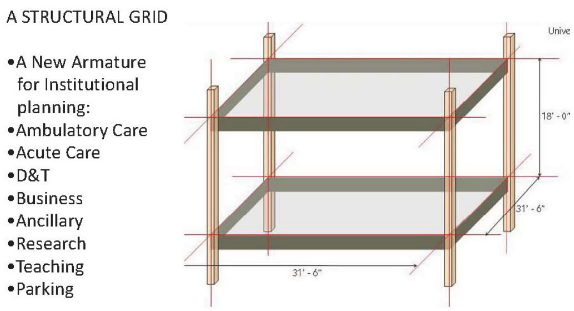
- Radical adaptability
- No functional compromise
- Initial economy
- Complete systems integration
- Holistic application
- Pre-engineering potential
- Pre-fabrication potential
- Uncompromising design latitude
- Speed to market

Universal Grid Theory has evolved as a research and practice project since 2005. Six major projects have been realized based on the theory. The theory is fundamentally the concept of planning and designing healthcare buildings within a three dimensional grid. This approach is useful in order to achieve measureable advantages in reduced capital cost and speed to market, in increased operating economies and in future adaptability. As of 2012 and the fourth iteratiion of the research, the grid is 31'-6" x 31'-6" x 18'-0" floor to floor. The horizontal dimensions derive from the development of multiple, detailed room prototypes for all key room typologies in clinical, research and academic environments as well as exploration of multiple blocking patterns yielding alternative circulation options within various bay multiples. The 31'-6" structural bay has been proven by analysis conducted by independent engineers and cost consultants to represent the most economical span for low to mid-rise steel construction for floor plates of between 30,000 - 100,000 SF. The 18"-0" vertical floor to floor dimension - like the interstitial system of the VAHBS - remains controversial. But evidence from built projects results in life-cycle benefits in the MEP systems. Finally, the UGT does not impose an architectural form for the buildings - many building forms are possible and have been realized.

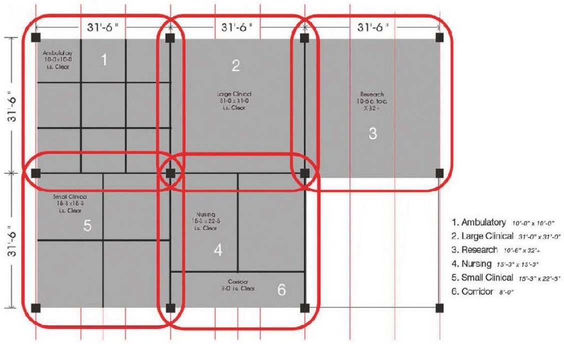




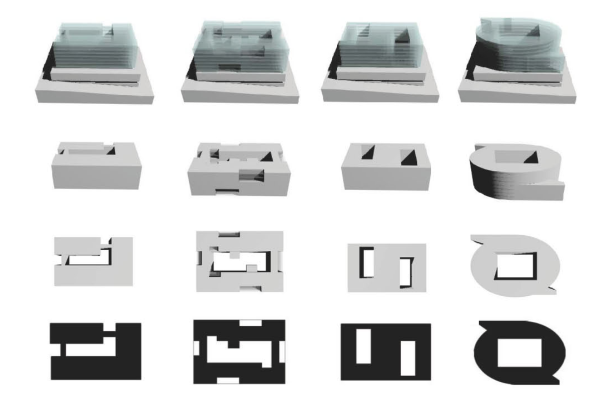
Universal Grid Theory




Cal-Pacific Medical Center / Cannon




NHP1 – University of Chicago / Vignoly-Cannon




Barnes-Jewish Hospital, St. Louis / Cannon

9.4 The Cost-Modeling Workshop

Cost Modeling Workshop: Analysis of Initial Capital Asset Investment and Future Costs of Adaptation

May 30 – June 1, 2012
National Institute of Building Sciences
1090 Vermont Avenue, NW, Suite 700
Washington, DC 20005-4950 / (202) 289-7800 x121

This by-invitation workshop is part of a research contract with the National Institute of Building Sciences under an IDIQ with the Office of the Chief Financial Officer TRICARE Management Activity, Office of the Assistant Secretary of Defense (Health Affairs). Task 5 asks for the research effort to:

> *Identify any associated cost premiums in initial capital costs and lifecycle return on investment (ROI) implications. All variables discussed shall be quantified. Qualitative variables shall be monetized to articulate the cash value to the organization if implemented.*

The goal of the workshop is to gain an understanding of the possibility of making reasonable predictions of the cost of flexibility strategies when considered over the life of a facility. The method used is a cost-modeling tool, which will be applied to specific "situations of change" brought by workshop participants. The participants represent public and private sector owner representatives, architects and engineering experts.

The workshop facilitator is Karel Dekker, KD Consultants, Voorburg, The Netherlands. Mr. Dekker has developed and used a cost-modeling tool based on the principle of facility flexibility, with many clients – public and private – in the Netherlands and in the EU.

Expectations

Our goal is to see what we know and don't know when the research question is to understand initial capital expenditures for flexibility vis-a-vis long-term return on investment.

We recognize that there is a wide range of flexibility strategies, and that the implementation of these strategies varies, as do the interdependencies among them, in terms of geographic location, market, client business structure, and so on. We recognize that making generalizations at a useful level of granularity about these questions is not a trivial problem. But we need to try.

The cost calculation model is a tool designed to deal with a particular level of granularity. We will use it to run "what-if" scenarios of change brought by the workshop participants.

To make the many variables and their interactions manageable, we use a THREE-LEVEL model to cluster these variables (and costs), a model already well-known in the real estate development market:

- **Primary System** (or "core and shell" or "base building") (100 year asset)
- **Secondary System** (or "tenant work" or "tenant improvements") (15-20 year asset)
- **Tertiary System** (or "FF&E" or "equipment and furnishings & finishes") (2-5 year asset)

We used this model because it clusters decisions in a way that corresponds with conventional project scoping and budgeting in the commercial marketplace, where the economic case for flexible infrastructure is made in a relatively transparent manner using familiar cost accounting. The three level model also corresponds generally with cycles of facility change, and in the private sector, with depreciation rates.

The cost data is there, somewhere (client records, construction company records, RS Means, etc), even if it is not systematically collected. Our best bet is a willingness to work together to figure out how we can advance our understanding of the cost of flexibility, for everyone's benefit.

Attendees

Karel Dekker, Workshop Leader
KD/Consultants BV
Strategic Research for Building and Construction
Voorburg, The Netherlands
(Formerly: Principle Advisor: Building and Infrastructure at TNO Bouw, and Head of the Department: 'Strategic studies, Quality Assurance and Building Regulations' of TNO Building & Construction)
karel@kdconsultants.nl
Steve Kendall, PhD (PI)
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skendall@bsu.edu
Thom Kurmel, DDes, AIA (consultant)
President, TDK Consulting, LLC
Thom.Kurmel@Gmail.com
David Clark, Senior Health Facilities Engineer
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Office of the Chief Financial Officer
Portfolio Planning and Management Division
David.clark@tma.osd.mil
David Marquardt, Chief
Medical Facilities Center of Expertise and Standardization
US Army Corps of Engineers
David.d.marquardt@usace.army.mil
Randy Kray, Senior Vice President
Science + Technology Director of Programming and Planning
HOK
Randy.kray@hok.com
Chuck Siconolfi, AIA, ACHA, LEED AP, Principal
Healthcare planning / HOK
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Simon Bruce, AIA, RIBA, EDAC, Vice President and Senior Medical Planner
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Tricare Management Activity
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Guy Kiyokawa, Colonel, Medical Service Corps, Director, Facilities
Assistant Chief of Staff Facilities
Office of the Surgeon General/HQ MEDCOM
Guy.kiyokawa@us.army.mil

Cost Modeling Workshop Executive Summary

Cost calculation is necessary for decision-making. The building economist should therefore calculate the future costs in a way that is enough for sound decision-making. Such analysis is important for public authorities, investors, the design team, and the construction companies and last but not least the one who ultimately pays the bill – the user.

"For some years, we have known that it is not a problem to build a new building, but to keep it usable in the long run. The usability of facilities is the subject of facilities managers or building management, while the costs are the subject of interest for life cycle costing. Facility management is planning over a rather short period (between 2-10 years), depending on the kind of use and use processes. The use of the building over a longer period is rather speculative. On the other hand, life cycle costing tries to calculate the costs of the building over its life, which is not possible since the use in the long run is unpredictable. We should not try to calculate costs on the basis of unpredictable expenditures. But for decision-making, cost calculation is necessary, so the building economist should calculate the future costs in such a way that it is enough for decision-making. Such analysis is important for public authorities, investors, the design team, the construction companies and last but not least the one who ultimately pays the bill – the user."
(Herman Tempelmans Plat, Professor of Building Economics, TUEindhoven, the Netherlands – 1990)

Future savings offset initial capital cost of implementing flexibility as a building strategy for hospital buildings. A Dutch study about design and construction flexibility of hospitals (discussed later in this report) gives positive findings about the implementation of flexible building strategies. The conclusions of that study are a basis for the present cost-study. But making this clear in the programming and design stage is not always easy. This is the reason that a cost-modeling workshop has been organized to discuss the economical advantages of a flexible building strategy for hospitals.

To facilitate the cost-modeling workshop in Washington DC, a tailor made cost-model has been developed. Using practical cases brought by the workshop participants, we could calculate different scenarios.

The outcomes of this exercise provide evidence that investing in several measures for flexibility can be very helpful to prevent later problems and reduce costs when adaptations of the hospital building are needed.
The most relevant flexibility strategies discussed were

1. Methods to make it easy to extend the hospital (vertically and horizontally)
2. Use of flexible wall and floor systems, and
3. Provision of extra space (buffers) for future adaptations and extensions of functions.

1 - Objectives

The main objective of this report is to make clear for the participants of the workshop in May 2012 that extra investments for flexibility in hospital building are relevant and can give a much better economical balance in the future. Further objectives are:

- Develop and facilitate the cost-modeling workshop in May 31-June 1, 2012;
- Develop and explain the cost-model to be used during and after the workshop;
- Give the results of the economical aspects of a Dutch study for flexible hospital design[1].

[1] Nicolai R, Dekker K.H., "Flexibility in Hospital Building" a strategy for the design and building

2 - State of the art

In this state of the art overview only the cost/benefit relationships of flexible buildings will be mentioned.

2.1 The Netherlands

2.1.1 Habraken and the SAR (Foundation for Architects Research)

Flexibility in building and construction has a strong relation with decision making about real estate projects. In the mid sixties Prof. John Habraken wrote the book "Supports: an Alternative to Mass Housing." [2] This was the first book to call attention to the relationship between flexibility and decision-making control. The basic insight in this book was that decision making about the more permanent part of a building – the base building (support) - should be separated from the decision-making about more changeable part - the infill (fit-out). The base building could be seen as the more socially valued part (of broader and longer-term value) and the fit-out as being of more individual interest (i.e. of interest to functionally defined units of control – e.g. departments) and their evolving priorities being somewhat independent of the more permanent part.

Habraken established the Foundation for Architectural Research in Eindhoven (SAR) in 1964. This was the first architectural research center in the world. It was set up to study how architects could design buildings without first knowing the floor plans (which were assumed to be variable and decided independently). A series of studies have been published about the organizational and technical aspects of the separation of "Support and Infill". In 1975 Prof. Habraken was appointed as Professor and Head of the Department of Architecture at MIT.

One of the first reports in English about the costs of flexible and adaptable structures and the impact of the separation of "support" and "infill" on building design and construction was published in 1981 by MIT and written by Karel Dekker and John Habraken,[3] This study was based at a Dutch study about the use of a very flexible industrial fit-out system in the housing sector. The main cost advantage is a very basic one: Because of a base building with a clear and "open" structure, not hampered by the entanglement of all installation technology, the construction time for the "support" will be much shorter, with evidence in lower building costs.
The same principles lead to lower building costs in the construction of "open" base buildings in hospital building, as evidenced in the cost studies presented here.

2.1.2 Foundation of Open Building (Netherlands)

The establishment of the "Foundation of Open Building" in 1984 gave a new impulse to flexible and adaptable building. The term "Open Building" came to be used to describe the technical aspects of separating base building from fit-out, linking this distinction also to industrial production of building parts, building regulations, finance, and logistics.
A new phenomenon was the combination of three principles:

a) Use of performance requirements
b) Separation of support (base building) and infill (fit-out) and
c) Modular coordination.

Studies about costs and flexibility were at that time mainly focused on housing. One of the most interesting reports in this period about the impact of a flexible open building philosophy is "Which Future

[2] N.J. Habraken, "Supports: an Alternative to Mass Housing." London: The Architectural Press, and New York: Praeger, 1972. First English language edition (Originally published in Dutch under the title: "De Dragers en de Mensen". Amsterdam. Scheltema en Holkema. 1962)
[3] Dekker K.H., Habraken J., "Supports can cost less money", MIT, Boston, 1981

for Housing." Part of this study was a cost/benefit calculation model to show the advantages of an open, flexible and adaptable building strategy related to three other building strategies. In this study the total life cycle costs for a housing area are estimated over a period of 50 years.[4]

The calculation methods used in this scenario/strategy study were also used in the cost studies for flexible hospital buildings.[5]

2.1.3 IFD building

Industrial, Flexible and Demountable Building (IFD building)

This special implementation program, funded by the Dutch government, ran from 2000-2005[6]. It focused on a building strategy that combines industrial production of component building, flexible structures and flexible layouts, and the use of demountable structures and elements. The distinction between support and infill was one of the fundamental principles of this strategy.

Some examples of IFD hospital buildings

• Reinier de Graaf Hospital, Delft (Construction begins fall 2012)
•Architect, EGM, Dordrecht, the Netherlands

Flexibility is foreseen at the levels of town planning (the urban fabric), the primary system and the secondary system. The urban fabric enables the extension of the building in horizontal and vertical directions. There are possibilities to transform parts of the building to apartments. Also there are buffers and neutral spaces for new functions in the future. The structure has been designed to add more floors if needed.

No detailed information is available about the extra costs for this flexibility approach. The chosen methods are similar to the recommendations of the Dutch study "Flexibility in Hospital Building". According to that study, the extra costs for this kind of flexibility strategies are for extra ground space and more façade and roof surface. Because of the clear basic building structure the extra costs are less than 1.5%.

[4] Wissema J., Dekker K.H., Randen van A., Bakens W. "Which Future for Housing", Scenario/Strategy Survey in cooperation with and on behalf of the Foundation of Building Research (financed by the Dutch Ministry of Economic Affairs). (published in Dutch)
[5] Nicolai R, Dekker K.H., "Flexibility in Hospital Building" a strategy for the design and building process, on behalf of the National Hospital Institute, Utrecht, 1990 (in Dutch)
[6] IFD bouwen, SEV, 2004

• Martini Hospital, Groningen (completed in 2007)
• Architect: Burger Gunstra Architects, Alkmaar, the Netherlands

The Martini Hospital Groningen (60.000 m2) has been designed as an IFD building. According to the architects of the hospital the building costs of this very flexible hospital do not exceed the normal costs for a general hospital. The separation of support and infill and the principles of IFD building have been used.

(This project is one of the "best practice" projects in appendix 8.3)

2.2 Europe

2.2.1 European research programs
In the report "Construction, a challenge for the European Industry", design for flexibility is defined as an R&D priority for the construction industry on behalf of the European Committee (DG XII). (Karel Dekker, KD/Consultants, 1992, EU Commission)

2.2.2 SUREURO 2000-2005
The SUREURO project, supported by the European Commission in the key action "The City of Tomorrow," was completed in July 2004. The targets were to stimulate and support the sustainable and consumer oriented transformation of (most) post war housing areas. Flexibility and cost items were related to the Open Building approach in this project. (Blomstrand J., Dekker K.H., October 2004, Kalmarhem, Kalmar)

1.2.3 UK studies

1. *Study over the 80-year life of a hospital*
   This is a case study based on the development of a major UK teaching hospital over the past 80 years. It includes a study of principles for the articulation of the value of flexibility to enable the designer to make an economic case for a flexible infrastructure.[7]

2. *'Duffle coat' theory of flexibility*
   Hospitals experience constant change of use, so flexibility for activity change is an accepted objective in hospital design. By extending the useful life, flexibility enhances the sustainability of investment in hospital buildings. A widely accepted strategy for flexibility is to design hospitals with a small number of distinct space types, repeating these types as often as possible. By

[7] *Flexibility in Hospital Infrastructure Design*, Richard de Neufville, Yun S. Lee, Stefan Scholtes, November 2008

analogy with Royal Navy duffle coats, that were loosely tailored and supplied in a limited variety of sizes, this can be called the 'duffle coat' theory of room sizing. Standardization of sizes may be desirable for the design, construction and maintenance of hospitals, but this study focuses on flexibility for activity change. In two mathematical simulations, the duffle coat theory of hospital flexibility was validated for the first time.[8]

2.3 CIB Open Building Implementation - Commission W 104

From 1996 to today, the CIB Open Building Implementation commission W104 is documenting and reporting on worldwide research related to the implementation of Open Building.
In November 2011, the 17[Th] conference of CIB W104 for the first time included a focus on the design of adaptable healthcare facilities in the dialogue of open building. (See proceedings pages 200-258)[9] The introduction of studies about healthcare facilities was relevant for the discussions about investments for flexibility in hospital buildings.

Interesting for the economical aspects of hospital building is the Open Scenario Planning for Healthcare Infrastructure (OPHI). This study investigated the concepts, tools and techniques that enable innovation and support the financial planning of built infrastructure. The aim: to improve decision-making for healthcare pathways across locations and settings through the development of a framework for the rationalization of existing properties and buildings.[10]

3 - Cost model

The cost model developed by KD Consulting for the NIBS Cost Modeling workshop May 31-June 1, 2012 consists of 5 separate parts
:

1. *Input-output model:*
   This is the main part of the model containing the most relevant input data and giving the results of the calculations for the different strategies for flexibility;

2. *Reference model:*
   A reference hospital with 200 beds with data and cost items was used. Also a schedule of adaptations in the future (future use scenario's) with both a traditional and a flexible strategy. The reference model also contains a series of examples for flexibility strategies with their buildings costs;

3. *Refurbishment costs:*
   Quick Scan to calculate refurbishment costs. Ten classes are defined, related to the intensity of refurbishment. This part of the model returns the costs per square foot for the ten classes of refurbishment;

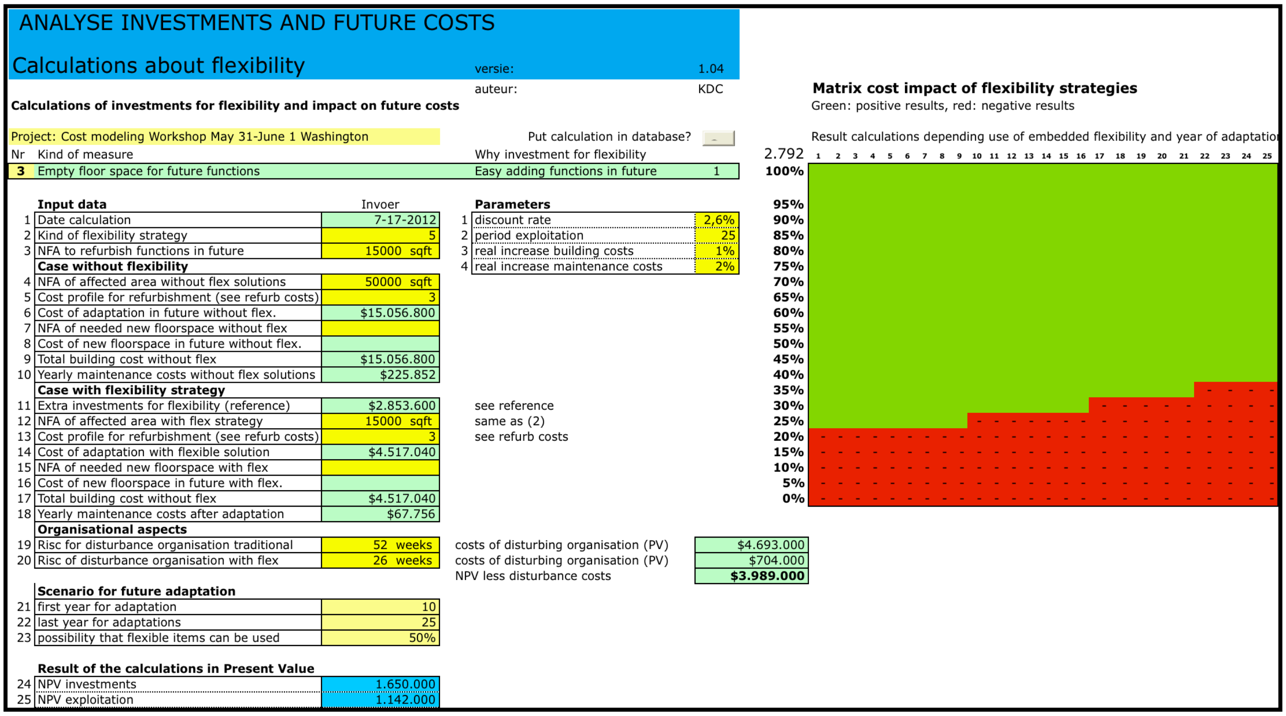
4. *List of flexibility items:*
   This part of the cost model has to be filled in with examples by the users of the model;

[8] *The Sustainable Schedule of Hospital Spaces: investigating the 'duffle coat' theory of flexibility.* William Fawcett MA PhD RIBA, Chadwick Fellow in Architecture, Pembroke College, Cambridge Director, Cambridge Architectural Research Ltd [Draft of March 2010 with amendments]
[9] *Proceedings: Architecture on the Fourth Dimension*. Joint Conference of CIB W104 and W110. November 15 – 17, 2011, Boston, Massachusetts, USA
[10] See page 233 of the Proceedings of the Joint Conference of CIB W104 and W110

5. *Database:*
   A possibility to store the different outputs of the calculations of the input-output model in a database.

3.1 Input – Output model

This is the heart of the cost model and combines the input data with the results of the calculations. The following 8 steps explain the separate parts of the input-output model. The numbers are related to the corresponding parts of the input-output model as shown in the next figures.
The figure below shows the overview of the input-output model.



ANALYSE INVESTMENTS AND FUTURE COSTS
Calculations about flexibility — versie: 1.04 — auteur: KDC
Calculations of investments for flexibility and impact on future costs
Project: Cost modeling Workshop May 31-June 1 Washington — Put calculation in database?

Nr	Kind of measure	Why investment for flexibility	
3	Empty floor space for future functions	Easy adding functions in future	1

	Input data	Invoer
1	Date calculation	7-17-2012
2	Kind of flexibility strategy	5
3	NFA to refurbish functions in future	15000 sqft
	Case without flexibility	
4	NFA of affected area without flex solutions	50000 sqft
5	Cost profile for refurbishment (see refurb costs)	3
6	Cost of adaptation in future without flex.	$15.056.800
7	NFA of needed new floorspace without flex	
8	Cost of new floorspace in future without flex.	
9	Total building cost without flex	$15.056.800
10	Yearly maintenance costs without flex solutions	$225.852
	Case with flexibility strategy	
11	Extra investments for flexibility (reference)	$2.853.600
12	NFA of affected area with flex strategy	15000 sqft
13	Cost profile for refurbishment (see refurb costs)	3
14	Cost of adaptation with flexible solution	$4.517.040
15	NFA of needed new floorspace with flex	
16	Cost of new floorspace in future with flex.	
17	Total building cost without flex	$4.517.040
18	Yearly maintenance costs after adaptation	$67.756
	Organisational aspects	
19	Risc for disturbance organisation traditional	52 weeks
20	Risc of disturbance organisation with flex	26 weeks
	Scenario for future adaptation	
21	first year for adaptation	10
22	last year for adaptations	25
23	possibility that flexible items can be used	50%
	Result of the calculations in Present Value	
24	NPV investments	1.650.000
25	NPV exploitation	1.142.000

	Parameters	
1	discount rate	2,6%
2	period exploitation	25
3	real increase building costs	1%
4	real increase maintenance costs	2%

see reference
same as (2)
see refurb costs

costs of disturbing organisation (PV)	$4.693.000
costs of disturbing organisation (PV)	$704.000
NPV less disturbance costs	$3.989.000

Fig. 1. Overview of the input-output model as used in the cost-modeling workshop

Step 1: Choosing the case for the flexibility strategy to be used in the cost model.
The yellow fields have to be filled with the following data:

- (1) The actual date;
- (2) Choose the number of the flexibility item. This can be one of the items from the list (see Fig. 17, section 3.4 below)
- Give the net floor area (NFA) of the functional required space to be changed (3)
-

	Input data	Invoer
1	Date calculation	7-17-2012
2	Kind of flexibility strategy	5
3	NFA to refurbish functions in future	15000 sqft

Fig. 2. Basic input data

Step 2: Choosing the input data for future adaptation without the use of a flexibility strategy. The yellow fields have to be filled with the following data:

- (4) Give the net floor area of the total affected floor space. This includes floor space in adjacent areas or on other floors;
- (5) Give the number of the cost profile for refurbishment according to part 3 (the cost of refurbishment profiles);
- (6) The building costs are calculated in the green field;
- (7) Give the NFA of needed new floor space (extension area);
- (8) Calculated costs of this new floor space;
- (9) Calculated total building costs;
- (10) Rough estimate of yearly maintenance costs of refurbished and new spaces.

	Case without flexibility	
4	NFA of affected area without flex solutions	50000 sqft
5	Cost profile for refurbishment (see refurb costs)	3
6	Cost of adaptation in future without flex.	$15.056.800
7	NFA of needed new floorspace without flex	
8	Cost of new floorspace in future without flex.	
9	Total building cost without flex	$15.056.800
10	Yearly maintenance costs without flex solutions	$225.852

Fig. 3. Example of input cost model without flexibility strategy

Step 3: Choose the input data for the future adaptation, this time with a flexibility strategy. The yellow fields have to be filled with the following data: (see figure below)

- (11) Give the extra investments of the chosen flexible strategy. See the reference sheet (figure 12) for examples;
- (12) Give the net floor area of the total affected floor space. This includes floor space in adjacent areas or on other floors;
- (13) Give the number of the cost profile for refurbishment according to part 3, the refurbishment cost model (see figure 16);
- (14) The building costs are calculated in the green field;
- (15) Give the NFA of needed new floor space (extension area);
- (16) Calculated costs of this new floor space;
- (17) Calculated total building costs;
- (18) Rough estimate of yearly maintenance costs of refurbished and new spaces.

	Case with flexibility strategy	
11	Extra investments for flexibility (reference)	$2.853.600
12	NFA of affected area with flex strategy	15000 sqft
13	Cost profile for refurbishment (see refurb costs)	3
14	Cost of adaptation with flexible solution	$4.517.040
15	NFA of needed new floorspace with flex	
16	Cost of new floorspace in future with flex.	
17	Total building cost without flex	$4.517.040
18	Yearly maintenance costs after adaptation	$67.756

Fig. 4. Case with flexibility strategy

Step 4: Setting the organizational disturbance time
In addition to adding substantial cost, refurbishment produces business disruption and dissatisfaction. There is usually a long wait during a pre-conversion period - producing an inefficient workplace. Then the construction nuisance follows, with noise, dust, temporary work elsewhere, business interruption, etc.

The cost of disturbance depends on the area in the hospital affected by the building activities. The costs of this disturbance on the primary processes in the hospital are very difficult to quantify. An average and rough calculation based on experience in the Netherlands as discussed in the next paragraph, can give a rough estimate of the kind of impact of refurbishment processes in a hospital. With an average cost of $1000 per patient day[11] and an average use of 760 square feet per patient, the disturbance costs will be - according to the experience in Dutch refurbishment cases - roughly 50%[12] of the costs per patient day in the affected area of the hospital. In the reference sheet (Fig. 5) the parameters for disturbance can be changed.

Average costs per patient week	$/day	7	$1.000	$7.000
Distubance cost per week	%	50%	200	$700.000

Fig. 5. Part of the reference sheet to change the parameters for disturbance costs

The impact on the primary processes of the organization is more costly then the difference in building costs. This kind of disturbance can be extremely costly if the building activities affect intensive functions such as the surgery area.

- (19) Disturbance during the refurbishment period in weeks without flexible strategy;
- (20) Less disturbance during the refurbishment period because of shorter building time and less affected space.

	Organisational aspects				
19	Risc for disturbance organisation traditional	52	weeks	costs of disturbing organisation (PV)	$4.693.000
20	Risc of disturbance organisation with flex	26	weeks	costs of disturbing organisation (PV)	$704.000
				NPV less disturbance costs	**$3.989.000**

Fig. 6. Disturbance in time and average costs during the refurbishment

Step 5: Changing the scenario parameters for this case
The yellow fields have to be filled with the following data (see example figure below)

- (21) Expected first year that the adaptation will be carried out
- (22) This is the last year of the expected period. (Same as period of exploitation)
- (23) The expected possibility that it will happen in the future in %.

	Scenario for future adaptation	
21	first year for adaptation	10
22	last year for adaptations	25
23	possibility that flexible items can be used	50%

Fig. 7. Scenario settings for the expected events

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[11] *Handbook of Health Economics*, Volume 1, Edited by A.J. Culyer and J.P. Newhouse
© 2000 Elsevier Science B. V All rights reserved, page 1500
[12] Nicolai R, Dekker K.H., "Flexibility in Hospital Building" a strategy for the design and building process, on behalf of the National Hospital Institute, Utrecht, 1990 (in Dutch)

Step 6: Output 1, results in net present value
Display of the results of the calculations in Net Present Value for investments and maintenance regarding the scenario settings. (See figure below)

	Result of the calculations in Present Value	
24	NPV investments	1.650.000
25	NPV exploitation	1.142.000
26	NPV Total saving in time	**2.792.000**

Fig. 8. Results of the case study in net present value

Step 7: Changing the calculation parameters (if needed).
The yellow fields can be changed. (See Fig. 9 below). A much higher discount rate has the result that future costs are less relevant. In that case investments for flexibility are less interesting if there are no adaptations in the first period of the exploitation.

	Parameters	
1	discount rate	2,6%
2	period exploitation	25
3	real increase building costs	1%
4	real yearly increase maintenance cost	2%

Fig. 9. Calculation parameters

Step 8: Output 2 Matrix
Display of the results of the calculations in a matrix. This matrix calculates the model 500 times with percentages from 0 – 100% and the year of adaptations from 1 – 25. The green field gives positive results of the output in NPV. The red field gives negative results.

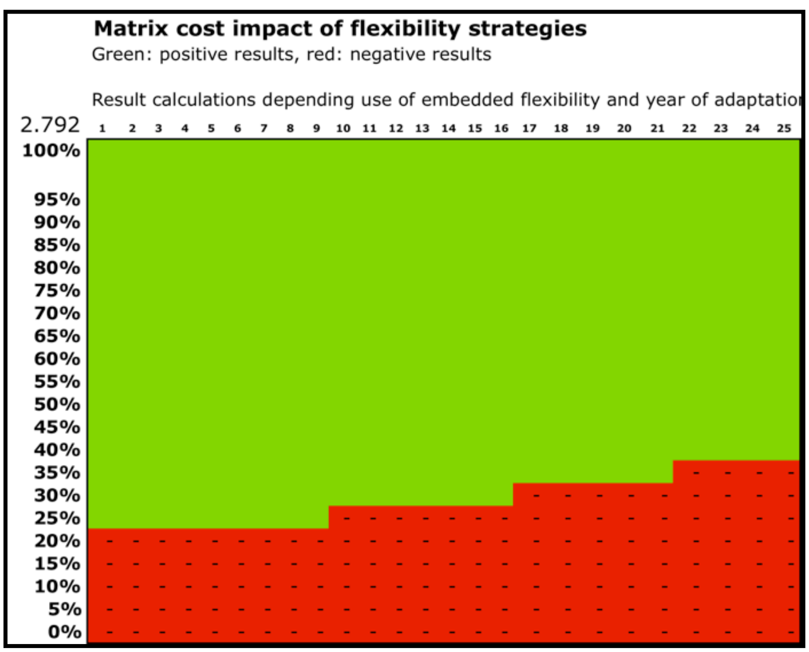


Fig. 10. Matrix with results of the calculations

3.2 Reference model

For a better understanding and an easier use of the cost model, a reference building is added to the cost model. The reference hospital has a capacity of 200 beds and a gross floor area of 15,000 square feet. This reference is only for using the cost model during the workshop and can be replaced by other users of the model. The cost data for this reference hospital are related to element estimates of some hospitals in the USA. The frequency for adaptations are related to the earlier referenced Dutch study about flexibility strategies for hospitals (Footnote 1).

Reference hospital

		units	values	quantity	total
1	Nr of beds	beds			200
2	GFA sqft per bed	sqft		750	150000 sqft
3	Number of floors			4	
4	Floor-space-index			0,8	
5	Investments per sqft/total	$/sqft	464	150000 sqft	$69.600.000
6	Cost of maintenance per year	$/sqft	9,28	150000 sqft	$1.392.000
7	Total cost of ownership	$/sqft	39	150000 sqft	$5.850.000
8	Total costs of adjustments	year	25	$1.530.061	$38.251.526

Fig. 11. Data for a reference hospital with 200 beds

Measures for more flexibility often require more investments for the buildings. In this example for a reference hospital, several flexibility items for both the primary and the secondary system are given. The costs in the table are for extra building costs and for extra maintenance.

Flexible strategy design - Extra investments for flexibility

Primary system (base building)					Secondary system (infill and fit-out)					
more ground space	flexible skeleton	flexible facades	extra empty space for future functions	extra capacity base installations	Multi functional rooms	Flexible walls e.a. Cable Stud	Flexible floors e.a. Matrix floors	Pluggable connectors	Total extra investments	Extra per square feet
20%	not extra	5%	10%	5%	not extra	1,95	1,95	not extra		
37500 sqft		$3	$190	$4		1,76	1,95			
$750.000		$ 452.400	$ 2.853.600	$ 591.600	$ 0	$ 263.250	$ 292.500		$5.203.350	$34,69
		$ 6.786	$ 28.536	$ 14.790		$ 2.633			$52.745	$0,35

Fig. 12. Overview of flexibility items for the primary and secondary systems

In the same reference model, examples are given (below – Fig. 13 and 14) of two scenarios for future adaptations in a period of 25 years. The financial impacts of future refurbishments are given for both a traditional and a flexible hospital.

Adjustments during 25 years lifetime in not flexible hospital

Year	description refurb actions	new sqft	costs per sqft	refurbishment sqft 1	sqft 2	Refurb profile	cost per sqft	Total costs	Present Value
1	Change of function rooms	0	$ 0	1500	1500	2	$ 188	$ 282.290	$ 282.290
2			$ 0				$ 0	$ 0	$ 0
3			$ 0				$ 0	$ 0	$ 0
4			$ 0				$ 0	$ 0	$ 0
5	Expansion building	2000	$ 488	1000	3000	10	$ 542	$ 2.600.737	$ 2.346.052
6			$ 0				$ 0	$ 0	$ 0
7	Expansion surgery rooms	0	$ 0	4500	18000	6	$ 448	$ 8.071.483	$ 6.915.367
8			$ 0				$ 0	$ 0	$ 0
9			$ 0				$ 0	$ 0	$ 0
10	Expansion care area	5000	$ 513	2500	10000	5	$ 421	$ 6.775.676	$ 5.373.354
11			$ 0				$ 0	$ 0	$ 0
12			$ 0				$ 0	$ 0	$ 0
13			$ 0				$ 0	$ 0	$ 0
14			$ 0				$ 0	$ 0	$ 0
15	Renovation cure area	0	$ 0	15000	30000	5	$ 443	$ 13.283.568	$ 9.261.026
16			$ 0				$ 0	$ 0	$ 0
17			$ 0				$ 0	$ 0	$ 0
18			$ 0				$ 0	$ 0	$ 0
19			$ 0				$ 0	$ 0	$ 0
20	Renovation care area		$ 0	6000	12500	7	$ 579	$ 7.237.771	$ 4.436.094
21			$ 0				$ 0	$ 0	$ 0
22			$ 0				$ 0	$ 0	$ 0
23			$ 0				$ 0	$ 0	$ 0
24			$ 0				$ 0	$ 0	$ 0
25			$ 0				$ 0	$ 0	$ 0
				30500 sqft	75000 sqft			$ 38.251.526	$ 28.614.184

Fig. 13. Scenario for adaptation in 25 years with impacts on building costs for an inflexible hospital

Adjustments during 25 years lifetime in Flexible Hospital

Year	description refurb actions	new sqft	costs per sqft	refurbishment sqft 1	sqft 2	Refurb profile	cost per sqft	Total costs	Present Value
1	Change of function rooms	0	$ 0	1500	1500	2	$ 202	$ 303.394	$ 303.394
2	0		$ 0				$ 0	$ 0	$ 0
3	0		$ 0				$ 0	$ 0	$ 0
4	0		$ 0				$ 0	$ 0	$ 0
5	Expansion building	2000	$ 488	1000	1000	10	$ 582	$ 1.557.643	$ 1.405.106
6	0		$ 0				$ 0	$ 0	$ 0
7	Expansion surgery rooms	4000	$ 497	500	500	6	$ 482	$ 2.230.853	$ 1.911.317
8	0		$ 0				$ 0	$ 0	$ 0
9	0		$ 0				$ 0	$ 0	$ 0
10	Expansion care area	5000	$ 513	500	500	3	$ 358	$ 2.741.478	$ 2.174.091
11	0		$ 0				$ 0	$ 0	$ 0
12	0		$ 0				$ 0	$ 0	$ 0
13	0		$ 0				$ 0	$ 0	$ 0
14	0		$ 0				$ 0	$ 0	$ 0
15	Renovation cure area		$ 0	15000	15000	3	$ 376	$ 5.636.199	$ 3.929.441
16	0		$ 0				$ 0	$ 0	$ 0
17	0		$ 0				$ 0	$ 0	$ 0
18	0		$ 0				$ 0	$ 0	$ 0
19	0		$ 0				$ 0	$ 0	$ 0
20	Renovation care area		$ 0	6000	6000	5	$ 500	$ 3.000.982	$ 1.839.329
21	0		$ 0				$ 0	$ 0	$ 0
22	0		$ 0				$ 0	$ 0	$ 0
23	0		$ 0				$ 0	$ 0	$ 0
24	0		$ 0				$ 0	$ 0	$ 0
25	0		$ 0				$ 0	$ 0	$ 0
				24500 sqft	24500 sqft			$ 15.470.550	$ 11.562.677

Fig. 14. Scenario for adaptation in 25 years with impacts on building costs for the flexible hospital

3.3 Quick scan investments for refurbishments

Quick Scan Refurb Costs

		Primary System, Base Building included primary installations						Secondary Infill system
	Decreasing factors	Foundation	Skeleton	Envelope	HVAC + piping	Electric installatio	Elevators	
	New construction	0,940	0,950	0,950	0,960	0,960	0,960	0,960
	Demolishing	0,920	0,930	0,920	0,950	0,950	0,950	0,950
	Renovation incl. demolishing parts	0,937	0,947	0,947	0,959	0,959	0,959	0,959
	Partial building costs	2%	9%	13%	11%	3%	3%	59%
7	**Profile refurbishment**	30%	30%	100%	100%	100%	100%	100%
	New Building Costs per sqft	2,78	12,53	60,32	51,04	13,92	13,92	273,76
	Prize level related to new building	120%	120%	110%	110%	110%	110%	110%
	Costs not corrected with decreasing factors	3,34	15,03	66,35	56,14	15,31	15,31	301,14
	Corrected by decreasing factors	3,74	16,54	66,35	56,14	15,31	15,31	301,14
	Factor corrected costs	1,12	1,10	1,00	1,00	1,00	1,00	1,00
		Total	Primary system	Secundary System				
	Costs New builing per square feet	$ 464	$ 190	$ 274	reference new building			
	Refurbishment costs per square feet	$ 475	$ 173	$ 301	related to chosen profile			

		Primary System, Base Building included base installations						Secondary system (infill)
	Standard refurb classification	Foundation	Skeleton	Envelope	HVAC + piping	Electric installatio	Elevator	
1	Very light building adaptation							30%
2	Adaptation of 60% infill							60%
3	Total new infill							100%
4	ditto + 30% envelope and installations			30%	30%	30%	30%	100%
5	ditto + 50% envelope and installations			50%	50%	50%	50%	100%
6	ditto + 75% envelope and installations			75%	75%	75%	75%	100%
7	remaining 70% foundatation and skeleton	30%	30%	100%	100%	100%	100%	100%
8	remaining 50% foundatation and skeleton	50%	50%	100%	100%	100%	100%	100%
9	remaining 25% foundatation and skeleton	75%	75%	100%	100%	100%	100%	100%
10	Total demolishment and new building	100%	100%	100%	100%	100%	100%	100%

Fig. 15. Quick scan method for calculations of the building costs for refurbishments

For a fast method to calculate the building costs of refurbishments we developed a quick scan method. KD/Consultants earlier developed the method. The model calculates the building cost per square foot depending the intensity of the refurbishment.. The user of the quick scan is able to change some parameter settings according to local circumstances. This is for the given building costs for new buildings en the partial division for the primary and secondary systems of the building costs related to the several building elements. The tertiary system is not embedded in the cost model.

Dr. Kendall provided the definitions for the primary, secondary and tertiary systems:

PRIMARY SYSTEMS: (“Core and Shell” or “Base Building”) usually including the structural system, roof, exterior facade, and the position of the main MEP “trunks” (if not also the main MEP “trunk lines” themselves – this may in some cases include the MEP systems serving dedicated “public” spaces such as egress systems, atria, and so on – i.e. the “permanent” spaces and their MEP systems); PRIMARY SYSTEM may also include, in some cases, the primary egress systems (corridors, fire stairs, elevators) that are considered to be permanent no matter what the spatial/departmental configuration may be over the life of the facility.
SECONDARY SYSTEMS: (“Tenant Work,” “Fit-out”) including the departmental separation walls, the partitions inside departments, and the parts of the MEP systems serving departments (including “built-in” equipment such as head-walls, power and low voltage lines, piping and other parts of the MET systems buried inside partitions – not classified and depreciated as “equipment.”).
TERTIARY SYSTEMS: (“FF&E” or finishes, fixtures and equipment) depreciated most quickly and also understood to be movable, removable, or replaceable without destroying or degrading what they are attached to.

An excel table calculates the combination of the profile for refurbishment with the calculated costs per square foot. See Fig. 16 below.

Table square foot costs by refurb profiles			Total	Primary	Secundary
	chosen profile ->	7	$ 475	$ 173	$ 301
1	Very light building adaptation	1	$ 97		$ 97
2	Adaptation of 60% infill	2	$ 186		$ 186
3	Total new infill	3	$ 301		$ 301
4	ditto + 30% envelope and installations	4	$ 351	$ 50	$ 301
5	ditto + 50% envelope and installations	5	$ 381	$ 80	$ 301
6	ditto + 75% envelope and installations	6	$ 418	$ 117	$ 301
7	remaining 70% foundatation and skeleton	7	$ 475	$ 173	$ 301
8	remaining 50% foundatation and skeleton	8	$ 487	$ 186	$ 301
9	remaining 25% foundatation and skeleton	9	$ 501	$ 200	$ 301
10	Total demolishment and new building	10	$ 516	$ 214	$ 301
11	Expansion building costs for new parts	11	$ 464	$ 190	$ 274

Fig. 16. Table with costs per square foot by different profiles for refurbishments

3.4 List for flexibility items used during the workshop

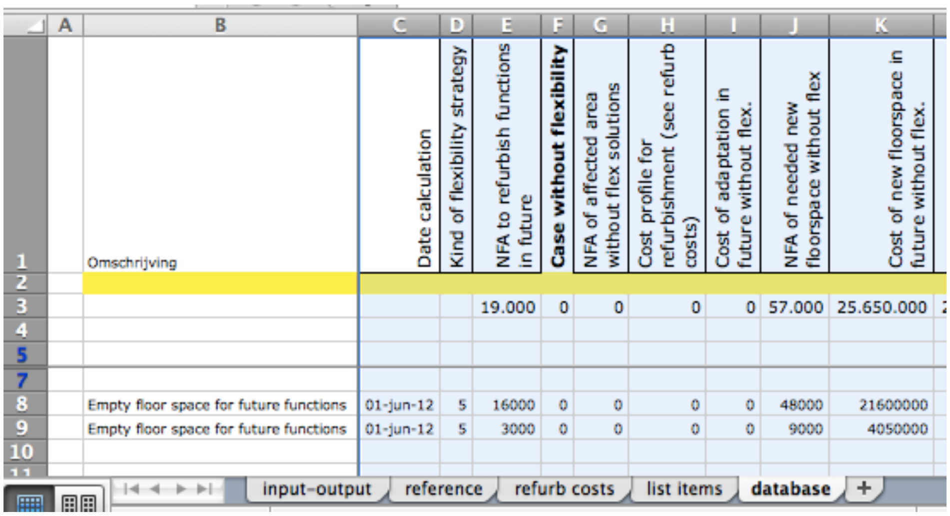
OVERVIEW ACTUAL FLEXIBILITY MEASURES		Is measure still actual?	CONSTRUCTION BASE BUILDING	CONSTRUCTION INFILL/FITOUT	INSTALLATIONS ELECTRIC SUPPORT	INSTALLATIONS ELECTRIC INFILL	INSTALLATIONS HVAC and piping BASE BUILDING	INSTALLATIONS HVAC AND PIPING INFILL	OTHER MEASURES
NR	Description flexibility item								
1	Walls Cable Stud	1		1		1			
2	raised floor with flexible piping	1		1				1	
3	Cable stud + matrix tiles	1		1		1		1	
4	Flexible facades for expansion building	1	1						
5	Empty floor space for future functions	1	1		1		1		
6	more landstock and flexible facades	1	1						

Fig. 17. List of flexibility items used during the workshop

The use of flexibility items is listed in a table. The topics in the table are corresponding with the data for the reference building and the reference measures for flexibility. For future use the user of the cost model can expand the table.

3.5 Database for the results

To store the results of the calculations the function of a simple database has been added to the model. (See excel sheet 'database' as past of cost-model)



	A	B	C	D	E	F	G	H	I	J	K
1		Omschrijving	Date calculation	Kind of flexibility strategy	NFA to refurbish functions in future	**Case without flexibility**	NFA of affected area without flex solutions	Cost profile for refurbishment (see refurb costs)	Cost of adaptation in future without flex.	NFA of needed new floorspace without flex	Cost of new floorspace in future without flex.
2											
3					19.000	0	0	0	0	57.000	25.650.000
4											
5											
7											
8		Empty floor space for future functions	01-jun-12	5	16000	0	0	0	0	48000	21600000
9		Empty floor space for future functions	01-jun-12	5	3000	0	0	0	0	9000	4050000
10											

Fig. 18. Database for results

4 Results

4.1 Workshop results

A discussion during the workshop on the difference between the physical flexibility in buildings and the organizational flexibility delivered very good insights into the scope of the subject and its complexity. The following chart of a decision-tree was a key document in putting the question of flexibility into a broader decision context.

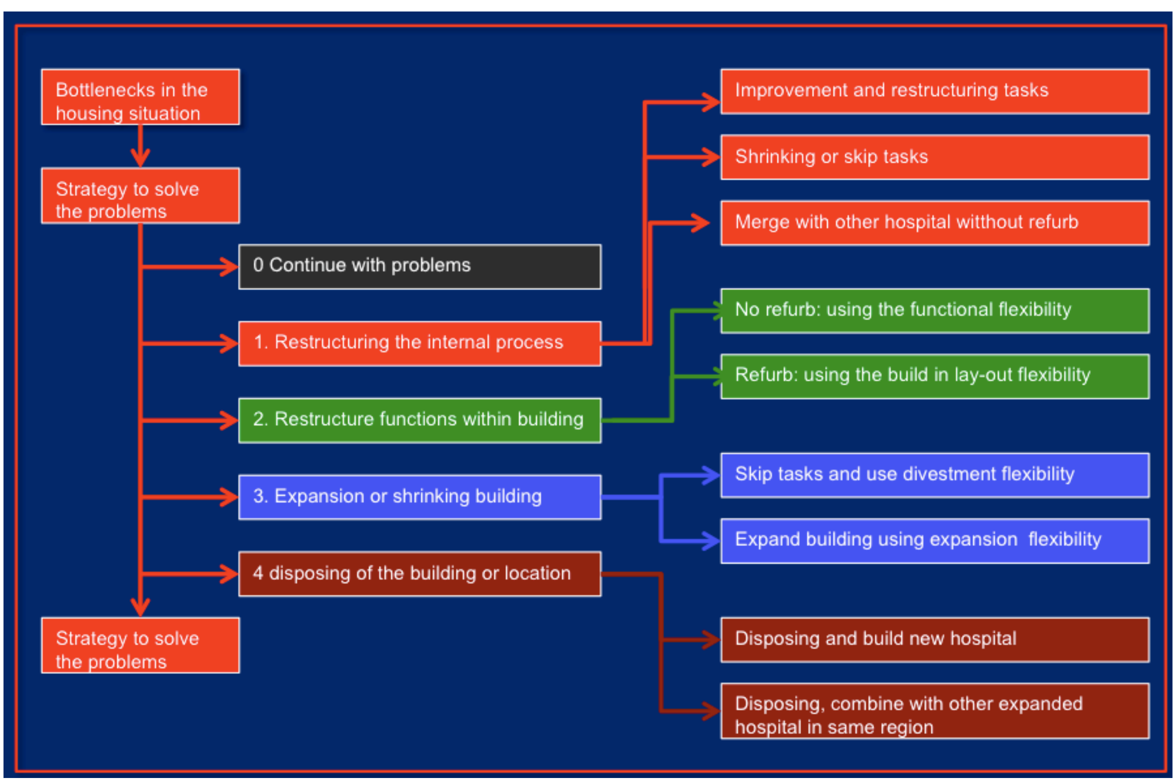


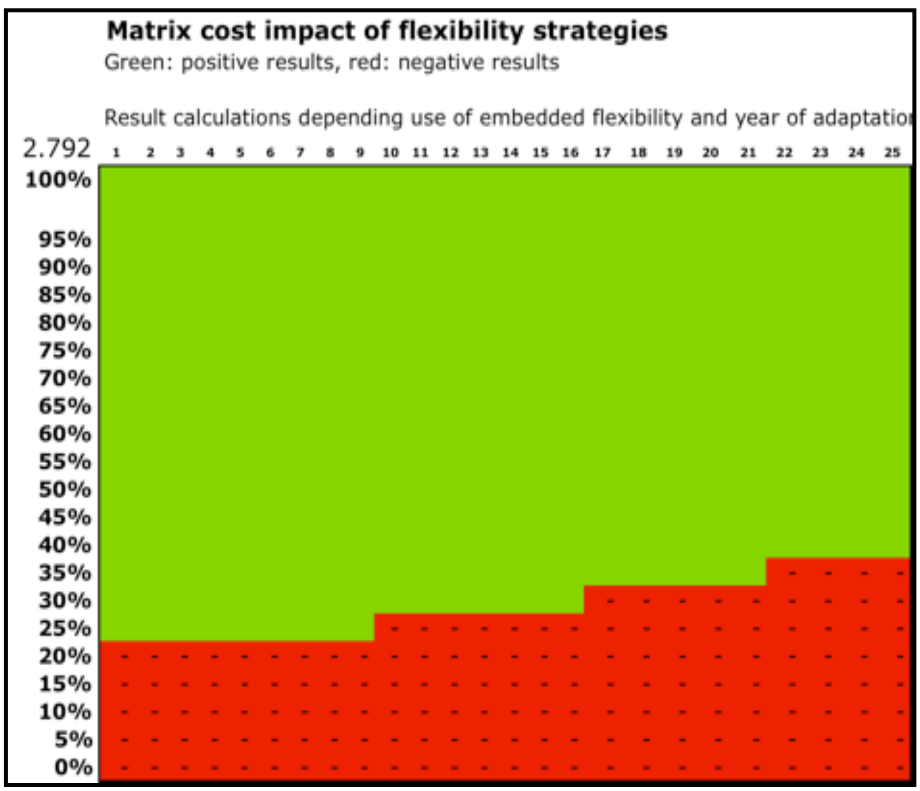
Fig. 19. Managing the hospital building and decision-making about process change or building strategies.

After explaining the cost model to be used in the workshop, several cases were calculated. The cases brought by the participants did not fit very well in the cost model as used at the first day, so adapting the model was needed. The next workshop day the cases were calculated with an improved cost model, so the results were much easier to understand. The impact of technical and flexible wall and floor systems were evaluated against the future advantage of easier and faster refurbishment. Also the “finger points” design with flexible facades gives the possibility to extend the building at the just place. The next table gives the examples as evaluated during the workshop.

Walls Cable Stud	flexible Electric system
Thick floor "pad" w ith flexible piping	flexible piping systems
Raised floor w ith flexible piping	1 + 2 both flexibility for electric and piping
Flexible facades for expansion building	Makes it easy to expand the builing
Empty floor space for future functions	Easy adding functions in future
More site area and flexible facades	Easy expansion of the building at location function

Fig. 20. Table with evaluated cases during the workshop

The cases with buffers or empty spaces to be used for future developments were especially interesting and the future advantages were very clear.



The green part of this picture shows the positive impact of empty spaces or buffers, to be used for future functions. If there is more then 20-30% chance that this space can be used the results are very positive. The impact of organizational disturbance is not yet embedded in this diagram. In step 4 from paragraph 5.1 the advantage of less disturbance from the refurbishment is roughly calculated. The advantage in less organizational costs is in this example is about 50% more than the advantage in building costs.

Fig. 21. Impact of Flexibility Strategies

4.2 Macro economic impacts
The service life of hospitals is mainly related to the time that the building can fulfill the functional requirements of the hospital organization. Because of the fast developments in the heath care sector, the risks that non-flexible buildings don't have the capacity to follow this changes in time at an efficient way. The consequences are a "progressive sub-optimization" of the functions in the hospital. Implementing a flexible building strategy for new and renewed hospitals could extend the lifetime of the buildings significant.

The macro-effects of this extended lifetime of flexible buildings are have been calculated for the Dutch situation.[13] (*Fig. 22*)

In the first period the difference in investments for new hospitals and the lower future refurbishing costs are growing slowly. After a period of 20-25 years the savings become increasingly significant.

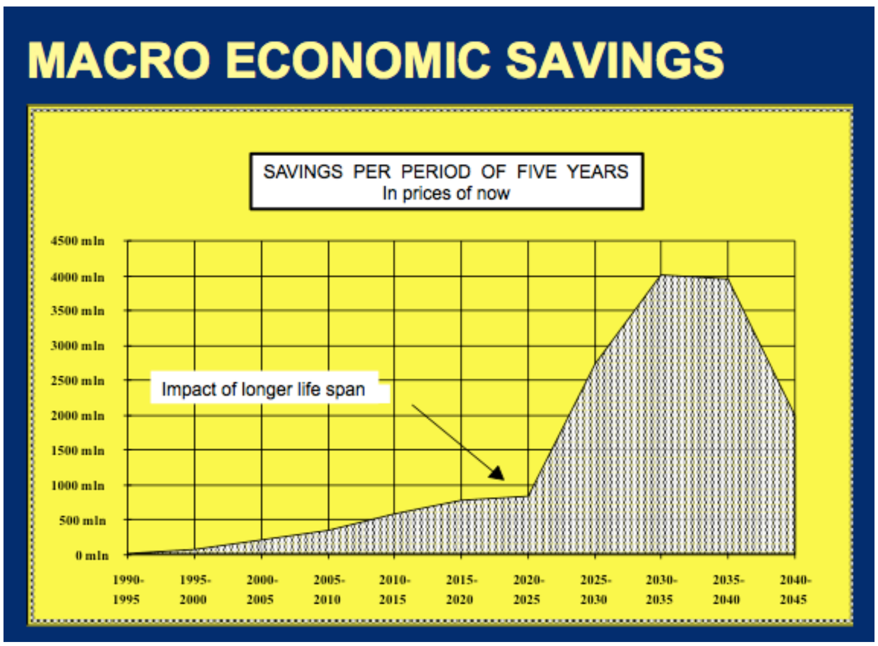


Fig. 19. Macro-economic savings

4.3 Conclusions from the cost modeling workshop

1. The presented conclusions from the Dutch study about flexibility design for hospitals were discussed and the participants of the workshop could conclude a consensus about the findings; (see for this conclusions paragraph 7.1)
2. The presented cases presented by the participants were relevant and could be calculated on cost/benefit aspects with the special prepared and during the workshop improved cost-model;
3. The use of a (improved and extended) quick-scan cost-model to evaluate the flexibility strategies in the program and design phase should be helpful for designers and decision makers.

[13] Nicolai R, Dekker K.H., " process, on behalf of the National Hospital Institute, 1990

5 Conclusions and recommendations

5.1 Conclusions and recommendations from Dutch hospital study

1. **Purchasing land:**
   The site has been big enough to design a staggered terrace building with open-end structures. This requires several tens of percent more land cost.
2. **Design and of construction preparation process:**
   The design and preparation process is structured so that decisions are taken "from coarse to fine," so that it is the greatest possible freedom exists for further development. Separate the decision-making procedures for the base building (primary system) from the infill (secondary system). This will lead to a much shorter preparation time and therefore will be cost-efficient.
3. **Program phase:**
   Define the flexibility requirements in the performance specification;
   The individual departments must always be indicated to what extent certain types of flexibility are needed there, including this on the basis of the degree of functional differentiation within the department. It should also be examined to what extent the flexibility of use can be promoted by alternate use of spaces and/or standardization of rooms or room sizes. For the department as well as for individual rooms indicate whether they can serve as a buffer;

4. **Design phase**
   The structure of the design and the layout of the design are crucial to the required spatial flexibility. This reflect 3 types of flexibility"

   Layout Flexibility - which should allow optimal internal alterations - in the layout promoted by 'soft' functions as a buffer between 'harder' functions to situate. A function can serve as a buffer if it has no high technical demands on the building states, and the place where it is not of great importance.

   Extension Flexibility - requires at institutional level sufficient ground for an entirely new department and open-ended at the main internal road structure at department level, it is open sides and open ends. The latter requires sufficient space between building-wings and terraces for higher floors.

   Disposal Flexibility - should allow the disposal of vacant positions without damaging the main structure of the base building;

5. **Construction phase**
   Layout Flexibility - distances between the columns must - at least in one direction - as large as possible. All 'hard' elements such as stairs, elevators and shafts should be located outside areas of function spaces.
   All internal separation walls must be taken away and added with a minimum of noise, dust and water pollution. Load-bearing walls should not be applied. Fixtures and plumbing fixtures should easily be taken away and placed.

   Extension Flexibility - requires easily removable walls. Re-Usability, an important cost advantage. Load-bearing walls should not be applied

Disposal Flexibility - required that the entire supporting structure [floors, columns, etc.] with a minimum of noise and vibration nuisance can be removed. Possibilities for application of a removable and re-usable skeleton should be examined, not so much as to save costs by reusing well as to promote the decision to be decommissioned when a building has an empty section;

6. **Installation technical services**
   Layout Flexibility - requires distribution with sufficient valves to achieve (local) changes without disturbing the surrounding features. Pipes must be easily accessible, both in the technical sense (removable ceilings, open shafts, etc.) and in a practical sense (minimal disruption or interruption of supply/drainage for others, including under-lying floors).

   Extension Flexibility - requires a slight excess of primary-distribution of nets and equipment therein built (distributors, pumps, fans, etc.);

7. **Operation phase**
   Application of the built in flexibility
   When the building is in use the organization have to perform the facility management at a "flexible manner" and with the knowledge of all the built in flexibility to respond to emerging needed adjustments. (See also fig. 18)

5.2 Conclusions and recommendations from this costs study

1. To clarify the economical consequences of a flexible design strategy for hospital buildings are very important to achieve a positive 'decision climate' for decision makers;
2. The conclusions of the Dutch study of flexible hospital design are also relevant for a building strategy for more flexible hospital design in the United States;
3. The developed cost-model for the cost-modeling workshop has a potential value to use this tool for evidence based decisions about the implementation of flexibility strategies for hospital buildings;
4. It will be recommended to develop an extended quick–scan cost-model for evaluating program- and design decisions for hospital buildings. The developed model by KD/Consultants can be used as basis for further development;
5. The impact on organizational disturbance costs by carrying out refurbishing projects is recommended

ANNEX 1, Cost table for differences in investments at start up

HOSPITAL STUDY IN THE NETHERLANDS

Table **Compare total costs of investments at start up**
costs x € 1000 - price level 2010

code		group of costs	Reference project	Strategy design	difference value	difference %
	210	foundation	2476	3993	1517	*61*
	220	skelet/basic construction	10136	7739	-2397	*-24*
	230	facades	5675	8109	2434	*43*
	231	roofs	1665	1646	-19	*-1*
	240	support finishing	856	798	-58	*-7*
	250	management costs/overhead	4131	3753	-379	*-9*
200		**Base building**	**24939**	**26037**	**1098**	***4,4***
	310	heating	1124	1214	90	*8*
	320	HVAC	2689	2689		
	330	water & sewage systems	1184	1244	60	*5*
	340	gaz/liquids	990	1020	30	*3*
	350	electrical installations	2002	2002		
	360	telecommunication	223	223		
	370	control installations	223	223		
	380	transport installations/eleveator	971	855	-117	*-12*
300		**Installations - support**	**9408**	**9471**	**63**	***0,7***
	10	housing patients	12197	11859	-338	*-3*
	20	research/labs	8539	8302	-237	*-3*
	30	cure areas	4857	4924	66	*1*
	40	paramedical services	3915	3820	-95	*-2*
	50	Education and control	1679	1628	-51	*-3*
	60	technical and facility managem	2225	1946	-279	*-13*
	70	facilities for personel	590	610	20	*3*
	80	traffic areas	2144	2361	217	*10*
	100	energy suystems	1104	789	-315	*-29*
^		**infill systems extra**	**37252**	**36240**	**-1012**	***-2,7***
	» »	**Total costs building**	**71599**	**71748**	**149**	***0,2***
400		**Equipment**	**7745**	**7745**		
	10	desiggn and consultants	10219	9697	-522	*-5*
	30	local taxes	666	666		
	40	interest during construction	7883	6524	-1359	*-17*
	50	preparation costs	102	102		
	60	start up costs	6160	6160		
0		**Perifere costs**	**25030**	**23149**	**-1881**	***-7,5***
	110	costs of ground	13750	17500	3750	*27*
	120	cables and pipes	563	563		
	130	traffic facilities	970	919	-51	*-5*
	140	garden outfit	281	408	127	*45*
100		**Grounds**	**15566**	**19391**	**3826**	***25***
	»»»	**Total investments**	**119939**	**122032**	**2093**	***1,7***

ANNEX 2, Cost table for differences in investments for all refurbishments in the life time of a hospital

HOSPITAL STUDY IN THE NETHERLANDS

Table **Compare total costs of adjustments of all changes in lifte time**
costs x € 1000 - price level 2010

code		group of costs	Reference project	Strategy design	difference value	difference %
	210	foundation	837	1042	205	*24*
	220	skelet/basic construction	1688	1019	-668	*-40*
	230	facades	1804	1691	-113	*-6*
	231	roofs	621	462	-159	*-26*
	240	support finishing	267	188	-79	*-30*
	250	management costs/overhead	1712	1138	-574	*-34*
200		**Base building**	**6929**	**5540**	**-1389**	***-20***
	310	heating	82	32	-50	*-61*
	320	HVAC	208	72	-137	-66
	330	water & sewage systems	6	12	-51	*-81*
	340	gaz/liquids	53	10	-43	*-82*
	350	electrical installations	107	19	-87	-82
	360	telecommunication	1	2	-10	-82
	370	control installations	12	2	-10	-82
	380	transport installations/eleveators	0	0		
300		**Installations - support**	**537**	**149**	**-388**	***-72***
	10	housing patients	7710	3941	-3770	*-49*
	20	research/labs	1384	272	-1112	*-80*
	30	cure areas	1924	167	-1757	*-91*
	40	paramedical services	1939	783	-1155	*-60*
	50	Education and control	997	392	-606	*-61*
	60	technical and facility management	202	76	-126	*-62*
	70	facilities for personel	0	0		
	80	traffic areas	223	0	-223	*-100*
	100	energy suystems	98	113	15	*15*
^		**infill systems**	**14477**	**5744**	**-8733**	***-60***
	» »	**Total costs building**	**21944**	**11434**	**-10510**	***-48***
400		**Equipment**	**PM**	**PM**	PM	
	10	desiggn and consultants	4191	2660	-1531	*-37*
	30	local taxes	195	141	-54	-28
	40	interest during construction	465	356	-109	*-23*
	50	preparation costs	42	27	-15	-35
	60	start up costs	0	0		
0		**Perifere costs**	**4893**	**3184**	**-1709**	***-35***
	110	costs of ground	0	0		
	120	cables and pipes	0	0		
	130	traffic facilities	36	0	-36	*-100*
	140	garden outfit	25	30	5	*22*
100		**Grounds**	**61**	**30**	**-31**	***-50***
	»»»	**Total investments**	**26898**	**14648**	**-12249**	***-46***

9.5 The Policy Seminar: Healthcare Facilities Design for Flexibility

A one-day POLICY SEMINAR, Sponsored by the Department of Defense and the National Institute of Building Sciences

Wednesday June 20, 2012 | 8:30 – 5:00 | Lunch provided
National Institute of Building Sciences
1090 Vermont Avenue, NW, Suite 700, Washington, DC 20005-4950

The seminar will focus on three main questions:

1. What is flexibility in the context of healthcare facilities: how do we account for and evaluate it?
2. How is flexibility implemented: through incentives, policies/requirements and management methods?
3. What is the cost of acquiring and using flexible healthcare facilities?

Participants in the seminar will:

- Discuss presentations by thought, practice and policy leaders in the healthcare facilities field
- Hear a report on initial findings to date – including outcomes of a recently held cost-modeling workshop
- Participate in formulating the research findings and draft policy recommendations along with Department of Defense officials

This by-invitation seminar is part of a research contract with the National Institute of Building Sciences and Ball State University for the Chief Financial Officer TRICARE Management Activity, in the Office of the Assistant Secretary of Defense (Health Affairs).

AGENDA

8:30 – 9:00	Welcome, Introductions and Summary of Policy and Cost Findings and Recommendations to date (Steve Kendall, P.I. and Thom Kurmel, Project Consultant)
9:00 – 10:00	Presentation 1: Creating Flexibility in Health Facilities+ Discussion (Kip Edwards, VP Development and Construction, Banner Health, Phoenix, Arizona)
10:00 – 10:30	Discussion during break
10:30 – 12:00	Presentation 2: System Separation – Strategy for Buildings of High Utility Value + Discussion (Giorgio Macchi, former chief architect, Canton Bern Office of Properties and Buildings, Switzerland)
12:00 – 1:00	Lunch and Learn (lunch provided)
1:00 – 2:00	Presentation 3: Universal Grid Theory in Use + Discussion (Kent Turner, President CannonDesign North America)
2:00 – 2:30	Discussion and Break
2:30 – 3:30	Presentation 4: Flexibility Tactics: Case Studies in Healthcare Facilities + Discussion (David Hanitchak, Principal, NBBJ Boston)
3:30 – 5:00	Wrap-up, Conclusions and Recommendation

Participants

Name	Position	Affiliation
Steve Kendall, PhD (PI)	Professor of Architecture	Ball State University
Michela Cupelo, M.Arch	Graduate Research Assistant	Ball State University
Thom Kurmel, PhD (Project Consultant)	President	TDK Consulting
Kip Edwards (in absentia presentation)	VP Development	Banner Health Phoenix
Giorgio Macchi	Architect	Former Chief Architect Canton Bern
Kent Turner	President North America	CannonDesign
David Hanitchak	Principal	NBBJ Boston
Lloyd Siegel	Office of Construction and Facilities Management, VA,	
Dennis Sheils	Office of Construction and Facilities Management, VA,	
David Marquardt	Director, Medical COE, US Army Corps of Engineers	
David Clark, PE	DoD Tricare Management Activity (TMA)	
Phyllis Kaplan, Architect	DoD Tricare Management Activity (TMA)	
Russ Manning	Senior Health System Planner (TMA)	
Robert A. Haddix	Chief of Acquisition, DoD Tricare Management Activity (TMA)	
Daniel C. Gerdes	MEDCOM HFPA	
William Caswell	US Army	Washington, DC
Jamee Plockmeyer	Navy Medicine	Washington, DC
Brent Willson, AIA	Senior VP	HKS Dallas
Rick Bond, AIA	VP Federal Healthcare	HKS Washington, DC
Francisco Gonzalez, AIA	VP Healthcare	HKS Miami
Tracy Bond, AIA	Senior Planner	SmithGroupJJR, Washington
Dave Treece,AIA	Senior Planner	SmithGroupJJR, Washington
David Chambers	Vice President Director of Consulting, Healthcare, HOK, Seattle	
Hank Winkelman, AIA	Principal	HOK
Billie Faircloth, AIA	Research Director	Kieran Timberlake, Philadelphia
David Hattis	President	BTI, Inc,. Silver Spring, MD
Sandy Gray	VP Cost Management	Cumming, Bethesda, MD
Roger Call, AIA	Director, Healthcare Architecture + Design, Herman Miller	
Phil Astley	Senior Research Associate University College London/Bartlett	
Noah Kahn	Manager of Project Metrics	Kaiser Permanente
Nanne Eliot	Program Manager	NIBS
Drew Rouland	Program Manager	NIBS

Presenters

Kip C. Edwards, Vice President, Development and Construction
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Kip C. Edwards
Vice President, Development and Construction
Banner Health

Banner Health

Creating Flexibility in Health Care Facilities

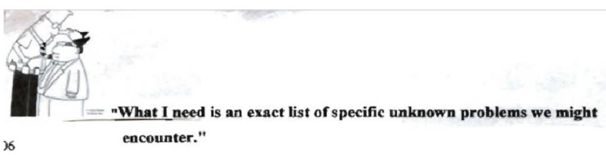
Kip C. Edwards
Vice President, Development and Construction

Facility Planning Priorities

- Flexibility
- Preplanned, Incremental Growth
- Flexibility
- Long Range Plan, Updated Every 3 Years
- Flexibility

Banner Health

Defining Flexibility



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Flexibility to respond to:

- technology
- care delivery
- market conditions
- economic conditions
- leadership strategy/direction
- laws/codes/regulatory
- industry changes/healthcare reform

Planned and unplanned growth and change

Banner Health

Flexibility tools:

- site size and configuration
- entitlements
- planned zones and directions for future expansion
- future floor additions
- soft space
- shelled space
- excess capacity in utilities
- ability to expand utilities
- pathways/space for future IT

Banner Health

When/what to create:

- Up front, now, as soon as you can, every time you can....think long term, lifecycle cost, not first cost.
- Make provisions for incremental growth.

Create and recreate the plan for the campus.

Banner Health

Medical Centers

Banner Health

Ideal Medical Center Campus Organization/Site Principles

- Size – 60 to 80 acres, can accommodate growth up to 600 beds plus diagnostic and treatment areas and several medical office buildings.
  - approximately 700,000 square feet
  - 5,000 plumbing fixture units
  - 250,000 square feet of MOB space
- Visibility and access from a Freeway or major, regional artery
- Access for right and left turns in and out (prefer traffic signal onto site); four lanes and/or turning lanes into the site (for emergency vehicles).

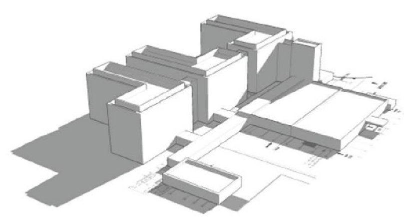
Banner Health

Ideal Medical Center Campus Organization/Site Principles (cont.)

- Depth and width to distribute parking and allow a ring road with sufficient stacking to exits.
- Separate locations for main entrance, emergency entrance, and materials entrance.
- Ability to build the main entrance, emergency entrance, materials entrance, and central plant once and never relocate.
- Infrastructure for utilities (multiple sources) and communications/data.

Banner Health

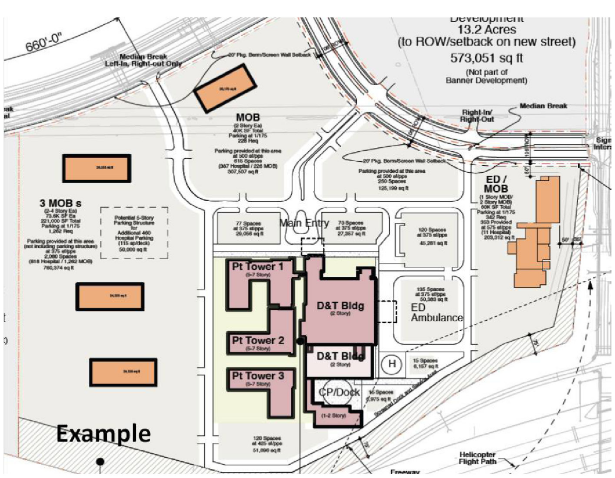
"Greenfield" Site Example – Verrado

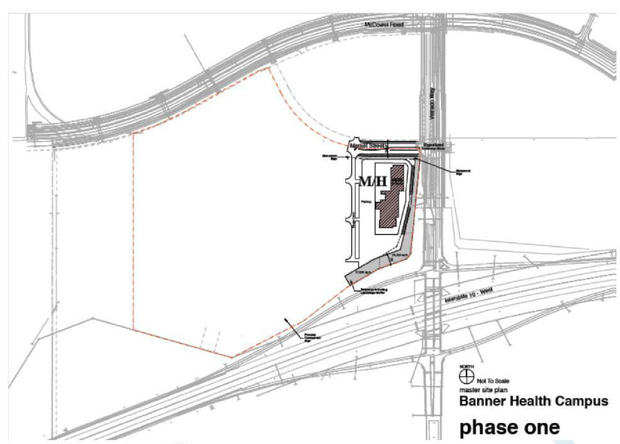


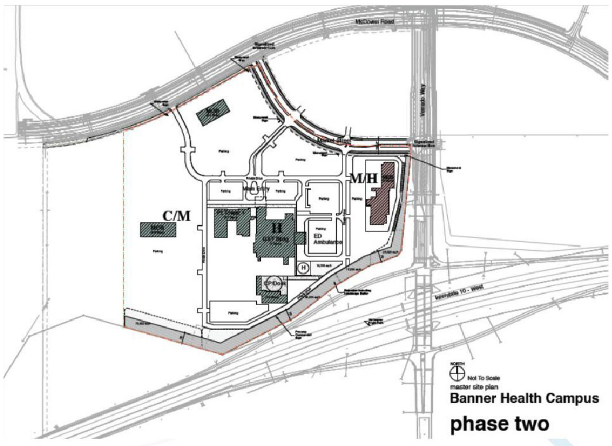
Isometric View
Freeway and Verrado Way View to North West

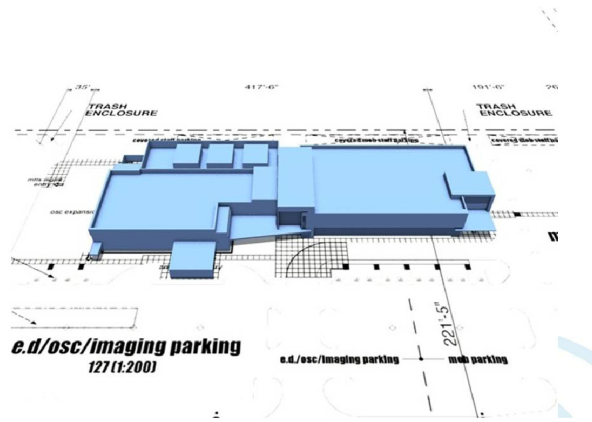
Hospital Massing Study
Not To Scale

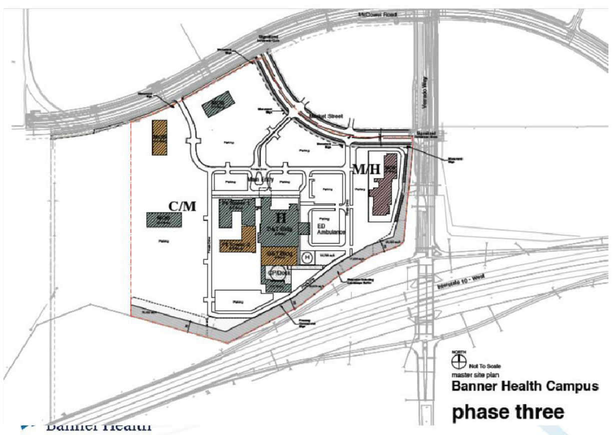
Banner Health

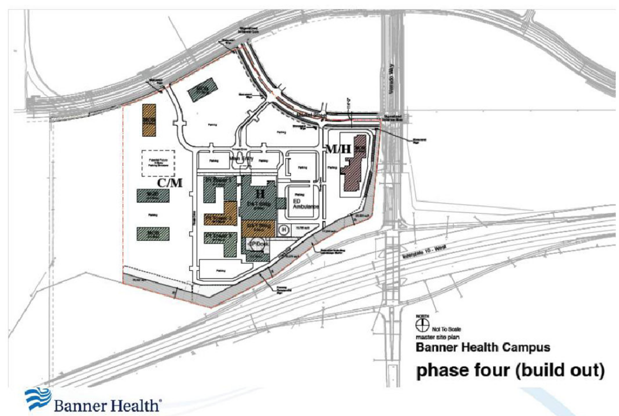




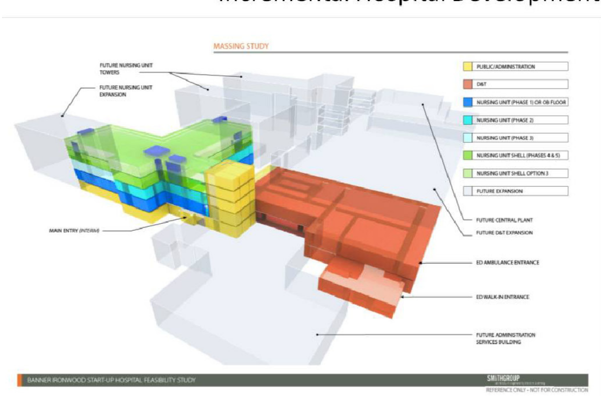






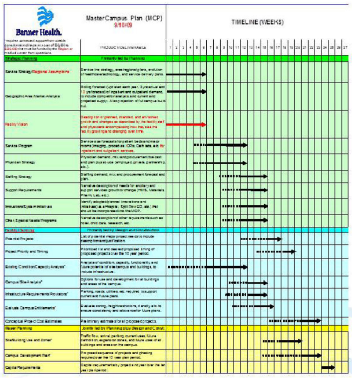


Incremental Hospital Development



"Greenfield" Site Example –
Banner Gateway

Master Campus Planning



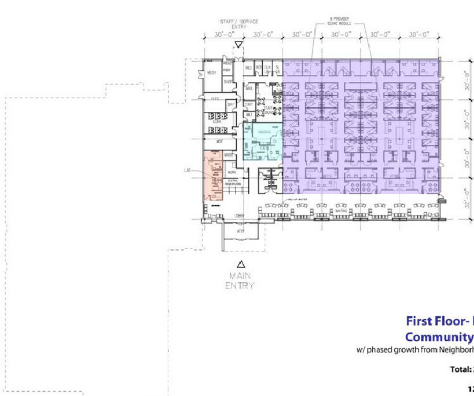
Master Campus Planning

Strategic Planning	Primarily led by Planning
Service Strategy/Regional Assumptions	Service line strategy, area/regional plans, evolution of healthcare/technology, and service delivery plans.
Geographic Area/Market Analysis	Rolling forecast (updated each year, 3 yrs actual and 10 yrs forecast) of inpatient and outpatient demand, to include competitor analysis, and current and projected supply. Also projection of full campus build-out.
Facility Vision	Description of planned, intended, and envisioned growth and changes as described by the facility staff and physicians encompassing how they see the facility growing and changing over time.
Service Program	Service size forecasts for patient beds and major rooms (imaging, procedure, OR's, Cath labs, etc. for inpatieint and outpatient services.
Physician Strategy	Physician demand, mix, and procurement forecast and plan plus source (employed, private, partnership, etc.).
Staffing Strategy	Staffing demand, mix, and procurement forecast and plan.
Support Requirements	Narrative description of needs for ancillary and support services growth or change (HIMS, Materials, Pharm, Lab, etc.).
Innovations/System Initiatives	Identify adopted/planned innovations and initiatives(i.e. eHospital, Split Flow ED, etc.) that should be incorporated into the MCP.
Other, Special Needs/Programs	Narrative description of other requirements such as hotel, child care, research, etc.

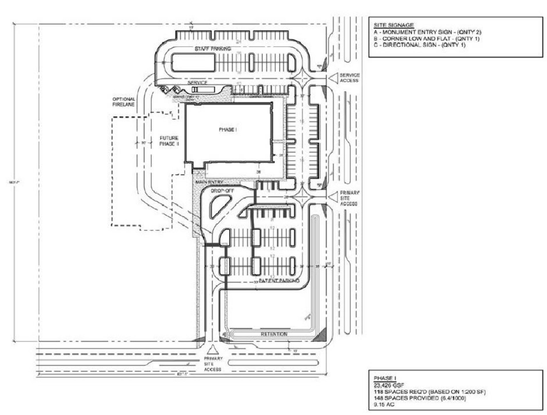
Master Campus Planning

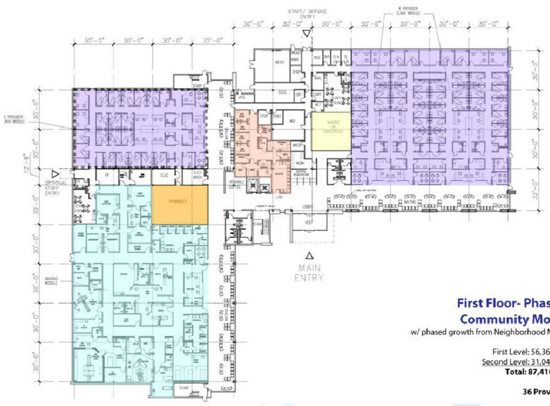
Facility Planning	Primarily led by Design and Construction
Potential Projects	List of potential major project needs to include description and justification.
Project Priority and Timing	Prioritized list and desired/proposed timing of proposed projects over the 10 year period.
Existing Condition/Capacity Analysis*	Analysis of condition, capacity, functionality, and future potential of site/campus and buildings, to include infrastructure.
Campus/Site Analysis*	Options for use and development for all buildings and areas of the campus.
Infrastructure Requirements/Provisions*	Parking, roads, utilities, etc. required to support current and future plans.
Evaluate Campus Entitlements*	Evaluate zoning, height restrictions, density, etc. to ensure consistency and allowance for future plans.
Conceptual Project Cost Estimates	Preliminary estimates for all proposed projects.

BANNER HEALTH CENTERS



First Floor- Phase I Community Model
w/ phased growth from Neighborhood Model
Total: 23,426 GSF
12 Providers





First Floor- Phase II
Community Model
w/ phased growth from Neighborhood Model

First Level: 56,369 GSF
Second Level: 31,041 GSF
Total: 87,410 GSF

36 Providers

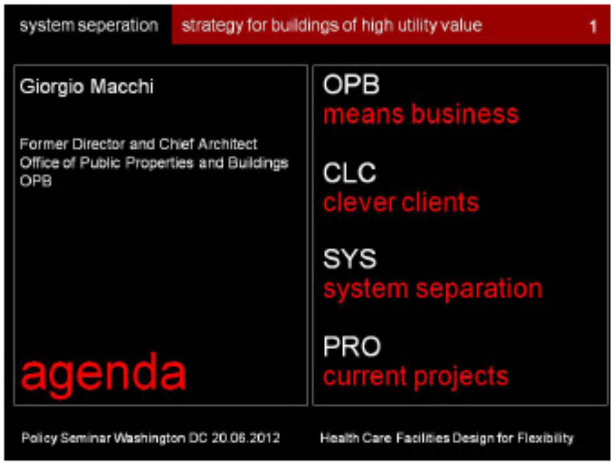
Banner Health

Questions/Comments

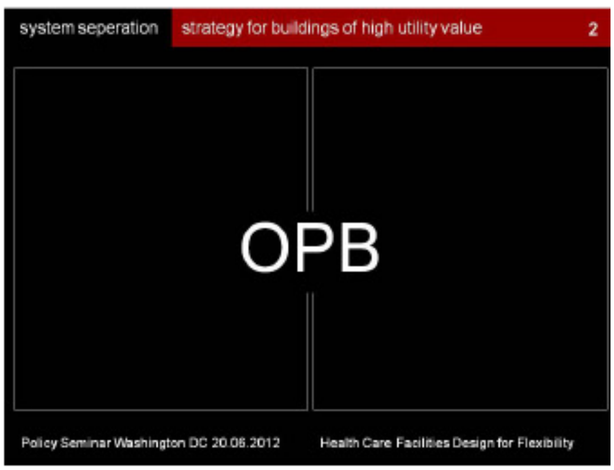
Banner Health

Giorgio Macchi

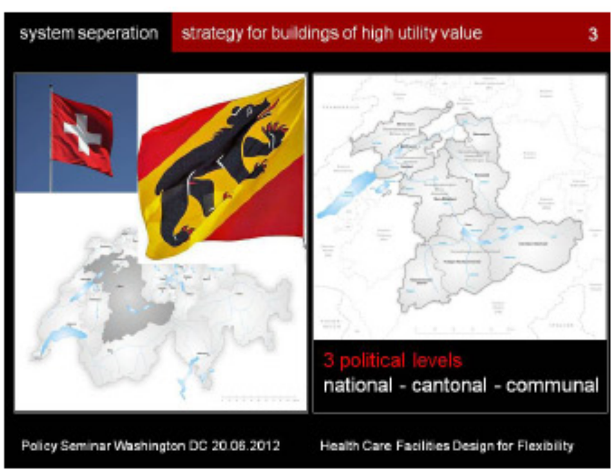
Former Chief Architect, Canton Bern Office of Properties and Buildings
Bern, Switzerland



Agenda
The subject I will present you is the strategy called system separation. Since inaugurating it in project procurement, we have steadily progressed concerning the quality of results, the political support and the echoes in the professional world. More and more other clients have declared it as guideline. SYS is a rather technical approach and has to be seen in a larger context. That's why I will also give you information on the Office of Public Properties and Buildings, on what is important for a clever client and I will point to specific aspects of current projects.

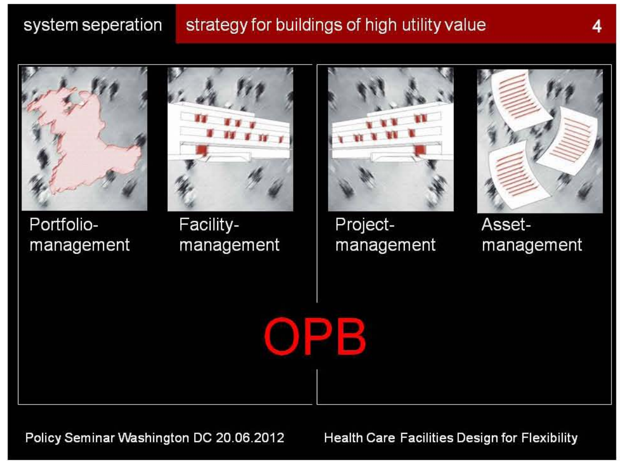


Office of Properties and Buildings



Switzerland is organized on three political levels: the national, cantonal and communal. Berne is one of the 26 Cantons, with two languages being geographically placed between the French and German speaking parts of the country. This cultural richness does not really solve our financial problems and the effort to explain our targets is not reduced. It makes us probably communicate more carefully. That's what I hope to do also in speaking to you.

The OPB is the Office for Public Properties and Buildings and is responsible for about 2000 buildings with a total value of 6 billions CHF ($6.2 billion). The OPB is owner and builder at once. That's a big advantage. The PFM is responsible for the strategic developments and financial implications, the FM for the maintenance and security of the buildings, the PM for the new construction and important transformations and finally the AM for all rent, sale and purchase contracts.

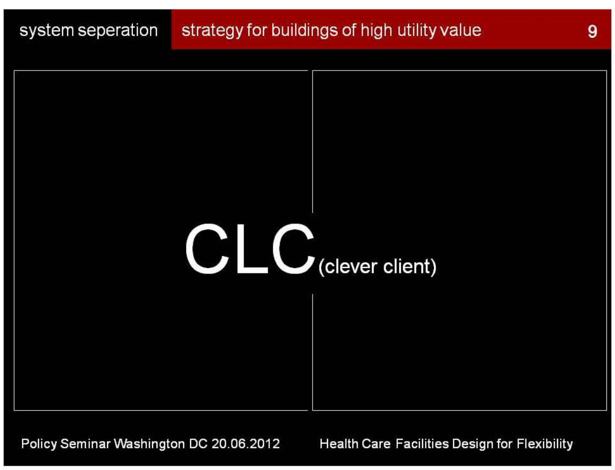


Our basic challenge is, referring to Albert Einstein, to see things as simple as possible, but not simpler. Our target is to create buildings with high utility value.

Thanks to an explicit priority not to neglect portfolio maintenance, we reach an average value of the whole portfolio of 80% compared with the new value. Economically that's a good performance.

Three factors - buildings, electricity and mobility/transportation - have almost equal environmental impacts on the environment. Knowing that, 5 years ago we reviewed our priorities. We still continue to optimize the buildings, but we give much more importance on electricity consumption and on promoting well- situated areas, thus minimizing the transportation impacts.

Concerning the healthcare facilities, the situation is rather curious. One could say the system is offbeat. The geographic distribution of hospitals is almost as it was at the time of the stagecoaches. The various political levels are very protective. What does that mean? For one thing, it means that it is not absolutely certain that today's hospitals will remain hospitals forever. For economic, ecological and political reasons, it is normal that building projects are faced with conflicting goals. Such conflicts may block the decision process. SYS helps to reduce this blocking effect of conflicting goals, and becomes a kind of anti-stress device.

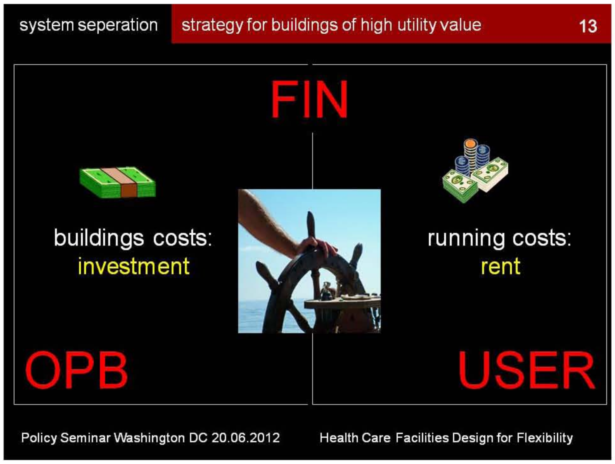


CLC
Based on our experience, a clever client has to observe three points:

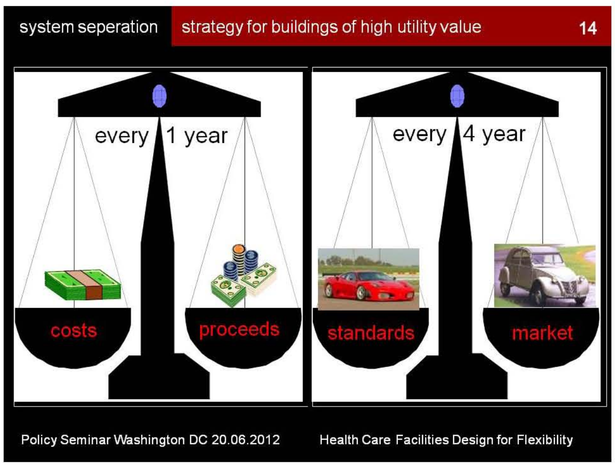
First: Before starting to plan, a client has to create a kind of pre-architectural scene. He has to activate long-term reflections and to prevent that the future is perceived on short-term user reflexes. He has to anticipate openness for the unexpected. He has to do his homework.

Second: Clever clients create a user culture. Without a user culture any investment becomes a bad investment. The potential of the new environment is not perceived. The crucial point is not the participation of the users in the planning phase but in a dynamic use of the buildings over the time. User culture also means to a great extent an economic responsibility on the user side.

At the present time, the users of public buildings have to pay no financial charge for the space they use. They have to negotiate, but there is no financial mechanism to do so. In accordance to the government, we developed an instrument to introduce a rent-model as a business solution for the whole administration and its institutions - hospitals, schools, prisons, etc.



The rent-model is quite simple. The OPB as owner is responsible to assure that the investments correspond to a real demand. The user departments rent the spaces and are responsible to have sufficient funds to pay the rent. The middle - and short - term operational responsibilities of the users and the long-term strategic responsibilities of the owner are correctly allocated.



Two kinds of balance were important in explaining the rent-model instrument. Every year the OPB has to show a financial statement and every 4 years the OPB has to prove that the prices are adjusted to the market.
But this instrument is not yet implemented. The opposition of the user departments is tremendous. Probably it is just a question of time until the financial commission of the parliament will mandate it, to make the annual running costs in the accounting departments of user organizations explicit. It is like the story about an American president who said to a group that wanted the change of a specific legislation: “OK, you have convinced me. Now make me come under political pressure.”

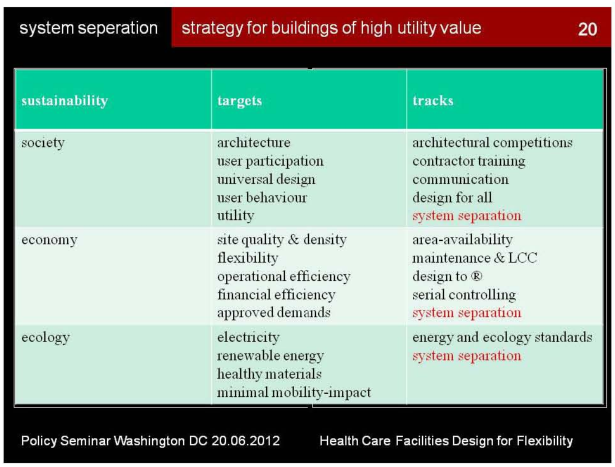
The American book “It’s Your Ship” impressed me very much. It shows the importance that the ship’s crew has to have a committed identification with the ship and its mission. Users often say they would feel much more responsible if the buildings belonged to them. I wonder if the navy commander was owner of the ship.

Now the third point: Clever clients create high utility values. High utility values are buildings that can be used well over a very long time, that are fit to be easily renewed and transformed, and that have a growing cultural identity.

One of the reasons why this rarely happens is that responsibilities are not allocated correctly. We have to point out that there are those responsible for the built infrastructure – ship or building - and others responsible for the ticket sales or the allocation of space and service levels. The realization of a complex investment affords cooperation; but that does not mean everybody has to talk about how a ship (or building) has to be made.

We agree with Otl Aicher, a German designer, who says that *management, not planning, is the essence of economics*. As a consequence, we cannot plan everything. We have to make uncertainty manageable.

In politics uncertainty is not really welcome. To get money you have to know what will happen. The parliament decides three times on a projects' financing - twice directly with the credits (appropriations), and the annual global budget approval. The question was: How can we make uncertainty practicable? I think we reached the key political players with the fact that there is one thing that is absolutely certain: Buildings have to be prepared for change! An investment that neglects this fact will become a bad investment. That is political language. The rest is hard work.

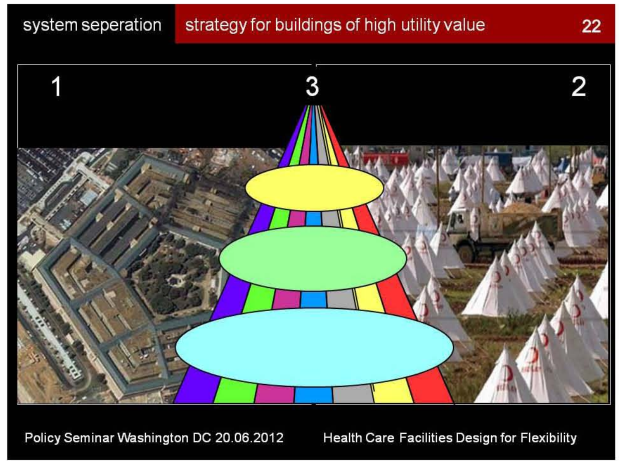


sustainability	targets	tracks
society	architecture user participation universal design user behaviour utility	architectural competitions contractor training communication design for all system separation
economy	site quality & density flexibility operational efficiency financial efficiency approved demands	area-availability maintenance & LCC design to ® serial controlling system separation
ecology	electricity renewable energy healthy materials minimal mobility-impact	energy and ecology standards system separation

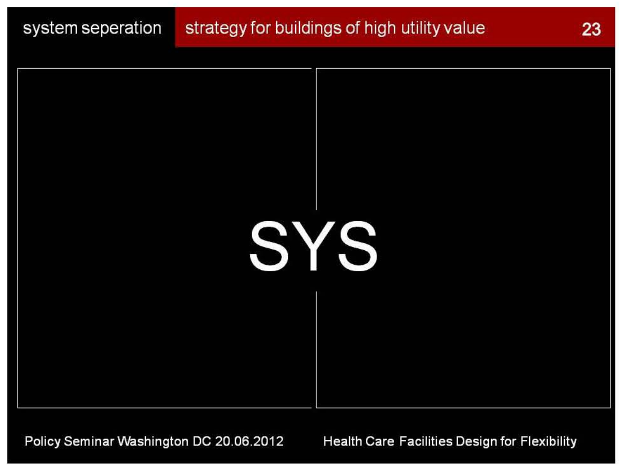
As a public client we have to keep transparent the criteria we apply. You see in the diagram an overview of the main criteria, structured following the three domains of sustainability. SYS appears in all three. Concerning society it means better utility over a long time. Concerning economy it means better decision conditions and optimized cost over a long time. Concerning ecology it means less waste over the whole lifecycle. So far so good, but there is still a problem.

When you ask for what time-slot an investment has to be planned, there is a certain irritation. Basically there are three solutions: Solution 1: Requirements are fixed for all that is and will be. Accordingly, buildings are conceived as a kind of fortress, protecting good ideas of today but also blocking future lessons learned and future developments. Solution 2: Requirements can't be predicted knowing things may change soon. Accordingly the buildings are conceived as temporary. Both solutions are not convincing when we talk about hospitals or public buildings. There must be better one.

You combine 1 and 2 and that's exactly what SYS does.

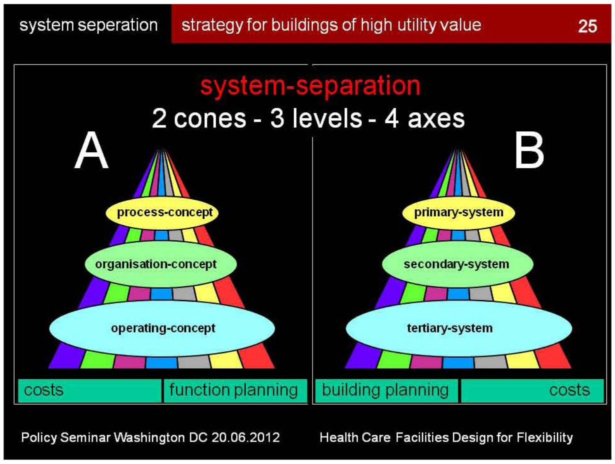


SYS
The strategy is called plain and simple SYS because the term points on its very basic idea. Separated in a clever way, things become more manageable.



The technique of SYS can be put on the formula: ff.ff - fix few to get flexibility but fix firm, to get reliability.

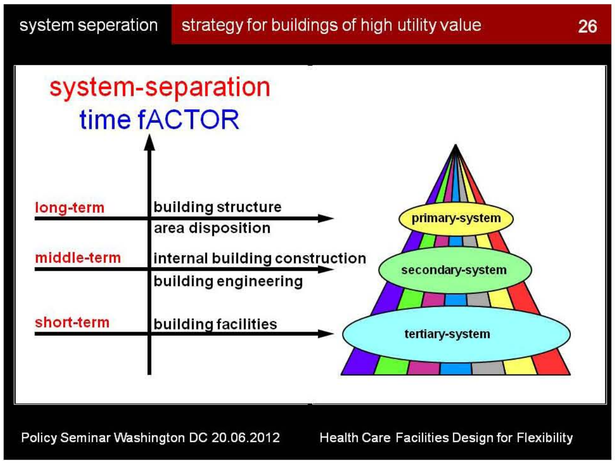
SYS requires transparency in what has a short- or long-term character, what we know and what we can't know. Of course there is always a certain reflex against the idea to build in solid materials something that is uncertain. But this conflict is immanent in every building project, whether you accept it or not. SYS works in a proactive way with this reality.



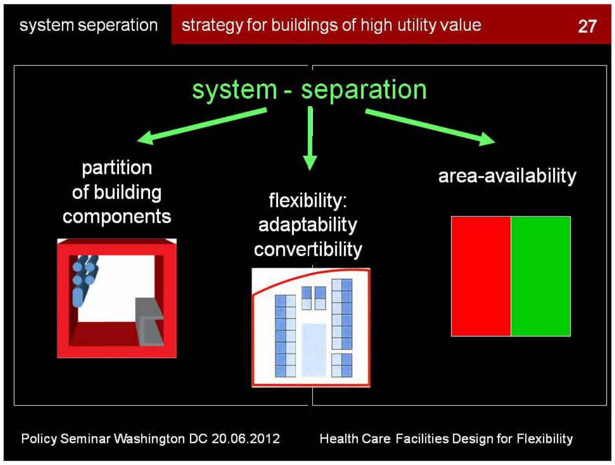
Planning and realisation are separated in three levels, referring to long-, middle- and short-term aspects.

Cone A shows the three levels for the requirement planning, with the process-, organization- and operating-concept.

Cone B shows the three levels for the building planning, with the primary-, secondary- and the tertiary-system. Each level is connected with a corresponding cost planning. 2 cones, 3 levels, 4 axes: an effective organizational precaution.



The primary-system has a long-term character and includes the area availability (site capacity or area for actual and future construction), the building structure and the facades. The secondary-system concerns the internal building construction (non-loadbearing walls) and the mechanical, electrical, plumbing systems. The tertiary-system includes the building facilities and equipment. The time factor becomes a great and sustainable impact indeed.

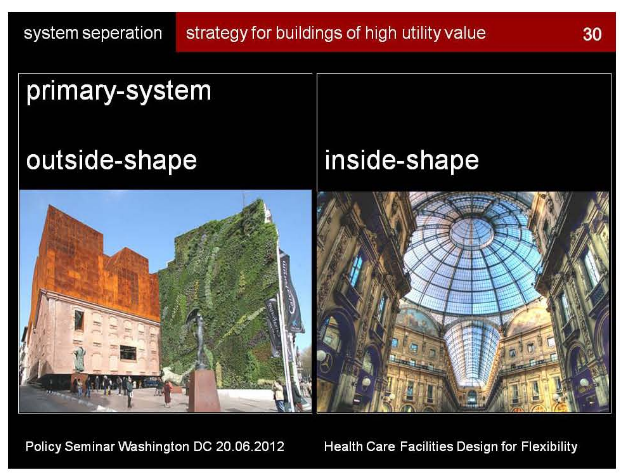


System separation requires three things: The partitioning or separation of building components, flexibility and area availability (site capacity). Concerning management, it demands strong hierarchical decisions, a great ability to abstract and strict control of all aspects of the project. And there is something else you can't miss when applying an non-traditional strategy:

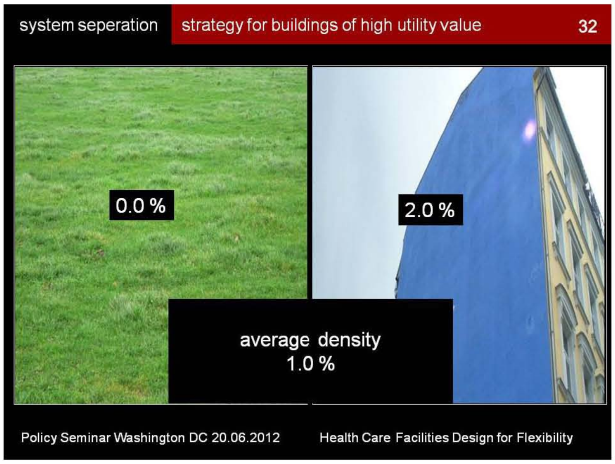
You need sufficient support from the policymakers. It was by this simple comparison with a bottle-crate that public opinion finally moved our way.

Of course we treat subjects like materials, aesthetics, energy and ecology. But system-separation points to very specific objectives. Very important for the PS (primary system) are the geometries, the load capacity and the floor-to-floor heights. Added net loads and added heights enlarge flexibility.

Without doubt, the long-term primary-system must have a convincing urban shape. It is not a black box without interface to the external and internal environments. The design of these interfaces has to be done very carefully, so as not to reduce the openness for secondary-systems and not to remain fuzzy without architectural identity.
Beside the well-known urban passage Vittorio Emmanuele in Milan I have chosen on purpose the recently transformed museum in Madrid, because of its vertical extension. It is one of the requirements that primary-systems have to fulfill - to be extendible horizontally and vertically. With this requirement, we discovered solutions nobody would have thought about.



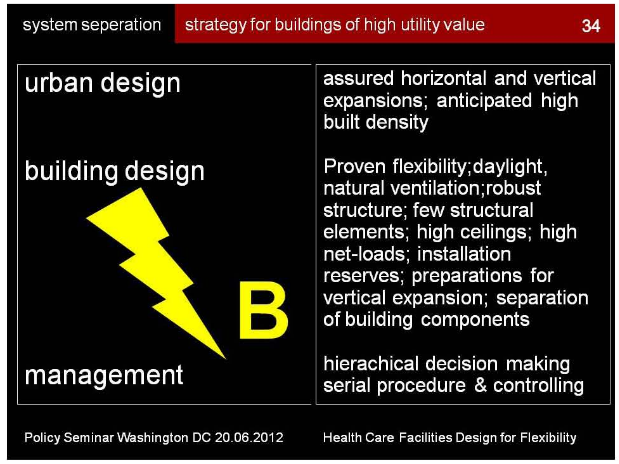
What we call area-availability is a reaction to the fact that today building regulations often limit the built-density to rather low figures. Hence area availability has two objectives: First - place buildings in such a way that vertical and horizontal expansions are assured and second – use well-situated areas with a high built-density capacity, even if such density is currently not allowed.



By doing so we are not anarchists. We just separate the politically fixed prescription from anticipated future legal constraints. In trivial language: Well- situated areas are divided in two stages. The first is exploited as if we were rebuilding the potential of the whole area. In 20 years a new generation will decide what they want to do with the still-available green grass. The fundamental point is to handle urban situations that remain explicitly open. That's a great challenge and not every architect's gusto.

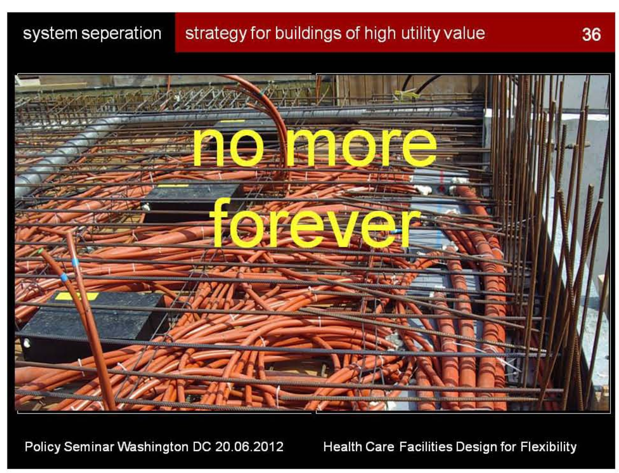
Actually system-separation is not an invention. Old buildings are often much easier to convert than new customized ones. The old Chocolate Factory in Bern has been transformed for the university. We got all we wished for: High density, high net loads, high ceilings and excellent user behaviour. Indeed a high utility value.
Please pay attention to the fact that the original branding spirit of the factory convinced the management to place the gothic cathedral and the Alps behind their buildings as an appealing horizon. Geographically, they are in fact on the other side! Sometimes you have to rethink and create new coordinates. The principles of SYS are such new coordinates for the Canton Bern.

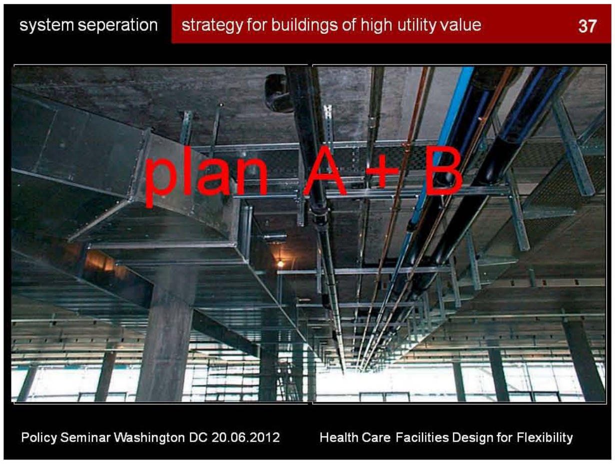
Let me resume and explain the yellow flash-arrow B:
The urban design assures horizontal and vertical expansions, anticipated high built density and an open urban conception.
The building design assures flexibility by appropriate geometries and dimensions. The key element is a robust PS, free of structural complications and with a minimum of structural barriers, high net-loads, high ceilings, stated installation reserves and structural precautions for vertical expansion. The partitioning (separation) of building components is a strict necessity.
The management imposes a firm quality control and project management structure, and hierarchical decision-making.
Now, what is it about the yellow flash-arrow B? It stands for plan B. Plan B assures the flexibility the PS has to have for SS's. You remember the coins and the words. It's the same thing here: It is much better to have a plan B that documents a definite change than to talk about how plan A can be modified, not knowing if the consequences of such modifications are seriously reflected in the PS design. Plan B is a good pillow for sleeping well, even in view of an impending "storm of change".



For all this work, we need planners and architects who are not fixed on icons, nor fixed on classical monuments free from technical installations, nor on icons with a celebration of those, providing only apparent flexibility.

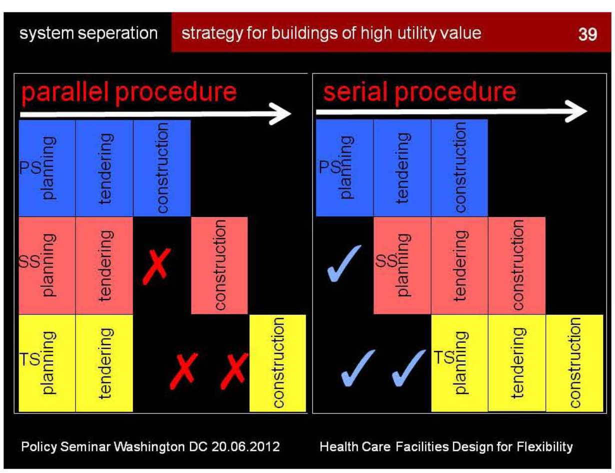
The picture shows the current practice. Some plans are made on site. Such pictures are no longer possible in our projects.





The PS has to guarantee that the SS is independent and can be renewed and transformed without giving much disturbance on adjacent zones. Instead of no plan, there is a plan A and there is a plan B. For us flexibility does not mean mass produced, removable walls. These solutions are much too expensive. The SS can be replaced and is built on very economical and traditional standards. Yet we can say that SYS buildings are very well prepared for more mass production, when the market has developed.

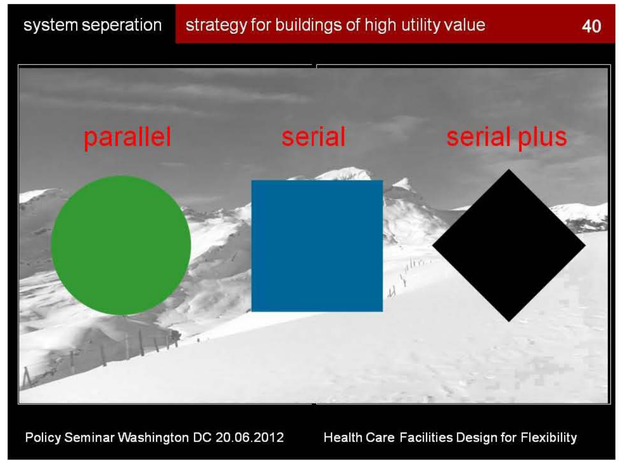
I think my collaborators made a good move by requiring the architects to report in writing how SYS is respected on each phase. These self-declarations have a very preventive effect. Phase by phase the PM controls the project quality and distinguishes three cases: approved, approved with changes to be made, and not approved - that means redo without added fee. This technique is quite new for planners and architects, because they are used to declare that problems in the project can be eliminated, by just going on. With that you enter into a never- ending fatal spiral.



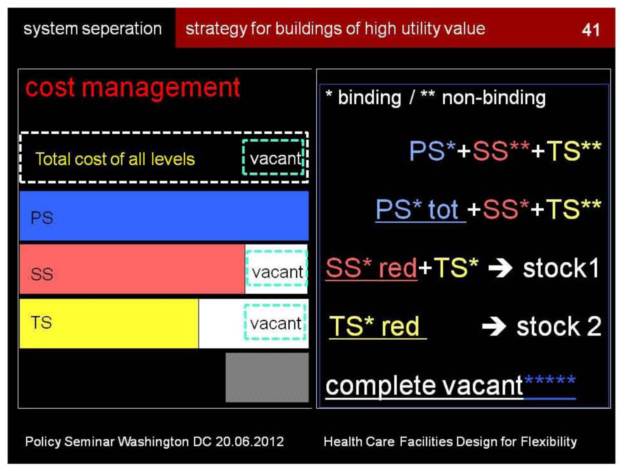
Now, what is the best way to realize SYS in planning, bidding and construction procedures? The serial procedure is a logical transfer of SYS on the procedural level. The systems are planned and realized in sequence with the great advantage that you make decisions concerning SS and TS with the current state of knowledge, just in time. You can include innovation and you insist on a sufficient autonomy of the systems. That's a kind of a first performance test for future changes.

It is absolutely clear that the serial procedure is more challenging than the parallel or all-in-one solution. But a clever client is much more interested in an updated final solution than in a stubborn execution of projects fixed overall in the beginning. The all-in-one solution blocks to a great extent any innovation on SS and TS level. Not so in the serial procedure. Here innovation can be approved and integrated.

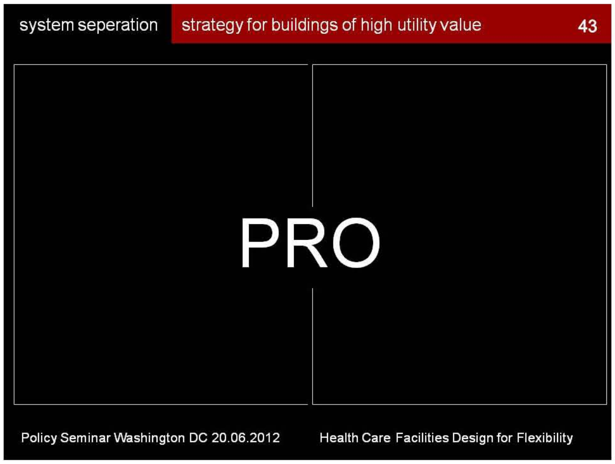
(Slide 40) You know the three types of ski slopes. Green are the easy ones, blue the more exiting ones and the challenging ones are black - for professionals. All-in-one corresponds to the green, serial to the blue. But what is the black? Black is high performance and means in terms of SYS that you chose the serial procedure and you mandate a specialized team for each system. That allows the client to have the maximum professionalism on each system level and at the same time the interfaces are transparent and omnipresent in the whole planning process. Here again, it's clear that the black slope is more challenging than the all-in-one solution. But a clever client has to think about who has to hold the whole in hand: he or the selected planners. And a clever client will come to the conclusion that it is up to him. One may say: Divide and conquer. The reason why a client may hesitate to choose the black slope could be the cost management. Professionally that's not well founded. Whether you accept it or not, in a complex building that has to be up to date the day after inauguration things change already while you are constructing it. So the management of costs is a dynamic subject per se in any case.
Now how can I - as client - keep the project and the budget in balance? Realistically there are two solutions: You have an adjustable budget or the project is adjustable. To keep the project adjustable means thinking optionally and when needed, to act optionally. An effective method is to define floor areas that are not filled-in on the SS and TS levels. We call them "shell" spaces. I will show you a quite simplified, but methodically correct schedule based on this method.



(Slide 41) The initial credit (appropriation) is based on a detailed and binding calculation for the PS-costs and a global estimate for the SS- and TS-costs that are not binding in detail. The implementation (construction) of the PS starts and in a second parallel step the costs for the SS are detailed and are declared binding for an area less than the total available in the PS. The area to be left vacant is defined and with it funds are held in reserve (stock 1) to cover possible cost risks. The implementation of the SS starts (in the specified area). A similar procedure is applied for the TS with a resulting stock 2. When some or all of the fund reserves remain available in the final phase of the project, the part of the PS left vacant can be filled in. Of course, the initial credit (appropriation) has a fund reserve or contingency, but that's business as usual. I would add that it is absolutely possible that the vacant floor areas held in reserve can become much more than empty space to fill up; they can become a strategic asset – the initial disadvantage of building empty space can turn into an opportunity. This process is much easier to implement when we use SYS.



(Slide 42) What's the state of the play? The main scope to keep the pedestal free and to give space for future development concerning decision making, buildings and sites is largely supported by the policymakers and by a growing number of key players on the side of architects and engineers. That's great. It is also great to be in good contact with people worldwide thinking about similar ways of working – some of whom are present here.

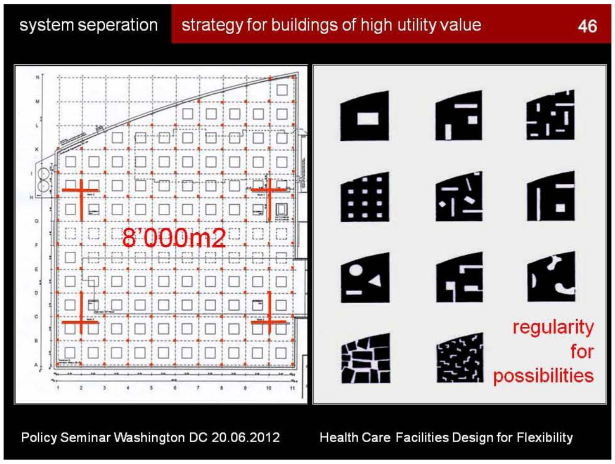


PROJECTS: Lets look at some projects:

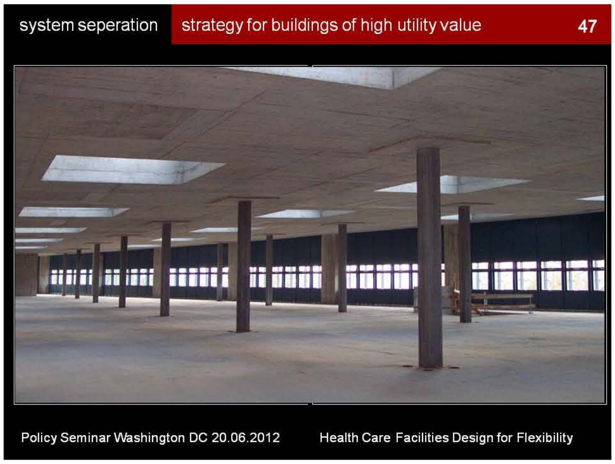
INO: INO was the first project guided by the strategy of SYS. It involves mainly the intensive care, emergency and surgery departments of the University Hospital of Bern. It had to be realized in two stages. The existing building was only 30 years old, but was not transformable because of the entanglement of all built components.

After having done our homework we launched an international competition for the primary-system, and afterwards separately the competition for the secondary-system. The team for the tertiary-system and the coordinating team were selected based on the competencies of the companies.
From the 10 project proposals delivered, 4 had the character of a robust primary-system. The winning project proposed an astonishingly open primary-system. It succeeded with the very big floor area of 50,000m2 in a compact horizontal volume with a characteristic shape.

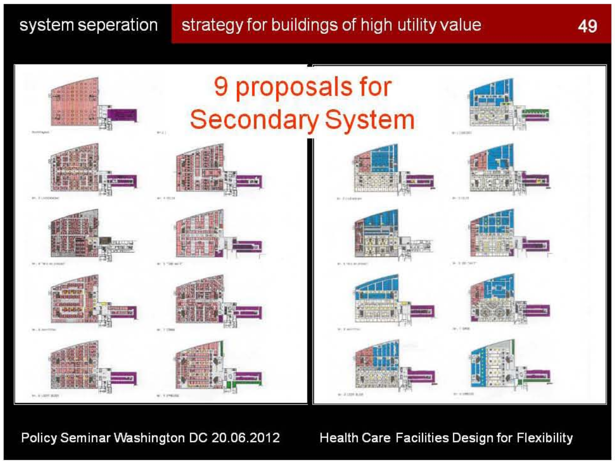
The spacious floors permit that an efficient organization and flexibility is assured.
The structural framework of the primary-system is a column-grid of 8.4m by 8.4m. The lateral structural stabilization elements are concentrated on four cross-elements. Each column-field permits a floor-opening aperture of 3.6m by 3.6m. These “knock-out fields” can be used in the secondary-system for daylight, visual contacts, stairs or elevators, ductwork, piping, and so on. All technical installations supplying one floor are installed on the respective floor. In following the principle of partitioning (separating) the building components, we have no installations buried in the concrete structural slabs.



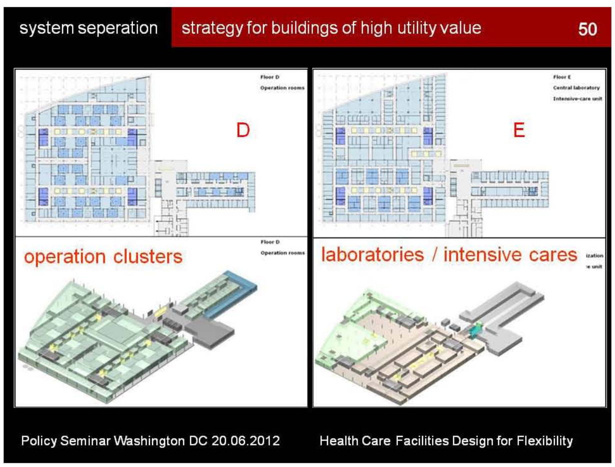
You see the interior of the PS with 500 kp net load and, after lessons learned in the first phase, 800 kp for the second phase of the project.



The facade of the first stage is a double skin, the inner part is wood with operable windows.



Parallel to the execution planning for the primary-system the competition for the secondary-system started. It was an absolutely positive experience to compare 9 very different functional solutions all within the same primary-system.



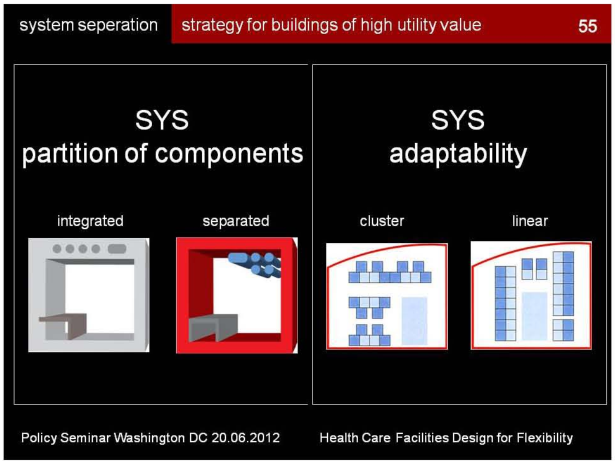
The winning secondary-system was quite innovative - the proposed cluster solution for the surgical operation units especially provoked great discussions in the jury and further planning.

The implementation of the SS and TS showed us how important it is to defend reserve spaces for installations.

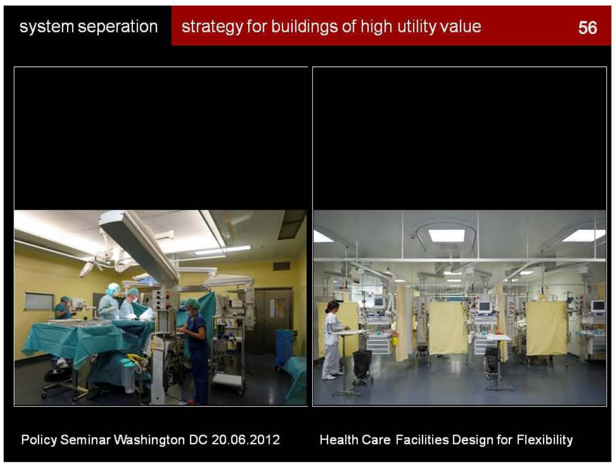
Some slides of the interiors

More views

Here you see the completed second phase (on the right), with the modified facades because of a strict budget limit.



We can conclude: INO respects the partition or separation of building-components. Geometries and structural dimensioning assure flexibility. With INO we reached a great part of our targets and of course we applied the lessons learned in other projects. What we did not succeed to do is to maintain separated contracting over the whole process. We had to replace the separate contracts by a single general contract over all for the second phase. Nevertheless separate contracts in the project planning (design) are the right way. For construction, one firm can be given both PS and SS work, but under separate contracts.



The final inauguration took place this June. A staff of 1,300 will use the building. The management is quite proud. A week ago the emergency department was tested simulating a disaster with 60 injured persons. All functioned perfectly, not hoping such a disaster will really happen.

Former women's hospital: The government decided to transform the more than 100 year-old women's hospital for use by the tax administration. We made a competition among teams of planners and building firms. The proposals had to show separated plans for PS and SS, prices included. SYS was strictly respected and it became a great success, even if it concerned, to a large extent, a transformation. The construction had started when one day the government decided that the tax offices have to go in a rented-office space, and that the building had to be used by the university. We stopped the work on the building site and in three month we managed the project use-change. That was only possible because of the precautions taken by SYS. The outcome was not at all an improvisation. The users are happy, even if they had practically no influence on the main plans.

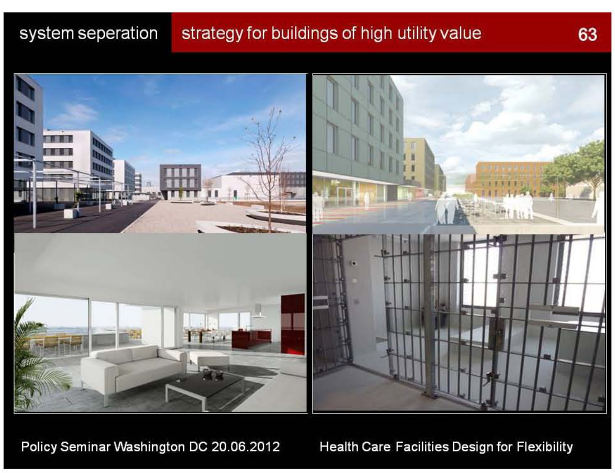
One may think we should have leased right from the beginning. Well, the rental building was not available at that time, and the priorities in the university had changed meanwhile. That's the reality one has to live with. Otherwise buildings would become determining, and that can hardly be a good purpose.

Sporting center: The existing university sports center had to be significantly enlarged. My target was to remain on the existing well situated, but already built-up site. Planners and users declared: That's not realistic and it would be much better to relocate on the adjacent open site area. SYS insists on the maximal use of well-situated areas, and this was a well- situated area. Many architects didn't participate in the competition because they had heard it would be a difficult task. The result is perfect. From the 20 proposals it was possible to find a very good solution and we could even obtain assurance that the main volumes can be enlarged vertically. The whole is built in wood. Well-managed competitions are a good way find to solutions nobody would have thought possible. A frequently asked question is this: Which stage in a building's life has to convince architectonically, the first or a possible future. My answer is always: Both. That's history looking forward. But we are not trained with that. We often look back, learning nothing. Sometimes it is helpful to make a little hint: Which do you love more, your child as a baby or as a grown-up?

Emergency Hub: The building for the emergency hub is in a zone with limited building height. You can build 4 floors of about 3m. We built 3 floors at 4m and assured a vertical expansion to 6 floors. The net-loads are quite high. The whole is built in wood. The site is under construction and discussions are already coming up to change the building constraints to make possible the vertical expansion and to bring in the alarm control center. Yes, the best would always be to know all and then to start building. But the best is often the enemy of the good. So SYS allows us to do good things and to let them become better and better over time.

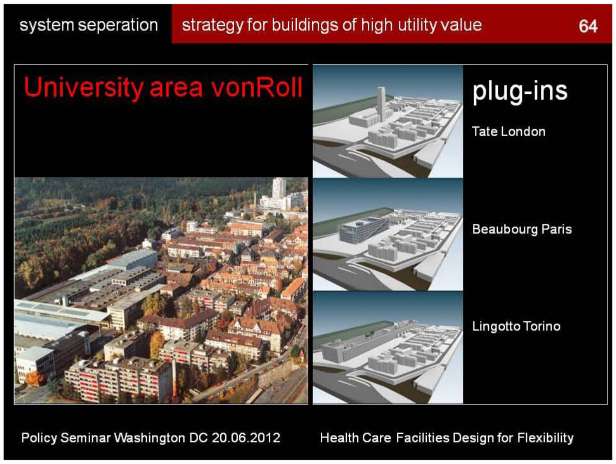
University for agriculture: The University for agriculture studies is an inter-Cantonal institution, therefore not our responsibility. There was a project ready to be built when the decision was made to transfer it to the Canton Berne. We said yes, but only if the project is modified to respect SYS. The government was not willing to miss the chance to get the University. The project had plenty of violations concerning SYS. The PS was not simple enough, plenty of barriers by structural elements and complications, no installation reserves, no precautions for vertical expansion. In brief, a beautiful project but not open for the demands in the future. We were under pressure and we knew that a leopard is not able to jump over his spot. Would the planners be? Within 6 month we succeeded. It was a real stress test and showed mainly one thing: The politicians were on our side!

District center: This is a Cantonal district center with prison, offices, courtrooms etc. I show you the project for two reasons. It is the first real PPP project in Switzerland. Well done PPP, not PFI, is a very strong method.



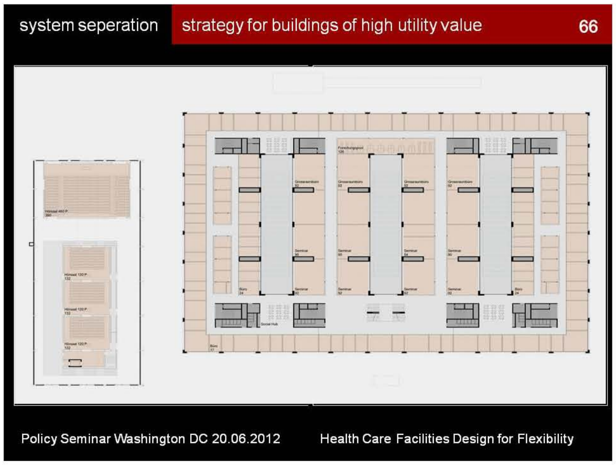
The second point is: In the competition phase, a plan B showed how the center could be transformed into housing. The project has been finished this year, well done and well managed with contracts over the next 25 years and SYS is strictly respected. It's a benchmark to keep in mind.

University von Roll: The project von Roll is the largest project at the time. A former industrial area is now built up for the university. To test the area-availability (site capacity) we often use the plug-in method. Instead of making feasibility studies we plug in well known projects to check the potential of the area. We made a competition for the PS and announced the succeeding competition for the SS. The whole was destined for the chemistry faculties. Laboratories formed the guiding standard.

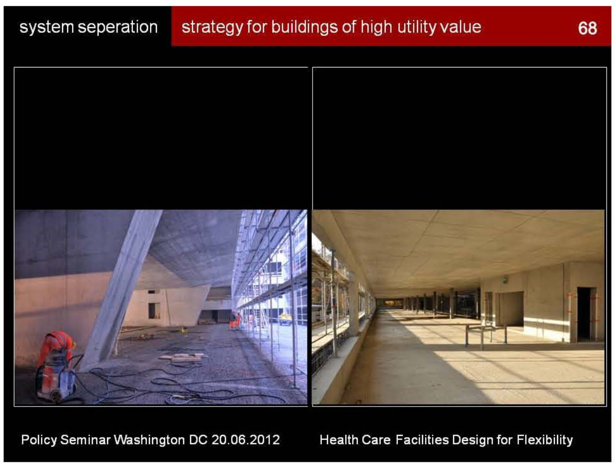


We chose a project with a robust PS. In view of the area-availability a second stage could overpass the current legal constraints.

The plan offers the demanded flexibility for various SS, precautions for vertical expansion and nonetheless

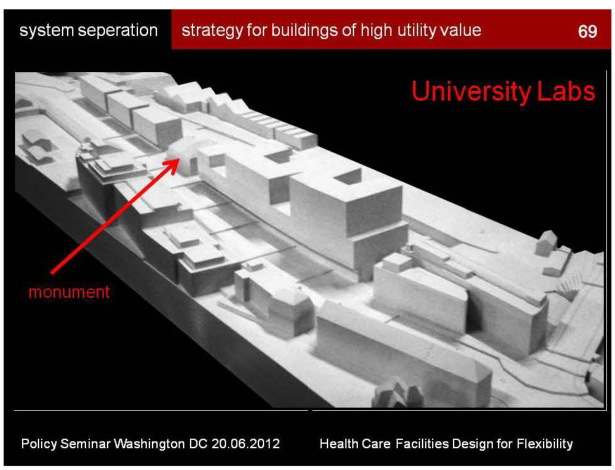


With a specific architectural shape of the PS.



The project is now in execution and you may guess: something was in the air. The government changed the allocation and instead of chemistry, human sciences had to occupy the building.

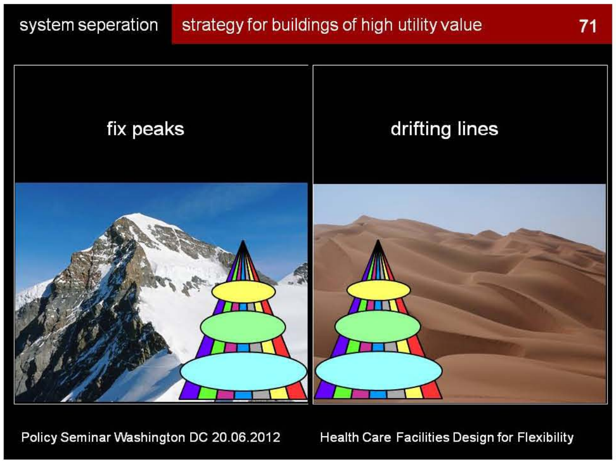
Not all projects have such changes, but we have learned to be prepared and we know how to manage it. But still we were quite surprised by what happened right after the decision: The new users came forward with the idea that human sciences need less ceiling height and therefore it would be possible to realize one more floor and that the architects were open for such a change. It was a short intermezzo. In fact, the building is under construction as if laboratories would occupy it. I am not worried about the users idea, it's absolutely their right to think for the short term, but the fact that the architects were not thinking long-term shows that you have to be very vigilant about SYS.



University Labs: This project plans laboratories for the university in the context of the university hospital. It's a very challenging project. The competition is now going on and the mandated firms made an absolutely perfect preparation to assure that SYS will be respected from the beginning. That proves that things become known and I am sure we have passed the critical point. The site has two protected monuments that reduce the density considerably. In accordance with the city administration we made a competition for an urban project fixing a minimal of total floor area. So we did not contest the monuments but insisted on the area-availability (site capacity). The result was that jury and politicians approved the demolition of one monument, one is maintained and the total floor area is guaranteed, creating an urban shape that has its roots in this economic-cultural fight.

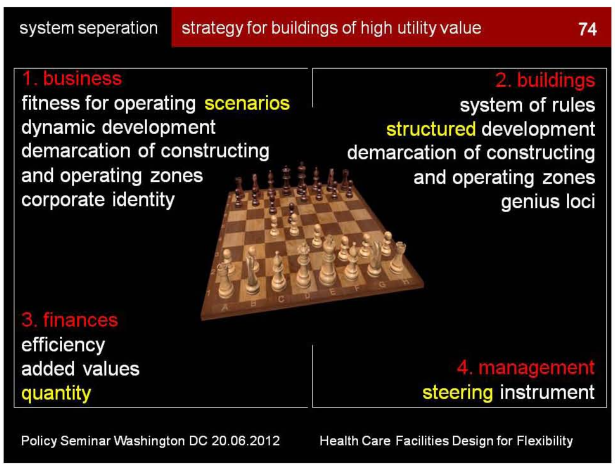
MAS: To finish a quite challenging project, it is the MASTER PLAN for the university hospital of Bern, where the INO was built.

In Switzerland we have a certain drive to climb the peaks but we are not very trained in managing moving landscapes. Fix points and drifting lines – a topic to be kept in mind in view of the master plan. The development of the university hospital area must be manageable at all times, but what will happen in the next years is absolutely open. The principles of SYS became the very basic guideline.

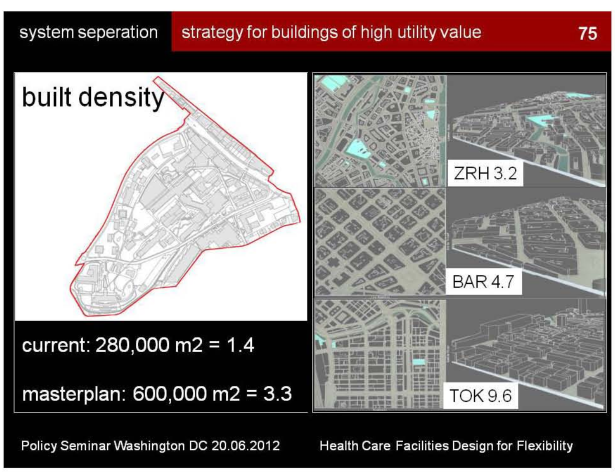


We realized, that what generally is called master plans are really more urban design projects than what we were in search of. The plan of Old Bern gave us some indications. Simple rules for a clear structure, variable infill for many centuries. And old Bern taught us furthermore: The cathedral originally had no pinnacle. It was added only 400 years later. We should probably apply more often the Gothic conception of “open-ended”.

We consolidated our perception of a master plan, incorporating old principles, like the three-filed-rotation and modern ones, like the hyper mobility of container logistics. The key formula was: The master plan is at all times defined but at no time definite!



The requirements were arranged in four groups:
1) The business criteria,
2) The buildings,
3) The finances and
4) The management aspects.

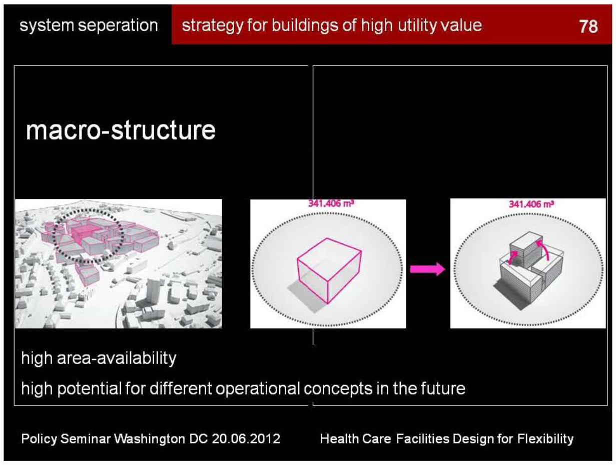


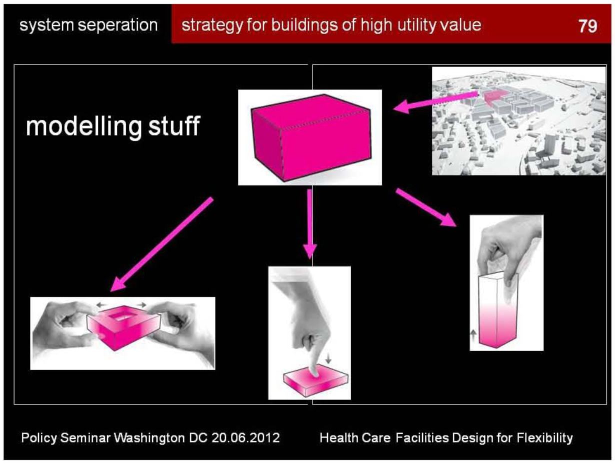
One of the very crucial settings on the client side was the question of quantity. Today we have a built density of 1 to 4. We looked around at Zurich, Barcelona, and Tokyo, and combined with a certain entrepreneurial ambition we fixed 3 to 3 with a total demand of 600,000m2 and a ceiling height of 4.5m. Good decisions I must say, with a big story behind them.

Here you have the visualizations of the seven delivered master plans elaborated in a strictly anonymous procedure by European architects and specialists. The winning proposal is on the left.

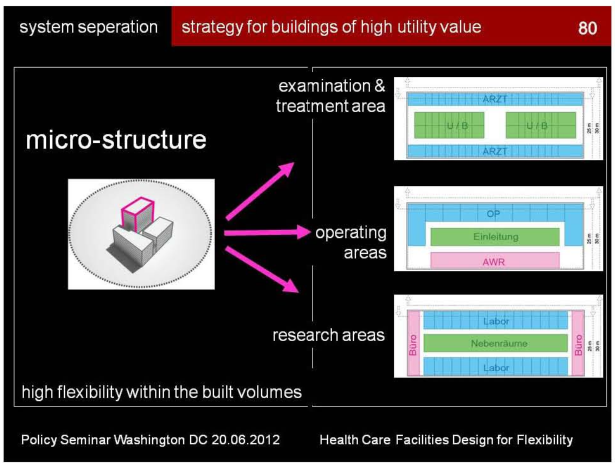
Already the mode of presentation of the winning proposal announced an untraditional understanding of what a steering instrument can be.
Thanks to our intensive preparations in the pre-architectural homework phase, we did not succumb to traditional perceptions and we kept the line. It's much easier to fall in love with an urban project than to massage your mind with defined rules and indefinite spatial shapes.

The chosen "master plan" defines a macro-structure composed with axes and building-fields. Each field is defined by a total of volume and its borderlines.





Do you remember the bottle-crate diagram? A similar trivial language explains how the volumes of the different fields can be handled. It is a kind of modelling stuff. By keeping the total of the volume, you are free to adapt the volumes.



The question was: Do we have in hand the right stuff? Yes we do. On the level of the microstructure we have dimensions suitable to the hospital requirements. The master plan guarantees system-separation and flexibility within the built volumes.

The master plan is not a building project. Architectural projects will be worked out in the coming years by specific architectural competitions. The winning “master plan” team has a contract to coach the ensuing projects over 15 years, systematically applying the principles of system separation.

Thank you.


system seperation
strategy for buildings of high utility value
82
thank you
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Health Care Facilities Design for Flexibility

Kent Turner
President CANNONDESIGN North America


HEALTHCARE FACILITIES
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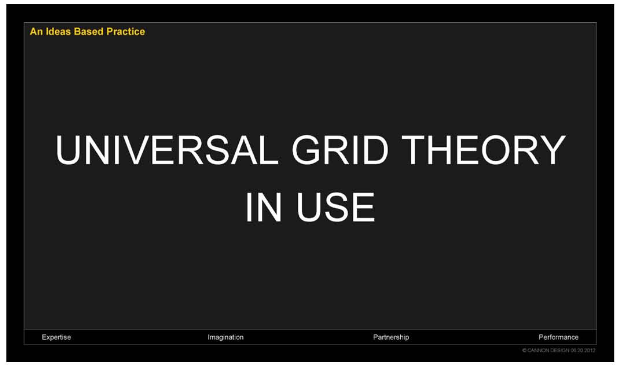
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UNIVERSAL GRID THEORY
IN USE
Expertise
Imagination
Partnership
Performance


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IN 1999, I RECOMMENDED TO A CLIENT THAT THEY REMOVE A BUILDING BUILT IN 1975.
Expertise
Imagination
Partnership
Performance


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(I DESIGNED IT.)
Expertise
Imagination
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IT WAS TIME TO REEVALUATE OUR APPROACH TO HEALTH SCIENCES FACILITIES PLANNING
Expertise
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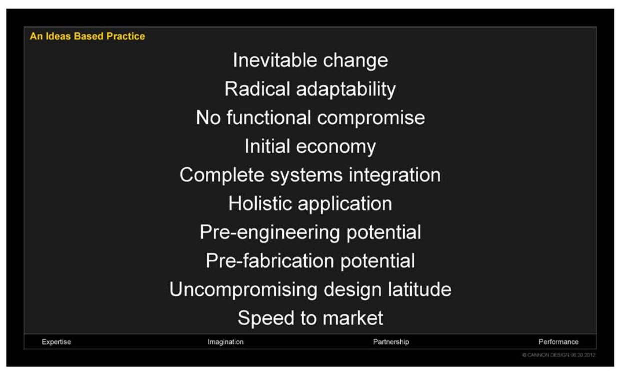
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Inevitable change
Radical adaptability
No functional compromise
Initial economy
Complete systems integration
Holistic application
Pre-engineering potential
Pre-fabrication potential
Uncompromising design latitude
Speed to market
Expertise
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Partnership
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A UNIFORM LOFT-STYLE,
HIGH BAY MODULE:
AN ARMATURE.
A RIGOR.
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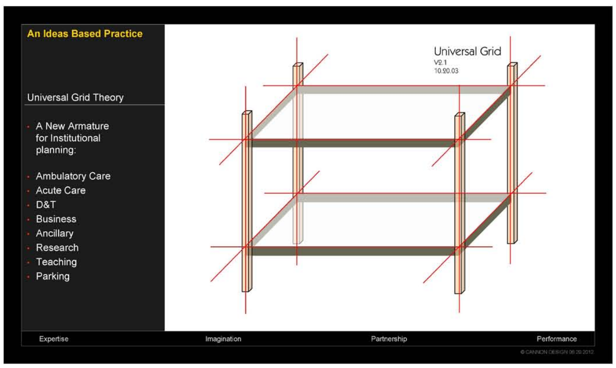
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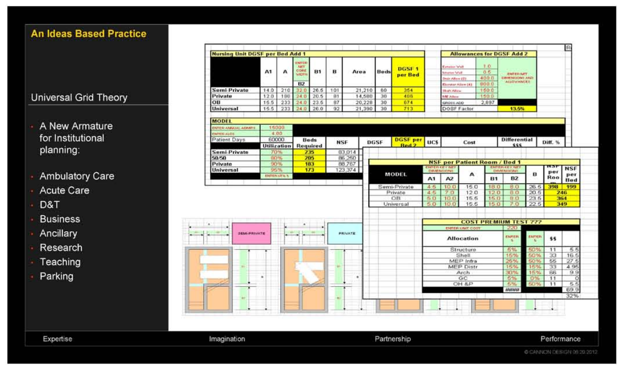
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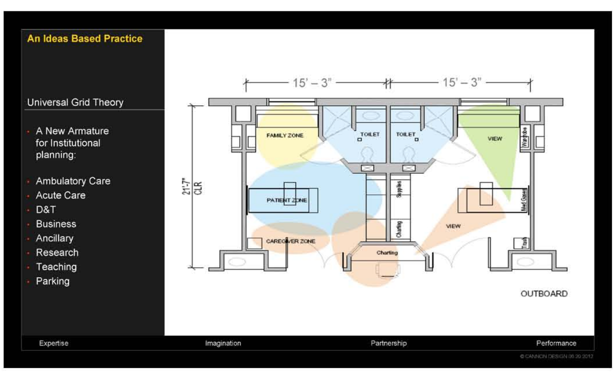
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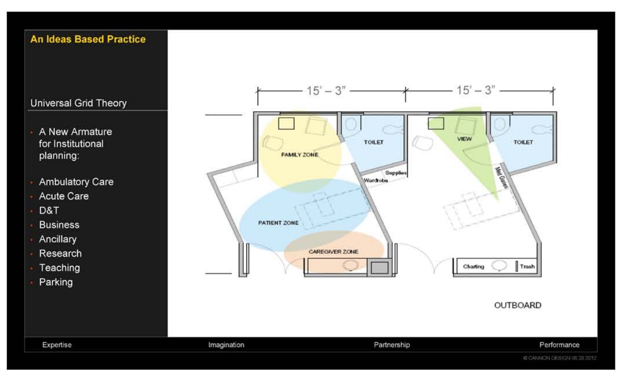
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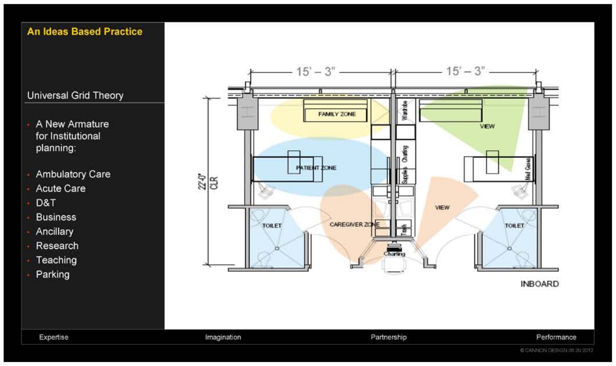
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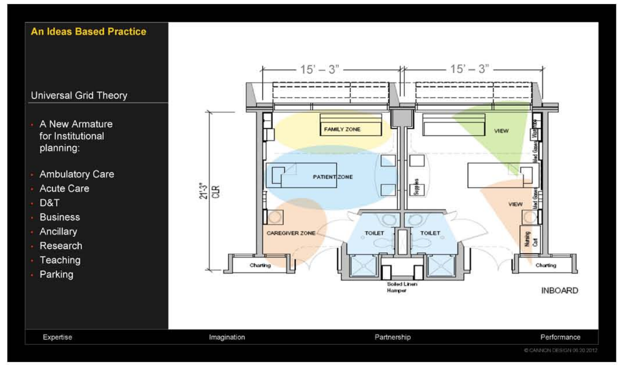
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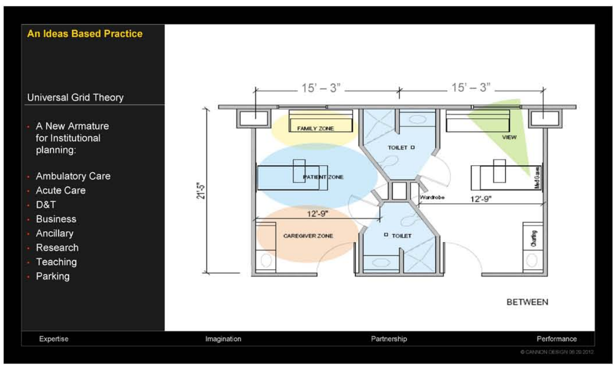
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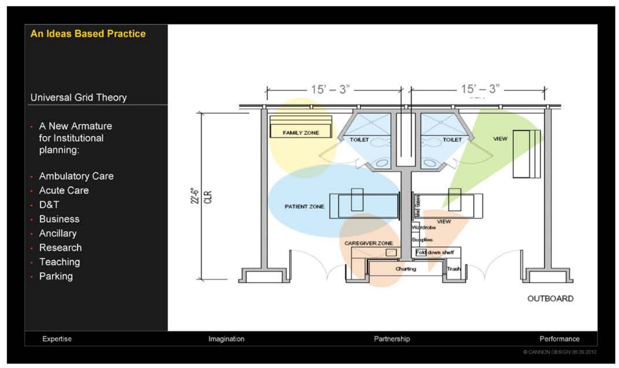
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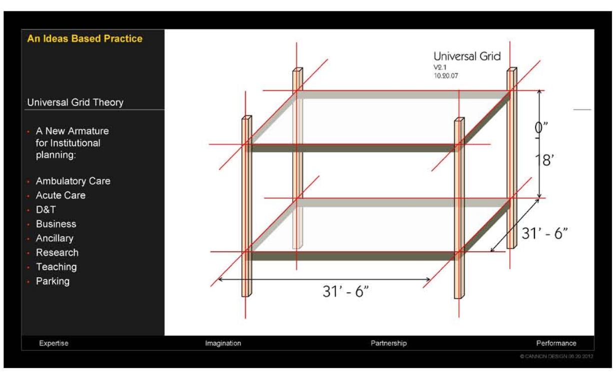
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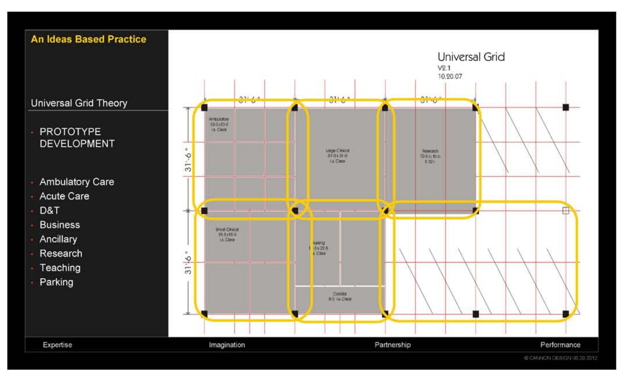
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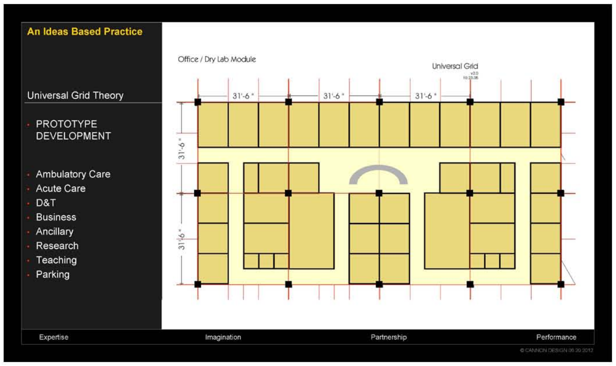
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Office / Dry Lab Module
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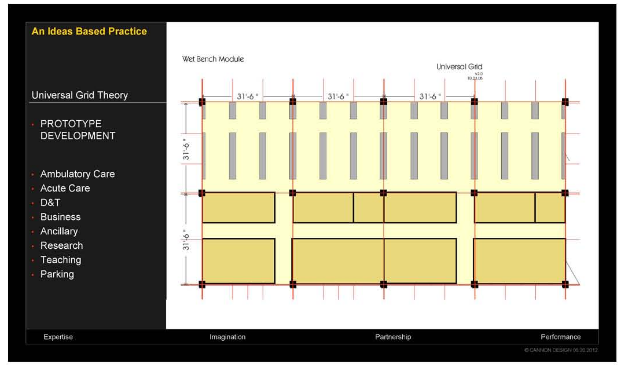
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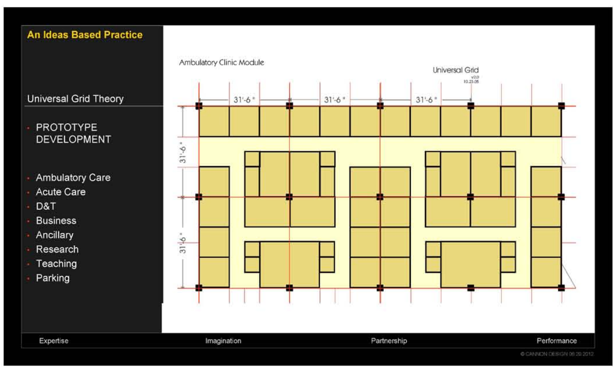
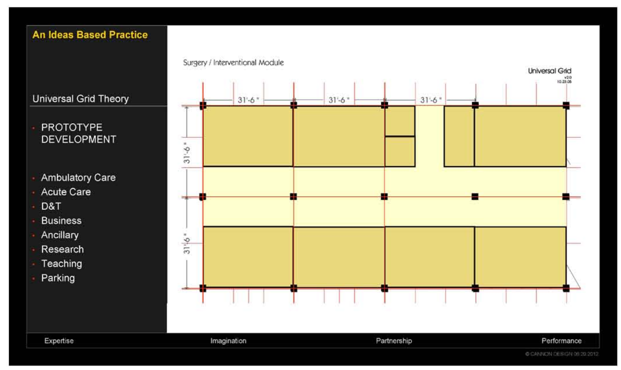
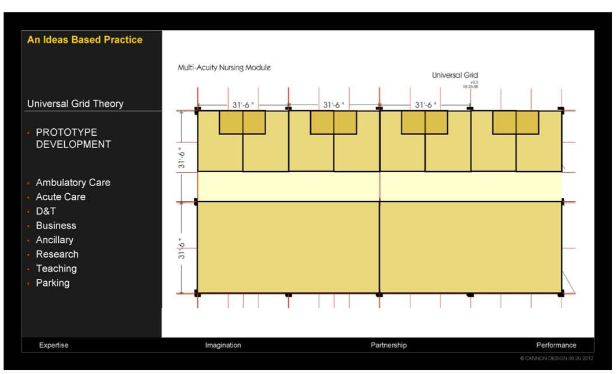
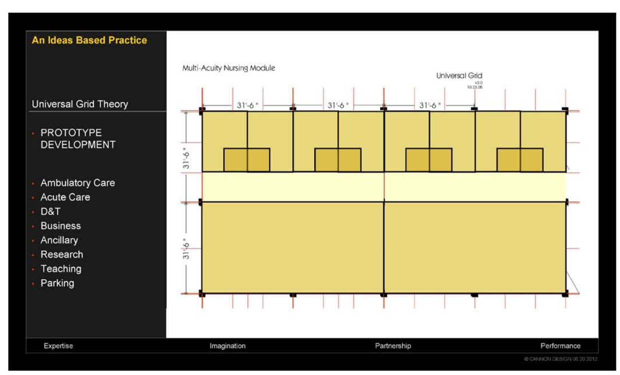
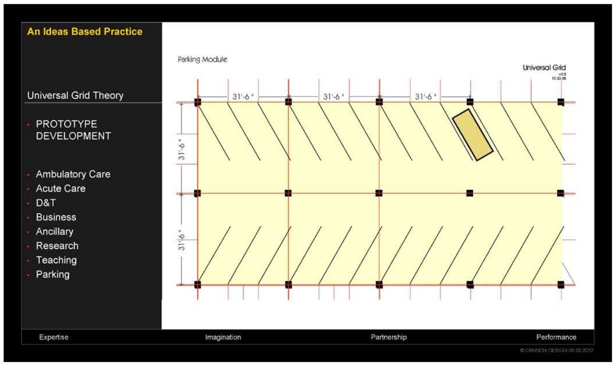
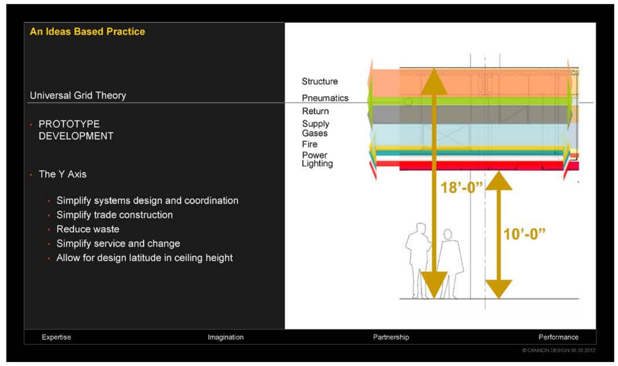

An Ideas Based Practice
Universal Grid Theory
PROTOTYPE DEVELOPMENT
Ambulatory Care
Acute Care
D&T
Business
Ancillary
Research
Teaching
Parking
Ambulatory Clinic Module
Universal Grid
31'-6"
31'-6"
31'-6"
31'-6"
31'-6"
Expertise
Imagination
Partnership
Performance

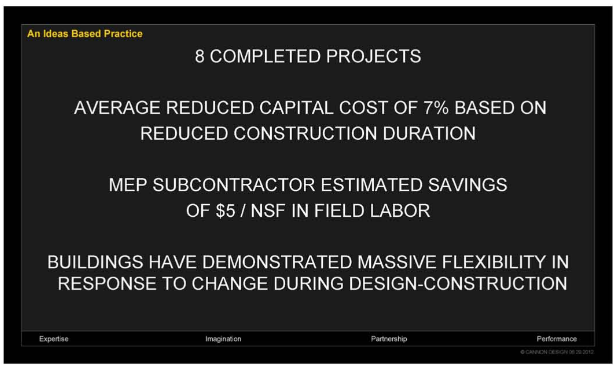

An Ideas Based Practice
Universal Grid Theory
PROTOTYPE DEVELOPMENT
Ambulatory Care
Acute Care
D&T
Business
Ancillary
Research
Teaching
Parking
Surgery / Interventional Module
Universal Grid
31'-6"
31'-6"
31'-6"
31'-6"
31'-6"
Expertise
Imagination
Partnership
Performance


An Ideas Based Practice
Universal Grid Theory
PROTOTYPE DEVELOPMENT
Ambulatory Care
Acute Care
D&T
Business
Ancillary
Research
Teaching
Parking
Multi-Acuity Nursing Module
Universal Grid
31'-6"
31'-6"
31'-6"
31'-6"
31'-6"
Expertise
Imagination
Partnership
Performance

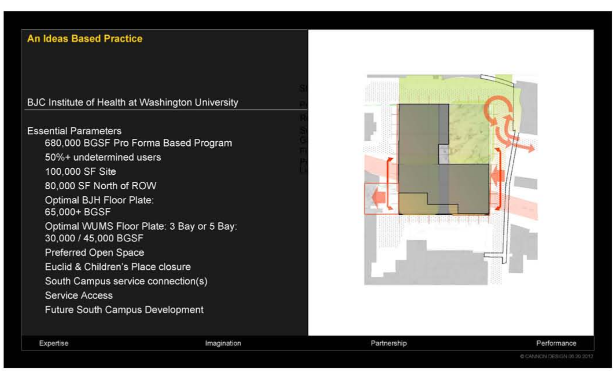

An Ideas Based Practice
Universal Grid Theory
PROTOTYPE DEVELOPMENT
Ambulatory Care
Acute Care
D&T
Business
Ancillary
Research
Teaching
Parking
Multi-Acuity Nursing Module
Universal Grid
31'-6"
31'-6"
31'-6"
31'-6"
31'-6"
Expertise
Imagination
Partnership
Performance


An Ideas Based Practice
Universal Grid Theory
PROTOTYPE DEVELOPMENT
Ambulatory Care
Acute Care
D&T
Business
Ancillary
Research
Teaching
Parking
Parking Module
Universal Grid
31'-6"
31'-6"
31'-6"
31'-6"
31'-6"
Expertise
Imagination
Partnership
Performance


An Ideas Based Practice
Universal Grid Theory
PROTOTYPE DEVELOPMENT
The Y Axis
Simplify systems design and coordination
Simplify trade construction
Reduce waste
Simplify service and change
Allow for design latitude in ceiling height
Structure
Pneumatics
Return
Supply
Gases
Fire
Power
Lighting
18'-0"
10'-0"
Expertise
Imagination
Partnership
Performance

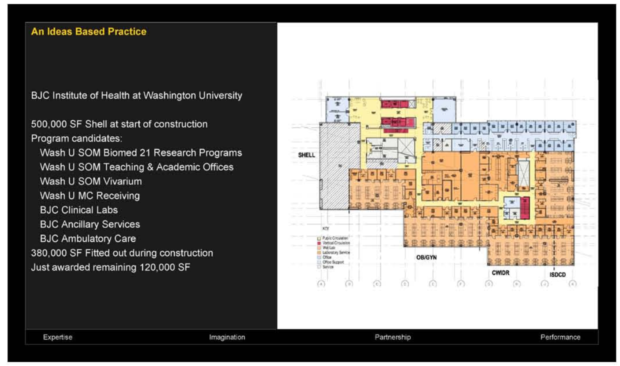

An Ideas Based Practice
8 COMPLETED PROJECTS
AVERAGE REDUCED CAPITAL COST OF 7% BASED ON REDUCED CONSTRUCTION DURATION
MEP SUBCONTRACTOR ESTIMATED SAVINGS OF $5 / NSF IN FIELD LABOR
BUILDINGS HAVE DEMONSTRATED MASSIVE FLEXIBILITY IN RESPONSE TO CHANGE DURING DESIGN-CONSTRUCTION
Expertise
Imagination
Partnership
Performance

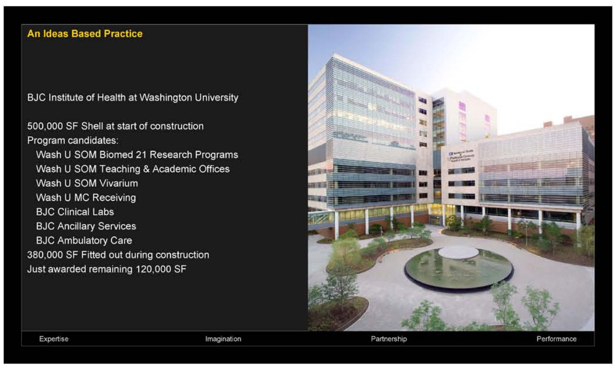

An Ideas Based Practice
COMPREHENSIVE STRUCTURAL VALUE ANALYSIS
82 FULLY DEVELOPED ROOM PROTOTYPE TEMPLATES
OPTIONS FOR
CORE. SKIN. INTEGRATED MEP SYSTEMS. CORES.
PRE-FABRICATION AND OFF SITE CONSTRUCTION
Expertise
Imagination
Partnership
Performance

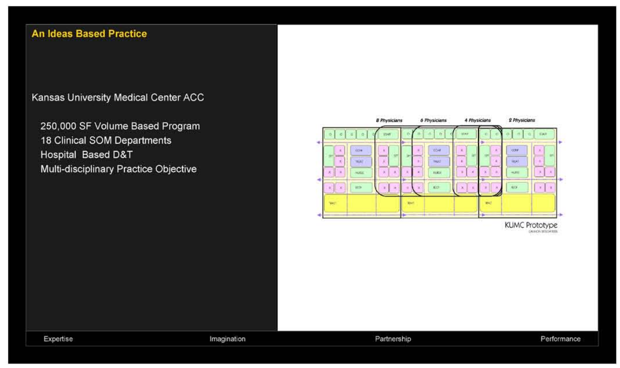

An Ideas Based Practice
BJC Institute of Health at Washington University
Essential Parameters
680,000 BGSF Pro Forma Based Program
50%+ undetermined users
100,000 SF Site
80,000 SF North of ROW
Optimal BJH Floor Plate:
65,000+ BGSF
Optimal WUMS Floor Plate: 3 Bay or 5 Bay:
30,000 / 45,000 BGSF
Preferred Open Space
Euclid & Children's Place closure
South Campus service connection(s)
Service Access
Future South Campus Development
Expertise
Imagination
Partnership
Performance

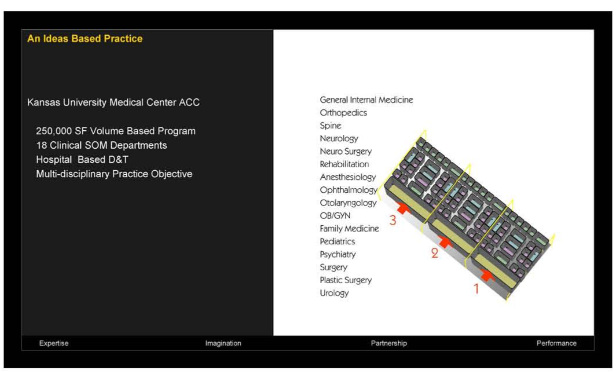

An Ideas Based Practice
Owner
Model
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
Programming
Schematic Design
Design Development
Construction Documents
Bidding
Construction
14 Months
Expertise
Imagination
Partnership
Performance

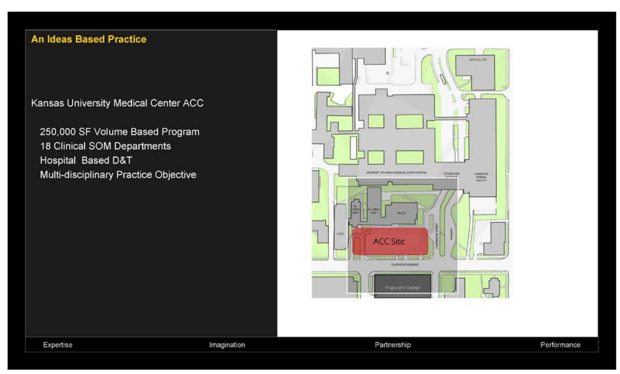

An Ideas Based Practice
Fast-Track UG Model
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44
Programming
Schematic Design
Design Development
Construction Documents
Bidding
Construction
5 Months
= $3.2M: Interest, Escalation, General Conditions and Accelerated Grant Revenues
Expertise
Imagination
Partnership
Performance

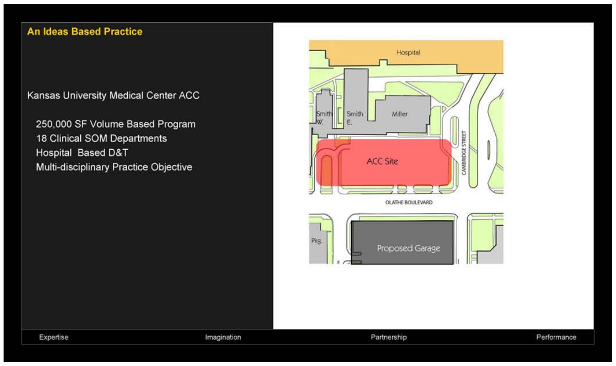

An Ideas Based Practice
BJC Institute of Health at Washington University
500,000 SF Shell at start of construction
Program candidates:
Wash U SOM Biomed 21 Research Programs
Wash U SOM Teaching & Academic Offices
Wash U SOM Vivarium
Wash U MC Receiving
BJC Clinical Labs
BJC Ancillary Services
BJC Ambulatory Care
380,000 SF Fitted out during construction
Just awarded remaining 120,000 SF
SHELL
OB/GYN
CWIDR
ISBCD
Expertise
Imagination
Partnership
Performance

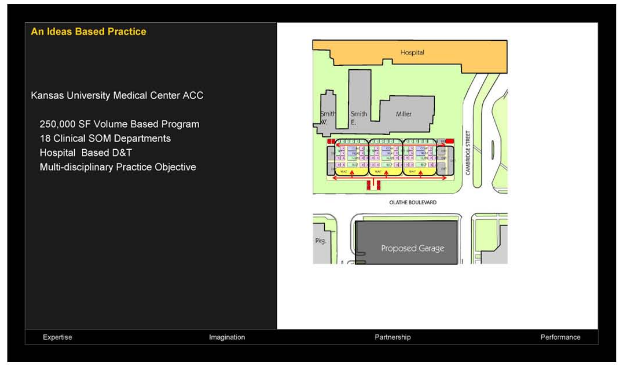

An Ideas Based Practice
BJC Institute of Health at Washington University
500,000 SF Shell at start of construction
Program candidates:
Wash U SOM Biomed 21 Research Programs
Wash U SOM Teaching & Academic Offices
Wash U SOM Vivarium
Wash U MC Receiving
BJC Clinical Labs
BJC Ancillary Services
BJC Ambulatory Care
380,000 SF Fitted out during construction
Just awarded remaining 120,000 SF
Expertise
Imagination
Partnership
Performance

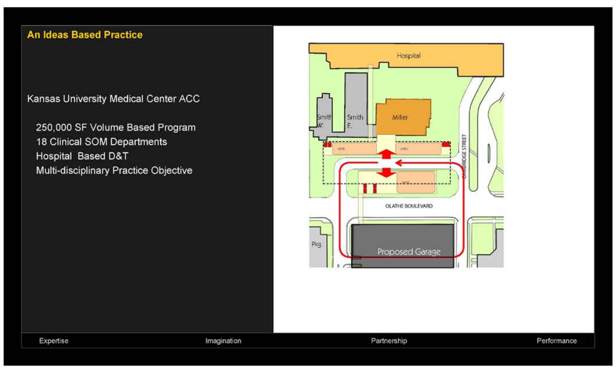

An Ideas Based Practice
Kansas University Medical Center ACC
250,000 SF Volume Based Program
18 Clinical SOM Departments
Hospital Based D&T
Multi-disciplinary Practice Objective
8 Physicians
6 Physicians
4 Physicians
8 Physicians
KUMC Prototype
Expertise
Imagination
Partnership
Performance

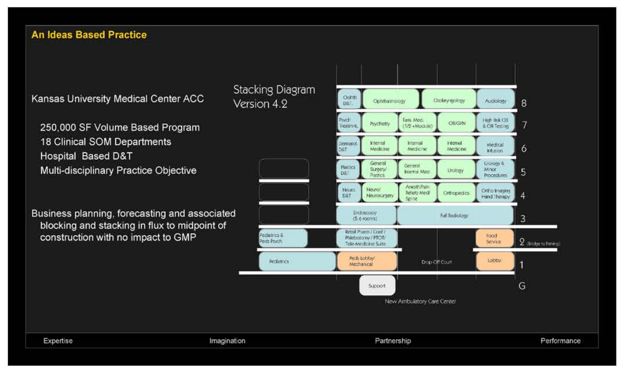

An Ideas Based Practice
Kansas University Medical Center ACC
250,000 SF Volume Based Program
18 Clinical SOM Departments
Hospital Based D&T
Multi-disciplinary Practice Objective
General Internal Medicine
Orthopedics
Spine
Neurology
Neuro Surgery
Rehabilitation
Anesthesiology
Ophthalmology
Otolaryngology
OB/GYN
Family Medicine
Pediatrics
Psychiatry
Surgery
Plastic Surgery
Urology
3
2
1
Expertise
Imagination
Partnership
Performance

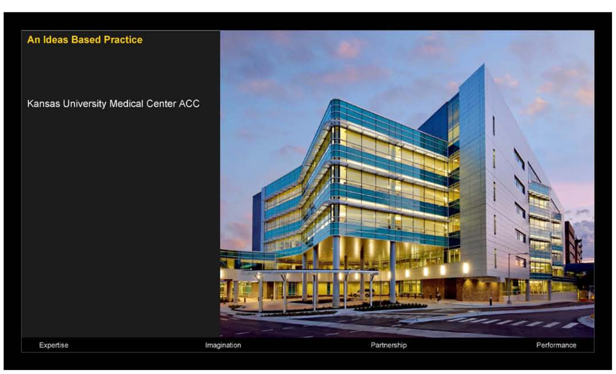

An Ideas Based Practice
Kansas University Medical Center ACC
250,000 SF Volume Based Program
18 Clinical SOM Departments
Hospital Based D&T
Multi-disciplinary Practice Objective
ACC Site
Expertise
Imagination
Partnership
Performance

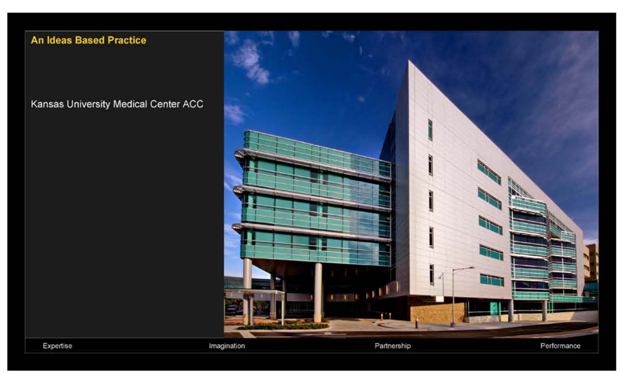

An Ideas Based Practice
Kansas University Medical Center ACC
250,000 SF Volume Based Program
18 Clinical SOM Departments
Hospital Based D&T
Multi-disciplinary Practice Objective
Hospital
Smith W.
Smith E.
Miller
ACC Site
CAMBRIDGE STREET
OLATHE BOULEVARD
Prkg.
Proposed Garage
Expertise
Imagination
Partnership
Performance

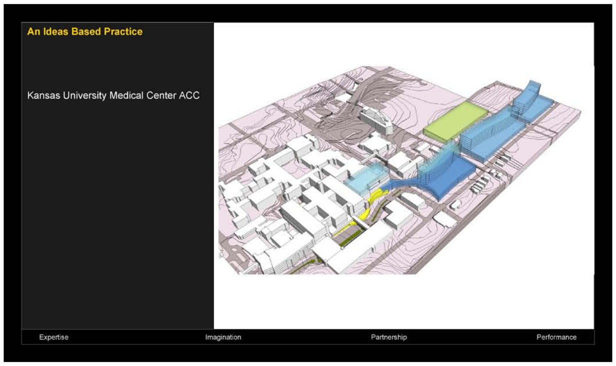

An Ideas Based Practice
Kansas University Medical Center ACC
250,000 SF Volume Based Program
18 Clinical SOM Departments
Hospital Based D&T
Multi-disciplinary Practice Objective
Hospital
Smith W.
Smith E.
Miller
CAMBRIDGE STREET
OLATHE BOULEVARD
Prkg.
Proposed Garage
Expertise
Imagination
Partnership
Performance


An Ideas Based Practice
Kansas University Medical Center ACC
250,000 SF Volume Based Program
18 Clinical SOM Departments
Hospital Based D&T
Multi-disciplinary Practice Objective
Hospital
Smith W.
Smith E.
Miller
OLATHE BOULEVARD
Prkg.
Proposed Garage
Expertise
Imagination
Partnership
Performance


An Ideas Based Practice
Kansas University Medical Center ACC
250,000 SF Volume Based Program
18 Clinical SOM Departments
Hospital Based D&T
Multi-disciplinary Practice Objective
Business planning, forecasting and associated blocking and stacking in flux to midpoint of construction with no impact to GMP
Stacking Diagram
Version 4.2
8
7
6
5
4
3
2
1
G
New Ambulatory Care Center
Expertise
Imagination
Partnership
Performance

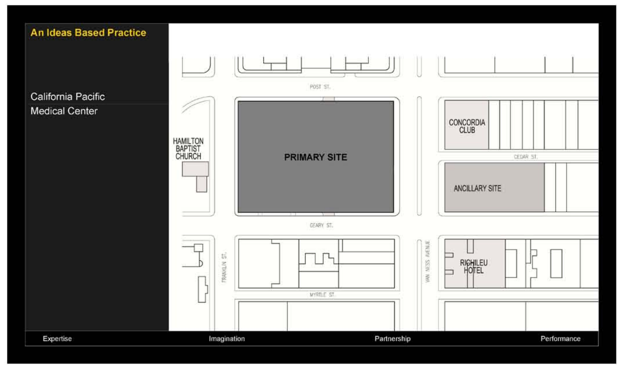

An Ideas Based Practice
Kansas University Medical Center ACC
Expertise
Imagination
Partnership
Performance

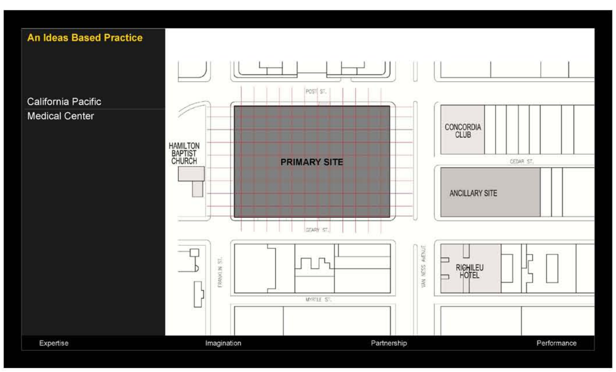

An Ideas Based Practice
Kansas University Medical Center ACC
Expertise
Imagination
Partnership
Performance

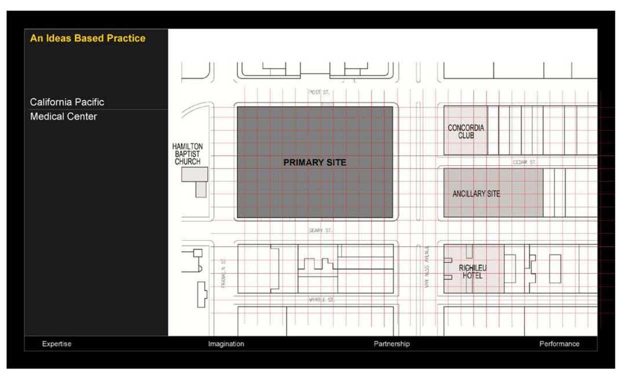

An Ideas Based Practice
Kansas University Medical Center ACC
Expertise
Imagination
Partnership
Performance

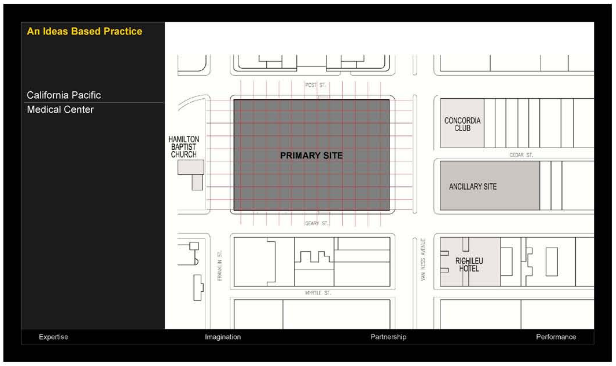

An Ideas Based Practice
Sample MP
UG Parti
Overlay
Academic
Faculty / Staff Destination
Student Life
Expertise
Imagination
Partnership
Performance

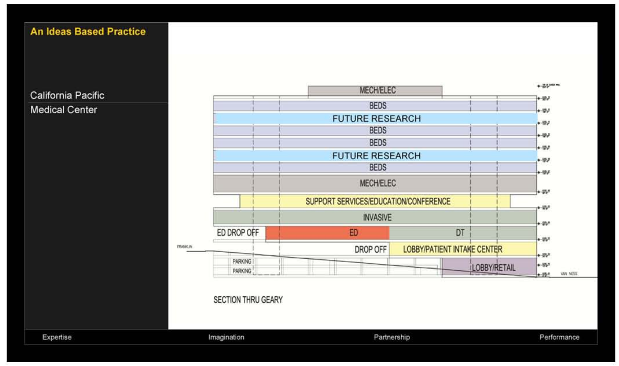

An Ideas Based Practice
California Pacific
Medical Center
Expertise
Imagination
Partnership
Performance

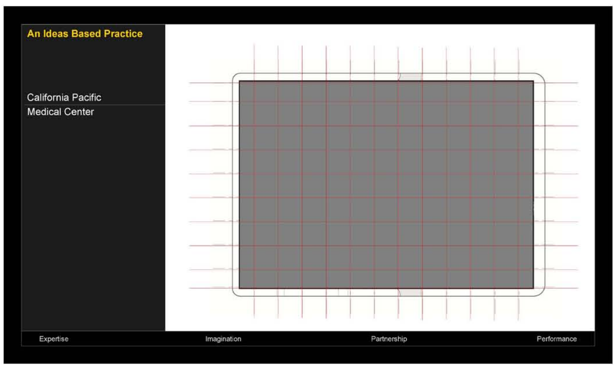

An Ideas Based Practice
California Pacific
Medical Center
HAMILTON BAPTIST CHURCH
PRIMARY SITE
CONCORDIA CLUB
ANCILLARY SITE
RICHILEU HOTEL
Expertise
Imagination
Partnership
Performance

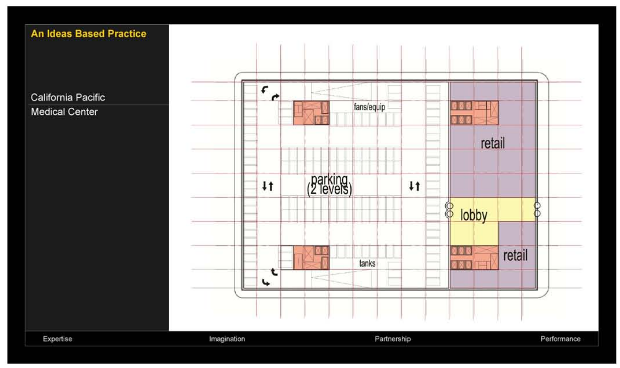

An Ideas Based Practice
California Pacific
Medical Center
HAMILTON BAPTIST CHURCH
PRIMARY SITE
CONCORDIA CLUB
ANCILLARY SITE
RICHILEU HOTEL
Expertise
Imagination
Partnership
Performance

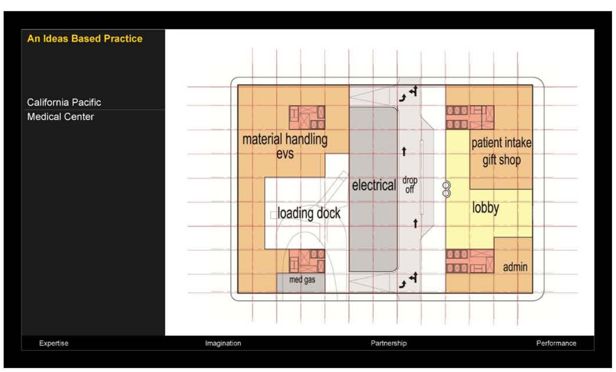

An Ideas Based Practice
California Pacific
Medical Center
HAMILTON BAPTIST CHURCH
PRIMARY SITE
CONCORDIA CLUB
ANCILLARY SITE
RICHILEU HOTEL
Expertise
Imagination
Partnership
Performance

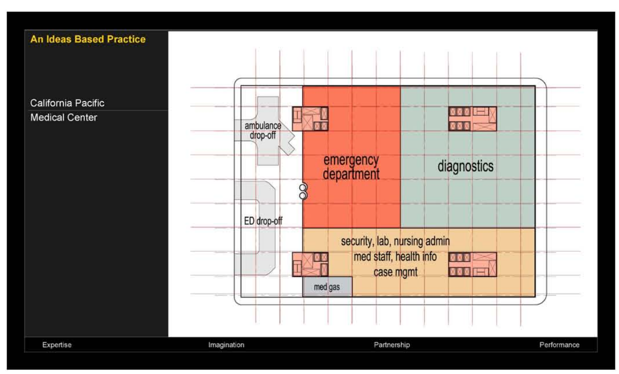

An Ideas Based Practice
California Pacific
Medical Center
HAMILTON
BAPTIST
CHURCH
PRIMARY SITE
CONCORDIA
CLUB
ANCILLARY SITE
RICHILEU
HOTEL
Expertise
Imagination
Partnership
Performance

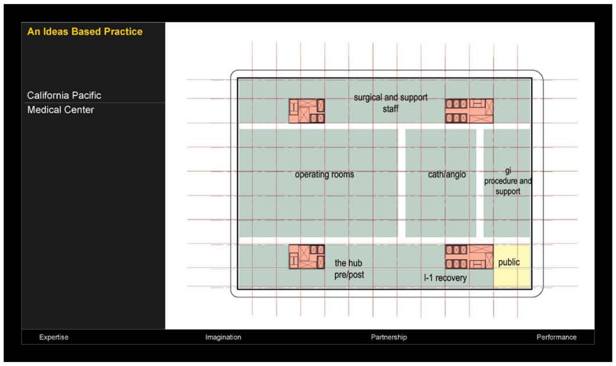

An Ideas Based Practice
California Pacific
Medical Center
MECH/ELEC
BEDS
FUTURE RESEARCH
BEDS
BEDS
FUTURE RESEARCH
BEDS
MECH/ELEC
SUPPORT SERVICES/EDUCATION/CONFERENCE
INVASIVE
ED DROP OFF
ED
DT
DROP OFF
LOBBY/PATIENT INTAKE CENTER
PARKING
PARKING
LOBBY/RETAIL
SECTION THRU GEARY
Expertise
Imagination
Partnership
Performance


An Ideas Based Practice
California Pacific
Medical Center
Expertise
Imagination
Partnership
Performance


An Ideas Based Practice
California Pacific
Medical Center
fans/equip
retail
parking
(2 levels)
lobby
retail
tanks
Expertise
Imagination
Partnership
Performance


An Ideas Based Practice
California Pacific
Medical Center
material handling
evs
patient intake
gift shop
electrical
drop
off
loading dock
lobby
med gas
admin
Expertise
Imagination
Partnership
Performance

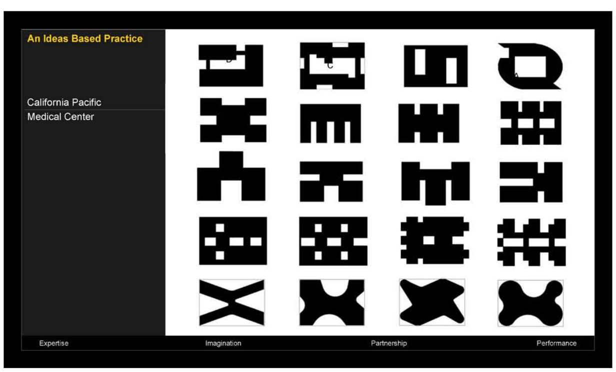

An Ideas Based Practice
California Pacific
Medical Center
ambulance
drop-off
emergency
department
diagnostics
ED drop-off
security, lab, nursing admin
med staff, health info
case mgmt
med gas
Expertise
Imagination
Partnership
Performance

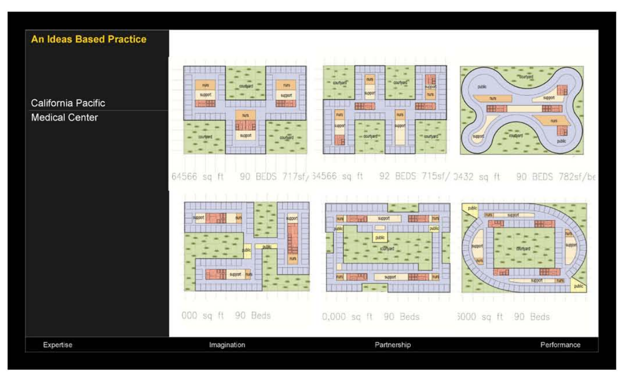

An Ideas Based Practice
California Pacific
Medical Center
surgical and support
staff
operating rooms
cath/angio
gi
procedure and
support
the hub
pre/post
I-1 recovery
public
Expertise
Imagination
Partnership
Performance


An Ideas Based Practice
California Pacific
Medical Center
28 Bed Unit
26 Bed Unit
28 Bed Unit
Expertise
Imagination
Partnership
Performance

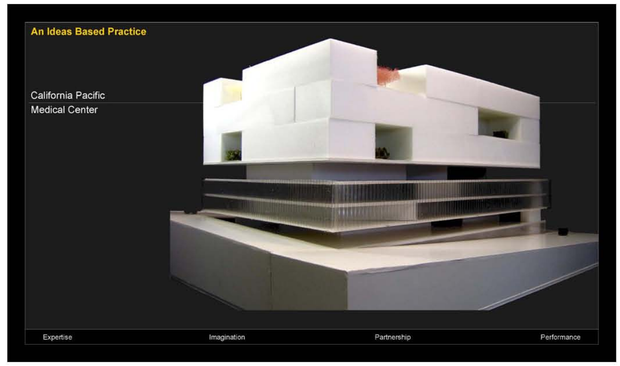

An Ideas Based Practice
California Pacific
Medical Center
42 Bed Unit
42 Bed Unit
Expertise
Imagination
Partnership
Performance


An Ideas Based Practice
California Pacific
Medical Center
30 Bed Unit
20 Bed Unit
30 Bed Unit
Expertise
Imagination
Partnership
Performance


An Ideas Based Practice
California Pacific
Medical Center
Expertise
Imagination
Partnership
Performance

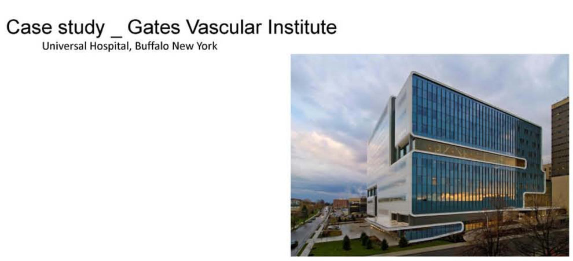

An Ideas Based Practice
California Pacific
Medical Center
64566 sq ft 90 BEDS 717sf/
34566 sq ft 92 BEDS 715sf/
3432 sq ft 90 BEDS
90 Beds
90 Beds
90 Beds
Expertise
Imagination
Partnership
Performance

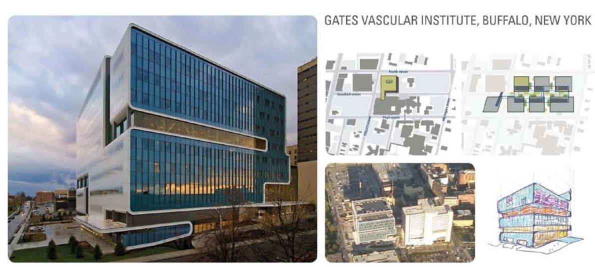

An Ideas Based Practice
California Pacific
Medical Center
Expertise
Imagination
Partnership
Performance

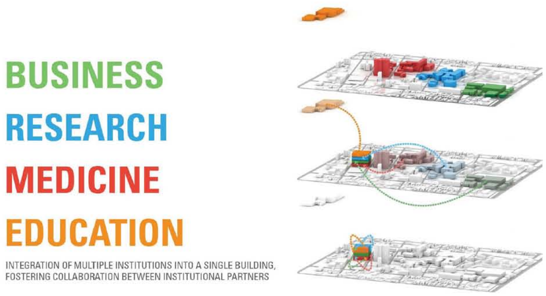

An Ideas Based Practice
California Pacific
Medical Center
Expertise
Imagination
Partnership
Performance

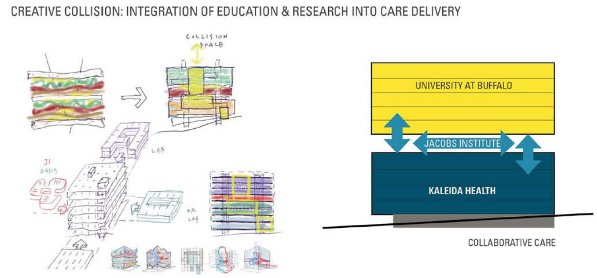

An Ideas Based Practice
California Pacific
Medical Center
Expertise
Imagination
Partnership
Performance

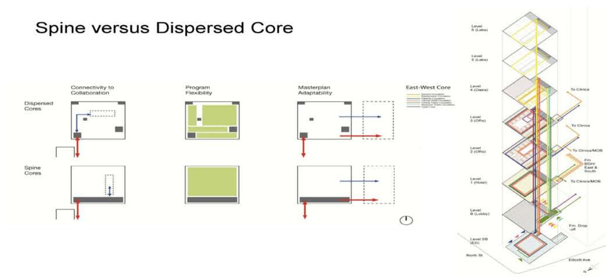

An Ideas Based Practice
California Pacific
Medical Center
Expertise
Imagination
Partnership
Performance

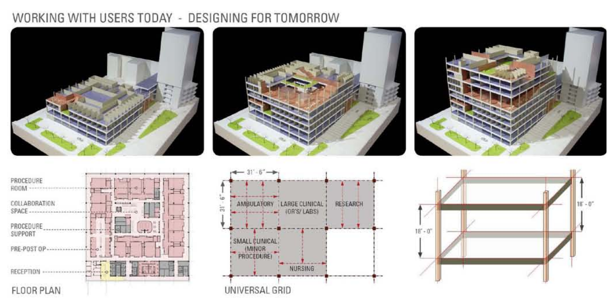

Case study _ Gates Vascular Institute
Universal Hospital, Buffalo New York

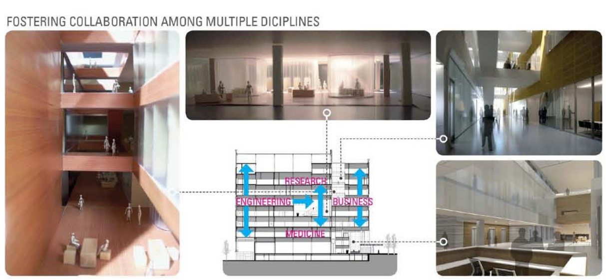

GATES VASCULAR INSTITUTE, BUFFALO, NEW YORK


BUSINESS
RESEARCH
MEDICINE
EDUCATION
INTEGRATION OF MULTIPLE INSTITUTIONS INTO A SINGLE BUILDING, FOSTERING COLLABORATION BETWEEN INSTITUTIONAL PARTNERS

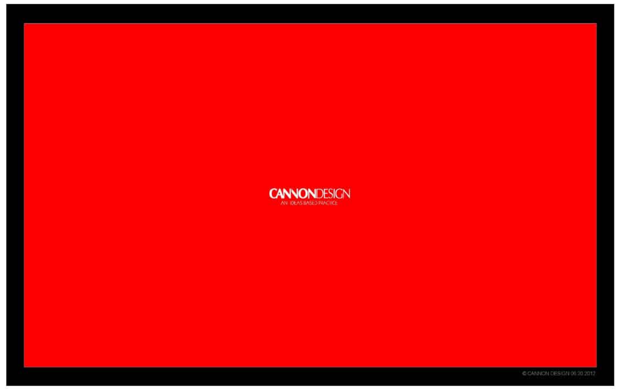

CREATIVE COLLISION: INTEGRATION OF EDUCATION & RESEARCH INTO CARE DELIVERY
UNIVERSITY AT BUFFALO
JACOBS INSTITUTE
KALEIDA HEALTH
COLLABORATIVE CARE


Spine versus Dispersed Core
Connectivity to Collaboration
Program Flexibility
Masterplan Adaptability
East-West Core
Dispersed Cores
Spine Cores


WORKING WITH USERS TODAY - DESIGNING FOR TOMORROW
PROCEDURE ROOM
COLLABORATION SPACE
PROCEDURE SUPPORT
PRE-POST OP
RECEPTION
FLOOR PLAN
AMBULATORY
LARGE CLINICAL (GR'D/ LABS)
RESEARCH
SMALL CLINICAL (MINOR PROCEDURE)
NURSING
UNIVERSAL GRID


FOSTERING COLLABORATION AMONG MULTIPLE DICIPLINES
RESEARCH
ENGINEERING
BUSINESS
MEDICINE


REFLECTING PUBLIC AND COLLABORATIVE SPACES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Flexibility Tactics: Case Studies in Healthcare Facilities

Healthcare Facilities Design for Flexibility Policy Seminar
Department of Defense and the National Institute of Building Sciences
David Hanitchak NBBJ 20 June 2012

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Flexibility Tactics: Case Studies in Healthcare Facilities

What is flexibility in healthcare design?

Flexibility Drivers and Challenges

Case Studies

Flexibility Tactics

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Flexibility Tactics: Case Studies in Healthcare Facilities
Flexibility Parameters

Flexibility is the ability to accommodate change

Scale and size are relevant:
from furnishings to urban scale; solutions may not involve contiguous sites at a network scale

Rate of change is relevant:
increasing rate of change, with increasing uncertainty

Context is relevant:
greenfield, legacy, space vs. time solutions

Time frame is relevant :
short, medium, long and even pre-construction

'Change' may affect capacity (growth or reduction of space) and/or change of use (upgrading or downgrading the intensity of use)

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Flexibility Tactics: Case Studies in Healthcare Facilities
Characteristics of flexibility in healthcare

- **Change is constant**: buildings are never finished, and much of change required is in response to non-facility drivers: reimbursement incentives, operational systems, access…
- **Change is unpredictable and uncontrollable**
  - Science and technology
  - Changing practice patterns
  - Market Incentives
  - Regulations for public health, safety, and privacy
  - Infrastructure demands
  - Consumerism
  - Demographics
- **The built environment is a result of action by many parties** – how do you make decisions in a principled way to maintain coherence?

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Healthcare Facilities Challenges

Organizational behavior affects capital priorities and decision making and therefor how 'change' is accommodated

Limited capital: competition for capital for IT, equipment, facilities

Focus on quick ROI

Focus on short-term priorities: incremental and expedient, though it may compromise strategic facility planning

Limited interest in improving facilities for low margin service lines or support functions

Tension between balanced planning and revenue generation

Tension between project delivery and accommodating change

Flexibility Tactics: Case Studies in Healthcare Facilities

What is flexibility in healthcare design?

Flexibility Drivers and Challenges

Case Studies

Flexibility Tactics

Flexibility Tactics: Case Studies in Healthcare Facilities
Change Drivers: Incidence

- Population growth/access
- Chronicity
- Lifestyle & culture
- Technology/Science/Rx
- New disease
- Healthcare reform

Net impact growth but not necessarily as in the past

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Change Drivers: Convergence of Service Lines

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Change Drivers: development of integrated care and 'centers'

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Change Drivers: Demand for Amenities & Security

Pressure to behave like retail and service industries
The MGH rooftop helipad is sized to for the president's helicopter.

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Change Drivers: shorter/faster building replacement cycles

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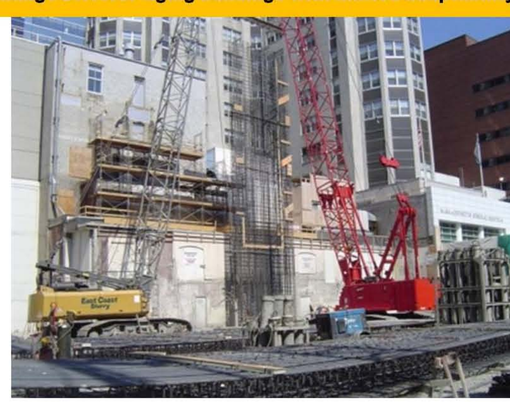
Flexibility Tactics: Case Studies in Healthcare Facilities
Change Drivers: aging buildings with limited adaptability



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Change Drivers: high infrastructure costs to continue current use

Anticipated Infrastructure Costs (not including floor renovations)

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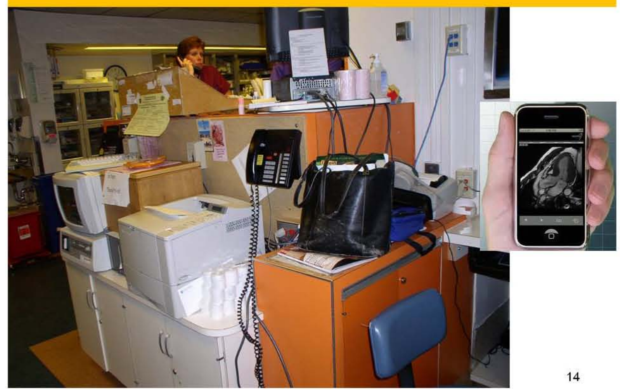
Change Drivers: Information Technology and pervasive computing



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Change Drivers: Demand for space

Demand for space due to practice and therapies

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Change Drivers: Demand for space

Demand for space due to practice patterns and inclusion of families

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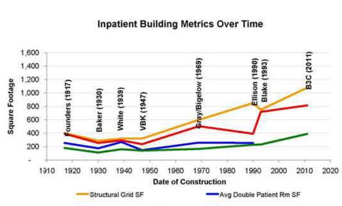
Change Drivers: Regulatory and Best Practices



Single rooms, more space per bed, more support space

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Change Drivers: Connections

More modular building complexes around circulation-organizing principles to enable relationships between existing and new construction

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Change Drivers: New Technologies

Technologies on 2-year cycle; major buildings on 5 – 10 year cycle.

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Change Drivers: Sustainability (broadly defined)

Patient safety
reduce falls, hospital-acquired infections, toxic exposures

Employee safety
reduce injuries, toxic exposures

Healthcare is second most energy intensive use in US
behind food service

Migrate to sustainable, renewable energy sources
to reduce costs

Patients and regulators have rising expectations

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Impact of national healthcare reform: changing demand

- Reform brings other types of change that affect strategies for facilities

- Pressure on reimbursement
- Accelerated shift to ambulatory driven by new technologies
- Inpatient roles continue to change
- Physician – Hospital relationships reshaped
- Increased demand for transparency and quality
- Demand for increased access
- Impact of aging Baby Boomers

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Impact of national healthcare reform: resources

Impact on capital

- **Political uncertainty** about extent and timing of reform: how and when to transition from fee for service to bundled payments or ACO's
- Larger healthcare systems are doing better than smaller systems, and that affects **capital availability** (2008: $60B; 2010: $30B)
- Challenge for non-profits: **where should the capital go**, outside to consolidate or inside to improve systems?
- **Competition** between construction (and then between big box and ambulatory), equipment and IT

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Flexibility Tactics: Case Studies in Healthcare Facilities
Impact of national healthcare reform: Strategic Responses

Corporate Strategy: reduce cost of care and increase ROI

- **Build facilities that can deliver lower cost of care** (outpatient centers, MOBs, retail clinics, etc); differentiate facilities on cost of operations
- Reassess evidence-based design models: **don't overbuild, don't oversize**
- **Improve building performance**: build facilities to enhance throughput and increase return on assets
- **Build in greater automation and IT**
- Invest capital to **improve operating efficiency** and provider productivity: integrating physical design with process design and LEAN
- **Consider real estate as an asset** rather than a facility: consider alternate funding and ownership mechanisms; liquidate under-performing assets; develop more rigorous business cases to acquire capital and justify need to build
- **Increase capital and facility planning horizons**

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Flexibility Tactics: Case Studies in Healthcare Facilities

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Flexibility Tactics: Case Studies in Healthcare Facilities
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Real estate approach (future): *retail*

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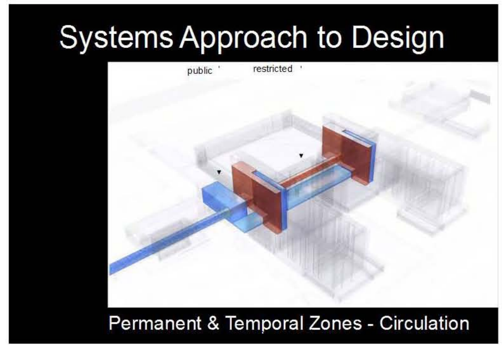
Flexibility Tactics: Case Studies in Healthcare Facilities
Banner Estrella: Systems Approach to Design

Systems



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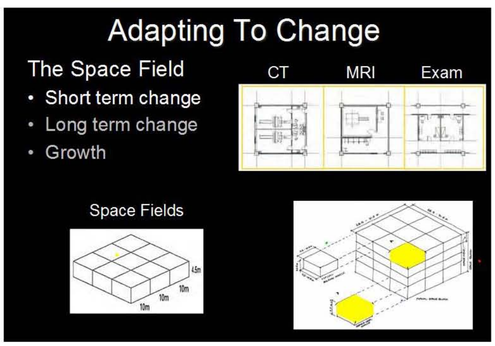
Flexibility Tactics: Case Studies in Healthcare Facilities
Banner Estrella: Systems Approach to Design

Short - term Change



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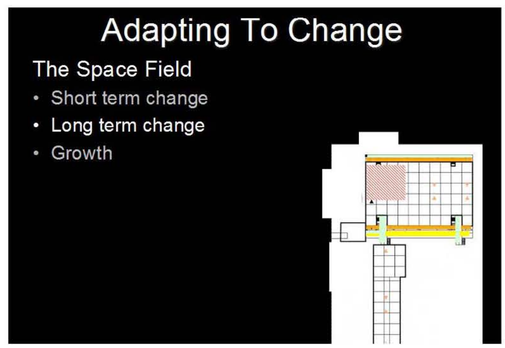
Banner Estrella: Systems Approach to Design

Long - term Change



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Banner Estrella: Systems Approach to Design

Growth

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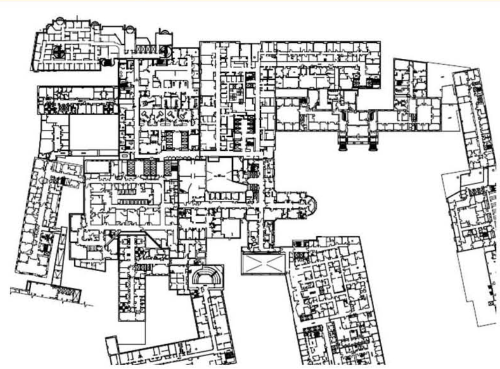
Greenfield vs. Legacy



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Legacy Adaptation

Older MGH facilities have been remarkably adaptable over their lifecycle

- They have **accommodated change:** new clinical practice patterns, new equipment and new code requirements, and have had long lives for their initial use.
- Some of our oldest buildings have **serviced the hospital for over 50 years** before receiving a major floor and infrastructure investment.
- Several buildings have significantly **extended their useful lives by accommodating other, lower intensity uses**, especially Inpatient buildings.

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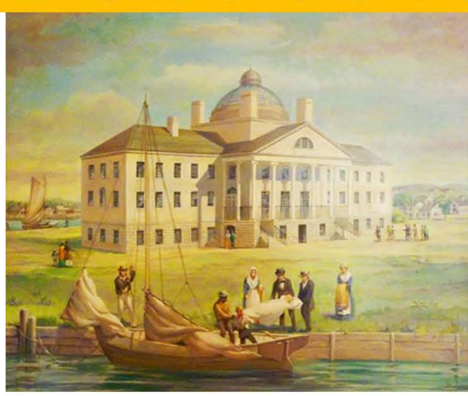
Flexibility Tactics: Case Studies in Healthcare Facilities
Bulfinch Building MGH (1821): ***anticipated growth, adaptation***



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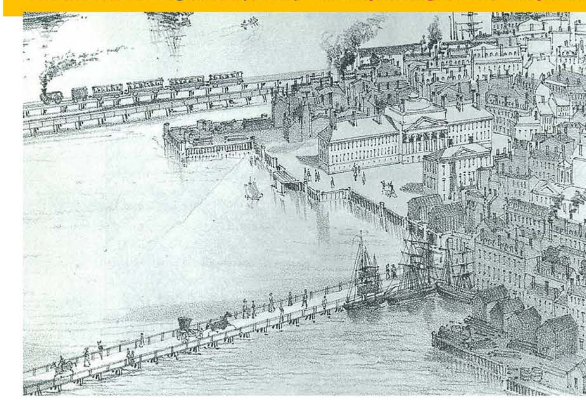
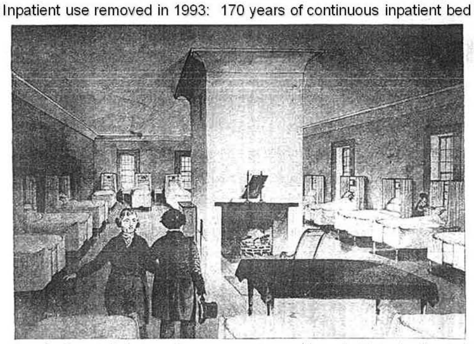
Bulfinch Building MGH (1848): ***anticipated growth, adaptation***



Flexibility Tactics: Case Studies in Healthcare Facilities
Bulfinch Building MGH (1853): ***anticipated growth, adaptation***

Flexibility Tactics: Case Studies in Healthcare Facilities
Bulfinch Building MGH (1821): ***anticipated growth, adaptation***

Last Inpatient use removed in 1993: 170 years of continuous inpatient bed use....



Two frock-coated doctors discuss a case in an old ward. Note the "central heating."

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Civil War (1860 – 1865): large wards have higher mortality than small

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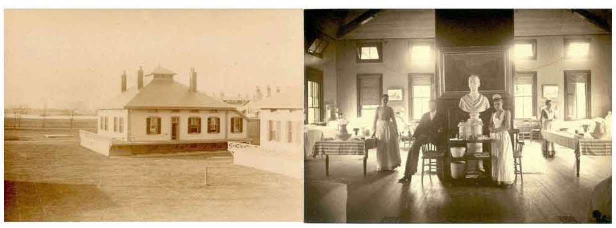
MGH Pavilion Wards (1873): Replacement Strategy



The Pavilion Wards 1873-5: buildings are replaceable modules within an armature of corridor and service connections.

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Flexibility Tactics: Case Studies in Healthcare Facilities
MGH Phillips House (1917): Adaptation

PHILLIPS HOUSE FROM CAMBRIDGE BRIDGE

Phillips House: access for the wealthy, but attempt to avoid disrupting hospital operations, leading first to horizontal, then vertical distribution of hospital services

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MGH Phillips House (1917): Adaptation and Change of Use

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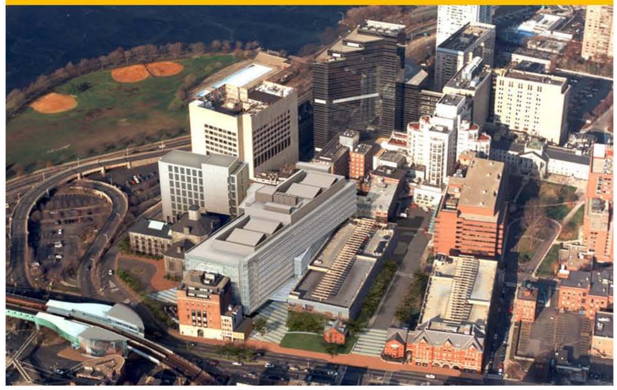
Flexibility Tactics: Case Studies in Healthcare Facilities
Yawkey Center for Outpatient Care: Growth via Operations



Flexibility Tactics: Case Studies in Healthcare Facilities
Yawkey Center for Outpatient Care: Growth via Operations

Narrow margins to support capital expense; can't afford *not* to build, and use, as much as possible and increases need for efficiencies in practice operations and space utilization to drive program design:

- Program Consolidation
- Standards/Modules
- Increased Utilization & Hours of Operation
- Enhanced Patient Flow
- Clinical & Operational Support Systems

Flexibility Tactics: Case Studies in Healthcare Facilities
Yawkey Center for Outpatient Care: Growth via Operations

The "Nine Commandments"

1. Standard hours of clinical operation 8am - 6pm, Monday – Friday
2. Allocation of space based on 70% utilization rate
3. Standard-sized exam and office
4. Clinical staff >.75 FTE to be assigned an office
5. Academic/departmental suites will not be located in the new building
6. Programs will share common spaces
7. Clinical programs will have 'level' schedules
8. Private MD's may be tenants if they are willing to share space with the clinical program and conform to operating guidelines
9. The building would be designed as a 'business class' (low-tech) ambulatory care facility

… Operationally Means:

Increase activity into/through the clinical space

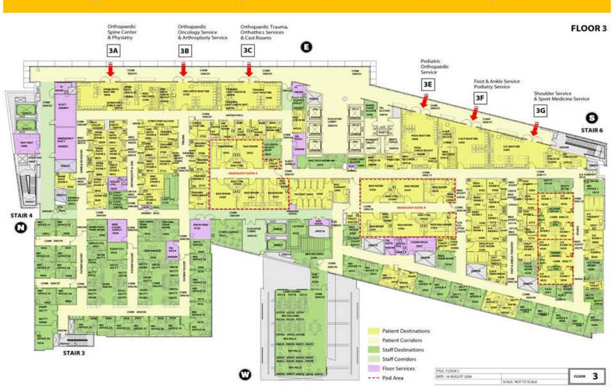
Agree/manage control over shared space/systems/staff

Change practice patterns for scheduling/use of clinical space

Adapt to separate locations for clinical vs academic activity

New job positions, new skill development, new accountabilities for practice support

Flexibility Tactics: Case Studies in Healthcare Facilities
Yawkey Center for Outpatient Care: Growth via Operations



Flexibility Tactics: Case Studies in Healthcare Facilities
Yawkey Center for Outpatient Care: Growth via Operations

Results

Wang ACC	1 visit / SF / year
Yawkey	1.5-1.7 visits / SF / year

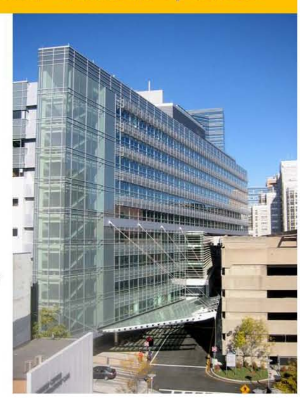
Lowered operating costs and energy use

Efficient operations

Higher patient satisfaction

Calm, supportive environment

Growth by operational efficiency and by expanding hours and days



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Lunder Building: Pre-construction Change

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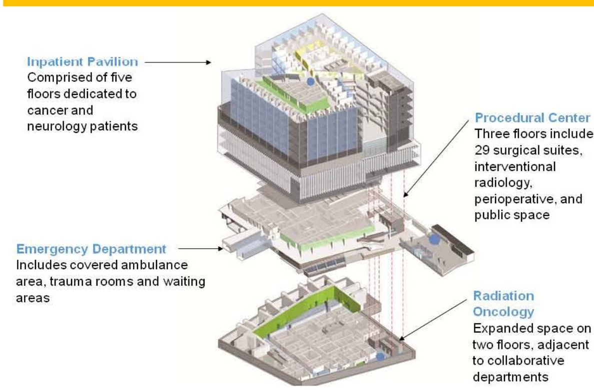
Lunder Building: Pre-construction Change



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Lunder Building: Pre-construction Change

Accommodating changing technologies (6-12 months into construction)

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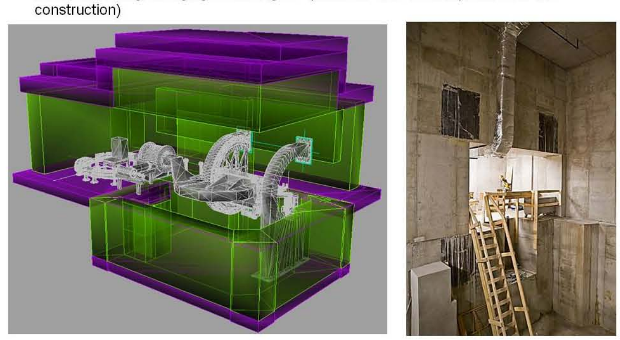
Lunder Building: Pre-construction Change

Flexibility Tactics: Case Studies in Healthcare Facilities
Lunder Building: Pre-construction Change

Accommodating changing technologies 'practical' due to BIM (18 months into construction)



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Flexibility Tactics: Case Studies in Healthcare Facilities
MGH Primary Care: Adaptive Interventions

Office policy: *increase office sharing, workrooms use*
Workspace adjacencies: *co-locate provider team members, exam rooms*
Support functions *to perimeter*
Design for operational efficiency

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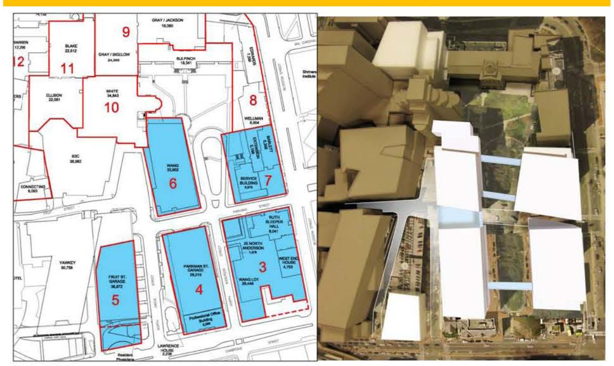
Flexibility Tactics: Case Studies in Healthcare Facilities
MGH Master Plan: ***anticipated growth, acquisition***



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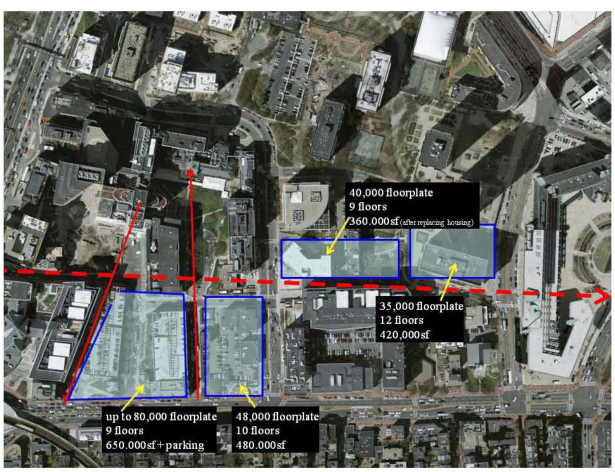

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Flexibility Tactics: Case Studies in Healthcare Facilities
Emerson Hospital vs Wang factory : *Real Estate Options*

Network Growth: Acquisition Options

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Flexibility Tactics: Case Studies in Healthcare Facilities
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Real estate approach (future): *real estate options, retail*

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Flexibility Tactics: Case Studies in Healthcare Facilities
Network Growth: Acquisition Options

Network Growth: where is the space?

- Retail US: 46.6 sf/capita (14.2 bsf)
- Retail GB: 23.0 sf/capita
- Retail Can: 13.0 sf/capita
- Retail Aus: 6.5 sf/capita
- Retail India: 2.0 sf/capita
- Retail Mex: 1.5 sf/capita

Retail space location based on market and access

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Flexibility Tactics: Case Studies in Healthcare Facilities
Network Growth: Acquisition Options

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Flexibility Tactics: Case Studies in Healthcare Facilities

What is flexibility in healthcare design?

Flexibility Drivers and Challenges

Case Studies

Flexibility Tactics

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Flexibility Tactics: Case Studies in Healthcare Facilities

For ambulatory care, flexibility means:

- Ease of access
- Larger floorplates to meet demand for larger, multidisciplinary programs
- Higher floor-to-floor to meet increased infrastructure requirements
- Integration of diagnostic/treatment technologies and ambulatory support
- Meet increasing demand for procedures requiring anesthesia
- Meet increasing demand for IT space
- Ability to adjust practice patterns to become more efficient
- Increase amenities

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Flexibility Tactics: Case Studies in Healthcare Facilities

For inpatient care, flexibility means:

- Maintain connections to supporting logistics
- Larger floorplates to meet demand for single patient rooms and additional support requirements
- Higher floor-to-floor to meet increased infrastructure requirements
- Integration of diagnostic/treatment technologies for critical access
- Meet increasing demand for IT space
- Ability to adjust practice patterns to become more efficient
- Simple floorplate shapes

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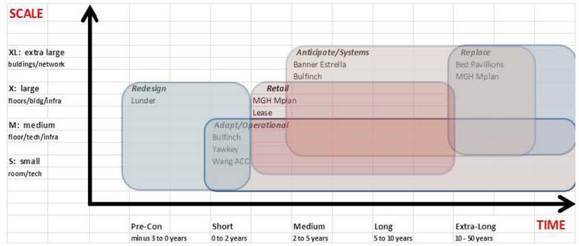
Flexibility Tactics: Case Studies in Healthcare Facilities



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Healthcare Facilities Design for Flexibility Policy Seminar
Department of Defense and the National Institute of Building Sciences
David Hanitchak NBBJ 20 June 2012

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Flexibility Tactics: Case Studies in Healthcare Facilities

Network metrics

- New metrics focusing on reducing cost and improving service *of systems*:
  - Reduce use of space (SF/visit or covered life)
  - Reduce cost of space delivery ($/SF)
  - Reduce operating costs ($/SF)
  - Reduce energy use (KBTU/SF)
  - Reduce plant value
  - Improve facility condition
  - Improve facility functionality and productivity
  - Improve access
  - Improve facility experience

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Flexibility Tactics: Case Studies in Healthcare Facilities

What is flexibility in healthcare design?

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Flexibility Tactics

Plus ca change, plus c'est la meme chose
(Alphonse Karr 1849)

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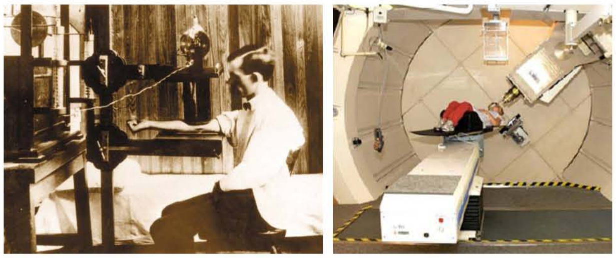
Flexibility Tactics: Case Studies in Healthcare Facilities
Specialized Facilities

Flexibility Tactics: Case Studies in Healthcare Facilities
New Technologies



Flexibility Tactics: Case Studies in Healthcare Facilities
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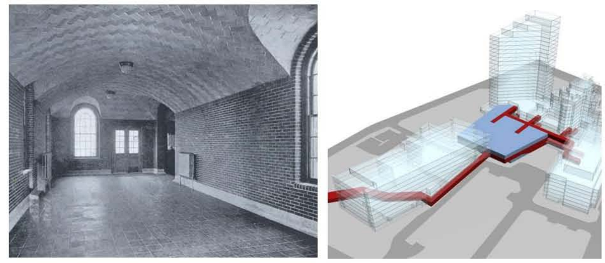

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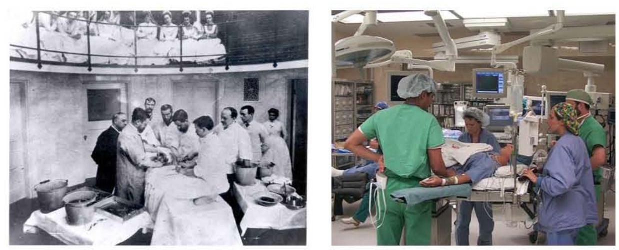

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Research

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Practice Patterns


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Providing the best possible care for…


Flexibility Tactics: Case Studies in Healthcare Facilities

…the patient.


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Adaptable technology systems


Civil War: 1860 - 1865

9.6 GSA / PBS Peach Book Summary And Analysis

The PBS Building Systems Program Revisited

Introduction

More than 40 years ago the Public Buildings Service (PBS) of the U. S. General Services Administration (GSA) embarked on an ambitious series of projects collectively known as the PBS Building Systems Program. The program was intended to dramatically change how both the government and private sector acquired general office space. Although the program began and ended decades ago, it may still offer valuable lessons for other initiatives aimed at improving the design and construction process and the responsiveness of buildings to the needs of their users over their life cycle. I have written this paper as the result of inquiries concerning the objectives, scope, management and results of the program.

Goals of the Program

As stated by the Comptroller General of the United States in his 1977 report, *General Services Administration's Use of New Construction Concept for Federal Buildings Not Yet Successful*, the goals of the GSA/PBS projects were as follows:

- To deliver buildings at a cost that would be equal to or lower than conventional construction costs;
- To deliver the buildings in a shorter time frame than GSA/PBS was experiencing;
- To provide buildings that had lower life-cycle costs than other Federal buildings;
- To deliver buildings of a higher-measured performance quality, principally in space flexibility, acoustics, illumination, and conditioned air;
- To stimulate new approaches to construction; and
- To precipitate a market demand for using the building systems concept in the Government and private sector.

GSA stated the goals of the program in the following manner, which placed greater emphasis on the ability of performance specifications to respond to the needs of a building's users and to foster innovation:

- Specify building performance that responds directly to the actual needs of the building users;
- Communicate user requirements to industry through precise, quantified criteria, which can become the basis for industry standards and further the development of performance-based standards;
- Free industry to innovate, limited only by the requirement that it provide the specified performance;
- Allow selection of building products based on performance, not on pre-selected product alternates;
- Control first cost without sacrificing performance by allowing trade-offs within the entire design, fabrication, and installation process;
- Decrease total cost of ownership of buildings through the optimization of construction, operation, and maintenance costs of the facilities; and

- Develop more effective techniques for managing the construction process contributing to greater efficiency of the entire industry.

The PBS Building Systems Program and Performance Specification for Office Buildings

GSA/PBS initiated the PBS Building Systems Program (BSP) in 1971 to meet the foregoing objectives. The program was implemented in three phases as follows:

- Phase 1: the Social Security Administration (SSA) Program Centers in Philadelphia, Pa (550,000 GSF); Richmond, Ca (550,000 GSF); and Chicago, Il (750,000 GSF);
- Phase 2: the SSA headquarters expansion Metro West Building in Baltimore, Md (1,350,000 GSF) and Computer Building in Woodlawn, Md (590,000 GSF); and
- Phase 3: the Federal Building and Parking Facility in Norfolk, VA (250,000 GSF).

Prior to the 1970s GSA used the conventional design-bid-build method of project delivery for new Federal buildings. In the late 1960s with cost escalating, Federal construction agencies encountered a serious cost-budgeting squeeze. Efforts increased to find superior ways to increase the efficiency and effectiveness of the construction process. During this period, PBS undertook, in cooperation with the National Bureau of Standards (NBS), the development of the building systems concept.

A 1970 GSA study on construction contracting procedures indicated that PBS was not following the practices of the private sector to combat rising costs by adopting new practices to reduce design and construction time and to maximize other cost-saving techniques. The report also stated that GSA's design-bid-build method of project execution took too long for the design and construction of major building projects compared to similar projects in the private sector. The recommendations of the report included the early completion of building systems' performance specifications, the implementation of project management, and the use of construction managers and phased design and construction of buildings.

The result of PBS' collaboration with NBS, a five-year effort, was the *PBS Performance Specification for Office Buildings*. The specification expressed in performance, rather than prescriptive terms, the requirements of the following seven subsystems of an office building.

- Structure: the structural frame of the entire building above the foundation;
- HVAC: air handling, filtration, heat exchange, distribution, and control equipment;
- Electrical distribution: office power, telephone and signal raceways, floor outlets, and luminaire wiring;
- Luminaires: lamps and ballasts required to provide uniform, task-oriented, and background lighting except in specified "out of system" spaces, e.g., corridors, toilets and lobbies;
- Finished floor: resilient flooring and carpet except in specified out of system spaces;
- Finished ceiling: ceilings in office areas; and
- Space dividers: partitions, doors and hardware, freestanding screens, and column covers but excluding fixed walls at the utility cores.

(Note: all elements of a construction project not included in the building system were defined as "out-of-system" construction.)

The performance of each of the seven subsystems was expressed in terms of the following seven attributes:

- Conditioned air;
- Illumination;
- Acoustics;
- Stability and durability;
- Health and safety;
- Maintenance; and
- Planning.

The required performance of each subsystem, e.g., structure, with respect to each attribute, e.g., stability and durability, was described in the following three terms.

- Requirements: a qualitative standard of the required performance, e.g., control deflection;
- Criteria: the quantification of the desired performance, e.g., the deflection of any horizontal part of this subsystem due to long term volume changes such as shrinkage and creep shall not exceed its span divided by 480; and
- Test: the method of demonstrating compliance with the criteria, e.g., calculation.

The requirements included in the performance specification pertaining to the attribute of planning were intended to assure that the building system was sufficiently flexible to allow the inevitable reconfiguration of the building's interior over time. (As noted below, the award calculation for the contract for the building system actually included the estimated cost of the reconfiguration of the buildings' office areas over the anticipated 40-year life of the buildings.)

Following are examples of these requirements for each of the subsystems, excluding the Finished Floor that had no attributes associated with planning:

- Structure: the subsystem shall require no changes when any other subsystem is changed within the parameters stated in the specification;
- HVAC: the subsystem shall be capable of accommodating changes in the size of any interior control zone. The minimum size of a control zone shall be 10'-0" x 15'-0";
- Electrical distribution: floor outlets shall be able to be located at any intersection of the lines of a staggered 60" by 60" grid;
- Luminaires: changes in this subsystem shall not require work in rooms otherwise unaffected by the planning change;
- Finished ceiling: this subsystem shall not impair penetrations for the installation of out-of-system ducts in the interstitial space between floors. The maximum area of penetrations shall not exceed 96 square inches; and
- Space dividers: partitions shall be locatable on the lines of a 30" grid coincident with the building's planning grid.

SSA Program Centers Project

The specification was initially used to procure an integrated building system consisting of the seven subsystems for the three SSA Program Centers. (A single building system contract was awarded for all three projects.) The acquisition of the building system was combined with the application of project management and the use of a construction manager and the award of multiple prime contractors for the out-of-system work, e.g., site clearing and execution, foundations, mechanical plant equipment, switchgear and electrical and telephone wiring, and interior construction in out-of-system spaces such as lobbies. (A total of 67 contracts were awarded for the out-of-system construction on the three project sites.)

The building system contract was awarded using a two-step formal advertised procedure. In the first step technical proposals were requested. The proposals were evaluated in relation to the performance specifications. Each proposal had to show how the offeror's proposed building system would comply with the performance specifications; how it would be tested; and how the system's design, fabrication, testing, and construction would be managed. (A total of 10 technical proposals were received from nine offerors)

After the evaluation, four proposals from three offerors were determined to be acceptable and the offerors were invited to submit price proposals. Only two of the offerors submitted proposals. It is understood that the third offeror declined to submit a price proposal because it could not meet the first cost price ceiling established by GSA for the building system contract. The price ceiling was required because, as described below, the award was based in consideration of additional, future costs, but GSA had a first-cost budget limitation.

Award Formula For The Building System Contract

Because each of the offeror's building system would impact the cost of the out-of-system construction, evaluation factors were established and applied to the proposed price of each building system. The building system contract was awarded based on a calculation composed of the following factors:

- The system price: the total proposed price of all material to be furnished and installed by the offeror;
- Bid equalization factors: a system of price adjustments established for each building system to account for costs imposed by the system's elements on the out-of-system construction, e.g., the costs of exterior walls and elevators due to the offeror's planned thickness of the floor-ceiling sandwich;
- The prorated bid price factor: a calculation that gave credit to a system with smaller columns that therefore provided more usable floor space within the same size building;
- The life-cycle cost factor: a computation of those life-cycle costs that could be objectively measured by calculation and confirmed by tests over the 40-year expected life of the building system; and
- Nine-year optional maintenance cost: the bid by each offeror to provide the Government with an optional maintenance contract for the building system for three years, with two renewable options. The option obligated the offeror to maintain the performance of the system, to provide normal housekeeping of the system elements, and to maintain the HVAC and luminaire subsystems. (The bid was a firm fixed price for only the first three-year period, with prices for successive periods to be adjusted according to the Consumer Price Index.)

The life cycle costs included in the award calculation consisted of the estimated cost of the following factors over the assumed 40-year life of each of the project buildings:

- Space adjustment: the estimated cost to make a prescribed set of changes in the interior layout of the building;
- HVAC operation: the estimated cost of operating the HVAC and electrical subsystems;
- Luminaire operation: the cost of relamping the luminaire subsystem.

The building system contract was awarded to the offeror that had the lowest total, calculated price although its first cost was higher than that of the other offeror.

The Project Team

The first group of projects, the three SSA Program Centers, was one of GSA's initial applications of project management. On July 30, 1971, the GSA Administrator issued an order governing the use of project management and setting forth the roles and responsibilities of a project manager.

The use of project management was permitted when one or more of the following conditions existed:

- The estimated cost of the project exceeded $2 million;
- Concurrent design reviews and either phased or turn-key construction was contemplated;
- Unusual organizational complexity was involved, including extensive interoffice or interagency coordination and support;
- Significant technological problems were anticipated;
- Expeditious handling was needed to satisfy urgent requirements.

The order further stated that the project manager would be assigned full time to head the project. He would operate pursuant to a written charter that assigned him by name; defined the scope of the project; and described his authority, responsibilities, operating relationships, and assignment and control of resources.

The charter for the SSA Program Centers designated the project manager as the single source of decision making within GSA and responsible for planning, directing, and controlling the definition, development, and execution of the project. He was also the contracting officer with final authority over all project funds.

The project manager operated with a small staff, relying on other GSA personnel for technical, administrative, budget, and legal support. A GSA resident engineer represented the project manager at each job site during construction of the Program Centers.

The project manager was also supported by a team of consultants. A major player was the Executive Architect/Engineer (A/E) who acted as an integrator and supported the work of the other team members. The specific duties of the Executive A/E included the following:

- Preparing a preliminary activity network and schedule for the project;
- Amending, as appropriate, the performance specifications;
- Preparing design concepts;
- Directing the work of Regional A/Es to assure compatibility with the building system;
- Developing the format for the building system technical proposals;
- Participating in the evaluation of the technical proposals for the building systems;
- Reviewing and recommending for approval the building system documentation prepared by the building system contractor;
- Reviewing and recommending for approval the foundation designs for the potential building systems prepared by Regional A/Es;
- Reviewing and recommending for approval each bid package for the out-of-system work.

Another key member of the project team was the Construction Manager. (A single construction manager was selected to support the construction of all three of the Program Centers.) Some of the construction manager's key responsibilities were the following:

- Implementing a construction management control system;
- Reviewing the plans of the Regional A/Es and suggesting economies, preparing estimates, and commenting on construction feasibility;
- Recommending packaging of the out-of-system work and reviewing the bid packages;
- Assisting the project manager in developing criteria for the evaluation of the building system technical proposals and participating in the evaluation;
- Developing bid equalization factors for use in evaluating the building system technical proposals;
- Conducting a value engineering workshop and studies;
- Providing general direction, inspection, and superintendence of the construction of both the building system and the out-of-system work;
- Establishing procedures to coordinate the work of all project entities;
- Maintaining jobsite records;
- Providing, on a reimbursable basis, services such as watchmen, fencing, first aid stations, temporary utilities, etc.

For each of the three Program Centers, a Regional A/E prepared the overall building configuration and design of the out-of-system work. These architects were also responsible for incorporating the building system into the design of the total building. Each of the Regional A/Es introduced individuality into the design of each building and compatibility of the building with its surrounding environment, despite the use of a common building system for a substantial portion of the building's construction.

The most innovative contract was the agreement with the building system contractor. It was a design-build (DB) contract long before the Federal government began to employ this method of project delivery. Further, because of the scope of the building system and the requirements of the performance specification, a multi-disciplinary team was required to respond to the request for technical proposal. The winning contractor for both the SSA Program Centers and SSA Administrative Headquarters Projects was a consortium of a major building products manufacturer, a national steel company, professional engineering firm, and a large construction management firm. The successful building system contractor for the Norfolk project was also a consortium led by a major building product manufacturer.

The scope of work for the building system required the contractor to perform the following:

- Coordinate the design of the building system with the design of the out-of-system construction;
- Prepare a detailed test plan for the building system and test the system;
- Produce the construction documents for the building system;
- Furnish and install the building system;
- Prepare the operations and maintenance manuals for the building system.

Work on the second group of buildings in the program, collectively known as the SSA Administrative Headquarters Expansion Project, began before the SSA Program Centers were completed. For these projects the performance specifications were revised. Significant revisions included the following:

- The acoustical performance specification was revised to incorporate the results of prototype testing performed as part of the Program Centers project, advances in the state-of-the-art, and the “open plan” approach to office design;
- The scope of the HVAC subsystem was increased to include the perimeter zone and prime energy converters;
- The lighting performance specification was revised to include more energy efficient fixtures and the use of a qualitative versus quantitative measurement of illumination; and
- Custodial services were removed from the maintenance option.

Like the Program Centers Project, the SSA Administrative Headquarters Expansion Project was managed by a project manager located in GSA’s central office. (The same individual served as the project manager for both the SSA Program Centers and SSA Administrative Headquarters Expansion Projects.) He was supported by a team that was very similar in its composition and functions to the team that supported the SSA Program Centers Project.

Prequalification of Building Systems and Management of the Norfolk Federal Building and Parking Facility Project

Implementation of the third phase of the Building Systems Program, the Federal Building and Parking Facility in Norfolk, Virginia, marked a significant departure from the first two projects in two notable ways.

It established a pre-qualification program through which building systems could be pre-qualified independently of the actual needs of a specific building project. The goal of the pre-qualification program was to limit the impact on the execution of a project of the time required to develop and evaluate a proposed building system. In the case of both the SSA Program Centers and SSA Administrative Headquarters Expansion Projects an extended period of time was required for the development of technical proposals and their evaluation as part of the procurement process. This delayed the preparation of the buildings’ designs and the start of construction.

The other significant change was that the management of the program was split between GSA’s central office and its National Capital Regional office. (The Norfolk Federal Building and Parking Facility is located in Virginia, which, at the time of the project, was within the National Capital Region.) This split in responsibilities would be repeated on other projects included in the PBS Building Systems Program. The region in which the project was located would have the same responsibilities as the National Capital Program had in the Norfolk project.

The prequalification phase was administered by GSA’s Building System Program Manager who was located in the Office of Construction Management within GSA’s central office. He was responsible for the prequalification of building systems. His duties included the following:

- The issuance of the Request for Technical Proposals;
- The evaluation of technical proposals received;
- Evaluation of proposed amendments to the performance specification and incorporation of approved changes into it;
- Providing general direction to the regional offices in the use of building systems on designated projects;
- Maintaining the confidentiality of the technical proposals of “acceptable” building systems retained by the government.

The actual application of a prequalified building system on the Norfolk project was managed by PBS personnel in the regional office. There was no project manager with authorities and responsibilities comparable to those of the project manager on the previous building systems projects. Instead, a contracting officer administered the building system, consulting, design, construction management, and out-of-system construction contracts with assistance drawn from the region's design and construction personnel operating within their functional organizations. Collectively they had responsibility for the following activities:

- Contracting for the design and construction of the project facility including making all contract changes within the administrative limitations of the agency;
- Reviewing and approving the design prepared by the project architect/engineer;
- Approving certification of the building system test results;
- Making progress payments to contractors;
- Making progress and final inspections of the building system and other construction.

The role of the Executive A/E was continued; however, the contractor was renamed the Systems Consultant. Like the Executive A/E, the Systems Consultant was responsible for optimizing the use of the building system and monitoring its interfaces with the out-of-system work. The consultant's responsibilities included the following:

- Assisting the project A/E during design development and the reviews of design concept drawings and building system contractor drawings;
- Assisting in the preparation of the bid equalization factors;
- Preparing energy cost computations;
- Assisting in the preparation of the Invitation for Bids for the building system and subsequent amendments;
- Attending the building system pre-bid conference;
- Assisting in the review of descriptive literature for the building system;
- Reviewing, after award of the building system contract, the system documentation and the test plan and evaluating the test results;
- Assisting in the coordination of the building system and out-of-system work during scheduling, preparation of working drawings, and construction.

The construction manager was responsible for the following:

- Preparing management plans for the entire project;
- Establishing and assuring compliance with the cost objectives of the project including the total construction cost estimates, the system price limit, and the bid equalization factors;
- Acting as a construction consultant to the project A/E during design preparation;
- Establishing the scope of packages for the out-of-system work;
- Assisting GSA in evaluating the building system proposals; and
- Providing general administration of job-site operations during construction.

The project architect executed the project's concept design, drawings used in the solicitation of price proposals for the building system, and the working drawings and specifications for the out-of-system construction. The A/E's responsibilities included the following:

- Siting, configuration, and general design of the project;

- Fulfilling user requirements and space programs;
- Working during design development to obtain the optimal application of the building system;
- Delineating the extent of the building system's use;
- Coordinating between the building system and the out-of-system construction;
- Working with the construction manager to establish and maintain project schedules and estimates.

Relationship between the "Out-of-System" and "In-System" Design Processes

The third edition of the PBS Performance Specification for Office Buildings provided for the prequalification of building systems. Building systems were prequalified against a set of prototypical drawings, i.e., the System Qualification Drawings. The technical proposals submitted as part of the prequalification process were based on the requirements of a set of System Qualification Drawings, the performance specifications, and other requirements of the RFP. The prequalification process was not dependent on the application of the building system to a specific project.

For a specific project, the first step in the design process was the development of concept design drawings for the project. These drawings were prepared by the A/E selected to design the project. The System Consultant assisted the project A/E in the preparation of these drawings. (The System Consultant was the successor to the Executive A/E.) The consultant provided advice on the requirements of the building system as specified in the performance specification.

Based on concept design, the project A/E prepared the System Contract Drawings. These drawings fully delineated the interfaces between the in-system and out-of-system construction. They were sufficiently detailed to develop cost estimates for the in-system and out-of-system construction, the building system price limit, bid equalization factors, and the scope of the out-of-system bid packages.

Simultaneously with the preparation of the System Contract Drawings, the project A/E prepared the working drawings and specifications for the foundations, site work, and utilities bid packages. The System Consultant provided data on the foundation loads for the prequalified building systems, which allowed preparation of the foundation bid package.

Once the Government approved the System Contract Drawings, the A/E began preparing the working drawings and specifications for the balance of out-of-system construction. Also, based on the approved System Contract Drawings, the offerors of the prequalified building systems prepared their price proposals and descriptive literature, i.e., technical material, management plan, maintenance plan, and proposed bid unit quantities. During this period the contracts for the building's foundations and the site work and utilities were awarded and construction work on the project was initiated.

Subsequent to award of the building system contract, the project A/E completed the working drawings and specifications for the remaining out-of-system construction. Simultaneously, the building system contractor prepared the construction documents for the building system.

Evaluating the Success of the PBS Building Systems Program

The Comptroller General of the United States performed the only assessment of the PBS Building Systems Program. The assessment was requested by Congress in February 1975 and was released on October 10, 1977. The Congress was concerned that GSA had proceeded with the second phase of the program, the SSA Administrative Headquarters Expansion Project, before the Program Centers "pilot" project had progressed sufficiently to justify committing funds for new facilities. Consequently, the Congress requested the Comptroller General to perform an intensive review of the SSA Program Centers Project and to comment on the superiority of the building systems concept over conventional construction.

The Comptroller General assessed the extent that the program centers project met its objectives. In summary, he reported the following:

- The program centers were not completed on schedule;
- Planned total construction costs were exceeded;
- Life-cycle cost objectives were not met;
- Claimed energy savings could not be verified;
- Serious and costly operation and maintenance problems occurred;
- The building systems concept has not spread.

The Comptroller General qualified his findings by stating that he could not determine the extent to which the building systems concept contributed to the failure to meet the project's goals. This was because of how intertwined its implementation was with other aspects of the project's implementation, e.g., the time required to select and acquire the project sites.

The target execution schedule for the three Program Centers was three years: one year for preconstruction activities and two years for construction. This was a 40% improvement over GSA's experience with projects of a similar scope, i.e., a five-year schedule. The Program Centers in Richmond, Ca and Philadelphia, Pa were completed in three years and seven months. The larger Program Center in Chicago was completed in four years and seven months.

Significant delays were experienced in site selection and acquisition, and the time required to prepare the building system technical proposals was significantly extended. Growth in the technical proposals' preparation was caused by uncertainty regarding site conditions and issues with the performance specifications. It was necessary to amend and clarify the specification.

The Philadelphia and Richmond buildings were constructed in the scheduled 24 months. Construction of the Chicago building required an additional 14 months, primarily because most of the pilings for the foundation were damaged by earth movement and had to be replaced.

Despite preconstruction delays, the Program Centers in Richmond, Ca and Philadelphia, Pa were still completed almost one and one-half years more quickly than GSA was experiencing on conventional projects. Even the Chicago project was completed in less than five years.

The success of these projects relative to GSA's typical timeline for a project of similar scope, despite their technical and management complexities was largely due to the use of project management. Specifically, a full time project manager, with virtually full authority and responsibility for the successful execution of projects, was the most significant reason they were completed more quickly than conventionally executed projects.

The budget for the Program Centers project was $110.5 million. The total estimated cost of the project, at the time of the Comptroller's report, was $114.9 million. Of the overrun, $3 million was required to cover the cost of the foundation problem in Chicago. The balance was set aside to settle additional, potential contractor claims. Overall, GSA believed that the project compared favorably to conventional GSA projects. Again, completion of the three Program Centers with a cost overrun of only slightly over four percent was attributable to the use of project management, which resulted in decisive leadership.

GSA responded to the Comptroller General's conclusion that the project's life-cycle cost objectives were not met and the claimed energy savings could not be verified. GSA noted that the project predated the emphasis on energy consumption and was the first time that GSA considered energy consumption in the award of a construction contract. The specifications for the building system were intended to provide a level of performance based on the comfort of a building's occupants and not energy conservation.

The measured energy use in the Richmond and Philadelphia Program Centers was 418,850 and 562,646 BTUs per net square foot, respectively, in their first year of operation. This was excessive compared to GSA's calculated national average of 300,000 BTUs. Although the design of the building system precluded implementing some energy conservation measures, some measures were implemented, which reduced the energy consumption by approximately 100,000 BTUs per net square foot in each building. A significant reduction was achieved through the removal of one lamp from the building system luminaires. While reducing the building's energy consumption, the elimination of one lamp lowered the level of illumination below the specified level.

As described above, the second generation of the performance specification expanded the HVAC subsystem to include the perimeter zones and energy converters. The expansion was intended to eliminate performance issues associated with the interfaces between the HVAC subsystem and mechanical equipment previously excluded from the building system, thereby providing greater opportunities to optimize the energy efficiency of the building system.

The Comptroller General reported that there were significant operations and maintenance problems with the Program Centers in Philadelphia and Richmond. (At the time of the report GSA did not have comparable experience with the Chicago building because of the delay in its completion.) Two maintenance contracts, one for the building system and one for the balance of the building, were problematic. To eliminate this problem GSA negotiated with the building system maintenance contractor to maintain the balance of the building. Because of the lack of competition, the resulting maintenance costs were significantly higher than for other Federal buildings. Further, despite a single maintenance contract for each of the buildings, problems with identifying maintenance and operating responsibilities persisted.

To avoid these problems on subsequent projects, the specification was revised to include only mechanical maintenance. All cleaning was eliminated from the maintenance option. Further, the Government could exercise the option in two ways. One option would result in the building system contractor being a prime contractor to the Government. (This option would be applicable if GSA was performing the balance of the building's maintenance with its own forces.) In the other case, the option could be exercised to make the building system contractor a sub to the maintenance contractor for the out-of system portions of the building.

The Comptroller General noted the diminished interest by industry in each successive building system procurement. On the SSA Program Centers Project, GSA received technical proposals for 10 building systems. On the SSA Administrative Headquarters Expansion Project, GSA received technical proposals for only three building systems. This number decreased to two technical proposals in response to the pre-qualification solicitation issued as part of the Norfolk project.

GSA acknowledged that the program did not simulate much industry interest in the total system concept. GSA stated that, on the other hand, selected sub-systems such as HVAC, finished ceiling, luminaires, and space dividers, all of which were referred to as the Integrated Ceiling and Background Sound System, had general widespread acceptance. (Since the 1970s the use of systems furniture and the increased density of workstations has made the Integrated Ceiling and Background Sound System obsolete.)

Like industry, GSA also lost interest in the program. In the letter under which it transmitted its comments on the Comptroller General's report, GSA pledged to make a thorough evaluation of the program after the completion of the SSA Headquarters and Norfolk projects. The evaluation would evaluate the six completed buildings in terms of quality, schedule performance, cost, operations and maintenance, industry participation and acceptance, life-cycle costs, and energy efficiency. This evaluation was never performed. Further, as described in the third edition of the performance specification, requests for technical proposals to pre-qualify building systems were supposed to be issued annually. Another request for technical proposals was never issued after the initial request associated with the Norfolk project.

In response to a request from GSA/PBS, in February 1983, the National Bureau of Standards (NBS) proposed a research plan to document and assess the effectiveness of the PBS Building Systems Program. The assessment was intended to assess how well the objectives of the PBS Building Systems Program were met in the six buildings built as part of the program. Further, NBS was to recommend to PBS opportunities to improve building technology and building procurement practices. NBS' plan contemplated assessing the actual performance of selected requirements of the building system. Specifically, NBS proposed evaluating acoustical performance, illumination levels, air movement, and the flexibility of the space as required by the planning performance requirements. It also intended to assess the success of the program in terms of its impact on the industry. The plan contemplated using the Delphi Method. A panel of building professionals knowledgeable about the program would be convened to provide their assessment of the impact of the program.

Observations

The PBS Building Systems Program demonstrated a number of issues with efforts to innovate in the building industry. The planning design and construction of buildings can be a lengthy process. If you add a period of operations and maintenance, the length of time gets even longer. Therefore, assessing the results of an initiative that requires feedback on a project's outcome can take a number of years to obtain. At the same time, initiatives often need senior management sponsorship. In the Government, senior leaders, particularly political appointees, are frequently replaced. (During the period of the PBS Building Systems Program the GSA had six different Administrators and PBS had seven different Commissioners.) The consequence is that it is highly likely the initiative's sponsor will depart before the feedback on the initiative is available. This was the case with the PBS Building Systems Program.

The other lesson is that it is important to have the entire organization embrace the initiative. In the case of the PBS Building Systems Program this was not the case. (Although GSA spent a considerable effort to educate the building industry about the building systems program and to encourage its participation in it by conducting three industry briefings in 1971 and 1972 and issuing weekly or bi-weekly project reports, it did very little to inform or involve its own staff in the program.) While the initial two phases of the program benefited from a dedicated project manager, it also moved the program out of the mainstream of activity in GSA and PBS. The impact of this isolation was evidenced by the December 1975 memo to the project manager from the Director of GSA's Operations Division. In his memo the director took exception to the claimed energy efficiency of the building system. In June 1976 GSA's Office of Buildings Management disagreed with a GSA news release, which stated that the building systems concept significantly reduced maintenance, operation, and alteration costs over the life of a building. Also, GSA's regional offices, which had the responsibility to execute the majority of GSA's building program, were never actively involved in the program until the National Capital Region became involved in the Norfolk project.

Version three of the performance specification stated that GSA contemplated a $650 million on-going program of Federal buildings for which the Building System Program was intended to provide a superior method of procurement. However, after the Norfolk project, no other Federal building was proposed for inclusion in the program. This was due in part to the lack of champions for the program in the regions and the evaporation of support in GSA's central office.

While the proposed NBS assessment was never performed, the description of its plan may be useful in assessing the application of flexibility concepts in building design and construction. The plan stated that GSA staff estimated that the requirements for flexibility were over-specified in the PBS performance specification. It further stated researchers at the Army's Corps of Engineers' Construction Engineering Research Laboratory and others questioned the cost effectiveness of flexibility requirements.

Footnote
In preparing this paper I relied heavily on the Report of the Comptroller General of the United States, *General Services Administration's Use of New Construction Concept for Federal Buildings Not Yet Successful*, dated October 6, 1977; the report *Documentation and assessment of the GSA/PBS Building Systems Program: Background and Research Plan*, dated February 1983, prepared by the Center for Building Technology, National Bureau of Standards, Department of Commerce; and the third edition of the *PBS Performance Specification for Office Buildings*, published in November 1975. I also received input from Mr. David Hattis, one of the authors of the original *PBS Performance Specification for Office Buildings*, dated January 1971, and Mr. William Brady, formerly a principal at the Leo A. Daly Company, which as a major player in the GSA/PBS projects.

About the Author

Mr. John Tato was the Assistant Project Manager for the SSA Program Centers project. He was subsequently the Building System Program Manger. In this capacity he managed the preparation of the third edition of the *PBS Performance Specification for Office Buildings* and the pre-qualification of the building systems that were invited to submit price proposals for the Norfolk Federal Building and Parking Facility.

Mr. Tato retired from the U.S. Department of State, Bureau of Overseas Buildings Operations in 2005. For the last several years at the Department, Mr. Tato managed the planning of its major construction projects. After retiring from the Department, Mr. Tato continued as a personal services contractor and consultant to the Department. His last assignment was managing the planning and procurement of the facilities the Department required in Iraq to support its 17,000 personnel after the withdrawal of U.S. military forces at the end of 2011.

Mr. Tato holds a Bachelor of Arts in Architecture and a Master of Architecture degree from Stanford University.

9.7 Research Team

Principal Investigator

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Dr. Kendall is a registered architect whose practice, academic and research career spans more than 30 years. He has professional and post-professional degrees from the University of Cincinnati, Washington University in St. Louis, and a PhD in Design Theory and Methods from the Massachusetts Institute of Technology (Professor John Habraken). Dr. Kendall practiced architecture for a number of years, designing hospitals, academic facilities, residences, and other building types. He has taught architectural design, urban design, building technology and theory courses at all levels of professional curricula in several universities in the US and abroad.

Dr. Kendall has written more than 50 papers, book chapters and technical reports, and has conducted many funded research projects. He has guest edited a number of journals and conference proceedings, and is on the editorial board of Open House International. He lectures widely to university and professional audiences, in the US and internationally. He is joint coordinator of the CIB Commission W104 Open Building Implementation (www.open-building.org).

His research focuses open building design and construction methods, encompassing studies of new organizational and design methods, logistics and technology needed to make buildings – especially large multi-tenant buildings - more adaptable, easier to customize to meet individual preferences and thus more sustainable.

His work focuses primarily on healthcare architecture and housing.

In 2010, Dr. Kendall formed a company – INFILL SYSTEMS US LLC – dedicated to selling products and providing architectural advisory services that help developers achieve adaptable, long-lived open building projects. http://www.infillsystemsus.com/

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Thomas D. Kurmel, DDes, AIA
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Colonel, U.S. Army Medical Service Corps (Retired)
Former Senior Military Advisor and Chief of Staff, Office of the Assistant Secretary of Defense for Health Affairs

Thom served from May 2004 to June of 2009 as the *Senior Military Advisor* and *Chief of Staff* to the Assistant Secretary for Health Affairs in the Office of the Secretary of Defense at the Pentagon. From May 2002 he led planning, budgeting, and acquisition of all DoD medical facilities as *Director, Facility Life Cycle Management Operations,* Office of the Assistant Secretary of Defense for Health Affairs, TRICARE Management Activity, Falls Church, Virginia. Thom is a Registered Architect and is currently president of his own consulting practice specializing in health systems and infrastructure strategy and planning.

Thom's experience includes Command of the US Army Health Facility Planning Agency, (Office of the Army Surgeon General) from December 1998 to May 2002, and numerous leadership and staff positions in the US and overseas.

Thom holds a Doctorate from Harvard University, 1991, and a BS in Architecture from the University of Nebraska, 1978.

Past honors include the Defense Superior Service Medal, Legion of Merit, Meritorious Service Medal, and the Defense Commendation Medal. He holds the Army and Secretary of Defense Staff badges, the U.S. Army Medical Department "A" Proficiency Designator in Health Facility Planning, and the Charles E. Christ Award for life long achievement in health systems management.

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Mr. Dekker is an architect and consultant with an engineering degree in building and construction. After ten years in architectural practice, he serviced as project manager in the National Housing Board, and then became director of ARO, a consulting firm in architecture, town planning and organization (1973-86). He then formed his own consulting firm – KD Consulting, focused on strategic research and development in construction (1986-1995). In 2000 he was appointed as Head of the Department Strategic Studies, Quality Assurance and Building Regulations of TNO Building and Construction (one of the largest independent research organizations in Europe). From 2000-2005, he was Principle Advisor, Building and Infrastructure at TNO Bouw. In 2005 he returned to private consulting at KD Consultants.

Mr. Dekker has also held a number of other positions:

2006-present	*Senior Researcher: Center of People & Buildings, Delft (www.cfpb.nl)*
2000-2008	Editor of "Ruimtelijke Investeringen", Journal for environmental planning & procedures
2005-present	Chairman of the foundation for study grants for refugees
2000-2004	**Scientific coordinator of the SUREURO project – see www.sureuro.com**
2000-present	**Reviewer of European RTD projects –**
1999-2003	Member of the steering committee of sustainable building: College of Buildings in the Health Sector
1995-2003	Member of the steering committee for sustainable building (SEV)
1995-2000	**Joint Coordinator (with Stephen Kendall) CIB W104, Open Building Implementation**
1989-2000	Member of the board of "Patrimoniums Woningen", a Social Housing Corporation in Voorburg
1986-2000	Part time Teacher, Building Economics BOB (Business Education Building and Construction) Education Management industry Teaching Open Building Technology and Economics
1977-1991	Member of the board of the Foundation of Architectural Research (SAR)
1984-1991	Member of the board of the Foundation of Open Building
1983 - 2006	Member of the Committee Reputation Promotion in the Building sector (NIMA)
1988 - 1991	Member of the working Committee "Terms in Building" of the National Normalisation Institute (NNI)

Mr. Dekker has authored or co-authored more than 75 academic and technical papers and had led a number of research teams on Dutch and European Commission research projects.

9.8 Acknowledgements

This research would not have been possible without the contributions, insights and time of many dedicated professionals in both the public and private sectors. Many of these individuals are listed in the report, as recipients of the survey, and as participants in the cost modeling workshop and the policy seminar.

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Giorgio Macchi must also be recognized for bringing to my attention his pioneering development and use-in-practice of System Separation. I believe that this approach is an important step toward open (flexible and accommodating) and thus sustainable architecture for the 21st century.

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