

FLEX



A STUDY OF FLEXIBILITY IN OUTPATIENT SETTINGS

A FOLLOW-UP TO THE CLINIC 20XX SERIES

A REPORT BY

CADRE | Center for Advanced Design
Research and Evaluation

SUPPORTED BY

Steelcase[®]
HEALTH

HKS

How do we define, and approach, flexibility to respond to a dynamic, ever-changing present?

FLEXX: UNDERSTANDING FLEXIBILITY TO DESIGN FOR AN EVER-CHANGING PRESENT

For many years now we have discussed, as a community, what the future of health care, and as a consequence, what the future of ambulatory care facilities might look like. In 2015, in partnership with HKS and JE Dunn, CADRE undertook a study of drivers, trends and patient/physician perceptions around what we called Clinic 20XX- Designing for an “Ever-changing Present” rather than a “faceless future”. Not surprisingly, flexibility came up as one of the key tenets.

In 2017, the CADRE team partnered with HKS & Steelcase Health, to dive deeper into this issue. Early on it was evident that while a severely over-used word, the definitions around flexibility were wide and varied. It was also evident that to truly push the boundary on designing for flexibility we may need to look at examples outside of health care. Finally, we realized that an ambiguous definition also hampered stakeholders’ decision making: owners often make a blanket request for ‘flexibility’, but some levels of flexibility require a strategic investment and a clear ROI. In other words, we were missing an actionable framework for flexibility.

Researchers at HKS and Steelcase got together to start chipping away at this question for CADRE. They did workshops and charettes, in-depth interviews with stakeholders, reviewed both peer-reviewed and gray literature, looked for health care and non-health care exemplars, and did a nationwide poll of what stakeholders (health care administrators, facility managers and nursing administrators) thought about flexibility, and what would they invest in. We asked hard questions about “over-investment” in flexibility, and how sometimes flexibility designed, is not flexibility deployed.

The result is this report - FleXX. It proposes a simple and actionable framework to address flexibility. It also calls out the need in to consider flexibility in operations and strategy prior to flexibility in space, and the need for space flexibility to support operational and strategic goals. Finally, it shares some implementation-ready design solutions- ranging from the FFE to shell/core and master planning that can be deployed immediately.

The collaboration between an architectural firm and a furniture solutions vendor allowed us to look at flexibility from a micro to a macro scale. We believe that this report only scratches the surface of this area of study, that will remain relevant at least for our lifetime. Will we see hospitals getting converted to residences, warehouses being converted to clinics, and clinics themselves constantly shape-shifting based on new technologies, procedures and patient/provider needs? Absolutely. Will change be a constant in our industry? Without a doubt. The opportunity lies in developing a clear framework, asking the right questions early, and having a decision-making process so the cost of flexibility (and there is a cost) can truly be leveraged as a strategic investment- one that meets both economic and ethical drivers- because the intersection of ethics and economics is where health care will always sit.

We invite you to join us in this investigation by sharing your thoughts, critiques, suggestions and examples, so we can address the wicked problem of change-readiness, to achieve better outcomes for all.



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00 INTRODUCTION

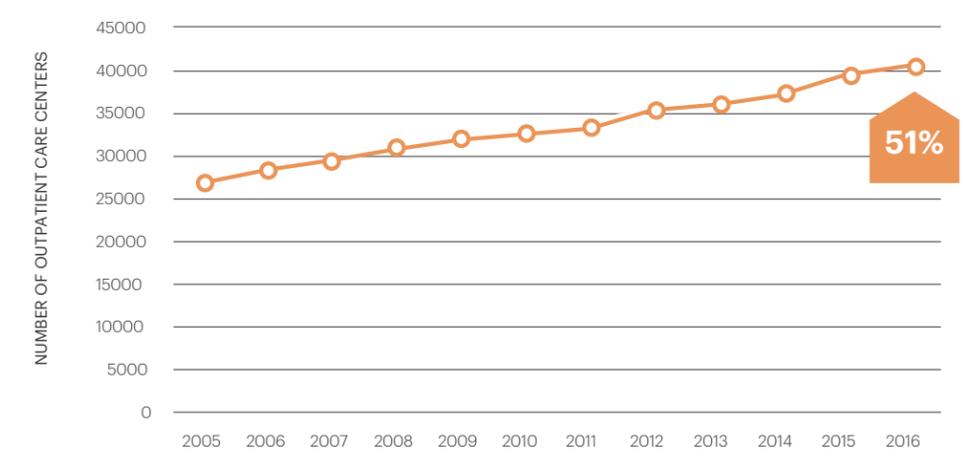
FLEXIBILITY - A CALL TO ACTION

Health care facilities are often designed for a long lifespan—planning for at least 30-50 years of occupancy. During their lifetime, facilities must adjust to new medical technology and equipment, demographic and epidemiological changes, and policy and regulation changes^[1]. Historically, these collective shifts stressed the capability of the building, and the typical response paired ‘building for now and expanding for tomorrow’. The exponential pace of change in recent years combined with a heightened focus on sustainability, however, requires a closer look at health facility design intent. While the entire system will benefit from such scrutiny, the focus of this paper is on the growing ‘out of inpatient hospital’ movement. Outpatient care centers have grown by 51% from 2005 to 2016, which doesn’t seem to be slowing down^[9].

“Technology is changing so fast that providers can bring care to the consumer quicker and in a different way. Providers recognize that they need to deliver care differently than they have in the past. They need adaptable real estate that can evolve with technology.”

– Mark Lamp, CBRE^[9].

📉 INCREASE IN OUTPATIENT CARE CENTERS



Information Source: CBRE analysis of U.S. Census data

This shift to outpatient care is propelled by several key drivers: changes in health policy and consumer driven health exchanges, changing demographics with a demanding millennial and aging boomer population, rapid advances in medicine combined with complexity in disease, and finally the big data and technology revolution. In combination, these drivers are propelling trends such as tele-health, mobile-health, population health, retail health, and coordinated health^[3]. Clinics of today are demanding the ability to be change-ready given uncertainty in the system,

rapid advances in medicine, changing patient expectations and provider demands, changes in technology and data, and a politically and ecologically unstable climate. Keeping up with clinical demands, a changing marketplace, and the rise of catastrophic events puts a challenge on health facilities.

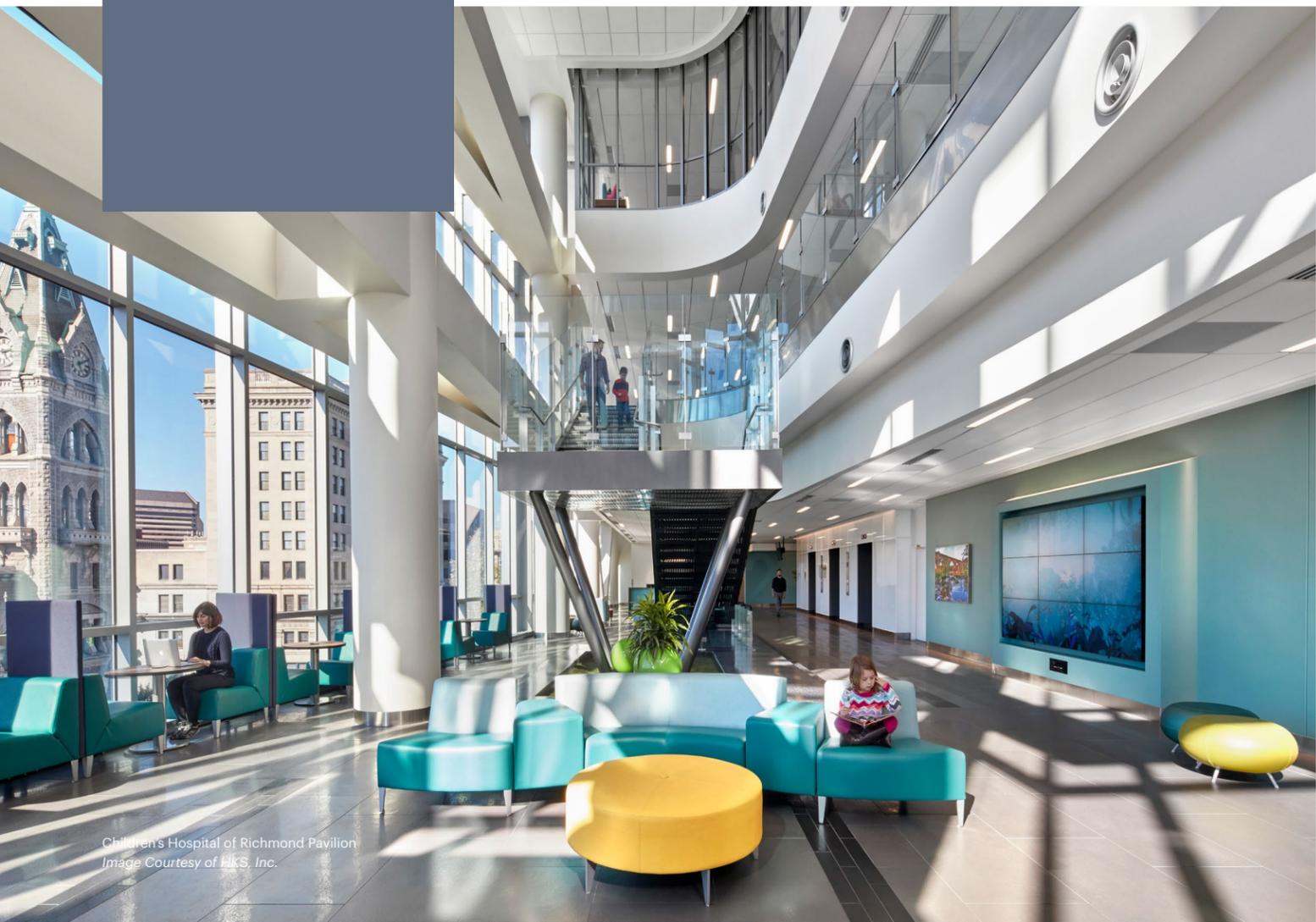
In Clinic 20XX, a study on how outpatient facilities can be designed in an uncertain health care landscape, flexibility emerged as a core tenet of change-readiness along with connectivity and unique sense of place.

Aim

To develop a framework to address flexibility in outpatient clinic settings to create change-ready facilities.

Objectives

1. To understand the various definitions of flexibility and nuances of commonly used terminology.
2. To understand the need for, challenges of, and expectations around flexibility in outpatient settings from three key stakeholder groups: health care administrators, nurse managers and facility managers.
3. To synthesize current frameworks of flexibility [from within and outside the health sector] into a simpler practice-focused framework for outpatient clinics.
4. To validate this framework based on insights from key stakeholders.



Children's Hospital of Richmond Pavilion
Image Courtesy of HKS, Inc.

METHODOLOGY

The research team conducted an extensive literature scan using Google Scholar for academic resources, and expert sites for gray literature (Center for Health Design, Google Scholar, Adaptable Futures, The Advisory Board Company etc.). Students from Kansas University were also asked to do a literature search on flexibility using academic databases, and shared key resources. A systematic literature review with clear inclusion and exclusion criteria was not conducted due to the exploratory nature of the work. Rather, a snowball method was used, where each key article was scanned for its relevant citations, which in turn were then studied. Two independent teams conducted the literature scan—one “analogous” team that worked on non-health care sources and one “HC” team that worked on health care and outpatient specific sources.

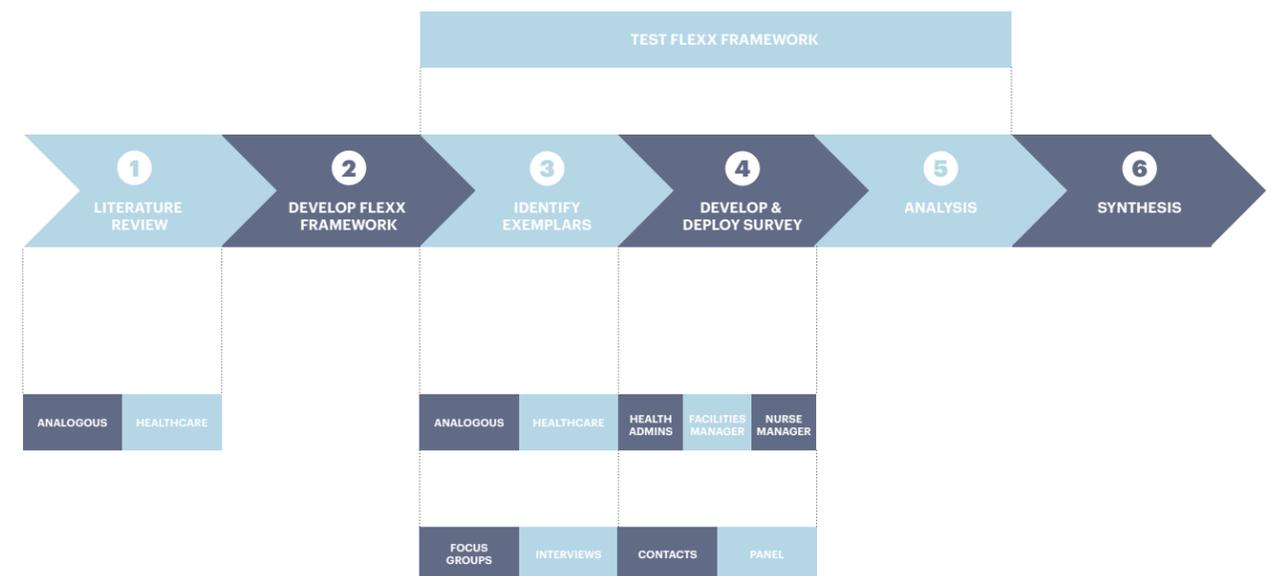
The research team synthesized the literature into key concepts and emergent frameworks, vigorously debating the variant terminologies for flexibility. Adapting Monahan’s (2002) work that most closely aligned with much of the literature on this topic, key insights were crystallized into a working framework for flexibility. Tables of exemplars were created to illustrate the key attributes the framework.

Once a framework was established, a nationwide survey was conducted to understand how the framework held up with real life decision-makers. The survey was directly sent to CADRE, Steelcase and HKS contacts who are in decision-making roles for health care organizations (a total

of 772 surveys were sent). Additionally, the survey was sent specifically to those in health care administrator, facilities manager, or nurse manager roles through a third-party panel. The survey covered six broad areas:

1. Definitions and attributes of flexibility
2. Prioritization and challenges of flexibility features
3. Responses to core framework attributes
4. Use of common tenets such as modularity and standardization
5. ROI on flexibility and successful/ unsuccessful examples of flexible design features
6. Demographic information including age, gender, years in profession, and professional role (e.g., health care administrator, facilities, nurse managers)

The combined survey data from the third-party panel and distribution lists resulted in 143 total responses. ANOVA tests were performed to examine for differences among job roles and between survey response sources. They were largely equivalent but when statistically different, controlled in subsequent analyses. Next, linear regression tests were conducted to identify predictors controlling for the roles and response sources. The survey results were used to gain further insight into outpatient flexibility, assess needs and appetite for flexibility as expressed by key stakeholders, identify common pitfalls, and most importantly test, and validate the proposed FlexX framework.



01 WHAT WE KNOW

Many definitions exist for flexibility. From existing literature, we have developed an emergent framework.

REVIEWING THE LITERATURE

Many Terms for Flexibility

Flexibility is far more than a facility concern, it affects facilities' ability to accommodate changing operational and functional needs^[18]. Additionally, a facility must accommodate emergent and unexpected needs that may be due to catastrophic events such as having surge capacity, which is defined by the American College of Emergency Physicians, as the measurable ability to manage a sudden influx of patients.

The complexity surrounding the concept of flexibility within buildings can be understood through different perspectives, ranging from a set of shearing layers of building components^[3] to a categorization of functional descriptions or attributes of flexibility^[14]. This study approaches a flexible physical environment as an affordance to all other organizational efforts - operational, managerial, or otherwise.

Although there may exist a colloquial sense of flexibility, the definition of flexibility among environmental design scholars and practitioners is not agreed upon. Adaptability, agility, and modifiability are among terms frequently interchanged with flexibility. Some scholars who used adaptability as a synonym of flexibility focus narrowly on how easily changeable with an existing structural system^[24]. Other authors^[17] consider adaptability to be a characteristic of flexibility. A synthesis of three existing frameworks presented by Monahan^[14], Pati et. al.^[17], and Till & Schneider^[26] was

performed to identify common terms that relate across the different frameworks.

The most common way to define flexibility is to present a set attributes or characteristics that make up flexibility. Monahan^[14] deconstructs flexibility into five spatial properties: versatility, modifiability, convertibility, scalability, and fluidity.

Similar qualities were addressed by other authors. For example, Pati and colleagues^[17] interviewed managers, nurses, and support staff at six hospitals and synthesized the findings into three categories: adaptability (associated with short-term operations, without physical environment changes), convertibility (permanently modifying an existing space for a new use), and expandability (increasing square footage of the facilities as an organization grows). While the simplicity of interchangeable terminology and a single definition based on structural change is easy to understand, the nuanced and indeed, real implications of flexibility as parsed by Monahan^[14], and Pati et al.^[17] provide clarity for the designer and client.

Versatility, modifiability, convertibility, and scalability are used as baseline descriptions throughout this study as these were often linked to the attributes discussed in other studies, while fluidity was not.

Versatility
immediate
multifunctional
use

Modifiability
speedy
reconfiguration

Convertibility
ease of re-design
in the future

Scalability
ease of
expansion or
contraction

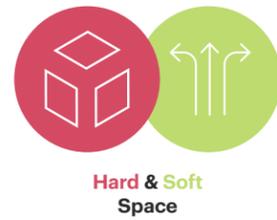
Fluidity
flow of
information,
gaze, sound, etc.

Hard & Soft Space

In their analysis on housing flexibility, Till and Schneider [26] conceptualized flexibility as bi-dimensional—soft and hard. Soft space embraces uncertainty and provides room for the user to adapt the space as they need rather than directing what activities can be afforded by the design.

Villa Verde in Constitucion, Chile is a low-income, incremental housing development. These “half-houses”, by Alejandro Aravena’s firm Elemental, illustrate the soft space principle - each house is built with one identical side fully built out, and the shell for the second. The unfinished half was to be designed by the user, not the architect.

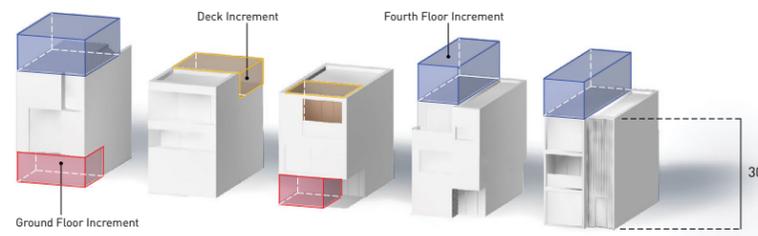
Inspired by this Chilean model of “incremental housing”, the Portola Garden Homes by IwamotoScott Architecture also illustrate the soft space principle. Pre-increment houses are built, and owners can increase their square footage through additional increments that can be added on.



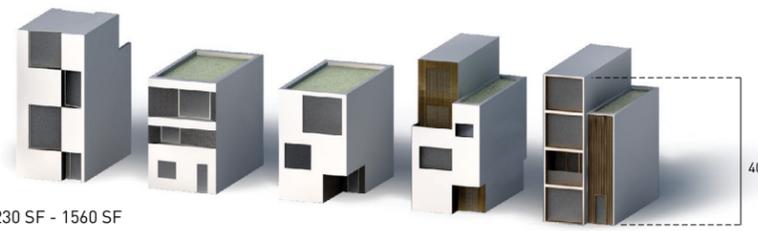
Soft space generally demands some wiggle room and perhaps some redundancy. It is based on a relaxed approach to both planning and technology. Hard space, on the other hand, refers to attributes that more specifically determine the way that the design may be used over time, such as built-in furniture. Interestingly, flexibility as ‘hard space’ is solely determined by the designer. Since all expected activities are fully specified in hard space, it does not require extra room for the user’s input. Therefore, it is generally employed where space is at a premium.



Pre-Increment Massing // Approx. 930 SF



Incremental Typology

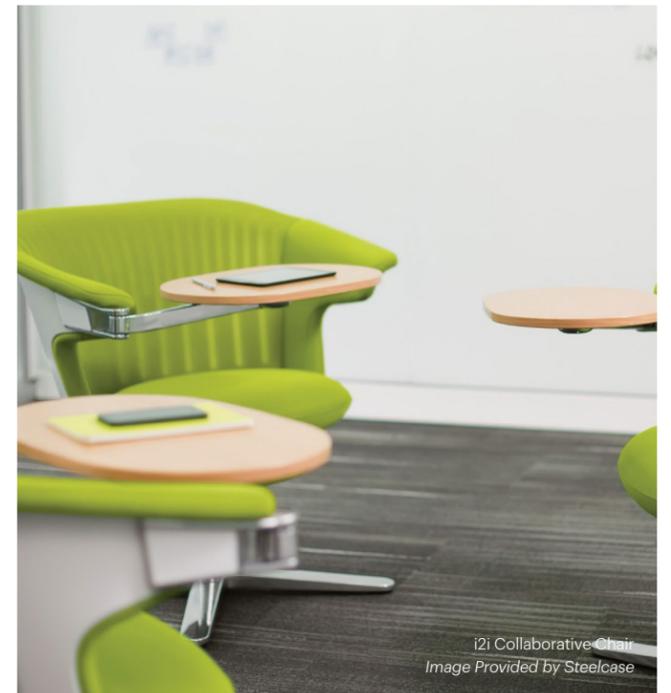


Post-Increment Massing // Approx. 1230 SF - 1560 SF

Portola Garden Homes by IwamotoScott Architecture
Image Courtesy of IwamotoScott Architecture



- Hard**
- + potential damage to finishes when relocating
 - + manual labor
 - + harder to move/relocate
 - + ensure pre-fab fits during construction



- Soft - Mobile Furniture**
- + less disruptive
 - + possible assembly/disassembly
 - + easier to move/relocate
 - + casement size openings important

Soft and hard space align well with Monahan’s spatial properties. As modifiability and scalability welcome user’s short-term and long-term inputs, respectively, they are related to soft space design approach while versatility can be either hard (e.g., built-in furniture) or soft space (e.g., multipurpose room), depending on how it is designed. Convertibility may be considered soft space in other types of buildings. However, in health care facilities, convertibility is likely limited to infrastructure requirements per room type. Therefore, convertibility in health care facilities depends on both soft and hard space.

A core component of flexibility, especially associated with hard space, is standardization [26]. Standardization is the development and implementation of a standard [20] [27], and research suggests that standardized environments can provide familiarity, routinizing care processes and

potentially reducing medical errors [19]. Monahan [14] links standardization to versatility and modifiability by use of standard parts that are easily interchanged.

The Joint Commission [25] suggests six strategies for flexible design for future changes in health care facilities:

1. Master planning for future expansion
2. Loose-fit design promoting extra sq. ft. for future changes,
3. Adaptable flexibility for multiple functions
4. Convertible flexibility for a new permanent use
5. Robust utilities having extra capacities for the future
6. Plug-and-play infrastructure to minimize interruption during future construction

These descriptors align well to the original presentation of Monahan’s [14] spatial properties.

📌 BUILDING LIFESPAN AND SYSTEMS

PRIMARY
LIFESPAN | ~100 YEARS

Base of the building with longest lasting components



TERTIARY
LIFESPAN | 5-10 YEARS

Infill of building with frequently changing parts



SECONDARY
LIFESPAN | 20 YEARS

Infill of building with frequently changing parts



Information Source: Kendall [10]

Flexibility: The Temporal Dimension

Flexibility may also be understood in the temporal dimension. Kendall [10] suggested three levels of building system lifespans: primary (about 100 years), secondary (about 20 years), and tertiary (5 – 10 years) systems. Pressler [16] categorized flexibility as short-term (e.g. operational changes within a day or a few days without structural modifications) vs. long-term (future major changes such as re-configuration, expansion or contraction) flexibility in health care facilities. Versatility and modifiability in Monahan's [14] are likely short-term whereas convertibility and scalability are long-term.

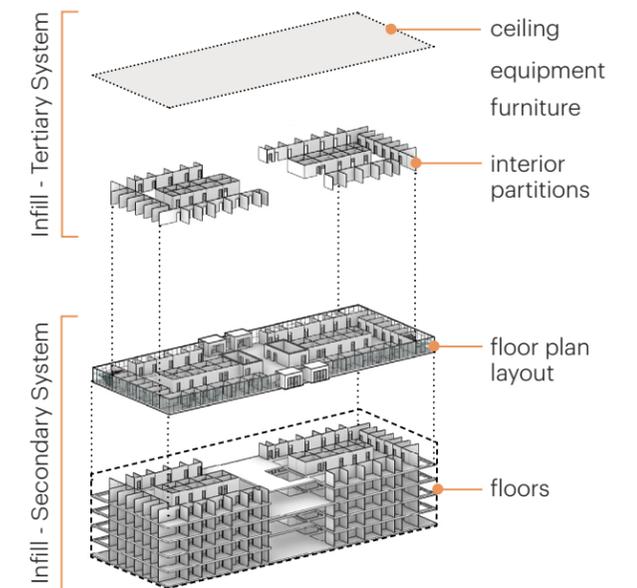
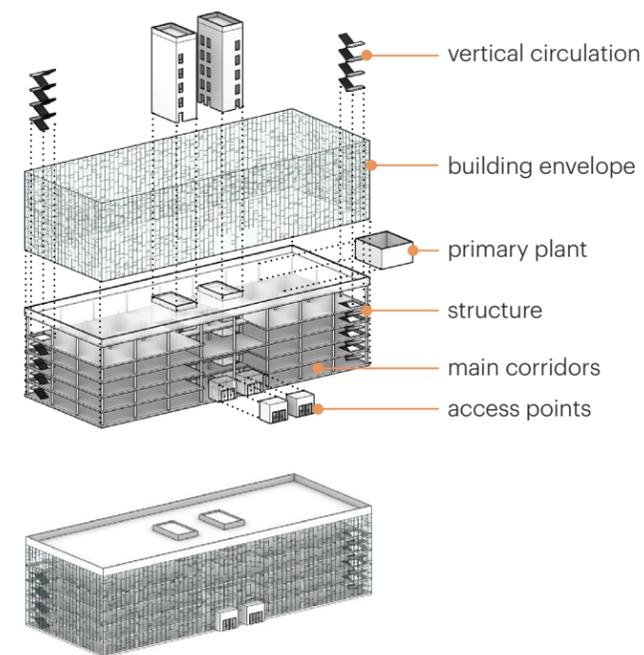
A well-established framework from flexibility comes from the residential sector via the open building [13] approach. The concept originated with residential architecture, most prominently in the work published by John Habraken [12], describing the design of buildings to be made through self-contained decision-making at many different levels, but in close relation to one another. Capolongo and colleagues [5] also refers to an approach which makes “a definite distinction among the components of a building, a distinction that is based on how long they are supposed to last and who should be able to alter them”. Both approaches imply temporal dimensions discussed above.

Building Component Distinction

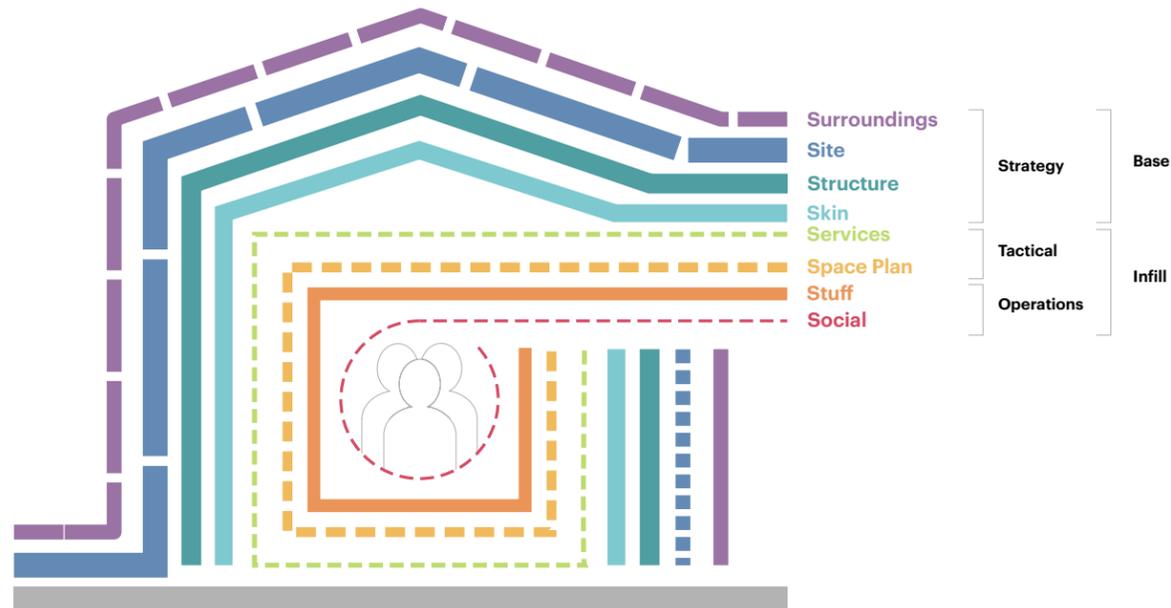
Capolongo and colleagues propose key distinctions within a building are the base building, the primary system, and infill, made up of a secondary and tertiary system. The two groups organize a selection of building components into understandable pieces where flexibility is different within each group. The base building refers to a combination of the longest lasting components of a building being the primary system which includes the structure, building envelope, vertical circulation, like stairs and elevators, lasting up to 100 years. The infill refers to the “frequently changing parts”, which make up the space planning configuration as a secondary system with attributes such as interior partitions, floors, and false ceilings lasting up to 20 years, and a tertiary system made up of furniture, fixtures, and equipment lasting up to 5 years.

To integrate this method into an applicable use, an evaluation tool was created and used on multiple case studies to test its effectiveness. Capolongo and colleagues [5] developed an approach to analyze buildings and a tool to test how flexible a building is. The tool consists of eight identified building parameters that relate to the open building approach; shape, structure, facade, building plant, expandability, restrictions, technologies, and exchangeability of larger equipment. The evaluation method is an example of how to apply the Brand's layers referenced in other work and the attributes of flexibility to understand where flexibility is most valuable, and potentially where to best invest resources for new projects. However, further discussion about evaluation tools is beyond the scope of this report.

📌 BASE BUILDING - PRIMARY SYSTEM



FUNCTIONAL AND BUILDING LAYERS



Adapted from Adaptable Futures [1] and Pressler [18]

Strategy, Tactical, Operations

Flexibility can also be described as strategic, tactical and operational. de Neufville, Lee, and Scholtes [6] applied Edwards’ [7] framework of airport systems to health care facilities and defined flexibility as strategic, tactical and operational. Strategic flexibility requires infrastructure and building envelope/ skin changes and has the longest life cycle whereas operational flexibility involves daily or weekly change/ operations (e.g. furniture). Tactical flexibility deals with spatial planning and operations within the building envelope and with the infrastructure. Flexibility both in building design and in management is hierarchical--smaller scale flexibility is limited by larger scale flexibility [6]. Logically, the temporal dimensions of flexibility are interrelated with building components characteristics; both seem to conceptually subsume under Monahan’s more abstract framework.

Building Layers

Similar studies and approaches toward flexibility in the built environment have been done by Adaptable Futures, a research group at Loughborough University focusing on “unpacking adaptability in detail looking at the complex web

of dependencies that induce, hinder, and accommodate change” [1]. Schmidt III [22] defines adaptability as “the capacity of a building to accommodate effectively the evolving demands of its context, thus maximizing value through life.” A framecycle diagram organizes a hierarchy of strategies for adaptability and their potential uses. This model also aligns with the four spatial properties from Monahan [14], and in fact extends it with two different categories; movable and refitable. An influential outcome of this investigation is a tool kit of different frameworks currently that extends the number of frameworks from 11 in Schmidt III [21] to 20 on their website [1]. These are presented as living frameworks, sought to be tested and revised through case studies and further investigations.

The presence of so many frameworks suggests the breadth of complexity surrounding the topic of flexibility/adaptability for buildings and numerous perspectives one could view it. One key tool in this work is an expansion of Brand’s [3] layers of the building to include social and surroundings. Social is an attempt to include human activity in and around the building, while surroundings are an attempt to consider the context in which the building was built.

Comprehensive Perspectives

Gathering from the literature there are clearly many different ways to view or describe flexibility and flexible spaces. It becomes significant to ensure a cohesive understanding of the different perspectives and how they relate to each other before attempting to design with these concepts. An outline of the common frameworks was examined and how the relating building layers to help find a common denominator between them. Doing so we can begin to extract meaningful concepts of flexibility and relate them to physical areas of the building which we can design.

Synopsis of the main perspective or overarching perspective helps to clarify how each of these frameworks are conceptually different. Categorizing each perspective as described in the assessed literature begins to frame the

lens under which flexibility is being used. Pairing each perspective with its definition allows clear understanding of what is meant by each perspective when used in context of design strategy. Essentially this is an outlined summary of the main concepts, meaning, and applicable flexible attributes that can be used for design.

Furthermore, we can view the different frameworks and how they relate to the building and design flexible solutions according to the appropriate building layer. From here we can begin to extract a more holistic understanding of what the implications might be if a flexible space is designed, what part of the building it relates to, how long to expect that design to be relevant, and what type of consultant or expert may need to be contacted for further clarification.

PERSPECTIVE	DEFINITION	CITATION
Attributes	The different attributes of flexibility such as Fluidity, Versatility, Modifiability, Convertibility, and Scalability.	Monahan, 2002
Soft / Hard	Hard space has limited change options from the design. Soft space has open options for the user.	Pressler, 2006
Temporal	The lifespan of building components such as short and long as well as: Primary (100 years), Secondary (20 years), and Tertiary (5-10 years). Operational - day-to-day; fast change Tactical - months away; slow change Strategic - years away; infrastructural change	Kendall, 2005 de Neufville, et al., 2008
Base/Infill	Primary purpose is differentiating the main macro systems of a building as the base building and the micro systems within it as the infill.	Kendall, 2000, 2011 Capolongo, 2016
Building Layers	Specific layers that make up the building. Referred to as shearing layers such as: Social, Stuff, Space Planning, Services, Skin, Structure, Site, Surrounding	Shuchi, 2012 Adaptable Futures, 2017



Surround Collection for Families in the Patient Room
Image Provided by Steelcase

SOCIAL



Sync Workstations
Image Provided by Steelcase

STUFF



ProMedica Health and Wellness Center
Image Provided by HKS, Inc.

SPACE PLANNING



Image Source: Getty Images

SERVICES



Centro Medico ABC Critical Care Tower
Image Provided by HKS, Inc.

SKIN



Phoenix Children's Hospital
Image Provided by HKS, Inc.

STRUCTURE



Intermountain Healthcare Layton Hospital
Image Provided by HKS, Inc.

SITE



Centro Medico ABC Critical Care Tower
Image Provided by HKS, Inc.

SURROUNDINGS

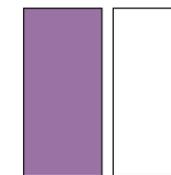
ATTRIBUTES TO BUILDING LAYERS

The four attributes of flexibility in Monahan's [14] work - versatility, modifiability, convertibility, and scalability - were supported by work from other scholars and were further used to organize examples of each concept. Fluidity, however, was rarely discussed in Monahan's or in others' work. This does not mean it is less important. Rather, we hypothesize that fluidity may be viewed as an outcome of flexibility or related to work flow or density of space, where the other four attributes of flexibility can be associated with space and other layers of the building directly. This paper focuses on Monahan's [14] versatility, modifiability, convertibility, and scalability as core attributes.

The core attributes are discussed in more detail in the following sections. Each of these attributes was examined in the context of the eight layers in Capolongo and colleagues' [5] - social, stuff, space planning, services, skin, structure, site, and surroundings--but not all the layers are equally relevant to each of the core attributes. A table is provided for each attribute comparing examples of each building layer, where relevant, from within health care and analogous examples outside of health care. In the next section we take the key attributes of flexibility and assess them in the context of building layers.

ATTRIBUTES AND LAYERS OF FLEXIBILITY

BUILDING LAYER	VERSATILITY	MODIFIABILITY	CONVERTIBILITY	SCALABILITY
Social People, flow				
Stuff Furniture, fixtures, equipment				
Space Planning				
Services MEP				
Skin Building envelope				
Structure				
Site				
Surroundings Master planning				



VERSATILITY

“I CAN DO DIFFERENT THINGS IN IT”

Versatility in a building is defined as the ability or intention for a space to be used for multiple and different functions with limited or zero change to tangible building attributes, where the user has agency.

Versatility, either designed as a hard space with fixed options for change provided from the designer or a soft space with open use, largely depends on the user. Often characterized by open space, basic affordances are provided to be used in a multitude of interdependent ways. A conceptual example of versatility is the “kitchen table”. A kitchen table is versatile because it allows differing uses without

physical transformation. Versatile design strategies tend to be conditioned with functionality and human engagement effecting operational strategies of the facility. Multi-use spaces are not ‘empty’ space. Rather design takes an efficient approach to maximize use through simple affordances providing the option to operate for different functions as needed.

VERSATILITY

ALLOWS MULTIPLE USES

BUILDING LAYER

EXEMPLAR

Social

People, flow

*Image Courtesy of David Savage
Designed by Norman Foster*

Maggie's Centres

Focused on social connection and community building



Stuff

Furniture, fixtures, equipment

*Designed by and Image
Courtesy of Steelcase*

Embold

Designed for clinical needs but can be utilized in other spaces as well



Space Planning

*Designed by and Image
Courtesy of HKS, Inc.*

Texas Scottish Rite Hospital for Children North Campus

Standardized patient rooms and core work spaces that are equipped for any clinic's needs



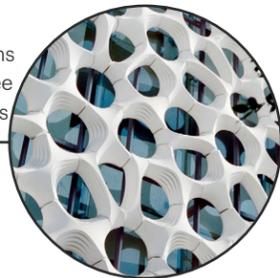
Services

MEP

*Designed by and Image
Courtesy of HKS, Inc.*

Dell Seton Medical Center at The University of Texas

HVAC equipment serving patient rooms installed in corridor for interruption free maintenance and room layout changes



Skin

Building envelope

*Image Courtesy of Alejandro Cartagena
Designed by Elegant Embellishments*

Manuel Gea Gonzalez Hospital

Double skinned facade helps clean polluted air and is a solar gain blocker



Structure

*Image Courtesy of Tayler Chan
Designed by Ludwig Mies van der Rohe*

Crown Hall

Column free space supported by a suspended roof structure; designed for multiple uses - exhibitions, studios, lectures and events



Site

*Designed by and Image
Courtesy of HKS, Inc.*

UCSD North Torrey Pines Living and Learning Neighborhood

Open, green space allowing for various outdoor activities, prominently located on-site



Surroundings

Master planning

*Designed by and Image
Courtesy of HKS, Inc.*

U.S. Bank Stadium

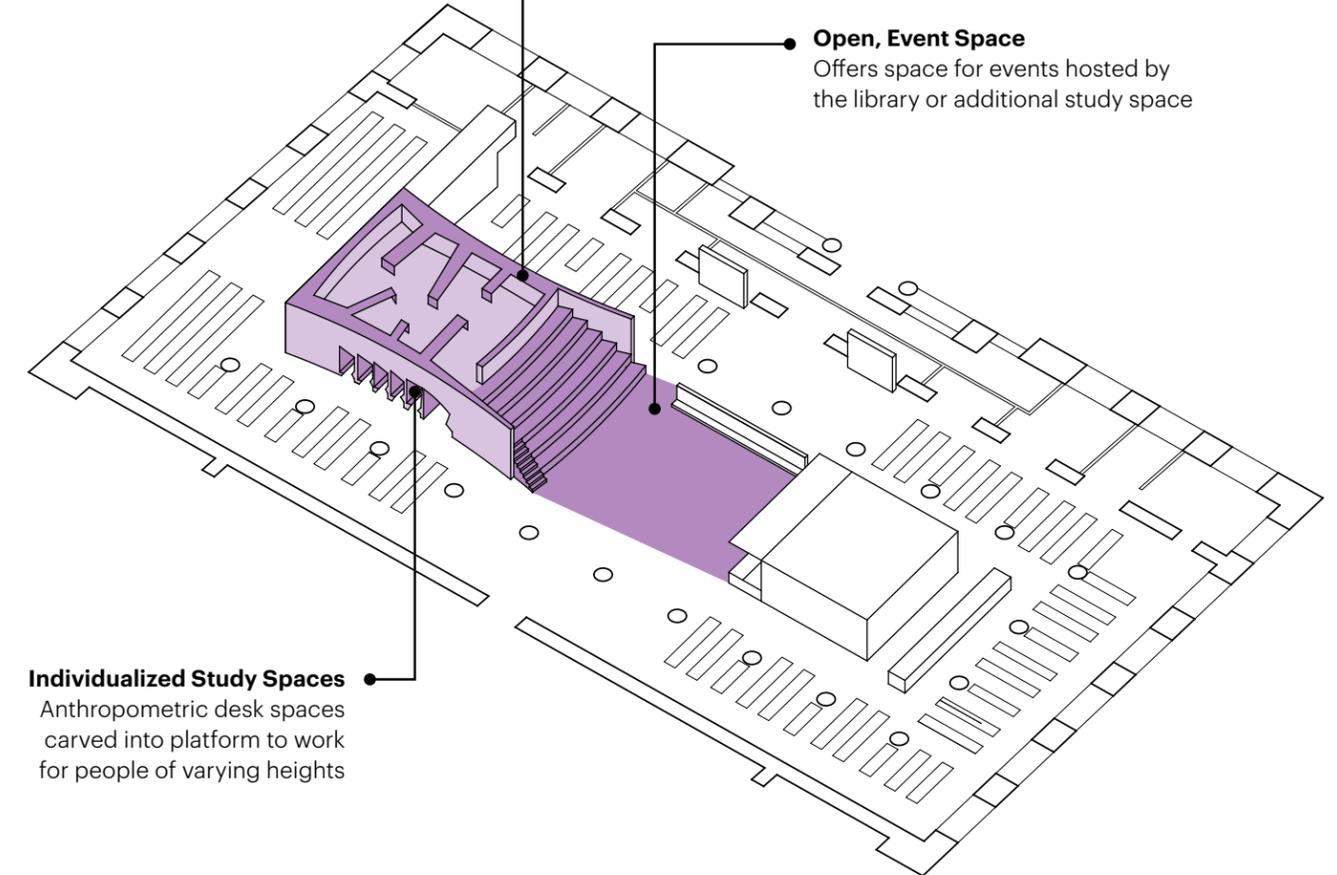
Designed as a multi-purpose venue and surrounding site, aims to enhance landscape and culture of the community

Multi-purpose, Elevated Platform

Large furniture piece carved for different functions, like studying, with large steps offering auditorium seating

Open, Event Space

Offers space for events hosted by the library or additional study space



Individualized Study Spaces

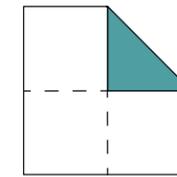
Anthropometric desk spaces carved into platform to work for people of varying heights

Adapted from MPdL Studio

RISD Fleet Library Renovation

Multi-use open space is a common design approach for many architectural projects, such as the Fleet Library renovation at RISD by Monica Ponce De Leon. The open space is positioned along the central axis of the existing library. The addition is a large platform and pavilion like structure flanking open space with mobile furniture intended to facilitate study and lounge. The project was envisioned more like a large furniture piece that is carved away for different functions. The elevated platform with large steps affords seating for audience and allows the

space to be re-programmed for events hosted by the library. A unique approach for greater versatility of this multi-use space is the series of individual spaces that range in anthropometric needs from the tallest man to the shortest woman for working desk dimensions carved into the base of the elevated platform. These working desks are examples of "hard" spaces where instead of a generic, 'one size fits all' work surface, the individual can pick and choose which space works for them. The dimensional gradient of spaces provides many different opportunities of engagement and use within the larger platform.



MODIFIABILITY

“I CAN CHANGE IT”

Modifiability in a building is an attribute that welcomes interaction from the user to physically change to a desired function within the space.

Modifiable attributes can adjust without any permanent infill structure change, i.e. interchangeable wall panels, modular/mobile furniture, mobile or plug-in play equipment, rolling partition walls, and accordion wall partitions. A conceptual example of modifiability is a baby crib which modifies to a bed, providing a different use given the change of need at the time of the

need. Modifiability in practice aligns mostly with the building interior. Notice the building layers associated with modifiability do not extend to the surroundings and are perhaps the most relevant at the level of “stuff” with prominence on FFE (Furniture/ Fixtures and Equipment) considerations. Many landscape elements can be modifiable as well.

MODIFIABILITY

MANIPULATE FOR DIFFERENT USES

BUILDING LAYER

EXEMPLAR

Social
People, flow

Sunderland Royal Hospital
SmartGlass modifies view from transparent to opaque as needed for privacy



*Image Courtesy of Smart Glass International
Design by NHS Trust, HDP Architects*

Stuff
Furniture, fixtures, equipment

Surround
Adjustable furniture for family needs
Norton Women's & Kosair Children's Hospital - NICU
Mobile walls for desired privacy



Designed by and Images Courtesy of HKS, Inc. and Steelcase

Space Planning

Arlington Independent School District Fine Arts Center
For performances, partitions can be opened to connect rehearsal room, open gathering space, and stair for socialization and study



Designed by and Image Courtesy of HKS, Inc.

Services
MEP



Skin
Building envelope

Al Bahr Towers
Computer-controlled, dynamic screen system, responding to the movement of the sun to avoid solar gain and glare

*Image Source: Getty Images
Designed by AHR*

Structure

Site

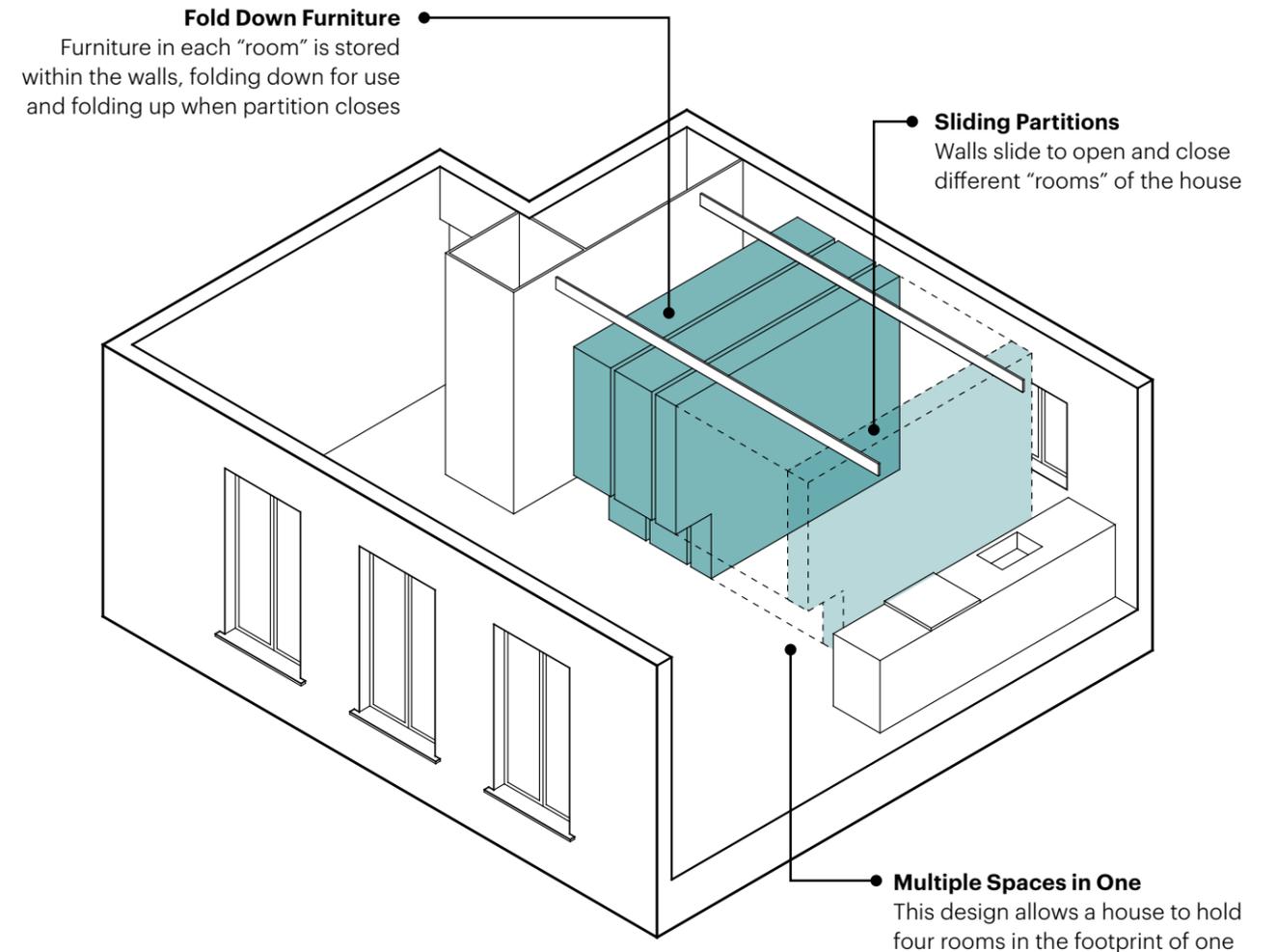
ProMedica Corporate Headquarters
This campus has an open, adjacent, green space that can host farmer's markets, festivals, temporary art installations, and movies in the park



Designed by and Image Courtesy of HKS, Inc.

Surroundings

Master planning



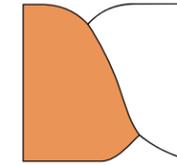
Adapted from PKMN Architectures

“All I Own House”

Modifiable design solutions are among the most popular methods for providing ad hoc flexibility to any spatial design and typically is exemplified in the furnishings and interior design. Open offices use modular desks systems, retail uses modular displays, and most open spaces provide mobile furniture for easy re-arranging of how the space can be used.

A great example of modifiability is the “All I Own House” by PKMN Architectures (no longer in business) as an approach to maximize usefulness of space through modification. The house is a small single-story house in Madrid that changed occupants and therefore lifestyles from simple to dynamic, accommodating a broader array of activities. PKMN’s solution was a somewhat unique approach of providing

three thickened walls hung on tracks to divide up half of the main open space of the house. As the walls slide along the track, they open some spaces and close other adjusting with the changing demand everyday use. The walls house storage for personal belongings, cleaning supplies, clothes, bookshelves, and more. On one end of the house a wall unit provides a fold down table opposite the fixed kitchen and utility for the working studio of the owner. Another unit provides a fold down bed and personal library on the opposite side. The third unit provides closet storage for clothes and faces the bathroom on the other end of the house. These common necessities allow a single space to be modified and operate as four different spaces with different uses and modifications within each.



CONVERTIBILITY

"IT CAN CHANGE"

Convertibility in a building is defined as the ability to replace the infill, while keeping the base building the same, in order to adapt for a new purpose.

A conceptual example of convertibility is the repurposed shipping container. The original purpose is to secure goods for shipment, but it can be reconfigured to provide different functions, including occupancy and shelter. It is similar to modifiability but operates at a slightly different scale of the floor plan. The most common example in practice is demountable

walls which can be reconfigured to make different room divisions. The success of convertible design strategies is closely related to the understanding of the associated building elements touching the piece being converted. If these related elements are not considered, the convertibility of the installed piece is severely hindered.

CONVERTIBILITY

ADAPT FOR NEW USES

BUILDING LAYER

EXEMPLAR

Social
People, flow

Stuff
Furniture, fixtures, equipment

Designed by and Image Courtesy of Steelcase

Convey
Modular casework installed on a rail system, allowing cabinetry to be moved, changed, and reconfigured with minimal dust and disruption

Space Planning

Designed by and Image Courtesy of HKS, Inc.

ProMedica Health & Wellness Center
Clinic modules are zoned with a consistent layout, allowing for various specialty clinics with little construction

Services
MEP

Produced by and Image Courtesy of SLD Technology

AirFRAME by SLD Technology
Prefabricated, modular OR ceiling, integrating air diffusion and lighting, allowing for changing light and boom layouts

Skin
Building envelope

Designed by and Image Courtesy of HKS, Inc.

Scott & White Reskin
Original facade modified with second layer, glazing system, for passive heat transfer efficiency

Structure

Designed by and Image Courtesy of HKS, Inc.

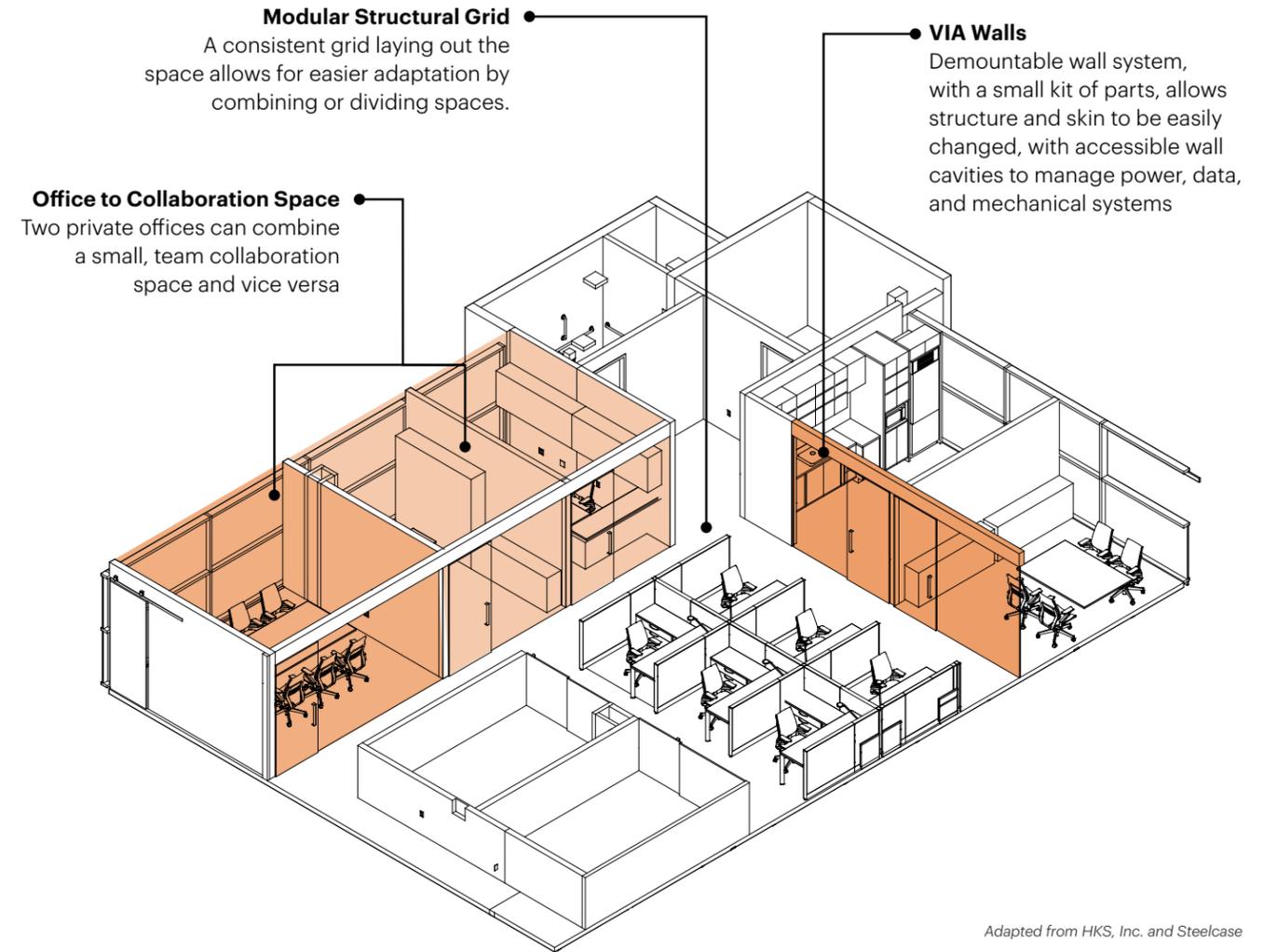
UT Center for BrainHealth
Existing, vacant building gutted to renovate and create a research center; structure added to enclose parking area and covered by existing building

Site

Designed by and Image Courtesy of HKS, Inc.

Lake Highlands High School HUB
Outdoor circulation and green space enclosed to physically and visually connect through a safe and restorative, multi-use, learning environment

Surroundings
Master planning



Adapted from HKS, Inc. and Steelcase

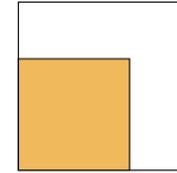
Phoenix Children's Hospital Administration

Convertible design solutions build in responsiveness to change. Design may recommend demountable partitions and moveable walls when future planning anticipates a state change, as demands shift and care models change.

The Phoenix Children's Hospital Administration building was designed with nimble adaptation in mind. The client had made a progressive leap from a siloed, closed office culture to a varied offering of work areas designed to bring people together. The design provided the ability to continue to transition spaces from closed to open, individual to team based, as their culture continued to evolve. Demountable partitions created universal modules of space that could

combine adjacent spaces into larger meeting spaces or transform into open plan workstations. The VIA system by Steelcase created a consistent framework, with a small kit of parts, allowing future adjustability of both the structure and skin with minimal disruption and cost.

Clinics are also beginning to evolve using convertible concepts. The same concept of a universal module allows offices to convert to patient modules if demand increases. A demountable wall system combined with a standardized modular clinic room planning kit makes it possible to adapt with less effort and suggests a smoother transition to a new functional layout.



SCALABILITY

"IT CAN GROW OR SHRINK"

Scalability is defined as the attribute that allows a building to expand or contract according to changing demands.

The capability of a building to expand or contract, requires a holistic understanding of all building systems. The structure and MEP systems are vital to a building's scalability and must be intentionally designed to allow efficient change to the building scale. These stipulations make scalability the most complex of the attributes of flexibility.

A conceptual example of scalability

is the International Space Station (ISS). The ISS is designed to expand and contract its functionality based on the implementation of new technology or additional spatial needs. The main pods are designed as a modular system that connect through a standard design. Each pod's function is independent to the connection mechanism, allowing pods to be added or removed wherever needed.

SCALABILITY

EXPANDS OR CONTRACTS

BUILDING LAYER

EXEMPLAR

Social
People, flow

Designed by and Image Courtesy of HKS, Inc.

HKS Headquarters Learning Center
Can be opened to connect with additional auditorium seating can capture passersby or closed to ensure privacy for smaller groups



Stuff
Furniture, fixtures, equipment

Designed by and Image Courtesy of Steelcase

Convey Modular Casework
Modular casework allows for standard room design including cabinetry, allowing for standardized duplication across facilities



Space Planning

Designed by and Image Courtesy of HKS, Inc.

McKay-Dee Hospital Center
Organized for future growth with plug and play chassis, while maintaining public circulation and wayfinding



Services
MEP

Image Courtesy of HKS, Inc. Product by Pivotek

Sanford Health Fargo Medical Center
Prefabricated bathroom modules, extensively prototyped prior to fabrication for easy installation



Skin
Building envelope

Image Source: Getty Images Designed by Studio Libeskind

Royal Ontario Museum
Addition expanded the occupiable space beyond existing street facade



Structure

Designed by and Image Courtesy of HKS, Inc.

University of Texas MD Anderson Cancer Center Alkek Tower
Oversized columns allowed for eight floor vertical expansion; expanded floorplates



Site

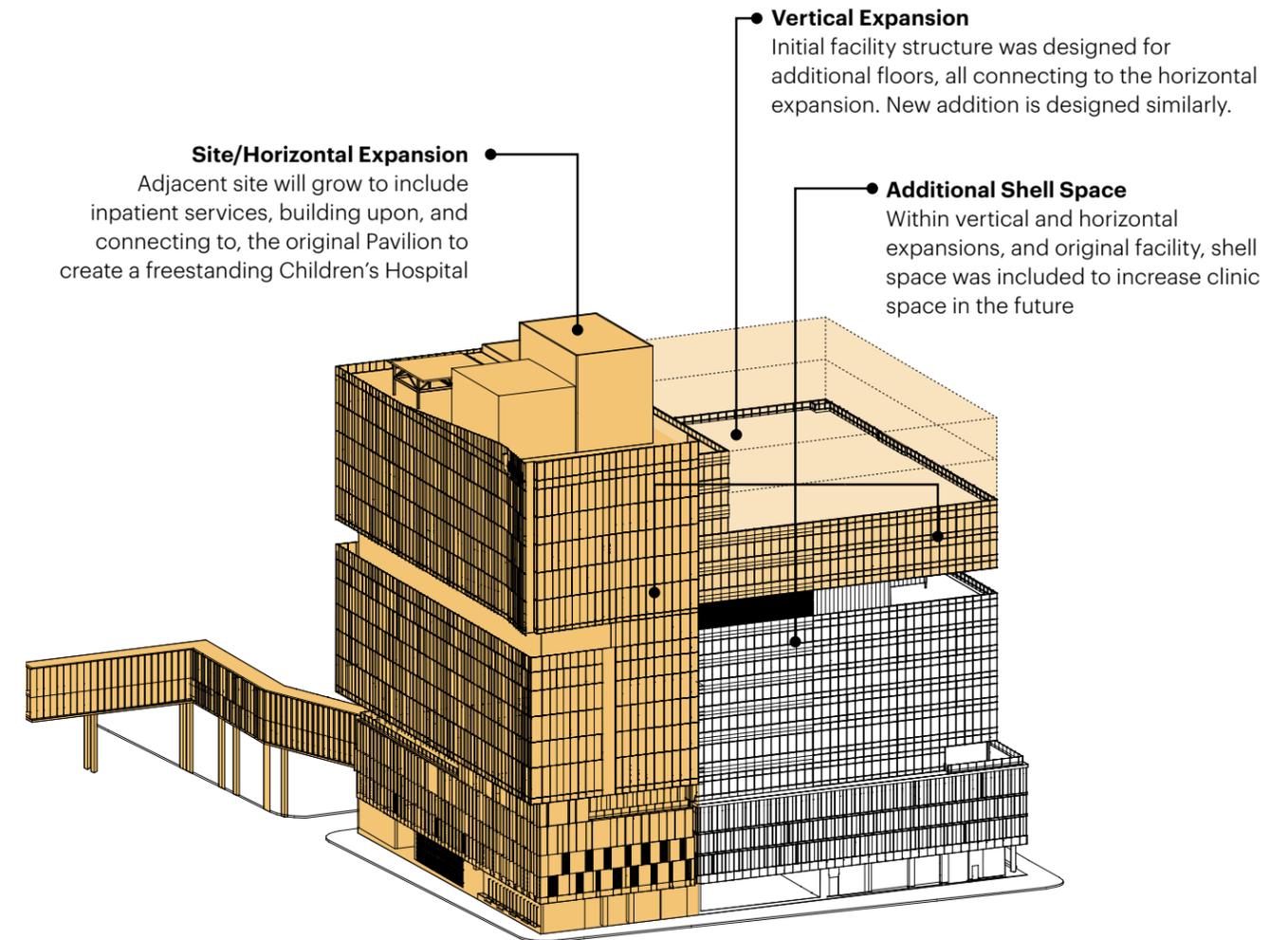
Image Courtesy of Melissa Hoelting Designed by Page

Center for BrainHealth, Brain Performance Institute
Site expansion planned on adjacent parking lot to provide more space and service offerings

Surroundings
Master planning

Product by and Image Courtesy of Weatherhaven

Field Hospitals (Level III) by Weatherhaven
Portable, medical shelters linked to interconnector kits, which link to a central corridor to create larger facilities



Adapted from conceptual rendering by HKS, Inc.

Children's Hospital of Richmond Pavilion

Scalability can be addressed through various methods, including shell space, oversized structural elements, and modular construction. However, majority of the time, the built environment is scaling up rather than growing smaller.

Virginia Commonwealth University Health's Children's Hospital of Richmond Pavilion by HKS, Inc. designed several of the building layers in their initial facility and its new addition to account for future growth potential. The first building, which opened in 2016, was comprised of a pediatric outpatient facility, with the capability to grow vertically by six floors and then horizontally into the adjacent site. These additions expand it into a full, freestanding children's hospital, a project that is currently being designed. The structure in the original building was designed to allow for vertical expansion. On the facade adjacent to the site for intended for the expansion, the skin installed was a less

expensive metal panel system, designed to be taken out entirely. This will allow the original building and the addition to be connected. Within the addition, there is planned shell space, allowing for additional clinical space in the future.

There are several explorations around scalability through the use of modular construction currently underway including Mott McDonald, Kattera, RAD URBAN, Kasita, SLI, ARUP, and others. It seems the industry is searching for a way to future proof for the retrofit of tomorrow. Numerous market research findings point to a sharp increase in housing and building needs. The methods currently being explored are promising, but a standardized solution has yet to be established industry wide, leaving an open opportunity for design exploration. Lessons from other complex, rapidly built typologies could be valuable for health care design, and the flexibility considerations for outpatient clinics.

REFRAMING FLEXIBILITY

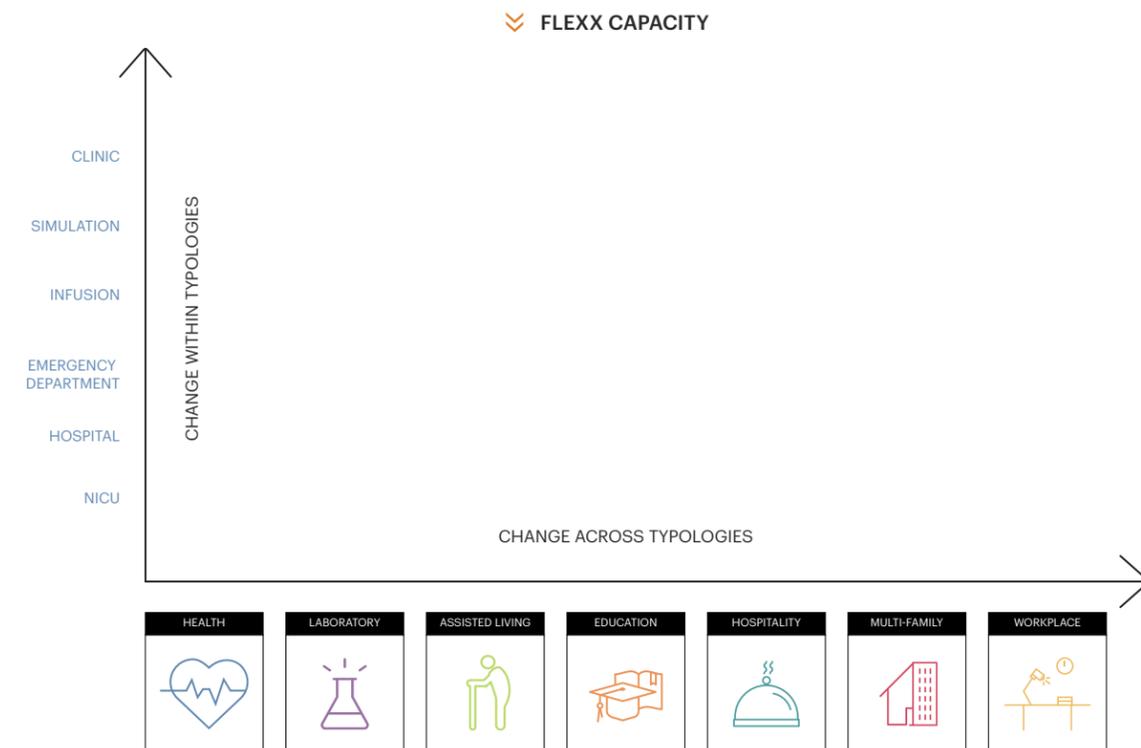
Flexibility has been examined from multiple perspectives including ease of change [14] [17], duration of attributes [10], and building layers [1]. Descriptions of the four different attributes along with examples within the different building layers is presented as a synthesis of current knowledge. The goal is to clarify where flexibility manifests within the built environment and provide a common understanding of what type of flexibility there is and where to best achieve it within the building.

Identifying the attributes of flexibility in the built environment requires a clearer conceptual definition of how each attribute is applied and in what application. Terminology is critical when discussing flexibility and is further complicated when used by those with different academic and professional backgrounds. It is important to develop a simple, actionable framework with clear exemplars and directives for use in general architectural practice, that are not limited to a health care context, but can be extrapolated to work for all types of buildings. The

level of FleXX can be thought of designing to flex within a single typology or across multiple typologies. Depending on the intended use of the building, each approach will require a different solution, developing a FleXX capacity.

To assist with determining a flexible solution, a framework is presented to provide a comprehensive understanding of the impact of each attribute. Each of these four attributes are provided on a spectrum addressing flexibility, including ease of change, type of change, who changes it, and the cost of change.

Each of these can affect the different layers of the building but may affect some more than others. To ensure a systemic approach to the built environment, all layers of the building must be considered ranging all the way from master plan to people, not only base and infill. It becomes important to understand what stakeholders feel about this approach before moving further.



	 <i>Kitchen Table</i>	 <i>Baby Crib</i>	 <i>Shipping Container</i>	 <i>International Space Station</i>
	VERSATILITY I can do different things in it	MODIFIABILITY I can change it	CONVERTIBILITY It can change	SCALABILITY It can grow or shrink
LEVEL OF EASE	 easy difficult	 easy difficult	 easy difficult	 easy difficult
EXAMPLES	+ multi-purpose space + built-ins with multiple uses	+ mobile furniture + moveable partitions + rolling equipment	+ demountable partitions + reconfigurable walls	+ structure +MEP
TIMEFRAME	 a single user can change use within minutes	 a single user can change within minutes to weeks	 a facility can change within weeks to months	 a facility can change within months to years
COST	 first cost	 first cost	 renovation	 new construction
STATE CHANGE	Adapt between states		Adapt to a new state	

ABOUT THE SURVEY

Using a third-party survey provider, a nationwide panel of clinical and facility leaders in outpatient facilities was conducted to understand the perspective of key stakeholders (health care administrators, nurse managers and facility managers of outpatient clinics) to test and further develop this framework as well as identify strategies for implementing flexibility. This survey was also sent out to email distribution lists from Steelcase & HKS.

The combined survey data resulted in 143 total responses from 40 health care administrators, 37 facilities managers, 51 nurse managers, and 15 in miscellaneous roles (table below). The respondents had an average of 28 years of experience their profession.

02 WHAT STAKEHOLDERS THINK

To understand the perspective of key stakeholders, online surveys were conducted.

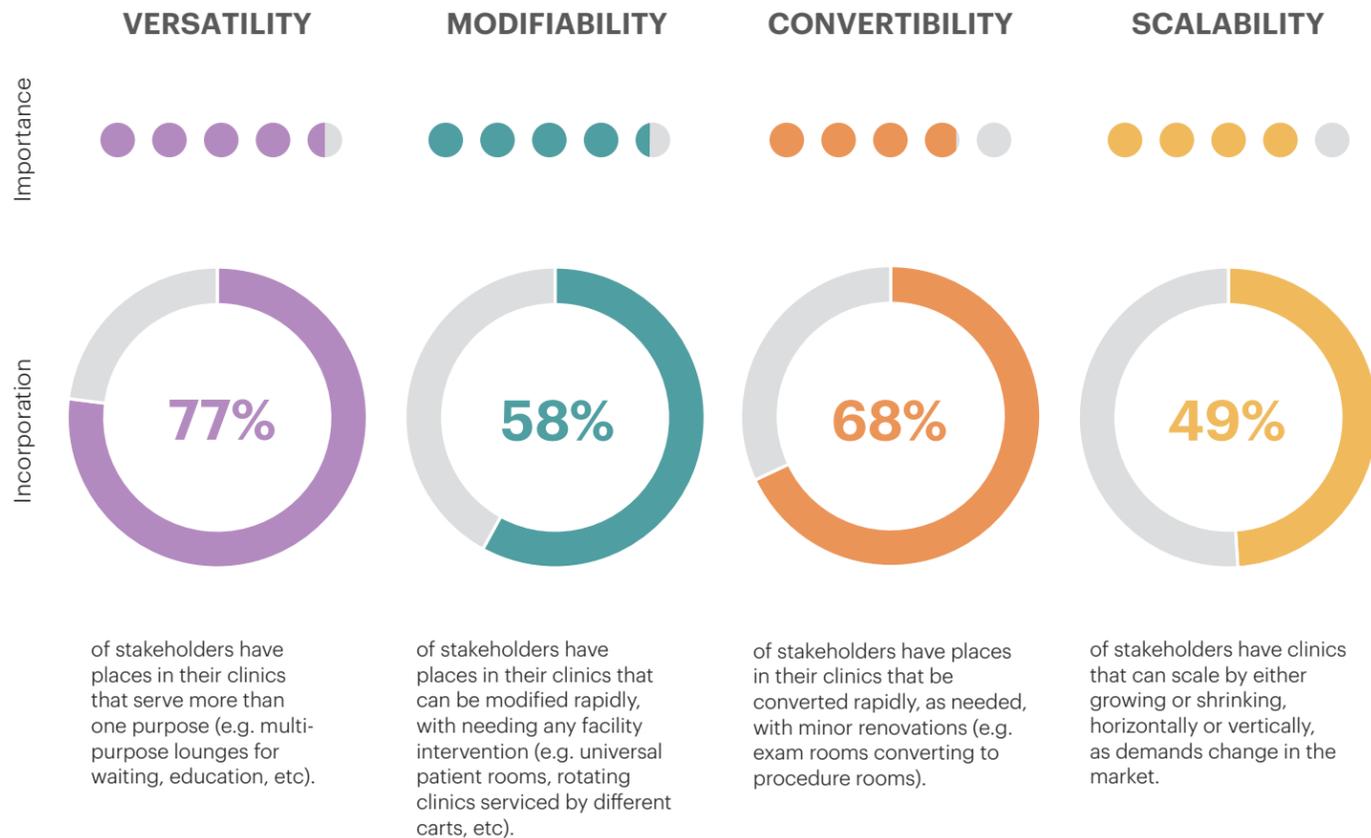


HOW DOES FACILITY INCORPORATION OF FLEXIBILITY ATTRIBUTES RELATE TO THEIR PERCEIVED IMPORTANCE?

To assess Monahan's (2002) revised framework, the survey participants were asked to rate the importance of the four attributes on a scale of 1-5, with 5 as the most important. The results showed versatility and modifiability were more important than convertibility and scalability (one-way ANOVA test, $p < .001$). Independent t-tests indicated the difference between the importance of versatility and of scalability was statistically significant,

and the one between versatility and convertibility was marginally significant (see figure below). Modifiability was not statistically different from any other attributes.

Survey respondents were also asked to indicate to what extent do their facilities incorporate flexibility attributes. Versatility and convertibility were most frequently incorporated.



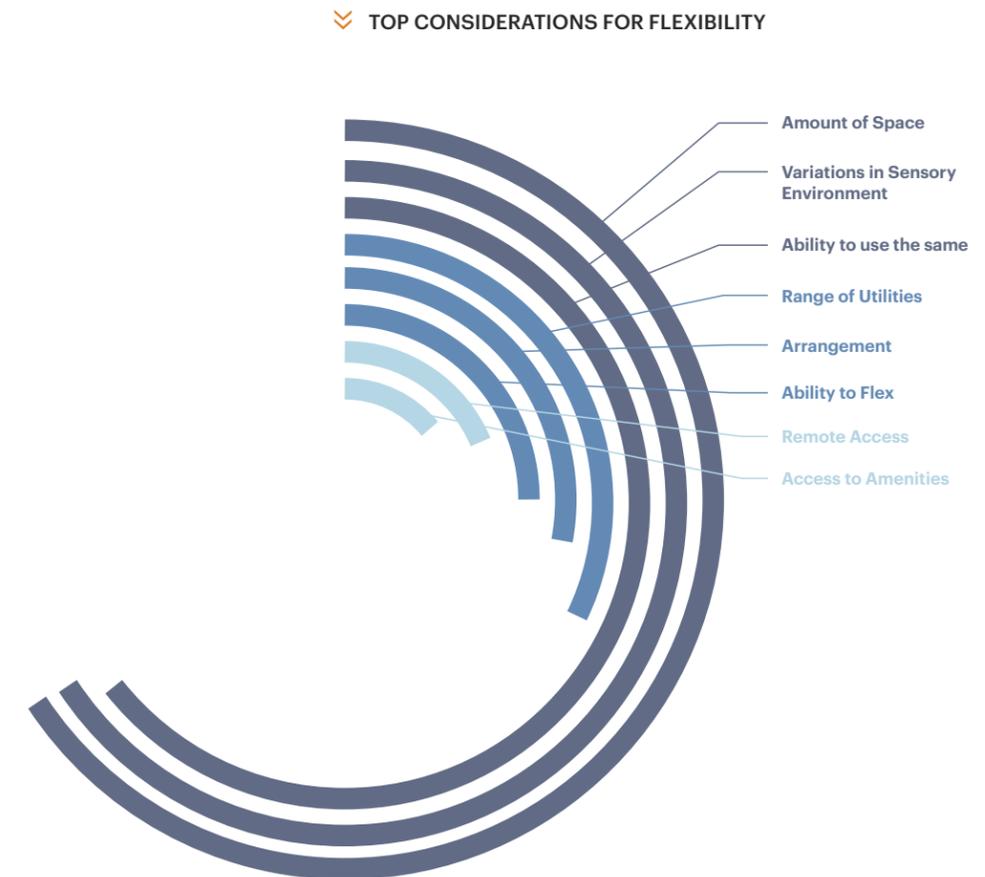
VERSATILITY IS THE MOST IMPORTANT AND INCORPORATED ATTRIBUTE WHILE CONVERTIBILITY IS HIGHLY INCORPORATED BUT LESS IMPORTANT TO STAKEHOLDERS.

WHAT ARE THE TOP CONSIDERATIONS FOR FLEXIBILITY?

Survey respondents were asked to choose their top three considerations for flexibility in the physical environment. Their options included amount of space (more or less square footage), range of utilities (e.g. data-ports, outlets, med-gases, vacuum), remote (web-based) access to depts/ services/ experts, ability to flex physician to exam room ratio, variations in sensory environment (e.g. lighting, acoustics, temperature), access to

amenities (e.g. dining, relaxation spaces), arrangement of furniture (desks, exam tables, chairs, etc.), and the ability to use the same space for different purposes.

The top three selected considerations for flexibility by survey respondents were amount of space, variations in sensory environment, and ability to use the same space for different purposes as significantly higher than other factors.



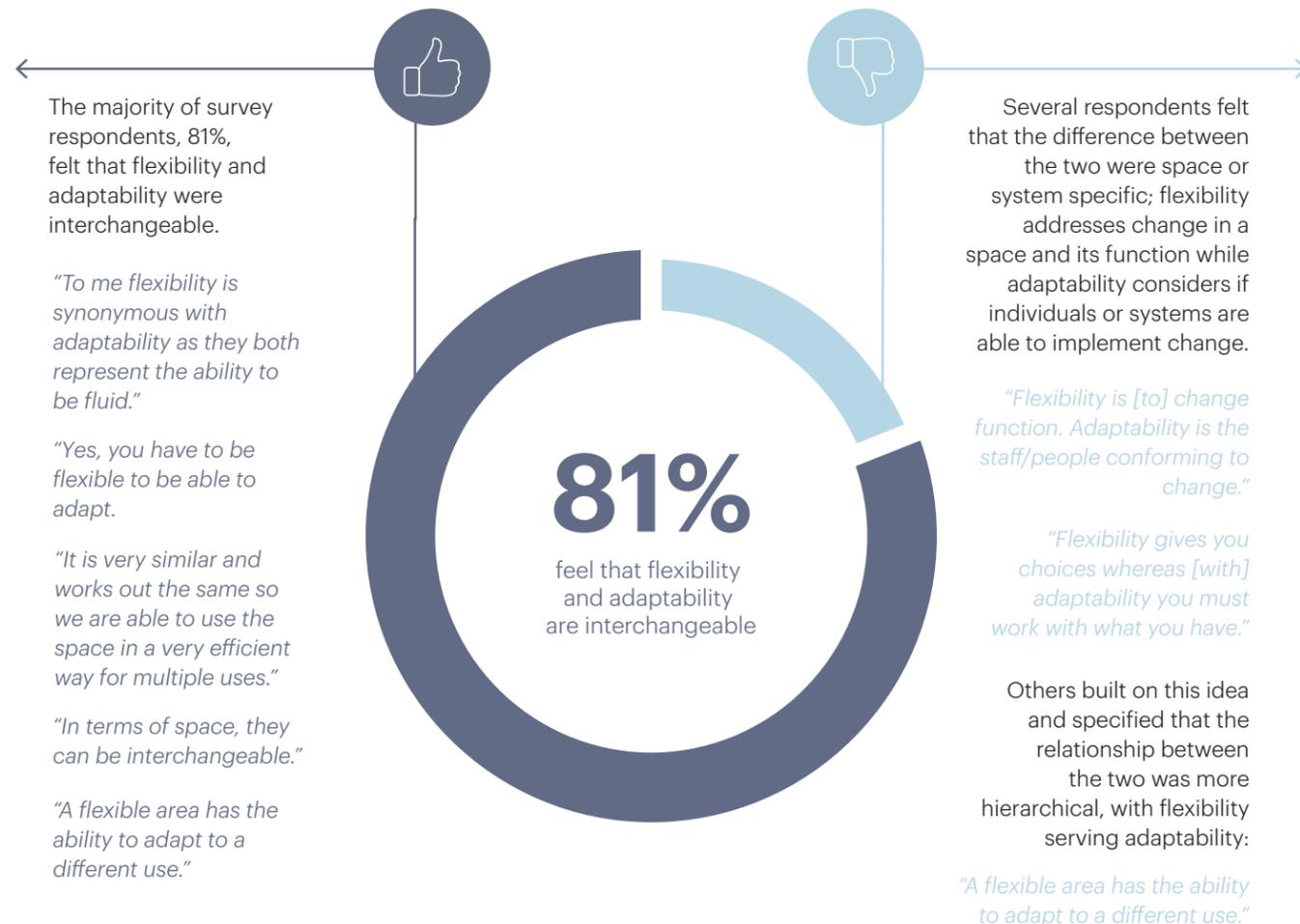
AMOUNT OF SPACE IN A FACILITY, VARIATIONS IN THE SENSORY ENVIRONMENT AND VERSATILE SPACES ARE THE TOP CONSIDERATIONS FOR FLEXIBILITY.

ARE FLEXIBILITY AND ADAPTABILITY INTERCHANGEABLE?

Survey respondents were asked if they thought of flexibility and adaptability as interchangeable - and if they did not, to explain the difference between the two terms. 81% responded that they felt the two terms were interchangeable. Those who did not often felt that there was a hierarchy between the terms or that they were space/system specific.

It is important to remember that a space can be flexible without the system or users adapting to it. A system and its users can adapt to change (sometimes inefficiently) without having the options flexibility can provide. Flexibility provides affordances for adaptability but does not dictate its occurrence.

INTERCHANGEABILITY OF FLEXIBILITY AND ADAPTABILITY



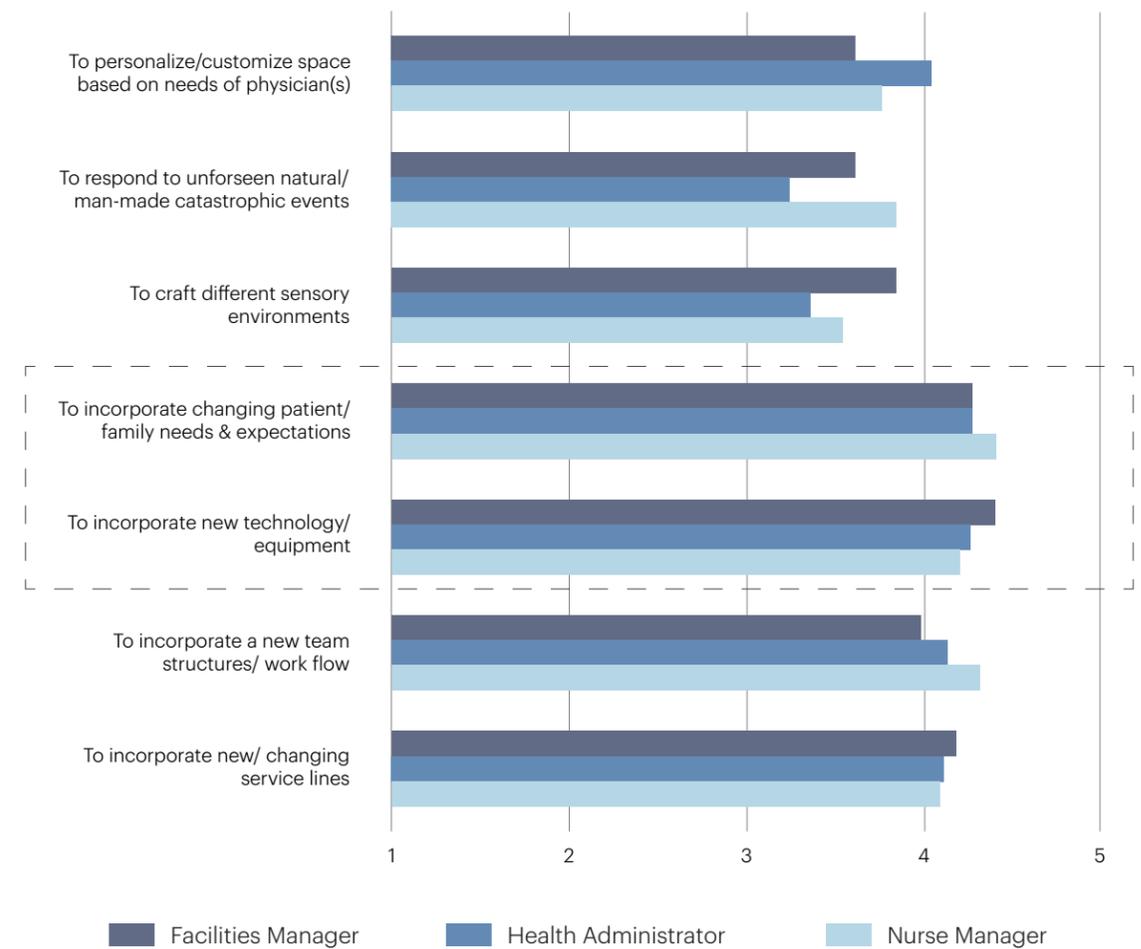
OFTEN USED INTERCHANGEABLY, THE DIFFERENCE IS THAT FLEXIBILITY ALLOWS YOU "TO" ADAPT.

WHAT DRIVES THE NEED FOR FLEXIBILITY?

When asked to choose from a predetermined set of responses for building flexibility drivers, incorporating changing patient/family demands and incorporating new technology and equipment, rose to the top. While the differences between different stakeholder groups was not statistically significant, it is interesting

to see that changing technology and equipment is critically important for facility managers. This speaks to the rapid change-rate of technology compared to the slower change- rate of facilities, and the need to sync these two resources for better care delivery.

NEED FOR FLEXIBILITY DRIVERS



INCORPORATION OF CHANGING PATIENT NEEDS AND NEW TECHNOLOGY ARE THE PRIMARY DRIVERS OF FLEXIBILITY.

DOES FLEXIBILITY HAVE TO COST MORE?

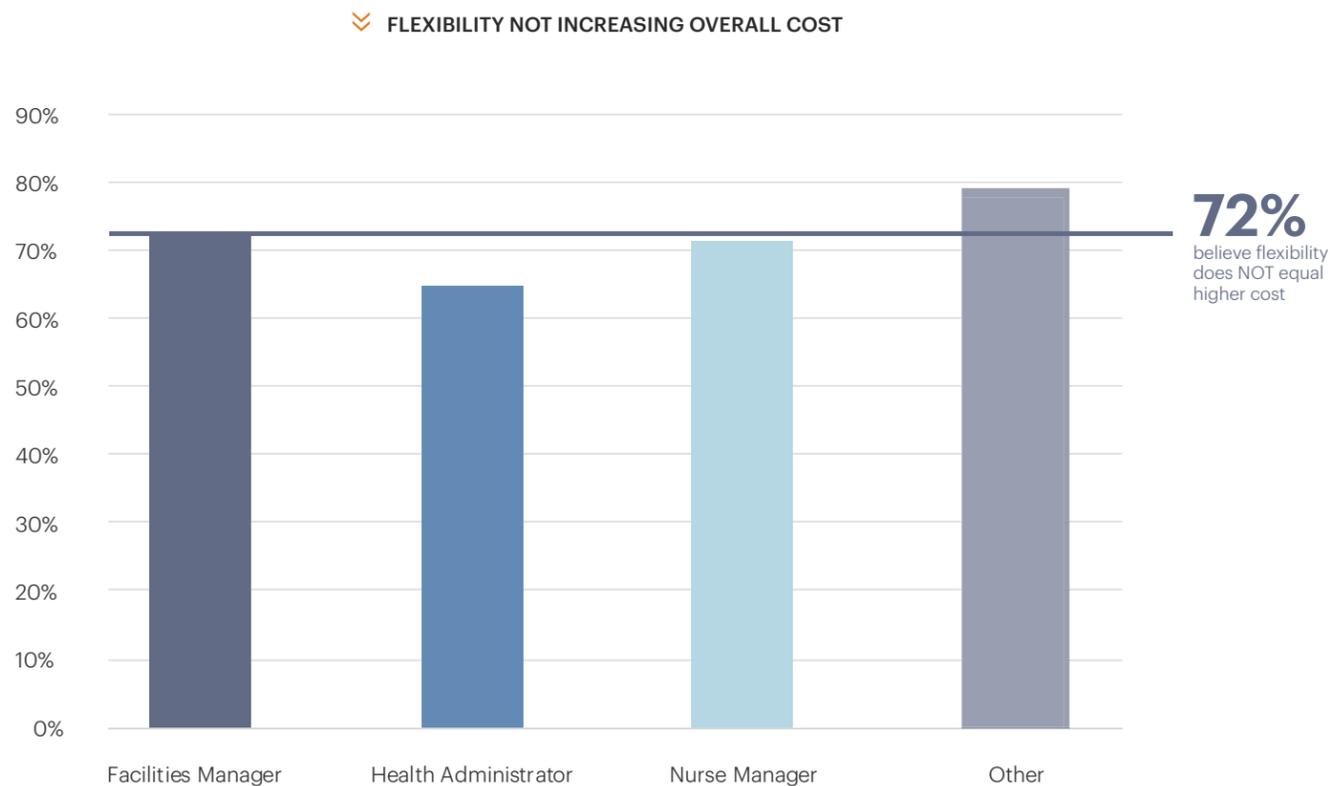
Given the importance of systemic flexibility and creating buildings that allow change over time (both short term and long-term), two key questions emerge:

Does flexibility have to cost more?

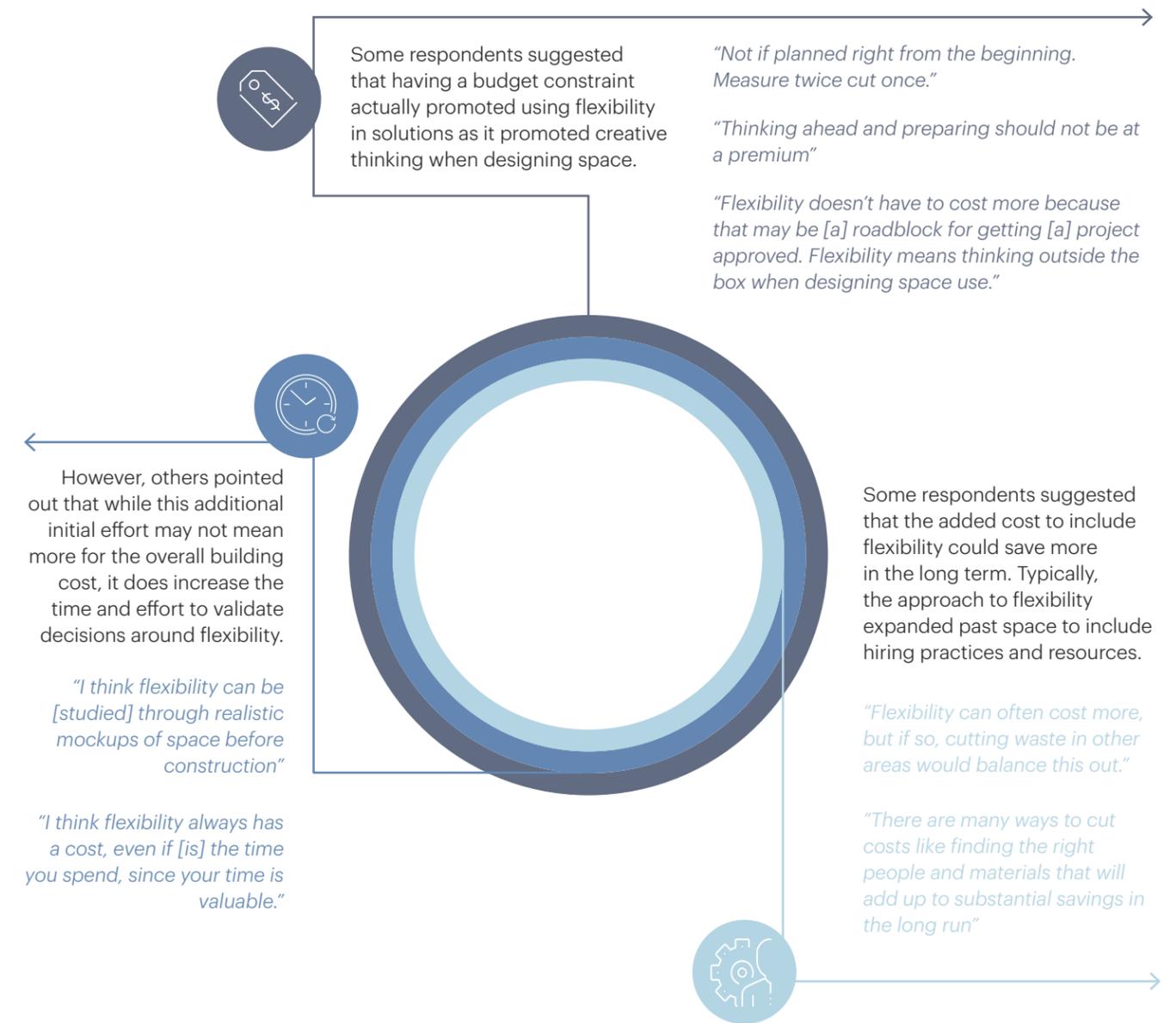
What creative solutions can we think of where flexibility is baked in and not a premium cost?

The majority of respondents (72%) felt that flexibility did not necessarily equate to a higher cost. The key was to incorporate flexibility as an operational strategy from the outset. If considered later in the building's life, it would mean a higher cost.

As shown on the next page, respondents consider the cost of flexibility not only in construction, but also in time spent during the process and in overall ROI.



STAKEHOLDERS FELT THAT FLEXIBILITY DID NOT EQUATE TO HIGHER COST, ESPECIALLY IF CONSIDERED IN TERMS OF LIFE CYCLE VERSUS FIRST COST.



Such theoretical discussions, while serving to define and understand needs, still require financial boundaries - how much would an owner/ stakeholder invest in flexibility?

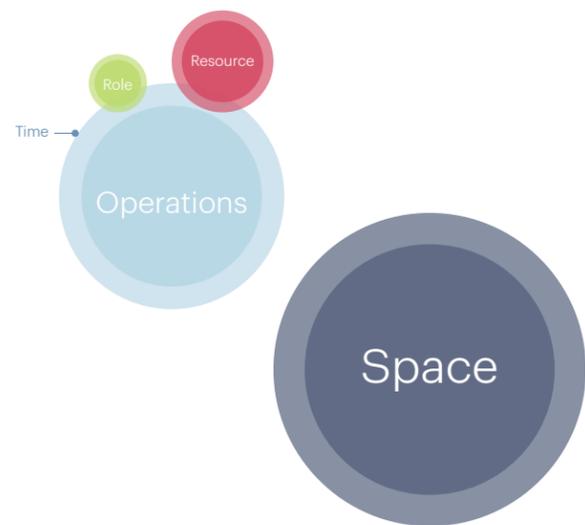
WHEN APPROACHING FLEXIBILITY IN THE DESIGN PROCESS, COST ASSOCIATED WITH BUILDING, TIME, AND EFFORT MUST BE CONSIDERED.

HOW MUCH OF A PREMIUM WOULD AN OWNER SPEND TO BUILD FLEXIBILITY INTO A BUILDING EARLY ON? WHAT WOULD THEY SPEND IT ON?

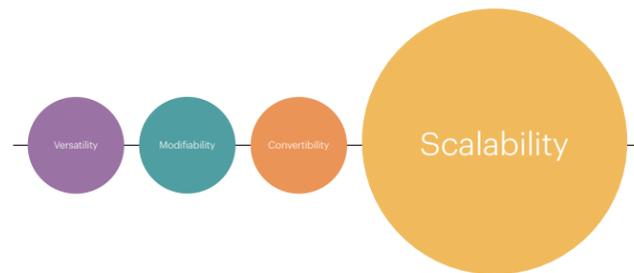


Respondents were willing to invest 20% more in capital costs if they could produce a significantly greater return, improve their bottom line, improve efficiency and productivity, or have more options for adapting as needed. The range of responses received was 1-75%.

DESIRED FLEXIBILITY COMPONENTS FOR INVESTMENT



DESIRED FLEXIBILITY ATTRIBUTES FOR INVESTMENT



Respondents are looking to invest in space and operational flexibility, which encompasses space, time, role, and resource flex. Respondents who specified space flexibility articulated a desire to invest in scalability more than the other attributes of flexibility.

STAKEHOLDERS ARE WILLING TO INVEST 20% MORE IN FLEXIBILITY EARLY ON TO HAVE SCALABLE SPACES.

WHEN IS FLEXIBILITY EXPECTED TO BE USED DURING A BUILDING'S LIFE?

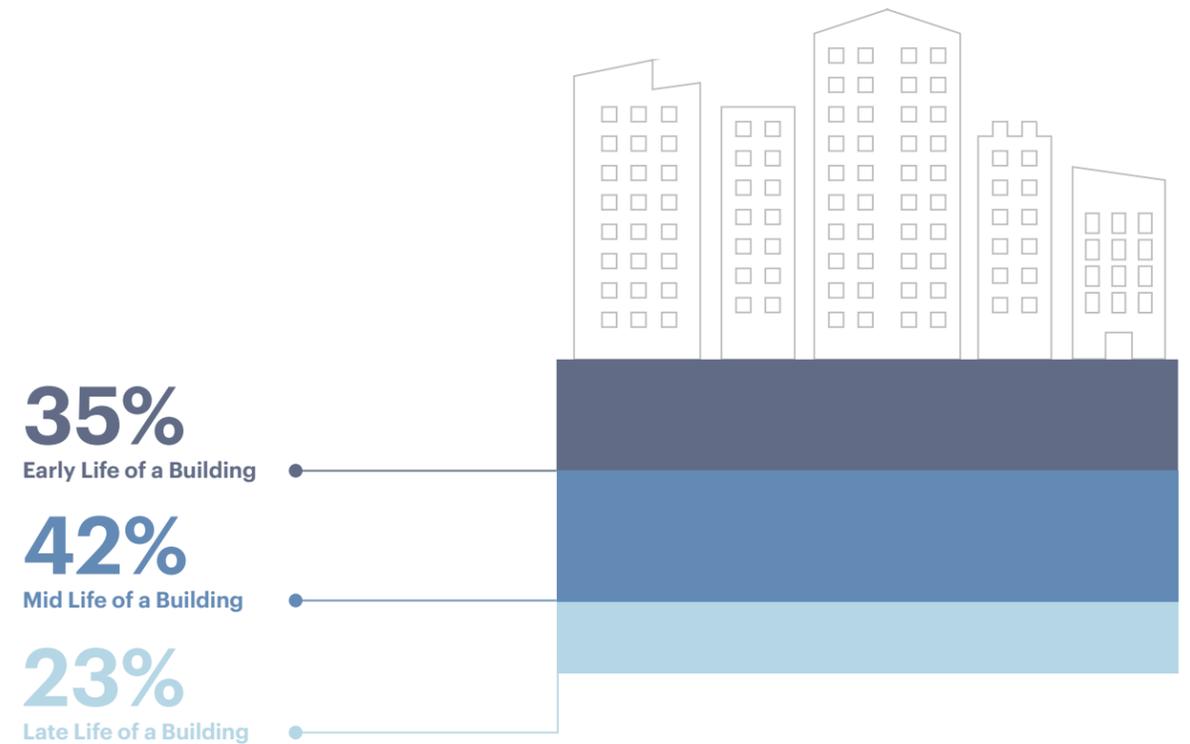
We asked respondents when in a building's life do they expect flexibility to be used. Majority of respondents expect to see it used early to midlife of their facility.

42% of respondents expect to see it used during the midlife of a building, leaning towards the attributes of modifiability and convertibility.

35% expect to see it used during the early life of a building, leaning towards the attributes of versatility and modifiability.

23% expect to see it used during the late life of a building, leaning towards the attributes of convertibility and scalability.

EXPECTED FLEXIBILITY USE DURING A BUILDING'S LIFE



FLEXIBILITY IS EXPECTED TO BE USED DURING THE EARLY TO MID LIFE OF A BUILDING.

HOW IS ROI FOR FLEXIBILITY INVESTMENTS RECOGNIZED? OVER WHAT PERIOD OF TIME?

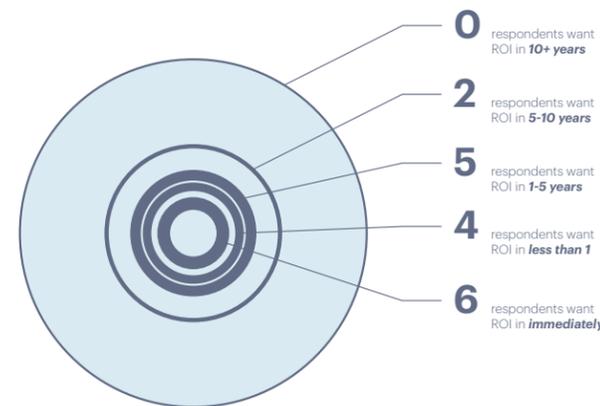
We asked stakeholders to tell us when and how they would know if they had received a return on their flexibility investment. 110 out of 143 total respondents answered, however not all specified how they would recognize flexibility ROI and over what period of time.

Qualitative analysis showed that stakeholders would overall recognize a return on their flexibility based on increased patient volume / organization growth, an improved bottom line, and planned flexibility being utilized and is functional. Increased profitability and that the planned functionality working and being used are indicative of receiving the return on investment.



QUALITATIVE COMMENTS ON RECOGNIZING FLEXIBILITY ROI

Many respondents did not specify a timeline for expecting to see a return on their investment. 17 respondents considered a certain time frame in which they would like to see their return while 5 respondents felt a certain rhythm of checking for a return would meet their needs. Several respondents felt there didn't need to be a specified timeline as long as they get what they are hoping for. Others were unsure since their goals were difficult to measure.



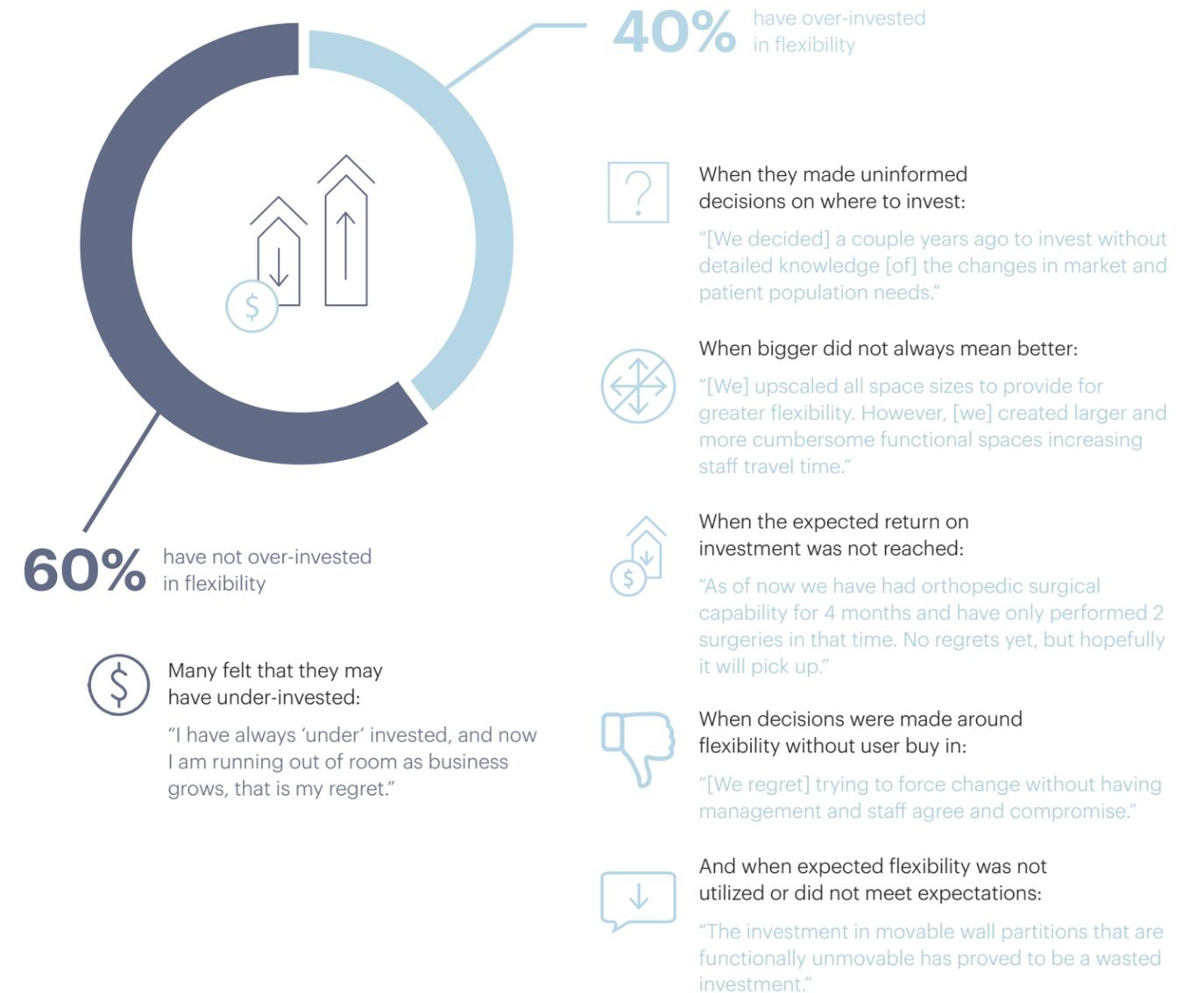
TIME PERIOD TO RECOGNIZE ROI >>

FLEXIBILITY SHOULD BE UTILIZED AS PLANNED TO INCREASE PROFITABILITY TO ACHIEVE RETURN ON INVESTMENT.

CAN WE "OVER-INVEST" IN FLEXIBILITY?

Ultimately, the investment in Flexibility must provide a tangible return on the investment to be considered strategic. In fact, when stakeholders were asked about "over-investing"

in flexibility, 60% said no, they have not over-invested in flexibility, and the other 40% responded yes, they had.



OVER-INVESTING IN FLEXIBILITY IS LESS COMMON; UNDER OR UNWISELY INVESTING IS MORE COMMON.

WHEN CAN A LACK OF FLEXIBILITY HINDER DESIGN?

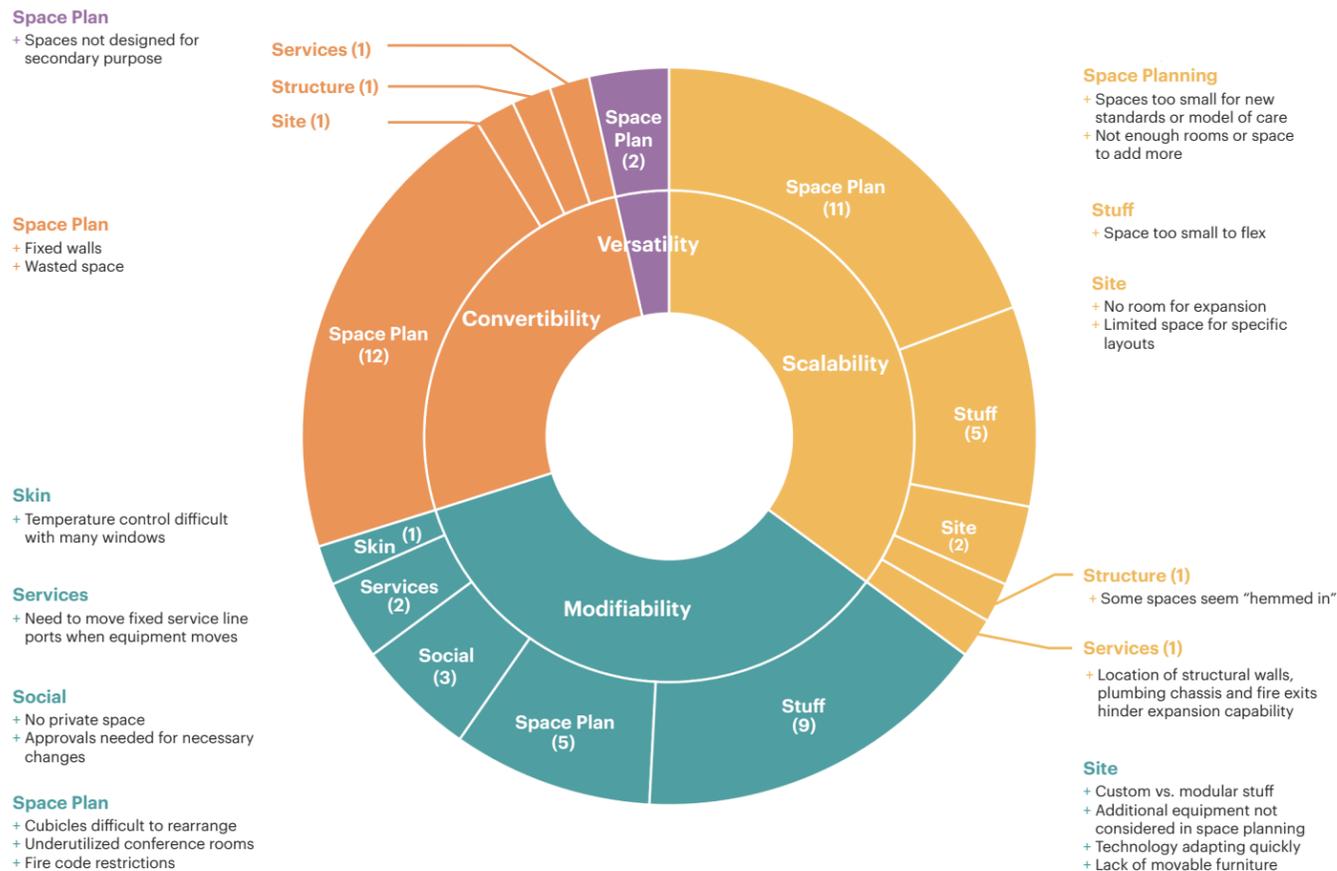
Stakeholders were asked to share examples of when design was hindered by a lack of flexibility. There were more responses associated with the base building (as opposed to the infill) compared to when flexibility was successfully or unsuccessfully implemented. This suggests that flexibility in the building infill is more visible overall and has historically been easier to implement. However, when the base building is unable to change due to a lack of flexibility, it becomes more apparent to users.

When looking at the building layers, the majority of the responses were focused on space planning. Convertibility was the most common attribute considered in space planning specifically with concerns around the lack of

reconfigurable walls and wasted space. For the attributes of flexibility overall, modifiability was most frequently mentioned as strategies that hindered design, followed by convertibility and scalability. Specifically, "stuff", furniture, fixtures and equipment, were most commonly mentioned. Furniture that doesn't move or cannot change to fit a different need, custom casework that cannot be used somewhere else if the use of that space changes, and the inability to adapt new technology are responsible for the most complaints.

Standardization of spaces, or room layouts, or modular features throughout the building design might provide a method to resolve these instances.

INSTANCES WHEN LACK OF FLEXIBILITY HINDERED DESIGN



FLEXIBLE "STUFF" - SHOULD BE ADDRESSED AND TAKEN INTO ACCOUNT DURING SPACE PLANNING.

WHEN HAS FLEXIBILITY BEEN SUCCESSFUL?

Stakeholders were asked to share examples when flexibility was implemented successfully. Responses provided were largely involved with a building's infill system. Only one response indicated a flexible MEP system designed for expected growth. This suggests that either social, stuff, and space planning are the most visible building layers for planned flexibility or that most stakeholders are considering short-term solutions for flexibility rather than long term.

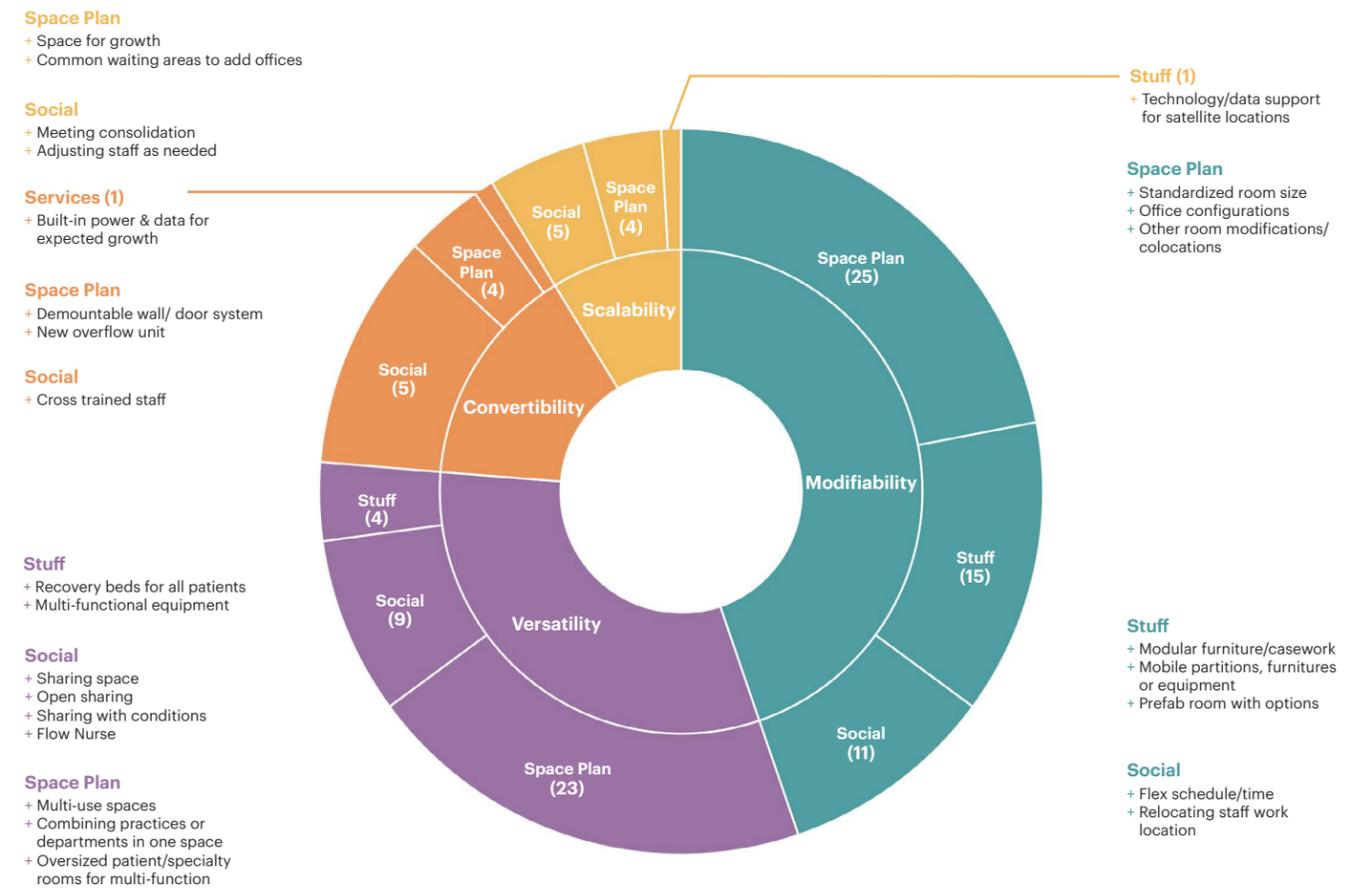
When looking at the building layers, a prioritized order seems to arise with space planning as the highest, followed by social and then stuff. For space planning, versatility was the most common attribute implemented through the utilization of multi-functional patient rooms, specifically being oversized to allow for different specialty types.

As for the flexibility attributes, modifiability was the most common response, followed by versatility. Space planning as a building layer was the largest for modifiability as well.

Standardized, reconfigurable spaces were the most common example of successful implementation of flexibility from stakeholders. Further research needs to occur to understand whether or not they are successful as well for operations or patient use. However, these responses could indicate that the conversation on flexibility is predominantly around the idea of re-configuring the patient room.

A comparison between successful and unsuccessful design strategies will help develop design implications for implementing of flexibility.

INSTANCES WHEN FLEXIBILITY WAS IMPLEMENTED AND SUCCESSFUL



RECONFIGURING THE PATIENT ROOM, WITH MODIFIABILITY AND VERSATILITY IS A COMMON, SUCCESSFUL FLEXIBILITY PRACTICE.

WHEN HAS FLEXIBILITY NOT BEEN SUCCESSFUL?

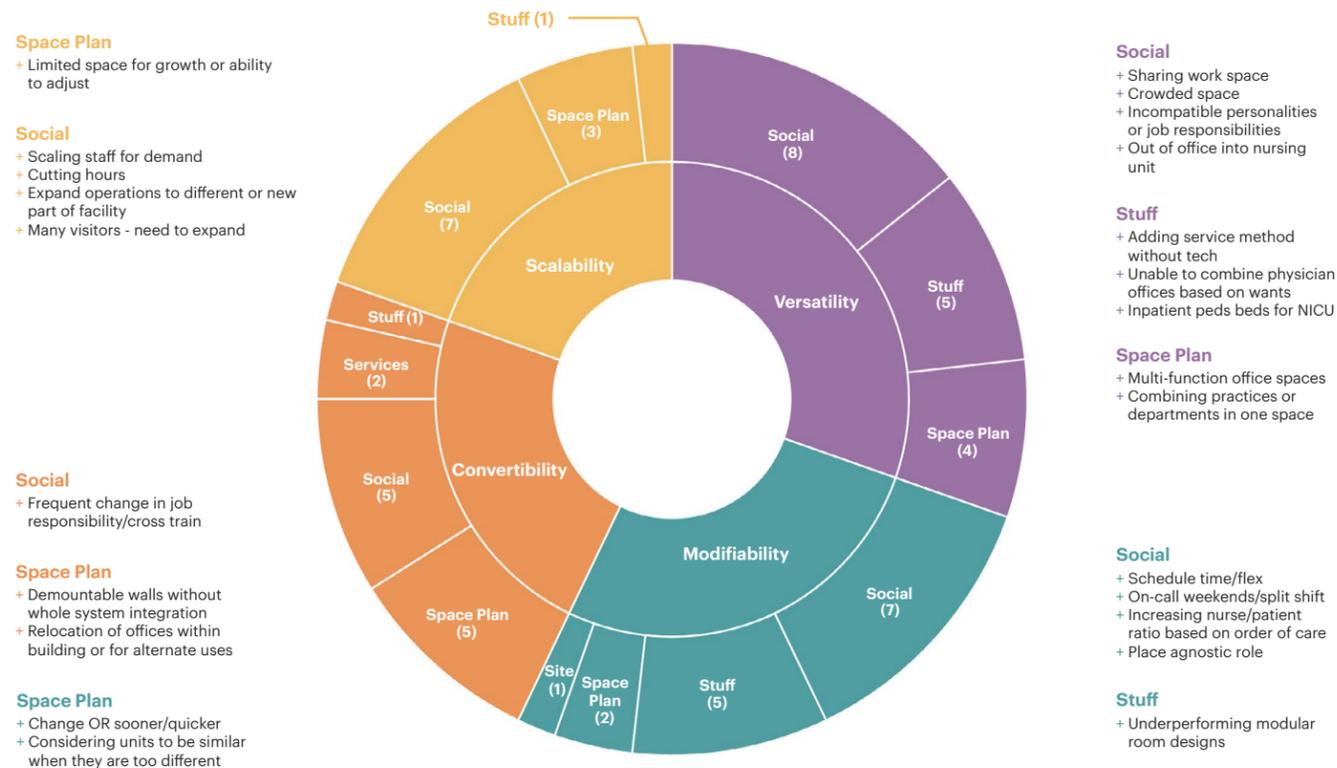
Stakeholders were asked to share examples when flexibility was implemented unsuccessfully. Responses provided examples of unsuccessful implementation of flexibility that were also largely involved with a building's infill system. Majority of the examples suggest failures of social or operational flexibility with the largest number of complaints regarding the sharing of workspace and time flex for staff schedules. Cross training staff was a common complaint as well, but with a consistency among the comments that the failure was due to the increased frequency of role change. Staff members appear to be able to learn multiple role responsibilities but require an appropriate amount of time in any one of them to be effective.

The building layers of stuff and space planning appear to be almost equal in disappointment. A failure to provide appropriate equipment for new services and underperforming modular rooms were common responses for stuff. For space planning the common replies were the inability to reconfigure during relocation or alternate

functions within the same building, as well as the limited ability to grow or adjust staff due to limited space. The flexibility attributes rank fairly close to each other and in the order of left to right in our spectrum with versatility being the largest, followed by modifiability, convertibility, and scalability. When the building is not able to convert or scale when needed it seems to be more apparent.

A significant comment on failed flexibility is installing a demountable wall system within a building without a full system (e.g. lighting, air vents, power outlets, etc.) to support it. The comment speaks to a lack of cohesive design of the building, and the requirement of understanding the system as a dynamic building solution rather than a static building solution. Designing for a flexible building the standard fixed and static solution of traditional design do not necessarily work. Instead a holistic approach is needed to ensure the related systems such as lighting, electrical, and others can flex or at least still function properly when the walls moves and floor plan changes.

INSTANCES WHEN FLEXIBILITY WAS IMPLEMENTED AND UNSUCCESSFUL



DESIGNED FLEXIBILITY IS NOT SUCCESSFUL WHEN ALL SYSTEMS ARE NOT ALIGNED.

HOW DO SUCCESSFUL AND UNSUCCESSFUL INSTANCES OF FLEXIBILITY COMPARE?

When, comparing the two response sets, there appears to be some contradictions. Firstly, there is an increased number of responses identifying social implementations of flexibility for operational purpose tends to be both successful and not successful. Looking at the individual responses of both implications suggests time flex or schedule flex is largely dependent on staff and operational specifics.

Cross-Training is another apparent contradiction, but with more successful examples (12) than unsuccessful examples (5) it appears job responsibilities can be shared successfully but with certain conditions. From the responses an example of successful cross-training of staff is to ensure that the time spent changing tasks is not too quick and allows for the staff member to mentally be able to perform the task at hand. Sharing space also appears in both tables as a prominent example. Comparing the few specific examples provided, the success of sharing space relies on particular conditions that all parties involved must agree upon. The examples where sharing space did not work seems to relate to personalities of individuals using the same space, and not necessarily a reflection of the space itself.

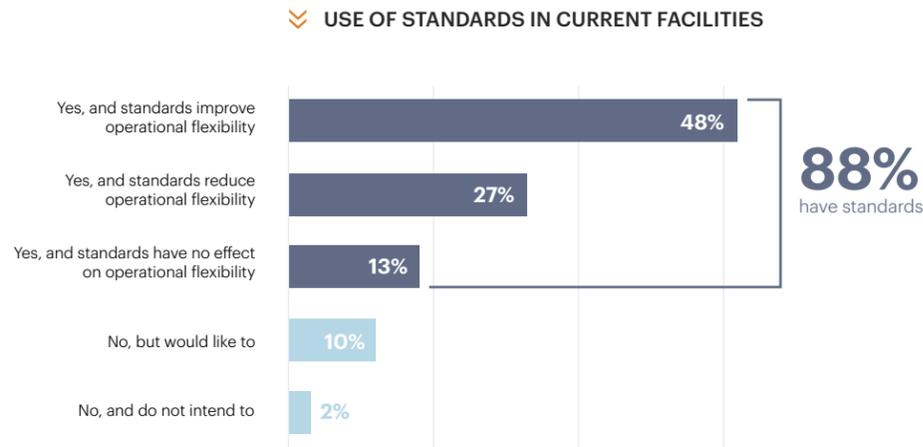
Along with social implementations, space planning is also prominent for both examples. Combining department uses to be more versatile for example, appears to work and not work, but again success appears to depend on the proper fit of who is sharing the space and their operational compatibility. Space planning examples of modifiability and convertibility are also included in both and suggests the need to better understand the related functions or systems to any given implementation of flexibility to be successful. For example, one response suggests demountable walls are not successful for convertibility if the relating systems do not also include the affordance to change. In all, when flexibility was designed for and succeeded it was due to a clear understanding of use and operation. It typically failed due to a lack of understanding of the system's relationships collectively. It should also be understood that the quantification of responses should not suggest a direct value measurement of flexibility, but rather a weighted one. Some indications of failures might be of greater value to clients and staff if implemented correctly, which might be more present when a lack of flexibility has hindered design.

<p>"We created split shifts within the department to covery heavy patient loads and lunch breaks."</p> <p>-Health Administrator</p>	<p>"I established a new position called 'flow nurse' to increase patient and staff satisfaction with the workflow."</p> <p>-Nurse Manager</p>	<p>"Removed existing office cubicles to create a flexible 'big room' that can handle large planning meetings and flex to provide hoteling spaces."</p> <p>-Facilities Manager</p>	<p>"Our outpatient clinical modules are identically provisioned, making each module 'agnostic' to the specialty using it."</p> <p>-Nurse Manager</p>
<p>"Our organization implemented an on-call system that required nurses to be on-call for a full weekend at a time and it was too overwhelming."</p> <p>-Nurse Manager</p>	<p>"Attempting to have staff change responsibilities day to day, they did better when responsibilities don't change routinely."</p> <p>-Nurse Manager</p>	<p>"We tried to 'share' space with two other disciplines - did not work well. Complains from nursing/providers."</p> <p>-Health Administrator</p>	<p>"Same sized exam room, offices and support spaces. Unfortunately, this requires more space overall, increasing operational cost and staff walking time"</p> <p>-Facilities Manager</p>

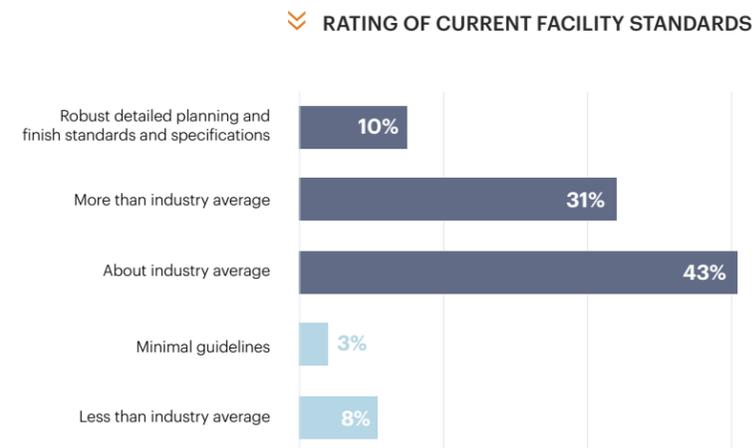
DEALING WITH THE HUMAN AND SPATIAL LAYERS DETERMINE THE SUCCESS, OR LACK OF SUCCESS, OF FLEXIBILITY.

DO STANDARDS HELP FLEXIBILITY?

When we asked stakeholders about the extent of their use of standards in their current facilities, 88% indicated that they used standards. Only 48% reported that having standards improved their operational flexibility while 27% of stakeholders believe that standards actually reduce it.



Respondents then rated their standards program - if existing - against their peers. 91% of the respondents indicated their standards were either about the industry average or above the industry average.



CURRENT FACILITIES LARGELY INCORPORATE STANDARDS THAT ARE AT OR ABOVE INDUSTRY STANDARDS. ONLY ABOUT HALF OF STANDARDS IMPROVE OPERATIONAL FLEXIBILITY.

HOW ARE MODULAR SOLUTIONS USED?

We asked stakeholders about the use of modular solutions in their current facility spaces and what modular solutions they use within those spaces. A five-point Likert scale ranging from 1 (not at all) to 5 (extensively) was used.

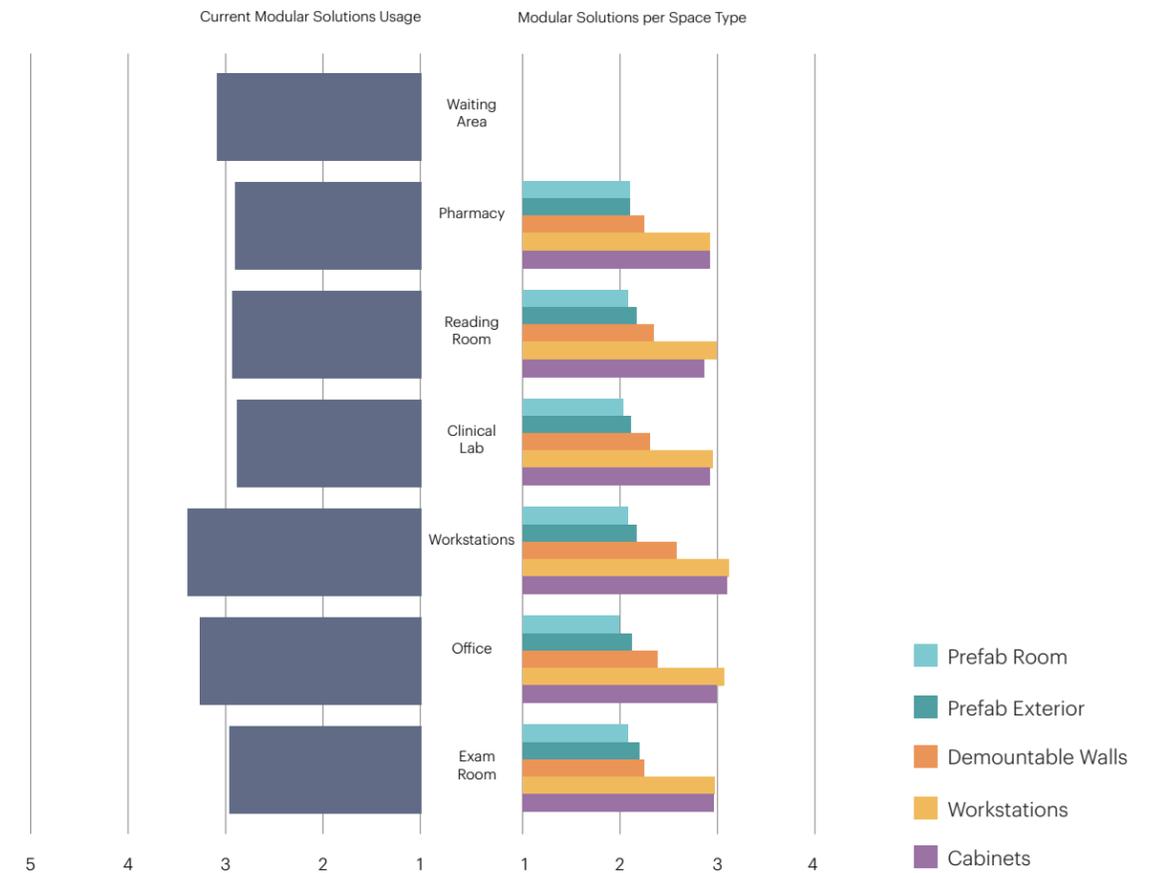
Results showed that the extent of modular solutions usage did not vary much between spaces. Respondents indicated the highest usage of modularity in workstations followed by offices. The least usage of modularity was found in clinical labs.

The follow-up questions measured the degree of modular solutions usage in a specific space. Cabinets and modular

workstations are more likely to be used than demountable walls, prefab exterior, or prefab room across space types.

Linear regression tests uncovered that modular solutions usage in offices, but not other areas, can predict the extent of use standards in survey respondents' current facilities. In other words, those who use modular solutions in offices are also more likely to be using standards.

Among the solutions, modular workstations in exam rooms and in offices, as well as prefab exterior panels in the pharmacy, contributed to the use of standards.



CABINETS AND MODULAR WORKSTATIONS ARE THE MOST LIKELY TO BE USED MODULAR SOLUTION ACROSS SPACES. MODULAR SOLUTIONS ARE MORE LIKELY TO BE USED IN OFFICES WITH STANDARDS.

HOW IMPORTANT ARE DISASTER AND CLIMATE CHANGE PREPAREDNESS?

The survey respondents rated the importance of both disaster and climate change preparedness using a 1 (not important at all) to 5 (very important) scale. Disaster preparedness was rated higher than preparing for climate change.

Linear regression tests were performed to examine the relationships among the attributes of flexibility, disaster preparedness, and preparing for climate change. The importance of convertibility, but not other attributes,

predicted the importance of disaster preparedness. In other words, stakeholders who valued convertibility higher, tended to value disaster preparedness as well.

The importance of scalability and, marginally, the importance of versatility, could predict the importance of preparing for climate change. Stakeholders who valued scalability higher, tended to value preparing for climate change.



BEING PREPARED FOR DISASTERS IS MORE IMPORTANT TO STAKEHOLDERS THAN PREPARING FOR CLIMATE CHANGE. STAKEHOLDERS WHO VALUE SCALABILITY ARE MORE LIKELY TO VALUE CLIMATE CHANGE.

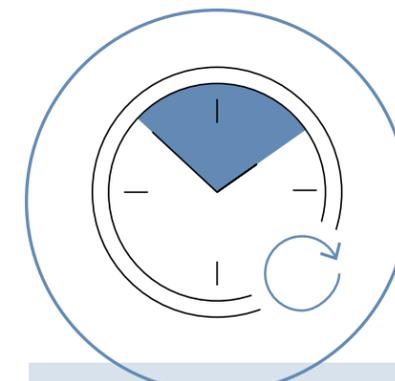
FLEXIBILITY BEYOND BUILDINGS

The responses from key stakeholders were also a reminder that flexibility is a much broader construct than space/facilities. In addition to space flex, three other types of flex emerged - time, role, and resource flex. These solutions can range from flexible hours, split-shifts, self-scheduling, cross-trained staff, more supervisory roles, multi-functional equipment, smaller/mobile equipment, to the leasing of equipment instead of buying. The layering of operational aspects of flexibility on spatial solutions can

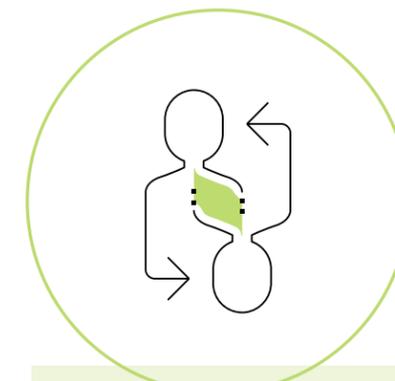
allow for systemic change and business resilience. This system of flexibility allows a building to adapt to a rapidly changing health care landscape in a more systemic way.

Spatial flexibility seems paramount for those whose business is the built environment. However, it is important to keep in mind that space, the "stuff" in the space, and the "structure" and "skin" around the space are all just resources for an organization/ system.

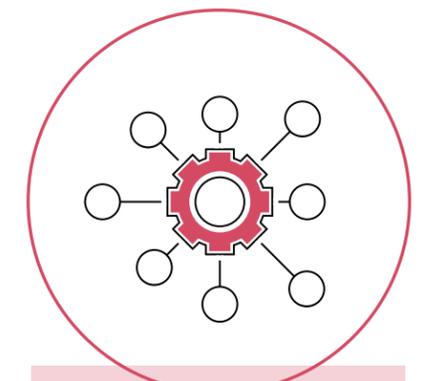
COMPONENTS OF FLEXIBILITY BEYOND SPACE



TIME FLEX
Related to flexibility in scheduling, hours of operation and staffing.



ROLE FLEX
Related to flexibility in roles and responsibilities of staff.



RESOURCE FLEX
Related to using resources - such as equipment, furniture, supplies, amenities, and even space - flexibly.

STAKEHOLDERS OFTEN THINK OF FLEXIBILITY IN TERMS OF OPERATIONS IN ADDITION TO SPACE.

ILLUSTRATING FLEXIBILITY IN PRACTICE

From the open survey responses, we report examples of positive flexibility implementations. Each item is organized according to the type of flexibility it most closely represents. The bulk of examples provided from our survey were related to versatility, modifiability or convertibility. Other than use of shell space, there were no positive examples shared by stakeholders for scalability. However, scaling of services by converting/ modifying the building was a common theme.

Standardization and modularity are common solutions to achieve flexibility. Other ideas also related to the use of prototyping and renaming of rooms to be more generic.

Additionally, the three flex components of time, role and resource were also mentioned. These are more operational aspects of flexibility affecting the use and function of any spatial solution.

✎ FLEXIBILITY BEYOND BUILDINGS

✎ FLEXIBILITY ATTRIBUTES

EXAMPLES

TIME

- + Shared rooms
- + Flex hours
- + Split-shifts
- + Self-scheduling
- + Cross-trained staff

"Our organization created split shifts for nurses and other staff to prevent worker burnout"

"Each full-time nurse has their own space, while knowing that flex time nurses may use that space when they are in the building. It allows for personal ownership of a space and encourages nurses to work in the office instead of at home."



ROLE

- + Supervisory roles for more employees
- + Cross trained staff

"I established a new position called 'flow nurse' to increase patient and staff satisfaction with the workflow."

"We cross train staff to at least 2 areas of my service line to allow staff to flex with the changing volume and acuity of patients. This allows us to minimize overtime, on call and agency use."

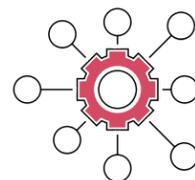


RESOURCE

- + Multi-functional equipment
- + Smaller/mobile equipment
- + Leasing instead of buying equipment

"We were beginning to see a younger workforce, so I decided to implement mobile tech into our routine and it has been a great success."

"Due to greater technology and smaller equipment, fewer people can perform more testing in a flexible laboratory setting."



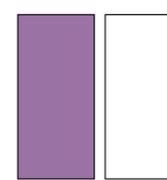
VERSATILITY

I can do different things in it

- + Open hall spaces
- + Multi-use spaces
- + Flex lab spaces
- + Shared spaces
- + Grouping of specialties
- + Removing partitions

"We have multipurpose rooms that can be used for staff meetings, staff training, patient support groups and 'potluck' luncheons for staff."

"Chemotherapy clinic [that] can accommodate any type of infusion or injection that a patient might need."



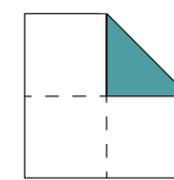
MODIFIABILITY

I can change it

- + Movable partitions
- + Rotating check-in spaces
- + Modular furniture
- + Ability to add beds
- + Standardization

"The use of wheeled infusion chairs instead of fixed chairs, allows for flexible seating options for our infusion patients."

"By easily moving workstations we were able to maximize changing flow patterns."



CONVERTIBILITY

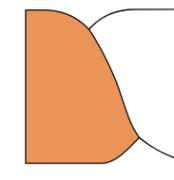
It can change

- + Hybrid OR
- + Modular walls
- + Storeroom to pathology lab
- + Early MEP planning

"Temporary offices that can become exam rooms."

"Built-in power and data in a 1st floor area that will eventually have kiosks for patients to do self-check in."

"We took 15 exam rooms and made them temporary offices for the physicians. We put the plumbing in the walls so that it will be easy to convert to a clinical space once the physician offices are moved."

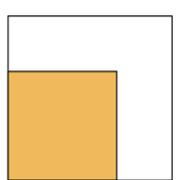


SCALABILITY

It can grow or shrink

- + Shell space
- + "Blow out" walls
- + Oversized structural members
- + Early MEP planning

"We have a shelled 5th floor in our new building and it is intended to be used as office space for physicians once the first 4 floors are at capacity."



03 A PATH FORWARD

Based on a literature review, exemplars, and online surveys, we consider a flexibility framework and summarize key insights.

REVISITING WHAT WE KNOW

In a rapidly evolving environment surrounding health care, static architectural solutions are beginning to hinder the ability to provide the best care possible. Understanding how a building can adapt from one static solution to another is time consuming and intensive. By extracting lessons learned from research literature, design examples, and stakeholder feedback, we can provide more effective design solutions

that can adapt to alternative and unforeseen demands. While many definitions of flexibility exist, with flexibility and adaptability often being used interchangeably, our research suggests that simply put, flexibility is an affordance of the environment that allows it to adapt to different needs. In other words:

BUILDINGS MUST “BE” FLEXIBLE
IN ORDER “TO” ADAPT.

We found many frameworks exist to explain different perspectives and characteristics of flexible spaces. Some common attributes that emerged were concepts of versatility, modifiability, convertibility, and scalability. Additionally, we found that the layered approach to flexibility of social, stuff, space planning, services, skin, structure, site,

and surroundings, to be a helpful framework for designers to work with owners. Finally, we found that stakeholders (administrators, nurses and facility managers) assumed that some flexibility was just part of good design, but long-term scalability they would pay a premium for (up to 20%).

FleXX
*to adapt by
being flexible*

Flexible environments enable operational, functional, demographic, climate, and market changes over time with optimal capital expenditure, allowing the building to be used as a strategic asset.

10 TAKEAWAYS

Our top ten can be summarized as follows:

1 Buildings must “be” flexible “to” adapt

Stakeholders (administrators, nurse managers and facility managers) believe facilities must be flexible in order for organizations to adapt and change. In other words, flexibility is the affordance of the built environment that allows organizations to change and adapt in response to external drivers that we cannot predict. The uncertainty is the X factor that we must be prepared for and is part of the FleXX approach.

2 V-M-C-S are the core tenets of FleXX

Flexibility for the built environment has different sets of considerations including: user/owner perspective, built elements that are affected, soft/hard, level of ease, duration of time to complete change, and when/how much investment should take place. These considerations also occur over various layers: social, stuff, space, services, skin, structure, site, and surroundings. Four core attributes for flexible outpatient environments are: Versatility (user/owner can do different things in a space without making any changes), Modifiability (user/owner can change a space without needing support from facilities/contractors), Convertibility (space can be changed but will need minor renovation and involve facilities), Scalability (space can physically grow or shrink but will need minor/major renovation and involve facilities).

3 Versatility & Modifiability are key FleXX attributes (baked into a design solution)

Of the four flexibility attributes- versatility and modifiability were rated the most important. Specifically having stakeholders consider multi-use spaces and standardized, universal rooms that allow users to adapt for a different function as successful examples of versatility. On the other hand, furniture/ equipment etc. that is not modifiable and spaces that do not easily adapt to a secondary purpose are some of the biggest dissatisfiers. However, stakeholders did not think this level of flexibility should be at a premium cost (especially if we think in lifecycle costs).

4 Flexibility should not cost more, but a premium cost for long-term scalability is acceptable

More than 70% of stakeholders hold that flexibility does not always have to cost more- it is a part of good design. However, the qualitative responses to this question suggest that they consider lifecycle cost, and not just first cost in making this determination. For example, stakeholders in this sample were willing to pay close to 20% in premium costs for convertibility and long-term scalability, with an eye to improving their bottom line and keeping their patients and employees satisfied. Stakeholders consider the amount of space as a top consideration for flexibility and want to invest in scalable spaces. Most examples of flexibility from stakeholders are at the infill level, and not in terms of transformation to the shell and core that form the base building. This suggests a need for further study (and education) about the long-term potential for building scalability at the structural level.

5 More space, more control, more choice

The top three selected considerations for flexibility were amount of space, variations in sensory environment (and control over them), and ability to use the same space for different purposes/ choices. Variations in sensory environment did not emerge as a key concern in our literature review, suggesting a need for future research. Balancing with more versatile, multi-purpose spaces with individual control over sensory environments can also be an interesting design challenge.

6 Flexible “stuff” should be considered separately

Facilities and their related “stuff” (e.g. furniture, fixtures, equipment) may change at a different rate and need to sync to support one another. Therefore, it is important that flexible stuff is addressed and taken into account during space planning.

7 Experience with modularity anchors on furniture

Modular workstation and cabinet solutions were more often found in the survey respondents’ facilities than demountable walls, prefab exterior panels, or prefab rooms. The survey results also indicated that rooms were more likely modified or converted from offices to something else (typically exam rooms) than any other change. This might contribute to survey respondents’ more frequent experience of modifying/ converting offices to another function than from any other type of spatial change.

8 Demountable Walls: Need for a systems approach

Movable/demountable walls are seen as a big need, but are contextual to the entire building system. Survey participants indicated that demountable walls were less likely used in their current facilities because they were too difficult to change. A key challenge is when demountable walls are not aligned with infrastructure affordances (MEP, lighting, etc.).

9 FleXX ROI yet to be determined and needs FleXX planning

It is not clear yet to stakeholders how ROI can be measured, and over what time. 1-5 years seems to be a comfort zone, and the metric is a combination of Organizational Growth, Improvement in Bottomline, Ease of Change, Increase in Patient Satisfaction, and Improvement in Employee satisfaction.

10 FleXX beyond buildings

Flexibility is not just spatially defined. Stakeholders have a different lens for thinking about flexibility including time, roles and resources. These are all needs for flexibility that designers can create in the built environment. The most prevalent forms of operational flexibility in this sample appear to be role flex (cross-trained staff, floating staff, shared staff etc.), time flex (innovative and flex hours of operation, and staff shifts) and resource flex (multi-purpose spaces, equipment & modular furniture). Adaptable organizations use building flexibility as a tool to accomplish organizational flexibility.



VERSATILITY

ALLOWS MULTIPLE USES

Design strategies and things to consider for Versatility as an attribute of space that allows multiple uses.

- + Properly size the space to accommodate different use requirements and incorporate the proper technology for each use type.
- + Think through day-to-day functions of users to ensure the appropriate selection of each room's furniture and equipment without super-specializing (unless absolutely essential clinically).
- + Incorporate furniture systems and accessories that are multipurpose and complement the multi functionality.
- + Design for multiple sensory experiences for a variety of patient needs and care plans by allowing individual control over sensory environment (like temperature/ lighting).
- + Allow for personalization and customization of shared spaces based on specific needs of individual departmental and their staff.
- + Select quality materials that respond to both light and heavy use.
- + Identify the specific functions for each multi-use spaces and coordinate their schedule to maximize room utilization.
- + Identify potential multi-function spaces to accommodate required space requirements for more complex future programs.

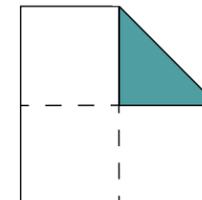


MODIFIABILITY

MANIPULATE FOR DIFFERENT USES

Design strategies and things to consider for Modifiability as an attribute of space which invites active manipulation, appropriation, and speedy reconfiguration.

- + Use mobile partitions and furniture that allow quick reconfiguration of the space with the help of light and movable elements.
- + Design to accommodate for different equipment providers and different space requirements and connections.
- + Select adjustable seating furniture that could also serve a sleeping or napping purpose as appropriate in spaces designed for this purpose, such as oncology.
- + Consider rail mounted equipment system for headwalls, allowing for quick adjustment and replacement of equipment needs.
- + Consider in-floor services via a raised flooring system for MEP systems, especially when considering infection control.
- + Select materials that respond appropriately to the different types of use.
- + Select furnishings that allow for ergonomic adjustments, accommodating different users and postures



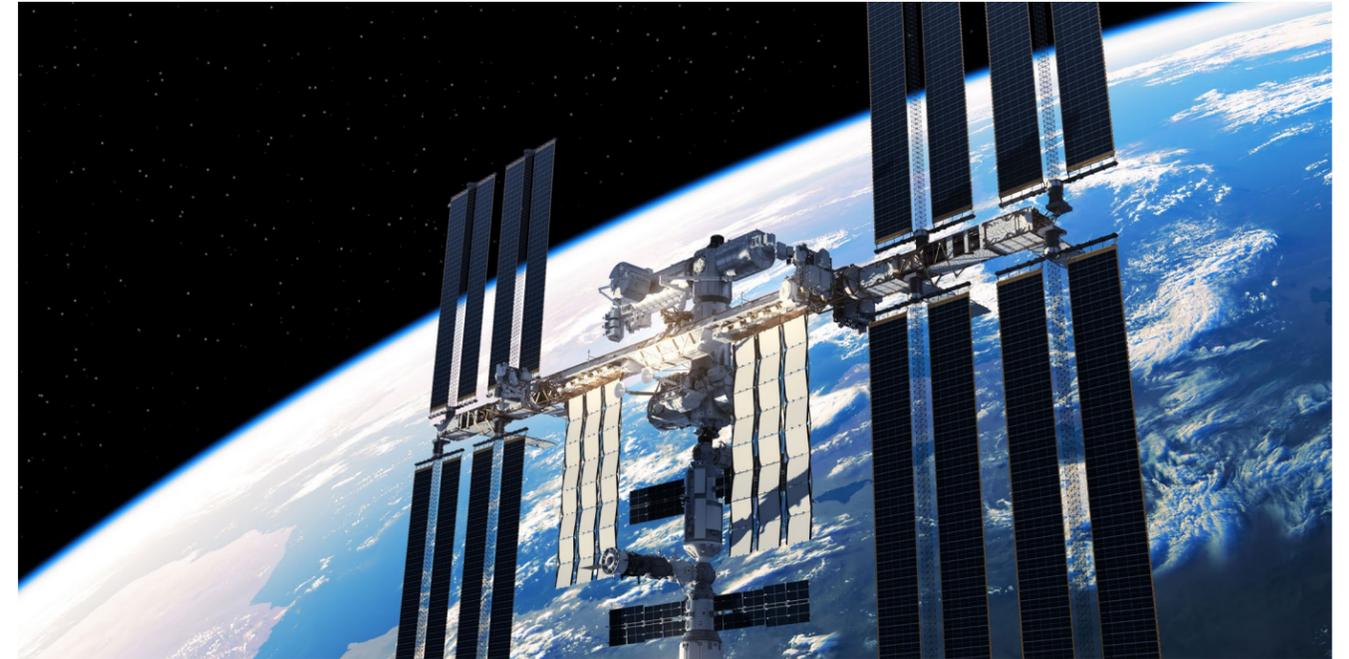
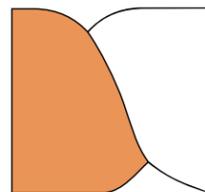


CONVERTIBILITY

ADAPT FOR NEW USES

Design strategies and things to consider for convertibility as an attribute of space adapts space for new uses and affords easier future re-design.

- + Space plan utilizing modular sizes that conform to different room types.
- + Plan and build utilizing universal planning and structural modules, such as universal headwalls, that would offer maximum flexibility for a variety of spaces.
- + Locate most services on corridor walls to minimize impact to utilities when removing internal walls.
- + Use modular prefabricated furniture in lieu of millwork so they are easily relocated and reconfigured.
- + Use continuous ceiling grid and modular lighting fixtures with quick connect that can be easily relocated.
- + Consider in-floor services via a raised flooring system for MEP systems, especially for infection control.
- + Strategically locate stack systems in centrally located areas with easy access for convertibility of spaces.
- + Consider using prefabricated, modular structural and MEP systems in high tech areas to allow for utility and equipment modifications.
- + Consider planning room adjacencies with demountable partitions that could be combined or subdivided

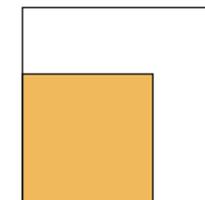


SCALABILITY

EXPANDS OR CONTRACTS

Design strategies and things to consider for Scalability as an attribute of space which can expand and contract.

- + Consider planning room adjacencies with demountable partitions that could be combined or subdivided allowing for expansion or reduction of future needs.
- + Careful consideration when planning and locating shell spaces so they would conform to a variety of modular room sizes and circulations, and take operational implications of a later build out, such as noise, materials movement, adjacencies, etc, into account.
- + Use systems, modular furniture and casework to add or subtract user capacity or storage.
- + Identify if project is a short- or long-term investment for the client and plan for services and utilities accordingly.
- + Plan and build utilizing universal planning and structural modules, such as universal headwalls, that would offer maximum flexibility for a variety of spaces.
- + Consider investing in utility system strategies that can save energy usage, and robust IT infrastructures with built in physical or cloud based expandability, designed with flexibility in mind for future project renovations and upgrades.
- + Strategically locate vertical stack systems throughout floors that allow for easy access for maintenance and alterations and size them with potential growth in mind.



STARTING A CONVERSATION AROUND FLEXIBILITY

The FleXX framework can be used to have conversations about organization and operations as well, illustrated below.

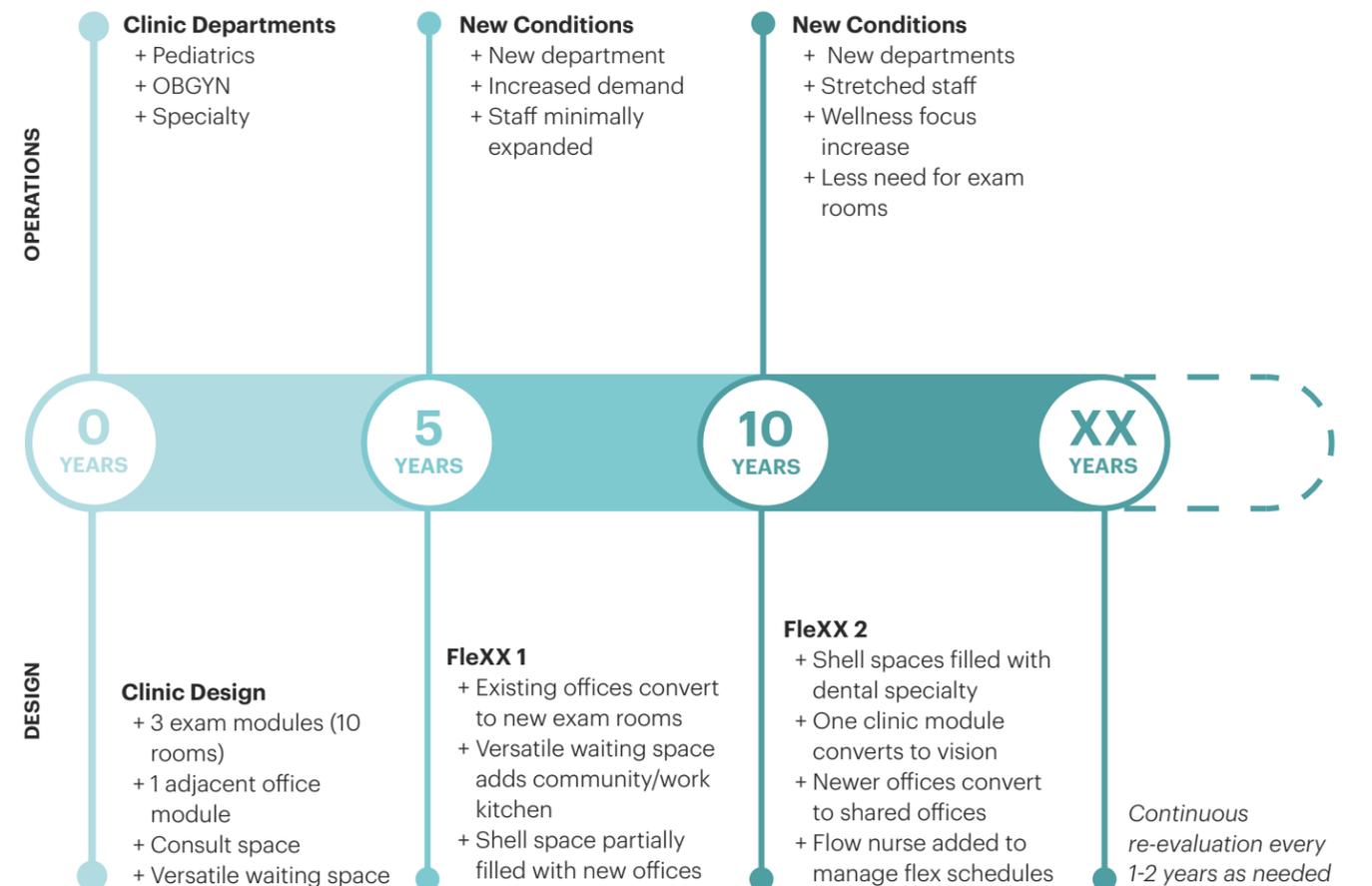
	VERSATILITY	MODIFIABILITY	CONVERTABILITY	SCALABILITY
SERVICE LINE	Are your service offerings versatile?	Can your service offerings be converted to a different typology?	Can your service offerings be modified - what kind of space needs would you have to think of if that happens?	Can your service offerings scale- allowing you as an organization to grow (or shrink) depending on the market?
HUMAN EXPERIENCE	Are you able to allow a range of experiences that meet the needs of a range of patients, providers, and community?	Are you able to modify this experience as needed?	Would you want to convert/ fundamentally change the type of experience? How do you see the experience your users have changing in the next 10 years?	Are you able to scale the experience - ranging from the highly personal to the highly communal, from subtle to celebrated?
OPERATIONS	Is your operational model versatile? Are you able to accommodate different patient and staff needs through role/ time flex options?	Is your operational model modifiable? Can you change it, if needed, for continuous improvement?	How will you convert your operational model to allow shifts in the market, or in the field? What if you have to switch completely?	How scalable is your operational model- can you handle lower or higher volumes?
UNFORESEEN CIRCUMSTANCES	Are you able to flex your operations and your spaces during man-made or natural disasters for multiple purposes?	Are you able to modify operations and your spaces during man-made or natural disasters for multiple purposes?	Are you able to convert certain sections of your unit to contain outbreaks, or address unprecedented needs?	Are you able to scale your operations to meet unforeseen needs- how does this affect your spaces?
SPACE	How Versatile are your spaces to enable all of the above?	How Modifiable are your spaces to allow all of the above?	How Convertible are your spaces to allow all of the above?	How scalable are your spaces to allow all of the above?

POTENTIAL CLIENT RESPONSE	VERSATILITY	MODIFIABILITY	CONVERTABILITY	SCALABILITY
	<i>My waiting rooms are designed as fluid zones which can reduce real estate needs, allow multiple uses (such as community fairs or receptions), have a range of amenities to appeal to a range of users, can double as triage areas during an emergency, and serve as a connector space for all my units</i>	<i>All my spaces have been designed on a modular basis such that I can modify my furniture for ergonomics, switch it out for change in operations [I just need to switch carts to make my exam rooms a different type of specialty], and have intelligent systems so I can control the sensory environment for enhanced experience. During a disaster situation I can easily wheel in an extra bed and be able to take care of more people, and I can convert a section of my clinic to a hyper-secure area for man-made disasters.</i>	<i>By using a universal 30 X 30 grid, with a modular space planning approach, movable walls, and grid-based MEP systems, I am able to change out my space to a different purpose within a matter of days. Buffer in ceiling heights, additional cabling and med-gases, and generously planned storage areas give me the opportunity to convert my primary care to specialty care/ surgical services if needed. I also believe the universal grid will allow me over the next 50 years to change my B-occupancy to I-occupancy or change the type of building altogether if needed.</i>	<i>We have an additional shell floor to allow for expansion when we grow. Our master plan site's potential new buildings if we need to grow. Within our clinics we have some shell areas we have plastered over allowing us to grow if needed.</i> <i>Our MEP and structural systems are designed to allow for easy expansion in the future.</i>

FROM DESIGNING TO MOBILIZING FLEXX: TAKING THE NEXT STEP

Our research suggests that strategies for designing flexibility exist, as does the willingness to pay for them, however a clear ROI is not evident just yet. Specifically, stakeholders reported that although they invest in convertibility and scalability, they don't always derive the full benefit, hence the storied, "we never moved our walls or casework". It appears that designing for flexibility may not be just about

planning for space and operations, but also planning for how flexibility, once designed in, is actually mobilized. At what pre-determined set of operational criteria does an organization choose to deploy a flexibility investment? One approach may be to develop a FleXX plan, where operational strategies are planned against specific spatial modifications using the FleXX framework.





Kitchen Table



Baby Crib



Shipping Container



International Space Station

VERSATILITY

I can do different things in it

MODIFIABILITY

I can change it

CONVERTIBILITY

It can change

SCALABILITY

It can grow or shrink

LEVEL OF EASE



EXAMPLES

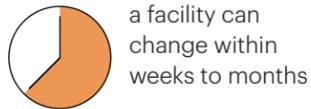
- + multi-purpose space
- + built-ins with multiple uses

- + mobile furniture
- + moveable partitions
- + rolling equipment

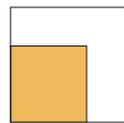
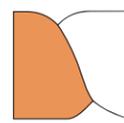
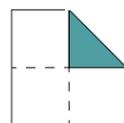
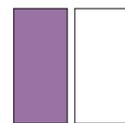
- + demountable partitions
- + reconfigurable walls

- + structure
- +MEP

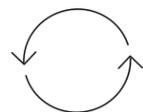
TIMEFRAME



COST



STATE CHANGE



Adapt between states



Adapt to a new state

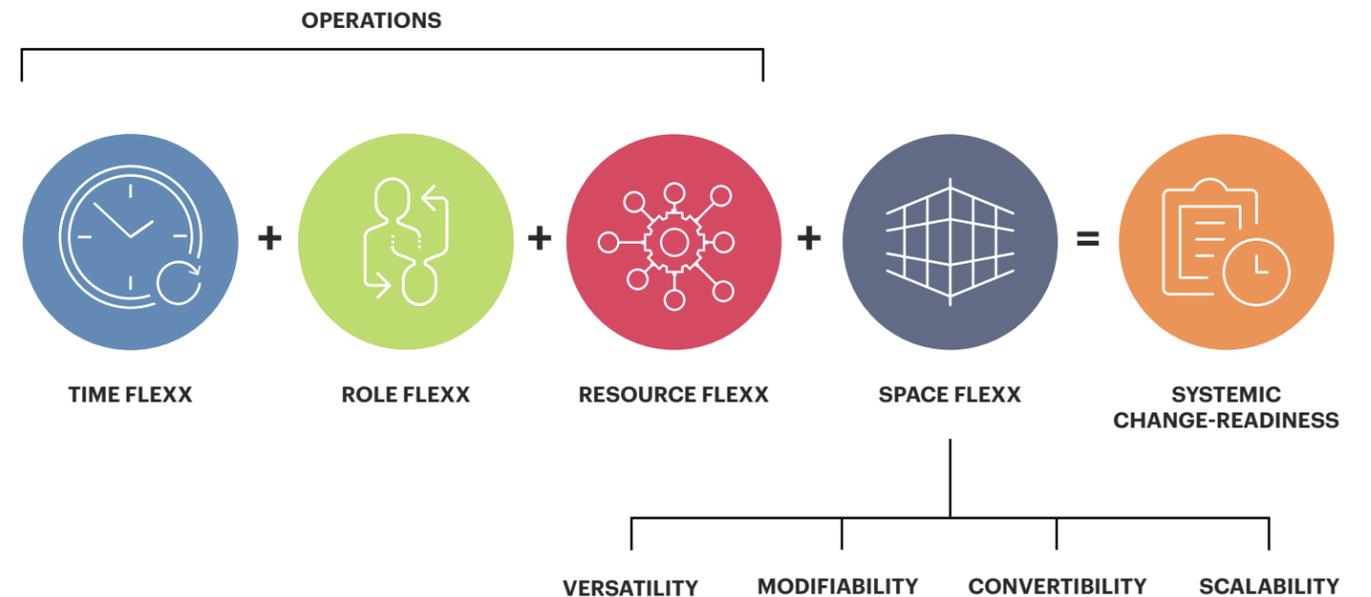
FLEXX RECAP AND NEXT STEPS

When we began this study, we intentionally started broad to understand the ambiguous concept of flexibility. From this emerged the four spatial attributes of flexibility - versatility, modifiability, convertibility, and scalability. For each of these attributes, we worked to understand their specific definitions, including ease of change, type of change, who makes the change, and the cost of change. We outlined these factors in our FleXX framework.

We tested and developed this framework by filtering real-life project examples (health care and analogous) through it. This identified further clarifications required so that a single aspect's place could be clearly differentiated between the building layers and the flexibility attributes. This framework was then validated with real life decision makers providing insight based on their needs and past experiences.

The FleXX framework promotes facilities being change-ready and serves as a foundation for conversations between owners, designers, and planners on how to plan and then mobilize flexibility in outpatient settings. It can also be applied to projects to create a "FleXX plan", where operational strategies are planned against specific spatial modifications over the building's life cycle.

The next step for this study is to try and test the FleXX framework on real projects, and study how flexibility can be planned and designed as well as strategically mobilized in order to provide meaningful impact and a sustainable ROI. Additionally, a deeper dive can be taken to analyze the FleXX potential facilities designed for, versus what they used, to further our understanding around successful design strategies.



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