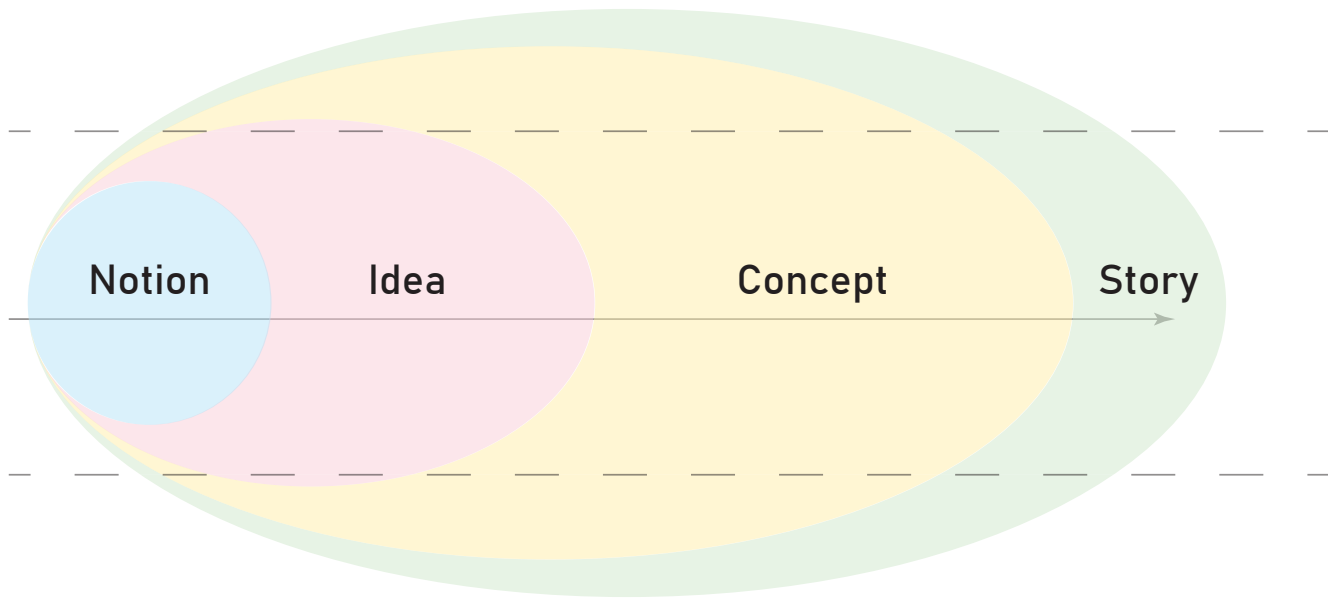


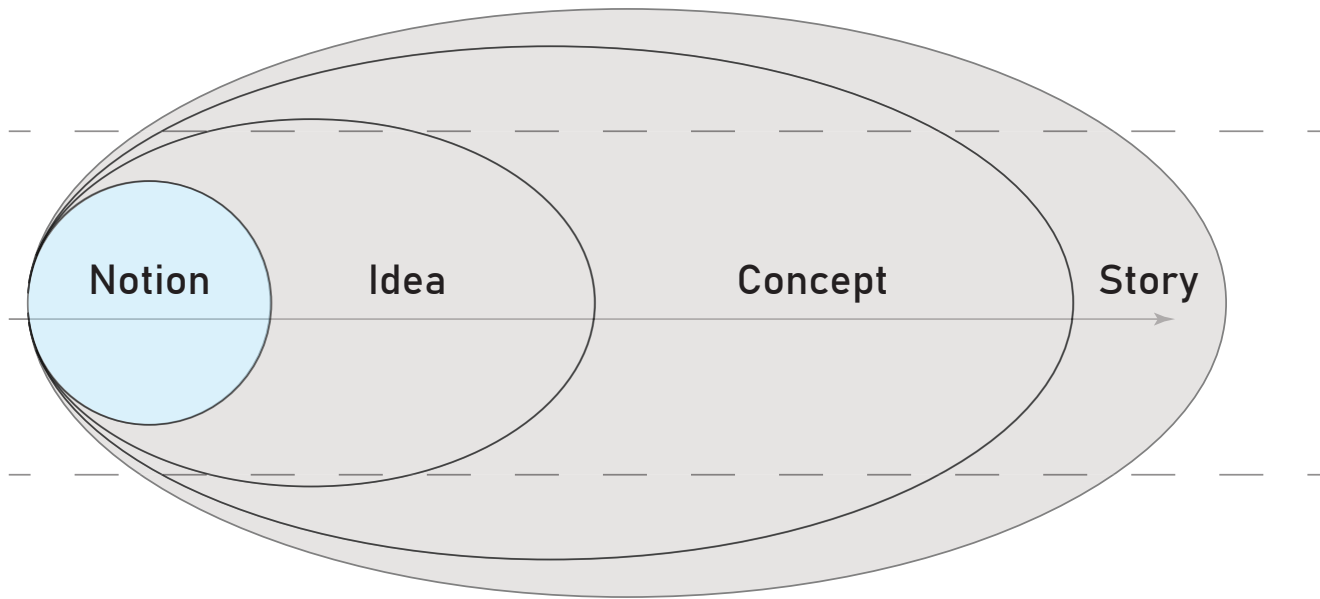
Design of and for Adaptive Reuse

A Way to Make MEPs Architecturally Relevant

Ian Primer

Advisor: Susan Massey





Notion

For a long time I have been fascinated by building systems, specifically MEPs as design elements in a building.

Using these systems as a design element appeared to be a way to create more complex design without extra construction investment.



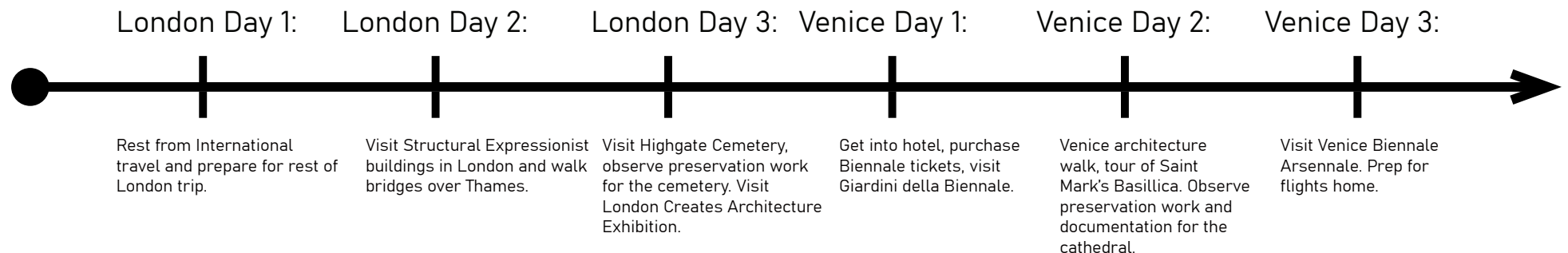
Pictures of the ceiling in an urban planning firm in Medellín, Colombia.



Working off existing frameworks and within a context that allowed me to avoid questions of construction coordination I applied to UROP to forward this investigation under the title.

Structural Expressionism in Adaptive Reuse Projects

The UROP grant I recieved funded this trip outlined below.



Notion

The architecture I saw on the trip provided me an understanding of how MEPs and structure were used in building construction.

Ironically, the temporary exhibits at the Venice Biennale served as better examples than the structural expressionist buildings in London.



Top: Neo Bankside Building
Bottom: Lloyd's Tower, London, UK

Two temporary exhibits in the Arsenale
section of the Venice Biennale

Notion

The Fall 2025 semester began with research into building systems so they could be properly deployed in design.

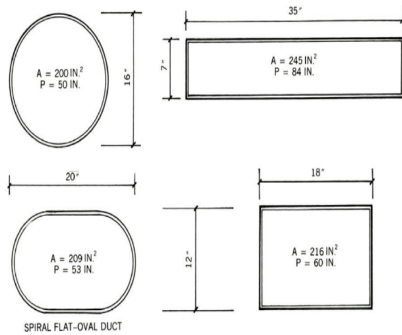


Figure 16.16a All these ducts have the same friction and, therefore, airflow capacity. The circular duct requires the least volume and material but has the greatest depth. (A = area, P = perimeter). In this example, the actual sizes are not important—only the relative sizes.

Norbert, 2014

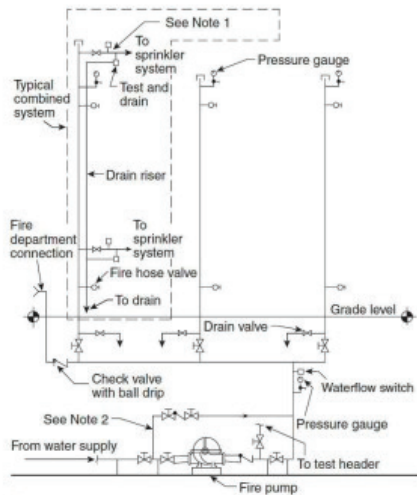


Figure 1-20 Schematic Diagram of Fire Pump with Bypass
Source: NFPA 20

DeHoyos, 2011

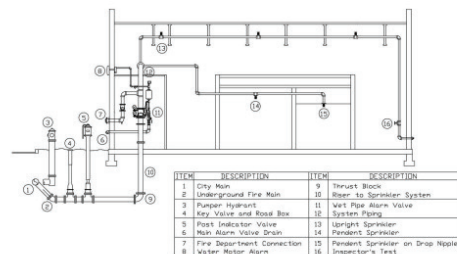


Figure 1-7 Wet Pipe Sprinkler System

DeHoyos, 2011

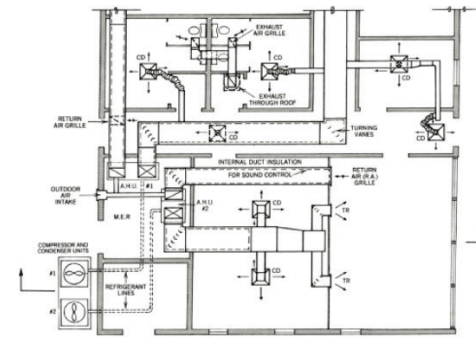
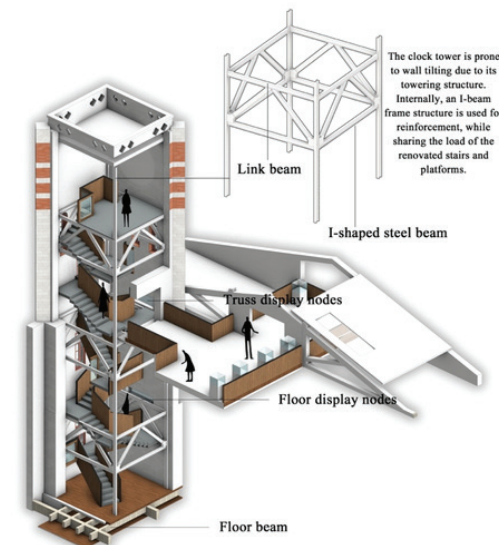
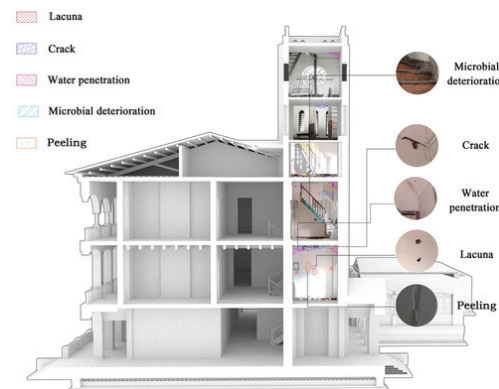


Figure 16.13b This plan shows a small two-zone office building served by two split systems. Double diagonal lines define supply ducts in section, while a single diagonal line across a rectangle defines a return duct. Abbreviations: TR = top register, CD = ceiling diffuser, M.E.R. = mechanical equipment room, A.H.U. = air-handling unit.

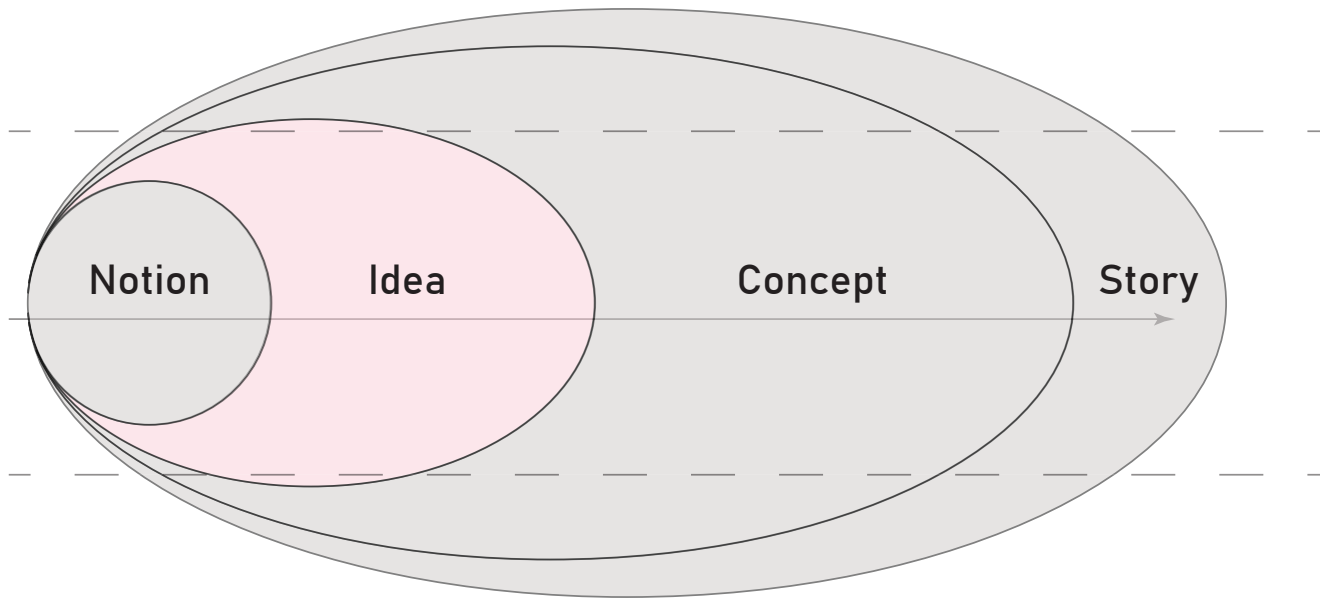
Norbert, 2014



Wang, 2024



Wang, 2024



After initial research, the project reconnected with its ideological bases.

Its architectural base is "The Art of Architectural Grafting" by Jeanne Gang

We need a new credo to guide our actions going forward. For too long, we have dismissed the care and reuse of what exists as backward, traditional, and anti-modern. Yet it actually requires us to practice in a more radical way. Grafting is part of this new way of thinking. By shifting our focus toward discovering the value in what remains and envisioning its reinvention, what will arise is a new environmental architecture that transforms waste into gold—finding climate balance while producing something original and compelling, even joyful, for our time.

Grafting/grafting/ is a design philosophy aimed at up-cycling existing building stock by attaching new additions (scions) to old structures (rootstock) in a way that is advantageous to both. The practice of architectural grafting connects the two to create an expanded, flourishing, and distinctive work of architecture.

ARCHITECT-GRAFTER'S CREDO: TEN POINTS

1 ENVIRONMENT

Just as living plant grafts are subject to their environments, architectural grafts must also weather their surrounding conditions. Climate-appropriate grafts have a better chance of surviving and thriving.

2 COMPATIBILITY

From horticultural and natural grafting, we learn that for two plants to successfully fuse, they must be compatible. It follows that to develop a successful architectural graft, architects must deeply consider how additions will find commonality with the original building and existing or commensurate will make the final project flourish.

3 REDUNDANCY

When the roots of plants graft in the wild, they reinforce the larger connective system that enables them to share resources as a community. The multitude of connections formed, with their density of contact points, provides a larger surface area for the exchange of molecules. This redundancy of connections promotes growth and development in plants, and the same principle applies to architecture. A high density of connections between the old and the new is advantageous on programmatic, structural, and aesthetic levels. In architectural grafting, the goal is to establish networks of connections in various ways, allowing different buildings or parts of a city to function as a unified whole.

4 PRECISION

Horticultural grafting performed above ground, in contrast to the spontaneous natural grafting of roots, demands a high degree of geometric precision. A sloppily executed graft will fail. Likewise, in architecture, successful grafting relies on a precise fit between the different parts. To create an elegant connection, each component must be carefully analyzed and matched with exactitude.

5 CAPACITY

In horticultural grafting, the existing rootstock serves as the foundation, while the scion's role is to expand and augment its capacity. Without the rootstock, the scion will not survive. Similarly, in grafted architecture, the original building cannot be removed entirely. It can, however, be pruned, just like the future addition or combined building, to promote growth, extend capabilities, and improve overall capacity. The architectural scion must always deliver new benefits to the original.

6 RECIPROCITY

Once grafted, the scion and rootstock plants remain genetically distinct, yet they develop the ability to influence each other physiologically. The two parts of a properly grafted building or city will also share a mutual influence. We can identify the reciprocal qualities of successfully grafted architecture, such as materiality, proportionality, or programmatic transformation. Reciprocity implies that the old imparts its time-tested qualities to the new, while the new, in turn, offers something novel back. Grafting signifies that the old, whether a building or a city, does not remain unaltered.

7 FLEXIBILITY

The rootstock of a fruit tree can accommodate multiple new scions that bear different varieties of fruit. It is even possible to graft scions onto scions. Similarly, the grafted architectural object or city is flexible enough to accommodate future options, just like the various ways in which rootstock and scion can accept grafts. The process of grafting in architecture always preserves opportunities for future changes to unfold.

8 JOINING

When plants are grafted, their joint serves as a visual indicator between the old and the new. It becomes a site of healing that often forms a thickened scar or callus. In architectural grafting, the joint should also provide insight into the project's history. The conventional practice of placing the joint, a significant tectonic moment, recessed in shadow might offer a visually clean appearance, but it misses the opportunity to tell the story of the fusion between distinct parts.

9 CARE

Developing a comprehensive understanding of the rootstock is essential for a successful horticultural graft. It is crucial to know about the original plant, appreciate its particular qualities, and care about its well-being and longevity. A successful architectural or urban graft also involves taking careful stock of the existing structure or urban fabric and caring about its continuation. This process is deeply satisfying for the architect-grafter, as it involves attentive research and the joy of discovery.

10 PLEASURE

A properly grafted building or city will offer users visual and experiential delight. There is inherent beauty in witnessing the transformation of something that has been repaired and continues to be useful, growing and evolving over time, weaving its own narrative. Like encountering a grafted apple tree, this pleasure stems not from nostalgia but from observing a living thing thrive and enjoying its tasty fruit.

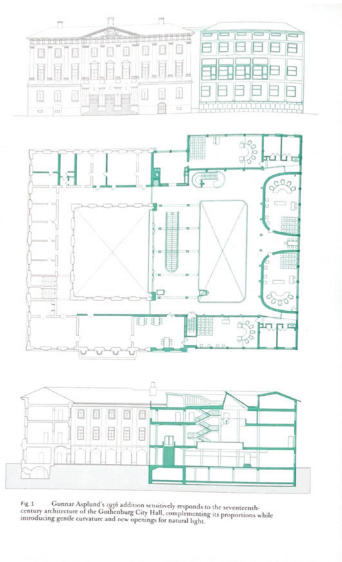


Fig. 1 Grafting of the Grafting City Hall, complementing its proportions while introducing graft structure and new openings for natural light.

Architect-Grafter's Credo: Ten Points and Five Projects

49



Fig. 18 CLEFT graft—This simple grafting method is commonly used to change the variety of fruiting and flowering areas. While both scion and rootstock are dormant, the two scions are placed into wedge-shaped openings and held in place by a rubber band or similar support.

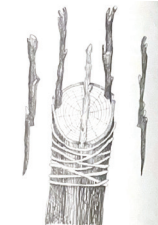


Fig. 19 BARK graft—Multiple scions are shaved on one side and placed into a single deep slit in the bark of the rootstock. The connection is sealed together through the bark flap. Redundancy is built into this approach, establishing the best performing scion to be kept while pruning the others.



Fig. 20 SADDLE graft—In this graft, the rootstock is cut horizontally and the scion is placed on top. The connection is sealed together through the bark flap. Redundancy is built into this approach, establishing the best performing scion to be kept while pruning the others.



Fig. 21 BRIDGE graft—This graft is employed to repair or replace a damaged area in a tree. The scion is placed on top of the rootstock, and the connection is sealed together through the bark flap. Redundancy is built into this approach, establishing the best performing scion to be kept while pruning the others.



Fig. 22 SPLICE graft—This graft is used to connect two plants that are of the same variety. It involves making equal and opposite cuts in the scion and rootstock, and the connection is sealed together through the bark flap. Redundancy is built into this approach, establishing the best performing scion to be kept while pruning the others.



Fig. 23 INTERSTOCK graft—This graft involves the connection of two plants instead of one. It is used when the desired fruiting or flowering plant cannot be directly grafted to the rootstock due to incompatibility issues. An interstock is employed to facilitate a successful graft, such as when grafting pears to quinces.

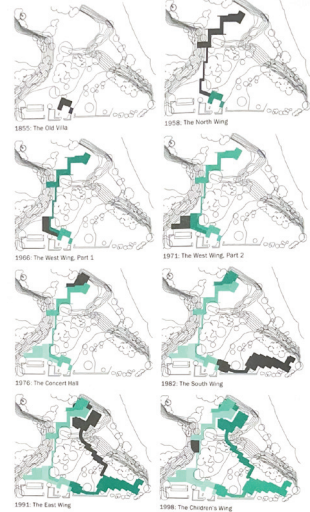


Fig. 3 The Lawrence Museum has grown over time with multiple extensions. Each new graft is precisely fitted to the previous building, and is designed to anticipate the corner of the next.



Idea

The spiritual inspirations for the study are an essay titled “Control, Anatomy, and the Legacy of the Haunted House” by Jacob Geller and a micro-game known as Anatomy.

Anatomy's malignant basement

6 Sometimes if I was bored at Shabbat services at my childhood synagogue, I would leaf through a translated copy of the Torah and look for interesting passages. The leprosy section was a favorite of mine. My father (page 148) is an environmental toxicologist and also loved talking about the leprosy house for what should be obvious reasons.

7 For my bar mitzvah, I had to write a mini sermon on a different architecture-focused section of the Torah: Exodus 25: 1-9; 31-40, which focused on the materials used to build the tabernacle. As a matter of fact, that bar-mitzvah sermon was probably the first architecture essay I ever wrote. Given how many words I've devoted to the shape and style of buildings in my adult life, this was either a fun coincidence or a sign from God.

8 This was the first video I released to over 10k subscribers (it came out immediately after my *Shadow of the Colossus* secret video). I was excited that there would be enough of an audience that perhaps multiple Henrys would feel personally targeted — including my best friend, who is named Henry. It's a dumb joke that doesn't really land, but this video came out in 2019; I was basically a toddler.

you don't have modern medicine, and you don't really know what leprosy is? Well, apparently, you shave and get clean, smear yourself with lamb's blood and olive oil, and hope. That's all well and fine. But then it gets weird. Or, **weirder**,⁴

Because in 14:37, it describes what to do when a house gets leprosy. A house! It describes a kohen, basically a rabbi, coming to the house and inspecting it.

"And he shall look at the lesion. Now, [if] the lesion in the walls of the house consists of dark green or dark red sunken looking stains, appearing as if deeper than the wall,"

And then we go on to describe what to do with a leprous house — you scrape its walls, you abandon it for days, and if the lesions return after all that,

"Now, [if] the lesion in the house has spread, it is malignant tzara'ath in the house; it is unclean."

And then you're supposed to demolish the house — there's no coming back from that. In literal terms, this is probably black mold, which is dangerous and is cause for vacating a house. But I'm fascinated by how it's **portrayed here**.⁷ The house itself is personified, and malignant. It's leprous. And like leprous people in that day, it's dealt with by excommunication. There's this notion that there's something "alive" about the house. But the only way they knew how to deal with it was just wait for it to die. And houses don't die easily. They just wait.

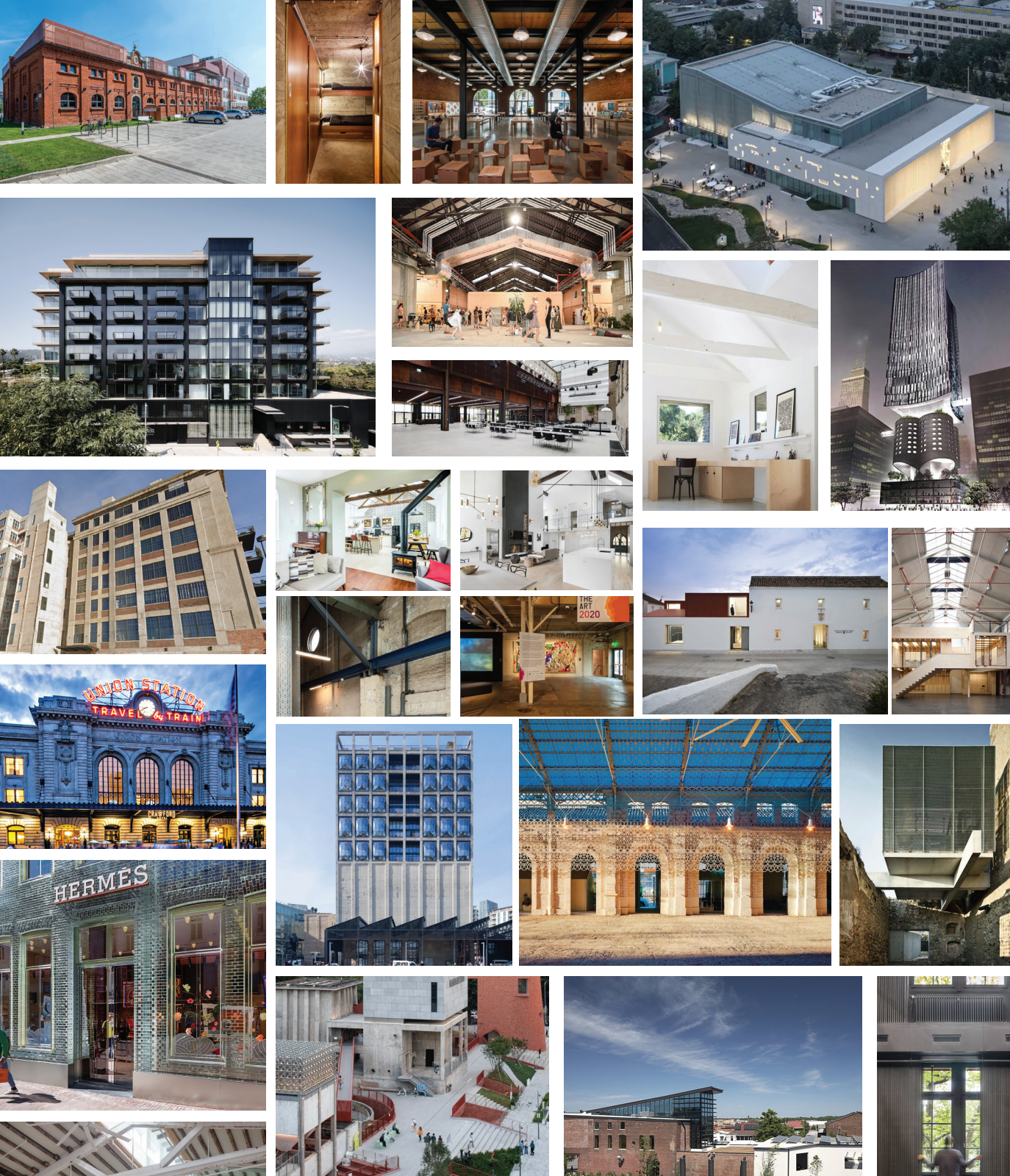
What happens to a house when it is left alone? It becomes worn, and aged. When its paint peels, its foundation begins to sink. It goes for too long unloved in. What does it think of? What does it dream?

Anatomy

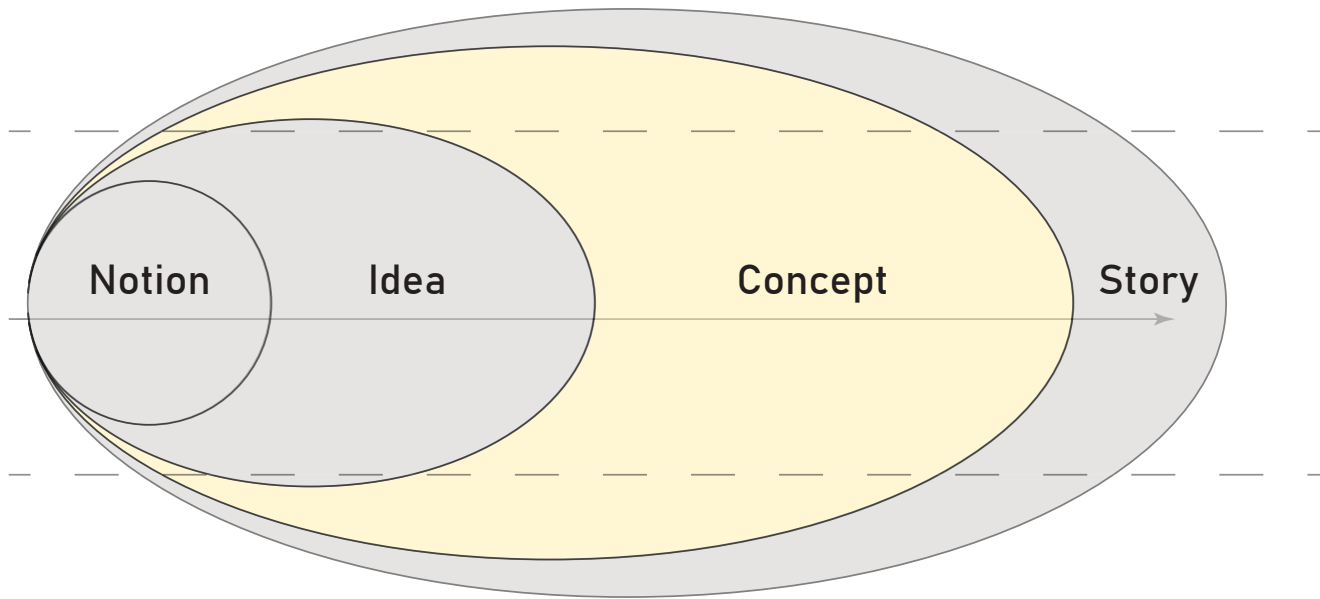
There's no subtle way to put this; the house in Anatomy hates you. And maybe it hates you, **Henry**.⁸ But moreso, it just hates humanity. It hates that you, as a collective,

Idea

After determining the general direction of the study, a range of adaptive reuse projects were chosen for visual analysis.

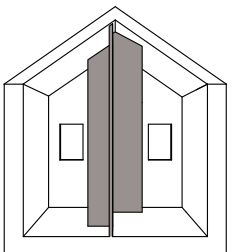
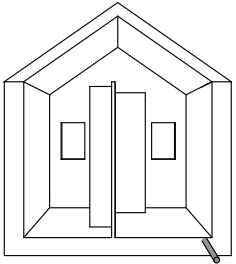
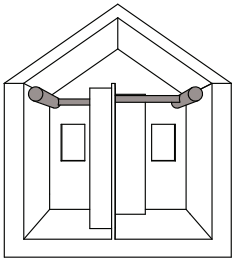
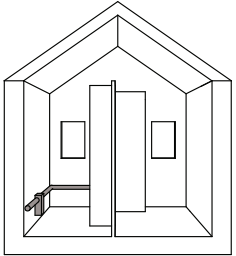
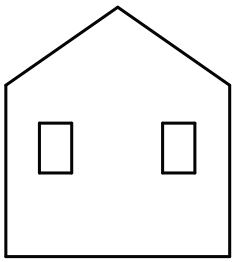


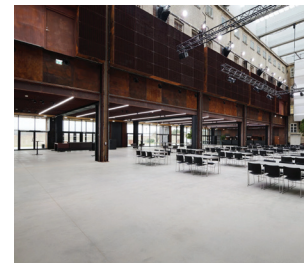
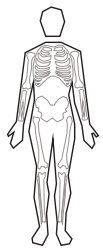
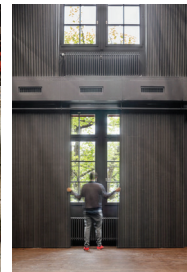
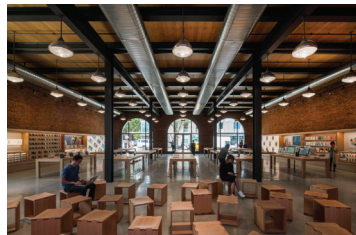
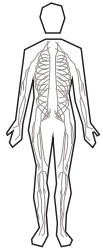
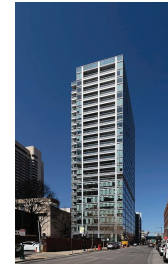
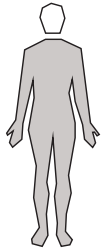
In Order from Left to Right:
 Faengslet Vestsalen-Cubo Arkitekter
 The Green Building-(fer) Studio
 Cultural Center in Brie-Opus 5
 Convent de Sant Francesc -David Closes
 Casa Meditariano, Alicante-Manuel Ocana
 The Chapel on the Hill-Evolution Design
 Pullman Market-Clayton Korte
 Fika Restaurant-Studio NAAW
 Apple Store Williamsburg-Bohlin Cywinski Jackson
 Jurkovic Heating Plant Reuse-DF Creative Group
 Church Conversion-Linthelen Design + Build
 Bar Ton Listening Bar-Anda Zota
 Gallery of Bovenbouwwerkplaats-Studioinedots
 The Mercury Store-Co Adaptive Architecture
 Wagenhallen Stuttgart-Atelire Buckner
 Bentonville Modernist Art Museum-Wheeler Kearns
 8899 Beverly Boulevard-Olson Kundig
 Franklin Tower-Gensler
 Crystal House-MVRDV
 Zeitz MOCAA-Rick Brown Associates
 2000 Little Raven St Denver
 House Within a House in Basel Factory-Stereo Architektur
 Cooking School in Ancient Slaughterhouse-Sol89
 Gallery of Leszczynski Antoniny Manor-Na No Wo Architekci
 Tselinny Center of Contemporary Culture-Asif Khan



Concept

The investigation started parallel to its inspirations through one to one comparisons between the human body and buildings.





Concept

Following this, different buildings were organized into different body system groups depending on what MEP system would be focused on for the building.

Left to Right:
 Crystal House-MVRDV
 8899 Beverly Boulevard-Olson Kundig
 Franklin Tower-Gensler
 WeWork Weihai-Linehouse
 Church Conversion-Linethelen Design + Build
 Bar Ton Listening Bar-Anda Zota
 Apple Store Williamsburg-Bohlin Cywinski Jackson
 Pullman Market-Clayton Korte
 Fika Restaurant-Studio NAAW
 The Mercury Store-Co Adaptive Architecture
 Wagenhallen Stuttgart-Atelier Buckner
 kHaus-Foketyn del Rio Studio
 Convent de Sant Francesc -David Closes
 Jægersborg Water Tower-Dorte Mandrup
 Cultural Center in Brie-Opus 5
 Faengslet Vestsalen-Cubo Arkitekter

Concept

Skeleton - Structural



Convent de Sant Francesc -David Closos



Cultural Center in Brie-Opus 5



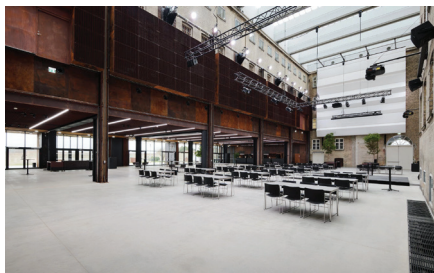
The Green Building-(fer) Studio



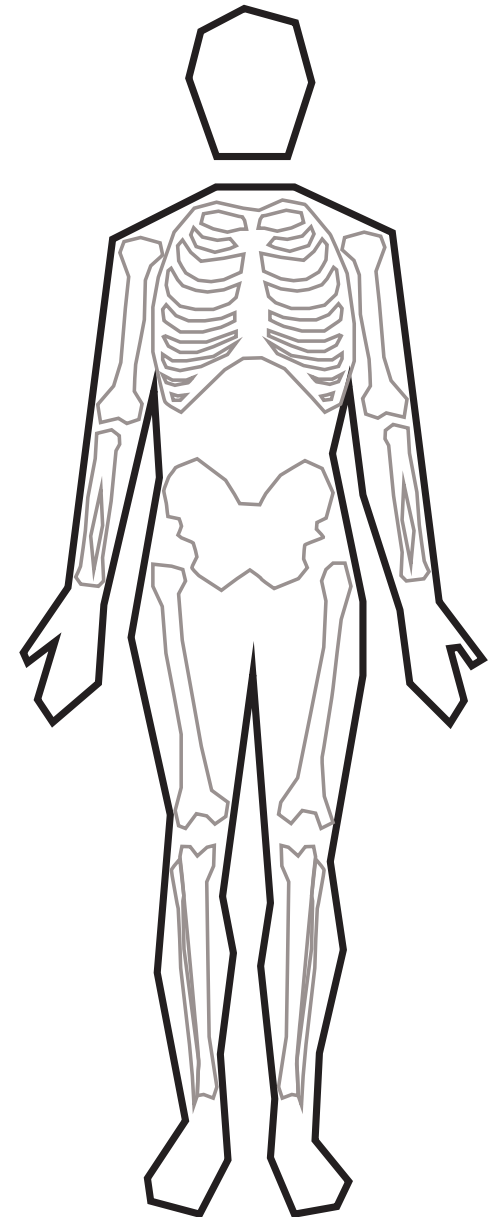
Casa Mediterraneo-Manuel Ocana



Jægersborg Water Tower-Dorte Mandrup



Faengslet Vestsalen-Cubo Arkitekter



Concept

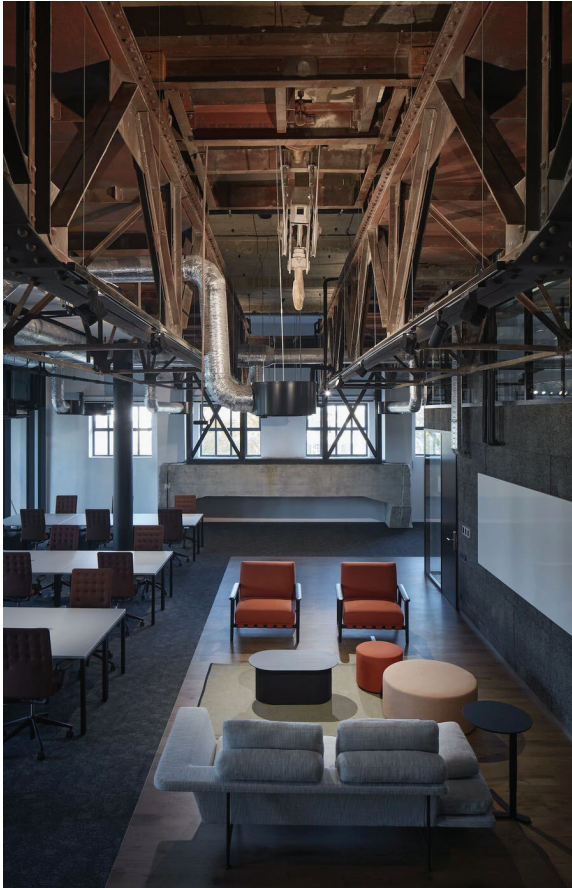
Immune System - HVAC



Apple Store Williamsburg-Bohlin Cywinski Jackson



Pullman Market-Clayton Korte



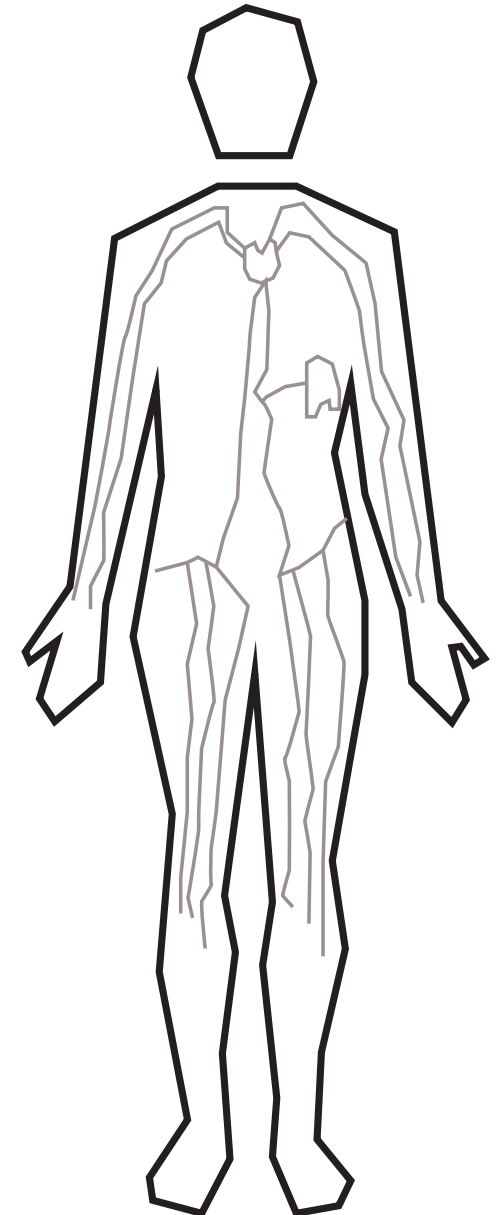
Jurkovic Heating Plant Reuse-DF Creative Group



Fika Restaurant-Studio NAAW



The Chapel on the Hill-Evolution Design



Concept

Nervous System - Electrical



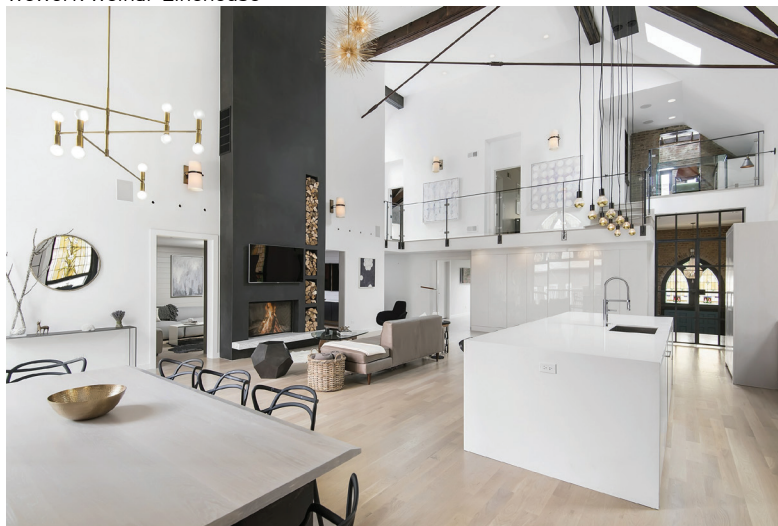
Bar Ton Listening Bar-Anda Zota



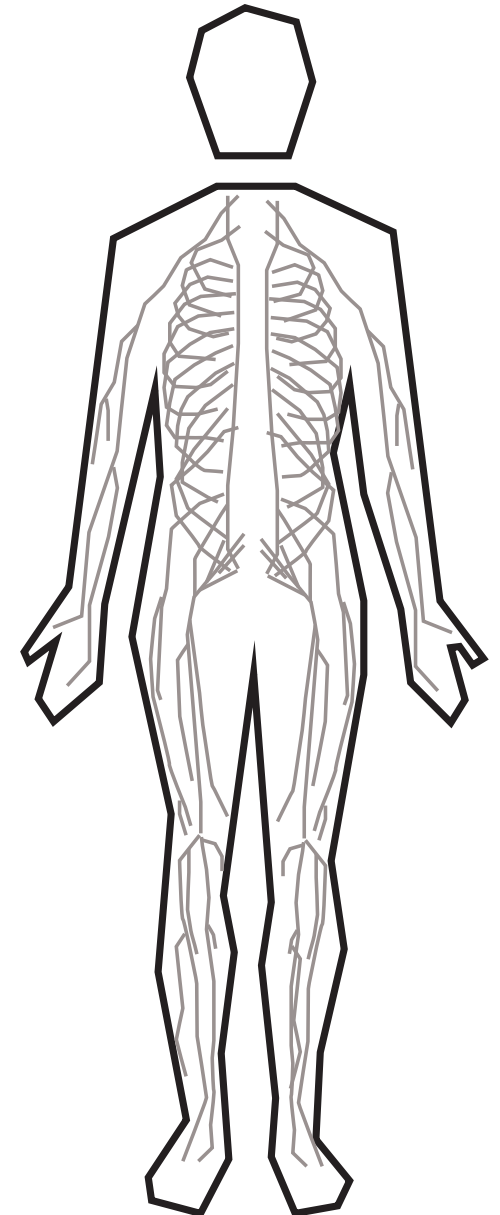
WeWork Weihai-Linehouse



Gallery of Bovenbouwwerkplaats
-Studioninedots



Church Conversion-Linthelen Design + Build



Concept

Circulatory System - Plumbing



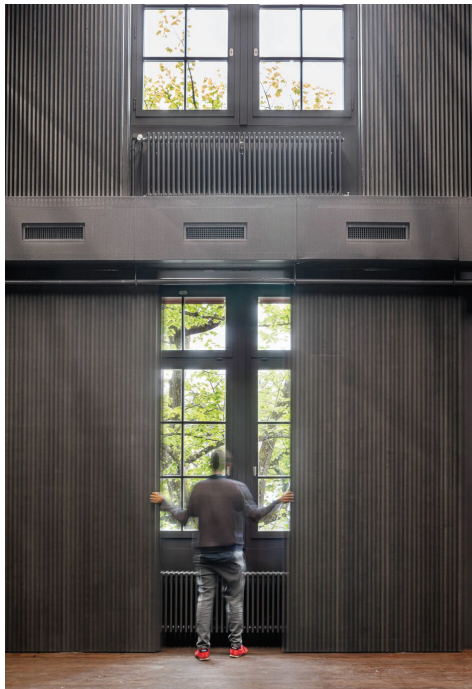
Wagenhallen Stuttgart-Atelire Buckner



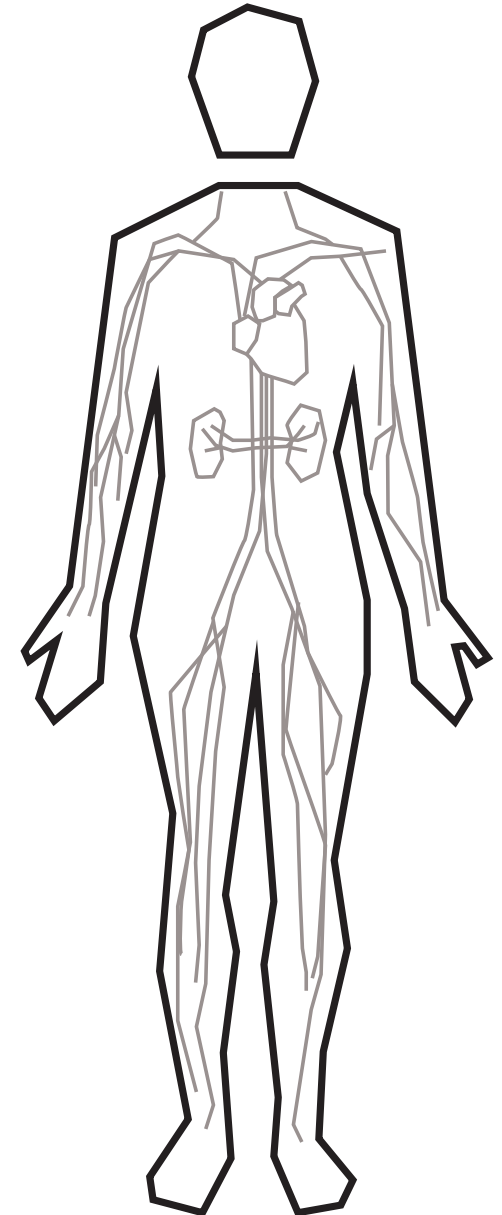
The Mercury Store-Co Adaptive Architecture



Bentonville Modernist Art Museum
-Wheeler Kearns



kHaus-Foketyn del Rio Studio



Concept

Skin - Facade



Zeitz MOCAA-Rick Brown Associates



Crystal House-MVRDV



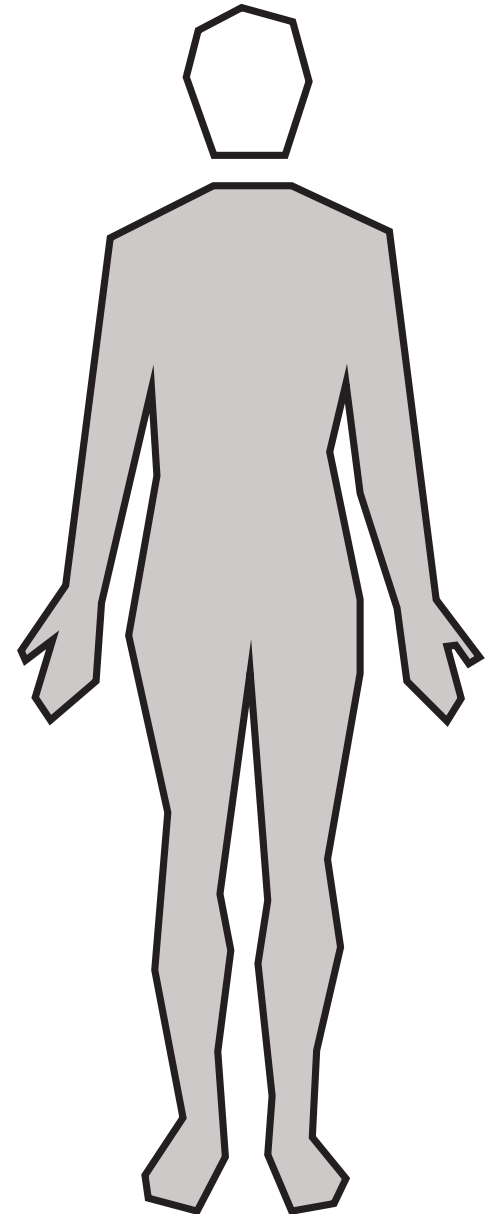
8899 Beverly Boulevard-Olson Kundig



Franklin Tower-Gensler



2000 Little Raven St Denver



Concept

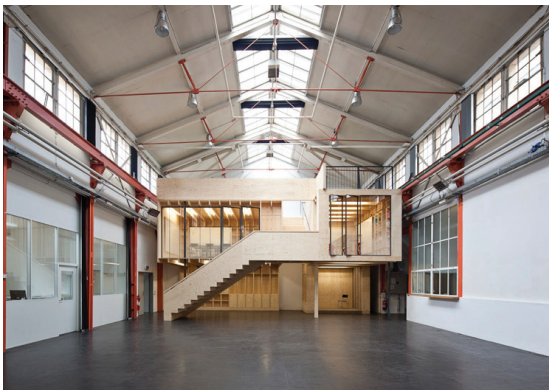
Additions - Prosthetics



Gallery of Leszczyński Antoni Manors
-Na No Wo Architekci



Cooking School in Ancient Slaughterhouse-Sol89



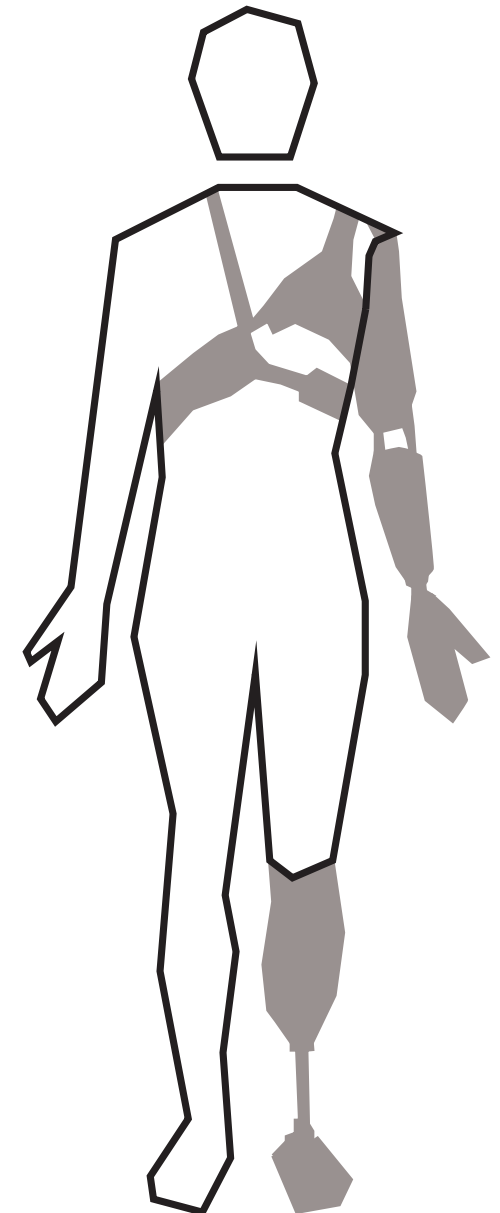
House Within a House in Basel Factory
-Stereo Architektur



Tselinny Center of Contemporary Culture-Asif Khan



Port House-Zaha Hadid



Concept

Theory - The Spirit



Union Station Denver Reuse-SOM



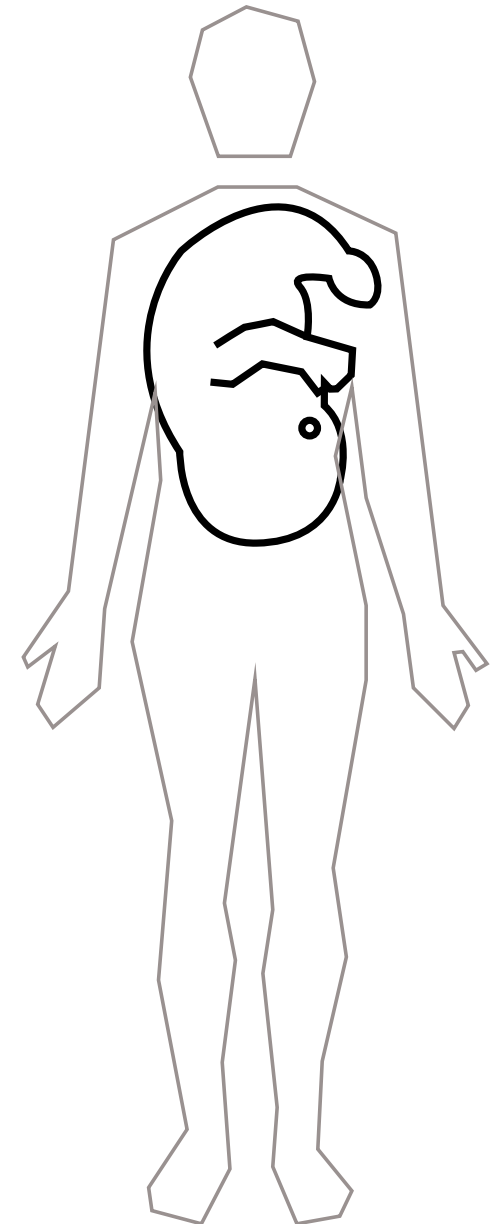
War Bunker Refurbishment-B-ILD



Printmaker's Studio-Modal Architecture



Prentice Women's Hospital-Studio Gang



Concept

After the initial 1 to 1 comparison was found to be insufficient, a new metaphor was embraced.

The building's structure and system was related to the body in a vague sense and partition walls and aesthetic elements were related to clothes.

Concept

Covering Up

A few general examples of construction strategies that excessively covered up MEPs and other systems were chosen to be discouraged within the study.

Painting Over



Bulkhead



Acoustic Ceiling Tiles



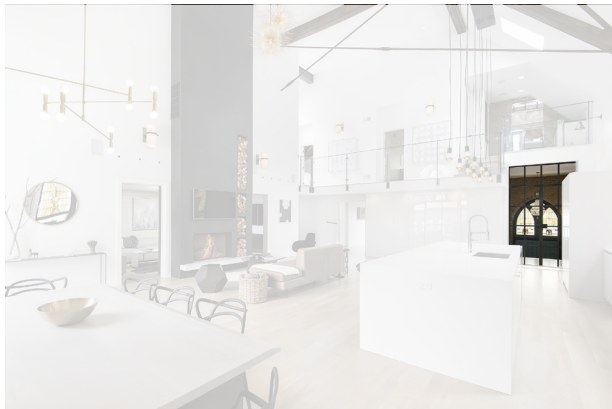
Furr-Outs



Implied Existence



Memento Mori



Imaginary Arrows



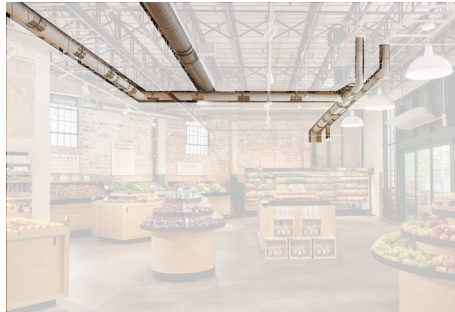
Exaggerations



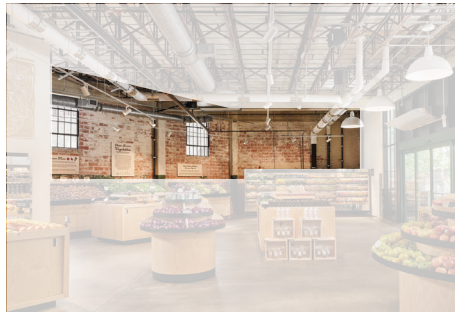
New Datum



Design w/o Addition



Authentic "Style"



Concept

Being Proud

A methods for a building to be proud were chosen as a way of understanding MEP design in adaptive reuse.

Separation Through Structure



Visual Parallels



Addition as Highlight



Heavy and Light



Bleeding Old and New



Concept

Being Proud

Systems as Highlight



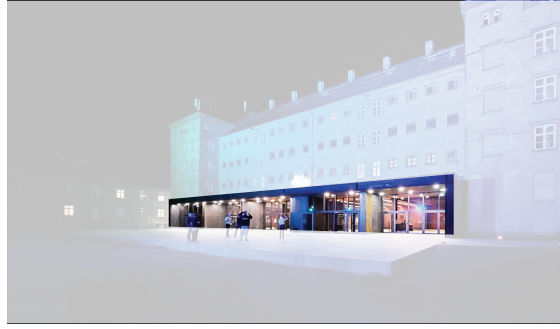
Systems as Endorsement



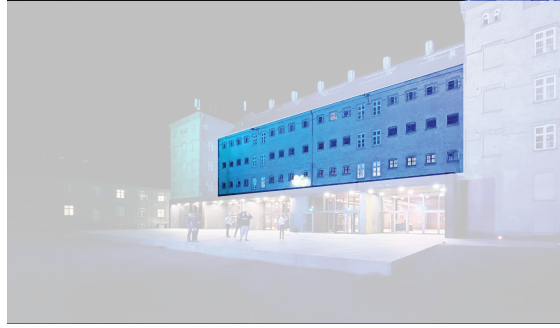
Partial Departure



Visual Parallels



Balanced Weight



Repetition Connection

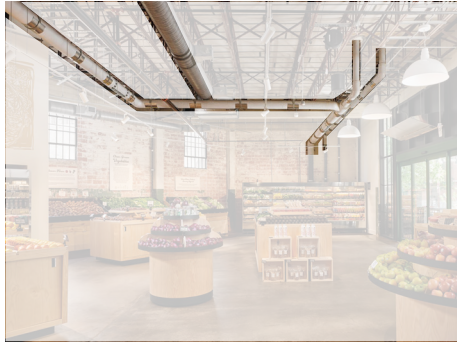


Wrap Connection



Concept
Being Proud

Concept



Pullman Market
Clayton Korte

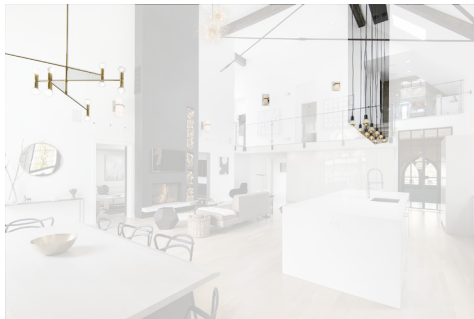
The Authentic 'Style'

Pullman Market chooses to display an interior that at least mimics the original brick of the building. This choice amongst others makes the building appear raw and authentic. The buildings original features and the bold inclusion of upgrades become the stylistic expression of the building. This decision saves money and creates a unique environment that by its nature is completely individual.



Complexity Without Addition

Typical use of drop ceilings hides systems and creates a monotonous display on the ceiling. By exposing the heat exhaust and HVAC, the roof plan becomes more visually complex and interesting. This leads the ceiling design to become an important part of the building's expression.



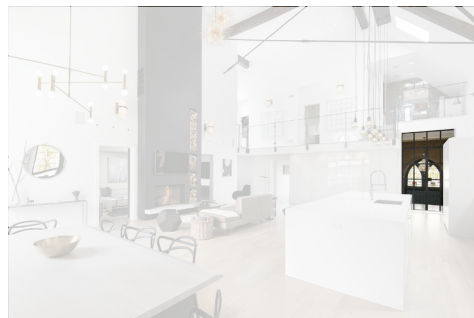
Church Conversaion
Linthelen Design + Build

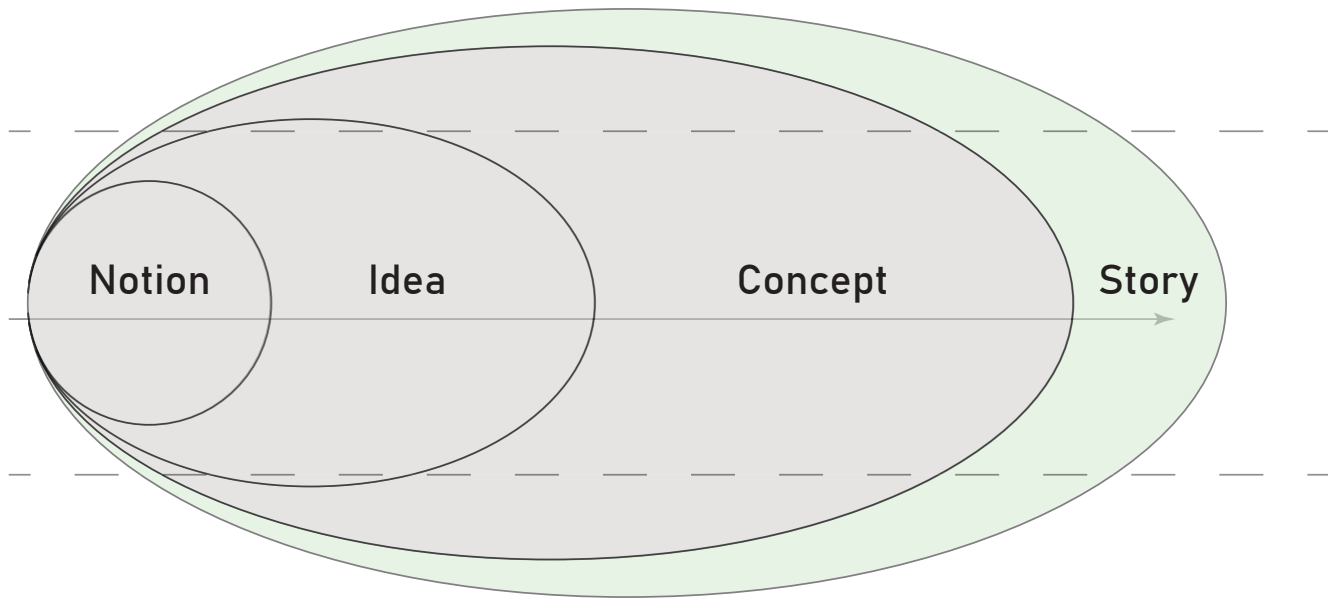
Memento Mori

The building is completely covered in new material. Like stretch marks, the building keeps some marks of its old form. The foyer keeps its originally exposed materials.

Implied Existence

The light fixtures of this building are either attached to the wall or drop far from the ceiling. This creates an imaginary line that goes up into the ceiling and exits the building. Similar to how we understand the human body has a spine, we understand this building has a spine from which its electricity runs.





Story

After a set of tools were developed for the design of adaptive reuse projects, South Boulder Recreation Center was chosen as the site for an example design.

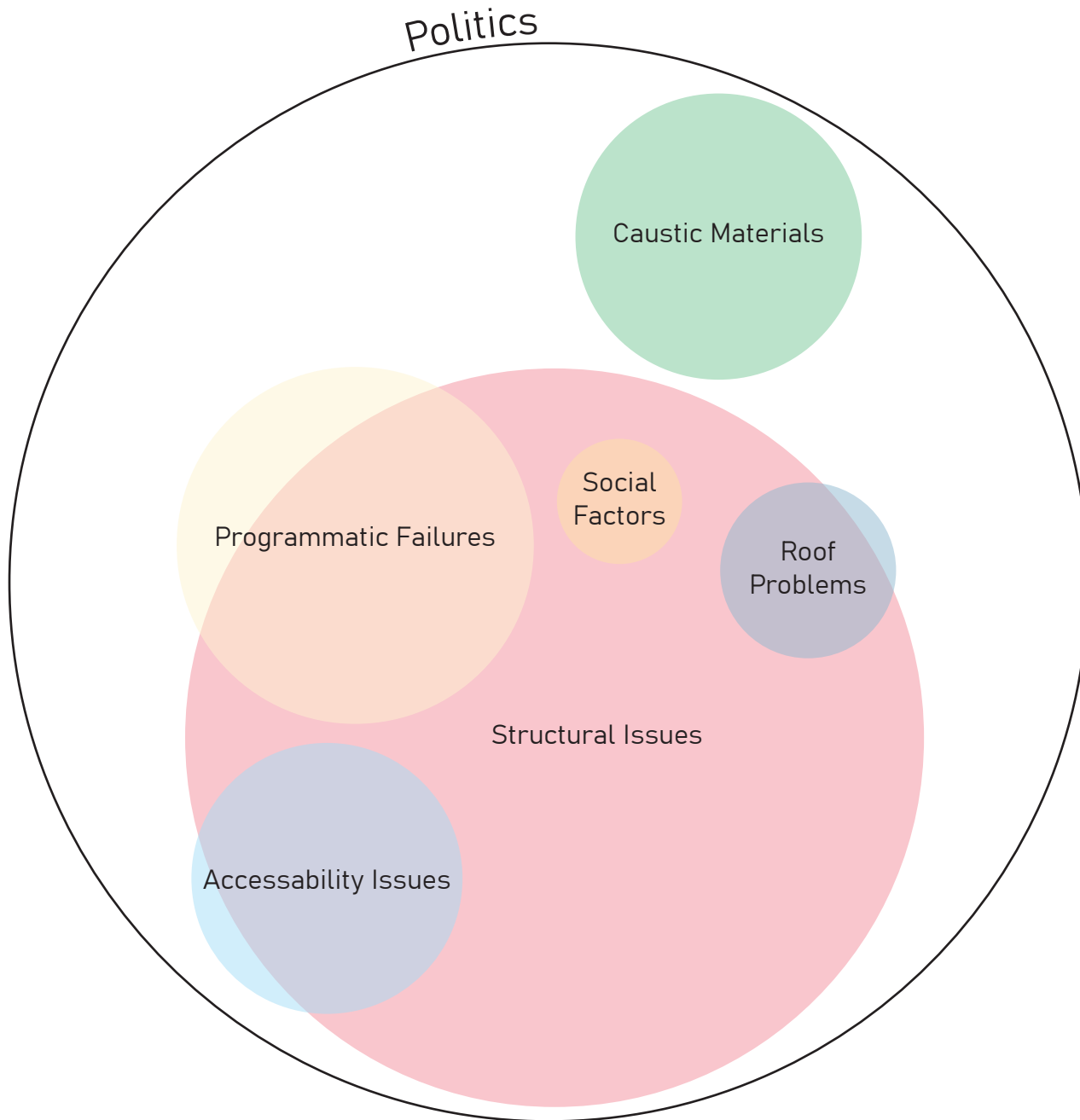


Pictures of South Boulder Recreation Center

Story

During initial site analysis of South Boulder Recreation Center progressed, it became clear the building was unfit for adaptive reuse.

From this realization came a bigger question: what elements of a building make it hard to adaptively reuse?



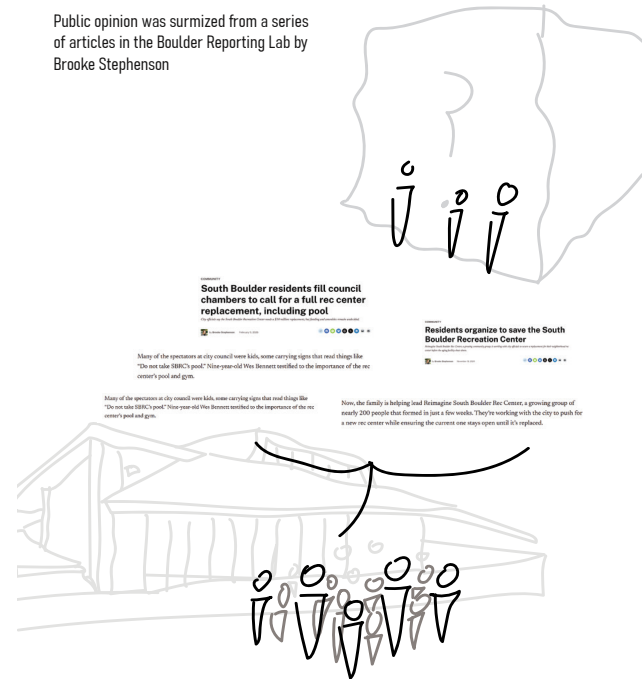
Bubble diagram of overlapping problems with SBRC

Story

What to do with an existing building is not just a question of design and cost, it is a question of community. In SBRC's case, the community isn't very concerned with the architectural character or historical value of the building. Both of these elements are typically key in keeping a building in existence.

What is keeping SBRC around currently is funding and programmatic concerns. The community is extremely invested in retaining a pool in SBRC or its replacement. The fear that a new building might cause the pool to be completely removed and never come back has made many residents terrified of the possibility of a new building. Despite this fear, most residents still argue in favor of building a new building and are more concerned with ensuring that the new building has a pool.

Public opinion was surmised from a series of articles in the Boulder Reporting Lab by Brooke Stephenson



Two different ways in which politics affect adaptive reuse

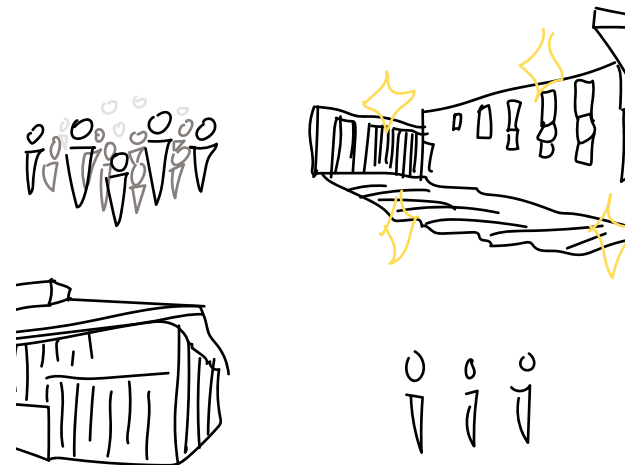
There is a common notion that new is better. This idea is not unfounded. Every year we unravel more about the truth of the universe and further hone our craftsmanship. Newer construction is able to avoid foundational problems that older projects simply had no way of anticipating.

Despite this, new does not always mean better. Older buildings, in theory, serve as a focus from which a project can grow. In theory, a project growing from an existing building should be able fund a greater square footage.

In practice, this is not the case. Older buildings are often more expensive to build with than to simply tear down and build new. Additionally, a new building means new program, allowing additional programs to introduce themselves as central elements.

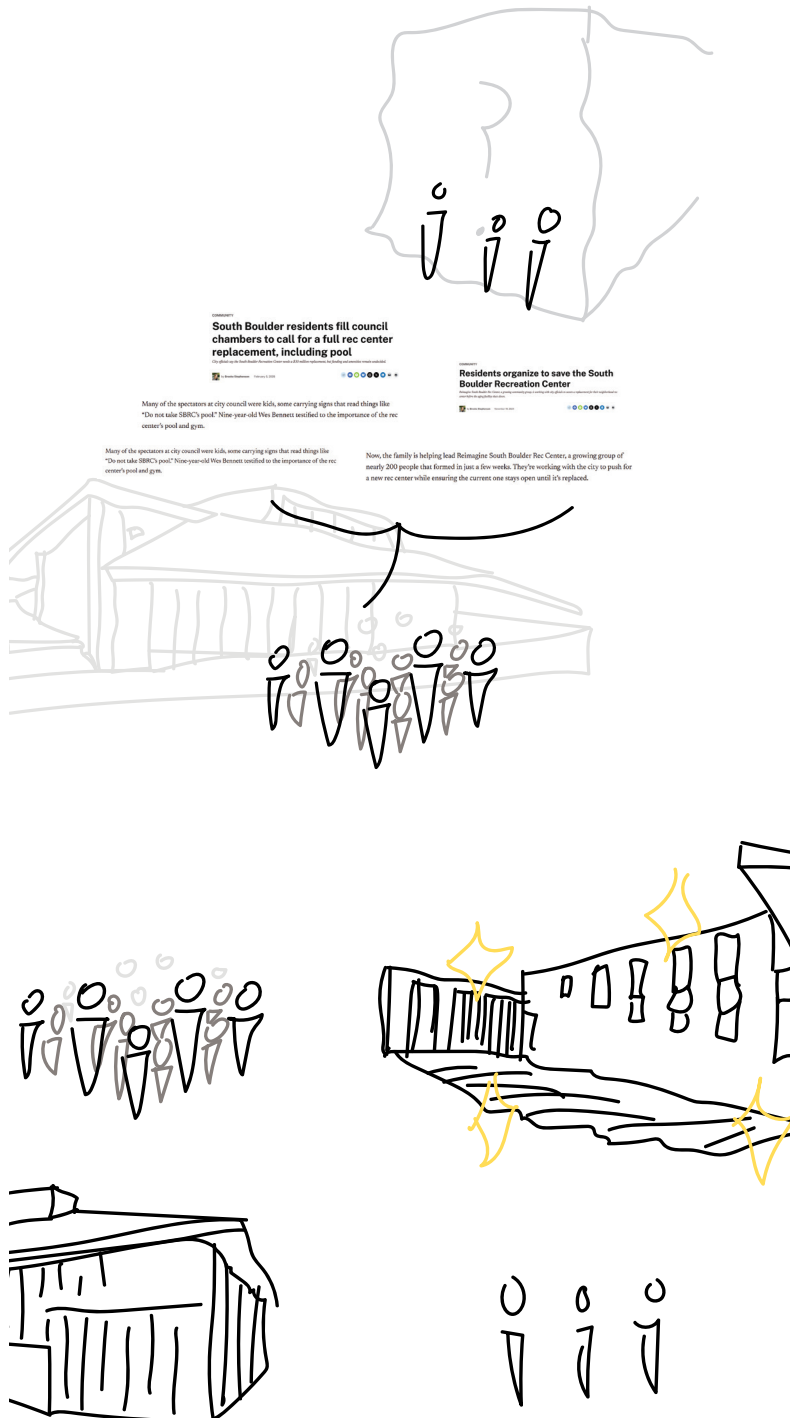
Compounding on all this, new buildings attract more excitement than old buildings. The City of Boulder has been struggling to maintain its existing public buildings due to sporadic investments. Buildings the city thought had a longer life span are in critical condition because it is hard to gather resources for something that isn't new and fascinating.

After the decision was made to tear down a Thorton Community Center, a sister building to SBRC, new programmatic opportunities were introduced. New encourages people to get their foot in the door.



Story

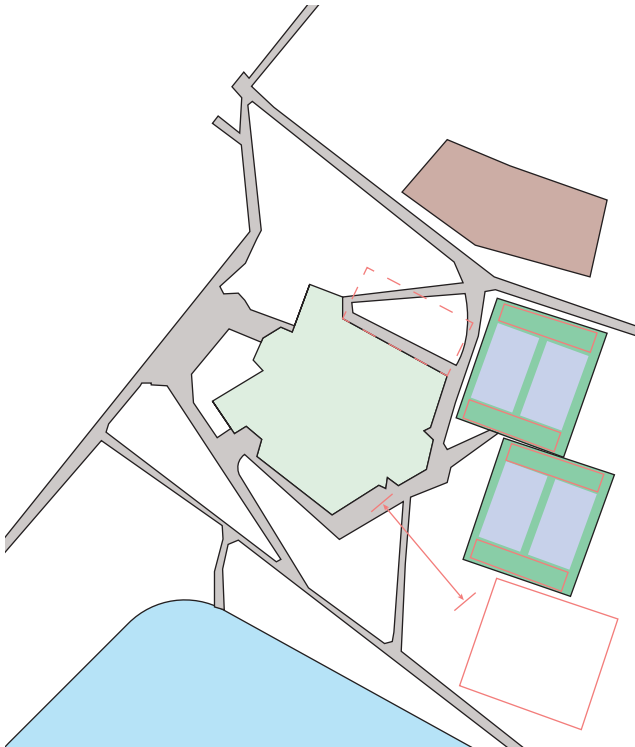
A major factor in the success of an adaptive reuse project is the politics surrounding its reuse.



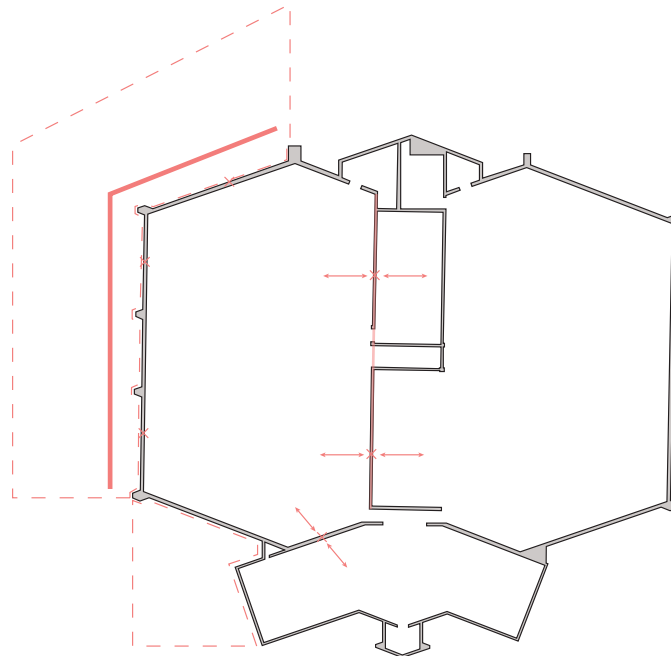
Story

A major factor in the success of an adaptive reuse project is the politics surrounding its reuse.

From a user's point of view the lack of sufficient program for certain activities and the lack of space for community make SBRC undesirable.



The landscaping around SBRC makes it difficult to add more outdoor program spaces within a reasonable distance of the building.



The buildings walls and program are difficult to manipulate to allow for socialization.

Story

From a designers point of view, layout, ability to expand, and materiality can all affect a buildings viability for reuse.

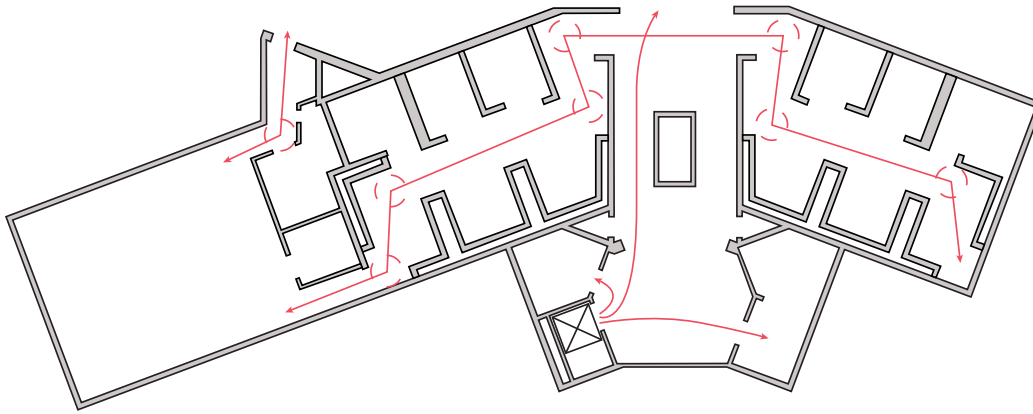


Diagram of the difficulty of navigating SBRC in a wheelchair.

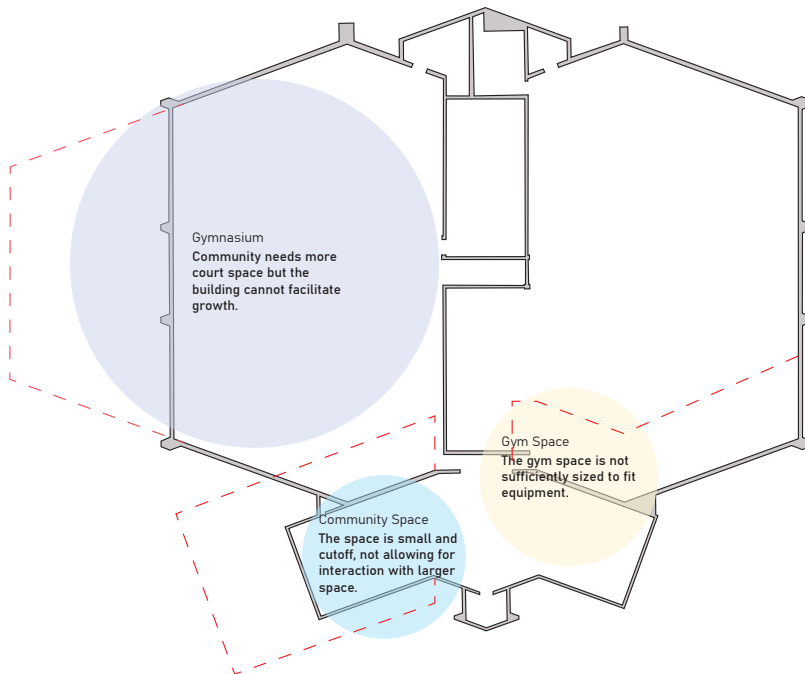


Diagram of points within SBRC that need expansion.



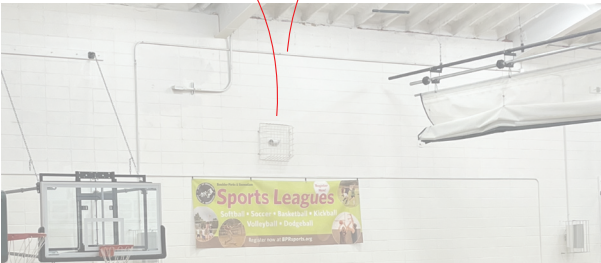
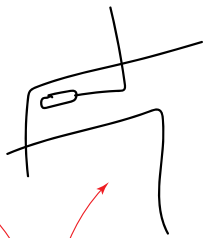
SBRC is littered with asbestos in all its construction materials.

Story

Despite its many failures, SBRC does have some elements that make it easier to keep around.



SBRCs design leaves many unexplored avenues, allowing future architects to easily participate in the dialogue of the building.



Many of SBRCs systems are exposed, making them relatively easy.

Thank You