Reimagining Urban Housing: Integrating WikiHouse Technology, and Open-Building Strategies for Resilient and Inclusive Communities

by

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Dalhousie University is located in Mi'kmaq'i,
the ancestral and unceded territory of the Mi'kmaq.
We are all Treaty people.

For my parents, with their unrelenting dedication, support, and hard work that got me here.... Yet also not to forget the og studio 3 characters that made sure I finished.

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Abstract

By integrating user participation, WikiHouse technology, and open-building strategies, this thesis aims to redefine urban housing by creating sustainable and inclusive communities that prioritize customization, adaptability, and community engagement. Through the utilization of WikiHouse as an infill system within multi-unit developments, the research seeks to empower residents and challenge the paradigm of one-size-fits-all mass housing. The study explores the benefits and implications of this integrated approach, including decentralized manufacturing, collaborative design solutions, and bridging the gap between concept and reality through technological advancements. By embracing user-driven design and balancing individual empowerment with expertise and adherence to building standards, the thesis strives to create housing environments that reflect residents' diverse needs and preferences while fostering a sense of identity, agency, and social vibrancy. Ultimately, this research contributes to transforming the urban housing landscape, promoting resilience, inclusivity, and responsiveness in creating sustainable and socially vibrant communities.

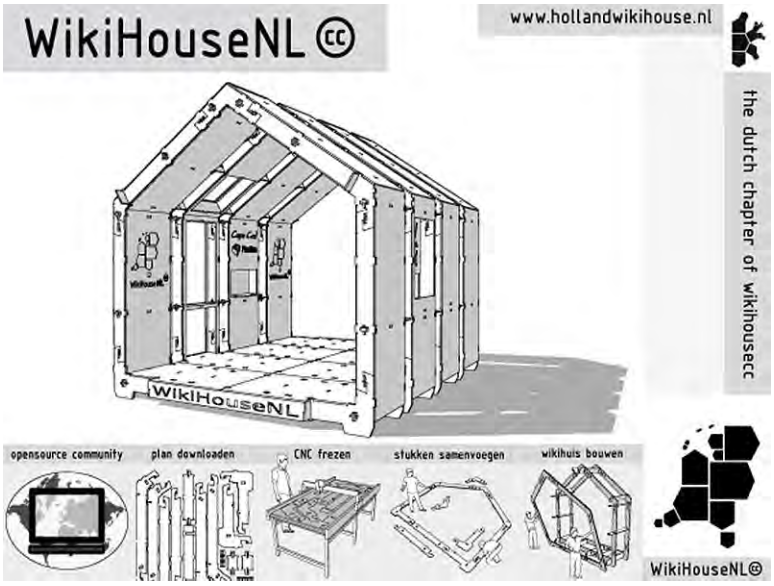
Chapter 01: Introduction

Thesis Question

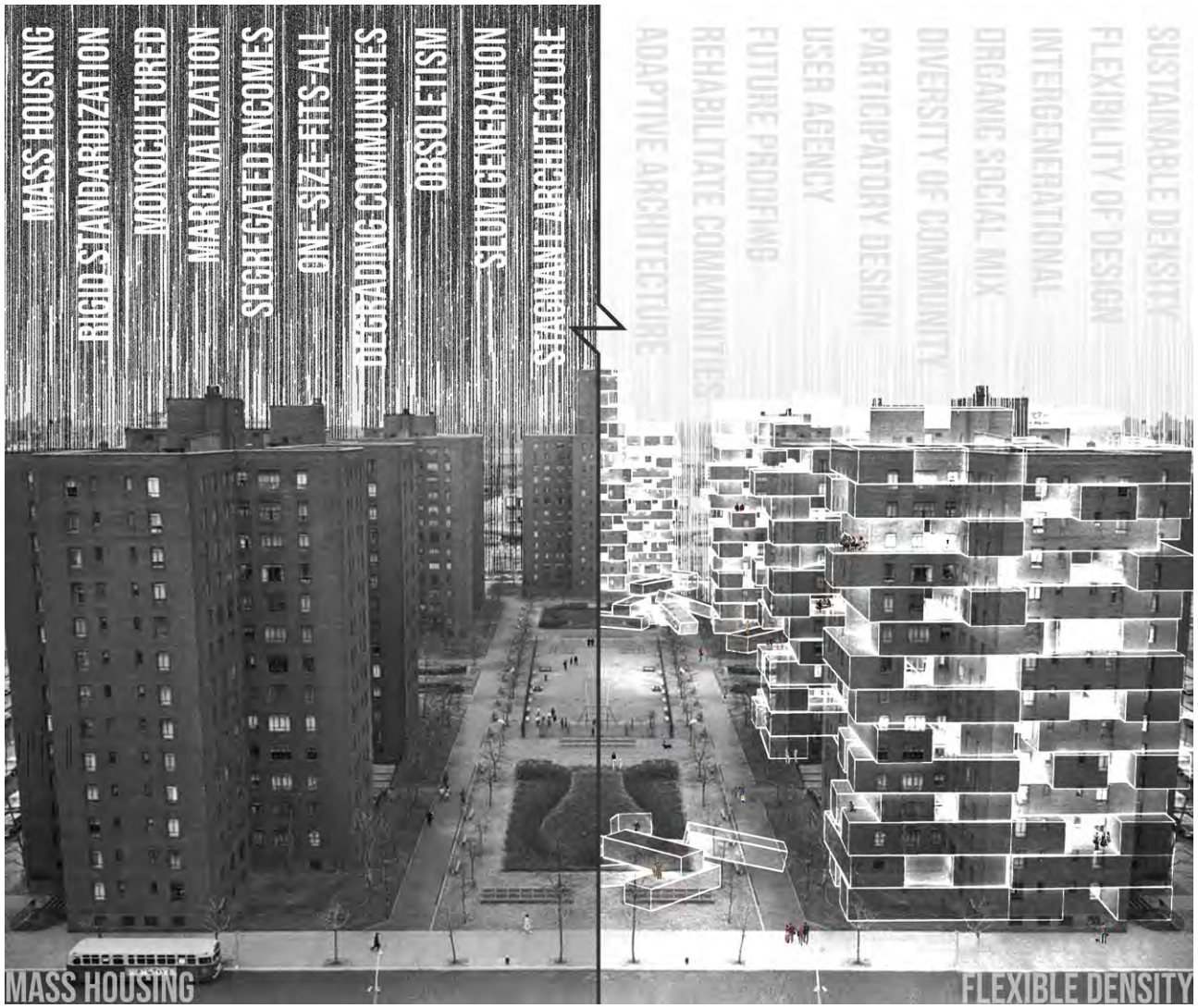
How can the integration of WikiHouse technology and open-building strategies revolutionize urban housing by prioritizing user participation, customization, and sustainability, and what are the implications for creating responsive, adaptable, and socially vibrant housing environments?

Thesis Statement

The proposal presented in this Thesis advocates for the integration of WikiHouse technology and open building strategies in multiunit housing. By adopting this approach, we can address current challenges while placing emphasis on important aspects such as customization, adaptability, sustainability, community engagement, and efficient construction. This alternative approach leads to the creation of vibrant, personalized, and sustainable urban environments that enhance resident satisfaction, social cohesion, and accessibility to housing.



WikiHouseNL Project Image (WikiHouse 2022)



“Design Wish Image V2” Oppositions: Mass Housing vs Flexible Density - Where does adaptability come into play (using the game Jenga as a visual metaphor) Base from Photograph: Bettmann Archive)

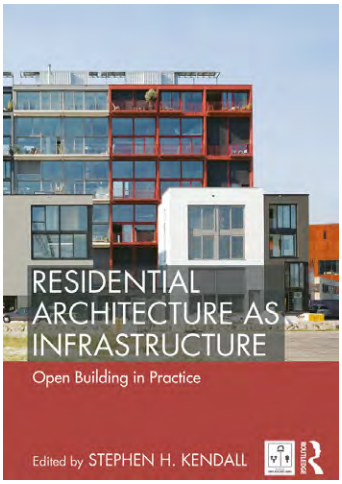
Main Issue

The main issue is how to empower communities and enhance the quality of urban housing through the integration of WikiHouse technology and open-building strategies. This approach tackles challenges related to user participation, customization, sustainability, community engagement, and efficient construction. This alternative methodology aims to create adaptable, sustainable, and user-centric built environments that promote resident satisfaction, social cohesion, housing accessibility, and habitability. This directly opposes current models that support over-standardization and mass housing that degrade our housing and urban environments through stagnant architectural and development practices.

Introduction

Providing quality housing in urban areas is a critical concern for sustainable development (Chen 2022 1536-1545). However, current models of mass housing often neglect user participation, customization, and sustainability, resulting in stagnant architectural practices and degraded urban environments (Jacobs 1961).

> We have to make possible the creation of districts which may grow old without becoming obsolete, which can absorb the latest ideas and yet have a sense of history. Districts in which the population can live for generations and which yet incorporate the potential for change. This is the opposite of what mass housing offers us. (Habraken 1972, 39)



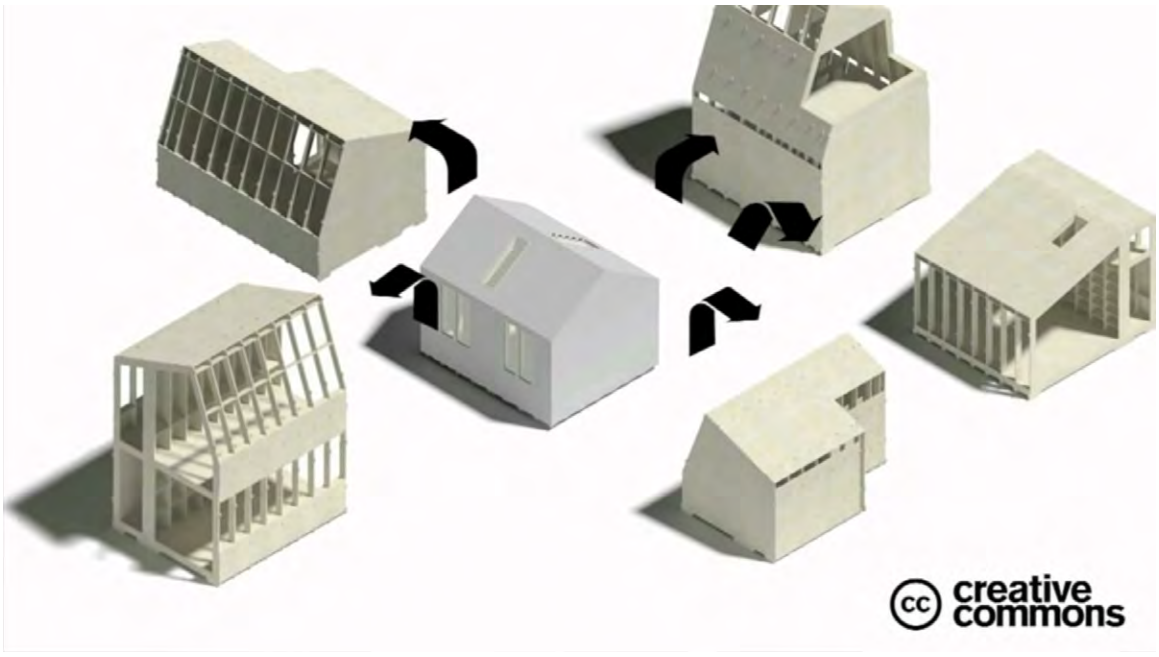
Stephen Kendall's most recent publication. Details the current state of events for Open building in the world and amalgamates several perspectives from a variety of authors and countries in a comprehensive overview. (Kendall 2022)

Recognizing that the multifaceted nature of quality housing encompasses affordability, accessibility, safety, and habitability; this thesis explores the potential of integrating WikiHouse technology and open-building strategies in urban housing to address these issues. By empowering communities, promoting customization, and embracing

sustainable design principles, this research aims to offer an approach to housing as an adaptable, user-centric, and environmentally conscious contributor to urban environments.

The theoretical framework establishes the conceptual foundations for the thesis, emphasizing user participation, community empowerment, customization, adaptability, and community engagement in housing design. It provides a basis for integrating WikiHouse technology and open-building strategies in urban housing.

By testing the feasibility of using WikiHouse technology as an infill in a base building, utilizing open building strategies, this research seeks to provide practical insights and recommendations for creating sustainable, participatory, and customizable urban housing solutions. By embracing this integrated approach, the thesis aims to contribute to the transformation of urban housing, fostering resilient, inclusive, and responsive communities.

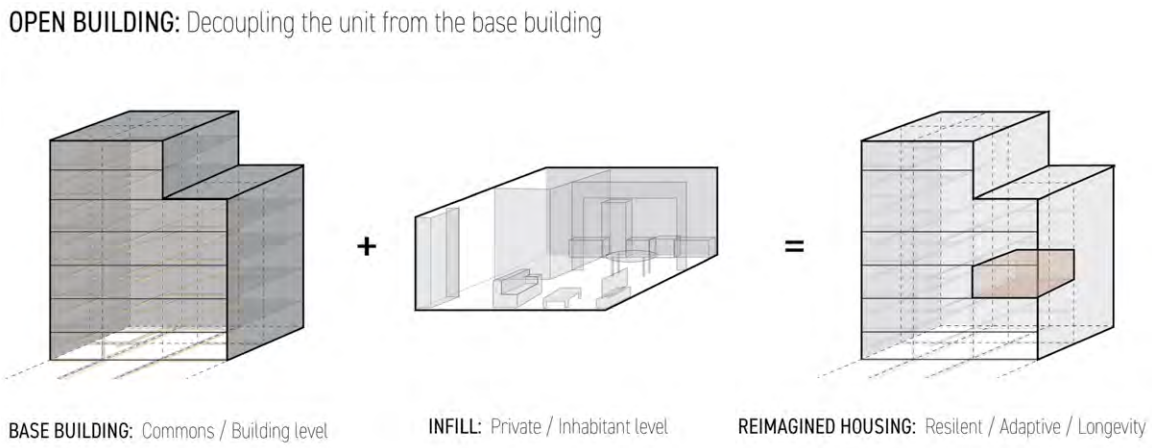


WikiHouse System, Chassis customization. Introduction video project image (WikiHouse 2022)

Open Building Strategies

Base Building *(supports)* **and Infill** *(unit)*

Open building is a progressive construction and design approach emphasizing adaptability and long-term sustainability. (Habraken, 1998) By incorporating the principles of open building, the built environment can evolve and respond to changing needs over time. One key aspect of open building is the ability to update building systems independently, thereby avoiding obsolescence and maximizing their longevity and resilience to change.

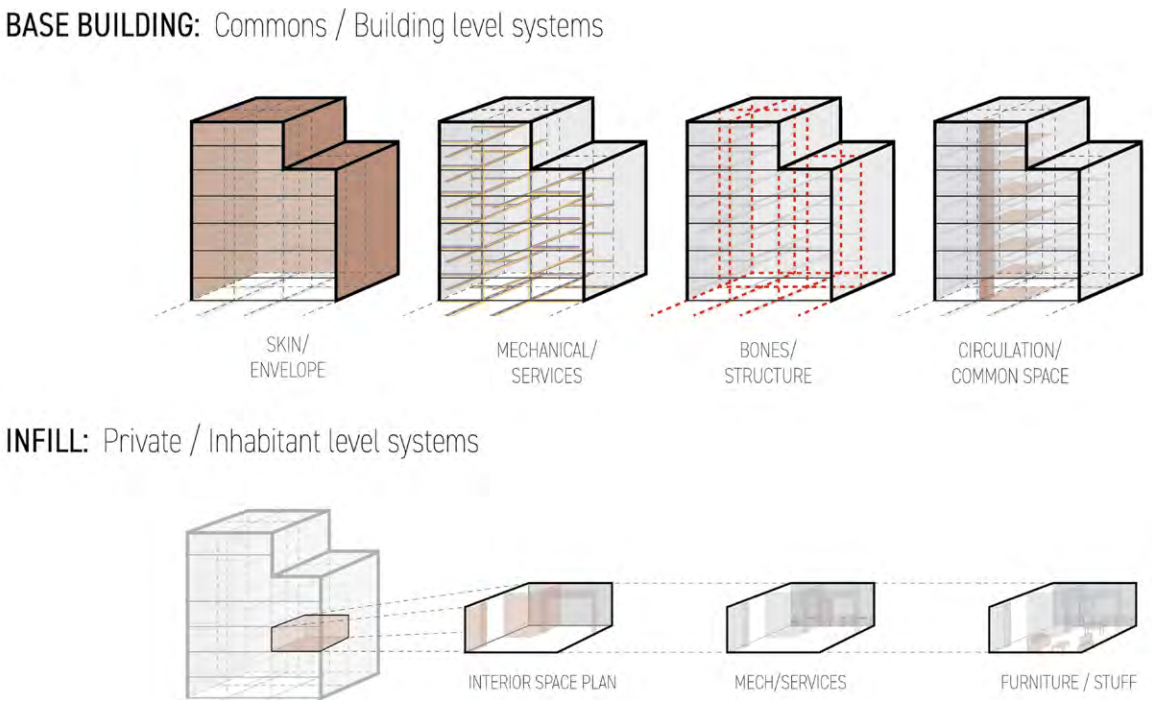


Basis of open building. Base building + Infill = An adpative resilient Built Environment (Image based on Habrakens diagram from ‘Supports, an alternative to mass housing’ (Habraken 1961)

> N. John Habraken advocates a clear distinction of the support and the infill and emphasizes that this is not only technical in nature, but more importantly focused on the ability to facilitate personal influence. The supports are part of the public domain and permanent, while the infill belongs to the individual owner/ user and is changeable. Participation and freedom of choice for the user is the key objective. (openbuilding.co)

In the context of open building, the implementation of independent building systems plays a vital role in mitigating obsolescence in the built environment. By decoupling systems and treating them as separate entities, the risk of an entire building becoming outdated due to the aging of

one system is significantly reduced. Instead, incremental improvements and updates can be carried out on specific systems, extending the building's lifespan.



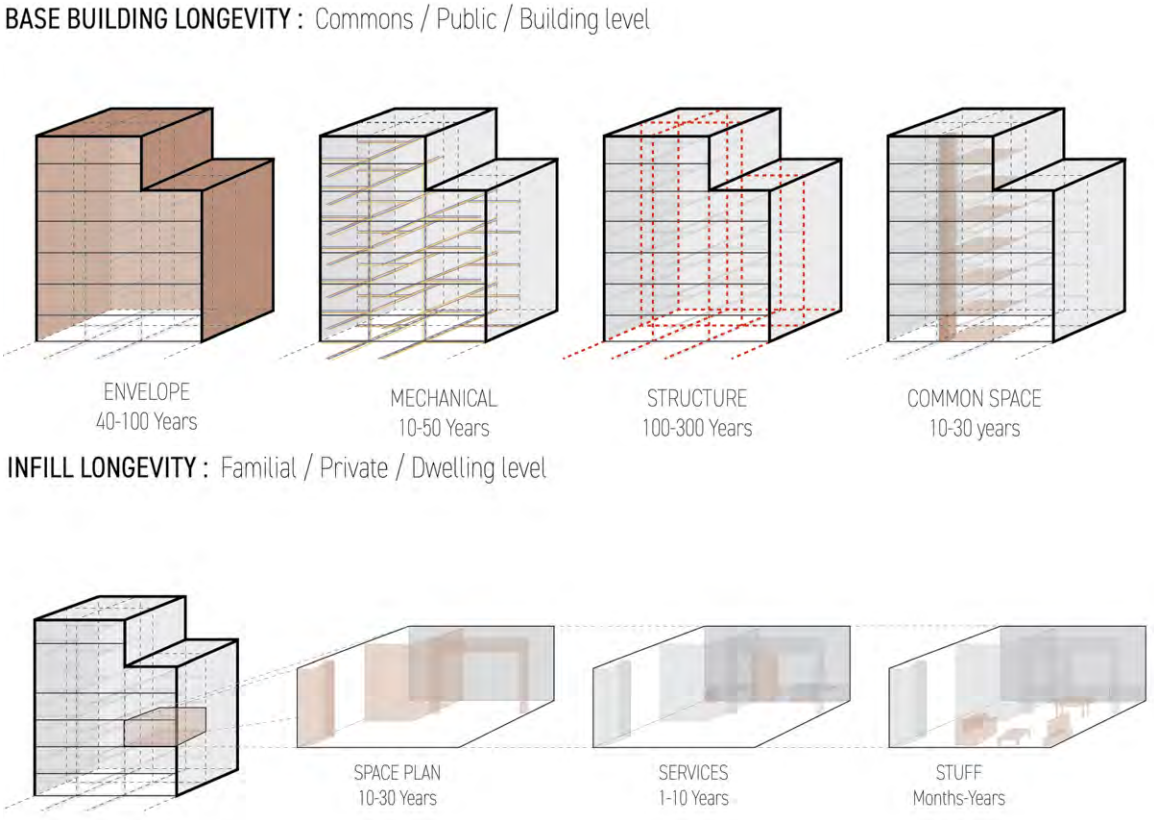
Basis of open building. Base building level vs Infill level (Image based on Habrakens diagram from 'Supports, an alternative to mass housing' (Habraken 1961)

This approach ensures that each component and system of the building can be assessed and upgraded as needed, promoting adaptability to evolving technologies, changing requirements, and sustainability standards. By avoiding complete building replacements, valuable resources are conserved, and the environmental impact is minimized.

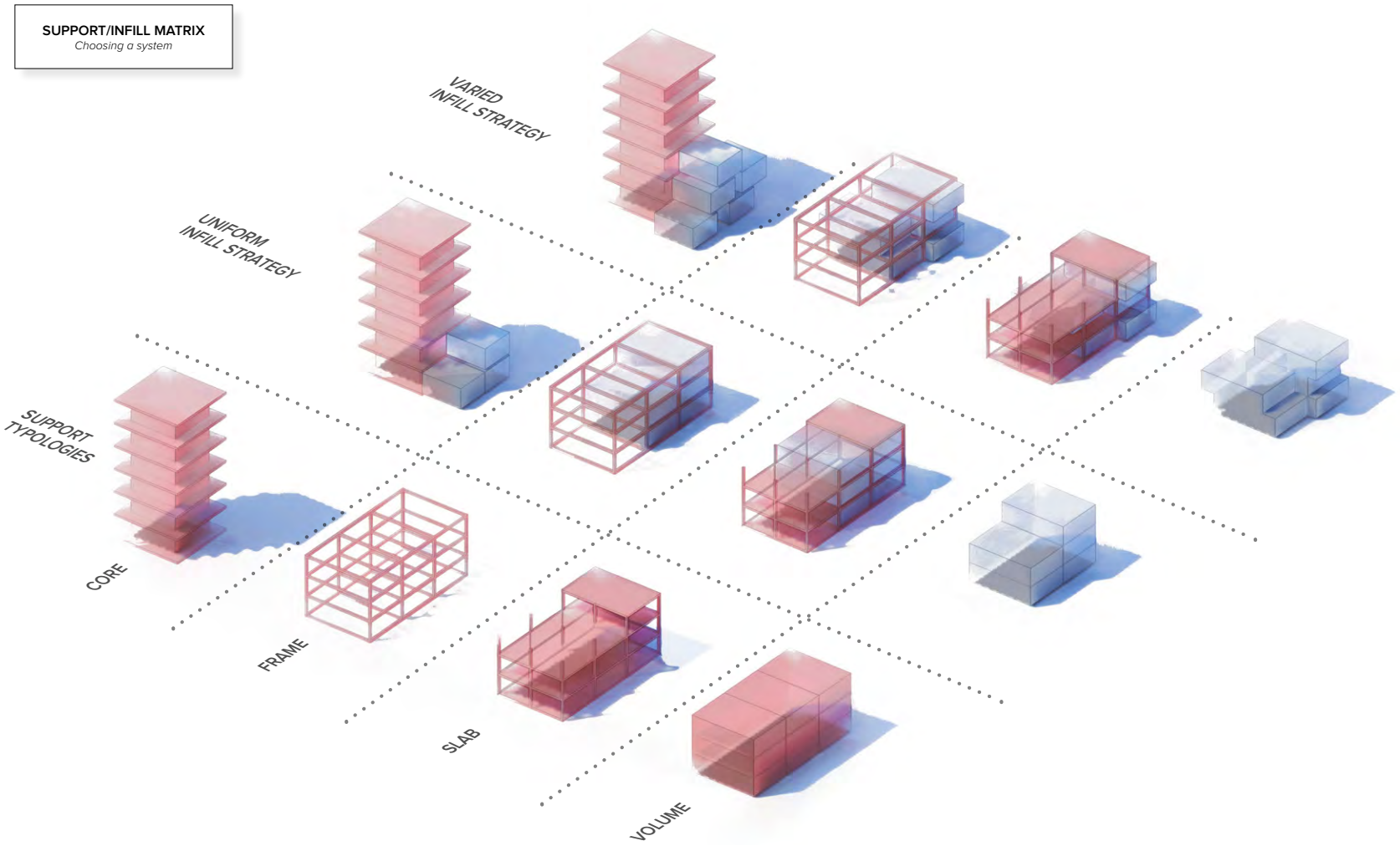
Moreover, the ability to update individual systems independently enables design flexibility and future proofing. New technologies and strategies can be incorporated without significant modifications or interruptions to the entirety of the building, resulting in enhanced efficiency, cost-effectiveness, and resilience.

By embracing the principles of open building and implementing independent building systems, we can create a built environment that thrives on adaptability, sustainability, and longevity, fostering a more sustainable and resilient future.

> The built environment has always been self-organizing. … Despite our increasing ability to effect large-scale change and our escalating ambitions, built environment follows its own laws. … Eventually, we must engage the environment's terms, not just our own intentions. … The idea that a living environment can be invented is outmoded: environment must be cultivated. This requires proper use of levels, judicious articulation of territory, and creative applications of types, patterns, and thematic systems. It must also ensure well-modulated distribution of control, compatible with an increasingly mobile and informed humanity. After all, it is by the quality of the common that environments prosper and by which, ultimately, our passage will one day be measured. (John Habraken 1998)

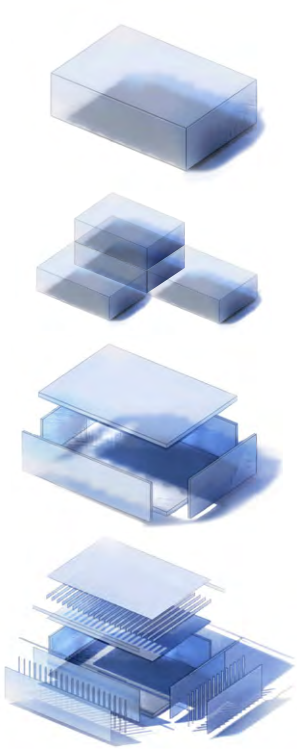


Basis of open building. Base building lifespan vs Infill lifespan (Image based on Habrakens diagram from 'Supports, an alternative to mass housing' (Habraken 1961)



Base building/Support x Infill Matrix. This diagram provides a quick overview of existing support and infill typologies. An early stage research diagram to help illustrate potential approaches. Inspired by Norberg's Futureproof thesis diagram (Norberg 2019)

PREFABRICATION MATRIX
Choosing a level of prefabrication



Level of Prefabrication	Type	Definition
	Complete Volumetric	Box-form, volumetric, completed buildings delivered to a building site
	Modular Volumetric	Structural, volumetric, potentially fitted -out units delivered to site and joined together or as pods connected to an existing structural frame pod.
	Panelized	Structural, non volumetric frame components which can be utilized to create a space. eg SIP's (structural insulated panels), MIP's (mechanicial insulated panels), precast concrete panels, and structural wooden panels.
	Component sub-assembly	Precut, preassembled components produced off-site and assembled on-site.
	Materials	Standard building materials used in on-site construction with no prefabrication conducted off site.

This diagram provides a quick overview of existing prefabrication/infill typologies. An early stage research diagram to help illustrate potential approaches. (Steinhardt et al. 2013 + Norberg 2019)

WikiHouse System

The WikiHouse initiative was established to democratize sustainable modular construction within an open-source framework, providing knowledge and tools to every citizen, community, and business (Wikihouse 2022). Architecture 00 leads this not-for-profit project, offering a system that enables anyone to download, customize, and fabricate affordable, high-performance buildings without conventional construction skills (00 2022).

Although this thesis will utilize WikiHouse's componentry, it diverges from focusing on standalone 1-3 story single units. Instead, it adapts the technology as an infill system within a multiunit development. This approach necessitates addressing the MEP (mechanical, electrical, plumbing) systems of the base building and the independent dwelling units (Kendall 2022). It presents an opportunity to develop a separate infill system specified by WikiHouse technology, with the fit-out engineered in various ways for independent occupancy units.

WikiHouse timelapse project image (WikiHouse 2022)

WikiHouse Mission Design Principles. The system uses many clever design principles as illustrated above that make it an adventagous methodology to utilize as an infill in an open building base building. (WikiHouse 2022)

Rationale

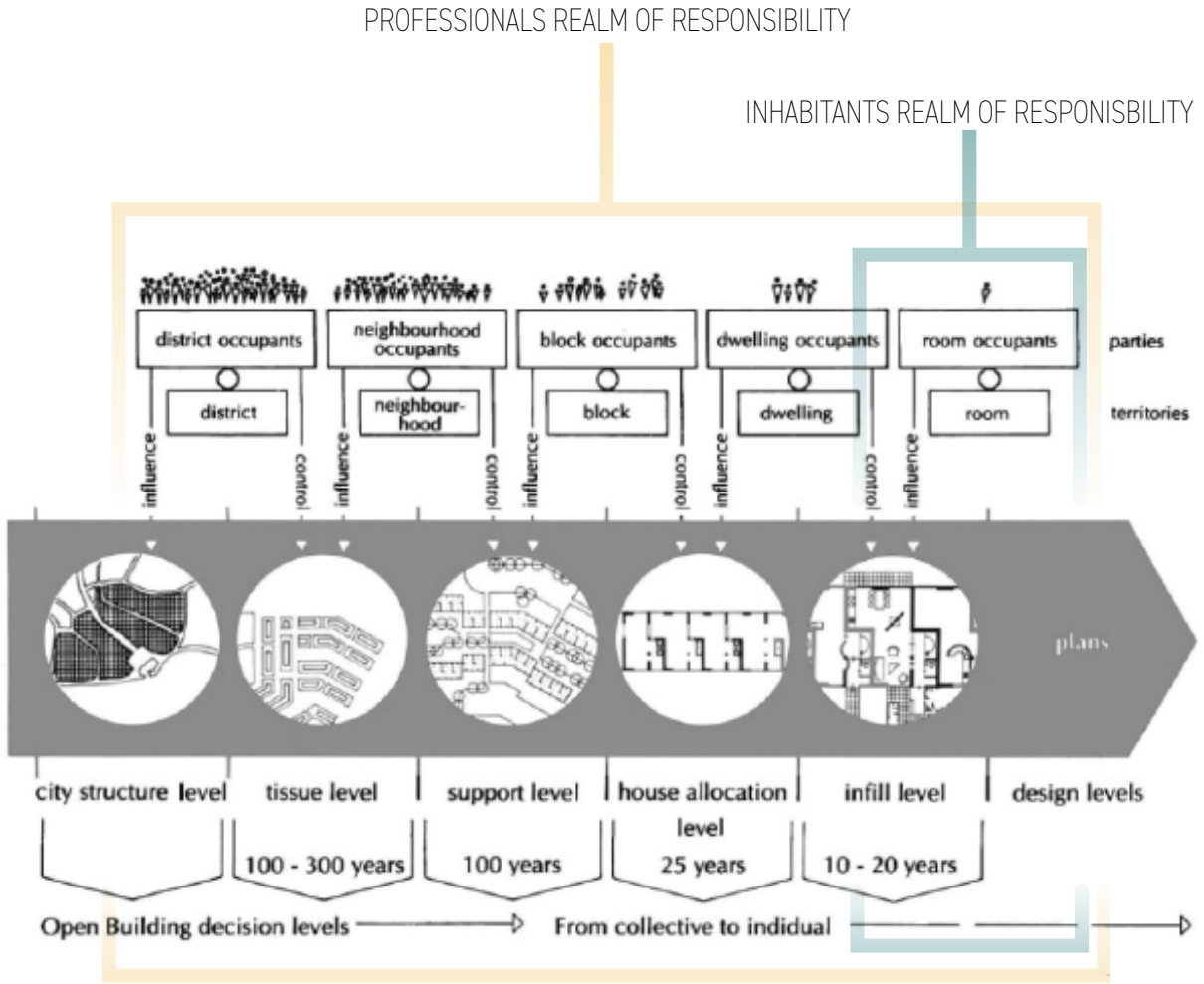
Utilizing the WikiHouse system as an infill strategy stems from its numerous advantages and design principles (Wikihouse 2022). By embracing a distributed network of small, local fabricators and assemblers collaborating on joint design solutions, WikiHouse promotes decentralized manufacturing (WikiHouse 2022). This approach allows fabrication in various locations, such as community maker spaces or remote facilities. As part of this project, an on-site fabrication studio will be established, which will later transform into a community maker space. Communal “making” will enhance the building’s communal aspects, promoting community and design as cohesive elements of the development process.

By expanding and integrating this system into a multi-unit residential development, this thesis departs from the conventional path. Instead, it proposes using WikiHouse as an infill strategy within a base-building support system. Instead of a one-size-fits-all approach, the focus shifts towards customization and individuality. The infill system provides flexibility, allowing each unit to be tailored to its occupants’ needs while still benefiting from the efficiency of off-site manufacturing.

Realms of Impact

In considering infill and support base building, it is crucial to acknowledge their reciprocal impact on each other. Traditional mass housing models often prioritize efficient design through a one-size-fits-all approach, disregarding individuality, agency, engagement, and a sense of identity. In contrast, the alternative approach proposed in this thesis challenges and reimagines the one-size-fits-all mass housing premise.

TRADITIONAL MODEL



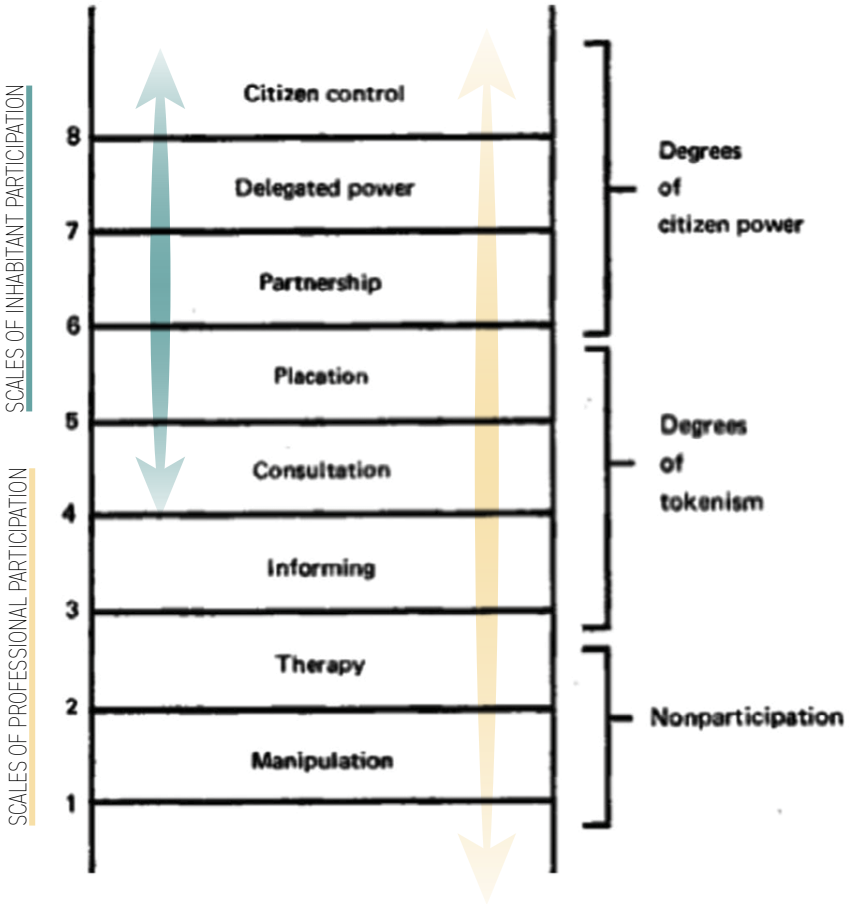
The conventional/traditional realms of responsibility illustrating traditional models. Illustrations over base image by Habraken (Habraken 1961)

Open Building is facilitated as a collaborative effort, but questions arise regarding the definition of scope and realm of responsibilities. Where do an architect's responsibilities end, and where do the inhabitants' responsibilities begin? While progress has been made in integrating open-building principles into the industry, much remains in experimental projects and case studies rather than widespread practice.

From pioneering projects to modern-day examples, the development of open building strategies has centred around building codes, practices, and their integration with participatory design models. Various approaches exist along a spectrum. Some projects favour an open-space methodology and a do-it-yourself mentality. In contrast, others seek to facilitate design through an architect-led system that ensures adherence to essential building practices and regulations. Notably, projects that strictly adhere to open building strategies without a definitive architect role, as defined by Habraken's concept of "supports," face challenges. In such models, inhabitants are responsible for the interior fabric beyond essential systems and the building's envelope, which can be a complex task and a weak point if entrusted to unskilled or unknowledgeable participants. However, technological advancements and the accessibility of modular building methods are bridging the gap between concept and reality, making such ideals more attainable and viable. Because they are more widely available and accessbile to the public, the technology is seeing more widespread usage in the everyday life.

As technology continues to bridge the divide, it becomes crucial to consider questions of control and influence over a project. Like Arnstein's ladder of citizen participation, there is a need to determine appropriate levels of citizen involvement,

from control to manipulation, and what benefits individuals, communities, and society. Architects have the opportunity to create environments that offer a chance for individual contributions, fostering a sense of ownership (Hertzberger 1991). Developing a sense of place and encouraging resilient societal values within projects helps determine who should be involved and how their involvement becomes a positive investment (Arnstein 1969). The gist of it is that it is an architects responsibility to ensure higher levels of citizen control and not just acts of tokenism or non-participation, by doing this they are ensuring a higher quality relation between inhabitant and home.



Conventional scales of participation, the proposed model encourages degrees of citizen power exclusively. Illustrations over base image by Arnstein. (Arnstein 1969).

Architectural practice is shaped by individual practitioners' ethos, methodology, knowledge, and standards. Just as there is a spectrum of responses to each project, there is also a range of appropriate levels of citizen participation. This thesis strives for a collaborative approach to challenge the dominant paradigm of mass housing by incorporating users in the design process. Methodologically, various participatory frameworks can be considered to facilitate customized, user-driven design, rejecting the notion of one-size-fits-all mass housing and instead choosing an approach that aligns with the project's scope and impact. By leaving the considerations of roles and responsibilities open-ended, the theory can be adaptable, considering relevant needs, values, and ideologies.

Realms of Impact: User Engagement Styles

For this thesis, consider the user intervention as a spectrum between three main scales:

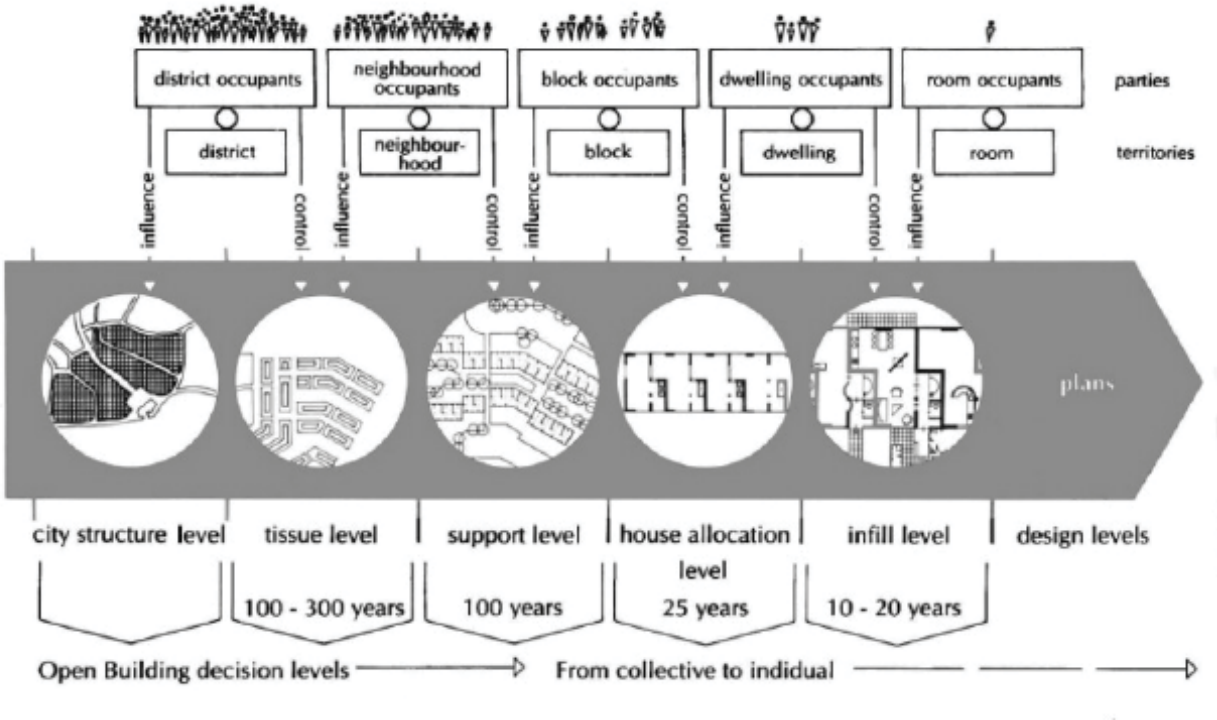
- DIY Project - The user fully embraces the making of the infill, utilizing the open-source technology, their design capabilities and construction skills in the fit-out of the unit.
- Collaborative Co-design Project - Utilizing professionals' skill sets in varying capacities, the individual cohabits with the design and building process.
- Turn-key Project – The user gives all responsibilities to professionals who will see the fit-out complete with their parameters and considerations reconciled professionally.

Not seen as hard-set levels, the user at each stage chooses their level of engagement, corporally or otherwise. It would be a transition from the traditional realms of responsibility to a sliding scale seeing the inhabitant as the key within the process.

PROPOSED MODEL

PROFESSIONALS REALM OF RESPONSIBILITY

INHABITANTS REALM OF RESPONISBILITY



Proposed realms of responsibility, Illustrations over base image from Habraken (Habraken 1961)

Realms of Impact: Role of the Architect

The integration of WikiHouse technology and open-building strategies in urban housing has revolutionized the conventional role of architects. Formerly, architects were regarded as the main authority in the designing and construction process, defining the structure and function of buildings. However, in this new paradigm, architects now act as facilitators, collaborators, and enablers of user participation, extending their role beyond design and construction.

The architect takes on the role of a mediator and collaborates closely with communities and residents to comprehend their requirements, aspirations, and cultural context. Through active engagement and participatory design processes, the architect empowers users to become co-creators of their living spaces. By incorporating user feedback and preferences, the architect guarantees that the housing design reflects the diversity and uniqueness of its occupants on an infill level while also setting the stage for cohesive social amenities for the community and its inhabitants.

Additionally, the architect’s knowledge is essential in coordinating the integration of WikiHouse technology and open-building strategies within the broader urban context. They navigate the intricacies of local regulations, building codes, and sustainability requirements, ensuring that the housing developments align with the broader objectives of sustainable and inclusive urban development. Their critical role is to facilitate the infrastructure supporting the infills, ensuring that the necessary supports are in place to enable the user as much as possible within their chosen engagement style.

The architect also plays a crucial role in bridging the gap between user-driven customization and the technical aspects of construction. They collaborate with engineers, builders, and fabricators to translate user preferences into feasible design solutions, incorporating the modular nature of WikiHouse technology and open-building principles.

Overall, the architect acts as a catalyst for change, advocating for user-centric design, sustainability, and community engagement. By embracing this expanded role, architects contribute to the creation of responsive, adaptable, and socially vibrant housing environments that foster a sense of place, identity, and belonging for the residents.

Summation

This thesis aims to introduce WikiHouse technology as an infill system in an open-building housing development to challenge the current mass housing paradigm. Embracing customization, collaboration, and open-building strategies, it seeks to empower individuals, foster community engagement, and create a sense of place. Through a thoughtful and adaptable approach to citizen participation and the realm of responsibilities, this thesis endeavours to redefine the role of architects and users in the design and construction process, ultimately creating more sustainable, inclusive, and personalized housing solutions.

Chapter 02: Opposition to Current Models

Integrating WikiHouse technology and open building strategies directly opposes current models that support over-standardization and mass housing, often leading to stagnant architectural and development practices, thus degrading our urban environments. This chapter elaborates upon the oppositions surrounding their integration:

Customization vs. Over-Standardization

Will customization empower residents to participate in the design process and promote unique living environments and pride of ownership.

Current models of mass housing often prioritize standardization and central control, where buildings are built using predetermined designs, units, and layouts, essentially lacking the inherent flexibility for users to customize the space for their needs (Habraken 1972, 1-20). This approach must be revised to consider residents' diverse needs and preferences. In contrast, integrating WikiHouse technology and open-building strategies allows customization and individualization. It empowers residents to actively participate in the design process, ensuring their living spaces reflect their specific requirements and preferences (Alexander 1977, 936). By opposing over-standardization, this approach promotes personalized and unique living environments.

Adaptability vs. Stagnant Architectural Practices

Can integrating WikiHouse technology allows for easy reconfiguration and modification, promoting adaptability and resilience.

Mass housing models often need more flexibility and adaptability. The rigid design and construction methods limit the ability to modify, update, or expand units as residents' needs change over time. The spaces can become incongruent with living because they are so tightly constrained by the patterns of building that they are no longer congruent with habitation (Alexander 1977, 941). This leads to a built environment becoming obsolete due to their inability to adapt to various habitation methods. Integrating WikiHouse technology and open-building strategies enables adaptability in design and construction (Habraken 1972, 74). The modular nature of WikiHouse allows for easy reconfiguration and modification, accommodating changing needs and lifestyles. This opposition to stagnant architectural practices promotes longevity, diversity, and resilience in the built environment (Sennet 1970).

Sustainability vs. Degrading Urban Environments

Can WikiHouse technology and open building strategies promote sustainability and resource efficiency, minimizing environmental impact.

Mass housing models often prioritize short-term cost savings over long-term sustainability (De Graaf 2017,415-425). They may use low-quality materials, have limited energy efficiency, and need more consideration for their environmental impact. Often, they cannot be influenced by new technical possibilities because instead, they depend

on the time it takes for the entire building to be worn out instead of incremental change, updates, and gradual renewal (Habraken 1972, 37). In contrast, integrating WikiHouse technology and open-building strategies promotes sustainability and resource efficiency. The use of digital fabrication techniques reduces waste and optimizes material usage. Incorporating energy-efficient features and sustainable materials minimizes the environmental footprint of the buildings. This approach promotes environmentally conscious and sustainable development practices by opposing the standards and practices that create rapidly degrading urban environments and housing. No longer would buildings and communities be rendered obsolete by rigid un-adaptable built environments (Habraken 1972, 74).

Community Engagement vs. Limited Resident Involvement

Can integrating WikiHouse technology foster community engagement and collaboration, enhancing social cohesion.

In mass housing models, residents typically lack involvement in the design and decision-making process. This deprivation of agency and community engagement can lead to a disconnect between residents and their built environment (De Graaf 2017, 61). Integrating WikiHouse technology and open-building strategies emphasizes community engagement and collaboration. It encourages residents to actively participate in shaping their living spaces and fosters a sense of ownership and pride in their community (Jacobs 1961, 58). This opposition to limited resident involvement promotes social cohesion and a stronger sense of community in urban environments (Kent 2019).

Efficient Construction vs. Monotonous Development Practices

How can WikiHouse technology promote efficient construction methods and diverse architectural expressions, to enrich urban environments.

Mass housing models often prioritize fast, highly standardized, cost-effective construction, leading to monotonous and repetitive architectural designs (De Graaf 2017, 82). In contrast, integrating WikiHouse technology and open building strategies promotes efficient construction methods while maintaining customizability, allowing for more diverse architectural expression. The modular construction approach and the ability to customize designs break away from standardized monotony and brings diversity to the urban fabric (Alexander 1977). This opposition to monotonous development practices enriches urban environments' visual and cultural expressions (Harvey 2012).

Chapter summation

In summary, integrating WikiHouse technology and open building strategies has the potential to oppose current over-standardization and mass housing models by prioritizing customization, adaptability, sustainability, community engagement, and efficient construction. This alternative approach seeks to create vibrant, personalized, and sustainable urban environments that enhance the well-being and satisfaction of residents, foster social connections, and breaks away from the stagnant practices that degrade our urban landscapes, communities, and housing.

Chapter 03: Utilizing WikiHouse Technology as an Infill Technology with Open Building Strategies

New architectural modular building technology has revolutionized the construction industry by offering innovative solutions that can align with open-building strategies in new and exciting ways. Open-building systems emphasize flexibility, adaptability, and user participation in designing and modifying built environments (Habraken, 1961). It is proposed that modular construction, coupled with open-building principles, enables the creation of highly customizable and sustainable structures. Utilizing WikiHouse as an infill technology in an open-building system can be a compelling approach to addressing the need for affordable, resilient, and sustainable housing in urban areas. WikiHouse is an open-source platform that provides design files and instructions for constructing modular, digitally fabricated buildings (WikiHouse 2022). It enables individuals or communities to create housing solutions using readily available materials and digital fabrication tools. This chapter will discuss important factors and advantages when utilizing modular WikiHouse Technology as an infill for an Open Building base building in an integrated approach.

Affordability

WikiHouse can offer cost advantages for making high-quality, customizable architecture accessible to more users.

WikiHouse's open-source nature and reliance on widely available materials can reduce construction costs (WikiHouse 2022). Enabling individuals or communities to construct their own homes promotes affordability and can

provide housing options for those with limited financial resources. The principles of their design are aimed explicitly at lowering thresholds of time, cost, risk, skill, and complexity at every stage (WikiHouse, 2022)

Construction and, specifically, multiunit housing projects often face budgetary constraints and tight construction timelines. WikiHouse technology offers efficient construction methods that can help streamline the building process. With Modular Prefabricated technology, the streamlined manufacturing process, reduced labour requirements, and shorter construction duration contribute to overall cost savings (WikiHouse 2022). This affordability aligns with open building strategies that aim to make high-quality, customizable architecture accessible to a broader range of users.

User Participation

WikiHouse can enable users to actively participate in the design and construction process, fostering a sense of ownership. The infill system is also designed to be relatively easy to construct, modify, and reconfigure, facilitating community engagement and participation.

Open building strategies prioritize user involvement and long-term flexibility in the design and construction process (Habraken, 1961). WikiHouse technology aligns with this principle by enabling users to participate in the creation of their living spaces actively (Priavolou and Niaros, 2019). With WikiHouse's open-source platform, individuals or communities can access design files, modify them to meet their needs and contribute improvements back to the community (Priavolou and Niaros, 2019). This way, the building can adapt to changing needs and preferences over time since the modules can be added, removed, or

rearranged. This participatory approach fosters a sense of ownership and empowers users to shape their living environments.

Multiunit housing often involves a diverse group of residents. Integrating open building principles allows for user participation in the design and customization of their living spaces (Habraken 1961). WikiHouse technology facilitates this process by providing residents with a platform to contribute to their units' design, layout, and functionality. Engaging residents in decision-making fosters a sense of ownership and community, increasing satisfaction and social cohesion (Kent 2019, 127-134).

Customization and Adaptability

Can WikiHouse technology allow for high levels of customization and adaptability in design to meet individual needs and preferences. Will customization and design adaptability empower users to tailor housing solutions to their specific needs.

WikiHouse allows for customization and adaptability in design (Priavolou and Niaros, 2019). Users can modify the design files to suit their specific needs and preferences, ensuring that the resulting housing reflects the unique requirements of the occupants. This customization aligns with open-building strategies and empowers users to actively participate in the design process. The platform's open-source nature enables users to tailor the design files to their specific requirements. Whether it is adjusting the layout, choosing from various module types, sizes, and configurations, incorporating particular features, or accommodating unique site conditions, users have the flexibility to create spaces that suit their preferences (WikiHouse 2022). This customization aligns with open-building strategies prioritizing individual needs. It

ensures that residents can create living environments that align with their unique requirements, fostering a sense of comfort and belonging.

Modular and Infill Construction

Is WikiHouse's modular approach well-suited for infill development, can it optimize land use and minimize disruptions.

WikiHouse is designed to be relatively easy to construct, even for individuals without extensive construction experience (Parvin 2013). The prefabricated components are manufactured using digital fabrication techniques, simplifying, and accelerating the assembly process (WikiHouse 2022). Its inherent accessibility can facilitate community engagement and empower individuals to participate in the construction of their own homes.

WikiHouse's modular approach to construction is well-suited for infill development. The modular nature of WikiHouse allows for the construction of prefabricated components off-site, which can then be assembled in these infill locations. This approach significantly reduces construction time compared to traditional methods, minimizes disruption to the surrounding urban fabric, and optimizes land use, making it an efficient solution for densifying urban areas responsibly (Priavolou and Niaros, 2019).

A modular technology-based open building could easily accommodate expansion or downsizing. Integrating or altering additional modules into the existing structure of the base building allows for future growth or adaptation without significant disruptions. This scalability aligns with open-building strategies that prioritize incremental development

and the ability to respond to changing spatial requirements (Kendall 2022, xii).

Sustainability and Resource Efficiency

Can WikiHouse technology promote sustainable practices through digital fabrication for efficient material usage and incorporation of sustainable materials.

WikiHouse promotes sustainability by emphasizing sustainable materials and efficient construction methods. The digitally fabricated components can be precisely manufactured, minimizing waste and optimizing material usage (Parvin 2013). Additionally, the system's modularity enhances the building's longevity. Other advantageous design principles include the promotion of circular lifecycles and designing for disassembly (WikiHouse 2022). Reusing and repurposing components can reduce the environmental impact, unlike conventional construction methods, thus reducing the need for complete demolition and reconstruction (Capra 2002, 102-105).

WikiHouse technology promotes sustainability through various means. Digital fabrication and modular construction techniques allow for precise manufacturing and efficient material usage, reducing waste (WikiHouse 2022). WikiHouse also encourages using sustainable and locally sourced materials and manufacturers, further minimizing environmental impact (WikiHouse 2022). By combining open building strategies with WikiHouse technology, sustainable and resource-efficient practices can be integrated into the construction process, contributing to a more sustainable built environment.

Multiunit housing often faces sustainability challenges due to increased energy consumption and shared resources

(Habraken 1961). Integrating WikiHouse technology and incorporating energy-efficient features, sustainable materials, and renewable energy sources can enhance the environmental performance of the building. Open-building strategies can encourage residents to adopt sustainable behaviours, creating a framework to promote resource conservation within the community.

Collaboration and Knowledge Sharing

Will WikiHouse's open-source platform foster collaboration and knowledge sharing within the community and among users.

WikiHouse's open-source nature fosters collaboration and knowledge sharing within the community. Users can contribute improvements, share their experiences, and collectively enhance the platform (WikiHouse 2022). This collaborative approach aligns with open-building strategies, emphasizing user participation and exchanging ideas.

Open-building strategies emphasize knowledge sharing, collaboration, and community engagement (Kendall 2022) WikiHouse's open-source platform facilitates these aspects by enabling users to contribute improvements, share their experiences, and collaborate (WikiHouse 2022). This cooperative exchange of ideas and knowledge strengthens the open-building movement and encourages continuous adaptive and incremental improvement in housing, building, and construction solutions.

Multiunit accommodation thrives when residents feel connected and engaged (Jacobs 1961). Open-building principles promote community engagement and collaboration (Habraken 1961). WikiHouse technology, through its open-source platform, facilitates knowledge sharing and

collaboration among residents (WikiHouse 2022). The proposed integration encourages residents to share ideas, expertise, and experiences, strengthening community and social interaction. Collaborative spaces and shared amenities can also be designed to promote interaction and foster a sense of belonging among residents.

Regulatory Considerations

Will local building codes and regulations be considered and adhered to when implementing WikiHouse technology.

Considering local building codes and regulations is essential when implementing WikiHouse technology as an infill strategy. Some jurisdictions may have specific requirements for construction methods, structural integrity, and safety standards (WikiHouse 2022). Adhering to these regulations and obtaining necessary permits and approvals is crucial to ensure the buildings meet the required standards. This thesis operates under the assumption that although the technology is being implemented in certain regions, such as the UK, it will be accepted by authorities with jurisdiction in the future.

Chapter Summation

While WikiHouse technology offers exciting possibilities for infill strategies, evaluating its suitability for specific contexts is essential. Factors such as local regulations, availability of digital fabrication tools, and community support should be considered. Proper training and education may also be required to ensure safe and effective construction practices.

WikiHouse technology can be a valuable infill strategy, offering affordability, customization, sustainability, and

community engagement. Communities and individuals can create affordable and sustainable urban housing solutions through digital fabrication and open-source principles. This could empower people and address the urgent need for such housing options.

Integrating WikiHouse technology into open-building strategies can transform infill development into a participatory, sustainable, and customizable process. Users become active participants in creating their living spaces, while the modularity and resource efficiency of WikiHouse technology offers opportunities for efficient and environmentally conscious production, development, and construction. This combination fosters a sense of community, promotes sustainability, and creates adaptable living environments that meet the evolving needs of users.

Integrating WikiHouse technology and open-building strategies in multiunit housing projects empowers residents through user participation, customization, sustainability, and community engagement. This integrated approach addresses the challenges of multiunit residential developments while creating adaptable and sustainable built environments that enhance residents' quality of life and foster a strong sense of community. This approach furthers innovation, promotes user engagement, and addresses the evolving needs of communities and individuals.

Chapter 04: Experimental Design

Thesis Design Study

This chapter presents the design experiment that was developed in tandem with the research and writing.

Considerations for Design Integration in the Urban Context

Mixed-Use Development

Incorporating WikiHouse technology in multiunit housing enables the integration of mixed-use spaces, creating vibrant and diverse urban environments.

Community Spaces and Shared Facilities

Planning of the Base Building allows for integration of community spaces and shared facilities within the housing complex, fostering social interaction and collaboration.

Public-Private Partnerships

Collaborations between public and private entities can facilitate the implementation of WikiHouse technology in multiunit housing, ensuring a balance between public interest and market-driven solutions.

Urban Revitalization

Implementing the proposed methodology of open building utilizing wikihouse technology in urban areas can contribute to the revitalization of underutilized spaces, promoting economic growth and community development.

Resilience as an Essential Principle

Modular construction provides a resilient solution, allowing for quick reconstruction and adaptation.

“Wish Image V1: The first wish image generated early in the design. A hybrid drawing which plays on interactive/adaptive architecture that can facilitate living in place for inhabitants.

Context

For the sake of testing its viability, a site in the East Village downtown region of Calgary, Alberta was purposely selected as the location to apply the basis of the thesis. However, it should be noted that the thesis has the potential to be applied in various urban contexts.

Calgary is a unique and lively cultural hub located in the foothills of the rocky mountains where the mountains transition to the prairies. The large downtown core is embraced by the Bow and Elbow rivers. Our specific focus is on a site in the East Village right at the edge of a community that has seen a recent revitalization. Specific

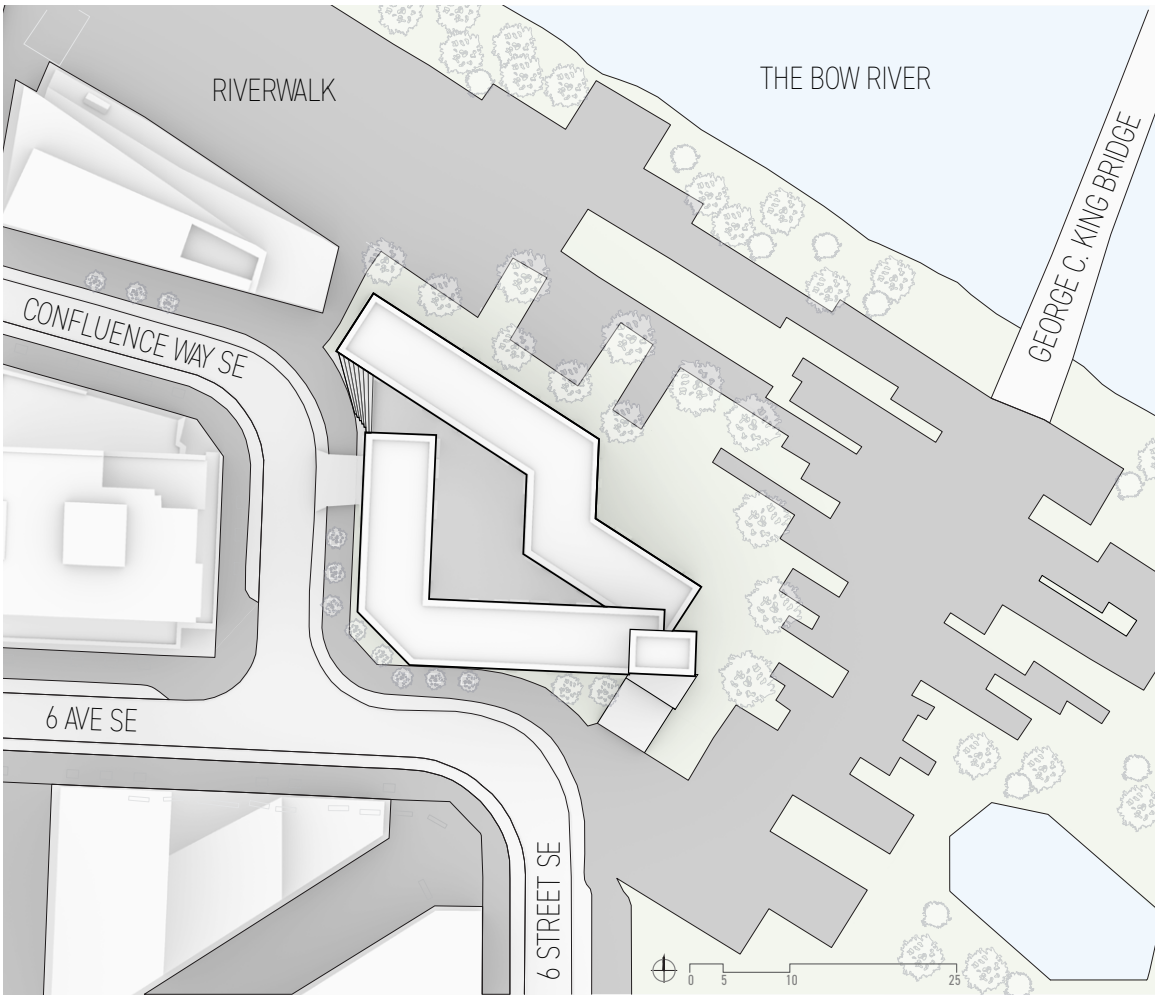
“Context Map: National Scope”

features include many essential amenities all within very close proximity.

The urban fabric integrates on the north edge to the Bow River and a large walkway which stretches from one end of downtown to the other and beyond. The river walk is a main commute route for pedestrians and bikes alike, of specific interest is the George C. King Bridge which ties communities north of the river into the east village and forms an essential communal node to the city.

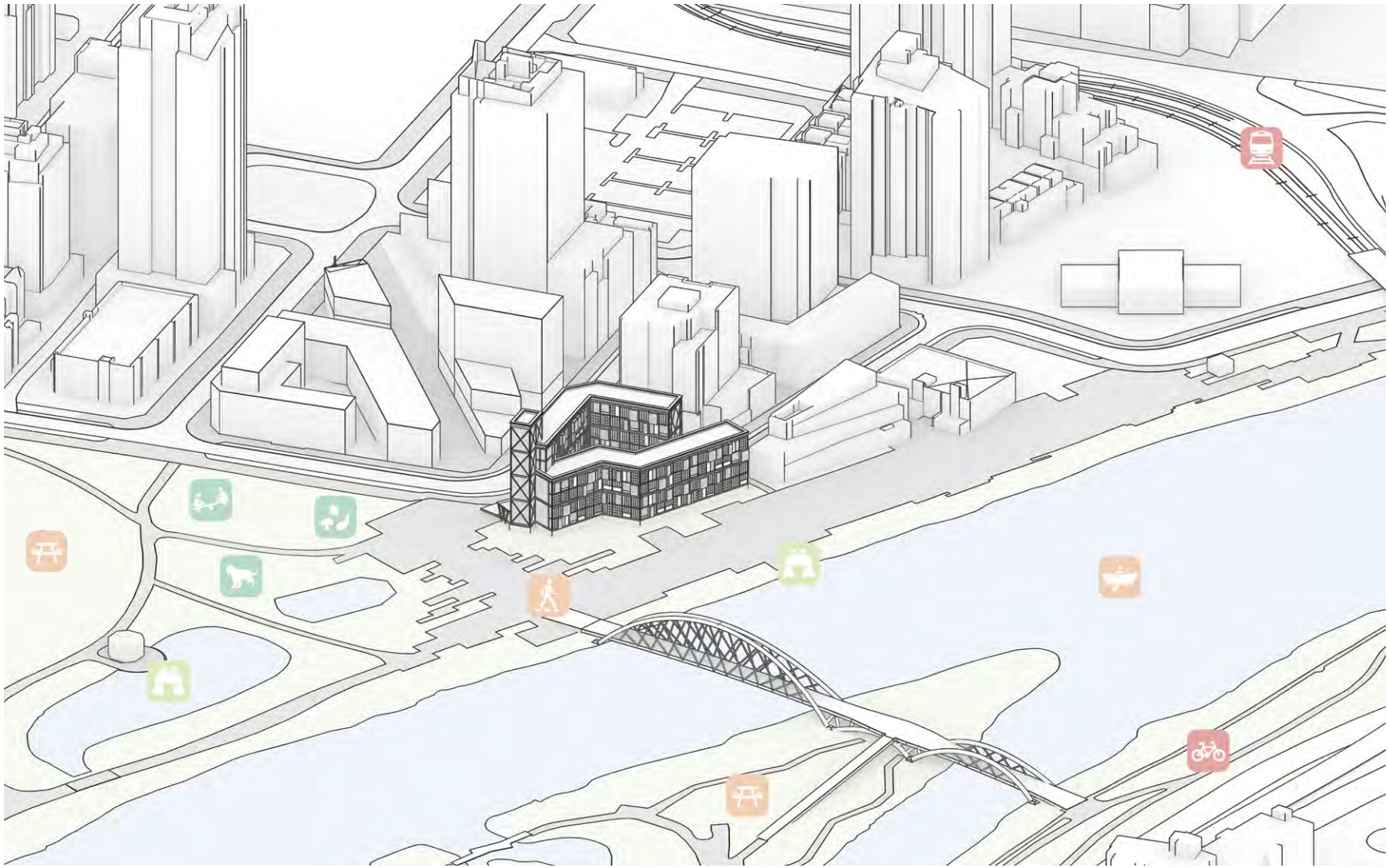
“Context Map: Calgary Downtown Core Scope”

"Context Map: Immediate Scope"

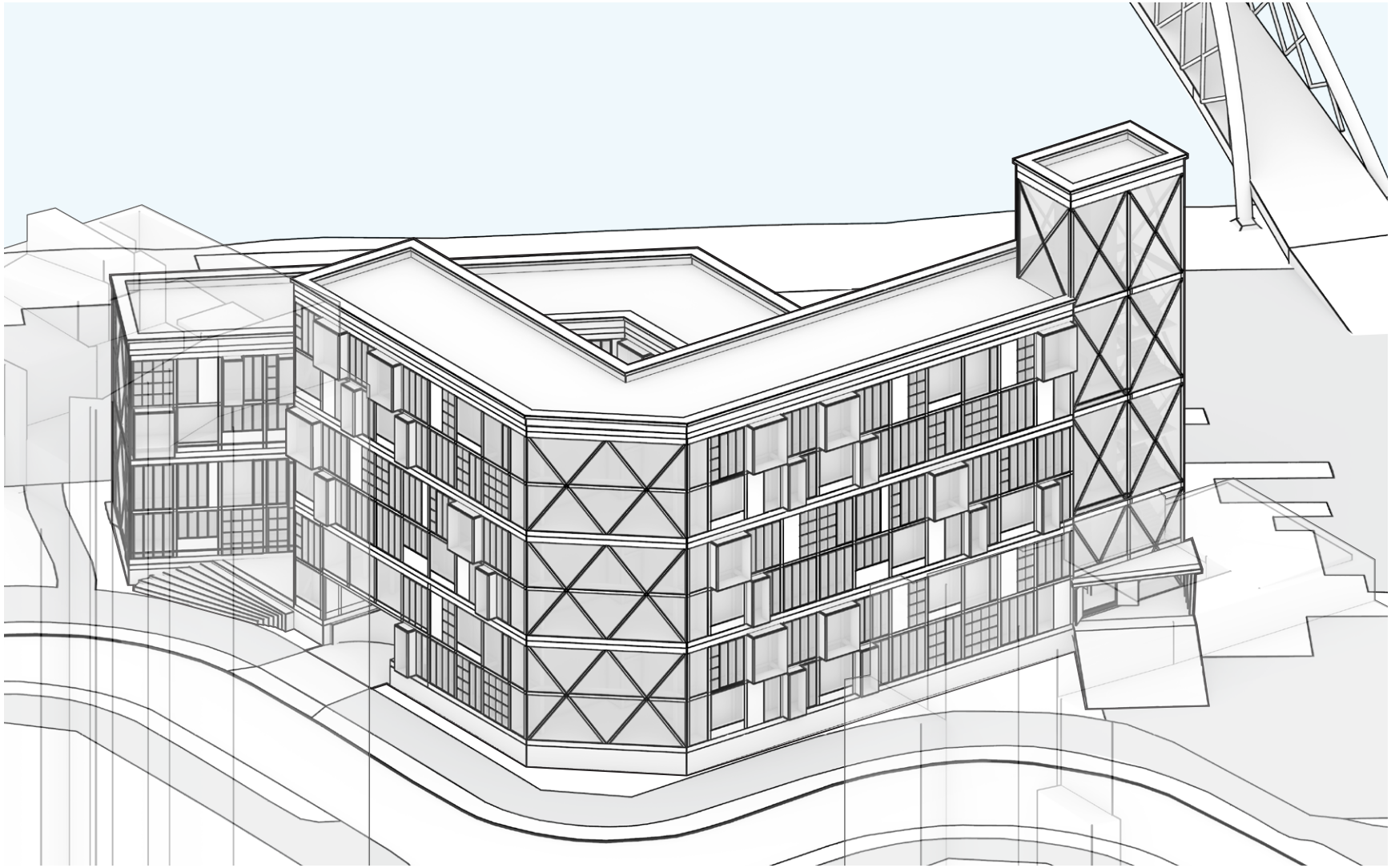


“Base Plan” An overview plan illustrating the immediate context in relation to the base building.

Amidst the immediate amenities included at this node are grassland park space, structured playground space, a community garden, an enclosed dog park, museums, libraries, grocery stores, an urban mall, winter garden park spaces (which include winter amenities such as a toboggan hill and skating rink) and many street and river walk level restaurants, cafes, markets, and boutiques. Much of this serves the building in its immediate vicinity and allows the development to take on a specific residential character.



“Context Axonometric” This drawing highlights the nearby amenities that facilitate the inhabitation of the base building.



“Streetscape” This drawing illustrates the interface between base building and the urban streetscape.

Streetscape

The previous illustration demonstrates the interplay between the base building and the surrounding urban streetscape. The streetscape drawing emphasizes the entrances, access points, and communal areas that welcome residents and promote engagement with the neighbouring community. The shared amenity spaces and central circulation tower are prominently showcased at the street corner, and where the river walk intersects with the urban street. The communal façade design stands out from the infill facades thanks to crossed timber elements that also function as structural shearing supports. This viewpoint offers a clear depiction of how the building's thresholds interact with its adjacent neighbours and the overall urban fabric.

Site Section

The site section drawing showcases the integration of thresholds, base building, and WikiHouse infills within a housing development. This drawing provides a visual representation of the different components and their relationships, highlighting the seamless transitions and connections between them.

The drawing depicts vignettes of inhabitation, focused on thresholds which represent the transition between public and private spaces. Beyond the thresholds, the section reveals the base building, which forms the structural support and houses the main mechanical, electrical, and plumbing (MEP) systems. The base building acts as a backbone, providing stability and infrastructure to the entire development.

“Site Section” A large section representing the base building in cross section. Inhabitation highlights indicate the specific thresholds throughout the building and help to illustrate the transitions from public city space, to communal building spaces, and finally the private infill inhabitation.

The section drawing also showcases the WikiHouse infills, which are integrated within the base building framework. These infills represent the individual dwelling units or modules that can be customized and assembled using the WikiHouse technology. The drawing demonstrates how the infills fit within the overall structure, utilizing the vertical and horizontal spaces available for MEP systems and creating a cohesive architectural composition.

Through this site section drawing, the interplay between thresholds, base building, and WikiHouse infills becomes evident. It visually communicates the integration of different components, highlighting the importance of smooth transitions, efficient MEP systems, and the cohesive design language that ties the entire housing development together.

The drawing showcases how people move around the building’s common amenity spaces, including the circulation areas and courtyard. It demonstrates how these spaces are interconnected and create a gradual transition from the public commons to the private living spaces.

“Thresholds: The civic street” A vignette illustrating the thresholds between public and private, building and context, prospect and refuge.

The street interface design includes a raised base floor that enhances privacy for residents while maintaining a prospective interaction. On the street features of greenery act as a barrier between the street and the building. The interface also provides a spacious pedestrian area for the community, setbacks aid in managing foot traffic, which can get heavy due to the convergence of the river walk and urban street in a community node.

“Thresholds: The pedestrian street” A vignette illustrating the thresholds between public and private, building and context, prospect and refuge.

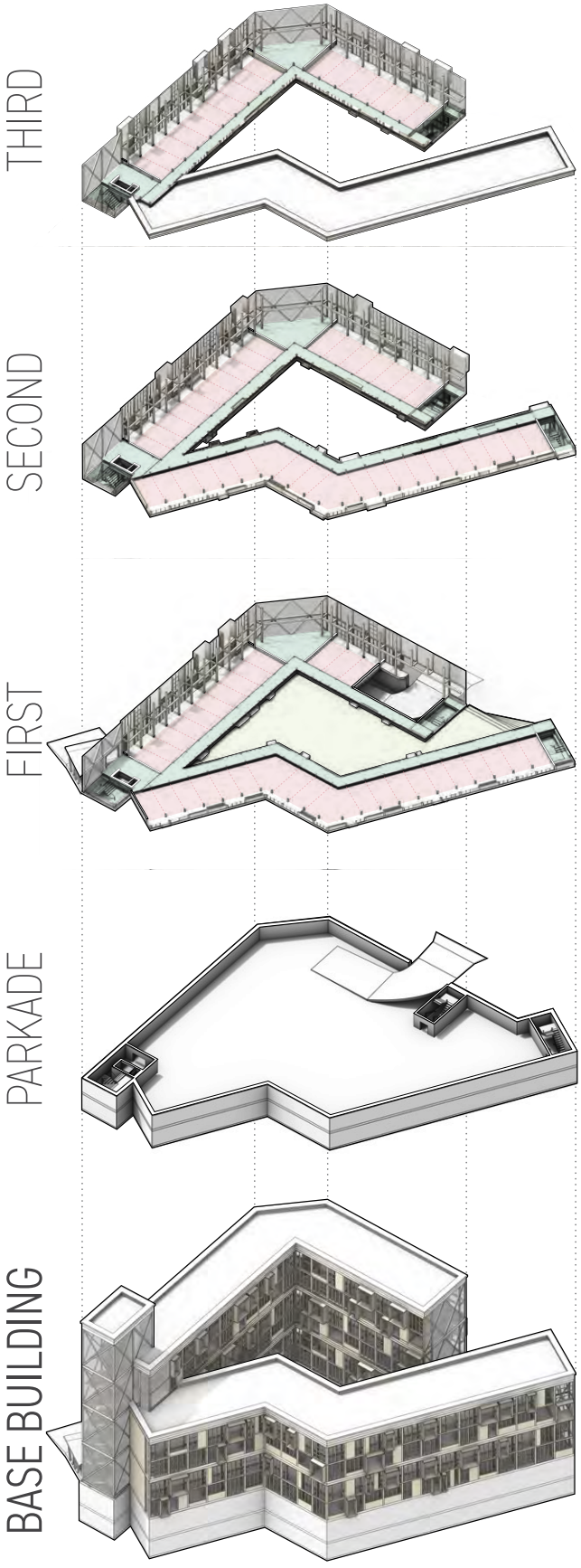
The raised base floor on the opposite side of the building serves both as a refuge and a prospective view of the pedestrian thoroughfare of the river walk. Additionally, it functions as a technical feature by elevating the base floor above the potentially dangerous flood levels of the Bow River. Landscaping beds and plantings act as a buffer to protect the lower levels, maintaining privacy and a sense of refuge within the private spaces of the building.

“Thresholds: The commons” A vignette illustrating the thresholds between public and private, courtyard and building, prospect and refuge.

The internal courtyard is located at a slightly elevated level compared to the streetscape and river walk, and it serves as a shared space for residents to interact. The raised internal circulation acts as a bridge between the commons and the infill, while also serving as a technical passage for the building’s systems under the raised floor elements. The circulation pathways create a buffer that helps define thresholds and gradually increases privacy for the unit entrances. Each unit faces externally and is supported by circulation corridors that border the internal courtyard.

“Thresholds: The interface” A vignette illustrating the thresholds between public and private, infill and commons, prospect and refuge.

In this final vignette, we see how the internal courtyard is connected to the upper level. The base building has two arms that gradually decrease in height towards the river, complying with the bylaw strategy. This design also allows the top floor of the urban side of the building to have a prospective view of the river and the hillside communities beyond.



DEMISING LINE OF BAYS

Depending on availability and unit size users can select a number of bays to infill according to their specifications

INFILL AREA

Indicated area shows the main intended infill area (not including the extended deck space or additional infill extensions on the second floor).

COMMUNAL AREA

Indicated areas include the central circulation tower and elevator, additional circulation stairwells, and internal common space which contains resident amenities.

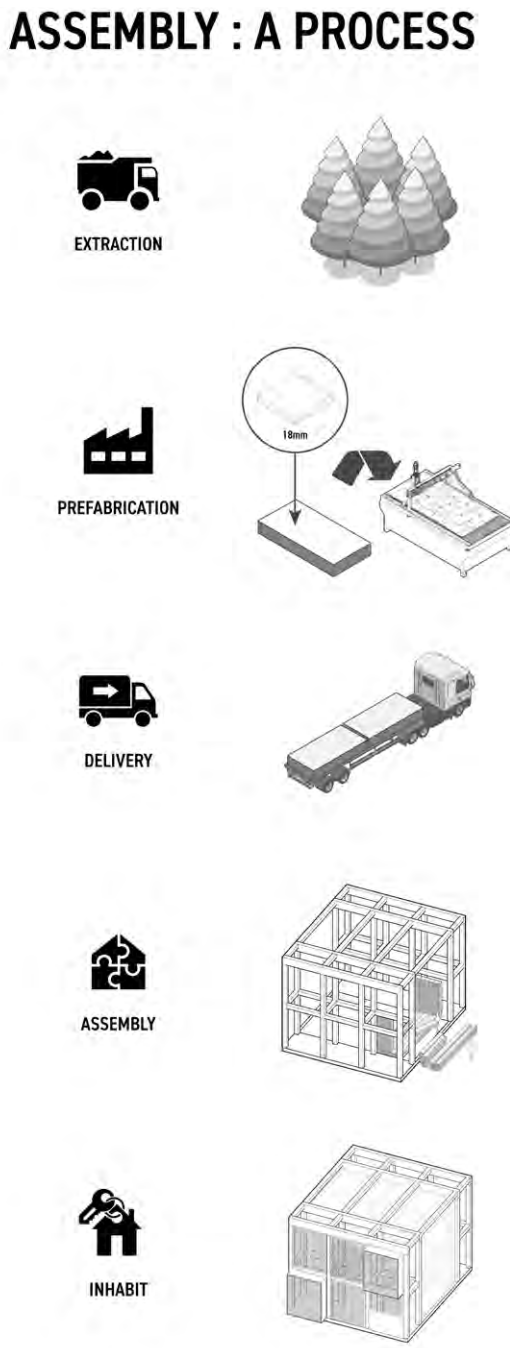
COMMUNAL COURTYARD

Located on the base floor adjacent to the communal circulation paths this space operates as a resident courtyard with planting, benches and tables. An external resident amenity designed for seasonal use and designed with landscaping appropriate for a winter garden due to the climate of the chosen site.

“Axonometric Plans” Stacked plans indicating the building break down of private bay vs communal spaces.

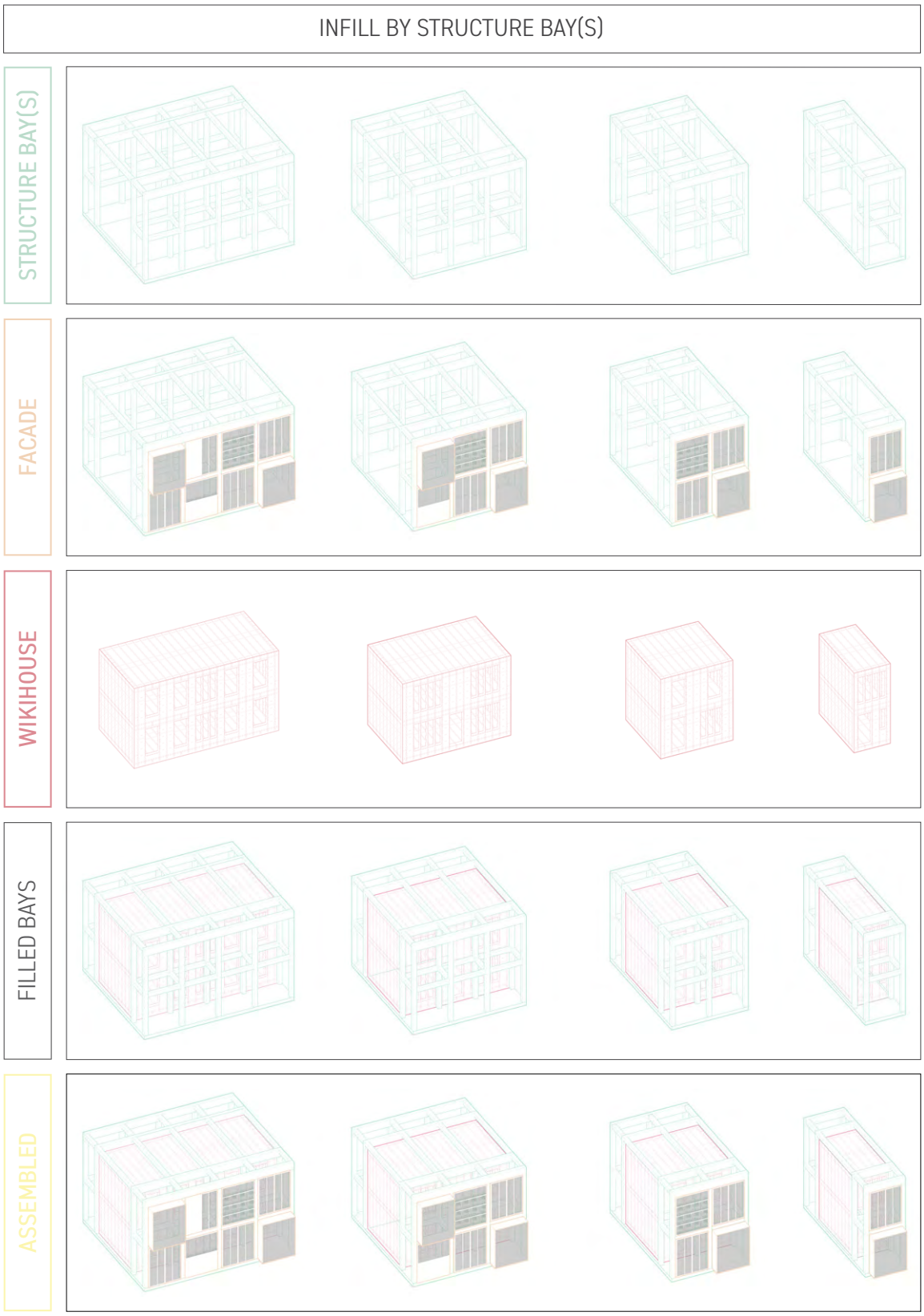
Base Building System

The base building while centred around an internal courtyard and buffered by common circulation paths is made up of systematic structural bays that help to holistically delineate the infill and common areas. Designed as a single loaded corridor in a courtyard typology the building keeps active resident spaces including the courtyard and circulation/ system paths on the interior side while offering the units each their own externally facing private enclosed façade space. The external buffer space between the main infill area and the façade is intended for residents to utilize as they see fit, whether they chose to expand their infill or maintain it as a type of solarium it is up to them. The bay itself is bookended by structural supports that allow for a variety of inhabitations styles or expansions, the only predeterminant constraint is that they cannot alter the essential structure of the base building nor interfere with the circulation pathway on the base floor of their double height bay. Beyond the Infill areas, the building facilitates circulation pathways vertically and horizontally, a freight elevator and amenity space for residents. These features are distinguished from the private infills externally on the façade using crossed timber members. The expression in the façade is illustrative of its internal relations in that manner; Infill is thus indicated by the façade plug and play componentry while resident amenities and commons space is represented by the crossed timbers façade. The structural detailing of the base building is best seen in the “Inhabited Render” drawing located on page 68 and the “Technical Interface” drawing located on page 61. There you can see the structural continuation, mechanical facilitation, and inhabited infill with its activated façade componentry.



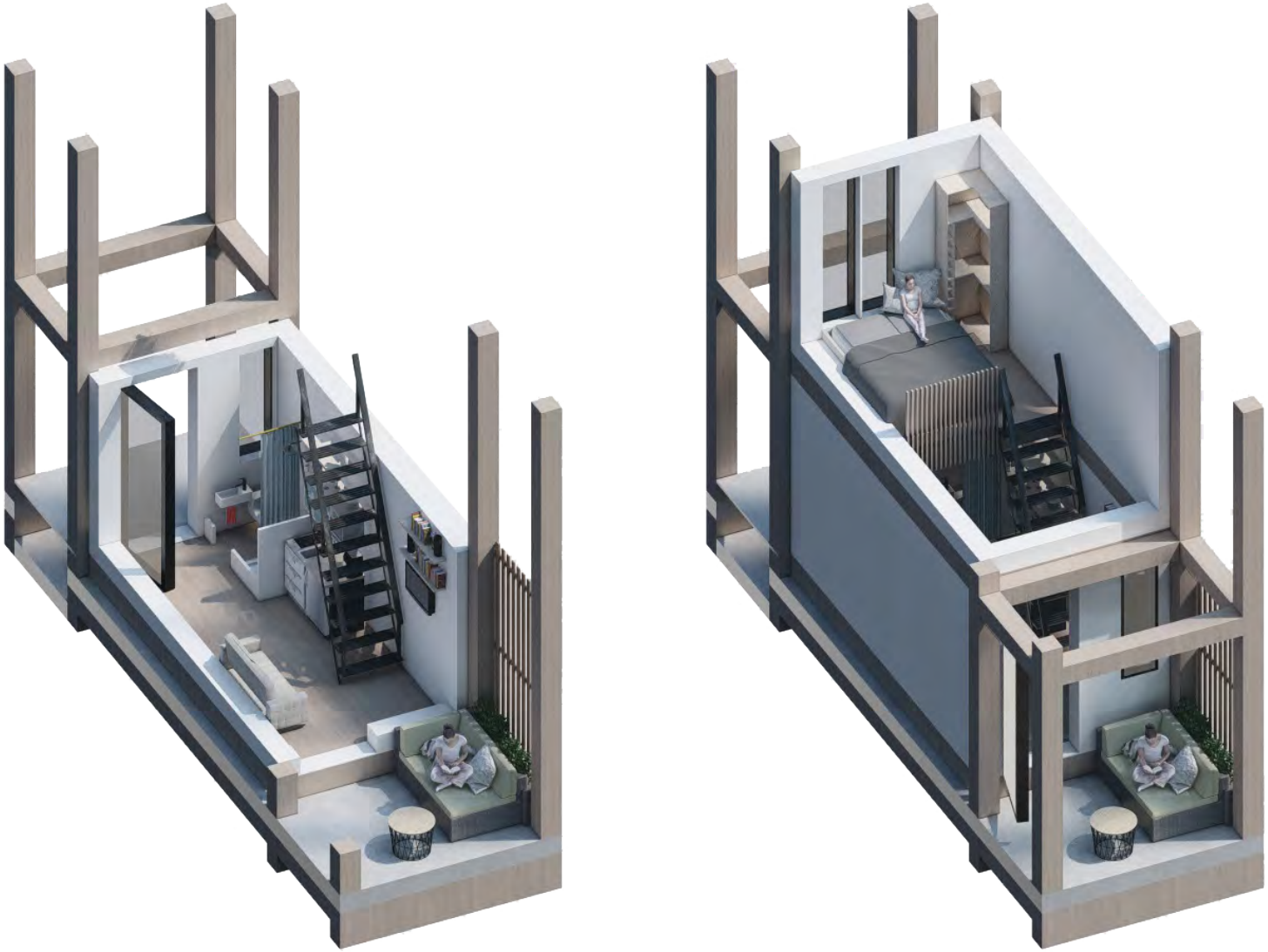
“Inhabitation: A Process” - A diagrammatic representation of the inhabitant life cycle potential Illustrated next to the base building standardized bay.

“Assembly: A Process” - A diagrammatic breakdown of the Wikihouse componentry process from extraction of resources to inhabitation of the infill.



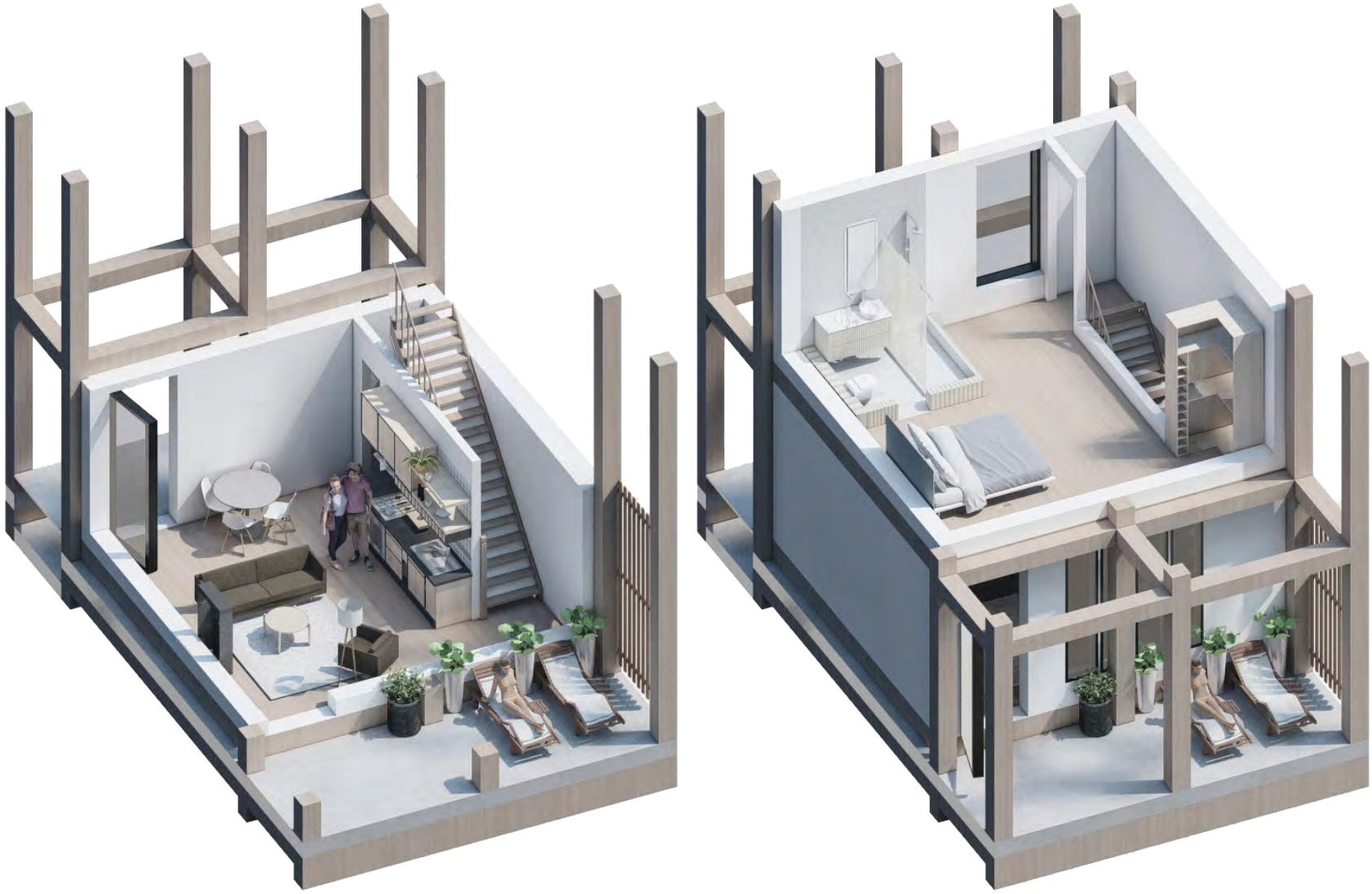
“Infill by structure bay(s)” A line drawing illustrating the interface of infill components with base building structural bays indicating the variety of sizing that units can take.

“Infill Example: Single Bay” A representation of possible inhabitation strategies for a single bay (Part 1/2)

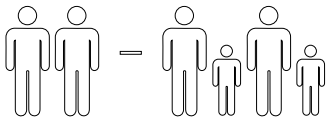


“Infill Example: Single Bay” A representation of possible inhabitation strategies for a single bay (Part 2/2)

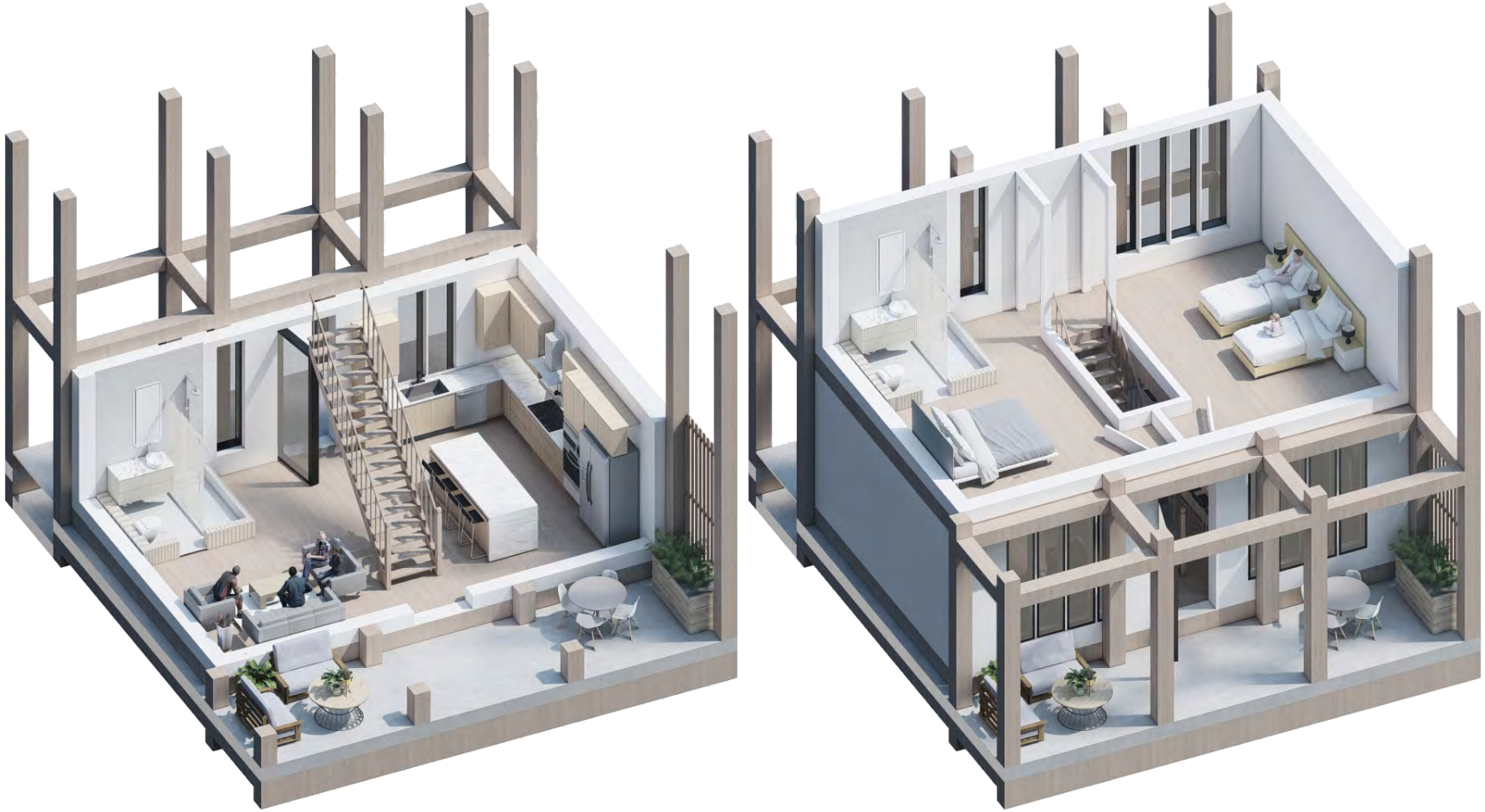
“Infill Example: Double Bay” A representation of possible inhabitation strategies for a double bay (Part 1/2)



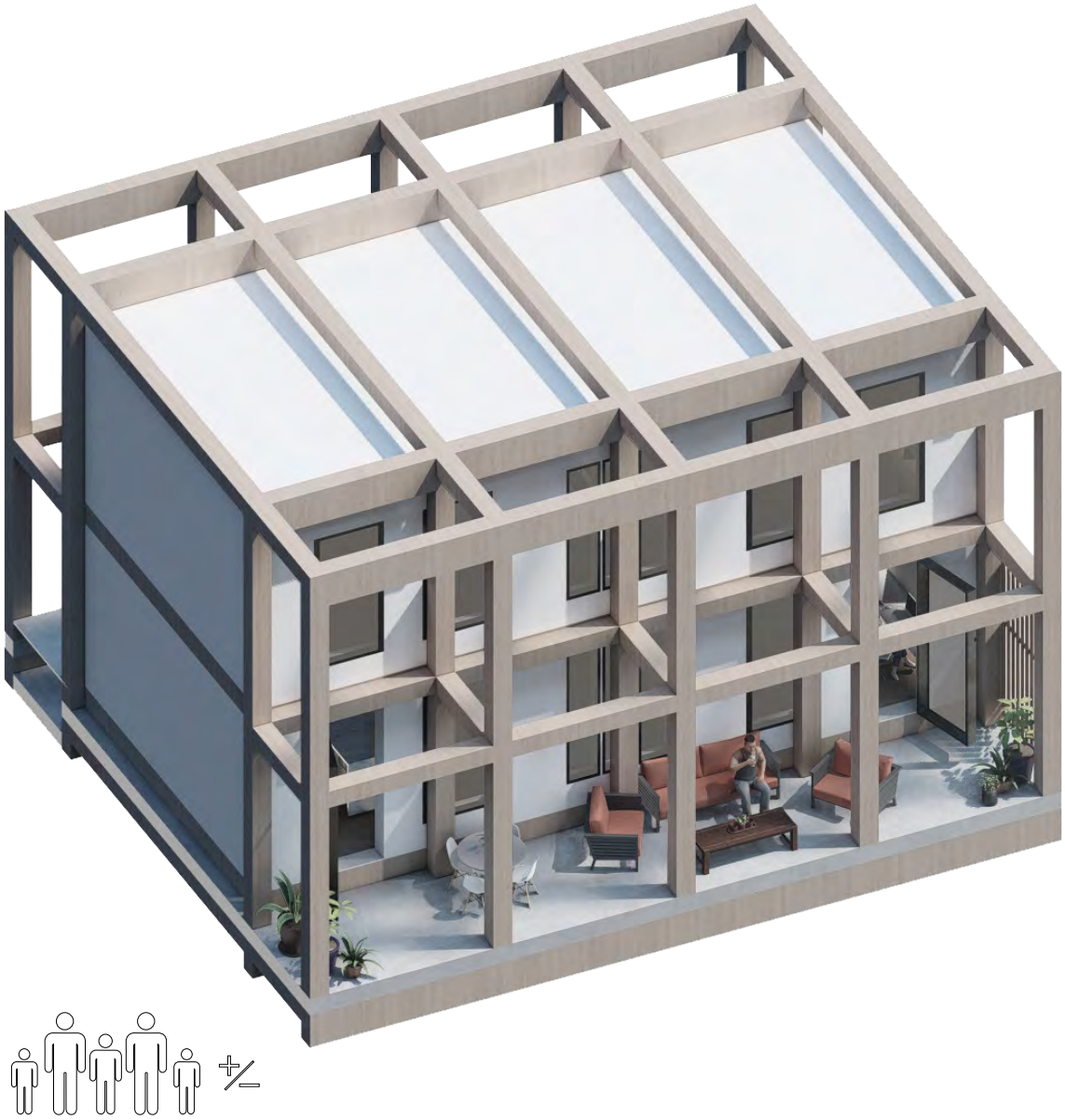
“Infill Example: Double Bay” A representation of possible inhabitation strategies for a double bay (Part 2/2)



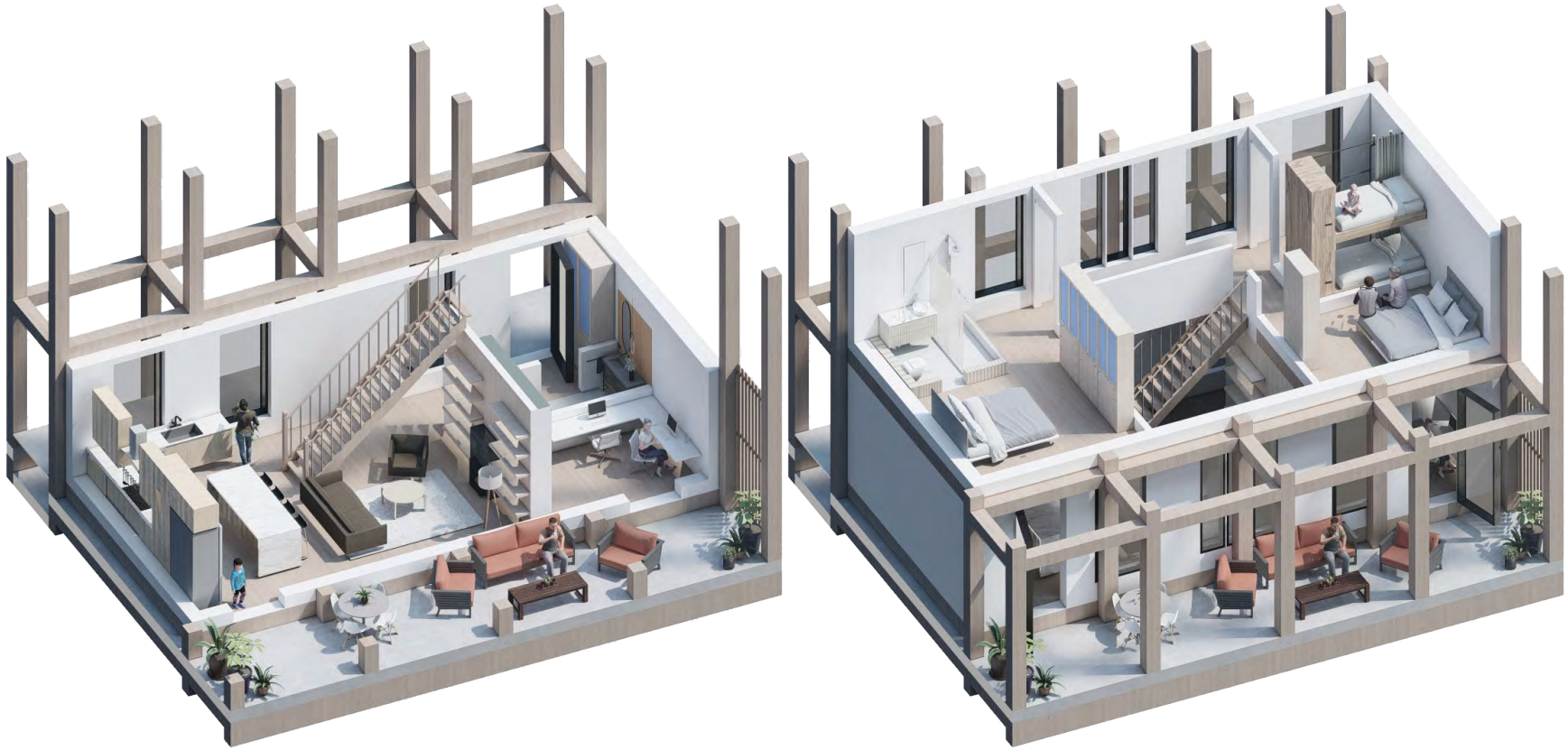
“Infill Example: Triple Bay” A representation of possible inhabitation strategies for a triple bay (Part 1/2)



“Infill Example: Triple Bay” A representation of possible inhabitation strategies for a triple bay (Part 2/2)



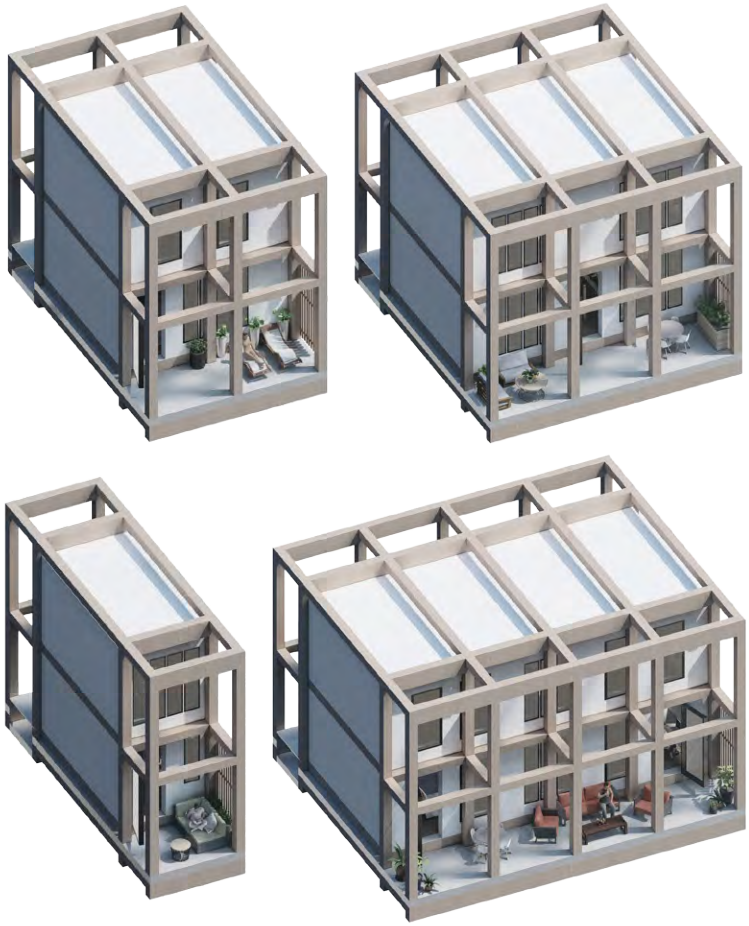
“Infill Example: Quad Bay” A representation of possible inhabitation strategies for a quad bay (Part 1/2)



“Infill Example: Quad Bay” A representation of possible inhabitation strategies for a quad bay (Part 2/2)

Unit Variance Examples

The examples provided above are meant to give a sense of some of the inhabitation strategies for a variety of unit sizes from a single bay micro unit to a large quad bay multiple generational family.



“Infill Examples” A variety of potential inhabitation styles + sizes

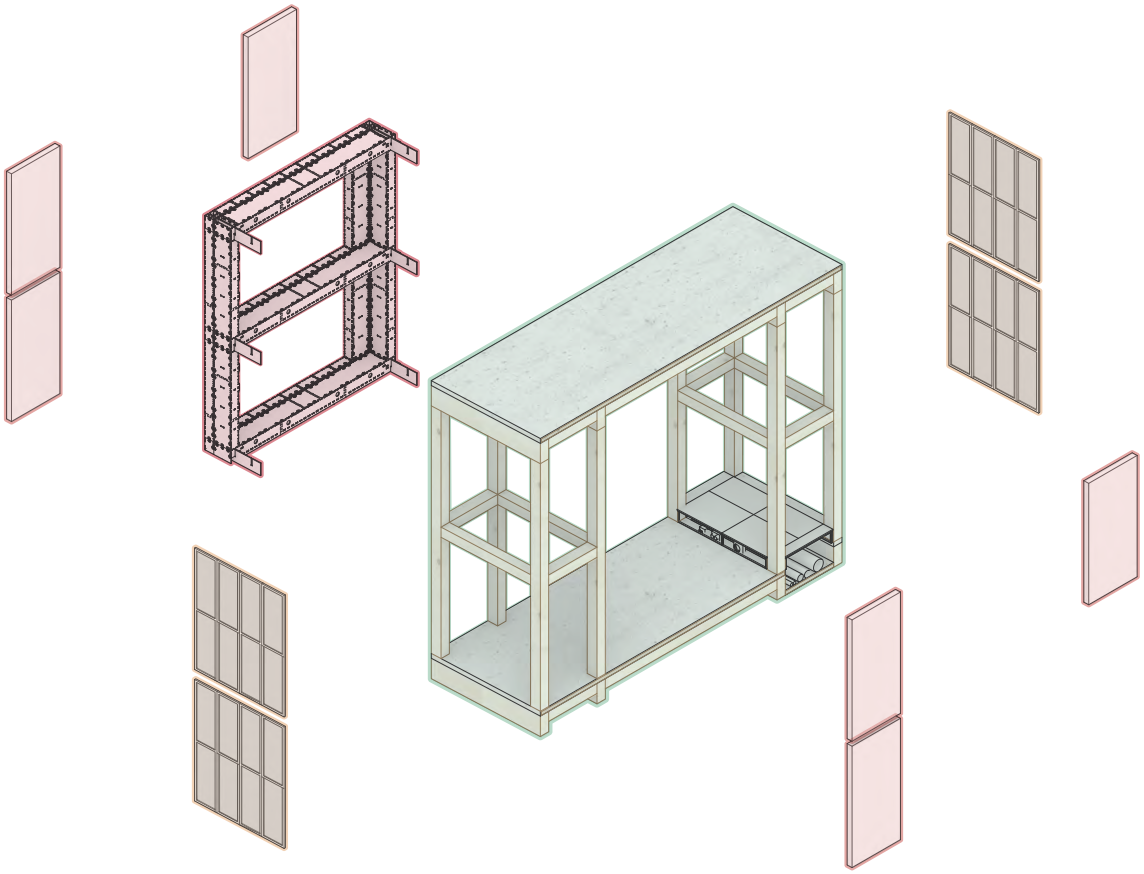
Technical Interface

This drawing illustrates the interface of infill components within the base building structural standard unit/bay. Each bay is able to encapsulate one unit or as previously specified they can be combined to expand the unit size accordingly. Throughout the building on the internal courtyard side raised floors serve as both the circulation routes and as the conduits

for services below. The CLT Concrete composite panel is dropped here to enable a deep alcove that is oversized for mechanical services, this is developed with the insight that the systems in place in the building upon completion might change over its entire lifespan. By robustly designing the technical interface of the base building both structurally and technically in the case of its mechanical systems we allow for a more adaptive building that can accommodate change and alterations more readily.

As part of the facilitation for alterations each bay is equipped with interface componentry that plugs into the building-wide system. The interface plug-in delineates what is common and what is private. This allows residents to plug their infill in at any singular bay along the length of their frontage. These systems operate much like how a suburban community would, where the streets and sidewalks serve as the conduit of services on a community scale each lot is facilitated by a technical interface where the civic services transition their control to the private systems.

The building-level systems are shown in additional detail in the “Inhabited Render” Drawing on page 68, within the sectional half of the drawing. Below the raised floors the drawing displays how the infill connects to the building-level systems. Each unit is serviced by a packaged terminal unit located within the raised floor cavity. Air exchange is facilitated by external venting through an exchange system that integrates with the facade. Infill-level systems beyond the interface are run through the hollow componentry of the Wikihouse building system. Floor components feature additional cross-component openings and access panels to facilitate the installation and servicing of inhabitants’ desired layouts.



BASE BUILDING : COMMONS / PUBLIC / BUILDING LEVEL CONTROLLED
Systems (Structure, Mechanical, Raised floors, Base floors) are entirely controlled building level.

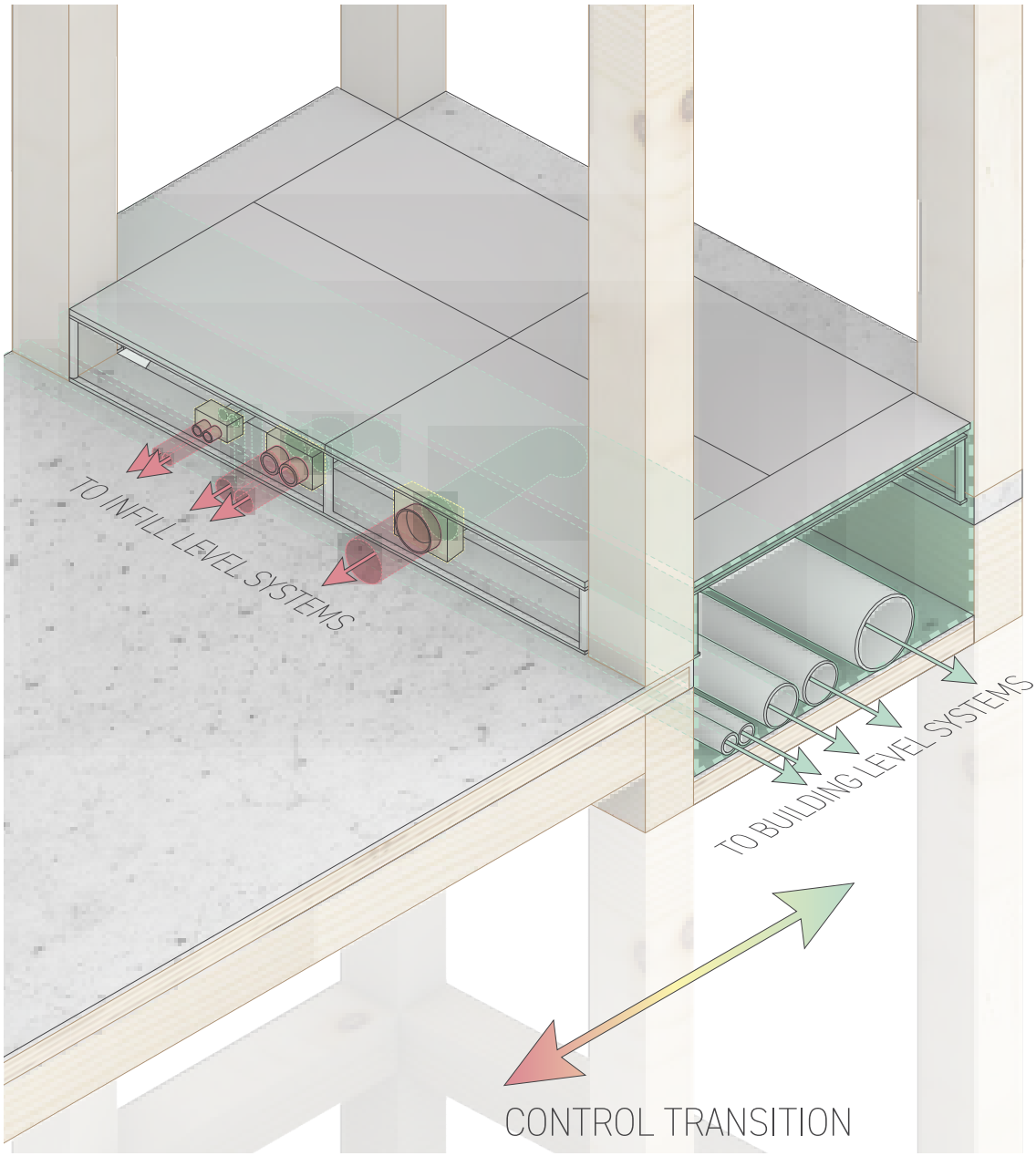
WIKIHOUSE COMPONENTS : INFILL / PRIVATE / USER CONTROLLED
Components are user controlled utilizing the open sourced Wikihouse technology to construct floors, walls and ceilings of the infill.

DELINIATING FENCE : INFILL / SEMI-PRIVATE / SEMI-USER CONTROLLED
Components are agreed upon by adjacent neighbours much like fences in detached homes.

FACADE COMPONENTS : INFILL / PRIVATE / SEMI-USER CONTROLLED
Components are standardized to fit facade infastructure, building level stake holders are incorporated in decision making process and installation.

INTERFACE : COMMONS / PUBLIC + PRIVATE / TRANSITIONAL CONTROL
Components are the interface connector for systems between the Base Building and Infill. Serves as a point of transistion between control areas.

“Technical Interface” An exploded axonometric drawing indicating the relevant infill componentry and the base building bay. Additionally supported with a interface detail for control transition between infill (inhabitant/private level) and base building (commons/public level). (Part 1/2)



BASE BUILDING : COMMONS / PUBLIC / BUILDING LEVEL CONTROLLED

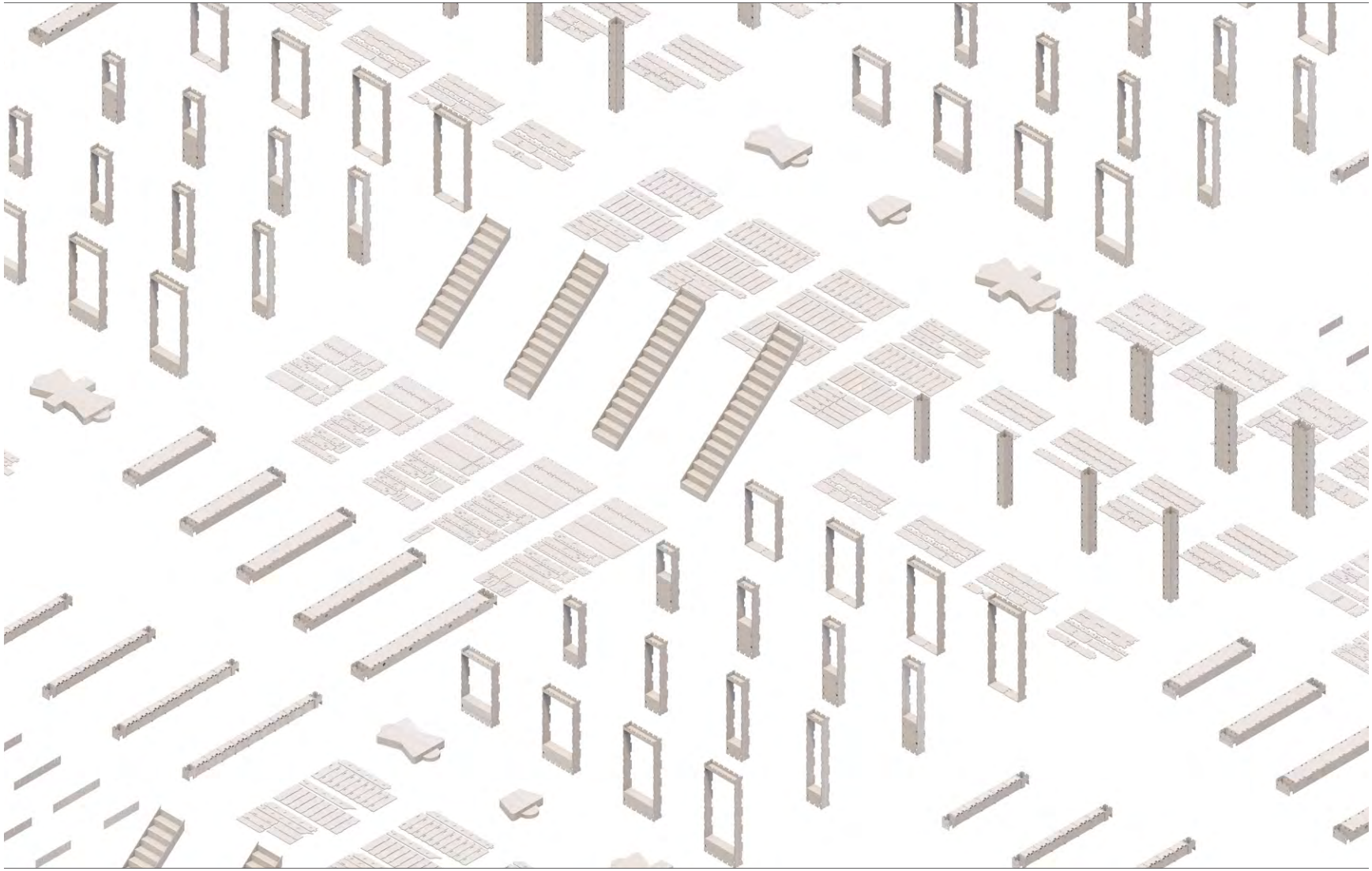
WIKIHOUSE COMPONENTS : INFILL / PRIVATE / USER CONTROLLED

DELINIATING FENCE : INFILL / SEMI-PRIVATE / SEMI-USER CONTROLLEI

FACADE COMPONENTS : INFILL / PRIVATE / SEMI-USER CONTROLLED

INTERFACE : COMMONS / PUBLIC + PRIVATE / TRANSITIONAL CONTROL

“Technical Interface” An exploded axonometric drawing indicating the relevant infill componentry and the base building bay. Additionally supported with a interface detail for control transition between infill (inhabitant/private level) and base building (commons/public level). (Part 2/2)



“Wikihouse Infill Components” A selection of the variations available for inhabitants to choose to evolve and adapt their infill bays.

FACADE COMPONENTS

VERTICLE COMPONENTS

HORIZANTAL COMPONENTS

“Facade Infill Components” A selection of the variations available for inhabitants to choose to evolve and adapt their infill bays.

Wikihouse Componentry and the Infill

The process of infill is made possible by using a range of components that are based on the open-sourced wikihouse building technology. While some modifications have been made to standardize the sizing, the components remain largely unchanged to ensure consistency and ease of use. These components make up the floor, walls, apertures, circulation, and ceilings of the unit. Users can customize and modify the components to meet their specific requirements within the given bay size limitations. For more information on the design, fabrication, and assembly, you can visit their website at wikihouse.cc. Additionally, this document includes three manuals (still in development) in the appendix.

Facade Componentry and the Infill

Initially, the façade starts with a basic bay block of full bi-folding windows, this ensures that the building is fully enclosed and inhabitable upon completion of construction. This distinction is made due to the severity of the climate in Calgary. It is necessary to facilitate the façade with standardized components to ensure its integrity, each component interfaces with a channel system built into the bay openings to ensure its enclosure against the elements. Over time the façade will naturally develop into an organic mixture characterized by the occupant’s choices. The following renders and drawings demonstrate an example of the anticipated organic mixture of façade components.

“IN CONTEXT: RiverWalk” Part of the vibrant lively network that makes up the river walk, the base building stands as a bookend to the most eastern edge of Calgary’s down town core.

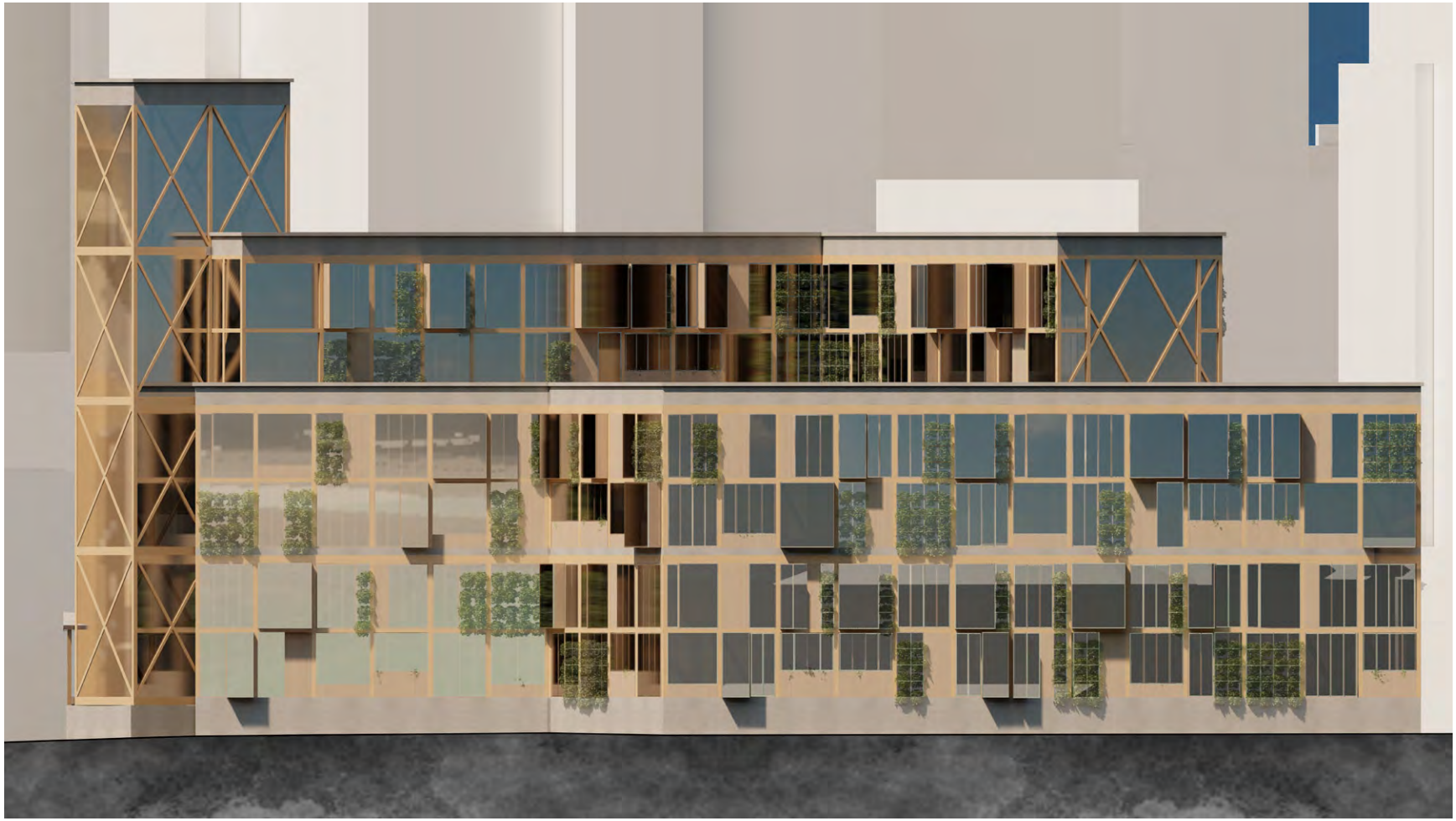
“IN CONTEXT: Bridge View” Looking back across Kings Bridge towards the eastern side of downtown where the base building rests.

“IN CONTEXT: River View” Across the water on St Patrick Island looking towards Kings Bridge towards the eastern side of downtown where the base building rests on the very edge.

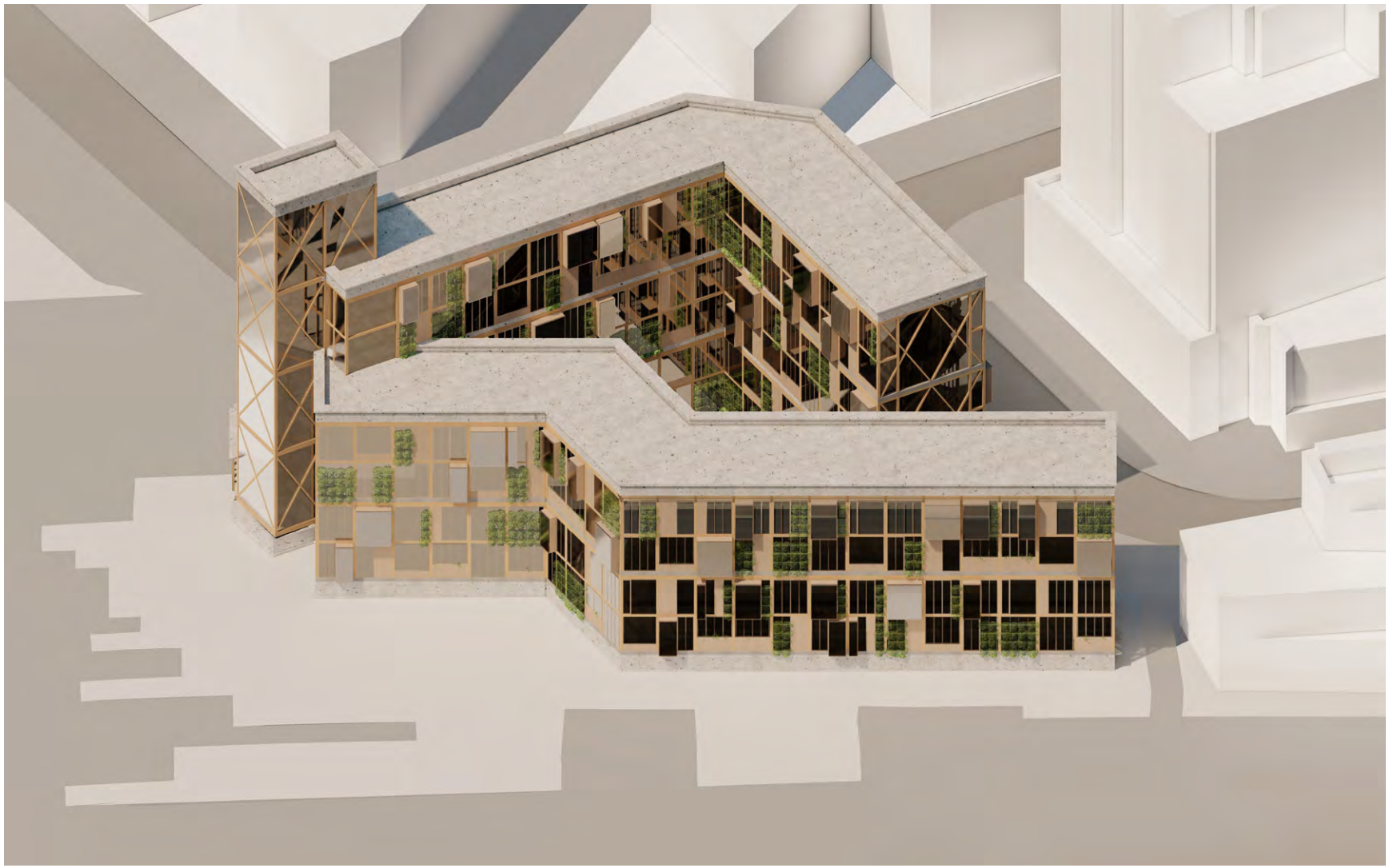
INHABITED: In this render we see an example of the natural organic mixed character the facade can present once inhabited and adapted over time. In both elevation and section the variations available are illustrated indicating a selection of inhabitation styles/adaptions for the infill amidst the base building systems and supports.

Inhabited Render

This drawing showcases the diversity of inhabitation styles and how they interface with the base building's technical aspects. The elevation and section reveal various infill styles, ranging from Wikihouse componentry to façade adaptions. Additionally, the drawing highlights the communal and private distribution of MEP systems, demonstrating how they cater to both the base building and individual units.



FACADE INHABITED ELEVATION: In this render we see an example of the natural organic mixed character the facade can present once inhabited and adapted over time.

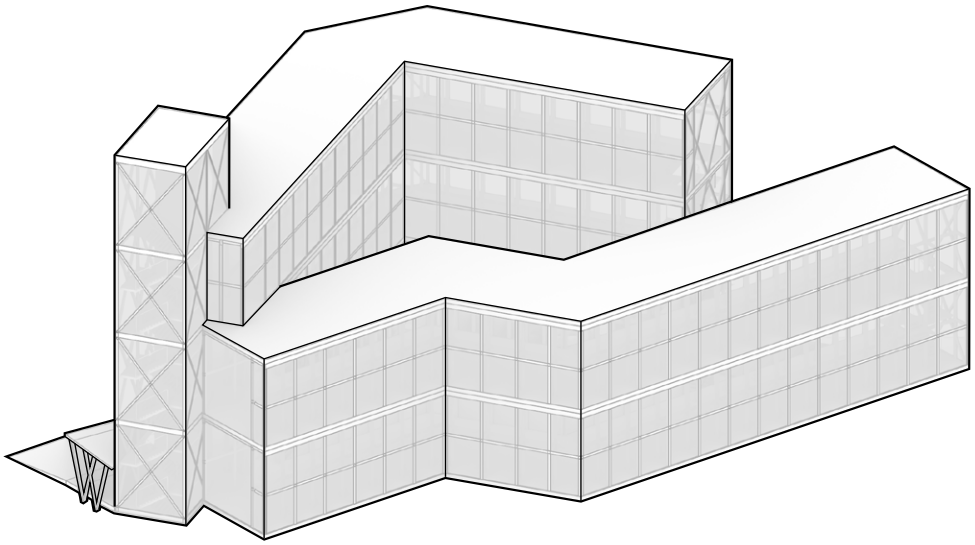


FACADE INHABITED PERSPECTIVE: In this render we see an example of the natural organic mixed character the facade can present once inhabited and adapted over time.

USER MANUAL : YOUR INFILL

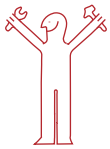
GETTING STARTED

This guide is provided as the introduction edition to a three part series of manuals provided by WikiHouse. In this edition you will learn the design parameters of the building system to better equip you in designing your own custom infill unit in your associated open building.



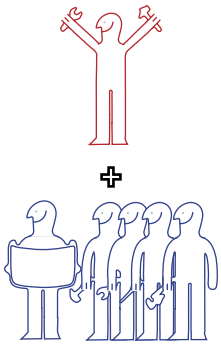
For the purpose of this user manual strip we will focus on the Open Building thesis proposal sited in East Village of Calgary, Alberta.

STEP ONE: Choose your engagement style



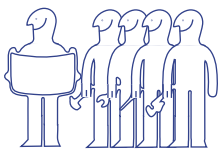
DO IT YOURSELF DESIGN:

In this engagement style you are the principle designer, fabricator, and assembler. You have choosen to take the whole assignment under your wing and will delegate tasks and facilitate the whole process yourself.



HYBRID DESIGN:

In this engagement style you have chosen to mediate the whole process by working with a design team that will orchestrate the process. There is still a moderate level of freedom to design, manufacture, or assemble yourself but you are supported by an experienced team that will help guide the whole process with you.

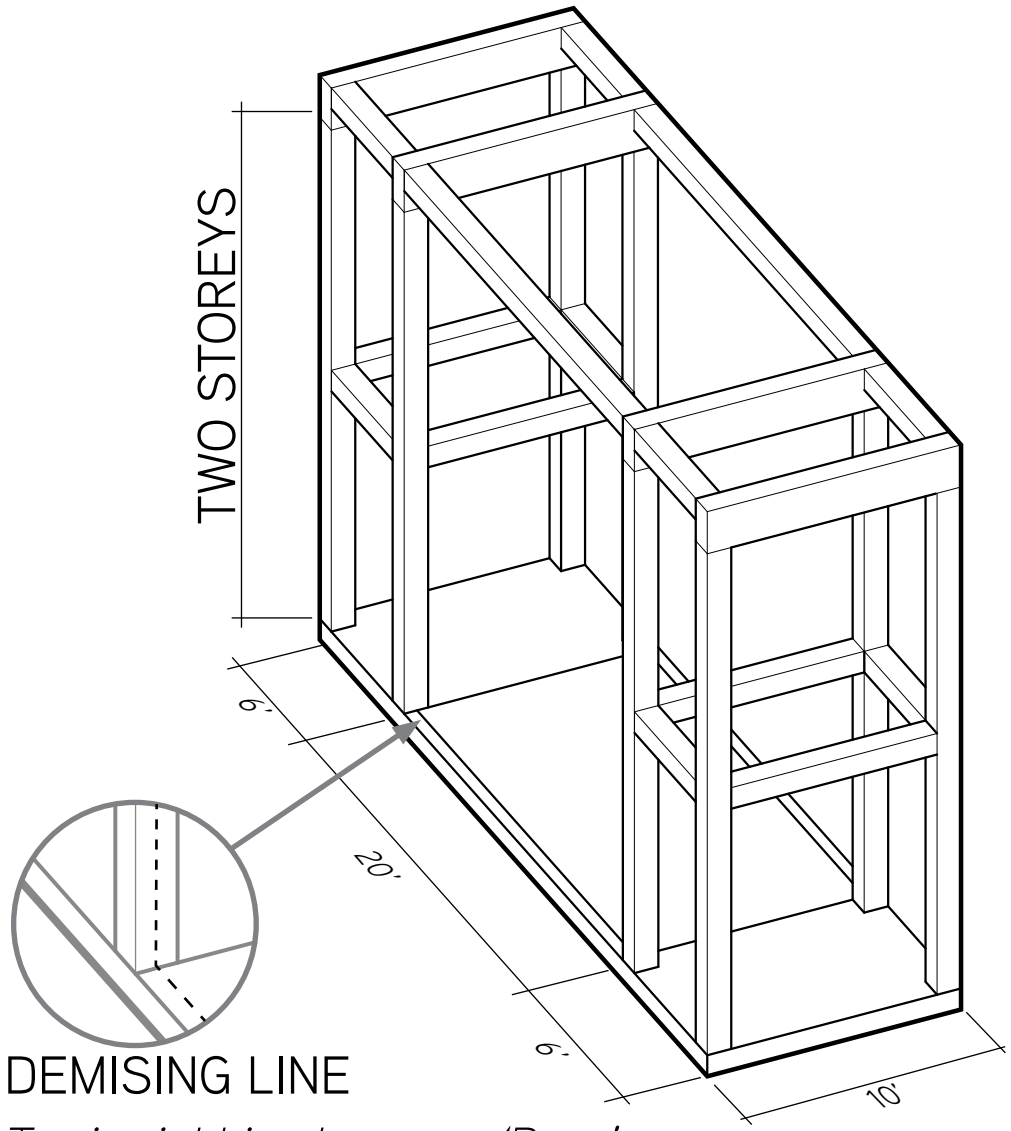


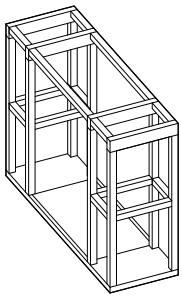
TURNKEY DESIGN:

In this engagement style you are completely disengaged from the design, manufacturing, and assembly. While parameters and desires can be expressed the level of engagement is minimal. You want a polished finished product orchestrated and assembled by a team of experts.

STEP TWO : Choose your size

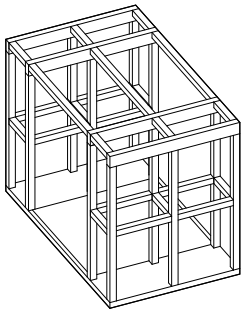
This step determines the size of your unit by allocating how many bays it will take up. Each bay is 10' by 20' and two storeys, adding additional bays expands the dimensions by 10', extending its facade frontage. Each type is described below to aid you in your selection, sizes are illustrated in a capacity analysis and compared to traditional bedroom sizes for ease.





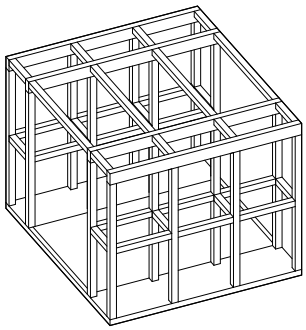
ONE BAY:

This unit size is typically considered a microunit. These units are good for one to two people generally. Typically this contains a studio style apartment.



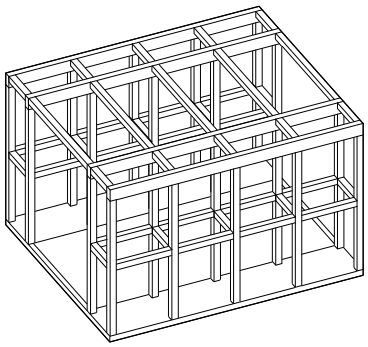
TWO BAY:

This unit size is typically considered a standard one-two bedroom apartment. These units can accommodate 2-4 people on average.



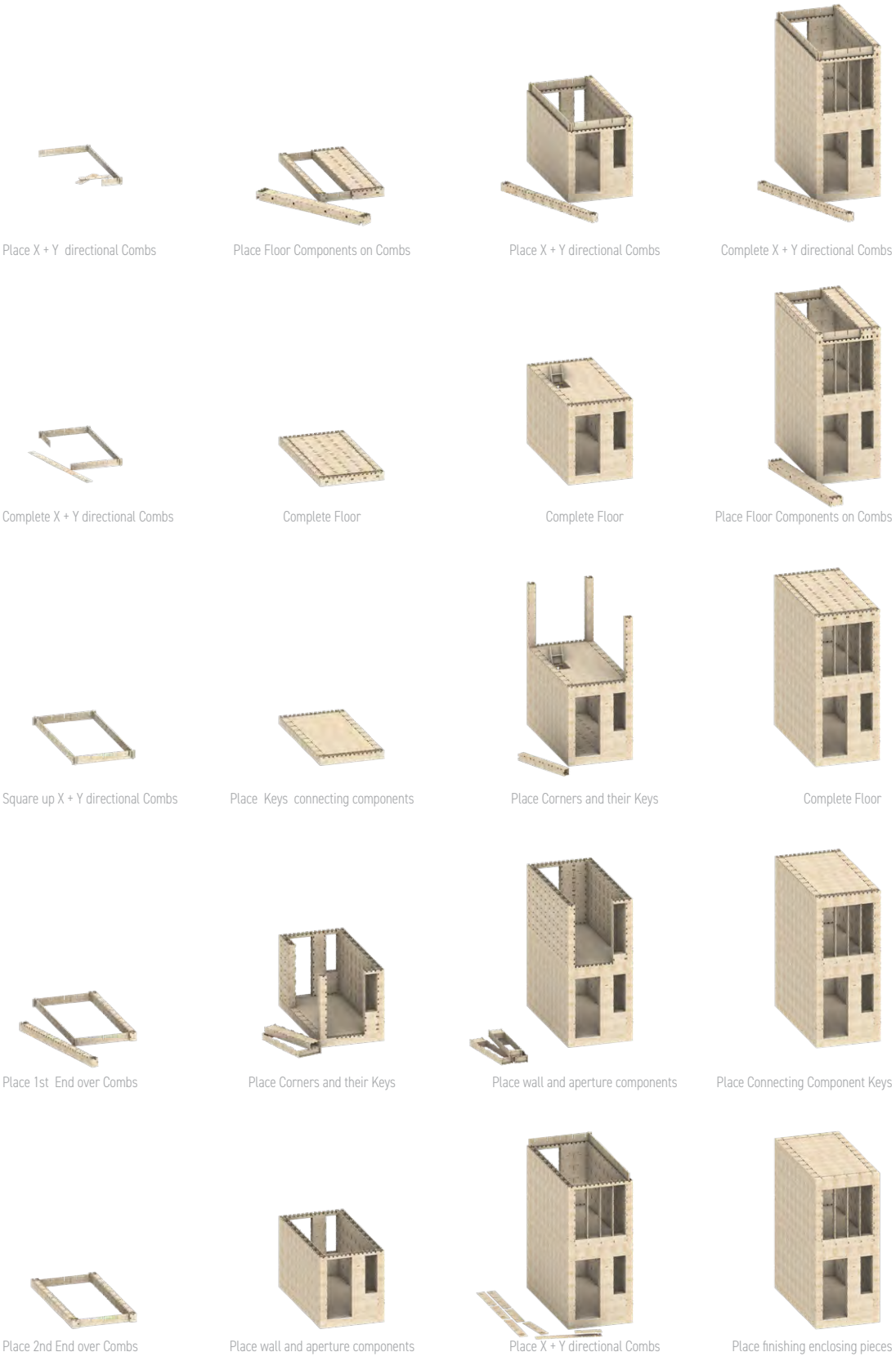
THREE BAY:

This unit size is typically considered a standard two-three bedroom apartment/home. These units can accommodate 3-6 people on average. These units are more common for familial accommodations.



FOUR BAY:

This unit size is typically considered a standard three-four bedroom apartment/home. These units can accommodate 4-8 people on average. These units are more common for familial accommodations.



“ASSEMBLY”: Presented in this strip is the step by step assembly of an example infill designed for a single bay using the Wikihouse componentry.

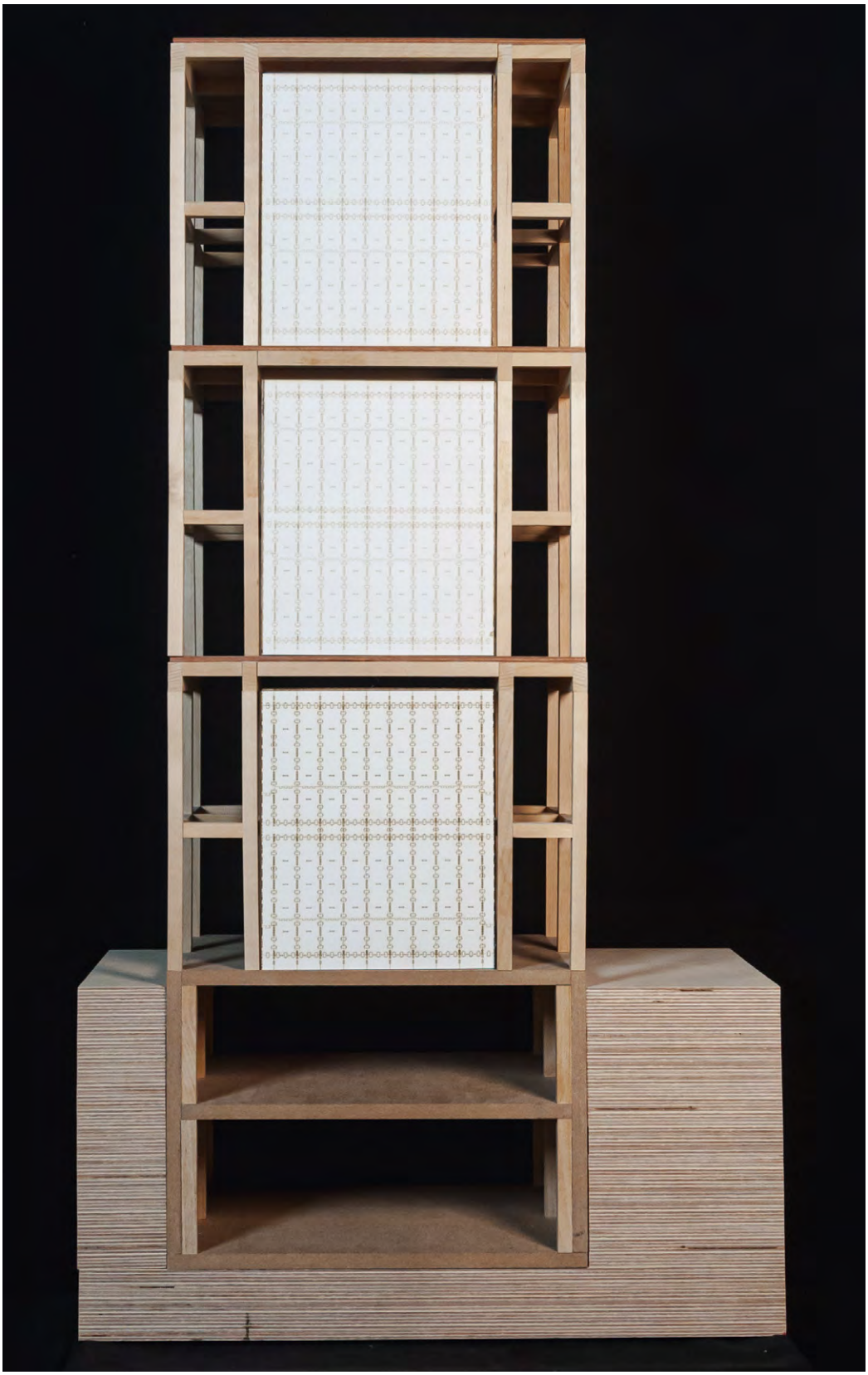
Making: Simplified Design Expression Modeled

The Key Section Model Part A: Base Building, Part B: Base Building with WikiHouse Components of Infill (Note the facade is not shown in these representations).

The Key Section Model Part A: Base Building (Note the facade is not shown in these representations).

The Key Section Model Part B: Base Building with WikiHouse Components of Infill (Note the facade is not shown in these representations).

The Key Section Model Part A: Base Building (Note the facade is not shown in these representations).



The Key Section Model Part B: Base Building with WikiHouse Components of Infill (Note the facade is not shown in these representations).

The Key Section Model Detail Shot Part B: Base Building with WikiHouse Components of Infill (Note the facade is not shown in these representations).

The Key Section Model Detail Shot Part B: Base Building with WikiHouse Components of Infill (Note the facade is not shown in these representations).

The Key Section Model Detail Shot Part B: Base Building with WikiHouse Components of Infill (Note the facade is not shown in these representations).

Chapter 05: Challenges and Limitations

The chapter presents the implications of the research findings, particularly the insights gained regarding the effectiveness of integrating WikiHouse technology and open-building strategies in a medium-density housing design approach. It addresses the limitations and challenges encountered during the research and design process and identifies further research and implementation opportunities.

Regulatory Barriers

Addressing potential regulatory challenges and advocating for supportive policies to encourage the adoption of WikiHouse technology in multiunit housing.

Building Regulations and Permits

Integrating WikiHouse technology and open building, strategies may face building regulations and permit challenges. Since these approaches often involve non-traditional construction methods, local building codes and regulations may need specific provisions to address them (WikiHouse 2022). This could lead to delays, complex interactions with the authority with jurisdiction, or additional requirements during the permitting process. Additionally, specific regional requirements for natural hazards such as earthquakes, hurricanes, flooding, or tornados may exist.

Quality Control and Standardization

Maintaining quality control in open building projects can be challenging due to the decentralized nature of decision-making and construction processes (Kendall 2022). Ensuring the finished structures meet safety standards and

quality requirements may require additional oversight and coordination among various stakeholders involved.

Technical Considerations

Identifying technical challenges and ensuring proper training and expertise for successfully implementing and maintaining WikiHouse technology.

Technical Expertise and Skill Requirements:

WikiHouse technology relies on digital design and fabrication tools, which may require specific technical expertise and skills. Architects, builders, and community members involved in the process must have the necessary knowledge and training to utilize the technology effectively. The learning curve associated with new tools and techniques could challenge some stakeholders.

Scalability and Adaptability:

While open building strategies and WikiHouse technology promote customization and adaptability, scaling these approaches to larger multiunit housing projects may present logistical challenges. Coordinating the customization and assembly processes across multiple units and ensuring compatibility with existing infrastructure and services can be complex.

Funding and Financial Models

Exploring funding options and financial models to support the integration of WikiHouse technology in medium-density multiunit housing projects.

While WikiHouse technology promotes cost-effectiveness through open-source design and prefabrication (WikiHouse 2022), Initial setup costs for acquiring digital tools and machinery may be a barrier for some communities or

organizations (Priavolou et al. 2019). Additionally, the overall cost-effectiveness may depend on diverse factors such as local construction regulations, availability of materials, and economic potential.

Community Engagement and Participation

Promoting community engagement and participation throughout the design and construction process, ensuring a sense of ownership and long-term sustainability.

While user participation and community engagement are fundamental principles of open-building strategies, it can be challenging to effectively involve all community members and stakeholders in the decision-making process. Balancing diverse opinions, interests, and preferences within a community can require robust communication, consensus-building, and facilitation strategies. The intention is to set up engagement and participation that will effectively impact the entire process; the risk of it becoming mere tokenism due to the complexity of its incorporation is very much a reality (Priavolou et al. 2019).

Public and Private Perception and Acceptance

Open building strategies and WikiHouse technology may face resistance or skepticism from traditional stakeholders in the construction industry who are accustomed to conventional building practices. Overcoming resistance and building trust within the industry and among potential users may require effective communication, demonstration of successful projects, and showcasing the long-term benefits of these approaches.

Chapter Summation

Recognizing and addressing these challenges through careful planning, collaboration, and adaptation of the strategies to local contexts is essential. While the potential challenges exist, they should not discourage exploration and implementation, as they can be overcome with proper support, knowledge sharing, and continuous improvement efforts. This thesis recognizes the challenges, and while a theoretical framework has been laid, further implementation, study, and research is still required.

Chapter 06: Implementation and Recommendations

This section develops design guidelines for integrating WikiHouse technology and open-building strategies in medium-density multiunit housing. It offers recommendations for architects, urban planners, and policymakers to implement user-centric, sustainable, and community-engaging approaches in multiunit housing projects. The guidelines aim to promote customization, adaptability, sustainability, and community engagement.

Several recommendations can be considered when implementing user-centric strategies using WikiHouse infill and open building systems in future urban housing projects. Here are some specific suggestions:

Community Engagement

Foster meaningful community engagement throughout the entire design and construction process. Establish platforms for gathering input, conducting workshops, and facilitating discussions to ensure that residents' needs, preferences, and aspirations are considered. Encourage collaborative decision-making to empower residents and create a sense of ownership in the housing project. Avoid tokenism and truly integrate the user into the design process via the conduit of the infill.

Design Flexibility and Customization

Embrace the principles of WikiHouse technology and open-building strategies to provide residents with design flexibility and customization options. Develop modular and adaptable building components that can be easily assembled and

modified to accommodate different spatial requirements, individual preferences, and changing needs over time.

Education and Training

Provide education and training programs to empower residents, architects, builders, and community members with the necessary skills and knowledge to use WikiHouse technology and effectively engage in open building practices. Workshops, hands-on training sessions, and knowledge-sharing platforms can help bridge the gap and build capacity within the community.

Sustainability and Resource Efficiency

Integrate sustainable design principles into implementing WikiHouse infill and open building systems. Emphasize energy efficiency, use of environmentally friendly materials, water conservation strategies, and integration of renewable energy sources. Further this by incorporating green spaces, rainwater harvesting, and urban farming initiatives to enhance the overall sustainability of the housing project.

Collaboration with Local Authorities

Collaborate with local authorities, policy makers, and regulatory bodies to develop frameworks supporting user-centric strategies and open building systems. Advocate for flexible building codes and regulations that accommodate innovative construction methods and encourage community participation. Seek partnerships with government agencies to streamline the permitting and approval processes.

Knowledge Sharing and Documentation

Document and share the knowledge from successful user-centric housing projects utilizing WikiHouse technology and

open-building systems. Publish case studies, best practice guidelines, and design principles to facilitate knowledge exchange among architects, urban planners, researchers, and other stakeholders. Create an open repository of design files, construction manuals, and lessons learned to support future projects. WikiHouse has begun developing a series of manuals and guidelines to aid in the design, construction, and production, utilize the information, expand on it, and continue collaboratively developing the system.

Long-term Maintenance and Support

Develop mechanisms for long-term maintenance and support of WikiHouse infill and open-building systems. Provide resources and guidelines for residents to self-maintain and adapt their homes. Establish mechanisms for ongoing community support, ensuring that residents can access technical assistance and resources for repairs, upgrades, and future modifications. The thesis proposes integrating a maker’s space that can serve these purposes but finding and developing user provisions will depend on the local context and established resources already in place.

Chapter Summation

By incorporating these recommendations, future urban housing projects can effectively implement user-centric strategies using WikiHouse infill and open building systems. Create housing environments that prioritize the needs and aspirations of residents, promote community engagement, and contribute to sustainable and inclusive urban development.

Chapter 07: Conclusion

Restatement of Thesis

The proposal presented in this Thesis advocates for the integration of WikiHouse technology and open building strategies in multiunit housing. By adopting this approach, we can address current challenges while placing emphasis on important aspects such as customization, adaptability, sustainability, community engagement, and efficient construction. This alternative approach leads to the creation of vibrant, personalized, and sustainable urban environments that enhance resident satisfaction, social cohesion, and accessibility to housing.

Next Steps

Society needs to reassess standardized urban housing models for their lack of intrinsic and adaptable diversity. The need to question why our sense of community has evolved or “devolved” by how popular housing methods were pursued and up taken. We need also to question the idea of ownership, why generations might never be able to own a home; but what if that model of ownership was also available within the urban environment, a solution to housing shortages but also sprawl might co-exist in flexible density.

Drawing Conclusions

In conclusion, this thesis has delved into the integration of WikiHouse technology and open-building strategies in the context of medium-density housing. We explored the background and principles of the WikiHouse system, which aims to empower individuals and communities by providing

them with the knowledge and tools to build sustainable, customizable, and cost-effective buildings.

By departing from the typical single-unit approach, we examined the potential of utilizing WikiHouse technology as an infill system within a more extensive multi-unit development. This departure optimizes the base building's mechanical, electrical, and plumbing (MEP) systems while allowing for personalized fit-outs in each dwelling unit. Integration of WikiHouse technology as an infill strategy offers the benefits of off-site manufacturing, rapid on-site assembly, and the flexibility to adapt to individual needs.

We also discussed the rationale behind selecting WikiHouse and the implications of its decentralized manufacturing approach. By engaging local fabricators and assemblers in collaborative design solutions, WikiHouse promotes community involvement and fosters a sense of ownership and belonging. The development of an on-site fabrication studio that transitions into a community maker space evolves and enhances the collaborative and communal aspects of the building process.

Furthermore, we delved into the realms of impact, recognizing the reciprocal relationship between the infill system and the base building. We challenged the conventional mass housing model, which often neglects individuality and agency, and instead proposed a participatory approach that values customization and user-driven design. By integrating open-building strategies and accommodating various levels of citizen participation, we can create environments that offer opportunities for individual contributions, fostering a sense of identity and resilience within the community.

Ultimately, our discussion highlighted the potential of WikiHouse technology and open building strategies to redefine the role of architects and users in the design and construction process. By embracing customization, collaboration, and the principles of sustainability and inclusivity; we can create housing solutions that are tailored to individual needs, promote community engagement, and contribute to the development of resilient and vibrant neighbourhoods.

Combining the efficiency of off-site manufacturing with the flexibility of user customization, WikiHouse and open building strategies offer a promising avenue for transforming the one-size-fits-all mass housing paradigm. As technology continues to advance and bridges the gap between concept and reality, it is essential to strike a balance between empowering individuals and ensuring the necessary expertise and adherence to building standards. Through an adaptable and thoughtful approach to citizen participation and the realm of responsibilities, we can shape a future where housing is sustainable, inclusive, and responsive to the diverse needs of its inhabitants.

References

Alexander, Christopher. 1977. *A Pattern Language: Towns, Buildings, Construction*. Oxford university press.

Arnstein, Sherry R. 1969. “A Ladder of Citizen Participation.” *Journal of the American Planning Association*, 35, no. 4. 216-224.

Brand, Stewart. 1995. *How Buildings Learn, What Happens After They’re Built*. New York: Penguin.

Capra, Fritjof. 2002. *The Hidden Connections, A Science for Sustainable Living*. Harper Collins. London.

Chen, Chong-Wen. 2022. “From Smart Cities to a Happy and Sustainable Society: Urban Happiness as a Critical Pathway toward Sustainability Transitions”. *Local Environment* 27, no. 12: 1536-1545.

De Graaf, Reinier. 2017. *Four Walls and a Roof: The Complex Nature of a Simple Profession. Cambridge, Mass:* Harvard University Press.

De Paris, Sabine Ritter, and Carlos Nuno L. Lopes. 2018. “Housing Flexibility Problem: Review of Recent Limitations and Solutions.” *Frontiers of Architectural Research* 7.1: 80-91.

Estaji, Hassan. 2014. “Flexible Spatial Configuration in Traditional Houses, the Case of Sabzevar.” *International Journal of Contemporary Architecture* ”The New ARCH“, 1, no. 1: 26-35.

Estaji, Hassan. 2017. “A Review of Flexibility and Adaptability in Housing Design. “*International Journal of Contemporary Architecture* ” 4; 37-49.

Habraken, John. 1972. *Supports, an Alternative to Mass Housing.* London: Architectural Press.

Habraken, John. 1976. *Variations : the Systematic Design of Supports.* Cambridge, Mass: Laboratory of Architecture and Planning at MIT.

Habraken, John., and Kendall Stephen. 2015. *Base Building-A New Infrastructure. https://www.researchgate.net/publication/257624543_Base_Building-A_New_Infrastructure*

Habraken, John., and Teicher, Jonathan, ed. 1998. *The Structure of the Ordinary : Form and Control in the Built Environment.* Cambridge, Mass: MIT Press.

Habraken, Nicolaas John, Klaske Havik, and Hans Teerds. 2011. “Definiëren en Loslaten / Interview Met John Habraken = Define and Let go / an Interview with John Habraken.” *OASE: Tijdschrift Voor Architectuur = OASE: Architectural Journal*, no. 85: 8–16.

Harvey, David. 2012. *Rebel Cities: From the Right to the City to the Urban Revolution.* London, United Kingdom: Verso.

Hertzberger, Herman, John Kirkpatrick, and Herman Hertzberger. 2015. *Architecture and Structuralism : the Ordering of Space*. Translated by John Kirkpatrick. Rotterdam: Nai010 publishers.

Hertzberger, Herman. 1991. *Lessons for Students in Architecture*. Rotterdam: Uitgeverij 010 Publishers.

Jacobs, Jane. 1961. *The Death and Life of Great American Cities*. New York: Random House.

Kendall, Stephen, and Teicher J. 2000. *Residential Open Building*. New York: E&FNSpon.

Kendall, Stephen. 2017. “Four Decades of Open Building Implementation: Realising Individual Agency in Architectural Infrastructures Designed to Last.” *Architectural Design* 87, no. 5: 54-63.

Kendall, Stephen ed. 2022. *Residential Architecture as Infrastructure : Open Building in Practice*. Abingdon, Oxon: Routledge.

Kent, Ethan. 2019. “Leading Urban Change with People Powered Public Spaces. The History, and New Directions, of the Placemaking Movement.” *The Journal of Public Space* 4, no. 1: 127–134.

Kroll, Lucien., and Peter Blundell Jones. 1987. *An Architecture of Complexity.* 1st MIT Press ed. Cambridge, Mass: MIT Press.

Kronenburg, Robert. 2005. “Flexible Architecture: The Cultural Impact of Responsive Building”. *Open House International* 30, no. 2: 59-65. https://doi.org/10.1108/OHI-02-2005-B0008.

Le Corbusier. 1927. *Towards a New Architecture,* by Le Corbusier [pseud.]. New York: Brewer and Warren inc.

Lifschutz, Ed. Habraken, N. John. 2017. “Loose-fit Architecture : Designing Buildings for Change.” *Architectural design* 87, no. 5.

Macchi, G. 2017. “System Separation: A Fitting Strategy for Future Development.” *Archit. Design*, 87: 76-83.

“Mission.” n.d. WikiHouse. Open Systems Lab. Accessed October 10, 2022. https://www.wikihouse.cc/mission.

Norberg, Kaj. 2019. “WikiHouse: The Futureproof House - Backcasting Architecture For Flexible Housing.” Thesis. Chalmers University of Technology Department of Architecture and Civil Engineering.

Parvin, Alastair. 2013. “ Architecture for the People by the People.” Video, 12:58. TED.

Priavolou, Christina and Niaros Vasilis. 2019. “Assessing the Openness and Conviviality of Open Source Technology: The Case of the WikiHouse.” *Sustainability,* 11. 4746. 10.3390/su11174746.

Schmidt, Austin, and Austin Simon. 2016. *Adaptable architecture : Theory and Practice.* London: Routledge, Taylor & Francis Group.

Sennett, Richard. 1970. *The Uses of Disorder: Personal Identity & City Life.* [1st ed.]. New York: Knopf.

Smith, Ryan E. 2010. *Prefab Architecture : a Guide to Modular Design and Construction*. Hoboken, N.J: John Wiley & Sons.

Till, Jeremy, and Tatjana Schneider. 2005. “Flexible Housing: the Means to the End.” *Architectural Research Quarterly* 9, no. 3-4: 2, 87–96.

Van der Lubbe, Marcel and Esther Stevelink. 2020. *Facades*. Rotterdam: GEVEL event.

“Wikihouse.” 2020. Architecture 00. September 24, 2020. https://www.architecture00.net/00projects/wikihouse.