

# مختبر الخطوط المتعددة الأساليب

PROPOSAL FOR THE NATIONAL  
PAVILION OF THE UNITED ARAB  
EMIRATES 2025

19TH INTERNATIONAL ARCHITECTURE  
EXHIBITION AT LA BIENNALE DI VENEZIA

PHASE TWO

# Permutable Assembly

*Towards A New Typology  
For Accessible Housing*

How can we rethink modularity with a systematic approach that considers qualitative aspects such as context and culture to generate a more individualized, adaptable, and accessible residential architecture?

The narrative of the United Arab Emirates’ dynamic evolution, especially in its early metropolitan beginnings, is intricately interwoven with the fundamental principles of modern modularity- whereby efficiency and rapid construction had been key themes to the impetus of cities. A cornerstone that distinguishes the country’s Real Estate development from its counterparts, both regionally and globally is the rapid development of its urban landscapes in light of a societal context that is transient and migrational. The symbiotic relationship between the UAE’s rapid developmental trajectory and the concept of modularity has forged a distinctive identity in the architecture of its cities.

This fast-paced urban progression has inherited some of its characteristics from global modern architecture, sometimes neglecting the essence of the vernacular locale in its representation and execution. Currently, residential Real Estate Developers have been catering to the rapid development of construction, specifically in the UAE, resulting in monotonous homes lacking character and adaptability.

Our proposal for the United Arab Emirates National Pavilion at the International Architecture Exhibition at La Biennale di Venezia tackles the necessity for increased adaptability in housing. This is particularly pertinent for a generation seeking greater flexibility in residential arrangements, along with a dynamic transformation in both the form and function of homes. We propose a new modularity for the 21st century, redefining the housing concept for enhanced adaptability and reduced monotony.

‘*Permutable Assembly*’ combines the advantages of modular prefab concrete construction, offering affordability and efficiency, with Large-scale Additive Manufacturing (3D Printing), providing speed and customization without extra costs. The architectural system overcomes the drawbacks of each technology, harmonizing assembly with regional vernacular forms and methods for enhanced efficiency. Positioned as a UAE-born solution, this innovative approach to housing addresses global needs while empowering a generation facing societal and economic complexities and environmental concerns. The UAE’s favorable conditions, including abundant land and sustainable development governance, make it an ideal backdrop for ‘*Permutable Assembly*.’ This initiative represents a ground breaking revolution in housing, reimagining modern architectural approaches through rapid construction and state-of-the-art robotic fabrication methods.

Concrete, the second most utilized material globally after water, raises environmental concerns due to its substantial contribution to CO2 emissions, reaching 8%. ‘*Permutable Assembly*’ acknowledges the environmental impact of concrete and proposes reducing it by utilizing natural aggregates and advanced construction techniques like 3D printing.

By incorporating recycled materials and minimizing construction time, the initiative aims to lower energy consumption and reduce the environmental footprint of this durable and widely used construction material.<sup>1</sup> The proposal emphasizes the universality and structural stability of concrete, underscoring the significance of investigating a more bionatural form of concrete.

Within the platform of the Biennale, ‘*Permutable Assembly*’ proposes an ongoing, immersive research project that works with the parameters of economic systems, proven to work well within the real estate market in the UAE. It is an attempt to reimagine the processes required to design, construct, sell, and inhabit houses in the UAE in light of novel advancements in technology alongside cultural and societal changes. The exhibition adopts the conceptual framework of a ‘Developer’s Showroom,’ aiming to steer the creation of an immersive experience whereby the exhibition architecture becomes part of the exhibited artifacts. Employing a modular system designed for demonstrable adaptability. Emphasizing their primary role in constructing living spaces, the modules redefine the exhibition space, turning it into content rather than a mere container.

<sup>1</sup> Moss, R. S. a. D., & Moss, R. S. a. D. (2023, November 22). What’s So Bad About Concrete Anyway? Emagazine.com. <https://emagazine.com/concrete-bad/>

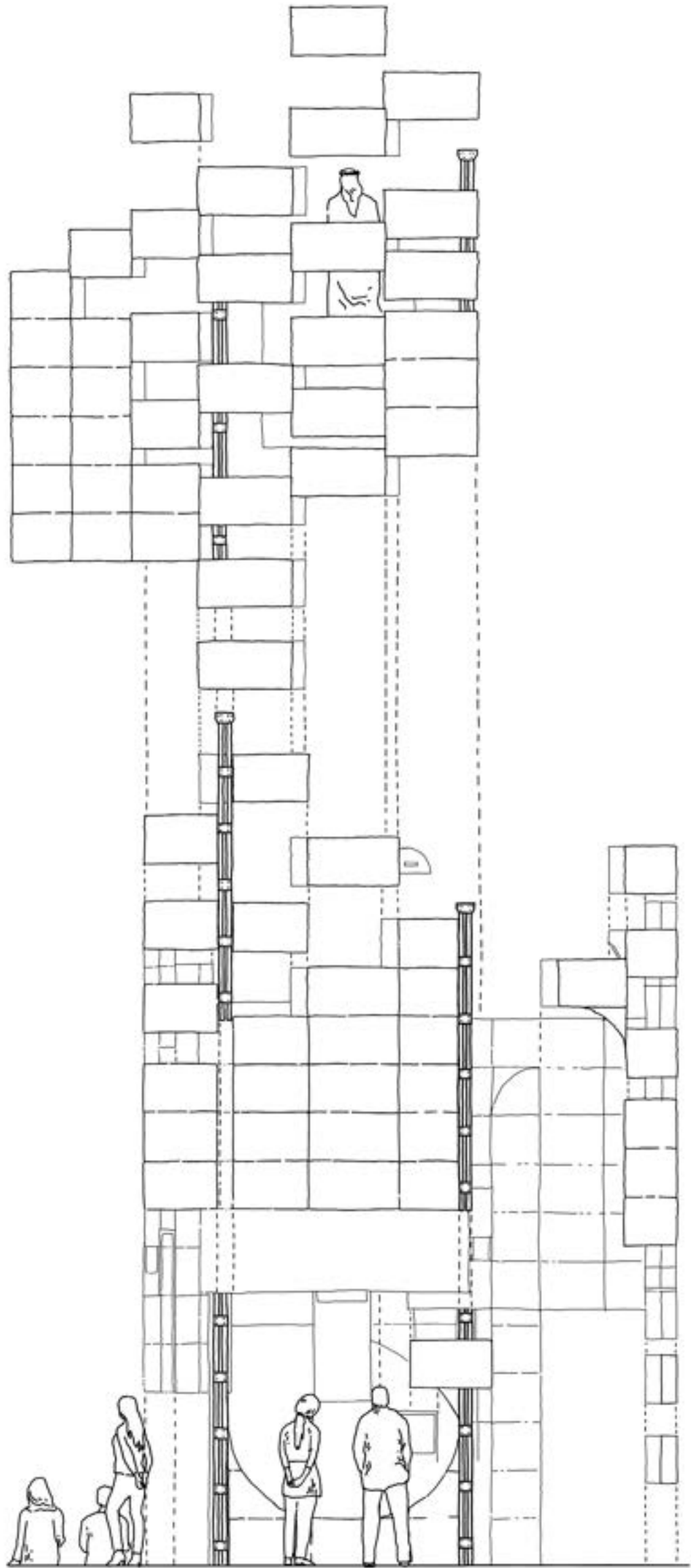


Fig 1. Modular Configuration of *Permutable Assembly* (illustration by Sarah Aladayleh, 2023)

# Permutable Assembly

*Towards A New Typology  
For Accessible Housing*

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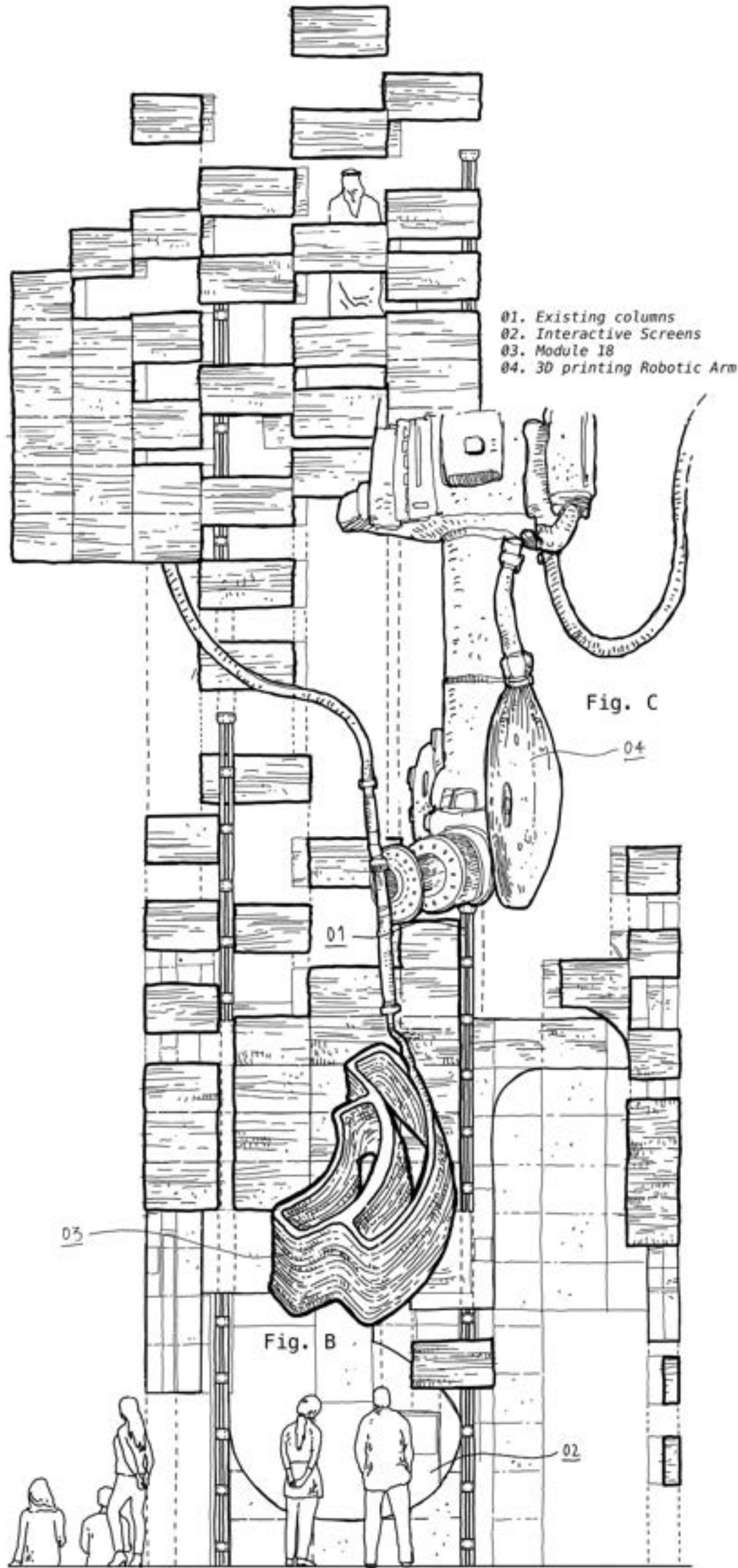


Fig 2. Contextual Adaptive System (illustration by Sarah Aladayleh, 2023).

## **Preamble**

**Within the captivating tapestry of the UAE's  
urbanscapes, its major emirates emerge as a  
testament to modularity, a concept deeply rooted  
in the region's historical nomadic traditions.  
While the city's skyline boasts the achievements  
of technological advancements in construction.  
*'Permutable Assembly'* is a research initiative that  
endeavors to reconcile modern approaches with the  
UAE's rich cultural and climatic urban landscapes,  
envisioning a future where modular adaptability  
harmonizes with individualized spatial responses to  
housing needs in this dynamic city.**

# 1

## History of Modularity in the UAE

### 1.1 Early History of Modular Bedouin Housing

Before the 1950s, the architecture of the United Arab Emirates was primarily influenced by regional tribal systems; the settled segment of society was referred to as ‘Hadhr’, while the transient society would be called ‘Bedu’. The two tribal cultures developed different shelters that pragmatically evolved and adapted to their environments and lifestyles.

When local Bedouin tribes moved between the coast and the desert to stay in cooler regions, they did so bringing along minimal equipment to support their nomadic lifestyles. During the sweltering summer months, shade and shelter from the harsh sun were desired. In winter, protection against the cold winds and rain impacted the construction of these shelters.

Those traditional bedouin structures used locally sourced materials. In the desert, one would find a woven tent made out of camel hair, the ‘Beit Al Sha’ar’ and along the coast, oases or mountainous regions huts were made from palm tree material, the ‘Areesh’. While parts of these accommodations were made on-site, others were brought along. The weight and portability of the structure become a driving design parameter. The available size of natural material determined the scale of those structures, representing the first form of modular housing in the UAE.

### 1.2 Regional Foundations: The Significance of Concrete Structures, and Prefabrication

The year 2025 would mark 70 years since the first recorded import of cement to the United Arab Emirates in 1955, inaugurating a new era in the built landscape of the country. What followed was the advent of modernity, the first whispers of concrete, a versatile and transformative material, reached its shores. A diverse population of expatriates immigrated to the country upon the discovery of oil, contributing to the establishment of cement and concrete factories in the UAE that soon would serve the needs of large-scale housing developments.

After the discovery of oil in 1966, and the establishment of the UAE in 1971, the architectural landscape witnessed considerable changes. The socioeconomic transformation had a direct impact on the UAE’s urban landscape, this period saw a transition from vernacular architecture, to modern structures made of concrete, steel, and glass. In a nation poised for accelerated urban development, this approach assumed paramount importance, catalyzing the rapid evolution of urban landscapes. Concrete more than any other material transformed how architecture/structures were built in the UAE in the mid-20th century.

The history of modular concrete prefabrication in architecture, originating in the early 20th century, reflects a response to significant shifts in construction methodologies driven by technological advancements, economic imperatives, and a focus on standardization. The surge in industrialization prompted the exploration of methods to expedite construction while maintaining structural integrity, with concrete emerging as a key focus for experimentation. Post-World War II, the global demand for swift reconstruction led to widespread adoption, notably by architects like Le Corbusier who utilized precast concrete panels for housing projects.

The advent of modular prefab concrete construction in the UAE in 1972, the establishment of the Union Cement Company, paved the way for concrete prefabrication.<sup>1</sup> This innovation marked a significant juncture in the realm of architectural methodologies, particularly notable for its expeditious building assembly capabilities. While modular concrete prefabrication isn’t entirely new to the MENA region, its historical use was primarily limited to industrial settings like oil and gas facilities.<sup>2</sup> Wider adoption in residential and commercial construction faced challenges like a preference for traditional methods, skilled labor limitations, and initial cost concerns. However, a recent shift towards faster construction, improved quality control, and sustainability is driving renewed interest. Success stories like Saudi Arabia’s prefabricated villa built in just two days and the modular concrete elements at The Red Sea Project showcase the potential for the technology’s speed and efficiency.<sup>3</sup> Additionally, DuBox, a regional leader in modular construction, has delivered various multi-story residential and commercial projects in the UAE.<sup>4</sup>

### 1.3 The Future of Modular Prefab Construction

Modular prefab concrete construction often have repetitive proportions and rigid aesthetics, due to the limitations of sacrificial formwork used for modular construction. While offering speed and affordability, challenges like complex logistics, high thermal mass in hot climates, and public perception regarding quality and aesthetics need to be addressed. Overcoming these, along with evolving regulations and limited standardization, is crucial for wider adoption.<sup>5</sup>

While “*Permutable Assembly*” envisions a future where modular housing transcends its current limitations, the proposal recognizes several existing hurdles in modular prefabricated concrete construction. These include the restricted design flexibility and public perception challenges that limit diverse expressions and wider adoption. Overcoming these barriers becomes a crucial research goal to realize the transformative potential of our proposed system and shape a more responsive, sustainable, and adaptable housing future for the UAE and beyond.

“The homes of a people have told us their stories, and I have never seen anything sweeter than the stories of the homes.”

”منازلُ قومٍ حدّثنا حديثَهم  
ولم أرَ أحلّ من حديثِ المَنازلِ.”

Abdul Baqi ibn Abi Hosn Almaari, 11 CE

عبد الباقي بن ابي حصن المعزّي، ١١ م

<sup>1</sup> Union Cement Company | *About Us* | Union Cement Company (UCC). (n.d.). <https://uccrak.com/about-us>  
<sup>2</sup> Shah, B. T. (2018, November 7). *Modular construction: faster, smarter, greener*. Property - Gulf News. <https://gulfnews.com/business/property/modular-construction-faster-smarter-greener-1.2169272>  
<sup>3</sup> *Saudi Arabia builds house in two days using modular concrete*. (2018, December 26). [www.middleeastarchitect.com](http://www.middleeastarchitect.com). Retrieved February 7, 2024, from <https://www.middleeastarchitect.com/insight/41612-saudi-arabia-builds-house-in-two-days-using-modular-concrete>  
<sup>4</sup> DuBox. (2021, August 26). DuBox | *Modular design and offsite concrete construction*. <https://www.dubox.me/>  
<sup>5</sup> Horinková, D., (2021). Advantages and Disadvantages of Modular Construction, including Environmental Impacts. *ResearchGate*. Retrieved February 7, 2024, from [https://www.researchgate.net/publication/356742795\\_Advantages\\_and\\_Disadvantages\\_of\\_Modular\\_Construction\\_including\\_Environmental\\_Impacts](https://www.researchgate.net/publication/356742795_Advantages_and_Disadvantages_of_Modular_Construction_including_Environmental_Impacts)

# 2

## The Beginnings of a UAE-Based Success Story

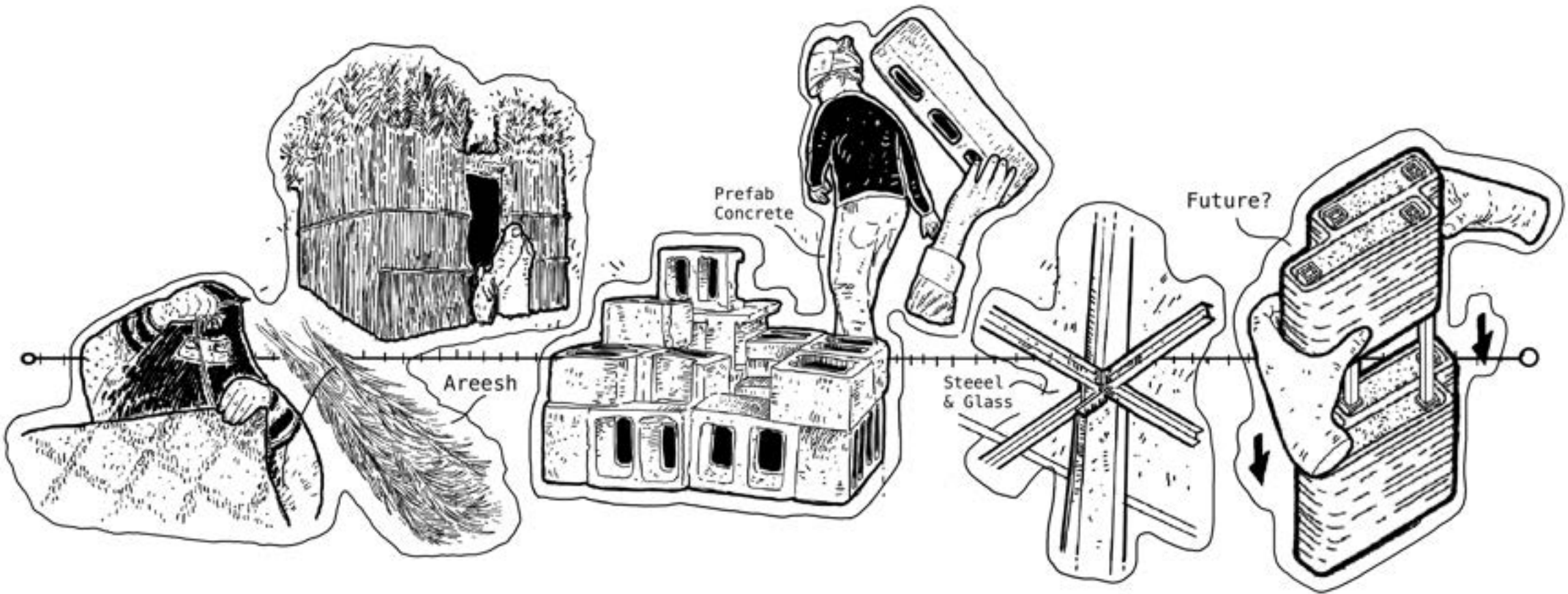
In 1975, Arenco Real Estate Company was founded, marking the beginning of the ‘Real Estate Developer’ era in the UAE, followed by Emaar Properties in 1997 and The National Investment Corporation in 1999.<sup>6</sup> Prefabrication and modularity offered a viable solution to the rising market needs, allowing for cost- and time-effective construction. In more recent history, the country has played a pivotal role in disseminating innovative real estate development practices throughout the Middle East and North Africa (MENA) region. Companies such as Emaar Properties exemplify a central contributor to this phenomenon. Leveraging its expertise, the UAE has been exporting its successful model of real estate enterprise across the MENA region. Emaar Properties, for example, has transformed the urban landscape in Egypt with Cairo Gate’s luxurious apartments and villas, while in Morocco, their Marrakech Beach development offers beachfront residences.<sup>7</sup>

The real estate industry in the United Arab Emirates (UAE) is a significant contributor to the global market, constituting 5.5 percent of the country’s GDP. EMAAR, a Dubai-based company, saw a 30 percent increase in brand value in 2023, ranking among the top 10 globally. The Abu Dhabi Investment Authority (ADIA) is a major global investor in real estate with assets exceeding 43.4 billion U.S. dollars. In Dubai, the real estate sector alone contributes 8.2 percent to the GDP.<sup>8</sup>

Recent visa reforms have increased the possibility of owning property in the UAE, supporting the appeal for longer-haul investment and encouraging a large percentage of the 90% of foreign residents in the UAE to make it their home base.<sup>9</sup> The flourishing economy led to a diversification of the UAE’s GDP, reducing dependence on oil and resulting in one of the world’s largest construction industries per capita. With the increasing interest in real estate development, local construction firms and innovative marketing campaigns emerged, drawing millions of buyers and residents to the UAE.



Fig 4. Real Estate Developer Brochure (Nakheel 2002)



History of Modularity in the UAE  
تاريخ النمطية في دولة الإمارات العربية المتحدة

Fig 5. History of Modularity in the UAE (illustration by Sarah Aladayleh, 2023).

<sup>6</sup> A A AL MOOSA. (2022, October 12). *Arenco Real Estate* - A A AL MOOSA. A a AL MOOSA -. <https://aaagroup.com/aaa-group-of-entities/arenco-real-estate/>

<sup>7</sup> Emaar Properties PJSC. (2022, September 28). *Cairo Gate - Emaar Properties PJSC*. <https://www.emaarmisr.com/en/our-communities/cairo-gate/>

<sup>8</sup> *Dubai's GDP grows 2.8% in Q1 2023 to reach AED111.3 billion.* (2023, August 8). mediaoffice.ae. Retrieved February 7, 2024, from <https://mediaoffice.ae/en/news/2023/August/08-08/Hamdan-bin-Mohammed-DubaiGDP-grows#:~:text=Dubai%27s%20Real%20Gross%20Domestic%20Product,4.4%25%20expansion%20of%20the%20economy.>

<sup>9</sup> Blogger, G. (2024, January 31). *UNITED ARAB EMIRATES POPULATION STATISTICS 2024*. Official GMI Blog. <https://www.globalmediainsight.com/blog/uae-population-statistics/#:~:text=The%20expat%20population%20totals%20around,natives%20in%20all%20economic%20sectors.>

# 3

## Architectural Synergy: Exploring UAE Modularity in Residential Design

### 3.1 Breaking Monotony: Form and Material in Response to Culture

In light of the technological advancements and societal reforms of the 21st century, there is an opportunity to reroute residential architecture in the UAE towards forms and materials that align with the local context. The story of the UAE’s progressive growth is intricately linked with modularity, and real estate development in the country is uniquely synonymous with this concept. However, the current trend in residential real estate has resulted in the construction of monotonous houses due to a lack of adaptability. Recognizing this, the concept of modularity and prefab construction emerges as a potential solution. By embracing modular prefab concrete construction, which offers affordability, rapid construction, and efficiency, coupled with advancements like Large Scale Additive Manufacturing for variation and customization without added costs, the UAE can reshape its residential architecture aligning with the cultural context.

### 3.2 Climate Responsiveness: Meeting the Growing Need

In response to the urgent demands of the climate crisis, the construction industry must pivot towards sustainable, technology-driven approaches to address environmental concerns. Additive manufacturing and modularity emerge as essential tools in this paradigm shift. These innovative technologies offer a range of benefits, including precise construction methodologies that significantly reduce material wastage and contribute to overall resource conservation. Additive manufacturing’s layer-by-layer construction process minimizes environmental impact by reducing the need for sacrificial formwork, a laboursome and material-excessive process that results in a lot of waste.

Concrete is one of the largest contributors to the increased CO2 emissions, specifically through the production of cement. Sustainable upcycled construction materials that are derived from by-products of various industrial and organic waste can amplify the positive environmental effects of the proposed system. Considering alternative forms of aggregates derived from locally available materials, waste products or upcycled substances can support a more environmental footprint of concrete constructions. Modularity complements these efforts by fostering adaptability and longevity, minimizing the need for frequent demolitions and reconstructions. By integrating additive manufacturing and a contemporary form of modularity into residential architecture, not only does the industry align with global sustainability goals, but it also positions itself as a proactive force combating climate change. Through the adoption of these technology-driven, sustainable practices, the construction sector can play a vital role in creating a more resilient and environmentally friendly future, especially in a place where construction is largely driven by concrete construction.



Fig 6. From Areesh Huts to Prefab Concrete Homes (illustration by Sarah Aladayleh, 2024).



Fig 7. Modular Facades in the UAE (photography by Dia Mrad, 2023).



Fig 8. 'The Palm' Real Estate Development Brochure (Nakheel, 2002).

# 4

## Addressing the Gap: Unveiling the Research Question

It can be argued through many exemplary projects, that the progressive urbanization of the UAE is driven by modularity and pre-fabrication, which paradoxically highlights the finite spatial variety associated with the construction process of current modular prefab systems. With a heightened emphasis on the quality of urban sensibilities and increasing population diversity in real estate, the UAE is witnessing a rising demand for adaptability. Simultaneously, there is a growing awareness of the importance of considering the specific socio-cultural and climatic context. Most developer projects rarely translate the symbiosis of traditional architecture into prefabricated modular housing structures resulting in sterile habitats that lack cultural identity, and that fall short of highlighting the architectural ephemeral quality, and connection to the context and climate.

**On the international stage of La Biennale di Venezia, we would like to provoke the question: “How can we rethink modularity with a systematic approach that considers qualitative aspects such as context, climate and culture to generate a more individualized, adaptable, and responsible residential architecture?”.**

‘*Permutable Assembly*’ aims to investigate the progression and evolution of modular housing in the UAE, and its role as a driver to establish the UAE as a leading territory to explore the future of housing globally. It aims to do so by surveying lessons learned from past endeavors, while envisioning modular adaptability as a way forward, to offer an individualized spatial response to housing needs. This initiative offers a UAE-born solution to the global urban migration challenge while navigating complex societal and economic dynamics and addressing environmental concerns.

Our proposal represents an innovative effort to revolutionize housing by envisioning an architectural approach to rapid construction, utilizing contemporary state-of-the-art technologies. ‘*Permutable Assembly*’ draws inspiration from its early UAE-born predecessors and extends the development of fabricated modules, considering initial module sizes while also aiming to address cultural and climate design parameters.

“No Bedouin tribe has ever stayed in one place, Their home is wherever they happen to be.”

وَلَمْ يَكُنْ بَدِيٍّ لِّحَيٍّ ثَابِتًا  
دَارًا إِلَّا كَانَتْ لَهُ مَحَالٌ

أَمْرُؤُ الْقَيْسِ  
Imru' al-Qays - 7 CE

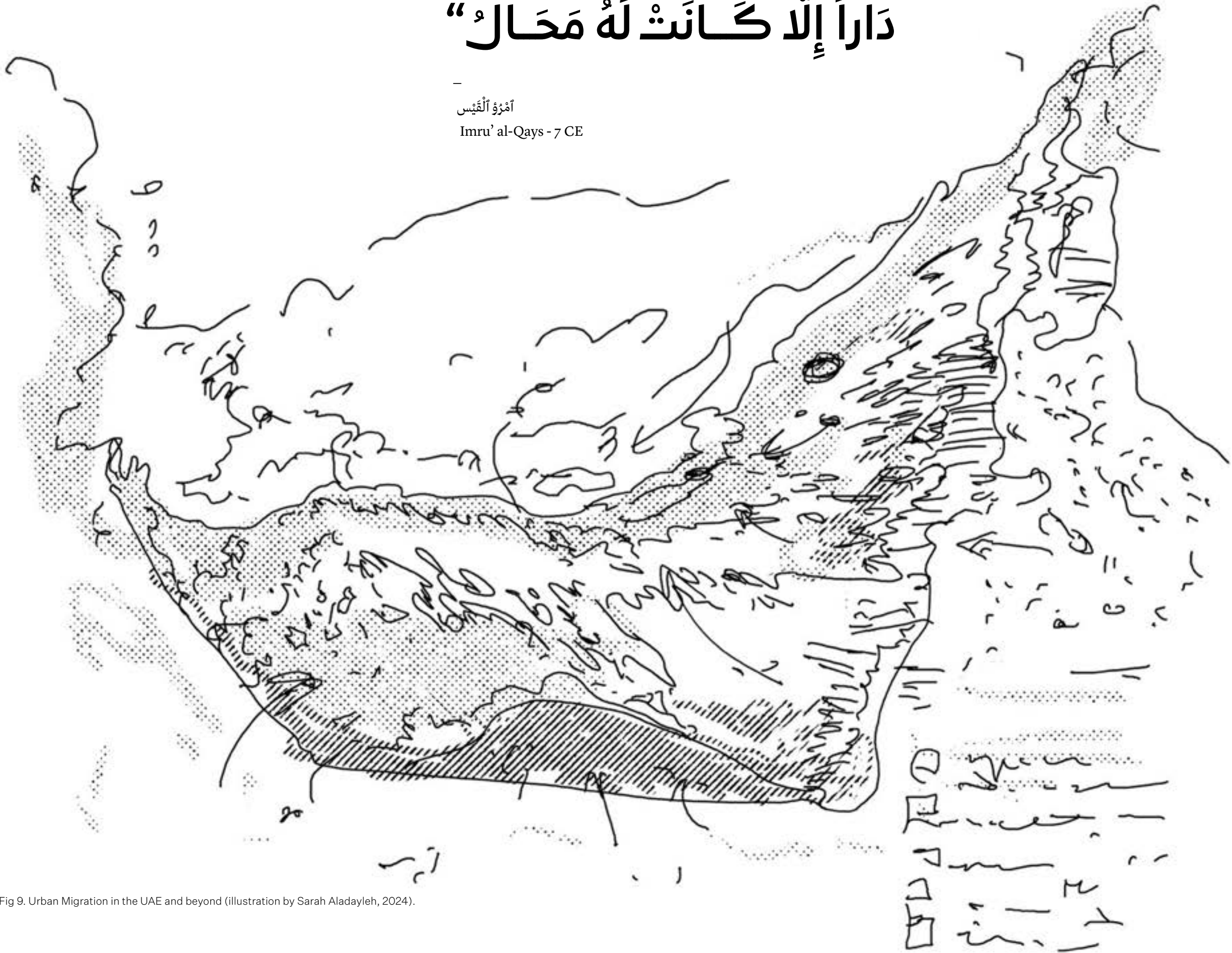


Fig 9. Urban Migration in the UAE and beyond (illustration by Sarah Aladayleh, 2024).

# 5

## Modularity For the 21st Century

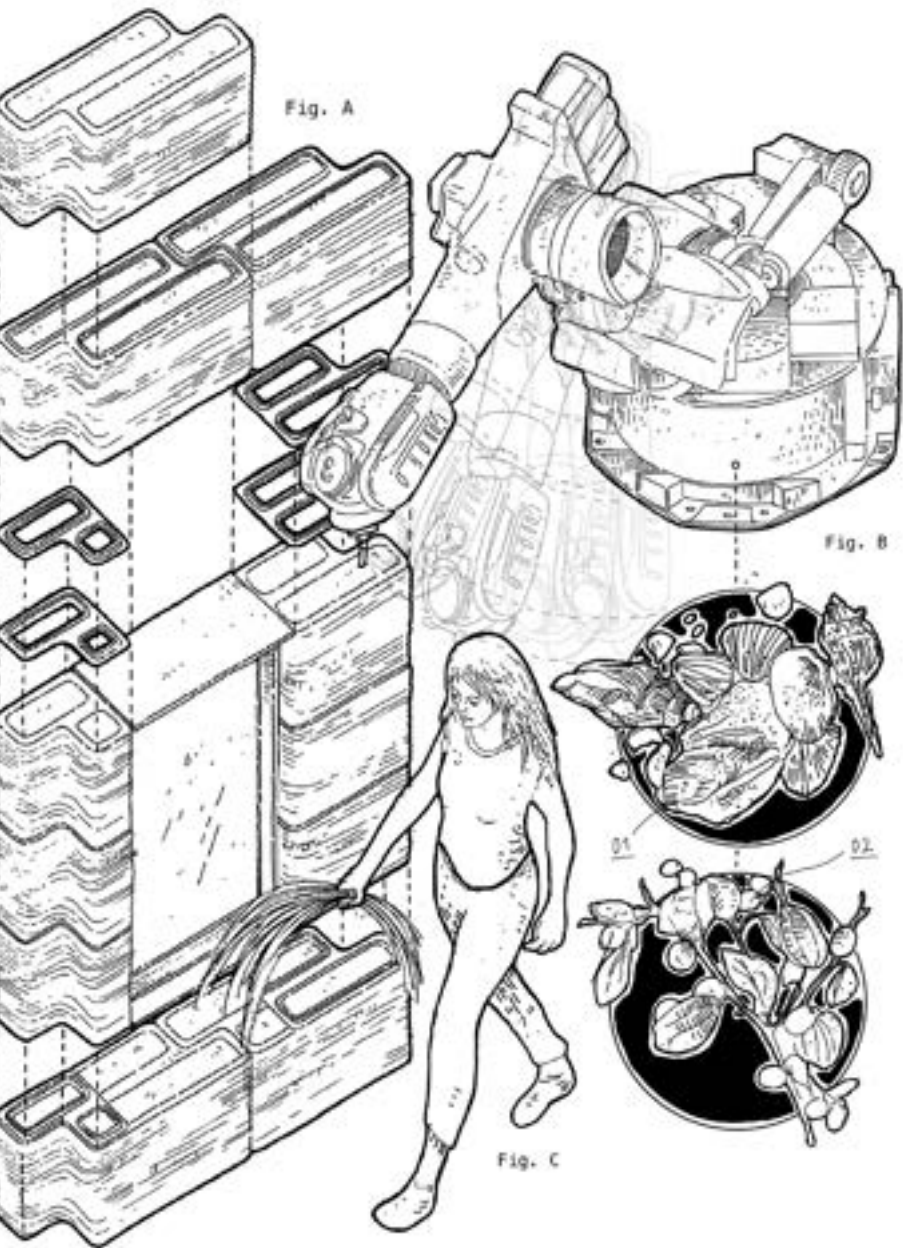


Fig 10. Circular Modularity (illustration by Sarah Aladayleh, 2023).

### 5.1 Novel Construction: Emergent Technologies

‘*Permutable Assembly*’ addresses the global urban migration challenge, aiming to provide an innovative response to the dynamic nature of the UAE’s ever-transitional social and economic development. By offering ecologically driven solutions, the proposal responds to key parameters as a driver towards a conceptual approach for adaptive housing. Leveraging the UAE’s abundant land, demographic diversity, and sustainable development governance, our proposal reimagines modern architectural approaches through state-of-the-art robotic fabrication methods, echoing vernacular forms and societal parameters while working within a circular material economy.

We propose the development of a systematic assembly of prefabricated modules that not only accelerates construction timelines but also allows for enhanced design precision. ‘*Permutable Assembly*’ aims for a future where we design and construct homes using a ‘kit-of-parts’, providing greater variations in building housing solutions while responding to climate concerns. This contrasts with the typical system of merely choosing the style or size of a desired house, almost as a template, as currently offered by themed urban developments. In our proposal, we also aim to incorporate the development of a material system that consciously integrates vernacular practices. Designed to better align with cultural and climatic aspects in the UAE, this integration allows for higher levels of adaptability.

It is not a coincidence that a country in urgent need of rapid urban development, such as the UAE, adopts modular prefabrication for constructing new buildings. Apart from concrete construction being the preferred system in the region, given the scarcity of timber and the impracticality of wood frame construction, modular buildings often display monotonous proportions and rigid aesthetics. This outcome stems from the constraints imposed by sacrificial formwork integral to the modular construction process.

### 5.2 A New Form of Modularity

In 2025 the current developer-driven models for real estate raise concerns about cultural compatibility and environmental impact. Alternative approaches include but are not limited to AI-powered participatory design, additive manufacturing, material science, automated construction, and decentralized construction networks for creating equitable and sustainable built environments and empowering homeowners. Here specifically, cities in the UAE such as Dubai can serve as a laboratory for modular urbanism for the 21st century, accelerated by the shift towards technology-driven and community-inclusive models for the future, where end users become active participants in the design and construction process.

The ‘*Permutable Assembly*’ system addresses the challenges posed by building codes for construction sites while considering the material aspects of the modular components. Our goal is to develop a comprehensive system that draws wisdom from regionally available materials, incorporating considerations not only for traditional or aesthetic aspects but, more importantly, for notions of climate design and interior space comfort. For instance, the use of seashells and lime wash, typical in regional construction, not only enhances longevity but also aims at cultural acceptability, aligning the ‘*Permutable Assembly*’ system with traditional local preferences for home construction. We aim to establish a comprehensive system that goes beyond 3D printed modules, addressing questions related to construction, transport, and connection, as well as insulation and carbon emissions. Significant focus will be placed on the development of a more sustainable form of concrete considering various natural aggregates as replacement.

### 5.3 Responding to Context and Ecology

The proposed material system for the exhibition of ‘*Permutable Assembly*’ at the Venice Architecture Biennale will address the several challenges imposed by Italian building codes and specific requirements of the National Pavilion of the UAE at the Arsenale space. Following the code limitations on weight and point loads, the modules, weighing approximately 80 kg if printed with regular cement, pose an important challenge. Building codes necessitate reducing the weight to 25 kg to enable construction workers to lift the modules. The 3D printing mix we intend to experiment with incorporates upcycled and recycled foam or polyester, fiberglass, and cement to reduce weight, therefore enhancing manageability while maintaining structural integrity.

Simultaneously, upon initial examination, building such a system acknowledges that our intention for lighter modules may present a distinct challenge, particularly in terms of structural stability. To address the lightweight nature of the modules, a sequential construction process is delineated. Sand is introduced into the cavity inside the bottom module, and custom water jet-cut angled steel plates, along with 1.8 m steel square section columns, are inserted and welded to reinforce the modules and enhance lateral stability.

While these aspects need further exploration, significant ongoing progress has been made in developing a modular system as a subsidiary project by MEAN and the Zayed University Fellowship, both of which are the core preoccupations of the curator. These platforms could be extended in terms of space and resources to develop this research at the National Pavilion of the UAE. An initial system for modular housing has been created, and tested at the studio to design houses that address construction and versatility aspects to achieve greater variety within a modular system and, consequently, finite combinations. However, more work can be done to consider aspects of culture, climate comfort, and early-stage involvement of homeowners in the development of their final housing plans. The system’s offerings and modular variety can be further expanded to comply with cultural appropriateness, such as private and public space considerations. The participation of the UAE community through targeted workshops will play a crucial role in this expansion.

# 6

## Research Methodology

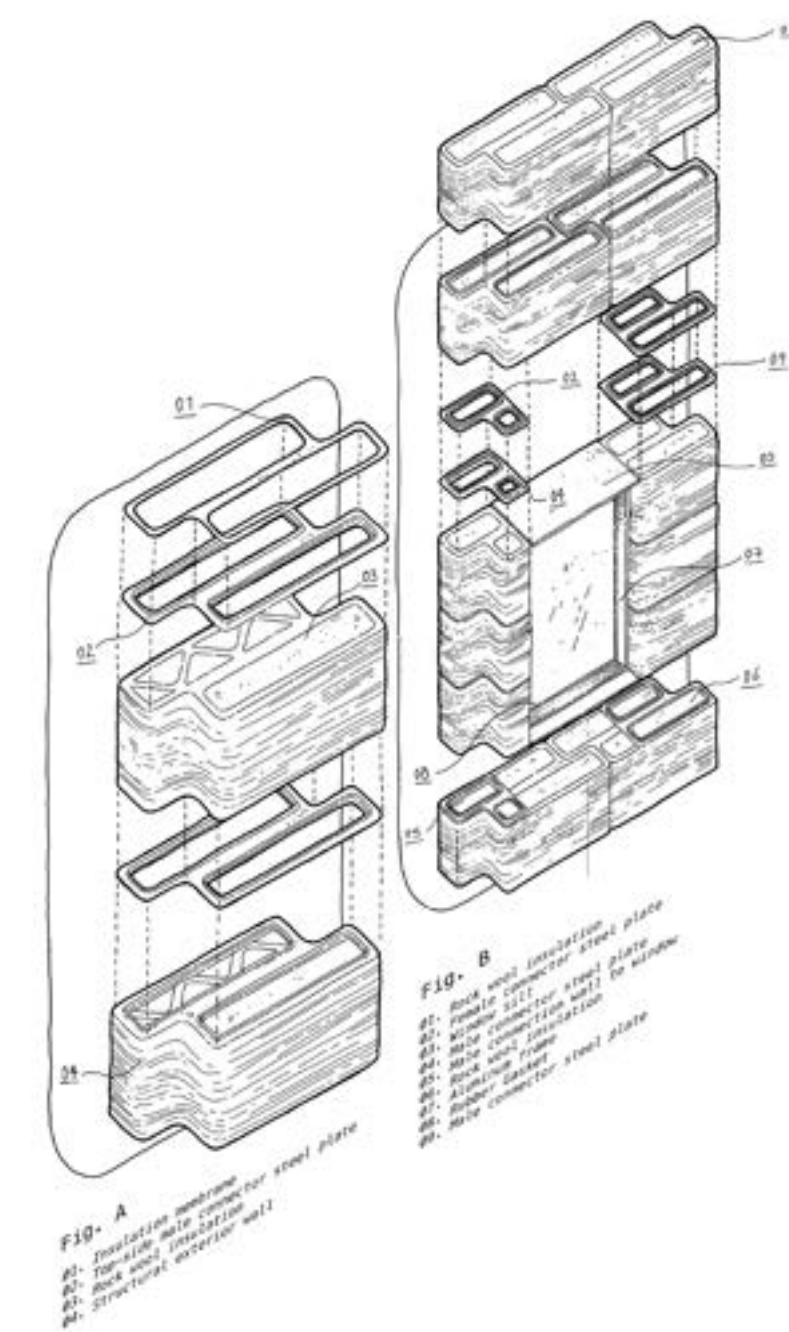


Fig 12. Permutable Assembly Wall System (illustration by Sarah Aladayleh, 2023).

‘*Permutable Assembly*’ aims to investigate the progression and evolution of modular housing in the UAE, and its role as a driver in establishing the UAE as a leading country for real estate development. The research proposes enhanced modular adaptability as a way forward to offer an individualized spatial response to housing needs. As such, the proposal will investigate the history of modularity in the UAE and explore aspects of an individualized approach to mass urban housing. Both research themes will mutually inform each other and will be supported by research work done as part of the Zayed University Research Fellowship, and design work at MEAN.

### 6.1 Research on the History of Modularity in UAE

To comprehensively explore the themes of modularity, our research employs a multifaceted approach, encompassing the collection of primary and secondary data through interviews, archival work, site documentation, and literature research. This methodology forms the foundation for developing a new modular system that delves into crucial aspects such as materials, climate-sensitive responses, and overall design strategy. The focus extends to documentation and archival research, specifically examining the evolution of modular housing typologies and urban development in the UAE. This investigation includes a detailed analysis of the presentation methods employed by developers. Concurrently, insights will be gathered through interviews with luminaries from various prominent real estate developments, providing valuable perspectives on the subject.

Our research endeavors to visually portray the history of urban migration and modular housing in the UAE. By establishing connections regionally and globally, we aim to highlight key events that have significantly influenced these trends. This holistic approach ensures a thorough exploration of modularity while considering the specific context of the UAE. As a complementary component, Dia Mrad’s photography work explores the evolution of modular housing in the UAE and how residents have ingeniously personalized these otherwise monotonous settings. In addition, this section of our research involves the collaboration of various scholars and writers who will contribute to the presentation and publication on the evolution of modularity in the UAE, the broader region, and its global connections. This inclusive approach aims to enrich the research with diverse perspectives and scholarly insights.

### 6.2 Exploration of Modular Material Research

The development of a new form of modularity will involve material testing and prototyping of innovative modules. These modules will be carefully developed, taking into account historical context research, construction aspects, and logistical challenges. Special attention will be given to material aspects, with a focus on climate-responsive design and adaptability to a culturally appropriate aesthetic and functionality. The cladding material mix developed for the modules will undergo testing based on the previously explained research, and a system for both interior and exterior cladding will be developed. Novel technologies, such as 3D printing, will play a crucial role in this phase. Collaboration with Italy-based pioneer WASP and academic institutions advanced in material research, such as TU Freiberg, will support this effort.

Sarah Aladayleh’s illustration work for the new modular system is integral to the creation of an open-source manual of instructions. Through her visual representations, the intricate details and assembly processes of the modular system will be clearly and comprehensively communicated. This manual aims to serve as a user-friendly guide, particularly tailored for individuals who may not have an architectural background. The manual will transcend traditional technical documentation, making the information accessible and easy to understand for a broader audience. This approach is aimed at empowering individuals, including non-architects, to actively participate in the assembly and customization of their modular homes.



Fig 11. Modular Concrete Housing (photographs by Dia Mrad, 2023).

# أنظمة المواد Material Systems

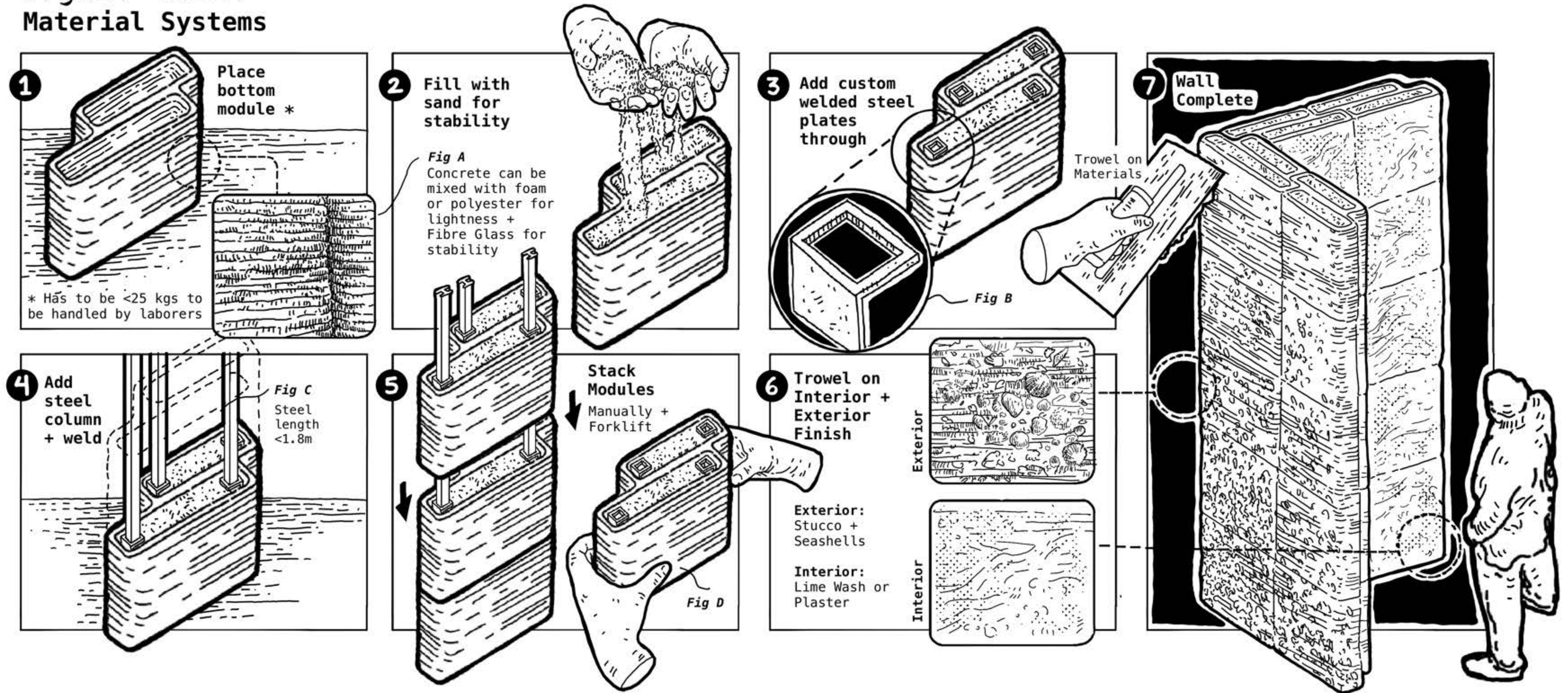


Fig 13. Modular Construction System of Permutable Assembly (illustration by Sarah Aladayleh, 2024).

# 7

## Exhibition Design Strategy

### 7.1 Exhibition Concept

The exhibition will unfold as an immersive journey within a futuristic showroom of *‘Permutable Assembly FZ LLC’*, an envisioned cutting-edge real estate and technology company. The pavilion, constructed from modular clusters, will symbolize fragments of living spaces or ‘chunks’ of houses, forming intriguing pockets that blur the boundaries between interior and exterior realms. In the pavilion space, visitors immerse themselves in a multi-directional narrative of diverse artifacts, where no single story or content medium dominates. This design allows exploration of the archaeology of the recent past and future spatial strategies. The experience is informed by historical, research-driven endeavors, inviting users to explore adaptable, modular solutions using novel technologies, rooted in hands-on experimentation and prototyping.

Visitors can engage with the exhibition narrative in a non-linear manner. Upon entering from the main entrance, they will delve into the UAE’s longstanding history, particularly regarding housing, modularity, and real estate development. Subsequently, they will explore a forward-thinking solution for an individualized approach. Alternatively, arriving from the Mexican pavilion, visitors will step into the future of modular housing, emphasizing a personalized approach through the configurator. They can then backtrack in time, gaining insights into the historical context that led to the proposal.

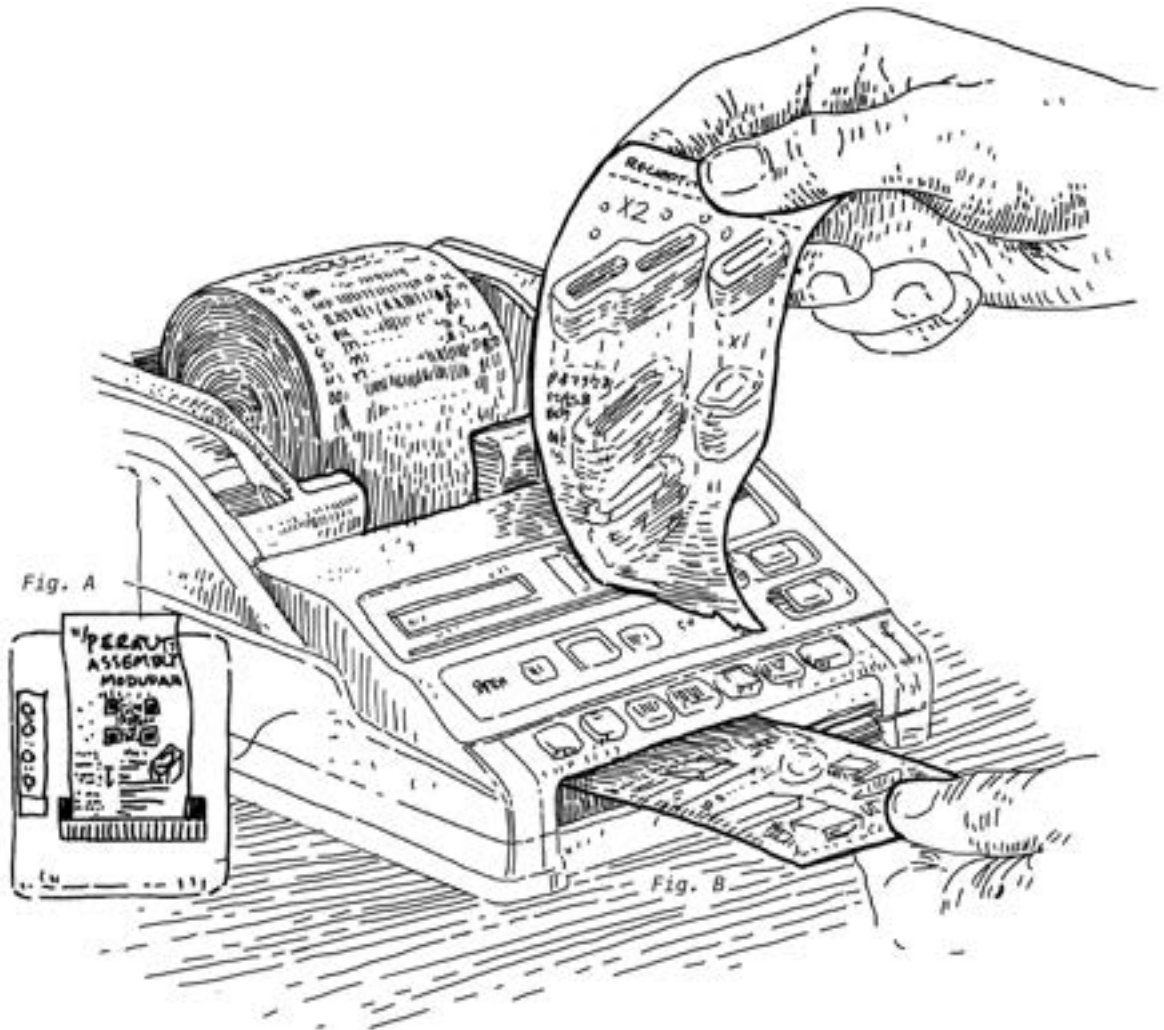


Fig 14. Exhibition Takeaway QR Code with the Envisioned Home (illustration by Sarah Aladayleh, 2024).

### 7.2 Exhibition Elements

Employing a layered storytelling approach, the exhibition seamlessly integrates a diverse set of curated artifacts, including the exhibition’s architecture, graphical instructions illustrating the modular system, a photographic and visual exploration of modular history in the UAE, and an interactive space for constructing your own house. This comprehensive narrative aims to engage visitors by offering a multifaceted understanding of modular housing, from its historical roots to its practical application, enriching the overall exhibition experience.

**I. The Modules** - The 3D printed modules of the exhibition from our developed Kit-of-Parts juxtapose material studies for climate-responsive building designs as 1:1 scale prototypes. These modules act as building blocks to plan the interior of the pavilion and can be used to customize modular homes. The parts represent the ‘elements’ that make up a house, prototypes investigating vernacular methods of construction, and experimentation in the use of organic materials in the Gulf region. The system showcases a new vision for constructing residential neighborhoods. Those modules inform interactive software, enabling an approach to personalized home designs that will be conceptualized based on personal narratives.

**II. The Houwi** - The exhibition aims for an experience through which the visitors become active agents driving the design process. Central to this is a gathering space inspired by traditional Emirati typologies, such as a ‘Houwi’ or ‘Majlis’. Crafted from modular units and featuring 3D-printed scaled representations resembling blown-up Lego pieces, this space explores the dynamic relationship between culture, modular design, and innovative building processes. Visitors engage in constructing their future modular homes within this environment, enhanced by a modular rug that represents plots of land. The focus is on individuality in the modular design of UAE homes and personalized permutations, offering a hands-on and immersive experience.

This playful and game-like aspect enhances the immersive experience, allowing visitors to engage in the construction process guided by projections onto the rug. The collaborative activity of ‘design and planning’ creates a space for exchanging ideas and stories, emphasizing architecture’s role in shaping community experiences and personal spaces. It goes beyond physical structures, encouraging visitors to consider not only the spaces but also the human experiences and memories that inhabit them. This approach makes architecture more accessible and facilitates the sharing of stories, fostering the creation of new connections.

The participatory approach is guided by a projected open-source user manual, providing direction and inspiration on using the modules. In an adjacent space, an AI-powered digital configurator generates dynamic module combinations, controlled within the canvas of the courtyard rug. The entire experience acts as a visual prototype, presenting a forward-thinking enterprise introducing a revolutionary model for residential real estate as a technology-driven product.

**III. The Combinatorial Housing Configurator (CHC)** - is a real-time, AI-driven configurator that simulates building your new home using our modular system. On a digital interface, visitors can use the building blocks and model their ideal home, receiving a final render and visualization of the efforts. The system prints out a QR code of the design, almost like a receipt which the users can keep and scan. The QR code takes you to a website where the 3D model of the house design can be viewed. The House model can also be explored using AR (Augmented Reality) on the screen of a phone or tablet by scanning the code using the camera of the device. The accumulated housing design will further serve as an archive for future housing development.

**IV. Photographs**- will be scattered across the exhibition, where visitors can get a glimpse into the current developer landscape of the UAE and how residents begin to individualize their numerous monotonous homes. These efforts are captured and serve as a testimony to the desire for personalization.

**V. Illustrations** - showcasing the complex history of local, regional, and global real estate development and the specificity of the UAE-based model will be encapsulated in a series of graphics.

**VI.Video** - A concise, lively animation crafted in the style commonly employed by developers for product marketing. This engaging video offers a whimsical yet informative imitation, elucidating the concept of *Permutable Assembly* with a touch of playfulness.

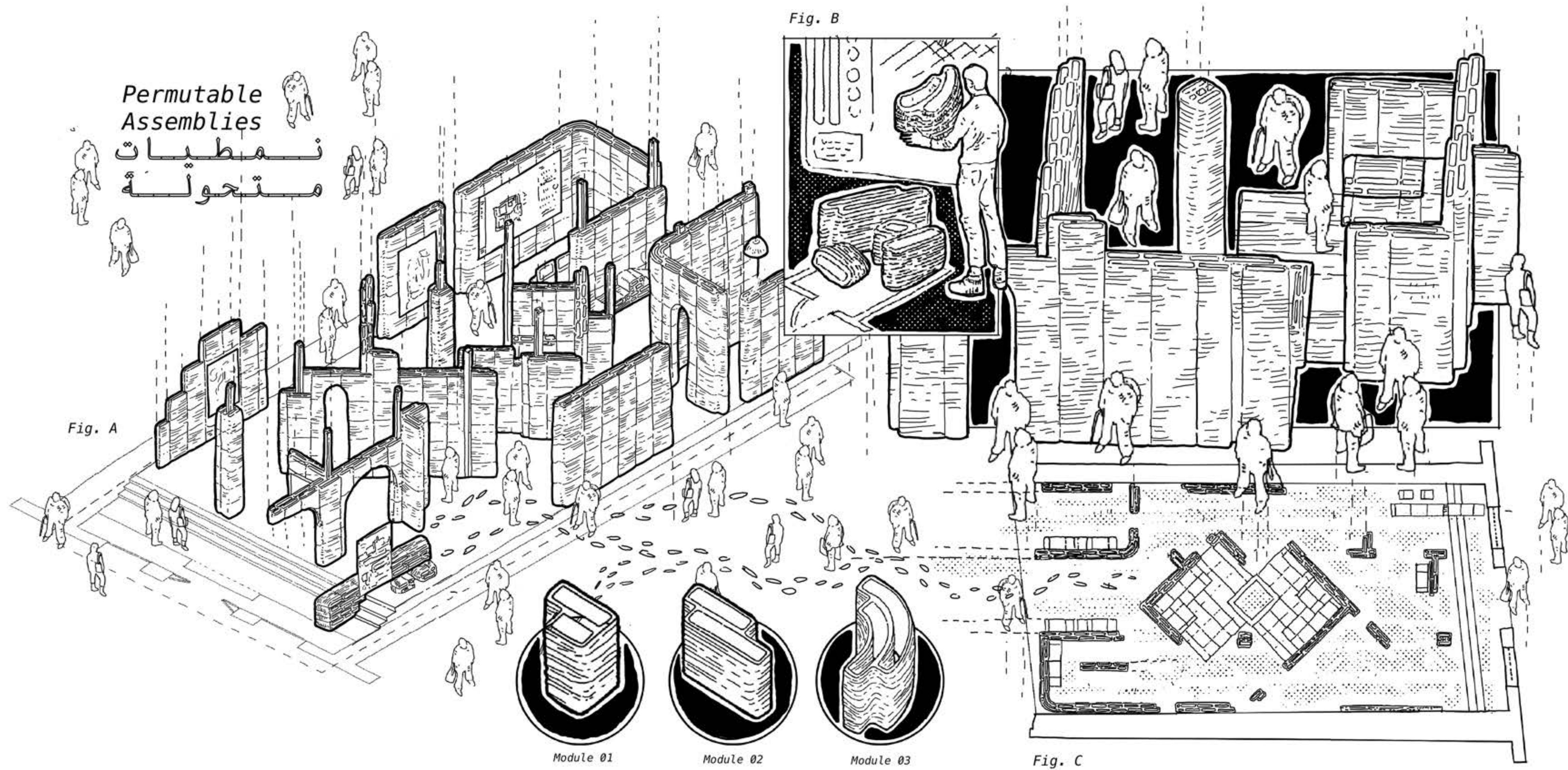
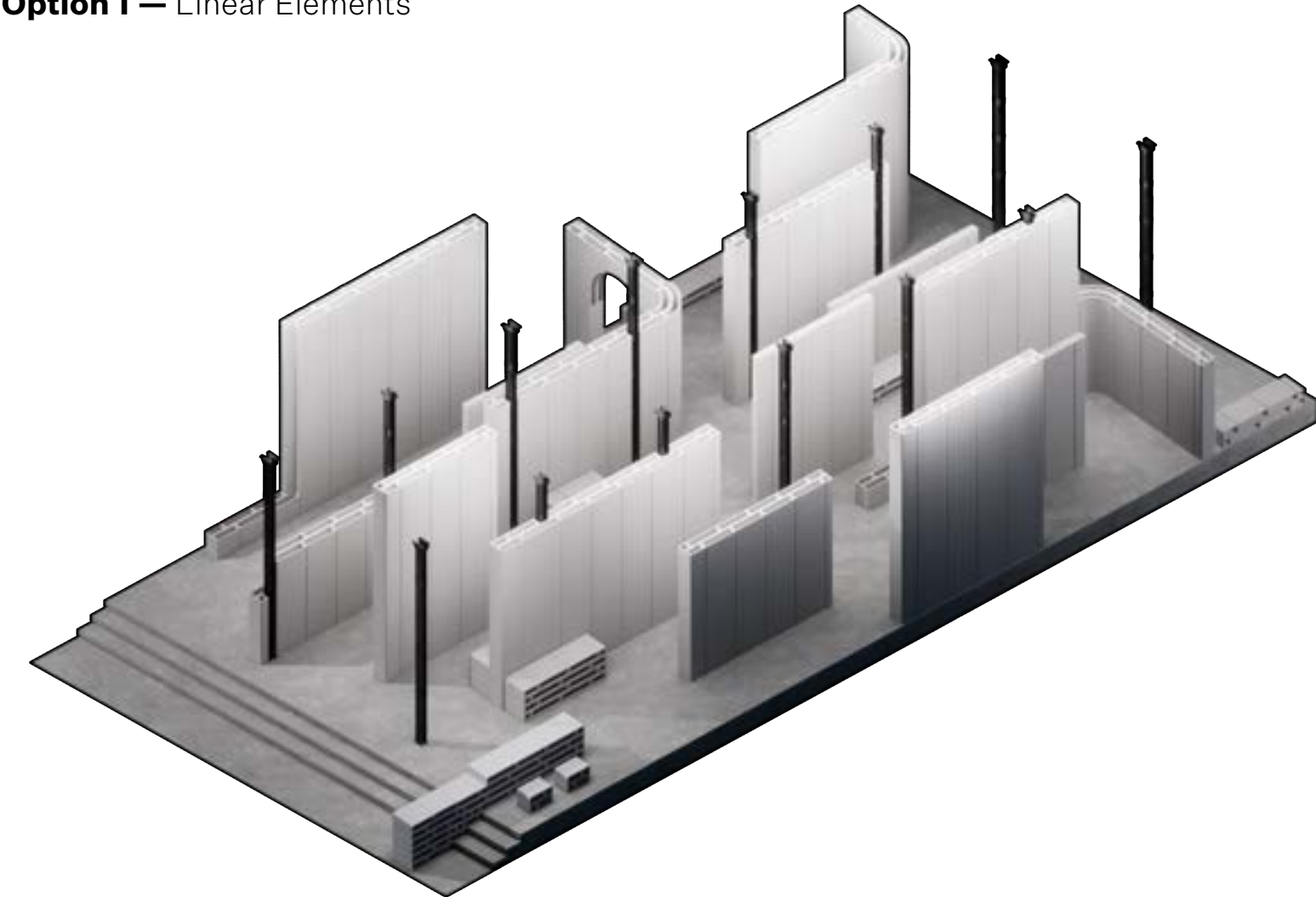
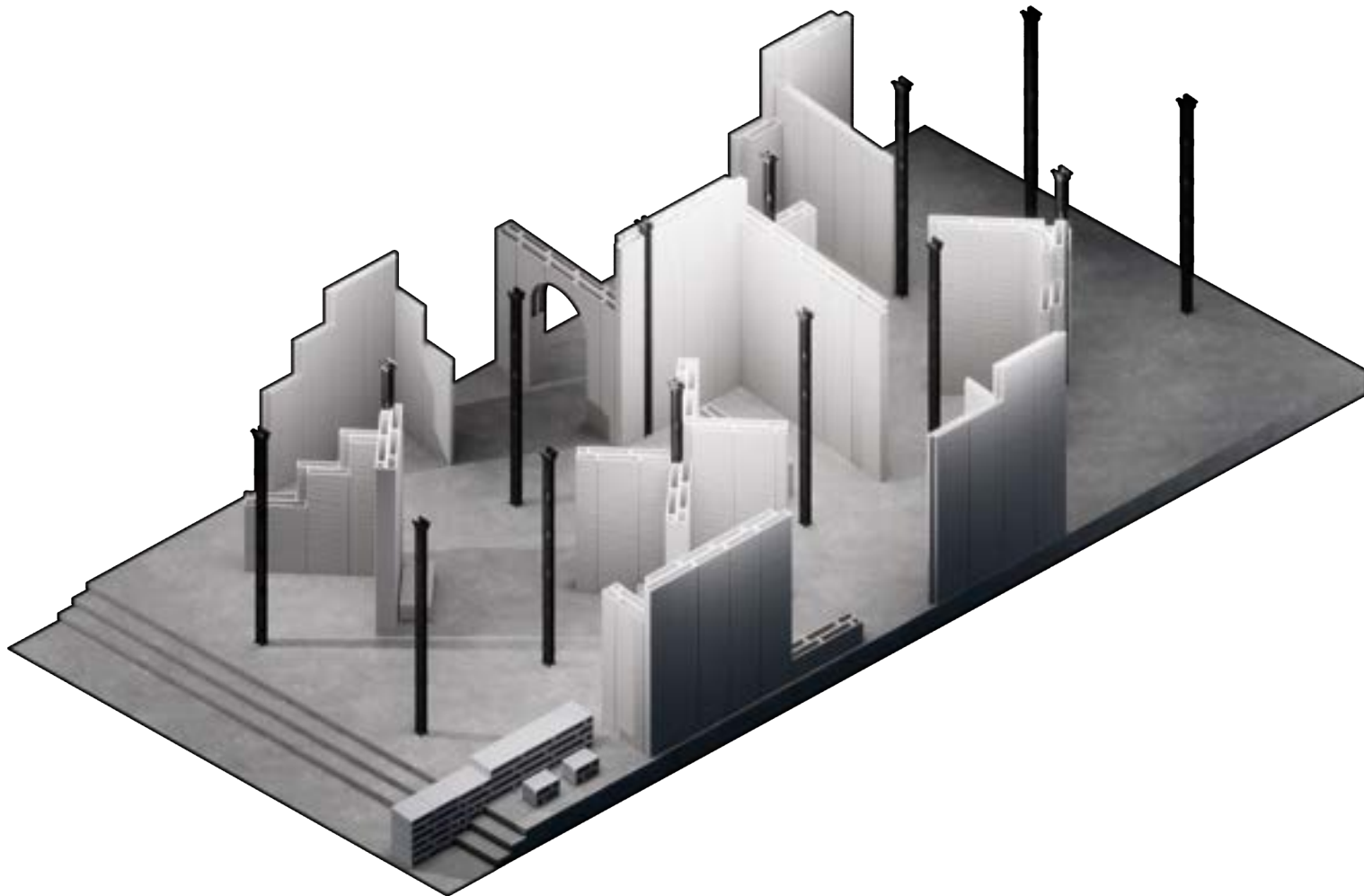


Fig 15. Exhibition Design Proposal for the NPUAE in Venice (illustration by Sarah Aladayleh, 2024).

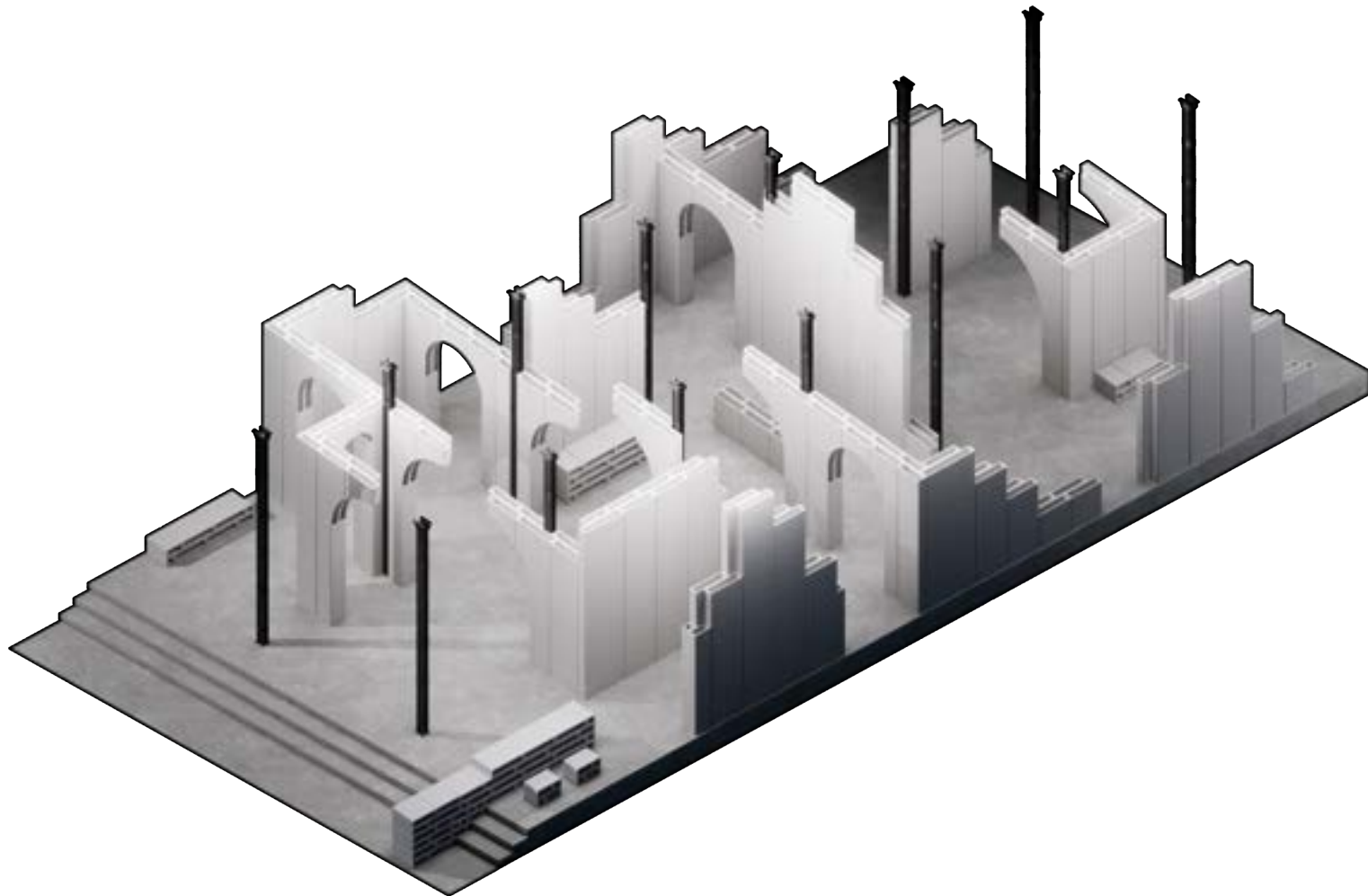
Option 1 — Linear Elements



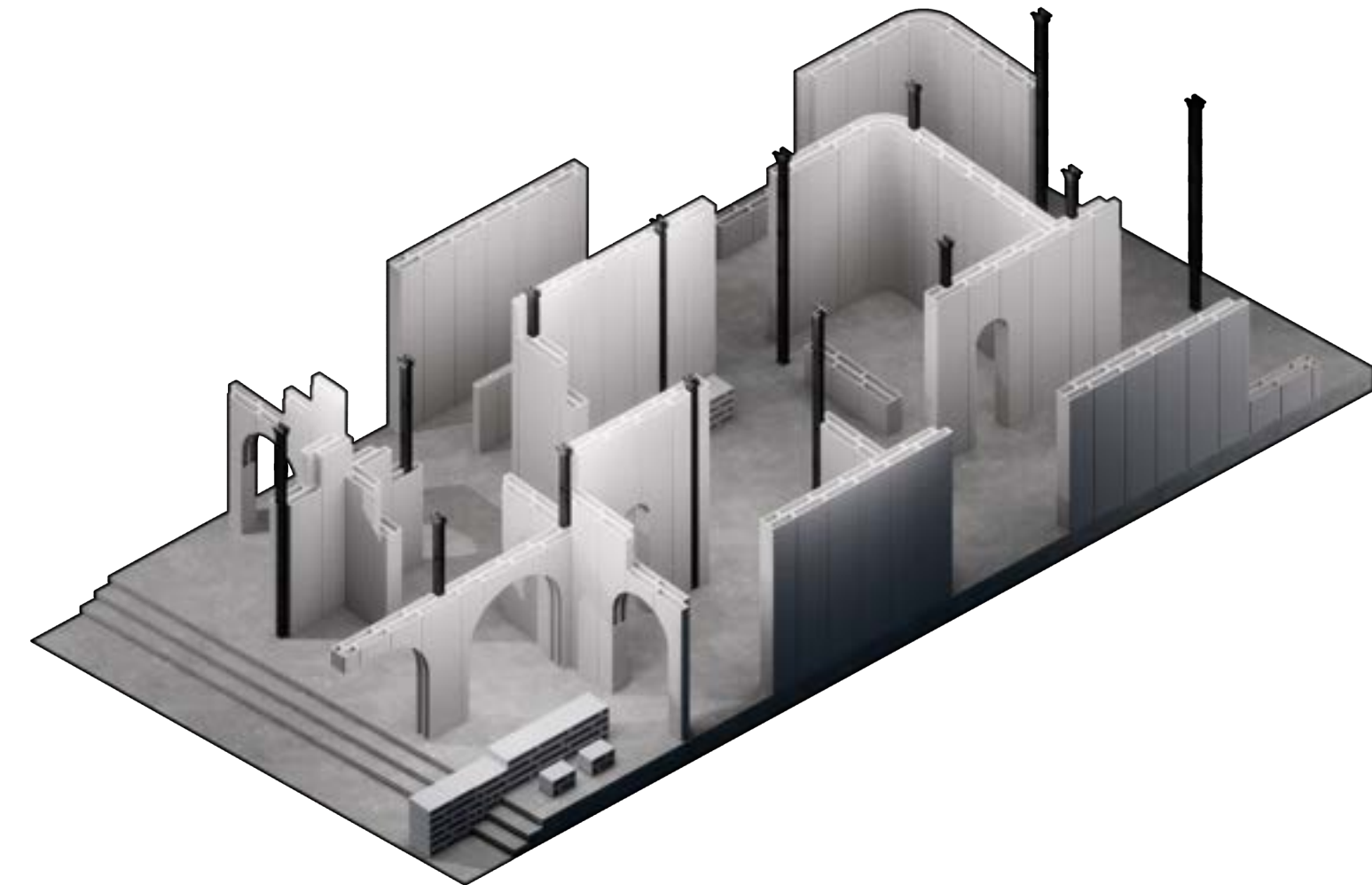
Option 2 — Building Fragments



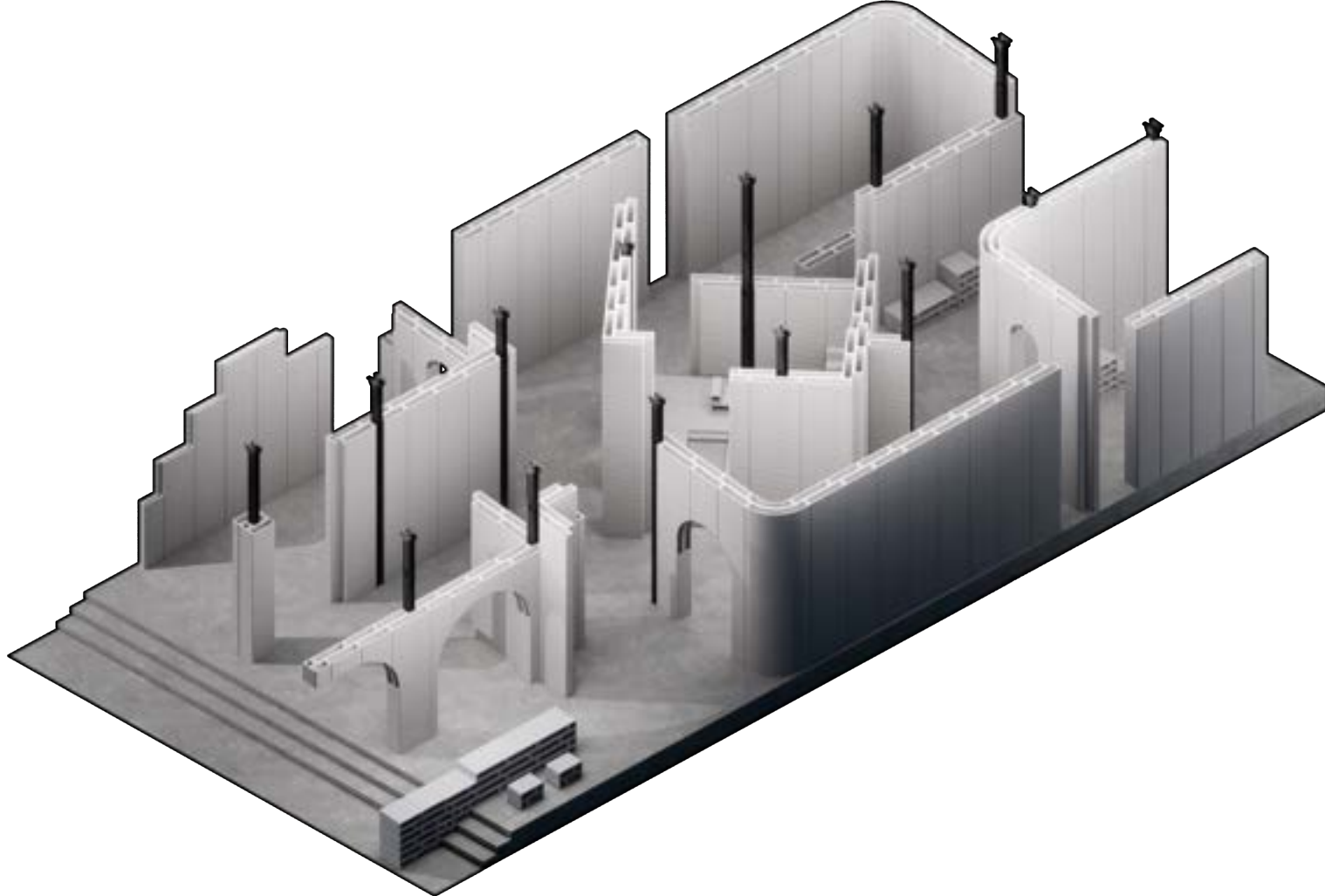
Option 3 — Spatial Portals



Option 4 — Past - Present - Future



Option 5 — Angled Courtyard



Option 6 — House as Theatre

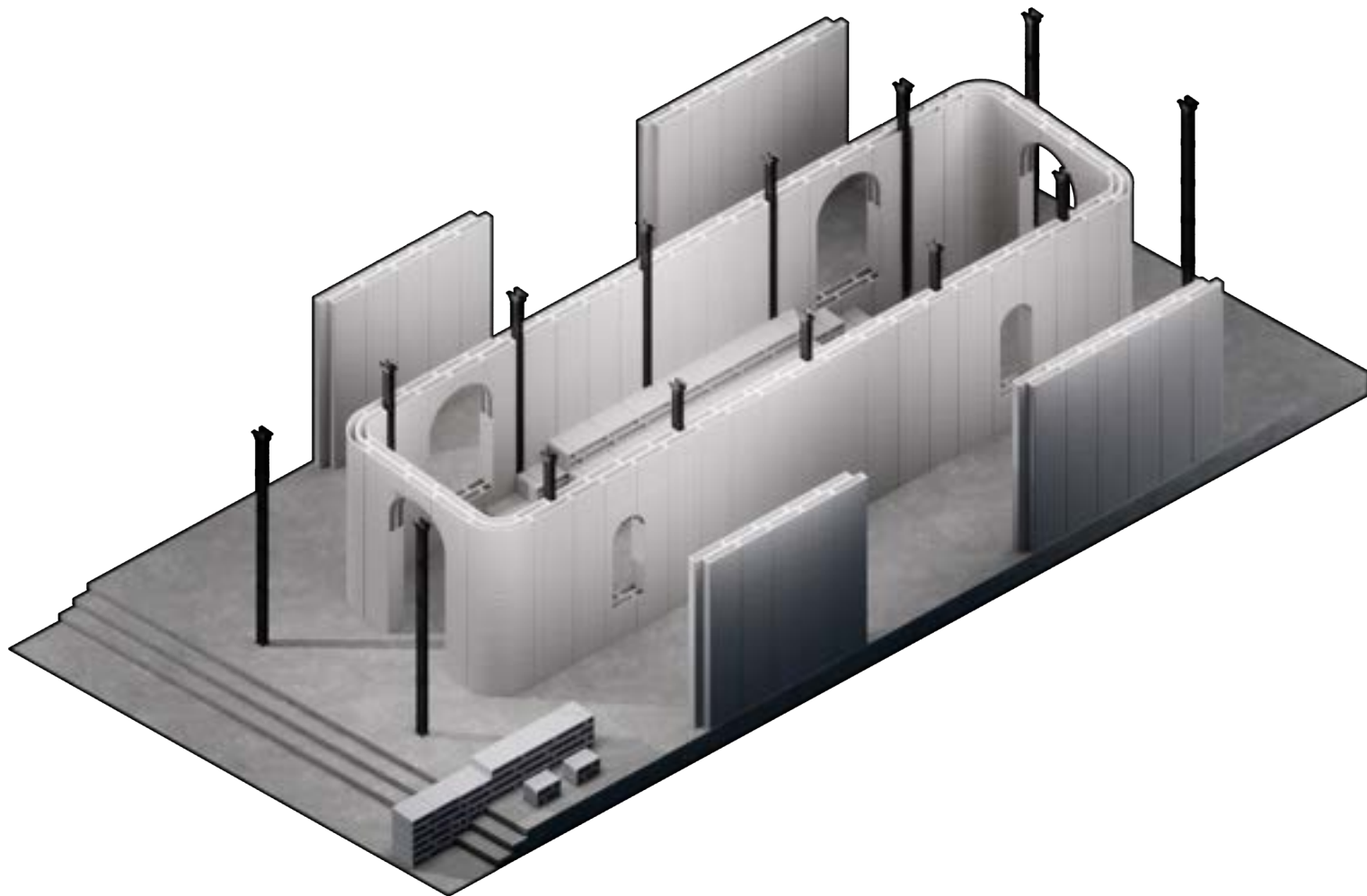


Fig 16. Exhibition Design Variations using our Modular System Demonstrating the Flexibility of the System (diagrams by MEAN, 2024).

The Combinatorial Housing Configurator

Photographs

Illustrations

**Idea:**  
Different  
interior and  
exterior  
material  
finishes



Video

The Houwi

Reception

**Idea:**  
Developer  
Billboard as  
Signage



Fig 17. Exhibitions Axonometric View (diagram by MEAN, 2024).



Fig 18. Exhibition Entrance (rendering by VIKSEL, 2024).



Fig 19. Central Interaction Space (rendering by VIKSEL, 2024).



Fig 20. The Combinatorial Housing Configurator (Rendering by VIKSEL, 2024).

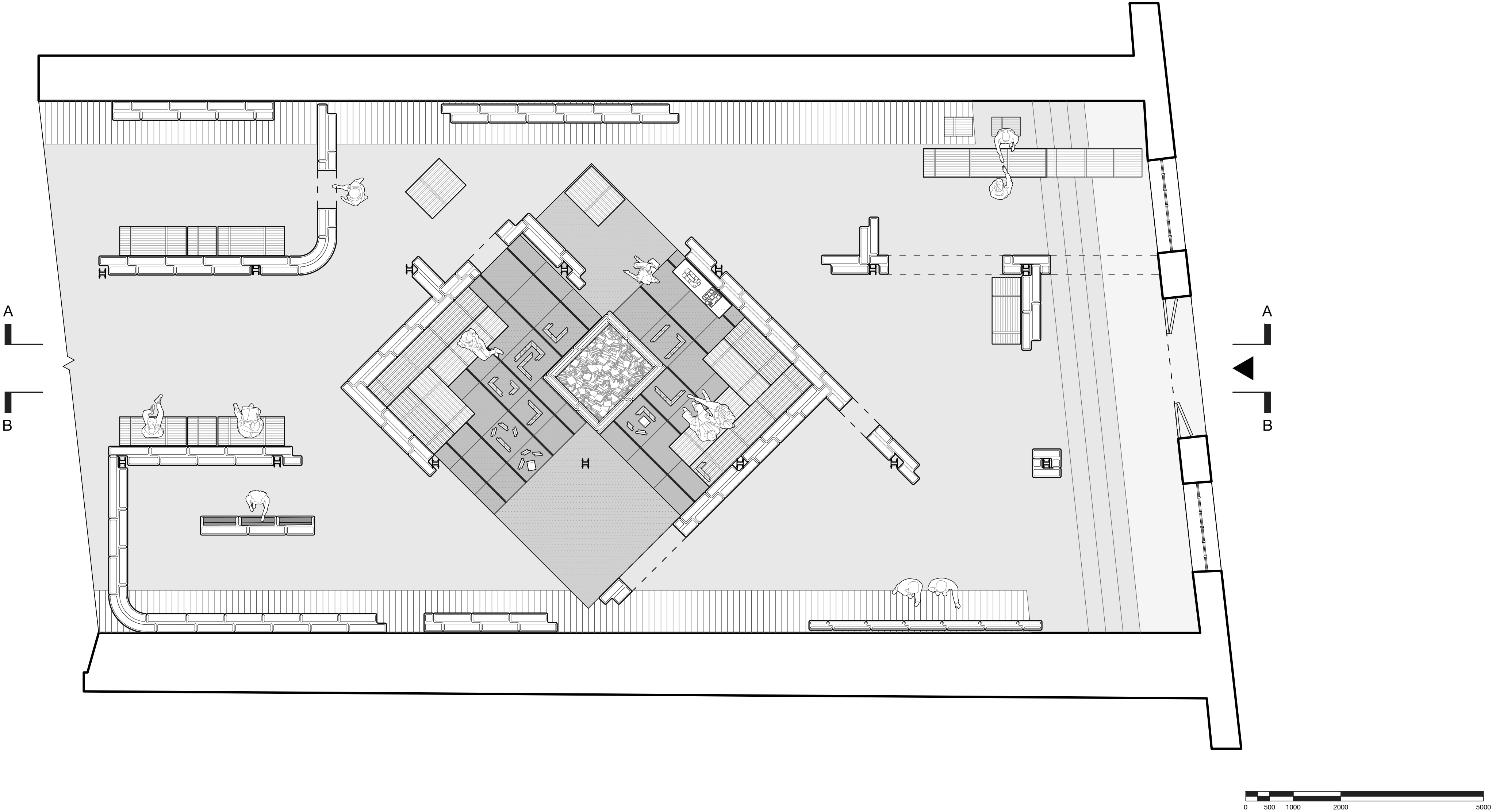


Fig 21. Exhibition Floorplan (drawing by MEAN, 2024).

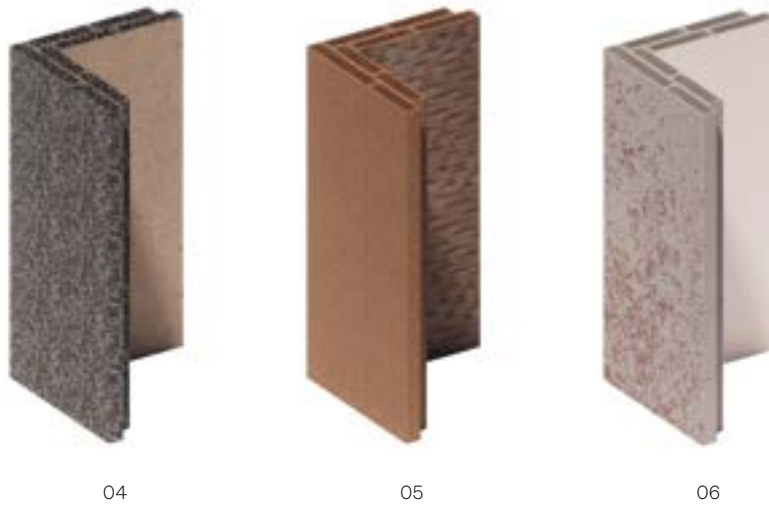
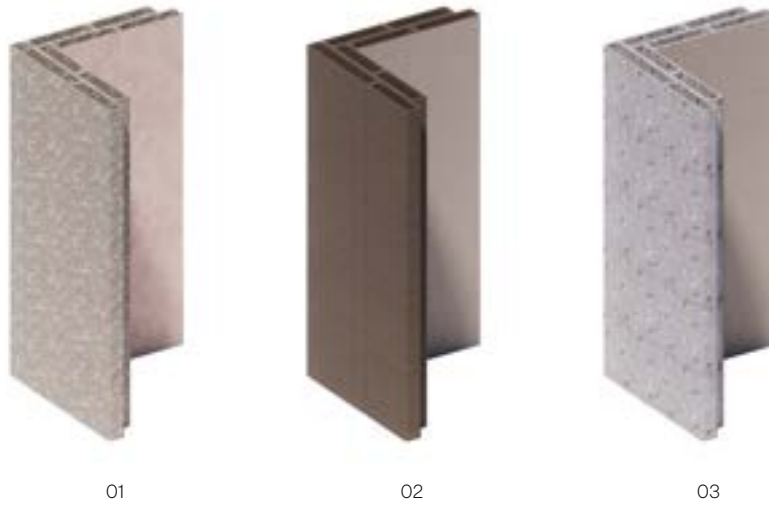
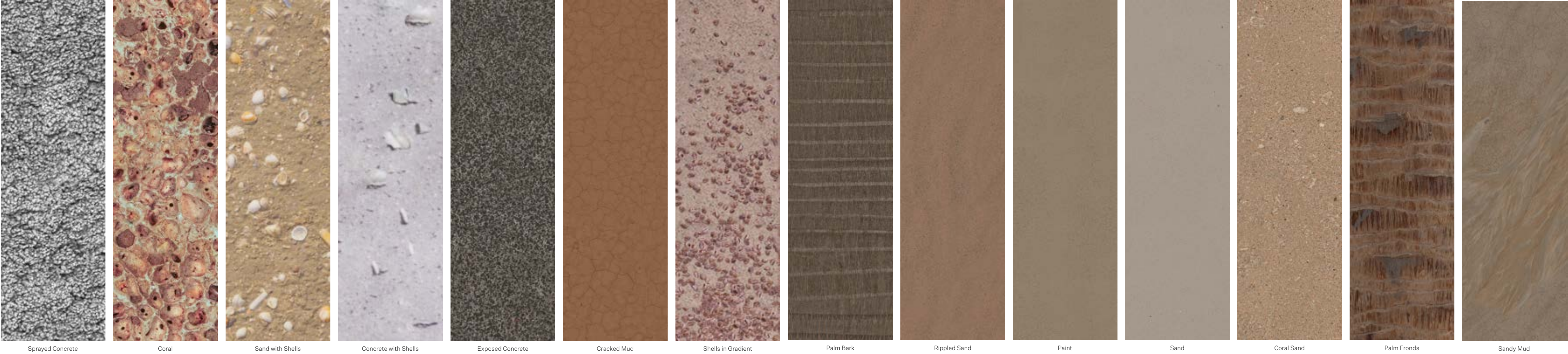


Section A



Section B

Fig 22. Longitudinal Sections of the Exhibition Space (drawings by MEAN, 2024).



**Preliminary Material Research Commentary**

In this material collection we explored sustainable solutions for the fabrication process while responding to historical and cultural connection to the region of the UAE. The preliminary material research for our modular system delved into vernacular materials and looked at options for local waste materials that can be incorporated into the manufacturing process.

Historically, the most common building materials used in the UAE were coral, sandstone, palm frond, and timber.<sup>10</sup> Due to coral being environmentally protected by the UAE<sup>11</sup>, we have opted to use recycled seashells from the seafood and aquaculture industries to create a biomaterial resembling concrete.<sup>12</sup> Seashells can also be processed into a fine aggregate, a coarse aggregate, filler, or even as cement replacement.<sup>13</sup> Similarly, palm fronds is a material that has historical value and can be recycled into insulation for the modules, with thermal properties comparable to fiberglass.<sup>14</sup> First findings have shown that a high amount of energy is needed to process construction waste into artificial reinforcement

fibers or aggregates; hence recycled seashells, palm fronds, palm husk, and date seeds are more suitable as reinforcement, aggregate, and thermal insulation for our 3D printed modules.<sup>15 16 17</sup>

Plaster has been used as interior finish in the UAE dating back to the Abbasid period between the 9th and 11th century AD.<sup>18</sup> The use of limewash finish was common in most UAE typical national housing typologies, the sha’bi house.<sup>19</sup>

<sup>11</sup> Badurunissa. (2022, December 16). An overview of Vernacular architecture in the UAE. RTF | Rethinking the Future. <https://www.re-thinkingthefuture.com/city-and-architecture/a8786-an-overview-of-vernacular-architecture-in-the-uae/>

<sup>12</sup> Conservation and Management Plan For Abu Dhabi and Eastern Qatar Coral Reefs. (2008, April). <https://wwfeu.awsassets.panda.org>. Retrieved February 9, 2024, from [https://wwfeu.awsassets.panda.org/downloads/coral\\_reef\\_management\\_plan.pdf](https://wwfeu.awsassets.panda.org/downloads/coral_reef_management_plan.pdf)

<sup>13</sup> Crook, L., & Crook, L. (2023, January 5). Sea Stone is a concrete-like material made from shells. Dezeen. <https://www.dezeen.com/2020/08/28/sea-stone-newtab-22-design-shells-materials/>

<sup>14</sup> Tayeh, B. A., Hasaniyah, M. W., Zeyad, A. M., & Yusuf, M. O. (2019). Properties of concrete containing recycled seashells as cement partial replacement: A review. Journal of Cleaner Production, 237, 117723. <https://doi.org/10.1016/j.jclepro.2019.117723>

<sup>15</sup> Luhar, S., Suntharalingam, T., Navaratnam, S., Luhar, I., Thamboo, J., Poologanathan, K., & Gatheeshgar, P. (2020). Sustainable and Renewable Bio-Based Natural Fibres and its application for 3D printed concrete: a review. Sustainability, 12(24), 10485. <https://doi.org/10.3390/su122410485>

<sup>16</sup> Adamu, M., Alanazi, F., Ibrahim, Y. E., Alanazi, H., & Khed, V. C. (2022). A comprehensive review on sustainable natural fiber in cementitious composites: The Date Palm Fiber Case. Sustainability, 14(11), 6691. <https://doi.org/10.3390/su14116691>

<sup>17</sup> Adefemi, A., Nensok, M., Kaase, E., & Wuna, I. (2013). Exploratory study of date seed as coarse aggregate in concrete production. ResearchGate. [https://www.researchgate.net/publication/288274103\\_Exploratory\\_study\\_of\\_date\\_seed\\_as\\_coarse\\_aggregate\\_in\\_concrete\\_production](https://www.researchgate.net/publication/288274103_Exploratory_study_of_date_seed_as_coarse_aggregate_in_concrete_production)

<sup>18</sup> Jumeirah Archaeological Site - Alchetron, the free social encyclopedia. (2022, August 30). Alchetron.com. <https://alchetron.com/Jumeirah-Archaeological-Site>

<sup>19</sup> COLOR IN THE UAE PUBLIC HOUSES on JSTOR. (n.d.). www.jstor.org. [https://www.jstor.org/stable/43030757?read-now=1&oath\\_data=eyJlbWVpbC6lmg9hQG0tZS1hLW4uZGVzaWduIiwiaW5zdGlodXRpb25jZHMlOltldlCjwcm92aWRkcl6lmdvb2dsZSj9&seq=6#page\\_scan\\_tab\\_contents](https://www.jstor.org/stable/43030757?read-now=1&oath_data=eyJlbWVpbC6lmg9hQG0tZS1hLW4uZGVzaWduIiwiaW5zdGlodXRpb25jZHMlOltldlCjwcm92aWRkcl6lmdvb2dsZSj9&seq=6#page_scan_tab_contents)

Fig 23. Materials & Finishes Options (textures by MEAN, 2024).

# 8

## Programming Opportunities

The concept of ‘Permutable Assemblies’ transforms the UAE Pavilion at the Venice Architecture Biennale into an intellectual hub and solutions-oriented lab for 21st-century housing challenges. This curated experience delves into the nation’s architectural heritage, real estate dynamics, material innovation, and participatory design.

**0- Pre-Biennale community workshops**

Collaborate with community members on finding spatial solutions to housing challenges using the 1:50 scaled modules to explore various culturally relevant topics such as privacy, climate, gathering, and interior/ exterior. The collected examples will inform the design strategy of the exhibition space.

**I- Lectures on Modern Modular Buildings**

Engage visitors with immersive lectures led by architectural historians, unraveling the evolution of modernist modular buildings in the UAE. Dive deep into design philosophies and trace the lineage of these structures that shape the nation’s built environment.

**II- Panel Discussions by UAE Real Estate Pioneers**

Elevate discourse with exclusive talks by pioneers in the UAE real estate market. Gain insights into the dynamic residential real estate sector, addressing developments, milestones, and challenges. Explore the global impact of the UAE real estate model through firsthand perspectives.

**III- Workshops on Building Material Science**

Immerse in cutting-edge workshops led by material science innovators. Explore the materiality evolution in UAE homes, spanning modern to contemporary design. Foster a dialogue on sustainable materials, promoting responsible and innovative construction practices.

**IV- Combinatorial Housing Configurator (CHC)**

Visitors to the pavilion can engage their creativity through the interactive ‘Combinatorial Housing Configurator.’ An AI-powered, custom-made, game-like interface that invites visitor participation to generate myriad configurations using the ‘Permutable Assemblies’ Modular System. Analyze results to showcase the versatility of adaptive modular design, possibly projecting configurations as an ‘Open Source Project’ for ongoing customization exploration.

**V- An Analogue Scale Building Experience**

Beyond the digital platform, invite visitors to engage in a hands-on building experience. Pick up 1:50 scale ‘Permutable Assembly’ modules and create scale models of future homes, turning the process into a fun and game-like activity.

**VI- Afterlife of the Pavilion**

To showcase the flexibility of the system, and to further enforce the idea of sustainable construction, whereby construction waste is upcycled and reused, upon dismantling the pavilion at the Venice Architecture Biennale Exhibition, we will ship the parts to the UAE and rebuild a different space for public gathering.

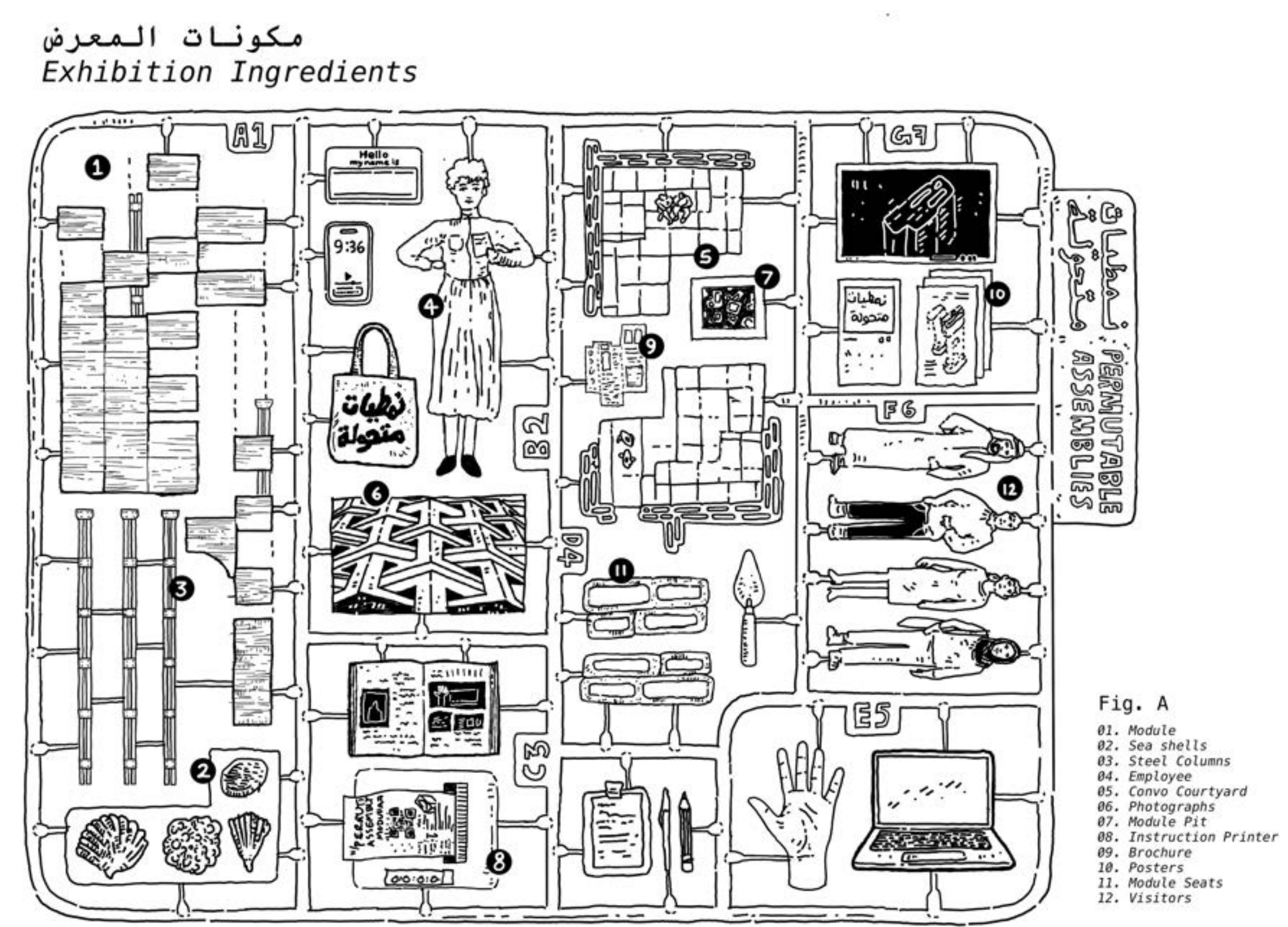


Fig. A

- 01. Module
- 02. Sea shells
- 03. Steel Columns
- 04. Employee
- 05. Convo Courtyard
- 06. Photographs
- 07. Module Pit
- 08. Instruction Printer
- 09. Brochure
- 10. Posters
- 11. Module Seats
- 12. Visitors

Fig 24. Exhibition Elements (illustration by Sarah Aladayleh, 2024).

# 9

## Publication Strategy

**9.1 Publication Conceptual Framework**

The publication is a crucial component of the exhibition complementing the content displayed in the physical exhibition space. The publication shares a detailed account of the historical context of modularity, discusses the drivers of modular development in the UAE, and serves as a research documentation of developing and prototyping our proposed form of modular housing.

The publication highlights the collected (visual, archival, and written) research in greater detail and brings forward a dialogue on modular housing and prefabrication with selected scholars. Additionally, the publication will also share the collected research through infographics and a developed timeline of modular development in the UAE placing its progress within a regional and global context. The commissioned photographs of Dia Mrad and illustrations of Sarah Aladayleh will accompany the collected research information.

**9.2 Publication Production**

The bilingual (Arabic and English) publication highlights the research, findings, and exhibition content with a playful interpretation of the curatorial framework, focusing on the hypothetical developer ‘*Permutable Assembly FZ LLC*.’ This approach extends to the design of the exhibition identity and the publication, combining formal and playful elements. Typography in the publication emphasizes simplicity and formality, utilizing a clean, modular grid-based layout that effectively blends imagery and text in a playful yet professional style.

The publication features a soft cover employing a flat-opening stitch-bound method with multiple signatures. The cover may incorporate artistic printing techniques like foiling, powder ink, or thick UV printing to enhance its tactile and visual appeal, mirroring textures from the exhibition. Internally, a blend of semi-glossy laminated paper for high-saturation images and matte paper for text-heavy chapters, including interviews, will be used. The book will be printed using the default four-color offset printing method.

A custom bilingual (Arabic and English) modular display typeface, specifically created for ‘*Permutable Assembly*’ is used throughout the exhibition, including signage and printed materials. The display typeface is paired with a modern serif typeface in English, and a modern Arabic Naskh/Kufi combination typeface for body text. This approach reflects the exhibition’s visual identity — balancing between seriousness and playfulness, aligning with the exhibition’s overarching curatorial framework.

The collaboration with Slanted Publishers, renowned for their expertise in publication design and distribution, is a strategic move to extend the exhibition’s reach beyond the biennale audience. By partnering with Slanted Publishers, known for their meticulous approach to printing and distribution, the publication benefits from high-quality production and a sophisticated distribution network. Printing in Italy, as confirmed by Slanted, ensures efficient and sustainable delivery while minimizing the logistical challenges linked to overseas shipping. This collaboration not only promises a publication of exceptional quality but also broadens the audience reach, leveraging Slanted Publishers’ established distribution channels and their reputation in the publishing industry. This partnership is expected to enhance the visibility of the exhibition, attracting a wider audience and generating increased interest and engagement beyond the biennale’s traditional scope.



Research content presentation



Fig 26. Publication Inspiration.

# 10

## Collaborations & Team Members

### 10.1 Collaborations and Team Commitment

‘*Permutable Assembly*’ aims to cultivate robust interdisciplinary collaboration, uniting diverse entities to conceptualize, envision, and develop an immersive, interactive-themed experience. Leveraging the expertise of **MEAN\*** (Middle East Architecture Network), a pioneering Dubai-based architecture practice established in 2018, the project benefits from the studio’s proficiency in designing modular systems, working at the intersection of material innovation and contextually responsive design. The collaboration with Italian 3D printing pioneers, **WASP**, situated in Massa Lombarda, Emilia-Romagna, further enhances material prototyping, a crucial aspect in the development of climate-responsive modular components.

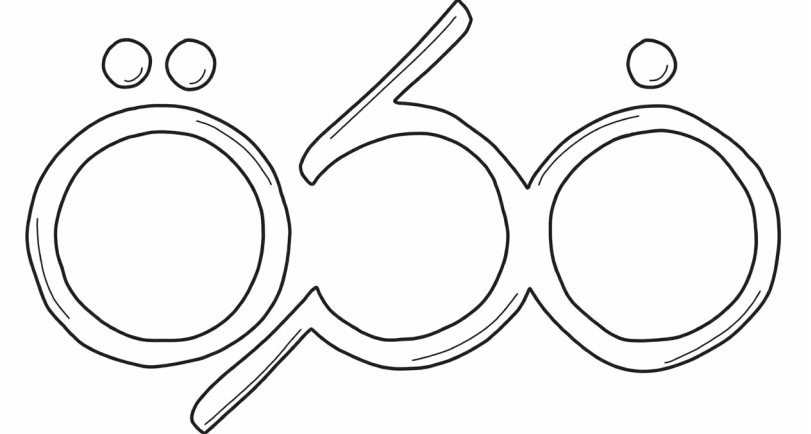
Moreover, the curator and co-curator receive support from a collaborative research project and an associated fellowship and research center at **Zayed University**. The ongoing multi-year funded research project, focused on developing an adaptive solution for social gathering spaces in the UAE, will provide crucial research insights into modularity, materials, prototyping, and the historical significance of culture, and climate, along with a range of vernacular architectural case studies.

**Fikra**, an innovative graphic design studio and community hub based in Sharjah, will contribute its skills in branding, exhibition signage, poster and publication design, and conceptualizing a modular graphic design approach for the pavilion. The involvement of the German-based publisher **Slanted**, known for its excellence in designing and publishing art books and magazines, will elevate the publication aspect of the exhibition and reach an audience beyond a typical architectural reader, thereby enforcing the dissemination of knowledge harbored through the course of this research.

Furthermore, Jose Sanchez, an Architect, Game Designer, and Associate Professor in Architecture at **Taubman College at the University of Michigan** and director of ‘The Plethora Project’, will be engaged in developing an interactive digital configurator, functioning as a design tool for crafting *Permutable Assembly* homes, thereby enabling visitors to simulate their ideal future homes and facilitating the publication of these designs through integrated back-end systems.

**Viksel**, a state-of-the-art render company is experienced in professional renderings for leading UAE based real estate developers. The Ukraine based studio will develop the video material for ‘*Permutable Assembly FZ LLC*’.

MEAN\*  
Middle East  
Architecture  
Network



Curator



**Riyad Joucka**

(based in Dubai)

– **Architect and Founder of MEAN/ Research**  
– **Fellow in Practice Zayed University**

- Full buy-out fellowship Fall 2024 and partial buy-out Spring 2025
- Part-time commitment in collaboration with ZU Fellowship

Curatorial Team



**Adina Hempel**

(based in Dubai)

– **Architect and Associate Professor Zayed University**

- Historical research, publication, and overall exhibition development
- Full course buy-out for Fall 2024 and partial Spring 2025 required
- Part-time commitment in collaboration with ZU Research Center

Curatorial Assistants



**Dheyaa Dheyaa**

(based in Dubai)

– **Architect at MEAN\***

- Research Assistant on history documentation and exhibition design
- Initially full-time, from January onwards the part-time support in research



**Omar Allabban**

(based in Dubai)

– **Architect at MEAN\***

- Research Assistant on modular development and exhibition design
- Initially part-time, from January onwards full-time in research

Design Team



**Salem Al-Qassimi**

(based in Sharjah)

– **Graphic Designer and Founder Fikra Design Studio**

- Publication design, signage, and branding
- Coordination with Slanted Publication



**Dia Mrad**

(based in Beirut)

– **Photographer**

- Work onsite in the UAE for one month
- Preliminary site research, documentation in the UAE, preparation for publication and exhibition.



**Sarah Aladayleh**

(based in London)

– **Architect at BIG**

- Work will be done remotely
- Development of open source instruction manual for publication and exhibition.



**Jose Sanchez**

(based in Detroit, Michigan)

– **Architect, Gamer Designer, Associate Professor Taubman College University of Michigan, Director ‘The Plethora Project’**

- Work will be done remotely
- Development of a game-like interface as a combinatory configurator of the modules that serves as an interactive design tool.

10.2 Videogame Examples by Jose Sanchez

Plethora Project  
Directed by Jose Sanchez

**Block’hood**  
Jose Sanchez - Director and Developer  
Bryan Zhang - Narrative / Game Design  
Alan Hung - Animation  
Gentaro Makinoda - 3D Artist / Architecture  
Selma Mutal - Composer / Composer OST

**Common’hood**  
Plethora Project & Kowloon Nights  
Jose Sanchez - Director, Screenwriter, Gamedesigner  
Shuruq Tramontini - Lead Artist  
Zach Day Scott - Lead Developer  
Dane Matthew Carstens - Developer  
Yucong Wang - 3D Artist  
Max S. - Marketing / Community Manager  
Selma Mutal - Composer / Composer OST

**Contributors**  
Andre Zakhya - Cinematography / Animation  
Tommy Tallian - 3D Character Artist  
Mark Marino - Screenwriting  
Vanille Velasquez - Voice Actor (Nikki)  
Ludmilla Klymenko - 2D Art  
Lajos Kolozsvari - SFX  
Carlos Jimenez - SFX  
Jason Della Rocca - Consultant  
Satrio Dewantono - Developer  
Kellan Cartledge - Environmental Artist / Developer  
Olga Orlova - Concept Art  
Kevin Wiratama - 3D Artist  
Shaq Aki - 3D Artist Characters



Fig 27. Block'hood (video game by Jose Sanchez, 2017).



Fig 28. Common'hood (video game by Jose Sanchez, 2022).

10.3 Modular Housing Case Study by MEAN\*

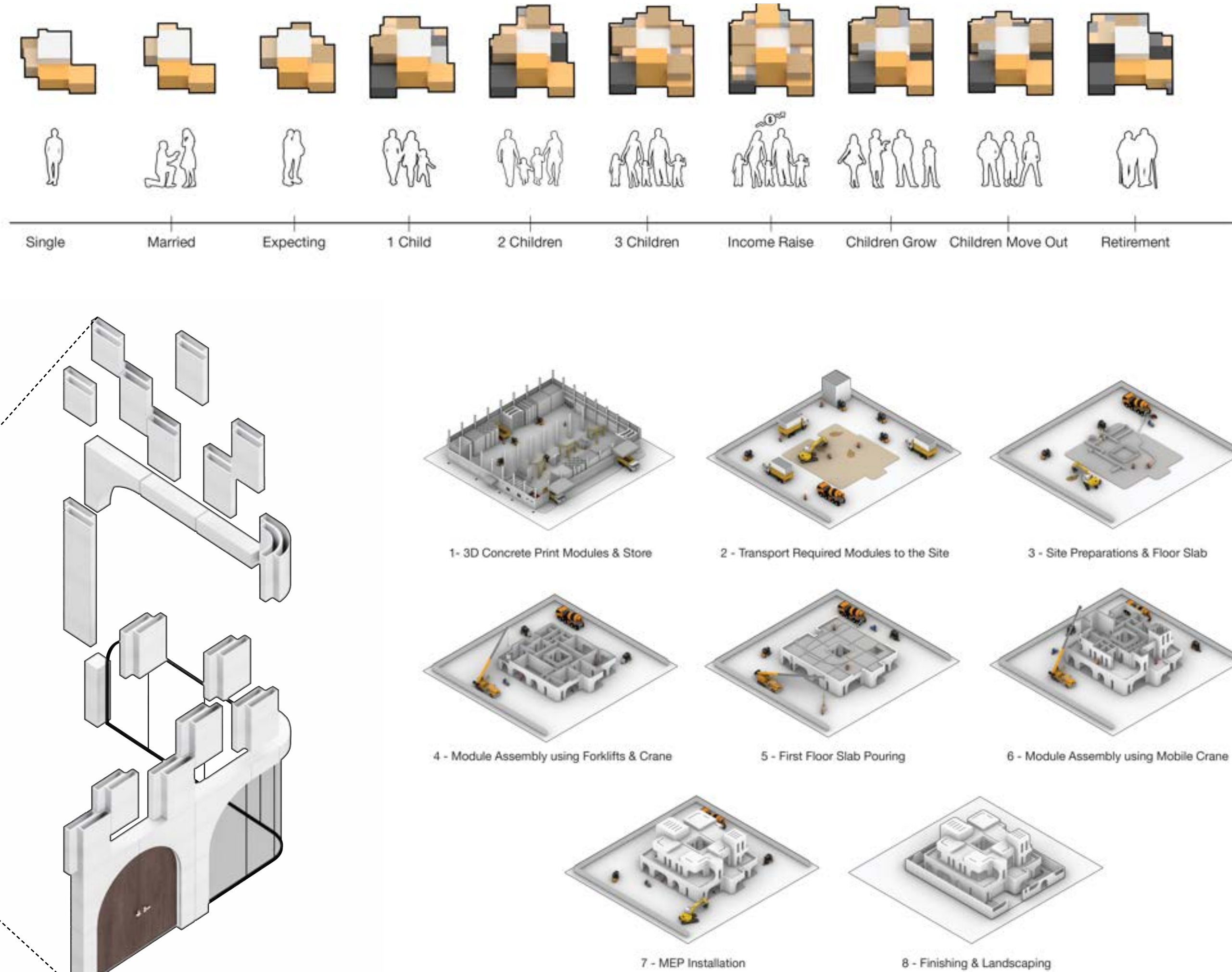


Fig 30. Meta-Modular House Assembly Process (diagrams by MEAN, 2023).

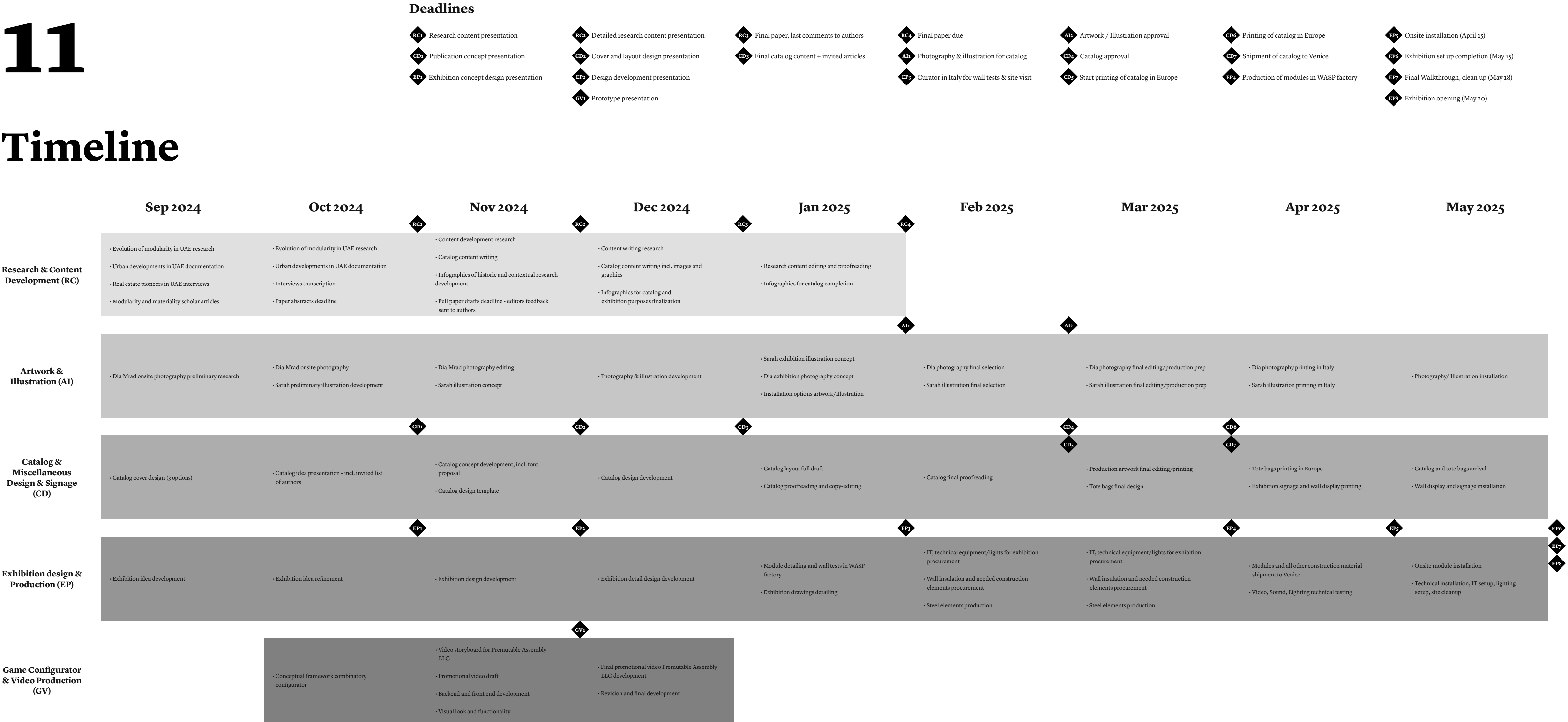
Fig 31. Physical 3D Printed Modules (photo by MEAN, 2023).



Fig 29. House Designed with *Permutable Assembly System* (rendering by MEAN, 2024).

11

Timeline



# 12

## Budget

| Item                  | Description                                                      | Amount      | Units     | Total         |
|-----------------------|------------------------------------------------------------------|-------------|-----------|---------------|
| Curatorial Fees       |                                                                  |             |           |               |
|                       | Curator Fee + travel/lodging                                     | \$35,000.00 | 1.00      | \$35,000.00   |
|                       | Co- Curator Fee + travel/lodging                                 | \$30,000.00 | 1.00      | \$30,000.00   |
|                       | Co- Curator Fee+ travel/lodging                                  | \$7,500.00  | 1.00      | \$7,500.00    |
|                       | Curatorial Assistant Fee + travel/lodging                        | \$5,000.00  | 2.00      | \$10,000.00   |
|                       | Graphic Design F+ travel/lodging                                 | \$15,000.00 | 1.00      | \$15,000.00   |
|                       | Contributors Team Fee + travel/lodging                           | \$7,500.00  | 2.00      | \$15,000.00   |
| Research              |                                                                  |             |           |               |
|                       | Archive Access Costs                                             | \$200.00    | 10.00     | \$2,000.00    |
|                       | Interview Costs                                                  | \$1,500.00  | 5.00      | \$7,500.00    |
|                       | Photography Permission Costs                                     | \$1,000.00  | 1.00      | \$1,000.00    |
|                       | Photography Test Printing Costs                                  | \$500.00    | 1.00      | \$500.00      |
| Exhibition Production |                                                                  |             |           |               |
|                       | Exhibition Design Fee (MEAN)                                     | \$15,000.00 | 1.00      | \$15,000.00   |
|                       | WASP Fabrication Project Managment                               | \$13,824.00 | 1.00      | \$13,824.00   |
|                       | Material Mix Supply                                              | \$1.30      | 104100.00 | \$134,913.60  |
|                       | R&D (Material and Module Prototyping)                            | \$21,600.00 | 1.00      | \$21,600.00   |
|                       | WASP 3D Printer Rental                                           | \$3,650.00  | 7.00      | \$25,550.00   |
|                       | WASP Fabrication Team Fees                                       | \$8,756.64  | 7.00      | \$61,296.48   |
|                       | Modules Shipping Costs (within Italy)                            | \$5,000.00  | 1.00      | \$5,000.00    |
|                       | 3D Printed Modules Scale 1:5                                     | \$30.00     | 300.00    | \$9,000.00    |
|                       | Installation Costs (Labour, Equipment etc.)                      | \$25,000.00 | 1.00      | \$25,000.00   |
|                       | Illustration Production and Installation Cost                    | \$1,500.00  | 5.00      | \$7,500.00    |
|                       | Photography Production and Installation Cost                     | \$2,000.00  | 5.00      | \$10,000.00   |
|                       | Promotional Video Production Cost                                | \$5,000.00  | 1.00      | \$5,000.00    |
|                       | Software Development for Interactive Module Simulator Cost       | \$10,000.00 | 1.00      | \$10,000.00   |
|                       | Interactive Screen Rental Cost                                   | \$1,500.00  | 3.00      | \$4,500.00    |
| Publication           |                                                                  |             |           |               |
|                       | Catalog Printing Cost                                            | \$25.00     | 3000.00   | \$75,000.00   |
|                       | Catalog Contributor's Fee                                        | \$1,250.00  | 5.00      | \$6,250.00    |
| Signage               |                                                                  |             |           |               |
|                       | Opening Wall Text Production Cost                                | \$5,000.00  | 2.00      | \$10,000.00   |
|                       | Larger Wall Signage Production Cost                              | \$7,500.00  | 2.00      | \$15,000.00   |
| Misc                  |                                                                  |             |           |               |
|                       | Tote Bags Production Cost                                        | \$4.00      | 5000.00   | \$20,000.00   |
| Total                 |                                                                  |             |           |               |
|                       | TOTAL REQUIRED BUDGET (FOR CURRENT DESIGN)                       |             |           | \$597,934.08  |
|                       | Zayed University Research Fellowship Contribution                |             |           | -\$150,000.00 |
|                       | Reduction of Modules from 553 to 200 Pieces                      |             |           | -\$97,909.00  |
|                       | FINAL PROPOSED BUDGET (INLCUDES REDESIGN OF THE EXHBITION SPACE) |             |           | \$350,025.08  |

# 13

## Feedback Questions Addressed

**How is this proposal different than a project like WikiHouse, which has already gotten a lot of traction?**

Projects like WikiHouse, initiated by ‘The Open Systems Lab’ which was founded by Alistair Parvin in 2011, followed earlier endeavours such as ‘The Open Source House’. This project was presented by ‘Architecture for Humanity’ at the 2006 TED conference- the project won the TED prize of that year. ‘Architecture for Humanity’ was co-founded by Cameron Sinclair and Kate Stohr in 1999. These projects serve as important precedents that focus on harnessing the advantages of digital fabrication to facilitate an open-source process of designing and building homes. The general goal of these projects is to grant autonomy to end-users, eliminating the need for consultants and consequently reducing the cost of constructing environmentally friendly homes.

While we acknowledge these projects as excellent case studies, it’s crucial to note that both primarily utilize a timber frame construction system, relying on wood—a scarce material in the region and a construction practice uncommon in the Middle East. Furthermore, these projects consider a demographic and audience belonging to regions like Europe and North America respectively. In contrast, *Permutable Assembly* builds on these projects by offering a culture and climate-responsive concrete modular prefab construction system for the UAE and the region. It does so by considering the architectural forms and cultural needs of the demographic of the region as a key parameter for the design process.

**The ‘kit of parts’ solution contradicts the criticism relating to the cookie-cutter typology of offerings currently available - how do you intend to address this?**

Modular prefab housing often offers specific types homeowners can choose from, this is presented in a specific style and size for the desired house. ‘*Permutable Assembly*’ offers building parts instead of full wall configurations, thus allowing for greater variety. While there is also an infinite combination of these building parts, the variety is infinitely larger. By providing a variety of module types, made possible through concrete Additive Manufacturing, we can create a kit of parts that explores numerous opportunities and scenarios for combinatory configuration. In traditional modular prefab systems, this level of customization is not possible as it radically alleviates the cost of construction.

Within the material system of ‘*Permutable Assembly*’, the end user takes authorship of the design by combining these parts to produce an effect greater than the sum of the individual components. They can do so based on their lifestyle, aesthetic, and pragmatic preferences. This emergent quality allows for more variations in architectural expression and a broader range of possibilities for design outcomes that suit the specific needs of the end user. It also results in residential communities whereby the homes of inhabitants reflect their unique architectural preferences- unlike the repetitive nature of current residential communities in the market. Additionally, the system is designed for easy dismantling and reconfiguration, enabling a house to adapt its form according to the changing needs of its inhabitants over time.

**How can the proposal tell a story of immediate-future housing without starting with a preconceived idea about an existing technological solution?**

Through the course of this research, we will be closely examining the current trends in the construction industry and the Real Estate market, aligning these aspects with the specific societal needs of the region’s demographics. Our research will delve into the recent history of modernity in the built environment in the UAE, tracing the evolution of modular construction leading up to its current technological applications. Our objective is to explore the motivations behind adopting both modular prefab construction and additive manufacturing, documenting their impact on the real estate market in the UAE and the broader region. We aim to identify challenges and implement changes that effectively address them.

**How can this proposal navigate away from the political complexities of home ownership within the UAE?**

Our research trajectory will explore the current offerings for potential homebuyers in the UAE market, primarily situated in freehold zones that allow non-local citizens to acquire land and real estate. While refraining from delving into political intricacies, our approach emphasizes a thorough understanding of the legal frameworks governing housing and real estate in the UAE. This involves examining property laws, regulations, and government policies to ensure our proposed housing solution aligns seamlessly with existing legal structures. Actively incorporating legal considerations into the design and implementation phases, our proposal aims for a harmonious integration of technological advancements while adhering to the legal parameters of home ownership in the UAE.

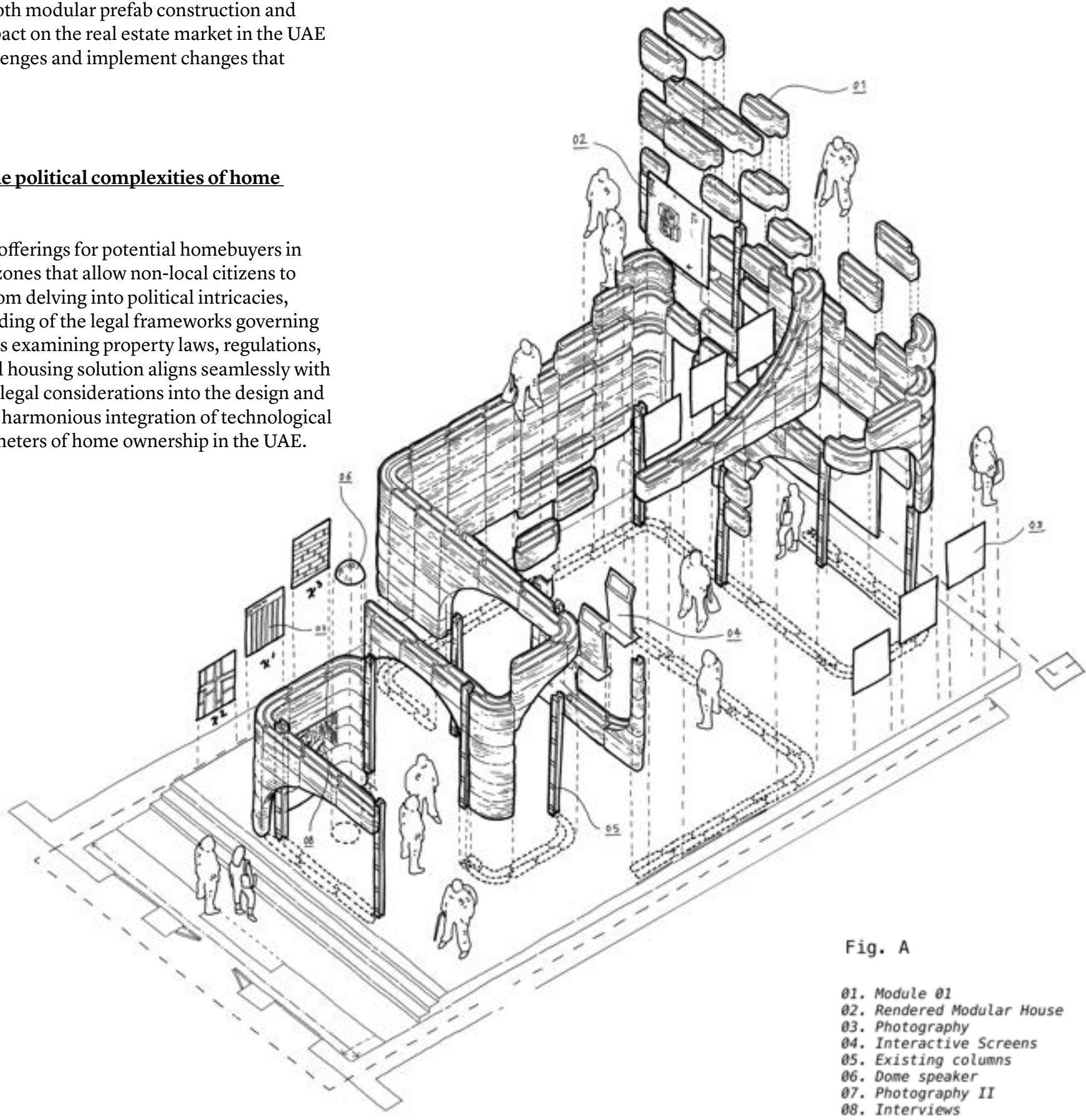


Fig. A

- 01. Module 01
- 02. Rendered Modular House
- 03. Photography
- 04. Interactive Screens
- 05. Existing columns
- 06. Dome speaker
- 07. Photography II
- 08. Interviews

Fig 32. Modular Pavilion *Permutable Assembly* FZ LLC (illustration by Sarah Aladayleh, 2024).

# Thank you.

