

Keywords

Metabolism movement
Circular design
Architectural history and theory

Abstract

Metabolism as the avant-garde architectural movement in Japan, reflects the thinking for the future toward changes, new technology, and social resilience by the 1960s Japanese architects. The movement is deeply rooted in the Japanese Buddhist belief based on reincarnation and architectural tradition based on dismantling.

From a functional point of view, 'Metabolism' emphasizes the flexibility or adaptability of buildings over time. In the view of materialization, 'metabolism' puts forward the idea of returning the material back to the economic cycle or return to nature. We see similarities in the concept of circular design, which also aims at making the building future-proof throughout its material life cycle.

Though the two movements share a high level of similarity in terms of initial concept and strategy, we turn to think about what the inspiration from metabolism would be under the scope of circular design nowadays at the architectural level. At the same time, we see that a new generation of architects is still drawing from the lessons of the Metabolists. They diverge from the fetish of megastructures to more human-associated and mobility aspects of Metabolism. By analyzing projects from Japanese architects Ryue Nishizawa from SANAA and Sou Fujimoto, this thesis aims to study the interpretation of metabolism in the current context at the architectural scale, focusing on how this philosophical concept gets reflected in architectural design, structure, and materialization.

Towards time-based architectural strategy: interpretation of metabolism under the scope of circular design

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Introduction

Metabolism is the circularity in temporal realm. (Igarashi, 2018c)

This analogy juxtaposes two predominant design methodologies: the metabolism movement of the 1960s in postwar Japan and contemporary circular design frameworks aimed at addressing climate change and resource overconsumption.

Circular design, now a central approach and methodology, advocates for a time-based and closed-loop approach to architectural materials. By applying the circular economy model to the architecture realm, architectural design transitions from linear, fixed models to loop systems that reimagine building lifecycles. This involves adopting design principles that could either expand the lifespan of architecture by designing structures that could facilitate flexible changes and adaptable reuse toward changing users' needs (rethink) or could reduce overall material consumption by improving material circularity (reuse, recycle) or material sharing (refuse, reduce).

On the other hand, the metabolism movement, as the first non-Western avant-garde architectural movement in 1960s Japan, reflected an acknowledgment of socio-economic processes and a fascination with new technology among Japanese architects like Kiyonori Kikutake, Kenzo Tange, and Kisho Kurokawa. The term metabolism refers to the principle of life, as the energy exchange between living beings and the environment. The city was considered as an organism and was treated as a growing framework constantly accommodating social changes. Therefore the key concept is to propose time-based and future-proofing architectural design strategies.

Functionally, metabolism emphasized the flexibility and adaptability of buildings over time, exemplified by projects like the Sky House by Kiyonori. Materially, metabolism proposed the concept of dismantling drawing from the Buddhist belief and also a common strategy for timber structure in traditional Japanese architecture.

Literature Review

Considering the state of the art of modern interpretations of the Metabolism movement, at the urban scale, Rem Koolhaas developed a well-articulated genealogy of this movement concerned with iterative evolution, which reviews the Utopian dream of architects and their attempt to radically alter Japan's physical and political landscape. Though the megastructures turn out to be unrealizable, the concept of metabolism turns out to be inspiring to the generic city of the future. (Koolhaas, Obrist, 2011) At a sociological scale, urban metabolism develops a model to facilitate the description and analysis of the flows of materials and energy within cities, implying metabolism under the current urban context (Lucertini, G., & Musco, F. 2020).

At the architectural scale, particularly within Japanese architecture, there is an interest in exploring the 'cultural continuity' from the metabolism group to see how metabolism has evolved and is interpreted in relation to circular design strategies nowadays. Following a generation map of mentor relationships established in universities and architectural firms (Fig. 1), this thesis delves into the concepts and works of postwar architects Kisho Kurokawa and Kiyonori Kikutake and the new generation of late 20th-century architects Ryue Nishizawa from SANAA and Sou Fujimoto.

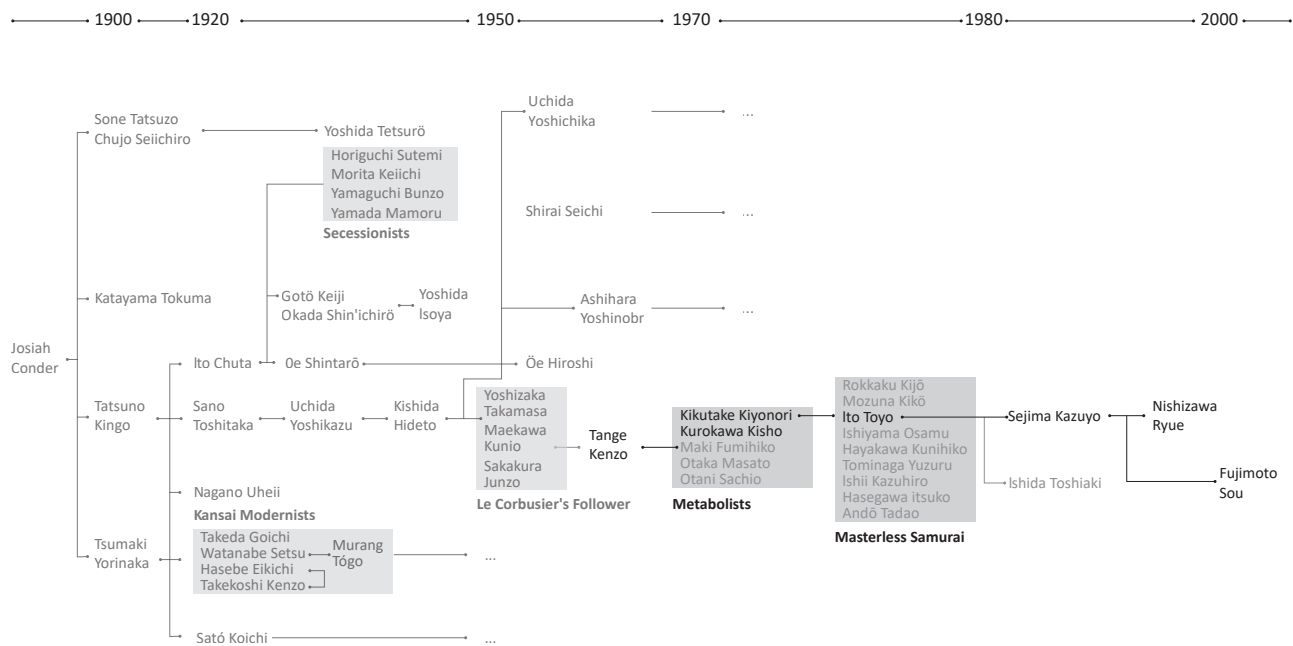


Fig 1. Genealogical chart on the overview of the relationships among prominent architects in Japan. (Igarashi, 2018c)

CHAPTER 1. OVERVIEW OF 1960S METABOLISM MOVEMENT

CHAPTER 1.1 Background and key figures of 1960s Metabolism movement

"The sun will rise again tomorrow"

In post-war Japan, the muddle city raised the debate on reconstruction strategy. The debates vary from rebuilding the city in the style of European cities or to base on the motif of broken walls. It was a moment when resources were limited while there was a high level of freedom for architects to depict the future-oriented city. In "The Theory of Behavioral Architecture", Kurokawa wrote the famous script of *Gone with the Wind* when he witnessed a loss of nature of the land. Therefore, he based his philosophy on the cycle of destruction of architecture, nihilism, and optimism. Such idea of cycle and reference to organic growth or evolution eventually led to the 1960s metabolism movement.

Kisho Kurokawa together with a group of young architects and designers, including Kiyonori Kikutake, Fumihiko Maki, and Noboru Kawazoe, published the metabolism manifesto at the 1960 World Design Conference. It was a response to a static and recent-devastated city, a rethinking of architecture as a tool for potential social changes, growth, and

evolution.

Afterward, The Osaka Expo'70 became a playground for Metabolism, an empty field to test their ideas about the future, equipment, and organic development. From the time of Expo'70, Tange Kenzo and the metabolism group began working at the international level and the architects started to walk their own path.

As the metabolism was targeted at the mobile city, at the architectural scale, the group faced challenges in terms of structural stability as the opposite of movement and dynamic. To solve this problem, they came up with the idea of megastructures that aim at constructing a giant framework for the whole city. The metabolism group considered that technology represented an expansion of humanity and with new technology they wanted to create a system in which the changes can occur within the framework of human discernment. (Kurokawa, 1977) However, this mega-framework concept turned out to be a utopian idea due to the lack of social, economic, or political support. Also, it could be seen as a fetish towards new technology though the advancement could not facilitate the implementation of such an ambitious movement.

CHAPTER 1.2 Philosophical concept behind metabolism movement

Looking at the philosophical concept or construction tradition behind the metabolism movement, it can often stand in comparison with Buddhist philosophy. Metabolism is based on the Buddhist concept of changeability, belief in reincarnation, and the aesthetic of the unfinished image.

As the Buddhist belief of reincarnation is rooted in Japanese culture and that Japanese beauty is based on the concept of dismantling, they believe constant dismantling allows them to continue expressing their identity and nothing is more lasting than changing. (Kurokawa, 1977) On the contrary, European beauty is based on eternity with the durable material of stone. With the culture of reincarnation and dismantling, Kurokawa took into consideration the relationship between artificial buildings and nature. He tended to think about the life cycle of building and emphasized the idea of returning the material back to the economic cycle or to return to nature.

The concept of changeability also refers to the life cycle of the building that the architecture should give possibilities for further interpretation by users, which shows the humanity aspect of metabolism. According to the manifesto, "the architect's job is not to propose



Fig 2. Sky House by Kikutake in 1958 with free plan on the first floor allowing flexible indoor configuration.

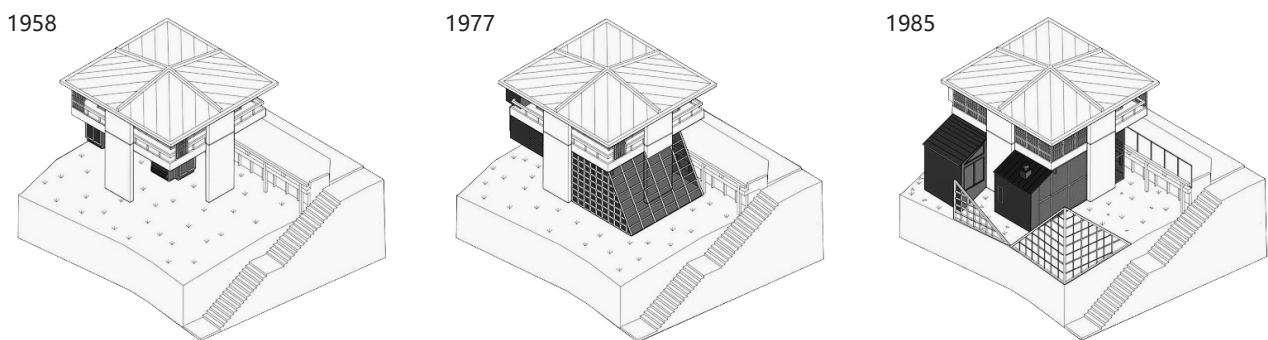


Fig 3. Process of transformation for physical structure adapting to the changing needs.

ideal models for society but to devise spatial equipment that the citizens themselves could operate". Overall, the metabolism movement put forward the idea of adaptability, flexibility, and recycling at both architecture level and materialization level, which implies similar keywords to sustainable circular design.

CHAPTER 1.3 Sky House, Tokyo, Japan (1958)

In the case of Sky House by Kikutake, we can see how certain features are interpreted at a residential scale by 1960s architects. The case perfectly responds to the manifesto by Kikutake that 'Contrary to the architecture of the past, contemporary architecture must be capable of responding to the changing needs of the contemporary era.' (Kikutake, 2016)

The sky house was designed and built by Kikutake in 1958 for his family. The 55 sqm square-plan house stands on four concrete columns. The upper floor has a free open plan with an exterior corridor (Engawa), a movable kitchen, and a toilet, while the ground

floor was left unfinished for further interpretation. The open ground floor was first occupied with a hanging unit from the concrete slab for the son's room and later filled with new units. Later the units were removed when the kids moved away. Over 50 years changes were made to the Sky House to adapt to the dynamic users' needs.

This 1960s case embodies the features of metabolism characterized by flexibility, adaptability, and a future-oriented mindset. The level of changeability relies more on the design of the structure. In the case of the first floor, the movable kitchen and open floorplan give possibilities of variable configurations in case of different short-term needs. While in the case of the ground floor, the structure was designed to be intentionally 'unfinished', which allows long-term changes due to the ever-changing nature of human life and social needs.

CHAPTER 1.4 Extension of metabolism movement

In contrast to Western modernism when Le Corbusier proposed "a house is a machine for living", metabolism proposed an organic perspective towards architecture as a system under growth and evolution, known as the "principle of life". Kisho Kurokawa went further for the Buddhist belief and developed the concept of symbiosis (co-existence) focusing on the relationship between two elements while allowing them to remain in opposition, which implies the co-living of humans and nature, co-existence of inside and outside, etc.. He proposed the intermediary space of different dimensions, space of transitoriness, and the space between interior and exterior as proof of his principle of life, which allows the opposing element to exist in harmony.

As Buddhism teaches the Buddha is present in the leaves and the branches and the roots and the trunk, so that there is no sense of rank, and everything has the same value. Symbiosis implies a flat hierarchy, without a center, and the individual elements can move

separately but are not completely independent. Kurokawa translated such metaphor into Loop space, with spaces intersecting with one another and following no sequences or hierarchy. Such a strategy could be seen in the case of the National Museum of Ethnology by Kurokawa in 1977 (Fig 4.). The framework is set among the four corner blocks, which makes additional buildings possible, and each unit has its own internal garden. In this way, each block holds its own loop system. The idea of blurring boundaries among spaces and eliminating spatial hierarchy could be seen in the projects of new-generation Japanese architects.

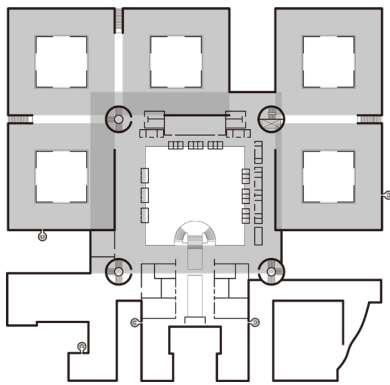


Fig 4. National museum of ethnology by Kurokawa in 1977 features in free plan and eliminating spatial hierarchy



Fig 4. Internal garden of National museum of ethnology

CHAPTER 2. METABOLISM MOVEMENT UNDER THE SCOPE OF CIRCULAR DESIGN

CHAPTER 2.1 Definition of circular design

Ever since the Industrial Revolution, a Linear Economy (LE) model of “make-take-waste” was adopted, supported by an abundance of resources. Considering the earth as a closed system, it becomes apparent that this model is restricted (Braungart & McDonough, 2002) Circular Economy (CE) is a new economy model based on circular principles relating to environmental, social, and financial assets (Verberne, 2016) that was proposed to limit the destruction of the earth.

The circular design is based on the circular economy to develop the quantity of restoration of resource flows at the nano level (buildings, products, components, and materials). The butterfly diagram (Fig. 5) illustrates the continuous flow of technical and biological materials through the ‘value circle’. The circular design strategy, known as R-ladder, is made up of 3 levels. Refuse and rethink at the top level, focus on using materials smartly at the design proposal stage. ‘Reduce’ at the second level includes using less new material but recycled material. Then it comes to reuse, repair, recycle, and recover.

Overall, circular design is a time-based design practice of creating durable, reusable, repairable, and recyclable products that generate zero waste to support a circular economy.

CHAPTER 2.2 Relations and similarities between circular design and the metabolism movement

Though being put forward at different periods and under different contexts, the circular design strategy and the metabolism movement share several notable similarities as two time-based concepts.

Both concepts are based on a time-based closed-loop system in architecture and material use. For circular design, the materials are designed to be kept in circulation as long as possible through R-strategies, while the metabolism movement emphasizes designing flexible structures capable of adapting to social dynamic along the lifespan, thus making the architecture effectively used as long as possible.

Moreover, the two concepts share the same goal of prioritizing resource efficiency, minimizing waste, and making architecture future-proof. The circular design emphasizes more on resources by maximizing the utilization of material throughout the lifecycle. The metabolism movement highlights the importance of synchronizing the physical trajectory of architecture with the social trajectory to ensure the long-term viability of the architecture. This approach is highly relevant to the ‘rethink’ strategy, which involves intensifying building use by reinterpreting the space or structure with new functions at the design proposal stage. Additionally, the strategy of leaving projects unfinished as we could see in the case of Sky House also implies the possibility and space of rethinking for users. Also, the strategy of easy dismantling or the concept of returning material back to nature proposed by Kurokawa shared a similar idea with the ‘recycle’ strategy.

Furthermore, both concepts draw inspiration from the principles of nature. Circular design deconstructs architecture into a collection of materials and emulates the regenerative cycles found in ecosystems, where materials are continuously reused, recycled, and regenerated. Similarly, in the case of the Metabolism movement, architecture envisioned the city as a dynamic system growing as organisms following the social changes, mimicking the resilience and efficiency of the natural ecosystem. However, there are certain differences between these two concepts. The circular design has a more explicit focus on the material life cycle, deconstructing the architecture into products of different materials and operating them at a micro-unit level. On the contrary, the metabolism movement focuses more on the interpretation of architectural space and its adaptation to social dynamics.

Considering the philosophical thinking or context behind the two theories, circularity is inspired by applying the biological model of circular economy to the architecture field while the metabolism movement is considered an architectural strategy toward social challenges for post-war Japan. Metabolism shows more consideration related to humanity, known as the ‘principle of life’. Especially considering the extensive concept of symbiosis and metamorphosis, they emphasize more on the relation between human and nature, which was later translated into architectural strategies to embrace social dynamics.

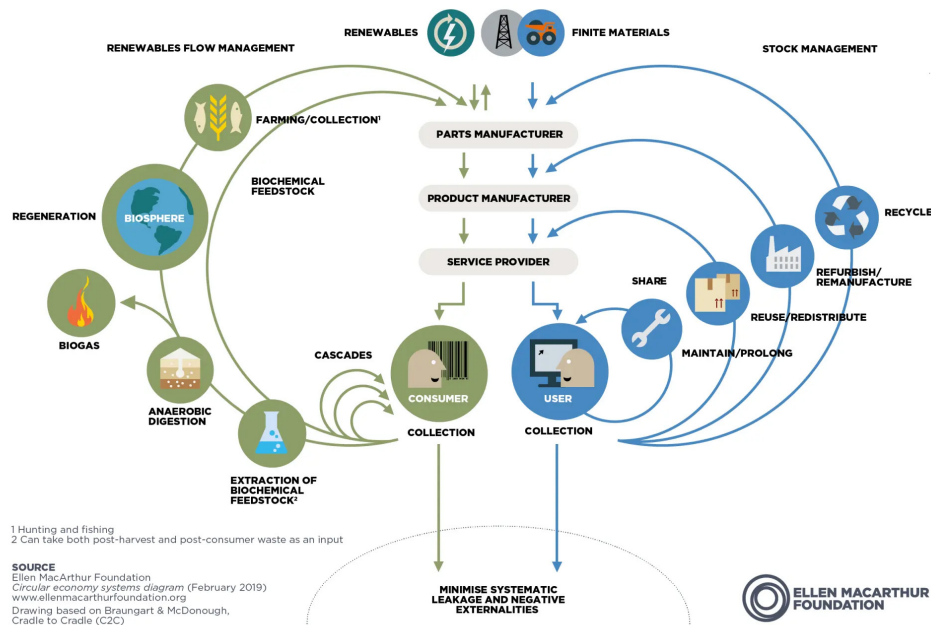


Fig 5. Circular design butterfly

CHAPTER 3. Case study

At the urban scale, certain metabolic ideas have been applied to the material flow study for time-based design strategies. To study this application at the architectural scale, the following architects and their projects are selected since they have a strong connection with the metabolism group through mentorship according to the geological chart (Fig 1.). And as new generation Japanese architects, it is inevitable to embrace the circular design mindset. By analyzing these projects, this thesis aims to study how the metabolic movement was interpreted in the current context for time-based circular design strategies.

CHAPTER 3.1 Toto Ito - SANAA & Ryue Nishizawa

Ryue Nishizawa and Kazuyo Sejima began their careers at Toyo Ito's office, and their designs bear certain inherited features such as simplicity, transparency, and an ethereal sense of lightness. Prior to Toyo Ito's collaboration with Nishizawa and Sejima, Ito was influenced by renowned architects such as Arata Isozaki, Kisho Kurokawa, and Kiyonori Kikutake, who were pioneers of the Metabolism movement. After graduating in 1965, Ito spent four years working under Kikutake, during which he absorbed Kikutake's

concepts of primitive free space, devoid of spatial hierarchies, which encouraged spatial flexibility and transparency. Ito distilled Kikutake's ideas into three key principles: Agricultural landscape, Primitiveness, and Symbolism.

Certain cultural continuity could be seen in SANAA's projects with primitive and open spaces revealing the echoes of the Metabolism ethos. Moreover, these concepts evolved under the current context by SANAA characterized by a commitment to simplicity while challenging traditional architectural forms and dismantling existing hierarchies to forge innovative new forms (Igarashi, 2018).

Moriyama House, Tokyo, Japan (2005): Objectives

Casa Moriyama stands as a compelling example of a residential-scale project boasting innovative form while effectively addressing the imperative of implementing a time-based architectural strategy in response to hypothetical socio-economic processes. The concept of "suburban," proposed by Yoshihary Tsukamoto, founder of Atelier Bow-Wow, sheds light on the urban crisis of block subdivision, wherein families are compelled to parcel out their properties and sell these fragments to others or investors (Dominguez & De Esteban Garbayo, 2018). Moreover, the fire regulation of having the exterior wall of all buildings to be set back 50 centimeters from the

edge of the lot created an even more fragmented urban landscape.

Strategical modular system towards changes

In response to the fragmented urban context and restricted regulation, Nishizawa devised an innovative intermediary design strategy to bridge the gap between single-family homes and housing complexes. He conceived a system of modular boxes housing respective functions, each with an independent structure that could function as autonomous organisms within the urban fabric. Instead of obeying the typical spatial hierarchy of residential buildings, Nishizawa deconstructed each functional space into one organism and implied no fixed circulation routes. The new system gives the possibility of multiple choices for subdivision and freedom of movement for both private and shared (Fig 6.).

This system considers long-term cycles within the generative city, as well as medium- and short-term changes corresponding to the evolving needs of tenants and homeowners. Despite the new level of flexibility given by the system, the new system also involves new living pattern with absence of borders, concepts of communal living and reconsideration of the balance between intimacy and social interaction. "Residents area free to choreograph their own experience". (Rob, 2007)

New interpretation of architectural metabolism

This approach bears a resemblance to the modular design systems of the 1960s, in which units could be added without altering the fundamental structure, as Fumihiko Maki posited regarding the concept of "group form." In the case of the Nakagin Capsule Tower from 1972, the vertical mega-system allows a movable capsule connected to the fixed central structure to accommodate changing living patterns (Fig. 6). It realizes the ideas of "metabolism," "exchangeability," and "recycling" as a prototype of sustainable architecture. (Kurokawa, 1992) However, in the end, the expansion at the base of Nakagin Capsule Tower was carried out in a conventional manner due to technological limitations.

Comparing these two cases, the capsule tower leans towards embracing changes through new technologies such as movable structures, while Nishizawa's approach embraces architectural metabolism and future-oriented residential building by rethinking how structurally fixed system could foster adaptable living patterns.

Under the scope of circular design

House Moriヤマ could be seen as an incentive to rethink the relationship between the city and human, shared and privacy. Also, it is a rethinking of shared and private resources.

By deconstructing those domestic functions into autonomous cubic boxes in the urban fabric, Moriヤマ House embodies the concept of urban living as 'living in the city'. (Fig 7.) Such new form of urban living implies minimizing the percentage of the intimate realm and maximizing the use of shared urban resources. On the other hand, by 'refusing' to privatize resources, it achieves a higher level of sharing resources, thus a higher level of resource efficiency. As Nina Bassoli calls "the hidden urbanism" in Japan, "it is possible to start out from the design of small places on the domestic scale and generate transformations on a larger scale, connected with an expanded dimension of living" (Bassoli, 2017) With such expanded dimension of living, the house Moriヤマ shows a deep reconsideration of how human co-living with the city and how to reduce overall resources consumption in the city.

CHAPTER 3.2

Sou Fujimoto

Similar to the case of Nishizawa, Toyo Ito influenced Sou Fujimoto as his mentor in his early career stage. The influence extends across various aspects of Fujimoto's professional trajectory, design approach, and architectural philosophy. They shared exploration of transparency, in-between space and innovative interpretation of structure.

House NA, Tokyo, Japan (2012): Objectives

House NA is a remarkable housing case that redefines the concept of dynamic living and relation between human and outer space within the dense urban fabric of Tokyo. The 914-square-foot residence stands as a bold counterpoint to the conventional concrete block construction. By contrast, the section is complex. Fujimoto tried to propose a form of living that echoes the nomadic lifestyle within a fixed domicile with such imaginative Escher-like spatiality which draws inspiration from the organic structure of a tree. (Fig 9.)

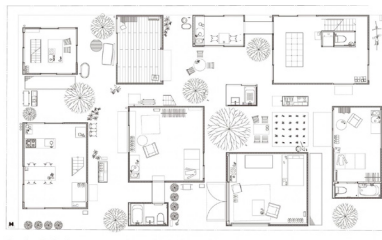


Fig 6. Moriヤマ House Plan with flexible system adapting changing living style along time

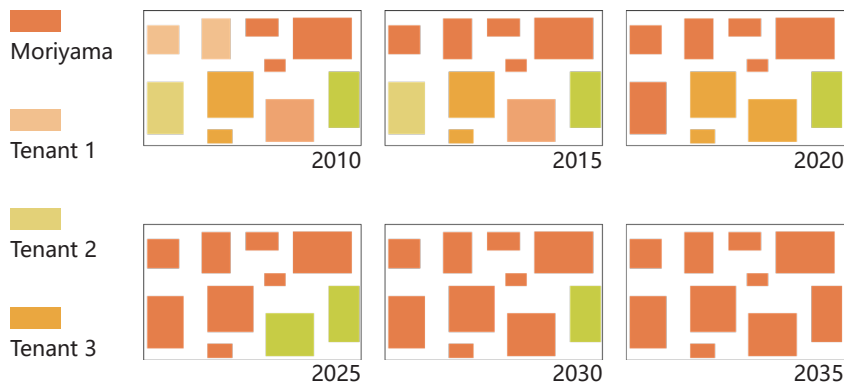


Fig 7. Moriヤマ House with blurred boundary between private and public realm, promoting the concept of 'living in the city'.

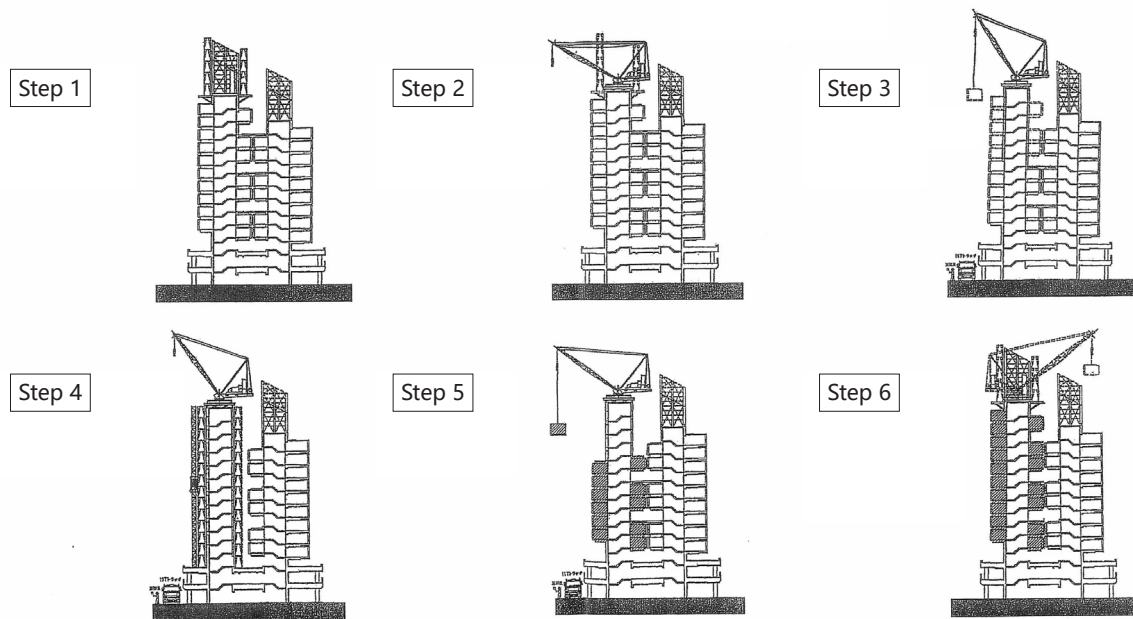


Fig 8. Process of replacing movable capsule from the central fixed structure of Nakagin Capsule Tower

Philosophical approach of intermediary space

As mentioned in the first chapter, Kurokawa extended the concept of metabolism to the idea of symbiosis, emphasizing on the coexistence and interpretation of opposite elements within the system. In other words, with the concept of symbiosis, the original idea of embedding chance of being dynamic in architectural design was translated or specified into embedding dynamic in spatial design.

In the case of House NA, it departs from the conventional residential spatial hierarchy and depart from the two-dimensional "free plan" but extend the idea of dynamic to three dimensions with free rooms. (Fig 10.) The project premises on a loose relationship rather than a rigid grid, as represented by boxes connected in a seemingly random manner under one roof. (Nuijsink, 2021) Fujimoto states, we could say that here we do not have only rooms, but one room (Fujimoto, 2011), or in the language of Deleuze and Barad that we have many rooms defined by intensive (rather than extensive) boundaries that enter into intra-active. Karen Barad introduces neologism interaction as a key concept in understanding the mutual constitution of different entities and entangled agencies. "In contrast to the usual interaction, which assumes that there are separate individual agencies that precede their interaction, the notion of intra-action recognizes that distinct agencies do not precede, but rather emerge through, their intra-action" (Barad, 2007). In other words, "distinct

agencies are only distinct in relational, not an absolute, sense, that is, agencies are only distinct in relation to their mutual entanglement; they don't exist as individual elements" (Barad, 2007).

With the free room concept, the project shows a strong architectural language for spatial relativity, where the boundaries between rooms are both defined and blurred, the whole system could be seen as one room, while the spaces within the system are separated but interrelated to one another. It recalls the concept of loop space, which eliminate spatial hierarchy and embed dynamic in spatial organization.

At the same time, referring to the symbiosis concept by Kurokawa, the façade could be seen as a membrane that bring together heterogenous elements to a while and allows intermediate spaces to arise in the process. In the case of House NA, the boundary between inside and outside is highly blurred. With the porch, terraces, balconies, making up of simple white steel flooring, the house gives similar experience of living in a tree, that is partially covered but the whole system is fully embedded in the natural context. It also recalls the concept of bring a nomadic lifestyle in urban context, which is a rethinking of coexistence between city and human.

From environmental point of view, such openness give possibility to natural ventilation and fenestration at proper position, which aligns with concerns for sustainability in circular design.

New interpretation of architectural metabolism

What people needed, Fujimoto argued, was no longer the functional organization of the machine age but rather flexibility and freedom of choice framed by a hidden order, akin to the organization of a forest (Inui, Fujimoto, Ishigami 2010). In the case of House NA, to achieve such dynamic or flexibility, Fujimoto adapts the strategy of deconstructing and reinterpreting conventional 'floor' and 'wall' systems to emphasize fluidity, openness, and adaptability. Similar interpretations of structural elements could be seen in the Sendai Mediatheque by Ito, in which pillars were not conceived as closed, giant concrete tubes, but transformed by their perforated, curved structure into an open space of communication.

In House NA, the floors ranging from 1.4m*2.5m to 2.5m*2.5m serve as multifunctional fields that enter relations with the other floors. However, the actual function is defined by the user as their with, according to Fujimoto, "an order can be made that incorporates uncertainty or disorder" (Fujimoto, 2008). The floor thus becomes at different moments a shelf, a sofa, or a chair (Fujimoto, 2011)

Instead of embedding possibilities of being changed in the short-term or long-term, the architecture itself is creating a system that relies on metabolism since the definition of space and function is time-based and fully relies on the interpretation of users. The project could be seen



Fig 9. House NA with blurred boundary to the outside and multifunctional floor defined by the users.

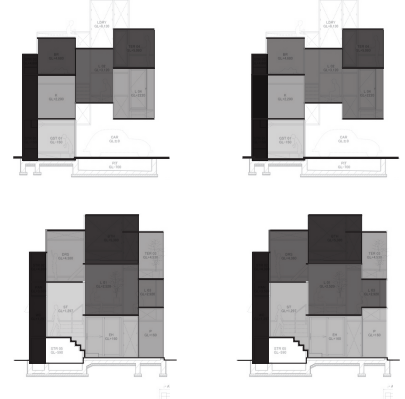
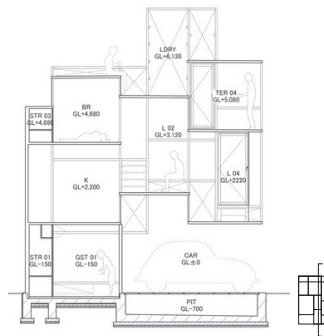
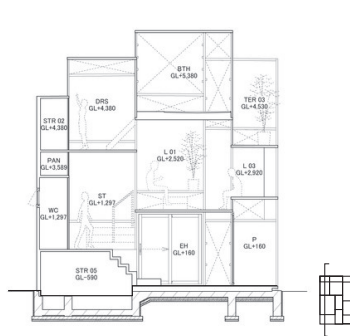


Fig 10. House NA - system of Free Rooms under one roof.

as a physical manifestation of the desire to live unfettered by traditional constraints, that attempt to strip away one's attachment to common shelter, to minimize the use of artificial resources, and to embrace the dynamic context.

CHAPTER 4. Conclusion

The two case studies show how the metabolism concept was interpreted in the modern context. Also, under the scope of circular design strategy, we see how the metabolism idea of designing flexible and adaptable space is highly relevant since they share the same goal of maximizing space durability by proposing time-based and future-proof strategies.

Compared to the 1960s architects, the new generation has shifted away from the fascination towards a mega-structure framework for architectural design but focuses more on the human scale experience. Both selected cases are in the dense urban fabric of Tokyo, therefore, both cases adapt very humble spatial or structural strategies to create flexible habitats in the city. In contrast to the 1960s metabolism group, when Japan

was bombed and being reconstructed, the proposal in the 1960s is more conceptual and experimental as we could see, for example, in the case of the Nakagin Capsule Tower, while the contemporary approaches are more grounded and targeted. Also, new-generation architects must follow stricter regulations and bear higher social expectations, leading to more pragmatic and practical design strategies.

In terms of structural or spatial strategies, the new generation of architects tend to introduce rather fixed architectural systems that could foster adaptable living patterns, while the 1960s architects tended to design changeable or adaptable structures as we could see in the case of Sky House with the unfinished open ground floor. In other words, the 1960s architects were more human-center, and they tried to create artificial structures adapting to variable social dynamics. On the other hand, the new generation of architects have a deeper rethinking of the relationship between human and the physical context. They tend to propose new forms of living that could easily align the changing social trajectory of users to the rather fixed physical trajectory of the building. Both strategies meet the metabolic call of treating architecture as a

growing organism within the city and provide spatial equipment that users could operate as Kiyonori suggested. However, the new strategies step forward and reflect a more fluid relationship between architecture and its occupants.

Under the scope of circular design, projects from the new generation of architects imply rethinking of the relation between human and city, as well as, human and natural resources. Such rethinking leads to concepts of sharing resources and refusing overconsumption. Both cases blur the boundaries between the intimate living realm and the public realm. In the case of House Moriyama, certain domestic functions are extended to the 'urban void' in between the white boxes for intimate function, blurring the lines between private and public as well as private-owned and shared resources. Promoting the living form of 'living in the city', urban integration, or co-living, increases resource efficiency. In the case of House NA, with the concept of a tree-like free room, the floor and wall system are translated into an undefined and multifunctional system. With the new system, the architects try to generate new spatial concepts for domestic buildings. With the multifunctional system, space usage gets higher efficiency, in other words, it reduces

resource consumption.

Overall, we see the new generation of architects continue the goal of the 1960s Metabolist group to design future-proof architecture. And the level of metabolic is interpreted in the context nowadays at both philosophical and practical levels. Such a goal is also highly related to circular design as the main global architecture concept nowadays towards sustainable building environments, which shows the forward-thinking of the metabolism movement, and we could still draw lessons from this avant-garde movement nowadays. By rethinking metabolism movement under the nowadays context and under the scope of circular design, it not only gives us an insight into flexible or adaptable design but also forces us to think about the new mode of living and consuming resources in the dynamic context.

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