The reintroduction of Japanese metabolism to sustainable architecture

Alexander Trudelle and Fan Zhang
1, 2 Griffith University, Gold Coast, Australia
Alexander.Trudelle@griffithuni.edu.au, Fan.Zhang@griffith.edu.au

Abstract: The Metabolist movement of the 1960s ended with the start of the energy crisis and sustainable consciousness. Despite its failure, metabolism provides meaningful and valuable explorations and references for the future design practice. Japanese Metabolism focuses on buildings that can adapt to changes and be re-creatable, not dissimilar to sustainability concerned with the adaptation to future occupants. This paper adopts a theoretical research method and expert interviews to describe and analyse metabolism and sustainability, compares their similarities and discrepancies, and explores the possibilities and opportunities of combining these two different design thinking. Results show that notion of sustainable architecture mainly concerns with technical domains rather than contribute to the setup of a wholistic sustainable system. Metabolism architecture is inherently sustainable, and its biological metaphor and systemic thinking can help sustainable design thinking build a resilience culture should they be combined. This study also proposes specific design guidelines and strategies for implementing this combined design thinking in the practice.

Keywords: Sustainability; Japanese Metabolism; prefabrication; cultural resilience.

1. Introduction

“The end of the 20th century can be considered to be the age of a vigorous technological development of man but, simultaneously, a period of considerable damage to his natural environment” (Cywinski, 2001, pp. 12)

Sustainability plays an integral part in the 21st century lifestyle. Everything from food, transportation, and infrastructure, to society has begun to reconnect with the natural systems. “Sustainability is a human project; an approach to structuring our relationships with the other kinds of systems and beings on our planet” (Parker, 2014, pp. 47). Architectural sustainability developed from a growing concern that humanity has been “pushing Earth systems to their limits where they will no longer be able to support the human prospect in the same way” (Jacques, 2014, pp. 19). It became a widespread concern around the idea of sustainability in the late 1980s when the ‘Brundtland Report’ from the ‘World Commission on Environment and Development’ called for sustainable development, defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (Brundtland Commission, 1987). This push was the first of many sustainable movements that revolutionized the world of architectural sustainability.
Japanese metabolism architecture grew from the ashes of world war II. After experiencing the destruction of the war, Kisho Kurokawa developed the theory of metabolism based on the fact that there must first be a destruction of the present growth for the new growth to evolve from the overgrown system (Taro, 2018). Kurokawa believed that Japanese metabolism architecture “was predicated on change” and therefore had no completed form (Taro, 2018, pp. 50). With the beauty of imperfection, the building was always growing and changing, much like the human body and society (Taro, 2018). Metabolism architecture is “built around a spine-like infrastructure with prefabricated, replaceable cell-like parts—easily attached and readily removable when their lifespan is over” (Craven, 2019). Japanese metabolism architecture was not only a design style, but also a philosophy that could be used as a guideline to keep up with a constantly growing city, moving ever faster towards closed communities and meaningless neighborhoods (Kurokawa, 1977).

The initial failure of Japanese metabolism architecture was probably because it was too radical and visionary for its time. The 1970s and 1980s also held various challenges for the philosophy. With the start of the energy crisis and the birth of sustainable design, the megastructure design quickly lost its popularity, being considered “dinosaurs of the modern movement” (Lin, 2010, pp. 516). However, seen from contemporary perspective, metabolism still provides meaningful and valuable explorations and references for today and the future design practice.

This study aims to examine the core tenets of sustainability and metabolism, compare their similarities and differences, and explore the opportunities of combining these two different design philosophies. Another aim is to propose design guidelines for practitioner architects to integrate the two design philosophies in current and future design practice.

2. Methods

To fulfill the first research objective, two different research methods were adopted—theoretical research and expert interview. To fulfill the second objective, the expert interview was adopted. Details for each method were as follows.

2.1 Theoretical research

This study adopted the theoretical research method to describe and critically analyze sustainability and metabolism. For each design philosophy, the overarching principles and features were reviewed, together with a case study utilizing this design thinking. The analysis also pointed out the similarities and discrepancies between the two design philosophies, along with the opportunities to integrate them.

2.2 Expert interviews

Due to lack of research literature in this topic, structured interviews were carried out to gain insight from experts in academia and design practice regarding the feasibility and necessity of combining Japanese metabolism architecture with sustainable design, and if possible, come up with applicable design guidelines for practitioner architects to implement integrated design philosophies. Interviewees should ideally come from various countries, must have at least 15 years of work experience in either academia or practice, and should be familiar with either sustainable architecture or metabolism architecture philosophy (ideally both). All research protocols have been fully approved by human research ethics committee in Griffith University.
The reintroduction of Japanese metabolism to sustainable architecture

The interview comprises 6 open-ended questions designed to allow for varied and explained responses from the participants. The interview often began with asking the participants their experiences in the field of architecture, specifically with sustainable and metabolism architecture. Then, the interviewer asked about the similarity with tiny homes and modular buildings, the issues with sustainability and metabolism, and how they could complement one another in these areas. If interviewees expressed favorable opinions on combining the two philosophies, the interviewer also asked them to come up with some integration guidelines and strategies. At last, interviewees were asked if they have any more comments or thoughts on this research topic. A total of 6 expert interviews have been conducted in July 2020 in the form of video calls. The demographic information of the interviewees can be found in Table 1. To analyze the interview results, standard thematic analysis was carried out.

Table 1 Demographic information of the interviewees

<table>
<thead>
<tr>
<th>Interviewee</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country</td>
<td>Canada</td>
<td>Australia</td>
<td>China</td>
<td>Australia</td>
<td>Australia</td>
<td>China</td>
</tr>
<tr>
<td>Profession</td>
<td>Professor of Architecture</td>
<td>Associate Professor of Architecture</td>
<td>Professor of Architecture</td>
<td>Professor of Architecture</td>
<td>Professional architect</td>
<td>Professional architect</td>
</tr>
<tr>
<td>Education</td>
<td>Master of Architecture</td>
<td>Master of Architecture</td>
<td>Doctor of Architecture</td>
<td>Master of Architecture</td>
<td>Bachelor of Architecture</td>
<td>Bachelor of Architecture</td>
</tr>
<tr>
<td>Experience</td>
<td>30 years in practice; 15 years in Academia</td>
<td>35 years in Practice</td>
<td>30 years in Academia</td>
<td>25 years in academia</td>
<td>15 years in practice; 16 years in Academia</td>
<td>20 years in practice</td>
</tr>
</tbody>
</table>

3. Theoretical research

3.1 Principles and features of sustainable architecture

Sustainable architecture has gained momentum, becoming a more prevalent design style as the increase of incentive programs, community awareness, and environmental problems drive socially conscious architecture (Parker 2014). However, as we develop more towards this ideology we leave behind the buildings of the past. These sustainable buildings usually employ the best combinations of sustainable and renewable technologies at the time of design but have little consideration for any change that may happen in the future or even beyond the buildings’ life cycle. Like all buildings, sustainable buildings can also have problems, however these problems not only cause issues to the building but also compromise the environmental aspect of a building. One example of this is the Philip Merrill Environmental Center, the first LEED platinum building under USGBC LEED, which suffered a failure of its building enclosure after only a few years (Desmarais, Gonçalves, and Trempe 2010). These failures have to potential to lead to "building enclosures result[ing] in environmental, social, and economical impacts that can reduce or even negate the positive effects of those green buildings” rendering the building no longer sustainable (Desmarais, Gonçalves, and Trempe, 2010, pp. 2). As humanity consistently faces disasters, land and housing shortages, and technological obsoletism we leave little benefit for innovation over elimination.
The Mesinaga Tower in Malaysia was to be a “progressive and environmentally responsible image that proved so valuable that it actually increased surrounding land value” and as a result implemented many sustainable design strategies prior to LEED (Leadership in Energy and Environmental Design) (Chan et al., 2004, pp. 2) The building implemented many sustainable design strategies for a high-rise building that included orientation for maximum efficiency, shading devices for passive cooling, vertical gardens that shade and ventilate the building, and open floorplans to promote natural ventilation shown in Figure 1 (Chan et al., 2004). The materials were also specifically chosen and placed to maximize efficiency with “[t]he core [using] extensive passive heating and cooling strategies [with] no mechanical support” (Chan et al., 2004, pp. 4). Furthermore, the east wall of the building, the concrete core, acts as a shade and heatsink; blocking out the eastern sun, and heating the building at night with radiant energy (Chan et al., 2004). As a sustainable building, steps are taken to lower energy usage including (but not limited to) natural ventilation and natural heating; methods that make it difficult to maintain an ideal temperature and can be difficult to adjust, a sustainability method that is not always acceptable in every climate.

Figure 1 Axonometrics: (Left to Right) Built Form; Planting and Sky Gardens; Solar Orientation; Shading Devices (Source: Chan et al., 2004)

3.2 Principles and features of metabolism architecture

The aim of metabolism is to “find catalysts for urban development to solve the issues that came with the rapid growth of megacities”, namely, “questions of land scarcity, housing shortage, and unplanned sprawl” (Schalk, 2014, pp. 293). The central essence of the metabolism movement is focused on the idea of interchangeability and perceiving a building structure as that of a living organism. Metabolism exemplifies this in the use of two elements, a centralized permanent ‘core’ representing the body of the structure, and transmissible modules, acting as appendages that can attach and detach from the core. In its building typology, the building physically evolves and changes over the course of its life, never truly ‘dying’ but responding to needs as they arise and changing in their absence.

The Nakagin Capsule Tower in Japan represents “the finest built work resulting from the historic Metabolist movement” (Lin, 2010, pp. 514). This building serves as the epitome of the metabolist movement and denotes both the beginning and end of the style. The building followed suit with the metabolist philosophy as it was designed to have interchangeable parts as the capsules surrounding the central column which was bolted on from 4 anchor points along the central column. These capsules were very small, only a few square meters in area and were to act “not [as] an apartment house”, instead “intended to provide single bedroom dwellings in the heart of Tokyo” as a temporary living or
The reintroduction of Japanese metabolism to sustainable architecture

workspace as shown in Figure 2 (Kurokawa, 1977, pp. 105). Designed as a response to ‘urban nomads’ these small capsules were intended to last for roughly 20 to 25 years before being replaced as a social necessity (Lin, 2010). The typical metabolist building featured a central column that would house the access and services to all of the attached modules and act as a stem to the building’s leaves. The idea of a metabolic city fell short when re-development overtook the potential to replace the modules and “[outpaced] the ‘metabolism’ that the Metabolists envisioned” (Lin, 2010, pp. 519). Metabolism only works if there is an aspect of growth rather than rebirth within a city, however favouring demolition over renovation regardless of the ease of access makes metabolic architecture redundant.

Figure 2: Axonometric of Capsule (Source: Lin, 2010)

3.3 Similarities, discrepancies, and opportunities

By reviewing previous literature on sustainability and metabolism, the similarities, discrepancies and opportunities for cooperation of the two types of design thinking have been synthesized as follows.

3.3.1 Similarities

Meike Schalk in the paper ‘The Architecture of Metabolism’ investigates and examines sustainable architecture present in “metabolist theories and products” (Schalk, 2014, pp. 279). In this paper, Schalk concluded that although the term ‘sustainable architecture’ did not exist in the 1970s, it was still present in the ideology of metabolism as it strived for a resilient world (Schalk, 2014). Schalk points out that sustainability and metabolism are driven by similar challenges—land scarcity, unequal development, pressure on infrastructures, and democratic issues in planning. The conference paper by Tharaka Gunawardena et al. (2014) discussed and compared the sustainable aspects of modular construction, showing unwitting research into sustainable metabolist architecture with modular systems that are a key component of the philosophy (Gunawardena et al., 2014).

3.3.2 Discrepancies

In regard to sustainability, Anna Hurlimann states that “there’s the need for adaptation, to physically adapt buildings and settlements to withstand present and future changes” (Harris, 2019). This style of
architecture carries a physical resilience, however, lacks any form of philosophical perspective of building resilience in its design methodologies. As Schalk (2014, pp. 280) points out, albeit “sustainable architecture” has been widely used in recent decades, “the term is mainly used to refer to recent ecotechnical building solutions, new materials, and ecolabeling, and rarely to social and cultural settings and practices.” This is where the introduction of Japanese Metabolism Architecture can compensate the shortfalls of sustainable design. While both sustainability and metabolism encompass the notion of resilience, the former physical, and the latter philosophical, Japanese metabolism style was designed to “[respond] to the human and environmental [catastrophes] ... [and] vulnerability to natural disasters” and as a result carries the potential for change (Schalk, 2014, pp. 280).

3.3.3 Opportunities

Through the use of Japanese metabolism architecture, sustainable architecture can further itself in efforts to lessen carbon footprints due to the heavy prefabrication of the buildings. “The prefabrication of buildings has proven to reduce construction waste by up to 52%” resulting in greatly “improved energy, cost and time efficiency of construction” (Gunawardena et al., 2014, pp. 1). This philosophical resilience that Japanese metabolism architecture promotes not only gives perspective to a building, but incorporates growth into a building that epitomizes life, a living building. Furthermore, a common adage in recent years is that the most sustainable building is one already built. Rather than replacing an entire building, renovation is most always preferred from a sustainability standpoint. With Japanese metabolism, this inevitable renovation that all buildings require at some point in their lifecycle, can be made more sustainably and even prolong the life of the structure (Elefante, 2012). As the initial failure of Japanese metabolism architecture was largely in part due to the era of its inception, there are seemingly less hurdles for the style this time around. As a combination between sustainability and metabolism, energy would not become an issue regardless of a potential crisis due to sustainability’s focus on energy conservation. Furthermore, the building type is not limited to megastructures, however the recent re-immersion of megastructures in overpopulated cities with high density provides additional opportunities for the implementation of sustainable metabolic architecture. The development of this style also gives room for the implementation of Japanese metabolism architecture and sustainable design into pre-existing styles as an additional feature. The sustainable modularity can be applied to any style of building, from art deco houses, to post modern art galleries. This style not only works well on its own, but also can be incorporated into many other styles symbiotically bettering the building.

4. Findings from Interviews

The interviewees’ opinions and ideologies bifurcated on whether metabolism is still valuable and whether the two types of design thinking should be combined. The following section summarizes a typical proponent (Interviewee A)’s opinion and a mixed opinion from intervieweeB.

4.1. Different opinions about integration

4.1.1 A typical proponent’s opinion

Professor A is a proponent of integrating the two types of design thinking. He works in the architectural discipline in Canada. He started his career by working with Ken Yeang. He has been involved in the architectural design of Menara Mesiniaga Tower in Malaysia, one of Ken’s most notable projects in
sustainability. Prof. A also has experience in modular construction in the form of panelized housing. When asked about the failure of Japanese Metabolism, Prof. A explained that “it came a bit too early” and that “societies were not quite ready at the time to accept it on a global scale”. Prof. A is very enthusiastic about the idea of incorporating Japanese metabolism into sustainable design and has shared many interesting opinions and views on the matter.

When talking about the relationships between the two types of design thinking, Prof. A has expressed that all metabolism architecture is inherently sustainable as the modules are prefabricated, and the smaller size allows for less energy use and higher density, and there is less of a footprint for demolition of the structure as the modules are removable. He sees metabolism as “sustainability without a label”. Prof. A believes that this inherent sustainability proves important to the collaboration of metabolism and sustainability as it can be difficult to get society to be sustainable when it does not benefit them directly. This underlying sustainability will allow those who would be more resistant to the notion of sustainable buildings due to the need for more effort on their parts to be open to the idea of a sustainable building without the same level of effort.

Another important view of Prof. A is his analogy between a metabolist building and a tree. He explains that the process a tree grows to fill the space below others resembles how metabolist buildings may be erected—they do not crowd the space of others; instead, they change direction to make their own paths. They are “living together as a community, ... [knowing] how to navigate past each other”.

4.1.2 A typical mixed opinion

Associate Professor B works in an Australian university with over 35 years of experience in practice and 16 years in academia and has an interest in Japanese metabolism architecture. During the interview Professor B expressed his opinion that Japanese metabolism architecture was past its time and that “Metabolist architecture occurred at a particular point in time and it had a particular … set of values” that we have moved past with some qualities being revisited now in the form of modular construction and smaller spaces. He does not believe that the Metabolist idea of “megastructures and plug-in cities” will be revisited due to the changed technology and political systems around the world. Because of this political situation where “countries are more focused on their internal issues, problems and approaches to things”, he believes that metabolism is less likely to succeed as it “demands too much of a commonality between all the participants in terms of build outcomes”. Another reason he believes metabolism to be outdated technologically is because “we’re in an era particularly with mass-production where [it no longer] requires every item to be the same” with mass-production accompanying mass-individualization, lessening the need for factory line construction as our technology promotes creativity.

Despite the above opinion, Professor B does believe that there are values in the Metabolism philosophy at the time, which is to build more sustainable, cohesive, and economical settlements with efficiency. The meta ideals still exist today, but how it is achieved has changed through production techniques and society, with underlying principles still present. Overall Professor B views the reintroduction of metabolism with a realistic sense of doubt due in part to the past failure and the association with old metabolism ideals, but believes there is an increasing interest in customizable, plug-in pieces for high-rises and apartments, especially regarding the more advanced construction requiring plumbing and electrical works. Despite the seemingly negative aspect of metabolism addressed in this interview, Professor B offers first-hand examples of what the original metabolism philosophy can be
changed to raise the social acceptance of the style in the 21st century, with the help of sustainable design.

4.1.3 A summary

Among 6 interviewees, 4 of them are favourable of reintroduction of Metabolism into sustainability, while another 2 have expressed some concerns and/or doubts. In general, there is a strong belief from the participants that the metabolist philosophy will take root in the 21st century and may fit well with experimental architecture. Of the participants that were unsure of metabolist architecture, there was still a belief that the style was appropriate to the 21st century, with underlying doubts due to the initial death of the philosophy.

4.2. Integration Design guidelines

The four interviewees in favour of integrating two design philosophies were further asked to propose integration guidelines. By carrying out a thematic analysis, these design guidelines have been categorized into 3 overarching categories: overall building, modular design, and structure.

4.2.1 Overall building

The following design guidelines focus on the overall design of the building in its final form, and the cooperation between the building and the site.

- Core + replaceable modules. A sustainable metabolist building should have a typical metabolism building typology, featuring a three-dimensional skeleton of long-term service structures, and various functional modular units of different life cycles.
- Sustainable design. The building design should seek to reduce environmental effects through the use of passive design. Passive design strategies should include natural ventilation through the vertical connection of building levels utilizing the stack effect. Building orientation and passive shading should be utilized to promote natural cooling methods.
- Creation of communal spaces. Communal spaces can be used as a method to break the dull matrix of modular units, and to create connection and communication between them.
- Resilience in physical form. Utilizing more resilient materials such as concrete or stone to maintain the building for longer periods of time with a primary focus on durability.

4.2.2 Modular design

These design guidelines focus more on the individual modules that are used as the primary aspect of metabolism design.

- Larger spaces. Typical metabolist buildings were designed as compact spaces, which might have limited the building functions and compromised user comfort. Larger spaces in modular units were ideal if possible.
- Prefabricated construction. Maintaining the prefabricated ideology promotes sustainability and fast construction.
- Removable modules. By having the modules easily removable and replaceable the building can grow and change.
4.2.3. Structure

These three guidelines focus on the structure of the building involving the style of structure and implementation of module movement within the building and alternate sites.

- Mobility. Allowing for ease of mobility of units on the site will promote the use of this feature.
- Built-in crane. The inclusion of a permanent crane within the structure of the building leads to ease of mobility.
- Permanent structure. The use of a stem (classic), cage (modern), or hanging (abstract) structural form.

5. Conclusion

Metabolism is a modern architecture movement originating in Japan, which sees cities and buildings not as static entities, but as living organisms. Sustainable architecture and metabolism architecture emerged from similar historical background, aiming to achieve similar goals of cultural resilience. However, sustainable architecture more focuses on technical aspects like materiality and technology, while metabolism proposes a systematic conceptual approach to reorganize the city and public systems. Integration of the two philosophies are therefore possible and beneficial, meaning that sustainable buildings will have prefabricated modular units that are movable and replaceable when their lifespans are over, and metabolism buildings will also incorporate sustainable design principles and features. Practical design guidelines and strategies were also proposed to integrate the two design philosophies.

Acknowledgements

The authors would like to thank all interviewees who have participated in this study, and all academics from the Architectural Design Discipline in Griffith University who have provided valuable suggestions to this research. The authors would also like to thank the reviewers’ comments.

References


