

Symbiosis: The Second Wave

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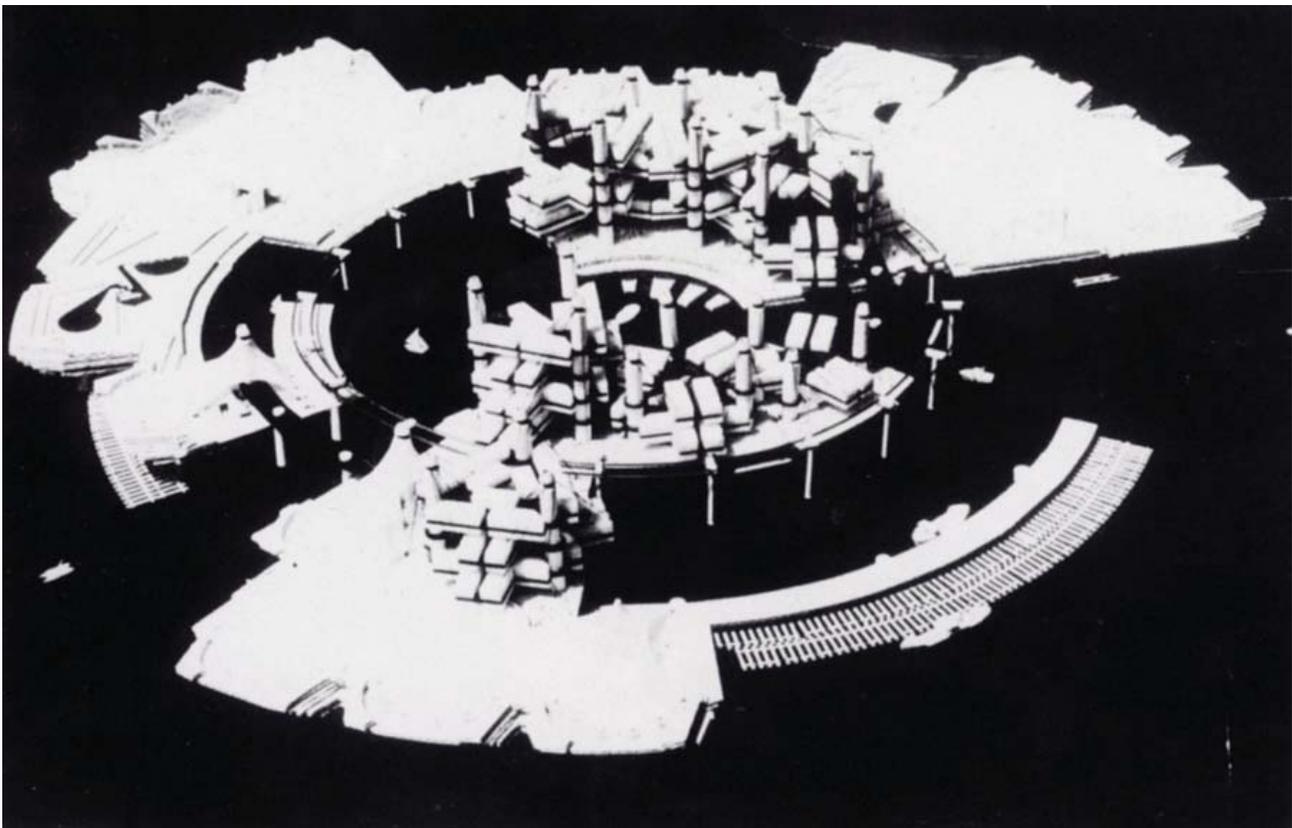


Figure 1. Hawaii floating city

INTRODUCTION

In 1960 Kishio Kurokawa, Fumihiko Maki and Kiyonori Kikutake published a manifesto titled 'Metabolism 1960: Proposals for a New Urbanism' to coincide with the Tokyo World Design Conference of the same year. The conference program was conceived by Kenzo Tange to address problems of industrialized growth and featured his own "Structuralist" plan for the reorganization of Tokyo. The

metabolism group took Tange's Structuralism as a point of departure to elaborate on their own approach to urbanization in reaction to the official demise of the modern movement just one year earlier.

In opposition to the rational western roots of the modern movement Metabolism was based on Buddhist concepts of changeability and renewal and the aesthetic of an unfinished image. The machinelike

mechanical model of the modern movement was replaced by a biological one in which the parts like living cells could come to life and die while the entire organism goes on living. According to the manifesto, "the architect's job is not to propose ideal models for society but to devise spatial equipment that the citizen's themselves can operate." This equipment consisted of prefabricated and interchangeable modular space units that could be plugged in and out of a structural frame as necessary.

In practice, however, many Metabolism buildings had a heavy industrial appearance that reinforced the very technological bias that they sought to overcome. Furthermore they never actually achieved the flexibility and interchangeability that was the essence of the underlying concept. Rather than a movement involving the simultaneous participation of various segments of society, metabolism was limited to a few isolated buildings by individual architects acting independently. These failures were due, not to a lack of vision of the founding members but to a lack of social, economic, or political support in an era when technological advancement could not yet facilitate the implementation of such an ambitious movement.

METABOLISM

The current environmental crisis is bringing professionals and communities together in an unprecedented fashion to address the formidable problems facing the world. The call for more efficient, environmentally friendly buildings and construction processes has brought prefabrication and modularity to the forefront of architectural discourse as it has not been since the metabolism movement of the 1960's. Many of the same issues related to rapid urbanization that were addressed by the Metabolist manifesto have once again become relevant. Kishio Kurokawa said,

"We have gradually come to realize that the survival of humanity depends on the symbiosis of the many life forms on our planet and we can no longer believe that the machine, scientific technology and the human intellect are all powerful". M to S

The architecture of metabolism posed a challenge to the machine age and proclaimed an age of life. The image of the living cell on which it was based encompasses notions of growth, division, exchange, transformation, autonomy of parts, deconstruction, recycling, rings and dynamic stability.¹ The goal

was to create architecture that would change, grow and metabolize and would encourage the participation of those who used its products. Metabolism devoted a great deal of energy to the topic of technology and human beings and is often thought of mistakenly as a technological movement but according to Kurokawa its fundamental concept was in fact symbiosis.² Architecture and the city were seen as open systems in time and space like living organisms. Kurokawa wrote

*"The essential difference between life and a machine is that a machine has eliminated all needless ambiguity being constructed solely on functional, rational principles, whereas life includes such elements as waste, the indefinite and play. It is a flowing structure forever creating a dynamic balance."*³

The field of industrial ecology which has continued to gain popularity since the early 1990s reiterates Metabolism theory based on the idea that mechanical and biological processes both involve the transformation of matter and energy and that therefore industrial manufacturing processes can perform like- and together with- natural ecosystems. Architecture is now being seen as one component of a larger natural system just as the Metabolism movement proposed.⁴ The philosophy of metabolism opposed western dualism and the opposition between man and technology and began with the assumption that man and machine can live in symbiosis. The architecture of metabolism was conceived as the architecture of temporariness, as expressed by Buddhism's concept of impermanence. It was an alternative to the western aesthetic ideals of the universal and eternal. Ise Shrine, Izumo Shrine, and the Katsura detached Palace, because of their respective histories of renewal were sited as the pretext for the movement.⁵

In his book *From Tradition to Utopia* Kiyonori Kikutake reflects,

*"I began to seriously consider methods that utilize natural resources without waste, that reuse materials by dismantlement and reassembly and allow for reconstruction. Metabolism was based on this idea"*⁶

The concept of Metabolism is universal and the designs placed an emphasis not only on the whole but on the existence and autonomy of parts. The movement addressed the relationship of cities to natural systems, buildings to the city and building components to the buildings. They were at once

interdependent and autonomous. With the idea of autonomy of the individual came the expression of capsule architecture where each individual living unit has an independent identity. Capsule architecture was not intended for mass production but was instead intended as deconstructed architecture and sought to create a plurality of new possibilities of combination.⁷ The inherent modularity of the capsule concept lent itself to prefabrication and started a wave of interest and research into prefabricated modular housing in Japan in the 1960s and 1970s.

PREFABRICATION

The contemporary movement towards a built environment that is more in tune with natural systems resonates with the metabolism theory of the 1960s. The modularity and prefabrication embraced by the metabolism movement is relevant to our current environmental crisis in several key ways. Prefabrication of building components in factories results in a minimization of construction waste and entire capsules or parts of them can be readily designed for reuse. Capsules also have the possibility of being regionalized with locally produced, renewable materials. This strategy would overcome the homogenizing effect of mass produced, generic architectural elements and would reduce the carbon footprint of buildings. The inherent accessibility of individual components optimizes the potential for commissioning and controllability of building systems in modular buildings.

Another attractive feature of the pre-fabrication process is enhanced quality control. Significant resources are spent on conventional construction projects to ensure that construction is proceeding according to plan but results are variable at best. Also, as energy usage in buildings has become a focus of attention in our global efforts to build sustainably, the promise of enhanced quality control through prefabrication has become more attractive. Quality is enhanced in a factory due to control of the environment improved supervision, automation and a greater focus on specific tasks.

AFFORDABILITY

As the cost of housing and construction prices soar, prefabricated buildings hold the promise of greater economy than their site built counterparts. While

the metabolism buildings were not built for economy per se the 100 sq. ft. capsules used by Kurokawa in the Nakagin Capsule Tower were said to be roughly the price of a Toyota Corolla. Assuming there is economy in numbers and even within a more contemporary scenario of mass customization we could potentially expect a 100 sq. ft. capsule equipped as a kitchen or bathroom to cost somewhere around \$10,000- \$15000 and a capsule that was strictly living space with no mechanical systems to cost considerably less which means that a 1200 sq. ft house [which would seem large if designed with the space saving features characteristic of Kurokawa's modules] might cost between 120 and \$150,000. In addition there is the cost of the core which gives the building structural support and contains circulation and utilities.

In the US the perception of affordability in prefabricated buildings has come with the negative perception of inferior quality. According to Dwell magazine "the manufactured housing industry is stigmatized" The Dwell home design invitational an international design competition to design an affordable prefab home has championed the image of prefab housing by producing reasonably priced prefabricated houses skillfully designed in contemporary styles. Dwells mission was not only to design affordable houses but to promote the image of prefabrication and modern architecture.⁸ Perceptions of prefabrication however may be culturally related and vary from place to place. In Japan for example prefabricated housing has been the norm for nearly a generation. There is a sense that prefabricated homes are modern and well suited to contemporary lifestyles. As Japanese people are also very fond of their automobiles one clever advertising campaign showed a man who had just finished washing his car turn the hose on his water proof, vinyl house to wash it as part of his weekend ritual. This is perhaps indicative of a move in Japan, away from the extended family structure towards the nuclear family where the house, like the automobile, is viewed more as a commodity than a permanent structure to serve a family for generations. With the increasing mobility and impermanence of the American populace this view of the house as a shorter term recyclable commodity is not out of the question.

RECENT PROJECTS

The recent resurgence of interest in recycled building



Figure 2. Nakagin Capsule hotel

materials and components has led to a worldwide movement to reuse shipping containers as literal building blocks. It is interesting to note that the capsules for the Nakagin Capsule Hotel while not recycled were fabricated by a manufacturer of shipping containers.

According to their website Container City™ is an innovative and highly versatile system that provides stylish and affordable accommodation for a range of uses. Devised by Urban Space Management Ltd, the Container City™ system uses shipping containers linked together to provide high strength, prefabricated steel modules that can be combined to create a wide variety of building shapes and adapted to suit most planning or end user needs. This modular technology enables construction times and cost to be reduced by up to half that of traditional building techniques while remaining significantly more environmentally friendly.

To date Urban Space Management Ltd has



Figure 3. Container City

successfully used the Container City™ system to create office space, retail space, artist studios, a nursery, youth centers and a live/work space.[website] It must be more than coincidence that the containers each have one round window reminiscent of the Nakagin Capsules.

Although the capsule idea has seldom been used in land based buildings since the Metabolism movement the Shipping industry has been making use of capsules for some time. Piikkio works is the world's leading manufacturer of prefabricated cabins and bathroom modules for ship owners and shipyards. The company has manufactured more than 60,000 custom-made modules for delivery in a variety of environments including offshore hotels. These cabins are prefabricated to include the full layout including furnishings, plumbing, and electrical systems ready to be installed into the ship frame. Prefabrication facilitates the management of the overall ship construction by reducing construction times, range of construction trades needed on site, and construction on site.⁹

Modular Building Systems

Modular buildings can be grouped into 3 general categories. The closed system approach emphasizes economy, rationality, and limited interchangeability of parts. It may offer some variety in the planning stages but once the layout is agreed to the prefabricated pieces are interlocked into a closed unit. The container city Buildings are of this type. The open system approach utilizes an open frame that allows modules to be added or taken away at any time. Le Corbusier experimented with this sys-

tem and there are several examples of buildings built this way during the 1970's in Japan. A mixed system represented by The Nakagin Capsule Hotel by Kurokawa contains fixed traditional architectural elements like a vertical circulation and utilities core with removable modules attached to it.¹⁰

Due to the Metabolism movements relationship to urban design theory and the necessity for buildings to change over time the mixed system was chosen for its architectural expression. In the mixed system the core is an extension of the urban infrastructure and the capsules allow for change. From a pragmatic standpoint the integration of a circulation and utility core with structural and mechanical systems in a mixed system offers enhanced accessibility to utilities, ease of commissioning, interchangeability and ease of upgrading parts.

A closed system on the other hand offers greater economy but does not offer the potential for organic growth and therefore was not conceptually appropriate for the Metabolism mission. The capsules of Nakagin were designed to be replaced periodically but during the 35 year life of the building, they were never replaced and now the building is scheduled for demolition without its inherent potential for rejuvenation having ever been tested. Nevertheless the mixed system accommodates the need to service utilities and upgrade components in a way that eliminates the expensive demolition work of taking off and replacing finish materials or cutting through concrete slabs to access utilities. The practical implementation of the vision of changing modules to upgrade a living environment may be a matter of economy and ease. If the capsules were economical and the process of changing capsules smooth and relatively effortless it is possible to imagine a segment of the population reveling in the opportunity to change their house every 5 years in the same way that they change their automobile without the upheaval and tribulation of having to change addresses altogether.

NEW TECHNOLOGIES AND MATERIALS

The sparse geometries of 20th century modernism were in large part driven by Fordian paradigms of industrial manufacturing, imbuing the building production with the logics of standardization, prefabrication and on-site installation.¹¹ Within this industrial manufacturing environment the visionary team who introduced metabolism to the world pushed

the technology of the time to its limits, but in many cases it was the limitations of that technology that led to a disappointing realization of the concept. Most buildings built according to Metabolism theory, including those of the group, were constructed along rather conventional lines inasmuch as they were not designed to be changeable or extendable and even if they were so designed, almost none was actually changed or extended. The Industrial aesthetic reflective of the technology of the time dominated the metabolism designs, yet flexibility based on interchangeability a fundamental aspect of the theory remained largely an elusive matter.¹²

The ideal of an infinitely flexible, changeable system that can expand contract, grow and die like a living organism could not be realized with the technology available at the time. However, as CAD CAM design and construction replace paper based processes and as design and construction processes globalize we will see ways of making places that privilege variety, complexity and local responsiveness rather than the standardization, repetition and tight spatial disciplines characteristic of the industrial era of which the metabolism movement was a part.¹³

Unlike the fragmented design and construction processes of the past, in the current technological environment, once a design has been digitally modeled, through some derivation process, it is ready for fabrication. We can think of a fabrication machine as a device that automatically translates a digital object in a design world into a physical realization. According to mid 20th century technology, the rationalities of manufacturing dictated geometric simplicity over complexity and the repetitive use of low cost mass produced components.¹⁴ But these rigidities of production are no longer necessary. Mass customization in stead of Mass production, made possible by computer driven technologies and their inherent potential for flexibility has further awakened a sense of arrival of a new era in industrial production.¹⁵ As digitally controlled machinery can fabricate unique, complexly shaped components at a cost that is not prohibitively expensive, variety no longer compromises the efficiency and economy of production.

Current digital technology has brought the construction industry to the brink of being able to realize the visionary designs of metabolism in a way that begins to mirror the diversity and complexity of natural biological systems. A recent development

in computer technology has been the introduction of the genetic algorithm into architectural design. The process involves the adaptation and translation of computer simulations of evolutionary processes in biology into the domain of architecture. This allows architects to breed forms and adapt their role from being form makers to decision makers within an organizational process.¹⁶

Trends in electronically enabled miniaturization and dematerialization also favor the controlled environment offered by prefabrication and the flexibility of open or mixed system modularity. Potentially we can think of all of the devices and appliances in a house as smart objects that can sense and respond to their changing environments and can act as servers in peer to peer networks. Many of these devices can be built into building components which will then need to be changed as technology changes.¹⁷

Although there is much promise offered by recent technological breakthroughs, the digital environment right now provides more capabilities than the design professions have been able to implement or even absorb. Many of the recent advances have primarily been manifested in allied design and production professions and not in the building industry per se. At the moment the building industry is still highly fragmented, consisting of diverse levels of technological sophistication. This ensures that the fabrication base for the building industry will remain for some time a mosaic of varying levels of more or less digitally integrated operations.¹⁸ While BMW unveils GINA its light visionary model concept car [BMW USA.com] progress in the build-



Figure 4. Digital Plasma Cutter

ing industry remains sluggish.

In addition to breakthroughs in digital design and fabrication technologies there have also been significant advances made in the development of stronger, lighter, more flexible and environmentally sensitive building materials. The list of innovations is too long to include here so the following is a brief discussion of just a few. Long fiber reinforced thermoplastics are a recent development where polypropylene or thermoplastic material is directly compounded with long glass fibers and then molded in one operation. LFRT have excellent mechanical properties and stiffness to weight ratio. New glass bending and tempering technologies without molds have taken the use of curved shapes to a totally new level while the production costs are approaching the level similar to flat tempering.

Structural insulated panels are available in a variety of skin and core material combinations. SIP panels are typically part of a modular building package that is prepared using CAD CAM technology. SIPs can be used for walls roofs and floors. A recent innovation in this technology is the panel by Ambiente Housing Midwest that utilizes recycled, crushed glass as the core of the panel, fiberglass for the skin and offers a minimum insulation value of R-30. Other company's panels utilize fiberglass, OSB or aluminum for the skin and EPS for the core. Reactive powder concrete is extremely workable, durable and yields ultra-high strengths without using coarse aggregates. Reaching compressive strengths of 30,000 psi, this new-age concrete also has tensile strength with the inclusion of steel and synthetic fibers and has been used to make shell structures that are as little as 20mm thick. Advances in steel and carbon fiber technology have resulted in higher strength lighter products than were available in the past. A recent breakthrough in Australian 'green' steel technology, derives carbon for steel making from recycled plastic bags and cuts coke and coal demand while reducing factory emissions.¹⁹

CONCLUSION

Recent advances in technology and the widespread awareness of an environmental crisis have given new relevance to the Metabolism movement of the 1960s. The movement is perhaps more important for its theoretical elaboration of the link between the natural and built environment than for any of

the actual projects that were built. In retrospect, the technology of the time was insufficient to realize the bold proposal of a plant like built environment that lived, grew, died and transformed in symbiosis with nature. In reality, the buildings were often heavy, machinelike, mega-structures with no potential for growth or transformation.

With the new tool of CAD CAM, for the first time there is potential for a direct connection between design and manufacturing in the building industry. With this technology comes an unprecedented potential for variety and diversity in products and building forms. Genetic algorithms offer the potential for bringing biological processes and architecture together in a tangible way. Advances in building materials and technologies are accommodating the construction of new building forms and answering the demand for the latest high tech systems.

In view of these developments and the need to create a built environment in symbiosis with the natural systems of our planet it is a good time to revisit the ideas of the Metabolism movement. With the

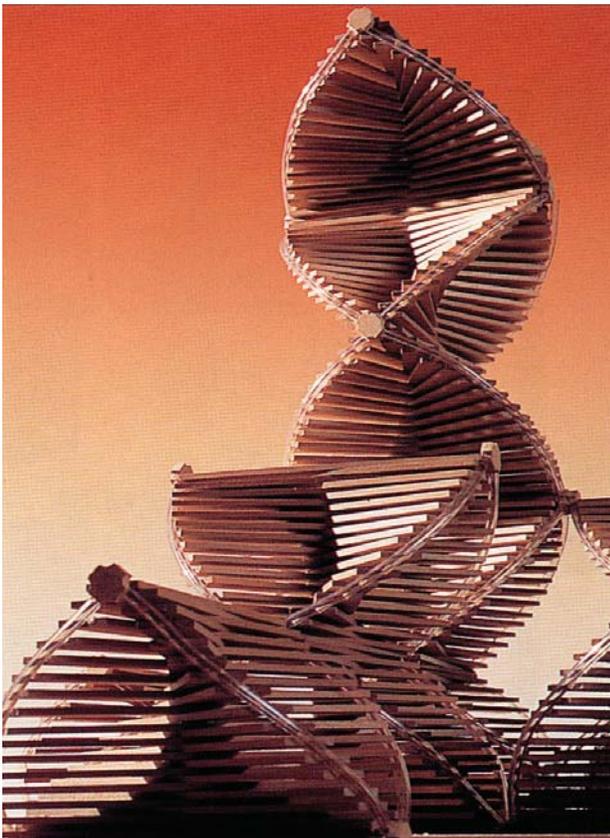


Figure 5. Helix City

powerful tools and materials at our disposal it is possible that the dream of buildings that can grow and transform in symbiosis with man, machine and nature can be realized in the near future.

ENDNOTES

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