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Revisiting Modular Design in a Contemporary Sociotechnical Context

Jeemin Sohn, Jungwoo Chae*

Seoul National University, Republic of Korea

* Correspondence: jeeminsohn@gmail.com

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ABSTRACT

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REVISITING MODULAR DESIGN IN A CONTEMPORARY SOCIOTECHNICAL CONTEXT

Jeemin Sohn & Jungwoo Chae*

Seoul National University

*jeeminsohn@gmail.com

www.nzaar.com

Abstract

The current housing market reflects a need for diversity and human centered design strategies. Similar housing conditions during the Post-war period during the mid 20th century experimented with modular design as an affordable and easy to manufacture housing typology. However, shifting attitudes during Postmodernism dismissed modularity as an inhuman design strategy. Recent social attitudes and growing technologies, however, have created a unique opportunity to further explore the true potential of modular design as a flexible, user-centered design method. Through analysis of previous modular methods, a contemporary modular design strategy was formulated. New production methods, computational design technologies, and distinctive designer-user relationship has allowed modular design to fully engage its diversity, adaptability, and customizability. The contemporary modular method looks at building from the inside out, analyzing the user lifestyle to inform the final output. Contemporary design culture is the perfect set of socio technological conditions to explore modularity as not only a production method, but a complete design strategy.

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1. Introduction

Housing has always been an integral clue in understanding the lifestyle, environment and cultural trends prominent in a society. The recent shift from a family orientated lifestyle to a more individual focused, single-member household culture is likewise evident in the current housing market- with its oversaturation of poorly constructed, highly repetitive housing options. These housing options reflect a dependence on mass production, trend sensitive attitudes, and economic optimization. Such consumptions patterns are the leading cause of the environmental deterioration in the Anthropogenic Era [6]. There have been numerous technological advancements in recent years that have allowed designers to develop mass customization strategies to help better the quality of life, yet little has been done in actualizing the socioeconomic desire for a more adaptable housing solution. In fact, the culture has shifted to one of rapid consumption due to affordable building costs and faster construction techniques. It

has become economically beneficial to constantly replace low cost, short lifespan structures than to build more expensive, long term solutions.

Similar housing conditions dictated the post-war period during the rise of Modernism and Postmodernism in the 20th Century, reacting, mainly, to war time efforts and shifting ideas towards industrialization in the Machine Age. Post-war scarcities and increasing stress on housing options led architects to explore the concept of modular design as a way to simplify the production process for a quick, easy to produce and build housing option that utilized the machinery of the war and the lack of skilled labor forces. However, the method was quickly dismissed with the growth of Postmodernism and more organic methods of design, leaving modularity as a brief design trend rather than a fully functional design system.

Henceforth, modular design has become a fragment, or an icon of modernism, that

quickly faded into design history without realization of the true potential behind the building methodology. Today, there is an increasing demand for a simplified building system that can encompass the potential and flexibility of mass customization, the affordability of mass production, and simplicity of a kit-of-parts design methodology.

The purpose of this paper is to twofold. First, is to provide the foundation definition of modularity as relevant in space design. Revisiting the ideas of modular design in Modernist and Post-Modernist architectural thinking will provide a way to understand the value of modularity in the framework of present day design. Specific case studies will also help inform the different sociotechnical reactions to modular design during the initial growth of modular design trends.

Second, analyses of previous modular methods will be used to inform a contemporary modular design approach that can best support the current housing market trends. Looking at the current sociotechnical climates, a new modular design method will be introduced to be tested in future research.

2. Research Methods

In order to properly define modularity, this paper will look at the different contexts in which modularity was used as a design method throughout the mid 20th century. Looking at the historical development of modular design, the analysis can inform the most plausible future form that modular design will take in the current sociotechnical context. Taking the characteristics specific to modularity as a design tool, rather than modularity as a cultural trend, we can reassess the value of modular design in a design culture that is better suited for such design strategies.

Specific case studies focusing on three distinct aspects of modular design- human

scale, system, and production- were analyzed to understand the aspects of modular design that were related directly to the sociotechnical temperaments of the generation as opposed to a reaction to modularity as its own system. Categorizing the case studies provides a way to better pin point the specific intentions of the project and thereby address the successes and failures in relation to the specific problems each project sought to address. Understanding the successes and failures of the different conceptualizations of modular design in real life situations can bring to light the concerns revolving modularity's seemingly limited flexibility.

3. Literature Review

As Human Scale. Human scale in space design is not a revolutionary concept. Rather, human proportions have always been deeply embedded in architecture from the construction of the earliest dwellings. Having been the first units of measure, human proportions provide an opportunity to introduce a “humanization of space.” [11] In other words, human scale provides a point of reference that gives measurements a physical embodiment and sense of realism.

The term ‘modular’ in reference to human scale is most often associated with Le Corbusier’s work on *The Modulor* published in 1950. Here, Le Corbusier explores a mathematical approach to the standardization of architectural design methodologies while relating to human proportions as the base unit of measure. The term ‘modular’, as used by Le Corbusier, is “the fusion of the notion of module with the notion of the golden section,” as a design standard [4]. In other words, modularity is a measurement tool that combines mathematical laws, such as the golden ratio or Fibonacci sequence, with human scale.

Le Corbusier’s work on the development of the human based module form will later inform a large part of the Modernist

movement and further explorations of modular design methodologies. Such modules based on human scale offer a better understanding of human relationship with spatial qualities and thereby better influence the theories that form the foundation of human factors and spatial behavior theories. Further developments using human centered modules also increases awareness with the user in the identification of spatial relationships. Playing on this innate understanding, modularity provides a unity in terms of spatial language that can work to highlight the important spatial qualities that are distinctive in a given space.

Following deductive reasoning, spaces that develop from a human based module must also reflect the same human-space relationship that informs the base module itself. In other words, the properties of the module transfer into the system in which the modules apply.

As a Production Method. A base unit, or the module, and central network system, or the framework, react to one another in modular designs allowing for an easier production process regardless of the complexity of the design. The repeating module simplifies the overall production requirements and utilizes a standardized set of units. Similar to the assembly line production method, modular design takes the same core concepts of Fordism into different methods of architectural building technologies.

The initial growth of modular design in the late 1920's was driven by CIAM and, perhaps more notably, Le Corbusier, in trying to achieve total function and optimization [12]. Scarcity of materials and the high demand for housing pushed designers to pursue maximum efficiency through minimal living and faster production methods. Such social pressures provided an ideal atmosphere to celebrate the hero of the war- industry. The factory process was perfected during the War,

allowing for mass production to grow at an incredible pace. Rather than dismiss the developments of the war time culture, mass production of materials was a way to utilize the new technologies and adapt them to fit the immediate needs of the post war society. Therefore, mass production and modularity developed a symbiotic relationship in this time as a way to provide quick solutions in a fast paced environment.

Prefabrication and modularity, though often used interchangeably, are two distinct products of the industry. While prefabrication is the standardization of materials and styles, modularity is the standardization of a module- a module that is designed specifically for a certain spatial quality or programmatic use. Furthermore, modularity suggests a movement or interchangeability in post-construction due to the use of uniform parts. In other words, whereas prefabrication relates directly to a type of material, the modules refer to a larger unit, allowing for a system to adapt and rearrange itself as necessary on any given system. Furthermore, modules are not limited to the dimensions and base units of prefabricated materials, but rather are limited to the modules themselves. Therefore, there is a flexibility in the development and redesign of the overall modular system regardless of the pre-existing components saturating the market.

An important factor in the popularity of modularity in the mid 20th century was the economic conditions that demanded an affordable solution to a large housing crisis. Affordability was a major asset to the modular design system, in that the simplification of the manufacturing and construction process allowed a quick and simple solution to the high demands of the market. The simple construction process eliminated the need for skilled laborers, thereby significantly reducing construction costs.

System. Modules alone cannot determine a modular design strategy. Rather, the modules are part of a unifying system that utilize the modules in the design strategy. Modularity, thus, can be understood as an adaptation of the kit-of-parts design mentality.

A central system or framework, provides an important unifying tool that allows for individual components to have the freedom to adapt to varying needs and programs. In terms of spatial qualities, the modular system is what gives a sense of unity and wholeness to the arrangement of the smaller unit pieces. Therefore, the language of the individual modules transfers into a larger spatial relationship that encompasses the simplicity of a repetitive unit with a complexity of a much more organic method of designing.

Such a method of design allows for the design system to be applied to larger scale projects such as those of urban settings. An urban solution to unify a diverse set of building conditions without sacrificing the integrity of individualism can be designed using similar modular theories. This system “suggests a morphology of reemergence and reintegration, as inhabitants come together and apart separately and create groupings that are housed in an outwardly unchanging, conglomerate structure.” [8]

In connection to the organic implications of the modules, the modular system also reflects a similar biological interpretation in that it stems from the natural laws and natural order. The parameters of the network system act as the boundaries for an otherwise freeform organization and arrangement of modules, thereby pushing designers to truly understand the conceptual theme of the spatial relationships designed.

4. Analysis- Case Studies

Table 1.1

Title	Description	Module Type	Modular Process	Evaluation
Sears Catalog Home Sears, Roebuck and Company, 1908-1940	The Sears Modern Home was a series of mail-order plans and materials, popular in the early 20 th Century. Families could buy prefabricated materials to build their homes. Prefabrication was introduced during this time as a way to mass produce raw materials.	Production	A kit of parts design method that incorporates a DIY culture	+Ease of manufacture +Affordability -Short Lifespan -No longer relevant to current housing market -Lack of customization
Unite d' Habitation Le Corbusier 1953	An early exploration of modular design, the high density residential project incorporates vertically L-shaped modular layouts, creating a more diverse set of housing options. The entire project is made from fifteen standardized measurements and is a mixture of both modular and prefabricated forms.	Human Scale	A base module developed from a series of human measurements to standardize building process	+Diversity of modules +Community identity and engagement -Structural limitations -Repetitive language
Plug-in City Archigram	A conceptual experiment, the Plug-in City is a test of modular urbanism, playing on the	System	A central structural network that	+Potential for growth +Interchangeability

1964	limitations of building lifespans. With a central structure, the different layers of the city are constantly replaced with updated versions.		connects different hubs throughout the city	+Organic approach -Lacking practicality -Urban language not related to individual modules
K67 Kiosk Saša Mächtig 1966	A modular fiberglass series, kiosks were designed to have an infinite number of arrangements and compositions that could allow for the kiosk to play any role. It was a way to fully embrace the industrialization, mass production, and urban efforts of its time.	Production /System	A repeating module that is mass produced to fit into one another for expansion	+Standardized production +Ease of manufacture -Repetitive spatial language -Lack of customizability
Habitat '67 Moshe Safdie 1967	While it is often referred to as a modular system, Habitat '67 was an experiment in pre-fabrication before modular design. Using completely prefabricated units, the housing complex is composed of interlocking forms that have the same fabricated modules, but the apartment size and scale varies from residence to residence.	Production	A stacking of modular apartments, arranged so that each apartment has its own private outdoor space	+Diversity in language +Mixed private/public spaces -Structural issues -Lacking spatial organization
Nakagin Capsule Tower Kisho Kurokawa 1972	The Nakagin Capsule Tower focuses on the temporal nature of buildings and architecture. A central tower holds together concrete modules, or capsules, that act as temporary housing. Each capsule is interchangeable and easily adaptable to fit different requirements.	Human Scale /System	A Metabolist approach to modular capsules placed within a central tower	+Conscious of design trends +Production simplification -Relevance -Maintenance issues
Better Shelter UNHCR, Ikea 2010	Better Shelter is a contemporary emergency housing option for displaced residents. The kit of parts is designed so that a group of four adult men can create a shelter that can last up to three years. Different shelters can be connected to make hospitals, schools, and much more.	Production	A kit of parts that allows for easy transportation and construction.	+Ease of transportation +Easy to produce +Quick solution -Costs more than existing tents -Lacking in organization methods -No education process for future integration

5. Results

Contemporary Modules. The ritualization of human life is not a new understanding of the human character—humans have long identified as creatures of habit. In just the past decade, the relationship society has

developed with this ritualistic approach has recently become much more involved with the digital realm. Constant attachment to smartphones and the internet has made physical communication much more immediate, yet distant. The personal

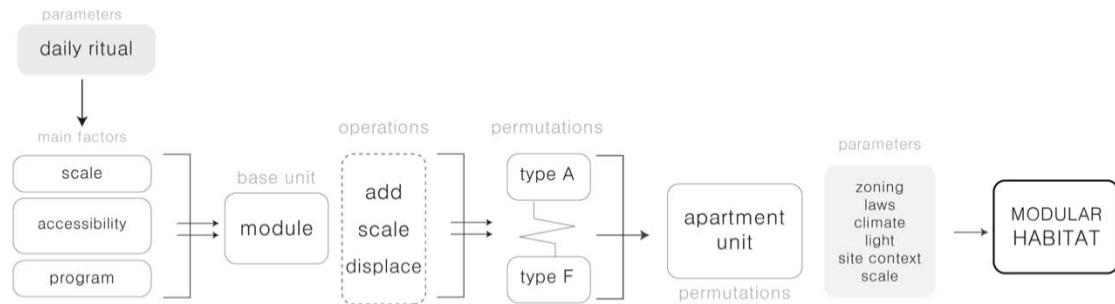


Figure 1. The Contemporary Modular Design Process

connections that were once established on a slow paced media has become an active, yet superficial, connection that reflects a desire for more, faster, and easier.

Therefore, our spatial modules are no longer family centered—rather the modules are spatially engaging while tied down to the immediate grid of the city. Grids, as the core foundation of planned cities, are not only an organizational tool, but rather the structural backbone for the city's energy, communication, and infrastructural requirements. In other words, the architecture of the city and the embedded spatial qualities are branches or nodes of the larger urban grid system.

Basic needs such as food, water, energy, and leisure remain the core aspects of a dwelling. These basic functions each encompass a unit module named bathroom, living room, storage, kitchen, and bedroom. Any combination of these units create the larger dwelling module. Different types of buildings have a unique composition and arrangement of these unit modules, along with additional unit modules depending on the type of structure. For instance, the office module can be composed of storage, kitchen, work room, and rest area. The way that these unit modules are interlocked is not directly related to the system in which the larger modules come together. Heavy emphasis is placed on the relationship of the system to the bigger modules, not the larger system to individual unit modules.

The contemporary module is developed to represent the different programmatic

elements of the dwelling, looking into the lifestyle of each user. By dissecting the lifestyle into different programmatic elements, there is an opportunity to create a kit of parts that give a power of choice to each given user. Rather than designing modules based purely on spatial qualities such as size or form, a program based module optimizes each module to the program while removing any dead space in the final composition of modules.

System. From the development of five unit modules, there are 120 different permutations available. Spatially speaking, the possibilities are much greater than mathematical calculations in that more operations are possible with each module type. Defining a set of operations that each module can undergo, adds to the possible variations. Rather than simply rearranging the modules, the operations can change the form of the modules themselves, to better adjust to the immediate needs of the uses. Through addition, scale shift, and displacement, we can begin to manipulate spatial qualities to best suit the personality of the user. The physical limitations of the site and initial massing operations will help to unify the language that these modules individually develop.

The relationship between modules can be simplified into three different operations—addition, scale, and displacement. With these different operations, a systematic language will be developed to simplify the production process and help in keeping within the boundaries of the architectural parameters for the project. The advantage of

utilizing permutation in design is the diversity that is created through the repetition of a singular element. This project will focus on these three operations, specifically, to simplify the systematic approach of the project and focus on the developing of the unit modules themselves.

Process. In essence, the module is a measuring unit for the arrangement of space and spatial qualities. There is a strong relationship between human scale and the module, and then the module to the site. This intermediate state of relationships is what allows for the user to become directly integrated into the site design process, to optimize the use of the space.

Rather than designing the module and adapting the system to a free site, this project will begin with a set of parameters to test the validity of the variability of modular design. Two factors arise in identifying the overall parameters for the project. First there is the issue of the site and the legal implications of the building codes. These restrictions will begin to inform the limits of the design configurations in terms of scale, composition, and orientation. The second restriction comes in the form of the massing studies of the architecture itself. Because the project is focusing on apartment style housing, a larger site must be broken up into a variety of different smaller units that then utilize the individual unit modules.

6. Discussion & Conclusion

The diminishing popularity of modular design methods largely been due to the socioeconomic climate as well as the technological limitations of the 20th century. Recent advancements in building technologies, as well as a more environmentally centered outlook on the flexibility and adaptability of vernacular architecture offers an optimal set of conditions to continue the experimentations with modular designs. The kit-of-parts mentality of modular systems allows for

designers to engage in a much more organic method of thinking that also ties together the mass customization demands of contemporary design.

The true potential of modular design has been dismissed in previous years due to the change in socioeconomic and sociopolitical climates. However, globalization and technological advancements in the recent decades has given a new set of parameters that allow for modularity to be revisited as a capable design strategy. There is a growing demand to merge together the existing mass consumption patterns with the desire for a more ecological understanding of design.

The contemporary modular design method is composed of two main pieces- the modules and system. The modules are a reaction to the existing spatial culture in existing housing types and the changing demographic conditions. Different modules are designed for different functions of a dwelling such as living, working, or leisure that are then put through three distinct operations- addition, scale, and displacement. Through space syntax and optimization algorithms, a variety of permutations will be designed to then inform to larger structure. Each apartment unit is then arranged onto the site that best utilizing the landscape potential while respecting the zoning laws.

The proposed modular design methodology reflects the current social desires for a flexibility and environmentally conscious design solution and takes full advantage of the growth in building technologies. Currently, the role of designer is becoming much more intimate with that of user as the do-it-yourself culture and mass customization practices spread. Therefore, it is important to understand that the contemporary designer is no longer the sole designer in any given situation, rather they are the bridge between pragmatism and individuality.

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