

DIMITROUDI MARIA  
FERNANDEZ ANA BEATRIZ  
VACHEZ MARIA INES

# **MODULAR ARCHITECTURE**



Kisho Kurokawa Architect and Associates, Nakagin Capsule Tower. 1972 © FALA



Prototype for Dymaxion House by Ruchard Buckminster Fuller 1945 © Alamy

# MODULAR ARCHITECTURE

## UNDERSTANDING THE CONCEPT

### ¿What is Modular Architecture?

Modular Architecture can be understood as the design of any system composed of basic components (modules) that can be connected together, most of the cases through interlocking.

The basis of modular architecture is that modules can be added, taken-off or replaced or without affecting the rest of the system. Therefore, repetition is one of the key characteristics of modular systems. There is also a need for an open plan, which works as the flexible scenario where modules can be arranged in different combinations.<sup>1</sup>

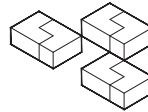
The opposite of a modular architecture is an integrated architecture, in which no clear divisions exist between components. The scales of modular architecture can go all the way from tiling and furniture, to city blocks or a complete urban plan. Although the concept of Modular Architecture was adopted in the beginning of the XX century, its actual origins can be traced not only far back in history, but also everywhere around the world.



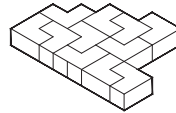
**Modules:** The basic component, in any scale.



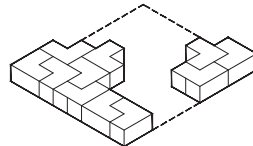
**Interlocking:** Modules are linked between each other.



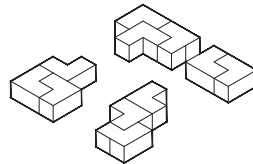
**Repetition:** The base modules can be replicated.



**System:** The combination of modules creates a system.



**Open plan:** Allows possibilities of combinations.



**Flexibility:** Combinations of modules allow for a flexible design.



Shabono Village in Venezuela. © Lars Løvold



Hatshepsut Temple in Luxor, Egypt. © Memphistours

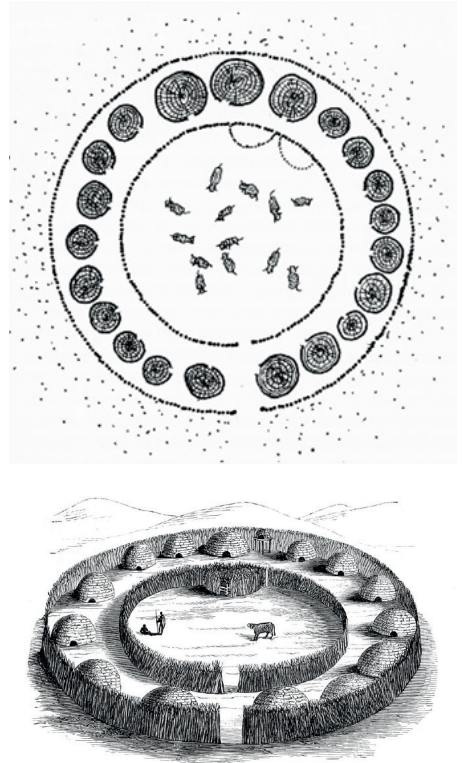


### Modular Vernacular

The concept of creating a component, and repeating it in an organized way, can be found in vernacular and traditional architecture. One clear example are the traditional Japanese houses, where an open plan is divided by sliding paper and wood panels which can be reorganized in order to allow a different room disposition. Modular vernacular architecture can as well be found in the traditional dwelling of the Mru and Malay people, in Malaysia, Bangladesh. They built their dwellings using only the available resources in their surroundings. A repetition of natural material modules allowed the houses to grow in order to house more inhabitants when the families grew. The same concept of repetition and modulation can be seen in the traditional Amazonian Shabonos<sup>2</sup>, which consist on villages composed by the repetition of concentric structures.

### Modular Ancient and Classical

Ancient civilizations had also each their own approach to modular architecture.<sup>3</sup> A series of component that created a system can

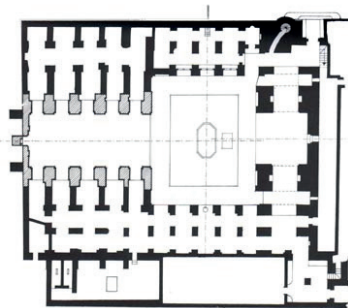


Plan of Zulu Settlement © Tumblr lva57hDSkt1qe0nlvo1\_500

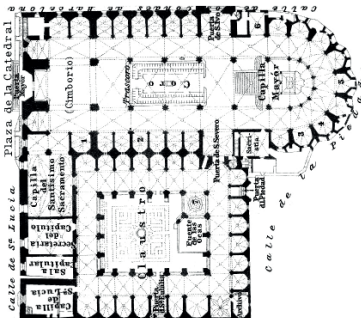
be found from Egyptian and Mesopotamian temples to Greek or Roman temples. Repetition was used as a composition tool to not only simplify and create a logic for the construction, but also as a symbol of power. Classic European and Eastern architecture follow too, a modular language that can be seen in gothic churches as well as in Middle-Eastern mosques.



Greek Temple Plan (Tholos.) © CC BY-SA 3.0



Mosque Plan in Iran © The Art and Architecture of Islam, p.216



Plan of Barcelona Cathedral © Alamy

## Modular Industrialized

With the industrial revolution and the popularization of steel structures, modular components were easily produced, transported and mounted.

The need for housing after the destruction of the wars, the rapid advance of industrialization and the rural to urban migration, led to a search for efficiency and rationalization of the building industry.<sup>4</sup>

Modern movements such as the Metabolism in Japan or the Bauhaus in Europe found solutions with prefabricated concrete modules, which maximizes the production of housing as if it was an assembly line. Standardized elements have long been used in modernist housing, perhaps most notably by architects such as Richard Neutra, Charles and Ray Eames and Pierre Koenig in California's Case Study House programme.

In the United States, a new tendency of modular pre-fabricated housing expanded throughout the entire country, making it the most affordable and popular way to bu-

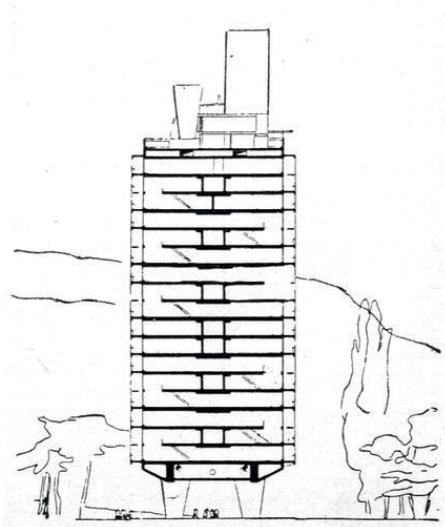
ild a house.

## Absence of Modularity

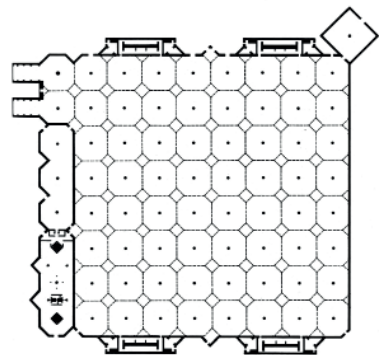
With the movement of arts and crafts, there was an intention for architecture to head towards craftsmanship and art, freeing it from the classical patterns and from the mass production of the industrial era. Later followed by art nouveau, whose principles were similar to arts and Crafts, adding as search to imitate nature in the design. Later on the XXth century, the deconstructivist movement<sup>5</sup> searched for a break of the modularity and stiffness of previous architecture movements.

## Modular Contemporary

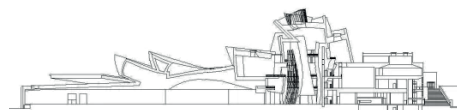
Nowadays, modular architecture positions itself as one of the most sustainable solution in building matter. As it involves a great deal of prior planning and preparation prior to the construction, there is a significant cut on expenses and waste on construction site. Nevertheless, the modernist tendency of reinforced concrete and some new slow-degrading materials is still dominant over other low-impact materials.<sup>6</sup>



Unité d'Habitation de Marseille, ©Fondation Le Corbusier.



Louis Kahn's Olivetti-Underwood Factory plan. ©Proyecto-s4esta



Guggenheim Museum Section. ©Autocadblocks



Oscar Niemeyer Housing in Hansviertel, Berlin. © Horst Siegmann



Social Design Collaborative, ModSkool in Dehli. Suryan//Dang.



# MODULAR ARCHITECTURE

## WHAT IS IT A MODULE?



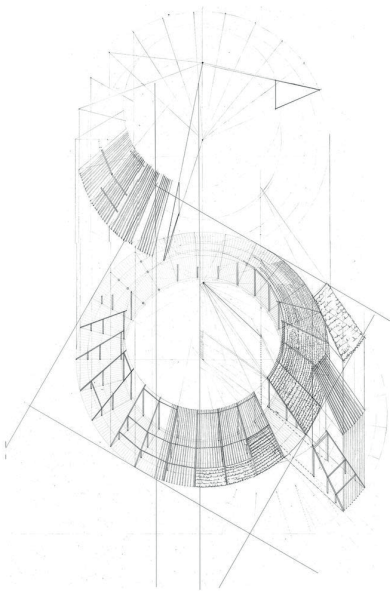
Rome, Forum. Fragments of column shafts that were 12 Roman feet long. Photo by L. Bosman.

Considering the above characteristics of the modular architecture is crucial to further analyze the concept of the module, how it is perceived in this research and what qualities we choose to investigate. According to Britannica < Module, in architecture, is an arbitrary unit adopted to regulate the dimensions, proportions, or construction of the parts of a building> <sup>7</sup>. This concept begins in antiquity by using the column as the main module of the construction and design process. The module in Vitruvius theory appears as a crucial tool in the design process,

but mostly as a method to achieve understanding of a proportional concept rather than standard measurements.<sup>8</sup> We see similar approaches in vernacular or traditional architecture of other regions as well. In Japanese architecture the rice carpet, called tatami, was the main module to give proportions and create a metric system while its multiple combinations determined the room sizes. Another example worth to be mentioned is the shabono communal dwelling of the Yanomami tribes located in Venezuela and Brazil. This circular construction is based



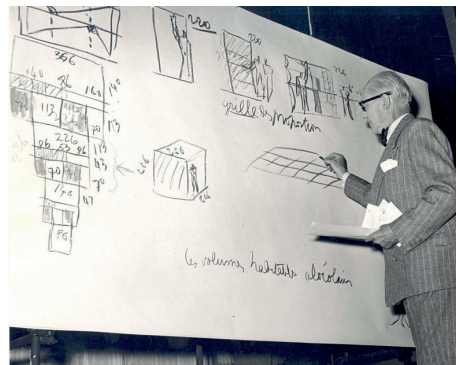
in a module maintaining mainly social criteria and parameters, by which is possible to create a general diameter of around 80m.<sup>9</sup>



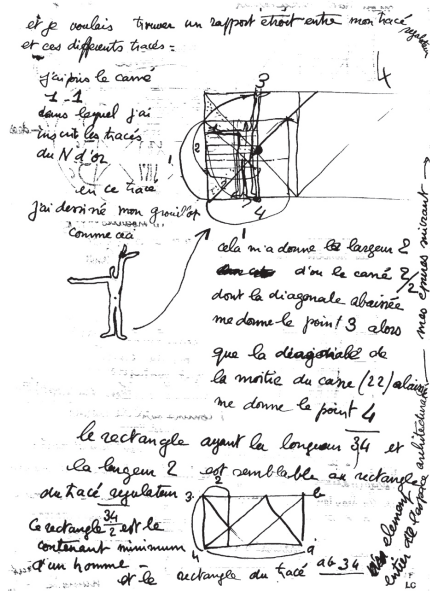
Exploded Axonometric of Shabono © TreeArchitect

The same interest in further updating the module as a proportioning system is obvious in the modern architecture, as well, where the new technological discoveries and mathematics influenced a lot the direction of the theory and practice of architecture. During the modern movement, modules were used throughout the design process to

organize the proportioning and dimensioning of the plans. Probably the most comprehensive system imagined in the 20th century was the Modulor of Le Corbusier. This proportional system was a product of collaborating work with various consultants as historians and mathematicians and referring to statistical measurements of the human body. As is well explained in the article “Le Corbusier’s Modulor and the Debate on Proportion in France :” the research undertaken in Le Corbusier’s studio thus articulated two themes that were in discussion in official and professional circles: the search for modules and serial measurements for building components, and the search for a mathematical grounding of the designs meant for reconstruction”.<sup>10</sup>



Le Corbusier lectures at the Milan Triennale, 1951, Fondation Le Corbusier.



Gérald Hanning, letter to Le Corbusier with an early sketch for a proportional system, 1943, Fondation Le Corbusier.

Module nowadays is also connected with a spatial component or a piece of a fixed designed system that serves to assemble the building in the construction site. The main aim is to guarantee that all the parts can form and complete the construction of the building without readjustments at the building site. This wasteless system diminishes the construction cost by far and can achieve mass production and flexible distribution so is reassured that the modules can be embodied in any plan. By this ap-

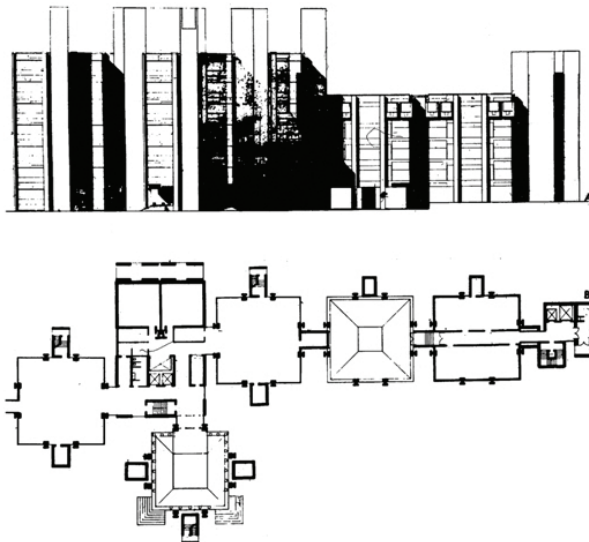
proach the prefabrication concept comes into being, and concrete, either precast or prestressed, is frequently used to produce modules that can be assembled in a variety of designs. <sup>7</sup> Prefabrication is an offsite fabrication when the components come on site only for assembly. Although modular design is deeply connected with architecture throughout its history the prefabrication concept that nowadays is connected with modular systems is an outcome of the industrial era. The term of prefabrication and the verb prefabricate was added in the dictionary only in 1932. <sup>11</sup>

Although prefabrication till now has passed through various stages (such as economical construction technique, new technological arena and mass production stepping stone) it is important to mention an architect that saw other qualities through this. Louis Kahn with his architectural interests directed in aesthetics and strong sensorial experiences in built environment, as well as his intention to connect with the architectural roots, approach the modular and prefabrication design in a way that can reveal the materiality, or a system and

method of construction for design ethics. A phrase used constantly by him and summed up his view was "What does a brick want to be ,'. His purpose was to achieve a creative solution for the prefabricated structure and through several of his projects transferred the prefabrication module from the construction industry to a more tectonic and architectural context.<sup>11</sup>

Module, as we realize, is a vague term with many perspectives and a terrain that constantly concerns architecture theory and practice. If we liberate this concept of the restrictions and limitations of the

standardized industrial perception we can achieve a dynamic tool and vocabulary. The module, as is indicated by its architectural history, can be expanded and transformed to a spatial generator, or unfold and reveal a platform that various disciples can form new realities. This capacity can serve to create a really flexible outcome and a perspective that is not determined by technological inventions but from the approach and the architecture vision. Specifically, thinking in a context of limited resources, the module can incorporate vernacular architectural and social parameters in a constructive way.



Richards Medical Research Laboratories (utsnitt, etter Norberg-Schulz), Louis I. Kahn, Lisens: Begrenset gjenbruk

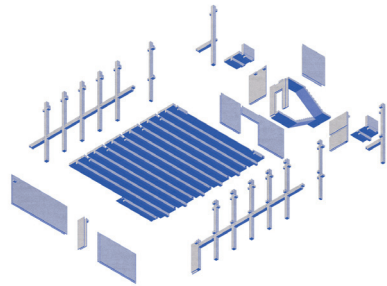
# MODULAR ARCHITECTURE

## SCALES OF MODULAR ARCHITECTURE

Taking into consideration the previous explanation about the module and the different modular qualities that can be achieved; we have noticed three different categories, three different scales of the modular architecture.

### A) Construction technique

To begin with, an interesting dimension of modular architecture is the ability to form an independent construction system. One interesting example that using a prefabricated modular architecture as a construction technique, through which it accomplished an inspiring outcome of how to develop this more industrialized technology in a creative way is housing project “Wohnregal” by FAR architects, located in Berlin. It is an example of how precast concrete elements, very common in the industrial warehouse-style buildings, can bridge important challenges with high architecture values that nowadays the construction faces. They used a prefabricated system with long spanning TT-beam that can support a precast ceiling without the need of interior structural elements. Using



Exploded diagram of the prefabricated elements, FARohn&rojas architects, Berlin, © FAR



Exterior view of Wohnregal, FAR fohn&rojas architects, Berlin, © David von Becker



Interior view of Wohnregal, FAR fohn&rojas architects, Berlin, © David von Becker

this method not only the construction cost is lower but offers free interior spaces with a 13m span from façade to façade, achieving a flexible clean plan that can be adapted in the need of the user and the changing urban life styles.<sup>12,13</sup>

A second example still in the family of the prefabricated modular architecture is the housing project VDC by the architecture studio Summary located in Portugal. This project uses a construction system named “gomos”, which

derived its principle by the logic of the prefabricated modules used to assemble the conventional sewer pipes. Following this logic, gomos prefabricated system consists of precast section modules that are joined in the construction site to create a continuous shell. The building process can be summarized in four phases: structure production, cladding and hardware, transportation and assemblage. This system as well as the previous one, was invented to minimize the cost ,as all of the components

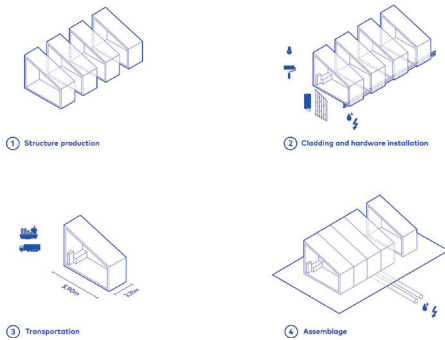


Gomos system, Summary architects, La Biennale di Venezia 2016, ©TIAGO\_CASANOVA





VDC housing project, Summary, Vale de Cambria, Portugal©SUMMARY



Building\_process, copyright SUMMARY

in factory, and to offer free and flexible interior configuration.<sup>14,15</sup> In Alejandro Aravena words, “SUMMARY’s proposed set of prefabricated elements has managed to balance the logics of prefabricated infrastructure and architecture as support”<sup>16</sup>

The last example in the scale of modular architectural comes from a more vernacular inspired

context. It’s the project Sandbag House by MMA architects 4, located in South Africa. This project uses the ecobeam sandbag structural system by which sandbags use as a component to fill a wooden frame. This module has load bearing capacities and is proposed as an affordable, green and adaptable modular solution.



Sand-bag houses, Freedom Park in Cape Town, South Africa ©MMA architects 4



Sand-bag houses, Freedom Park in Cape Town, South Africa ©MMA architects 4

Apart from its technical characteristics that are suitable for places with limited access to resources, a collective procedure emerges through this as this construction method doesn't need only experienced builders but is friendly also for local and inexperienced people.<sup>17,18</sup>

## **B) Modular Building Systems**

This scale consists of an example of modular architecture that maintains expanded spatial dimensions. The modules form small units which by multiplication, packing

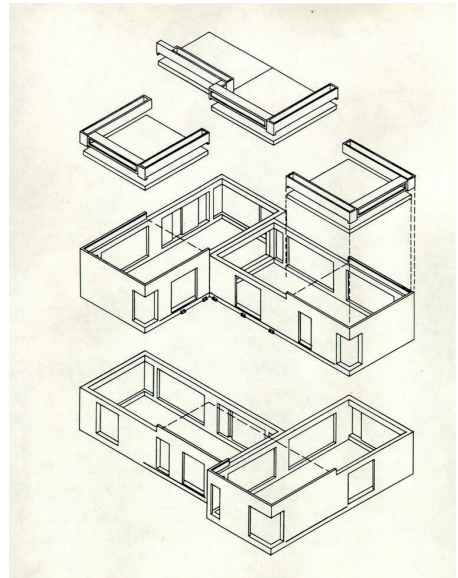
and links shape the final building. It is worth mentioning that the common ground that shares this kind of project is the intention to include urban and communitarian principles in their design. We can assume that when the inspiration is derived from city metaphors and the creation of a community spirit, the modular approach serves to bring this idea into being.

A project that is well fit into this scale of modular architecture is the Habitat 67 by the architect Moshe Safdie, located in Canada. The building is shaped by a com-

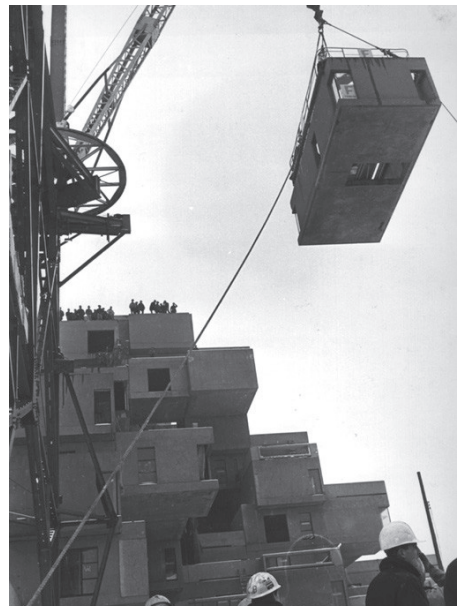


Habitat67, Montreal, Photo by Wladyslaw via Wikimedia Commons

position through stacking of a basic spatial concrete module that consists of the main living unit. It was a project of prefabricated modular architecture that proposed a solution to a dense urban space with its vertical growth. He tried to achieve two contradictory goals, first a low construction cost by the use of prefabricated elements and second to emerge a new typological housing approach where suburban qualities can be transferred into high dense urban regions. As is referred to the article about Habitat67 in Archdaily , “by stacking concrete “boxes” in variant geometrical configurations, Safdie was able to break the traditional form of orthogonal high rises, locating each box a step back from its immediate neighbor. This ingenious method provided each apartment with a roof garden, a constant flow of fresh air and a maximum of natural light: qualities which were unprecedented for a twelve story apartment complex”.<sup>19</sup> It is interesting to notice Safdie’s thought about the sense of Habitas’67 from an interview in “Dwell” that sums up the vision behind this project:” Well, I think prefab is an issue unto itself, in the way that Habitat ’67 is



Habitat67 module,  
© (2001) Canadian Architecture Collection, McGill University 4



© (2001) Canadian Architecture Collection, McGill University





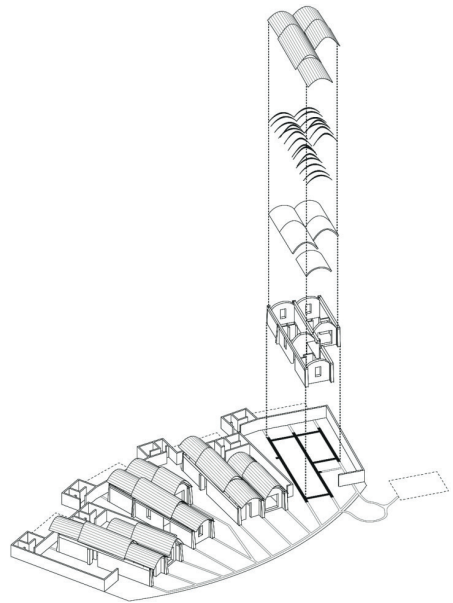
Perforated window of Gando Teachers Housing, Photo by Erik-Jan Ouwerkerk



View of Gando Teachers Housing, Photo by Erik-Jan Ouwerkerk

really two ideas in one. One is about prefabrication, and the other is about rethinking apartment-building design in the new paradigm. I'm a believer in the technology of prefabrication and the efficiency it can bring, but it's no guarantee of anything in terms of the quality of the environment. It depends on the design of the building` ` .<sup>20</sup>

Another project that is interesting to further describe is the Gando Teachers' Housing by Kere Architecture, located in Burkina Faso. The vernacular typology of housing that exists in this region affected and inspired mostly this project as the houses are formed by a sequence of dwelling modules that can be combined in a flexible way, creating diverse sizes depending on the inhabitant's needs. The site configuration follows rules of the traditional Burkinabè compound, as the arc layout that was chosen to arrange the six units is a common approach in this region. This housing project applies a sustainable approach, and the update of traditional construction methods with innovative ideas, as the combination of adobe walls with cement and granite foundations.<sup>22</sup>



Exploded Axonometry , Gando Teachers Housing, Kere Architecture, ©Kere Architects

As Kere himself states “a key objective of the project was to involve the surrounding community in its construction. The simplicity of the design and minimal use of purchased materials makes the model easily adoptable and adaptable by members of the community who plan on building or extending their own homes”.<sup>21</sup>



## C) Landscape-urban furniture

Another scale of modular architecture we notice in the landscape design, were modules used to create new topography or from bottom up approach where modules are in between urban furniture and artificial landscape aiming to form a collective public space. A project that takes those aspects into consideration is the SCHLICKEYSEN modular furniture system by Enorme studio, located in Spain. This furniture consists of a metal base that works as a frame where the curved bricks fit into it.



SCHLICKEYSEN, Madrid, photo by javier de paz garcia



SCHLICKEYSEN, Madrid, photo by javier de paz garcia

By the diverse combinations that can emerge the basic module can create different conditions and configurations in the public space.<sup>22</sup> Finally, the last example to be included in this section is the Zighizaghi, a multi-sensorial urban garden created by OFL Architecture, located in Italy. In this example the modules that have hexagonal shape, create a new urban topography where social interaction and sensorial experiences are the main objective.<sup>23</sup>



Zighizaghi project, photo by OFL Architecture

# MODULAR ARCHITECTURE

## MODULAR ARCHITECTURE IN CUBA

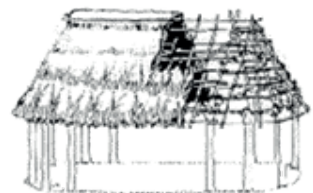
### Vernacular Architecture in Cuba

This type of architecture is most important in this particular investigation since it is projected by the inhabitants of the region or historical period, as a result of empirical knowledge, the experience of previous generations and experimentation.

One of the most interesting construction systems used by our aborigines (taínos), that have transcended to this day in our rural environment, is the Bohío, mainly due to its adaptation of the climatic conditions of the country and the ease of obtaining the materials used from the immediate surroundings without serious economic investments. A Bohío is a rustic cabin or house built with wood, yagua, reeds or straw. It can have rectangular or circular plan. This elements were repeated to compose the taíno villages.

A particular topology in which the influence of indigenous models can be clearly seen is the Bohío de Culata, with semi-circular side walls, a combination of the circular plan of the primitive caney and

the rectangular layout of the traditional hut.



examples of vernacular architecture in Cuba,  
resource unknown

Other traditional construction techniques that are very old, are the mud walls or bahareque walls- with an internal structure or a framework of trunks and branches that supports an outer layer of mud that covers it, giving it the appearance of a continuous wall, even though it is composed by a structure of wood elements.

In the tobacco agri-business in Pinar del Río, the houses of picking, curing and leaf deposits continue to be built with traditional local materials. Everything seems to indicate that although other constructive solutions have been tried, conventional (vernacular) structures manage to maintain better conditions of temperature and humidity, which guarantee a better quality during the drying and curing process of the tobacco leaves.

Lastly, it is important to mention the varentienrra. It is a rustic construction of yagua or guano, generally used to store materials and shelter from the calamities of time and hurricanes. In ancient times it was also called Bahío or Bohío, or also Rancho de Vara en Tierra. Commonly it touches the

ground and only has a front Wall with its door, it can be practically described as a hole in the ground with a gabled roof on top, or what could be said as a “house without walls”.<sup>26,31,35,38</sup>



examples of vernacular architecture in Cuba, resource unknown

# Modular Architecture in the housing policy at the Beginning of the Cuban Revolution:

One of the first and most important goals of the cuban revolutionary government was to provide a solution regarding the shortage of housing. In this spirit, the National Institute of Savings and Housing (INAV), chaired by Pastorita Nuñez and Gonzalez, was created and put in charge of the construction of multi-family buildings and single-family homes, as well as some independent buildings distributed across the country between 1959 and 1962. This organization marked a momentous time in the production of social housing in Cuba since the triumph of the Revolution, as well as a change of approach towards the cuban housing policy.

When cubans hear the phrase “casas de Pastorita”, urban ensembles of high quality housing built in the beginning of the Revolution across the country, come to mind<sup>39</sup>.

In this moment in time the mass production of housing was a social necessity, therefore in an attempt

Forms in which the houses are connected through circulation	Placing of the circulation in relation to the volume	Diagram	Examples
I Two units connected by a staircase.	Typology I A: Two semi-detached houses connected by a vertical circulation (generally a staircase) in the front of the building, expressed in an overlapped volume.		
	Typology I B: Two semi-detached houses articulated by a vertical circulation nucleus (generally a staircase).		
	Typology I C: Two semi-detached houses connected by a vertical circulation nucleus (generally a staircase) incorporated in the building volume.		
II Multiple units connected by an external gallery.	Typology II A: Multiple row houses with a gallery or circulation corridor connected to a vertical circulation volume, overlapped to the volume of the building. In this case, the vertical circulation volume, may contain staircases and elevators.		
III Multiple units connected by internal staircases and elevators (tower type).	Typology III A: Row houses blocks, with a vertical circulation volume (staircases and elevators) between them.		

to shorten and simplify the design and construction process, modular architecture was a highly exploited strategy. The following examples illustrate how the INAV used modular architecture to achieve a certain variety to its building proposals that would be both efficient and aesthetically pleasing. The diagrams show how both housing units and vertical circulation nucleuses were used as modules that are rotated, repeated, and overlapped in different manners.

In itself this arrays of modules become modules themselves. Ensembles such as the comprehended by two units connected by a

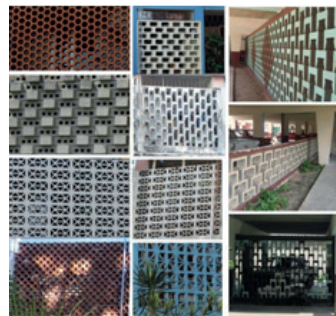
times, composing a single apartment block that is then repeated across the urbanization itself as a module. They can be joined in a linear row, or a tiered row, composing different variants that help minimize the monotony that can affect projects such as this. The structure expresses itself with clarity, defining a reticular formation, in which the building is never closed in the main facade, but instead it recesses producing balconies and terraces, and a wide range of latticework closures generating various compositions that invest it with an abstract characteristic, as well as guaranteeing the necessary cross ventilation to the apartments. The stairwells become articulating volumes in every model. In all the variety the vertical movement module turns into a reference point crowned by the

water deposits in some, or integrating brickwork walls in different combinations. Precisely this module and its position, overlapping the prime volume, is what this buildings are known for.

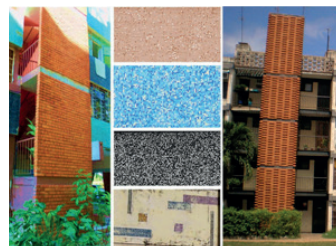
The materiality of this buildings is characterized by the use of non-structural artisanal elements such as bricks and ceramic modules to conform inner and outer linings, as well as multiple types of latticework closures. Blue, ochre and beige tiles under the openings are also really common.<sup>40</sup>



Conjunto INAV. Centro Cívico. Foto. Gabriela Glez, 2014.



Cierres de celosías en los edificios. Photo by Ruslan Muñoz Hernández y María Victoria Zardoya Loureda.



Buildings outer linings, photo by Ruslan Muñoz Hernández and María Victoria Zardoya Loureda.



In this early stage the Unidad Vecinal Camilo Cienfuegos (housing unit Camilo Cienfuegos) built in Havana stands out, as the first project of the Cuban Modern Movement to receive the condition of National Monument.

### **Modular Architecture in the Design of Schools in the Beginning of the Cuban Revolution**

The buildings that immediately followed the Revolution appeared to attempt something new. Conceived with the freshness of a pioneering enterprise, they were executed on an ambitious scale and delivered utopian ideas with limited resources. Designed by the Cuban architect Ricardo Porro and his Italian colleagues Roberto Gottardi and Vittorio Garatti, the Escuelas Nacionales de Arte (ENA)



Escuelas Nacionales de Arte, Ballet school, photo by La Arquitectura de la Revolución Cubana 1959 – 2018 Relatos históricos regionales – Tipologías – Sistemas.



Escuelas Nacionales de Arte, photo by Owen Lin.

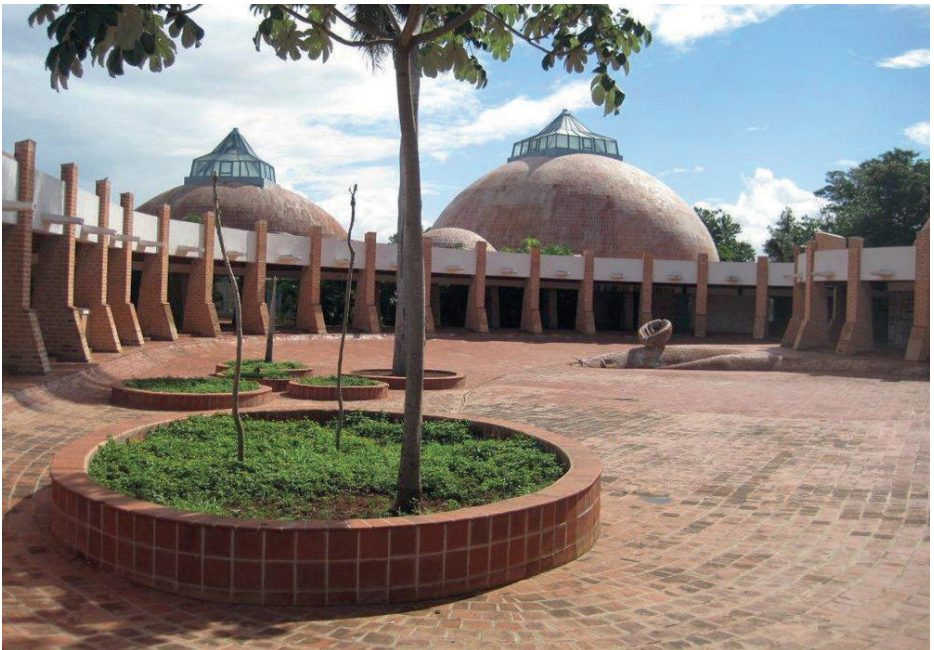
are among the foremost examples. Constructed between 1961 and 1965, these schools stand out for their high architectural and design quality.

Built on the grounds of a confiscated private golf course in the western suburb of Country Club—today called Marianao—the complex consisted of schools of ballet, contemporary dance, music, plastic arts, and drama. The architects worked individually, each designing one or two schools, but as a group subscribed to a set of guiding design principles including the siting of the complexes according to the existing topography, the use of brick and terra cotta tile, and a timbered vault construction.

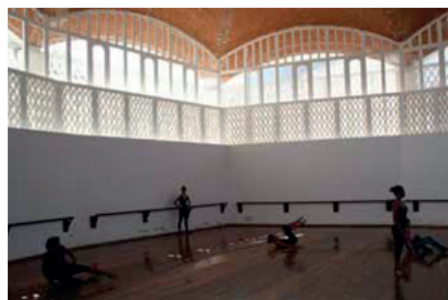
Work on the ENA was ultimately halted and the highly idiosyncratic project officially discredited, but

not before substantial construction was completed on most of the schools. Each complex comprises a series of buildings—theaters, classrooms, studios, offices, and practice rooms—connected by a series of open-air and covered spaces reminiscent of a traditional tropical city, between which the galleries and corridors stand out as one of the most important elements of Cuban traditional architecture.

The building complexes flow along the hilly contours of their park setting. Some of the buildings remain in use today; others lie abandoned. The modernism of the ENA represents a rejection of many of the ideas that propelled the International Congresses of Modern Architecture (CIAM). By applying older technologies to new conditions the ENA's design raised a challenge to then-entrenched notions of linear progress.<sup>30</sup>



Escuelas Nacionales de Arte, Photo. FERNANDEZ ANA BEATRIZ, 2020



Escuelas Nacionales de Arte, Photo. FERNANDEZ ANA BEATRIZ, 2020

## Las Terrazas

Las Terrazas is a small community in the municipality of Candelaria, in the Artemisa Province. The complex is also located at the eastern end of the Sierra del Rosario Biosphere Reserve. The community of Las Terrazas stands out as one of the most interesting projects in Cuba that makes use of modular architecture. To save on construction costs prefabricated concrete internal and external walls were used. It consists in an entire community/village built mostly on a system called Sandino, which is a prefabrication constructive solution of lightweight elements based on reinforced concrete columns and simple concrete panels. This system also allows to solve the roof with corrugated asbestos cement, asbestos gutter, light concrete slabs and cast slabs. The first brick of the Las Terrazas complex was laid in 1968 and three years later in 1971, its first dwellings were inaugurated, but its construction process continued well until the second half of the 80s, with the execution of the apartment buildings and the service center.

The houses were built purely on Sandino with more elaborate designs based on the new adaptations that allowed to incorporate solutions never achieved before. In these dwelling ensemble there are both single-family homes and multi-family buildings. The latter are composed of clusters of reflected pairs of dwelling units joined by circulations and community spaces in between them that in time have either turned in businesses of the house owners or shared spaces.

In this example both separate dwelling units, as this clusters act as modules that are serialized forming buildings of different sizes. While single-family homes are used as modules that scatter through the terraces that characterize this geographical area. In the service center, the construction system is based in both in situ cast reinforced concrete and pre-fabricated elements, to adapt to the complex topography, creating most interesting designs.



Multi-family building, Las Terrazas, photo by La Arquitectura de la Revolución Cubana 1959 – 2018 Relatos históricos regionales – Tipologías – Sistemas.



Las Terrazas, Source unknown



Las Terrazas, Source unknown



Las Terrazas, Source unknown



The whole ensemble is structured in a very interesting manner as a result of great site study that adapts to the topography and natural environment of the location. This project also served as a trial for the posterior construction of the Moka Hotel, that is located on the other side of the ensemble, and advocates implicitly important principles, as does the rest of the community, aimed at the protection of the surrounding nature. The area Las Terrazas, in which the hotel was built, is a reforestation and ecological project.

Consequently, the hotel had to be designed following the same ecological mindset. For instance, the hotel is built in-between trees, and there are holes in the roof on several locations so the tree can actually grow through the roof. In this case the use of reinforced concrete prevails, and the project assumes the 90s codes for hotel architecture, that while logical regarding its period of construction, otherwise breaks away from the concepts managed, up until the design of the settlement.



Las Terrazas, Source unknown



service building, Las Terrazas, photo by La Arquitectura de la Revolución Cubana 1959 - 2018 Relatos históricos regionales - Tipologías - Sistemas.





Reparto Camilo Cienfuegos, Santa Clara, 1961, photo by Archivo del MOP.

## Conclusions

### Feasibility:

Cuba's mild subtropical climate and its wide spectrum of natural building materials such as earth, bamboo, palm yaguas and other types of grasses, as well as artisanal ceramic elements, offer broad possibilities for non-prefabricated modular designs. The assimilation of vernacular codes offers easy solutions requiring little specialized labor, due to the lack of a high degree of thermal insulation requirement nor complex damp-proofing. Unfortunately, the availability of higher tech building materials continues to be challenged by the embargo, so the application of industrialized modular architecture would be reduced to large scale projects.

### Potentials:

Cuba's actual socio-economic si-

uation requires of mass construction of dwellings in order to house the growing population, especially in La Habana, due to the immigration from other provinces; which is leading to the overcrowding of existing buildings as well as the rise of illegal settlements (slums). Modular construction allows to drastically reduce construction time, which also results in a reduction of cost, mostly because of the faster return on investment. This solution can allow for dwellings to be constructed in a short period of time, specially the industrialized type, in which the time of site preparation can be used to manufacture the prefabricated modules. Also as a nation that gets most its revenue from tourism, modularly built hotels are also a potential, since they can start generating revenue 30% to 50% sooner than a

# MODULAR ARCHITECTURE

## MODULAR ARCHITECTURE IN CUBA

built hotel. Modular architecture can also contribute towards higher sustainability, since industrialized modular buildings can be disassembled and the modules relocated or refurbished for new use; and there is also less material waste in its construction. In rural regions of Cuba, non-prefabricated modular architecture has great potential. Usage of local materials such as earth, bamboo, and other grasses, as well as ceramic elements, in the generation of modules through assimilation of vernacular codes can aid in construction of quick and affordable housing solutions that do not require high degrees of skill or tools/machinery.

### **Disadvantages:**

The application of industrialized modular architecture would be reduced to large scale projects, because of the complications of access to prefabricated elements. In addition, low-tech structures for modular architecture in the rural areas would often require a higher degree of attention and maintenance to ensure its durability.

### **Adaptations:**

As mentioned in the investigation

modular architecture solutions were assumed by the massive construction movement in Cuba since the beginnings of the Revolution. The microbrigada movement also assumed this solution, but as it recruited minimally trained builders that were obliged to follow generic international standards rather than adopting details better tailored to regional specificities and local materials, the movement had many shortcomings that resulted in its decline.

### **Perception:**

As a result of the microbrigada movement assuming modular architecture, and being widely constructed across the country the local opinion on this architecture typology is linked to their viewpoint of this certain type of construction. Problems as poor environmental design, site adaptation, building isolation and deserted public areas, are linked to the concept of modular architecture. However, examples with comprehensive site analysis such as the Las Terrazas community are better received by the public because of its assimilation of conventional Cuban architectural codes and color palettes.



1. <https://www.webopedia.com/definitions/modular-architecture/>
2. Lin Shan En. 2020. Growing Architecture: Modular & Adaptable Systems of Vernacular Architecture. [https://issuu.com/linshanen/docs/aa\\_slides\\_\\_1\\_](https://issuu.com/linshanen/docs/aa_slides__1_)
3. Roldán-Medina, Francisco Javier. (2012). Method of Modulation and Sizing of Historic Architecture. Nexus Network Journal. 14. 10.1007/s00004-012-0125-5.
4. Frontisi Claude. Hector Guimard entre deux siècles. In: Vingtième Siècle, revue d'histoire, n°17, janvier-mars 1988. pp. 51-62. DOI : <https://doi.org/10.3406/xxs.1988.1958>
5. Stoudi, Dima (2020) What is Deconstructivism? Archdaily article. <https://www.archdaily.com/899645/what-is-deconstructivism>
6. Souza, Eduardo. (2020) Can Good Architecture Exist Without Modulation? Archdaily Article. <https://www.archdaily.com/951887/can-good-architecture-exist-without-modulation>
7. The Editors of Encyclopaedia Britannica, "Module", in Encyclopædia Britannica, July 20, 1998, <https://www.britannica.com/technology/module-building>
8. Bosman, L., 2015. Proportion and Building Material, or Theory versus Practice in the Determination of the Module. Architectural Histories, 3(1), p.Art. 10. DOI: <http://doi.org/10.5334/ah.cm>
9. „The Shabonos: Circular Communal Dwellings of the Yanomami Tribes in Venezuela“ in ArchEyes, April 21, 2016, <https://archeyes.com/yanomami-communal-shabono/>.
10. Cohen, J-L 2014 “Le Corbusier’s Modulor and the Debate on Proportion in France”. Architectural Histories, 2(1): 23, pp. 1-14, DOI: <http://dx.doi.org/10.5334/ah.by>
11. Prefab Architecture: A Guide to Modular Design and Construction, Ryan E. Smith, James Timberlake (Foreword by), Copyright © 2010 by John Wiley & Sons, Canada
12. Wohnregal project, FAR fohn&rojas, <http://www.f-a-r.net/en/projects/>
13. Wohnregal project, FAR fohn&rojas <https://www.dezeen.com/2020/11/01/wohnregal-far-housing-concrete-prefabricated-ber->



lin-architecture/

14. VDC, Summary, <https://www.dezeen.com/2020/11/05/vdc-summary-housing-portugal-prefabricated-concrete-modular-architecture/>

15. VDC, Summary, <https://summary.pt/works/gomos-system/>

16. VDC, Summary, <https://www.theplan.it/eng/award-2018-mixeduse/vale-de-cambra>

17. Sandbag house, MMA Architects4, <https://inhabitat.com/sand-bag-house-mma-architects/>

18. Sandbag house, MMA Architects4, <https://www.livinspaces.net/projects/architecture/standing-on-sand-the-sand-bag-house-by-mma-architects-in-freedom-park-south-africa/>

19. AD Classics: Habitat 67 / Safdie Architects, <https://www.archdaily.com/404803/ad-classics-habitat-67-moshe-safdie>

20. „A Look Back at Habitat 67 with Moshe Safdie“, by Amanda Demaron, <https://www.dwell.com/article/a-look-back-at-habitat-67-with-moshe-safdie-4035f224>

21. Gando Teachers' Housing, Kere Architects, <https://www.kerearchitecture.com/work/building/gando-teachers-housing>

22. Gando Teachers Housing by Kere Architecture, Ana Menendez, Metalocus, <https://www.metalocus.es/en/news/gando-teachers-housing-kere-architecture>

23. Schlickeysen bricks, Domus, [https://www.domusweb.it/en/news/2017/05/09/enorme\\_studio\\_schlickeysen.html](https://www.domusweb.it/en/news/2017/05/09/enorme_studio_schlickeysen.html)

24. Zighizaghi, urban Next, <https://urbannext.net/zighizaghi/>

25. <https://archleague.org/article/the-architecture-of-the-cuban-revolution/>

26. <https://ecured.cu/varentierra>

27. <http://oncubamagazine.com/ciencia/un-invento-cubano-contra-los-ciclones/>

28. <https://paismaravilloso.wordpress.com/2012/07/07/varentierra/>

29. <http://www.tubabel.com/foros/tema/47352-vara-en-tierra>

30. <https://www.archdaily.com/427268/ad-classics-the-national-art-schools-of-cuba-ricardo-porro-vittorio-garatti-robert-gattardi>

31. <https://revistavitral.org/vitral32/patrim.htm>

32. <https://www.google.com/amp/s/www.absolutviajes.com/cuba/la-vi-vienda-taina/amp/>
33. [https://www.ecured.cu/Arquitectura\\_Vern%C3%A1cula](https://www.ecured.cu/Arquitectura_Vern%C3%A1cula).
34. [https://www.ecured.cu/Boh%C3%ADo#Boh.C3.ADo\\_cubano](https://www.ecured.cu/Boh%C3%ADo#Boh.C3.ADo_cubano)
35. <http://www.banrepcultural.org/blaavirtual/geografia/geograf2/bari4.htm>
36. [http://bo.kalipedia.com/kalipediamedia/historia/media/200807/31/hispuertorico/20080731klphishpr\\_11\\_les\\_SCO.jpg](http://bo.kalipedia.com/kalipediamedia/historia/media/200807/31/hispuertorico/20080731klphishpr_11_les_SCO.jpg)
37. <http://etimologias.dechile.net/?bohi>.
38. Revista Socio – Cultural del Centro Católico de Formación Cívica y Religiosa. Edición No. 32 de 1999.
39. Las “casas de Pastorita” en La Habana by Ruslan Muñoz Hernández y María Victoria Zardoya Loureda  
<https://www.google.com/url?sa=t&source=web&rct=j&url=https://rau.cujae.edu.cu/index.php/revistaau/article/view/356&ved=2ahUKEwjHy-cuuqKbuAhUDpFkKHVsMAxAQFjABegQIAhAB&usg=AOvVaw3hvmC-dOyINAVUWatdqkFlj>
40. La Arquitectura de la Revolución Cubana 1959 – 2018 Relatos históricos regionales – Tipologías – Sistemas  
[https://www.google.com/url?sa=t&source=web&rct=j&url=http://www.uni-kassel.de/upress/publik/978-3-7376-5049-6\\_cuadra\\_CUBA\\_12MB.pdf&ved=2ahUKEwi3ztfHqKbuAhWB1FkKHa77AxwQFjAAegQIA-hAB&usg=AOvVaw3CsmBsZuV-xS5w\\_5DihAiM](https://www.google.com/url?sa=t&source=web&rct=j&url=http://www.uni-kassel.de/upress/publik/978-3-7376-5049-6_cuadra_CUBA_12MB.pdf&ved=2ahUKEwi3ztfHqKbuAhWB1FkKHa77AxwQFjAAegQIA-hAB&usg=AOvVaw3CsmBsZuV-xS5w_5DihAiM)