

# MODERNITY AND TECHNOLOGY

## On Modular Design and Symmetry: the cases of Rudolph M. Schindler's housing

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### 1. Introduction

Any housing design involves a certain degree of organizing principles in a standard housing unit and the consequences of multiplying the unit in some larger assembly. Recently, there has been interest in the development of housing solutions, many of which question design strategies and compositional methodologies in order to develop new alternatives for topological diversity and spatial flexibility (Gausa, 1998). These recent interests underlie the continuity of the built environment inherited from the past. The value of examining the precedents is to gain a better understanding of current housing issues. Lessons extracted from the study act as a normative force with minimal dependence on external issues and thus are much less vulnerable to changing circumstances. Accordingly, these lessons are applied as canonical solutions and pedagogical references to the wider understanding of the structure of complex housing problems as well as the development of new housing typologies, which can then be adapted for contemporary housing development.

Perhaps, the most prevalent principles in housing designs are modular idea and symmetry. Modular idea has been prevailed in an attempt to minimize building costs as well as to execute simple but accurate construction (Heath, 1925; Bemis and Burchard, 1936). It leads to various advantages, including standardization of many building components for mass production in manufacturing and optimization of floor plans. Symmetry is another significant principle in housing designs. Although symmetrical operations function as the organizational mechanism for housing designs, few housing studies have concentrated on constructive principles and applications of symmetry.

This paper analyzes a series of Rudolph M. Schindler's housing designs in the consecutive use of modular idea and symmetry as

compositional methodologies.

### 2. Modular Idea and Symmetry

Many housing designs may seem random, but a closer look demonstrates that they follow certain rules, at least simple repetition of a standard unit. Both modular idea and symmetry as formal methodologies are of utmost important as vehicles to guide all the components in the housing and to organize its spatial layouts so that several housing designs may be neatly described and characterized within a given taxonomy.

Schindler's consecutive housing developments interacted and explored both principles outright. Schindler started using his unit modular system as early as 1920. He promoted this method in his article, "Reference Frames in Space" (1946), asserting, "Proportion is an alive and expressive tool in the hands of the modern architect who uses its variations freely to give each building its own individual feeling."

His system offers various merits in rational planning and construction. His use of the system is grounded in two guiding principles. First, all locations and sizes of the parts with respect to the whole are precisely identified during the construction process. Thus, no obscure or arbitrarily unrelated measurements are involved in the unit system. Second, the unit system offers the means to visualize "space forms" in three dimensions. He argued, "... And last, but most important [part of the unit system] for the 'space architect,' must be a unit which [the architect] can carry palpably in his mind in order to be able to deal with space forms easily but accurately in his imagination." This leads to a search for a basic unit of length for the building, where the dimensions are integer multiples or subdivisions of the basic length. Herein, there needs to be coordination between the architects of the buildings and the manufacturers of the components. A different basic unit module can be chosen for certain purposes or different sizes of the building.

Schindler recommended 48 inches (4-foot) as the basic unit, to be used with simple multiples and with 1/2, 1/3, and 1/4 subdivisions. Among the subdivisions, with only a few exceptions, 1/3 and 1/4

are used for vertical modules in his works. This choice has two reasons. First, the unit must be related to the human figure to satisfy all the necessary sizes for rooms, doors, and ceiling heights; second, for practical reasons, the 48-inch module fit the standard dimensions of materials and common construction methods available in California at that time. He utilized his unit system in a square grid pattern. Numbers and letters are laid out on the grid on the floor plans in sequence and the vertical module is identified with an elevation grade. This pattern was original to Schindler. The grid was presented on drawings and on the house in his earlier designs, yet they disappear from the house and, at times, from the drawings. However, this does not mean he abandoned his system; on the contrary, his system remains embedded in the designs as underlying principles.

With Schindler's system, symmetrical operations are extensively used in his housing designs. Although never written, his conspicuous application of the symmetry idea overlaying a 48-inch unit system is consistent and worthy of investigation. While bilateral symmetry in architecture, which refers to such operations as reflection, is the most often encountered concept of symmetry in the classical period, Schindler explored symmetries other than traditional bilateralism in housing designs.

Symmetry applications in Schindler's housing designs are manifold. They apply to the housing organization as a whole. They also apply to a standard unit, typological variations, and their layouts. Symmetry applications in a housing unit may be local or global. Local symmetries of an individual housing unit effect a number of distinct applications to derive various spatial groups of global symmetry. If symmetry applies as the underlying principle of the unit design, then variations can be achieved by breaking the symmetry.

It is necessary to briefly introduce the notion of symmetry operations. Symmetry operations are concerned with spatial displacements which take a shape and move it in such a way that all the elements of the shape precisely overlay one another, so that, despite the displacement, the shape appears not to have been moved from its

original position. The motion of rotation through 90 degrees is called a symmetry operation of a square. Mathematicians call the collection of all the symmetry operations or motions that leave a particular geometric object fixed its symmetry group. The symmetry group of a square has eight spatial transformations, including four rotations (through  $0^\circ$ ,  $90^\circ$ ,  $180^\circ$ ,  $270^\circ$ ) and four mirror reflections (along the two orthogonal axes and the two diagonal axes). In general, the symmetry group of a two-dimensional design can be either finite or infinite. Infinite groups are the symmetries of infinite patterns such as tilings or wallpaper patterns. Infinite symmetry groups include the motion of translation which is a lateral shifting of the entire pattern by one unit. Point groups are finite symmetry groups and correspond to a finite design, such as a single square. Earlier papers (Park, 2000) proposed a theoretical model for analyzing and synthesizing architectural designs by using a mathematical technique.

### 3. Housing Designs of R. M. Schindler

Before we analyze Schindler's housing, it is worth looking at Frank Lloyd Wright's housing designs, since Wright's designs greatly influenced Schindler. Wright's emphasis on the unit system and symmetry is illustrated in his article, "In the Cause of Architecture" (1908). Originally designed in 1900, Wright's Quadruple Building Block first appeared in "A Home in a Prairie Town" in the 1901 issue of *Ladies' Home Journal*.

In the design, Wright rotates and reflects a standard house plan to introduce variety into the streetscape. The standard unit plan of the Quadruple proposal consists of two interpenetrating masses anchored by a central hearth under the class of Prairie Houses. Although two overlapping parts along the two major orthogonal axes seem to account for much of the design, a closer analysis reveals that multi-axial symmetries are superimposed. One consequence of the superimposition is the loss of global symmetry with the preservation of local symmetries. Each house is set on four equally subdivided lots, sharing a common backyard in the

center of all four houses.

The first scheme shows a pinwheel clustering of four individual houses around the corner of a square site. Each house orients a different direction but faces the street and has its own entry. The second scheme shows each of the clustering of four houses lining both sides of the street in a mirrored format based on the tartan grid (McCarter, 1997). Along with the entry driveways, the four houses share a large open court, yet another four houses, two from the first group, share their backyard.

The pinwheel type of quadruple block plan, in particular, has been a theme in many of Wright's later housing designs including C. E. Roberts (1900-03), the non-competitive entry for a city Residential Land Development competition (Chicago City Club Competition) of 1913, St. Mark Tower of 1927, Broadacre City of 1934, Suntop Quadruple Houses of 1938, the Crystal Heights project and the Ardmore Experiments of 1939, Cloverleaf Housing project of 1942, and the Rogers Lacy Hotel project 1946-47. The unit design of all these projects is asymmetric, but their clustering comprises in pinwheel fashion. Later, the pinwheel concept is applied to an

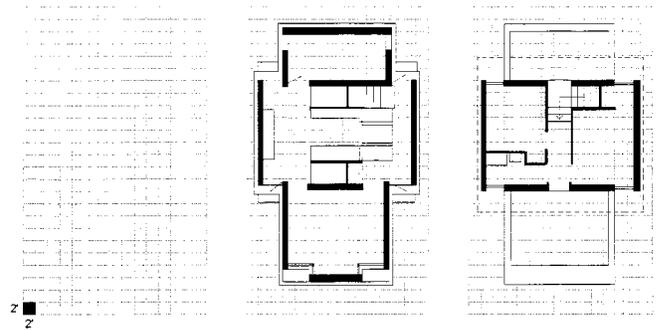


Fig. 1. *The Monolith Homes for Thomas R. Hardy (1919), Standard Housing Unit (left, 2-foot unit grid; middle, first floor plan; right, second floor plan).*

individual building in the St. Mark Tower.

A layout almost identical to the Quadruple plan was included in Wright's Wasmuth portfolio (1910). Schindler had familiarized himself with Wright's housing scheme before coming to the States. In fact, Wright's portfolio significantly contributed to Schindler's early development of architectural thought. Schindler recalled his impression of the portfolio as a student in Vienna: "I immediately realized – here was a man who had taken hold of this new medium.

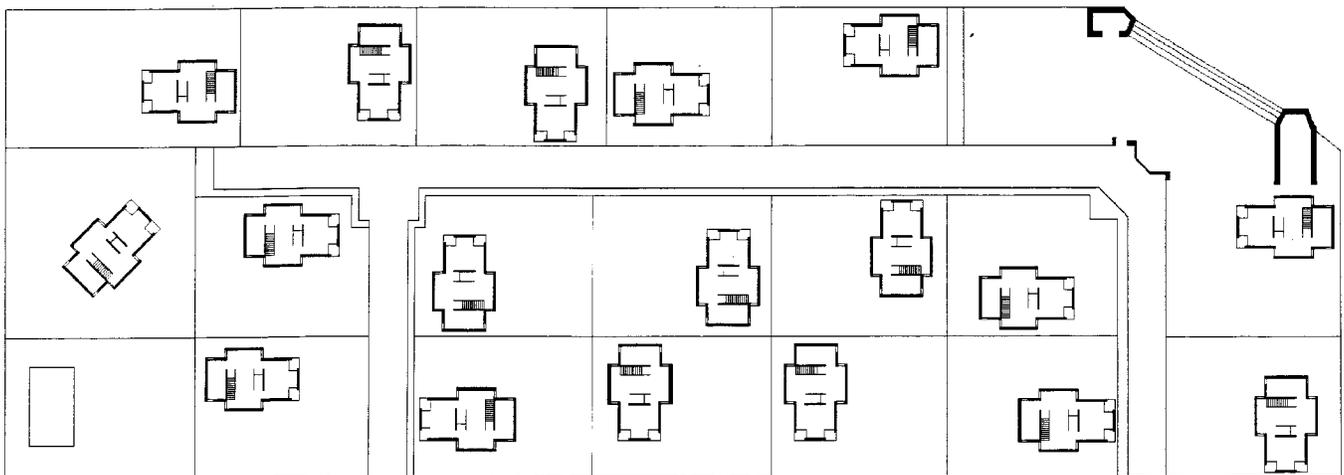


Fig. 2. *The Monolith Homes for Thomas R. Hardy (1919), Site layout*

Here was 'space architecture.'" A survey of consecutive housing projects by Schindler depicts that the interweaving of ideas of the unit system and symmetry was one of the major compositional tools throughout Schindler's career.

### 3.1 The Monolith Homes (1919)

Schindler's early housing design, the Monolith Homes for Thomas R. Hardy (1919), for F. L. Wright during Wright's prolonged absence in Tokyo for the Imperial Hotel exhibits a strong use of symmetry. The detailed structure of the house portrays the monolithic character of the concrete construction, in which the whole structure acts as a single unit, which would appear in many of his later projects, in particular, the Schindler Shelter. The cruciform ground plan of a standard unit contains the living room in the front, dining room and kitchen in the middle, and a storage area in the back. Above, a corridor lies between two bedrooms. The geometry of a standard unit house is juxtaposed by the strong cross axis, horizontal and vertical. Unlike the superimposition of a variety of subsymmetries on top of the unit grid system characteristically shown in later projects such as the Free Public Library Project (1920) and Popenoe House (1922), this unit only used biaxial symmetry (Park, 1996, 2001). The floor plan is based on a 2-foot unit square grid. The same unit module is applied as a vertical module in his section drawings. In this project, Schindler experimented with his early conception of the unit system before adopting it concretely.

In Monolith Homes' site layout, eighteen units of the standard unit are set on roughly equally subdivided lots mostly in an orthogonal direction, sharing a community garden and laundry room. With a closer look, their disposition derives from four quarter-turns, or 90° rotations in their layout, except for one 45° rotated unit. Unlike the two orthogonal axes of the unit plan, this layout uses purely rotational symmetry. The Monolith Homes project stands out as one of his earliest housing experiments of this kind.

### 3.2 The Pueblo Ribera Court (1923)

The same idea applies Schindler's San Diego project, the Pueblo Ribera Court. This multiple housing is superimposed on 4-foot by 4-foot unit grid lines. Its vertical module is based on a 16-inch



Fig. 3. The Pueblo Ribera Court (1923), Standard Housing Unit on top of 4-foot grid.

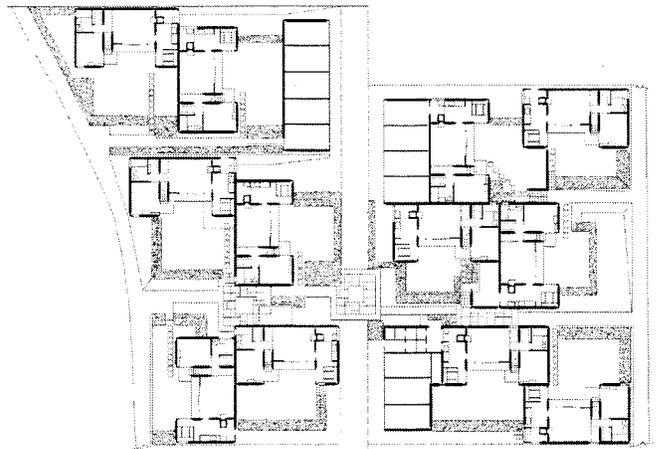


Fig. 4. The Pueblo Ribera Court (1923), Site layout

dimensioning system, which controls not only the height of the room but also of the doors and furniture in the room. Schindler applied his Slab-Cast Construction method where a layer of concrete forms was poured "all around the house by means of wooden forms." Each unit of the single story has a living room which opens to an outdoor patio with a kitchen, a pantry, and a porch in one wing; and a bedroom, a bathroom, and a closet in the other wing. The roof is treated as a roof top terrace suitable for sleeping or living. Although the underlying part of a unit plan exhibits a single orthogonal axial

symmetry, the overall space of the unit is asymmetrically planned. Strictly speaking, the unit design abandons its strict symmetry.

The layout of this unit is the most elaborate one among his housing designs. McCoy (1960) praised the plot plan of the housing as "excellent." Gebhard (1980) continued the praise, saying "From a

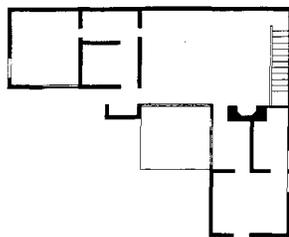


Fig. 5. The Harriman project (1924-25), Standard Housing Unit

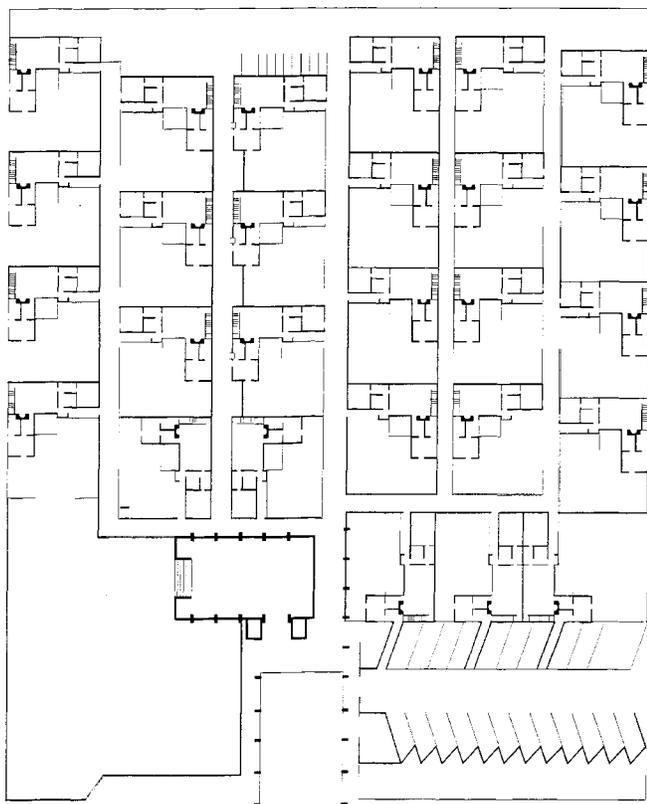


Fig. 6. The Harriman project (1924-25), Site layout

planning point of view, it was successful in almost every regard: in its streetscape, with its contrasts and contradictions, its coherence and irregularity; in its provision for maximum privacy for each unit ... " There are two major grouping ideas with regard to symmetry. First of all, each asymmetric unit is clustered with pairs forming an L-shape, providing "maximum privacy for each unit." Their grouping is based on a standard housing unit rotated and reflected. Six groups of twelve standard housing units are arranged into four quarter-turns and mirrored reflections. Schindler's intention is revealed in his own description of the project, "by grouping and turning the units each of them obtain a private patio and the combination achieves architectural form as a whole."

### 3.3 The Harriman Project (1924-25)

The symmetric approach further developed into the Harriman project (1924-25), which is a relatively a larger assembly. Unfortunately, this project was not sufficiently developed to be built. Nevertheless, it clearly reveals Schindler's concern for housing layout. Schindler used an L-shaped asymmetric standard unit on a rectangular lot and he used diagonal, not bilateral, axial symmetry. This approach seems to be the result of his early test of the Pueblo Ribera Court. Rather than pair clustering, an L-shaped single unit bounded with one blank wall of another unit provides enclosed privacy for the outdoor patio. As a matter of fact, the sketch of the parti of the Pueblo Ribera Court is found next to the Harriman project floor plan. The floor plan includes a sleeping room, a living room, a kitchen, and a porch on the ground floor and also a roof deck on top. Although not identified in the plan, the Pueblo Ribera Court's floor plan must be based on his 4-foot unit system.

The whole lot is configured by an 8-foot wide street with a 4-foot wide back lane and is subdivided assigning each unit lot a typical 46-foot by 46-foot. Housing units share a major playground and community hall next to the entrance court. A parking garage is planned close to the entrance, and common storages are in the back of the layout. Six rows of twenty-seven units are arranged to exploit all the planar symmetry transformations including reflection, translation, rotation, and glide reflection. In the same year, Schindler developed another housing, called Gould and Bandini Workmen's

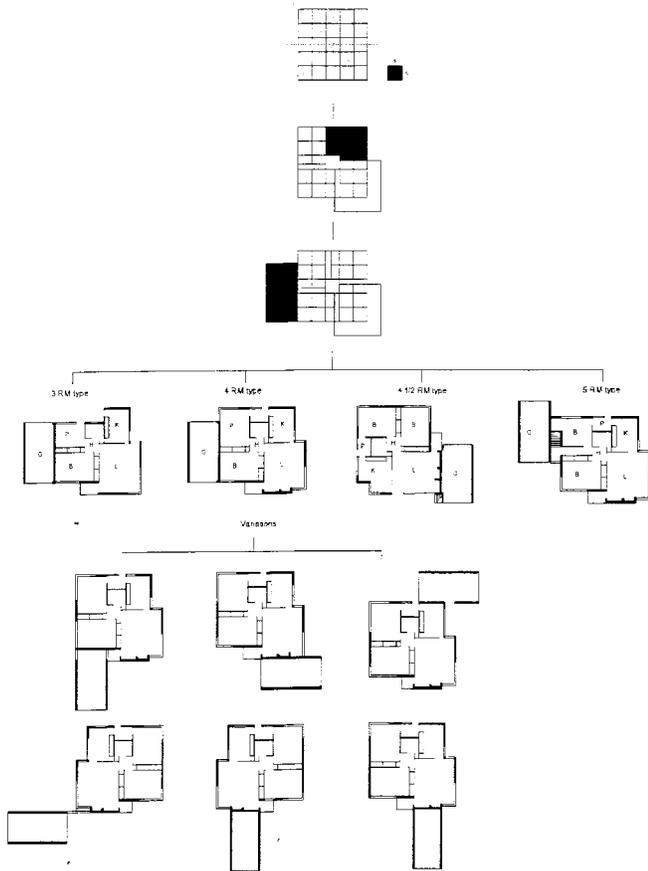


Fig. 7. Taxonomy of the Schindler Shelter with the Shell Construction System: At the top is the 5-foot unit square grid; below this is the basic spatial organization with standard kitchen, bathroom, and laundry unit. The rest of the house as a one-piece-shell is divided by removable closet partitions. Pinwheel type of symmetry guides the internal structure of the shelter. At the next level of the taxonomy is the garage added on any side of the house as a separate unit; the next level down shows four different room types derived from the basic parti. The last level is six spatial variations of the four room types.

Colony. This floor plan is reminiscent of his later Schindler Shelter project, but its assembly is based on simple mirrored reflection only. This same symmetry idea applies in his Highway Bungalow

Hotel plot plan (1931).

**3.4 The Schindler Shelter (1933-42)**

Schindler’s use of the unit system and symmetry in housing design is highlighted in the Schindler Shelter project, developed from 1933 to 1942. This unbuilt project offers a rich source of evidence of the way in which Schindler makes full use of symmetry. The project was intended to provide urban dwellers with an opportunity to attain economic security as well as comfortable suburban shelter. Schindler responded to the program with issues of flexibility of the floor plan, expandability for the changing needs of a growing family, minimum maintenance, new construction methods, and new materials. Above all, a key factor in his proposal was to provide a variety of optimum space layouts and multiple unit orientations with the integration of both systematic spatial composition and autonomous construction techniques. Although the development of the project spanned more than ten years and a series of shelter plans underwent a variety of spatial transformations, they all share common compositional principles. Two different types of housings are developed based on two different types of construction: the Shell Construction and the Panel Post Construction.

The ground floor plan of the Shell Construction is based on a 5-foot square unit grid, which is rare to Schindler. Along with the unit grid,

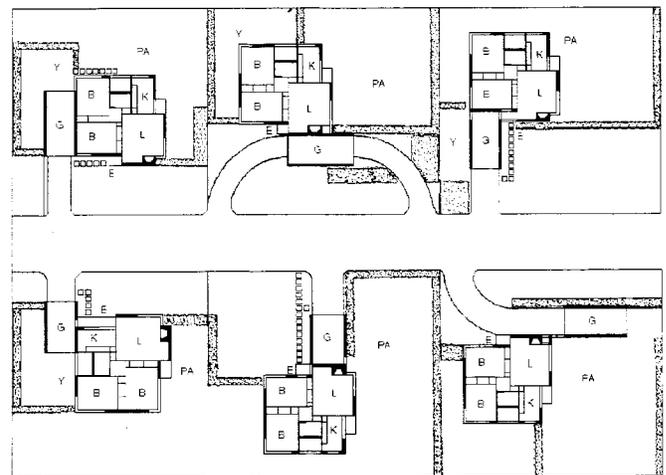


Fig. 8. The Schindler Shelter project, 1933-42, Site layout

the symmetry governs the internal structure of the spatial composition in each scheme as well as its variations. The internal organization is subdivided by removable closet partitions, which enhance spatial flexibility, and is set along the pinwheel type of rotational symmetry. The partitions are designed to be removable such that each space is easily expandable. A garage can be added to any side of the house as a separate unit. Instead of providing only a standard unit with fixed layouts, a series of variations are provided. These series of unit types are based on the same underlying organizational system. Based on the unit, some modules are added and subtracted to produce variations in both layout and size. Schindler developed four different types of the shelter plans as well as six variations of 4-room type to fulfill various spatial requirements of the users. Their differences are based on the number of rooms, for example, 3, 4, 4 ½, and 5-room type. Schindler further rotates and reflects a four-room type shelter to obtain even more variations.

The generation of a standard unit and its variations further questions how to arrange those in a larger planning. Schindler expanded the possibilities of combining units into groups anywhere in the U.S. Schindler offers the street front pattern of six housing arrangement as an example, although end-on units, courts, clustering pattern, or pinwheel format of court pattern could be other options. The shelters line both sides of the street, providing independent and easy access to the shelter. His example reflects and rotates only a 4-room type shelter. Again, a garage is added in different locations. No single garage location to the shelter is the same as the others. Shrubs border each lot property, providing each unit its own front yard and backyard.

When a standard unit and its variations are arranged in a mixture, possibilities of their groupings will be considerably increased in a variety of layouts. Although not fully explored, Schindler must understand the idea. Minor variations in the architectural theme of each unit provide an identity for each dwelling, precluding its monotonous character. Also, additional structures such as pergolas, a cantilevered entrance or a deck, and a built-in flower box further foster a dwelling identity. In addition, a row of trees around the

entire block near the sidewalk and trees or shrubs between the units provides visual protection, maintaining privacy and demarking their territory.

Schindler developed another set of designs with his own Panel Post Construction system. Unlike the 60-inch (5-foot) unit module of the Shell Construction, a 48-inch (4-foot) unit was used for the schemes as well as components of the Panel Post Construction. This system is based on modular prefabrication of building components and jointing. According to this system, a shelter is made out of 9 interchangeable basic prefabricated modular components which were designed to be mass-produced in a mobile factory and then assembled at a job site. Partitions and walls are made of cheap, flexible new material, such as plywood, boards, metals, etc., since they form a non-load bearing structural system. The posts bear all structural loads and function as the structural skeleton that supports the roof and sustains the wall, window and door panels. Joint details lacking any construction ambiguity are extremely simple to produce and easy to erect in the field. The posts are shaped like crosses and erected at standard distances so that the panels can be inserted into the grooves of the posts. Components are assembled in a post in one of four ways. The post joint system is designed to permit the connection of panels in four-side joints. Four-foot wide panels are connected to each other into grooves side by side; one is plus and the other is minus. It is a kit-of-parts solution to the affordable housing problem. Similar systems have been developed by Wachsmann and Gropius (1941) and by Faller and Lenart (1986).

Four basic types for the Panel Post Construction are identified with regard to their room size. Like schemes with the Shell Construction, four variations of a standard two-bedroom house are further identified. The room grouping was almost identical to those of the Shell Construction. The schemes were a product of the same compositional theme as the Shell Construction. However, the characteristics of the design appear to be very different from those of the Shell Construction. Here, differences in design stem from differences in the construction system. Schindler never provides

any site layout using the scheme.

#### 4. Conclusion

This paper discussed Schindler's use of the unit system and symmetry in his housing designs. In sum, the interplay of the unit system and symmetry has evolved into a surprisingly large number of spatial compositions of housing units each with their own variations. Like Wright, Schindler's early principles recursively apply to numerous later housing designs. Such recursion could be considered as a source of continuity of theme and variations in his housing design. Although the style of the housing variations may differ from one to the other, the method remains unaltered as the most essential basis of architectural continuity.

Lastly, the results of this study can be further developed and utilized in practice. A comprehensive use of the principles could be addressed for practical applications to arrive at a variety of alternative solutions of topological diversity in contemporary housing designs.

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