

Precedent and Progress of an Idea: Quadruple Building Block and the Schindler Shelter

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Abstract

This paper is developed based on a document presented at the 5th Congress and Exhibition of the ISIS-Symmetry, held at the University of New South Wales, Sydney in July 2001. It takes as its point of departure of searching for formal methodologies for the description and construction of architectural designs. Its applications in the analysis and synthesis of housing designs are discussed and new possible housing assemblies in an urban scale are suggested with the same principles. The valuable insight of this study is to suggest symmetry principles as design strategies and compositional methodologies in order to develop new design alternatives for topological diversity in housing designs.

This paper outlines mathematical concepts of transformations in design and comparatively analyzes F. L. Wright's Quadruple Building Block and R. M. Schindler's Schindler Shelters to show how these concepts are strategically employed as thematic elements in the unit design as well as the variations in housing. Skylight designs of both architects are also analyzed to summarize their conscious interests of the concepts. This paper concludes that both architects consciously exploit the principle of symmetry to generate both interior room variations and multiple housing units. The two housing designs represent good examples of our complementary reasoning between precedent and progress: Wright's design as a precedent, and that of Schindler, a notable progression.

Keywords: symmetry, F. L. Wright, quadruple building block, R. M. Schindler, Schindler Shelter

Introduction

The value of examining historical precedents in architecture resides in searching out underlying principles rather than exemplifying any particular stylistic discipline. Principles extracted from this examination function as pedagogical references to the wider understanding of complex existing designs. Also, these principles act as a source of knowledge for new design development. Hence, rigorous research of historic precedents is extremely valuable for notable design progress. The paramount significance of the idea is similarly found in many other creative disciplines.

Of various principles in architecture, this paper focuses on symmetry. Symmetry often prevails in architectural design as an underlying principle of spatial arrangement (Weyl, 1952). Symmetry may be local, or global. Arrangements of the components that show a high degree of order may fail to have any global symmetry, yet the design represents the embedding of such components

with various local symmetries. In design, it may be more meaningful when one reconciles within the composition subtle local symmetries within the global symmetry to create asymmetries.

Symmetry operations are concerned with spatial displacements which move a design in such a way that all the elements precisely overlay one another so that, despite reorganization, the design retains its original appearance. Subsymmetries arise from a curtailment of some of these operations: formally, selecting subgroups from the group of symmetries. The employment of the multiple subsymmetries in housing designs is manifold. They apply to the overall housing organization as a whole. They also apply to a standard unit with its typological variations and the grouping of multiple units into a larger assemblage.

Frank Lloyd Wright and Rudolph M. Schindler provide two housing examples, the Quadruple Building Block and the Schindler Shelter, that consciously exploit the principle of symmetry to generate both interior room variations and multiple house orientations within city blocks. They represent good examples of our complementary reasoning between precedent and progress: Wright's design as a precedent, and that of Schindler, a notable progression.

This paper briefly outlines use of multiple

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subsymmetries in the analysis and synthesis of architectural design. The value of this study is to suggest symmetry principles as design strategy and compositional methodology in order to develop new housing design alternatives for topological diversity. Second, Wright's Quadruple Building Block and Schindler's Shelter design are analyzed and compared to show how symmetry principles are strategically employed in their unit variations, clustering and orientations on site. In addition, skylight designs of the two architects are shown to amplify their conscious employment of symmetry principles in minor details.

Multiple Subsymmetries in Architecture

In architecture, bilateral symmetry, which refers to mirrored reflection, is the most often encountered concept of symmetry in the classical period, and found in the façade as well as the floor plan of a building. However, in the twentieth century, architectural designers have explored various symmetries other than traditional bilateralism. They exploit all four types of planar symmetry transformation - reflection, translation, rotation, and glide reflection - to building designs, and particularly in housing designs. For instance, Le Corbusier, in his maison minimum schemes, exploits all the planar symmetry transformations (March and Steadman, 1971).

There is another type of symmetric application where several layers of symmetry are manifest in the parts of the design. At times, symmetries are hardly distinguishable by mere observation, despite an almost obsessive concern for symmetry. Such complexity arises from a multiple superimposition of symmetries with architectural elements. Manifold use of subsymmetry principles also increases multiple sequential design variations, preserving the fundamental principles unchanged as transformations take place. The variations can then be combined into higher-order larger assemblies on a city block.

Accordingly, it is crucial to introduce a formal methodology which clearly explains how various types of symmetries are superimposed in design. Let's begin with a concise summary of the mathematical structure of symmetry groups for a regular polygon, before proceeding to applications. The methodology will provide not only the description of symmetrical structures of a design, but also provide the deeper insight for generation of new designs by combination of various symmetries.

In two-dimensional plane symmetry there are two groups: the finite and the infinite. The finite group is called the point group and spatial transformations take place on a fixed point or line. The transformations involve rotation about the point and reflection along the line, or combination of both. In the point symmetry group no translation takes place. For the infinite symmetry group, spatial transformations occur where the basic movement is either translation, or glide reflection. Within

this group, designs which are invariant under one directional translation are called the frieze group; designs under two-directional translations are called the wallpaper group. Examples of the frieze group and the wallpaper group in housing arrangements are easily found (March and Steadman, 1971).

In this discussion, emphasis is given to the application of point group symmetry of the regular polygon. There are two finite point groups in the plane: C_n (cyclic group) and D_n (dihedral group) where 'n' represents the period of the group or the number of $360/n$ rotations. The number of elements in a finite group is called its order. The symmetry group of D_n has order $2n$ elements, while C_n has order n elements. The symmetry group of the square is the dihedral group D_4 of order 8. The subsymmetries of the regular polygons such as equilateral triangle, square, pentagon, hexagon, heptagon, etc. can be considered. For example, the symmetry group of the square comprises the eight distinguishable operations such as four four-reflections and quarter-turns. The symmetry group of the square forms ten different subsymmetry designs (Park, 2000).

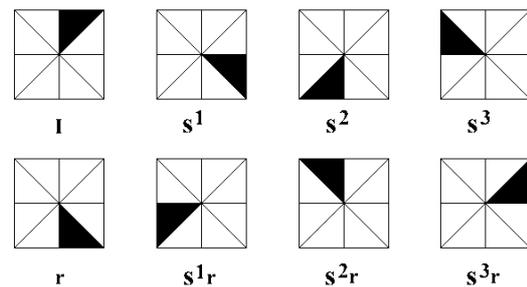


Fig.1. The Symmetry Operations of a Square Labeled as I, s, s², s³, r, sr, s²r, s³r: 'I' denotes identity; 's' denotes a quarter turn clockwise rotation of the square; and 'r' denotes a mirror reflection of the figure

To better explain, consider a more easily recognizable polygon, the rectangle, since the simplest possible elements are preferred to elucidate the increasing complexity and diversity encountered in this exercise. The reason for using the smallest possible motif is that on the one hand, the hierarchical structure of the whole pattern is clearly revealed; on the other hand, developments in complexity will occur rapidly by adding other symmetric motifs, one-by-one (Budden, 1972). The rectangle has two mirror reflections and two rotational symmetries of the order two. This forms five different subsymmetry designs as shown below.



Fig.2. Five Unit Motifs (from left to right): a motif with two mirror and rotational symmetry (D_2); a motif with a 180° rotation (C_2); a motif with vertical reflection (D_1); a motif with horizontal reflection (D_1); a motif with no symmetry (C_1).

This principle can be applied in the development of housing design. Each housing unit may present a distinct subsymmetry; or, a multitude of subsymmetries may be superimposed in an individual design. In either instance, a number of asymmetric housing designs can be produced. Although the resulting configurations of such a design may appear differential or complex, there will exist strong connection among variations. There are two possible ways that a group of multiple subsymmetries may be employed in a single design as a whole: stacking and superimposition.

Whereas each symmetric motif may be applicable as a housing unit plan, stacking distinctive subsymmetries in each floor level can generate a wide variety of multiple story housing units, depending on how intricately symmetry principles are applied. A few of the simplest examples are shown below.

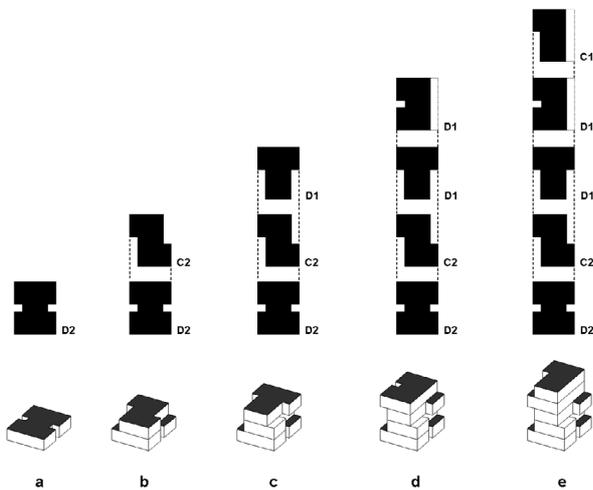


Fig.3. Multiple Story Housing Unit-prototypes Stacking Subsymmetries of a Rectangle: Using the above symmetry of the rectangle, we begin with the full symmetry of the rectangle at the ground level (a). The second floor illustrates the C_2 rotational symmetry where floor plane is arranged based on the half-turn rotation (b). The third level represents D_1 symmetry at the vertical mirror axis (c) where the fourth floor is set along the horizontal mirror axis (d). The top-level has no symmetry, which is denoted as C_1 (e).

The above mechanism illustrates possibilities for generating diverse housing units. If additional elements are augmented in each, the combinatory possibilities for

generating unit variations are enormous. Independent elaboration of these arrangements into some larger assembly creates a variety of housing patterns. To test, a variety of housing units are arranged on a city block. Multiple unit plans are set out on an equally divided grid-lot - perhaps the simplest possible urban component.

When symmetrical or asymmetric units are clustered on a site, the number of emerging combinatory possibilities for a group of housing types leads to synoptic patterns of spatial organization. Clustering creates irregular patterns; the resulting layouts implement dynamic physical manifestation along the streetscape, emphasizing the visual effect. Such arrangement creates a sense of movement and orientation, enabling an enormous variety of possible arrangement.

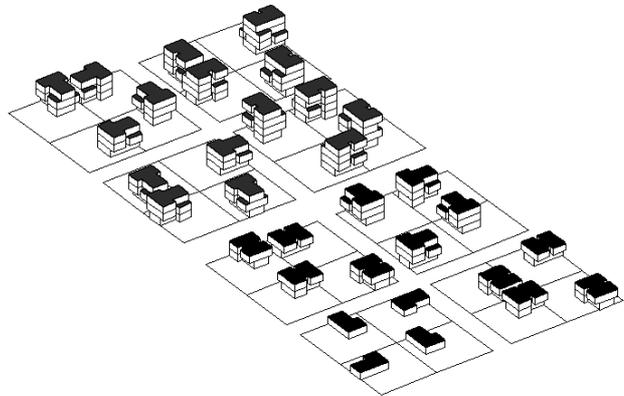


Fig.4. An Arrangement Where Various Types of Housing Units are Blended in a Larger Assembly

Some low shrubs or trees are added between units and a garage can be added to the composition. These minor additions allow identity for each housing unit, creating subtle variation. The combination of those unique elements will provide a richly textured neighborhood setting.

Interestingly, this symmetric approach was a practical convention in classical as well as modern architecture. The Pantheon by Hadrian, the Popenoe House of 1922 by R. M. Schindler (Park, 2001), Louis Kahn's National Assembly building in Bangladesh (Park, 2000), Candilis-Josic-Woods' housing designs (Woods, 1968), and most recently, James Stirling's Walt Disney Concert Hall proposal (1987) are all good examples which explore a variety of subsymmetries superimposed one upon the other around a central focal point in their design.

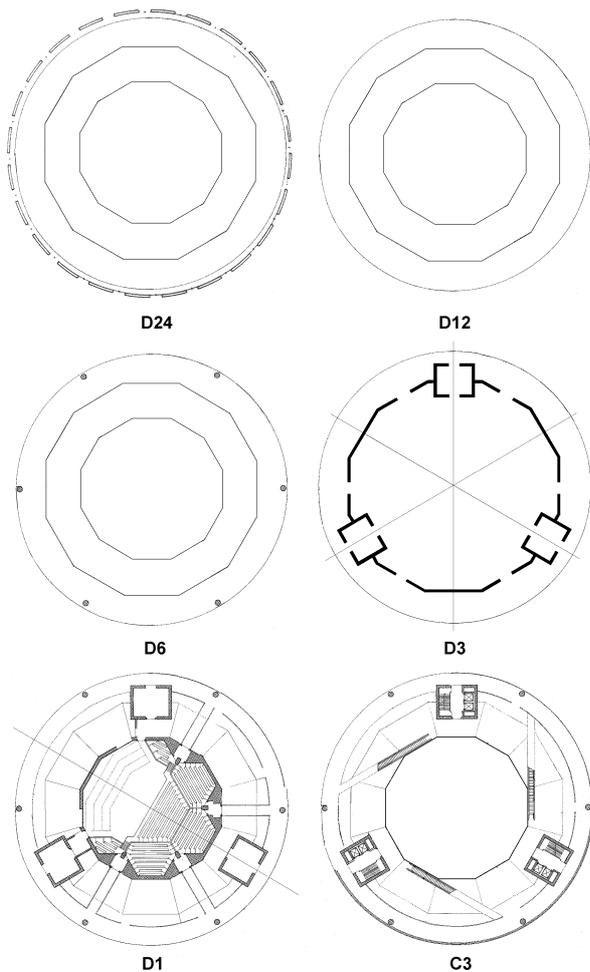


Fig.5. James Stirling, Walt Disney Concert Hall Proposal, Los Angeles, 1987. Subsymmetry analysis of the first floor plan of the auditorium. At the top left, the full symmetry of 24-gon (D_{24}) is shown with regard to external columnar walls. At the right, the symmetry of 12-gon (D_{12}) is manifest in the division of the circle which determines the development of the detailed plan of the auditorium. In the second row, the diagram at left illustrates hexagonal symmetry where six major columns are juxtaposed to support the upper part of the auditorium (D_6). At the right, interior walls and staircases are arranged in the full symmetry of the equilateral triangle (D_3). At bottom left, the central auditorium and entrance gates are set along the axis at the first level (D_1). The diagram at bottom right illustrates 120-degree rotations of staircases and elevators (C_3).

With the multiple uses of symmetry principles, complex designs as a whole can be decomposed into parts for analysis. Conversely, these parts can be recombined into multiple sequential designs using the same principles. Moreover, the use of the symmetry principles range from simple ornaments to window details, a single house, multiple housing and larger urban designs. The complementary applications of the symmetry idea are extremely valuable in a constructive sense, as Cohen illustrates in his book (2001). Symmetry principles can be extended in development of

contemporary housing design to generate a diversity of architectural prototypes.

A promising approach with regard to this methodology is its application to identify symmetry principles in existing housing designs. This identification encourages discovery of new patterns and enables understanding of the underlying organizational geometry in architectural composition.

Analysis now focuses on two housing examples: Wright's Quadruple Building Block and Schindler's Shelter. These two examples are analyzed in terms of individual units as well as their assembly in site planning. The two projects are strategically chosen since they present the two architects' visionary notion of the social housing design. And also, the symmetry method as a key underlying principle is applied in the development of the housing designs. By comparing and analyzing the two architects' work, it is possible to demonstrate the conscious and continuous application of symmetry in their architectural designs.

F. L. Wright and R. M. Schindler

Schindler studied at the Imperial Institute of Engineering in Vienna from 1906-1911. In 1910, a year before graduating, he studied under Otto Wagner at the Imperial Academy of Fine Arts. During this period, he also joined Adolf Loos' *Bauschule*. In June 1914, he came to Chicago to work for Ottenheimer, Stern, and Reichert.

Schindler saw Wright's architecture as a prime example of space architecture in practice. He testified that Wright's work first entered his consciousness in Vienna. After conceiving his space concept in the Styria mountains, Schindler was given the opportunity to look at Wright's Wasmuth portfolio by a librarian in Vienna. The portfolio contributed significantly to the early development of Schindler's 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. Here was 'space architecture'." In his 1916 lecture notes, Schindler also rhapsodized about Wright's work: "the craftsman's mastery is his virtuosity in playing with his forms."

In 1917 Schindler joined Wright's office and worked in Chicago and at Taliesin, originally on the Imperial Hotel project for Tokyo. Schindler was the best-educated and most experienced architect in Wright's employ. Letters between Schindler and Wright, only recently discovered, show Schindler was made superintendent of Wright's office in Chicago, then Los Angeles, during Wright's long absences in Tokyo. Furthermore, until now it was generally assumed that Schindler came to Los Angeles only to supervise developments on Olive Hill for Aline Barnsdall, the oil heiress. In truth, he continued to supply drawings for the Imperial Hotel and dealt with American suppliers Schindler was, like Wright to Sullivan, more than just another draftsman. From 1917 to 1921 he was, for all intents and purposes, Wright's

partner in all but name.

Wright's Quadruple Building Block

Wright developed a social housing project called the Quadruple Building Block, first appearing in "A Home in a Prairie Town," in the 1901 issue of *Ladies' Home Journal*, and originally designed in 1900. Although developed in several versions, all share common compositional principles. The standard unit-plan of the Quadruple proposal consists of two interpenetrating masses anchored by a central hearth and fitting within the classification of Prairie Houses. Although two overlapping parts and two major orthogonal axes seem to account for much of the design, closer analysis reveals multi-axial symmetries are also superimposed.

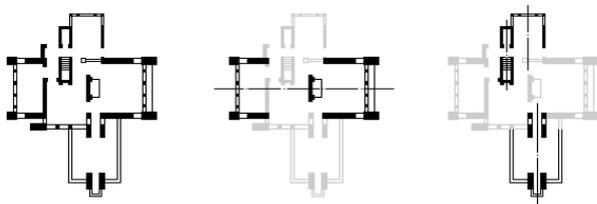


Fig.6. Frank Lloyd Wright, Quadruple Building Block 1901. Left, a standard unit plan; Middle, elements and sub-elements, which are bilaterally symmetrical along the longitudinal axis; Right, elements and sub-elements along the latitudinal axis.

One consequence of the superimposition is that global symmetry is lost even while local symmetries are preserved. Wright uses similar approaches in his various Prairie Houses.

The proposal includes two different symmetric employments in site layout: the pinwheel type and the mirrored reflection type. Each house is set on four equally subdivided lots, sharing a common backyard in the center for all four houses. The first scheme shows a pinwheel clustering of four individual houses around the corner of a square site. Each house is oriented toward a different direction, but faces to the street and with an individual entry. In this scheme, Wright never included a garage and driveway for any transportation. The second scheme shows each of the clustering of four houses line both sides of the street in a mirrored format based on the tartan grid (McCarter, 1997a). Along with entry driveways, the four houses share a large open court, while yet another four houses, (two from the first group) share the backyard.

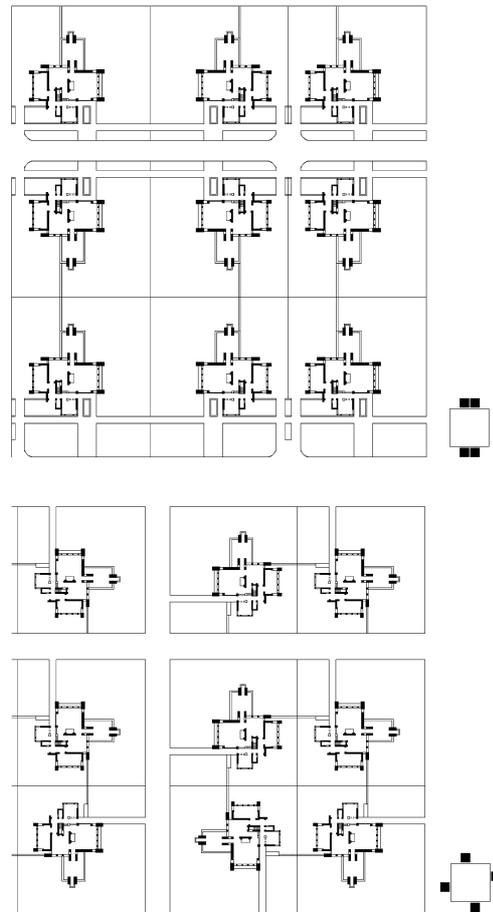


Fig.7. Two Arrangements from Wright's Wasmuth Portfolio (1910). Top, a pinwheel type of grouping of a standard unit; Bottom, a mirrored grouping.

Wright in 1916 described the project as it impacts each householder: "His building is an unconscious but necessary grouping with three of his neighbors', looking out upon harmonious groups of other neighbors, no two of which would present to him the same elevation even were they all cast in the same mould. A succession of buildings of any given length by this arrangement presents the aspect of a well-grouped buildings in a park, *of greater picturesque variety than is possible where façade follows façade*" (Wright, 1992). He goes on to say that "architectural features of the various buildings in the general public group recognize and emphasize in an interesting way the street vistas, and nowhere is symmetry obvious or monotonous. The aim has been to make all vistas equally picturesque and attractive and the whole quickly harmonious." It is true that the entire housing complex was laid out in a way that their elevations could be varied according to building placement. The resulting variation captures the complex rhythms as seen in indigenous building. The symmetric transformation denotes difference in exterior, enabling variety in the streetscape. Thus, when seen from outside, the strong symmetry will be lessened.

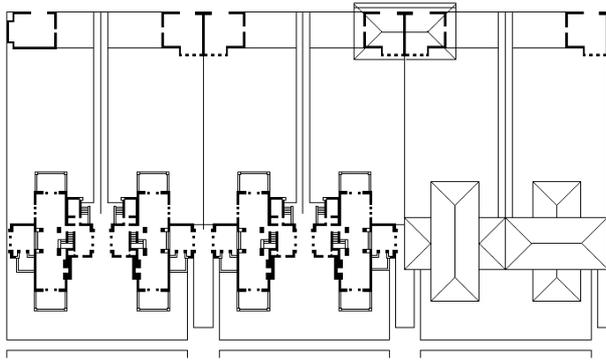


Fig.8. Street Front Layout for Charles Roberts, 1903

The pinwheel-type quadruple block plan has been a recurring theme in Wright's numerous later housing designs. Such a recursive theme could be considered the source of continuity in variations for his housing design. The theme recurs in a series of later housing projects such as that for C. E. Roberts in 1900-03, the non-competitive entry for a Residential Land Development competition (Chicago City Club Competition) of 1913, St. Mark Tower in 1927, Broadacre City of 1934, Suntop Quadruple Houses of 1938, the Crystal Heights project and the Ardmore Experiments of 1939, Cloverleaf Housing project 1942, and the Rogers Lacy Hotel project 1946-47. The unit design of all these projects is asymmetric, but their clustering is comprised in pinwheel formation. Also, the pinwheel concept is applied either in grouping or in an individual building (for example, St. Mark Tower).

Wright's use of symmetry principles in housing design has influenced other architects, in particular, Schindler. 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 in the portfolio before coming to the United States.

The Schindler Shelter

Schindler also made frequent use of symmetry in housing design. A survey of early housing projects shows clear use of rotation and mirrored reflection in his planning. Schindler's early housing design, the Monolith Homes for Thomas R. Hardy (1919), (made while working for Frank Lloyd Wright during his prolonged absence in Tokyo) exhibits a strong use of symmetry. The geometry of a single house-unit is based on two cross axes, horizontally and vertically (Gebhard, 1980). The standard unit is then assembled in four quarter-turns, or 90° rotations, on a site plan. The Monolith Home stands out as one of his earliest housing experiments of this kind. The same idea applies to Schindler's built project in San Diego, the Pueblo Ribera Court (1923). Although the underlying *parti* of a unit plan exhibits single axial symmetry, the overall space of the unit is asymmetrically planned. Strictly speaking, it abandons

rigid symmetry in the unit design. The asymmetric units are clustered in four quarter-turns to obtain private space. The architect's intention could be read 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." The symmetric disposition of a housing unit continues to the Harriman project (1924-25). Six rows of twenty-seven L-shaped asymmetric units are arranged so as to exploit all possible planar symmetry transformations (reflection, translation, rotation, and glide reflection).

Schindler's use of symmetry in housing design culminates in the Schindler Shelter project, developed from 1933 to 1942, but never built (Garland, 1993). The project offers a rich source of evidence for the way in which Schindler makes full use of symmetry to generate both interior room variations and multiple building orientations. The shelters were intended to provide urban dwellers an opportunity to obtain economic security as well as comfortable suburban shelter. Schindler responded to the program with such devices as flexibility of the floor plan, expandability for 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 with the integration of both systematic spatial composition and autonomous construction techniques. Although the architect continuously developed the scheme over ten years and a series of shelter plans underwent a variety of spatial transformations, they share common compositional principles. The hierarchical order of spatial organizations and their logical variations are observed among his schemes shown below.

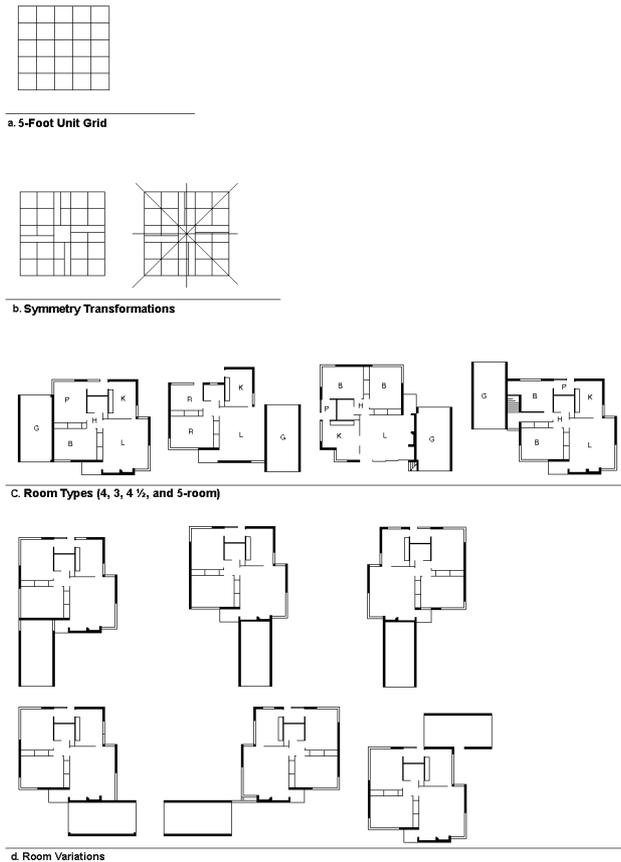


Fig.9. The Schindler Shelter, Spatial Taxonomy, Top (a) shows 5-foot unit grid. Second row (b) shows basic symmetry transformations; pinwheel type of rotational symmetry for the internal organization and four reflections in its four axes for external variations. The third row (c) shows four different room types (3, 4, 4 1/2, and 5-room). The bottom row (d) shows six variations of the 4-room type where basic unit is rotated and reflected, and then, the garage is added any side of the basic unit.

The floor plan is based on a 5-foot unit grid. The internal organization of the unit is subdivided by removable closet partitions (thus facilitating spatial flexibility), and exhibits pinwheel-type rotational symmetry. The partition is designed to be removable such that each space is easily expandable. The garage can be added to any side of the house as a separate unit. This additional garage unit creates a dynamic exterior aspect. Additionally, instead of providing only a standard unit with fixed layouts, the architect further rotates and reflects a four-room shelter type with different garage locations to obtain a series of variations. Based on the *parti*, some unit modules are added and subtracted to produce variations in both layout and size. Schindler developed four different types of shelter plans, with variations, to fulfill various spatial requirements of the users. Their differences are based on the number of room types, for example, 3, 4, 4 1/2, and 5-room types. Unlike

Wright, Schindler provides numerous methods to generate unit variations.

The generation of variations raises questions of arrangement in a larger assembly. In the earlier paper, we tested how a variegated arrangement might be obtained with more or less standard designs. Whereas Wright's housing clustering is rather strict, Schindler opened the possibilities of combining units into groups, anywhere in the U.S. Schindler, in fact, provides only a street-front pattern of six housing arrangements as an example. End units, courts, clustering pattern, or pinwheel-format court patterns are among other options.

Schindler also listed six additional methods of generating variations in site planning. He believed that minor variations in the architectural theme of each unit might provide an identity for each dwelling, creating subtle differentiation. He writes, "[The] plan shows some variations of layout and street front design due to changes in location of garage only. Further possible variations include: 1) Use of several basic types; 2) Reversal of exposures (mirror picture); 3) Addition of pergolas, etc; 4) Combining of houses into groups; 5) Color of building; 6) Planting".

Schindler's argument for a variety of shelter designs within a unified compositional principle is that, despite the geometrical similarities of each unit, their various arrangements in a city block offer a distinctive streetscape from the pedestrian's perspective.

Skylight Designs

The thematic use of symmetry between Wright and Schindler is extended to two skylight designs in their church buildings. The first is the stained glass of Wright's Unity Temple designed in 1905 (McCarter, 1997b) and the next is Schindler's use of the skylight design in the Bethlehem Baptist Church of 1944 (Garland, 1993). Interestingly, Wright wanted to cover the whole skylight with individual designs in various symmetric arrangements, yet Schindler simply clustered them in pinwheel.

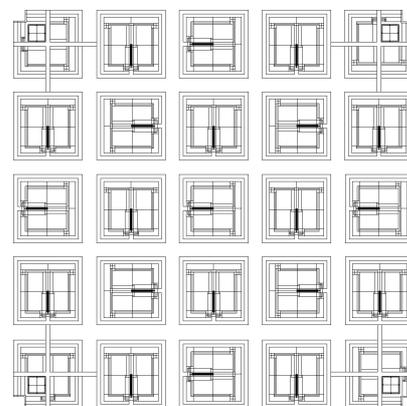


Fig.10. F. L. Wright, Skylight from the Unity Temple

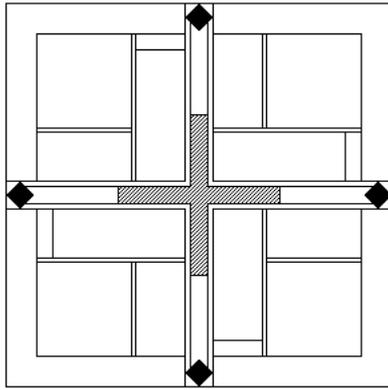


Fig.11. R. M. Schindler, Skylight from the Bethlehem Baptist Church

In the Unity Temple, square skylights are set in a dynamic and asymmetrical pattern with individually symmetrical unit design. In fact, the double-height of the central sanctuary space is covered with the 25 stained glass skylights where a standard unit design, based on orthogonal symmetry, rotates and reflects, and another unit design set at each of the four corners creates variety in arrangement. Wright used the whole ceiling space as his drafting board and had almost all palettes of symmetry operations of the square. With Schindler the situation is reversed. In his church design, Schindler responded in a clustered way as Wright did in the skylight design in the Willets House of 1902. The skylight design is set along the cross-axial *parti*, but each unit, carefully subdivided to form an asymmetrical design, is set in a pinwheel. Schindler could have selected a unit design and arranged it in a different way, but he remains as simple as possible. Without doubt, both architects greatly appreciate the principle of symmetry in their design. Although style may differ from one to the other, both share an underlying logic of spatial compositions.

Conclusion

Symmetry as an underlying principle of spatial composition in housing is discussed with regard to the possible use of analysis and synthesis in architectural design. This paper illustrates how subsymmetries were applied in a distinctive housing design and its derivative variations. Housing units with various superimposed subsymmetries in a single housing design are arranged on an urban grid configuration to illustrate layout possibilities.

Both Schindler and Wright's housing have been analyzed and compared to show how basic symmetry operations have been applied. It demonstrates that while Wright rotates and reflects a standard house unit to regroup them in a larger assembly, Schindler uses a variety of symmetries in the creation of unit variations

as well as their assembly. It is not surprising that Schindler, fully aware of the principles behind Wright's Prairie ideology - and a creative designer in his own right - further develops Wright's ideas in his own design. If Wright's use of symmetry is a pioneering and positive precedent, Schindler's progressive application is subtle and intriguing. This analysis proves that the symmetry principle is a key compositional device in their housing designs. Although both projects have been developed more than 10 years, their underlying principles have not changed. For both Wright and Schindler, the use of symmetric operations is conscious and intentional, not only in macroscopic building design, but also minor details. Undoubtedly, such an extraordinary precedent would be of great benefit in Schindler's development.

The results of this study can be further developed and utilized in practice. Comprehensive application of these principles could be addressed for practical use to arrive at a variety of alternative solutions, enabling topological diversity in contemporary housing designs. Symmetry can act the primary vehicle to govern and organize the spatial composition in housing design. As this paper has shown, symmetry is far from a boring, tedious notion of a classical ideal. The potential lies in use as a strategy and new design tool in the contemporary architect's hands.

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