GEOMETRICAL RELATIONSHIPS AND DESIGN PROCESS OF THE PLAN OF MIES VAN DER ROHE’S FARNSWORTH HOUSE

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No formula or mathematical relationship is said to form the basic for the proportions of Mies’s Farnsworth House. However, Golden Rectangles form the interior spaces. Furthermore a double-square forms the basic proportions of the preliminary plan. Mies’s order, “the successful relationship,” in the plans of the Farnsworth House is achieved by various geometrical relationships.

**Keywords:** Mies van der Rohe, Farnsworth House, geometrical design method, proportion, golden ratio, order

1. Preface

The Farnsworth House (Fig. 1, 2, 3, 4 1946-51) is the best materialization of Mies van der Rohe’s ‘Less is more’ and one of the most beautiful houses in the 20th century. The house is a glass-walled rectangular box supported above the ground. The roof and floor are bounded by thin channels and supported by four wide flange columns welded to these channels on each side. The terrace is set to the lower (south) – relating to the drawing – side of the house and slides to the left (Fig. 5). The left side of the house is an open porch.

The design was started from 1946 and exhibited in 1947 Mies’s retrospective at the Museum of Modern Art in New York (Fig. 6). Initially the house was conceived as a bolted frame with concrete floor and terrace and plywood core walls. In 1949 it was started all over again. It is during 1949-51 that the house was evolved into an all-welded structure with expensive interior, Roman travertine floors and primavera core walls. After 1949 the cost was estimated for houses of three sizes: 84 by 30 by 10 ft, 77 by 28 by 9 ft and 77 by 28 by 10 ft. The final size of the house, the roofed area, is 77 by 28 by 9 1/2 ft (Fig. 5). The interior measures 55 by 28 ft, the porch 22 by 28 ft and the terrace 55 by 22 ft. The long side span is 22 ft and the cantilever is 6 ft. The columns divide the long side of the house into the ratio of 1:4:4:1 and that of the interior into the ratio of 1:4:4:1. The rectangle enclosing the whole is 99 by 50 ft. The ratio of the long side to short one is 1.98 : 1. The rectangle is similar to a double-square. That of the interior is 1.96 : 1. The interior is also similar to a double-square. Are these coincidental similarities (Fig. 7)? How did Mies design such a house with almost nothing restricted? It is said that “no formula or mathematical relationship forms the basic for the proportions.” The proportions of the interior spaces, however, are basically derived from a figure consists of Golden Rectangles (Fig. 8). Are the proportions of the whole of the house also derived from a specific geometrical relationships? How did the proportions of the house produced? How is Mies’s order, “the successful relationship of the parts to each other and to the whole,” achieved in the plan of the Farnsworth House?

By the way there remains a preliminary plan (Fig. 9) that relates to the model exhibited at MoMA in 1947 Mies Exhibition

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It has two bed areas and a piece of furniture (Fig. 9: a) between entrance and core. In the model such a piece of furniture (Fig. 6: A) can be also seen between entrance and core. That shows that the preliminary plan is just of the model, or the plan and model are at least closely relates to each other.

Then the preliminary plan is investigated to make clear the “formula or mathematical relationship” and the design process of the house.
2. Geometrical relationships in the preliminary plan

From measurement of the drawing with the interior of the preliminary plan (Fig. 10) the ratio of its long side to its short one is closely similar to 2:1. That is, the interior is closely a double-square. The rectangle enclosing the whole is also a double-square (Fig. 11). The columns divide the long side of the house into the ratio of 1:4'4:4'1, that of the interior 1:4'4:1 and that of the whole 1:4'4:4'4:1 (Fig. 10). This is the same as that of the final plan (Fig. 5). And with the short side the ratio of the house to terrace is 5:4 (Fig. 10).

By the way with an elevation (Fig. 12) in the early stage, in about 1946, the roof and floor planes are supported by four columns and cantilevered at each end. And from measurement of the drawing the ratio of the span to the cantilever is possibly 4 to 1. Then the columns divide the long side into the ratio of 1:4'4:4'1 (Fig. 12) like that of the preliminary plan (Fig. 10).

These ratios, however, are still uncertain because of measurement of the drawing. The drawing (Fig. 9) may become somewhat deformed. Then the possibility of a double-square is needed to be proved from the dimensions. The plans of the estimated three houses above mentioned are unknown. However taking account of the point of time when the plans were estimated, after the year 1949, it is reasonable that their columns also divide the long side of the house into the ratio of 1:4'4:4'1 and that of the interior into the ratio is 1:4'4:1.

The proportions of the estimated houses are derived from the ratio of 1:4'4:4'1. For instance with the 84 by 30 ft plan (Fig. 13) the long side is 84 ft, the cantilever is 6 ft (84 ft/14) and the span is 24 ft (6 ft × 4). Then the length of the interior is 60 ft (6 ft + 24 ft + 24 ft + 6 ft). The interior is just a 60 by 30 ft double-square. With 77 by 28 ft plan the interior is a 55 by 28 ft rectangle and the ratio is 1.96 : 1. These dimensions prove that the interior is basically thought to be a double-square.

Although it is said that “no formula or mathematical relationship forms the basic for the proportions,” interestingly a double-square, the ratio of 2 : 1, forms the basic for the proportions of not only the interior but also the whole in the preliminary plan.

3. Design process of the preliminary plan

Can a design process of the preliminary plan be logically speculated from the geometrical relationships, two double-squares (Fig. 10, 11)?

The starting-point of the design is certainly a double-square, a 2 by 1 rectangle. It forms the interior space. It can be thought to measure 60 by 30 ft (Fig. 14).

In the longitudinal direction roof and floor planes are supported by three columns and cantilevered at each end (Fig. 15). The ratio of the span to the cantilever is studied about several ratios (Fig. 16). The structural bay, the rectangle enclosed by four columns, is 4U by 5U (24 by 30 ft). Then the interior is a 10U by 5U (60 by 30 ft) rectangle. The three columns divide the long side into the ratio of 1:4:1.

For the porch the floor is extended inevitably at least by one bay (4U by 5U: 24 by 30 ft) because of the structural bay. The roof
Fig. 14 Interior of a double-square

Fig. 15 Ratio of the span to cantilever and structural bay

Fig. 16 Sketch of the ratio of the span to cantilever, 3:1

Fig. 17 Porch of one structural bay

Fig. 18 Terrace length

Fig. 19 Proportion of the terrace

Fig. 20 Two bed areas in the interior

Fig. 21 Position of the core

Fig. 22 Whole plan consisting of the same ratio, 4:5, rectangles

Fig. 23 Golden rectangles and double-squares in the final plan
and floor are supported on each long side by four columns. Then the roofed area is a 14U by 5U (84 ft by 30 ft) rectangle (Fig. 17). The four columns divide the long side into the ratio of 1:4/4:4:1.

Though several arrangements of the terrace are studied in the early design stage (Fig. 12), it is finely set adjacent to the lower side of the porch for landing on the ground (Fig. 18). In order to get down to both upper and lower from the terrace it has to slide to the left from the porch by one bay length (4U: 24 ft). And to get down from the porch the length of the terrace is at least 10U (60 ft) because of the structural system (Fig. 18). The terrace is supported on each long side by three columns. Then the total length of the plan is 18U (108 ft) (Fig. 18). How is its width decided?

Here a double-square also forms the rectangle enclosing the whole plan (Fig. 19). Then its short side is 9U (54 ft). As the result the short side of the terrace is 4U (24 ft). The terrace is a 10U by 4U (108 by 24 ft) rectangle.

The whole rectangle (Fig. 19) is similar to the interior (Fig. 14). The ratio, 4 to 5, of the structural bay (Fig. 15) is the ratio of the terrace width to the roofed area one, 4 to 5 (Fig. 19).

The right bed area (Fig. 20: Bed 1) is set parallel with the short side of the interior and the left bed one (Bed 2) does with long one. As each bed area is a long rectangle, the core is a little recessed to the right. Although the lower side of the core is nearly coincident with the horizontal center line of the interior (Fig. 21:XX), at first glance simple geometrical relationships cannot be found between the core and the other elements. But paying attention to the whole plan, an interesting geometrical relationship can be found. Making a rectangle (ABCD) in the interior between the right end of the terrace and that of the interior, its vertical center line (YY) is just coincident with that of the core. The fire place is nearly in the center of the rectangle (ABCD). In this way the terrace and the core are indirectly related to each other.

This rectangle (Fig. 21:ABCD) symmetrically enclosing the core consists of two 4U by 5U rectangles (Fig. 22), the rest of the interior is half of it, two quarters of it. The porch is also a 4U by 5U rectangle (Fig. 22). Further the terrace consists of two 4U by 5U rectangles turning at a right angle (Fig. 22). The preliminary plan consists of the rectangles with the same proportion, 4 to 5.

4. Preliminary plan to the final plan
Due to a rise in cost by high quality after 1949 the house is redesigned. And the proportions of the interior spaces are produced by golden rectangles. Interestingly with the final plan the deck chair (Fig. 23:A) on the terrace is just set parallel with the diagonal of the whole plan. As the whole plan diagonal is incident with the interior one, the deck chair is related to not only the whole plan but also the interior.

5. Conclusion
Although in the final plan exact double-squares certainly disappears, probably because of practical requirements and it is said that “no formula or mathematical relationship forms the basic for the proportions,” with the preliminary plan in about 1947 (Fig. 9) double-squares, 2 by 1 rectangles, are used for the proportions of the interior and the whole. In the derived design process of the preliminary plan double-squares take a very important role. Although it is not its real design process, the proportions of the preliminary plan can be almost derived by a double-square and the structural system, the ratio of the span to the cantilever, 4 : 1 (Fig. 14–19).

With the preliminary plan the interior and the whole are related by a double-square (Fig. 10, 11), the terrace, the porch and the interior by the rectangle with the same proportion, 4 to 5 (Fig. 22), even the core and terrace are related to each other (Fig. 21). And in the final plan the interior spaces are entirely related to each other by golden rectangles. Even the deck chair and the whole plan is related to each other (Fig. 23).

Mies said that order achieves “the successful relationship of the parts to each other and to the whole.” His order, “the successful relationship,” in the plans of the Farnsworth House is basically aimed to achieve by various geometrical relationships.

Notes
1) Schulze, Franz & Windhorst, Edward, A CRITICAL BIOGRAPHY AND REVISED EDITION, Mies van der Rohe (Chicago: The University of Chicago Press, 2012) p. 252. 2) Ibid., p. 252. 3) Ibid., p. 253. 4) Teterhoff, Wolf, MIES VAN DER ROHE, The Villas and Country Houses (New York: MoMA, 1981) p. 130. “Since the client was a single woman, who wanted to use the structure only periodically as a vacation and weekend house, the floor plan could be completely attuned to the needs of the single person. A further advantage proved to be the remote situation in the middle of a still largely undisturbed riverbank landscape, far from any other buildings or public roads. There was therefore no need to screen the house from the outside or even to divide it up into individual areas of privacy. With the exception of the most private necessities, for which (in the event of guests) two separate bathrooms were provided, all the functions of daily life take place in a single large space that is organized into four areas, at least suggestion, by the projecting side walls of the closed core area.”
A double-square is geometrically a special form. Therefore it is difficult to think that both of the interior and whole detailed dimensions in the early stage are an approximate double-square rather than a precise one.

There remains a sketch plan with 30'. The '30' possibly shows 30 ft, the short side dimension of the house. (The Mies van der Rohe Archive, ed. Franz Schulze, (New York; Garland, 1992) vol. 13, p. 118)

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An enlargement of the elevation is possibly set at the left end of the house (Fig. 24).

See note 5.

Fujikawa, J. recalled that Mies was a practical architect: with the Lake Shore Drive "Mies made the comment that... the proportions (20th floor) were perfect... the additional floors... give a less desirable mass." (Mies's Office 1945-1970: a/a, 81-1, p. 177) the proportion of Crown Hall were altered by Mies due to cost consideration. (p. 178.)

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