INTRODUCTION

Utrecht double house is designed by the Netherlands’ architect group MvRdV at the site by the Utrecht city park. The original buyer didn’t mean to or need to have whole ground he bought, so that they looked for partner to take over one-third of space. And it became the original idea of site design. According to their wishes of space usage, instead of traditional straight wall divided two dwellings in one site, two neighbors had space intersection to fit their need in space, and their wishes are the main concepts of space transformation [1]. As shown in figure 1, original buyer owns the larger part of building, which is white part, and partner owns the smaller part of building, which is shaded part.

SITE / FLOOR PLAN

Basically, as in figure 2, double house is a platonic solid cubic shape with a mall part of subtractive form at bottom-right corner. The shape is not completely cubic due to the relationship of site and its neighbor houses. Two sides of neighbors are not parallel to each other and double house can extend its border of box to as closed as to the right side of neighbor. As shown in figure 3, site plan are arranged along with two sides of border of neighbor houses, so that it made the shape of oblong. In floor plan, as in figure 4 through a to e, layout of two family spaces consistently arranged at left and right but different size of layout in each floor. Ground site only use two-thirds of intended floor plan, and two families share equally. Up to first floor most of spaces are arranged as living room space to larger family. On the contrary, smaller family has living room space on most of second floor. The space ratio for two families at third floor switch back again that larger family has larger space. Generally, the ratio of total floor plan is also one-third to two-thirds, which as their shares of ground site.

FAÇADE / FENESTRATION

About the fenestration of double house, most of public spaces have large window facing front and back. Only private space such as bathroom and bedroom have bear wall cover inner space. As floor plan design, represented in figure 5, the bedrooms for larger family are arranged at the second floor; the bedrooms, bathroom, storage are arranged at the first floor, third floor and forth floor, so that these area are shaded in building façade. As the concept of Nolli map, public space are open and white as figure void, and private space are
shaded as figure object. The purpose to set the large window facing front and back is because its site is by the city park and the frontal of building is facing the park. Larger window offers better view for both dwellings [2] and both families have equal view from their living room and dining room. Two dwellings have their own entrances: one is at front and the other at side. Though they have their own space in the house, they have to share exterior space: garden [3].

TRANSFORMATION
The zigzagging partition is not come from nowhere. Each of space interlocking in two dwellings is been calculated precisely to meet the initial ratio of space arrangement of one-third to two-thirds. Architects try to use interlock approach to obtain more living spaces stretch across the entire width of the site. As transformed in figure 6 [2], initial division of two families is subject to the proportion. Then space trading is made in following transformation that upper left block is moved to bottom center. After the first attempt to rearrange two spaces, smaller block exchange is considered at the second transformation. Because of the disadvantage of top two blocks exchange lead one family to lost top floor and roof space, another attempt is made to keep roof. But third transformation also cause the result that one dwelling only has useful space centralized at the third floor. Newer compromise approach is only change more smaller blocks from bottom-left to
upper-right. It leads the final sketch model as shown as the diagram in bottom-left at figure 6. After main shape is obtained, few specific blocks swap between two dwellings to balance the private shaded parts in elevation. At the final transformation we can see that whole interlocking spaces are asymmetric, even no partial symmetry.

**TYPOLOGY**

General speaking both sides of dwelling have linear organization along with the staircase bottom-up. Assuming there is a plane formed by y-axis and z-axis, all living spaces can be reached with shortest distance from central plane, and each floor can easily intercommunicate to each other through central plane.

To analyze more detailed about organization of house, exploded diagram can be applied not only for organization, but can also help understand about building structure. As demonstrated in figure 8, the massive wall on the side of building provides structure and organization. Two staircases in dwellings also represent the main axis of building circulation [4].

**STRUCTURE**

Double house has special zigzagging partition structure hanging the living spaces and private spaces like bedrooms and bathrooms in the air without column structure support. The mechanical support and construction procedure must be designed carefully. In double house component model which is built by Illinois Institute of Technology demonstrated the procedure and mechanical design [5]. Shown in eight step model in figure 9 through a to h, site model is the first one, then at the second step model in figure 9b main walls go up at two edges of site.
Dividing walls in figure 9c is the first and main structure challenge in the project that only two walls at the ground floor support whole 4 floors. In figure 9d, small box of bedrooms hang on two sides of edge walls with only support from walls. The gravity and bad equilibrium points might cause the structure problem as shown in figure 10.

In diagram the blue part are the support of component, and the orange part are the possible collapse point in each box and each turn on the dividing wall. In component model and diagram shows the potential mechanical problem but it may have been fixed by stronger material such as steel frame structure. Those are the information which can not be presented in diagram.

In figure 9e, the construction kept going to install groups of small spaces such as bathroom and closet. By now most of the living space is shaped. In figure 9f, vertical circulation is formed by installing the staircase in both dwellings. After roof, windows, and few small walls are done, the project was complete.
Actually the structure has its own design of mechanical balance. In figure 11a to c [1], a simple design of diagonal frame across different plane from one edge to another distributes the force and weight from top to the ground, which can be seen in figure 12.

Because of the design of cross frame structure, force not only distributes horizontally and vertically, but also goes diagonally to prevent the structure failure from enormous force gather in one week point. A triangular mechanical structure is formed in figure 11a, so that the main support to smaller dwelling is reply on this triangular distribution design. The main support to larger dwelling is shown in figure 11b. A column in driveway provides important support to right part of structure. The force is shifting from center to side and distribute the force to two ways to both center support and side support. In figure 11c, the support from edge walls and dividing wall distribute the force vertically. Combining these three distribution design any force from any place in the house can successfully relay to the ground either go vertically, horizontally, and diagonally. These cross frame structure complement the week of last force distribution design and its disadvantage shown in figure 10.