RECONSTRUCTIVE ANALYSES ON ARCHITECTURAL DESIGN PERFORMANCE FOR THE SPATIAL SUSTAINABILITY BY INTERACTIVE SHAPE GRAMMARS

[1]PHAM NGOC QUYNH GIAO, [2]SEUNG-HOON HAN

[1,2]School of Architecture, Chonnam National University, Korea
E-mail: [1]quynhgiaopham2910@gmail.com, [2]hshoon@jnu.ac.kr (Corresponding Author)

Abstract- Planar construction for traditional spaces might be described as wide, flat and gray. At first glance, this study would comprehend inquisitive appeal from these factors and how to generate a functional work both voyeuristic and appropriates advantage of maximum natural as the composition in decades. The enterprise commonly used design principles relating to elementary geometry and composed of geometric transformations in mathematics to induce form focal points for the shapes scheme. This paper focuses on major inquiry into three famous planning constructions of traditional buildings in Japan, analyze and formulate inferences about hypothetical design methods, the utilize of language shapes grammar formation on building premises, from measurement to make conclusions on innovative approaches and build ground-based architecture using basic geometric methods.

Keywords- Design Performance, Shape Grammar, Transformation, Geometric Methods, Deformation, Formulation

I. INTRODUCTION

Shape grammar is a concept introduced in a journal paper by George Stiny and Jaymes Gips in 1997, in which it is said to be a specific class of production system to create geometric shapes. And the shape grammar is helping us investigate the language of two-dimensional and three-dimensional spaces. A shape grammar minimally consists three basic rules: rules started, one transformation rule at least, and one rule ended. In particular, the rule started is required to have inception of the progression with shaping commences. Rules of termination are compulsory to make the manner of shaping that brings to a standstill. The simplest way to interrupt the process is a shape discipline eradicating reconnoiter.

The shape grammar is positive when it is confined to a miniature space, and helps clarify issues such as the layout of the generation of an internal structure refinement. The rules typically defined shape of the small shear, and a shape grammar remarkably contains a lot of rules of transformation. A shape grammar system extensively has working superficies where the created geometry is displayed.

The pedigree engine checks the existing geometry, often referred as Current Working Shape (CWS). If multiple rules are applied, the generation engine has to choose a better rule to operate. If there are several matches, the engine will terminate depending on its configuration and implementation, such as application for the rule to all matches in parallel and/or application for the rule to all matches serially which might lead to inconsistencies or choose one of the detected matches and application for the rule to only this match as George Stiny mentioned by his book, "Shape talking about seeing and doing."

The aim of this study is to introduce some interactive concepts of the shape grammar to be used for evaluating traditional buildings as the following: analyses on the traditional case models by architect Tadao Ando, analyses on his geometry commonly used in design, findings for the combined method based on surface geometry works, findings for the geometric formulas applied in the design of premises, and revealing the relationship such as the ratio of the sides in geometric measurement, the ratio of geometric measurements types together and so on.

II. ANALYTICAL DETAILS

2.1. Settings and Procedures

The processing was acquired the relationship interregnum in the middle of shape grammar and traditional design models in Japan, and this study has conducted the following themes. Foremost, the original frugal shapes absorbed from the general planning of the construction including the size of the cube have been handled. Afterward, this research initiated to rebuild faces based on the essential shapes and divided into steps with overall ground has combined with the shape grammar rules. From the steps the rules were incorporated for induce Ando shapes frequently used to assemble the general premise of his creatures and eventually the overall conclusions for the entire progression.

The order to conduct the research work is as follows. Foremost, this study will learn the basic characteristics of the works, determined by the work surface. After that, this paper based on the analyses of ground to transform plan geometric dimensions correlate it with such illustrations. The next step is researched and assumed the relationship relating the geometry together, and how transformations in geometric models are used in the main planning. In this surrounding, this study sketched several mathematical formulas and methods to construct an interval in erections by the architect.

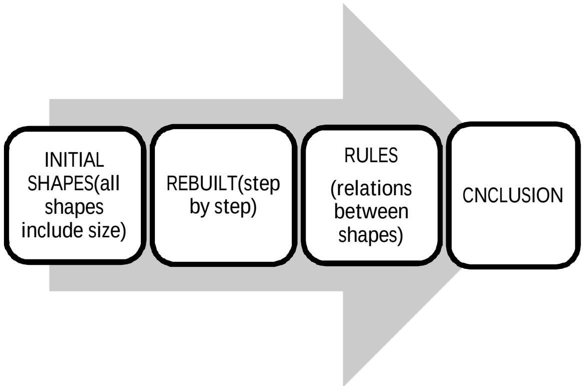


Fig.1. Analysis of Block Processing

2.2. Analysis Targets

Two buildings have been chosen from Tadao Ando's works for the analyses with shape grammars: Kidosaki House (Case 1) and Church on the Water (Case 2). The area of the first case is located where the building is not densely populated suburb. The house was designed to require a couple and their parents. Surrounding buildings are straight and hit the wall with a curve at the entrance half. The building consists of three floors serve different needs for many generations, though all linked by approximately the end of the garden, where all the rooms are light and welcome atmosphere. The goal of the project was to maintain the independence of each family living in the house. The project consists of a cube, 12 meters per side, was divided into four parts in the center and a curved front wall near the entrance. Tadao Ando succeeded in creating enough private space, filled with fresh air and created a conduit for the family members.

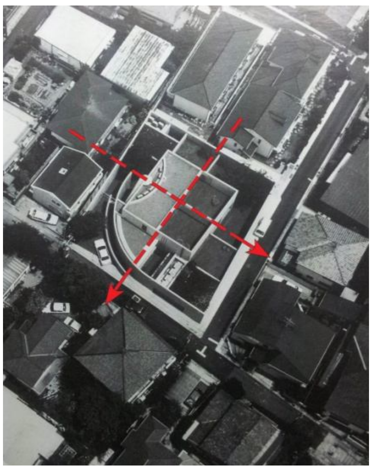
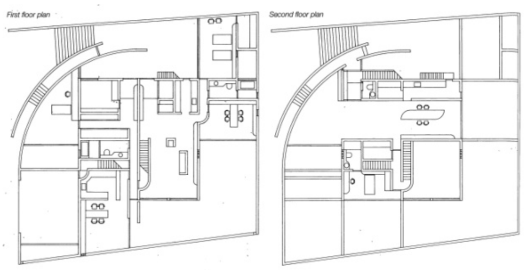


Fig.2. Site Plan of Case 1



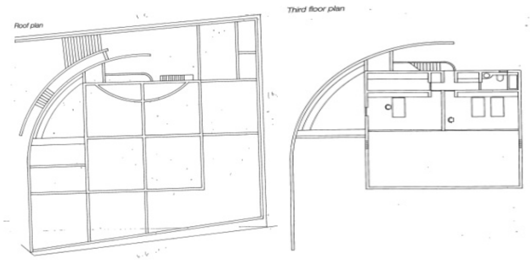


Fig.3. Floor Plan of Case 1

For the second case located in an area deep in the territory of Hokkaido, the church was created of two overlapping squares with different sizes. The church was situated in the mountains with green trees and a small lake surrounded by a frame works perfect beauty modifies according to the season of the year. Surrounding the church are L-shaped walls free standing aside and covering to the back of the church. The praying area have not windshield, is an open space overlooking the lake and the sky, as if to hand out to touch the world. Church interiors direct drop a line with external nature giving the viewer a sense of the harmony with nature around unqualified.

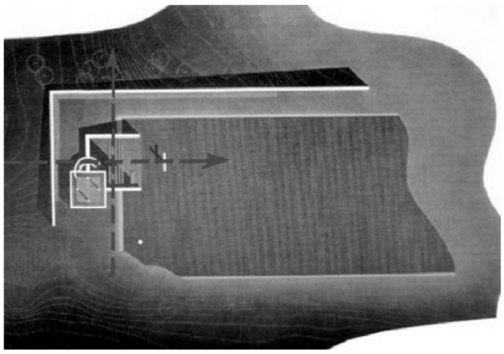


Fig.4. Site Plan of Case 2

III. ANALYSES AND DISCUSSIONS

3.1. Deformation Steps for Case 1

According to the case study of home general planning of Case 1, this study observed the elements from the basic geometric shapes and had a link to each other under the formula in terms of the circumference geometry and acreage. The analysis starts with a basic setting to physique a square, called the square A, with side lengths x of the square, the intersection of the median, to be Z.

Beginning with the square's edge length x, this step comprehend a circle known as B and the center O and diameter d of B are calculated by $dB = 12x/5$; that is, Circle radius $r = d / 2 \Rightarrow RB = 6x / 5$. Similarly this procedure figured a B1 circle with center O1 and Diameter $dB1 = 5x$; that is, Circle radius $r = d/2 \Rightarrow RB1 = 5x/2$. Then, the geometry shaped to a B2 circle with center O2 and Diameter $dB2 = 4x$; that is Circle radius $r = dB2/2 \Rightarrow RB2 = 4x/2 = 2x$. Then, subsequent circle B3 exists with center O3 and Diameter $rB3 = dB3/2 = 9x/5$, and so Circle radius $dB3 = 18x/5$.

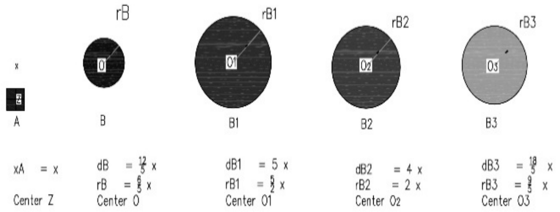


Fig.5. Shape Definitions of Case 1

Initially, starting on the steps to build up the surface of Case 1, based on the principle of variable geometry Stiny George, this step noticed on the plan that can be started from a basic square named A with edge length x. The next square was rotated by 3 degrees with the origin at point A1. From that square, A is multiplied by 4 times and then the size of one side is x. In addition, from 4 square combinations coupled together, this initial consortium to multiply by 3 times to make the overall basic premises of the Kidosaki House can be 12 squares by the same size.

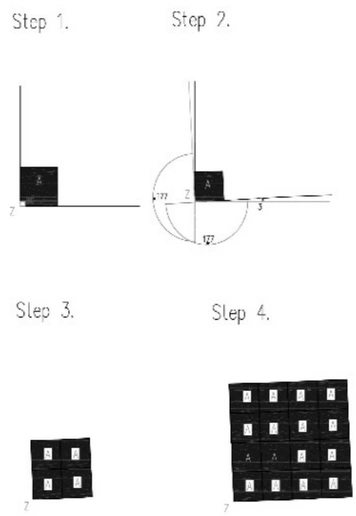


Fig.6. First Stage: Deformation of Case 1 (Step 1 to 4)

The top edge of the new combination square, at the midpoint of an edge, next step took the midpoint at the center, created a circle with a diameter called B 12x / 5 with x, and were a measure of one side of the square A. Retaining part of the circle cut two points inside the square, and the rest are discarded. It maintained to add a different circle called A1, center O1 is the intersection of a median line of the combination square, and the rest are straight lines extending at an angle alpha of a '= 10 ° cutting edge alpha a = 10 degrees of angle. This angle is formed from a combination of edge forming the initial square. Diameter circle A1 DB1 = 5x with x is the length of the square edge A. Continued to grasp partial circle combination square cut in the corner and remove all the rest of the circle. Constructed a straight line from the origin coordinates Z made an angle of 100 degrees with the line d '. Constructed a line d " 'perpendicular to the line d' at I.

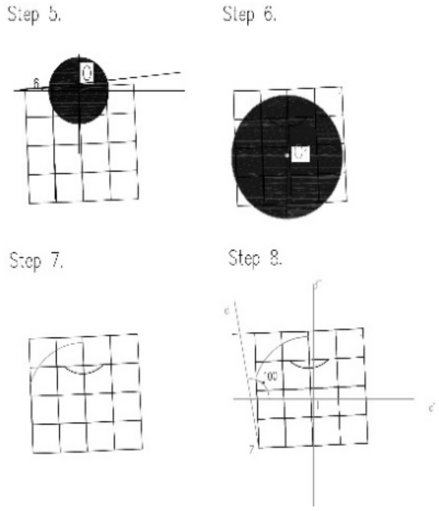


Fig.7. Second Stage: Deformation of Case 1 (Step 5 to 8)

Next, it constructed a circle O2 center coincides with the intersection of the line I d 'and d': Circle B2, O2 center DB2 diameter dB2 = 4 x and radius rB2 = 2 x. Then, it constructed a line d " 'parallel to the line d' 'and exposure to circle B2, O2 center in Point I', line d " 'becomes tangent to the circle B2. In this step, the geometry deleted all parts of the line d " 'and circle B2, O2 center, retained the intersection. And, it added a circle B3 with O3 center, this circle has DB3 = 18x / 5, RB3 = 9x / 5. Similar to step 11, one provision retained partial circle B3 communicate with the unit a square A, Z minds to build the original.

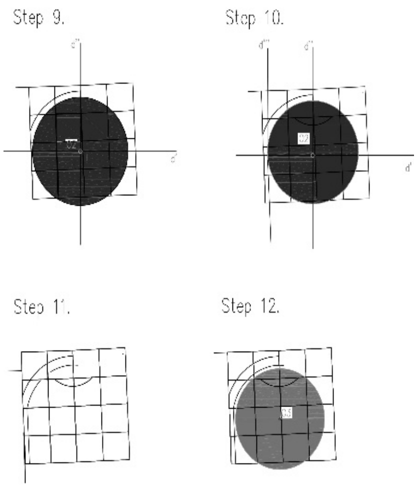


Fig.8. Third Stage: Deformation of Case 1 (Step 9 to 12)

Similar to the above steps, the shape removed the part of the circle B3 and O3, and retained a center lane parallel arcs with the arcs of the circle B2, O2 center. From the origin point Z, it drew a straight line with Zz create 'an angle of 10 degrees, this line cut line d' at point D and this step noticed straight angle created by Dd 'and straight line traced the origin Z also form an angle of 10 degrees. Next step will left the essential part of all the straight lines and square crossed from the previous step. The final result gives a complete ground need restructure.

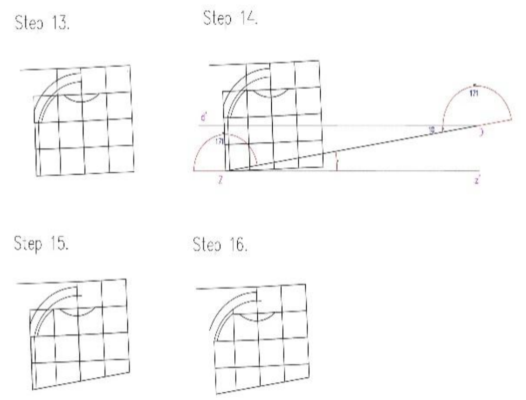


Fig.9. Final Stage: Deformation of Case 1 (Step 13 to 16)

3.2. Deformation Steps for Case 2

From the plan position of the Church on the water, this study analyzed the show ground contributed of the following basic geometries: a square, the center Z, and side length x. And, next equations express the configuration of Church on the Water: (1) Square A1, Z1 center, side length x1 = 7 / 10x, (2) B circle, center O, the diameter d = 2 / 5x, radius r = 1 / 5x, (3) B1 circle, center O1, diameter d = 1 / 5x, radius r = 1 / 10x, and (4) Rectangle C, Y center, with length a = 6x, width b = 8 / 5x.

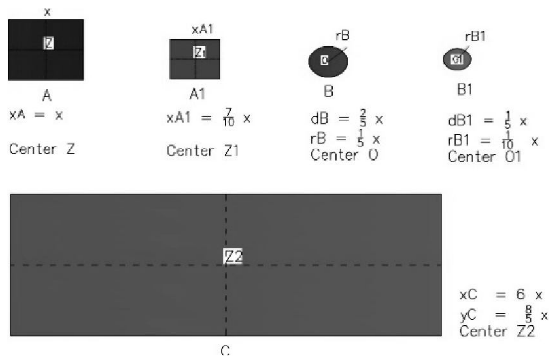


Fig.10. Shape Definitions of Case 2

Initially, with drawing a square A, Z center to the edge is x and it divides the edges of the square A 3 equal parts. With drawing more squares, A1 and Z1 are centered on point of intersection coincides with two sides of the square A, and edge length A1 is x1 = 7 / 10x. The square edge A is extracted.

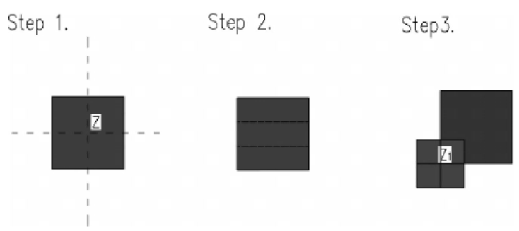


Fig.11. First Stage: Deformation of Case 2 (Step 1 to 3)

Next, with dividing the edges of the square into 9 sections A1 and connecting points dividing the sides together, the geometry with the A1 square is divided into 81 small squares next to a small square of size 7 / 90x. B above a center circle O lies on one side of the midpoint A1 square, a circle with a radius equal to RB = 5x. Then, it continues for building a circle with center O1 B1 with concentric circles B, center O, radius Rb1 = 7x.

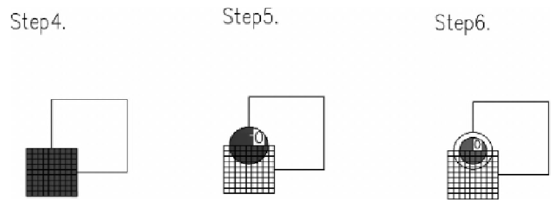


Fig.12. Second Stage: Deformation of Case 2 (Step 4 to 6)

From the center coincides with the center O1 O and the midpoint of the square edges A1, it built a line through the median cut Zz O 'of the A1 down to form a 30 degree angle. Afterwards, with cutting up a center line O, this shape creates a 30 degree-angle with the median of the A1, and I keep part B and B1 circle located in the upper left half. Choosing 4 points with E, F, G, and H, is to be the midpoint of a small square next to the 81 squares of the A1, and this 4 conditions are located on the median line of the A1.

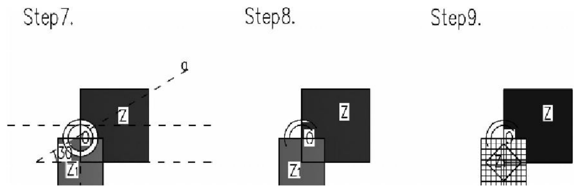


Fig.13. Third Stage: Deformation of Case 2 (Step 7 to 9)

Creating up to four small circles on the columns of the church in the center is the point E, F, G, H, and the diameter of the circle respectively dE = dF = dG = dH = x1 = 7 / 90x. Rectangle C was built with two medians intersect, the center Z2. The width of the rectangle edge C is 6x, and the length is 8 / 5x. Thereafter, 11 steps to complete construction of the space created Church on the water.

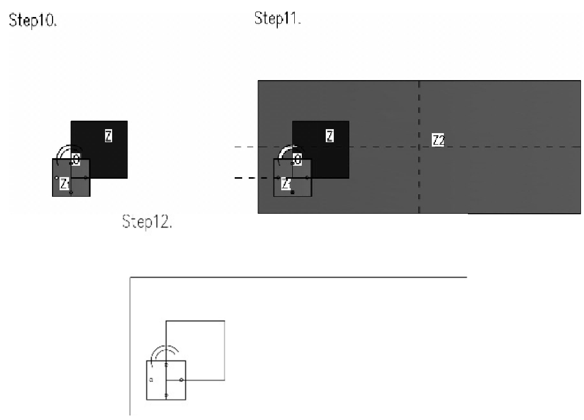


Fig.14. Final Stage: Deformation of Case 2 (Step 10 to 12)

3.3. Relationship between Two Cases

When this study observed two squares A and A1 in position on the ground, it is turned out if it splits an edge of the square A into 3 equal parts, that the shape would have an edge length of squares A1. A1 of the square coincides with another part in the two sides of the square A, infer diagonally across the center of the square A to Z, and coincides with the center of the square A1 Z1. With maintaining an effort for the case divided four sides of the square into 9 equal parts, linking points being a square is divided into 81 small squares. Captivating the midpoint of EF edge of the square A circle draw two concentric circles B and B1 respectively radius r B = 5x and radius RB1 = 7x.

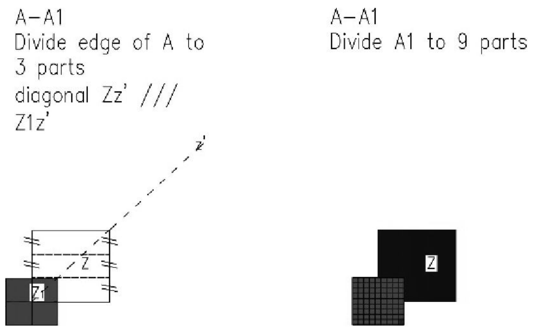


Fig.15. Relationship between Two Shapes

CONCLUSION

From the principle of study was created by George Stiny and his concept, Shape Grammar, a research process required to rebuild the creation of Tadao Ando in a way completely different from the concept analysis previously plan given. The results of the research process on Kidosaki House and Church on the Water were the first step for the study of other works of Tadao Ando, and the study aims to conclude the new regulations in the creation and construction of a residential premises, based on elementary shapes and geometric calculations in mathematics.

The paper on the initial step of the overall conclusions would expand and further research in the articles analyzed later. The purpose of this research is to study a quantity of plan creature and discover particular thinking hypothesis aims to build up the plan, discovered design style as well as the Tadao Ando geometrically often used in his works. The conclusions below were various critical assumptions about how to physique buildings premises of Tadao Ando. Tadao Ando frequently exploits geometric shapes in basic, such as triangles, squares, rectangles, circles, lines and line segments to create surface appearance. The geometry was regularly modified with the following factors after all: Overlap, Division into small equal pieces, Expunged parts of the geometric area and circumference, and the size of the edge flanked by the relevant percentage figure. Also, Tadao Ando normally used the corners with a size of 3 degrees to 15 degrees and 75 degrees, also utilized that the measurement is odd; it represents one of the definitive factor is a change in geometric angles. Transformations in geometry are also important and can be described as follows: parallel, overlap, and division, tangent intersect or overlap, isoforms, and is centered on a line stretching, concentric. Finally, a relationship among to get the edge and the radius, diameter together has been found with the following regulations; Measurements edges ratio generally from small to large are correlated with each other, measurements the diameter and radius are from miniature to outsized rate as the edges, and taking advantage of the angles to create interesting accents to the plan.

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