THE SHAPE GRAMMAR OF RUDINARA RESIDENCE

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ABSTRACT: *The shape grammar which derived from the design analysis of the award-winning Rudinara residence is presented in this paper. Such an inspiring design as Rudinara has a potential to become a new local style in architectural composition. However, there were less effort, if any, to analyse and discuss on the design and documenting the findings for the benefit and easy reference of others especially architects and designers who wish to manipulate the design style for their new projects. Shape grammar is a method to analyse and understand known and existing designs and to produce new designs through computation with shapes. Details from the analysis of Rudinara were used to establish the design rules for basic composition which were then applied to create new designs. Step by step application of the rules and generation of Rudinara design is shown and at the end of this paper two new basic compositions derived from the application of the Rudinara grammar are revealed together with the impressions of the detailed design.*

Introduction

Rudinara is a handmade timber house one of its kind in the world located in the district of Sepang in Selangor. Designed by a renowned local architect, Ar. Jimmy Lim, the house is a breakthrough in timber house design and a masterpiece of vernacular architecture as it assimilates modern and contemporary design with traditional concepts, construction materials and methods in a natural setting. The design style does not replicate other popular and known styles such as Balinese, traditional Malay or English. The novelty of its design and construction method has won the house the prestigious Aga-Khan Award, the most celebrated award in architecture among Islamic communities in 1998 (MTC, 2007, Salinger, R. 2007).

However, less has been said or discussed concerning the design principles and style of the house which made up such an interesting composition. In the midst of the same popular styles which made up most of our architectural landscape again and again, the emergence of a new style will add to new variety and diversifyng our vocabulary of architectural styles. Therefore this paper attempts to establish the design principles or rules that govern the order and composition of the house. However, due to the interest of the shape grammar method, the main concern of this research is the study on the physical form of the house without concerning for other intangible factors. Thus the analysis among others will concentrate on the shape of the floor plans and the shape of the building components such as wall and roof, and the relationship between each components. Once established the rules will be applied to create new and diverse houses designs which have the same style and characteristics as the original Rudinara residence.
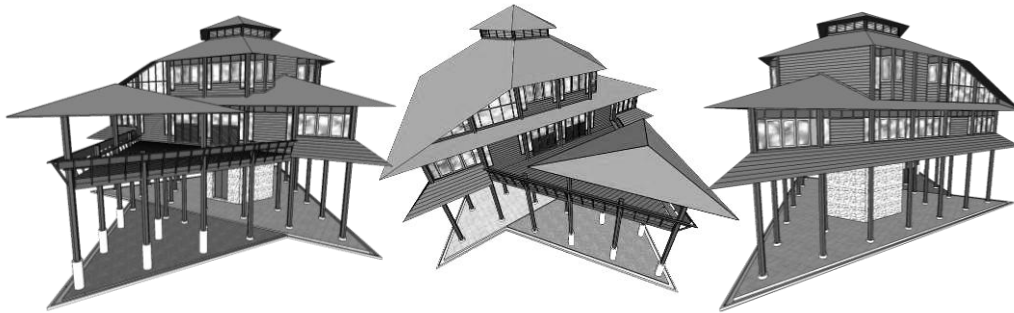
Figure 1: The Rudinara residence as seen from different angles

The Shape Grammar Method

Shape grammar is a method or system for creating new and original designs and also understanding known and existing designs and compositions through computations with shapes (Knight T., 2006[a]). The application of shape grammars can be either a by-hand application or a computer implementation, in two-dimensional or three-dimensional environment. It generally consists of one or more starting shapes as known as the initial shapes or vocabulary elements, and one or more shape rules. The rules constrain the ways the initial shapes may be self-transformed or combined with another similar or non-similar shape. A shape rule is presented in a graphical form and consists of an image on the left-hand side (LHS) which represents the initial shape prior to the transformation, and the right-hand side (RHS) representing how the shape in LHS is to be transformed or combined with another shape to generate a new object or design. The rule is applied only when the shape or sub-shape in the design matches the rule and it is a repetitive process with the results of each generation depending on the results of the previous generation.

In architecture shape grammars have been utilized firstly to analyse existing and historic styles, and manipulating the design principles or rules to create new and diverse designs. Secondly it were used extensively to create original designs and compositions which involved with the definition of new languages or styles of design from scratch (Ismail A.H., 1988). Some examples of the first type of shape grammars application are the prairie houses grammar (H Koning and J Eizenberg, 1981), the Mughul garden grammar (Stiny and Mitchell, 1980), and the Japanese tearoom shape grammar (Knight T., 1981), while the latter are as shown in figure 2 below. The beauty of shape grammar lies on its ability to make possible multiple design solutions rather than a single solution which is normal in the traditional way of designing.
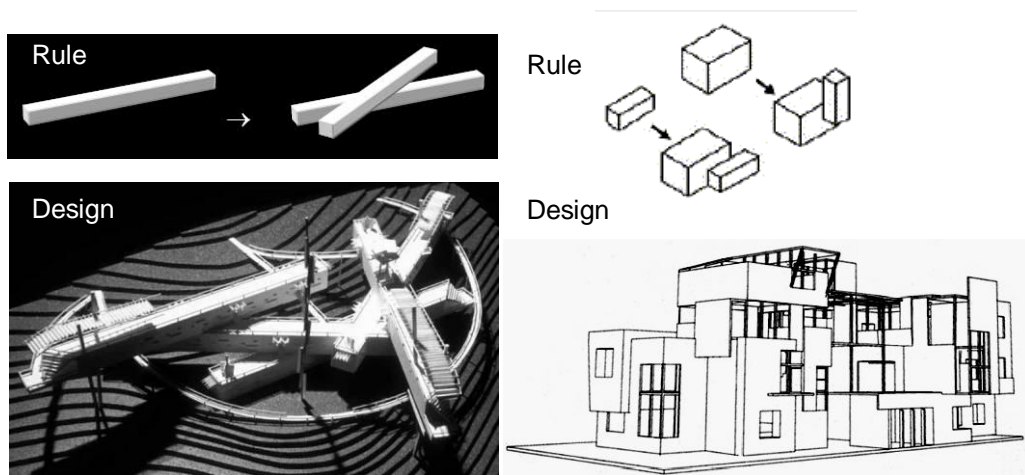
Figure 2: Left: Design of Historical Museum, San Gimignano, Italy by Randy Brown. Right: Design of an apartment house complex by Murat Sanal (source: Knight T., 2006 [b])

Design Rules of Rudinara

The house consists of two habitable floor with a central services and staircase core. The lower floor plan is formed by two adjoining different size triangles with the bigger one accommodates the living area, dining area, kitchen and a bedroom with the hexagonal core right at the center, while the smaller one is actually a verandah which serves as an outdoor living area. The upper floor plan is hexagonal in shape with an attached triangle, which is the void over the living area below, and houses the master bedroom, a bathroom and a study room, as well as the hexagonal core at the center. Just above the core at the second floor there is a clerestorey which is also hexagonal in shape, which provide lighting and natural ventilation to the core. It is identified that the shape of the house is not determined by the function of spaces it contains but rather vice versa.

The timber post and beam structure of the house was aligned in a triangular grid system with each grid unit measuring 3 metres by 3 metres by 3 metres consists of three columns and three beams as seen in figure 3 below. Thus, the triangular grid unit is the initial shape in this grammar. Therefore the overall shape and spaces of the house were constructed using the combined units of the grid or a smaller scale of the basic unit. Furthermore the core too was made of combination of six basic units while all the internal walls were built on the grid lines. However, excluding the core, the main combination for creating the shape of the floor plans is in a group of four units which resulting in a bigger triangle. The basic group was transformed through rotation, translation and reflection to create such shape as seen in Rudinara.
One of the main rule of the transformation is that the lower floor should be created first and the group should only form a basic main floor in the shape of a triangle or a

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hexagon with the core as the center for the floor generation. The shape of the core should follow the shape of the main floor yet in a smaller scale. From the main floor the group is further transformed to create extensions and consequently expanding the overall design provided that the new members are directly connected to the main floor. If the rule is violated then the member will be removed from the design. Once the basic lower floor design is established then only the generation of the upper floor will commence. The upper floor should have the same main floor design as the lower floor to begin with however the extensions should be less or as many as the lower floor at any corner of the main floor. Then, a clerestorey is created above the core and finally the whole building was elevated from the ground on stilts about three metres high and the overall basic composition of the house is complete.
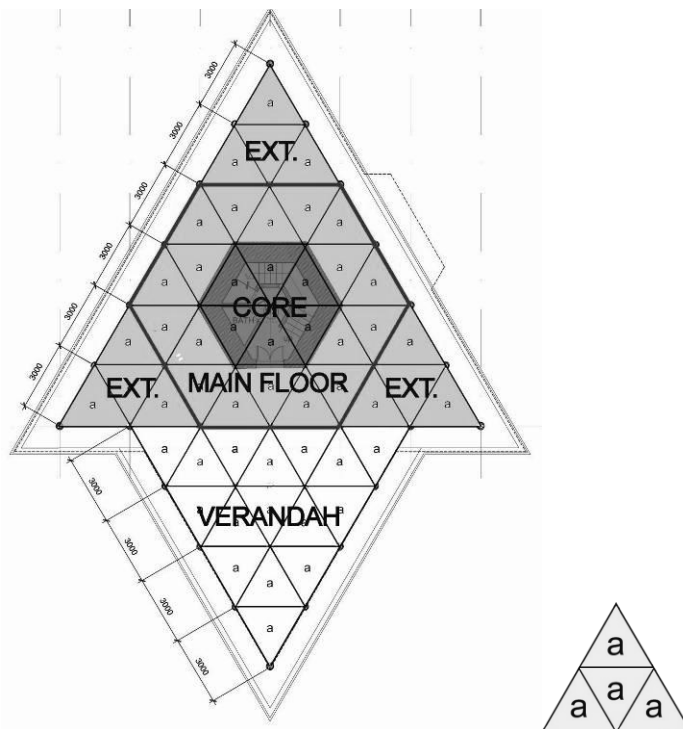

Figure 3: Left: the structural grid of the house made of the basic unit 'a' and all the sections of the floor. Right: a group of four grid units.

To more diversifying the possibilities of new design generations using the same set of rules as applied to Rudinara, some of the rules are considered as non-obligatory or optional such as the creation of a clerestorey and the rising of the building on stilts. After the completion of the basic composition then functions can be assigned to the spaces and the next step is to finish and embellish the design by creating the roofs and ornamenting the composition. Unfortunately this paper will not discuss in detail the rules for creating roofs and ornamentations.

There are several types of ornamentation which can be applied to the basic composition and all are non-obligatory. The major ornamenting component is the verandah which acts as an outdoor living area, as is the case in Rudinara, or as a car porch especially if the building sits on the ground.

Railings should be created when the verandah is elevated from the ground. A protrusion in a shape of semi elongated hexagon can be made at any square shaped external wall segment to give more room to the space inside. In addition, where necessary a twin semi perfect hexagonal extensions can be added at different wall segments however it is constrained only to the top floor. To complete the embellishment process, windows and doors are placed at appropriate locations.

In this grammar only pyramidal roof type is permitted and the shape of a roof should take as its base the form of the space it covers underneath together with a normal roof overhang. As in the case of Rudinara, the shape of the roofs varied from level to level which includes a simple triangular base shaped roof at the verandah, a triangular shaped roof at the main first floor area, a combination of hexagon and diamond shaped roof above the second floor area and a perfect hexagonal shaped roof at the peak. Some of the roof can be extended from above the upper floor to the above of lower floor thus creating a diamond shaped roof. As such, triangular or chamfered square walls are created beneath the roof where the space normally perform as a void over the lower floor.

By applying and sequencing all the above rules which include the rules for creating basic composition, roofs and ornamentations, the grammar will regenerate the design of Rudinara residence and also creates new and diverse designs.

Generation of Design

Figure 4 below demonstrates the step by step process of the application of rules and how the initial shape evolves from a single object to generate the completed design of Rudinara. Each arrow represents one rule applied to the previous evolution of design, however rules should be written separately, one rule in a line, and in a different graphical interpretation so it can be utilized in general to generate other designs. These illustrations only serve to simplify and facilitate the understanding of how the shape grammar works as the list of rules is too long to be presented in this brief paper. As seen in figure 4, the rules applied are only creating the basic composition, roofs and certain ornamental elements. The rest of the rules applied unfortunately are unable to be described. Nevertheless the end result of the application is presented as the completed design of the original Rudinara.
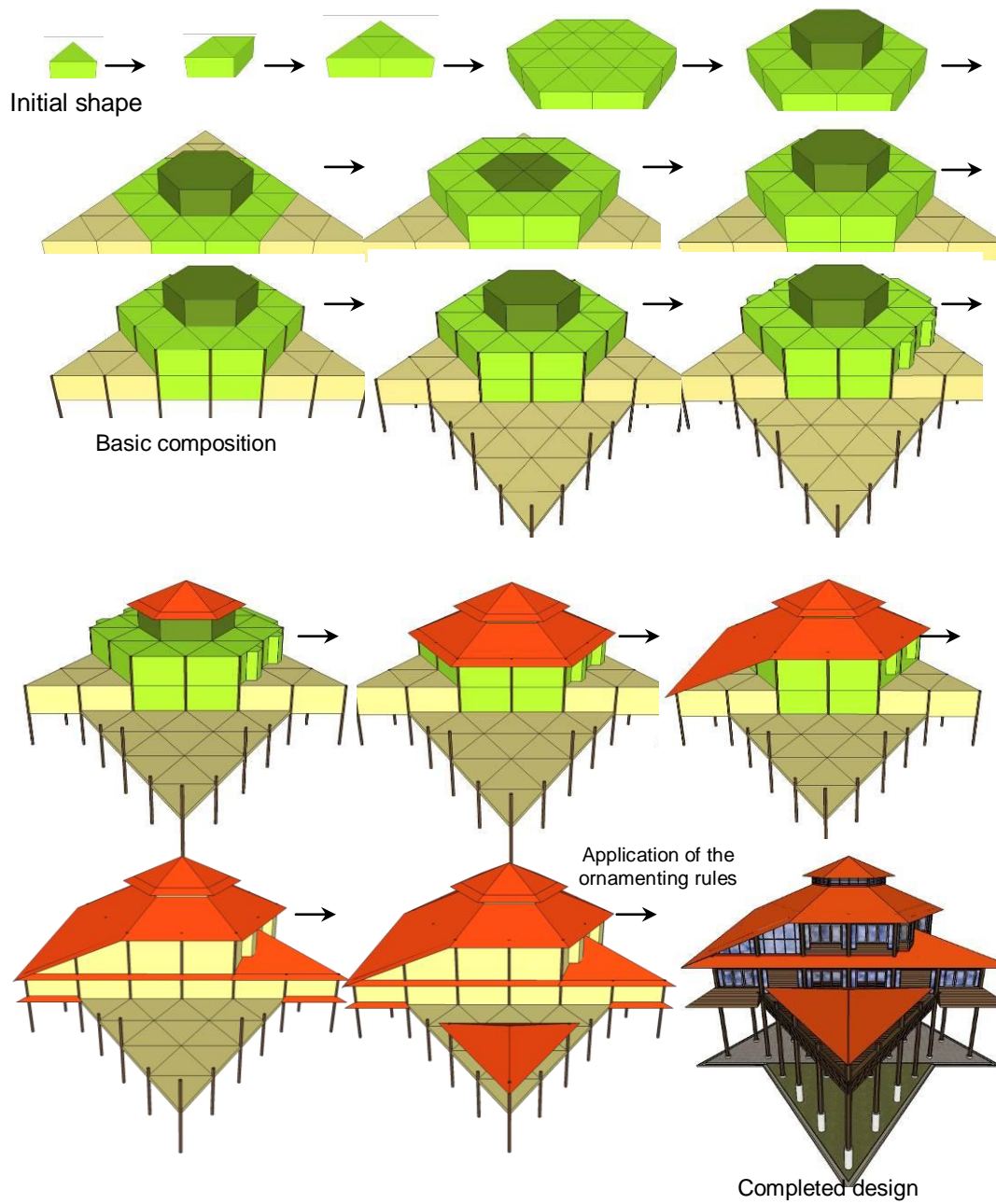
Initial shape

Basic composition

Application of the
ornamenting rules

Completed design

Figure 4: The generation process of Rudinara design

The New Rudinara-Style Designs

The new Rudinara-style house designs resulting from the application of the same set of rules as applied to Rudinara is presented in figures 5 and 6. In figure 5, the basic composition derived from a triangular shaped main floor which was further expanded into a fan shaped object. The composition is then embellished and completed as seen in these three impressions. This is a good example of a Rudinara-style design which does not raised on stilts as opposed to the original design.
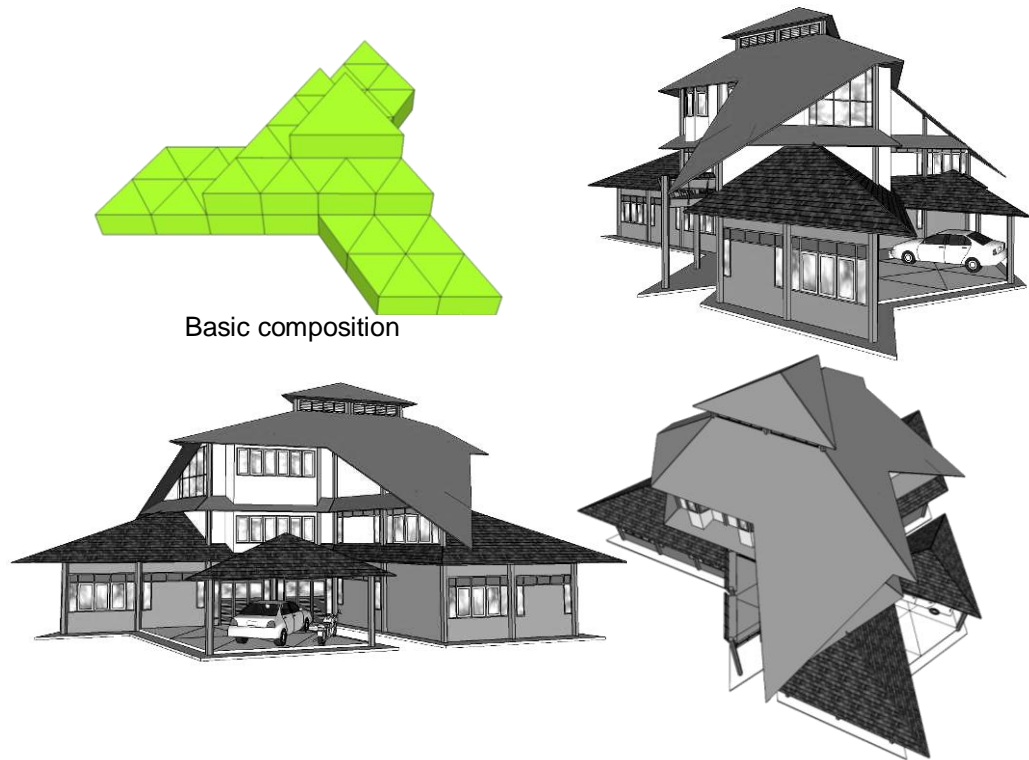
Basic composition

Figure 5: New Rudinara-style design which is not raised on stilts

Figure 6 on the other hand shows an example of a Rudinara-style house design with a main floor shape of two adjoining hexagons which is further transformed to generate a basic composition. However, only one hexagon can contain a core and a clerestorey to maintain the hierarchy of the whole composition. Rules are then applied to raise the composition on stilts as similar to Rudinara, to shelter with roofs and to embellish with ornamental elements to complete the design.
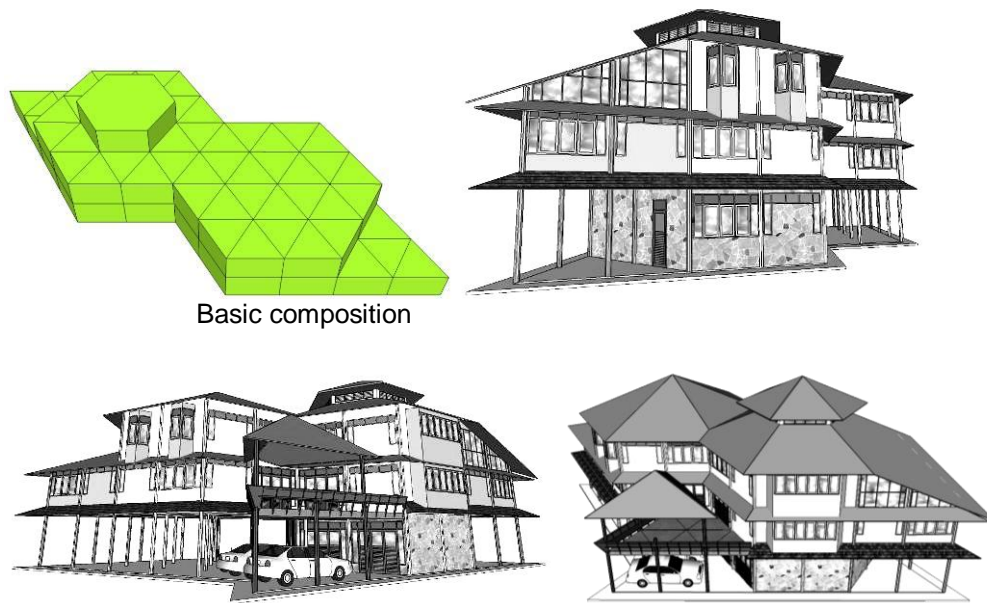
Basic composition

Figure 6: New Rudinara-style design raised on stilts

Conclusions

Shape grammar has been proven to allow for the analysis of the existing Rudinara design to be carried out in a rather technical yet systematic way. The beauty of this method lies on its ability to make possible new design generations using the same set of rules as applied to Rudinara. The grammar may not only be applied to generate house designs but also large institutional building designs. However, to this point this paper only described the working theory of the grammar based on a by-hand application. A larger potential of the grammar is yet to be revealed with a computer implementation of the grammar which involves with a computer-programming skills, and is expected to be carried out by a program-literate individuals.

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