Meta Form as a Parametric Design Language

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Abstract: This study is about building a conceptual architecture called Meta-form that can perform the acts of parametric design to generate various house forms. The study limits its scope to four genotypes of residential houses in the world. Typological Analysis is employed as a technique of distinguishing the key variables shared by the built forms. The result, with respect to each genotype, there are specific meta-form systems account for the generation of cases of phenotype by assigning different values to each corresponding parameter. With its generative power the meta-form system is evidently a useful tool to assist type-based form productions. As such, the parametric values also acquired the descriptive power of specifying built form characters.

Keywords: Meta form; genotype; phenotype; typological analysis; parametric design.

Introduction

Thinking in meta-level is an important genius of human intelligence. It has been developed in philosophical analysis for a long time, and has been frequently applied in ‘Artificial Intelligence’ (AI) since 1990s. In the field of architecture design, this concept was referred (Rittel, 1971) in 1970s. In the last decades there has been progress on the relationship between meta-think and design method. The relevant studies involve ‘Capacity Design Methodology’ (Habraken, 1976; Wang, 1993; Lin and Wang, 2003) which capable of providing aids in design process, and ‘Shape Grammar Meta Language’ (Liew, 2003) which applied computational language in analysis of architecture forms.

Although growing numbers of studies have considered the positive potential of meta-thinking in design process, little attention has been given to ‘meta-form’. This study was aimed at the constitution of built forms at a theoretical level. The purpose is to build a conceptual architecture called meta-form that can perform the acts of parametric design to generate various house forms. In methodological hypothesis, the idea of meta-form is based on the conviction that most built forms, known as phenotypes, can be deduced from some small categories of genotypes, which suggests that the relationship between phenotype and genotype can be described by generative processes in explicit language. The research methods primarily involved a general survey and typological analysis of built forms all over the world.

It is not the intent of this paper to critique the actual manipulation in design or to discuss the practical factors which had affected the building process. It is suggested that the relationship between genotype and phenotype is not one-to-one. Meta-form system is expected to work well with its generative power and be a useful tool to assist typed-based form productions rather than a model for explaining the natural and social forces.
Four genotype: Fundamental concept in constructing forms

Enclosure, Extension, Concentration, and Deployment, numerous phenotypes could be deduced from these four genotypes. This concept is based on a methodology hypothesis that each genotype contains a fundamental idea of form constructing.

Enclosure
The idea of Enclosure is about the differentiation of center and surrounding. The courtyard houses in Iran, Kuwait, China, Spain and Morocco are the typical phenotypes. It also contains the center-hall-room houses in Egypt and covered-yard house in Xingjiang China. And the yard house in desert area of India and Syria. These cases above, no matter the centers are open or not, the assemblages all have an intention to enclose.

Extension
The idea of Extension is: a main body extends attached units. The typical phenotypes are the traditional house in Malaysia, the Shoin-Style house in Japan, and the ‘Usonian House’ invented by F.L. Wright. The assemblages all have a main house. Other spaces connect with main house partly, and have an intention to extend outward.

Concentration
The idea of Concentration is aggregation and propagation. It usually contains one or several parts in a whole. These parts have intension to aggregate and lean on each others. The typical phenotypes are timber framed houses in North America and Europe, half-timber houses in Germany and France, traditional hut in India, and the farm houses known as ‘Gashu’ in Japan, even the Victorian-Style house popular in England and America in the 18th. These houses present as single buildings. In most cases, the internal is partitioned to units; in some of cases, the single building is aggregated by many pods.

Deployment
The idea of Deployment is different from the other three genotypes. The concept of its constructing is not based on the differentiation of main/sub, inner/outer. Space units are either freely disposed or based on other reference system beyond form. The compound house in Cameroon, Mali, and Bali belong to phenotype of deployment.

Nine meta-form as generative language

In this section, exemplar cases of phenotypes with respect to each genotype are collected for detailed analyses. Typological Analysis is employed as a technique of distinguish the key variables shared by the built forms under study that are responsible for the genotypical characteristics. What follows is the typical species of each genotype. There are two species of Enclosure: Outward loop and Inward loop; two species of Extension: Radial and Branch; two species of Concentration: Divide and Aggregate; and two species of Deployment: Grid and Figure.

Enclosure: Outward loop
After analyzing considerable cases of Enclosure, this study distinguished two typical species from the phenotypes. One has a particularly intact or important central space and is named Outward loop. Take the courtyard house in Tunisia (Fig 2-1) as an example, it has a court as a main part and the other space units surround it as a geometrical center. The schematic diagram shows an embryo of meta-form. The feature of its form is a predefined core space
designed by Andrea Palladio (Fig 4-1) as an example, it has a relatively main space. In addition, the extensions trace two obvious polar axis to develop, one is the vertical axis of main space, the other is perpendicular to the vertical axis. The schematic diagram shows an embryo of meta-form of Extension. The feature of its form is the space groups outside the main space have a trend to place along polarity axis. (Fig 4-2)

**Extension: Branch**

Non-symmetry or skew-symmetry is the feature of another species of Extension, which named Branch. Take Katsura Imperial Villa (Fig 5-1) as an example, it doesn’t have apparent polar axis. There is no dominative relationship of orientation and position between main body and extensions, and between extension and extension. The schematic diagram shows the other embryo of meta-form of Extension. The feature of its form is: extensions are disposed on the random joints along the edge of main body, and

which is the radial center of space surrounded (Fig 2-2).

**Enclosure: Inward loop**

Another species of phenotype of Enclosure with an intact enclosing space named Inward loop. Take the courtyard house in Shanxi, Province of China (Fig 3-1) as an example, it contains an enclosing wall. Space units are placed along the inner side of closing wall to a ring-shape and the central area isn’t deposed any house. The schema diagram shows the other type of embryo of meta-form. The feature of its form is: spaces have a trend to aggregate as a ring-shaped area (Fig 3-2).

**Extension: Radial**

After analyzing the cases of Extension, the study distinguished two typical species. One has features of polarity and symmetry relative to the main body which named Radial. Radial is the first schema of the genotype of Extensive. Take the Villa Barbaro designed by Andrea Palladio (Fig 4-1) as an example, it has a relatively main space. In addition, the extensions trace two obvious polar axis to develop, one is the vertical axis of main space, the other is perpendicular to the vertical axis. The schematic diagram shows an embryo of meta-form of Extension. The feature of its form is the space groups outside the main space have a trend to place along polarity axis. (Fig 4-2)
Deployment: Grid
Except disorder cases, one species of the phenotype is based on a grid system, which named Grid. Take the traditional Balinese house compound (Fig 8-1) as an example. Rooms and central yard as well as the family temple are disposed on nine-square. The layout is with regard to a grid called “Vastu Purusha Mandala” (Fig 8-2).

Deployment: Figure
The other typical phenotype is the form from analogy, the positions of space elements usually reflect to some totem, which named Figure. Take Dogon compound (Fig 9-1) in west of Africa as an example, the positions of spaces correspond to important parts of human body (Fig 9-2).

Concentration: Divide
Each extension has random joints to posit next part as well. (Fig 5-2)

Concentration: Aggregate
Another species of phenotype of Concentration is internal of a single building partitioned to units, which named Divide. Take Jenisch Haus (Fig 6-1) as an example, it’s a typical big house. The internal of it is partitioned to three main bays by two parti-walls. The schematic diagram shows the embryo of meta-form of Divide (Fig 6-2).

Concentration: Aggregate
Another species of phenotype of Concentration is Aggregate. Take Victorian-Style House (Fig 7-1) as an example. It was the aggregation of seven dependent units. The schematic diagram shows the embryo of meta-form of Aggregate (Fig 7-2). The feature of its form is: the internal units are not totally lean on each other by parti-walls.

Meta-form as a parametric design language
Based on the results of analyzing the typological features of each phenotype, the meta data contents...
of each genotype are structured. In such a way, the corresponding phenotype variations can be produced by manipulating parametric values. What follows illustrates a parametric system formulated as Meta-form Divide and shows the capability of generating a built-form by specifying the parameter values (Fig 10).

**Parameters of meta-form divide:**
- Space: (Shape (rectangle, other), Size (Width/Depth, other))
- Divide: (Direction (X, Y, other), Sector (number), Dimension (h-n-n, m-n-m))
- Selection: (Space (name), (E, F))
- Extension: (E, F)

**Conclusion**

Meta-form is a conceptual architecture which is construed as an explicit language to construct built forms by type-based description. The language can be expressed through oral, parameter as well as computer. For the purpose of establishing design-aids tools which can also be employed as a computational means for acquiring architectural knowledge, this study has a challenge in searching and distinguishing the meta data. The result presented in this paper is not the final status. It would be difficult to complete the work because of the great amount of material. Even so, the current progress has shown a full potential and worthy of further studies.

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