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A FORMAL APPROACH FOR THE INTERPRETATION OF CULTURAL CONTENT(S)

Evolution of a Korean traditional pattern, Bosangwhamun

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Abstract. This paper develops a formal approach to investigate the evolution of a Korean traditional pattern, *Bosangwhamun*. The approach employs the structure of symbolic memes embedded in the pattern as a framework of hierarchical decomposition of a pattern to describe an evolutionary development process of a given pattern with a set of rules in shape grammar as style changes. Further, the formal descriptions of the given pattern become the basis for generating its variations. With this process, the validity of the rules and their appropriateness in the representation of *Bosangwhamun* are examined.

Keywords. Culture; memes; shape grammar; hierarchical decomposition; Korean traditional patterns.

1. Introduction

There have been various formal approaches to performing content analysis on

visual records, especially on patterns. Shape grammars, one of many formal approaches used for the content analysis, are production systems that generate and analyse designs (Stiny, 2006) and are successfully employed for representing the formal structure of given visual records or artefacts with a series of shape rules (Knight, 1980; Cenani and Cagdas, 2007). Further, shape grammars have proved to be valuable for learning about styles and languages of designs (Stiny and Mitchell, 1978; Knight, 1981; Koning and Eizenberg, 1981; Buelinckx, 1993; Li, 2004). They are also descriptive enough to reveal simplicity or regularities behind designs.

In Korea, however, little research has focused on integrating computational or systematic approaches to find and capture unique cultural characteristics of Korean traditional patterns and to trace the hidden cultural identity from the shape and arrangement of the patterns. Moreover, in order to evaluate similarities and differences between two different styles which have symbolic memes in their structure, the grammar needs to be developed for explaining such meta-contents like semantics, functions or structures. That is, the interpretation of patterns with strong awareness of their cultural identity and the changes has been problematic in shape grammar so far.

As a method of explaining symbolic memes with shape grammar, we propose the structure of symbolic memes in a pattern as a place holder for delivering such meta-contents. Compared to Liew's (2004) meta-grammar, which adds more complexity to the description of the design, the structure becomes the apparatus for decomposing the given pattern with a hierarchical order for its analysis in the process of shape grammar formulation.

2. The study of Bosangwhamun

The study of culture provides substance for defining the identity of each human group. The identity becomes an essential component for maintaining the evolution of the group in various exchanges with other groups over history. As one of the approaches in cultural study, content analysis has been employed for finding significant relationships between the observed human behaviors, including words and artefacts, and the underlying constructs that explain a broad trend to prefer certain states of affairs over others (Hofstede, 2001). The representation of the outcomes from the analysis explains the cultural development of each group by characterising the commonality of the records in the group, by differentiating its records from the others and by providing substance for understanding mutual influences among different groups (Distin, 2005).

In this research, a Korean traditional pattern, *Bosangwhamun,* is selected for introducing the framework of hierarchical decomposition and its applica-

tion for conveying meta-contents in shape grammar. The framework is developed from the understanding of various symbolic memes of the pattern, which are stratified through the ages.

2.1. A BRIEF HISTORY OF BOSANGWHAMUN

Bosangwhamun (BSWM) translates to the pattern *(mun)* of an imaginary holy flower *(Bosangwha)*. It originates from the ancient Egyptian and Mesopotamian Palmette pattern shown in many western traditional patterns. In the 4C B.C, Greek Acanthus style was introduced to Eastern cultures as a source of Palmette, an artistic motif resembling the fan-shaped leaves of a palm tree, by Alexander the Great. In Eastern cultures, the variations of the original Palmette have specific 'regional characteristics,' including BSWM. During the Sassanian Persian Dynasty, the Palmette pattern was influenced by the Greek Acanthus. The normal Palmette motif was reconstructed into a newer one, the combination of the Half Palmette leaves. BSWM flourished in the Korean peninsula during the Early Unified Shilla Dynasty, transferred from the Tang dynasty of China with Buddhism and underwent numerous iterations of both form and meaning. BSWM and its components are believed to be transferred to some Japanese traditional artefacts later.

2.2. SELECTED BSWM PATTERNS

Four samples of BSWM were chosen according to their clarity in well preserved relics and topological coherence with stylistic shifts over time during which the pattern developed in Korea. The selection includes two tiles from the early Unified Shilla Dynasty (A.D. 7C), a circular tile from the late Unified Shilla Dynasty (A.D. 8C), and a musical instrument from the Korea Dynasty (A.D. 13C) as shown in figure 1.

(a) BSWM_A *(b) BSWM_B* *(c) BSWM_C* *(d) BSWM_D*

Figure 1. Four samples of Bosangwhamun.

3. A hierarchical decomposition of BSWM

The hierarchical decomposition starts from defining the metaphorical structure of the pattern. The symbolic memes in BSWM define the identity of the pattern as an ideal holy flower. The structure of the symbolic memes becomes

a template that allows us to decompose the pattern into typical components in the taxonomy of the flower. The hierarchical decomposition applies the construction method of BSWM to establish the morphological relationship among the components of the structure and to provide the sequential procedures of the transformation functions that organize the formation of the pattern. When the sequential procedures are laid out on the metaphorical structure as a set of rules, the structure becomes a *global geometry* that governs the formation of the pattern. Each place holder of the global geometry becomes an individual component of a local geometry that maintains the transformational functions among its contents.

3.1. METAPHORICAL STRUCTURE

The metaphorical structure of BSWM is based on the evolution of symbolic components in the pattern including Palmette, Lotus, and In-dong-dang-cho, a Korean vernacular plant motif frequently employed for various decorative patterns. The archetype of BSWM is the combination of two half Palmettes from Persian Empire. With the Buddhist influence from China, Lotus becomes the central component of BSWM between the Palmettes. As the pattern is employed for a tile design that requires the usage of four corners and their combinations, In-dong-dang-cho is added to the pattern to satisfy the requirement. The structure further develops into four components including *seed* (inner and outer), *calyx* (calyx and intermediate calyx), *flower* (inner, half Palmette, intermediate petal), and *corner* (flower, petal, band). The original Palmette and lotus components in BSWM disappeared or distorted due to the fall of Buddhism from the Korea Dynasty to the Joseon Dynasty. Each component of BSWM is replaced by a Korean vernacular motif with rough abstraction and generalization. The symbolic relationship among the components fell apart and only figurative aspects of the pattern were imitated in later periods of Korean history.

3.2. CONSTRUCTION METHOD

The construction method guides various transformational functions for organizing the contents of BSWM and provides the geometrical relationship within a metaphorical structure. It allows the consistent replication of the central portion of the pattern. An example of the process of constructing BSWM and its four corners in a traditional practice is shown in figure 2.

3.3. GLOBAL AND LOCAL GEOMETRY OF BSWM

The study of BSWM starts from the hierarchical decomposition of the pattern

into global and local geometry. Global geometry regulates the boundary condition of local geometry. On the basis of metaphorical structure and construction method of BSWM, the global geometry of the pattern is defined as a schema that can be referred to illustrate the basic elements of motif. The basic elements are employed for making the shape rules of BSWM (figure 3).

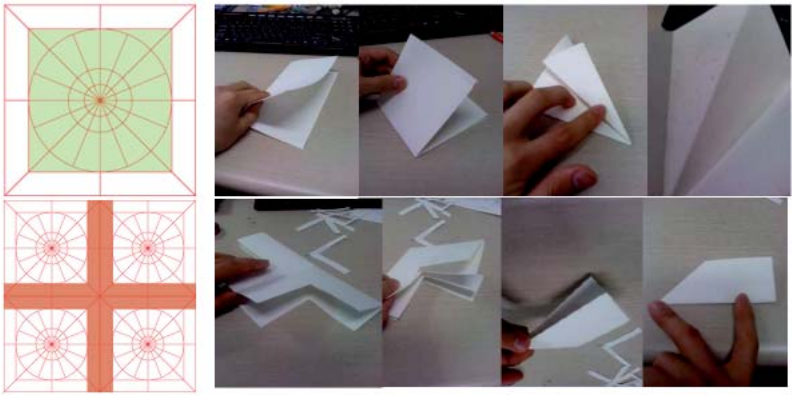


Figure 2. An example of the construction method.

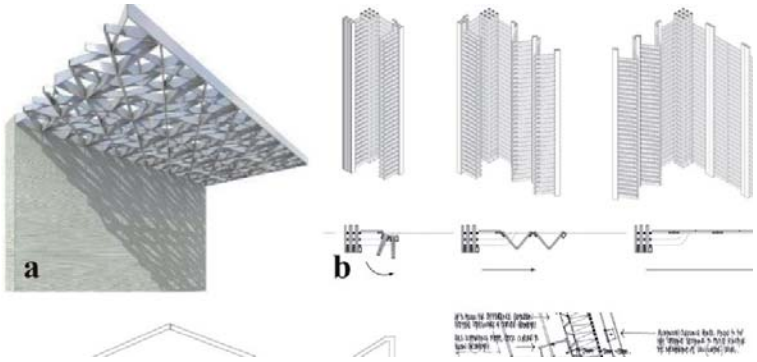


Figure 3. Global geometry as a schema in shape grammar.

Once the global geometry has been established, finer components within the major metaphorical categories can be described in figure 4.

Local geometry is a formal relationship among basic elements within each placeholder defined by the global geometry. The place holder consists of the sum of minimal divisions indexed by different colors as shown in figure 5.

4. Analysis in shape grammar formulation

Formulating a descriptive grammar of the decomposed patterns is a process of subdividing all the basic elements of the pattern into the local geometry of BSWM, confirming the global geometry. Shape grammar formulation also

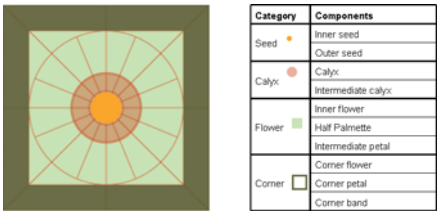


Figure 4. Metaphorical components of BSWM in global geometry.

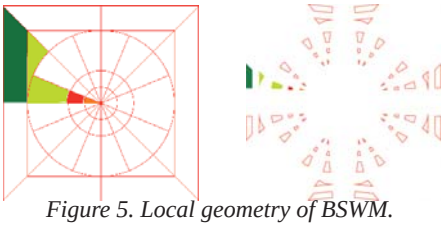


Figure 5. Local geometry of BSWM.

requires a registration process to establish a catalogue of the set of rules to describe the components of the global geometry before the contents of each component of selected BSWM samples, which belong to the same geometric structure, can be compared in depth (figure 6).

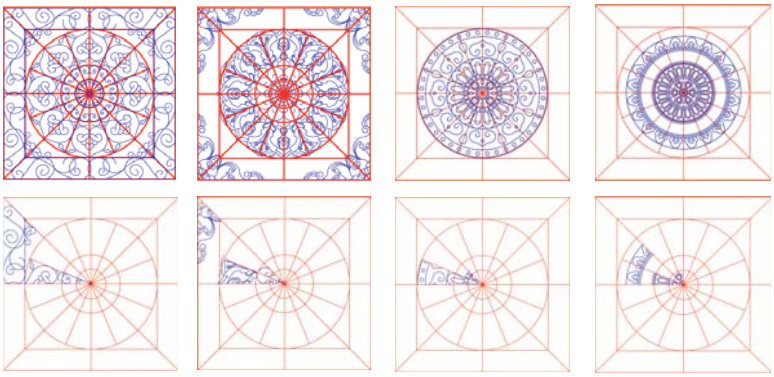


Figure 6. Minimal geometries for symmetric iterations for each pattern.

4.1. ANALYSIS OF BSWM_A AND ITS SHAPE RULES

After recogniing the global and local geometry of BSWM, the analysis of BSWM_A starts by decomposing basic elements of the artefacts into the global geometry as a template. The decomposition of the pattern into the geometry allows us to compare the elements belonging to a counterpart within the global geometry. By registering the formal relationship among the elements in the global geometry, the transformational functions employed for the relationship are rewritten as the series of the rules in shape grammar. The

registration processes for BSWM_A includes registration of the SEED, registration of Intermediate CALYX, registration of FLOWER (PALMETTE), and registration of CORNER. For example, figure 7 shows registration of FLOWER (PALMETTE). Having combined all registration processes, registration of BSWM_A is completed as shown in figure 8.

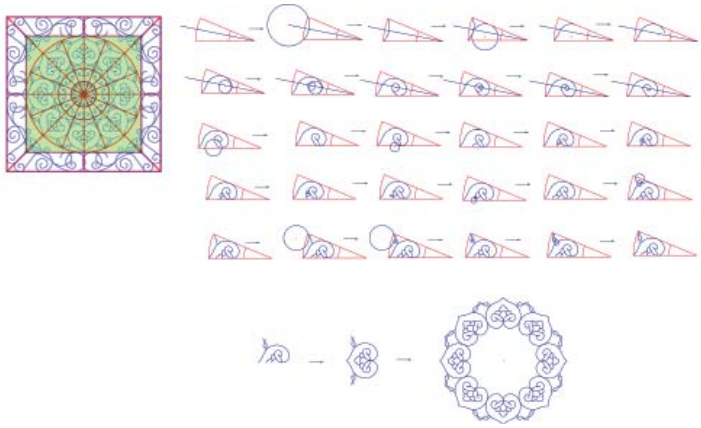


Figure 7. Registration of FLOWER (PALMETTE).

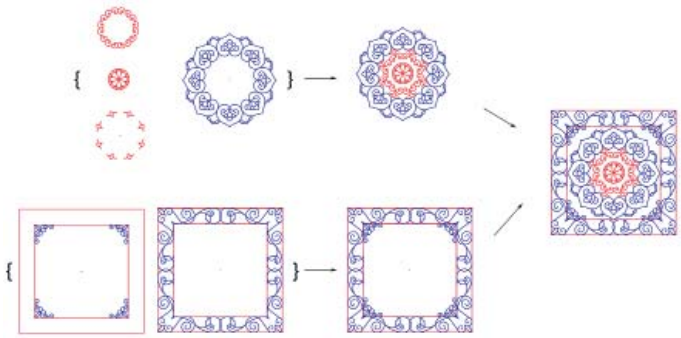


Figure 8. Registration of BSWM_A.

4.2. COMPARISON AMONG BSWM_A, BSWM_B, BSWM_C AND BSWM_D

Despite the topological coherence among four patterns, three noticeable evolutionary directions are observed through the hierarchical decomposition of the patterns as below:

1. The usage of a pattern in different artefacts is a critical factor to decide components of BSWM. The functionality of an artefact regulates formation of the global geometry. As an example, patterns in the early Unified Shilla Dynasty (A and B) have boundaries since many BSWM variations in the

period are represented on bricks and tiles, which requires consideration of four corners.

2. Due to the problem of transferring the pattern to next generation by copying the product, the construction method was distorted and reinterpreted arbitrarily. The patterns in the early Unified Shilla Dynasty (A and B) have a single symmetric shape in a same local geometry while the others have two different symmetric shapes. This breaks the efficiency of using transformational functions in the construction method.
3. Cultural changes cause different transformations of the symbolic memes in the pattern. The patterns in the Unified Shilla Dynasty (A, B and C) share similar degrees of symmetry, i.e. 22.5 and 45 degrees, while the last one has 60 degree of symmetry in the seed area. A lotus motif in the seed became less significant in BSWM due to the fall of Buddhism. Accordingly, the number of seed changes from multiples of eight to multiple of six.

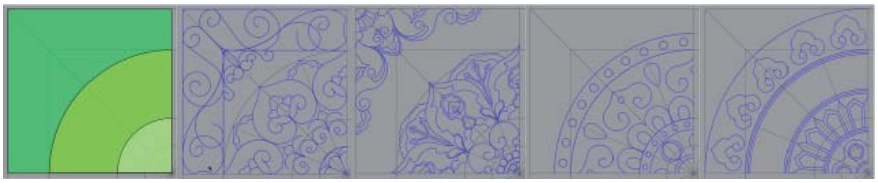
5. Synthesis in generative process

With the generative capabilities of shape grammar, the analysis of the selected BSWM examples provides the resources for producing morphological descendents of the selected BSWM. For this synthesis process, we implement SD2, a generative shape grammar tool developed as a part of the research project 'Design Synthesis and Shape Generation' (DSSG) (Lim, et al., 2008) in order to support shape synthesis in conceptual design (McKay et al., 2008). SD2 can create a shape rule, detect shapes from a design, replace them by pre-defined shapes in a given shape rule library, and automatically save the design history.

To make common basic elements for the four BSWM examples, which have different symmetries, a quarter of the global geometry was used as shown in Figure 9. The basic elements of each pattern are then defined and categorized into three sections as shown in the first picture in Figure 9. In our preliminary experiment, we defined 15 elements in the seed and calyx (yellow) areas, 19 elements in a part of flower (light green) area, and 14 elements in the corner and a part of flower (green) area from the four BSWM. This allows us create up to 4,800 combinations; however, many of these would not be recognizable as BSWM. Our trial of BSWM generation with design students indicates that around 200 combinations can be accepted as BSWM. The basic elements were considered as the partial elements of the motif of BSWM, which is a (lotus) flower.

With the basic elements of BSWM and SD2, we were able to generate new BSWMs that inherit geometric coherence from the existing ones. Some examples of new BSWM composited using the basic elements are shown in Figure 10, and they clearly show similarity with the original BSWM A to D.

The current SD2 system does not support a detection of scaled shapes. In theory, however, shape rules can be applied to scale shapes which allow broader detection of emergence. Thus, more combinations are possible if we consider scaling of the basic elements. For example, BSWM A and C can be merged and can simply substitute their scaled seed, calyx and boundary into the other patterns without losing its geometric coherence.



Global *BSWM_A* *BSWM_B* *BSWM_C* *BSWM_D*

Figure 9. Quarter part of global geometry and BSWM patterns A to D.

Figure 10. Three examples of new BSWM composited by the existing four BSWMs.

6. Discussion

The structure of symbolic memes embedded in the pattern that we have proposed here has not been applied to shape grammar so far. The place holder for delivering the meta-contents provides the framework of hierarchical decomposition for the given pattern to analyze it using the process of shape grammar rules, to produce the variation of it and to compare it with other patterns. The possible number of variations generated by the given four BSWM patterns shown in section 5 is approximately 4,800, which allows significant diversity to be considered. This suggests to us that our proposed structure is plausible enough for shape grammar to retain its generative power and significance.

Features of the shape grammar can also help us to find and describe unique cultural characteristics of Korean traditional patterns and to trace the hidden cultural identity from the shape and arrangement of the patterns. Most of the traditional patterns in Korea have been copied and transferred through the ages not by *copy-the-instruction,* how patterns are developed, but by *copy-the-product,* visual mimicry, within very exclusive apprenticeship without considering instrumental components of the patterns, which establish (1) their

identities, (2) the process constructing the patterns, and (3) the practical application of the patterns. Due to the lack of such documentation, the construction process of many Korean traditional patterns became extinct and distorted. Moreover, treating cultural elements with *copy-the-product* introduces the possibility of producing errors of interpretation, which are often problematic to isolate and remove later in the process. In contrast, shape grammar formalism, a kind of *copy-the-instruction* method, treats cultural subjects algorithmically and pragmatically, and thereby serves as a powerful tool for capturing the *ordering principles* and for constructing a systematic archive, with localized errors, that researchers could use to comprehend the subject at hand.

In our future work, we hope to analyze more BSWM patterns to validate the structure of symbolic memes we proposed here. Once the structure is shown to be generalized in Korean patterns, we aim to use the structure to compare with another culture's floral patterns to annotate the similarities and differences. We expect that the result will give us interesting insights to compare different cultures in general.

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