Understanding the Basic Language of Jewellery Design by Shape Grammar

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Received: 11 January 2023; Revised: 26 March 2023; Accepted: 27 March December 2023; Published Online: 20 June 2023

Abstract

This paper proposes a new method for explaining design through science. In this study, we focus on the conceptual design phase, where the centre of evolving new and creative ideas is located. Shape grammar and shape rules are investigated and applied to study how designers are working to understand the design conditions and identify the final solution during this conceptual design phase. Therefore, ideas of shape grammar, shape rules, and shape transformations are used to capture how designers transform shape from one state to another through sketching until they achieve their goals. Special consideration is given to the field of jewellery design. The results of the experimental study led to the development of understanding of shape transformations during the sketching of jewellery items.

Keywords: Conceptual design, Jewellery design, Product design, Shape grammar, Sketching process

Introduction

In the product design process, conceptual design is the centre in which creative ideas are developed (Jin & Benami, 2010). Conceptual design is an early stage of product design in which designers typically generate broad and various alternatives (French, 1999).

Sketching is a creative design process (Verstijnen, van Leeuwen, Goldschmidt, Hamel, & Hennessey, 1998). In conceptual design, sketching is a constructive tool that is mostly used in different scenarios such as transmitting the designer's ideas, understanding and analysing problems, and exploring design alternatives (Kielarova, Pradujphongphet, & Bohez, 2013). In the conceptual design stage, designers usually use two iterative-interactive processes, seeing and moving, for exploring their sketches (Schon & Wiggins, 1992). Seeing is considered as a reinterpretation process of design elements in a sketch, while moving is counted as a transformation of the reinterpreted design elements. With the work consisting of seeing-moving cycles, a series of related sketches is created by recognizing, associating, connecting, repeating, and elaborating the design elements (M. Prats, Earl, Garner, & Jowers, 2006).

Shape grammar is considered as a production system (Stiny, 2006). Shape grammar generates new designs in accordance with sets of shape rules. The working concept of a shape grammar is the recognition of a given shape and its possible spatial replacements; compiling rules; and exploring the shape grammar (Stiny & Gips, 1972; Tapia, 1999). Shape grammar executes any designs by formalizing the spatial relationships between their design elements (Miquel Prats, Lim, Jowers, Garner, & Chase, 2009).

Shape rules are created to transform initial shapes and sub-shapes within the shape grammar to create a new shape. The functions of shape rules are to recognise the shapes to be replaced and to

describe the replacement process. Shape rules, therefore, are used to explain shape transformations between sketches, in accordance with schemas, in a visual way (Miquel Prats et al., 2009; Stiny, 2006).

In this study, special consideration is given to the field of jewellery design. Consequently, the experimental study of jewellery design was established with the ideas of shape grammar, shape rules, and shape transformations to understand how designers create designs through their sketching process. The proposed methodology is expected to be a starting point for understanding the language of ornaments.

Methodology

As mentioned before, in this study, we focus on the field of jewellery design. The experimental study of sketching in jewellery design was performed with the aims of collecting and analysing information about the ways in which designers explore their design concepts and to observe and study how they transform shapes and design elements in sketches while exploring design ideas.

The experimental study of the sketching process of jewellery designers was organized in the following steps:

1. In the case study, we experimentally investigated the design of jewellery earrings, bracelets, and pendants.
2. We started from analysing the fundamental elements of jewellery items.
3. The elements were classified into shapes and sub-shapes.
4. We attempted to capture the shape rules, which jewellery designers use during developing shapes or sub-shapes from one state to another.
5. We developed shape grammar of jewellery earring design according to the shape rules we captured from the previous stage.

Results

In our experimental observations, we found several issues that are explained as follows. Jewellery design is an industrial design that requires the balance of aesthetics and function. Consequently, jewellery design involves the skills of development, analysis, and creativity.

Jewellery design typically starts with design concepts, which are provided by either the customers or the designers themselves. Later, designers transform design concepts by sketching design ideas in the forms of shapes, lines, curves, and functions of jewellery products. This process is called concept generation in the conceptual design stage and it requires a series of design ideas in the form of sketches.

The results of our experiments show that the interaction between the designers and their sketches are represented by a finite number of shape rules. Those shape rules formalize the shape reinterpretation and shape transformations.

The sketches were mostly manipulated using more than one shape rule at the same time. Some of the sketches from our sketching experiments are shown in Figure 1.

In the experiments, we choose simple geometric shapes like triangle, square, or circle to design earrings, because with simple shapes it can easily be seen how the shapes were transformed.

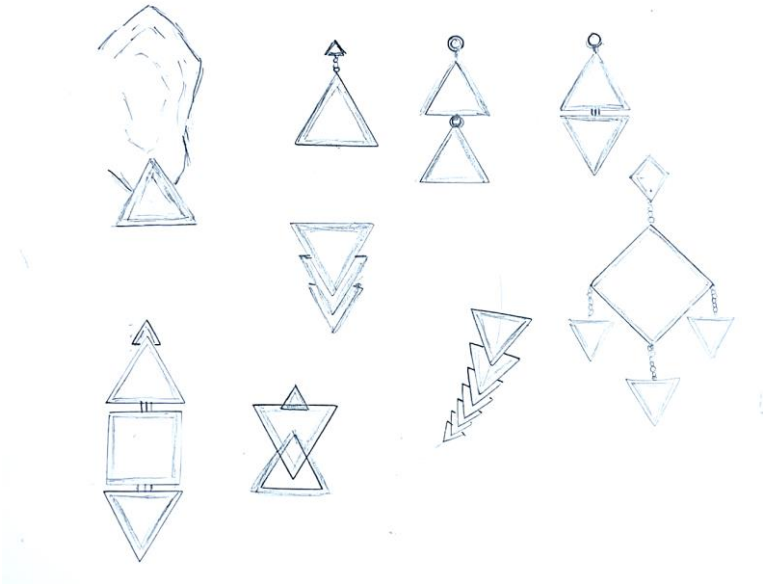

Figure 1 Some sketches obtained in the experimental investigation.

We also studied further the sketches of professional jewellery designers like Maurice P. Galli, Dominique Riviere, and Fabfan Li. We found that in their plate 39 (Galli et al,1994), the structural sketches for a link bracelet show that in each design only a few main shapes were first created, and then they were transformed by repeating the shapes and translating them along the axis of the bracelet, while some of them were rotated to create a pattern as illustrated in Figure 2. The shape grammar of the design of the link bracelet clearly contains shape rules such as repetition, rotation, translation, scaling, and adding new shapes.

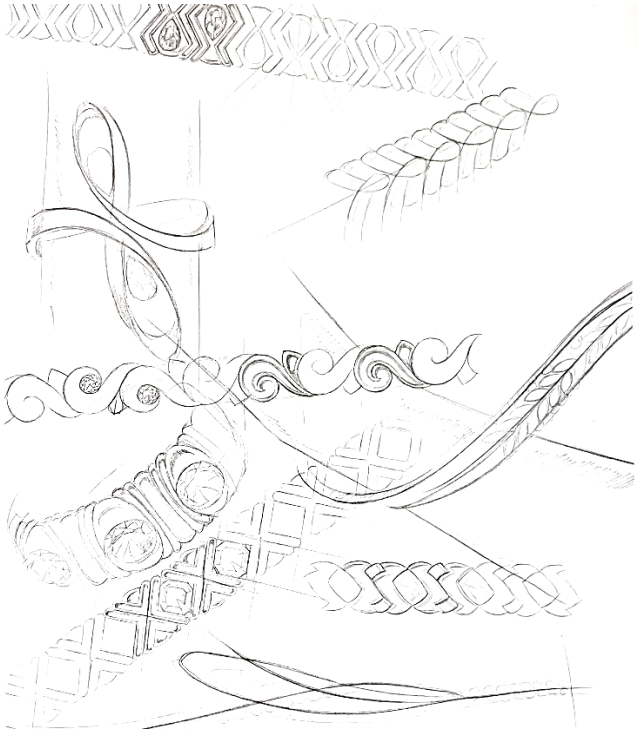

Figure 2 Structural sketches for a link bracelet (Galli, Riviere, & Li, 1994)

In our previous research, we studied Lanna motifs such as the so-called Lai-Sae motifs in Baan Wualai silverware. The Lai-Sae motifs are decomposed from several design elements, illustrated in Figure 3, (Kielarova & Jankam, 2019).

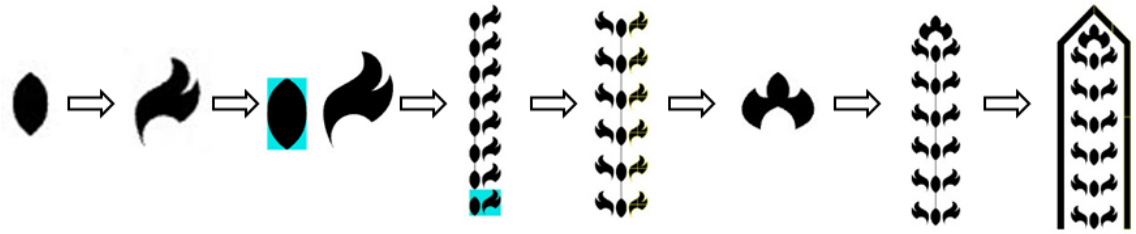

Figure 3 Shape grammar of Lai-Sae motifs in Baan Wualai silverware (Kielarova & Jankam, 2019)

We applied the Lai-Sae motifs to designing jewellery pendants as shown in Figure 4.

Figure 4 A Jewellery pendant designed using shape grammar with Lai-Sae motifs (Kielarova & Jankam, 2019).

From the observations made in several experiments, we found that designers create new designs using transformations of shapes and adaptations of design precedents. The following are the common shape rules often exploited in shape transformations and adaptations:

- Moving a shape to a new position,
- Rotating a shape around a centre or an axis,
- Rotating a shape along a cure or a line,
- Scaling a shape,
- Shearing a shape,
- Mirroring a shape on a vertical or a horizontal axis,
- Repeating a shape and scaling, moving, and rotating the copy to create a new pattern,
- Combining at least two shapes to create a new one,
- Dividing a shape and changing a part of the shape
- Adding a new shape.

Discussion

Based on the experiments, the basic language of jewellery items can be described by a shape grammar through shape interpretation and shape transformation. Shape transformations are employed to describe the connections between sketches according to shape rules. It is extremely difficult to construct shape grammars that cover the whole range of jewellery design styles. As described in the results section, different design styles come from different shape grammars. However, the key common shape rules often exploited, can be captured as summarized in the previous section. Nevertheless, more case studies are needed for further observations to make the study of the basic language of jewellery design more solid and close to its natural language.

Conclusion and Suggestions

By combining art and science, this paper indicates that science can help us to understand the creation of artworks such as jewellery design. In this paper, shape grammar, a scientific method, is used to understand and explain how designers are working on their sketches. The research is mainly based on the experimental investigation of the sketching process of jewellery designers. The investigation was aimed at understanding the transformations and developments of idea sketches. The analysis of the experimental data, therefore, led to the definition of a set of shape transformation rules, which are commonly used in jewellery sketching. This study focuses on design exploration in terms of shape rules used during transforming shapes. Shape transformations performed in the sketching process of jewellery design were observed, which led to the identification of how designers transform shapes from one state to another in a logical manner, which can be explained through shape grammar and shape rules.

Shape grammar, shape rules, and shape transformations can be coded into a computer-aided design program to automatically generate a large set of design alternatives for designers. Shape grammar is also useful for novice designers and design students.

Acknowledgments

The research was funded by the Fundamental Fund of Naresuan University with Contract No. R2565B041. The authors would like to gratefully thank all participants in this research for their collaborations.

References

French, M. J. (1999). *Conceptual Design for Engineers*: Springer London.

Galli, M. P., Riviere, D., & Li, F. (1994). *Designing Jewelry: Brooches, Bracelets, Necklaces & Accessories*. Atglen, PA: Schiffer Publisghing Ltd.

Jin, Y., & Benami, O. (2010). Creative patterns and stimulation in conceptual design. *Artificial Intelligence for Engineering Design, Analysis and Manufacturing, 24*(2), 191-209. doi:10.1017/S0890060410000053

Kielarova, S. W., & Jankam, K. (2019). *The Application of Shape Grammar and Genetic Algorithm in Automatic Creation of Baan Wualai Motifs for Silver Jewelry Design.* Paper presented at the Naresuan Research and Innovation Conference, Phitsanulok, Thailand.

Kielarova, S. W., Pradujphongphet, P., & Bohez, E. L. J. (2013). The Framework of Generative Design System using Shape Grammar for Jewelry Design. *International Journal of Intelligent Information Processing, 4*(2), 1-13.

Prats, M., Earl, C., Garner, S., & Jowers, I. (2006). Shape exploration of designs in a style: Toward generation of product designs. *Artificial Intelligence for Engineering Design, Analysis and Manufacturing, 20*(3), 201-215. doi:10.1017/S0890060406060173

Prats, M., Lim, S., Jowers, I., Garner, S. W., & Chase, S. (2009). Transforming shape in design: observations from studies of sketching. *Design Studies, 30*(5), 503-520. doi:https://doi.org/10.1016/j.destud.2009.04.002

Schon, D. A., & Wiggins, G. (1992). Kinds of seeing and their functions in designing. *Design Studies, 13*(2), 135-156. doi:https://doi.org/10.1016/0142-694X(92)90268-F

Stiny, G. (2006). *Shape: Talking about Seeing and Doing*. Cambridge, MA: MIT Press.

Stiny, G., & Gips, J. (1972). *Shape grammars and the generative specification of painting and sculpture.* Paper presented at the Information Processing, Amsterdam, Holland.

Tapia, M. (1999). A Visual Implementation of a Shape Grammar System. *Environment and Planning B: Planning and Design, 26*(1), 59-73. doi:10.1068/b260059

Verstijnen, I. M., van Leeuwen, C., Goldschmidt, G., Hamel, R., & Hennessey, J. M. (1998). Sketching and creative discovery. *Design Studies, 19*(4), 519-546. doi:https://doi.org/10.1016/S0142-694X(98)00017-9