A NON-CONVENTIONAL METHODOLOGY FOR INTERIOR PRODUCT DESIGN USING CONCEPTUAL DESIGN PRINCIPLES AND PARAMETRIC TOOLS

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ABSTRACT: The conceptual design stage involves a compound set of objectives and constraints such as issues of function, aesthetic and ergonomics. Furthermore, computational design methodologies offer a great number of advantages for engineering and manufacturing processes. Through the coupling of conceptual design stage with parametric modelling methods, the present research aims towards a non-conventional design technique that enhance product designers' contribution to developing innovative and useful everyday products based on parametric design creations. The suggested approach allows a valuable perception of the design objectives and reinforces product designers in their decisions to find solutions. This research presents a number of illustrative case studies from interior design point of view (e.g. furniture and decorative items). Finally, the paper concludes with suggestions for further research and development for the coupling conceptual design and parametric modelling methodology.

KEY WORDS: Conceptual Design, Parametric Design, Product Design, Non-Conventional Design Techniques, Interior Design.

1. INTRODUCTION

The term non-conventional methodology for product design is used to characterize a particular design process that uses conceptualism in parametric design. Specifically, conceptual design stage is an experimental and primitive level of the design process in which industrial designers face a compound compilation of objectives and constrains [1]. These include generation and exploration of possible design solutions, evaluation of generated solutions based on specific design criteria and finally the creation of imaginative forms and innovative ideas [2]. The main CAD-based tool for the production of these conceptual design forms is parametric design. In parametric design, forms are shaped by values of parameters and equations are used to describe the relationships between the forms. Therefore, interdependencies between forms can be established and their behaviour under transformation can be defined both mathematically and geometrically [1, 3].

Non-conventional methodology for product design offer obvious advantages for product design processes. Through the coupling of conceptual product design with parametric modelling methods, this paper presents novel techniques that enhance industrial design contribution to building innovative design concepts based on parametric methodologies. The aim is to systematically combine both the proposed approaches in order to achieve non-conventional outputs while innovation is obtained.

2. CONCEPTUAL PRODUCT DESIGN

Conceptual Product Design (CPD) is perceived mainly as an art than an actual science. Actually, the core of CPD methodology is based on the design thinking principles. The concept of design thinking involves solving complex problems, which require curiosity, imagination and creativity in order to generate, explore and develop possible solutions, with increased value for the end user [4]. The proposed CPD framework, followed by a number of industrial designers incorporates several sessions of creative processes similar to design thinking tools (i.e. brainstorming, mind-map, mood boards and sketching) with an aim to find alternative ideas for each product [5]. Especially, conceptual sketches are important to the phenomena of emergence and reinterpretation during early design activity. Emergence refers to new thoughts and ideas that could not be anticipated or planned before sketching [6]. The main objectives and constrains of Conceptual Product Design stage are abstract notions of function and aesthetic, performance, project requirements, manufacturing constrains and construction costs. These are the basis that must be translated, in a manageable way, to design guidelines and produce the final product geometry.

3. NON-CONVENTIONAL METHODOLOGY FOR PRODUCT DESIGN

The present paper discusses the process of identifying the digital form design process in which computer simulation software tool is used to generate forms in 3D space. These parametric

generative forms aim on designing innovative useful and everyday products for interior use (Product Design Stage and Parametric Modelling Stage). The proposed forms created were directly associated with the Conceptual Design Stage. The proposed framework (Figure 1) depicts the complete procedure proposed for achieving successful designs.

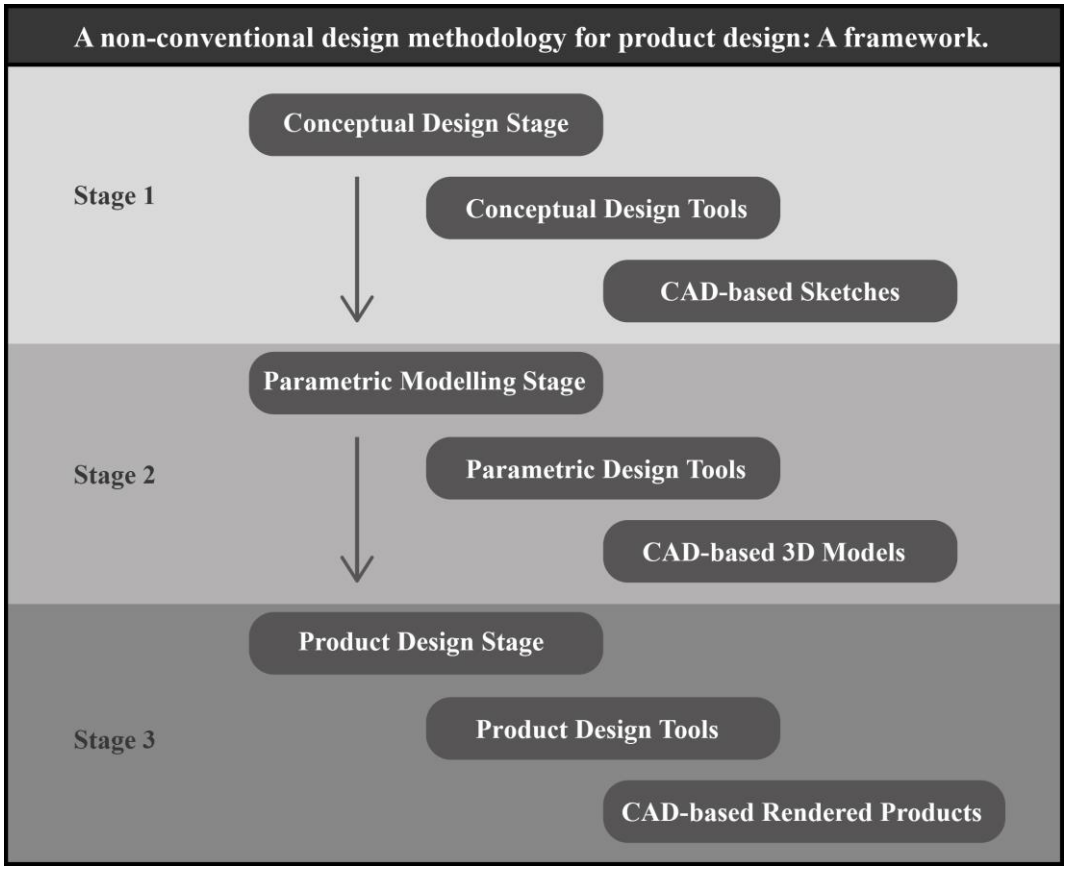

Figure 1. A non-conventional design framework for product design.

Stage 1 - Conceptual Design Stage: Computer based sketches were used in order to describe each idea in a conceptual level with the appropriate abstractions. Before this, concept ideas emerged from the use of creative tools (i.e. mind-map and mood-boards). Specifically, the use of mind-map offers a visual diagram that organizes the complete concept design principles and the mood-board is used to convey the main idea of concept to a visual design representation. In other words, pass the ideas from abstraction into something more meaningful and easier managed.

Stage 2 - Parametric Modelling: Parametric modelling began by analysing existing info from the previous stage, focusing on aspects such as the different shapes of the model. The resulting set of specific geometry information was subsequently translated into a collection of parameters according to the proposed software rules. Software environment generated a number of different forms, which were developed by the main concept. Finally, the designer chose the optimum form depending on specific criteria that represent the overall idea of the product.

Stage 3 - Product Design: The final stage of the product design aspects embodies the transformation of the 3D parametric forms into integrated products. The CAD-based 3D rendered products from this stage are concepts for further design research including manufacturing and financial issues to be dealt with.

4. IMPLEMATION TOOLS

In the implementation of the design system of 'non-conventional methodology for product design', three different software environments were used, one for each stage. The proposed software environments were:

- Krita® for the CAD-based sketches during the Conceptual Design Stage,
- Grasshopper® for CAD-based 3D forms/models creation based on a number of parameters incorporated (Parametric Modelling Stage) and
- Blender® for final product renderings and the creation of high quality images for each product (Product Design Stage).

5. CASE STUDIES

The research presents two illustrative case studies from the interior design point of view. The first case study involves the design of a sofa, based on biomimicry, and a second one which is a vase for decoration purposes. Both the geometries are non-conventional representations of unusually designed products.

5.1 The Sea-wave sofa

Biomimicry is an approach to innovation that seeks sustainable solutions to world fabrication challenges by emulating nature's patterns and strategies. The main idea is that nature has already solved many of the problems we are grappling with [07]. Animals, plants, and microbes are the perfect designers with huge experience in construction and manufacturing projects.

The purpose of this case study is to create a sofa, which imitates the shape of sea waves. All conceptual pieces of information were generated from using creativity tools such as mind-map, mood-board and CAD-based sketches (Figure 02).

In the digital parametric design, chain curves, non-uniform rational lines, nurbs, bending and minimal surfaces can be effective in structural modelling of the geometric design process [08]. The final form of the sofa is generated by using specific parameters in a computational design environment. Inspired by the sea waves, the polymorphic sofa is comprised from a specific number of parts that are connected to each other by central axes, which have cylindrical shape. The connections are typical rubber bands that give the bench its springy quality, while ensuring lateral stability of the installation as a whole. The total shape of sofa imitates the sea waves' movement by using layer-by-layer technique which was created automatically (Figure 03).

Finally, the third stage presents images of product renderings (Figure 04). The material that was selected for the presentation of the final product is wood. In many aspects, wood is an advantageous material due to its natural structure, lightweight, high strength, non-waste to the environment, and its ability to be produced. It is environmentally sustainable and can be used outdoors. In terms of usage, it is preferred because it is a warm looking material [08].

The sofa can be used in modern environments that art and design issues are treated as a priority. It is in these cases that the cost is not the most important thought and the designer can provide high quality, trendy and without restrictions outcome.

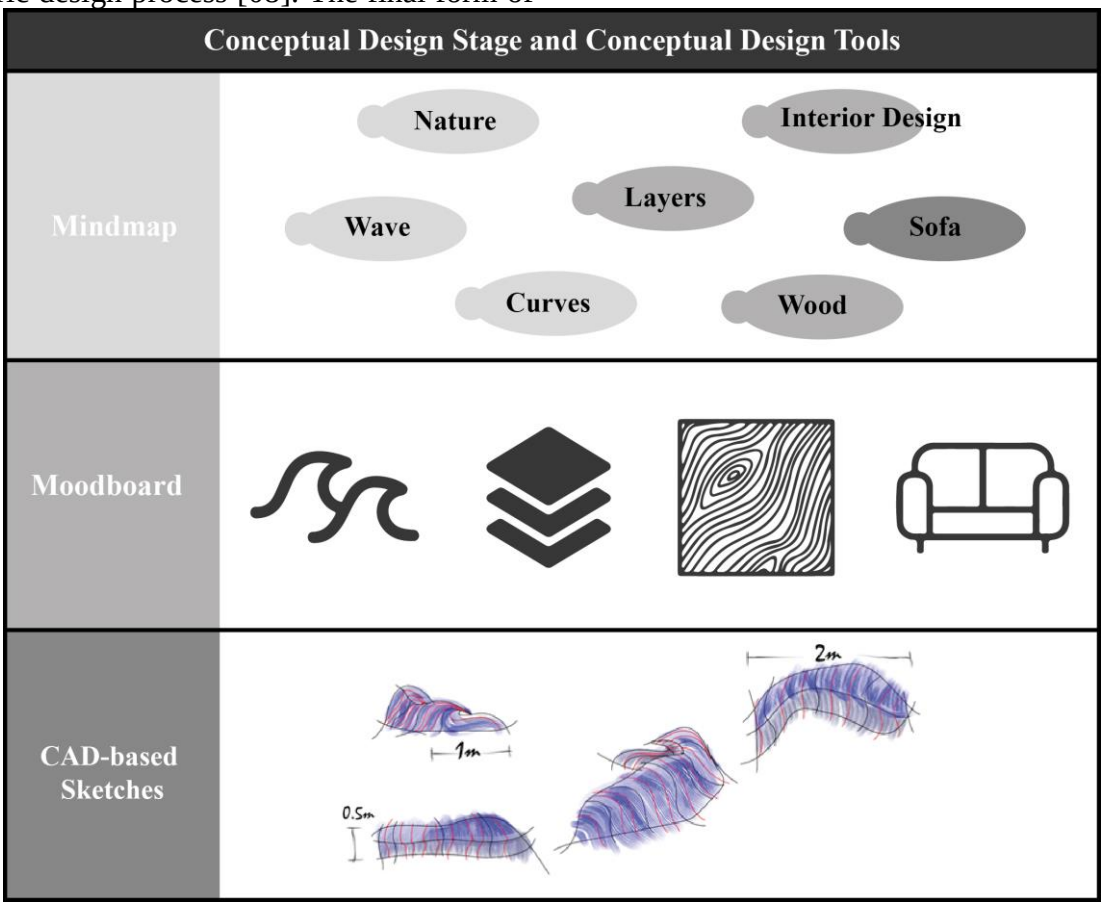

Figure 2. Visual elements form conceptual design stage.

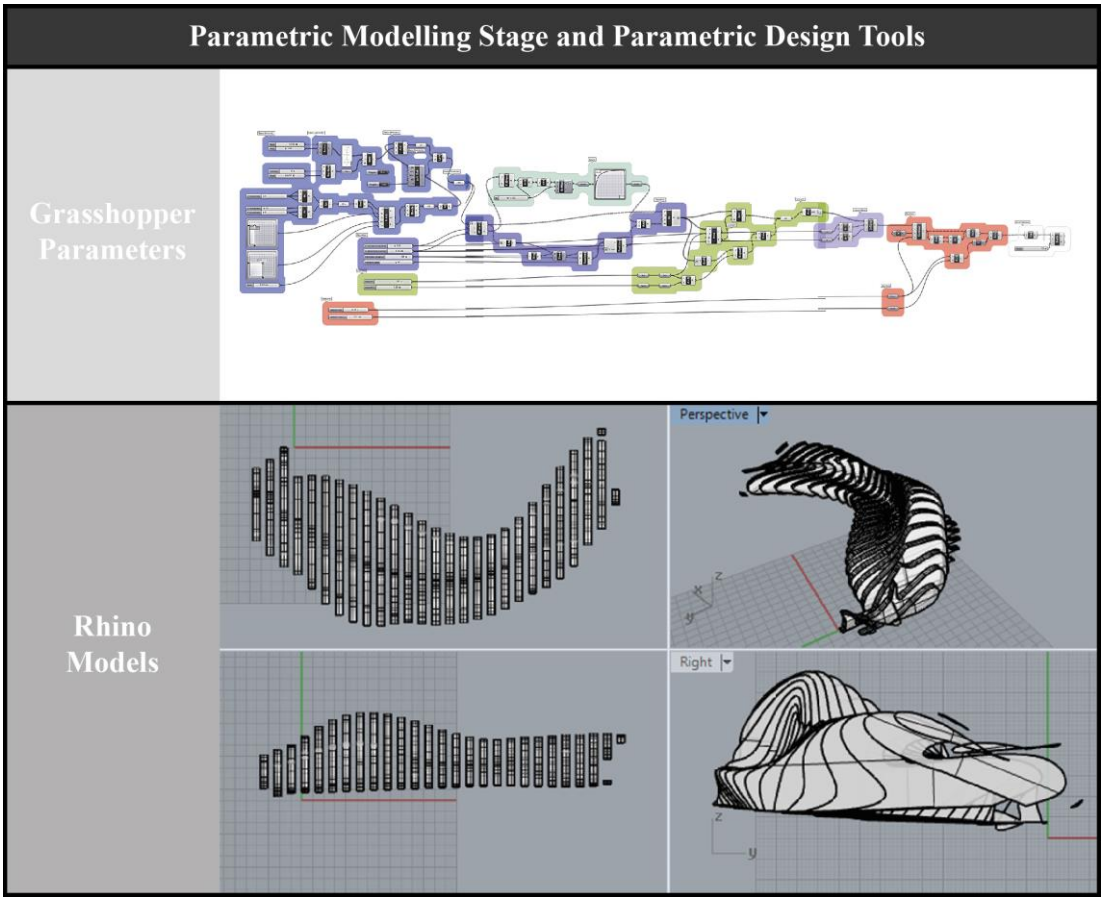

Figure 3. Model parameters and CAD form of sofa.

Figure 4. Final renderings of sofa.

5.2 The Bamboo Vase

Bamboo is one of the fastest growing giant grasses in the world; it has a number of advantages when used as a construction material [09]. Bamboos are generally hollow tubes with some nodes along their length. Specifically, the bamboo structure consists of these elements: interior wall, exterior wall, node, internode, wall thickness and branch (Figure 5).

Furthermore, these elements were translated into design parameters for the new forms generation from the specific parametric environment. A series of vase products inspired from bamboo is presented in Figure 6. The morphology of the bamboo's structure is indicated for design inspiration. A complex geometry was used as the basis for designing new and fashionable versions of the classic vase, which is commonly used by people for in-house decorative use (Figure 7). A number of different colours can be used with an aim to satisfy a greater audience and provide a successful product.

In addition, the use of such tools offer the possibility to easily build a variety of non-conventional geometries and being able to select the best that fits the needs of the end user.

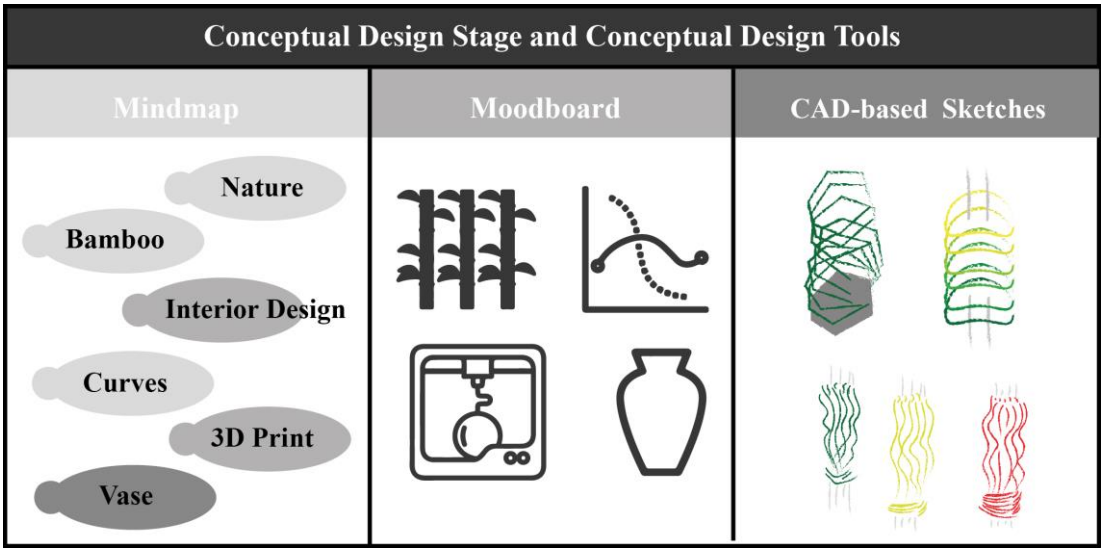

Figure 5. The inspiration of bamboo vase.

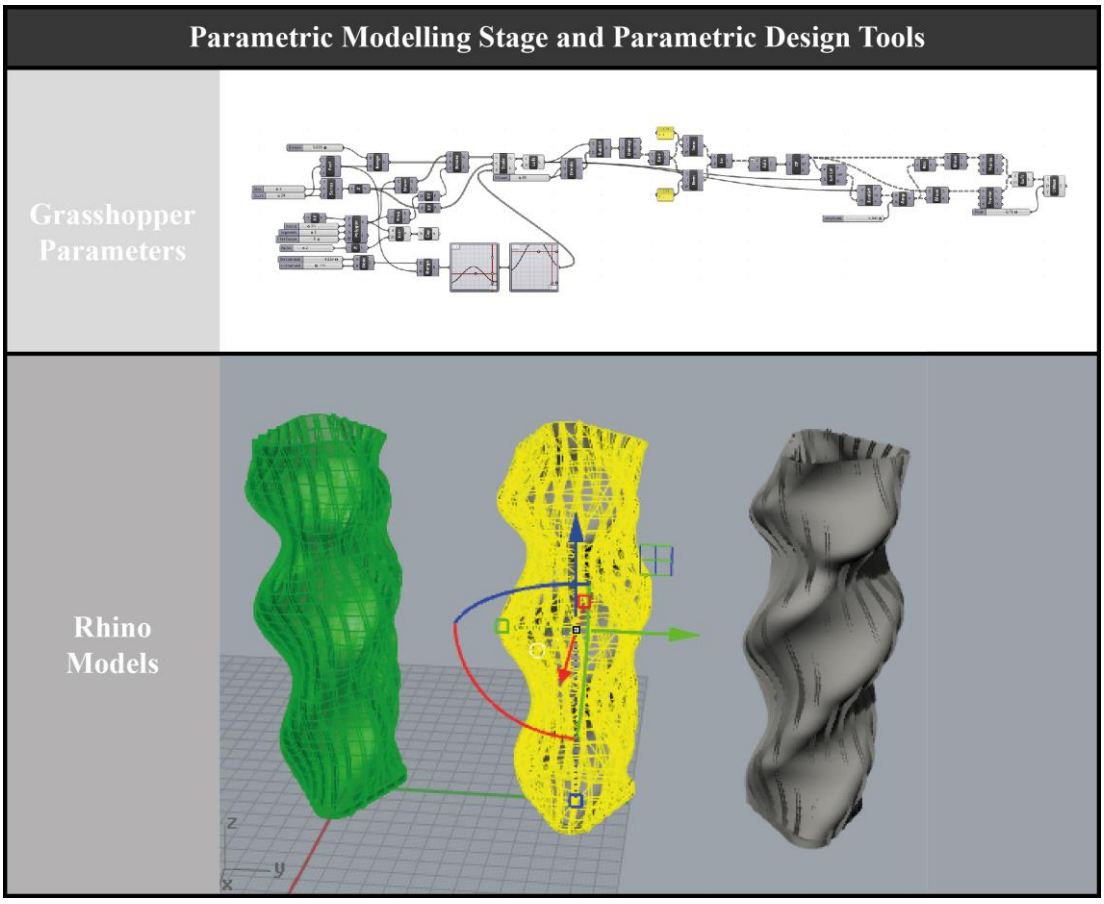

Figure 6. Model parameters and CAD forms of vase.

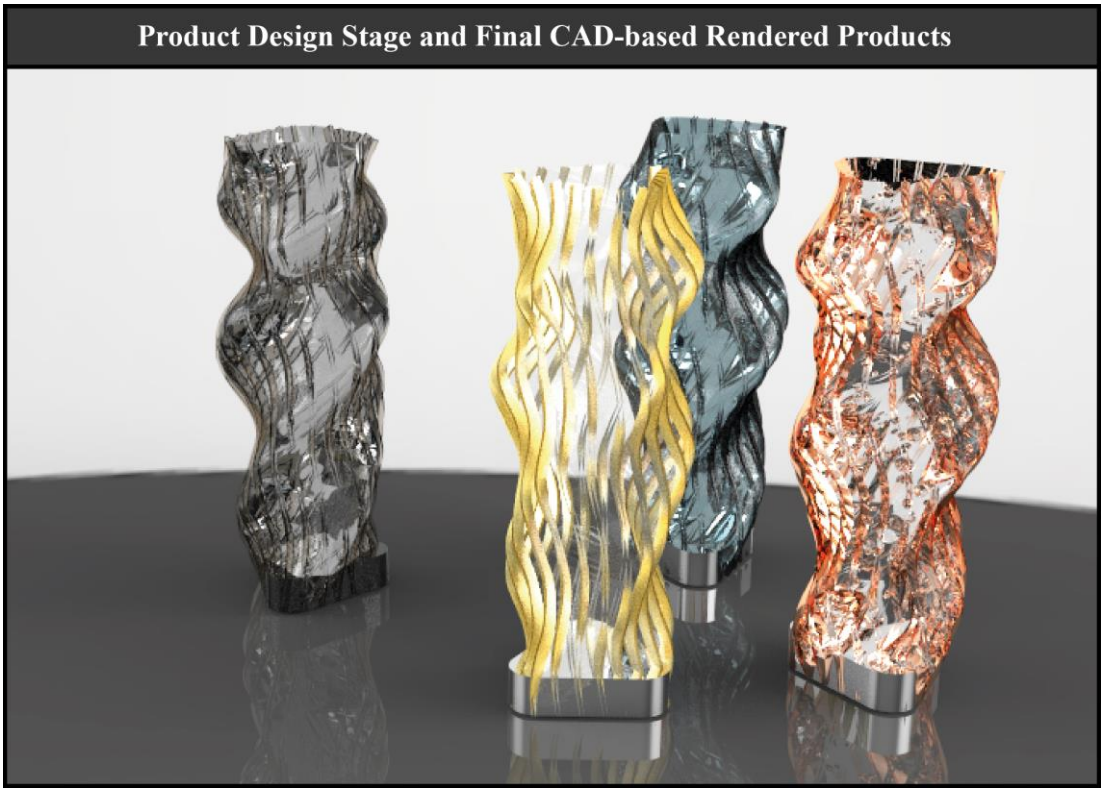

Figure 7. Final renderings of bamboo vase.

6. SUMMARY

The paper aims at developing a new non-conventional methodology for form generation, focusing on the conceptual stage of the design process. Non-conventional methodology for product design offers a great deal of advantages for product design. Furthermore, this research reports experimental parametric design procedures as an emergent computational methodology to form generation based on conceptual product design techniques. The core idea of this paper is a combination of two different design approaches: the conceptual design and the parametric design. Both approaches unite under the same roof and create a newly proposed non-conventional methodology.

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