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THE "DO-IT-YOURSELF (DIY)" BRAND DESIGN STRATEGY THROUGH COMPUTATIONAL DESIGN TOOLS

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Abstract: *The three-dimensional form of a product is a key element in the development of a brand identity through the computational design methodology. Brand identity has an in-depth relationship with the object's shape and product assembliness. In traditional mass production design methodologies, designers encode specific parameters into design rules that aren't used by end-users to customize their own products. The "Do-It-Yourself (DIY)" process enable users to express themselves through the design thinking approach. Self-design is a form of co-creation between designer's knowledge and customer's skills according to the branded product design parameters. Under this statement, the object's geometrical form and the product assembliness are fundamental principles in the promotion of a holistic design identity to the industry and to the market. The current paper combines the use of computational design with specific parameters of DIY bookcase/desk (i.e., height, length, width, number of shelves, etc.) in order to develop a generative design system for the mass customization of DIY bookcases/desks alternatives. The results from the end-user application offer, automatically alternatives 3D models under the "Do-It-Yourself" brand umbrella.*

Key words: computational design, branding, do-it-yourself, self-design, design thinking, mass customization

1. INTRODUCTION

The multidimensional role of brand identity embodies the product's shape and the final object's assembliness (Manavis & Kyratsis, 2021). Furthermore, the aforementioned modern approach of product brand image also includes design elements like material's texture and roughness, color, and the unique design style of the specific brand. Nowadays, novel Computer Aided Design (CAD) systems afford advanced features and capabilities that can be used to produce unusual geometries in product design engineering field (Tzotzis et al., 2021). More specifically, computational design is a supportive methodology for designing branded products according to the brand-new theory of the holistic design strategy. The Do-It-Yourself (DIY) design methodology refers to the specific creative approach in which designers thinking like end users. That means, the DIY projects includes toolkits, templates, tools, information, inspiration, and preliminary designs from designer's point of view (Hoftijzer, 2017). Finally, the DIY activities can be seen as the most self-sufficient ways of designing and making your own products.

2. LITERATURE SURVEY

Throughout literature there are reports about many theories and techniques related to the DIY design methodology and the self-design approach. Furthermore, some researchers developed applications for the automatic design of products via computational design tools according to mass customization concept (Kyratsis, 2020). All that -automated produced- geometries and forms are related to the unique brand image of the specific designer or design firm as reference.

2.1 The IKEA effect

Norton et al. (2012) refer the definition of the IKEA effect as the increase in valuation of self-made products. More specifically, the IKEA effect was seen when individuals who build IKEA boxes, folded origami animals, and built objects from a set of Legos (as a part of Norton's experiment) were willing to pay more for their finished product than the same product that was assembled by an expert (Ling et al., 2020). According to Kim (2015) the specific strategy (IKEA effect), while enjoying a marketing effect, has become an opportunity for promoting transformation to a practical customer-oriented, differentiated furniture image solely for IKEA.

2.2 The 'Do-It-Yourself (DIY)' design methodology

The Do-It-Yourself (DIY) design process enable users to express themselves through the design thinking approach. Hoftijzer (2017) refer that nowadays DIY has a contemporary role in market as a result of the computer science and digitization tools (i.e. user generated content made). Prendeville et al. (2017) provides a formulation of fourteen DIY principles (i.e. use modular design, use commonplace materials, facilitate for flexible construction, etc.). Furthermore, the DIY design approach applies to a great number of consumer products (i.e. furniture, electronic gadgets, jewelries, etc.).

2.3 Mass customization concept

Product customization uses a flexible production system to deliver a product to order that matches the needs of an individual user (Randall et al., 2003). Mugge et al. (2008) refer that product personalization gives individual users the opportunity to act as co-creators and partly conclude the appearance and the functionality of the product they buy. Furthermore, Mugge et al. (2008) suggest seven specific dimensions of mass customization concept: mental effort, physical effort, flexibility, initiation, goal of product personalization, personalization moment, and deliberateness. Ardito et al. (2011) presents a paper that explores the roles of end users in the life cycle of interactive system for furniture design. Kyratsis et al. (2019) present a case study that follows the automatic design process of a bicycle, which is a product that can undergo many design changes throughout its life cycle. The presented case study makes use of a CAD based API in order to show that key advantages of using it.

2.4 Computational design approach

Efkolidis et al. (2020) define the computational design approach as the modern design methodology of using textual or visual programming interface to create and modify forms and geometries. Furthermore, Krause (2003) dealt with the development of applications, by using the computational design methods to generate structures or objects. According to Sequin (2005) CAD tools (included generative design tools) are progressively also becoming more suitable for aesthetic engineering. Kyratsis (2020) presents a great number of design examples that are related to the automated process of producing unusual 3D forms for 3D printing applications. The implementation tools of the proposed computational design examples are Rhinoceros3D™ and Grasshopper™.

2.5 Product shape design as brand element

Manavis and Kyratsis (2021) note that branded product identity becomes a holistic design strategy to increase competitiveness though marketing and promotional tools. According to this theory, Manavis and Kyratsis (2021) present a novel methodology for automatic creation of products based on specific brand elements. All products are based under the main theme of Cycladic marble figurines from the Early Age, supporting Greek souvenir industry. Similarly, Castro e Costa et al. (2019) present a methodology that describes the development of a computational design system for the mass customization of ceramic tableware based on specific shape grammar rules. Castro e Costa et al. (2019) propose an online design application for the end users for the creation of their own products according to the design rules. Finally, Lopes Garcia (2018) describes a grammar-based design tool for the concept phase of multipurpose chair design (The ChairDNA Design Tool). The specific application enables the generation of alternative models of chair according to the manipulation of their parameters.

3. PROPOSED METHODOLOGY

The basic idea for the present research paper combines a number of concepts. The main reason of these design concepts is the automatic creation of products based on specific branding elements. This methodology was developed according to the computational design approach by using parametric pieces of software (Rhinoceros3DTM, GrasshopperTM and Shape DiverTM). Finally, a case study presents the customization design of unique 3D forms of bookcases/desks based on the concept of Do-It-Yourself (DIY). The proposed methodology is a result of two different design fields, a) the study of brand elements (branding principles) and b) the study of computational design techniques – computational design principles (Figure 1). Some of the branding principles according to the bibliography are brand identity, meaning, response and relationship (Phillips et al., 2014). Furthermore, concepts like decomposition, pattern recognition, data representation, generalization, abstraction, and algorithms are the fundamental

elements of computational design thinking (Khan & Awan, 2018). The workflow of the proposed framework works with the following procedure: a) designer investigates a great number of products under the main brand concept, b) all the common branding elements - shape, geometry, style, texture, colour, materials etc., are transformed to design-rules according to grammar-based theory. The third and the final step is about the generation of the computational design models that they are based on parameters, which include all the brand references. The following case study investigates the automatic creation of furnitures under the specific Do-I-Yourself characteristics as branding elements.

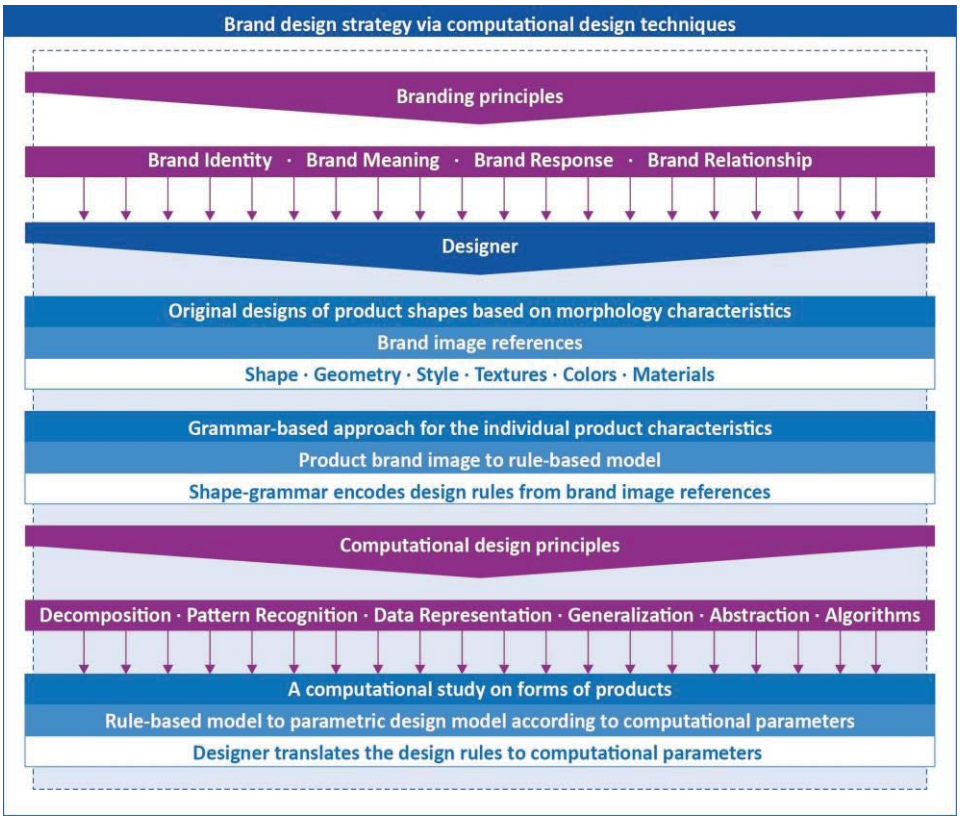

Figure 1: The proposed framework of the methodology

4. APPLICATION DEVELOPMENT

The application was designed with simplicity and ease-of-use in mind by using the helpful toolbox of Shape Diver™. Furthermore, the development of the application follows all the principles of user design experience for customized products: customization process, starting points, incremental refinement, exploit prototypes and the teach the customer (Mugge et al., 2008).

4.1 Design workflow and application

Every end-user of the proposed application is ready to create unique 3D models for alternative products under the original brand image. More specifically, the end-user specifies design solutions within the original branding concept by using the specific parameters which were developed by the designer at the stage of the computational design (Figure 1). Furthermore, the application exports a great number of crucial file formats for product design and product manufacturing purposes (Figure 2). Specifically, the application exports four different file types: a) an STL format of the produced 3D forms, b) a DWG file format with all the technical details of the final 3D products, c) a JPEG photo with the rendered version of the object and, d) a PDF report which includes all the step-by-step instructions for the final furniture's construction. The whole process of the proposed application it is known under the name of “Product Shape Generation to Support Brand Identity Elements”.

4.2 Implementation tools

The development of the application was based on three different design and programming pieces of software – one for each separate stage of the initial framework (Figure 3). More specifically, Rhinoceros3D™ was used for the CAD models visualization during the design process. Grasshopper™ was used for 3D CAD-based forms (according to CAD parametrization) and finally, Shape Diver™ was used for the application development. The Shape Diver™ is an online platform that it allows to end-users to design their own products under the specific parameters which are developed form designer's point of view.

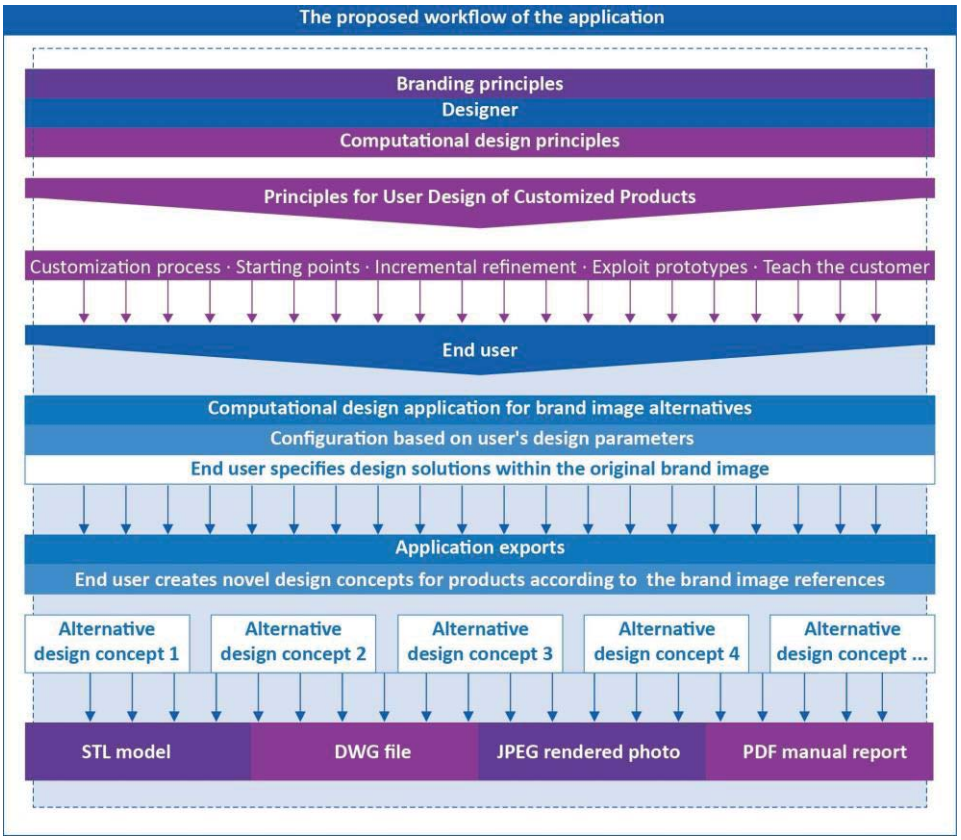

Figure 2: The proposed workflow of the application

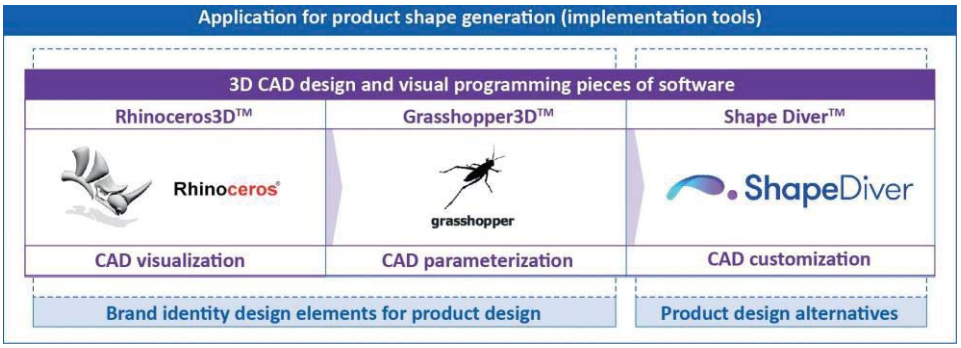

Figure 3: Implementation tools

4.3 Case study: D.I.Y. brand design strategy

The central idea is to model a modern bookcase/desk focused on the specific design-rules and parameters in relation with the brand elements of DIY style of construction. Some of these parameters are the number of shelves, the type of supports and the specific dimensions of each element separately. The basic model of the bookcase will be the initial reference for all the produced models that they will be

customize via the proposed application (the end-user's point of view). Figure 4 illustrates the main concept of Do-It-Yourself brand strategy for furniture design via computational design tools.

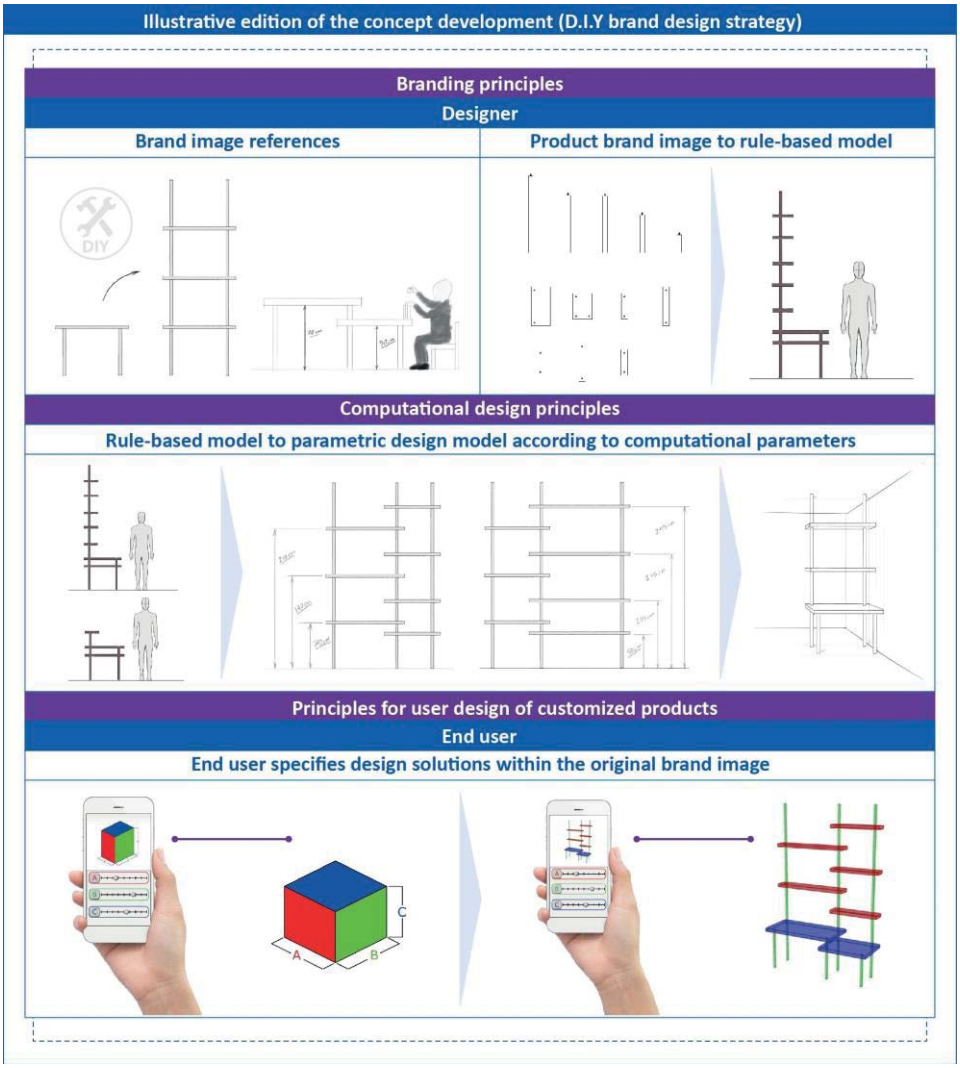

Figure 4: The main concept of the D.I.Y. brand strategy for furniture design via computational design tools

The brand image references of DIY design style are a) the type of assembiness and b) all the single elements that finalize the construction. Figure 5 illustrates the bookcase classification according to design style and the three different levels of the bookcase ontology. It is crucial to write down that there are too many similarities into bookcases designs between the varieties defined. Authors set six different categories for the common bookcase product: the traditional bookcase, the modular, the ladder, the corner, the floating and finally, the free style bookcase. All of the aforementioned type bookcases were used to create the design rules. Additionally, the authors note the object's ontology into to the single elements of the common shape of a bookcase. More specifically, a bookcase can be built from the following individual elements: shelves, supports, legs, back, side parts, uppers, cupboards, and drawers. All these different elements were translated to primitive shapes according to shape grammar methodology, in order to develop a parametric model. The developed case study encompasses three basic stages for programming and built the required customized products. The first part, named "Original Model", second is the "Rule-based Model" and finally, the third part is the "Parametric Model". Figure 5 illustrates the proposed three different parts of the customized product (section of the schematic bookcase for case study). The first part (Original Model) uses as an input the results of research about the bookcases classification and all the data from object's ontology. The next part of the procedure (Parametric Model) uses a piece of visual programming code written in Grasshopper3D^{TM}. At this stage, elements of the original model are translated to primitive geometries via shape grammar methodology.

The final step (Parametric Model) uses Grasshopper3D™ for creating the appropriate visual programming code. A series of design parameters and constraints is introduced, and the end-user is able to change them within a range of values. These configurations can generate a great number of alternatives based on the original model. Figure 6 illustrates the parameterization of the DIY-brand image of bookcase and desk.

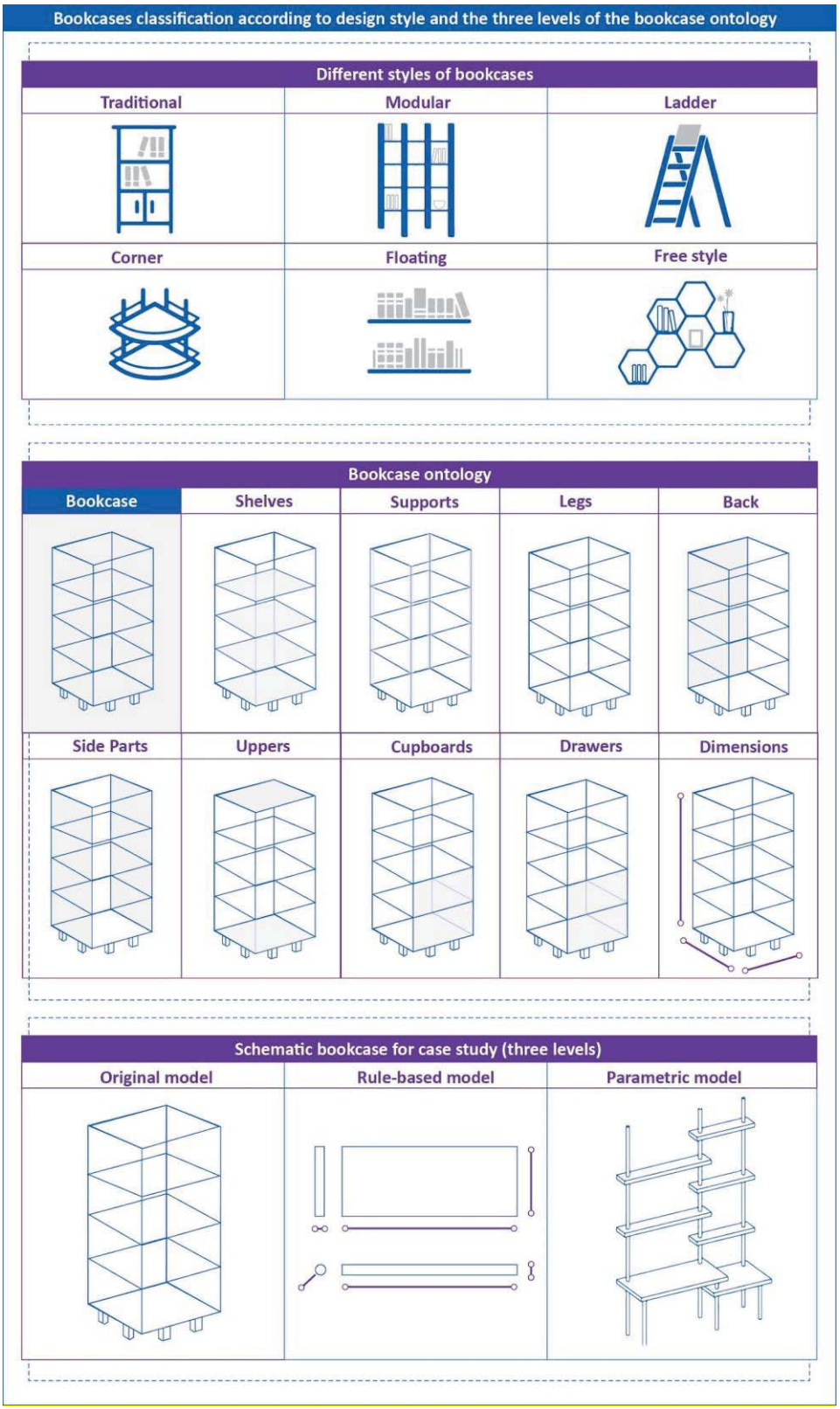

Figure 5: The illustrative edition of the framework and the application concept (D.I.Y. brand strategy)

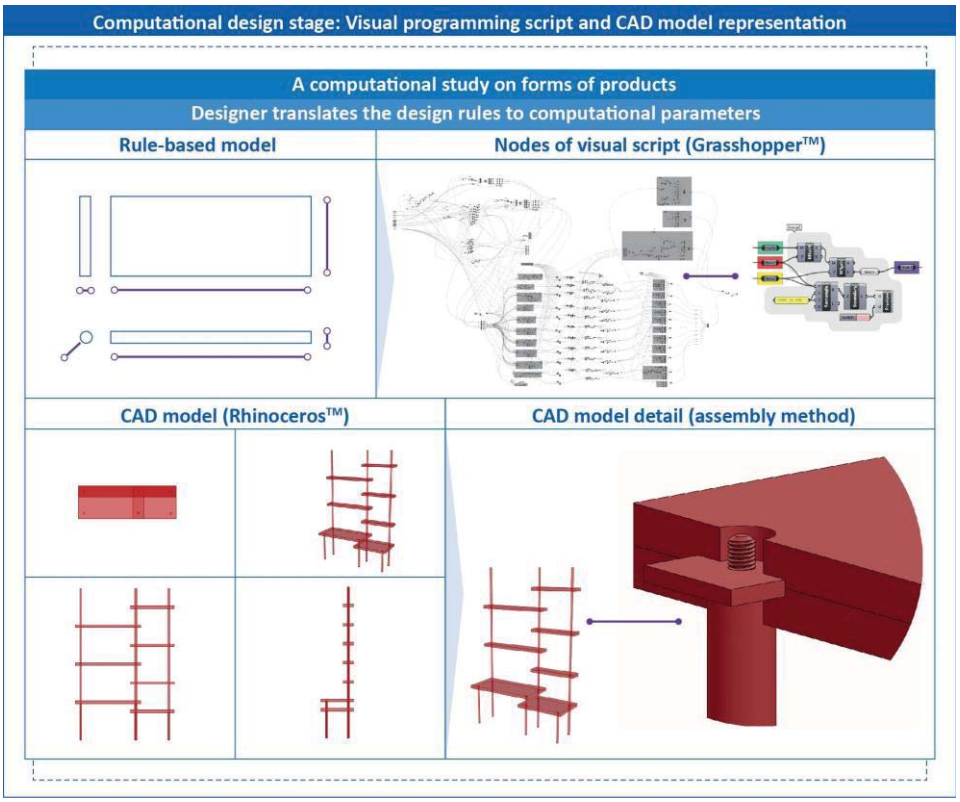

Figure 6: Computational design stage

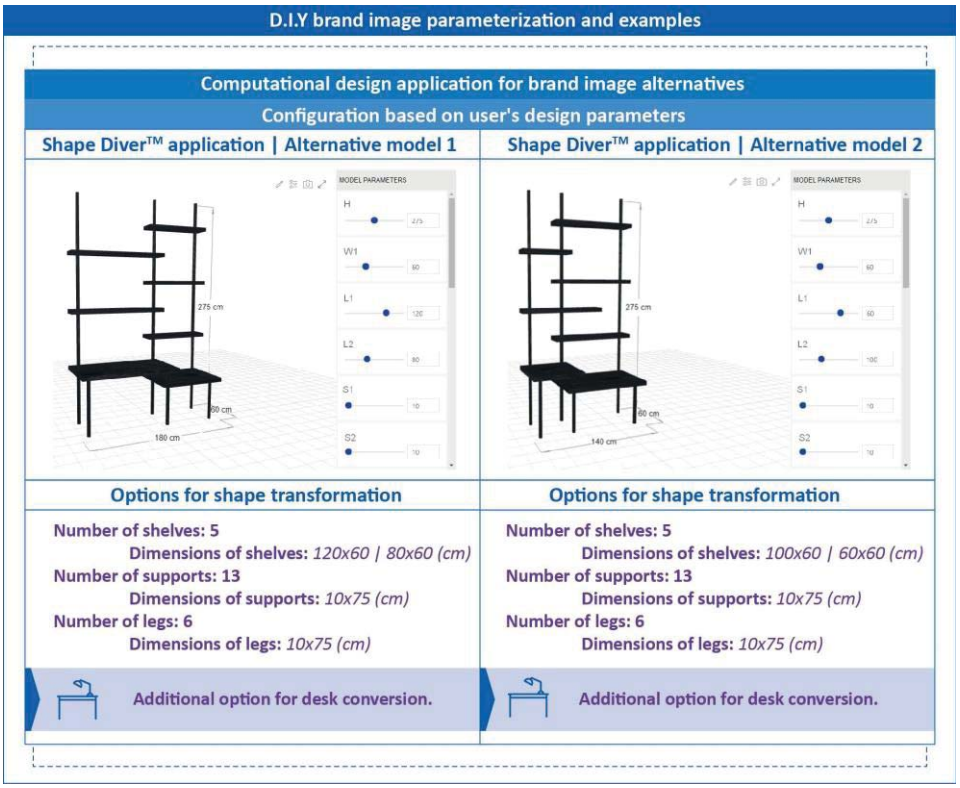

Figure 7: New bookcases/desks models and their technical specifications

The present case study shows an application for automatic creation of unique 3D forms with the aid of Rhinoceros3D™ and Grasshopper™. The end-user of the proposed application (Product Shape Generation to Support Brand Identity Elements) is able to insert numerical values for the parameters

required by the online platform of Shape Diver™. Each design of bookcase/desk includes the following types of design-rules/parameters: number of shelves, dimensions of each shelf separately (length, width, height), number of supports, dimensions of each support separately (length and radius), number of legs, dimension of each leg (length, width, height). Figure 7 illustrates the final stage of the complete procedure and presents two alternative design (Alternative Model 1 &2) from the original shape DIY-branded bookcase. This approach emphasizes the development of a complete family of furnitures according to the all-branding rules that they were developed by the authors. The proposed models were produced under the Shape Diver™ online platform. All the numerical values (as shown in the Figure 7) are correspond to the real size furnitures.

4.3 Exported product design applications

The end-user is able to create his own bookcase according to DIY brand identity. In this case, the user has the responsibility to fill all the parameters to online application of "Product Shape Generation to Support Brand Identity Elements". The proposed methodological framework exports four types of file formats in order to development four specific applications for product design field. The STL model of a 3D form is a very useful format for digital fabrications purposes. Furthermore, the technical drawing (DWG) file is the most important element in order to produce the final furniture from a specific manufacturing procedure. The next exported file is about a rendered photographic representation of the shape. The production of the JPEG photograph it is based on the main characteristics of rendering synthesis: materials, textures, shadows, lights, and the environment elements. Finally, the application of "Product Shape Generation to Support Brand Identity Elements" exports a PDF report with all the instructions about the assembly of the final product. The construction manual is a very useful tool to the end-user for the final assembly of the bookcase.

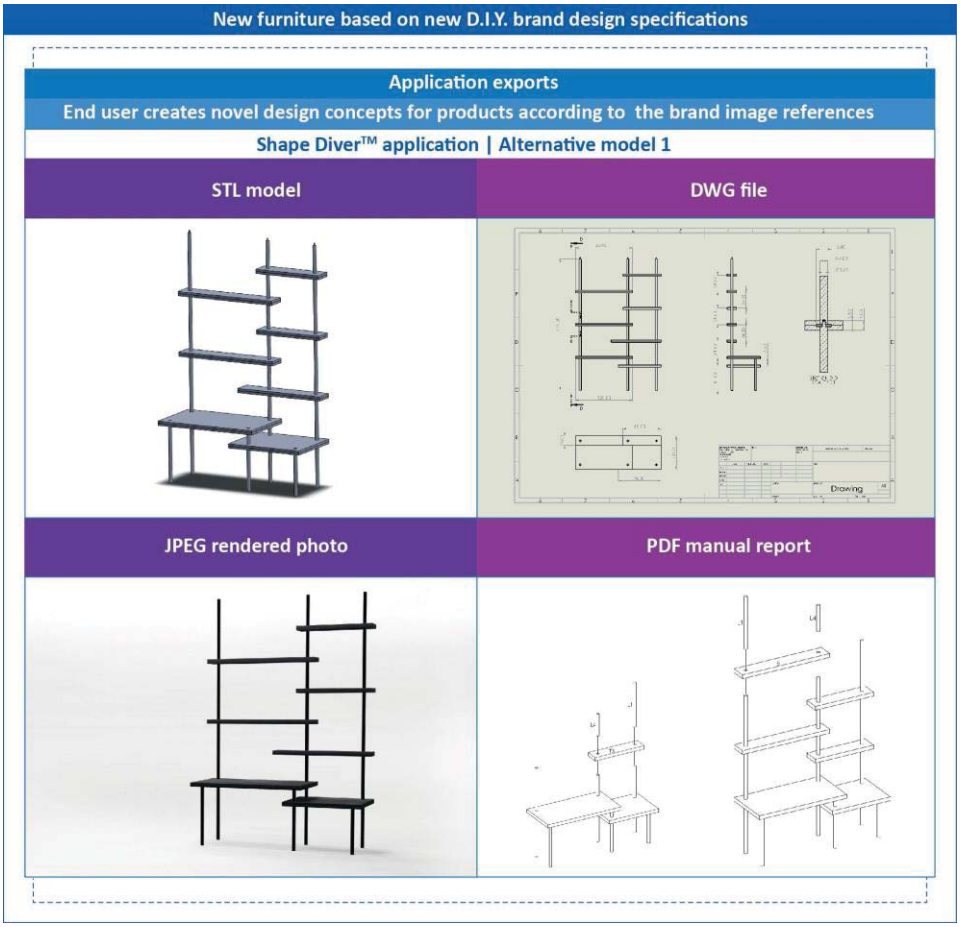

Figure 8: Application exports

5. CONCLUSIONS

The present work aims at developing a new methodology for product generation, focusing on product's image. The core idea of this paper is a combination of two different approaches: the computational design and the branding theory. Both approaches unite under the same framework and create a novel idea about an application of "Product Shape Generation to Support Brand Identity Elements". The purpose of this app is to explore, how to produce a series of similar products under the main theme of D.I.Y. method. The proposed application offers a great deal of advantages in the field of product design.

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