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## A case-based approach for industrial design

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### Abstract

Creativity is often perceived as putting old ideas in a new order. Case-based design suggests searching, reusing and combining existent design information and recalling past experiences in order to breed better, creative designs. In case-based design, new solutions to a problem are generated by using domain knowledge implicitly. Specific characteristics of already existent samples are utilized, a solution set is created, and the optimum solution is selected. Lastly, adaptations are made on the selected item to fit in the problem limitations and to fulfill the requirements. This paper discusses methods for design knowledge management through application of case-based design operating with generative logic. Within the paper, an interactive case-based design platform is proposed in which contributors are able to diversify a product or generate new product concepts without having a specific education or experience of design. The contributors are aimed to carry out the design practice by combining parts of different designs existent in the platform. Basically, 2D images of certain products such as traditional Turkish tea pots, drink containers, and glasses are divided into parts equivalent in size. These size equivalent parts are put together within a computer program in order to create product varieties or new product concepts. By proposing the mentioned platform, the creative capacity of case based design is aimed to be investigated.

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### 1. Introduction

The routine design process is generally based on modifying already existent examples in the solution domain. In fact, the indispensable facility of the design process, namely creativity, is regarded as the unusual and surprising combinations of old ideas (Boden, 1991). Due to similarity over product line or among specific customized products, reuse suggests itself as the technique to facilitate efficient and cost effective product

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development. By reusing previous cases, design time and cost are reduced. However the lack of reuse can be due to lack of institutional memory of related designs and the art of specialization (Tseng, Jiao, 1997).

Case based reasoning combines a memory centered cognitive model describing how to use and reason from past experiences and a technology for finding and presenting such experiences (Domeshek, Kolodner, 1992). Utilizing such a cognitive process, case-based design appears as an experience based method starting from complete cases. The experience base which enables tradeoffs between several functions makes the method superior to rule based and model based systems. Besides, the implicit utilization of the domain knowledge enables to avoid the knowledge elicitation bottleneck of knowledge based systems (Tseng, Jiao, 1997).

Within the study, a digital case based design platform is proposed. The platform is based on a work which was displayed in an exhibition in 2007. The model was then transferred to a program in which certain designs are divided into components and reduced to two dimensional representations. The program enables the non-designers to participate in the design process.

## **2. Case-Based Design**

The routine design practice consists of modifying past work and reusing old cases in similar projects. In such a situation, a case-base operates as a library of product models and design information for both the clients and the designers. Briefly, case based design (CBD) is a specific kind of case based reasoning in which the information is searched, retrieved, reused and evolved respectively.

### *2.1. Case-based reasoning*

Case based reasoning (CBR) originates from ideas on memory structure with cognitive and psychological motivations. It assumes that humans often rely on specific past experiences rather than following a set of general guidelines (Schmitt, 1994) (Popova et.al. 2002). Empirical knowledge is significant in reasoning process as previous experiences help in understanding new situations and in finding solutions to new problems. Though, experiential knowledge is crucial in both routine tasks and tasks requiring special skills (Johansson, Popova, 2002).

Design act can be regarded as a problem solving process. In routine design work, most of the problems have been solved before in many cases over and over again. However, the computer support used by designers still lacks the ability to use experiential knowledge in a rational way (Johansson, Popova, 2002). In problem solving process, the main emphasis is on memory with respect to computation. In fact, case based reasoning is actively used in everyday life; as in the form of judgment based on precedents in law or medicine. CBR is useful whenever reasoning from first principles will not achieve the desired results either because the situation is complex or the relation between the problem and solution are not known (Schmitt, 1994). Instead of rule-based reasoning process, the design problem solving becomes an analogical reasoning process with case-based reasoning (Xiantao, Jianghong, 2007).

### *2.2. The CBD process and creativity*

CBR provides a methodology which works together with analogical reasoning for directly using previous designs in a new design problem. The features of previous designs are often used by combination and adaptation in design process by making changes on a recalled design to fit into new situations (Akbulut, 2010). However the expert knowledge in CBD is not compiled and stored, but is available only implicitly in a database of previous design cases (Gero et.al, 1997). The knowledge structure is used in remembering, understanding, experiencing and learning and it changes as a result of experience. Case based designs are evolved in such a way that cases are indexed, stored and adapted to suit new situations (Popova et. al, 2001).

The information utilized by designers are divided into three categories as structured data (e.g. standardized product models), weakly structured data (e.g. texts, tables, briefs), and raw data (e.g. sketches, raster or animated images) (Simoff, Maher, 1998). In CBD, the information used is generally in the form of raw data. CBD can support efficient information management in collaborative design. Although it cannot replace designer's expertise, they can manage great information quantities and provide basis for problem solving (Popova et.al 2001). A unifying product platform through which to view, extract and integrate past experiences is available supports effective decisions in CBD (Tseng, Jiao, 1997).

### 3. The Tool

The proposed tool for case based design process is based on the computer implementation of an interactive 3D platform "turn and form" which participated in the 2007 dated Gazi University Faculty of Fine Arts academic staff exhibition called "+18". (Figure 1,2)



Figure 1,2: "Turn and Form" in exhibition

#### 3.1. Turn and Form

Turn and form is an interactive platform in which the contributors are able to variate a product without having a specific education or experience of design. The contributors are aimed to carry out the design practice by blending elements of different designs on the platform. As a result, each contributor forms product variations with his/her own approach.

Turn and form is a case based interactive platform which is constituted with 2D representations of certain designs. It is aimed to provide a joyful design medium even though the variation alternatives are limited. The contributor constitutes new designs by combining certain parts of diverse products identified within the platform.

The work consists of three sets. Each set involves 6 samples divided into 9 identical squares. These nine partitions are exposed on nine cubes on whose sides representations of product components are fixed. The images on the first set are the variations of traditional Turkish tea pot. On the second set, images of various containers for soft drinks; and on the third set images of various glasses for alcoholic drinks are used. Each set involves 6 images which are to be crossed with each other. The contributors try to recombine the parts of the images and reach a new combination by turning the cubes.

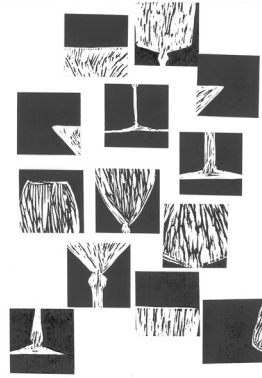


Figure 3: Product partitions of alcoholic drink glasses.

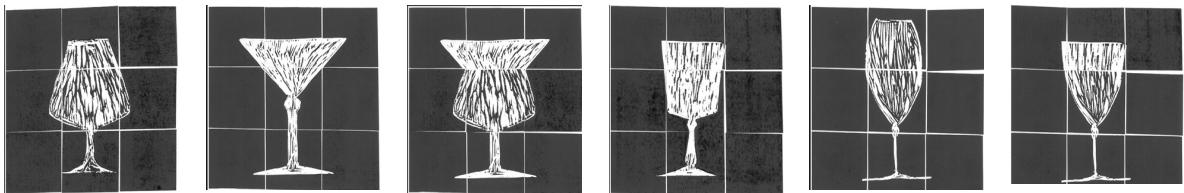


Figure 4 (a,b,c,d,e,f): Original designs and variations raised

### 3.2. The program

The presented program, based on Visual Basic 6, is thought to be the computer version of the Turn and Form tool. The program involves the same images used in the 3D tangible tool. Instead of presenting the images on the sides of the cubes, the computer application presents the whole as an image stock divided in size equivalent parts (Figure 5). The contributor is free to choose a part of any image and combine it in the space provided in the program interface.

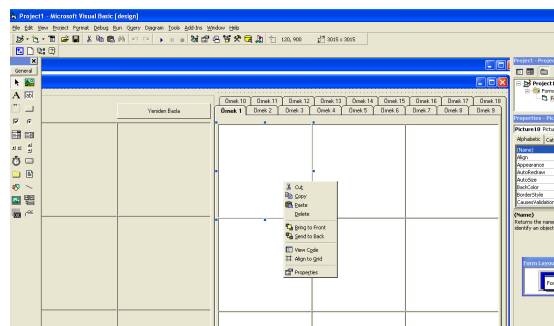


Figure 5: The program interface

#### 4. Conclusion

As a design method, depending on raw data and experience, CBD appears to enable non-designers to participate in the design process. Moreover, its rule-disengaged nature enhances creativity by facilitating intuitional approaches in the process.

The emergence of the tool can be elaborated in two transformation procedures; in the first step, the already existent designs were transformed into 2D representations by traditional paper based methods and linoleum prints. The 2D visuals were arranged as the pieces of an interactive game to breed new designs. In the second step, these visuals were transformed into components of a digital game. Again, the goal of the game was to breed new designs. The already existent designs were divided into pieces whether in the form of particular components or strokes and shades.

Either in the tangible game platform or in digital application, the tool provides ready details and lines to be used in design. Although for the study, the number of samples was limited to 18 in three concepts; it can be increased with certain 2D work. The simplified 2D visuals are in the form of both the iconic components (as the lids, pot stills, or stems) and the lines allow the participants to blend and create new products and attributes. The digital platform is superior to 3D platform in such a way that all the concepts and parts are freely available. However, the square pieces limit the combination freedom by not allowing overlapping them. Each new design is compelled to emerge in the square platform by conjoining the square pieces.

The tool can serve as an effective means for collaborated product design by creating a broad library of existent designs and by removing conjoining constraints.

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