A Product Design Approach by Integrating Axiomatic Design and TRIZ

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Abstract. The purpose of this research intends to integrate the strengths of axiomatic design (AD) theory and theory of inventive problem solving (TRIZ). This study establishes a systematic product design model by adopting some major tools from AD and TRIZ such as functional requirements, design parameters, design matrix, contradiction matrix and inventive principles. Furthermore, the proposed model’s efficiency is analyzed and evaluated by a case study of a Handheld GPS product. Results indicate that the design model which combines with two theories can find out the usability problems and solutions efficiently. When applying the proposed model on product redesign or new product development may avoid the cost waste and increase the design efficiency and usability during the product design and development processes.

Keywords: Theory of Inventive Problem Solving, TRIZ Theory, Axiomatic Design, AD, Human-Machine Interface Design, Product Development, Handheld satellite omniselector.

1 Introduction

Nowadays, there are different kinds of products in the consuming electronic markets, and the competitions among these industries are severe fiercely. Thus, in order to gain a significant market share in the world, products have to be not only innovated efficiently but also fitting the consumer requirements effectively.

Axiomatic design (AD), developed by Nam Pyo Suh, is a human-machine interface design tool using matrix methods to systematically analyze and transform customer needs into functional requirements (FRs) and design parameters (DPs) [2]. The relationship between functional requirements and design parameters is represented in a design matrix. Good (decoupled) designs can be represented by nxn triangular matrices, e.g., all entries above the main diagonal are zero. The best (uncoupled) designs can be represented by nxn diagonal matrices [2], [5], i.e., all entries off the main diagonal are zero. On the other hand, a coupled design is undesirable, because when a DP is modified, there is no effective solution for undesirable change on multiple FRs.

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Previous studies indicated the powerful function of AD may enhance product and process design abilities of the Research and Design department. Axiomatic design may help designers to structure and understand design problems [5]; however AD doesn’t provide inventive principles or design suggestions to product designers [6], [7], [11], [12].

Theory of Inventive Problem Solving was developed by Genrich Altshuller and his colleagues, and is now being developed and practiced throughout the world. "TRIZ" is the acronym for this theory in Russian [1], [10]. TRIZ is a dialectic way of thinking in finding a suitable solution while facing a design predicament [4], [8]. The contradiction matrix of TRIZ provides designers which of the 40 inventive principles have been used most frequently to solve a problem that involves a particular contradiction [3], [9].

Therefore, unlike AD, TRIZ can provide concrete design suggestions. However, TRIZ does not locate design problems based on users needs like AD does. The purpose of this research intends to integrate the strengths of AD and TRIZ. This study wants to establish a systematic product design model by adopting some major tools from AD and TRIZ such as functional requirements, design parameters, design matrix, contradiction matrix and inventive principles. In addition, the proposed model’s efficiency is analyzed and evaluated by a case study of a Handheld GPS product.

2 Methods

The proposed product design approach is shown in Figure 1 and briefly introduces in the following sections.

The first step is to analyze consumer needs of an existing or new product by AD’s FRs and DPs. After completion of drawing the hierarchical diagrams of FRs and ADs, a design matrix may build based on the relationships between FRs and ADs. The items which need to be decoupled or uncoupled on a design matrix indicate the design issues to be addressed to increase usability.

Second, designers may consider these design issues and examine related engineering parameters one by one. The engineering parameters want to improve and may get worsened can locate design contractions by TRIZ’s contradiction matrix. Then, designers may find out and adopt suggested inventive principles from TRIZ’s contraction matrix to redesign or design products.

Finally, designers reconfirm the relationship between FRs and DPs of a new design on a design matrix until the contradiction is solved. In other words, a more decoupled or uncoupled design matrix represents this design solution with higher usability and users satisfactory.

The above procedures of the proposed model’s efficiency is analyzed and evaluated by a case study of a hand-held satellite omniselector (Model number: GPSmap 60CSx) of the Garmin Corporation in Taiwan (http://www.garmin.com.tw/) (see Figure 2). Detailed description is illustrated in the Results section.