

Development of An Innovative Design Process for Green Products

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Abstract

Under the growing trend of environmental protection, many different eco-design methods have been proposed, at the same time, there are many TRIZ tools used to support these processes. In this study, we proposed an innovative design process for green products. This process includes three frameworks-collaborative design, innovative design environment, and the green product design system. Collaborative design framework aims to assist the designer and their upstream and downstream partners to combine their ideas by CSCW tools. The innovative design environment includes data layer, information layer, and knowledge layer, analyzed through the data exchange, information sharing and decision making during the design process. The green product design system was consists of the problem analysis, problem solving, and solution evaluation used to assist the design process with collaborative coordination and information recording. This construct integrating the design ideas, knowledge exchange, problem solving and feedback for the green product design process.

Keywords: col laborative design, innovative design environment, green product design system

1. Introduction

Under the growing trend of environmental protection, many different eco-design methods have been proposed. In various fields, researchers all do their efforts to create new products to fit the new global standard. Many advanced countries even listed Green Design Rules as the first priority in government policy. In the past, products have been designed without consideration of the impact on environment. Traditional factors considered in the product design process are function, quality, cost, and safety. Now, it is imperative to consider the environmental impact of products throughout their life cycle. At the end of the traditional instruction or regulations only focused on manufacturing process. However, the adverse effects on the environment may occur in the life cycle stages, such as the recycling, distribution, and any kind of material collected. Therefore, companies need to analyze and evaluate the influence from product's entire life cycle, in

order to focus on the core issues, and solve the problem effectively.

In recent years, many eco-design methods have been proposed [1] and many innovative tools and methods were used to eco-design process[2]. [3]. But how to analyze the design problem and how to evaluate the design result are seldom explored in previous researches. For that reason, how to construct an integrated method to solve green design problems would be the key point. In this study, some design tools such as the TRIZ tools [4], computer supported cooperative work tools collaborative design concept and knowledge management environment creation were used to construct innovative green product design system.

2. Literature Review

2.1 TRIZ

TRIZ was a theory developed by Genrich Altshaller in Russia, who had analyzed over 400,000 patents to

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construct the contradiction matrix and 40 inventive principles [5]. TRIZ was based on the patents and used for system analyzed and problems solved through inventive principles. TRIZ was a complex system including Inventive Principles, Contradiction Matrix, Ideal Final Result (IFR), S-Fields, Function Analysis, Separation Principles, Subversion Analysis, Trimming, etc. Among these tools, the contradiction matrix along with 40 inventive principles is the most famous tool. TRIZ also can be seen as a symbol of a set of tools, a method, a way of thinking and a philosophy [6]. Altshaller analyzed thousands of patents and identified the same fundamental problems and found solutions. TRIZ was a tool with knowledge and experiences of the world's best inventive concept for design engineers to handle these conflict conditions during the innovative design problem solving process [7]. The most important parts of TRIZ was the contradictions, through analyzed large amount of patents' problems and solutions, the ideas were created to solve the problems. In the field of science, TRIZ was an innovative tool providing a systematic process to confirm and solve problem, many scholars have proposed some new contradiction matrices in their researches. A hierarchical view of TRIZ was shown in Fig. 1.

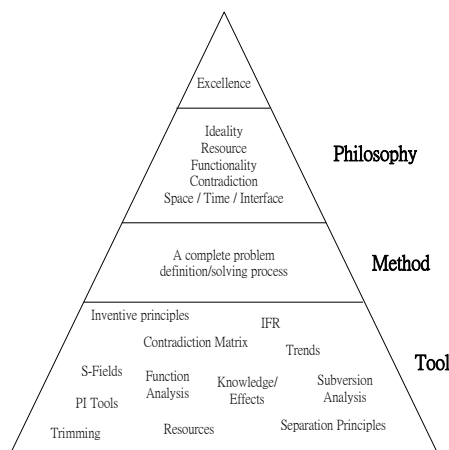
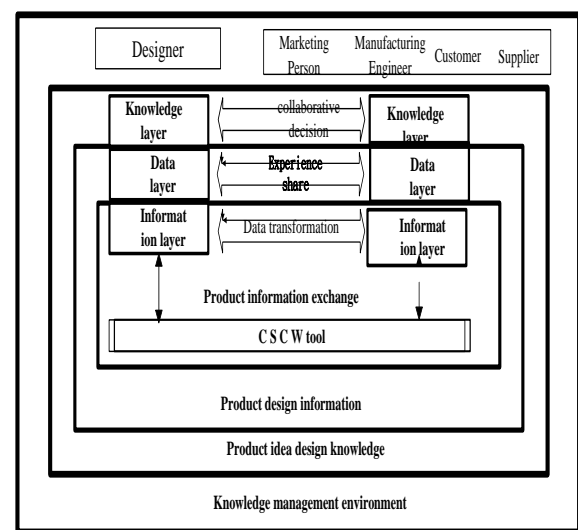


Fig. 1. Hierarchical view of TRIZ

2.2 Green design

Product design concerning environmental impacts has many expressions that include ecological design,

environmental design, environmentally conscious design, environmentally responsible design, sustainable design, green design , etc. The purpose of green design was to decrease the environmental impact during the product life cycle: raw materials, preliminary design, detailed design, manufacturing, assembly, packaging and transportation, use, and disposal [8]. Liu & Chen (2001) combined engineering parameters in TRIZ method with the 7 Eco-Efficiency Elements put forth by the World Business Council for Sustainable Development (WBCSD), allowing designers discovered the engineering parameters needed [9]. Micheline and



Razzoli proposed a model including three types of innovations, product-innovation, function-innovation and method-innovation [10]. Horváth presented that the eco-design research was used to investigate the concepts of corrective products, to reduce the environmental humiliation, and ameliorative products, and to cope with the environmental effects [11]. Dewulf and Duflou discussed how to integrate different levels into the business operations, and proposed a concept of the 3-layered framework for eco-design [12]. Trappey, Chen, Hsiao, and Lin proposed an integrated green product design methods and system. Though there are many researches try to develop a systematic method in order to design products complying with natural and economic needs [13].

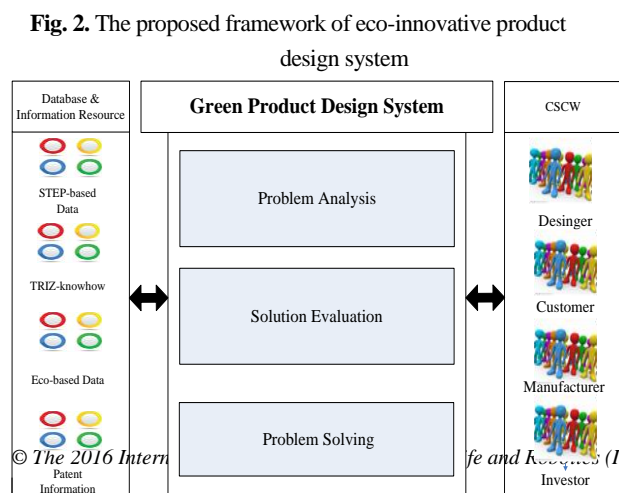
3. Framework and methodology

In this paper, a framework and its related product design process for eco-innovative product design were proposed and shown in Fig. 1. and Fig. 2.

The design environment framework for green innovative product was proposed and shown in Fig. 1. In this framework includes three layers: data layer, information layer, and knowledge layer, which deal with the collaborative (products) detail design, idea design and activities of knowledge management. Products data exchange provided by data layer, it also used for data standard exchange. Information layer provided information sharing with products design. Knowledge layer can provide experience and knowledge to make right decision. Therefore, if green design and innovative design could be integrated in knowledge layer, it could be efficiency to develop products for highly value.

In Fig. 2, a green product design system was proposed and shown. At left side, collaborative design knowledge includes general product design knowledge, TRIZ innovative principles, green design guidelines and regulations. At right side, design team includes designer, customer, Manufacturer and vendor. The CSCW tool can support the collaborative tools and method for members located on different places. Design Team could share or exchange information through the CSCW tools immediately. At the top, green design process and knowledge management includes: product design and develop process, knowledge exchange and collaborative design information system development.

Fig. 1. Design environment framework



4. Conclusions

In recent years, in order to fulfill end user demands and environmental awareness, TRIZ and eco-design concept get more attention of the academy and industry. The most important contribution of this paper is to propose an innovative design process for green products. This process includes three frameworks-collaborative design, innovative design environment, and the green product design system. Collaborative design framework aims to assist the designer and their upstream and downstream partners to merge ideas by CSCW tools. This eco-innovative product design system was consist of data flow from designer, consumer, manufacturer... to transport, collect and feedback during the life-circle, then it also could be used for data exchange, information sharing and collaborative decision-making through CSCW. The collaborative design in this model consists of three layers: data layer, information layer, and knowledge layer, which corresponding to different level from lower-higher in the design process. The lower layer could support higher layer, higher layer provided lower design with directives and regulations to avoid form the wrong decision-making or the unsuitable design, then delayed the products entered to the market and production costs increasing.

This innovative product design system was based on knowledge management construct illustrated a new collaborative model to create green products. Since many research aimed to green design and innovative design, but very less study focused on collaborative design within knowledge management. In the future we will try to build the prototype of knowledge management for the green product design.

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