A Novel Methodology of Product Design from Life-cycle Orientation

Ting Li

Wuhan polytechnic university, Wuhan, China

Corresponding E-mail:tingli221@163.com

Keywords: Product Design; Life-cycle; Consumption Modelling

Abstract. As the trend of economic globalization is continuously enhanced, product faces more and more market competitions. In order to survive and development, product has to push out the product that meet the requirements of market with quicker speed(time to market), higher quality, lower cost and better service. Obviously, quality has become the key to market competition.The model includes four steps which are System Requirement Analysis, System Capacity Modelling, Equipment Consumption Modelling and Support Plan for Equipments' product life-cycle Management. In the end, authors outline the future work of this research.

Introduction

In 1984 Nigel Cross published "Developments in Design Methodology", collecting influential articles about methods and procedures of design over past two decades. His paper reflected developments in the design research community. The approach was defined as "…. the study of how designers work and think; the establishment of appropriate structures for the design process; the development and application of new design methods, techniques and procedures; and reflection on the nature and extent of design knowledge and its application to design problems [1].

First generation researchers such as Archer and Jones proposed that the design process is based on logical analysis and creative thinking[2].The iteration process is very time-consuming and ex-pensive, returning to earlier stages to modify the designers' ideas often results in long lead time and high cost of introducing a new product to the market. More-over, the design philosophy that form follows function is no longer sufficient; the aesthetic aspect of a product has become a more and more important element for success. The shift in manufacturing paradigm will have a deep impact on design and operation of future manufacturing systems.

The development of computer based design has given rise to beguiling but rather rigid images and this in turn has caused researchers such as Soufi & Edmonds to observe that current Computer Aided Design (CAD) systems do not provide sufficient support to the early conceptual stages of design[3]. For designers, it is important to understand how invention works in design, where and how it breaks down. One of the inventive processes is conceptual design where inspiration and Conceptual design is normally optimized by iteration due to the lack of ideas at the early stage of design.While, conventional quality design is serial design mode oriented product design process, so that couldn't consider manufacturability, assembling and maintainability as soon as possible, and lacked another departments of production[3,4], which results to the disconnection between design and manufacturing process, poor design quality, interminable product developing time.

Therefore, formation process of product design quality process is analyzed in depth, organization and functional model of product lifecycle oriented quality design are established, and the key technologies of product lifecycle oriented design quality control are studied, prototype system of product lifecycle oriented design quality control system is designed and developed, which can realize organ integration of collaborative design and quality control.

Proposition of a method for PDN

There are generally two routes for PDN. In the first, design is based on biological system functions learning from nature by means of physical, chemical, engineering.

Stage 1 Capturing surface geometrical information A professional designer observes a biological object such as an apple or a bird to get bio-inspiration. With expert knowledge, experience and talent, he/she uses his/her imagination to design either a predefined product or something totally new. The output is usually a 2D sketch (free hand drawing) which can be scanned to get digitised geometrical information in a format suitable for later processing to generate the geometrical information required for 3D models using the algorithms in Stage 2. Alternatively, an engineer measures geometrical and color data directly from a natural object. The out-puts are normally various sets of space points in xyz coordinates for geometrical data, and letters, such as R, G and B for colour. These are 'point clouds' which can be processed to generate information for geometrical design (such as 3D models).

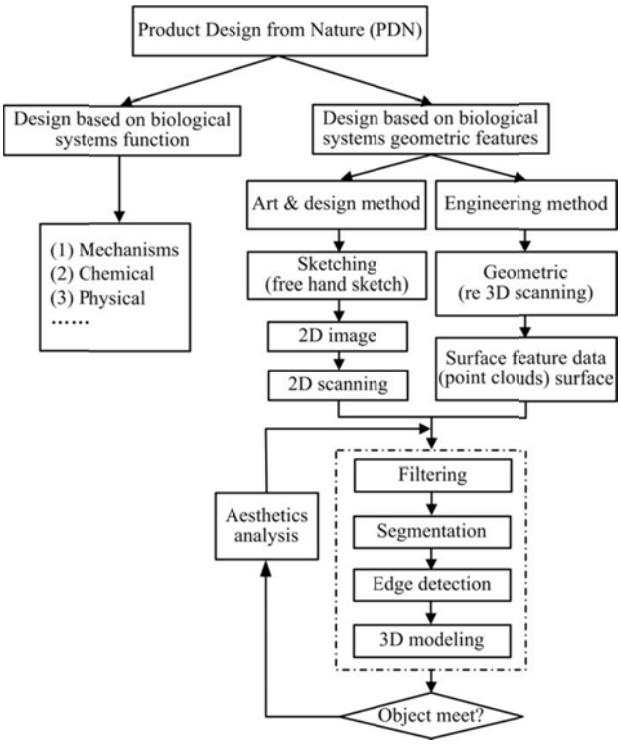

Fig. 1 The proposed method for product design from nature.

Stage 2 Building a 3D model

This consists of filtering, segmentation, edge detection, initial 3D modelling, iterative analysis/ optimisation for the final 3D models, considering also the aesthetics. There should be sufficient collaboration between professional designers, engineers and 3D modellers. The inputs from designers should be effectively integrated into 3D modelling to retain aesthetic beauty in the designed product. The inputs from engi-neering design and 3D modeller are used to build 3D models that are suitable for production in Stage 3. In this stage, various algorithms have to be applied.

Stage 3 Manufacturing a prototype

The aim of any product design including PDN is to provide a description for manufacturing a physical product. This is important for successfully integrating bionic engineering into the development and manufacturing process. So the natural stage of the proposed method should be to build some prototypes for testing, quality control and production of the product for market. Various rapid prototyping techniques/methods are available commercially. Typical methods include rapid prototyping, high-speed machining, laser cutting and processing etc.

The innovation is the integration of art design with engineering design for PDN. A number of algorithms have to be used, some have been developed, but some still need to be developed. Owing to the limitation of space, the following sections will discuss each of them only briefly. A full study will be reported later.

Integrated Platform of CSCW

In order to realize collaborative quality design, CSCW architecture is needed to be constructed, which is composed of CSCW tools, quality information sharing, quality tools etc., consequently. The integrate platform of CSCW could be divided into four layers: communication layer, quality information layer, collaborative working layer and application, which is shown as Fig. 2.

Communication layer: It provides communication tools between QFD deployment and FMEA analysis, which are applied to collaboratively complete by all designers. Therefore, the tools seemed especially important to assure quality. These tools mainly are composed of two categories: one category is the asynchronous communication tool collection; the other category is the synchronous communication tool collection.

Quality Information layer: Quality information was integrated and shared in the whole process of product designs, the integrating and sharing tools can record the design process and share the related quality information easily. In the process of product design, we also should fully consider the traditional QFD material and the design documents, as well as the safety.

Collaborative working layer: In the process of product design, quality design group needs the sharing workspace respectively, which made them realize collaborative operation on some same task. The main tools included: whiteboard, QFD collaborative edition,

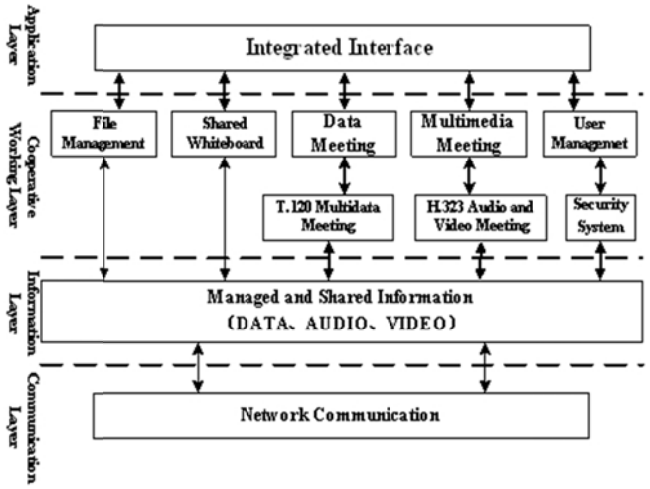

Fig 2. Integrated platform of CSCW

Conclusion

This paper proposed a method for innovative product design from nature, coupling aesthetic intent and geometrical characteristics, exploring the interaction between designers and nature systems. This would considerably reduce the lead time of innovative product design and development from nature at low cost. The method needs to be further developed before it can be used in real product design from nature. In particular, great efforts have to be made on how to design and develop an effective and efficient algorithm to build a 3D model from a designer's 2D sketches and how to design and develop a computer system either work-station-based or web-based (though web-based is preferable) as a platform for both art designers and design engineers to effectively collaborate during the optimization of the design and aesthetics to increase the marketability of the products.

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