

# The Innovative Bike Conceptual Design by Using Modified Functional Element Design Method

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## Abstract

The purpose of the study is to propose a new design process by modifying functional element design approach which can commence a large amount of innovative concepts within a short period of time. Firstly, the original creative functional elements design method is analyzed and the drawbacks are discussed. Then, the modified is proposed and is divided into 6 steps. The creative functional element representations, generalization, specialization, and particularization are used in this method. Every step is described clearly, and users could design by following the process easily. In this paper, a clear and accurate design process is proposed based on the creative functional element design method. By following this method, a lot of innovative bicycles will be created quickly.

**Keywords:** conceptual design, functional element design method, generalization, specialization, particularization

## 1. Introduction

Design in black box is the most commonly used in practical design. But, it is not popular for study and learning [1]. In this study, we analyze functional elements and try to solve the black box problem of creating new concepts for innovative bicycles. Every innovative bicycle has one or more creative functional elements. If we choose several suitable creative function elements in our design, then we can come up with a new and creative bicycle.

Liu and Wu have proposed the representations for bicycle characteristics, but the process for bicycle design is not mentioned in the study [3]. This paper proposes representations for bicycles. By using symbols representations, bicycles can

be represented simple and quickly for innovation design.

Ke considers bicycle to be a module product. Thus, in terms of different design and combination in spare parts and components, there are four factors that can directly impact on the difference of the class level and price of a bicycle: function, material, appearance and manufacturing quality. In his study, he also mentions that in defining the position of a new product, three indexes as new material, new function and new purpose can serve as the course of research and development [4]. Therefore, in the creative design of bicycles, function and material are very important factors.

In the study of Ma, it has proposed that module design is a concept of introducing part/component module into the design process and to simplify and organize various components/parts by application of systematic method. In so doing, it can raise the functional performance and adaptability of bicycles so as to satisfy the application requirements [5]. In the study, it disintegrates a bicycle into various element component modules with each component representing one function. Accordingly, a component can also be regarded as one functional element.

In Hung's study, he divides a bicycle into five components as frame structure, front, rear suspension mechanisms, steering handler, and seat for engaging conceptual design. In the final stage, he conducts a concrete integral design of integrating various systems by establishing an integration process through applying morphological matrix [6]. In terms of shortfall, since his design divides a bicycle into five components, which constrains the definition of bicycles into a narrow one and easy to limits the

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design result, rendering an unfavorable impact on the creative design. In his study, he has proposed that the future development of bicycles can be divided into five categories: 1) Use of new materials, 2) Addition of new functions, 3) New riding ways, 4) Introduction of new electronic products, 5) Dedicated developed products depending on respective market requirements. His research has proposed that in the future creative design of bicycles, addition of new functions is an indispensable link. Thus, it is very important to more focus on choice and integration of new functional elements in the design process.

Ji has categorized the spare parts/ components of a bicycle according to function into the following six major systems: 1) Transmission system, 2) Steering system, 3) Wheel system, 4) Braking system, 5) Vehicle frame structure system, 6) Gear system, [7].

Chang categories on bicycle composition, he divides the functions of a bicycle into seven major systems: 1) Transmission system, 2) steering system, 3) Wheel system, 4) Braking system, 5) Structure system, 6) Fitting system, 7) Accessory system[2].

At present, the traditional methods used for designing bicycles lack analysis and induction, it much limits the design development with creative concept. This study would continue the former research about the design process for innovative bikes [2]. The purpose of this paper is to help designers to produce their creative design concepts by applying massive support of functional elements in a short time and modified the proposed design process.

## 2. Functional Elements Representation

This research collects 242 award works of bicycle products between 1996 and 2006 from the bicycle design competitions. The Bicycle Design Competition is sponsored by the Department of Industrial Technology, Ministry of Economic Affairs, R. O. C. and managed and produced by the Cycling & Health Tech Industry R&D Center. The first such competition was the "1996 Taiwan Creative Bicycle Design Competition." The study sort out these award works into a comparison table on functional elements according to year sequence order and serial number. The award works were preliminarily categorized into "Standard" and "Specific" cate-

gories. "Standard category" means a normal bicycle category and is similar to the market-sale riding bikes in structure which signifies a bike with simple change of appearance and style. "Specific category" is comparatively different to the riding way, structure and functions of market-sale bikes, such as contractible, different way of storage, or addition/subtraction of certain functions. Cite bike for example, we do a functional nature analysis. Before such functional element analysis, we define various elements as shown in the symbol figure. Each functional element has its own represent symbol. The batch number for addition of function P can be known in the categories of Standard and Specific types. Addition of function P shows the addition and subtraction change for many bike designs. Therefore, we give these serial numbers as P01, P02, P03 ... in our analysis process [2].

For transform a bicycle into a symbolized representation, a process is suggested here: 1. take a picture of a bicycle; 2. find functional elements of the bicycle; 3. mark symbols on every functional elements of the bicycle; 4. check and note the connecting relationship between every two functional elements.

By the process, every bicycle has its own symbolized representations by the functional elements.

Take a normal bicycle as an example, we mark various functional element symbols on the bike, and then connect and define the relationship between various functional elements. Under normal circumstance, when various functional elements are inseparable, we use solid line to show the connection between various functions, which indicates their direct connection; when it is indirectly driven by chain-like object, we then use a solid line with an arrow. The arrow points at functional elements from human-driven end. Accordingly, we can have a functional element representation as shown in Fig. 1 [2]. Where **S** means seat, **C** means control, **W** means single wheel, and **⊙** means driven by human power.

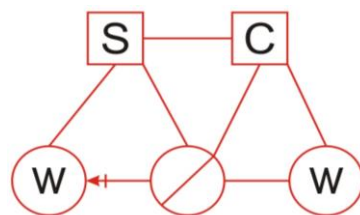


Fig. 1 Functional element representation of a normal bicycle

### 3. Original Design Process

The original innovational design process for bicycle is proposed in Liu's research [2], but the design process is not clear enough to operate step by step. The design process is proposed and shown as Fig. 2.

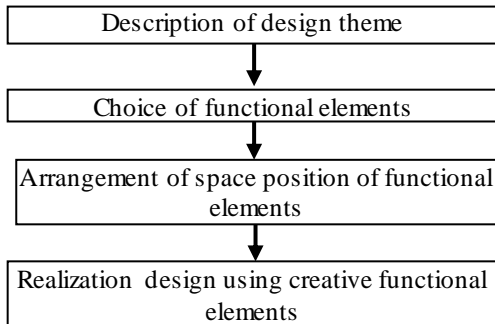


Fig. 2 The bicycle design process using functional element representation

In the first step, the designers' descriptions for design theme are necessary. The theme is decided by personal preferences or design constraints. The description is more clearly, the selecting of functional elements is more easy

and fast.

In the second step, functional elements are chosen in accordance with the contents described. The constraints of combination of a bicycle need to be considered. So, some elements are necessary.

In the third step, functional element symbols are arranged for new design concepts. According to designers' need for creative functional elements, relative positions are arranged. Here designers need understand the rational rules of bicycles for arranging functional elements.

Finally, according bicycle's creative functional element symbol table, the representations obtained from previous step are transformed into new design concept of bicycles.

### 4. Modified Design Process

For the design process mentioned above, there are some places interpret unclear thus designer will be hard to work following the process step by step. Therefore, the modified design process is proposed and shown as Fig. 3.

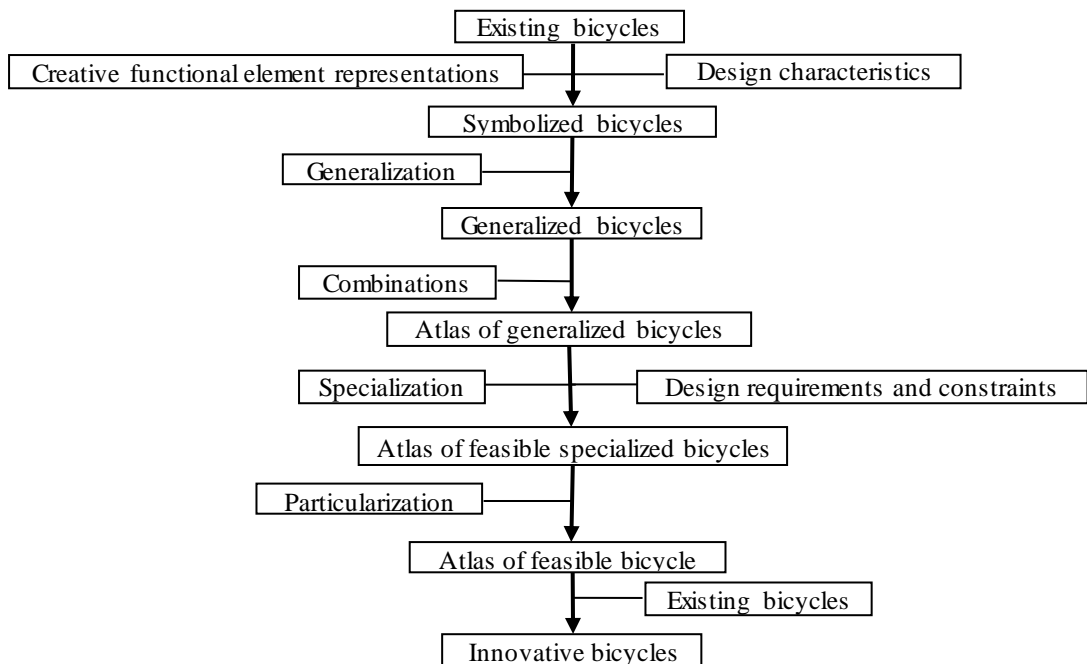


Fig. 3 The modified design process

In step 1, a designer needs choose an existing bicycle for developing. By analyzing the existing bicycles, design characteristics are collected. By creative functional elements representations, bicycles are symbolized.

In step 2, symbolized bicycles are generalized. Every symbol is meaningful for symbolized bicycles. By generalization, every symbol would be changed to a non-meaningful symbol.

In step 3, from generalized bicycles and combination, different topology could be used for designing. Thus, atlas of generalized bicycles is obtained.

In step 4, by specialization, every non-meaningful symbol in atlas of generalized bicycles is assigned a creative functional element one by one. During assigning process, design requirements and constraints are considered at the same time. Atlas of feasible specialization bicycles are obtained in this step.

In step 5, feasible specialization bicycles are particularized. The form of all bicycles can be observed easily.

In step 6, by deleting the existing bicycle in atlas of feasible bicycle in step 5, innovative bicycles are obtained.

## **5. Conclusions**

The approach proposed by this research is to modified functional elements design method for bicycle design. The advantage of this approach is the possibility of creating more concepts easily, but the original process, designer is hard to follow step by step for designing. In this paper, a modified process is proposed and divided into 6 steps clearly. The creative functional element representations, generalization, specialization, and particularization are used in this method.

When designing innovative bicycles, designers just need finish the process and innovative bicycles will be obtained.

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