Symbiosis: Creativity with Affective Response

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Abstract. The objective of this research is to present the symbiosis concept that integrates creativity and the recent research issues in affective response to products shapes. The major idea behind this study is systematically using affective response and design axiomatic in rational way through creativity approach that support on creativity stimulation for current highly competitive market. The practicality of the proposed methodology involved affective response measurable system that based on Semantic Differential (SD) method and interrelated computational regulation, creativity approach that based on Sensuous Association Method (SAM) and Creativity-Based Design Process (CBDP), and integrated mechanism using Axiomatic Design (AD) method.

Keywords: Affective Response, Creativity Approach, Axiomatic Design Method.

1 Introduction

In the highly competitive market, the customer-oriented creativity has become a great concern of most companies [3, 6, 13, 19] as shown in Fig. 1. How to conduct customers' affection into the process of product shape manipulation is a new trend and strategy, which called "Form follows Affection".

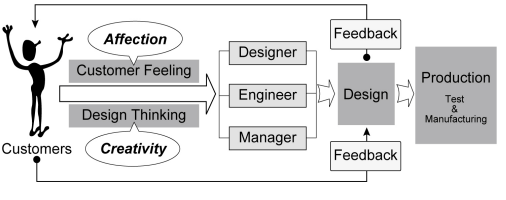

Fig. 1. Diagram of the customer-oriented New Product Design (NPD) process concept

Affective response is said to be a common customers' psychological response to the perceptual design details of the product [7, 15]. When customers contact with a specific product, the shape can evoke specific affection. A growing number of

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research studies are now available to shed some light on relationship perception among affective response and product shape [1, 2, 4, 9, 10, 11, 13, 19]. However, few studies have been down on the effect of how make the creativity product which involve affective response. According to above researches, how creativity stimulating to designers that based on the affective response considered into design thinking field become the new design issue. The purpose of this paper, therefore, is to present the symbiosis concept that integrates creativity and the recent research issues in affective response to products shapes.

In the view of the above research purpose, several major sets of research points to be addressed in this study are as follows: (1) how affective response can be acquired and measuring, (2) how affective response can translating into creativity thinking, (3) what approach can encourage creativity, (4) how achieved symbiosis concept that mechanisms can support each other. To achieve those research points, several tasks are structured as follows. The second section deals with the theoretical foundations on affective response and creativity for the development of the research. After that, research methodology is presented, with affective response measurable system, creativity approach and integrated mechanism. System architecture and a set of operating interfaces are described for the research implementation. The mobile phone as the case study used in the implementation.

2 Background Review

2.1 Affective Response on Product Features

2.1.1 Customers' Affective on Product Shapes

Crozier (1994) indicated that the psychological responses to products are influenced by the product's appearance and that's why product appearance plays a significant role that could convey a designer's ideas and provide consumer visual references in affective response. Customers who are inexperienced with a product may focus primarily on the first impression and the styling of the product; they expect a product to be a living object that expresses an emotional image via its shape [10, 15]. Therefore, customers' affective of product shape become an important issue for designers and highly competitive market strategy.

2.1.2 The Measurement of Customer's Affective Response

Subjective assessments are commonly used to evaluate affective response; ask persons and they will answer how they feel and what they like. It is, however, important to conduct such assessments in a structured manner so that the results are reliable and valid and can be compared across different products and different cultures. In order to investigate the customer's perception, feeling and emotion, Osgood et al. (1957) propose Semantic Differential (SD) method, which is one of the most frequently used procedures for getting meaning space from well-prepared samples by investigation of the qualitative scale using numerical mapping relationship between the samples and the related words and convert into proper numerical data [13, 15, 21]. In this method, the subject's perception of product forms is quantified on a numerical scale. Many researchers have used this method to study

specific aspects of product form, including styles, colors, and other attributes in product design [11].

2.2 Creativity Approach on Design Process

2.2.1 Sensuous Association Method (SAM)

The sensuous association method (SAM) is developed by Chou et al. (2004). This creativity method is based on the naturally sensuous ability of human being that used for refreshment of sensuousness and association of inspiration, and it can be regarded as a creativity tool for encouraging designers' potential to produce innovative ideas quickly. The method contains four personal behaviors of human sensuousness and one extrinsic influence of the environment. They are expressed as follows (Fig. 2):

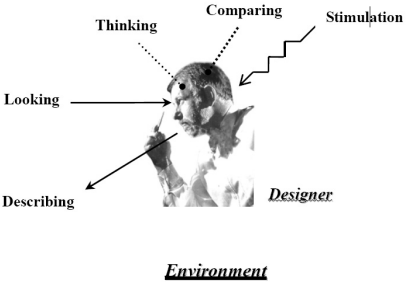

Fig. 2. Diagram of the Sensuous Association Method (SAM) (from [3])

(1) *Looking*: information input course, (2) *Thinking*: inference and re-association course. (3) *Comparing*: extraction and restructuring course. (4) *Describing*: creativity output course. (5) *Stimulation*: catalysis and outburst course.

2.2.2 Creativity-Based Design Process (CBDP)

Product development is often described as an iterative process to find solutions that fulfill a given requirement specification [17]. Jones (1992) proposes design process includes three essential stages: (1) Divergence, (2) Transformation, and (3) Convergence. As shown in Fig. 3., the *divergent* stage is an analytic process for searching the problem space, which can be described as "breaking the design problem into pieces". The *transformation* stage is a synthetic process for generating the solution space, characterized as "putting the pieces together in new ways". The *convergent* stage is an integration and evaluation process for finding applicable sub-solutions and optimal design solutions, described as "testing to discover the results of putting the new arrangement into practice".

2.3 Axiomatic Design (AD) Method

To design, we have to go from "what" in the functional domain to "how" in the physical domain, which requires mapping. Axiomatic design is a principle-based

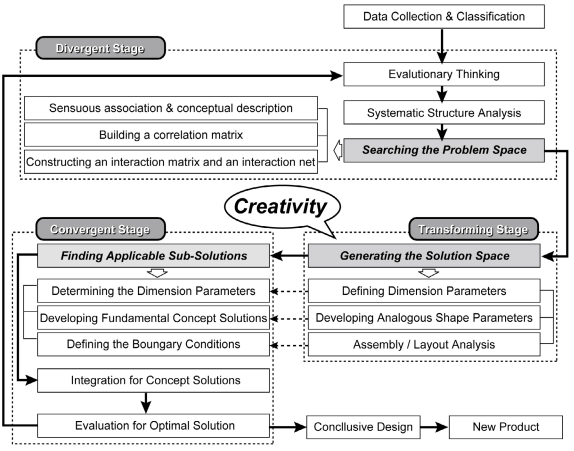

Fig. 3. Framework of the Creativity-Based Design Process (Re-drawn from [3])

design method focused on the concept of domains guides us to mapping among design requirement, design solution and decomposition developed by Dr. N.P. Suh at MIT [16]. The primary goal of axiomatic design is to establish a systematic foundation for design activity by two fundamental axioms. The basic postulate of the axiomatic approach to design is that there are fundamental axioms that govern the design process. The axioms are formally stated as:

Axiom 1: The Independence Axiom - Maintain the independence of Functional Requirements (FRs).
Axiom 2: The Information Axiom - Minimize the information content in design.

The first axiom is called the independence axiom focuses on the nature of the mapping between "what is required" (FRs) and "how to achieve it" (DPs). It states that a good design maintains the independence of the functional requirements, where FRs are defined as the minimum set of independent requirements that characterize the design goals. The second axiom is called the information axiom establishes information content as a relative measure for evaluating and comparing alternative solutions that satisfy the independence axiom where the design that has the smallest information content is the best design [16, 20].

3 Methodology

3.1 Affective Response Measurement

3.1.1 Knowledge Acquisition Using SD Method

SD method is frequently used to acquire and evaluate the customers' affective response. The historical data about the customers' affective needs of mobile phones assorted according to well-known affective words related to mobile phones includes: Portable, Sturdy, Enjoyable, Dignified, Cheerful, Natural, Delightful, Stimulating, Comfortable, Dazzling, Mature, Fashionable, Friendly, Cute and Futuristic [13, 15]. The affective words will be store into affective database.

3.1.2 The Measurement Mechanism

Based on SD method, Yang et al. (1999) propose the mathematics equations for SD method measurement. The sequential scaled numbers provide quantitative information for each affective word, it define S_{jk}^{λ} as SD method scores for subjects, where λ is design element number, i is affective word number, and j is item number. Also can define SM_i^{λ} as average value for each word on each element, shown in equation (1), where n is the total number of subjects, which means a representative value of the target customer group for each affective word on each design element. These values for each sample are used as criterion variables in estimating the relationship between affective words and design elements in the regression model. Equation (2) is to find coefficients a_{jk} in order to minimize the deviation between estimated values and real values.

$$SM_i^{\lambda} = \sum_{j=1}^{n} S_{ij}^{\lambda} \tag{1}$$

$$y^{\lambda} = \sum_{j=1}^{m} \sum_{k=1}^{c_j} a_{jk} x_{jk}^{\lambda} + e^{\lambda} \tag{2}$$

$$x_{jk}^{\lambda} = \begin{cases} 1, \text{where a sample } \lambda \text{ corresponds to item j and category k,} \\ 0, \text{otherwise} \end{cases}$$
$$\sum_{k=1}^{Cj} x_{jk}^{\lambda} = 1. \tag{3}$$

a_{jk} is called partial regression coefficients or category score (weight). y^{λ} and x_{jk}^{λ} is the criterion variables and explanatory variables, respectively. The estimated values of a_{jk} can be derived by solving a simultaneous equation composed of equation (2). For example, if there are fifty samples, fifty simultaneous equations can be composed. Practically, criterion variables y^{λ} correspond to SM_i^{λ} gained from SD evaluation and explanatory variables x_{jk}^{λ} have 0 or 1 according to the composition of the design elements on each sample [21].

3.2 Creativity Approach That Integrates SAM and CBDP

According to the foundation theories of creativity on behaviors of SAM and process of CBDP, the synthetic model for describe creativity approach shown in Fig. 4.

The Divergent can occur among Thinking stage to Describing stage; after describing, through Comparing and re-Thinking, than re-Describing can be Transforming stage and stimulation; the recursion from describing stage to comparing stage can be Divergent.

3.3 Integrating Axiomatic Design (AD) Method to the Creativity Approach

In order to achieve the integration mechanism, the AD method is the way it supports on combination work. The integration diagram is shown in Fig. 5. Based on AD method theory, the mapping process between the domains can be expressed mathematically in terms of the characteristic vectors that define the design goals and design solutions (Fig. 5).

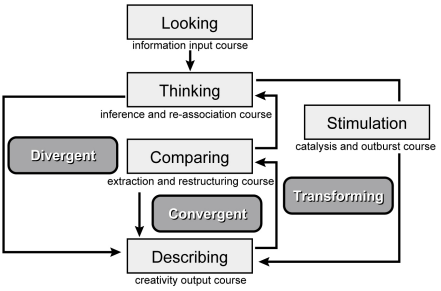

Fig. 4. Diagram of Creativity Approach

To design goals, dependent on Independence Axiom of axiomatic design theory, which classifies the design into three A matrix: Uncouple design, Decouple design and Couple design as shown in equation (4) [12]. Supporting that A matrix into process of the creativity mechanism. Decouple matrix support on process of the Divergent to Transforming; Couple matrix support on process of the Transforming to Convergent; and Uncouple matrix support on process of the Convergent to Divergent.

$$\begin{pmatrix} x & 0 & 0 \\ 0 & x & 0 \\ 0 & 0 & x \end{pmatrix} \quad \begin{pmatrix} x & 0 & 0 \\ x & x & 0 \\ x & x & x \end{pmatrix} \quad \begin{pmatrix} x & x & x \\ x & x & x \\ x & x & x \end{pmatrix} \tag{4}$$

Uncouple Decouple Couple

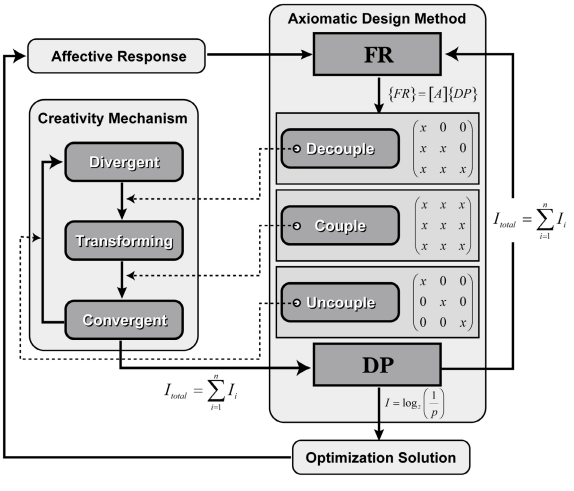

Fig. 5. Diagram of Symbiosis System

Equation (5) is a design equation for the design of a product. The set of functional requirements that defines the specific design goals constitutes the $\{FR\}$ vector in the functional domain. The set of parameters in the physical domain that has been chosen to satisfy the FRs constitutes the $\{DP\}$ vector. $[A]$ is the design matrix that relates FRs to DPs and characterizes the product design.

$$\{FR\} = [A]\{DP\} \tag{5}$$

According to the Information Content Axiom of axiomatic design theory, I_i for a given FR*i* is defined in terms of the probability P_i of satisfying Fr*i* (6). A design's information content is calculated according to the logarithmic expression equation (7). The minimum Information Content (I) is optimization solution. When there are n functional requirements, the total information "content (I_{total})" is given by equation (8).

$$I_i = \log_2 \frac{1}{P_i} = -\log_2 P_i \tag{6}$$

$$I = \log_2 \left(\frac{1}{p} \right) \tag{7}$$

$$I_{total} = \sum_{i=1}^{n} I_i \tag{8}$$

4 Prototype System Implementation

Our system is divided into five parts, which include client graphical user interface (GUI), intra-system GUI for design work stakeholders, affective response measure

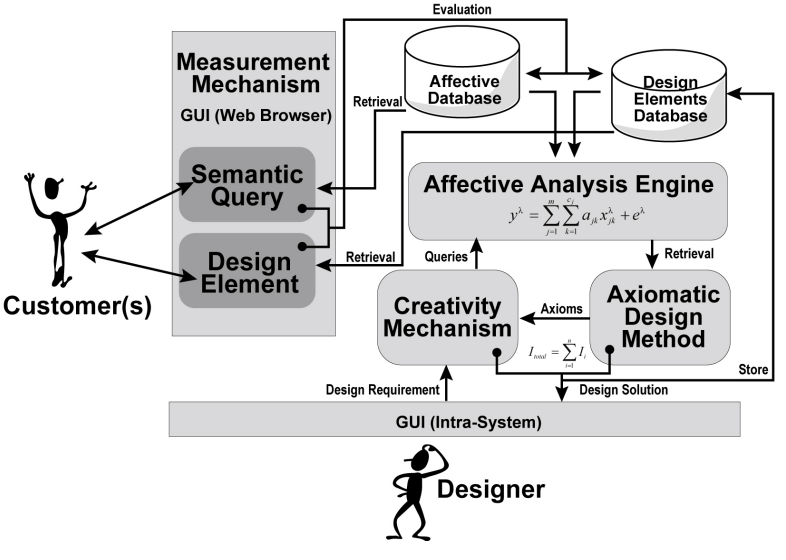

Fig. 6. System Architecture

mechanism, creativity mechanism and AD method axiomatic based. Fig. 6. shows the architecture of system of this paper.

When designers want to create a product, they should know the customers' feeling. The affective response measure mechanism provides to evaluate affective response through semantic query. Customer can see the design elements directly and answer their response via web browser and evaluative data will be stored into affective database automatically. Then, when designers need to call the affective response data, they can directly use intra-system to acquire the information. When designers operate the intra-system, they can input the design requirement that is related with affective response and the system will call data from affective database through affective analysis system and provide the data and statistics into creativity mechanism. Based on the data, designers not only can know the design information depending on the customers' affective response, but also can utilize the data to re-associate, restructure, break or compose, which are supported from axiomatic design (AD) method. During this process, designer can saw the design elements via requirement set, looking in such elements, think about that and they will describe what they think compare with the requirement set. They also can see the description of each result on message area. Of course they can add some comments inside. According their thinking and looking, after comparing among each design elements, they can choose the design element into re-associate area, and then construct the solution, re-analyze with new requirement or break again they can decide. Such process can stimulate the creativity thinking via continuously looking, thinking, describing and comparing. After that, they can using design element to re-associate, re-construct to encourage design think. Finally, through the AD method can support designer to find the optimization solution that conform to requirement. The interface of operating system is shown in Fig. 7.

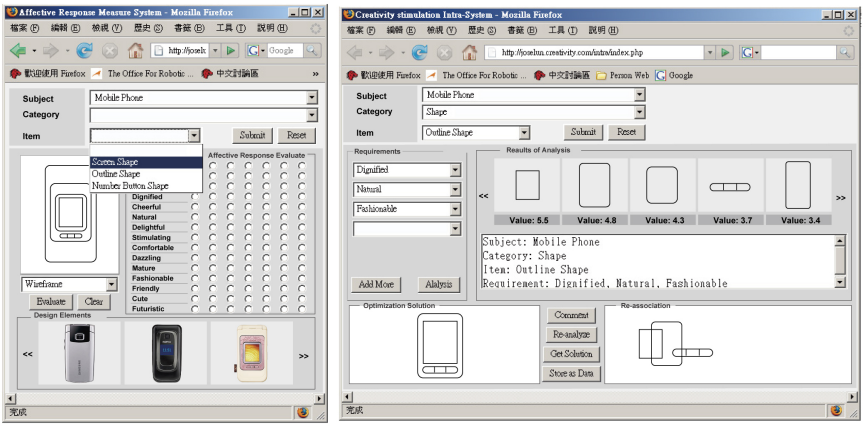

Fig. 7. A snapshot prototype interface of the affective response measure system (client) for customers and creativity stimulation system (intra-system) for design work stakeholders

5 Conclusion

In this paper, we present symbiosis concept that integrates creativity and affective response to product shape as the mentioned at the beginning. Based on several foundational theoretical backgrounds, this paper is systematically using affective response and design axiomatic in a rational way through creativity approach. The prototypical computational tool can encourage creativity thinking to design-related stakeholders through continuous manipulation of convergence-divergence for design elements based on previous case that was evaluated form customers and AD method. In the future, we anticipate that the research is needed on the results of effectiveness of using AD method in creativity process. We are hopeful that future research will provide more detailed experiments for possibility to practical issues.

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