



# Conceptual Framework for Affective and Cognitive Product Design

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**Abstract.** In this study, we proposed a conceptual framework of affective and cognitive design based on human-product interaction. Then a systematic approach based on the proposed conceptual framework is presented for the development of an assistive system for designers to gather information and data on how to design new affective and cognitive products. This research can be considered particularly important as it can be extendable to a broad variety of industry and concentrate in aspects of the product from the individual element level.

**Keywords:** Affective design · Cognitive design · Human-product interaction

## 1 Introduction

At a start of a new product development, aspiration and intention to generate affective and cognitive successful design are key goals in the design process. Establishing requirements from consumer needs is the most commonly used method to approach when developing a new product. Ideally, previous researches of affective product design emphasized on the needs as well as hedonic aspects of the product as design requirements [8, 11]. However, when we focus on affective aspects of the product, we need to analyze and understand more deeply what aspects of the product influence on the affective experience of users.

Previous researches mostly focus on the impact of affective design on the user and customer value. Khalid and Helander [10] proposed a systematic framework that enables to identify and organize customers' needs in product design. Holistic attributes, styling and functional design were taken into consideration for the framework. Including affective factors on the design of product is a challenging task. Affective and cognitive system are highly correlated with positive user experience from the product [6]. Affects refers to the emotions, sentiment and attitudes that are raised as response from the interaction with the product while the cognitive system deals with the interpretation of the knowledge, meaning and beliefs from the product [7].

During the development stages of the product, designers easily face frustration as not knowing how or what aspects should be considered to get a new affective and cognitive product. Therefore, providing a systematic approach to enable and facilitate the design of cognitive and affective design is of importance.

The objective of the present study is to suggest a systematic and conceptual framework that can assist designer to include affective aspects demanded by the user, based on human-product interaction models, design space of products, and affective attributes. Human-information processing model and perception of product was evaluated to identify elements of the product that can be considered as affective factors related on to design of affective and cognitive product. Thus, suggesting a systematic approach for the development of system with data that can assist designer with their activities.

## 2 Theoretical Background

Since Desmet and Hekkert [5] when users interact with a product, their emotional experience is related to aesthetic experience of the product and experience of meaning of the product. Aesthetic experience refers to the previous knowledge and perception of the look and feel of the product, whereas the experience of meaning is more related to the memory, meaning and metaphor that the product has [5]. Carliner [2], proposed a framework for the design of information consisting of three aspects. Physical level design which can be linked with surface, texture, and sound design; cognitive level design, which consists on the logic that the product has, how understandable and memorable are; and lastly the affective level design which consisted on the emotion and feeling of the user through the product. Jordan [9] defined the pleasure that users expect when interacting with a product as a benefit that user feel from the perspective of user in 4 categories, ideo-pleasure, socio-pleasure, physio-pleasure, and psycho-pleasure.

Therefore, the present study presents a framework, taking into consideration three different area: (1) Human-product interaction model, (2) Design space, (3) Affective design attribute. The human-product interaction is based on the information processing model where the human perceives information by sensory organs and processes it in their cognitive system to then finally provide an outcome of that information [2]. In this research, therefore we developed the conceptual framework based on three categories: perception design, cognitive design, and affective-response design. The perception design refers to the visual, tactile, and auditory elements of the product that influence on the perception of the product by the user. The cognitive design deals with understandability, memory, and attentional elements from the product. The affective-response design includes elements such as cultural aspects, social aspects and aesthetic aspects of the product. The design space consists of the components that a product has and are considered in the design process, for instance the color or shape of the product [3]. Finally, the affective design attributes refer to the attributes that the product has that influence on the positive affective experience of user in their interaction process and response [5].

### 2.1 Human-Product Interaction

Carliner [1] introduced a three-part framework for information design based on physical, cognitive, and affective aspects of the human-information processing model. Research of Carliner [1, 2] proposed a model for information design on three levels: (1) physical,

cognitive, and affective based on theories of education and instructional design. The physical level is related to design of documentation that assists users to find the required and desired information. The cognitive level design refers to the process where the information is analyzed and understood by the user to achieve their goals. The final, affective design level is the one that motivates the user to perform a task.

Helander [7] proposed a conceptual framework for hedonomics, which refers to the design of pleasurable product and tasks. These model was based on human-information processing which includes the human sensorial perception of the physical object, the cognitive processing of information that finally influences on the response of users.

Since the result of the analysis of previous researches, it is possible to note that it is important to take consideration of aspects of the information processing model for the design of product. Thus, we considered physical level, cognitive level and affective response level of design for the development of the affective and cognitive design framework.

## 2.2 Affective Product Design

Beyond the importance of the usability of product, emotional and affective aspects of the product are considered relevant for the improvement of user experience when interacting with a product. Norman [12] presented three levels of emotional design: (1) visceral design, (2) behavioral design, and (3) reflective design. Visceral design refers to the initial emotional reaction from the user toward a product by the perception of sensory signals, for instance the “look and feel” of a product. The behavioral design level is related to emotional feedback from the use and performance of the product. Thus, it takes into consideration the function of the product, understandability, usability and physical feel aspects. The reflective design level deals with aspects of the message, culture and meaning that the product transmit to the users.

Desmet [5] presented three types of product experience in the interaction process of users with a product. The aesthetic experience from the beauty and “look and feel” of a product and experience of meaning which refers the memory, meaning and metaphor that the product has. Both aspects merge together will influence on the emotional experience of the user for a product. Further research from Desmet [4], proposed a typology of user emotions when interacting with products. The study presents 9 categories of positives emotions: empathy, affection, aspiration, enjoyment, optimism, animation, assurance, interest, and gratification.

Most of the previous studies focus on physical level design as hedonic and aesthetics aspects of the design. Although those aspect of the product plays a key role in the affective experience of the user, we should also consider a wider perspective of what is affective design.

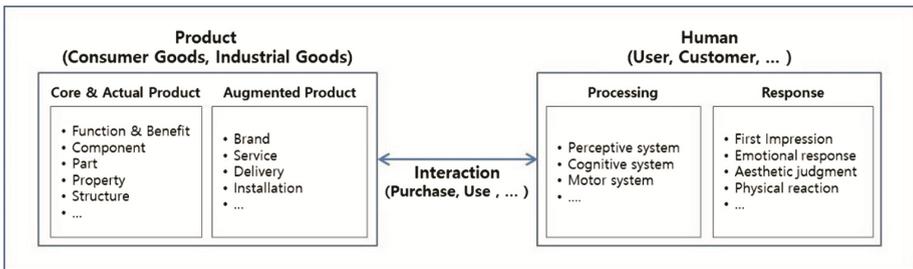
## 3 Proposed Conceptual Design Framework

In the present study we present a conceptual framework of affective and cognitive design based on human-product interaction model, product design dimension, and affective

design attribute. In this research, we categorized the human-product interaction in perception design, cognitive design, and affective-response design. The perception design focuses on visual, tactile, and auditory elements of the product that influence the perception of the product by the user. The cognitive design deals with understandability, memory, and attentional elements from the product. Finally, the affective-response design includes elements such as cultural aspects, social aspects and aesthetic aspects of the product. Product design dimension refers to the component that composes a product. For instance, color, material, shape, sound architecture. These components of the product were divided so as to facilitate the users with information based on the different attributes. Finally, the affective design attributes refer to the product, human, and interaction attributes that are classified to influence on the affective and cognitive experience of the user.

### 3.1 Affective Design Framework from the Human-Product Interaction Model

From the review of previous studies, we explain the interaction between human and product as following (see Fig. 1).



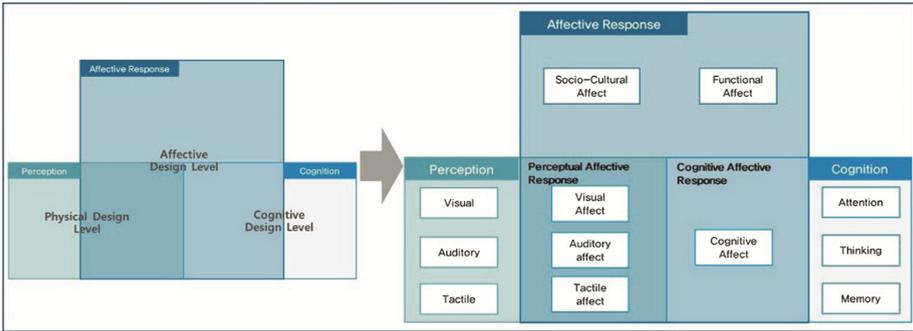
**Fig. 1.** Aspects of the product and human that influence in the process of human-product interaction.

The product, consumer goods and industrial goods, can be analyzed in two aspects: the core or actual product, and the augmented product. The core or actual product refers to the components that the product has, the functionalities, specifications of the hardware and software, the structural shape, and so on. On the other hand, the augmented product refers to aspects of the products that are presented from the brand, the service the company provides, how it is delivered to the consumers and installation process.

The human, users and consumers, is divided in two aspects in the human-product interaction: processing and response attributes. The processing aspects of human refers to how users perceived the product, how it is addressed in the cognitive system, and how the motor system react to the product input. Hence, the aspects of the user are derived from the human-information processing model. For the response perspective of the human, the model considers the emotional response, aesthetic judgment, physical reaction, and first impression attributes as a result of the interaction of the user with the product. The interaction process includes not only the real use of the product but also, steps such as the decision making process when purchasing a product.

Considering the different aspects of the phenomenon when a human interacts with a product, we can conclude that the affective and cognitive experience is significantly important to be taken into account when developing a new product. As a result, from the three level of design (physical design level, cognitive design level, and affective design level) 12 modules based on the results of the studies.

As shown in Fig. 2, the perception category explains visual, auditory, and tactile sensorial role for the affective human-product interaction. Therefore, assistive information for designers will be based on physical design of the product. The cognitive category refers to how information is processed when interaction with a product. Therefore, aspects of the product that influence to the human attention, thinking strategy and memory will be considered. The perceptual affective response category mostly deals with aesthetic experience that are results of the product physical design. On the other hand, the cognitive affective response level is related to the experience of meaning provided by the product. For instance, the metaphor of that product transmit. The perceptual and cognitive affective response categories represent the relationship between affective response from the human and the physical and cognitive design attributes of the product. That is, it mostly focuses on the result obtained by the interaction with the product. Finally, the affective response category is the result of the product user interaction that forms the experience and value of the product. Therefore, it takes into consideration socio-cultural aspects such as public values, social values, and personal value. Functional affect focuses on usability aspect of the product that influence on users' affective experience. For instance, the ease of use or accessibility of the product.



**Fig. 2.** Proposed framework to explain affective and cognitive aspects of the product from the product-human interaction model.

### 3.2 Product Design Dimension

The design space enables to divide the product into component. The product design dimensions selected for the proposed framework are the traditional aspect of the product that are associated in the decision making process. These component include:

- *Material* refers to the substances that make up a product. Physical properties of a product can be determined by the type of material. In fact, inner materials can

determine the properties such as the weight of the product, and materials used for the surface of a product determine properties such as the texture of the product. In addition, some materials, such as metal and wood, imply their distinct properties to the users themselves.

- *Color* refers to the wavelength of light received by visual perception processes of a user and can be automatically perceived first by the user in the process of perceiving product appearance. Each color can convey particular emotions to the user, and combinations of colors can also create moods. Color is also generally dependent on cultural contexts.
- *Shape* refers to the external form of the product that can be tangible by the user. The space of the products plays an important role in the design of the product as it defines and influence in the first impression of the product and provides knowledge of “what” type of product it.
- *Function and Application* refer to activities that the product can provide to users. A product is generally developed to perform one or more activities which help users make their tasks easier. The user gives utilitarian values of a product depending on how well the product performs its defined tasks, which can be described as performance of a product.

Aspects of the design space are considered of relevant important in the overall process of product development and design. It important to take into consideration all aspects of the design space provide an affective and cognitive successful design to the user.

### 3.3 Affective Design Attributes

We gathered affective and emotional adjectives related to product affect and affective experience with product and service. A total of 832 words were extracted from previous researches, commercials, review of products, and trend reports. A filtering of repeated words and similar were was conducted and end up with 165 words. We divided and categorized each word in each of the 12 categories of the previously presented conceptual framework. In this research, we only focused on developing two of the twelve categories: socio-cultural affect and functional affect.

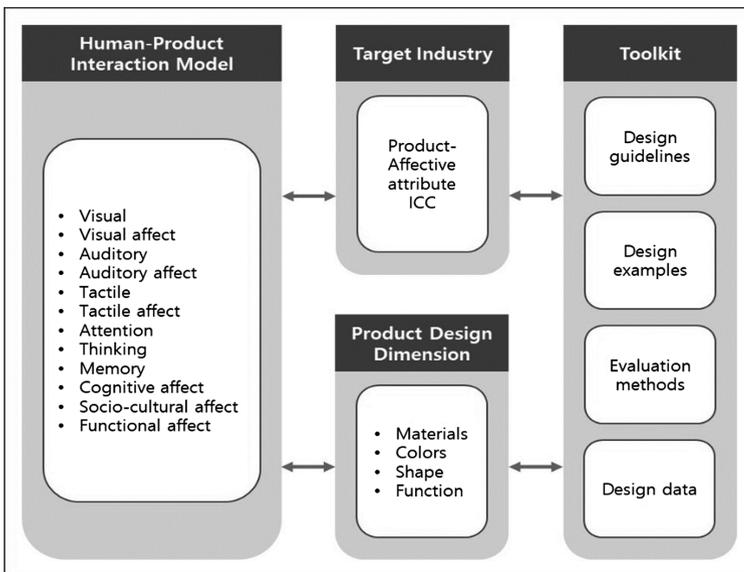
Table 1 shows the affective attributes obtained from the categorization of affective words. For this research, we only presented the results of the two categories based on the affective response from the proposed affective design framework.

**Table 1.** Affective attributes for socio-cultural affect and functional affect category

Socio-cultural Affect	Functional affect
<ul style="list-style-type: none"> <li>• Eco-friendly</li> <li>• Public interest</li> <li>• Cultural difference</li> <li>• Generation Gap</li> <li>• Popularity</li> <li>• Belongingness</li> <li>• Connectedness</li> <li>• Identity</li> </ul>	<ul style="list-style-type: none"> <li>• Ease of Control</li> <li>• Responsiveness</li> <li>• Comfortability</li> <li>• Intuitiveness</li> <li>• Controllability</li> <li>• Flexibility</li> <li>• Accessibility</li> <li>• Durability</li> <li>• Maintainability</li> <li>• Safety</li> </ul>

### 4 Affective and Cognitive Assistive Design System Development

Based on the proposed conceptual framework for affective and cognitive design, we present a systematic method to implement the developed framework in the development of an assistive system with affective and cognitive information. Figure 3 shows a summary of the system architecture. The human product interaction model includes the 12 categories each with their affective design attributes. Then, an interclass correlation coefficient (ICC) analysis is conducted to see the relationship between the affective



**Fig. 3.** Systematic development of assistive design system based on the proposed conceptual framework for affective and cognitive designing.

design attribute and product from the target industry. The rating is done by experts of the field with a 5 points likert scale to evaluate the correlation.

Data gathered for the system, are organized based on the affective design attributes from the proposed framework on affective design and the product design dimension. The organized data can be presented in the form of toolkit. For instance, design guidelines, design sample examples, evaluation methodologies, and design specific data. These toolkits can vary depending on the target industry as the affective design attribute changes depending on the target product. Since, the systematic system development process presented in these research, it enables to be used as basis for system development for other industries to assist in the design process of new product.

## 5 Discussion and Conclusion

Based on the presented framework, we propose a system that can assist designers to include affective and cognitive aspects to the design of product. Not only for one specific industry, but also with the structure of the system, it enables to be extendable to other industries. On the other hand, this study the inter correlation analysis between the affective design attribute and product design dimensions were conducted from the designers' perspective. Thus, further research from the user perspective is needed so as to understand the gap between both perspectives. Further research to analyzed and develop specific and affective attributes each of the 12 categories of the proposed framework should be done.

Also, a common problem for designer is when they are required to develop new affective products. It is easy to end up focusing on aesthetic aspects of the physical design of the product, forgetting all the others attributes, such as functionality, of the product. Good examples are products that are beautiful but has no usable function, that ends up to be unsuccessful in the market. That is, because there was a lack of understanding of what is required to make an affective design. To solve the cognitive and affective design issues presented to designers in the product development process, the current study suggests a conceptual framework for affective and cognitive design, and based on that framework, it suggest a system with human-product information that can assist designer.

Researches on affective design, mostly focus on affective aspects of a product and attributes linked with one product. However, in this study, we emphasis on the extendibility of framework for different industry and products. The framework presented in this study enables designers to be uses as basis for any product development process. Based on the proposed framework, we proposed a system that can provide designer with data to assist them in the process of affective design. Each data was gathered based on elements of each category. Then, they were arranged to provide a more accessibility system as a tool. The system consists of four main information that provides design guidelines, empirical design data, successful design cases, and finally methodology to assist the evaluation of design. We expect that this study can contribute to better develop affective and cognitive product design for developers. Mostly for small industry and start-ups with low resource for expert designers.

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