DEVELOPMENT OF A PRODUCT WITH PLEASURE: MODELING THE BIONIC DESIGN APPROACH

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Abstract: Bionic design has been broadly used in product design as a catalyst to evoke young consumer pleasure. The aim of this study is to develop a model for the development of a bionic product in order to evoke consumer pleasure. The Pleasurable Bionic Products Design Model (PBPDM) was developed in this paper based on the results of research and a review of the literature. A case study and experiment were conducted to support this design model. The findings show that practitioners valued both the ‘user concerns board’ and ‘bionic image board’ as effective and affective tools to communicate ideas and define design criteria, and to further develop concepts and form generation. ELM was also found to be a valuable tool for inspiring lateral thinking when performing ideation towards pleasure.

Keywords: Bionic design, pleasurable product, product development

1. Introduction

Why was the Volkswagen New-Beetle such a popular vehicle? Some argue that it was because of its beetle shape and “smiling” appearance that evoked a sense of joy. Research results have shown that the appearance of products is a critical determinant of consumer response and product success [1, 2, 3], particularly when the product conveys pleasure [4, 5, 6, 7]. This trend has been tested in consumer market sales. For instance, the Volkswagen New-Beetle automobile saw a 54% increase in U.S. sales during 1998-1999 while the iMac computer increased in market share from 3.5%-5.3% in 1997 [8]. These results imply that product appearance is an important attribute in evoking pleasure and thus carving out a share of competitive consumer markets.

In the development of pleasurable products, bionic forms have been broadly used in product design as a catalyst to evoke consumer pleasure. While a number of studies have focused on the processes of bionic product development; few studies have focused on how to evoke consumer pleasure. In this study, we focus on validating our model through the development of a bionic product, which can enhance consumer pleasure. Our results show the potential of enhancing form development at the ideation stage. The model should also be able to benefit designers seeking to find a variety of bionic forms which can evoke a feeling of pleasure in users.

2. Literature review

The model developed in this study was based on research results in four categories: emotional product, bionic product, emotional appraisal, and product development theory. The development of this model is based on the general product development theory. To embed pleasurable effects, modifications to the theory were made as required. As with many developing theories, this model started with an understanding of users, in order to identify user desires and fulfill user requirements, thus evoking their pleasure. The basic concept of this model is taken from emotional appraisal theory, which posits two sources of variance: users and products. Each variance appears on an image board, the key stage in which users familiarize themselves with the consumer desires, and with bionic forms.
2.1. Emotional product theories

Jordan [9] is one of few researchers to address products with pleasure. He classified product pleasure into four categories: physio-pleasure, psycho-pleasure, socio-pleasure and idea pleasure. The first category contains products with physio-pleasure, which evoke pleasurable sensations, for example, through touching or seeing something. The second is psycho-pleasure. This relates to the cognitive demands and emotional reactions engendered through experiencing the product. For instance, a good icon interface on computer screen allows users to recognize its meaning easily, evoking their psycho-pleasure when they use it. The third contains products with socio-pleasure. In this category, products can facilitate social interaction. For example, a mobile phone can provide socio-pleasure when used to chat with friends. The fourth is idea-pleasure, which pertains to people's values. These include tastes, moral values, and personal aspirations. With products, this relates to the aesthetic nature of a product and the values that it embodies. For instance, a product made with recycled material can evoke a user's idea-pleasure, if the user feels that environmental issues are important. In general, these pleasures can be mixed within the products. Users can perceive more than one type of pleasure in a single product. For instance, a person's physio-pleasure may be evoked directly through perceiving a product with elegant shape and luxurious materials, as with the iMAC computer. Consumers may share modern and stylish products with their friends, obtaining pleasure by displaying their personal tastes. In this case, the person experiences both physio- and socio-pleasure. Hence, pleasurable product design is a holistic design process, while pleasurable responses involve complicated cognitive and affective processes. To deal with the complexity of the emotional response, the current study attempts to formulate a systematic approach to design that produces pleasure in the consumer.

Norman [11] argues that there are three levels of product emotions in design: visceral design, behavioral design, and reflective design. Visceral design concerns the appearance of a product: form, textures, and patterns, the key elements that make a powerful first impression. When the form mimics bionic shapes, it offers a strong appearance and can elicit viewer emotions. Behavioral design concerns the function, performance, and usability. In bionic design, ergonomics and usability have association with structure and movement of a mimicked bionic shape; reflective design concerns the meaning derived from the mimicked bionics. The understanding of meaning depends on the cognitive processes that involve knowledge and life experiences. The bionic form used is required to be recognized and also to be meaningful to the users in evoking pleasure. Norman's category of product emotions is adopted in this paper because it covers the basic aspects of a product: the product form, function/usability, and meaning of products.

In sum, based on the underlying the similarity of each characteristic of the theories reviewed, Norman's (2004) theory was adopted as a reference to categorize pleasure because his theory, with regard to consumer products, appears to adequately encompass other theories. However, in order to describe the research focus on bionic forms visually, we have refined the three levels of product emotion and summarized product pleasure into three types of pleasure: appearance pleasure, interactive pleasure, and reflective pleasure (see Table 1). Appearance pleasure deals with emotion derived from product appearance; interactive pleasure deals with emotion when using or operating on the products; reflective pleasure deals with emotion derived from product meaning. Overall, these three types of pleasure can describe a vast array of consumer pleasures evoked by products. As a result, they were integrated into the design model.

Table 1: Comparison of two theories

<table>
<thead>
<tr>
<th>Types of pleasure</th>
<th>Appearance pleasure (Evoked by seeing product appearance)</th>
<th>Interactive pleasure (Evoked by interacting with product)</th>
<th>Reflective pleasure (Evoked by understanding the meaning of the product)</th>
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<tbody>
<tr>
<td>Norman's (2004)</td>
<td>Visceral level emotion</td>
<td>Behavioral level emotion</td>
<td>Reflective level emotion</td>
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2.2. Bionic product in evoking consumer pleasure

In the examination of the literature on bionic and pleasurable products, we found that certain attributes are valuable for the development of product forms that evoke consumer pleasure. These include using less abstract forms, adding facial features, and utilizing cartoon forms [11]. These are applied to the development process in this study.

2.2.1. Bionic form as a catalyst

For many years, designers have been inspired by bionics, which are associated with terms such as 'biomorphic shape,' 'organic form,' and 'freeform' [12]. Coates argued
that due to empathic response people form emotional bonds with pets and other animals [13]. This implies that biological objects have a greater connection with human emotions, such as pleasure. In this study, bionic design is defined as ‘the design derived from shapes, mechanisms, or concepts mimicking natural objects (such as human figures, animals, plants, or natural elements) whose intention is to evoke the user’s emotion of pleasure.

An example of products inspired by bionic forms is cars. Car designers frequently exploit animal imagery, and the resulting images encourage users to make associations between the car and a particular animal [14]. For example, the BMW Z3 uses the imagery of fish gills to highlight features in the car’s body. While this delivers a beautifully detailed car body, it also encourages viewers to make such an association, which in turn makes the viewer feel pleasure.

Observing the current market, we found that there are three types of bionics applications: ‘bionic formation’, ‘structure/function’, and ‘image’. ‘Bionic formation’ involves inspiration derived from the shape, color, material, textures, and other aesthetic characteristics of nature; ‘bionic structure’ derives from the structures or mechanisms of nature; ‘bionic function’ derives from the function of natural objects; and bionic images involve the understanding of natural object imagery. These three types of forms were used in the design process due to its strong connection with product forms.

2.2.2. The enhancement of product form towards pleasure

Product appearance is a critical element in evoking pleasure. In research, we found that there are three important characteristics in the manipulation of form, which may efficiently affect product emotion: less abstraction, human facial features, and cartoons.

First, Wu and Chang [11], in their bionic product form research, show that the less abstraction a bionic form displays, the stronger the pleasurable responses in viewers. Isamu Noguchi, a Japanese-American sculptor, states that even purist geometry is not completely abstract [15]. He implies that the boundary between concrete and abstract shapes is based on how many similarities or differences there are between the designed object and the actual object being mimicked.

As previous research shows, human facial features can add pleasurable value. Lundqvist et al. [16] commented that facial features, including the shapes of eyebrows, eyes, mouth, and nose, can convey psychologically useful information. In particular, the eyebrows, mouth, and eyes have a strong emotional impact on subjects. The elliptical eye headlight design of the Peugeot 106 is an example [14]. Chang and Wu [17] state that consumers are fascinated by the use of human shapes with facial imagery in designs, and this elicits their pleasure. These results imply that facial features are useful for the enhancement of pleasure.

Kobayashi and Hara [18] state that humans have the highest emotional recognition rate of cartoon-like synthetic faces. This is apparently because products with cartoon-like shapes remind the user of cartoon characters from childhood, and that such characters are a very good medium to express emotions [19]. McCloud [20] also observes that cartoon characters play an important role in the perception of the expression in evoking user emotion.

2.3. Emotion appraisal theory

Desmet and Hekkert use appraisal theory to develop an understanding of product emotions [21, 22]. In this study, appraisal theory (Figure 1) is used as a basic concept in the construction of a model of the development of pleasurable products. Appraisal theory contains three parameters: ‘concern’, ‘stimulus’, and ‘appraisal’ (see Table 2) [21, 23]. ‘Concern’ is a more or less stable preference and involves ‘goal’, ‘standard’, ‘attitude’, ‘novelty’, and ‘needs’ [24, 25, 26]. ‘Goal’ refers to the state of affairs that humans desire to obtain – how they would like things to be. For example, consumers buy, own, and use products because they believe such products can help them achieve their goals. Air conditioners, for example, can fulfill the goal of having cool air in the summer. ‘Standards’ refer to how we believe things should be. They represent our beliefs, social norms or conventions. For instance, a reliable car should provide safety devices. A stylish computer may represent a user’s personal style. ‘Attitude’ refers to users’ dispositional likenings for certain objects or attributes of an object. This can be with respect to aspects or features of products such as product shape, color or material senses. For instance, we have attitudes towards product color (I like red color.), style (I like modern style.), and usage (I like to have a powerful engine for my car.). ‘Novelty’ refers to any product (feature) that is appraised as novel; and ‘needs’ refer to the need of exploration, curiosity and understanding from the stimulation of product. ‘Stimulus’ is any perceived change caused by events, objects, or agents that can potentially elicit emotion. ‘Appraisal’ is a non-intellectual, automatic evaluation of the significance of a stimulus for one’s
personal well-being.

In this paper, a bionic product is considered a stimulus that evokes pleasure if user can understand the product semantics and further perceive benefits derived from the product. For example, a consumer might experience an emotion (pleasure, joy, happiness) if the concern toward the products is appraised as relevant to a consumer's concern [21]. In other words, consumers may feel pleasure when their concerns were fulfilled perfectly by the stimulus of the bionic product. The appraisal model was developed to address pleasurable emotions during the development processes. Further detail is offered in the model development section.

![Diagram of Pleasure Theory](Image)

**Figure 1. Basic model of pleasure theory**
(Modified from Desmet's appraisal theory, 2002)

<table>
<thead>
<tr>
<th>Concerns</th>
<th>Bionic images (Stimuli)</th>
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<tr>
<td>(e.g. Goal, standard, attitude)</td>
<td>(e.g. Form, structure, meaning)</td>
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<th>Table 2: Emotional appraisal theory</th>
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<tr>
<td>Goal</td>
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<td>Standard</td>
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<td>Attitude</td>
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<td>Needs</td>
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<td>Stimulus</td>
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<td>Appraisal</td>
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2.4. The development of pleasurable products

Traditional product development research has largely focused on the design methods of general product development. Few researchers have focused on emotional product development. Studies exploring emotional product development include Desmet [22], which offers nine sources of product-evoked emotions for creating product ideas, McDonagh, Bruseberg & Haslam's [27] product personality profiling (PPP), mood board, and image boards for brainstorming and ideation, McDonagh & Storer's [28] style boards, and Veryzer's [29] design perception model (DPM) for the assessment of affective perception. In this paper, these methods and tools were applied to the development process.

Scenarios are a popular tool used in IDEO, a well-known design firm, because of their benefit in allowing exploration and communication of user experiences such as physical sensations, social, and cultural context [30], associated with consumer concerns about products. Along with scenario design, mood board and image boards are often used for finding and communicating design concepts and further creating valuable ideas. To exploit the advantages of scenario design, the current study uses image boards to explore and identify user concerns (attitude, goal and standard) and relative bionic form (shape, color, material). As tools, user concerns and bionic image boards display images, which allow participants to have their personal inspiration and to describe their emotions and opinions individually through communicating with team members. Moreover, by observing these images, participants and designers use them to translate their emotions into a visualized representation for the target market.

Successfully approaching bionic design, Lodato [31] suggested four stages: (1) Select features of a living organism that exceeds current technological capabilities, (2) Derive principles and processes responsible for their superiority, (3) Develop models and methods to describe biological systems in terms useful to designers, (4) Demonstrate the feasibility of translating this knowledge into dependable and efficient hardware. This design process demonstrates an effective concept to approach bionic design. However, the research did not address the details of applying the theory and model to an actual design process. The current research attempts to develop a systematical design model to fill this gap.

3. Pleasurable bionic product design model (PBPDM)

Pleasurable bionic product design is a process of exploring bionic elements and further defining them in order to create a product that can evoke consumer pleasure. The PBPDM shown in Figure 2 is developed based on three categories of research: the product development process, emotional appraisal theory, and bionic design. To adopt both Ulrich, and Eppinger's [32] concept development and Lodato's [31] bionic design stages, the PBPDM was
structured around six development stages: understanding users, collecting bionic images, emotional links/ideation, identifying optimal concepts, detailed development, production execution (Figure 2). The first stage collects users' concerns adopted from the first step of understanding users in Ulrich, and to Eppinger's design process. The second stage concentrates on the collection of bionic forms, using Lodato's design stages. These two types of information were further applied to the emotional link model (ELM) in stage three. In this stage, emotional appraisal theory was used as a base for ELM as a method to evoke the user's emotion of pleasure if the user's concerns have connected with the bionic form of object. After selection of a final idea at stage four, in stage five the product form is enhanced using three principles when developing form details. The last stage is product execution.

The six stages of the development process are described as follows.

1) Understanding users: To create a bionic product that produces pleasure, it is first necessary to understand the intangible desires, aspirations, and perceptions of the user toward the tangible product attributes, to find a strong relationship between a user and product, such as memories associated with a product, and to explore user social contacts [33]. In other words, user concerns should connect to emotional bonds with products, cultural contexts, implications of lifestyles, social value systems, and stereotypes of the underlying meaning of the products, along with attitudes towards product aesthetics [27].

At the beginning of this stage, participants are asked to collect pictures regarding user concerns under the topic selected. To do so, participants may observe the using environment, events, and occasions and further collect parallel images related to attitude, goal, and standard, which confirm product features such as appearance, function, usability, and social value. For instance, when designing a teapot, participants may use a white living room picture to illustrate a clean and white stylish interior, which may represent participant attitude concerning product color in the using environment. Similarly, a picture showing an expensive sports car may represent consumer concerns about the product, which symbolizes style and social status, and is an extension of taste and style. Participants are then required to analyze and discuss the collected pictures, based on their understanding of consumer concerns. Finally, design criteria are determined at the end of this stage.

2) Collecting bionic images: Based on design criteria, the second stage is focused on the gathering of a variety of bionic pictures, as many as possible. To collect images efficiently, the bionic pictures collected by participants should be associated with the product appearance, function/usability and product meaning. For instance, in designing an ice axe, its operational function of digging into ice might be associated with the action of a woodpecker chiseling into wood; suggesting that the collection of woodpecker images is a valuable image that describes the function of the axe. Again, the shape of a strong muscular arm indicates the metaphor of a strong handle used as an ice axe handle. Hence, a muscular arm associated with a handle image may be selected as visual information for the bionic image board.

To emphasize social interaction in a tea set design, a picture of a group of people in chatting and laughing is used to illustrate social interactive value. At this stage, use of
product semantics theory is encouraged in developing a product form. Product semantics include metaphor, simile, allegory, analogy, and similar ideas. In general, the more visual information presented, the greater the chance to stimulate brilliant concepts at the next stage.

3) Emotional Links/Ideation: This stage is a critical process for developing concepts, which describe the form, function, and features of products [34]. In order to achieve a successful pleasure-producing product concept, the Emotional Link Model (ELM) (Figure 3) is created especially for ideation. ELM, a sub-set of PBPD, is a design linking system that primarily contains two variances, user concern images and bionic images, derived from the previous two stages. In emotional appraisal theory (Figure 1), user concern images can refer to concern parameters, while bionic images act as stimuli. Consumer pleasures were evoked when product attributes are appraised positively. In this stage, the collected photographic images are reorganized and classified into three aspects: attitude, goal, and standard, for the convenience of ideation. The bionic images derived from the last stage were also classified into three groups of information: formation, structure, and images, for ease of identification of, and association with, user concerns. Creating an emotional product relies on the development of a strong positive emotional connection between the user and the product. To be successful, observation of these two types of image boards is required, in order to find a meaningful connection between consumer concerns and the meaning of the product form, when brainstorming. This step may be repeated until participants’ desire and expectations are fulfilled with an ideal form. To accomplish this step, an optional coding system for ELM is also suggested and discussed at discussion section.

4) Identifying optimal concepts: In this stage the quality of created ideas is evaluated. The optimal idea, at this stage, should be associated with bionic form and should evoke consumer pleasure affectively. The pleasure may derive from a pleasant appearance, good interaction, and strong social meaning. Based on above three aspects, participants were asked to identify the optimal idea and label it with ‘post-it’. The idea with the greatest number of stickers represents the optimal idea and is selected as the final idea for further, more detailed development.

5) Detailed development: This unique stage is the process for the enhancement of product form towards pleasure. Based on the authors’ [11] previous study, three principles were found and applied to modify product form in order to build attachment of pleasure into the design. The three principles are (1) less abstract forms have a greater chance of evoking user pleasure; (2) bionic forms with eyes and a mouth as part of a product features have a positive effect on consumer pleasure; (3) lines or shapes mimicking cartoon characters are a good medium to express pleasure. They can be very useful to modify the details of final idea in order to add extra pleasurable value to the design.

6) Production execution: At this stage, it is ready for engineering and manufacturing. There is no further discussion on this stage, as it is not the focus of this study.

4. An example of bionic product design for pleasure

A workshop was conducted with a focus group of six second-year design students (two male and four female) from Chang Gung University. Their mean age was 20. The workshop was conducted over a period of four weeks during a product design class. Each class lasted three hours and met once a week. An open questionnaire survey was surveyed after finishing the workshop. The process is described below.

Stage 1. The project started with a lecture regarding the design theme, the content of pleasure, and pleasurable products. The PBPD was explained to the participants, who then were asked to select a design topic used in daily life and start with research. In this case, a tea set was selected and relevant pictures were collected from various resources associated with user concern (attitude, goal, and standard). Broadly, participants put the focus on the concerns of user desires, use environment, when use occurs, what types of activities does use involve, and their expectation of product attributes such as appearance, function, usability, and meaning.

Based on the understanding of the users of the tea set, participants started to collect pictures related to appearance
(color, material and shape) and to use scenarios such as the Japanese tea ceremony, tea garden, and teatime. Everything related to the tea set was also collected as a reference for later ideation. The pictures then were categorized to into three groups, attitude, goal, and standard, and displayed on an image board. After observing the images, participants discussed the images with each other and further identified design criteria for next stage.

Stage 2. Participants were asked to collect a variety of bionic pictures (animals, plants, humans, and natural objects), which could be associated with the design criteria concluded in the previous stage. In other words, collected bionic images were related to aspects of consumer attitudes, goals, and standards. For example, participants collected black and white penguins, and a white lily flower, to express their expectation of having a bright and pure color for the tea set on one hand, and colorful flowers to represent a colorful tea set on the other hand. Further, jelly fish and water images were collected to represent the possibility of using transparent materials in design. For the shape, participants selected chickens, birds, penguins, and flowers to represent the possible shapes of the tea set. To demonstrate the goal of fulfilling user needs, the tea set requires a body volume great enough to accommodate sufficient liquid. Participants collected a variety of bionic images as samples, which included a chicken, a bird, a tangerine, a kangaroo, an apple, and a lantern flower. Their bodies basically demonstrate a perfect capacity volume. For structure oriented images, participants collected images of the pitcher plant N. clefta, a tree branch, and a leaf stem as metaphors to emphasize 'structure' images. However, these images were not used in the design because they do not have the distinguishing the features of a tea set design. In terms of social value, pictures of social interaction and sharing with friends were collected. For instance, an image of a group of penguins playing on the ice together was collected to represent social value. For ease of identification of images, the bionic pictures were then roughly grouped into three categories: formation, structure, and social value. At the end of this stage, two image boards were created, a user concern board created at stage one, and a bionic image board created at this stage.

Stage 3. At beginning of this stage, the ELM was explained to the participants, who were asked to use it for developing concepts. To do so, participants observed images by switching back and forth between the 'user concerns board' and 'bionic image board' and then brainstormed with other participants. For instance, participants observe a picture showing a stack of stones and commented that its simple, smooth and natural-look shape delivered fresh, natural images. Therefore, the stone image as a metaphor was transferred to a tea set design, in an attempt to conform to participant expectations of having a tea set to use in an outdoor environment (Figure 4). When observing an image of people drinking and chatting with friends, participants said that a tea set has the mission of enhancing social value through interactive activity. In this case, participants developed a tea set emphasizing the parent-child relationship while observing the image of a hen with a chick. Named coco-chichi (Figure 4), this tea set permitted users to use it at tea time as a part of social activity. Participants further commented that the tea set design reminded them of the story of a hen and baby chickens at the farm, which became a topic in chatting, in turn evoking pleasure.

The ELM allowed participants to improve their ideas. For example, participants came up with another greater idea by adding a tray to the tea set when observing the picture of baby birds sitting in the nest with their mother. The nest image made participants imagine adding a tray as a base for the tea set (Figure 5). At that point, coco-chichi became not just a tea set but an object with a story. Participants commented that the parent-child relationship built a metaphor of emphasis on the relationship among users when drinking tea.

![Figure 4: Examples of ideation](image1)  ![Figure 5: Final sketch of the tea set](image2)

Stage 4. Participants evaluated ideas for further development. This judgment was based on the understanding of consumer perceptions, design criteria, and the subjective pleasure responses of the participants towards the idea. To do so, participants were asked to use 'post-it' stickers to mark the idea. In this case, coco-chichi received the largest number of stickers and was selected for further detailed development.

Stage 5. To improve the level of pleasure the product produces, participants played around with the proportions of shape. They added a dot to represent an eye on the pot and cups shown in Figure 5. Along with this pleasurable
form, participants formed the coco-chichi object to achieve success in three emotional aspects: appearance, interaction, and product meaning, which may also confirm not only the product shape ergonomically, but also a unique function for drinking tea at the end.

Stage 6. The design is accomplished at this point and ready for manufacturing. Participants may further determine colors. It is hoped that the result of this tea set can fit user expectations and finally evoke consumer pleasure.

5. Experiment

To validate the pleasurable quality of the design result, an experiment was conducted to test consumer pleasure evoked by the tea set with bionic form, when compared with the other three represented tea sets.

5.1. Method

Subjects. Judgment sampling was adopted for this study. 89 volunteer college students participated in the test, 35 males and 54 females. All participants are between the ages of 18 to 20 (Mean = 19.2, SD = .57).

Stimuli. Four tea sets were selected as stimulus for the test (Fig. 6). To select stimuli, tea sets of three different styles were collected from stores: round, columnar, and a combination of the previous two shapes. The reason these three tea sets were selected is because they represented the majority of tea sets. The fourth tea set was the physical model representing the result of the workshop. To avoid effect bias, the four stimuli were coated with white paint.

<table>
<thead>
<tr>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>S4</th>
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<tbody>
<tr>
<td>Column-round style</td>
<td>Bionic style</td>
<td>Column style</td>
<td>Round style</td>
</tr>
</tbody>
</table>

Figure 6: Four stimuli (Tea sets)

Measure of pleasure. The scale for the assessment of consumer pleasure evoked by product appearance developed by Chang and Wu in 2007 was used to measure the effects of these four stimuli [34]. The scale contained 17 items scored on 7-point Likert scales.

Procedures. The test was conducted in a Computer Laboratory. Each participant sat in front of a computer monitor, at a comfortable visual distance, while the stimulus was displayed. Upon experiment commencement, the Oxford English Dictionary definition of ‘pleasure’ was explained to the participants. Four stimuli were then displayed on the screen in three different sequences to reduce confusion. Each group began with a different image and a different sequence.

After perceiving each image, participants were asked to check the level they thought most closely indicated their feeling on the 17 item scale. There was a 20 second dark screen interval between images, and this process was repeated until the four stimuli were all viewed.

5.2. Results

Data was analysis by ANOVA, Within-Subject and Univariate tests for overall effects. The results show no different between males and females F (1, 631.01) = 2.05, p > .05. The statistic data shows the results of the Within-Subjects Effects test, which found that four tea sets showed a significant main effect on pleasure difference (M = 71.98 vs. 94.47 vs. 63.82 vs. 72.19, F (7, 348) = 3.23, p = .002). The result indicates that a participant’s pleasure response to each tea set was different. Furthermore, a paired comparison the four tea sets showed S2 > S4 & S1 > S3, meaning that the pleasure evoked by the coco-chichi tea set (S2) displayed the greatest intensity among the four tea sets.

6. Discussions and suggestions

In general, the results of this research show that PBPDMD is a useful model in creating bionic products that evoke pleasure. This was evidenced by the results of the experiment and the open questionnaire survey. Where participants commented that the use of ELM provides a basis for an easy and effective process to create pleasurable qualities automatically.

Second, participants agreed that image boards are a good tool to approach innovative ideas, while visual imagery was useful as a catalyst that helped participants to have great inspiration during communication and ideation. In fact, two separated image boards (i.e. the user concern board and the bionic image board) can provide an immediate efficient and effective response. Particularly, the user concern images emphasize a user-centered design approach in terms of the fulfillment of consumer aspirations and can avoid becoming trapped in the traditional product-oriented mindset. In this way, participants can focus more on the discussion of user concerns.

Third, the ELM was seen as a valuable model in developing ideas. The link between the ‘user concern
board" and the "bionic image board" allows participants to create ideas using a strong visual stimulus. Participants commented that the great benefit of using this model is that the random linking process provides a good opportunity to tap abstract concepts and to discuss ideas when observing images. The images board allows them to tap the idea through observing one or more pictures, while, at the same time, allowing them integrate their thoughts for an improved idea.

Fourth, using the three pleasurable principles as a catalyst provides a valuable reference to improve the final idea. Participants commented that it was fun to draw the details with a bionic feature, to manipulate lines, surface and shapes to produce cartoon proportions, and to play around with the level of abstraction. This process does provide a quick way to create pleasurable forms. However, the challenge of this process is that the form development has also to confirm both ergonomic comfort and visual pleasure at the same time. It takes time to test the ideal form before finding the best one. Hence, how to manipulate surfaces and features in order to address both ergonomic problems and maintain a pleasing appearance required many trials. Further study is required to clarify this complicated step.

Fifth, as constructed under the emotion appraisal theory, this model can apply to the development of other types of products that evoke pleasure, such as cultural and aesthetic oriented pleasurable products. To do so, it can simply replace the bionic imagery with cultural and aesthetic imagery during the process. However, this also requires to have a further study.

Some disadvantages were mentioned and suggestions made for the improvement of this model. First, a lack of pictures or a problem finding ideal images may affect the quality of the brainstorming, since brainstorming requires the image board for discussion. To solve this problem, we suggested writing down the concepts/ issues using texts on the image board, instead of pictures. Further, to take advantage of the new technology, video media such as a short scenario film might be useful to powerfully illustrate information. Second, participants felt that the ELM is a useful method for concept development, but for laypersons and low-level students who have less experience in ideation, problems may be encountered in efficiently achieving creative aims. At this point, for the layperson we suggest an alternative approach for the ELM that involves a matrix arrangement. The alternative method is to first find the major images/factors on each image board, and then arrange these key images/factors in a grid along the horizontal and vertical axis. The key images/factors can appear as either text or codes. For instance, the key images in the user concern board are coded as A1, A2, A3, G1, G2, G3, S1, S2, S3, I1, I2, I3,..., where A stands for attitudes, G for goal, S for standard and, in bionic image board F1, F2, F3, S1, S2, S3, I1, I2, I3,..., where F stands for formation, S for structure, I for image meaning. Using this code system, participants can easily select any key images from the two image boards and attempt to create an idea. For example, the combination of brightness image (A1) and lily flower (F1) taps the idea of having a lily teapot to fulfill the concern of having a bright teapot. The matrix arrangement was not used in this workshop, because participants felt comfortable using the image boards. However, we suggest using this matrix method when encountering problems creating ideas during brainstorming. Third, at stage four, to determine a potential idea for development is a critical step in product success. In this workshop, a post-it sticker was used to score the concept, because of its ease of use. However, other measurement ideas are available. Further research to construct better measurement scales to identify optimal ideas is suggested. Fourth, the participants in this study were limited to young college students, a segment that does not begin to cover the entire range of users. Hence it is suggested that future research concentrate on other age groups.

7. Conclusions

In this paper we propose, develop, and validate the PBPD to create a bionic product for the evocation of consumer pleasure. With this systematic approach, both laypersons and designers can approach the design process easily and accomplish a design that evokes pleasure. The ELM is a valuable tool in developing product concepts with emotion, and it is possible to extend it to the development of other types of product, which also attempt to embed product emotion. In addition, the three pleasure principles provide an affective way to manipulate the details for enhancement of product.

Participants agreed that observation of images is an efficient way to communicate user concerns with layperson, to create a product with the inspiration of biological resources, and finally to transform thought into a creative idea. Overall, this research demonstrated a valuable model, and that the world around us offers unlimited resources, which designers can draw upon to facilitate powerful and innovative new design thinking.
References