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Research on the Application of Emotional Design in a Heated Non-Burning Tobacco Product

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Abstract. To explore the application of emotional design theory in the design of a new heated non-burning tobacco (HNB) product. Based on Norman's three levels theory of emotional design, this research redesigns HNB products from the aspects of instinct, behavior, and reflection on the appearance of products, interactive experience, and users' deep emotional experience. It makes the product more in line with the temperament and characteristics of the young group, improves the user experience, and meets the emotional needs of users in different scenes.

Keywords. Emotional Design; HBN Product; Product Design; Design Application

1. Introduction

With the development of the times and the progress of society. Users' needs have changed from material to spiritual, from process-oriented to personalized. Designers' design concepts and design methods are also being continuously optimized.

At present, with the number of smokers in the world remaining high, the related HNB products will receive market attention. At the same time, with the younger smokers, the psychology of mainstream consumers is changing. Whether from the appearance, ergonomics design, or user experience are difficult to meet young consumers' preferences. Therefore, there is still a lot of room for improvement in HNB product design.

This paper explores the application of emotional theory in HNB product design, which made the product design process into emotional factors, enhanced the affinity of products, and enhanced user experience at the same time so that users got more emotional satisfaction.

In this paper, we first analyze and sort out the three levels of emotional design theory and the current situation of HNB product design by using a literature review and competitor analysis; secondly, we systematically refine and summarize the emotional design framework of HNB products according to user requirements and the emotional design theory; finally, we apply it to an HBN product design to prove the feasibility of the design framework.

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In the HBN product emotional design framework, we systematically grasp Norman's three levels of theory. On the visceral level design, we start from the form, color, and material elements of HNB products to build a pleasant sensory experience as a whole; on the behavioral level design, we use simple functions and processes, humanized and interesting interactions, timely prompts and feedback to jointly create a good user experience; on the reflective level design, we systematically shape a deeply emotional experience by creating diversified product connotations, stimulating users' emotional resonance and pointing design symbols to connotative meaning.

2. Research Background

2.1. The Theory of Emotional Design

2.1.1. Research Status of Emotional Design

In the book titled "Emotional Design" [1], Donald A. Norman presents the "Emotional Design Hierarchy Model" from the perspective of cognitive psychology, which divides the user's cognitive processing into three levels: visceral, behavioral, and reflective. The visceral level refers to the sensory stimulation brought by the product, which causes the brain to make a quick judgment and send signals to the motor system; the behavioral level is designed to focus on the use of the product, the pleasure, and efficiency brought by the process of operation; the reflective level design emphasizes the meaning of the product, which generates deeper emotions within the user.

In the last two decades, an increasing number of researchers have focused on the study of emotional design to promote positive emotions or pleasant experiences of users through the design features of products and services [2, 3, 4, 5]. Research in this area can be broadly divided into the following two application directions.

The first research direction focuses on the optimization of product appearance, shape, material, color, or interface design. Hsiao, K. A. et.al. [6] investigate the structure of the relationship between the manipulation of product shapes and emotional responses. Taking cars, sofas, and kettles as examples, they use factor analysis to analyze the basic factors of product shape that can stimulate consumers' favorite emotions and extract four basic factors: the trend factor, the emotion factor, the complexity factor, and the potency factor. Chang, C.C. [7]indicates that the visual comfort of a product is evaluated based on its overall image, color, texture, interface, function, and line elements.

The second research direction focuses on promoting engagement and fluency in the process of user-product interaction, arguing that the fluency of interaction with feature use will positively impact the overall user experience [8, 9]. The core of the research is how to improve the user's interaction experience while providing the basic functions they need. For example, by introducing digital games and their special mechanisms (interactive dialogues, prize and achievement systems, sensory stimulation, etc.) that deepen the user's immersion and sense of accomplishment in the product interface or the teaching process, the actual user experience is optimized [10, 11, 12, 13, 14]. Tetsuro Ogi [15] and Neal M. [16] investigate design support and design evaluation via virtual reality, augmented reality, and tele-immersion technologies. Researchers in human-robot interaction [17]also turn their eyes to emotional design, which can elicit (e.g., pleasure)

or prevent (e.g., displeasure) determined emotions, to regulate the emotional interaction between the individual and the product (e.g., robot).

2.1.2. Three Levels of Emotional Design

Emotional design is a design concept that focuses on the inner emotional needs of the user. Emotional design divides people's emotional experience of objects into three levels: the visceral level, the behavioral level, and the reflective level. [1] The concept of emotional design values the emotional needs of consumers in terms of personality and experience. It enables users to gain emotional interaction value in the process of implementing the technical functions of the product.

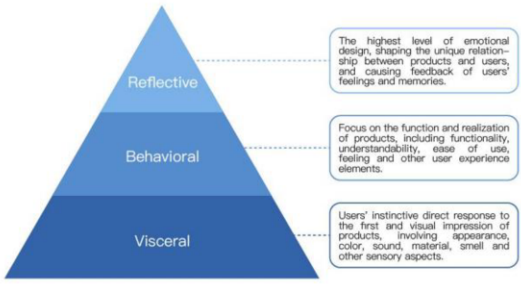

Figure 1. Don Norman's 3 levels of emotional design (drawn by author, based on [1]).

The visceral layer of emotional design is related to the feelings brought directly to the user by the product, which is the first impression given to the user by the product, including external features such as shape, material, and color. In this layer, the product interacts with users from the sensory perspectives of vision, touch, and hearing, so as to stimulate users' emotions at the initial stage.

The behavioral layer of emotional design focuses on the interaction between the user and the product or service, which contains more logical thinking and rational expression to further strengthen the user's emotions. The behavioral layer can be evaluated in terms of usability and ease of use, where usability represents the product's ability to solve problems, which is a reflection of the product's ability to meet user needs and its basic functions.

The reflective layer of emotional design mainly starts from the spiritual and emotional level of resonance, aiming to create emotional resonance and provoke users' thinking through the human-centered and temperature-sensitive design form of the product. At the same time, it can deepen the user's memory about the current product or service, thus generating a pleasant experience and longer-term dependence, and eventually forming a complete emotional cognition.

2.2. Design of New Heated Tobacco Products

With the gradual strengthening of global tobacco control efforts, the tobacco industry has entered a new era of demand development and evolution. Electronically heated tobacco combined with electronic technology, with high controllability and stability, has become a new tobacco product in the research field. [18] New heating non-

combustible tobacco products (also known as low-temperature cigarettes) are a new type of tobacco product, which is heated by a special heating source to the tobacco filaments. When it is heated, the nicotine and flavor substances in the tobacco filaments will produce smoke through volatilization, thus meeting the needs of smokers.

At present, the common overseas "heated non-burning tobacco products" include IQOS of Philip Morris International and Glo of British American Tobacco. Among them, Filmore International's IQOS has a more fashionable design, uses high-quality fabrics, and is comfortable in the hand. British American Tobacco's Glo appearance is more conservative, and most of the product color is black, white, or traditional metallic yellow, which lacks a sense of trend. To Norman's three-level theory, most product designs only involve the visceral and behavioral levels. However, the control of user experience and human-machine interaction design of these products has not been able to meet the emotional needs of consumers.

3. Methodological Framework and Application of HNB Product Emotional Design

In terms of the emotional design of an HNB product, we focused on the psychological demand and emotional experience of the younger generation consumer group. Through emotional thinking, the overall image of HNB products, such as appearance, function, and use pattern, becomes young, fashionable, and avant-garde.

Based on Norman's emotional design theory, in this section, we develop the design framework of HNB products (Figure 2) and apply it to the design of HNB products.

In this study, we designed an HNB product named "AbsorBor". In the visceral layer, we consider the modern and fashionable shape, the harmony and simplicity of color, and the weight and texture of materials; In the behavioral layer, we simplify the function and use process, pay attention to the humanized and interesting usage, and increase the timely prompt and feedback; In the reflective layer, "AbsorBor" achieves the diversification of product connotation and inspires the emotional resonance of users in the process of using the product.

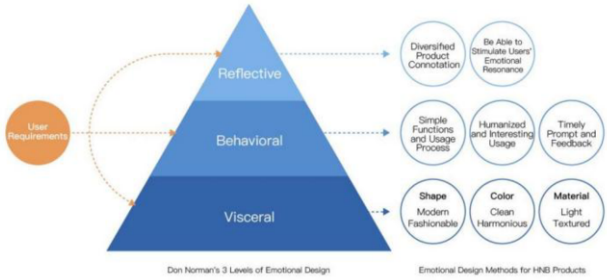

Figure 2. HBN products emotional design framework.

3.1. Visceral Layer of Emotional Design

According to Norman, the visceral layer is designed for people's first reaction, the appearance and form of products are very important [19]. For the young group, the appearance of the product is the key factor that determines whether they are attracted to and create an impulse to buy [20]. Designers can design the visceral layer of HNB

products from the aspects of form, color, material, etc., to enhance the pleasure of users at the sensory level.

3.1.1. Design of the Shape Elements

According to the characteristics of the young generation, interesting, novel, and fashionable product shapes are more likely to attract their attention and stimulate their desire to buy and use them.

The design inspiration for "AbsorBor" comes from beverage bottles (Figure 3). The shape of the cylinder is easier for users to hold, and the curve is more smooth and simple in visual presentation. It combines industrial style with modern style, which is more in line with the product idea with a modern feeling and younger age. In addition, different from the direct insertion of HNB products on the market at present, our design adopts oblique insertion, which not only caters to the user's holding and suction action but also has certain innovations.

3.1.2. Design of the Color Elements

The target users of HNB products are the young generation aged 20-35, They are mainly college students and young white-collar workers, and there will be a lot of semi-public places use requirements. Therefore, overall harmony and cleanliness are very important in color matching.

"AbsorBor" is available in two color schemes, one with white and dark grey, the other with lavender and light green and white gradient (Figure 3) The application of the Morandi color system makes the product not conspicuous and dazzling in public places, but without losing the sense of mystery and advanced [21]. In addition, the Morandi color system is accepted by most people because of its strong inclusiveness of people, space, and time [22]. And the top cover adopts the design of a translucent frosted texture, which reduces the industrial sense of this kind of tool product, and makes the overall color of the product bright and clean.

3.1.3. Design of the Material Elements

Different materials express different emotions. Since the user will be directly in contact with the HNB product when holding it with their hands, the different materials will intuitively affect the user's tactile experience. In the selection of product materials, we mainly considered their safety, weight, and surface roughness.

Based on the above three considerations, the main shell of "AbsorBor" is made of high-quality engineering plastics (Figure 3). At the same time, the surface metallization process is processed, and the engineering plastic with the metallization process is strong, durable and anti-corrosion [23], which makes the product reflect the metal texture and reduces the quality of the product by 2 times. Finally, paint is sprayed on the surface of the product to enhance the user's experience when grasping and using it. This design ensures the user experience of the product and also satisfies the new generation of smokers' pursuit of young, fashionable, and interesting products.

Figure 3. Shape, color, and material of "AbsorBor".

3.2. Behavioral Layer of Emotional Design

The design of behavioral layer focuses on the function and usability of the product. Functionality alone is not enough, good design also requires a good experience for the user. Designers can design the behavioral level of HNB products from the aspects of product function, usage, interaction, and feedback, so as to improve the user experience at the user level.

3.2.1. Simple Functionality and Using Flow

The use scenarios of HNB products are mainly semi-public places. The usability and ease of use of products are very important, and it is not suitable to add too complex functions. At the same time, we should try to shorten the steps and processes of using HNB products. If the use process is too complicated, it may make users lose patience and become agitated.

This design met the demand that HNB products were mostly used in semi-public scenes. In the use process, only one button (Figure 4a) needs to be controlled to complete the entire use process of the product (long press -- on/off; Short press - switch mode), greatly shortening and simplifying the use process, so that the product can quickly meet the needs of users in any scene.

3.2.2. Humanized and Interesting usage

The use of HNB products should have two characteristics: Firstly, humanized. Users may use HNB products in different scenarios, and the gender and occupation of users are different. Therefore, these factors should be taken into account when using the products. Secondly, interesting. Young users are interested not only in the appearance of a product but also in the way it is used. We started with the use behavior such as holding and suction, and give it a new meaning.

The design inspiration for this product came from beverage bottles. The fresh and natural style avoided the cold industrial feeling, which could be well integrated into most scenes in life. At the same time, the cigarette was inserted diagonally (Figure 4c), which was more suitable for the holding Angle and fully considers the ease of use and comfort. At the same time, HNB products in the shape of beverage bottles were not common, which satisfies the young people's psychology of seeking novelty and interesting things. When using the product, users' inner pleasure and satisfaction will be improved again.

3.2.3. Timely Prompt and Feedback

As an electronic product, it is necessary to give the user prompt feedback on the status in time. If feedback is delayed or not available, people will have negative emotions such as confusion, frustration, doubt, and anxiety [24]. Effective guidance based on users' interaction habits will relieve their stress and anxiety.

The product through a button and an LED light implemented all operations and all state feedback. When the user presses the switch and the blue light flashes, the device starts. Press the button to start heating. The indicator light (Figure 4a) is yellow, which means that the cigarette is in preheating, red, which means that the cigarette is being heated (the heating temperature has been reached), and green, which means that the cigarette is in cooling. Long press the switch again, and the indicator light off indicates shutdown. The electricity is prompted by the indicator light, which has four grids. When it comes to electronic products, especially addictive ones like e-cigarettes, electricity tends to cause anxiety. Therefore, the power prompt function gives them more sense of security and avoids anxiety, confusion and frustration.

Figure 4. Left: front view of "AbsorBor", right: cigarette is inserted diagonally in "AbsorBor" ((a) button: control the product on/off and mode switching; (b) indicator light: prompt the user of the current status of the product; (c) cigarette socket).

3.3. Reflective Layer of Emotional Design

Norman believes that the design of the reflective layer is often related to the meaning of the product, the memory it may evoke, or the personal image, and the activity of the reflective layer will determine the overall impression of a person on a product. Therefore, if HNB products and their use process can help users establish a good personal image, generate emotional resonance, and make them have positive emotional experiences such as satisfaction, pride, and identity in the interaction with the products, then the design purpose of reflection layer is achieved.

3.3.1. Product Shape Semantics Convey Specific Emotions

Product shape semantics can express many specific emotions. For example, the tea filter designed by Alessi once led the appeal trend of daily life utensils. Many interesting product designs are full of individual emotional displays. These designs based on reflection layer make the form of the product have the function of exposition, which is more interesting than the traditional serious design, and can stimulate the user's perception and resonance.

The design of "AbsorBor" integrates the intention of a trendy beverage bottle (Figure 5a), conveying the cultural proposition and spiritual connotation of product spontaneity

and freedom. The interesting shape of the product, fashionable color matching, and advanced materials, from multiple sensory channels, convey the ultimate experience of the product to young users. The morphological features belong to the visceral layer, but through the semantic meaning of "beverage bottle", the visceral layer is connected with the reflection layer and carries the emotional catharsis and expression in the reflection layer.

3.3.2. Design Enhanced Implicit Communication

From a product design point of view, it is important to provide effective and perceived communication that makes the user experience easy. On the behavioral level, many positive interaction designs are carried out to improve the efficiency of manipulation. but on the reflection layer, it shortens the gap between people and broad product interfaces on an emotional level.

The product's design is naturally reminiscent of how we drink water on a daily basis, and the way the cigarette is inserted is similar to the tilted straw in a water glass (Figure 5b). With this design, users can quickly understand how to use the product without any instruction manual. It avoids the frustration caused by the difficulty of using most tool-based products. On the contrary, users get a sense of accomplishment in the process of using products and thus form emotional personal satisfaction in the reflection layer.

3.3.3. Design Symbols Point to Connotative Meaning

By means of a series of symbolic words that can convey thoughts and feelings[25], such as visual perception, graphics, aesthetics, and culture, product design can transform abstract emotional concepts into tangible forms, complete the emotional transmission between people and products, and achieve the purpose of conveying emotion and meaning.

"AbsorBor" applies the form of a beverage bottle as a design symbol to the appearance of the whole product. Although it is abstract in form, it can be recognized by users who accept the design, and most people feel the sense of happiness and pleasure brought by drinking the beverage. The connotation of "beverage bottle", directly conveys to the user the stimulation and excitement directly to the taste buds through the appearance.

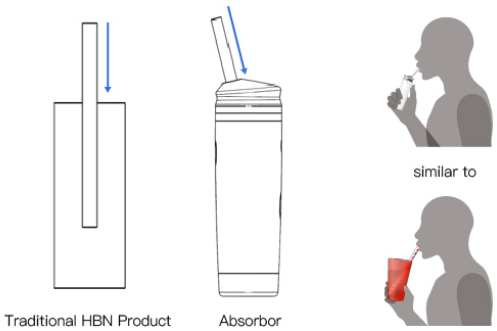

Figure 5. (a) The diagonally inserted cigarette makes "AbsorBor" look like a beverage bottle. (b) Smoking with "AbsorBor" is similar to drinking with a straw.

4. Conclusion and Future Research

In the context of industrialized production, most mass-produced products are generally characterized by functional convergence and interactive ease of use. Therefore, design methods that focus on user experience and emotion will give products stronger competitiveness and expressiveness. For consumers, the demand for personalized products is becoming increasingly strong, and in the context of increasing homogenization of product functional attributes, human-centered emotional product design is gradually penetrating into people's spiritual connotations. On the basis of focusing on user experience, the emotional feedback brought by the product to the user will become more valuable and meaningful.

Emotional design, as a human-centered design method, is still under continuous development and exploration. With the gradual flourishing of computer science and artificial intelligence technology in the Internet era, the innovative forms and functions of products are constantly iterating, and the emotional design method combined with technical algorithms is expected to become a new research trend. We will continue to explore how to combine the traditional product form with the characteristics of the product itself and user requirements to produce appropriate and personalized emotional design solutions.

References

[1] Norman D. A. (2007). Emotional Design: Why We Love (or Hate) Everyday Things. Available online at: https://books.google.com/books?id=QtWSu3zBtPoC&pgis=1.

[2] Jordan P. W. (2002). Designing Pleasurable Products-An Induction to the New Human Factors. London: Taylor and Francis.

[3] Green W., Jordan P. (2003). Pleasure with Products: Beyond Usability. London: Taylor and Francis.

[4] Amic G. Ho; Kin Wai Michael G. Situ (2012). "Emotion Design, Emotional Design, Emotionalize Design: A Review on Their Relationships from a New Perspective". The Design Journal. 15 (1): 9–32.

[5] Van Gorp T., Adams E. (2012). Design for Emotions. Waltham, MA: Elsevier.

[6] Hsiao, K. A., & Chen, L. L. (2006). Fundamental dimensions of affective responses to product shapes. International Journal of Industrial Ergonomics, 36(6), 553-564.

[7] Chang, C.C.(2008).Factors influencing visual comfort appreciation of the product form of digital cameras.International Journal of Industrial Ergonomics,38(11/12),1007-1016.

[8] Hancock P. A., Pepe A., Murphy L. L. (2005). Hedonomics: the power of positive and pleasurable ergonomics. Ergon. Design 13, 8–14. 10.1177/106480460501300104

[9] Hassenzahl M., Tractinsky N. (2006). User experience - a research agenda. Behav. Inform. Technol. 25, 91–97. 10.1080/01449290500330331

[10] Cowley B., Charles D., Black M., Hickey R. (2008). Toward an understanding of flow in video games. Comput. Entertain. 6:1 10.1145/1371216.1371223

[11] Jin S.-A. A. (2012). Toward integrative models of flow: effects of performance, skill, challenge, playfulness, and presence on flow in video games. J. Broadcast. Electron. Media 56, 169 – 186. 10.1080/08838151.2012.678516

[12] Argenton L., Triberti S., Serino S., Muzio M., Riva G. (2014). Serious games as positive technologies for individual and group flourishing, in Technologies of Inclusive Well-Being, eds Brooks A. L., Brahnam S., Jain L. C. (New York, NY: Springer;), 221–244.

[13] Alexiou A., Schippers M., Oshri I. (2012). Positive psychology and digital games: the role of emotions and psychological flow in serious games development. Psychology 3, 1243 – 1247. 10.4236/psych.2012.312A184

[14] Morford Z. H., Witts B. N., Killingsworth K. J., Alavosius M. P. (2014). Gamification: the intersection between behavior analysis and game design technologies. Behav. Anal. 37, 25–40. 10.1007/s40614-014-0006-1
[15] Ogi, T. (2011). Emotional design in the virtual environment. In Emotional Engineering (pp. 103-117). Springer, London.
[16] Neal M. (2012). Creating and maintaining psychological flow state in augmented reality applications, in EEE International Conference e-Learning, e-Business, Enterp. Inf. Syst. (Las Vegas: e-Government;).
[17] Ayanoğlu, H., & Duarte, E. (2019). Emotional design in human-robot interaction. Springer International Publishing, Cham.
[18] Lu Zheng, Qunye Hong, Jinbang Wang, et al., Analysis on Patent Technology of Domestic Fuel Heated Cigarettes, Tobacco Science & Technology, 2018, 51
[19] Norman, D. A. (2004). Emotional design: Why we love (or hate) everyday things. Civitas Books.
[20] Promjun, S., & Sahachaisaeree, N. (2012). Factors determining athletic footwear design: A case of product appearance and functionality. Procedia-Social and Behavioral Sciences, 36, 520-528.
[21] Peiyao Li, A brief analysis of the visual experience of Morandi colors in soft clothing. Ming Attitude, 2019, (08):160.
[22] Bin Xue, Application research of Morandi color system in modern packaging design. Green Packaging,2022 (08):72-75.
[23] Norman, D. (2013). The design of everyday things: Revised and expanded edition. Basic books.
[24] Amsel, A. (1992). Frustration theory: An analysis of dispositional learning and memory (No. 11). Cambridge University Press.
[25] Fei Hu. Industrial Design Symbol Basics. Beijing, High Education Press, 2007:104