Research on the application of neuroaesthetics in industrial design

Mei Sun¹, Haocheng Han² and Quanhong Jiang¹,³

¹ School of Foreign Languages, Beihang University, Beijing, China; ² Shoue college, Beihang university, Beijing, China ³ Email: jiangquanhong@buaa.edu.cn

Abstract. People's pursuit of aesthetic emotion is rising day by day, they pay attention to the practicality of products with a higher pursuit for the beauty of products. Industrial design takes the product design as core, the artistic decent expression is an indispensable link. The emergence of neuroaesthetics has laid a solid foundation for exploring the connection between individual nerves and product design. This paper introduces the history of industrial design, analyzes its development stages through comparison of different cases, and discusses the application principles of neuroaesthetics in industrial design.

1. Introduction

Industrial design is the core of product design[1]. It is a scientific and aesthetic relationship between the designer and the object, and its purpose is to benefit mankind and design for a more reasonable and comfortable human existence[2]. Product design is based on the aesthetic principle, the use of scientific knowledge and technical means, to give existing materials with a certain shape and unique functional quality, in order to meet the material and spirit of people's actual life, to meet the spiritual needs of one of the aesthetic degree of products[2].

What kind of products are beautiful? What kind of product is exciting? Individual aesthetic, aesthetic psychology, social environment and other factors will have an impact[3]. Among them, neuroaesthetics is an indispensable important branch.

The emergence of neuroaesthetics has given us an exploration into the relationship between individual nerves and product design[4]. Starting from the cognitive nerve base of aesthetics, we are presented with a holistic aesthetic research path that goes through cognitive nerve elements, general psychological process, individual aesthetic existence and social psychological culture. Along the way, we will see how the brain recognizes beauty or ugliness, and what factors can influence the brain's judgment of beauty. On this basis, we can further think about whether some reflection mechanism can be applied to product design, so as to achieve the core purpose of product design. This paper is dedicated to explore neural aesthetic relationship with the industrial design in product design.

2. Industrial design

2.1. History of industrial design

The history of human design activities can be roughly divided into three stages: the initial stage of design, the stage of handicraft design and the stage of industrial design[2]. Design appeared long before people realized that the so-called design appeared. Design of infancy originated in the initial
stages of the development of human society, in the Stone Age, the homo sapiens has clear purpose when making stone tools, such as nut shell, with the failure that will need to make head heavy large stones, if you want to cut things, the need to make a sharp point in front of the ribbed stone, this is the first design. In the slave society, people began to produce metal tools and ceramic utensils, which marked that human beings entered the period of creative activities to change the characteristics of materials through chemical changes. This period was the stage of handicraft design in the history of design.

After the rise of the industrial revolution, mechanized mass production of various products, making the design activities will enter a new stage of industrial design. The stage of industrial design can be divided into three periods: the first period is from the second half of the 18th century to the early 20th century, which is the incubation and exploration stage of industrial design. During this period, while the traditional handicraft design gradually transitioned to industrial design, a variety of design ideas presented a state of contention among hundreds of schools of thought, and explored the development path and direction of industrial design from different perspectives and ways.

The second period, between the first and second world wars, was the period in which modern industrial design came into being and developed. During this period, a systematic theory of industrial design was developed and spread around the world[3]. The third period was after the second world war, during which industrial design, industry, science and technology and commerce were closely integrated and achieved significant development as a whole[5].

The industrial revolution adopted mechanized mass production, which promoted the division of labor and the development of commerce. With the development of commodity economy, manufacturers with fierce competition use excessive decorations to improve their competitiveness in the state of mass production. However, this is a fatal problem that wastes products and damages their functions at the same time[5]. The adornment design of this kind of formalism, inspired a few designers to undertake designing reform from the reverse side. The arts and crafts movement initiated by Laskine and Morris in Britain started the wave of design reform from the second half of the 19th century to the early 20th century. They tried to establish a new design standard to avoid the disadvantages in industrial design, put forward the advanced thought of "the combination of beauty and technology", advocated being faithful to the material, and opposed excessive decoration, which became an important mark in history[6].

Since 1900, new technologies and materials have emerged one after another, facilitating the development of new functions of products, while traditional concepts and forms have been unable to adapt to the requirements of new functions of products[7]. The great depression from 1929 to 1933 established the position of industrial design in the United States. At that time, American laws stipulated the price of products, manufacturers could only attract consumers on the appearance, quality and function of products, so industrial design became a necessary means for enterprises to survive. After World War II, the methods of American industrial design had a wide impact on all industrial design fields in the world, and industrial design was highly valued. Due to the focus on industrial design, Japanese products have achieved great success in the international market, from the initial imitation, to enjoy a high level of international reputation and status. Send this, industrial design is real and greatly square appear before us.

2.2. Definition of industrial design
From the development history of industrial design, it is not difficult to see that the emergence of industrial design is for the better life of mankind. From the primitive Stone Age to the wave of design reform in the second half of the 19th century, it is implied that the standard of "good design is that can serve human beings better". This implication is exactly the same as the definition of industrial design: industrial design is developed with the development of modern industry and the improvement of social spiritual civilization, and with the increasing awareness of human culture and the pursuit of a new way of life. It is a new interdisciplinary subject integrating science and aesthetics, technology and art, material civilization and spiritual civilization, and natural science and social science[2]. It takes
the product design as the core, simultaneously the transmission design, the environment design, the enterprise image design summarizes among them[5]. It is a scientific and aesthetic designer's relationship with things. Its purpose is to benefit human beings, design for more reasonable and comfortable human existence, and design for higher human needs. It requires strict division of labor and close cooperation among all parties.

Industrial design does not belong to the west, nor does it belong to the east, it belongs to all mankind[5]. The development of industrial design is not independent, but closely related to the development of human nature, economy, technology, literature and art[8]. This paper is based on this, from many factors might affecting industrial design to choose one of them to discuss.

2.3. Features of Industrial design nowadays

Just as mentioned above, industrial design serves human beings. No matter how it develops and changes, it always puts people at the core. From the glass bottle of Coca-Cola and the first beetle to the interior and shape of America's first spacecraft, industrial design was refreshingly introduced in the last century. And in the 21st century, the Internet success for human to realize the global village, in the village of access to information ability is stronger, the businessman saw the people of all kinds of psychological, so pay more attention to industrial design, product such as Apple, Huawei, Millet to high technology as the core competitiveness of companies, products to various aerospace company and the national construction of the station, these places after have the technology to industrial design will need to pay enough attention to an era when "face" in this new century successfully survive. And what's special about this time? It is Internet. There has never been a time in human history when all kinds of data and information can be gathered into people's hands in such a large amount and in such a universal way. In the meantime, the businessman saw infinite business opportunity, had the product with reliable quality, but how to return good product to describe better than itself, let the person that does not have demand originally even involuntary dig out of one's pocket buy account?

Similar to the web design, UI design and other product designers surfaced. To this, the present stage of the traditional industrial design is not just a narrow sense of engineering design, with things to the requirement of the engineering beautiful sex has also increased, at the present stage industrial design because of its product design and the Internet have made a lot of contact area, so the technology and aesthetics is tied in the position in industrial design.

As mentioned above, in the industrial design in the second half of the 19th century, due to the wave of design reform, industrial design focused more on "practicality and usability" than on aesthetics[9]. However, after the birth of the Internet, although the design of the Internet also emphasizes the practicality like clear goal and simplicity, the demand for more digital products, such as mobile phones and tablets, as well as website theme, and other design aesthetics, has reached another level.

3. Neuroaesthetics

Nerve aesthetics is a relatively new field, there is no absolute authority and formal definition[4], so here first to discuss is about the definition of neural aesthetics, applied in science and technology highly developed today, the humanities and natural science research in recent years has been for humanists. Against this background, neuroaesthetics emerged based on the development of aesthetics for two thousand years and combined with the achievements of modern science and technology[3]. With the development of science and technology, hundreds of thousands, the doctor could feel their patients' pulse with medical instrument. Likewise, in such level has reached a new level of science and technology today, the traditional method of metaphysical philosophy and aesthetics has not fully meet the demand of people's thought, the human desire through the use of existing technology for brain sciences, obtain experience principle about aesthetic mechanism.

As the aesthetic subject, human beings have the ability to discover, create and appreciate beauty through various means and ways[10]. Conscious aesthetic activities of human beings are mainly aimed at aesthetic objects, such as visual works of art (such as patterns), which later extend to literature, music and dance. In the past, when people engaged in, discussed and studied these aesthetic activities,
they basically only carried out from the perspective of humanism and ontology. Until the 1990s, the latest progress in cognitive neuroscience inspired western cognitive scientists and philosophers have scientific thinking, they switched their attention to art and philosophy and aesthetics, from Western Europe and North America neuroscientists and neuropsychologist started from neuroscience, cognitive science, psychology, and evolutionary biology perspective to explore the aesthetic cognitive mechanism and so on[4].

Once the theory of aesthetic cognition is solved and reasonably used, neuroaesthetics will have a broad development prospect in the field of human real life and spiritual life, and may even be transformed into a new growth point of productivity and industry. By studying the neural mechanism embodied in the aesthetic experience, the neuroaesthetic cognitive theory explores the mystery of human thinking and seeks the answer to the basic problems of aesthetics. Of aesthetics at the same time, neural cognitive theory can be used to create practical value, for example, can use the aesthetic cognitive mechanism and influence factors on the product of art and design.

4. Application of neuroaesthetics in industrial design

4.1. Physiology state and the interest that decides physiology state

Many areas are involved in aesthetic cognitive processes, and brain functions related to aesthetics do not work alone to produce beauty. This has been demonstrated by various researchers using a variety of neuroscience and psychological research.

Physiological state determines whether a cognitive activity is aesthetic cognitive activity[4]. In life, when there is a lack of some survival needs, such as thirst or hunger, the body is in an unbalanced state, will form an unpleasant feeling and survival needs. After supplementing with water or food, the body returns to a state of equilibrium after the survival needs are satisfied. The experience and feeling of this state of equilibrium is called pleasure. Aesthetic, the basic human body in a state of balance, there is no urgent need for survival. At this time, through the visual and auditory perception of the shape can also obtain pleasure. That is, the sense of pleasure generated by the satisfaction of survival needs is pleasure or good feeling. The sense of pleasure arising from the perception of the shape of things is aesthetic. In other words, pleasure and beauty are caused by things that are good for people. The difference between the two is that pleasure is caused by the intrinsic advantageous value of the advantageous thing. Beauty is caused by the appearance of something good. Health directly affects the functioning of the brain and other sensory organs.

The state of health can directly affect people's survival needs and determine the benefit value of aesthetic cognition of some aesthetic objects on the whole. It is impossible for a man suffering from illness to enter into a disinterested aesthetic state. Think poppy beautiful people, for example, is far away from the drugs, they will only spend poppy unconscious into the flower that favorable cognitive model, and if someone was made of poppies drugs torture of body and mind, clearly feel poppy hazardous, the appearance of poppies will establish vertical connection with hazardous, form associated with disgust poppy cognitive modules. A poppy is not beautiful in these persons’ eyes. On the one hand, the gender of the aesthetic subject depends on the physiological state, on the other hand, it affects the aesthetic cognitive process, which is reflected in the value of the essence of aesthetics.

4.2. Evolutionarily determined genes and their applications

Aesthetic objects conform to the principle of evolution, which is one of the cornerstones of neural aesthetics[11]. Ramachandran's peak conversion principle and Chatterjee's demonstration on facial beauty, body beauty, landscape beauty and other aspects are all based on evolutionary principles. The evolutionary reason is often hidden in people's subconscious, or hidden memory is not easy to be detected, but this is the fundamental theoretical basis of the recognition of neuroaesthetics.

So how does this influence our aesthetics? The first and most straightforward is reproduction. Secondly, it is the emotion of aesthetic subject. Emotional attitude of an external object is subject, from ancient times to the present evolution of genes make people for some visual factors stimulation
and tactile stimulation produced different emotions, as the first section says, whether these feel emotion of human self in "safe mode", and determine whether tend to favor state, such genes from spontaneous judge whether gave us "pre-conceived" produce the experience of aesthetic feeling. In terms of reproduction, gender differences make men and women have different needs for survival and mating, so aesthetic cognition is different[12]. In addition, the evolutionary basis of aesthetic cognition is also determined, and gender influences the survival needs in the evolutionary process, thus forming different aesthetic cognitive preferences.

Visual stimuli have a greater impact on emotion. Vision is interested in finding safe and comfortable living environments, life-sustaining foods, and healthy offspring of the opposite sex. So see beneficial and advantageous, the thing that concerns with physiology pleasant sensation produces good impression, cause the tendency of affection, may produce aesthetic feeling. Red gives people a warm feeling, because the sun, fire is our source of heat, Green makes people feel the vitality of life, because green plants are the foundation of life, can let a person satiate hunger. But the sting of the wind and the rain is often a daunting thing, causing alarm in the unconscious. Although frogs and toads are of the same family, toads are ugly to people because their slippery, cold and poisonous skin makes people afraid and disgusted, but green frogs are quite pleasant by comparison. Evolutionary genes dictate many aspects of human aesthetics.

4.3. Memory and its application

In addition to above discussed factors, the influence of people's different backgrounds on aesthetic cognitive process is also widely recognized by neuroaesthetes. Others, like expertise and preferences and emotions, are based on context and memory. Memory is divided into conscious explicit memory and unconscious implicit memory, which play different roles in aesthetic cognition theory[10]. Lederer identified two stages in the cognitive processing of aesthetic appreciation: aesthetic judgment as implicit memory processing stage and explicit memory processing stage. Artworks were classified in the memory level and incorporated into the cognitive module of aesthetic subjects, which greatly increased the fluency of aesthetic cognitive processing. Meanwhile, Chatterjee points out that memory is evoked in the later visual process and involved in aesthetic cognitive processing, and memory is a component part of aesthetic cognitive processing input[3]. Locher even thinks that aesthetic cognitive processing depends on memory activation to some extent.

Memory can be divided into long-term memory, motor working memory and workspace memory, which have an impact on aesthetic cognitive creation process. Jacobs also proposed that the aesthetic experience of literary reading is originally the activation process of memory. The level of aesthetic subject's professional knowledge and skill is one of the important concerns in aesthetic cognitive theory research in recent years. It is no exaggeration to say that all in human beings should be built on the basis of human memory. Human life has a social attribute, and the social attribute is built by each person with a little bit of memory. A person's background, cultural knowledge and understanding of various objects are based on his or her past memory. When aesthetic appreciation of an object is carried out, he or she will be called upon uncontrollably and participate in aesthetic appreciation. This is an important perspective of aesthetic appreciation from the perspective of neural aesthetics mentioned above.

4.4. Objective factors and their applications

The objective factors of aesthetic cognition are mainly related to aesthetic objects, including their backgrounds, types and characteristics. When the combination of color, shape, texture and other formal elements conforms to the rules of symmetry and balance, harmony and contrast, people will have a sense of beauty[12]. The background of aesthetic object includes historical background, social background and environmental background, which is an important part of aesthetic cognition and involves the influence of culture, politics, religion and other aspects[4]. Background will influence the aesthetic subject for stakes cognitive aesthetic object.
The starting point of aesthetic object determines the kinds of aesthetic cognition: the starting point of visual aesthetic cognition is the main object of visual input, music aesthetic cognition is the starting point of the main hearing object input, literature is the starting point of the main aesthetic cognition and visual information content of the reading input, and dance aesthetic cognition is the starting point of the main hearing, vision and motion system input. The characteristics of aesthetic objects will stimulate people visually[1]. Through this kind of stimulation, if the processing aesthetic fluency can be improved or reached a certain height, people will have aesthetic feeling[13]. Similar to the title of aesthetic object, the symmetry, complexity, style and other characteristics of its shape will have an impact on the smoothness of aesthetic processing.

The title of aesthetic object can provide additional information of aesthetic object and help people better understand the intention that the object wants to express, thus affecting the overall aesthetic cognitive processing process. Chatterjee suggests that the title of a work of art helps promote processing fluency and deepen the aesthetic experience, guiding the brain in how to process the contents of an artwork[10]. The contrast of visual aesthetic objects also affects aesthetic cognition. The smoothness of the processing is powerful and explains the overall simplicity of visual pleasure rather than slight preference. Components of the motor system involved in exploring visual stimuli can influence aesthetic judgments because they lead to smoother experiences. Chatterjee proposed that people prefer objects that can be processed smoothly[3].

Fluency is affected by object features, such as symmetry, circular background relationship and aesthetic subject's experience, etc. Moreover, processing fluency is related to aesthetic pleasure. Chatterjee found that metaphase visual processing involves stimuli with features (as described above) that have attractive or pleasurable properties and are involved in the frontal and parietal attention circuits[7]. Moreover, these characteristics of stimuli are shaped by human evolution and human self-interest.

At the present stage, many designers advocate simple beauty, and reshape the characteristics of these objects in the simple beauty, at least to make the aesthetic object look comfortable in the form, easy to produce beauty. Although the original designer emphasized the concept of humanity, but this does not mean that a design without beauty can become the art of collection. It has made a good foundation in formal beauty and symmetry, and has made great efforts in the design of "alien" head, and has been highlighted in symmetry beauty and smoothness. Such application is a good explanation of materials.

5. Discussion and suggestion
Science and technology have made people's lives more convenient and hommization. Based on this background, industrial design will also present different design characteristics from the past, and will be more closely integrated with the Internet. Enterprises need to make changes in the process of product design, product strategy planning and operation mode to adapt to the development of the Internet and meet the actual needs of today's consumers for products. Product design occupies a large part of industrial design, product design in the future will have an inseparable connection with the Internet, emotional design is the general trend, to create a relaxed and comfortable life, not only to meet the different needs of users with high-tech, but also to increase emotional design, in order to improve the user's use experience[4], which requires designers to be big.

The public's emotions are assured. For example, logo design or website design of various companies will depend more on the relationship between memory and neuroaesthetics mentioned above, such as visual applications, color, pattern form, etc. In addition, with the development of the times, there has never been such a big difference between each person's psychology and personality. The development of interactive design will pay more attention to people's inner thoughts. In this regard, if we can use the necessary factors of neuroaesthetics to find the psychological orientation of most people, we will be able to make a successful industrial design product.

As mentioned above, industrial design ultimately exists for the sake of human comfort, and has its purpose. In this paper, the principle of neuroaesthetics and the cases applied to practical products are
described from the perspective of the cognition of neuroaesthetics to the outside world. But in the commercial mode, the product will be affected by some uncertain factors, not all aesthetic subjects will be in the above norms. In addition, the starting point of this paper is based on the perfect engineering of a product (that is, the product has its usefulness and no specific design error). Under such circumstances, aesthetics has received unprecedented attention, so it is urgent to apply neuroaesthetics to industrial design. In fact, many designers have already applied neuroaesthetics unconsciously with their own knowledge and the psychology of many people, but they have not narrated this process with applied neuroaesthetics.

References

[1] L. Zhang 2018 Discussion on the expression method of product integrated design in industrial design Entrepreneurs 33 147
[2] Z. Zheng 2009 The Evolution of Industrial Design Jiangnan University
[3] F. Meng 2018 Aesthetic Emotion in the Horizon of Cognitive Neuroaesthetics Jilin University
[4] Y. Wang 2018 An approach to western neuroaesthetic theories of aesthetic cognition Jilin University
[5] W. Zhang 2016 A Brief Analysis of Chinese and Western Design Aesthetics Modern communication 17 82
[6] H. Zeng, S. Wang 2017 Aesthetics: the Way to Happiness: A Study of Aesthetic Psychological Thought and Positive Emotion in Chinese Traditional Culture. Journal of Guangzhou University(Social Science Edition) 05 34-40
[7] D. Li, J. Xu 2010 The History of Modern Industrial Design is a Progressive History of the Continuous Improvement of Human Status. China Market 41 27-29
[8] J. Shi 2011 Probe into the Techniques Based on Mechanical-electrical Integration in Coal Enterprises. Sci-Tech Information Development & Economy 10 170-172
[9] Y. Xia 2017 The Power and Development of Aesthetics in Design. Peak Data Science 09 81-82
[10] S. Shao 2017 A Study of Rudolf Arnheim's Psychological Theory of Aesthetic Intuition. Jilin University
[11] B. Xu 2006 From pleasant sensation to beauty. Shandong University
[12] Y. Zhu, T. Zhang 2009 The Design and Aesthetic, The Research Based on the Relationship of Product Appearance Design and the Public Aesthetic Taste. Art and Design 03 187-189
[13] K. Yu 2005 On the Constitutive Principles of Design Beauty. Academic Exchange 04 191-193