Analysis of the Constituent Elements in the Design of Solar Photovoltaic Products

Wang Hong
Jiangsu Finance and Accounting Vocational College, Lianyungang, China
1093933740@qq.com

Abstract. By analyzing the design concept of photovoltaic product design, the components of photovoltaic product design are obtained. The sustainable development of solar photovoltaic product design will be integrated into all aspects of people's daily life, and its functional value will become increasingly prominent.

1. Introduction
Under the background of the shortage of mineral energy in the earth and the increasingly severe environmental pressure caused by traditional energy sources, the development and utilization of new green energy has become one of the mainstream trends in product design and development in the future. As one of the most promising sustainable energy sources, solar energy has the characteristics of universality, safety, reliability, noise-free, pollution-free, low control, low failure rate and easy maintenance. In the foreseeable future, it has broad market prospects. With the rise of the green trend, the design of solar photovoltaic products has become the focus of attention in the world.

2. Solar energy application in product design

2.1. Overview
At present, there are three ways to use solar energy: one is photothermal conversion, the common conversion device in life is a solar water heater; the other is photochemical conversion, which is a process of converting into chemical energy by absorbing light radiation to cause chemical reaction; Photoelectric conversion, that is, direct conversion of solar energy into electrical energy, the actual application of solar photovoltaic cells. The direct conversion of solar energy into electrical energy through photovoltaic cells is the most important form of solar energy utilization. The main goal of solar photovoltaic product design is to effectively apply the sustainable use of solar energy to product design, and to present the added value of product design perfectly, thus driving user participation and interaction.

2.2. The design concept should be reflected in the design of photovoltaic products

2.2.1. Green ecological concept. Photovoltaic products embody the awareness of green environmental protection technology, are a green product, and meet the green design of one of the modern ten design concepts to the greatest extent. As long as there is light, it can be used without any cost of photovoltaic energy, and has been applied to many fields such as construction, roads, vehicles, household products, portable products and so on.
2.2.2. Innovative design concept. Innovation is the soul of product design. Using TRIZ innovation theory to provide more theoretical support for conceptual design, so that the design has a clear goal and ideal solution, which helps designers to complete design integration [1] (Table 1). Today, energy conservation and emission reduction and green ecology are the lifestyles advocated by people, and more companies are joining the research and development of new energy products. Photovoltaic products are products that adapt to social trends and are an innovative product. The purpose of photovoltaic products is to create a more reasonable and harmonious social lifestyle.

| Design steps                  | Analysis result                                                                 |
|------------------------------|--------------------------------------------------------------------------------|
| Design goals                 | Photovoltaic products are beautiful in appearance and easy to use; humanized and intelligent in operation; perfect combination of photovoltaic technology and product design |
| Product ideal solution       | Based on a specific group of people, ergonomic, user-friendly design, comfortable operation |
|                              | Convenient, fast and easy to use                                                |
|                              | Appearance is suitable for the environment, no pollution, energy saving and environmental protection |
| Reach the obstacle of the ideal solution | The combination of technology and products is not in place | There is no technology to make the battery lasting powered. The battery and the electric board are bulky, the appearance is complicated, and it is difficult to operate | New working principles and technologies are still not available, and the role of design cannot be fully utilized. |
| How to solve the problem     | Unified PV product logo, model | New technologies, new principles, applications of new materials | Give play to the new value of design and apply the design invention to the product |
| Promote the formation of ideal solutions | Increase technical content | Increase design investment | Improved design of the product |

2.2.3. Humanized design concept. Product design should be people-oriented, and in the process of product realization, it should be integrated into the care and thoughtfulness of people. For the PV series products, attention should be paid to the satisfaction of people's use. Customized products are designed according to different levels of human needs, from physiological needs, safety needs, social needs, respectful needs, and self-fulfilling needs.

3. Components in the design of photovoltaic products
Based on the design concept that photovoltaic product design should embody, photovoltaic products should reflect the following design elements:

3.1. Technical structural elements
The direct conversion of solar energy into electrical energy is a product of the photovoltaic effect, which is one of the photoelectric effects. The so-called photovoltaic effect is a kind of internal photoelectric effect, which refers to the phenomenon that light causes a potential difference between different semiconductors or semiconductors and different parts of the metal to be combined. It is first the process of converting photon light into electrons and converting light energy into electrical energy. Secondly, it is the process of forming voltage. With the voltage, if there is communication between the two, a circuit of current will be formed. The material of the solar cell is mainly composed of an array of semiconductor junctions. Solar power generation is the application of the photovoltaic effect of a semiconductor junction, while semiconductors and junctions are the basic functional components of a solar cell.
3.2. Functional design elements
For product design, the “form following function” is the principle of constant, and the core of the product is the function of the product. When designing products, whether it is the use of materials, the choice of structural form, the shape of the form and the processing of the process, it is inseparable from the core of product function. In that kind of product design, functional elements play a vital role [2], designed to meet the needs of consumers. The starting point of the design is function, which is the embodiment of the requirements and scientificization of the demand [3]. In the design process of photovoltaic products, we must first meet the problems to be solved by similar product functions, and then explore the combination with technology and appearance.

3.3. Formal design elements
Form belongs to the sensible field of product design. It is subjective and intuitive. It is obvious by the designer's internal speculation. Different people will have different psychological feelings or evaluations, representing the differences between products and belonging to social culture.

![Figure 1. Solar sewage purifier](image)

Photovoltaic technology is used in photovoltaic upstream products, such as batteries and panels. Due to the limitations of the shape of these panels, the current design is bound to a large extent. For photovoltaic products, in order to ensure the correct installation of photovoltaic modules, it is necessary to make them more beautiful and reasonable in shape, in order to achieve the best benefits. As shown in the solar sewage purifier shown in Figure 1, the design concept of this product is good, but the appearance of the product is not easy to understand. The external structure is an intuitive understanding of us when we use it. It mainly plays the role of external form and internal function. The internal structure plays a central role. In the design of the design, we must grasp the internal structure of the product and start with the internal structure. [4] In any case, photovoltaic cells are moving toward a lighter and smaller model.

3.4. Interface design elements
The interface design of photovoltaic products can express interface information from both visual and tactile sensations. The design procedure of product aesthetics should be determined from the requirements of the appearance of the product. The basic use, function, manufacture, logo symbol and style should be established according to different needs. This should consider all aspects of factors
such as ergonomics and manufacturing. Material and engineering processing technology, human psychological experience, symbolic expression of the aesthetic effect, the representative company's corporate or functional aesthetic effects, as well as social factors, people's habits, etc., based on the above elements, comprehensive analysis of the reconstruction of specific products Interface image. The essence of photovoltaic products is to use new energy, environmental protection and energy conservation, and should be comprehensively designed according to its main functions and market positioning. In the future, photovoltaic products will be more relevant to human life. It will meet people's visual aesthetic requirements while satisfying people's functions.

3.5. Color Design Elements
The color design of photovoltaic products can be analyzed from the following aspects; the shape of the product, the environment in which the product is used, the material of the product, the function of the product, and the popular color. Two methods are commonly used in product color design: one is to directly design the color of the hue, brightness and purity of the color; the second is that the designer expresses the visual and psychological feelings required by the color design through the language. Translating it into the operation of the three elements of color is called a semantic design based on semantics. [5]

3.6. Surface material elements
In the design of photovoltaic products, designers should master various technical means, pay attention to the close combination of technology and materials, color, and indispensable, make full use of the long technology to achieve the best design results. Different design plans are made according to different products, but its direction is unchanged: In the design of the product, the parts that can be directly contacted by the human body and the places where the eyes can directly see should be made of materials with comfortable touch and excellent processing. The materials bring different surface textures. Through the choice of materials, the comfortable tactile effect can be improved, the product's pleasantness can be increased, and the product's spiritual taste can be shaped to achieve product diversity and economic effects.

3.7. Ergonomics elements
The remarkable feature of ergonomics is that on the basis of carefully studying the characteristics of the three elements of human, machine and environment, the scale of the product should be strong, and the form should be coordinated with the dimensions of the human body during operation and coordinated with the use environment. This system is referred to as a "human-machine-environment" system in ergonomics. [6] In this system, the interaction and interdependence of the three elements determines the overall performance of the system. In the design of photovoltaic products, the principle of ergonomics should be considered, and the product design conforming to the ergonomics principle not only makes life more comfortable and convenient, but also makes the relationship between product users and products become harmonious.

4. Conclusion
Solar photovoltaic product design has covered all aspects of human life, and it has raised the traditional concept of product design. It uses solar energy as an energy source to break through the limitations of market space, improve the diversification of product design functions, and increase the market value of products. It is based on high-tech industrial products and has established a product design science system that is closely related to daily life. Excellent solar photovoltaic products not only bring convenience to people in basic functions, but also actively expand more extended functions to allow users to enjoy the joy of products. Make full use of and develop solar photovoltaic products, continuously expand the functionality of product design, improve the application system of solar energy in product design, achieve sustainable economic development, and achieve human-machine-environment integration.
References

[1] Zhou Su, Zhang Lina, Chen Minling. Innovative Thinking and TRIZ Innovation Method [M]. Beijing: Tsinghua University Press. 2018 (07).

[2] Wang Yuyu. Art Design [M]. Beijing: Beijing Normal University Press. 2015, 12.

[3] Chen Wenlong. Product Design [M]. Beijing: China Light Industry Press. 2017, 59.

[4] Bian Shouren. Product Innovation Design——Deconstruction and Reconstruction of Industrial Design Projects [M]. Beijing Institute of Technology Press, 2002, 12.

[5] Bai Renfei. Product Design "Creativity and Methodology" [M]. Beijing. Chemical Industry Press, 2016 (02).

[6] Ding Yulan. Ergonomics [M]. Beijing: Beijing Institute of Technology Press. 2017 (01).