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## **RESEARCH ON SERVICE SYSTEM DESIGN BASED ON VISUALIZATION OF SUSTAINABLE PRODUCT CARBON FOOTPRINT**

*Chenyang Sun*

School of Design, Hunan University, Changsha, China; zzwgysunny@163.com

*Jun Zhang*

School of Design, Hunan University, Changsha, China; zhangjun@hnu.edu.cn

### **ABSTRACT**

The environmental impact of product production and consumption is gradually receiving attention. Visualization of carbon footprint is one of the main methods for promoting and developing sustainable products, and it is gradually receiving widespread attention from the international community. This paper first summarizes the current research status of carbon footprint and carbon footprint identification at home and abroad, and finally proposes a design method and implementation approach of carbon footprint visualization service system based on the product life cycle.

Key Words: Sustainable Design, Carbon Footprint, Visualization, Service design

### 1. INTRODUCTION

In recent years, with the deterioration of the ecological environment and the increasingly prominent environmental problems such as the resource crisis, they have become one of the important obstacles to human survival and economic development. The international community has begun to pay attention to environmental issues. To fundamentally resolve the contradiction between resources, environment, and economic development, we must start by changing the traditional production methods of producers and the consumption habits of consumers. And we should design a service systems for the product cycle to reduce their environmental impacts at all stages of the life cycle, “Procurement. - Manufacturing - Distribution - Use - Recycling - Disposal - Waste, etc.”, to reduce the environmental costs of the product over its life cycle (Ljungberg L Y., 2007), and exploring the promotion of sustainable products and its conceptual approach, attempting to bring the concepts of “environmental attributes”, “sustainability”, “carbon footprint”, “carbon labeling” into the marketing system of goods and the factors that influence consumer consumption decisions.

### 2. RESEARCH ON CARBON FOOTPRINT AND CARBON FOOTPRINT IDENTIFICATION

The United Kingdom proposed the concept of carbon footprint in 2006 (Carbon Trust, 2007). Carbon Trust in the United Kingdom defines the carbon footprint as a method and technique for accounting for greenhouse gas emissions in the supply chain of products in terms of carbon equivalents (Carbon Trust, 2007). The Environmental Technology Action Plan defines carbon footprint as greenhouse gas emissions from human activities (calculated as carbon dioxide equivalents) (BP, 2018). The Global Footprint Network defines a carbon footprint: the amount of carbon dioxide produced by humans while harvesting energy from fossil fuel combustion (GFN, 2007). The more authoritative definitions of Thomas Wiedmann and Jan Minx, the carbon footprint is the amount of greenhouse gas emissions generated during human activities or product life cycles and expressed in terms of carbon dioxide equivalents (Wiedmann T & Minx J., 2007). The carbon footprint is based on life-cycle analysis and evolved from the ecological footprint (Wiedmann T & Barrett J., 2007). Life cycle analysis is the systematic assessment of the environmental impact of a product or service throughout its life cycle from manufacturing to consumption (Hammerschlag R & Barbour W., 2003). The life cycle also includes the entire process of mining, refining, manufacturing, transportation, distribution, use, maintenance, recycling and final disposal of raw materials (Wackernagel M. & Rees W.E., 1996).

The carbon footprint identification is a concrete manifestation of the product’s carbon footprint, which shows the amount of greenhouse gases in the process from production to transportation to sales (some carbon footprint markings also include consumer use and disposal processes) (Wiedmann T & Minx J., 2007). One of the purposes of the identification is to enable companies to better communicate with their consumers about product information, to show consumers the contribution of companies in reducing emissions, and to provide consumers with carbon footprint information for consumers to compare products (Foran B et.al., 2005). As shown in Figure 1, many countries and regions around the world have their own carbon footprint identifications.



[Figure 1] Carbon footprint identification in different countries and regions

At present, there are few studies on the design of carbon footprint and carbon footprint identification service system at home and abroad, and most of the research focuses on the impact of the carbon footprint identification itself or the influence on consumers of carbon footprint identification itself. In addition, many are researching on certain factors, such as product packaging and factors affecting consumer spending, etc. Joseph Murphy (2007) in his research on the adoption and use of carbon footprint identification products, he studied the factors that influence consumers’ adoption of carbon footprint identification products as income, education and

socioeconomic status, and factors affecting consumers' use of carbon footprint identification products. For product type and revenue. Beattie (2008) in a project study on carbon footprint identification information and consumer response, pointed out that providing carbon footprint information for products is conducive to promoting consumers' green consumption behaviour. At the same time, in the sub-project of the project, Beattie also studied the attractiveness of the carbon footprint identification products to consumers and suggested that the company should put the carbon footprint identification information in the position of product packaging design that is more likely to cause consumers to resonate emotionally (Geoffrey Beattie, 2009).

In the product marketing process, visualizing products from raw materials to finished products to recycling production processes and carbon dioxide emissions throughout the life cycle is one of the effective measures to guide environmental consumption. With the introduction of environmental issues such as "climate change" and "white pollution", more and more consumers are beginning to pay attention to sustainable product design, and there are many consumers who are willing to change their purchasing behaviour to protect the environment. Consumers are gradually increasing their environmental awareness and beginning to pay attention to the environmental attributes of products. The gradual preference for sustainable products with environmental attributes will enable companies to develop sustainable product design processes and implementation specifications, improve product sustainability and enhance corporate image. In turn, it promotes the development of sustainable consumption, which will form a sustainable closed-loop ecology, making sustainability one of the important factors affecting the social, economic and ecological environment. Through carbon footprint visualization, companies enable consumers to have a quantitative understanding of the environmental impacts of product production and use, thereby guiding their consumption decisions. Therefore, it is of great practical significance to study the design of service systems for carbon footprint visualization and carbon footprint identification.

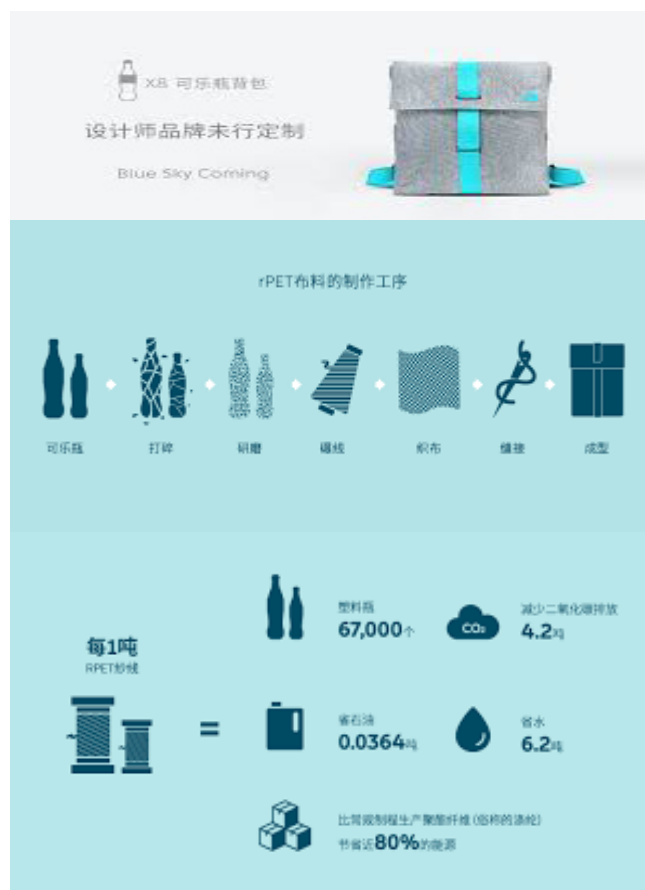
### 3. DESIGN AND IMPLEMENTATION OF SERVICE SYSTEM FOR PRODUCT CARBON FOOTPRINT VISUALIZATION

Today, "products (including physical and non-material products) are platforms for providing services" and "services are the main source of profit" (LUO Shi-jian & ZHU Shang-shang, 2011). Services can create value without wasting material and continuously create value through the product's complete life cycle (LUO Shi-jian & ZOU Wen-yin, 2018). The essence of service design is to design an effective model for organizing and planning people, infrastructure, communication, and various components of tangible materials in the service system (Vargo S.L. et.al., 2008). Product Service System Design (PSSD) is based on PSS, mainly for the strategies, concepts, products (material and non-material), management, processes, services, applications, recycling, etc. involved in product service systems for systematically planning and design (LUO Shi-jian & ZHU Shang-shang, 2011).

#### 3.1. Carbon footprint visualization

The company's carbon footprint analysis is the first step in sustainable development. By visualizing the production process, material structure, recycling method, and energy consumption and visualizing the carbon production savings in the process "selection - manufacturing - use - recycling - reuse - disposal", then applying them to all phases of the product lifecycle, which in turn manages and optimizes production and transportation processes, reducing CO<sub>2</sub> emissions, and creating sustainable product service system designs for producers and consumers. Through product carbon footprint analysis, the company visualizes the carbon footprint of products to achieve better communication with consumers. It can not only serve as a social responsibility measure for enterprises but also improve internal operations and save costs. Marketing strategies help companies gain a competitive advantage. In addition, it is an effective way to meet market demands and meet international requirements. They are a bridge to promote communication and cooperation.

Marketing incentives are divided into products, prices, distribution and promotions. Carbon footprint visualization is the stimulus that is reflected in products or distribution in marketing stimuli (Xue Qiang et.al., 2003). It stimulates consumers by showing consumers certain attributes of the product, thereby causing the consumer's psychological activities, forming an attitude toward the product and ultimately leading to changes in behavior. According to existing research, product information has a significant impact on consumer attitudes and behavioral changes (Loureiro M., 2003). As a product or distribution information stimulus, carbon footprint visualization affects consumers by providing offline consumer information, product packaging design, and online merchandise details, product parameters, etc. Product attitude. Today, when online shopping is so developed, it is one of the marketing strategies that companies promote to buy. Carbon footprint visualization provides consumers with an extension of product information that allows consumers to understand the carbon footprint of their products throughout their life cycle, from material extraction and material selection to product manufacturing, use, recycling and reuse to disposal. The complete process and process can help consumers to have an intuitive understanding of the environmental impact of the product and the product itself, to better evaluate the product and make their own choices. As shown in Figure 2, the eight Coke bottle backpacks released by Weilai in 2018 will focus on product production processes, innovative processes and carbon footprint emission reductions. The visualization allows consumers to visualize the low carbon properties of this product, which is also the marketing strategy of this product. This kind of marketing method can also be borrowed into more commodity fields and become the main marketing strategy for sustainable products in the future.



[Figure 2] NIO Life, 8 Coke bottle backpack product introduction

### 3.2. Carbon footprint identification

Product carbon footprint identification is an innovation in communication between enterprises and consumers (Munksgaard J & Pedersen K A., 2001). The carbon footprint identification is the stimulus that is reflected in the product through marketing stimuli (Xue Qiang et al., 2003). It also stimulates consumers by showing consumers certain attributes of the product. As a product information stimulus, the carbon footprint identification on the product packaging provides consumers with information about the product's interests, which influences the consumer's attitude towards the product, and is also one of the marketing strategies that the company promotes. The carbon footprint identification is also an extension of product information that shows the amount of greenhouse gases produced throughout the product life cycle. Its deeper meaning is to reveal that the company pays attention to the use of resources and the improvement of the production process at all stages of designing and producing the product, so as to optimize the production process and reduce the greenhouse gas emissions of the products. This indicates to a certain extent that the carbon footprint identification product is not only an environmentally friendly product but also its quality will be improved due to the optimization of the production process. The core attributes that consumers consider when selecting products are quality, brand, etc. Therefore, the carbon footprint identification becomes one of the important attributes that consumers consider when selecting products.

### 3.3. Government guidance and publicity education

Government policy support and guidance are indispensable key elements in the low carbon process. The guidance of policies and the improvement and supervision of laws and regulations can promote the rapid promotion and development of product carbon footprint. Carbon footprint visualization is not limited to carbon footprint identification or green packaging. The government should promote the development of carbon footprint and carbon footprint identification from the product life cycle and global perspective. For example, the Japanese government began implementing a carbon footprint system in 2009 to comprehensively record the carbon dioxide emissions of the product life cycle. Through the visualization of carbon emissions, the carbon emissions of commodities are clearly displayed in front of consumers, which provides an important basis for consumers to choose low-carbon products so that the low-carbon consumption concept is transformed into actual consumption behaviour and passed. We will play a guiding role in demand and supply, and promote low-carbon technology innovation in the production field, thereby promoting the low-carbonization of the entire society.

It is also crucial to the cultivation of low-carbon awareness in the whole society. Cultivating public awareness of energy conservation and emission reduction, guiding the direction of mass consumer behaviour is conducive to environmental protection, and has become an important challenge for implementing national sustainable development strategies and safeguarding measures to address climate change. Enhance the awareness of low-carbon people in the society, give them a deep understanding of low-carbon sustainable products, and promote their development

of low-carbon living habits; improving the recognition of top management is an important factor in the successful implementation of carbon footprint visualization. It can promote low-carbon education for employees and suppliers, so that design developers can deeply understand the relationship between products and the environment, analyze the impact of the various stages of the product throughout the life cycle, and find breakthroughs in reducing carbon emissions point.

#### 4. CONCLUSION

In recent years, with the development of the economy, the contradiction between resource and environmental issues and human social development has become increasingly prominent. Climate change has also become the focus of global attention. People are paying more and more attention to sustainable design, and consumers are addressing key players in climate change action. The service system design that visualizes the carbon footprint of the product throughout its life cycle allows consumers to have an intuitive understanding of the environmental impacts of the product. It is one of the effective measures for enterprises to guide consumers' consumption decisions on environmental protection, the government to cultivate public environmental awareness and consumers to develop environmental consumption habits.

#### BIBLIOGRAPHY

1. BP (2018), *What is a Carbon Footprint?* Internet site: [http://www.bp.com/liveassets/bp\\_internet/globalbp/STAGING/global\\_assets](http://www.bp.com/liveassets/bp_internet/globalbp/STAGING/global_assets)
2. Carbon Trust (2007), *Carbon Footprint: An introduction for organizations*.
3. Carbon Trust (2007), *Carbon Footprint Measurement Methodology*, Version 1.1, The Carbon Trust, London, UK. <http://www.carbontrust.co.uk>
4. Foran B, Lenten M, Bilek, M (2005), *Integrating sustainable chain management with triple bottom line accounting*, *Ecological Economics*, 2005,52:143-157 pp.
5. Geoffrey Beattie (2009), Information of carbon labeling and consumer response, final project report, *The University of Manchester Sustainable Consumption Institute*.2009(10).
6. GFN. Ecological Footprint Glossary (2007), *Global Footprint Network*, Oakland, CA, USA, Accessed July 2007.
7. Hammerschlag R, Barbour W (2003), *Life-Cycle Assessment and Indirect Emission Reduction: Issue Associated with Ownership and Trading*[J], *Institute for Lifecycle Environmental Assessment (ILEA)*, Seattle, Washington, USA, May 2003.
8. Joseph Murphy (2007), *Governing Technology for Sustainability [M]*, First published by Earthscan in the UK and USA, ISBN: 978-1-84407-345-0.
9. Ljungberg L Y (2007), Materials selection and design for development of sustainable products [J], *Materials & Design*, 2007, 28(2):466-479.
10. Loureiro M (2003), Rethinking new wines: implications of local and environmentally friendly labels [J], *Food Policy*, 2003,28, pp.547-560.
11. LUO Shi-jian, ZHU Shang-shang (2011), *Service Design*[M]. Beijing: China Machine Press, 2011.
12. LUO Shi-jian, ZOU Wenyin (2018), Current Status and Progress of Service Design Research[J], *Packaging Engineering*, 2018, (24): 43-53.
13. Munksgaard J, Pedersen K A (2001), CO2 accounts for open economies: producer or consumer responsibility[J], *Energy Policy*,2001,29:327-334pp.
14. Vargo S L, Maglio P P, Akaka M A (2008), On Value and Value Co-creation: a Service System and Service Logic Perspective[J], *European Management Journal*, 2008,26(3):145-152.
15. Wackernagel M. and Rees W.E(1996), *Our Ecological Footprint-Reducing Human Impact on the Earth*[M], New Society Publishers *Gabriola Island*, B.C., Canada.
16. Wiedmann T, Barrett J (2007), *Companies on the Scale-Comparing and Benchmarking the Footprints of Businesses*[C], *International Ecological Footprint Conference*, 2007, May 8-10, Cardiff, UK.
17. Wiedmann T, Minx J(2007), *A Definition of 'Carbon Footprint'*, *ISAUK Research & Consulting, Research Report*, <http://www.isa-research.co.uk/reports>.
18. XUE Qiang, ZHU Yuan, LI Ying (2003), Principal component analysis of factors affecting consumers' pre-purchase information search [J], *Journal of Dalian Maritime University*, 2003 (2).