

Research on 3R Design of Straw Woven Living Products based on Green Design Concept

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Abstract. Explore the 3R design strategy of straw woven living products from the perspective of green design. By analyzing the characteristics of traditional straw weaving technology, based on the principles of reduction, reuse and recyclability of 3R design, the green design strategy of straw woven living products is put forward, and the product development and life cycle are divided into design stage, use stage and abandoned stage, and the ideas of reduction, reuse and recycling and the implementation strategies of each link are put forward. Traditional straw weaving technology conforms to the idea of green design. The introduction of the 3R design strategy not only opens up the development path for the contemporary inheritance of traditional straw weaving technology, but also provides ideas for the realization of the green design of modern living products. The integration of straw weaving technology and 3R design will have important practical significance for cultural heritage, product development, resource conservation and environmental protection.

1 Introduction

With the development of modern design, designers create a good way of life and living environment for human beings, at the same time, they also cause great damage to the ecological environment of nature. In this context, designers began to reflect on the responsibility and role of design, green design came into being. As one of the folk traditional handicrafts, straw weaving technology covers the primitive simplicity design philosophy, and there is no lack of the concept of green design from materials to crafts, so it is necessary to dig out and support modern design.

2 Overview of green design

2.1. What is green design?

Green design, also known as ecological design and environmental design ^[1], means to fully consider the impact on resources and environment in the whole life cycle of the product, and minimize the negative impact of the product and its production process on the environment by optimizing the material, process, function, quality and other factors of the product. The concept of green design reflects human reflection on the ecological environment damage brought by modern science and technology, and it is also the return of designer professional ethics and social responsibility.

2.2. Principles of green design

There are six principles of green design ^[2]:

2.2.1. Make the best use of resources. We should minimize the consumption of non renewable resources, give priority to the use of renewable resources, and make full use of materials in the whole life cycle of products;

2.2.2. Make the best use of energy. We should priority to choose renewable energy and optimize the energy structure, such as the choice of solar energy, wind energy. At the same time, the energy consumption of products should be minimized in the design;

2.2.3. Minimize pollution. We should fully reduce the negative impact on the environment from material selection, processing to product use;

2.2.4. Humanized design. Consider human factors in the design, so that the product maximally caters to people lifestyle and even leads people lifestyle;

2.2.5. Selecting advanced technology. Green design as a comprehensive cross design concept, technical innovation is also its necessary premise;

2.2.6. Get the best comprehensive benefit. We should pay attention to the optimization of social benefits,

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economic benefits, ecological environmental benefits and human development benefits.

3 Overview of Straw weaving technology

3.1. The origin of straw weaving technology

Straw weaving is a traditional handicraft spread among Chinese people. It is a kind of handicraft technology that uses the flexible herbaceous plants produced in different areas as raw materials for weaving processing to make various articles for daily use. There is evidence that Chinese straw weaving is at least 7,000 years old, and the earliest straw relics discovered so far have been proved to be made by Hemudu people. It is recorded in the book of rites that in the Zhou Dynasty there was a kind of straw mat made of the stem or leaf of cattail called "Guan", and at that time, there was also a profession specialized in straw weaving called "grass worker" [3]. Straw weaving is widely distributed in China, mainly including Hebei, Henan, Shandong, Zhejiang, Guangdong, Hunan and other places. Due to different raw materials of each place, straw weaving technology has its own characteristics, but it also maintains the common characteristics of straw weaving.

3.2. Current situation of straw weaving technology

With the development of the industrialization of human society, many traditional folk handicrafts are confronted with development bottlenecks and even on the verge of being lost due to the problems such as fewer inheritors and great difficulty in promoting handicrafts [4]. Especially in the consumption era of fast fashion, traditional straw products lack a sense of design and modernity because they are not properly integrated with the modern lifestyle, which is difficult to be accepted by modern household style, resulting in the development of the traditional straw weaving technology being blocked. Therefore, it is necessary to combine contemporary life style and design trend, deeply explore and give play to the advantages of traditional straw weaving technology, find the path of innovation and development of traditional straw weaving technology in contemporary design, so as to activate folk traditional handicraft culture and support contemporary design [5].

4 Straw plaited article and 3R design

4.1. Characteristics of Straw plaited article

Straw plaited articles are selected from natural plant materials, which can be made into a variety of daily necessities such as straw mats, straw shoes, straw hats, baskets, straw shoes, carpets, handbags, toys, etc. It has the characteristics of beautiful and durable, safe and environmentally friendly, economical and practical.

4.1.1. Attractive and durable. Straw plaited articles retain the texture and texture of natural plants, showing a simple and elegant style, and are rich in hand-woven rich texture, which adds a bit of decorative beauty. At the same time, most of the materials used for straw weaving have stronger tensile strength, folding resistance and wear resistance, so they are durable in use.

4.1.2. Safety and environmental protection. In modern life, people must take "environment-friendly" as a yardstick, and give priority to those green products that avoid chemicals such as formaldehyde and harmful substances such as heavy metals in the process of production in choosing living products. Straw plaited articles just meet this standard. The herbaceous materials are natural and environmentally friendly, the processing technology is non-toxic and harmless, the waste products are easily degraded, so they have good safety and environmental protection.

4.1.3. Economical and practical. The straw plaited article have very high economy value, which are easy to regenerate and can be processed circularly. The product processing cost is low, and it is light and portable, which can save the transportation cost. At the same time, the herbaceous material has a mild nature and good breathability, so the straw plaited articles are comfortable to touch. They will not be cold in winter and hot in summer. In short, they are very practical.

4.2. What is 3R design?

The 3R design is also known as the 3R principle of green design, namely, reduce, reuse and recycle [6]. Its purpose is to control the consumption of materials and energy from the source of design and minimize the damage to the ecological environment caused by waste and energy consumption. The combination of traditional hand-made straw weaving technology and 3R design principle can provide double guarantee for green design.

4.2.1. Design principles for Reduction. From the perspective of resource conservation and appropriate utilization, energy saving in the process of production, processing, transportation, circulation and consumption is realized by reducing the weight, quantity and area of materials, so as to save resources and reduce waste. Reduction design can start from two aspects: ① Moderate development, that is, in product development, we should reduce product design that does not meet the needs of users and is not a necessity of life, pay attention to the foresight and moderation of development and design, and adhere to the "market demand as the guiding principle". ②Resource reduction, that is, in the use of resources, we should pursue the comprehensive benefits of low input and high output, strictly control the consumption of materials, labor, machines and other aspects to ensure the maximum use of materials.

4.2.2. Design principles for Reuse. From the perspective of reuse, it can continue to play a role by reusing the original waste materials or structural components that have been out of the product consumption track into the appropriate structure. To achieve this, it is necessary to fully consider the possibility of reusing the discarded straw plaited articles in the design stage. Generally, the sustainable development of straw woven living products can be achieved through the optimization of structure, the simplification of modeling and other methods.

4.2.3. Design principles for Recycle. From the perspective of regeneration, the recycled waste products or component materials can generate new material resources and continue to be used through the treatment of recycling processing technology. The natural herbaceous materials used in straw plaited articles can be used as raw materials for processing many materials, so they have strong regeneration.

5 The 3R design strategy of straw woven living products

The 3R design idea of straw woven living products cannot simply consider the sustainable use of new materials generated from waste materials after recycling processing. But, we should give priority to the design principle of reduction and reuse, in order to minimize the waste of recycling processing in artificial aspects while achieving the recycling use of resources, so as to reduce the load of ecological environment.

The 3R design procedure and strategy of the straw woven living products (See Figure 1), from the perspective of green design, the life cycle of living products is divided into "design stage, use stage and abandonment stage". Then, the 3R design concept is mapped to the specific implementation of each link, and the following strategies are put forward for the 3R design of straw woven living products.

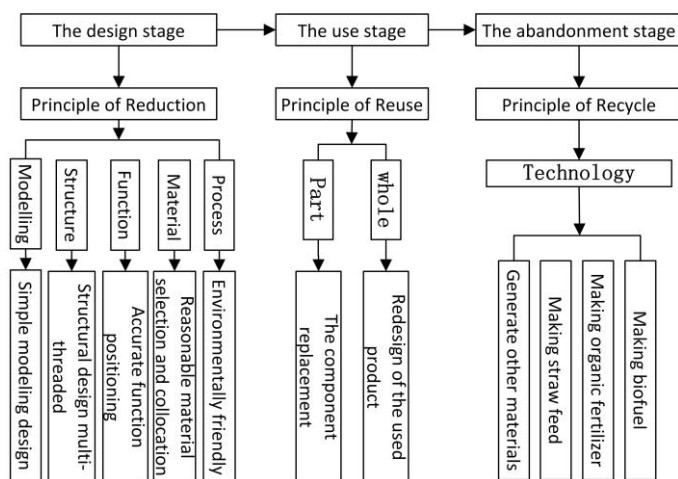


Figure 1. The 3R design process and strategy of straw woven living products.

5.1. The design stage-- Principle of Reduction

In the design stage, we should adhere to the principle of reducing design, take market demand as the guide to start the design orientation, consider the possibility of using straw plaited articles in the contemporary lifestyle and the future development trend, adopt the elastic strategy to reduce the waste that may be abandoned due to some functional changes in the future, and realize the reduction from five aspects of modelling, structure, function, material and process respectively purpose of design.

5.1.1. Simple modeling design. To save resources and reduce costs is the purpose of green design. The modeling design of straw plaited articles is simple and full of rural flavor. It pays attention to practicality in product design, such as straw woven baskets, vases and other shapes are simple geometric forms, without any extra decoration, expressing the design concept of "less is more". This green tradition should be continued in the modern development of straw woven living products,

and all modeling designs have their functionality to reduce the waste of resources caused by unnecessary material use and processing. We can use the method of modern design to add some auxiliary functions to the traditional straw woven products through reasonable design, or develop some new use functions in combination with contemporary lifestyles, so as to extend the use cycle of straw woven products and achieve the purpose of saving resources at the same time.

5.1.2. Structural design multi-threaded. Structure is mainly a way to support and load-bearing, only a reasonable structural design can achieve material reduction and reuse. The maximum utilization and the minimum destruction in the structural design is also a way to achieve reduction, so multi-threaded structural design can be considered. The so-called multithreading is borrowing the multithreaded programming theory in software engineering. In the structural design of products, the multithreading of product structure can be realized by modularization, multi-function, split combination and other methods, so as to improve the recyclability of materials or parts. For example, for a straw woven

product with a modular combination design, each independent module has its own independent use function, and the combination with other modules can generate new use functions, so as to achieve the effect of

$1 + 1 > 2$ (See Figure 2). Even if one part of the series modules is damaged, the use of other modules will not be affected, so as to minimize the waste of resources.

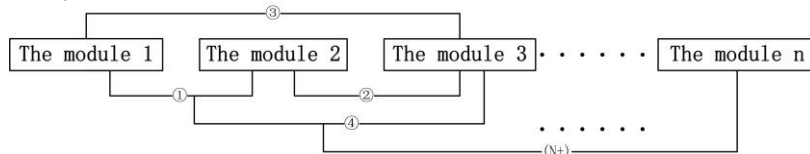


Figure 2. Principle of modular structure design.

5.1.3. Accurate function positioning. The functional positioning in product design should be closely related to market demand, and so should the straw woven living products. The function positioning should be based on the market demand, to avoid the waste of material resources and design labor, so as to realize the reduction

design. The functional positioning of straw woven living products should pay attention to the living needs of contemporary people and accurately target the target group. The determination of product function should start from the psychological and behavioral characteristics, usage habits, behavioral needs, psychological desires and usage scenarios of the target group (See Figure 3).



Figure 3. Product functional positioning.

5.1.4. Reasonable material selection and collocation. First of all, we should choose the materials reasonably. Choosing the right material to do the right design is a good interpretation of the principle of reduction design. Due to the different producing areas, the raw materials of straw weaving have their own advantages and disadvantages in the aspects of smoothness, flexibility and abrasion resistance, etc. In the product design of different use function and use occasion, the appropriate raw materials should be selected according to needs. For example, straw slippers, straw handbags and other products that have close contact with people's body, considering the comfort in use, we should choose materials with smoother softer texture and better abrasion resistance, to avoid discomfort caused by friction and short-term waste caused by damage of articles.

and accurate size, so as to make full and reasonable use of ingredients. In the production process, the processing procedure should be minimized, which can not only set off the unique charm of the main material straw weaving, but also conform to the design principle of reduction.

Secondly, we should reasonably mix the materials. The selection of matching materials can be precisely matched according to the use and environment of straw products. For example, when we designing furniture products such as seats with high load-bearing capacity, it is usually necessary to use hard wood or metal materials as the bearing frame [7]. At the same time, the selection of frame materials should be based on the bearing capacity

5.1.5. Environmentally friendly processing technology. There are eight processing methods in the traditional Straw weaving technology, which are weaving, jacquard, knotting, plate-nailing, embroidering, pasting, Embellishing and painting [8].

"Weaving" is the first process, and also the main process method of all straw woven products, that is, weaving all kinds of grass into 0.3-1.2cm wide straw braids. "Jacquard" technology is to use the technique of picking up a section of weft every other warp line in the process of weaving to form jacquard patterns of various graphic patterns, which is called "jian jing tiao wei" in Chinese. "Knot" is to use the method of winding, twisting and fastening to make patterns. "Plate nail" is to use tools to connect geometric patterns together to get a composite pattern. "Embroidery" is to heat the semi-finished products to make them flat, and then embroider various decorative patterns. "Paste" is to cut the cloth or fur which has become flat after sizing into

the required pattern, then paste it on the formed product, and finally fix the edge with the embroidery process. "Embellishment" refers to the insertion and fixation of material beads, mica sheets, plastic or metal accessories for decoration on the formed products to achieve the purpose of beautification. "Painting" is to draw decorative patterns with color pigments on the formed straw plaited articles.

All of the above, the first four belong to modeling process and the last four belong to surface decoration process [9]. All of them are made by the most primitive hand-made, energy consumption and environmental pollution are close to zero, which conforms to the principle of reduction design.

In addition, in the color processing of raw materials, the primary color or natural color is preferred. We can also innovate environmental protection processing technology, for example, we can change the color of straw plaited articles by fumigation.

5.2. The use stage-- Principle of Reuse

In the use stage of straw woven living products, we should pay attention to the design principle of reuse, improve the utilization rate of finished products and extend the life cycle. We can start from the following two aspects.

5.2.1. The component replacement. If there is damage to parts in the use of straw woven living products, component replacement can be used to extend the using life of the product. The straw woven products are quite different from other living products in connection mode. Other living products are connected by adhesives, screws and other ways. The straw woven living products are connected by means of weaving, knotting, plate-nailing, etc., which is convenient for disassembly and connection, and it is more convenient to replace if it is a modular, combined-split structure. This method of replacing parts conforms to the design principle of reuse, which can effectively extend the service life of straw woven living products and reduce the rejection rate.

5.2.2. Redesign of the used product. When the product is damaged, it can be redesigned into a new product through the reuse of materials, so that the product can obtain a second life. In the process of using straw woven living products, if the whole structure is damaged and can no longer be used, users can be provided with old-for-new services. The recycled used products can be redesigned by the designer, that is, the discarded straw woven products can be simply transformed to evolve into new products. For example, the damaged straw hat, basket, vase, etc. can be transformed into lamps, watches, etc. according to the proper design of the damaged parts, so as to realize the continuation of the product life cycle (see Figure 4).

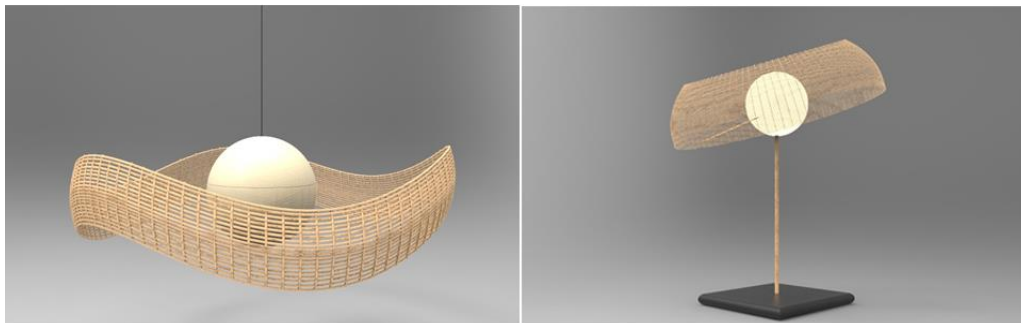


Figure 4. Lamps and lanterns transformed from used straw woven product.

5.3. The abandonment stage-- Principle of Recycle

At the end of the product life cycle, it enters into the abandonment stage. Due to the loss of use value, the idea of recycling can be considered for abandoned products, that is, recycling of materials can be realized through recycling and reprocessing. At present, the reprocessing technology of straw weaving materials is relatively mature, and there are several recyclable schemes to choose.

5.3.1. Generate other materials. Straw for straw weaving is also a raw material for other materials. As early as the Han Dynasty in China, hemp fiber was invented as the raw material for papermaking. Later, it

gradually developed to use rattan skin, bamboo, wheat straw, straw and other raw materials for papermaking. Therefore, the waste straw woven products can be used as raw materials to generate various kinds of paper, and can also be used to generate more widely used cardboard materials such as corrugated paper, so as to realize the regeneration of materials. In recent years, there are more processing technologies of making environmental friendly tableware with plant fiber, such as rice husk tableware. This kind of new material has the characteristics of natural, non-toxic, easy degradation, non pollution, high temperature resistance, etc., which conforms to the environmental protection concept of green design.

5.3.2. Making straw feed. In the breeding industry, there is a simple technology to make straw feed, which is

mixed processing of straw of the family Gramineae, wheat and rice husk, weeds, etc., and pretreated with preparation, just like imitating the fermentation environment of cattle stomach, decompose plant fiber fermentation into natural straw feed suitable for pigs, cows, sheep, chickens and other livestock. Most of the raw materials of straw plaited articles are straw of the family Gramineae. As long as there is no toxic pollution in the use process after the products are discarded, they can be used as the main raw materials for straw feed and play a full role.

5.3.3. Making organic fertilizer. Agricultural planting advocates the idea of returning straw to the field. The material of abandoned straw woven products can also be composted to produce straw bio organic fertilizer, which can not only return to nature, but also nourish the growth of new straw plants, so as to achieve real resource recycling.

5.3.4. Making biofuel. The raw materials of straw plaited articles can be used for burning or heating. With the development of science and technology, it can also be made into the more environmentally friendly biofuel through biotechnology to reduce human dependence on oil.

6 Conclusion

Since the earth's "energy crisis" broke out in the 1970s, the concept of green design has attracted more and more attention. The combination of 3R principle of green design and traditional straw weaving technology into the design of living products not only carries forward the simple and natural thinking of straw weaving technology, but also conforms to the sustainable design principle of contemporary design. It enriches the exploration of product design between traditional craftsmanship and green design, so it has high promotion value.

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