Design Studies and Intelligence Engineering
L.C. Jain et al. (Eds.)

doi:10.3233/FAIA231501

Design of Fast-Growing Plant Material Woven Furniture Products Based on Sustainable Concepts

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Abstract. In today's society, with the growth of population and energy consumption, various natural resources are rapidly depleted, and traditional handicrafts are on the verge of being lost because they do not meet the needs of modern life. Fast-growing wood product weaving is a social activity made by artificial weaving using bamboo, rattan, willow, grass, hemp, palm, etc. as raw materials. Woven furniture made of fast-growing wood is a new type of furniture with great development prospects. It is environmentally friendly, has aesthetic appeal, and has cultural connotations. Starting from the aspects of green environmental protection, culture, fun, simplicity, etc., it provides an idea for the innovative design of this type of furniture. Taking bamboo as an example to illustrate sustainable furniture design strategies.

Keywords. Sustainable concept; fast- growing plants; furniture design

1. Sustainable design concept and overview

In 1987, in the article "Our Common Future" published by the United Nations World Commission on Environment and Development, "sustainable development" was defined for the first time as: sustainable development that effectively meets the needs of the present without affecting the needs of future generations. This shows that on the premise of achieving economic development and people's prosperous lives, we can fully realize the protection of the ecological environment and the rational use of natural resources [1]. Liang Ting, a scholar at the Hong Kong Polytechnic University, explained the concept of sustainable design: Sustainable design is different from design that usually only uses physical products as output. Instead, it establishes and develops sustainable design that meets the special needs of customers by combining products and services.

Sustainable design is based on sustainable development and strives to achieve sustainable development of humans, nature, society and ecology. Furniture is ubiquitous in people's lives and cannot be separated from it. From production to use to disposal, it is closely related to the ecological environment and inseparable from sustainable development. Sustainable furniture design refers to the application of sustainable development concepts in the furniture design process. This article will analyze the design forms of rapidly growing plant material woven furniture products based on the concept of sustainability, and propose corresponding solutions using bamboo furniture nas a example.

2. Fast-Growing Plant Materials for Woven Furniture

The materials for weaving furniture from fast-growing wood materials are easy to obtain, and there are many materials to choose from. The weaving methods of various materials will have some subtle differences, and the final results will also have some subtle differences. Bamboo is exquisitely woven, rattan is exquisite, willow is rough, and straw is soft. All kinds of materials can be combined with each other. It is a kind of furniture with great development potential. Depending on the softness, suppleness, toughness, and thickness of the woven materials, their strengths and weaknesses can be exploited. In the process of making furniture and daily necessities, bamboo and rattan combinations and willow grass combinations are more commonly used. Using short-cycle plants as raw materials, we weave a green and environmentally friendly product, which is a product that is very popular among contemporary consumers. In addition, this type of furniture is both creative and beautiful in its woven patterns.

Bamboo woven furniture is made of bamboo as the main body. It is a household item that uses other materials as the skeleton and bamboo as the veneer to fill the skeleton. It is usually made of a combination of bamboo and wood or bamboo and rattan [2]. Its types include bamboo dining tables and chairs, sofas, coffee tables, side tables, screens, etc. Compared with willow and rattan furniture, the processing procedures of raw materials such as bamboo strips, bamboo strips, and bamboo strips are much more complicated. Although the bamboo decorative surface made by this method is more refined, the cost and labor are relatively high. In the creative design of contemporary furniture, bamboo is an important structural form, which proposes a new idea for the fusion of traditional and modern furniture. There are various ways to connect the frames of bamboo furniture, inheriting the wisdom of traditional Chinese handicrafts. As shown in the following diagram, it can be generally divided into three methods: bending, wrapping, and inserting.

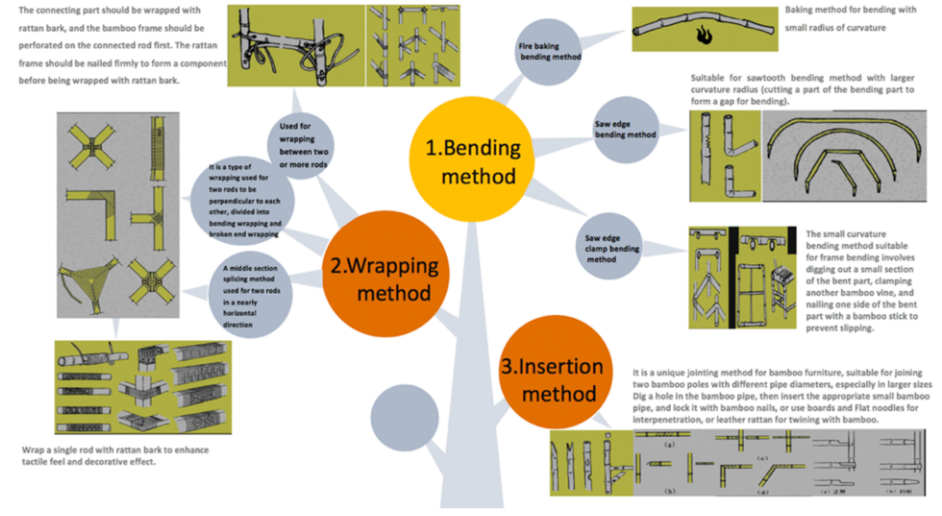

Figure 1. Joining methods for bamboo furniture frames

With the development of the times, various new technologies for bamboo materials are rapidly developing, new products are constantly emerging, and the scale of industrialization has significantly increased. Bamboo bending furniture, which is deeply

loved by consumers, has emerged in the market. Bamboo curved furniture is usually composed of several bamboo curved components and connectors, demonstrating a sense of curve and softness in form. However, due to the different unit compositions of bamboo furniture, there are also differences in its processing methods. According to the different classifications of furniture materials, their bending components usually come in different forms such as round bamboo tubes, bamboo strips, bamboo strips, and bamboo laminated timber. The addition of bamboo bending technology not only makes furniture decorative, practical, and interesting, but also adds a unique cultural atmosphere. As shown in Figure 2.

Figure 2. Bamboo furniture

Rattan furniture, also called “rattan big pieces”, is a kind of furniture made of thick rattan as a frame and wrapped with rattan bark and stem core. It includes chairs, stools, sofas, beds, tables, tables, shelves, and cabinets, cabinets, screens, etc., are all elegant and exquisite. In addition to rattan leather furniture, rattan core furniture, rattan furniture, and polished rattan furniture, there are also many kinds of rattan furniture such as rattan bamboo, rattan wood, and rattan steel, which are durable and durable. Rattan furniture is made from fast-growing plants and has the most types and styles. This is mainly because the thickness of rattan materials is different. Thick rattan can be used as bones, while thin rattan can be used for weaving [3]. Nowadays, some people use paper, plastic, leather and other materials to imitate the rattan craftsmanship to create "imitation rattan furniture", which is very similar in visual and aesthetic terms, is low in price, and has great development potential. As shown in Figure 3.

Figure 3. Rattan furniture

Straw weaving is a handmade product made of various soft herbs, with wheat straw, corn husks, and cattail woven as the main materials. Straw furniture is mainly small furniture such as poufs, futons, and low tables. Air-dried water hyacinth is a good textile material, but its production process is complicated and requires drying of the material. The water hyacinth house has sofas, chairs, stools, lamps, beds, flower utensils, etc. The materials are naturally rough, the color is elegant, and the texture is thick. It is not only green and environmentally friendly, but also brings a sense of leisure and wildness to the

room. Currently, this type of furniture is mostly available in foreign furniture markets, but its popularity in China is not high. As shown in Figure 4.

Figure 4. Straw furniture

Wicker furniture is a kind of furniture made of wicker. Traditionally, it usually refers to willow composite furniture. It uses wood as the skeleton, uses the whole willow as the warp, and the willow bark to weave the weft. It is woven through weaving and two-way. A kind of furniture made by latte art and other methods [4]. Modern willow products can also be combined with materials such as metal and plastic, but willow wood is more commonly combined with traditional willow products. Wicker furniture is lightweight, practical, and beautiful. Its weave pattern is unique, its material texture is natural, and it has a great decorative effect. Wicker furniture can be roughly divided into tables, chairs, cabinets, shelves, beds, outdoor leisure, etc. With the changes in modern people's lifestyles, wicker furniture is dominated by casual style. As shown in Figure 5.

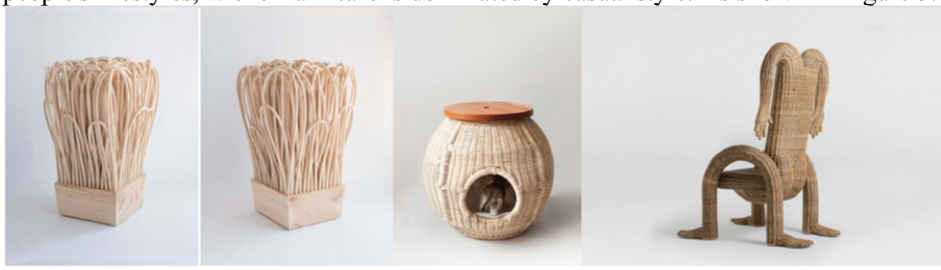

Figure 5. Willow furniture

When it comes to woven furniture made of fast-growing wood, the first thing that comes to mind is rattan and bamboo furniture. The development of these two types of furniture has attracted more attention, and willow products are more famous. However, from the perspective of raw materials, rattan is highly moisture-loving and mainly grows in the tropics and subtropics. However, my country's rattan resources are relatively scarce and harvesting is difficult, and the processing process of bamboo is relatively complicated, resulting in high production costs. Qiliu is a plant that is relatively easy to survive. It likes fertilizer, water and rain, and its growing season is very short. It can be harvested twice a year. It has a wide range of growth, its raw materials are much cheaper than rattan bamboo, and its processing is relatively simple. In addition, wicker products are elegant in color, durable in the sun, come in various patterns, and are beautiful. Under the current dual background of "green environmental protection", "traditional craft protection" and “humanistic care”, the art of “willow weaving” has huge space for innovation and huge market value.

3. Analysis of fast-growing plant material woven furniture design

3.1 Environmentally friendly

Environmentally friendly furniture is a whole process from raw materials to production, use to recycling. It causes less pollution, wastes less energy, and can be degraded and recycled. During use, the material factors of the product cause minimal damage to the human body. From the functional perspective of furniture, it can reduce unnecessary functions and will not waste resources.

It is made from fast-growing tree species and natural materials. Its growth rate is faster than ordinary wood, which can realize the sustainable utilization of raw materials and is easy to decompose naturally after being discarded. We use green, fast-growing plants as raw materials to design woven furniture, and summarize the design points into two aspects: material and function. The materials used can be divided into: woven raw materials and auxiliary frame materials. In terms of woven materials, try not to dye or spray them as much as possible to retain the original color of the plant and reduce the pollution of colorants [5]. You can choose metal or logs as auxiliary frames. The wood uses a traditional willow frame, which can be more flexible when weaving, but avoid using plywood that releases formaldehyde. The metal frame is combined by welding. When designing, you must consider the focus point of the weaving in advance to ensure that each side has four sides, or a closed side weaving frame. If necessary, you need to discuss it with the craftsman. communicate. The structure of the product should be very simple, minimize unnecessary functionality, and combine environmental protection with simple beauty.

The “straw stock” created by Juan Cappa uses natural fast-growing material straw combined with a simple metal frame to create a sustainable and environmentally friendly furniture design.

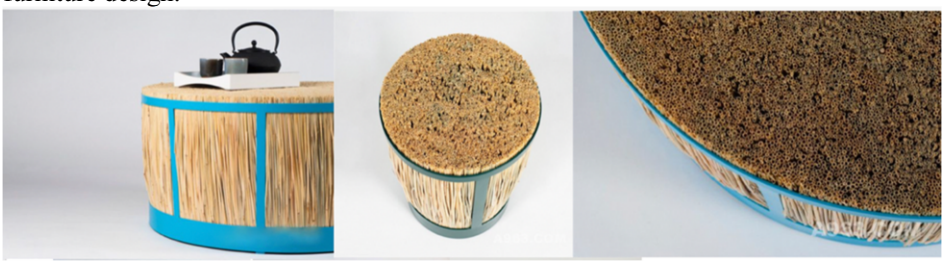

Figure 6. Straw furniture by Juan Cappa

3.2 Cultural type

Cultural design is to integrate the culture of weaving raw materials, weaving equipment culture, traditional ecological culture and traditional culture into furniture modeling. This type of furniture culture is carried out at the subconscious level and introspection level. It awakens or increases human memories of culture through changes in the external form of furniture. At the same time, it can also use the surrounding atmosphere to It creates an emotional interaction between people and objects (woven furniture), thereby conveying thoughts on consumer culture.

Culture makes people think deeply and settle their souls, while living space is a place where people can rest physically and mentally. Through cultural decoration,

people's emotions can be improved, and at the same time, culture can bring People's spiritual satisfaction and happiness make products resonate emotionally with consumers. However, unlike the bedroom, the living space is a window that communicates between the inside and the outside of the home, which allows this type of home cultural design to develop in the direction of decoration, with aesthetics as the main purpose and practicality as the auxiliary. In the cultural design of furniture made of fast-growing plant materials, the selection of culture is an important link. It must match the material according to its characteristics and combine it with the cultural form that it adapts to. Simply pile them up, but look for cultural connotations that can inspire people. Try to think about the combination from the perspective of the reflective layer, analyze different cultural groups, and “prescribe the right medicine”.

3.3 Simple type

The admiration for simple design is also due to the development of society. In this era of extremely abundant materials, there are many things to choose from, and the same is true for external stimulation. “Five colors make people blind, five tones make people deaf, and five flavors make people taste bad.” It's cool. Things are born for people and used by people. When it becomes an obstacle that prevents you from doing things, it will become easier and easier.

Dazzling excitement and products also encourage people to tend towards simple designs, and some people have begun to pursue a simple life. Less is more, more is more confusion. The simple design of fast-growing plant woven furniture is to meet the most fundamental needs of users. It is not only an expression of the simple furniture form that people choose, but also affects people's lives.

The specific design performance is to cut off unnecessary functionality, decoration and interest in the furniture to achieve the purpose of moderation. Secondly, we must abandon some unnecessary things. Because human energy is limited, the shapes of furniture that can be used are also limited. Things that are unnecessary or not suitable for your own development should be abandoned. When designing, and try to avoid useless furniture. Finally, to liberate people from dependence on items, this requires furniture to adhere to its proper functions and bring maximum appeal to users. The design of simple and fast plant material woven furniture should follow the concept of "less is more", maintain basic functions, focus on function, and pursue the texture of the product in the few places where the design effect can be achieved.

4. Sustainable Design Strategies for Bamboo Furniture

4.1 The strength of bamboo

Bamboo material itself has high mechanical strength and is very easy to split. From the data in the table below, it can be seen that the tensile strength of bamboo can reach about twice that of wood, and the compressive strength is more than 10% higher than that of wood. Even under the same unit weight, the tensile strength of bamboo can even exceed that of steel by 2-3 times. From this, it can be seen that bamboo is very suitable for making furniture in terms of mechanical properties.

Table 1. Strength Comparison of Bamboo, Wood, and Steel

Type		Tensile strength (Mpa)		Compressive strength (Mpa)	
		Weight	Average	Weight	Average
Bamboo	Moso bamboo	1947.9	2086.3	642.0	488.5
	Steel bamboo	2835.6		541.8	
	Lacquered bamboo	1822.4		358.9	
	Hemp bamboo	1952.3		411.5	
Wood	Cedarwood	713	1008	404	427
	Chestnut wood	985		359	
	Pine	1302		527	
	Birch	1035		428	
Steels	Mild steel	3780-4251	5170-5563	The tensile strength of metal materials is called compressive strength.	
	Semimild steel	4400-5000			
	Semihard steel	5200-6000			
	Hard steel	7300			

Bamboo has high mechanical strength, strong compressive and tensile properties, and bending resistance. From a physical property perspective, as long as suitable material selection and processing methods are used, bamboo is very suitable for furniture production.

4.2 Design strategies to cope with changes in color texture

The so-called natural bamboo utensils are bamboo utensils that use bamboo as raw materials and then undergo physical treatment. The color of such bamboo is difficult to grasp. The color of bamboo is not cyan as seen from the outside, but some are yellow, some are white, and some are black.

As long as they are natural-colored bamboo utensils, during long-term storage and daily use, their colors will generally range from green (white) to yellow (yellow), and then to reddish brown. This is because of the characteristics of bamboo itself, which will change according to the environment. Change with change. Therefore, we cannot conclude just from the color that yellow is the bamboo inside, green is bamboo green, and bamboo green is not necessarily cyan. To judge whether it is bamboo green, it depends on whether there is a layer of sodium-like substance on its surface. Things, this red represents old things, or it may be an old color. This is a kind of high-quality natural bamboo that will change color after some changes; from green to yellow, then to black [7]. The reason why they become dark is because these bamboo utensils did not have time to dry during storage and use, or were soaked in water for too long, or were made of tender bamboo or Yinshan bamboo, so these bamboo utensils will not be used in the future. They will become moldy and black. Such bambooware has no collection value, and most of them are defective products that have passed the test of time. This is also a problem we want to avoid when designing.

The color and texture of bamboo itself will change with age, and it will also be affected by the surrounding environment. As the age of the tree increases, the yellow and red colors of the bamboo will become darker and darker. At the same time, the brightness of the bamboo will also decrease, and the color will become more stable, from green to yellow-green, then to yellow, and finally Black spots appear. The bamboo furniture

meticulously designed by German designer Stefan Dietz in Figure 7 gradually changes its processing surface from light green to gray, restoring the true color of bamboo as much as possible and allowing users to see the age of the product. The original bamboo, with the passage of time, will present a buckwheat color and become more distinctive in this type of bamboo furniture.

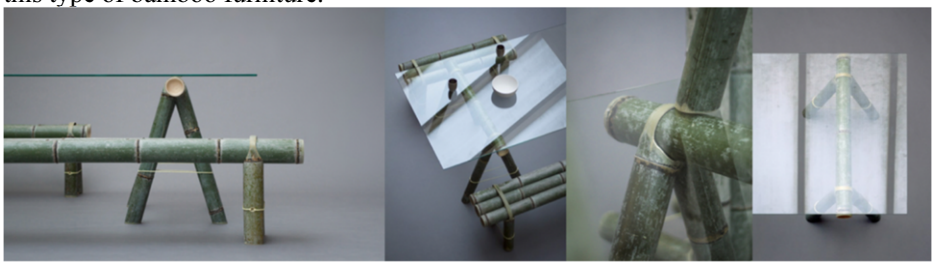

Figure 7. Bamboo furniture by German designer Stefan Dietz

4.3 Design strategies to deal with bamboo cracking and damage

After a set of bamboo furniture is completely damaged, it can be disposed of reasonably even when the bamboo is broken. For example, a broken bamboo strip can also be modified according to your own needs, including bamboo strips, bamboo strips, bamboo filaments, etc.

Composed of different types of bamboo, after the existing form changes, the same material can produce more and more novel effects. The bamboo sticks are handmade with no other connection methods, subtly expressing the characteristics of bamboo and looking both vivid and interesting. During manufacturing, the designer will split one end of the bamboo in half, then hammer it to form a dandelion shape, and then carefully stack each piece of bamboo together to form a huge Ottoman-style structure. The originally hard material became extremely soft at this moment. After careful design in figure 8 by Stefan Dietz, bamboo furniture consists of a bamboo bench and a pair of brackets, which can be fixed together with a single rope to support the entire desktop. If there is any damage, reassemble it again to restore its use status.

Figure 8. Design strategies for furniture cracking and damage

4.4 Design strategies for convenient packaging and transportation

During the handling and packaging process, the sustainable development of bamboo furniture is expressed as the smallest possible size, lighter mass, and less easily damaged parts, which embodies the sustainable design concept, including the energy consumption

during transportation. Consumption, labor handling cost, occupied space, damage rate during transportation, consumption of packaging materials, etc. Stefan Dietz's bamboo furniture can be packaged flat, solving the problem of large and heavy handling space. Soba reinterpreted the traditional bamboo bench by incorporating clever twisting structures into the bamboo structure, making it easy to assemble bamboo furniture and achieving flat packaging. Using powerful fiber ropes and wooden handles at both ends, the joints need to be tightened for assembly. A connecting strip is left around the top of the leg stick of the bracket, which can be assembled in just a few minutes, making packaging and transportation convenient and easy.

Therefore, reasonable design must be carried out based on the physical and chemical properties of bamboo in the early stage of design. It's cleverly designed to fit all parts into a small space.

Figure 9. Strategy for assembling components

4.5 Design strategies for bamboo recycling

With the reduction of global forest resources and the strengthening of environmental protection awareness, finding low-carbon, environmentally friendly, and sustainable materials has become a top priority in the field of materials research in various countries. Bamboo materials are renewable resources with a short growth cycle of 4-5 years, while wood typically has a production cycle of over 15 years. As the world's preferred alternative to wood resources, bamboo will usher in important development opportunities. Compared to wood, bamboo has stronger regeneration ability, clear bamboo grain, beautiful board surface, natural color, pleasant bamboo fragrance, and more elegant texture, making it an ideal substitute for wood and other materials Secondary utilization of waste bamboo, such as crushing it and processing it to make it into new composite materials; realizing the secondary utilization of its value in the weaving process and making full use of its value.

Although bamboo grows rapidly, it is not an inexhaustible resource. Therefore, the secondary utilization of waste bamboo, such as crushing and processing it into new composite materials; Realizing the secondary utilization of its value during the weaving process and fully utilizing its value will be particularly important. In cities, companies related to discarded furniture and second-hand furniture can be set up to recycle and reuse furniture materials that can still be used but have been thrown away, dismantle damaged furniture, and reassemble recyclable parts. It is hoped that with the assistance of the government, this information can be properly disposed of and the concept of sustainable development can be promoted on a larger scale.

Figure 10. China's bamboo production and year-on-year growth rate

5. Conclusion

Under the concept of sustainable development, research on rapidly growing plant materials needs to be continued to make woven furniture product design more possible. In this process, it is necessary to fully tap the advantages of each material, deeply tap its technological potential, combine traditional handicrafts with new processes and technologies, and serve society and people's lives, using concise visual formal language for innovative design. This article studies and briefly elaborates on the design application forms in the field of sustainable bamboo woven furniture, and proposes corresponding solutions from different perspectives.

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