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CHILDREN FURNITURE DESIGN FOR SUSTAINABILITY

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ABSTRACT

Through analyzing the process of design and research in the children's furniture work, "Accompany", the paper explores the relationship between the behavior of children aged 3-12 and their furnitures, and proposes the concept of "sustainability" in children's furniture design, which is proposed to be "growing up" along with the growth of children. The "Accompany" is assembled by the limited number of standard wooden parts and hardware, and able to be re-assembled to the new furnitures by choosing the different combinations of the standard parts and fittings. This design fits the characteristics and behaviors of children in their fast growing period of time. "Accompany" provides the sustainable usages to meet the demands of rapid growth of children.

Key Words: Children's Furniture, Sustainable Furniture Design, Furniture Design

1. INTRODUCTION

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Sustainable design is the principle of designing the products and services that meet the needs of the present without compromising the functions and improve the performance of the functions by the process of design to apply with reducing negative impacts on environment and health. Sustainable furniture design must have three characters: the first is the resource saving and environment friendly to protect the Earth; the second is to provide the users with health usage; thirdly, the furniture should be used for long-term. (Hao-ming Zhou, 2011) If the furniture in the materials choosing, producing, packaging, transporting, using, durability, maintenance and recycling etc. meets the above characters, it can be considered as sustainable furniture.

Children's furniture should be designed to meet the needs of children both psychologically and physiologically, be consistent with children's behaviors, and provide a set of the functions such as sitting, lying, and supporting or appliances such as item storing. Without seriously considering the psychological, physiological and behavioral changes in the childhood, the long-term use of an unreasonable sized furniture may lead a child to develop a series of problems such as poor bone development, poor eyesight and etc.

2. THE CHARACTERS OF CHILDREN FURNITURE DESIGN FOR SUSTAINABILITY

There are three characters in children furniture design for sustainability.

1) Multifunction

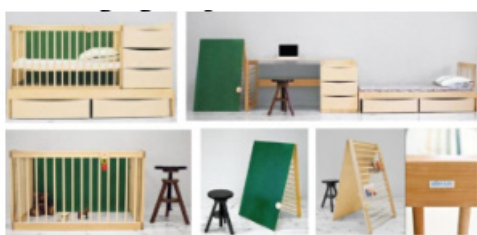
Ideal children's furniture should meet the different needs of children in the different situations, so it must be multifunctional. It means that the furniture has many practical functions; on the other hand, it can be realized by the transformation of furniture functions by adjusting and adding parts. Figure 1 shows the furniture "Smart Kid" designed by Adensen Furniture. The multifunctional kit starts out as a crib, but it can easily be disassembled and reassembled as a playpen, a desk, a chalkboard, a book rack, or a junior bed for child age up to 10 years old.

2) Transforming

For the purpose of multifunction, children's furniture needs to be transformable. Furniture functions can be changed by the various combination of the structures with adjusting furniture angles or sizes to achieve the new functions of the furniture. The work of the "Smart Kid", known as transforming design, not only saves parents the hassle of arranging furniture in and out of the house to meet their child's evolving demands, but also saves both money and natural resources.

3) Growth

Children's furniture under the concept of sustainable development must have the features of extensibility and adjustability. The main performance is that the size of furniture can be extended, the angle of furniture can be adjusted. The adjustments can fully meet the needs of children in the different ages. Figure 2 show Tripp Trapp designed by Peter Opsvik. A children's growth chair, by adjusting the distance between pedal and seat, it can be used in different age groups from infant to adult.



[Figure 1]Smart kid [Figure 2]Tripp Trapp

3. THE DESIGN OF "ACCOMPANY"

According to the degree of psychological and physiological changes in the different period of children, children can be divided into four periods: Infant (0-1 years old), toddler (1-3 years old), pre-school age (3-6 years), school age (6-12 years) and teenager (12-18 years old). (Yuan Xu, Lan Shi, 2008) This paper focuses on discussing the desk design for children of aged 3-12 years.

In different age, children have different demands for game, reading and learning for desk, and they should use desks in different sizes and heights for each activity. If every piece of the required furniture is purchased, it not only costs lots of money but also needs some considerable storage spaces for the discarded furniture in the future. The "Accompany" furniture, with the concept of sustainable furniture for children, combines limited parts and components into multiple types of furniture to meet the various needs of children at different ages, and through adjusting the size of desktop and the height of desk to attain the objective of growing up with children. The work extends the life time of the furniture, achieves the goal of the multifunction furniture and reduces the cost in an effective and sustainable way. At the same time, the structure, materials and colour meet the need of growing up children.

3.1 Ergonomics

Human factors and ergonomics are the psychological and physiological principles for designing (and engineering) of products, processes, and systems. The goal of human factors is to reduce human error, increase productivity, and enhance safety and comfort with a specific focus on the interaction between the human and the thing of interest. (Wickens, Gordon, Liu, 1997) It provides appropriate human parameters and furniture parameters. In the process of operation or the use of products, human health will not be affected. Children furniture should be designed restrictively according to the children's standards.

In the design of "Accompany", the principles of ergonomics are complied with. By analyzing the relationship between "Accompany" and children's body morphological characteristics, physiological data such as age and body size, the size of furniture is carefully considered. "Accompany" is not only compatible with the human dimension in height, but also fits for the fast growing height of children.

1) Body morphological characteristics of children

The growth and development of children in childhood is rapid, and the various parts of the body change rapidly. The growth of height and weight is faster; the skeleton is soft and elastic, and a child's bone is easy to bend and deform after being compressed. (Yahui Xiao, 2012). At this stage, special attention should be paid to the sitting posture. The ergonomics of children furniture design is particularly important; the muscles of children in early childhood are softer than adults, with more water content, less fat, protein and inorganic substances, and they are easy to fatigue during activities, but it recovers quickly.

2) Height and weight of children

The rapid growth of children aged 3-12 years old is obvious both psychologically and physiologically. The height of children is 90.8-101.8 cm in the age of 3, 110-123 cm in the age of 6. The height of children grows about 20 cm in three years. The weight of a baby is around 12-17 kg at age of 3, 18-25 kg at age of 6. According to the above statistical data, children's desks must be replaced. The consideration of size, stress and other factors must be included in the design process for children.

"Accompany" can be adjusted to different size and height by using hardware and embedded part. The table height is 40cm at age of 3 and grows up to 50 cm at age of 5. The height and size of the table are designed to be adjustable for the changes in height and sitting height at different age.

3) The relationship between desk and stool

According to the National Standards of the People's Republic of China of "Functional sizes and technical requirements of chairs and tables for educational institutions", for every 8 cm increase of children, the desks will be raised by 3 cm, and the chairs will be raised by 2 cm. Children aged 3-4 years are suitable for desks height of 43-46 cm and chairs height of 23-25 cm. For children aged 5-6, desks and chairs are required with height of 49-52 cm and 27-29 cm. Children aged 7-8 years are suitable for desks height of 52-55 cm and chairs height of 29-30 cm. For children aged 9 to 10, desks and chairs with height of 58-61 cm and chairs of 32-34 cm are suitable. For children aged 11 to 12, tables and chairs of 61-64 cm and 34-36 cm are suitable. It is accurate for most children to choose the height of desk and chair according to their age. But for some children, it is more accurate to choose furniture by their height than to choose the height of desk and chair according to their age. The lowest desk height and chair height are set at 37 cm and 19 cm, which are suitable for children in the range of 75-89 cm. The highest height of the desk is set at 79 cm, and the chair height is set at 46 cm. It is suitable for children over 180 cm. This standard desk and chair is suitable for the majority of people, except for special groups.

The furniture can be adjustable by which the size of the children's furniture can be adjusted according to the change in children's height. "Accompany" can be adjusted to different size of desktop and height by hardware of Invis joining system and Clamex P. Considering the stages of children's growth, processing methods and modular design, the desk legs of this scheme are divided into three lengths of 40 cm, 10 cm and 5 cm to meet the needs of children with different height. The height of desk and chair match the height of the form of "Accompany".

3.2 Structure

The structure should be reasonable structure and structural safety. Reasonable structure refers to the facts that the rational structure of the furniture is easy to assemble and disassemble according to the structure itself. At the same time it applies in the design process with no harmful substances released during and after the installation. Children have a strong curiosity about external things, but concept of self-protection is weak. The furniture must have the smooth surfaces and high quality parts to achieve the goal of safety to children. With the reasonable strength for children to beat, shake, move and tap, the furniture must be robust enough and without falling off small parts during the installation and the life cycle in use.

"Accompany" is to use the idea that the desktop and legs will grow with the growth of children according to their age. Therefore, the convenient, beautiful and safe way of connecting the desktop and legs is extremely important. The scheme uses Invis joining system and Clamex P which developed by Lamello, Switzerland.

1) Invis joining system

Invis joining system is a magnetically operated screw connection that can joins and releases without physical contact and is completely invisible. Rotary magnet-operated screw connection that are completely embedded in each component, using a special magnetic actuator that operates beside the component. (Figure3) It can be tightened and loosened again, which is the ideal connecting parts for installing leg structure of "Accompany".

2) Clamex P

Lamello sets standards with the Clamex P-System that it comes to joining work pieces. It is used to connect the desktop and desktop or stretchers (or protective board), which enables strong connections with the work pieces without the need for tools. The form-locking P-System anchorage Clamex P does not require glue or screws. The furniture fitting is characterized by its small 6 mm tool openings for hex keys. (Figure 4)

“Accompany” requires a small number of parts and is simple to be assembled, so it is easy to be converted between the desk of different sizes and height. The different works can be reciprocally converted in a frequent way. The Invis joining system and Clamex P are hidden in the materials so that no harm for children to use. Over 3 years old children, they can master a variety of more skilled movements. Sports and games can not only enhance children’s physical abilities, but also help children to explore, understand and experience the changes of the world. It makes children exciting in the process of participating in some housework with parents. During the converting furniture process, parents can invite children to join the job. It is just like playing game with parents. The children’s ability is improved. So “Accompany” will bring happiness to children.



[Figure 3] Invis joining system [Figure 4] Clamex P [Figure 5] Color system

3.3 Materials

There are two kinds of wood used in “Accompany”. One kind wood is certified by the Forest Stewardship Council (FSC), another kind wood is modified wood.

FSC is an independent, not-for-profit, non-governmental multi-stakeholder organization, established to promote the responsible management of the world’s forests. FSC forest management certification confirms that the forest is being managed in a way that preserves the natural ecosystem and benefits the lives of local people and workers, all while ensuring it sustains economically viability. So the wood on FSC certification is regard as sustainability.

In order to increase the supply of timber resources, the artificial fast-growing forest has vigorously been developed. The fast growing wood of artificial forest has the disadvantages of loose materials, low density, poor dimensional stability and poor resistance to rot, which leads to poor product performance and low added value. In order to efficient use of low-quality fast-growing wood, modified wood is researched. Wood modification is the technologies with which the properties of wood are permanently altered by heating at high temperatures or reacting with low molecular weight monomers or oligomers. The specific properties of wood are consequently improved and certain new characteristics imparted due to the modification. The modified woods can resultantly serve for a longer term compared to the non-modified ones. The tension due to the lack of wood resource can be reduced. (Yanjun Xie, Qiliang Fu, Qingwen Wang, Haigang Wang, 2012) So modified wood is also a sustainable materials.

3.4 Finishing

Children’s respiratory tract is short and narrow, respiratory mucosa is tender, respiratory frequency is fast and uneven, alveoli are small and easy to be blocked, vulnerable to dust particles and other harmful substances. At the same time, children’s breathing volume is 50% higher than that of adults in terms of body weight. The air quality of living space is very important for children’s health. Unfriendly furniture will release harmful gases in the air, which will harm children’s living space. In order to protect children’s physical health, furniture should use environmental protection materials. (Erxiang Yan, Dongjiu Yu, 2017)

Wood wax oil is used in the work for furniture surface finishing, which is coating for wood products environmentally. The raw materials are mainly made of refined linseed oil, palm wax and other natural vegetable oils combined with vegetable wax and some other natural ingredients. Therefore, it does not contain toxic components such as triphenyl, formaldehyde and heavy metals, and has no pungent odor. It is a really environmental protection materials.

3.5 Color

Children are naive, lively and lovely. They like bright and rich colors. The color design of children’s furniture is moderate, harmonious, high saturation and high brightness. It is not only conducive to children’s healthy emotional development, but also improve children’s color aesthetics.

Because the “Accompany” will accompany children for many years, it will supply three kinds of color scheme: wood color, white color and color system.

Wood color, the selection of beech, ash, pine, which shows pure wood color, brings people fresh and warm effect. For the children in different age, there will be feel comfortable and natural to use. Because it is proved that the wood with high brightness value could produce the elegant, simple, passionate emotional association. The wood with low brightness value made the person produce the traditional, heavy, gorgeous, and distinguished emotional association. The wood with unclear texture produced a simple sense of perception. The texture clear wood could produce the gorgeous, elegant, and natural emotional association. (Tinyu Jia, Xiaoting Niu, 2017)

White is also a very versatile color.

Mental performance such as curiosity, fantasy and bright colors attraction is quite well developed in pre-school age, so the third color scheme is color system to satisfy children's psychology. Color system uses the same hue, but different lightness. They are both united and changed easily. Through different color matching, it can meet the preferences of children in different ages. It is analyzed below the color of pink and blue used in "Accompany".

In Europe and the United States, pink is usually associated with girls, while blue is associated with boys. Colour was first used as a gender marker in World War I; pink was first used as a feminine marker in the 1940s. It was found that the female preferred red-purple color in spectrum, while the male group preferred yellow-green color. So the color system is chose pink and blue(Figure 5).

The furniture designed for girls is pink, which has three degrees of brightness. Customers can customize or choose according to their preferences. It can be monochrome or from top to bottom deep pink to light pink. On the contrary, light pink to deep pink can be assembled. Bright and soft colors make up a very vivid scheme. And blue scheme is designed for boy.

3.6 Scheme

The design scheme adopts the structure of detachable components to encourage children to participate in the process of the transformation between different forms and increase parent-child interaction. "Accompany" uses multi-color scheme to meet the preferences of different customers, it meets the needs of children at different stages of growth by changing the size of furniture. The design scheme can stimulate the usage of the product and improve the efficiency of the product.



[Figure 6] Installation diagram [Figure 7] The first type

"Accompany" is the kind of furniture that accompanies children to grow up. The furniture consists of a desk-top of 60×40 cm, several desk legs of 40 cm, several desk legs of 10 cm, several desk legs of 5 cm, the stretchers (or protective board) and hardware of Invis joining system and Clamex P (Figure 6). These simple components can be combined into four different types of desks, stool and storage basket for children in different ages to play, read and study.

"Accompany" is designed into four types to meet the demands of children in four different age groups. By taking consideration of psychological and physiological characteristics of children, "Accompany" is designed to meet the needs of children through a variety of functional changes.

1) Type one: desks for 3-4 years old children

The desks are designed for reading, playing and placing when children are about 3 to 4 years old(Figure 7). There are three kinds of desk in this type. Children begin to develop and exercise the motor function at this age, they can choose the plastic toys to disassemble and assemble. On the desk with protective board (Figure 7a), children can play with small toys such as space sand or Lego without dropping the toys into the ground. The second one (Figure 7b) is also for playing toys such as the block on the desk with extra desk legs of 10 cm and 5 cm attached to the shorter desk. When the customer doesn't use the extra desk legs, the desk legs can be used as toys for building blocks. The desk legs with the installed the wheels is transferred into a small train, and it is one of the favorite toys for children aged 3 to 4. The third one is a normal desk with the small train on the desktop(Figure 7c).

2) Type two: basket and desk

The second type(Figure 8) is basket and desk. The basket is convenient for children to collect toys. If children need to read, the furniture can be installed as a desk, just like Figure 8, the desktop is bigger than the third desk in Figure 7.

3) Type three: desks for 5-6 years old children

The third type is designed for 5 to 6 years old children while children gradually enter the learning stage. Desktop requirements increase, desk height also needs to be increased. At this time, the original two small desktops(in Figure 7) are connected together into a desk of 80×60 cm or 120×40 cm. The height can be adjusted according to the height of the child. Another desk(in Figure7) can be installed into a stool in Figure 9.

4) Type four

The fourth type is a standard desk for children over 7 years old (Figure 10). During this period, children's learning content increases, and the required desktop area also increases. The desk size can be adjusted and combined



[Figure 8] The second type [Figure9] The third type [Figure 10] The fourth type [Figure 11] Line type [Figure 12] L type

according to the size and characteristics of room space, such as Line-type(Figure 11), L-type(Figure 12), etc. Height can also continue to increase according to the height of the child. In order to increase the strength of the desktop, the protective board will also be used as stretchers of the desk.

3.7 Packaging

“Accompany” extends the principles of sustainable development in the life cycle of children furniture. “Accompany” is a combination of wooden parts and a number of hardware, and therefore the furniture can be flat-packed, which is not only convenient but also reduces the cost of transportation.

4. CONCLUSION

The work, “Accompany”, meets the needs of children’s rapid growth, and highlights the design concept of growing up with children together. The furniture is applicable to different age children and so easy to make extensive transformation through the different combinations and updated parts. Thus, the life time of the furniture is naturally extended and the effectiveness of furniture in long term using has been achieved.

The concept of growing up with children in furniture design is an effective solution and an important manifestation for the concept of sustainable design, which leads the development of children’s furniture into a more secure, more practical and more environment friendly direction. In short, The concept of Children Furniture Design for Sustainability reduces family costs, production costs, saves the materials and protects the environment.

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