Method and application research on sustainable development of industrial products

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Abstract. Now the humanity faces the population growth rapidly, the natural resource short, the environmental pollution is being serious and the humanity immoderately develops the natural resource, creates the crisis for own survival environment. Besides destruction caused by production process of industry and agriculture, massive trash from people daily life also creates enormous destruction for ecological environment. Now people gradually realized the vital role to the environmental protection of design and the sustainable development design becomes the focus of attention. This paper focuses on how to save energy and protect environment in the process of production and emphasizes a minimal impact to environment between industrial design and consumption. Besides, on the basis of environment protection and sustainable development, it put forward the necessity of applying the idea of sustainable development to carry on the design and puts forward the design method of sustainable design combiningthe needs of industrial design and the design implementation.It provides the theory basis and the instruction for our country industry product design, which has vital significance regardless of on product competition or economicaldevelopment for social and economy.

1. Introduction

Now the humanity faces the population growth rapidly, the natural resource short, the environmental pollution is being serious and the humanity immoderately develops the natural resource, creates the crisis for own survival environment. Besides destruction caused by production process of industry and agriculture, massive trash from people daily life also creates enormous destruction for ecological environment. In the past few decades, environmental protection technology used in the manufacturing process has made considerable progress such as using appropriate technology and clean production. Now people gradually realize the important role of environmental design and sustainable development design has become the focus of attention.

Sustainable design puts the sustainable development thought into the process of product design and sees the ecological environment and economic development for as an integral whole, which can make more efficient use of resources, energy, and reduce environmental pollution to a minimum.Traditional product design theory and method takes people as center from the needs of people and sees solving problems as the starting point regardless of the impact on the environment of subsequent product production and resource consumption in the process of use. As a result, the theory and method of traditional product development design must carry out reform and innovation.

Green consumption is the need of economic development. People have to replace the present extensive consumption way by way of green consumption to meet the needs of the social and economic development.At present, people's consumption concept is not for comfort life based on a large number of consumption resourcesbuta lot of resources and energy saving on the basis of obtaining comfortable life. In order to adapt to such trend, product designers face the challenge of how to make product design balance with environmental protection tomeet the requirements of environmental protectionfrommaterial and designandcombining with visual effects of packaging materials , protection and all aspects together to finally get the green products.Sosustainable design is the inevitable requirement of green consumption.

Currently, sustainable design research focuses on the rational use of energy, raw materials such as resources waste product recycling and disassembly, etc. They solvesmaterials selection and recycling technology among the process of production as follows:

(1)Rational use of energy, materials, etc.

(2)Waste product recycling and disassembly

(3)Other related issues:safety and health problems have also been put forward onto the research level.Because the toxin of lead is great, for nearly a decade, it has restricted or banned in paint, gasoline, and many other products. So many research puts on finding materials to replace lead.

2. Concept and characteristics of sustainable development design

2.1 The putting forward of sustainable development design

Sustainable development design is put forward based on the following factors:

1、Environmental problems

The development of the technology makes human intervenenatureattheirwill.Accompanied by the design and production of material wealth is a large amount of consumption of natural resources, which puts a serious threat to human survival and continuous development of coevolution with earth and humanity.

2、Population

There are 6 billion human beings, in the 21st century, the population will greatly increase due to the improvement of the quality of life and the progress in medicine.We will face an aging population.By 2015, the world's population is expected to reach 7.5 billion.Too much of the population and the demand for material bound to lead to more serious damage to ecological environment.

3、Culture

With the improvement of environment protection consciousness, it make human’s consumption consciousness change from the level of product to the service level, from "thing for me to use" to "make the full use" so as to fully use of limited resources.

4、Technology

The development of science and technology provides material and technical guarantee for new design theory—"sustainable design".Sustainabledesign concept is not only a kind of new technology especially the design way matching with computer, network and artificial intelligence but also a consumption way using service as the core and a new way of life.

2.2 The concept and connotation of sustainable development design

1、The concept of sustainable development design

The so-called sustainable development design means putting design behavior into the "human—machine—environment" system under the guidance of ecological philosophy to not only realize social value, protect the natural value but promote the common prosperity of human and nature.Sustainable product design is the designmanagement for environment.Under the principle of advocating moderate consumption, it makes the product get reasonable allocation of resources at the different stages of the life cycle.

2、The connotation of sustainable development design

Sustainable development makes people follow a new ethic, moral and values.Its essence lies in fully use of modern science and technology to vigorously develop green resources, develop clean production, improve and optimize the ecological environment and prompt the harmonious development of human and nature. Specifically:

Attitudes towards nature:human and nature in harmony;

Economic level:optimizationlevel based on knowledge economy

Economic feature: effective, harmonious, recycling economy;

System recognition：network structure for control and adaptation;

Consumption symbol: comprehensive development demand of nature, society and economy;

Production pattern: Intelligence transform and recirculation system;

Energy input: clean and alternative energy;

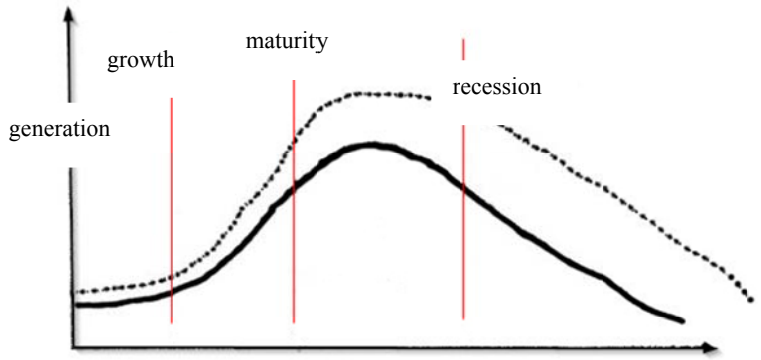
Environmental response: environmental cooperative coevolution and renewable resources [1].

2.3 The main content of sustainable development design research

1、Product life cycle

Sustainable design is oriented to the design of the product life cycle. From different angles, the product life cycle have different dividing ways.From the angle of marketing, from putting new products into the market to exiting the market life cycle process, itcan be divided into four stages, namely generation, growth, maturity to recession which can be seen in figure 2-1.

From the viewpoint of design and development, it classified into the traditional design of product life cycle and sustainable development design of the product life cycle.The traditional design of the product life cycle includes extracting raw materials from the environment, processing into productsand flowing to consumers to use.Inorder to eliminate or reduce environmental pollution, product manufacturing needs to consider how to use the circulation and reuse to properly handle the productandneeds to put the problem of product waste into the design process.Therefore, sustainable design refers to the sum total of all stages involved: from raw material production, product manufacturing, assembly, packaging, transportation, sale, use and recycling reuse and, as shown in the figure 2-2



Product Life Cycle

Figure 2-1 Product Life Cycle

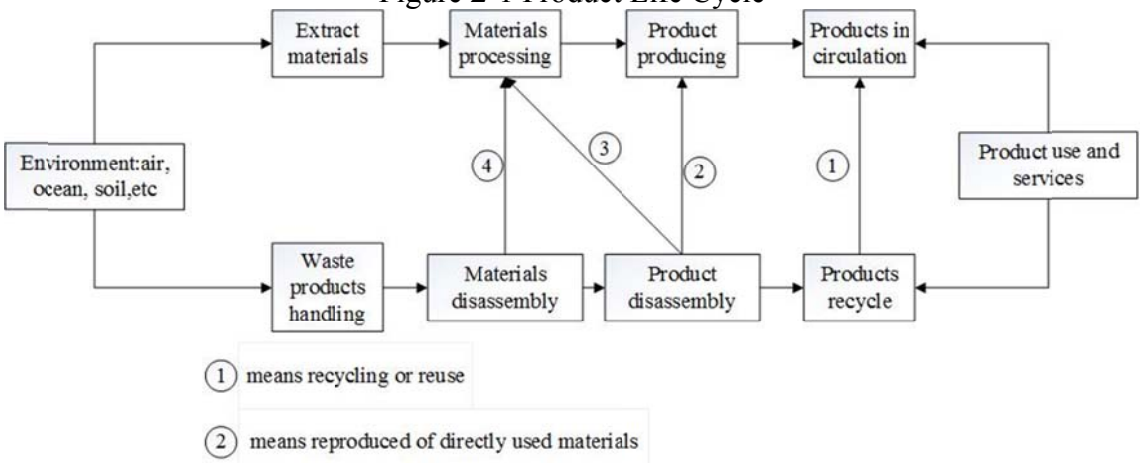


Figure 2-2Relation between product life cycle and environment

2、Main content of sustainable product design research

Throughout the product life cycle in the process of sustainable development,itsmain content of design research are as follows:

1、The material selection and management of sustainable design: consider the rational use of material or energy;

2、Module design of sustainable design (function of optimization design) : emphasis on the function effect, people-oriented, active use of the theory of human body engineering to optimize design process;

3、Sustainable design of product recyclability design (recycling design) : emphasis on the importance of design management in sustainable design to reduce the environment and negative impact on human body;

4、Sustainable design of assembly and disassembly design: design of easy disassembly and maintenance and recycling and reusing efficiently after the product scrap, which can be divided into the following table.

Extend the service life of products	Extend the service life of materials
Selection of materials	Short of product consuming
Management of craft procedure	Efficient distribution system
Improvement of management	Environmental effect analysis method
Design of analysis factors	Determine the scope of analysis
Listing inventory analysis	Impact assessment
Impact of ecological system	human health and safety risk assessment
Product system risk assessment	

3. Sustainable development design of industrial products

3.1 The selection of green materials

1、The concept of green materials

Greenraw materials are also known as ecological raw materials, refers to the use of those with good performance or function, and less resource consumption, less pollution to the ecological environment and helpful for human health, high utilization rate of renewable or recycled.In preparation, use, waste and recycling use of the whole process, they are harmonious with the environment.That is to say, green raw materials is to make the traditional raw material more perfect, and reform according to the connotation of environmental problems.

Less resource consumption in the production of raw materials; used harmful substances in the process and easy regeneration cycle after abandoned, theyaredemands for the performance of the greenrawmaterials.In addition to the advanced nature, raw materials used in manufacturing, distribution, abandoned the entire life cycle must have a coordination and ecological environment.Besides, raw materials needs to be comfort. These three kinds of performance of raw materials constitute the concept of green raw material which can be shown in figure 3-1 [2].

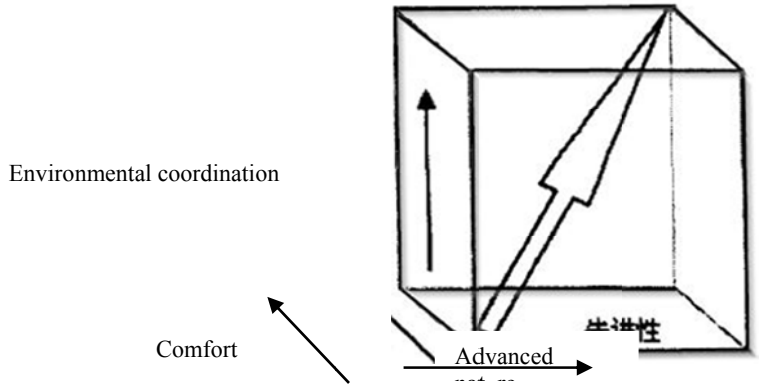


Figure 3-1T Origin rdination of green materials performances

2、Selection of green materials

Green materials are the precondition of the sustainable development of the product design. Usually, it can consider how to select raw materials from two aspects:

(1)Using recycled materials as much as possible, and apply cycle to the abandoned and production process

(2)Using non-recyclable materials as little as possible and for those raw materials must use you should design a recycling system.

Specifically, it can follow the following principles:

(1) First choose renewable materials and try to use recycled materials to improve resource utilization;

(2) Choose low power consumption,non-toxic,lesspollutionand non-corrosive materials as far as possible;

(3) Choose materials with good environmental compatibility and choose less type of materials of the same type as far as possible to facilitate effective recovery of disposed products;

(4) Materialsshould label its version, type, level, etc. to facilitate recycling. Such as choose environmental protection refrigerants in the refrigerator production process in order to reduce the destruction of the ozone layer.

The table of refined principles of material selection can be seen as follows.

Table 3-1 Refinedprinciples of material selection

Selection Principles	Selections Factors
Avoid using restricted materials	Lowest impact on environment
Decrease types pf materials	Simplify recycling process
Use same or similar in additional part to reduce incompatible materials	Shorten time of material disassembly and classification
Label material name on all the parts	Accurate recognition and classification of the material to raise the content of the material
Use recyclable materials	Stimulate the market of production recycling
Use recyclable materials and take single component material(without additive element)	Shorten abandoned material to improve the value of product life cycle
Avoid composite materials	Composite materials refers to non-single component materials which not suitable for recycling
Use high strength material in moving parts	Shorten mass of moving parts to save energy
Using low alloy ratio which has better recycling performance than high ratio one	The more pure metal material is, the more widely use in recycling it has
If using mental, different metal materials can be connected to each other	Aluminum, steel, magnesium alloy can use crusher crushing to have rapid recovery
Harmful materials should make clear label and be easy disassembly	Eliminate the negative effect of parts

3.2 The management of green materials

Green materials meet the needs of sustainable development, achieve the unity of development and the environment and the combination of modern and long run, which satisfies the need of modern people to live and work in peace and contentment, longevity and health and does not harm the future generations'greater demand of environment, resources.Green materials, compared with the traditional production material, can be summarized as the following five basic characteristics:

(1) Its production materials use natural resources as little as possible but extend the use of tailings and waste residue, waste liquid, etc.

(2)It takes manufacturing process and production technology with low energy consumption and pollution- free.

Many products especially consider the compatibility of different parts on the assembly line.If two materials can be used as a mixed material, they are compatible.Reasonable use of the compatibility between different materials can decrease the repeated use and reduce the production cost. Keep the material of the oneness, immiscibility, no glue as far as possible can improve material recycling use.The following table lists the compatibility between different materials.

Table 3-2 Compatibility of glass

Legend		Additive materials							
●	Compatible								
Θ	Limited compatible	Glass bottle	Window glass	Wine bottle	Crystal	TV screen	TV glass shell	TV tube neck	Liquid crystal display
O	Incompatible								
Basic materials	Glassbottle	●	O	O	O	O	O	O	O
	Window glass	●	●	●	O	O	O	O	O
	Winebottle	●	Θ	●	O	O	O	O	O
	Crystal	O	O	O	●	O	Θ	Θ	O
	TV screen	Θ	Θ	O	O	●	Θ	O	O
	TV glass shell	O	O	O	Θ	O	●	●	O
	TV tube neck	O	O	O	Θ	O	O	●	O
	Liquid crystal Display	Θ	Θ	O	O	Θ	O	O	●

Table 3-3 Compatibility of mental additive

Basic mental	Incompatible element	Depreciation factor
Cu	Hg、Printed circuit board	Arsenic、antimony、nickel、Al
Al	Cu、Fe、Polymer	silicon
Fe	Cu	Tin、Zn

(3)In the process of preparation or production, formaldehyde and halide solvent or aromatic hydrocarbonscannotbe used. Products cannot contain mercury and its compounds. It also forbidden to use metals such as lead, tin, chromium and its compounds of pigments and additives. Table 3-4 shows the impacts of materials for environment.

(4)Product design is to improve the production environment, improve the quality of life.The product does not harm the human body health but should be beneficial to human health.The product has many function such as antibacterial, sterilization, mildewproof, deodorant, heat insulation, flame retardant, fire prevention, temperature, humidity, degaussing, ray, antistatic, etc.

(5)Products can be recycled or recycling without polluted waste for the environment.

Table 3-4 Impact of materials on environment (the lower coefficient, the lower impact)

Plastic	Mental	Others
High density polyethylene2.9	Al(100% recycle)1.8	Ceramics0.5
Polypropylene3.3	Steel 4.1	Wood 0.7
Low density polyethylene 3.8	Steel plate 4.3	Paperboard 1.4
PVC 4.2	Stainless steel17	Paper(100% recycle) 1.5
Polyethylene terephthalate7.1	Al 18	Glass 2.1
Polystyrene8.3	Cu(100% recycle)23	Paper(0% recycle) 3.3
Acrylonitrile,butadiene,styrene 9.3	Cu(60% recycle) 60	Cellulose 3.4
Polyamides 13	Cu(0% recycle) 85	Rubber 15
	non-ferrous metal 50-2000	

4. Application of substantial development design

Today, technology, design, construction, furniture, lamp, fashion and art are in mutual penetration.With the development of science and technology, especially the appearance of new

materials and new technology, the connotation and extension of modern furniture is constantly expanding.High-tech comprehensive intervention and comprehensive application of new material, new process, furniture design innovation constantly change human life, work, leisure way.Modern furniture is from practical life material appliance to spiritual aesthetic cultural products which not only makes human life and work more convenient and comfortable, efficiency, also can give a person with aesthetic pleasure and joy of spirit.

4.1Polluted materials in current furniture

According to the data provided by association of Chinese interior decoration show that indoor air pollution caused by furniture alreadybecome the third largest polluter after construction pollution and decoration pollution. The main pollution source of indoor air pollution is chemical pollutants in furniture materials, therefore,to a certain extent, cut off the source of the chemical pollution in environment have played an important role in preventing cancer. Table 4-1 indicates the influence of formaldehyde for human health.

The international mandatory standard GB18584-2001-limits of harmful substancesin the wooden furnitureininterior decoration regulates that furniture formaldehyde release limits to 1.5 mg/L using dryer method to measure, shown in the following table [3].

Table 4-1 Influence of formaldehyde for human health

Formaldehyde concentration (ppm)	Impact on human health
0.00-0.05	Non-influence
0.05-1.50	Affect central nervous
0.05-1.00	Foul smell
0.01-2.00	Dazzling
0.10-25	Wind eye
5-30	Wind eye and lung injuries
50-100	Lung injuries, combustible
>100	Death

Table 4-2 GB18584-2001 harmful substances limits in wooden furniture

Items	Limits
formaldehyde release mg/L	≤1.5
heavy metal content mg/kgDissoluble lead	≤ 90
Dissoluble cadmium	≤ 75
Dissoluble Cd	≤ 60
Dissoluble mercury	≤ 60

4.2The standardization design of furniture

Design is the soul of the furnitureand is also the key to realize standardization of furniture. Design decidesthe production plan, raw materials procurement, production process, adjustable machine number, equipment type, machining accuracy, quality and production costand so on.Therefore, standardization of design is the most important factor to affect the level of standardization of the whole enterprise. An enterprise should pay more attention on the standardization of product designin addition to strengthening modelling, function design to implement the strategy of low cost and improve market competitiveness. From a comprehensive angle to consider and implement standardization of materials, process, equipment, parts, hardware fittings and operation process, it can make the enterprise internal truly economical, practical, efficient, economic and can realize furniture with minimal plate implement multi-functions. This is the tenet of standardization and also the forever goalof furniture enterprise [4].

Main content to implementing standardization of furniture:

1、Standardization of product design

Product design is the first step of production. As the furniture life cycle shortens constantly, biannual exhibition make furniture enterprises difficult to cope with.One of the most headache is

the new product development.If design standardization degree is higher, the development of new product can in an orderly,easy and quick way.

2、Standardization of raw materials

Raw material is the material basis for the enterprises to carry out production. In furniture manufacturing, material costs often account for about 50% whose reserves account for half of the entire enterprise liquidity.Standardization of raw materialsnot only ensure the quality of products but also can promote the saving of raw materials, simplify the procurement, order, check, verification and storage of raw materials to reduce the reserves of raw materials, accelerate cash flow and reduce manufacturing costs.

3、Standardization of hardware joints

The characteristics of board type furniture determines its reliance on hardwarejoints.Leave the modern hardware accessories, board type furniture doesn'texist.With the development of furniture industry, furniture has put higher demand on hardware accessories like universality, interchangeability, function and decoration. Hardware accessories conforms to 32mm system，whichprovides the technical supportforstandardization, series and generalizationofhole processing and installation.

4、Standardization of code management

At present domestic furniture industry, each enterprise has its own codeand it is difficult to unify.No matter for the individual or the whole furniture industry, this kind of chaos are not conducive to the development and promotion. Therefore, seek and develop a set of furniture industry standardization of coding method as soon as possibleis the top priority for the enterprise.

5. Summary

Sustainable design is still in the development of perfect because of the wide disciplineinvolvedand multi-disciplinary cross research field. As a result, the implementation of sustainable design needs from the perspective of system and a comprehensive analysis and coordination from technology, art and management three aspects to do whichneedsthe joint effortsofsocial the researchers.Sustainable development in the field of industrial designis a great social system engineering, which must form anoperationmechanismwithcollectivization, scale and procedureandneeds the participationofgovernment, enterprise and consumers.

References

[1]Xu Ping, Pan Lin.Green Design [M].Jiangsu Fine Art Press.2001.

[2].Liu Zhifeng, Liu Guangfu. Green Design[M]. China Machine Press.2000.

[3]Wu Meiyan.Coating and finishing of wood materials [J].Coating industry. 2002:35-36.

[4]FumioShimizu,DavidPalterer.TheLitalianFurniture. Tokyo GraphieshaPublishingCo.Ltd.1991.