Xi'an Jiaotong-Liverpool University

西交利物浦大学

Department of Architecture and Design

Raising environmental awareness

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Raising Chinese consumer environmental awareness

Abstract

This project aims to address, explain and analyze the severe social problem of the widespread use of plastics. Society is increasingly concerned about the ecological impact of plastics and their threat to food safety and public health. Microplastics, among other things, are everywhere, found in Marine environments, living things, salt, and even the human body. However, there are currently no effective technical methods to treat and remove microplastics from the environment. Public attitudes are, therefore, critical to reducing plastic emissions. The project targets Chinese consumers and aims to reduce people's use of plastic through videos and to make alternative products. The authors conducted the project through research, literature analysis and case studies, stop-motion animation, user scenarios, and user testing. The advantages and disadvantages of video communication and products are analyzed, and finally, the combination of video communication and products is chosen to solve the research problem. In addition, the paper also examines the shortcomings of the design results and research prospects.

Keywords: Environmental Protection. Plastic. Animation. Microplastics. Bioplastics

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唤醒中国消费者的环保意识

摘要

本项目旨在解决广泛使用塑料的严重社会问题，并对其进行解释和分析。社会越来越关注塑料的生态影响及其对食品安全和公众健康的威胁。微塑料，除其他外，无处不在，在海洋环境、生物、盐，甚至人体中都有发现。然而，目前还没有有效的技术方法来处理和清除环境中的微塑料。因此，公众的态度对于减少塑料排放至关重要。该项目以中国消费者为目标，旨在通过视频和产品减少人们对塑料的使用。作者通过研究、文献分析和案例研究、定格动画、用户场景和用户测试来开展该项目。分析了视频通信和产品的优缺点，最终选择将视频通信和产品结合起来解决研究问题。此外，论文还分析了设计成果的不足之处和研究前景。

关键词：环境保护，塑料，动画，塑料微粒，生物塑料

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Contents

I. Introduction

1.1 Introduction of the Thesis

This thesis presents an investigation to support animated design to raise environmental awareness. Plastics are one of the fastest-growing engineering materials (Lee et al., 2020) because of their low cost, versatility, and durability. Although they facilitate people's lives and contribute to social development, their widespread use is causing severe environmental problems (Bi et al., 2021). More than 300 million tons of plastic are reportedly produced globally each year, of which around 10% end up in the ocean, and indeed every piece of plastic we consume has the potential to end up in the sea. Plastics that are difficult to degrade can remain in the environment for over a century, thus impacting the environment. Studies have shown that since the mass production of plastic began in the 1950s, humans have produced 8.3 billion tons of plastic, of which 6.3 billion tons have become waste. Only 9% of plastic waste is recycled, 12% is incinerated, and 79% ends up in landfills or the natural environment. Without changes in plastic production patterns and solid waste management, humans will produce 12 billion tons of plastic waste by 2050. (Fig.1.3.)

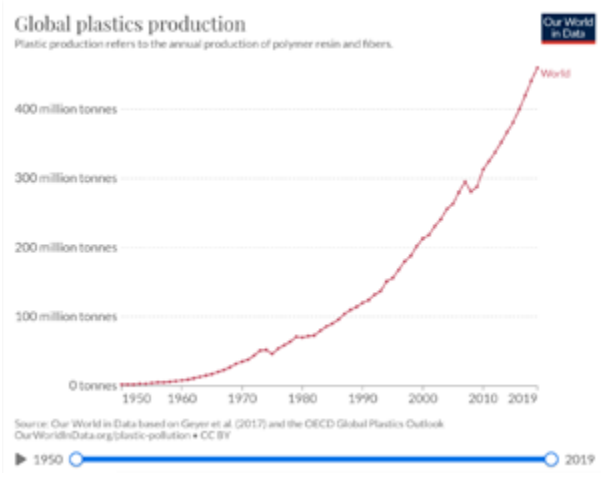


Fig.1.1.: Global plastics production

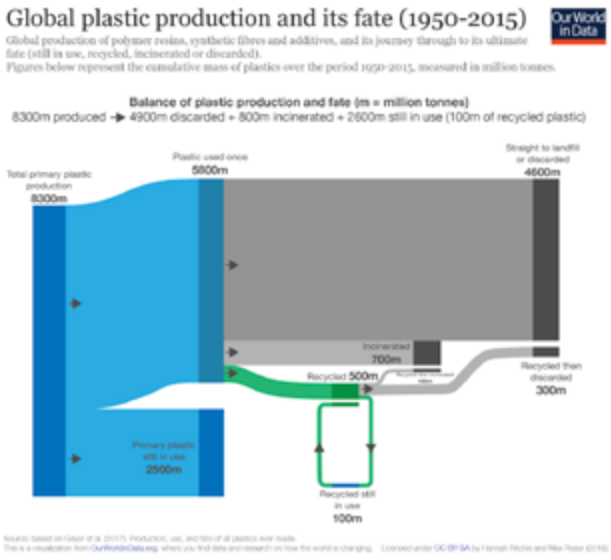


Fig.1.2.: Global plastic production to fate

1.2 Review of the literature

This chapter focuses on plastic and the different types of plastic pollution. The need to prevent microplastics from affecting human life is analyzed in terms of publicity and the need to raise environmental awareness. The authors examine the advantages and disadvantages of video output and product design and the five existing methods for raising ecological awareness.

1.3 Research questions

Identify the most significant impact of plastic waste on human life and how this can be reduced.

1.4 Research Methodology

This chapter focuses on the research methods used in this paper. They are interviews, literature analysis, case studies, mapping, user scenarios, and user testing. Through these research methods, the authors have analyzed and concluded the importance of raising environmental awareness and that the video plus product output format is ideal for ecological awareness.

1.5 Conclusion

This chapter has summarized the study's background, social status, research process, and design process above. It has also clarified the limitations of this study and the plans and prospects for further research in the future.

II. Review of literature and Case Studies

2.1 Literature

2.1.1 What is plastic/microplastic?

Plastics are polymeric materials that can be molded or shaped, usually by applying heat and pressure. (e.g., plastic bottles, etc.) accumulates in the earth's environment and adversely affects wildlife, wildlife habitats, and humans. By the end of the 20th century, plastics were a persistent pollutant in many environmental and ecological niches, from Mount Everest to the ocean floor.

Microplastics are plastic particles with minimal particle diameters and textile fibers. There is no consensus in academic circles on the size of microplastics, and plastic particles with a particle size of less than 5mm are usually considered to be micro granules. It is estimated that there are over 5 trillion plastic particles in the world's surface waters. (Fig.2.1.)The formation of microplastics began with the emissions of chemical plants, the plastic pellets of some industrial products, and the pellet content of cleaning products used by women, but also, of course, the large number of microplastics produced by the physical, chemical, and biological treatment of some plastic waste. There are also some plastic products that we use in our lives, which are exposed to the sun and wind, which does not make it degrade completely, but mentions that it becomes smaller and produces microplastics. So, much plastic waste turns into these tiny ocean killers that are hard to notice and concern.

Microplastics are divided into two main categories: primary microplastics and secondary microplastics. Primary microplastics are plastic granules of industrial products discharged into the water environment through rivers, sewage treatment plants, etc., into cosmetics containing microplastics or plastic granules and resin granules used as industrial raw materials. Secondary microplastics are pellets made from large plastic wastes that have undergone physical, chemical, and biological processes resulting in splitting and volume reduction.

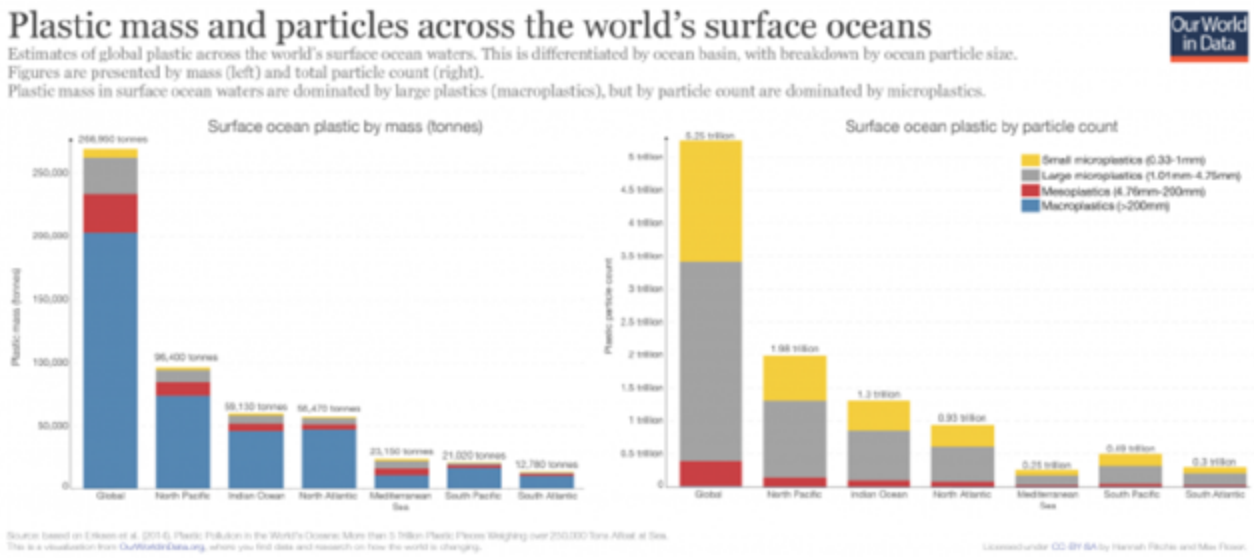


Fig.2.1.: Plastic particles in the world's surface ocean

Pathways for the production of primary microplastics

Personal toiletries: Microplastics are used as raw materials in Iquique care products and cosmetics for various applications, such as carrying active ingredients, exfoliating, or adding viscosity. After use, unique products containing microplastics are discharged directly into homes, nodes, hospitals, and wastewater, including beaches.

Synthetic textiles: Washing synthetic textile clothing in laundries or at home produces primary microplastics due to the abrasion and shedding of fibers. The fibers are then discharged into sewage and possibly eventually into the sea.

Tires: tires subjected to wear and tear during use produce particles, which are synthetic polymers on the outside of the tire, known as styrene-butadiene rubber, mixed with natural rubber and many other additives. These fine particles are either blown away by the wind or washed down the road by rain before reaching the water's surface and possibly the sea.

Sources of waste plastics

There is a growing global focus on tackling the pollution of waste plastics. The United Nations Environment Program has launched several large-scale global campaigns to reduce, reuse and recycle waste plastics, such as the global Clean Ocean Campaign launched in 2017, which calls on governments, industry, and consumers to reduce the production and overuse of plastics, and the inclusion of waste plastics under the Basel Convention in 2019. In 2019, they will bring waste plastics under the control of the Basel Convention. The US, Europe, Japan, and other developed countries and regions have established a series of conventions, policies, and regulations to establish a legal system for the prevention and control of plastic pollution, such as the Resource Conservation and Recycling Act in the US, the EU Plastic Restriction Order in the EU and the Promotion of Effective Use of Resources Act in Japan.

a. The impact of plastics on oceans and seabirds

One of the sources of marine microplastics is the decomposition of large plastic litter. When plastic litter enters the ocean, it gradually photodegrades or breaks down under the action of environmental factors such as heat, light, and chemistry to form microplastics, which change in elastic strength, color, shape, and size, thus making it easy to be swallowed by zooplankton, benthic organisms and fish in the marine environment and stored in the digestive tract, or even directly into tissues and cells, endangering the growth of organisms. The main effects of large plastic litter (such as synthetic fiber rope, plastic sheeting, bungee cords, fishing nets, trawls, and other discarded fishing gear) on marine life are entanglement, restricted movement, and feeding, leading to death. Some marine animals accidentally ingest plastic litter and suffer physical blockages in their digestive systems, reducing nutrient absorption and causing starvation or digestive damage, leading to death. With more attention currently being paid to the tragic events that have occurred to seabirds, sea turtles, and marine mammals, and an increasing number of entanglement and

feeding impacts on other organisms such as fish and invertebrates, marine plastic litter and microplastics have become a significant threat to marine ecosystems.

Marine wildlife such as seabirds, whales, fish, and turtles mistake plastic waste for prey; most subsequently die of starvation as their stomachs fill with plastic. They also suffer lacerations, infections, reduced swimming ability, and internal injuries. Globally, 100,000 marine mammals die each year due to pollution. This includes whales, dolphins, porpoises, seals, and sea lions. (WWF) Seabirds' digestive tracts contain microplastics to varying degrees. The plastic particles ingested by seabirds are closely related to the similarity of their natural diet, with microplastics that are more similar in shape, size, and color to their raw diet being more abundant in seabirds. The accumulation of plastic in the body is threatening plastic accumulation in the body threatens the survival of an increasing number of organisms.

Along with physical pollution, plastics also bring with them compound corrosion. Organic monomers and toxic additives in plastics, such as plasticizers, flame retardants, and antibacterial agents, can also be released into the ocean and cause decay. At the same time, microplastics can enrich persistent organic pollutants and heavy metals from the surrounding environment during their migration process. For example, ingesting polyethylene pellets combined with PAHs, PCBs, and PBDEs by Japanese cyprinid fish caused the transfer of adsorbed pollutants and produced liver toxicity and abnormalities. In addition, some bacteria, viruses, and microalgae can also produce biofilm on the surface of microplastics and inhabit and accumulate. These microplastics, enriched with microorganisms on their surface, can also enter the organism and infect it.

b. The impact of plastics on climate

Microplastic pollution can be a severe hazard to the marine environment, the soil environment, and the atmosphere. The diameter and volume of microplastic particles are relatively small, making the specific surface area of microplastic particles larger for the same unit. The larger the specific surface area, the stronger its ability to adsorb pollutants. Once microplastic particles enter the marine, soil, and atmospheric environment, they will meet with these organic pollutants and, through their powerful adsorption, can collect these organic pollutants, thus posing a greater risk to the environment.

When plastic waste is incinerated, it releases carbon dioxide and methane into the atmosphere, increasing emissions and contributing to global warming. 2019 saw the release of a new report, Plastics, and Climate. The report states that in 2019, the production and incineration of plastics will emit 850 million tons of carbon dioxide (CO 2), a greenhouse gas, into the atmosphere. To current trends, annual emissions from these sources will grow to 1.34 billion tons by 2030. By 2050, plastic could emit 56 billion tons of greenhouse gases, accounting for 14% of the planet's remaining carbon budget. By 2100, it will emit 260 billion tons, more than half of the carbon budget. These are production, transport, incineration, methane emissions, and the impact on phytoplankton.

c. The economic and social impact of microplastic pollution

Due to their low cost and broad applicability, plastics are increasingly used in society. They estimated that by 2050 there will be an additional 33 billion tons of plastic products on the planet, and the amount of plastic entering the environment will undoubtedly put a more significant strain on the environment. Plastic packaging, plastic containers, and even the increasing number of medical plastic infusion tubes are significantly increasing direct human contact with plastics, and this direct and continuous exposure can increase the accumulation of microplastics in the human body through ingestion, dermal and respiratory effects, with consequent impacts on human health. At the inaugural UN Environment Assembly on 6

June 2014, UNEP released two reports, UNEPYearBook2014 and Valuing plastic, which noted that a large amount of plastic litter in the oceans is a growing threat to the survival of marine life and is conservatively estimated to cause economic losses to marine ecosystems of up to US$13 billion per year. The proportion of plastic litter in the seabed is also increasing yearly, as plastic is difficult to degrade. This proportion will continue to rise as the seabed accumulates plastic litter, leading to a progressive increase in the impact of seabed microplastics on marine ecosystems.

d. The impact of microplastics on human health

In mid-2019, the University of Newcastle, Australia, was commissioned by WWF to estimate the global per capita intake of plastic based on a combination of 52 existing studies: The global per capita intake of plastic particles is around 2,000 per week, weighing 5 grams of plastic, roughly the weight of a credit card. Their structural monomers (e.g., bisphenol A mainly caused the health hazards of plastics themselves), additives (e.g., plasticizers, halogenated flame retardants), or a combination of both (e.g., antibacterial polycarbonate). Depending on the composition of the monomer and the characteristics of the type of additive, some plastics and additives may have adverse effects on human health. The negative impact of plastic structural monomers and plasticizers on human health can be severe enough to cause hereditary lesions, cancer, and other acute and chronic diseases. In contrast, less severe effects include irritation of sensory organs, endocrine disruption, respiratory difficulties, etc. Organisms at the lower end of the food chain rapidly consume wandering microplastics, such as mussels and plankton, which cannot be digested and only take up space in the stomach, causing disease and even death. The organic pollutants attached to microplastics add to the damage caused to these organisms.Most importantly, microplastics can accumulate along the food chain. As organisms at the higher end of the food chain prey on organisms at the lower end of the food chain, microplastics remain

unabsorbed. They will accumulate more in organisms at the higher end of the food chain, gradually increasing the damage. Studies have shown that the human digestive system does not absorb microplastic particles in fish and shellfish, but they are not entirely excreted. The accumulation of these microplastic particles in the human body can cause damage to the immune, lymphatic, nervous, reproductive, and endocrine systems. If they absorb microplastic particles with heavy metals, they can directly affect the human kidneys, which can cause various diseases. Women of childbearing age are the most vulnerable to these

Adverse health effects of plastics to human being

Plastics	Harmful monomers/components	Main applications	Adverse health effects
Polyvinyl chloride	Vinyl chloride	Food packaging materials, containers, cosmetics, pacifiers, toys, water pipes, etc.	Can lead to cancer, birth defects, genetic changes, chronic bronchitis, ulcers, skin diseases, deafness, failing eyesight, indigestion and liver dysfunction
Phthalates	Diisononyl phthalate	Water bottles, etc.	Endocrine disruption problems and associated with asthma, developmental and regenerative disorders
Polycarbonate resins	Bisphenol A	Plasticizers	Cancer, impaired immune function, suffering, obesity, diabetes, ADHD, etc.
Polystyrene	Styrene	Containers, plates, toys, etc.	Irritates the eyes, nose and throat and may cause dizziness and coma. Causes increased incidence of cancers of the lymphatic and haematopoietic system, etc.
Urea-formaldehyde resins	Formaldehyde	Particleboard, plywood, building insulation, fabric decoration	Causes birth defects and genetic changes, inhalation of formaldehyde can cause coughing, throat swelling, watery eyes, breathing difficulties, headaches, skin rashes
Polyurethane foam	Toluene diisocyanate	Cushions, mattresses, pillows, etc.	It can cause bronchitis, coughs, skin and eye problems, and produce serious lung problems
Polyacrylic acid	Acrylic acid	Adhesives, contact lenses, disposable nappies, paints, etc.	Can cause breathing difficulties, vomiting, diarrhoea, nausea, weakness, headache and fatigue
Polytetrafluoroethylene	Tetrafluoroethylene	High and low temperature resistant, corrosion resistant materials, insulating materials, anti-adhesive coatings, etc.	Can irritate the eyes, nose and throat and may cause breathing difficulties

Fig.2.2.: Adverse health effects of plastics to human being

hormone-disrupting chemicals and are more likely to damage their immune and reproductive systems.Pregnancy and care products, such as baby bottles, pacifiers, and plastic feeding utensils, put babies and children at a very high risk of exposure. In a recent report on human health published in the British journal Nature Food, researchers have recently discovered that plastic micro-particles may be released from baby bottles containing polypropylene when they are used to make standard formula milk powder, a result that directly affects the

most vulnerable humans in the early stages - babies. Under the World Health Organization's recommended conditions for sterilizing and preparing formula milk, a team of researchers from Trinity College Ireland tested the number of plastic particles released from 10 baby bottles, representing the majority of bottles available on the global online market. They were either made of polypropylene or contained polypropylene-based accessories. The team found that the number of plastic particles released from each bottle ranged from 1.3 million to 16.2 million. The bottles removed plastic particles over the 21-day test period, and the number of plastic particles released varied depending on factors such as water temperature. The Irish team developed a potential global model of initial human exposure to plastic particles using these data. They estimate that infants fed with polypropylene bottles are exposed to an average of 1.6 million plastic particles per day during the first 12 months. The results of this study highlight the need for further research into the effects of plastic particles on human health, which is still poorly understood.

2.1.3 Sources of waste plastics

According to their sources, waste plastics can be divided into four categories: industrial, agricultural, medical, and domestic. Waste plastics from industrial sources mainly refer to waste and waste industrial plastic products produced during the plastic molding and processing process, mostly from transparent sources, relatively concentrated, with good quality raw materials and high recycling value; waste plastics from agricultural sources mainly include waste agricultural land film, greenhouse film, agrarian pipes, pesticide packaging, etc., of which agrarian agricultural film is the most significant amount of waste. It is difficult to dispose of after use and destruction, remaining in the fields, not easy to degrade, polluting farmland and endangering the ecological environment. Waste plastics from medical sources mainly originate from primary plastic products used in the process

of medical and health care and epidemic prevention, such as protective clothing, medical surgical masks, protective goggles, etc., which are hazardous wastes with direct or indirect infectivity, toxicity, and other hazards; waste plastics from domestic sources are waste plastic products generated from daily life activities, with wide varieties, widely dispersed and difficult to collect, such as plastic bottles, plastic bags, paper-plastic composites, and other hazardous wastes. Plastic bottles, plastic bags, pa-per-plastic composites, and other plastic products have lost value.

2.1.4 What is bioplastics

As the relative authority on bioplastics, the European Bioplastics Association defines bioplastics as either bio-based or biodegradable plastics and includes materials that combine both properties.

According to the definition of the European Bioplastics Association, bioplastics are:

(a) Bio-based plastics: i.e., plastics derived from renewable resources.

(b) Biodegradable and compostable plastics: biodegradable polymers that meet all scientifically recognized normative criteria for the biodegradability and compossibility of plastics and plastic products. Generally, in Europe, it refers to EN 13432, in the United States to ASTM D6400, and in other countries to ISO 17088.

These standards focus on the source of the raw material and the functionality of the product, respectively:

(a) The focus is on the source of raw materials. Unlike traditional plastics, which use fossil carbon, bio-based polymers use carbon from renewable resources such as sugar, starch, vegetable oils, and cellulose. Corn, potatoes, sugar cane, grains, and wood are the most common feedstocks. The percentage of renewable carbon in the product can be determined using ASTM D6866. Not all bio-based plastics are degradable and compostable; they can

also be non-biodegradable.

(b) The focus is on the functional “biodegradability” or “compossibility” of the product.

A recognized test standard must confirm the compossibility of the product (European EN 13432, the legal standard for compostable plastics in all EU countries, US: ASTM D6400, other countries: IS0 17088). It must certify manufactured products by an independent third-party certification body and bear the certification body’s logo.

It derived not all biodegradable and compostable plastics from renewable resources; We can also derive them from petroleum.

Global Bioplastics Market Distribution

The bioplastics market is mainly located in Europe, North America, and the Asia Pacific. Europe is the central hub of the bioplastics industry and is a relatively mature region for the development of bioplastics, holding a significant position in bioplastics research and development, and is the largest industrial market in the world. Europe’s favorable political and economic conditions have facilitated the expansion of the bioplastics market, resulting in numerous collaborative developments in the industry and a significant shift in the traditional European plastics industry landscape, but the market growth rate for bioplastics in Europe is low. The Asia-Pacific region is a major production center, with approximately 70% of the world’s injection molding infrastructure located in Asia. Its market size is expected to overtake that of Europe in the coming years, with fast growth rates as an emerging market. North America is located between Asia and Europe in terms of size and growth rate. Other regions are relatively small, with a combined size of less than 1/4 of each of the three major regions. However, the market is large and is a bright spot for bioplastics promotion, and they expected its growth rate to show rapid growth.

2.2 The current state of the plastics problem in China

2.2.1 The problem of plastic pollution in China

Plastic pollution and severe air pollution have long plagued China. While plastic has brought convenience to people's lives, it has also brought unmanageable environmental consequences, which people call "white pollution." The annual production of plastic in the world is 100 million tons, if calculated at 15% of the plastic yearly waste volume, the annual plastic waste volume in the world is 15 million tons, and the plastic yearly waste volume in China is more than 1 million tons, the proportion of waste plastic in the rubbish accounted for 40%, so many waste plastic as garbage is buried in the ground, no doubt to the already lack of arable land to bring more pressure. Numerous countries treat waste plastics by incineration (thermal energy recycling) or reprocessing and manufacturing (product recycling). Both of these methods allow waste plastics to be recycled, saving resources. However, the disposal of waste plastics is still a major environmental problem, as incineration or reprocessing can produce gases that are harmful to humans and pollute the environment.

China is predominantly agricultural, with 768.5 million of its 1.3 billion people living in the vast rural countryside. This national condition determines that agriculture is the basis of the national economy. Agricultural plastic products have become indispensable production materials for the development of modern agriculture, it is an irreplaceable technical measure to resist natural disasters and achieve stable, high yield, high quality, and high efficiency of crops, and has been widely used in China's agriculture forestry, animal husbandry, and fishery industries, agriculture has become the second largest consumer of plastic products after the packaging industry. Waste plastic products mixed in the soil continue to accumulate will affect the absorption of nutrients and water crops, resulting in crop yield reduction. Secondly, they pose a threat to the survival of animals. Animals swallow waste plastic products abandoned on land or in bodies of water as food, leading to animal deaths. Last

year, 20 herders killed nearly 1,000 sheep on the shores of Qinghai Lake, resulting in economic losses of around 300,000 yuan. Sheep like to eat plastic bags wrapped in oily residue, but often even plastic bags together, due to ingested plastic stays in the stomach for a long time and is difficult to digest; these sheep's stomachs are crowded, can no longer eat, and finally, only be starved alive. This is common in zoos, pastoral areas, rural areas, and oceans.

Furthermore, waste plastics landfilled with waste not only take up numerous lands, but it does not restore the occupied land for a long time, affecting the sustainable use of the land. Waste plastic products that go into domestic waste will not degrade for 200 years if I landfill them. Moreover, plastic bags are made from petroleum, which not only consumes numerous resources but cannot be decomposed and can pollute land and rivers when buried underground.

2.2.2 Current treatment measures taken

In 2019, the amount of plastic waste was about 6.3×107 t. Among them, disposable plastic products, such as plastic bags, agricultural films, and beverage bottles, amounted to more than 2×107 t per year, which is the primary source of "white pollution." In addition, plastic products such as home appliances, automobiles, and construction products are becoming obsolete and are an essential source of waste plastic. In China, waste plastics are mainly recycled, incinerated, disposed of in landfills, and accumulated in the environment: 30% of waste plastics are recycled, 14% are burned to generate heat, and 36% are landfilled or discarded at will, causing severe environmental pollution.

For decades, China has relied on superficial policies targeting plastics to reduce domestic waste. This has included a ban on free shopping bags and carrier bags - data from a 2016

survey indicated a reduction of more than two-thirds in plastic bags in supermarkets and shopping centers - and a ban on the production, retailing, and use of any product less than 0.025mm thick. China's Plastic Pollution Control Act 2020 is the right action needed to tackle a real environmental problem. Through the national plastic pollution control program over the next five years, the consumption of single-use plastic products will be significantly reduced, and it will promote alternatives in China. China's laws and regulations may not be a perfect model, but the country has built its own workable and culturally subtle solution. It is also attempting to promote plastic alternatives such as bamboo, wood, and paper (as well as scientific research into biodegradable plastics) and to remove plastic waste from major lakes and rivers, tourist attractions, and rural areas over the next five years. Public awareness of microplastics is low in China, and the more the public knows about plastics and microplastics, the more willing they will be to take action. Public awareness is also an important influencing factor.

2.2.3 Citizens' awareness of environmental protection at this stage

Although citizens have become increasingly aware of environmental protection in recent years due to their education, family environment, and other influences, environmental protection is very vague. Only a few citizens comprehensively understand the concept of environmental pollution. Only if citizens have a thorough understanding of the concept of the environment can they participate in protecting the environment and raising awareness of environmental protection. For example, if a project is to be built in a particular area, the project will cause little or no pollution to the surrounding environment. Still, some citizens have limited knowledge of the environment and are influenced by some wrong opinions, so they spread rumors on the internet and in society that the project is polluting, causing social panic and even boycotting the project.

Raising citizens' awareness of environmental protection laws can benefit the protection of their interests and society's harmonious and sustainable development. Raising citizens' awareness of environmental protection laws means combining their interests with environmental protection and increasing understanding, concern, and action on environmental issues by giving people greater access to environmental rights.

2.2.4 Strategic thinking on strengthening environmental awareness for all

Raising awareness of environmental issues is key to putting sustainable living in people's minds and is an opportunity to educate people and spread information to help protect nature. Social media is a powerful tool for creating change. In 2019, the average internet user spent 144 minutes a day on social media - over 2 hours! They spent only a fraction of this reading news and getting more information, but it is still a huge opportunity to raise awareness of environmental issues. The world of social media has proliferated over the last decade, and there are now many ways to reach people by creating different types of media.

a. Establish a dedicated environmental education and publicity website

With the development of science and technology in China, information technology and networking technology are being used in people's daily lives and work, and people are communicating through the internet. Environmental protection departments can use information and networking technology to set up particular environmental protection websites. This is a great way to promote environmental protection awareness, create an environment for learning about environmental protection, and guide public opinion in the right direction. In addition, it is essential to clarify the value of environmental protection and pollution treatment on environmental education websites so that the public can start to raise their awareness of environmental protection.

In environmental protection work, it is necessary to use multimedia platforms to promote and publicize public awareness of environmental protection and ecological protection behavior with the help of correct public opinion guidance. Using new media techniques and knowledge of new media is an effective way to integrate new media with environmental protection propaganda and to use new media methods to promote environmental protection.

a. Shaded Sea (Fig.2.3. & Fig.2.4.)

This is the interactive art installation 'Shaded Sea,' which wants to show that the power to change plastic overuse is in our hands. The work aims to continually create awareness of the problem of plastic in our oceans, as 10% of the 260 million tons of plastic produced each year still ends up in our oceans.

It uses sensors, and fast image tracking as the plastic sculpture follows every movement of your hand. At first, there is something hypnotic and elegant about the plastic pieces floating out of the vast rubbish heap in front of Hawaii, but slowly you realize that the plastic will always follow you as long as you are around.

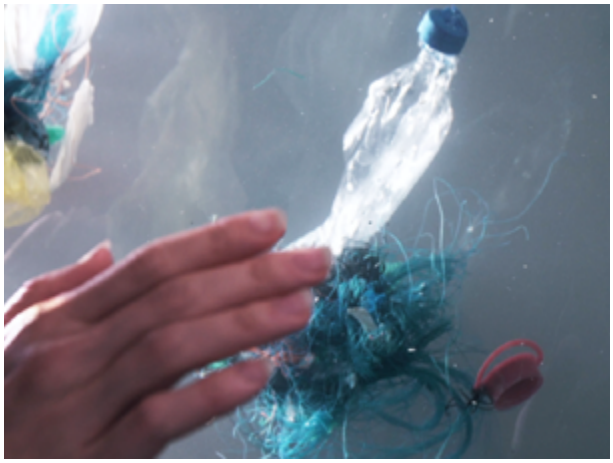


Fig.2.3.& Fig.2.4: 'Shaded Seas' by Thijs Biersteker. Commissioned by Science Gallery Dublin for the exhibition PLASTIC.

b. Plastic Reflectic (Fig.2.5. & Fig.2.6.)

'Plastic Reflectic' is an interactive and dynamic installation used to inspire, educate and provoke thought and interaction. It allows the viewer to reflect on the concept of the growing problem of plastic in our oceans.

These plastics enter the natural food chain from human waste, slowly intertwining with our muscles and fatty tissues, turning humans into plastic. The installation reflects its audience

with plastic pixels made from marine plastic worldwide. Interaction with the building empowers the viewer with the idea that their actions at this moment can influence the growing problem of plastic later on.

Fig.2.5.& Fig.2.6: 'Plastic Reflectic' by Thijs Biersteker, Casper vd Meer, Thomas voor 't Hekke and Bas van Oerle

c. Plastic coral ecosystems (Fig.2.7. & Fig.2.8.)

Because of humanity's habit of wasting and not recycling plastic without thought, we will soon face a future in which the oceans are full of plastic waste. All the world's corals will perish and be replaced by beautiful plastic waste. So, for the future of the dreaded plastic coral reefs, this infographic introduces the idea called the 'Plastic Coal Ecosystem Campaign.' This infographic is ironically executed not for visual aesthetics but so that it makes the viewer aware. Each beautiful plastic coral carries an important message and a dense message. The waste we produce daily from plastic bottles, polystyrene foam, pipes, bowls, plastic bags, etc., floats in the ocean for a long time. The future sea may look great but be full of plastic debris. If we don't find a solution, the plastic ocean won't contain any natural corals but will be inhabited by plastic waste coral reefs.

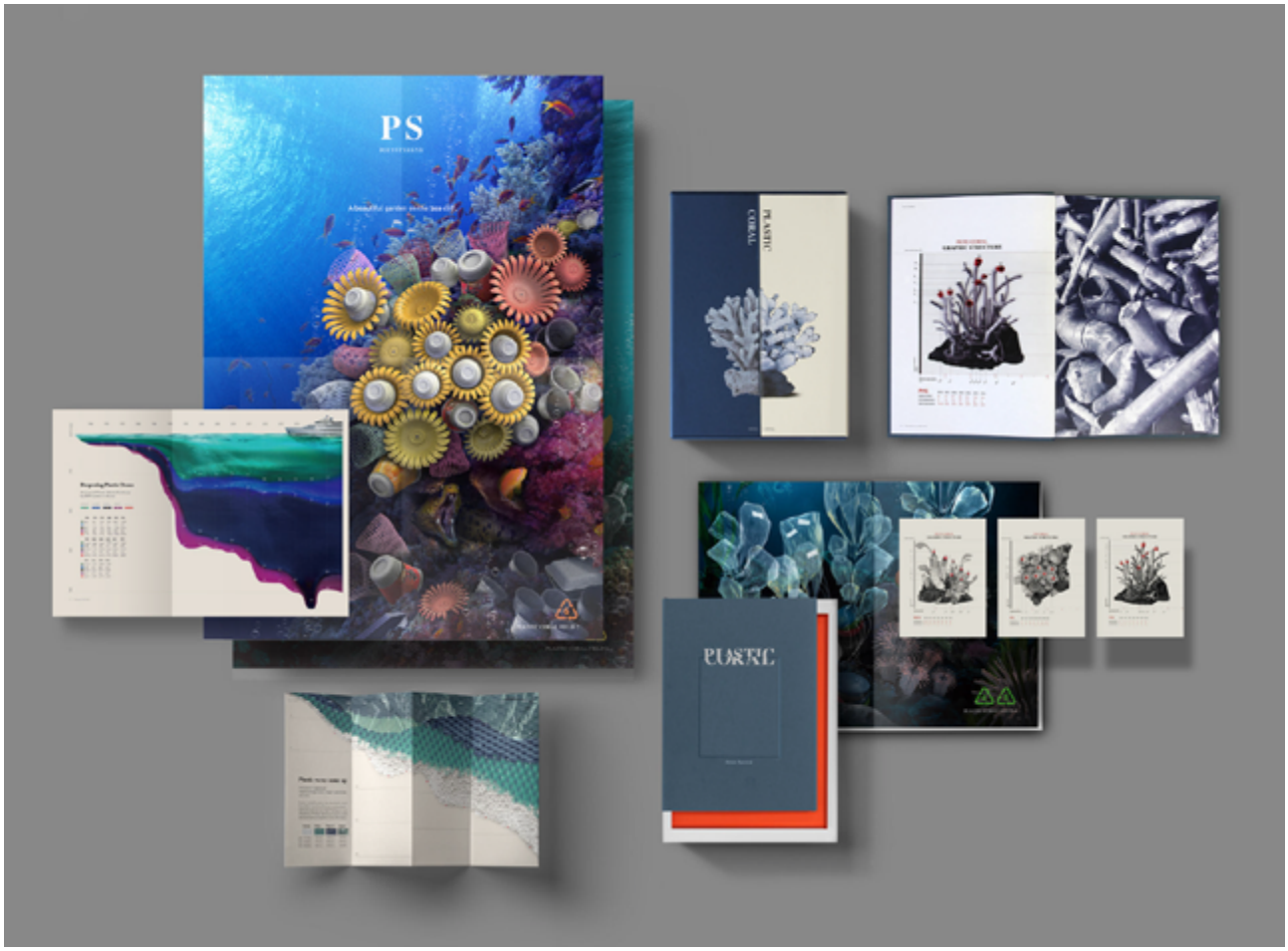


Fig.2.7.& Fig.2.8: Plastic coral ecosystems

d. Plastic tree (Fig.2.9.)

At Art Basel Unlimited 2015, the fair's unique platform showcased works that transcended the traditional art fair stand. The Promenade Gallery featured a massive installation by Cameroonian artist Pascale Martine tayou. "The 'plastic tree' spans the vast length of the all-white interior gallery wall, jutting outwards towards the approaching visitor.
Branches of varying distances and sizes grow horizontally from the surface, subverting our everyday experience and traditional relationship with trees. Instead of leaves, the edges of the bark are brightly colored plastic bags roughly tied to each organic limb. While this work is a visual symbol of the harmful effects of pollution and consumerism on the environment, Plastic Trees also investigates the artistic qualities of plastic as a medium and its combination with natural materials.

Fig.2.9.: Plastic tree

IV. Research Methodology

4.1 Introduction

A design research methodology is a method and a set of supporting processes and guidelines that can be used as a framework for conducting design research. The author focuses on qualitative research through questionnaires, surveys, literature analysis, case studies, sketches, experiments, and user testing.

4.2 Questionnaires

A questionnaire is a set of printed or written questions with a choice of answers designed for a survey or statistical study (Oxford Languages). The questionnaire was used to collect 100 Chinese consumers (aged 18+).

Questions:

1. Do you know what microplastics are?

Don't know 66% Know some 20% Know all 14%

2. Do you know that bottled water contains microplastics?

Don't know 59% Know some 28% Know all 13%

3. Did you know that convenient tea bags produce many microplastics when brewing tea?

Don't know 79% Know some 4% Know all 17%

4. How long do you think it takes for degradable microplastics to degrade?

Don't know 48% Know some 31% Know all 21%

5. For degradable microplastics, how long do you think they take to degrade?

17% a. Less than ten years

41% b. Decades to a century

35% c. Several hundred to several thousand years

7% d. Longer

6. What are the possible sources of microplastics in water? (Multiple choice)

90% a. Degradation of large pieces of plastic debris by fragmentation

55% b. Activities such as ship transport and fishing

80% c. Particles from cosmetics and fiber emissions from clothing

40% d. Natural disasters and agricultural production

7. Where do you think microplastics may be found? (Multiple choice)

79% a. Marine life

79% b. Soil surface

66% c. Human organs

83% d. Domestic water

72% e. Daily consumption of aquatic products

8. What do you think are the possible risks of microplastics in the ocean? (Multiple choice)

93% a. Affecting the normal physiological functions of marine organisms, causing them to become sick or die

69% b. Carrying pathogenic bacteria that affect the stability of the ocean

83% c. Pollute the ocean

83% d. Suck up organic pollutants and move with ocean currents causing chemical hazards to the ocean

9. Which products in your life do you think contain microplastics? (Multiple choice)

86% a. Cosmetics, clothes, washing machines, etc.

93% b. Plastic waste

52% c. Food

59% d. Drinking water

76% e. Detergents with cleaning effect, disinfectant water

10. What is the most significant proportion of the plastic waste generated in your daily life?

72% a. Takeaway or takeaway packaging (including meal boxes, cutlery packs, bags)

14% b. Plastic shopping bags Express parcels

14% c. Plastic bottles

0% d. Snack packaging

From the questionnaire, we have come to three conclusions.

a. Most Chinese consumers do not know and understand microplastics, nor do they have the means to do so

b. The widespread use of plastics is a serious social problem that everyone is aware of

c. Consumers are willing to learn about microplastics and take practical action

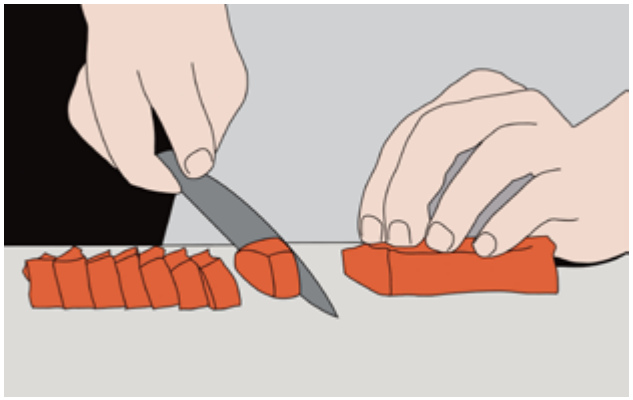
Consumers have too little knowledge of microplastics and do not understand them and the substantial harm they cause to human health and livelihoods. The measures that we have now do not fundamentally change people's perceptions.

4.3 Literature analysis and case studies

The literature section is divided into two main directions: microplastics and the current state of the plastics problem in China. The author has searched a large amount of literature through different sources. In the microplastics section, the paper attempts to identify what plastics and microplastics are, to understand the various types of microplastics and the dangers they pose, and thus understand that raising environmental awareness is necessary. The section on the current state of the plastics problem in China analyses the current plastic pollution problem faced by China and the range of measures taken by the government. Also, it carries out some case studies designed by some designers to raise environmental awareness.

4.4 Animation

Visual methodologies are becoming increasingly evident in the social sciences. Media such as film, sound, still photography, electronic digital media, and content objects encompass these methodologies. Guillemin (2004) argues that information creation is necessary for drawing and that visual products are the result. The author uses animation as a research method in this project.



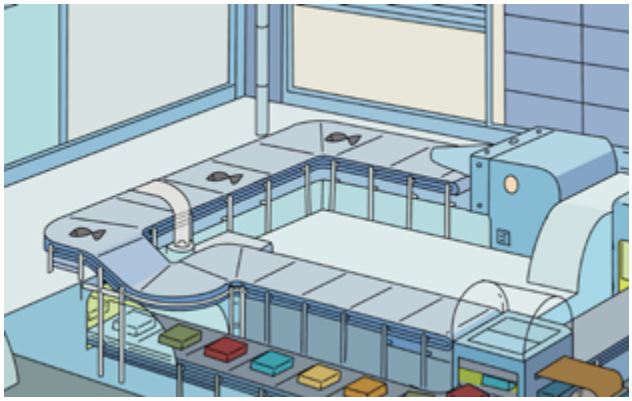


Fig.4.1&4.2.: Animation

The author uses two animations, namely, the process of organic fishing and the operation of the industrial fishery. The first animation shows that the fish in the reservoir is clean and pollution-free, and can be processed and eaten directly at the dinner table. The second animation shows the assembly line process, where people catch fish from the sea and go through a series of operations to enter the factory. Not drawing the results gives people a direct idea of what will happen next.

4.5 User research

The goal of user research is to put your design project in context. It helps you understand the problem you are trying to solve; It tells you who your users are, in what circumstances they will be using your product or service, and ultimately, what they need from you (the designer)! UX research ensures that you design with users in mind, which is key if you want to create successful products.

Why do they choose to use plastic products?

· No substitute material

· Express packaging will be affected

· Low cost

· Ease of access

· It's not up to the consumer

· It can be recycled

What is the most wasted plastic product?

· Garbage bag

· Plastic packing

· Takeaway packing · Plastic bottle

· Toiletries

What concerns do they have about alternative materials? · Replace plastic

· Will the cost go to the consumer

place/price · Harmful

· Appearance · Smell

· Function

· Procurability

4.6 Website/App design

Responsive Web design is a choice: By building websites that meet users on the platform and device of their choice (mobile or desktop), companies can meet the need for agile content delivery and engagement. At the same time, mobile apps offer a new way to connect with your users by making your brand part of their local mobile ecosystem. While there are advantages to both approaches, the increasing need to shift to mobile-first makes

an application-driven strategy worth considering. Through the website and app, consumers can better communicate with each other and master knowledge about plastics to arouse consumers' awareness of environmental protection.

The author hopes that through the dissemination of the website /App, Chinese consumers can better understand the knowledge and harm of plastics, so as to awaken consumers' environmental awareness.

Fig.4.3&4.3&4.5.: Website/App design

V. Process/Result

5.1 Design Inspirations

In recent years, with the improvement of public awareness of environmental protection, the continuous breakthrough of production technology, and the expansion of application fields, bioplastics are in a critical development period, and their future consumer market is expected. The promulgation and implementation of a “plastic ban” in various countries will try to curb the spread of plastic waste. Bioplastics have become the new favorite to replace traditional petroleum-based plastics because of their green, environmentally friendly, renewable, and easily degradable advantages. With the increase in human demand for bioplastics, the successful development of new bioplastic products, the refinement of application scope, and the continuous growth of production capacity, bioplastics will usher in a substantial growth period, and the bioplastics industry will be further globalized.

5.2 Moodboard

At the earliest stages of the design process, it is essential to set a tone regarding aesthetic ideas, colors, emotional values, technology, and even target users and uses. This tone comes from the client’s description of the vision for the future product or family. These attributes influence the designer’s research process, and this tone is often more pleasant yet ineffable. As a result, designers usually think visually, so having a set of images can quickly convey information that would take a long time to explain in words (Lee, 2019). The author chose the following photographs to compose a mood board (Figure 5.1), the materials used, and the products referenced.

Fig.5.1.: Moodboard

5.3 Material testing

With a wide variety of materials and treatments on the market, testing can help narrow down the options to find the best one for the intended use. As mentioned earlier, many industrial applications perform tests to demonstrate that the material meets a given standard or specification or to verify that it meets other strict criteria before being used.

5.3.1 Natural pigment

The edible natural pigment is an integral part of food additives, which can be divided into natural and synthetic pigments according to their sources. Modern medicine has proved that most synthetic dyes have specific toxicity. Some even have a carcinogenic effect, which has gradually been eliminated. And natural dye, because of its numerous advantages, more and more consumers favor. China is a significant resource country with vast natural pigment reserves, which have excellent potential for development. For example, there are nearly 20 kinds of natural pigment resources in the Changbai Mountain area, among which the most significant reserves are 45,000 tons of Schisandra Chinensis and 35,000 tons of mountain grape. The Wuhan Institute of Botany, Chinese Academy of Sciences, has investigated and

evaluated 113 plant pigment resources in China. Shandong University studied 65 kinds of bilberry resources in China and found that 18 of them have excellent development value. The investigation data of edible natural pigments in Sichuan Province showed that there were 96 kinds in 35 categories, most of which were valuable for development. Therefore, finding and developing more natural dyes has become the general trend in the development of food pigments.

Characteristics of natural pigments

Advantage

a. It comes from nature and has high safety. There are numerous kinds, natural colors, and pharmacological and nutritional values.

b. It has a unique flavor and adds food flavor. It comes from a wide range of sources and can be developed and produced by selecting raw materials according to local conditions.

c. The color imitation of natural products and the nature of color chromatography are better.

Disadvantages

a. Tone is susceptible to the pH value, metal ions, light, heat, oxidant, etc., and poor stability. It is vulnerable to external influences in the process of processing and circulation.

b. Low chromophore content, poor color compatibility, poor color compatibility with different pigments, it is rare to have any hue as the cost is relatively high.

c. Product difference is significant due to different raw materials, production places, or processing methods, the production of the same variety of colorants in the composition, and nature is difficult to be entirely consistent.

The primary process of this product is to collect the raw materials of natural pigment plants through sorting, washing to remove mud, drying to draw water, and then crushing by the shredder, placing in the solution of soaking extraction, extraction of liquid through separation, concentration, drying, refining, and finished products.

The technological process is as follows:

Raw material separation - washing - dry grinding - solvent extraction - filtration separation - drying - refinement - finished products

Fig.5.2.: Nature pigment

5.3.2 Why egg shell

The world has processed eggs for over 100 years, and they expected global egg consumption to rise to 70 million tons by 2015, 70 percent of which will come from Asia. China has the highest poultry production and consumption of poultry eggs, accounting for approximately 35% of the global total. Hebei, Henan, Shandong, Liaoning, and Jiangsu are the central egg-producing provinces in China. Every year after consuming numerous eggs, abandoned eggs can reach more than 4 million tons (eggshells account for 12% of the whole egg weight). Hatcheries, food processing plants, biological products factories, and other units will discard many waste eggshells and egg whites, waste eggshells, and often emit a pungent smell; residual organic substances also cause severe pollution to the environment.

Eggs have been part of the diet of numerous cultures for centuries. At present, egg whites

have been a popular area of research because of proteins such as lysozyme, but humans in many cultures have known how to use eggshells since ancient times. Because the waste eggshell contains a lot of calcium, keratin, collagen, and other components, the research on the eggshell is attracting more and more attention. Disposal and comprehensive utilization of waste eggshells can reduce environmental pollution and improve the added value of egg products and increase economic benefits.

As the largest producing country and consuming country of the egg, most of our country remains in the use of fresh eggs, as many eggshells are not well utilized.

Material collection process

1. Clean the collected eggshell at the beginning to remove the mud and sand attached to the surface of the eggshell and other visible solids. The cleaning process is completed by rapid stirring. The sewage is treated under leakage and precipitation, and the clean water is recycled after treatment.

2. Drain the eggshells and dry them in a Muffle oven at 250 degrees Celsius for sterilization.

3. Pulverize the eggshell with a grinder, pass the sieve 625 mesh, and collect the eggshell powder. The resulting products can be fillers for coating, cement, and building materials

Fig.5.3.: Eggshells

5.3.3 Why coffee ground/Tea residue

Coffee ground

In producing instant coffee, coffee grounds account for 67% of the mass fraction of dry coffee. Coffee grounds are mainly used for fuel and feed abroad but are mostly discarded as waste at home, wasting resources and polluting the environment. According to research, coffee grounds contain more than 14% of oil, and solvents can extract coffee. The pigment of coffee grounds can be obtained by alkali extraction, filtration, and concentration.

Tea residue

With the development of the social economy and the improvement of people's living standards, China's urban household garbage has also increased substantially, among which 40% ~60% belongs to kitchen waste. Someone mainly divided this kitchen waste into kitchen waste generated in family life, kitchen waste left after cooking, and kitchen waste generated in other places, which are the focus and difficulty of household waste classification and treatment. How to realize kitchen waste's harmless treatment and resource utilization has been a hot topic at home and abroad. The organic matter content of this kitchen waste is vibrant. After the proper treatment, they can convert it into new resources and realize resource regeneration.

Tea residue is one of the kitchen wastes that need to be disposed of every day. China is a significant producer of tea. However, Chinese people, regardless of their age, always drink tea. Older adults like to make tea; young people like milk tea. Therefore, people's demand for tea gradually increased, followed by the output of tea residue will increase;

If we don't make good use of tea leaves, we will waste resources. Most of the waste tea residue is treated by fuel or landfill, which has low economic benefit. To improve the resource utilization rate of tea residue, tea residue has been used to make animal feed, paper products, and activated carbon deodorization. Turn waste into treasure and realize the secondary utilization of tea residue resources well.

Fig.5.4.: Tea residue

5.4 Prototype

Plastic is everywhere in the ocean, and when it is thrown into the ocean by tourists or made its way into the sea through household waste disposal, it can lurk there for a long time. Tight-knit plastic toys like Legos are no exception; even the deepest parts of the ocean are already full of this junk.

A recent study by the University of Plymouth in the UK found that they estimate Lego bricks to last between 100 and 1,300 years in the oceans. Dr. Andrew Turner, associate professor of environmental science, who led the study, said: “Lego bricks are one of the most popular children’s toys in history, and one of the attractions is their durability. “We were surprised at how strong it was, even though it probably hadn’t worn down significantly in the ocean for decades.” For the study, published in the journal Environmental Pollution, the researchers focused on Lego bricks washed up along the coastline of southwest England. After cleaning 50 weathered Lego blocks made of acrylonitrile-butadiene-styrene (ABS) collected from the beach, the researchers measured the mass of the blocks and the size of the studs in the lab. X-ray fluorescence (XRF) spectrometers were then used to determine the chemical signature of each block and, based on the results of the presence or absence of certain elements, to determine how long the partnerships would last. “By comparing the blocks to unweathered sets purchased in the 1970s and 1980s, the researchers were able to determine how worn it was and thus how long the blocks would last in the Marine environment,” the researchers said. The researchers found that the Lego blocks had discolored and become smooth, that some of the structures had cracked, and that the wear patterns of the Lego blocks after they had been soaked in water showed that they were failing into microplastics, which are

Fig.5.5.: Lego in the decomposition process

Fig.5.6&5.7.: Egg shell production experiment

Material testing and proportioning study are essential steps in the design process. Both are processes that determine whether the product is finally formed through the repeated modification of the material ratio, and by referring to the existing market products of the ingredients of the comparison, the more suitable production proportion. Finally, I use eggshells, natural dyes, gelatin, glycerin, and water for my products. It made products with natural shades of different colors.、

VI. Discussion and conclusion

6.1 Discussion

According to research, microplastics are harmful to human health. Although public awareness of environmental protection has increased and the rate of waste is gradually decreasing, it is still a severe social problem. Today, environmental campaigns are largely

outdated government campaigns, have no real social significance, and do not fundamentally raise awareness of microplastics. The masses do not readily accept this due to ancient propaganda methods. The research question for this project is how to use the website and design to raise environmental awareness. In response to this research question, the author designed a website and app and used bioplastic products to raise ecological awareness.

6.2 Restrictions

Although the animation design adds some fun to this serious topic, the website /app itself is not very good at attracting consumers to browse and study. The author's approach may not be fun or convenient enough for consumers. Because only a small number of people can browse the website in real life, although the app design content is increased, it will still lead to ineffective communication. There is no denying that communication through websites and apps has good educational significance. When consumers browse the website and app, they can access 80% of the information about plastic issues, including, of course, the information on plastic matters in China and the current policies implemented by the Chinese government, and gain a lot of insights. Creative animation gives users a sense of freshness, and the open ending allows them to meditate independently.

6.3 Future Work

In the results of the study, the website and the product itself do not connect well. Due to the epidemic and time constraints, the final purpose was not clear in the design process. For the future improvement of the project, they can shoot different videos according to the output of the product, so that consumers can make them by themselves, which will be more attractive. The second problem that needs to be improved is that we should focus more on one aspect in the limited time. The simultaneous appearance of websites, animations, and products will cause a sense of disarray and a lack of connection.

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