DEPARTMENT OF INDUSTRIAL DESIGN

THE DEVELOPMENT OF NEW COMPOSTING EQUIPMENT FOR KITCHEN WASTE

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SEPETEMBER 2020

A research dissertation submitted to
IND 402, Xi'An Jiaotong-Liverpool University in partial fulfillment of the requirements for the degree

THE DEVELOPMENT OF NEW AUTOMATIC COMPOSTING EQUIPMENT FOR KITCHEN WASTE

Abstract

From the perspective of product innovation, this project aims to solve the kitchen waste generated in people's daily lives and degrade it into organic fertilizers. This will reduce the waste of land resources and air pollution caused by waste incineration and landfill, reducing the government's financial pressure to realize society's sustainable development and resource reuse. China has strengthened its garbage disposal policies in some areas, such as Beijing and Shanghai. Under the pressure of such policies, residents need to install a garbage disposal device at home to achieve garbage sorting. Most residents will choose the connected garbage processor (kitchen waste is directly flushed into the sewer through the garbage crusher). This kind of product has high efficiency and has higher requirements for water pollution and water treatment. The project aims to develop a new intelligent kitchen waste composting equipment, which belongs to an independent kitchen waste processor. The research and design will combine resource reuse, adopt the technological method based on microbial natural

degradation of kitchen waste, and combine artificial intelligence to accelerate the breaking down the process and shorten the composting cycle. This is through the research process for understanding users' awareness of garbage classification and environmental protection measures, which currently suffer from the pressure of no policy. The proposed design scheme's target users will be families with planting and flower raising habits, strong environmental protection awareness, and certain economical income levels. The proposed design scheme is to design an intelligent and efficient kitchen waste disposal (independent type) - intelligent composting box. The goal of this design is to help users to classify waste more easily and to solve the problem of kitchen waste treatment. In this case, it can also produce organic fertilizer as a growing compound.

Keywords: product innovation, kitchen waste, organic fertilizer, composting equipment

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Document date: 27/11/2020

新型全自动餐厨垃圾堆肥设备的发展

摘要

这个项目从产品创新的角度出发，旨在解决人们日常生活中产生的厨余垃圾，并将其降解为有机肥料。这将减少垃圾焚烧和填埋造成的土地资源浪费和空气污染，也降低了政府在实现社会整体的可持续发展和资源再利用方面的财务压力。中国在部分地区已经强化了对于垃圾处理的政策，比如北京和上海已经有了强制措施，在此类政策压力下，居民需要在家中选择安装一种垃圾处理器以达到垃圾分类处理的目的。大部分居民会选择连接式的垃圾处理器（厨余垃圾通过垃圾粉碎机直接冲入下水道），此类产品有较高的效率，对水污染和水处理的要求也就更高，本项目旨在发展一种新型智能厨余垃圾堆肥设备，属于独立式的一种厨余垃圾处理器。研究设计将结合资源再利用的理念，采用基于微生物自然降解厨余垃圾的技术方法，结合人工智能，加快分解过程，缩短堆肥周期。这是通过研究的过程，目的是了解目前处于无政策压力下的用户的垃圾分类意识和环境保护措施。建议设计方案的目标使用者，将是有种植和养花习惯、有较强环保意识和一定经济收入水平的家庭。提出的设计方案是设计一个智能高效的厨余垃圾处理(独立型)——智能堆肥箱。本次设计的目的是为了帮助用户更容易的对垃圾进行分类，解决厨余垃圾的处理问题。在这种情况下，它还可以生产有机肥料作为生长化合物。

关键词

关键词：产品创新、厨余垃圾、有机肥、堆肥设备

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文件日期：27/11/2020

Acknowledgement

First and foremost, I would like to thank Prof. Richard, my graduate tutor, who generously gave me a lot of effective suggestions in the whole process of the project, such as the selection of product materials, model making, product cost and market, mechanical experiment of the project, etc. I also want to thank Prof. Thomas for his serious help and advice on my dissertation and project. Secondly, I would like to thank my friend Zhao Zishi, a classmate in my graduate project, who has given a lot of advice and help in product appearance and computer model making. Of course, I should also like to thank my alma mater, Xi'an Jiaotong Liverpool University, for providing me with a good learning environment, comfortable model studio and graduate studio, as well as kinds of literature.

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Introduction

1.1 Background research and problem identification

China has a significant level of waste pollution. As early as 2004, the total amount of waste in China exceeded that in the United States, becoming the country's largest waste. At present, the annual output of domestic waste in China is about 400 million tons, increasing about 8% every year. Over the years, we have paid a high environmental and health cost due to poor garbage disposal, which affects the future of human beings, other creatures, and even the whole earth. From January 1, 2018, to July 1, 2019, Shanghai banned the import of waste and implemented waste classification. Not only is Shanghai a busy conurbation, but the whole of China has a fast-growing problem. While Guo (et al. 2017) consider that effective and corresponding waste classification, recycling measures, and appropriate composting technology can control and improve waste pollution.

With urbanization and population growth, kitchen waste will also increase correspondingly. Kitchen waste mainly consists of oil, water, fish, meat, bone,

leftovers, etc., which is the same in the global scope. About 74 million tons of kitchen waste are produced in Europe, about 1.6 million tons in Australia, and about 30 million tons in China; the total amount of kitchen waste in these countries exceeds 30% of domestic waste. In general, kitchen waste is directly sent to landfills, burning, or landfills, increasing resource consumption, environmental degradation, and human diseases. For example, due to kitchen waste's high moisture content, the landfill will pollute the surface water; the incineration of kitchen waste consumes many energy resources and maintains a shallow moisture content (Shi. Y et al. 2020).

Food in its production stage will significantly impact the environment, the whole process includes its planting to food processing, but people's eating habits and choices will have a certain degree of impact and guidance. Therefore, food-related processing and waste production will cause corresponding environmental pollution. Each year, an estimated one-third of food production and processed food (equivalent to 1.3 billion tons, worth about $1 trillion) end up rotting in bins of consumers and retailers or deteriorating due to poor transportation and harvesting. Two billion people are overweight or obese around the world. Land degradation, declining soil fertility, unsustainable water use, overfishing, and the marine environment's degradation are all weakening the natural resource base's capacity to provide food. The food sector accounts for about 30% of the world's total energy consumption and 22% greenhouse gas emissions (Responsible Consumption and Production, 2020).

1.2 Meaning of the research design project

The design purpose of this project is to reduce the generation of kitchen waste in the source, that is, every household, or help the household to classify the waste. The harm of kitchen waste is self-evident.

First of all, the purpose of solving kitchen waste is to eliminate the hidden dangers in people's daily life. Kitchen waste is straightforward to deteriorate, rot, ferment, breed mosquitoes, and flies, produce a large number of toxins and send out odor gas, pollute the water body and the atmosphere, and directly into the sewer will cause blockage; the source is complex, containing various bacteria and pathogens, which may harm human health due to the food chain.

Second, reduce landfill or incineration. The recycling of kitchen waste will greatly reduce the amount of landfill. Because of urbanization, the available land for burying is reduced, and the amount of garbage produced by the rising population is also increased. It is difficult to locate the incineration plant. Many cities have not been properly treated and utilized due to the high moisture content and low calorific value

of kitchen waste, thus occupying a large amount of landfill capacity, which is the main source of landfill gas and leachate, resulting in a large increase in the cost of secondary pollution prevention. It can reduce the final treatment capacity of waste, reduce the number of secondary pollutants generated in the landfill, improve the calorific value of waste incineration, and improve incineration power generation's utilization efficiency. To reduce the pressure of society and government.

Third, kitchen waste can be transformed into organic fertilizer, feed, oil, and other resources through various technical means. Wang (et al. 2019) assert that Kitchen waste is a carbon source and an excellent nutrition source. The assessment of the life cycle shows that the recycling of kitchen waste is conducive to energy balance. As kitchen waste contains oil, rich sugar, and protein, it provides a good growth condition for microorganisms and has a high utilization value of bioactive resources. Kitchen waste is used for fuel production, including biodiesel, methane, hydrogen, and fuel ethanol. Agricultural uses include the production of animal feed and organic fertilizer. Furthermore, Lin (et al. 2018) noted that hydrogen is attractive as a clean energy carrier because of its high energy content. From the perspective of the green or circular economy, biohydrogen production by dark fermentation / anaerobic digestion using organic biomass waste is the most concerned.

With the depletion of non-renewable resources such as oil, to meet the growing demand of the population for resources, waste recycling is an effective solution. For

example, daily kitchen waste, including leftovers, bones, vegetable roots, and leaves, can produce 0.3 tons of organic fertilizer per ton as long as it is composted in a situation by biotechnology.

1.3 Research question

This case's research scope is narrowed down to the following areas: waste classification and recycling concept, user experience design, domestic composting technology, and product combination.

The general research question is:

Based on the trend of environmental protection and the popularization of domestic waste classification policy, how can people solve or reduce kitchen waste at the source (every family) through the combination of composting technology and the innovative design of products?

Following the central question, a few sub-questions are proposed as below:

- How to reduce the composting cycle by artificial intelligence?
- How to improve the user experience during the composting process?

- How to deal with compost fertilizer?
- How to help users simplify the complicated composting operation steps?

1.4 Design opportunities

According to the Industrial Chanel (2019), in 1955, the first garbage disposal unit entered the Chinese market. Since 2001, the government departments began to promote the kitchen waste disposal unit, encourage and guide the qualified household garbage disposal unit. Xiamen, Shenzhen, and other cities took the lead in requiring new houses equipped with kitchen waste disposal unit. In 2016, the sales volume of kitchen waste disposal units in China was 1.478 million, accounting for 14.6% of the global market share, second only to the United States. However, due to China's large population base, garbage disposal's popularity rate is less than 0.1%. With the implementation of the waste classification policy and the government's strong support for kitchen waste disposal, the kitchen waste disposal has a broad prospect, and the consumer demand will be further released.

During the period of 618, 2019, the sales of garbage processors of all platforms grew rapidly, among which, the first hour of a small platform on June 16 increased by more than 300% year-on-year; the sales of garbage processors of JD in half an hour of June 18 reached 3.5 times of last year; the sales of Suning e-commerce in one hour increased by 1433% year-on-year. In addition to improving people's living standards and environmental protection awareness, the sharp increase in kitchen waste disposal

sales is mainly driven by recent waste classification policies. On July 1, 2019, Shanghai will soon implement Shanghai Municipality regulations on domestic waste management, officially stepping into the era of mandatory garbage classification. It is planned to achieve the mandatory classification management of domestic waste by the end of 2020. Driven by Shanghai's garbage classification policy, the demand for garbage disposal has exploded (Industrial Chanel, 2019). Therefore, this paper's design proposal has great development space, and the market gap is also very high.

Literatures Review and Case study

2.1 literature review

The classification of food waste gradually affects the efficiency of municipal solid waste management, and the low efficiency of food waste classification affects the possible social cost to a certain extent. Yu and Li (2020) noted that when the scoring rate of kitchen waste increases, the net carbon emission, acid gas emission, and accumulated energy demand is reduced. The production of this reason is related to the calorific value of incineration raw materials and the consumption of energy products. The research written by Hwang (et al. 2020) shows that the effect of different additives on kitchen waste composting is also different. In the experiment of composting, the composting process with mature compost and earthworm compost increased the temperature obviously, prolonged the composting time, but reduced the emission of NH3 and greenhouse gas.

There are two types of kitchen waste disposal devices. The first one is the connected kitchen waste processor (installed under the water bucket). The food residue is

washed into the pipe when cleaning dishes can be directly crushed. This type of product is currently a mainstream product in China's kitchen waste disposal market. It cleans the kitchen by smashing and grinding the kitchen waste before and after meals and then washing away with water. This product's garbage processor can deal with food waste such as spareribs, chicken bones, melon skins, nuts, eggshells, vegetable leaves, and leftovers. At present, the connected kitchen waste processor mainly drives the high-speed rotation of the internal rotary table through the motor's operation so that the kitchen waste collides with the crushing hammer under the action of centrifugal force to achieve the crushing effect. This treatment method is designed without a blade, and the machine is generally provided with overload protection.

Independent kitchen waste processor: it can be divided into two types: drying type and biological type. The mixed type processor with two functions is generally divided into biological types. The characteristics of the two kinds of food waste disposal devices are different, and their working principles and final products are also essentially different. As the independent kitchen waste processor does not involve sewage discharge, it will not cause an additional burden the urban pipe network and sewage treatment system.

China's kitchen waste processor: from regional distribution, China's kitchen waste

treatment industry is mainly concentrated in Jiangsu, Zhejiang, and Guangdong. The three regions' annual export volume exceeds 1.1 million units, accounting for 98.7% of its total export volume. In terms of sales volume, the sales volume of kitchen waste processors in China has reached 1.478 million units, of which the sales volume of the engineering market is about 1 million units, accounting for 68%, and the retail market (including e-commerce) accounts for 32%. Overall, the popularity rate of kitchen waste processors in China is still low, and the main sales market is still supporting villas and new high-end communities.

Since the beginning of the new year, the sales of kitchen waste processors have soared by 1474%, and the industry is expected to usher in a big explosion in 2020. With the compulsory implementation of garbage classification in various cities, garbage classification has become a hot spot of public concern, among which kitchen waste treatment will be the top priority. Especially in the year of acceptance of 46 pilot cities of garbage classification in 2020, the outbreak of kitchen waste-related fields is also expected. According to the industry forecast, the kitchen waste processor will achieve continuous growth of 30% - 35% in the next few years, the potential storage space is expected to exceed 58 million units, and the retail space will exceed 110 billion yuan. Therefore, it can be seen that the prospect of kitchen waste disposal in the Chinese market is quite considerable.

There are three main reasons: first, the national development and Reform Commission, the Ministry of Housing and urban-rural development, and the Ministry of ecological environment jointly issued the implementation plan of urban domestic waste classification and treatment facilities to supplement the weak points, which clearly put forward the requirements of promoting the construction of kitchen waste treatment facilities according to local conditions and steadily improving the level of kitchen waste treatment; Secondly, it is difficult to classify kitchen waste, because of its diverse composition, mixed dry and wet, different self fermentation conditions and different decay degree, it needs to be distinguished from other types of garbage; Third, after the implementation of waste classification, many places require broken bag treatment for kitchen waste, which is not convenient for residents. With the appearance of a kitchen waste processor, the household units which produce a large amount of kitchen waste can deal with it on the spot, which saves the trouble of breaking bags and sorting.

Due to the promotion of policy, garbage classification has gradually spread from local to national. At present, in Beijing and Shanghai, market sales have begun to rise rapidly. Beijing has issued the "Beijing Municipal Regulations on the management of domestic waste," which advocates that qualified residential quarters and families should install kitchen waste treatment devices in line with the standards; in Shanghai

while issuing the guidance on the allocation of domestic waste sorting facilities and equipment in Shanghai (for Trial Implementation), it encourages the installation of kitchen waste collectors in areas where conditions permit and newly-built fully decorated houses In the future, the garbage disposal is likely to become the standard for new houses. " An industry person analyzed.

The introduction of various waste classification policies promotes kitchen waste treatment enterprises' development and prompted more people to choose to join the waste treatment industry. One of the most obvious changes is that more and more enterprises have launched offline experience stores and launched kitchen waste disposal products, so that consumers can not only understand through the Internet but can experience and feel the charm of the products personally, to improve their purchasing power. Besides, with the continuous economic growth and urbanization acceleration, urban food waste production continues to rise. It is estimated that the total amount of the catering industry in the whole year will exceed 60 million tons, and the amount of household kitchen waste will be even greater. The emergence of garbage processors greatly improves the blindness and error of garbage classification. Its design concept helps people distinguish "wet garbage" and "dry garbage" to a certain extent, which is also one of the most effective ways of garbage classification after the implementation of a series of "garbage classification" policies.

2.2 Case Study

Figure 2.1 is the product of BIAOLAN company, and this is their star product. This product is an excellent composting product. It uses aerobic composting technology, natural fermentation, and microbial degradation to complete the whole composting process. The whole composting cycle is about two months, and the volume is 220l. This product is very suitable for families with gardens, but it is not suitable for indoor use. This product may be more suitable for foreign countries, such as Nordic countries, Finland, etc. However, most families in China do not have enough space or a garden to use this product.

(figure 2.1, main product of BIAOLAN)

Figure 2.2 is another product by the BIAOLAN company. This product is through EM bacteria (EM bacteria is a kind of mixed bacteria, generally including photosynthetic bacteria, yeast, Lactobacillus, and other beneficial bacteria. It can be used for food additives, breeding disease control, soil improvement, rooting and strong seedlings, sewage treatment, etc.) fermentation for composting, the output is concentrated liquid, users can use 1:10 water to dilute and irrigate flowers, but this product can only solve relatively simple kitchen waste, such as skin, rotten vegetable leaves, etc. This product's composting cycle is about one month, but its treatment range is limited; its volume is minimal, only 10L.

(Figure 2.2, mini compost bin of BIAOLAN)

Figure 2.3 is a current intelligent compost bin which is designed by Yongerjia Company. The design principle of this product is similar to the design suggestion in this paper. The heating device accelerates the composting process. The internal rolling device stirs the kitchen waste and the added biological sheath species to combine with oxygen for aerobic fermentation fully. This product is suitable for indoor use, and its composting cycle is shortened to about one month. However, when using this product, we cannot add kitchen waste to the inside, which leads to the problem that kitchen waste cannot be recycled in the family. Moreover, when the composting process is completed, users need to remove the fertilizer from the box. From the user experience, it greatly reduces the user's feeling. Moreover, due to the central mixing shaft, to a certain extent, it will There will be a lot of dead corners in the product due to the obstruction of users' taking out fertilizer and cleaning.

(Figure 2.3,Yongerjia kitchen waste disposal semi-automatic machine)

Compared with the existing intelligent composting box, this project's design is deepened in an aesthetic sense, and the product structure and user-centered design are deeply studied. For example, this project's intelligent composting box does not need to touch the composting process and touch the fertilizer and kitchen waste with hands in the whole process of using, and it will not smell bad smell during the composting process. At the end of composting, users can take out a bag of waste bags that are already fertilizer from the smart composting bin. This greatly improves the user experience because, in the previous survey, Chinese users are more resistant to the smell of composting and the feeling of dirty fertilizer. However, the core composting technology is similar to the existing products on the market. The existing intelligent composting bins on the market, such as yongerjia's garbage processor, have a

decomposition rate of 95% of kitchen waste. The average decomposition time from kitchen waste to fertilizer is about 24 hours, with no pollution emission. The capacity of 15L is suitable for families above 8-10, and the power consumption is 1.5 kWh per day. It adopts the technology of microbial fermentation and decomposition. Microorganisms decompose kitchen waste into 5% organic fertilizer and 95% gas, and the gas is discharged after reaching the standard through the ion oxidation catalyst deodorization device. It is made of engineering nylon, a new material for decomposition tank. Its characteristics are high-temperature resistance, bacteria inhibition, and good sealing performance. The material of engineering nylon is resistant to high temperature and can inhibit bacteria. The bacteria inhibition rate is as high as 99.9%.

The project adopts 20g stainless steel 316, 22 gauge in in-text boxes, and the outside boxes will use polycarbonate 4mm wall thickness. The handle part was suitable for thermoplastic elastomer; this kind of material will be softer. Silicon is more suitable for cover connection. The feet of the project will usage 2 center meters silicon. Additionally, the texture of the surface would better be frosting.

2.3 Composting technology

In terms of composting technology, Fan (et al. 2018) mention that composting this

process can be used as an environmental and economical technology for waste treatment. Composting is a biochemical process that uses bacteria, actinomycetes, fungi, and other microorganisms widely distributed in nature to promote the transformation of biodegradable organic matter into stable humus under certain artificial conditions. Its essence is a kind of fermentation process. In composting, organic carbon is breathed and metabolized by microorganisms, thus reducing the carbon-nitrogen ratio. The generated heat can make the compost temperature reach more than 70 ℃, killing bacteria, insect eggs, and kill weeds.

According to the degree of oxygen demand in the composting process, it can be divided into aerobic composting and anaerobic composting. The design suggestion of this paper is to use aerobic compost. Aerobic composting is carried out under aerobic conditions with the help of aerobic microorganisms. In the composting process, the soluble organic matter in the organic waste is absorbed by the microorganism through the cell wall and cell membrane of the microorganism; the solid and colloidal organic matter first adheres to the outside of the microorganism, then decomposes into the soluble matter under the action of the extracellular enzyme secreted by the microorganism, and then penetrates the inside of the cell.

2.4 Types of kitchen waste that can be composed

Compostable waste is a kind of material which is suitable for microbial fermentation and fertilizer. Including leftover food and other perishable food, kitchen waste, branches, flowers, and plants can be composted garbage. The compostable waste is collected and transferred to the composting plant. After the composting process, such as fermentation and decomposition, the compostable waste can be turned into sanitary and odorless organic fertilizer, which can be used as fertilizer for plants and soil improvement. Garbage composting is a method of garbage treatment and utilization. It uses bacteria, yeasts, fungi, and actinomycetes existing in garbage or soil to make the organic matter in garbage undergo biochemical reaction and degradation (digestion), forming a material similar to corrosive is used as fertilizer and used to improve the soil. Garbage composting technology has long been applied in China's agricultural activities, and as scientific research, this rule began in 1920.

The operation of composting is generally divided into four steps:

① The best moisture content of the homogeneous waste is 45-60%, and the carbon-nitrogen ratio is about 25:1. If it can not meet the requirements, it can be mixed into sludge or feces;

② Bacterial decomposition (or fermentation), under the appropriate conditions of temperature, moisture, and oxygen, aerobic or anaerobic microorganisms rapidly propagate, garbage begins to decompose, and all kinds of organic matter are transformed into harmless fertilizer;

③ It can be applied when it is completely decomposed;

④ Storage or disposal, the fertilizer is stored, and the fertilizer is separately landfilled.

In a narrow sense, kitchen waste generally refers to raw materials and finished products (cooked food) or residues needed in family life and diet, which can be divided into cooked kitchen waste, including leftovers, leftovers, etc.; raw kitchen waste includes a peel, eggshell, tea residue, etc. In a broad sense, kitchen waste also includes used chopsticks and food packaging materials. In this project, we mostly refer to the narrow sense of kitchen waste. Rice, noodles, fruits, meat, fishbone, etc., are all decomposable kitchen waste, but beef bone, pig bone (large bone), shellfish, tea bag, etc., are not decomposed. Due to Chinese people's catering characteristics, kitchen waste's moisture content is as high as 74%, and the salt content (sodium chloride) in kitchen waste is high. If the kitchen waste with such a high moisture content is directly mixed with other wastes for landfill, leachate will be formed under the action of high pressure and microorganisms. Leachate is not easy to degrade and contains highly toxic carcinogens, one of the persistent garbage treatment diseases. Once the leachate leaks out, it will cause secondary pollution of garbage. Therefore, high salt and high oil food must be washed before composting; high oil food will reduce the decomposition rate.

2.5 Waste classification policies in the world

Zhao and Wang (2019) discover that Japan has formulated professional laws to clarify kitchen waste recycling. In 2000, Japan promulgated the law on promoting the recycling of food recycling resources, which requires putting an end to the serious waste of food in the whole country, and issued the relevant regulations on the recycling and reuse of food waste. The incentive policy is perfect, and the emission target is clear. In the study written by Guo (et al. 2017), Japan has a “special calendar” from the government that designates specific days to dispose of specific garbage.

The legislation of the United States requires the transportation of kitchen waste. The prevention and control of solid waste pollution act of the United States require emergency measures to deal with the possible problems in the recycling and transportation of kitchen waste. American residents have a good sense of environmental protection. "Kitchen waste crusher" is almost a necessary waste treatment equipment for every family, and the kitchen waste without oil is directly broken into the sewer with it. The government designates corresponding enterprises to

collect and dispose of other kitchen wastes containing grease and then recycle them.

The UK has taken measures in the source treatment, standard classification, and combination of government and enterprise of kitchen waste have been very mature in this respect. Set up a special recycling point to ensure the timely treatment of kitchen waste. In order to better collect oil waste, the government has set up waste gas oil recovery points in the residential communities.

Germany has more than 800 laws to deal with garbage. Establish a waste disposal company to collect and dispose of domestic waste in time. Waste sorting and collection began early in Germany. It has hundreds of different garbage treatment companies responsible for garbage collection and treatment in different regions. Every year, residents receive a "garbage disposal schedule" containing information about when to clean up what kind of garbage.

Research Methodology

3.1 Quantitative or Qualitative research

Qualitative research method refers to a method or angle to study things from the internal regulation of things according to the attributes of social phenomena or things and the contradictory changes in the movement. In qualitative research, we should directly grasp the main aspects of things according to certain theories and experiences and temporarily omit the difference of homogeneity in quantity. Quantitative research

is generally carried out to obtain statistical results for the population of specific research objects. Qualitative research has the characteristics of exploration, diagnosis, and prediction. It does not pursue accurate conclusions, but only understands the problem, finds out the situation, and obtains perceptual knowledge. The design proposed in this paper will adopt a combination of the two.

In choosing between a quantitative approach and a qualitative approach, the combination of quantitative and qualitative research methods may be a better choice. The book written by Hunt (1991, cited in Park 2016) discovers that the quantitative research method plays an important role in the legitimacy of research, while the qualitative research method is not conducive to the justification but conducive to discovery. Both qualitative research and quantitative research belong to sociological methods. Qualitative research refers to the experts in this industry, according to personal intuition and feeling experience to see some fresh data, make a judgment method, put forward preliminary opinions, and then make a comprehensive summary. Quantitative analysis refers to the use of modern mathematical methods, according to some data processing, the establishment of digital models to find the relationship between variables, and so on. It can be said that quantitative research is more accurate, while qualitative research is highly subjective. Qualitative research is also based on quantitative research, which is a further deepening of quantitative research. Quantitative research mainly adopts a high-level mathematical model for analysis,

while qualitative research will appear a little rough. Quantitative research and qualitative research are mainly different in concept, and the analysis methods adopted are also different. Quantitative research is based on a large number of data analysis, while qualitative research has many subjective factors. For example, user interview, questionnaire, usability test, focus group, A / B test, website/log traffic analysis, eye movement test, etc. If we classify the research methods, we can divide them into qualitative research and quantitative research. A / B test, website/log traffic analysis, eye movement test, and questionnaire are quantitative studies, while others are qualitative studies. For example, researchers want to develop a vertical news app for Internet users. If researchers want to study the relationship between user job positions and reading preferences so that researchers can operate recommendations, researchers can first get some basic data through quantitative research and then conduct qualitative research -- for example, interviews can be conducted according to the selected candidates and behavioral variables, and then The results will be quantitative validation analysis - such as questionnaire survey, website traffic logs analysis, to get the correlation degree mathematical model. Therefore, when choosing user research methods, we must first determine what researchers want to know and then choose methods. It is better to combine these methods.

3.2 Questionnaire

The questionnaire will be adopted in this study. The design researcher would better understand user requirements and pain points through the questionnaires, which helps for further design practice.

The following questions will be covered in the questionnaire survey: (a). whether the user is in a city with a waste classification policy; (b). the price range of such products acceptable to the user; (c). whether the user has a strong sense of environmental protection and waste classification; whether he is willing to use such products; (d). whether the user can tolerate the relatively messy and, to some extent, unpleasant smell produced in the composting process; (e). the daily average output of household kitchen waste; (f). the capacity of household kitchen waste bin; (g). education background of users; (h). the number of users' families.

3.3 Interviewees

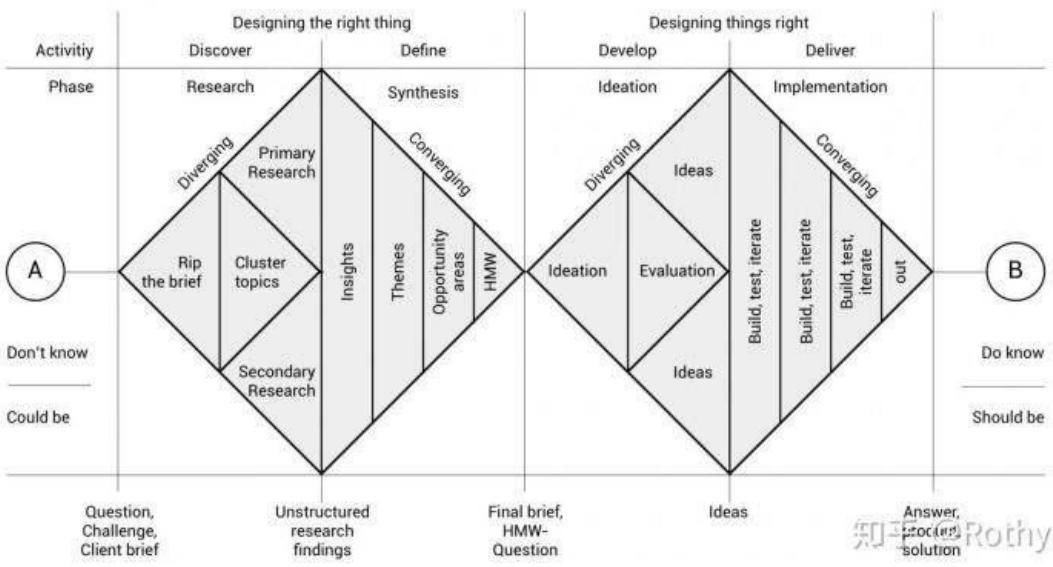
The interview method can collect not only demand and breadth information but also obtain level demand by deep questioning for a certain question. It can understand the information about the behavior, motivation, attitude, and personality of the products (or interfaces) we are related to. The design proposal in this paper interviewed a large number of users. The author entered a WeChat group of 1000 people. The chat group users are senior users of Biaolan products and had a profound exchange and intense discussion with them. At the same time, the director and product sales manager of Biaolan were contacted for an interview. In addition, I had a detailed conversation

with the general manager of a waste treatment and recycling company in Ningbo and studied the methods of waste treatment and recycling.

3.4 Double diamond model

In terms of the design approach, the double diamond model could be a good choice. Lindly (2018) assert that product design is a complex subject in modern society, including many skills and applications. It is no longer a purely creative problem-solving activity. A good idea or innovation is enough to promote a new product. The process of the double drilling model describes the process of divergence and contraction in the design process. It is proposed by the British Design Council, which is a thinking mode used by designers. The British Design Council originated in the field of industrial design. This model is a linear process, focusing on the design process before the final plan is produced. Because industrial design creates real products, it is costly to modify the products that have been manufactured, and it takes a long time to obtain market feedback on the products, so the solutions that work through their methods are generally more perfect. Design Council (2007) mentioned that the discovery stage is one of the most critical stages, and it is also the stage that can make the best use of the designer's knowledge and skills. The early stages are called fuzzy front-end (FFE), and FFE is increasingly used to describe the early stages of the innovation process in which ideas are formed (Rhea 2003, cited in Design

Council). Thus, what happens in FFE is the most promising way to improve the innovation process. The previous stage in the double drill model is very detailed and thorough in the exploration, investigation, query, definition, observation, and focus.



(figure 3.1: Double diamond model)

Figure 3.1 shows Dan Nessler's improved and subdivided double drill model in 2016. He sorted out the possible work details of the actual work and filled in the model. The essence of the double drill model is a way of thinking about the problems and solutions in the composition of the design. It is also a popular way of thinking among designers at present. The focus of the whole design process is to think about the right and wrong of the problem itself and whether the solution finally returns to the original origin. The people-oriented design proposed by IDEO and the Stanford Design Institute's design thinking process is the derivatives of logical thinking in this model. The essence of design is a process from "unknown" to "known" from "maybe" to "should be." At first glance, this process is direct and linear. In fact, it is a cyclical

process because the creation itself is constantly bringing positive and positive effects on people's lives in new ways. It can be seen from the figure that the double drill model is a structured design method, which is divided into two stages, from divergence to convergence, and then from a point to the final design results. The first half is the stage of research and implementation; the second part is the stage of research and development. In the specific stage, the designer's way of thinking will show a regular trend of divergence > collapse > divergence > re collapse, just like two diamonds juxtaposed together.

Here is the schedule of my entire project, which is derived from the four phases of the twin drill model. Since I have done sufficient preliminary research and research stage in the first semester of graduate study, I have adjusted the schedule of this project. Most of the time is arranged in the second stage of the double drill model; after aiming at problems, the design thinking will spread to the final project presentation.

Phase I – Concept design (27/04/20): This stage is devoted to literature research, user research, design concept, and sketch drawing. It is mainly to complete the preliminary work of the design.

Phase II – 3D model & physical model (07/06/20): This stage is devoted to the 3D modeling of the design, the production process of the studio, and the repeated research of the physical model. It needs to overcome a lot of technical problems and complete the user test.

Phase III –Modeling (07/10/20): This stage is dedicated to completing the final product physical model, which needs to be involved in the factory's manufacturing process.

Phase IV – Design Development (07/12/20): This stage is devoted to completing the final paper of the design proposal and reflecting on this design.

3.5 Design tools

In the design process of this project, many design tools such as wood board, storyboard, personas, physical model, computer model, mechanical test, prototype, etc., are used to improve the project. Other design tools will probably be used in this design proposal, for instance: SWOT, shadowing, user stories, in-depth interviews, context mapping personas, brainstorming, experience prototyping.

In the final design, I chose to learn to use C4D (CINEMA 4D) modeling. C4D has File conversion advantages. The project files imported from other 3D software can be used directly without worrying about the problems such as the broken face, file loss, etc. The fur system of C4d is easy to control, can model quickly, and can render all kinds of desired effects. With its fast rendering speed, Cinema 4D can create the most textured and realistic works in the shortest time. It will provide artists with a new dimension and method and add an absolute weapon to Cinema4D. It changes the mapping mode similar to matrix into extremely simple, effective, and convenient. A single object, after wonderful arrangement and combination, and with the help of various effectors, you will find that monotonous simple graphics will also have

incredible effects. C4D has a rich and powerful preset library. You can easily find out from its presets that you need models, maps, materials, lighting, environment, dynamics, and even camera lens presets, greatly improving our work efficiency.

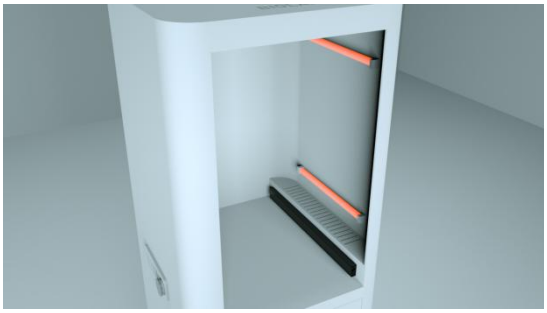
Design process and results

4.1 previous 3D model and sketches

The following picture is the 3D model of the product in the early stage. After in-depth research and investigation in this period, I have carried out a secondary design for it. After that, I will show a sketch of my new design by hand. In the early design, two separate boxes are used, but such a design greatly increases the floor area and corresponding space, thus increasing the cost of all the required, artificial devices twofold. The model in this stage will occupy much space when placed in the kitchen

environment or a certain position in the room, and the design of two independent boxes means that two heaters, two air valves, two vibration devices, and two temperature and humidity monitors must be installed in the internal structure. The two red and blue buttons on the top correspond to the red and blue handle box below. The original design idea is that when one box is used for composting, the other can meet users' needs to continue to store kitchen waste. Therefore, when one tank completes the composting process, and the kitchen waste stored in the litter box is almost the same, users can take out the organic fertilizer for use and carry out a new round of composting on the second box full of food waste. This design meets the purpose of continuous composting while collecting kitchen waste.

(figure 4.1, General view of previous 3Dmodel)

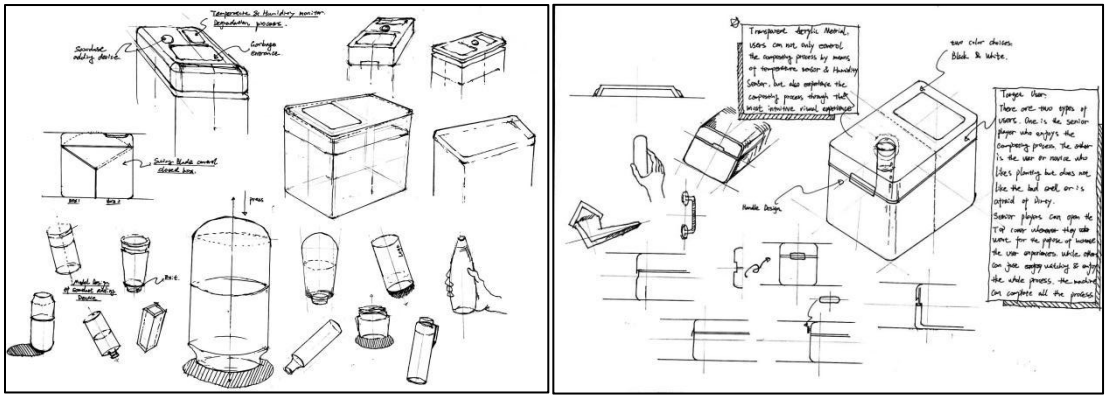


(figure 4.2(top left corner), The state of the previous 3D model when it was opened; figure 4.3(top right corner), The internal structure of the previous 3D model and shows the heater; figure 4.4, Automatic packing device of compost bin based of previous 3D model)

The above three pictures are 3D model renderings designed in the early stage; the preliminary design is completed in the pre-graduate course. I am interested in this project. In the graduate project, I choose to deepen the research and design of this project. As shown in the figure above, several design elements in the preliminary design, automatic garbage bag packing device, and double box design are also used in the later design. As for the heater, which is a technical feature of the artificial

intelligence composting box, the ideal composting environment can be achieved by controlling the temperature in the tank during the composting process. The design and application of the automatic garbage bag packing device are to avoid direct contact with the organic fertilizer after the composting process and smell the bad smell produced in the composting process to a great extent in the whole product use process.

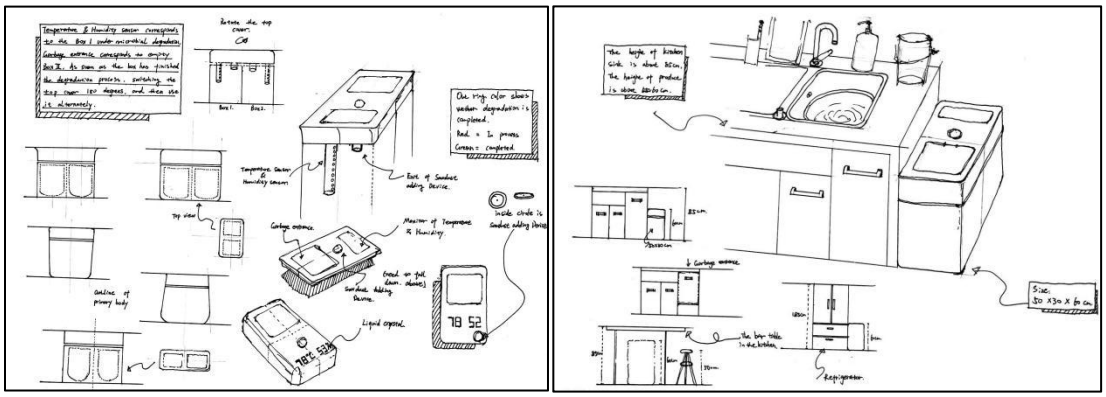
Therefore, before the start of the whole project, the whole design framework has a certain concept and direction, and the sketch has been drawn. In the process of sketch drawing, this project has referred to many existing products and determined the main design style and direction of the project.



(figure 4.5(left), Drawing for the design of the layout of box top cover (humidity control) and the design of the chip adding device; figure 4.6(right), Drawing for the design of box handle.)

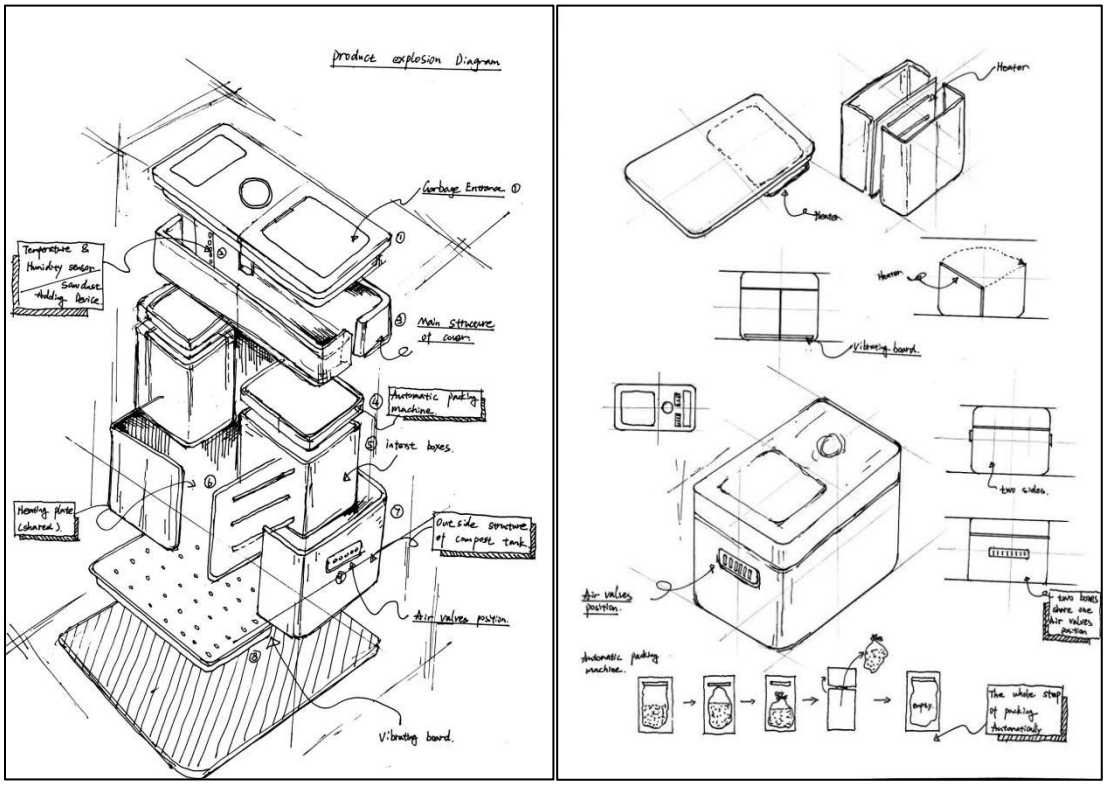
Figure 4.5 develops the shape design of the sawdust additive and the frame design of the project's top cover and discusses the possibilities of the internal structure. The top

frame includes a display of temperature and humidity sensors, a timer for the composting process, and the location of the sawdust adding device, and the arrangement of the main entrance to the bin. Figure 4.6 mainly develops and designs the possibility and shape design of this project handle. The handle design of this project is designed with relevant human factors principles and methods and is improved from the perspective of ergonomics and user experience design.



(figure 4.7(left), is drawn for the design of box shape; figure 4.8(right), is drawn for the design of box size.)

Figure 4.7 mainly developed the internal structure design of the project, including the relationship between the two built-in boxes and the external structure, the position of the internal temperature and humidity sensors, the position, and space of the vibration plate. In addition, there is also part of the roof shape design, including shape and thickness. Figure 4.8 mainly explores the size of the project and its corresponding environment. This hand drawing mainly explores the size of the main furniture in the kitchen environment and selects the appropriate product size. For example, the appropriate size of the project is determined according to the height of the dining table and the height of the island platform.



(figure 4.9(left), Drawing for the design of whole structure; Figure 4.10(right), Drawing for the design of some devices.)

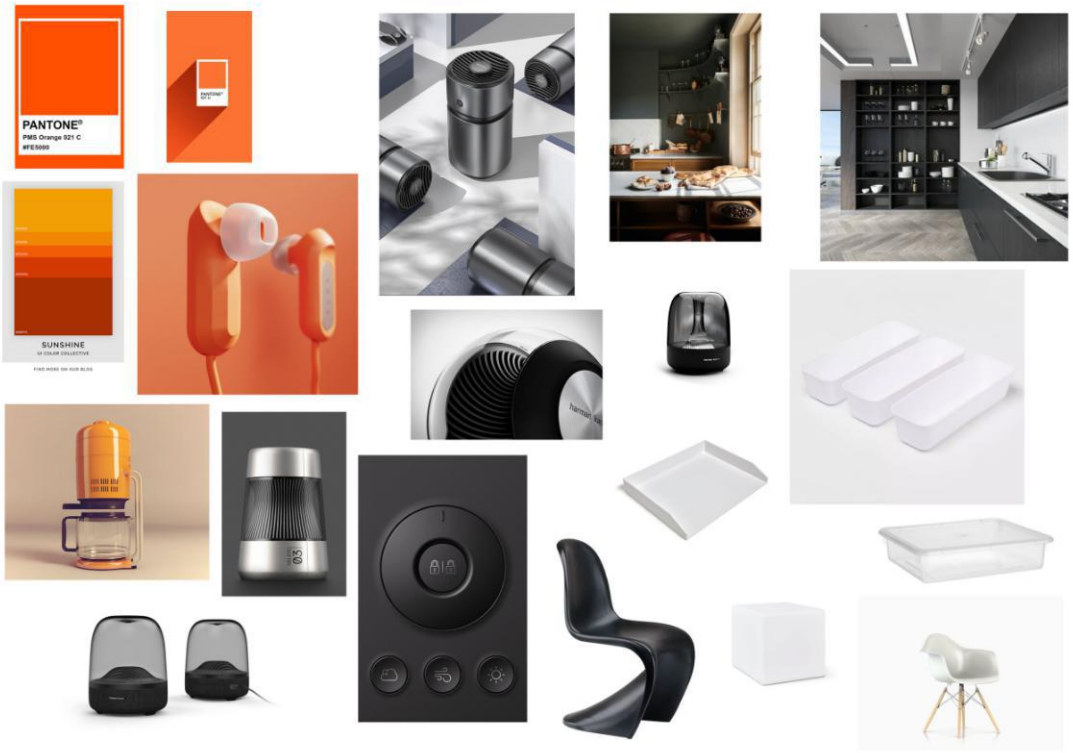
The primary overall structure of the project is mainly designed in figure 4.9. Figure 4.10 mainly designs the whole process of packing garbage bags of the built-in automatic garbage bag packing device in this project, and discusses two possible internal structures, and determines one of them. Finally, the position and shape of the design of the air valve of the whole project are developed.

This section is the preliminary research of this project, including the transformation of the previous design and new design, which is initially shown in the way of hand-painted. According to the in-depth research and design, the project gradually

establishes computer models, physical models, product prototypes and mechanical experiments, etc.

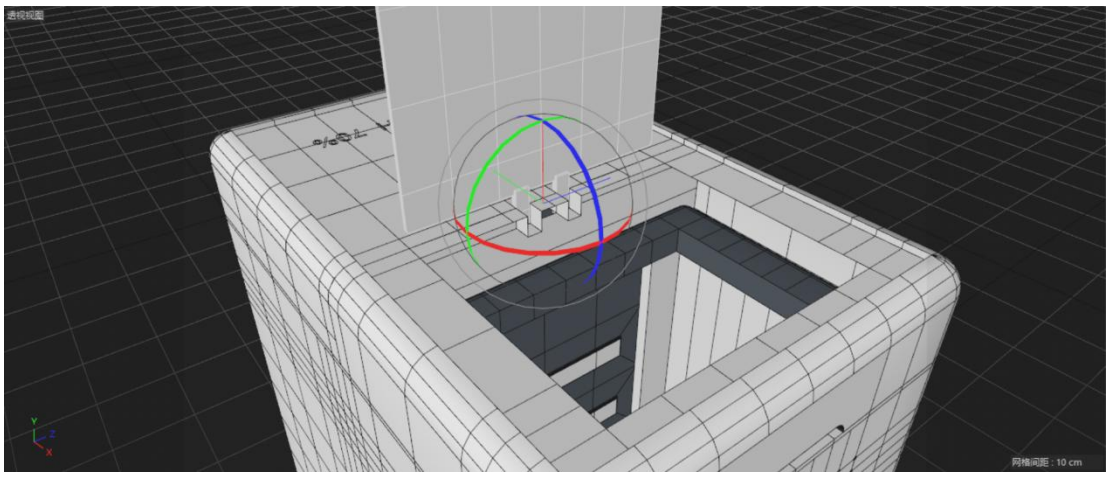
4.2 Mood board and computer 3D model

Based on the previous paragraph's research, this paragraph is used to describe the development of the wood board in the design process and the new computer 3D model based on the wood board. Wood board refers to collecting colors, images, digital assets, or other materials recognized by users and products, which can cause some emotional reactions, as a reference for design direction and form. Designers use it to examine colors, patterns and convince others of the reasons for doing so. From the point of view of design, in the early process, it can be used to summarize the personality of the product to see the whole picture. From the future, we can get the consensus of the user's character, which can be combined with the real image. From a commercial point of view, it can establish a consensus of the production team on the visual sense of the product; determine the main product characteristics at an early stage, and in a high-level way, it can save time and cost and meet expectations; it can be used to understand and convey the personality of the product and meet the sensory issues.



(figure 4.11, Mood board)

After the development and research of the wood board, the project established a new computer model.



(figure 4.12 & figure4.13, The process of establishing computer 3D model)

Figure 4.12 and figure 4.13 show the process of Tracking computer 3Dmodel. Picture 4.14 shows the new 3D computer model of the project. The project adopts two main colors, black and white, and develops two different modes, translucent and opaque shell or top. The translucent top and main body may greatly increase the user experience. Users can observe the composting process more intuitively from the top of the project through the translucent roof design, which can greatly increase users' interest in the process of using the product. As shown in the Mood Board for the project, the standard orange color was used at the junction between the top and the main body of the project (the standard color was decided during the subsequent prototyping process). Moreover, translucent main body design can be in the heater

process that buys works, send out the light that gives orange. This should be to have a certain enhancement on a beautiful degree.

(figure 4.14, New computer 3Dmodel)

Figure 4.15 shows the explosion, the scene usage diagram, the top cover layout, and the translucent state of the side view and top view. Additionally, figure 4.16 shows the possibility of different colors matching in the new design of this project. It can be seen that the main color is based on black and white colors, but the application of transparency is selected in different positions.

(figure 4.15, Computer model explosion diagram and scene usage diagram of the project)

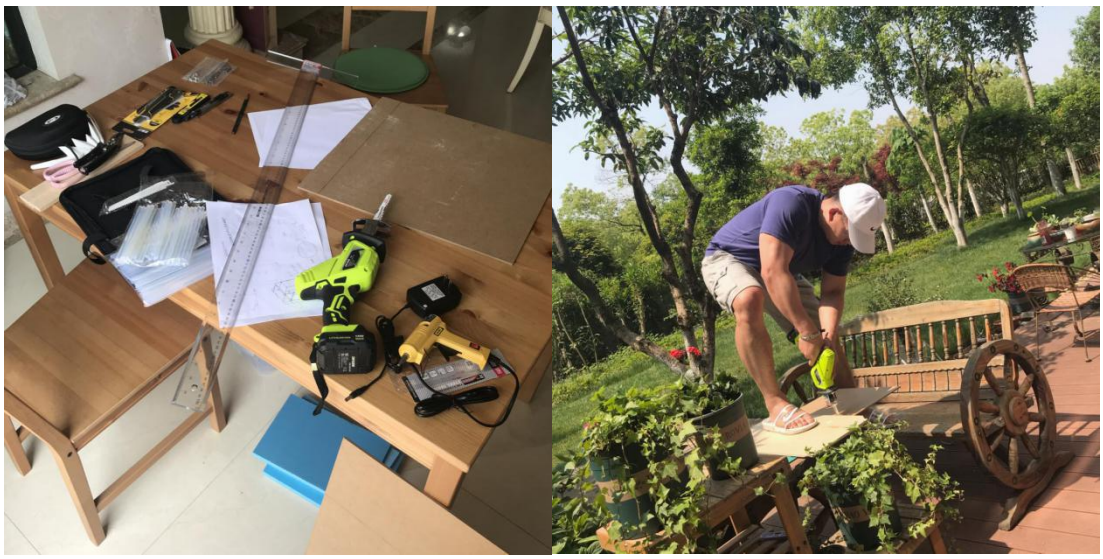
(figure 4.16, Color selection of computer model in this project)

4.3 Physical model

As one of the expression ways of the design scheme, the model can assist the conception, deliberation, and research of design scheme, and improve the ability of transformation from a plane drawing to a three-dimensional model, which is of great significance in the study of design major. Model making learning runs through the whole process of professional learning. Through the study of model making system, designers' hands-on ability can be cultivated, and the important position and role of model making in the whole process of product design can be further understood, so as to provide better service for product design, the importance of model making to product design specialty is self-evident.

There are some limitations in the expression of three-dimensional shape on a two-dimensional plane because it can not truly show the design content in all aspects, so only through model making can the deficiency of two-dimensional design performance be made up. This method's product model has a three-dimensional and all-around display effect, which is convenient for comprehensive design analysis and research. Find out the shortcomings and deficiencies in the design so as to constantly supplement and improve the design. Through the production of the product model, designers can gradually have the ability to shape the space shape, and directly express the design ideas in the form of space. In the design performance, through the process of repeated consideration and adjustment of the form, scale, structure, color materials,

and other factors, we constantly obtain various intuitive feelings, which leads to design association. Only through the repeated test and deliberation of the model can we have the thinking of design problems and further produce the sprouting of innovative consciousness. Any design is produced in the process of finding problems and solving them further.



(figure 4.17, The process of making physical model)

(figure 4.18, Physical model of the project)

Figure 4.17 is the image of final physical model. As you can see, the side door is designed to better show the internal structure of the physical model.

4.4 Final 3D model

In order to provide different varieties in the market, I have developed three different sizes of products. The large and medium versions are suitable for standing on the floor, the small version is suitable for putting them directly on the table, and the big and small versions are open on the top. The middle version is garbage poured from the side. This version is more suitable for products placed under the table or made into a cabinet.

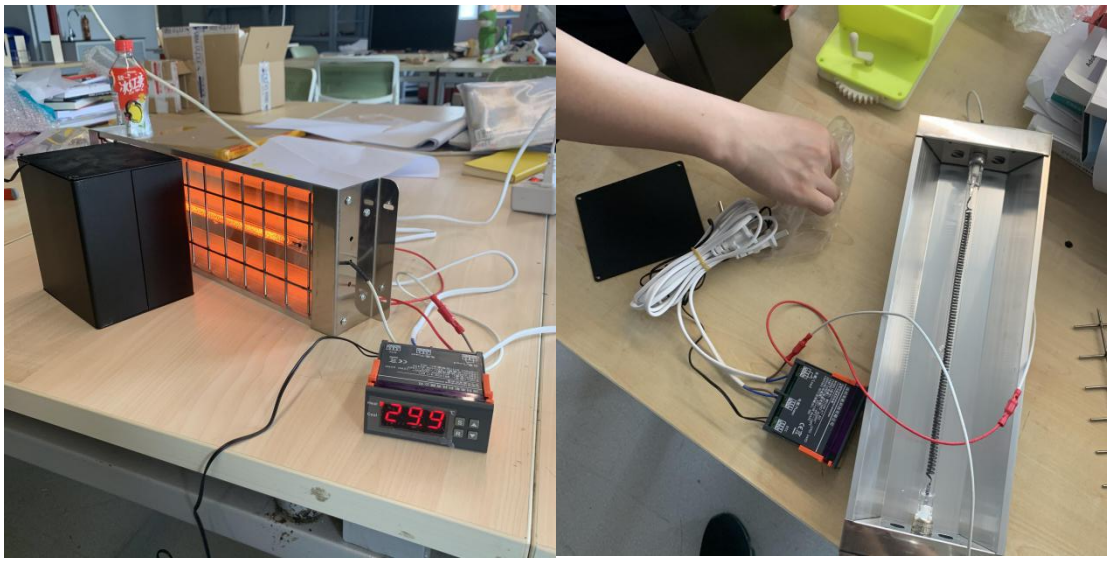
(figure 4.19, Final 3D model)

(figure 4.20, The medium model in the final model)

Due to the connection of the bottom vibration plate, I denied the idea of making the side of the medium-sized version into a pull-out door. Instead, the height of the top cover was increased and the overall proportion of the product was adjusted. Therefore, the height of the entrance was increased, which was convenient for users to dump garbage.

4.5 Mechanical test

In terms of mechanical test, i adopted single tube (600w) and one 3mm Aluminum box and a temperature controller and monitor. The purpose of the mechanical experiment in this project is to test the thermal conductivity and high temperature resistance of the aluminum built-in box when the heater is heated.



(figure 4.21, Experiment of materials and aluminum materials in mechanical experiments under high temperature.)

With the development of a large number of modern new materials, the prospect of industrial design is broader and more challenging. The value of industrial products is further enriched and improved. The design contents of industrial design, such as modeling design, color design, green design and processing technology, are more closely related to materials. Under certain conditions, industrial design and materials are mutually infiltrated and integrated, The development of materials promotes the development of industrial design, especially in the 21st century, the application of new green materials in industrial design has been more extensive, which plays a positive and important role in improving the environment and enriching life.

4.6 Prototype

Product model is the three-dimensional image of product design concept, and is an important expression method for designers to express design ideas. It can directly reflect the designer's design ideas, fully reflect the visual and touch feeling of three-dimensional space, and show future products. This paper starts from the characteristics of product model, production process of product model, production principle of product model, etc, The position and function of product model in product design are expounded.

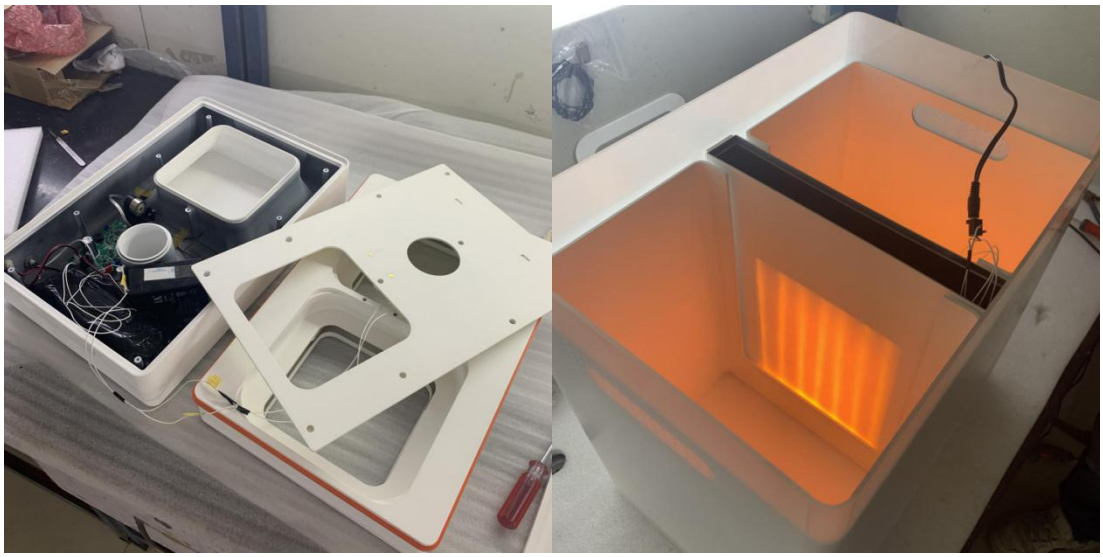
(figure 4.22, Prototype.)

Finally, with the joint efforts of the factory, the prototype of the project is completed.

(Figure 4.22) the size of the product model is 1:1 model size. Figure 4.23 shows the standard color of this project which is PANTONE Orange 021 U.

(figure 4.23, Standard color, PANTONE Orange 021 U)

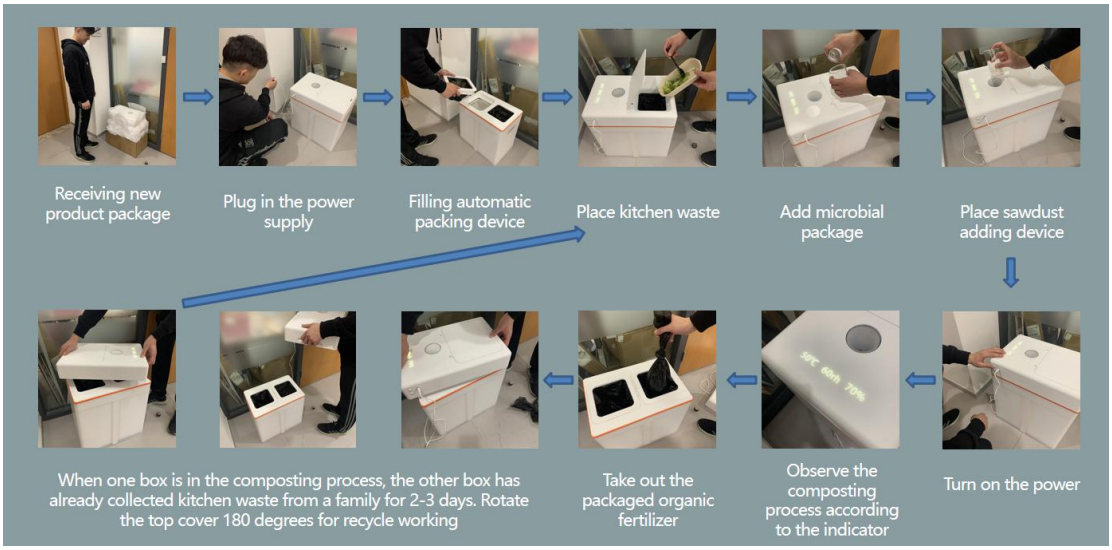
The following pictures show the production process of the product prototype, in which the internal space structure of the product is determined, including vibration plate, central heater, circuit arrangement, etc.



(figure 4.24, The process of making prototype)

With regard to the word 'experiential' - research activities based on observing the user experience of composting - and using 'new design concepts' to test user experience. Prototype design is very valuable: it can understand the existing user experience and background; explore and evaluate design concepts; convey ideas to the audience (Suri.J.F & Buchenau.M, 2000).

User Evaluation



(figure 5.1, Story Board)

Figure 5.1 shows the use process of the new product in this project. The user will first receive the package of the new product after purchase. After unpacking the package, the power supply will be connected to charge the product. The next step is to install the garbage bag automatic packing device. After these preparations, users can put kitchen waste into the dustbin. This is followed by the addition of microbial packs (to accelerate the composting process) and sawdust (to control moisture during composting). After completion, the power supply can be turned on for microbial composting. Users can monitor the composting process through the user interface at the top of the product, including the temperature, humidity and time progress during the composting process. After finishing the composting process, users can take out the

packaged organic fertilizer from the inside of the composting box. When one box is in the composting process, the other box has already collected kitchen waste from a family for 2-3 days. Rotate the top cover 180 degrees for recycle working.

After most of the project was completed, we conducted a user survey. In addition to asking basic information (name, age, gender, occupation, family number) of the other party, the survey also set up some questions. These questions will be shown to users in the form of pictures. After a brief introduction to the functions and functions of the project itself, questions are raised.

Questions:

1: How many people are in the user's family

2: Do users have the habit of growing flowers and planting

3: Is there any policy pressure on waste classification in the area where users are located

4: What is the first impression of this product design?

5: What is the evaluation of the product's appearance design or aesthetic feeling?

6: Under the pressure of waste classification policy, are users willing to use or purchase kitchen waste processors? Do they prefer inlaid kitchen waste processors or

stand-alone composting equipment?

7: Is the process and operation of the product convenient?

8: Is this product suitable for an indoor family kitchen, or is there a suitable place to use and place it?

9: How much is the right price (three sizes)?

10: Do you have any suggestions on the design or use of this product?

The sample size of this user survey is 10 people, 6 men, and 4 women, 6 people in the 20-30 age group, 3 people in the 30-40 age group, and 1 person in the 40-60 age group. The results of this user survey show that most users are basically satisfied with the appearance of the product, but some users are not very satisfied with the standard color of the product. They think that dark color or green product appearance is more appropriate, and dark green may be a good choice. In terms of purchase intention, most users prefer independent kitchen waste composting equipment. Some users think it is more practical and convenient; some users think it is more interesting. However, several other users are not willing to buy such composting equipment. They think that it is very troublesome to treat the organic fertilizer produced. Compared with the inlaid kitchen waste processor, the shredder is a more convenient choice. Moreover, some users feel that there is no larger space in the kitchen to visit, such as a kitchen waste processor. They often use plastic bags instead, Because they do not cook very

often. It can be seen that most people prefer to choose independent kitchen waste composting equipment, whether they have the habit of planting and raising flowers, and whether they often cook at home. The above factors do not affect their purchase intention largely, but are more likely to be their subjective ideas and environmental protection meaning. Most of the users who have the habit of planting flowers and those who are not too busy in their daily life will choose the independent kitchen waste processor of this project. Most of these users are retirees, housewives, environmentally conscious users, and young family users who have the habit of planting flowers and flowers. However, they do not pay much attention to the function and treatment of organic fertilizer produced by this product. For people who have no planting habits, they may throw it into the garbage can like garbage. What they care about is whether this product can help them classify garbage and dispose of kitchen waste. Whether the product can handle the odor and its power consumption, and whether it is safe, most users have raised relevant doubts. For the treatment of odor, the original design intention of this project includes this point, but for the power consumption and safety of the product, so far, there is no accurate answer.

Discussion

In this paper, these contents will be summarized: the theme, the reasons for choosing this theme, the proposal of research questions, design process, design methods, tools to be used in the design, expected objectives, value framework, target users, scope and limitation. The theme of this paper may be to design a product that is convenient for people to classify kitchen waste and make intelligent compost to produce organic fertilizer. Therefore, my target users will be those who have the habit of planting flowers and fruits, or those who have an outdoor garden at home, and those who have children at home. In this way, they will have space and need to deal with the organic fertilizer produced. However, at present, China's garbage classification policy is not fully promoted, only in a tiny number of cities for demonstration and popularization. Under the high pressure of the policy, the impact on people's ideological changes in the city is tremendous, which will greatly affect the final data and results in the future customer needs of research.

The goal of this design proposal is to improve people's awareness of environmental protection and the habit of waste classification through this product design, which can effectively help people to solve the daily generated kitchen waste and increase the popularity of kitchen waste disposal in the domestic market. Design a product with

better material, shape, and finishing, which is welcomed by the majority of users.

The design process of this project is basically consistent with the design logic of the double drill model. In the early stage, the existing composting products in the world, the composting technology, and national policies in different countries and regions, the pressure of policies in different regions of China, and the trend and design opportunities of composting products in this field were investigated, and the corresponding questionnaire survey and research were also done. After the divergent investigation and research, the project focuses on the fully automatic kitchen waste processor which is satisfied with the Chinese market and can be satisfied with indoor use. After determining the problem, it enters the second stage of the double drill model, the divergence of design ideas. This project from the sketch, literature research, physical model, and mood board determines the design style, computer model, mechanical experiment, and other different design means, to achieve the final design results. This project adopts linear design, strictly manages the time and steps in the design process, follows the design logic of the double drill model, and basically finds out the plan, and finally achieves the design goal. In the design process, this project studied all kitchen waste disposal and composting equipment in China market and studied and investigated the composting technology and product appearance of the popular composting equipment abroad.

In terms of limitation, this project is to develop a new type of fully automatic kitchen

waste composting equipment. Its limitation is that the fertility of organic fertilizer produced by the accelerated composting process may not be defined temporarily. The fertility of this organic fertilizer may be lower than that of organic fertilizer produced by the natural composting process. Another limitation of this project may be that the number of samples surveyed by users may not be enough because the project's development area is not under the pressure of government policies, and the collection of all user data may not be so comprehensive.

For future work, it is possible to define more precisely the material selection of products. Because of the development of a product after entering the factory, the first batch of production may choose better materials and finish technology to test the market reaction, but the cost will be relatively high, and the profit margin will be relatively small. The second batch of production will choose the appropriate materials and technology. The quantity of this batch of products will not be too large, will produce relatively good profits. By the time of production of the third batch of products, there should have been relative market feedback for this product. The production quantity of this batch will be vast, and the selected materials and processes are also very suitable, which will generate relatively large profits.

Appendix

With regard to user evaluation, at the end of the project, collecting relevant data and interviewed users. In this appendix, we will summarize several distinct user groups and give critical views and suggested user comments.

User 1: Miss Cheng, 25 years old, university degree, urban white-collar, family size of 1, living alone. There is no habit of planting and growing flowers, there is no policy pressure of garbage classification in the living area, and there is no contact with the kitchen waste processor and any composting equipment. Before introducing the product and its use, Ms. Cheng was asked about the information in this project. She said that she did not quite understand what the product was used for and could not obtain the basic information of the product through the first visual experience. For the appearance of the product, she said it was lovely and quite satisfied. After that, we introduced the basic information and operation methods of the product. She said, "this thing is perfect for people like her who do not often cook at home. It is more convenient to deal with kitchen waste. Nevertheless, for those people who often cook at home, it can be more troublesome because it will be filthy. We have to solve the output, mosaic kitchen waste. The processor will be better. ". As for the operation mode of the product, she said it was quite easy to understand. She said, "I think the medium-sized product is too large, too heavy, and inconvenient to move. The small

one is adorable.". Small 1000-2000 RMB is the appropriate price, medium-sized 2000-3000, large-scale 3000-5000. She said that the main buying group might be strong or young families, and the elderly may be a minority depending on their needs. For this product design, she asked, "if you need power, if you need power, it is not easy to put it in the kitchen because it is impossible to put the garbage can on the kitchen table. It is disgusting." Is this product heavy? Is the garbage heavy? How about taking it? Do you have a bad smell?

User 2: Mr. Zhou, 39, is a private enterprise owner with a family of four. He has the habit of planting and growing flowers. He lives in an area under pressure of garbage classification policy. He is also considering purchasing kitchen waste composting equipment recently. His first impression of the product was that it was relatively simple and regular, but white was not very good-looking. He thought that environmental protection products should be dark or green. The product is inconvenient to move and carry, and it is not easy for non-first floor residents to use it (before introducing the operation method of the product to Mr. Zhou). He is more inclined to buy independent kitchen waste composting equipment because he thinks it is more hygienic and convenient to handle. The price of small size is 400-500, and that of medium-sized is 500-1000. For the design of this product, he raised a lot of questions, such as the safety of the product, because it needs to be heated for a long time, whether the product is safe, if there are children at home, will the product be safe if he is away from home for a long time when traveling? The point number of the

product is not high. If it is very power consumption is also an important factor affecting his choice. Whether the treatment of odor is appropriate and successful, after all, it is used at home. Is it inconvenient to dismantle, clean, and maintain the product?

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