

Exploring the design of storage furniture for small spaces, that is more usable and appropriate for the urban working class in China.

by

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***MASTER OF DESIGN
IN
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ABSTRACT

This paper discusses how to design storage furniture for the Chinese urban working class with small living space. Through the preliminary design research and product analysis, modular design is carried out and culture is added to the products. Modular design plays a very significant and important role in modern furniture design. It can effectively use space and provide the possibility for users to freely combine products within a certain limit. The main purpose of this paper is to explore how to achieve good human-computer environment interaction of furniture products to create new storage furniture suitable for small spaces. In this paper, the whole design process is clearly divided and displayed, showing how the guiding ideology of harmony between man and machine environment is to implement the design process from beginning to end. Finally, by applying the new product to the specific use environment and interacting with specific users, it can be seen that the modular design idea has played an important role in the system design of human-computer environment. Users can easily assemble, disassemble and store the product as a whole. It is convenient to transfer the product for the daily use of the target population and when they are faced with such situations as moving, rather than discarding it as before. Finally, it has the significance of reducing resource waste and protecting the natural environment. Finally, this is a valuable and meaningful exploration. Furniture designers can get ideas from it, and consumers can have more choices.

ACKNOWLEDGEMENTS

Thank my mentor Richard Appleby very much. Thank you for your careful teaching and thought guidance, and for giving me different ways of thinking and inspiration directions in the process of this project. I also want to thank my classmates and parents. With your help and support, I was able to complete this project. Without the love and encouragement of all the above people, this project will not be realized. It can be seen from this that the completion of the design cannot depend on a single person. It is with the help and competition of peers and the help and support of teachers and elders that the entire project can be successfully completed.

DECLARATION

I hereby certify that this report constitutes my own product. If other people's language is listed, it is indicated in quotation marks. If I use another person's language, thought, expression or writing, I will give appropriate trust. I declare that this paper describes the original works that have not been awarded any other degree by any institution before

YuTong. Yang

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Figure1 Furniture rubbish discarded by people at will



Figure2 Narrow and crowded living environment of urban working class in China

The current situation of Chinese working-class home space

According to the China working class credit development report released in 2017, more than one quarter of China's employed population currently belongs to the working class. Such a large population plays a very important role in the economic development of China (Pun, 2020), where working classes have to suffer some of the most embarrassing and difficult living conditions in the largest cities. Taking Yuzhong District, Chongqing, China in 2012 as an example, 43.6% of the people who own real estate have two bedrooms and one living room, while 29.1% have only one bedroom and one living room. Among the rental families, 47.9% of the people live in one room and one living room, and 34.7% live in one room single room. In China, with the rapid growth of house prices, the number of renters is also increasing. The living area of these families is generally less than 40 or 50 square meters, where their indoor storage space becomes very limited and difficult to manage to store all their belongings. For constructional materials, plywood has become the best choice for their cheap and easy to assemble furniture. Although the durability and texture of this furniture is poor, and the aesthetic feeling at the cultural level is weak, there is very little choice of reasonably priced furniture types that are both practical and long-lasting. In addition, it is worth noting that these people often need to move due to work and housing reasons. where their furniture will be simply be discarded rather than moved to the next apartment. Subsequently, China has a huge amount of wasted furniture every year. Taking the Baiyun District, Guangzhou City, in China as an example, by 2017 the average annual output of large furniture waste in Baiyun District was about 12000 tons. Such a large number of abandoned furniture has brought a very bad impact on the environment and earth resources. A considerable part of the reason why this furniture is discarded is because of it's poor quality, troublesome movement and fixed size. When the user changes the use environment or moves to a larger or smaller living space, it is difficult for them to adapt the furniture system to the new space and is costly to transport during the move.



Figure3 Multi functional furniture



Figure4 Folding furniture



Figure5 Modular furniture

How to improve

At present, the housing price in China remains high, and the small living space of the working class in these big cities has become the norm. Then, it is necessary to start from the existing interior space, and change the selection and layout of furniture in the interior space to improve the problem of limited space and messy objects as much as possible. At the same time, the furniture can be used for a long time and cope with different use environments, and they can continue to be used after moving to reduce waste.

This project starts with the design of storage furniture. Storage furniture is almost a necessary item in every family. Although it is not impressive in general, it is very practical and important for the storage of the whole room. Therefore, it is very meaningful to review and redesign storage furniture to meet the needs of consumers.

Now there are a lot of furniture that can be easily stored in the market.

Plastic storage cells, which often appear in Japanese family storage, are very popular. These storage cells can be stacked freely, with light weight, and can effectively use three-dimensional space. In the case of limited plane area, it can save space to the greatest extent by stacking the items orderly. Such orderly placement can also facilitate users to take and store items.

Or it can be a storage rack made of wood. In this case, objects are exposed, which is easier to take and stack, and clothes can be directly hung for storage. However, in the wooden storage rack, items should be placed in order and three-dimensional space should be used, otherwise a lot of storage space will be wasted.



Figure6 Simple wooden furniture

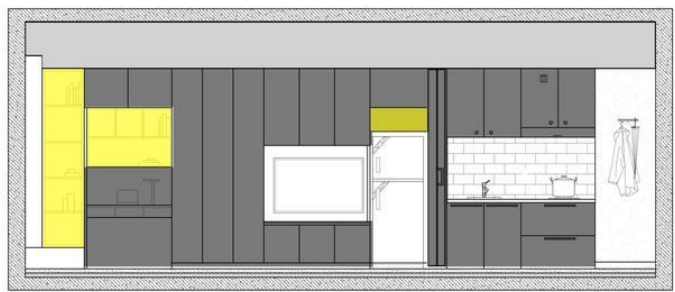


Figure7 Small storage furniture

Research Value & design opportunity

Research value:

By exploring different storage furniture used by different users in different use environments under the human-computer environment system, users can find the most suitable products for them and realize the inconvenience of other products. Find the best solution for them. At the same time, this project can also show the innovation direction and new innovation dimensions of storage furniture products to furniture manufacturers from different angles. In the long run, it can improve the market vitality of storage furniture products. From an academic point of view, this project explores the potential of modular design and system design in improving user experience, and how to combine modular design and interactive design with traditional furniture design and production process, so that manufacturers can produce in terms of function and shape, and the market can produce better products that are more suitable for most consumers. Subsequent designers and researchers can also find examples from furniture product design for reference.



开放隔口占20% 封闭柜门占80%



开放隔口占20% 封闭柜门占80%



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百家号/木桐设计事务所

Figure8 Indoor storage rules

In modern times, good and reasonable household storage should follow these laws:

1. Adjust measures to local conditions

There is a corresponding relationship between the storage content and the use space of the home, which requires users to diversify and evenly arrange the storage space according to the use function of the space. In short, there is at least one locker in each space. This is only the minimum to meet reasonable storage requirements. At the same time, users should give full play to the inherent advantages of each space and reasonably plan the location of lockers. Based on the user's usage habits, the orderly storage of items should also meet the "principle of proximity", that is, easy use and easy return. It is important to help the family members in the same living space develop and maintain good storage habits. If they do not do this or do not do it well, cross storage is likely to lead to chaos.

2. Land occupation $\geq 12\%$

Storage proportion=(storage projection area/housing interior area) * 100% $\geq 12\%$, which is an empirical value recognized by the public after extensive practice. For example, for a small and medium-sized apartment with an area of about 100 square meters, the floor area of the storage cabinet should be about 12 square meters. For the limit, it should not be less than 10 square meters(Lu,2016). The relationship between storage and space is the same as that between memory and computer. The larger the memory, the smoother the computer will be after a long time of use. On the contrary, if the storage space is lower than this value, how to arrange the layout for storage will still face the problem of messy storage caused by insufficient space. It should be added that the larger the storage space is, the better. A balance needs to be reached between them. In addition, it is worth noting that the smaller the housing area, the larger the storage ratio. For example, for a 30 square meter one room household in a metropolis, if users want to live a more comfortable life, the storage proportion should reach 20%, which indicates that there is a starting amount in the storage space. Because no matter how small the living space is, the most basic storage space required by users is indispensable.

3. Stereo integration

Taking building houses as an example, China had only 6 storeys of multi-storey houses a few years ago, but when the houses were planned to be 18 storeys, the same floor area would triple the number of households, which means three-dimensional. When the government resets several nearby villages in the city, one village will be relocated to a high-rise building, and these high-rise houses will be concentrated in one community, which is the meaning of integration. Correspondence is the same in home storage. In the indoor area as small as possible, the use of three-dimensional integration design concept can expand the storage capacity. Therefore, instead of choosing several small storage furniture, it is better to adopt the storage mode of high efficiency large storage cabinet.

4. Pareto principle

Pareto principle has universality in all aspects of society, which must also be used for home storage. The indoor space of many users is messy, and the living room is mostly cluttered with small objects. Even if there are furnishings worthy of appreciation, they have been covered by messy debris. Therefore, it is necessary to hide 80% of the chaos to reveal 20% of the beauty. This principle should also be followed in the design of cabinets. Just like in the sample room, most of the first time consumers see are all open display cabinets, which are full of books and exquisite furnishings. But in real life, every day there will be the transfer of goods and the production of sundries, so the cabinet will fall and appear very messy. Therefore, 80% of the cabinets should be equipped with cabinet doors, and 20% should be used as display and storage areas (Milton, 2013). Only in this way can there be hidden leaks, which can have strong storage practicality and beautiful display performance. Although the cabinet door is completely closed, it is not reasonable enough. For the design of cabinets in such strong functional spaces as hallways, kitchens, bathrooms, and housework areas, a certain door free storage area must be reserved to store items that are frequently used every day so as to avoid the annoyance of repeatedly opening and closing the cabinet door, so as to make the operation easier.



Figure9 Clean indoor environment

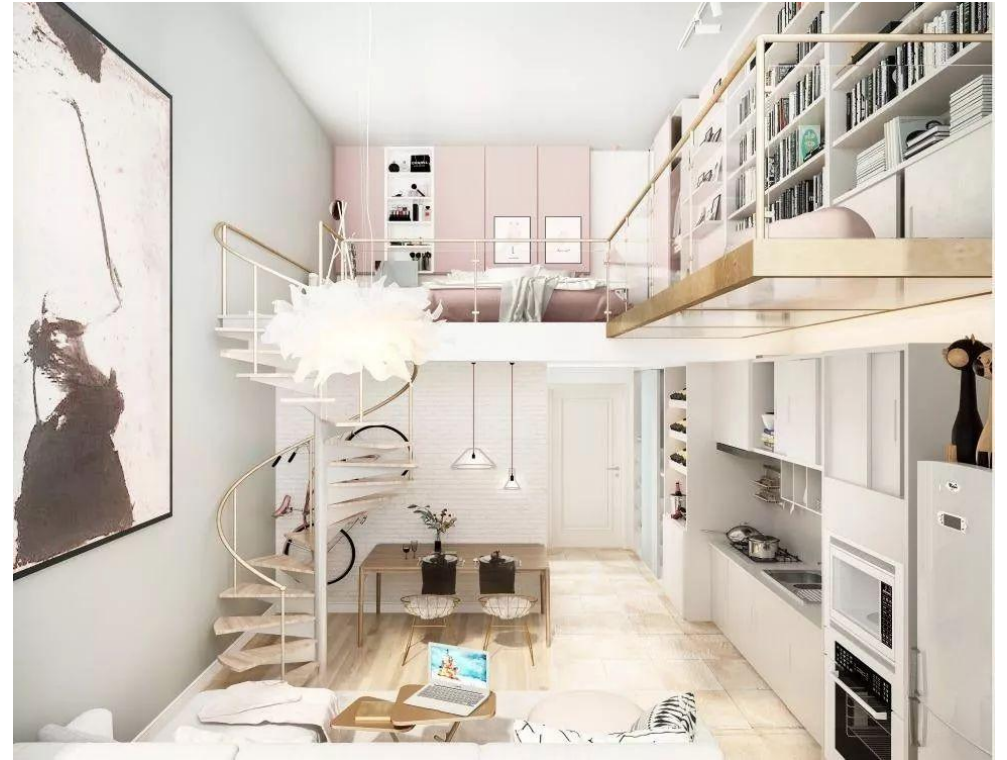


Figure10 Neat duplex apartment interior

Scenario & Users analysis

Scenarios and user analysis can clarify the specific ideas and directions of furniture product design, find out the exploration difficulties in the process and make the design more in-depth and authentic. Scenarios and user analysis enable designers to think about needs from the perspective of users and consider the systematic relationship between human and computer environments as a whole, rather than determine design trends based on designers' personal aesthetic and functional preferences

	living space	Time indoors	Item quantity	
single	20 to 50 square meters of single room or apartment	Sleep for seven hours on weekdays, stay at home for the remaining seven hours, and stay at home for 21 hours on weekends on average	There are fewer male items than female items, and the space for non large items is basically enough	
couple	50 to 100 square meters of apartment or community housing	Sleep for seven hours on weekdays, stay at home for the remaining seven hours, and stay at home for an average of 19 hours on weekends	There are male and female articles, and things are sometimes stacked	
Family	80 to 120 square meters of housing	The parents are the same as above, except for the children's sleeping time, the rest of them spend eight hours at home on average every day	There are many kinds, and sometimes the storage space is not enough	

Wen hua Li
25
Location: beijing
accounting

I live in a small apartment in the Fifth Ring Road of Beijing, covering an area of 45 square meters. I go to work at 9 o'clock and work at 6 o'clock every day. I occasionally work overtime. It takes me more than half an hour to commute on the way, and I sleep more than 12 o'clock every night. Because I'm the only one in my family. I don't have many things, but I don't have much room to save money and rent. Now I usually collect things in the plastic lockers I bought. It can put a lot of things, but the things are packed together, so it's a bit messy. There are not many things placed outside, because there is no place, and because the air here is not good, it is easy to accumulate dust. Some of my favorite electronic products can only be received in the drawer. I think the storage rack on the desktop used in college is very easy to use, which can save a lot of space, but because it is too big to fold, it was thrown away after graduation. My current working salary is average, and I may move after the year. I have lived here for nearly two years. When the time comes, the things in the house may be thrown away if they are useless.

Ming wang & yue zhao
26 & 26
Location: shanghai
Engineers and marketing personnel

My boyfriend and I live in a community in Puxi, Shanghai. The rent is not cheap. The area is only over 80 square meters. Two bedrooms and one living room. No large pets such as cats and dogs are allowed. We've been here for almost a year. Work requires overtime, which is hard. Sometimes I come back after nine o'clock in the evening. The things of the two of us are in a mess. My dresser is small, and many cosmetics and skin care products cannot be placed. My clothes are a little more, usually stacked in the wardrobe. We didn't buy additional storage furniture, so far we have used the original cabinets. There are few cabinets in this house, and all the extra things are in the second bedroom. Sometimes it is not convenient to find them. I think there are simple shelves on the Internet, and some of them want to buy, but my boyfriend doesn't know how to take them away when he moves, so he advised me not to buy them. But I still think it's inconvenient to put things in disorder. In the future, I must be able to put things in order in my own house.

Yu liu & yi qian & ping liu

30 & 30 & 1

Location: shenzhen














Personnel of the System Department & Personnel of Security

Department & child

Our family of three now lives in Nanshan District, Shenzhen. Now we are under heavy pressure from the monthly housing loan. The children in our family are only over one year old, and they spend a lot on food and clothing. There are children's things everywhere in a 100 square meter house. My wife and I have a lot less things than before, but there is still not enough room at home. My computer is in the master bedroom. There is a bookshelf beside it. It was installed more than a year ago. Now my things are mainly put on the top, and my wife's things are put on another cabinet. This bookshelf was bought to store books. Now there are many children's books piled on it. Some of my books can only be received elsewhere. My wife and I can't put any more clothes in the wardrobe. Some of them can only be stacked at the bottom of the wardrobe. Would it be better to buy a shelf that could be stacked together? I'm used to this shelf now. Let's make do with it. In the future, considering that children may buy boxes for storage

User & market research

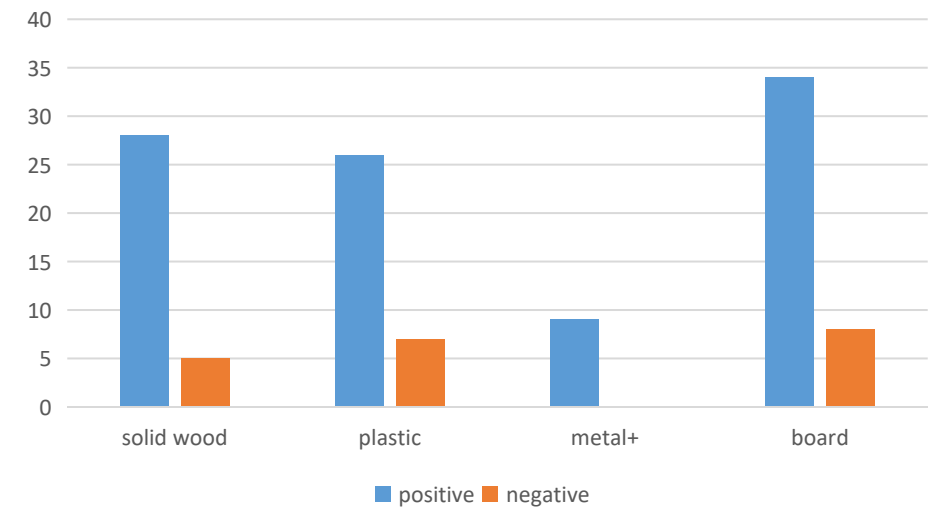
Market and user research can further understand the corresponding attitude and acceptance of consumers and the consumer market towards the target products, and can better ensure the authenticity and reliability of the actual design by comparing the advantages and disadvantages of existing products in the market horizontally. The collection of consumer product use evaluation can also truly reflect the user's preferences and potential needs.

													
material	wood	wood	wood	wood	wood	wood	wood	multiple materials	multiple materials	plastic	plastic	multiple materials	multiple materials
removable or not	no	no	no	no	no	yes	no	no	yes	yes	yes	yes	no
cost	high	high	normal	normal	high	normal	normal	high	normal	low	low	normal	high
durability	high	high	high	normal	high	normal	high	high	normal	low	low	normal	high
storage efficiency	high	high	normal	normal	high	normal	normal	high	normal	very high	very high	high	high

The storage furniture products on the market are mainly fixed products that cannot be disassembled. These products have a long history of modeling and become a classic choice for consumers. Most of them are wood products with good stability, can bear large weight, and can meet the daily storage needs of most consumers. Because these products are too classic and their form and function remain unchanged for a long time, many users actually ignore the obvious disadvantage that they cannot disassemble them. Nowadays, the working class in big cities move frequently and their living environment is mostly rental housing. They hardly need to buy large pieces of furniture in their daily life, and their storage needs still exist, sometimes because their objects are complex or even more demanding. At this time, they will face a more embarrassing situation, that is, the existing products can not better meet their real life storage needs. Looking around, fixed storage products occupy the vast majority of the market share. Therefore, plastic storage furniture that can be combined has gradually increased in recent years. These plastic products are quite different from the traditional wood storage furniture. They are cheaper and require users to assemble the components themselves with light weight. Users can easily assemble them for use. When they don't need them, they can take them away or discard them as garbage. Because they are easy to disassemble and cheap, users won't feel trouble or distressed about the price. However, the load-bearing capacity of this plastic product is worrying, and it is mostly used in the storage scene of clothes with light weight. In the face of a variety of storage furniture products on the market today, it is a necessary step for design research to use design methodology to integrate, summarize and analyze

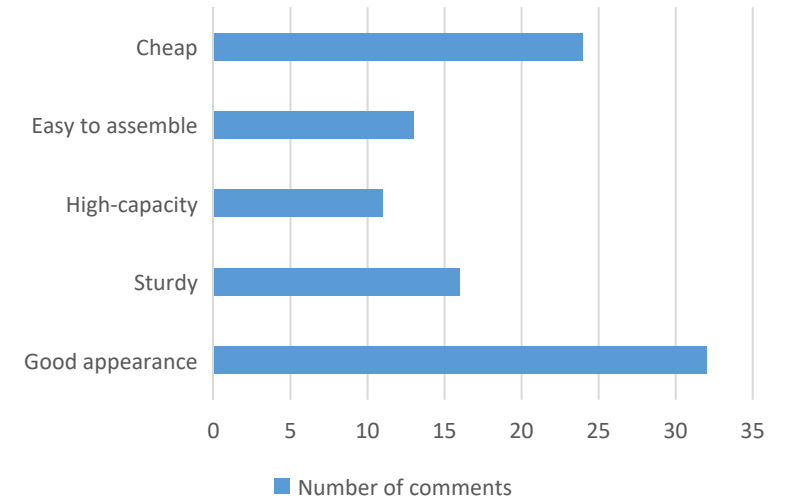
By listing the representative products of the same type of storage furniture on the Internet, it can be found that the price, durability and functionality of furniture products with different materials, shapes, combination methods and the same storage function are different. It is a consensus that expensive products are generally of good quality, while really good quality and cheap products are rare. Although the overall sales volume of products with the advantage of low price is fair, the corresponding negative comments and negative feedback are also very large. The target products to be designed need to combine the advantages of products in these markets and try to avoid their corresponding defects.

Feedback analysis of users of different types of storage furniture

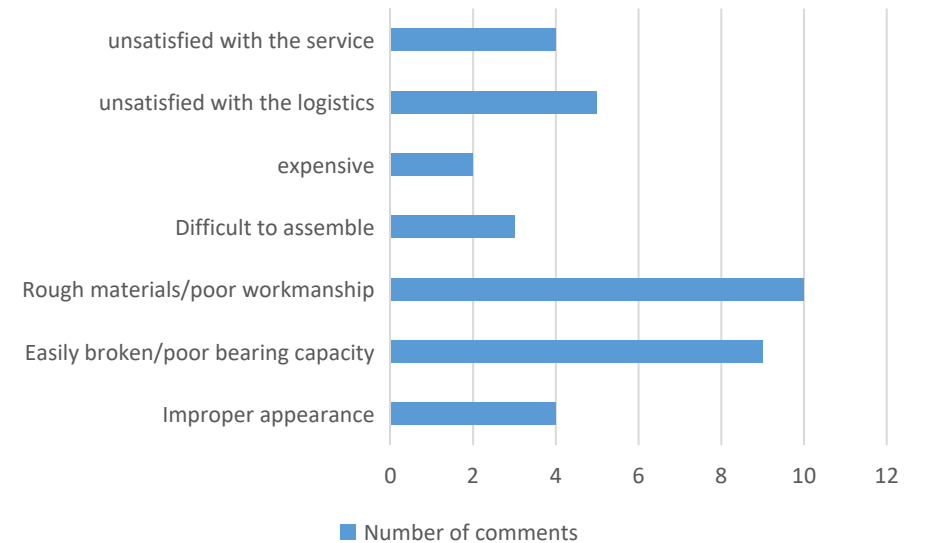


Relevant conclusions can be drawn after collecting consumer feedback of the above products on the Internet. Wood storage furniture has the largest variety and quantity, and also occupies the largest market share. The number of plastic storage furniture is the second largest, and the average price is the lowest. Metal storage furniture has the least quantity and the most expensive average price. Therefore, people have the most feedback on the use of wood storage furniture. Consumers' bad comments on them are mainly due to their poor quality of materials, which are not firm, durable or easy to assemble. The high praise is mainly due to their excellent quality, low price or simple assembly. Among them, the plastic storage furniture has the largest proportion of bad comments, and the negative feedback from consumers mainly comes from instability, easy to break up and problems arising from logistics. Metal products are generally expensive, with good quality, and the proportion of poor evaluation is relatively small. Consumers pay more attention to the material of wood storage furniture, especially the difference between solid wood and board. Some shoddy businesses often suffer more criticism. And consumers of cheap board products do not care much about the shortcomings of the board. They think the quality can be satisfied with the price.

Reasons for positive comments

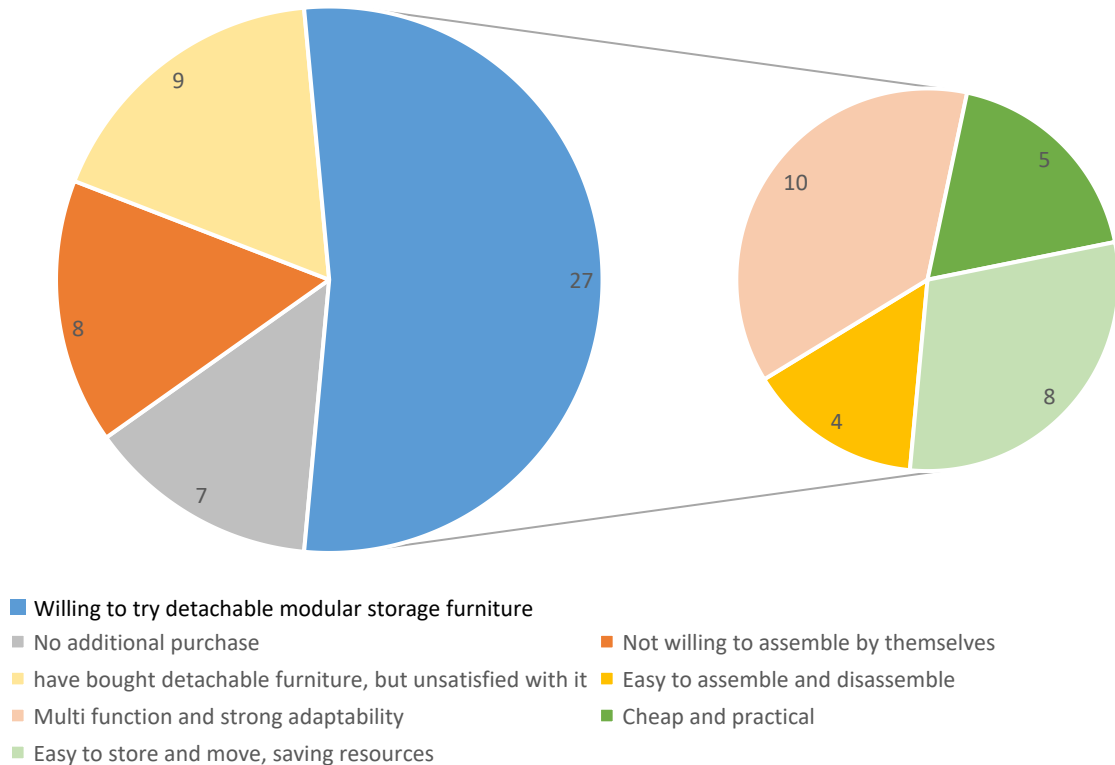


Reasons for negative comments



The opinions and attitudes of various types of consumers towards removable storage furniture were collected by questionnaire. It can be found that more than half of consumers are willing to try the new type of removable furniture, and they pay more attention to its versatility and storage capacity, that is, whether it can adapt to a variety of needs and space environments, and whether this removable function can improve its storage capacity and reduce the space it occupies. Consumers have a certain thirst for new products and relatively high expectations, which requires designers to meet the potential needs of consumers as much as possible, design high-quality products that can truly improve the level and ability of consumers' storage, improve their existing insufficient storage status, and improve their convenience and satisfaction of life.

Survey of users' opinions on storage furniture



Investigation on purchase and use intention of storage furniture
添加问卷说明

* 1. What is your gender?
 male
 female
 secrecy

* 2. What is your age?
 10~20
 20~30
 30~40
 40~50
 50+
 secrecy

* 3. What is the size of your living space?
 10-
 10~30
 30~50
 50~70
 70~100
 100+

* 4. What is the number of storage furniture in your living room and living room?
 none
 1~2
 2~4
 4~6
 6+

* 5. Have you ever moved or planned to move?
 yes (跳转到第6题)
 no
*此题设置了跳转逻辑

* 6. If you have ever moved, have you ever discarded furniture because of moving?
 yes
 no

7. If you need to buy storage furniture, how do you want it to meet your requirements?

appearance

Large capacity

Strong bearing capacity

cheap

Easy to assemble

Removable and flexible assembly

Adapt to indoor environment

Firm and durable

texture of material

* 8. What is your attitude towards furniture that needs to be assembled by yourself?
 Not accepted
 Can try
 Willing to accept
 Depending on the situation (e.g. cheap enough, or attractive style)

9. Why are you dissatisfied with some furniture? (Please answer if you have...)

	plastic	panel	solid wood	metal
expensive	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
unstable	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Rough, poor texture	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Difficult to assemble or disassemble	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Difficult to move	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Poor appearance	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Small capacity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Take up too much space	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Understanding the needs and commonalities of target users can be a guide and reference in the design process. User centered scientific design is one of the core ideas of modern design. The needs of "people" guide designers to eliminate false and retain true in the specific design process, and strive to design according to the actual needs of users. This can not only increase the authenticity and practicability of the final design results, but also explore the correct design direction for enterprises, so that they can produce high-quality products that can meet their own interests and please consumers. The project also takes the actual needs of the target users as the core consideration, while making bold innovations, it also keeps in mind the daily storage needs of the working class in big cities, and makes efforts to improve the storage conditions of the target consumers by combining design methods such as modular manufacturing and ergonomics.

Research question & Methodology

The main research question is How to use design process to change behaviors of modern urban working-class people, to improve their crowded and chaotic living environment? The next step is to Determine the style of storage furniture, such as cabinets or shelves? And determining modular units and specific connection methods. The form should be practical and convenient for storage. After that, specific materials should be determined and various attempts should be made

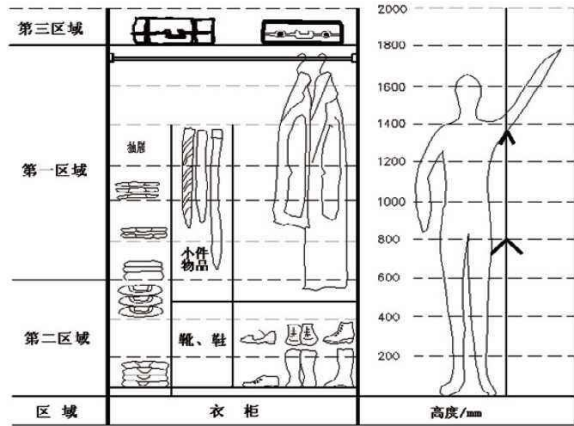


Figure11 Internal area arrangement of wardrobe

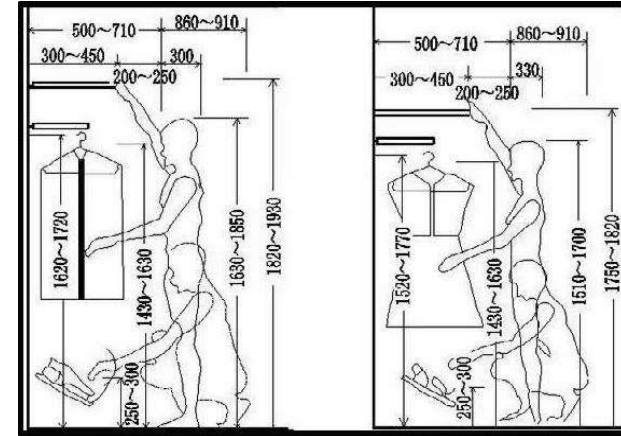


Figure12 Different body dimensions of the cabinet



Figure13 Items placed inside the wardrobe

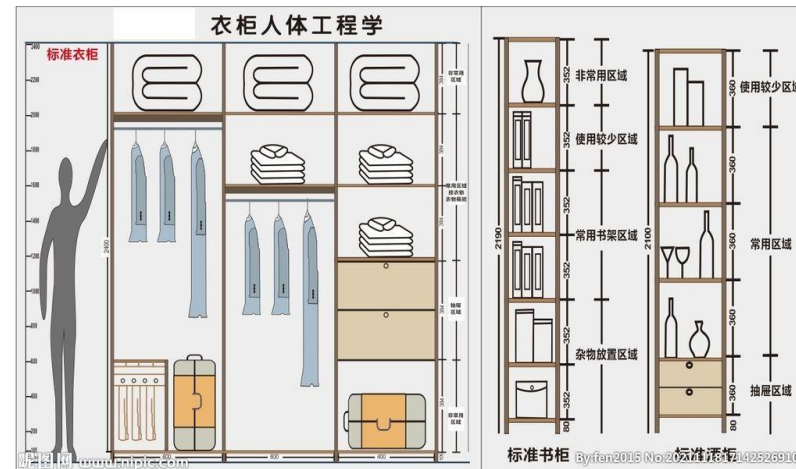


Figure14 Multiple content layout methods of the cabinet

Human, machine and environment

The analysis of "human, machine and environment" factors in furniture design is the most basic design criteria and requirements

The introduction of ergonomics in furniture design provides scientific basis and theoretical support for the function and authenticity of products. Ergonomics is a science that is used to explore various factors in anatomy, physiology and psychology of people in a certain work environment, study the interaction between people, machinery and the environment, and study how to uniformly consider work effects, health, safety, comfort and other issues in work, family life and leisure(Zhang,2020). Modern furniture designers need to consider the relationship between "consumers", "furniture" and "space" when designing products.

The dimension parameters of human body in ergonomics provide theoretical reference and basis for the design of furniture dimensions. Due to the use characteristics of furniture, there are three size design standards: 5% represents "small size", 50% represents "moderate size", and 95% represents "large size".

The furniture designer should reasonably select the percentile for design according to the use and use of furniture. In the design of storage furniture, its length, width and height should be considered, and the size and position of the cabinet door should consider the user's body size. At the same time, the partition arrangement in the cabinet needs to consider the convenience of people to take and the size of things to be placed.

In appearance, good color design of furniture can alleviate eye fatigue, regulate mood and improve life satisfaction. At the same time, the design of furniture should fully consider the personal situation and environment of consumers, so that the furniture can be perfectly combined with consumers and the environment, so that it can be used sustainably, and achieve the effect of optimal utilization of resources.

As an indispensable and important article in daily life, the first condition for the existence of furniture is functionality. Similar to general industrial products, the functionality of furniture determines its shape, shape and materials. The bearing capacity of furniture at the artistic level requires that its form and shape have a certain sense of beauty, and the shape of furniture is not only the innovation of form and the expression of formal beauty, but also the use of this form to fully realize functionality, achieve the unity of form and function, and achieve the unity of beauty.

Make full use of space pattern, transform small storage space into large storage space in function, improve family living conditions, and coordinate with interior design style or environment to create a pleasant living space. For example, the indoor corner space or corner space is generally difficult to use. If it is empty, it will waste space and affect the aesthetics. Therefore, furniture can be customized according to the size of the space, furniture size and consumer needs, such as cabinets,

In this way, the "consumers", "furniture" and "space" are fully coordinated to achieve the highest efficiency. The use of wall space and stair corner space to make storage shelves and bookshelves is unique, but also expands the storage space, so that small units show the greatest practicality.



Figure15 Modular Design in Product Design

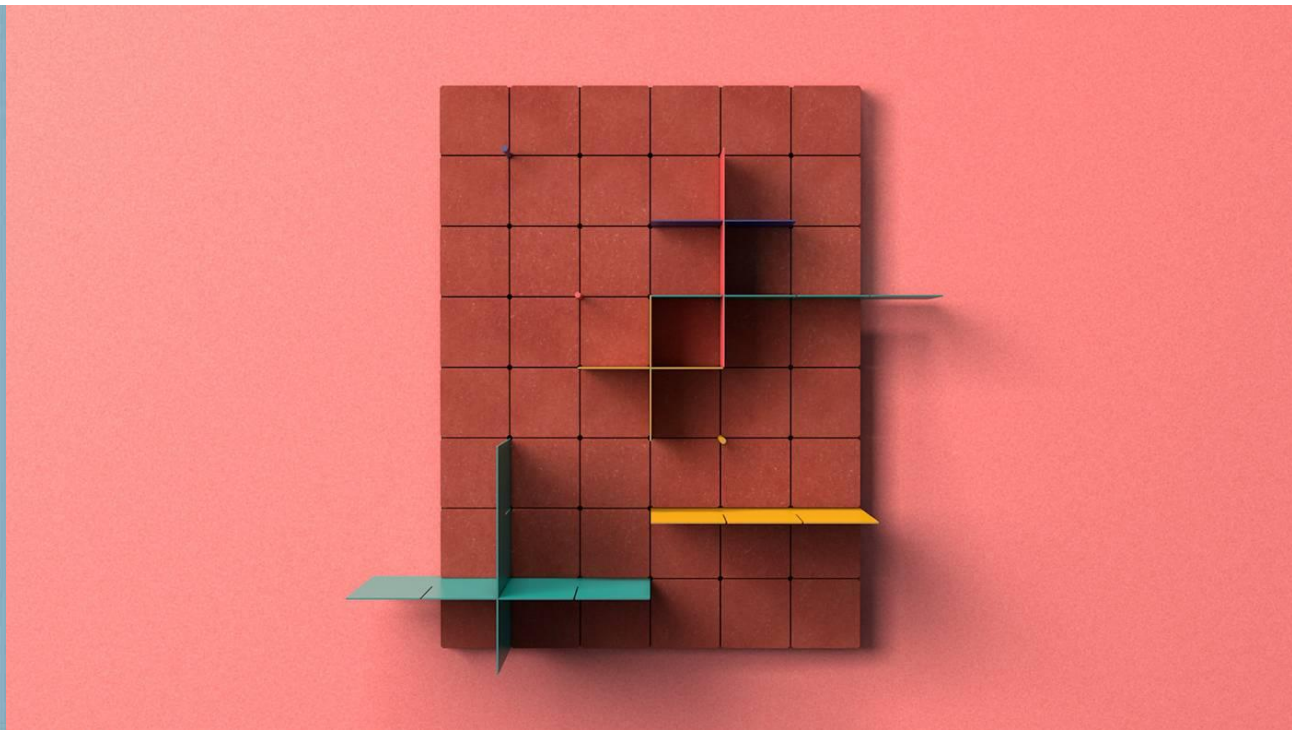


Figure16 System design of products

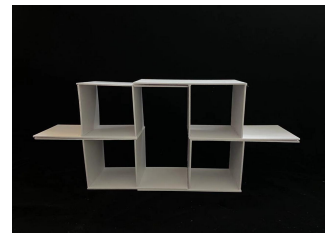
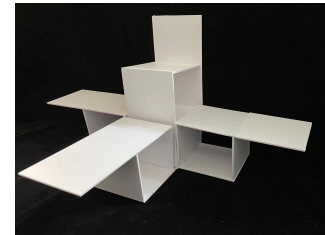
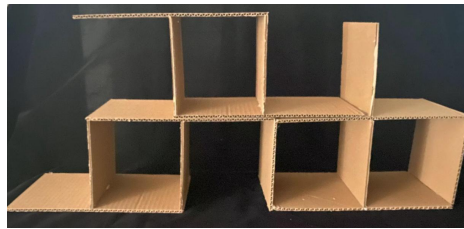
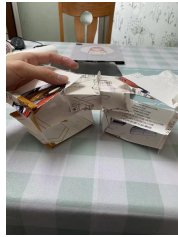
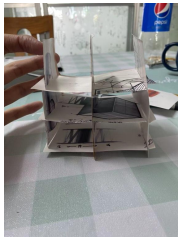
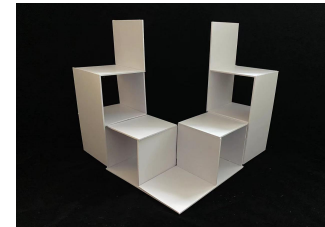
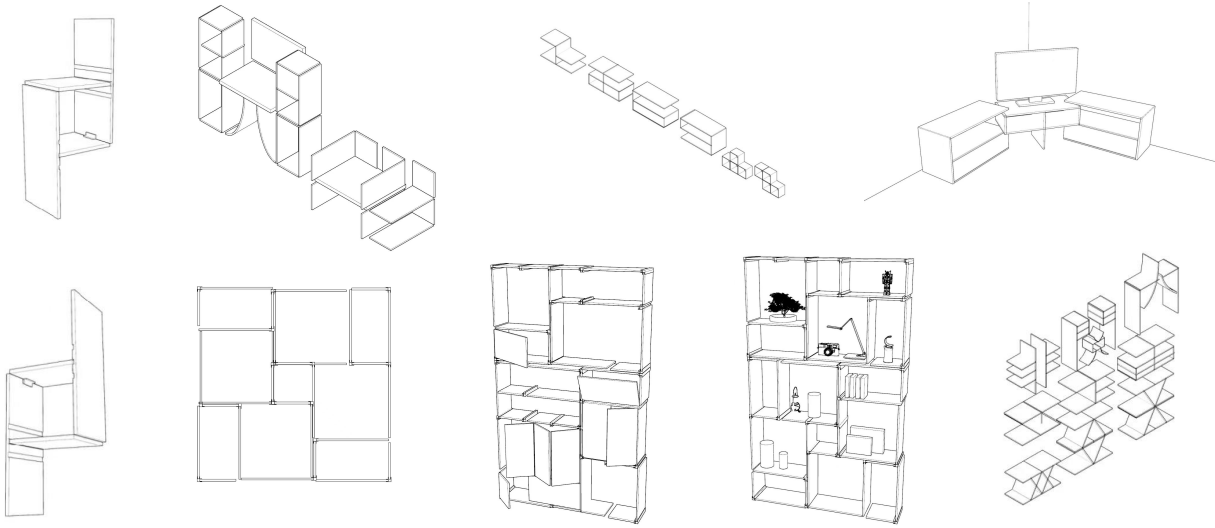
Modular design method

In the current Chinese market, consumers' personalized demand for furniture has become increasingly prominent. How to meet this demand has become the key to the development of more and more furniture manufacturers. It is quite difficult to balance the two in order to meet the development mainstream of modern mechanized production, save costs and improve the market competitiveness of products. As one of the solutions, customized furniture solves the problem from the sales side. It can create high-quality furniture, but the cost is high and it is difficult to adapt to the mass consumer market.

Modular design is to solve problems from the design side. Modularization aims to achieve the purpose of combining diversified furniture by designing standardized and universal functional modules. At present, modular design has great development potential in the furniture industry, because it can not only solve the problem of personalized needs, but also achieve low cost and high efficiency.

Modular design belongs to the category of methodology, which has been greatly developed in other industrial industries. Due to the change of furniture consumption environment and manufacturing environment, modular design has been applied in the furniture industry with its unique advantages. For furniture used in urban housing, the contradiction between personalized demand and the production of furniture enterprises has become increasingly prominent in recent years. The exploration of modular design has just started. There are few systematic furniture modular design theories in the whole industry to guide enterprises to conduct production practice.

For the modular design of furniture, designers need to divide and design a series of furniture functional modules based on the functional analysis of furniture, and form different furniture through the selection and combination of these functional modules to meet the diversified needs of the market. Compared with traditional design methods, modular furniture design has many new features. First of all, it is aimed at the design of modules and furniture product systems. It is necessary to design both modules and finished furniture products. Secondly, it quickly combines standardized and universal parts into furniture, which can realize the diversification of furniture. Modular design is different from standardized design. Standardized design brings a single product, while modular design considers the diversity of modules that can be combined into products at the beginning of design. Therefore, modular design is a method to realize product diversification on the basis of standardized design.



Material testing

Most of the existing storage furniture on the market are fixed cabinets or shelves. The materials are wood, plastic and metal. Most products are made of wood. There are high-end products, which are made of good wood such as walnut and mahogany. They are beautiful and elegant in shape, large in size, and cannot be assembled or disassembled.

Cheap products are made of plates, which are easy to assemble but difficult to disassemble. The shape of panel products is more flexible and lighter than that of solid wood furniture, but the texture is poor, and the characteristics of panels are not conducive to modular assembly such as punching and splicing. There is an assembleable cabinet made of cheaper solid wood. However, it only divides the large volume cabinet into small squares for assembly. The squares are still not detachable, which still occupies a large space, causing inconvenience for storage.

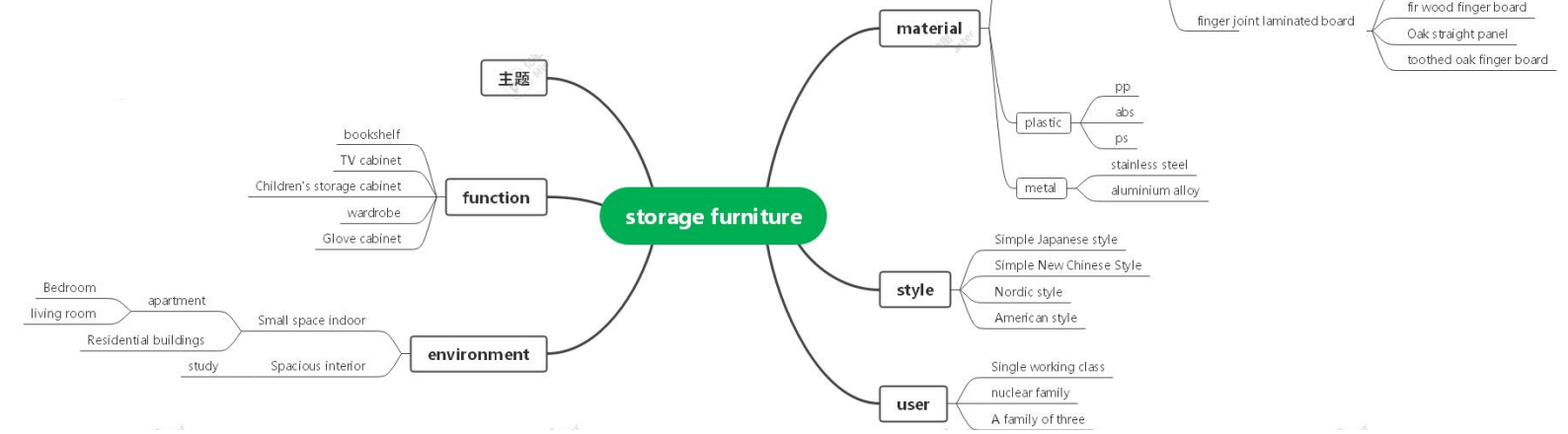
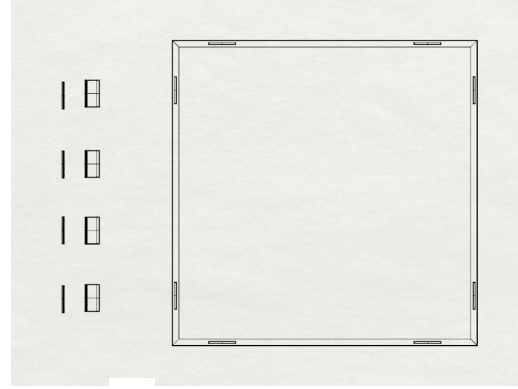
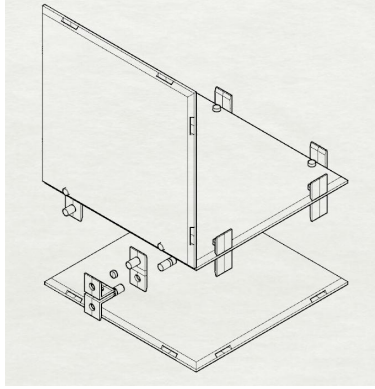
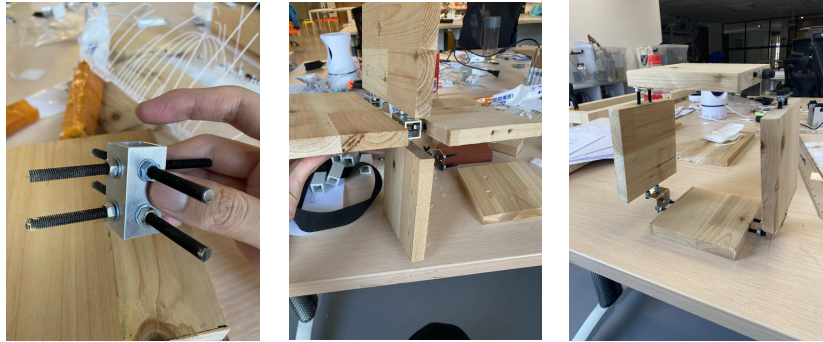
The cabinets made of plastic are mainly shelves and storage compartments with drawers. Plastic is easy to be plastic and light, but its bearing capacity is poor and unstable, and its texture and aesthetics are poor. Therefore, plastic is generally not used as the main material for storage.

The metal is mainly used as the material of the shelf, and is generally not used for placing in the residents' homes as a daily use to carry a large number of items. Metal furniture is solid and can be disassembled generally, but the disadvantage of metal furniture is that it is heavy and expensive.

It is preliminarily decided to use wood as the main material for design. The test samples are: African red rosewood, American black walnut, German beech, African sandalwood, Balsa wood and tung wood. The measured water content is: 6.1, 6.3, 6.1, 6.7. The first three hardwoods have the best quality and are relatively solid under cutting test. As light wood, Balsa wood and pine wood have soft texture, so it is judged that they are not suitable for cabinet supporting furniture. The prototype of plastic products made by 3d printing is also selected. Plastic is easy to be plastic, but the strength problem needs to be solved.



Product evaluation

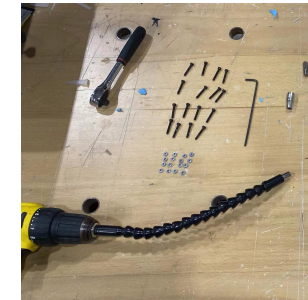
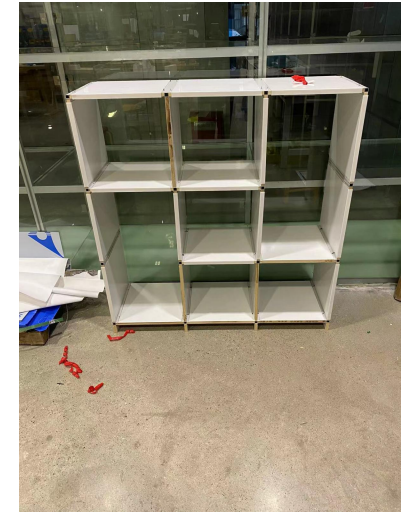


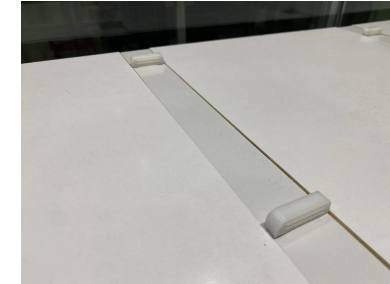
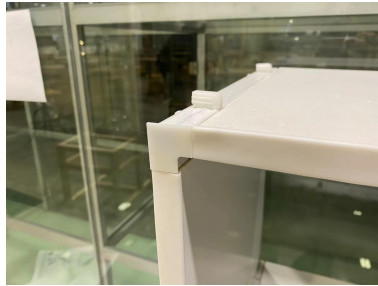
The publication model was initially made with pine boards as the main body, aluminum tubes and screws as the connecting pieces, and their functionality was further tested. It is found that this connection mode is not reliable during frequent plugging and unplugging of connectors and disassembly. It is easy to loosen and fall off longitudinally, and this connector is too heavy despite its small size, which will increase the weight of the whole furniture and also increase the cost. Therefore, after many tests, it decided to give up this scheme. Next, 3d software is used to model, and the second version of the model is made with 3d printer. The reduced version model made of this kind of plastic meets the needs of loading and unloading on the surface. However, it is difficult to make long rectangular holes in the cross section of the board on the wood. If plastic is used for making, the strength will be reduced, and the cost will be increased due to the need for mold opening and complex manufacturing. Therefore, this scheme is also abandoned after considering the cost. After considering the modeling, functionality and price factors from the overall perspective, it was decided to select the aluminum strip with lower price and sufficient strength as the connector, so as to avoid the paint plate as the main load-bearing material for trial manufacturing.

Through the investigation and research on storage furniture, it is found that modern indoor furniture mainly features simple straight lines, and most storage units are square shapes, which can save the space occupied by them to the greatest extent and increase the storage space. Board furniture is favored due to its low price and light weight. Although the traditional solid wood storage furniture has a good texture, it is expensive and difficult to assemble. It is rarely used in rental houses or other small spaces for working-class living. The disadvantage of the board is that it can not bend and shape the surface freely like the solid wood. Now the common boards on the market are density board, plywood, blockboard, paint free board and finger joint board. Among them, the paint free board with the best appearance and relatively strong appearance is a more appropriate choice. This material has a smooth surface, no need for additional painting, and is light and firm, which is a good choice for a variety of load-bearing indoor furniture. Compared with the solid wood taking beech as an example, beech is particularly heavy and expensive. For the working class in Chinese cities, the cheap, high-quality and beautiful characteristics of paint free panels can well meet their aesthetic and functional needs. It should be noted that the edge of the paint free board, as a plate material, is easy to produce rough burrs after cutting, so it is necessary to carry out edge wrapping processing.

Product introduction

In the process of making the model, a woodworking saw was used to cut the plates, and a touch lathe was used to cut the edges of the cut plates to make them fit with the connecting pieces. The overall production process implements the modular design idea, and the combination of a single board and a connector is regarded as a module unit, so that users can combine multiple units into a shape that can adapt to different situations. The connectors are divided into four types of equal length, which can be combined with different shapes of boards. The screws and nuts fixed through holes are standard parts, which can be adapted to the corresponding wrench and socket for the convenience of users to disassemble and assemble by themselves.





Users can use a variety of tools for assembly, which improves the freedom of assembly of the product. The appearance of this product is flat and simple, and it implements the design concept of "less is more" of modernist design, which can naturally adapt to different living environments and use environments of different users. At the same time, its functionality and practicality as a storage furniture can meet the storage needs of most consumers. The modular design reduces the manufacturing and transportation costs of the furniture, so as to make more profits for consumers. At the same time, users can purchase and assemble the spare parts of this product separately. Its advantage is to create a new type of removable storage furniture for the existing furniture market, which can be assembled or disassembled by users themselves. After disassembly, it occupies a small space and can be stored flat.

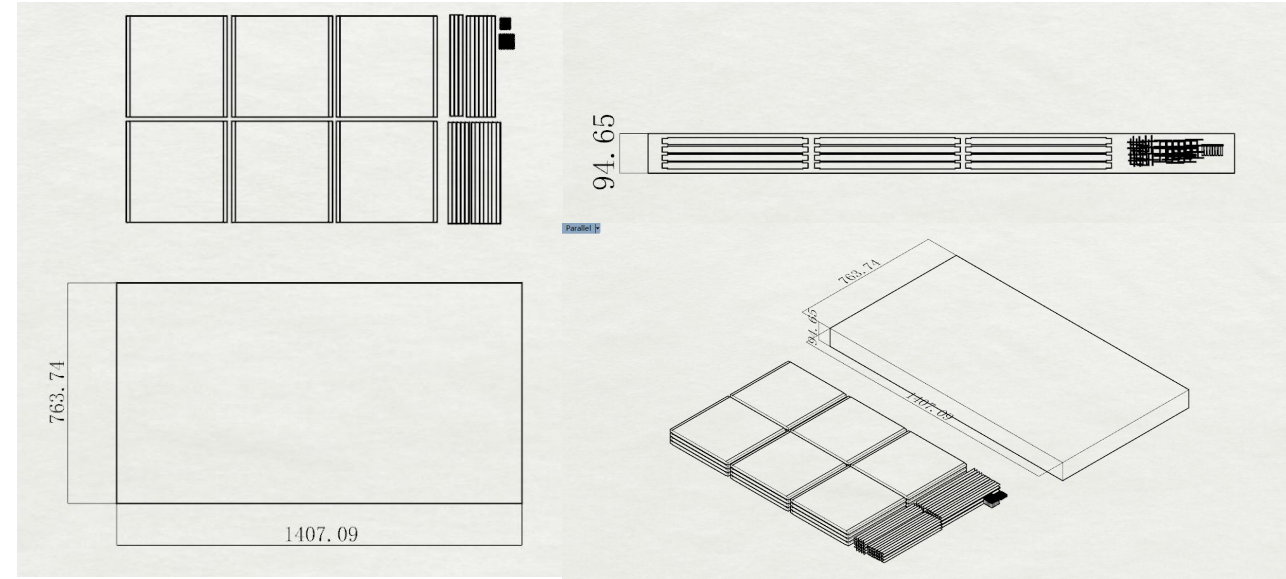
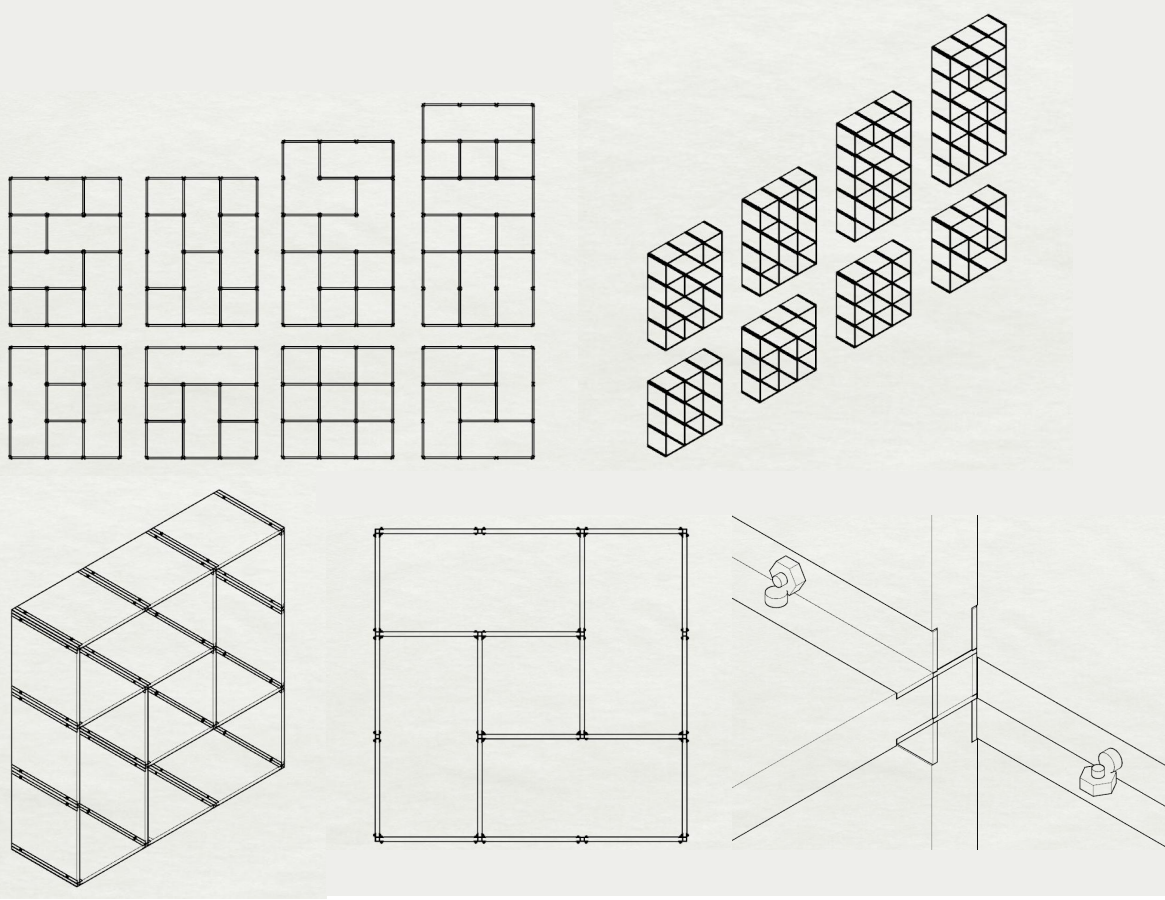


NO CLIMBING
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Assembly Instructions
Please read the instructions carefully before starting the assembly.
1. Check the parts list and ensure you have all the components.
2. Follow the steps in the order provided.
3. Use the provided tools to ensure proper assembly.
4. If you encounter any issues, please contact our customer support.
5. Thank you for choosing our product.







The product has a variety of combination methods for different users to use, and consumers can combine the product into a variety of forms according to the different storage volume and content. When the product needs to be moved, such as moving, users can disassemble it into multiple parts for small volume packaging and transportation. This reduces the waste of resources and environmental damage caused by discarded furniture waste.

The final effect of this product can show the charm of horizontal and vertical Chinese character strokes from the perspective of the front shape, and it also contains the oriental philosophy design thought of "Founder". In terms of design practicability, users actually participate in the overall design of the product in the process of manually assembling the product. The final step of the product manufacturing process is to complete the assembly in the user's home. This also means that consumers themselves have become designers of products. When the user disassembles and assembles the product for various reasons to change its shape, the significance of modular design will be reflected. Whether the partition is added or removed, it is the user's use behavior for actual needs. Such behavior not only changes the product's shape, but also changes the user's use of the product, which is actually a process of redesign. As a designer, it is necessary to ensure that this process is as simple and easy as possible, and at the same time ensure the firmness and reliability of the whole product, so as to make the user's free combination and free action more flexible and comfortable. Just as more and more products on the market choose to use flat packaging, this product also chooses to use this low-cost and efficient packaging and storage method. All parts of this product can be placed together, which greatly reduces the space occupation rate. The plates can be stacked and the connectors can also be placed crosswise, so that the whole can be put into a rectangular corrugated box with low height for circulation and transportation.

Producing process

The following table lists the specific manufacturing methods of the furniture. Each step has corresponding quality inspection to ensure the stability of quality and the reliability of functions. The overall production process also realized cost saving

Step 1

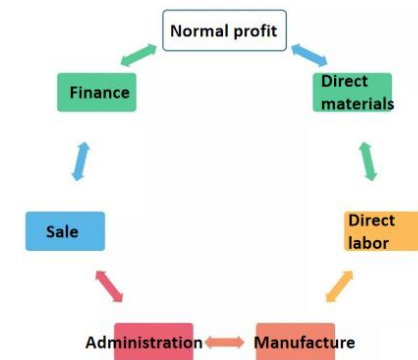
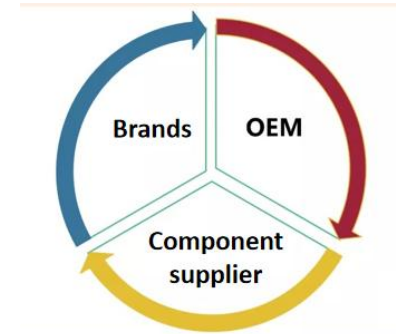
Cut the board, and then put the cut board on the woodworking CNC machine tool for edge cutting
 Materials involved: wood (plywood, laminate, etc).
 Equipment used: wood cutting machine, woodworking CNC machine tool.

Step 2

Cut the metal connector into sections and grind it (this step can be completed in the metal processing plant or the furniture factory).
 Punch holes at the corresponding parts of the board and the metal connector
 Materials involved: wooden boards, metal connectors.
 Equipment used: metal cutting machine, grinding machine, drilling machine.

Step 3 (this step is completed by the user, and the furniture factory needs to assemble a part of it for inspection)
 The wooden board and the metal connector are assembled together to form a module unit, and then the whole furniture is assembled.
 Materials involved: boards, metal connectors, screws, nuts.
 Equipment used: screwdriver, wrench, electric hand drill.

Process Flow Diagram	Processing method (manual or equipment)
Reject ← NG ← IQC (Incoming Quality Control)	manual operation
↓ OK Wood cutting + CNC Woodworking →	Equipment operation
↓ Check1	manual operation
↓ NG ← IPQC (In Process Quality Control) Rework ←	manual operation
↓ OK Metal and wood drilling + Metal cutting and grinding →	Equipment operation
↓ Check2	manual operation
↓ NG ← IPQC Rework ←	manual operation
↓ OK Assembly test	manual operation
↓ FQC (Final Quality Control) ↓ Packing	manual operation



Cost analysis

The final cost is controlled at about 347 yuan, while the selling price after taking profits into account is about 430 yuan

Direct cost:

1. Material cost

a) Timber cost: 150

b) Hardware, packaging price: 75

c) Price of paint materials: 0

The sum of the above three items is the material cost: 225

2. Labor cost

Labor cost is calculated as 15% of the total material cost (including all indirect and direct labor costs): 33.75

3. Water motor material loss cost

6% to 10% of the total material cost: 18

The direct cost is accumulated from the above three items: 276.75

Indirect costs:

Depreciation of fixed assets is calculated at 5% of the direct cost: 13.84

Business cost is calculated by 5%: 13.84

Financial expenses are calculated by 5%: 13.84

The transportation cost is calculated according to the actual situation: 5

Tax shall be calculated at 7% of the above cumulative amount: 22.63

Profit is calculated at 30%: 83

Suggested selling price: 430 RMB



Conclusion

The project better implements the user centered design idea, and uses the modular design concept to design a new type of removable storage furniture for the working class in Chinese cities. The product has a simple appearance and good functionality, and can adapt to a variety of use scenarios for different users. At the same time, because of its detachable characteristics, it can reduce the furniture discarding phenomenon caused by users' moving, thereby reducing resource waste and protecting the earth's ecological environment. The advantage of this project is that the specific use scenarios and consumption levels of users are considered as much as possible, and the product cost is reduced as much as possible while meeting the product quality. The disadvantage lies in the lack of consideration of actual production and the investigation and research on the objects stored by users. The final product may be slightly lacking in practical authenticity to some extent due to the failure to take all types of storage objects into account. This point needs to be further considered and improved in the design process after the designer. In general, the project can provide some inspiration for the design and production of furniture market, and guide enterprises to design and manufacture more high-quality and inexpensive products that meet the needs of consumers from the perspective of users.

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