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Fine Design of Wardrobes Based on Analysis of Changing Behavior in North China

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Abstract: ***Fine design of wardrobes based on clothing change behavior analysis is an important way to improve the quality of wardrobe design and enhance user experience. The North China region of China has distinct climate characteristics throughout the four seasons, requiring different combinations and choices of clothing to adapt to different climate conditions. This study mainly selects the North China region of China for analysis, and analyzes the changes in clothing matching in certain seasons, such as morning, afternoon, and evening. Through the analysis of the changing behavior in the four seasons of North China and the mixed application of ergonomics and other methods, the research and analysis methods for the refinement design of wardrobes are emphasized.***

Keywords: Clothing change behavior analysis, Ergonomics, Wardrobe refinement design, Parametric design, Modularity.

1. Introduction

With the continuous improvement of the socio-economic development level in North China, the living standards and consumption index of the people are constantly improving, and people's requirements for the quality of living environment are also increasing. Especially in terms of clothing, with the accelerated pace of changes in popular clothing, people's types and quantities of clothing continue to increase, and higher requirements are also put forward for wardrobes.

The climate in North China is dry, and the indoor and outdoor temperatures vary greatly. People need to change into appropriate clothes at any time. Therefore, as the main furniture for storing clothes, the design of the wardrobe not only needs to meet basic storage needs, but also needs to be finely designed according to people's changing behavior to improve usability and comfort.

The aim of this study is to analyze the changing behavior of people in North China, understand their needs and habits when choosing, matching, and changing clothes, and propose a refined design plan for wardrobes. Specifically, we will focus on the spatial layout, functional zoning, and storage methods of wardrobes, aiming to design wardrobe products that better meet people's usage habits and needs.

2. Research Methods

2.1 Clothing Stacking Size Statistics Table

The team compared the sizes corresponding to the international size chart and calculated the length, width, and thickness of clothes of different sizes after folding, providing corresponding data basis for stacking zoning and cabinet size design in subsequent design.

	B	C	D	E	F	G
1	type	goods	style	Size (waist, hips, length, hem) (length and width)	Statistics (waist, hips, length, hem) (length and width)	texture of material
2	the Spring and Autumn Annals	Top up girl	loose coat	Short windbreaker	39 99 63 57	Polyester/polyester fiber, nylon/nylon
3					40 103 64.5 58	
4					41 107 66 59	
5					42.3 112 67.5 59	
6						
7				Long windbreaker	44 100 104 65	Spandex/Lycra, Polyester/Polyester Fiber
8					45 104 105 66	
9					46 108 106 67	
10					47 112 107 68	
11						
12				Jacket		Polyester/Polyester Fiber
13					44.5 110 68 59	
14					46.5 114 70 60	
15					170/92A 48 118 72 62	
16					49.5 122 74 63.5	
17						
18				mlb	52 108 68 58	Polyester/Polyester Fiber
19					54 112 70 59	
20					56 116 72 60	
21					58 120 74 61	
22						
23				Cardigan	36 96 58 54	wool
24					37 101 60 55	
25					38 106 62 56	
26					39 111 64 57	
27						
28				Suit jacket	38 94 50 58	Spandex/Lycra, Polyester/Polyester Fiber
29					39 98 52 59	
30					40 102 54 60	
31					41 106 56 61	
32						
33				Sweatshirt jacket	59.5 128 67 58	Polyester/Polyester Fiber
34					61 132 70 59	
35					62.5 136 73 60	
36					64 140 76 61	
37						
38			Internal construction	Bottom layer shirt (mostly in one size)	160/90 34.5 82 50 59	
39					165/88A 36 98 56 58	
40					170/92A 44 94 58 60	
41						

Figure 1: Statistical Table of Clothing Stacking Sizes Source: Author's self-made

2.2 Parameterized Human Scale Measuring Instrument

In order to better parameterize the design of the wardrobe, the team has developed a human scale measuring instrument. Measuring instrument. It mainly consists of two sets of clamping workpieces that can move freely, simulating different heights of shelves when a person is using a wardrobe. For the impact on the comfort level of clothing retrieval and other actions, a technology device with precision down to millimeters can be configured to accurately calculate the most suitable layer height for users, providing the most comfortable user experience.

2.3 Modular Wardrobe Space Design

Modular design refers to dividing the internal system of an object into modules from top to bottom, reflecting its internal characteristics. The modular design of wardrobes involves breaking them down into smaller sub modules, designing each module independently, and ultimately assembling them into a larger system. Simplify and unify through standardized design principles, and finally combine the specific functions of each part according to the user's various functional usage needs, in order to meet personalized design requirements.

Figure 2: Parameterized Human Scale Measuring Instrument Source: Author's Self Taken

Figure 3: Modular wardrobe designed with NOM+AOD Source: Network

3. Discussion

3.1 Analysis of Four Seasons Clothing Changing Behavior in North China

The analysis of clothing changing behavior aims to analyze the storage needs and specific storage locations of clothing by examining the frequency and location of people changing clothes in the home environment. According to the changes of different seasons within a year and the changes of morning, afternoon, and evening time within a day, people living in different regions will have different clothing changing behaviors. Therefore, adapting to local conditions and individuals, by analyzing physiological differences, gender, age, physical condition, physiological and psychological characteristics, preferences, and other aspects of the human body, summarizing the rules of changing clothes behavior has important guiding significance for wardrobe design.

城 市 City	年平均气温（摄氏度）Annual Average Temperature (℃)	年极端最高气温（摄氏度）Annual Maximum Temperature (℃)	年极端最低气温（摄氏度）Annual Minimum Temperature (℃)	年平均相对湿度 (%) Annual Average Humidity (%)	全年日照时数（小时）Annual Sunshine Hours (hour)	全年降水量（毫米）Annual Precipitation (millimeter)
北 京 Beijing	13.6	37.2	-19.6	56	2285.0	686.5
天 津 Tianjin	13.6	36.9	-19.9	61	2475.1	913.9
石家庄 Shijiazhuang	15.3	39.1	-15.0	58	2889.7	1063.0
太 原 Taiyuan	11.7	37.2	-19.4	58	2214.1	593.3
呼和浩特 Hohhot	7.7	34.9	-30.0	49	2734.3	390.7

Figure 4: Climate Analysis of North China

Source: China Environmental Statistical Yearbook

The spring temperature in North China varies greatly, with significant temperature differences between day and night. The early spring season is relatively cold, and as time goes by, the temperature gradually warms up. The demand for clothing is to balance warmth and lightness. Residents choose to wear warm clothes such as down jackets and sweaters when the temperature is low in the morning and evening, and can change into thin jackets or windbreakers when the temperature rises at noon during the day. For the convenience of adjusting clothing according to changes in temperature [1].

The summer temperature in North China is relatively high, especially during the day when the temperature often exceeds 30 ℃, and in some areas it can even reach over 35 ℃. At the same time, summer is the rainy season in North China, with a lot of precipitation, accompanied by weather phenomena such as thunderstorms and strong winds. The demand for summer attire. Mainly lightweight, breathable, and sun resistant. Residents tend to wear lightweight and breathable clothing, such as T-shirts, short sleeves, shorts, dresses, etc., to dissipate heat and reduce sweat accumulation. At the same time, due to the strong ultraviolet radiation in summer, it is common to choose clothes with sun protection function such as sun protection clothing when engaging in outdoor activities. At the same time, clothing accessories such as sun hats and sunglasses are also chosen to prevent skin damage from ultraviolet rays. In summer, due to high temperatures, residents change their clothes more frequently, which increases the frequency of changing laundry and bathing.

The autumn climate in North China is mainly characterized by coolness, dryness, large temperature differences between morning and evening, and low precipitation. From summer to autumn, residents gradually transition from short sleeved or thin long sleeved clothing to long sleeved shirts and sweaters. Due to the large temperature difference in autumn, residents pay attention to the balance between warmth and breathability when choosing clothes. For example, they wear long sleeved shirts or thin sweaters in the morning and evening, and can pair them with jackets or windbreakers during noon to adapt to temperature changes. In autumn, residents pay more attention to warmth and comfort in material selection, such as choosing wool and cotton clothing similar to spring, in order to cope with the large temperature difference in autumn. Residents in North China adopt layered dressing for changing clothes. It is both warm and easy to adjust clothing according to temperature changes.

The climate characteristics of winter in North China are cold, dry, and often windy and snowy weather. The temperature in winter in North China is low, often reaching the lowest temperature in mid January. At the same time, due to the influence of winter winds, there will be more snow and wind in North China, further strengthening the cold feeling. The primary need in winter is warmth, so residents tend to choose clothes with good insulation properties such as down jackets, woolen coats, and sweaters. In strong wind and snow weather, residents will also choose clothing such as assault jackets, waterproof snow boots, windproof jackets, etc. to ensure that they are not affected by wind and snow during outdoor activities, while internal clothing is often paired with thermal underwear, sweaters, etc. In winter, there is often heating indoors in North China, so residents indoors will take off their jackets and wear thinner and lighter clothing. Finally, due to the lower temperature in winter, the human body is less likely to sweat, and the frequency of bathing and bathing will also decrease compared to summer.

3.2 Analysis of the Movement of Changing Clothes in the Morning and Evening

The analysis of the clothing changing process is to analyze the series of actions that users take from morning till night to change clothes, store and organize clothes, and based on this, analyze the types of wardrobes in different spaces and the required functional zones.

Let's take workdays as an example and start the analysis in chronological order

After waking up in the early morning, users first need to dress and wash up, and then return to the bedroom to undress and change clothes. At this time, the user takes off their pajamas and puts on their daily underwear, such as a base shirt and leggings (if it is in spring and autumn, they may change into autumn clothes and pants) after breakfast and dinner. Users often go out to work, and at this time, they will complete actions such as putting on socks, shoes, and jackets at the entrance, accompanied by some external decoration. For example, hats, sunglasses, etc. (if it is winter, scarves, gloves, etc. may be worn)

When the user returns home at noon, the first thing they need to do is undress and put on their coat and exterior. Place them separately in the entrance cabinet and between the soil. Then have lunch and go out to work after finishing the meal. Complete the actions of putting on socks, shoes, and jackets again at the entrance. (At this time, if it is in spring and autumn, the jacket may be changed to adapt to temperature changes within a day)

When the user returns home in the evening, the first thing they need to do is undress and place their coat and exterior decoration in the entrance cabinet and between the soil. If it is autumn or winter at this time, place the coat and jacket in the secondary laundry area. After washing hands in the bathroom, remove the undershirt and leggings and switch to home clothes or pajamas. The clothes that are changed at this time are mostly placed in the dirty clothes basket.

Figure 5: Analysis of Changing Movement Line
Source: Author's self-made

Time period/action	Detailed description	Precautions/Special Situations
Waking up in the morning	Dressing, washing, and grooming	-
	Return to the bedroom, undress and change clothes	Take off your pajamas and put on your daily underwear, undershirt, and leggings (you may change into autumn clothes and pants in spring and autumn)
After breakfast	Preparation for going out to work	Wearing socks, shoes, jackets, and accessories (hats, sunglasses, etc.) at the entrance (scarves, gloves may be added in winter)
Go home at noon	Strip placement	Take off your coat and exterior, and place them separately in the entrance cabinet and the dirt room
	Lunch and dining	-
	Get ready to go out to work again	Wearing socks, shoes, and jackets in the entrance hall (jackets may be changed in spring and autumn to adapt to temperature changes)
Go home in the evening	Strip placement	Take off your coat and exterior, place it in the entrance cabinet and the dirt room (autumn and winter coats may be placed in the secondary dressing area)
	Wash hands in the restroom	-
	Change into home clothes/pajamas	Take off the undershirt and leggings, change into home clothes or pajamas, and put the clothes in the dirty clothes basket

Figure 6: Analysis Table of Clothing Changing Behavior
Source: Author's self-made

3.3 Parametric Analysis of Clothing Stacking

For lightweight clothing such as T-shirts and shirts, they can usually be folded in half along the centerline, and then folded in half along the cuff direction to form a rectangular block. This stacking method not only saves space but also maintains the cleanliness of clothing. The size after stacking is approximately 30 centimeters long and 25 centimeters wide, and the thickness varies depending on the clothing [2].

Close fitting clothing such as undershirts and leggings can be adjusted and folded according to their actual size. Generally speaking, the length after stacking is about 33 centimeters, the width varies depending on the clothing, and the thickness also varies depending on the material and thickness of the clothing. Thick clothing such as sweaters can be stored flat and folded or rolled up to avoid deformation and reduce space occupation.

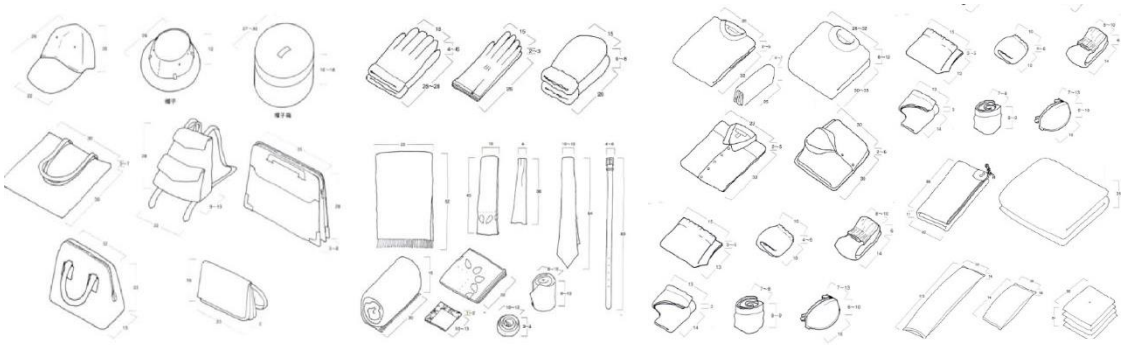

Figure 7: Partial analysis of clothing stacking dimensions
Source: self-made by the author

Clothes Type	Stacking height (cm)	Stacking width (cm)	remarks
Pants (regular)	15~20	25~35	When stacking pants, pay attention to aligning the legs to avoid creases
Pants (long pants, thick)	20~25	25~35	Thick pants have a slightly higher height when stacked, but the width changes little
shorts	10~15	20~30	Shorts are stacked at a lower height and have a width similar to pants
Sports pants	15~20	30~40	The material of sports pants is relatively soft, so it is important to maintain the shape when stacking them

Clothes Type	Stacking height (cm)	Stacking width (cm)	remarks
Shirt (regular)	10~15	35~45	The shirt is relatively thin, so pay attention to keeping it flat when stacking
Shirt (thick)	15~20	35~45	Thick shirts stack slightly higher in height
T-shirt (Summer)	5~10	30~40	Summer T-shirts are lightweight and have a lower stacking height
T-shirt (long sleeved)	10~15	30~40	Long sleeved T-shirts are slightly thicker than summer T-shirts and have a slightly higher stacking height
Coat (short)	15~20	40~50	When stacking short jackets, pay attention to maintaining the shape
Coat (long)	20~30	40~60	When stacking long jackets, the height is higher and the width increases accordingly
Sweater (thin)	10~15	35~45	When stacking thin sweaters, it is important to avoid excessive compression
Sweater (thick)	15~25	35~45	Thick sweaters have a higher height when stacked, but the width changes little

Clothes Type	Stacking/Storage Height (cm)	Stacking/storage width (or diameter, cm)	remarks
Underwear (regular)	5-10 (stacked)	10-20 (width of individual underwear)	Underwear is relatively thin and can be stacked in multiple layers
Underwear (thick)	10-15 (stacked)	10-20 (width of individual underwear)	Thick underwear has a slightly higher height when stacked, but the width changes little
Socks (regular)	5-10 (stacked or storage box)	5-10 (length or diameter of individual socks)	Socks can be stacked in pairs or stored in a sock storage box
Socks (thick)	10-15 (stacked or storage box)	5-10 (length or diameter of individual socks)	Thick socks have a slightly higher height when stacked, but the width changes little
necktie	5-10 (rolled up)	5-15 (tie width)	Tie can be rolled up for storage, saving space
scarf	10-20 (stacked or rolled up)	30~60 (scarf width)	Scarves can be stacked or rolled up for storage, depending on the size of the scarf

Clothes Type	Stacking height (cm)	Stacking width (cm)	remarks
Half length skirt (short)	10~15	30~40	The short skirt has a low height and moderate width when stacked together
Half length skirt (mid length)	15~20	35~50	The height of the mid length skirt is slightly higher when stacked, and the width also increases accordingly
Dress (short)	15~20	40~60	When stacking short dresses, pay attention to keeping the hem flat
Dress (long)	20~30	40~60	Long dresses have a higher height and wider width when stacked together

Figure 8: Statistical Table of Clothing Stacking Sizes
Source: Author's self-made

The size after stacking varies depending on the size and thickness of the sweater, but usually the length and width do not exceed 30 centimeters. When stacking pants and skirts, it is recommended to fold them in half along the centerline and then roll them up along the hem or skirt direction. This stacking method not only saves space, but also maintains the neatness of the pants and skirt. The length after stacking is about 40 centimeters, the width varies depending on the width of the pants/skirt, and the thickness also varies depending on the clothing. If space permits, it is recommended to hang and store heavy clothing such as jackets and jackets to maintain their shape. If stacking is necessary, ensure that it is neatly stacked to avoid deformation. The size after stacking varies depending on the size of the clothing, but usually the length and width are relatively large. Coats, windbreakers, and other long jackets are recommended to be hung and stored due to their long shape and tendency to wrinkle [3]. If it is necessary to stack, try to avoid prolonged stacking to avoid affecting the shape of the clothing. When stacking, the stacking method can be adjusted according to the actual size of the clothes. Small

items such as underwear and socks can be stacked in pairs or by category for easy storage and retrieval. The size after stacking varies depending on the size and material of the clothes, but they are usually relatively small.

4. Fine Design Strategy for Wardrobes

4.1 Functional Module Design Based on Ergonomics

The advantage of modular design in wardrobes is that they can be customized according to the needs of different users and the characteristics of different layouts. This not only reduces the usage space, but also provides users with a personalized aesthetic experience in terms of aesthetics. Modular design can enable large-scale mass production of a single product, reducing production time and labor costs, while also reducing production costs. The combination design between modules allows for free assembly, easy disassembly, and the ability to replace individual modules and recycle them, reducing resource usage costs and extending the lifespan of the wardrobe [4].

The ergonomic wardrobe design fully considers human scale and usage habits, ensuring comfort during use. For example, the height design of the hanging area will take into account the user's height to ensure that long coats, dresses, and other clothing can be easily hung up, avoiding inconvenience caused by excessively high hanging areas. At the same time, the height of the stacking area and drawer area will be reasonably set according to ergonomic principles, making it convenient for users to organize and retrieve clothes [5].

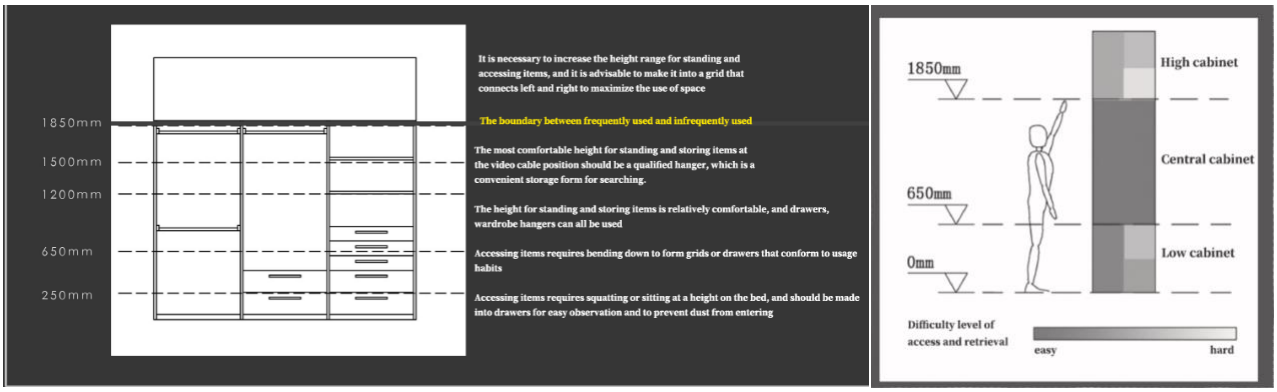

Figure 9: Ergonomic Dimensional Analysis in Cabinet Interaction

Source: Author's self-made

Hanging area: The hanging area is a very important part of the wardrobe, suitable for hanging clothes such as jackets, coats, suits, skirts, etc. that need to maintain their shape.

Long clothing area: used for hanging long coats, dresses, and other long clothing, with a height set between 1.4 and 1.8 meters, which can be adjusted according to the height of family members.

Short clothing area: used for hanging short clothes such as shirts and jackets, with a height of about 0.9 to 1.2 meters.

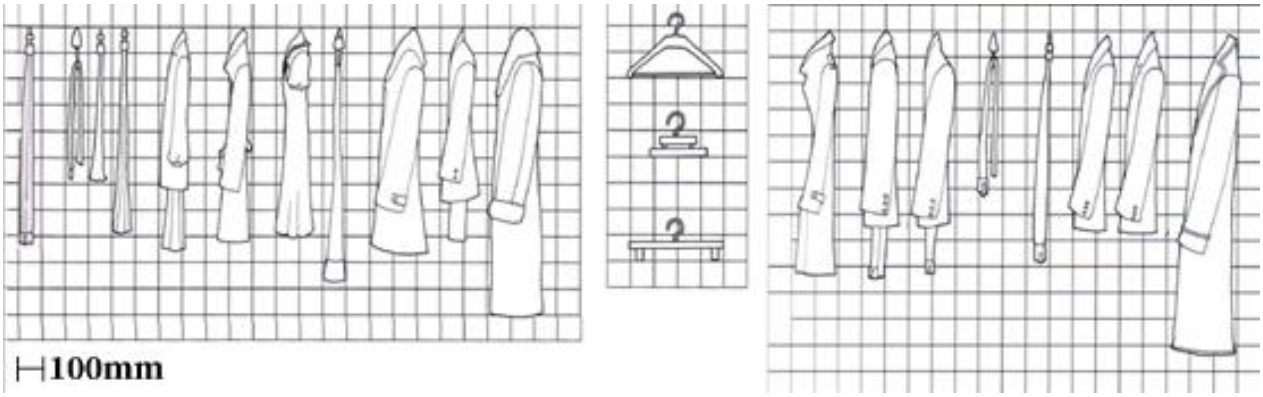

Figure 10: Schematic diagram of reference dimensions for some clothes in the hanging area

Source: self-made by the author

Pants rack area: Set up a dedicated pants rack with a height of 0.8 to 0.9 meters and a suitable width, which can hang multiple folded pants.

Stacking area: The stacking area is suitable for placing foldable clothing such as T-shirts, shirts, sweaters, etc. Different sizes of stacking compartments can be set according to the type and size of clothing. Smaller stacking compartments can hold small items of clothing such as underwear and socks; Larger stacking compartments can accommodate thicker clothing such as sweaters and T-shirts. Used for stacking sweaters, pants, handbags, and other items. The height of the stacking area should be between 0.3 and 0.5 meters for easy access. Use storage boxes or drawers to further divide the space, improve space utilization, and create classification labels.

Drawer area: The drawer area is usually used to store small items such as accessories, ties, scarves, etc. Different sizes of drawers can be set according to the size and type of items. A

divider can also be installed inside the drawer to better classify and store items.

Used for storing small items such as underwear, socks, jewelry, etc. The height of the drawer should be designed according to the size of the item, and the height of a regular drawer is generally around 19 centimeters. Drawer dividers can be used to further divide drawer space and make items more organized [6].

Special storage area: If there are special needs, such as storing large items such as suitcases and bedding, a special storage area can be set up in the wardrobe. These areas can be customized according to the size and shape of the items to ensure that they can be stored neatly and orderly. Used for storing large items such as seasonal clothing and bedding. This area is usually located at the top or bottom of the wardrobe, arranged according to the design of the wardrobe. You can use storage tools such as barnacles to store seasonal clothes, which not only saves space but also prevents moisture and dust [7].

Figure 11: Actual application of drawer area, stacking area, and special seasonal storage area
Source: self-made by the author

4.2 Seasonal Adjustment

Spring and Summer:

Place lightweight clothing such as short sleeves, shorts, skirts, etc. in an easily accessible location, such as the upper layer of the hanging or stacking area.

Collect heavy winter clothing such as coats, down jackets, etc. into the storage area or at the bottom of the wardrobe.

Autumn and Winter:

Place heavy clothing such as sweaters, coats, down jackets, etc. in an easily accessible location.

Put summer lightweight clothing into the top of the storage area or wardrobe.

5. Conclusion

In the future, the market for panel cabinet furniture still has broad development space. In the design and development stage of products, standardization, scaling, and disassembly of production and manufacturing should also be fully considered. With the continuous improvement and development of the theory of refined wardrobe design, wardrobe design is gradually shifting from standardization to standardization + adjustability. The refined wardrobe design based on changing behavior has a significant driving effect on improving the actual user experience, meeting personalized needs, and enhancing the storage efficiency of wardrobe space.

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