

Researching the modular design of beauty products for home use

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Abstract: According to the relevant data, the current beauty products market segment is substantial, and the increasing demands of women for personal care have made it essential to purchase beauty products suitable for all body parts in order to achieve optimal care effects. This study utilizes the modular design concept, a green design application, to conduct functional cutting designs for beauty products such as beauty instruments, eye beauty instruments, water light instruments, and scraping instruments. Based on target group research and in combination with the functional characteristics of beauty products, an optimized design scheme for home beauty products is provided.

Keywords: Home Beauty; Product Design; Modular Design; Intelligent Design

1. Introduction

Since the 1960s, with the rapid development of industrialization, people's lives have changed from the era of scarcity to the era of excessive consumption. A large number of homogeneous goods are flooded into our lives, leading to increasingly serious problems such as environmental pollution, resource waste and ecological imbalance. In this case, green design emerged at the historic moment. The concept of green design and sustainable design makes design a link between human and nature, and gives us a space to think about how to achieve a benign balance between the two. This study takes the design of modular home beauty products as a practical case, and puts forward the view that product design can effectively achieve a benign balance between resources and resource use^[1].

2. Related work

With the rapid development of China's economy and the increase in residents' disposable income, the scale of China's home beauty instrument market is also expanding. According to statistics, it rose from 3.82 billion yuan in 2017 to 9.76 billion yuan in 2021, an increase of 19.9 percent compared with 2020. In the future, the market is expected to continue to grow with the further increase in the penetration rate of home beauty devices in China.

According to Jingdong International data from January to October 2022, the proportion of functional products in the home beauty product segment is relatively uniform, indicating that there is a consistent target demographic for beauty products with various functions and suggesting potential for users to purchase multiple products with different functions. This underscores consumers' inclination towards multifunctional solutions.

From a resource utilization perspective, modular design has significant practical implications within this context as it can better cater to diverse consumer needs while extending product life and reducing resource waste. Therefore, amidst the rapid expansion of China's home beauty instrument market, promoting modular design transformation within home beauty products holds positive significance and potential for sustainable growth.

2.1. Research status at home and abroad

The concept of "Module" originated in the German machinery industry in the early 20th century. The so-called "modularity" means that "semi-autonomous subsystems (modules) are associated with other subsystems according to certain rules to form a more complex system or process." In his book Design

Methods and Application of Modularity Principle, Professor Tong Shizhong explained that modularity is a study on system levels, which sorts out the functions of each level in the system, and then breaks down the sub-levels serving different functions, and thus establishes the final target product of the module system, which is the result of the selection of modules and the design combination. In addition, the book also mentions the application of modularity in machinery, electronics, ships, construction, electricity, products etc. [2]. Starr defines modularity as a component that can be individually designed, manufactured, and realized through different combinations of patterns. He believes that module is basic unit for systems (products), should have independent function, standardized interfaces, interchangeable characteristics. In their book *Design Rules - The Power Of Modularity*, Karlis Baldwin and Kim Clark also pointed out that "module" refers to large systems has its own structure and function, and each element is independent but interrelated[3]. In product design, Fuhua wang designed modular travel tool Troval, the handle part composed by three black accessories, top electric toothbrushes, three different types shaver heads ,also can change into flashlight light source when needed. In addition, the handle can accommodate USB charging cable, charging plug inside[4]. In clothing design field, clothing brand Tsumori Chisato introduces modular jackets can be stitched together .Each "module" such as sleeves, trouser legs ,neckline individually designed ,each module connected by zippers buttons, freely combined according user needs. Under premise give full play user autonomous ability, module design better reflects designer's concept. Modules broken down while maintaining relatively consistent style. As shown in Figure 1.



Figure 1: Modular travel tool Troval (left) Tsumori Chisato Detachable Jacket (right)

The world's first home "beauty device" is the loofah, a pure natural tool used for personal body and face cleaning. Subsequently, sponges and other skin-cleaning tools gained popularity worldwide. With technological advancements driven by big data and consumer upgrades, home beauty equipment has become increasingly high-tech. The introduction of beauty equipment often involves new scientific and technological terms such as pulse, radio frequency, photon therapy, virtual reality simulation, etc., taking advantage of the rise and popularity of the internet era.

From 2015 to 2021, China's cosmetics industry has experienced rapid development with diverse participation from brands. This trend can be mainly categorized into five sources: European and American brands including Colleilee and Ferrol; rising Israeli brand Tripollar; Japanese and Korean brands such as YA-MAN, ReFa, Hitachi ARTISTIC&CO; Swedish brand FPREO which launched the Luna cleanser in 2013 triggering a new revolution in beauty care; Miniso's launch of a cleanser priced at 29.9 yuan in 2018 which sold over 1 million units that year. As shown in Figure 2.



Figure 2: Ferrol Facial cleanser (left) Mingchuang Youpin Facial Cleanser (right)

The year 2015 marked a turning point for FOREO, as the company achieved significant success and numerous brands recognized the immense potential of the Chinese beauty device market. As a result, companies such as Panasonic, Yamue, Refa, and others also introduced their beauty products into China.

According to Effervescent VCR, "Ameng's revenue in China grew at a rate of 17.9 percent from 2016 to 2019. In just three years, the Chinese market accounted for more than 15% of the company's revenue. As of 2019, the company's revenue in the Chinese market reached 267 million yuan, accounting for 20% of the total revenue." It can be said that this period is considered as the golden age of beauty equipment; besides Ameng, other high-end brands such as Pu Chu and Zeus have also entered China. As shown in

Figure 3.



Figure 3: Displays the most popular beauty instruments categorized by brand.

In their research on "Modular Design of Beauty Instruments", Wei Hao, Wang Fenghua^[5] and their colleagues proposed a modular approach to the design of beauty instruments. This approach involves breaking down the overall functionality of the instrument into smaller modules, allowing for easier management and combination of different functions. They outlined the steps for achieving functional decomposition as follows: (1) acquisition of user requirements; (2) determination of functions; (3) functional decomposition; (4) division of function modules; and (5) evaluation and adjustment of functional module division. The concept of combining various functional modules in this design is valuable for reference in similar research. However, the method for replacing consumables through threaded structures may not be suitable for home beauty products. Therefore, further study will focus on designing how to replace modular functional modules based on product usability. As shown in Figure 4 and 5.

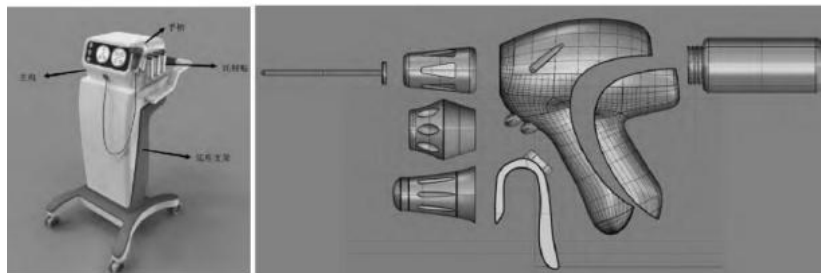


Figure 4: Overall effect of beauty instrument Figure 5: Function module breakdown of the handle

The continuous development and improvement of production have led to a shift in people's requirements from mass production to individualization and diversification. As a result, many manufacturing enterprises are placing great emphasis on aligning design and production with customer needs in the shortest possible time. In today's market, the increasing demand from customers can be effectively addressed through a modular approach. Modularity enables rapid product design, meeting customer needs while also reducing design cycle times, cutting production costs, and enhancing enterprise competitiveness^[6].

2.2. Revised sentence: Survey of home beauty product users

According to the 2022 White Paper on Women's Fine Aesthetics, the target demographic for Fine Aesthetics includes individuals aged 18-45 who regularly participate in skincare, cleaning, makeup, and related activities. The nationwide report surveyed 1,618 participants and revealed that Chinese consumers demonstrate a strong willingness to invest in high-tech skincare products. Additionally, 70% of respondents believe that functional skincare technology possesses significant barriers to entry and cannot be easily replaced. Furthermore, 40% are open to increasing their investment in "technology" for functional skincare products. Nearly 80% of respondents reported using beauty devices more than twice a week; specifically, 80% for facials and 60% for eye and neck treatments. These findings indicate that respondents maintain stringent standards for personal care, necessitating the purchase of various beauty products tailored to different body parts.^[7]As shown in Figure 6.

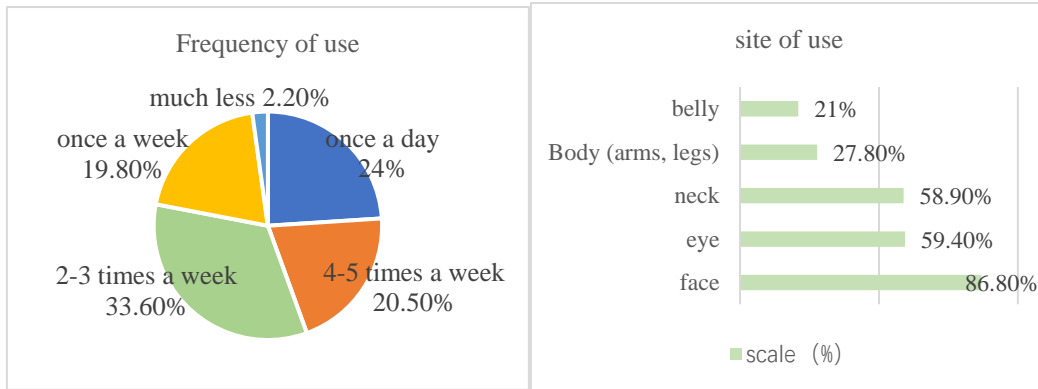


Figure 6: Users' use of beauty devices in "White Paper on Delicate Aesthetics of Women 2022"

In the majority of survey participants, there is a diverse and evident demand for efficacy in beauty instruments. Almost half of the respondents believe that one of the pain points with beauty products is the lack of obvious efficacy. There are both objective and human factors contributing to this lack of effect.

According to the data, some buyers of beauty instruments do not fully understand their functional principles, usage steps, or operation techniques, leading to improper use which significantly reduces skincare effectiveness and may even have negative effects. Another significant factor is the difference between facial skin and eye skin, resulting in unsatisfactory outcomes when using beauty instruments for eye care. The skin around the eyes is approximately a quarter as thick as facial skin and has only about half as many sebaceous glands. Additionally, it has fewer sweat glands and sebaceous glands than facial skin, lower collagen content, insufficient moisturizing ability, increased susceptibility to damage and fine lines due to less collagen and elastic fibers in its dermis. Furthermore, frequent blinking (over 20,000 times per day) combined with prolonged exposure to electronic devices can lead to fatigue and laxity in eye skin. As shown in Figure 7.

Given these differences between facial and eye skin characteristics, it is clear that separate care instruments are necessary for each area in order to achieve optimal skincare results. Therefore this study conducted a functional modular design approach for beauty products based on these findings.

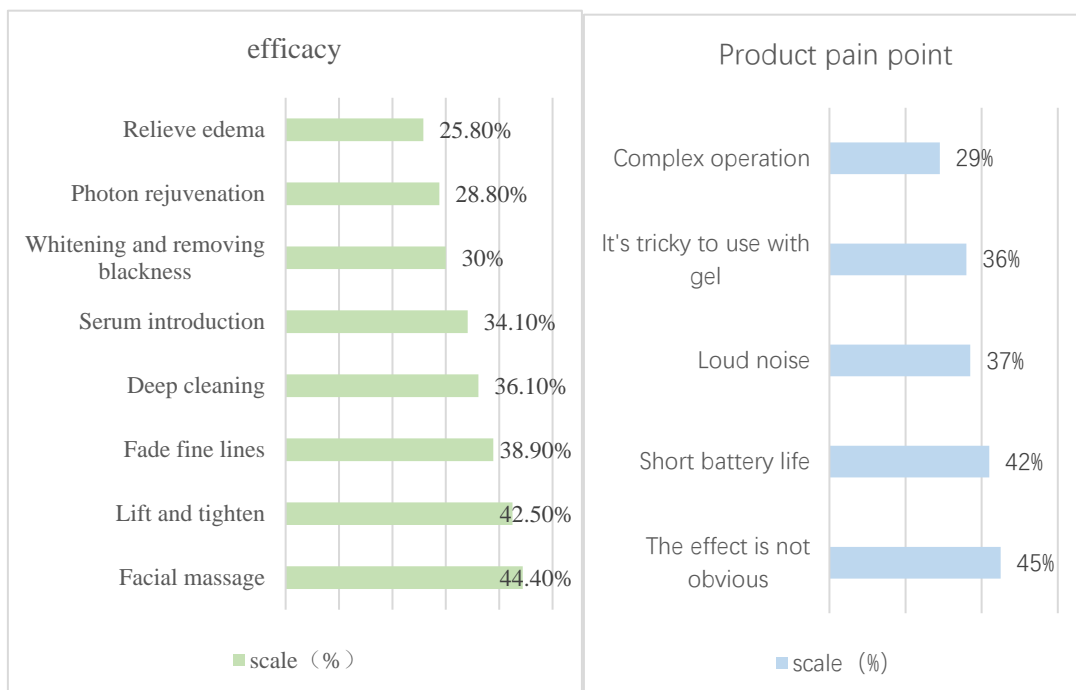


Figure 7: Beauty product needs of users of the White Paper on Delicate Aesthetics for Women 2022

2.2.1 User journey map

To gain a more comprehensive understanding of users' needs and pain points in the process of using products, such as home beauty products, the user's daily use of beauty products is analyzed, their behavior

path is visualized, and a complete user journey map is constructed [8], as depicted in Figure 8. According to the observation, women's skincare process is generally divided into two stages: cleansing and treatment. The analysis of various stages reveals that the motivation for skincare is driven by poor skin condition, and most women prefer efficient and simple skincare routines, which can be met by home beauty products.

Taking facial care as an example, users need to use cleansers and other products in the cleansing stage. Analysis of usage scenarios and environments indicates a requirement for waterproof and easy-to-clean products. In the treatment stage, data survey shows significant differences in attributes between facial and eye skin, requiring targeted beauty care products.

Upon completion of each treatment stage, users experience a sense of satisfaction. By analyzing user behavior behind their motivations, thoughts, emotions, combined with existing beauty products usage patterns; exploration was conducted around simplifying product usage through modular design of various home beauty products.

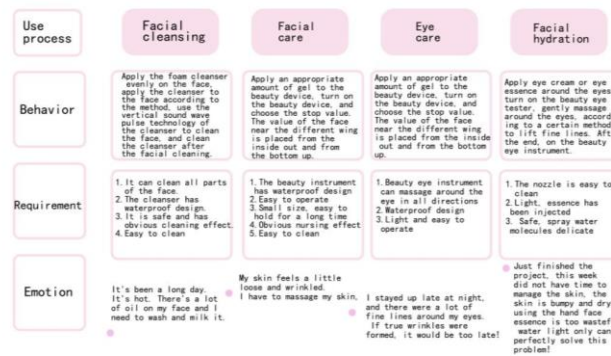


Figure 8: User journey map

2.2.2 Competitive product analysis

According to the user demand positioning in 2.2.1, we have identified and analyzed the pain points of users, as well as conducted a comparative analysis of the sales of beauty products on e-commerce platforms such as Taobao and Jingdong. Based on this analysis, we have selected several beauty products with strong sales and reputation for competitive analysis. Utilizing SWOT analysis, we have outlined the strengths, weaknesses, opportunities, challenges, and design trends of these beauty products. As analyzed in Table 1.2.3.4.

Table 1: Analysis of competing products of beauty instruments

Product picture					
Name	Find light ARF001A	YA-MAN MAX II	Very cute M12	Flower to Pro	Morpho Zeus
Technology	Radio frequency Micro current Infrared light Red light				Radio frequency Micro current Electrical pulse Tricolour light
Efficacy	Firming light lines Lift outline Rejuvenating muscle base Lighten skin tone				
Electrode tip	6 triangular pieces	6 lobes	12 lobes	Six rings	6 lobes
Shape	Rounded triangular prism	Runway circle	Smooth iron shape	cylindrical	Organic cylinder
Materials	Titanium Platinum gild				
Hue	Matte black	Matte black	Aurora red Luxury joaquin	Matte black	Champagne gold Hoary Moon Silver

Table 2: Analysis of competitive products












Product picture					
Name	YA-MAN ACE Eye	Boxury	TriPollar Miracle Young	dr.arrivo Vegas2	soulink
Technology	Radio frequency Micro current	Radio frequency Micro current Temperature control, waterproof	Radio frequency temperature control	Micro current, pulse, red light	Radio frequency, micro current
Efficacy	Firming around the eyes Fade eye lines	Light eye lines, eliminate eye bags, fade dark circles	Fade fine lines, thermal massage	Tira skin rejuvenation	Activate collagen and fade fine lines
Electrode tip	Toroidal sheet	4 grains spherical	4 grains spherical	4 round pieces	4 round pieces
Modality	Cylindrical cut	Petal columnar shape	Angular column shape	knife-like shape	ellipsoid
Materials	Titanium, platinum, gold plated, ABS				
Hue	Gradient metallic blue	Colored pearlescent	Matte black	Champagne gold	Colored pearlescent

Table 3: Analysis of competitive products of Gua Sha board

Product chart			
Name	Zdeer intelligent scraping board	Crippleddol stone needle push and scrape rod	AUX craping instrument
Technology	Vibration, temperature control		Magnetic wave resonance, temperature control, red light
Efficacy	Massage, scraping, hot compress	Warm channels to drive away cold, warm and nourishing channels and collaterals	Fade fine lines, thermal massage
Shape	Oblateness	Oblate cylindrical combination shape	Oblate ellipse combination
Materials	Stone needle, ABS		
Hue	Plain white	Plain white	Emerald green

Through market analysis of popular home beauty products, it is evident that most beauty instruments feature a raised electrode head with a predominantly columnar shape. However, brands such as Very Cute and Find Light have ventured into organic forms with recognizable products like the Very Cute M12 and Find Light collagen cannon, indicating potential for further exploration in beauty instrument design. Consumer preference leans towards noble and elegant styles, characterized by the extensive use of frosted black, champagne gold, and a mix of metal and plastic materials. These instruments typically boast smooth organic shapes with delicate colors and subtle effects like gradual transitions and pearl luster. Gua Sha instruments vary significantly in shape due to different usage scenarios; white is commonly used to convey simplicity and elegance associated with "health preservation" or Zen aesthetics. Water light meters opt for white and silver hues for professional recognition while Moranti color schemes and artistic patterns emphasize visual appeal.

Table 4: Analysis of competing products of water and light instrument

Product chart			
Name	BIOLAB hydractinometer	GX.DIFFUSER Oxygen injector	MEIBOYI Oxygen injector
Technology	Aqua Atomization Shine Fog light	Constant pressure nanojet	Nano atomization, micro current, LED red light
Efficacy	Deep absorption, more water light	Nano water refill ,oxygen injection skin	Moisturizing and rejuvenating skin
Shape	Organic form	Cylindrical airbrush shape	One piece airbrush shape
Materials	ABS, PC, 316 metal	Stainless steel, ABS	ABS
Hue	White, metallic silver	Emerald green, very low blue, sandy purple	Pearl white, frosted powder, bright flour, star black

2.3. Research on home beauty product design

2.3.1 Design orientation

This home beauty product is designed for women aged 18-35 with a consistent beauty and skincare routine. The modular design of the beauty instrument, beauty eye instrument, water light instrument, scraping instrument, and other functional modules allows for different product functions to be achieved through the combination of basic modules, making home beauty products more convenient and resource-efficient.

2.3.2 Usage scenario analysis

According to the characteristics of the target population, the use of beauty products in daily life can be primarily categorized into home and outdoor settings. The main usage locations include powder rooms, bedrooms, hotels, and other similar environments. With changing usage scenarios, users may have the need to carry these products outdoors; therefore, beauty products should possess lightweight and portable features. Additionally, a modular design concept with detachable components allows for flexible structural changes to achieve convenient portability.

2.3.3 Analysis of use links

From the perspective of user demand analysis, the requirements for beauty products from users are concise, scientific, and safe. In order to reduce user time during usage, simplified design can be implemented in the product usage process. This can mainly be reflected in three aspects: First, through product modular design, unnecessary parts can be selectively omitted during use and assembly of necessary parts can be expedited. Second, key instructions should be as simple as possible by integrating switch and mode switching functions into one key to simplify user operation and enhance user experience. Third, a temperature recognition module should be added to automatically shut down the machine when the temperature exceeds a certain standard to prevent low-temperature burns.

2.3.4 Design of beauty products for "Four Seasons" home.

During the initial design phase, the product underwent a brainstorming process. Drawing from the concept of modular design, detailed descriptions were provided for the appearance, structure, function and usage status of home beauty products. These descriptions served as the basis for selecting schemes for further in-depth design, as illustrated in Figure 9. Through the redesign of its appearance, combined with product packaging and storage, explore the appearance structure in line with female aesthetics and ergonomics.^[9]As illustrated in Figure 10.

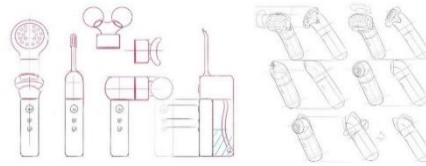


Figure 9: Modular design sketch of personal care products

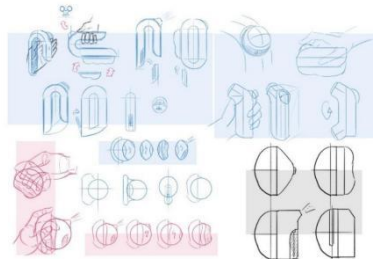


Figure 10: Product form brainstorming

The design scheme was refined based on sketching, with assistance from Rhino7 for modeling, as depicted in Figure 11. Market research results indicated that dark color combinations convey elegance and generosity, while metal gradient colors evoke a sense of technology and the future. Additionally, light luxury Morandi color matching highlights nobility. After careful consideration and discussion regarding product characteristics and user preferences, four vibrant and elegant color combinations were selected. The inspiration for the "Four Things" comes from Tao Qian's "Traveling Oblique River," which describes a serene spring day where friends gather to appreciate beautiful scenery. The "Four Things" refers to four modular beauty products designed to understand and meet users' needs while accompanying them through enjoyable experiences. As illustrated in Figure 12.

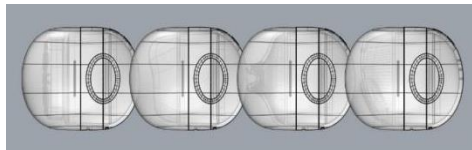


Figure 11: Product modeling



Figure 12: "Four things" series of home beauty products

The facial care module is named "Snow", inspired by Xue Zhaoyun's "Wanxisha": "More than enough to hate the country and the city, how many red tears cry Gusu, leaning on the wind and looking at the snow skin." The shoulder and neck module is named "Moon", the stone in the module comes from outer space, which can not help but remind people of the moon, and the moon is often used as a symbol of purity, which coincides with the semantics of the product. The skin moisturizing module is "Haze", Bai Juyi's "Twenty Rhymes for Summer Newly Planted Bamboo by Secretary Lu" says: "Before night, the green haze enters, and the first autumn dew group." The "haze" is the mist in the mountain forest, which reflects the natural and refreshing mist sprayed by the product. The eye care module is "Willow", implying that the product can bring users eyebrows and eyes like willow. As illustrated in Figure 13.



Picture 13: Four Scenes of Snow, Moon, Mist and Willow

2.3.5 Product size exploration

Measurement Item	percentile	18~60 years old (male)							18~55 years old (female)						
		Age group	1	5	10	50	90	95	99	1	5	10	50	90	95
Hand length		164	170	173	183	193	196	202	154	159	161	171	180	183	189
Hand breadth		73	76	77	82	87	89	91	67	70	71	76	80	82	84
Index finger length		60	63	64	69	74	76	79	57	60	61	66	71	72	76
Index finger proximal knuckle width		17	18	18	19	20	21	21	15	16	16	17	18	19	20
Index finger distal knuckle width		14	15	15	16	17	18	19	13	14	14	15	16	16	17

Figure 14: Basic hand size in Human Body Size of Chinese Adults

The size of the product should fall within a moderate range. Being too small may hinder force application and result in excessive local pressure, while being too large may compromise stability and hand force. As illustrated in Figure 14. The final determination of the product size was based on the five basic hand sizes of female adults (18-60) as specified in GT/T10000-1988^[10], as shown in Figure 15.

The finger grip notch design takes into consideration the hand position when holding the product, enabling improved grasp during use. The grooves are strategically located at the joints of the modular design to provide lateral resistance for easier disassembly and reassembly of other modules, as depicted in Figure 16.

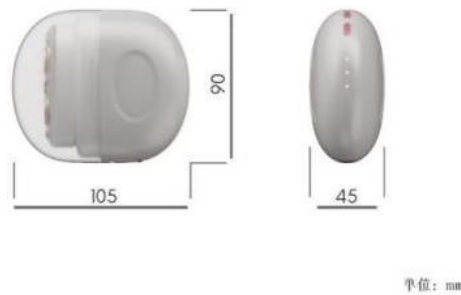


Figure 15: Product dimensions

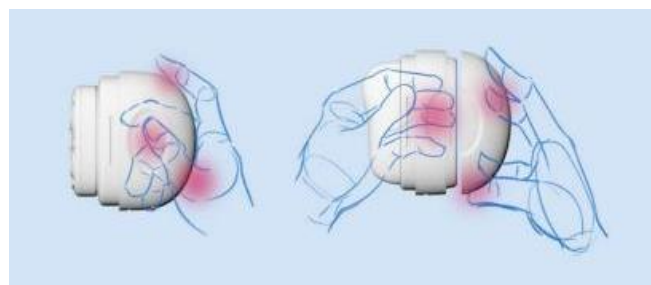


Figure 16: Product ergonomic design

2.3.6 Design display

The product is divided into four modules: facial care, shoulder and neck care, skin hydration, and eye care using the modular concept. These modules are connected to the base module through sensing components, with a buckle design between the functional module and the base module. The functional module can be easily replaced by pressing the connection key, thus enhancing the efficiency of skincare. As depicted in Figure 17.

The facial care module "Snow" integrates two modes of cleansing and skincare, allowing the product to be used with various mediums for skin cleansing and maintenance. The shoulder and neck care module "Moon" utilizes stone needle trace elements to generate heat, deeply nourishing the skin while promoting relaxation of the body and mind. As depicted in Figure 18. The skin moisturizing module "HAZE" features a sleek design, enabling easy insertion of essence for enjoying fine small molecules of hydration. The eye care module "Willow" is equipped with a dual electrode head to enhance skincare efficiency, while its raised contact head allows users to perform comprehensive eye area skincare from any angle. As

depicted in Figure 19.

To facilitate easy cleaning of the storage box, a magnetic module is incorporated into the bottom of the product design, saving users time after their skincare routine.^[11]As depicted in Figure 20.

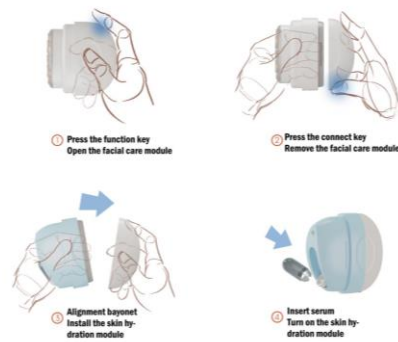


Figure 17: Use flow chart

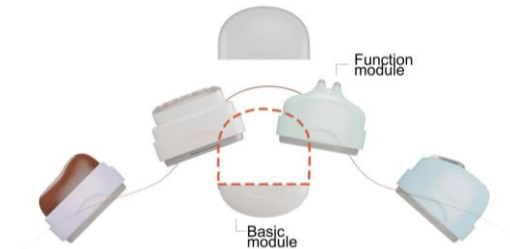


Figure 18: Module composition

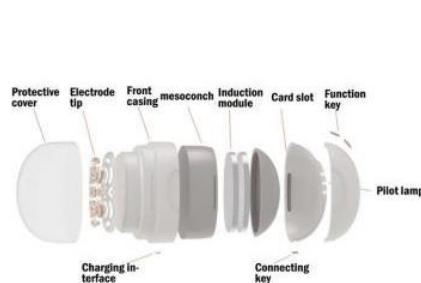


Figure 19: Product explosion diagram



Figure 20: Product storage box

3. Results and discussion

Through the modular design of home beauty products, the market segment of beauty products is simplified, which provides a new thinking direction for solving the need for more personalized and diversified development of products. While meeting the needs of users, the design cycle is shortened to a certain extent and the production cost is reduced. According to the results of user survey analysis, the design of "four things" home beauty products makes their skin care more professional, more convenient and more efficient, and the modular design reduces the cost of their experience of various high-tech beauty products. The decline in the cost of experience will expand the audience of home beauty products, so as to increase the public's trust in home beauty products, which is conducive to the promotion of high-tech beauty products and the improvement of public acceptance.

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