

Research on Ice and Snow Sports Glove Design Based on the KANO Model

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Abstract. With the continuous popularization trend of ice and snow sports, the scale of crowds participating in winter outdoor sports such as skiing and ice skating keeps expanding. However, the decline of human terminal circulation capacity under low-temperature environments causes hands to become stiff and flexibility to decrease, which affects sports safety and experience quality. Traditional winter sports gloves mainly focus on thermal insulation performance, but they still have deficiencies in joint movement, operation flexibility and intelligent auxiliary aspects. This paper takes young ice and snow sports participants as the research object, introduces the KANO model to conduct classified research on user demands, identifies basic demands, one-dimensional demands and attractive demands in ice and snow sports glove design through user interviews, competitive product analysis and demand attribute evaluation. On the basis of demand analysis, combined with flexible materials, ergonomics and intelligent temperature control technology, a design scheme of ice and snow sports gloves integrating flexible joint auxiliary structure and active heating system is proposed. Research results show that users' core demands for winter sports gloves not only concentrate on thermal insulation performance, but also pay attention to hand movement freedom, wearing comfort and intelligent experience. Among them, active temperature control, flexible joint support and precise fitting become important design directions to improve user satisfaction. This research provides references for user demand transformation and product innovative design of ice and snow sports equipment.

Keywords: KANO Model; ice and snow sports equipment; intelligent gloves; user demand; product design; ergonomics.

1. Introduction

In recent years, driven by the continuous advancement of the National Fitness Strategy and the social influence brought by the Winter Olympics, ice and snow sports have gradually entered the mass leisure consumption field from professional competitive sports. The development of the ice and snow sports industry not only promotes the growth of the sports equipment market but also puts forward higher requirements for humanized design of equipment products. Relevant studies point out that China's ski equipment industry is still in a stage of rapid development, and there is room for further improvement in product innovation capacity and high-end equipment research and development [1].

During ice and snow sports, the hand, as an important human operation part, needs to complete movements including holding ski poles, adjusting equipment and controlling body balance. Nevertheless, low-temperature environments reduce peripheral blood circulation, decreasing finger mobility and impairing sports performance. Current winter sports gloves on the market mainly adopt thick thermal insulation materials to enhance cold resistance, yet some products feature heavy structures that reduce finger flexibility, failing to meet young sports users' comprehensive demands of "thermal insulation + free movement". As users' consumption demands shift from function satisfaction to experience optimization, product design needs to pay more attention to implicit user demands. As a user demand classification tool, the KANO model can classify user demands by analyzing the non-linear relationship between satisfaction and different product attributes, thus helping designers clarify the priority of product functions. In recent years, the KANO model has been widely applied in product development and service design fields to improve the accuracy of demand

identification. Relevant studies combine user feedback data with the KANO model to classify and analyze the importance of product demands, providing a basis for design decision-making [2].

Therefore, this paper takes ice and snow sports gloves as the research object, establishes a user demand analysis path through the KANO model, and explores design strategies of intelligent sports gloves suitable for young mass ice and snow sports scenarios.

2. Winter Outdoor Sports Design Path Based on the KANO Model

2.1. Overview of the KANO Model

As user demands gradually shift from single function satisfaction to comprehensive experience improvement, traditional product development methods dominated by designers' experience struggle to accurately identify users' real demands. Hence, in modern product design research, how to scientifically acquire user demands and realize effective transformation from demands to design elements has become an important research direction for improving product competitiveness.

Proposed by Japanese quality management scholar Noriaki Kano in 1984, the core idea of the KANO model is to classify and evaluate user demands by analyzing the non-linear relationship between product functional attributes and user satisfaction. Compared with traditional demand analysis methods, the KANO model not only focuses on "what users need", but also on the differing impacts of satisfaction degree of various demands on user satisfaction.

According to the correlation between demand attributes and user satisfaction, the KANO model generally divides user demands into five categories: (1) Must-be Quality Demands Must-be quality demands refer to basic functions that users believe products must be equipped with. When a product contains such functions, users will not feel obvious satisfaction; but if the function is missing, users will generate prominent dissatisfaction.

(2) One-dimensional Quality Demands One-dimensional quality demands show a positive correlation with user satisfaction: the higher the product performance, the higher user satisfaction.

(3) Attractive Quality Demands Attractive quality demands refer to unstated user demands that can generate extra satisfaction once equipped in products.

(4) Indifferent Quality Demands Indifferent quality demands are demands that exert no influence on user satisfaction whether they are satisfied or not.

(5) Reverse Quality Demands Reverse quality demands mean functions regarded as demands by some users but a "burden" for others; satisfying such demands will reduce satisfaction of part of users.

By classifying demand attributes, the KANO model helps designers clarify the importance of different functions, avoid function stacking during product design, and realize optimized allocation of demands under limited design resources [3].

2.2. Applied Research of the KANO Model in the Product Design Field

In recent years, owing to its capacity to effectively identify the hierarchy of user demands, the KANO model has been widely adopted in industrial design, service design and product innovation research fields. Relevant studies indicate that this model can well reflect users' real perception of product functional attributes and assist designers in completing transformation from user demands to design strategies. For instance, Zheng Zhenhua et al. carried out improved design research on intelligent sweeping robots based on the KANO model and FAST-FBS theory, classified product functions into must-be, one-dimensional and attractive demands through user demand analysis, and further built mapping relationships between user demands and product functions [4]. In addition, in other user-oriented product design research, researchers gradually adopt demand analysis models to assist design decision-making. For example, Luo Jie and Xiang Xiang conducted design research on age-friendly home care beds through user surveys to acquire demands and established a transformation path from user demands to design schemes with scientific evaluation methods, verifying the effectiveness of conducting product design research based on user demands [5]. The KANO model can accurately screen core functions concerned by users and anchor product innovation

paths, effectively enhancing the matching degree between design schemes and user demands. In summary, this model is suitable for product design research with three core advantages: first, it divides different types of user demands and clearly defines the priority of product function development; second, it excavates latent unexpressed user demands to point out directions for product innovation; third, it builds a transformation bridge between user demands and product design strategies to strengthen the precision and pertinence of product design.

Thus, applying the KANO model to ice and snow sports glove design research can effectively identify differences in young ice and snow sports users' demands for thermal insulation, mobility, safety and intelligent experience, providing theoretical support for the subsequent construction of design schemes.

2.3. Construction of Ice and Snow Sports Glove Design Path Based on the KANO Model

Ice and snow sports feature low temperature, high humidity and high dynamics; users' demands for sports equipment cover multiple layers including basic cold-proof functions, sports mobility, operation efficiency and emotional experience. Therefore, this paper takes young ice and snow sports participants as target users and introduces the KANO model into ice and snow sports glove design research, constructing a four-stage design path: "user demand acquisition — demand attribute analysis — design strategy transformation — product scheme verification".

The specific research procedures are as follows: Firstly, analyze young ice and snow sports users' usage behaviors to acquire demands related to glove products via literature research, user interviews and scenario observation. Secondly, sort and classify collected user demands, distribute KANO questionnaires to judge demand attributes, and divide demands into the five aforementioned categories. Finally, confirm design priorities according to demand classification results and complete transformation from user demands to product functions.

This research path can realize a complete closed loop from user demand identification to product design practice, offering a systematic research method for innovative design of ice and snow sports equipment.

Figure 1 Design flow chart Stage 1: User demand acquisition; Stage 2: Demand attribute analysis; Stage 3: Design strategy transformation; Stage 4: Product scheme output Stage 1 module includes literature research, research questionnaires and user interviews, all inputting data into demand summarization block; demand summarization outputs data to KANO questionnaire distribution block in Stage 2; KANO questionnaire distribution outputs data to five-category demand division block; five-category demand division transmits results to design priority confirmation block in Stage 3; design priority confirmation transforms demands into glove functions, then outputs complete scheme in Stage 4.

3. Research on Design Demands of Winter Outdoor Sports

3.1. Construction of User Portraits

To clarify young ice and snow sports users' practical demands, this study combines user interviews and questionnaire surveys to conduct demand research on target users. User portraits are established by analyzing users' basic attributes, sports behaviors and product usage experience, further extracting key demand factors affecting user satisfaction to provide a basis for subsequent product design.

3.1.1. Research Methods and Object Analysis

This study carries out research targeting young users with ice and snow sports experience. According to consumption characteristics of winter sports crowds, target users are defined as ice and snow sports participants aged 18–35, including university students, young office workers and ice-snow sports enthusiasts.

Two major research methods are adopted: (1) Questionnaire Survey Method Online questionnaires are distributed to obtain users' basic information, sports habits and usage conditions of existing gloves.

Survey contents cover user age, sports type, sports frequency, equipment purchase experience and problems encountered during usage.

(2) Semi-structured Interview Method In-depth interviews are conducted with partial users with skiing experience; open-ended questions are used to understand users' real experience in actual sports, including cold hands, operation difficulties and comfort.

A total of 100 questionnaires were distributed, 93 valid questionnaires recovered; meanwhile, five users with ice and snow sports experience were selected for interviews. Statistics of basic user information are shown in Table 1.

Table 1. Basic Information of Research Respondents.

Research Dimension	Classification	Proportion
Age	18–25 years old	59%
	26–35 years old	41%
Gender	Male	58%
	Female	42%
Sports Type	Skiing	68%
	Ice Skating	32%
Sports Frequency	1–3 times per month	61%
	More than once per week	39%
Experience of Purchasing Professional Equipment	Yes	73%
	No	27%

Survey results show that young users already possess certain consumption awareness of professional equipment; when selecting winter sports gloves, they no longer merely focus on price, but attach greater importance to product functions, usage experience and technological attributes.

3.1.2. Analysis of User Behavioral Characteristics and Pain Points

Collation of questionnaire and interview results reveals the following major behavioral characteristics of young ice and snow sports users. Firstly, users sustain sports for a long time: most users conduct sports for 2–5 hours per session, which easily leads to hand temperature drop under long-term low-temperature environments. Therefore, sports equipment needs stable and lasting thermal insulation capacity. Secondly, high-frequency hand operations exist during sports: skiing requires holding ski poles, adjusting fixing devices and using mobile phones for shooting and recording, demanding gloves to not only resist cold but also maintain sufficient finger mobility. Thirdly, as sports consumption patterns upgrade, users' demands for sports equipment shift from basic function satisfaction to experience optimization and intelligent service integration; sports goods design begins to focus on user experience, function integration and intelligent technology application [6]. With the development of intelligent wearable devices, partial users expect sports equipment to provide more active information feedback such as real-time temperature detection, intelligent adjustment and status reminders.

Based on user behavioral analysis results, user demands are summarized in Table 2.

Table 2. Analysis of User Behavioral Demands.

User Behavior	Existing Problems	Design Demands
Long-time outdoor sports	Hand temperature reduction	Improve lasting thermal insulation capacity
Holding ski poles & adjusting equipment	Gloves restrict movement flexibility	Optimize hand structure
Shooting & recording during sports	Frequent glove removal required	Improve operation convenience
Pursuit of premium sports experience	Single functions of traditional products	Add intelligent interactive functions

3.1.3. Construction of User Portraits

Young ice and snow sports user portraits are built according to users' basic attributes, behavioral characteristics and demand pain points.

Figure 4 Portrait of Young Ice and Snow Sports Users

Centered on user avatar, four modules extend outward:

1. Crowd Characteristics: 18–35-year-old youth group; university students & young office workers; participate in skiing/ice skating on weekends or holidays.

2. Consumption Characteristics: Willing to purchase professional equipment that upgrades sports experience.

3. Behavioral Characteristics: Value sports performance; simultaneously care about product appearance and technological sense.

4. Core Demands: Thermal insulation & safety; mobility & comfort.

In summary, user research demonstrates that young ice and snow sports users' demands for winter sports gloves have gradually shifted from simple "cold-proof protection" to "function promotion and experience optimization". Therefore, subsequent design should take users' real problems as a foundation, clarify the importance of different functions via scientific demand classification methods, so as to realize effective transformation from user demands to design schemes.

3.2. Competitive Product Research

After completing user demand analysis, representative similar products on the market are investigated to further understand the current development status of winter outdoor sports gloves. Functional features, structural forms and user experience performance of different products are analyzed to summarize design trends and deficiencies of current winter sports gloves, providing a basis for extracting subsequent product demands.

Current winter sports gloves on the market are mainly divided into three categories: traditional functional sports gloves, intelligent heating sports gloves and professional outdoor protective sports gloves. Traditional functional products mainly adopt waterproof, windproof and thermal insulation materials to meet basic protection demands; intelligent heating products add electronic heating modules to enhance adaptability to low-temperature environments; professional outdoor products pay more attention to ergonomic design and comfort during sports. Therefore, three representative product types are selected for analysis from dimensions including product positioning, core functions, structural features and existing deficiencies

3.2.1. Selection and Analysis of Competitive Products

(1) Traditional Ski Sports Gloves. As the most widely used winter sports equipment type on the market, traditional ski gloves focus design on cold resistance, waterproofing and windproof performance. Such products usually adopt multi-layer composite structures including outer waterproof fabric, middle thermal filling layer and inner warm material to strengthen protection under low temperatures. Nevertheless, relying solely on thickened materials to improve thermal insulation increases overall glove volume, restricting finger mobility. During actual sports, users need to hold ski poles and adjust equipment; heavy structures reduce operation flexibility.

(2) Intelligent Heating Sports Gloves. With the development of intelligent wearable technology, enterprises start applying active heating technology to winter sports equipment [7][8]. Intelligent heating gloves are powered by batteries and adopt heating elements to continuously warm hand areas, improving usage experience under low-temperature environments. Such products effectively solve the problem of insufficient sustained thermal insulation of traditional gloves, yet additional batteries, circuits and control modules increase product weight. Meanwhile, users must consider battery endurance, charging convenience and long-term operational stability. Hence, further lightweight optimization is required for current intelligent heating products.

(3) Professional Outdoor Protective Sports Gloves. Professional outdoor brands pay greater attention to ergonomic design, adopt elastic materials, three-dimensional tailoring and partitioned

structures to boost product fitting and sports adaptability. Compared with traditional products, such gloves possess advantages in mobility and comfort, but their functions remain limited to passive protection, failing to respond fully to user demands such as intelligent temperature control and status feedback.

Competitive product information is sorted shown in Table 3.

Table 3. Analysis of Winter Sports Glove Competitive Products.

Product Type	Representative Product	Product Image	Core Functions	Advantages	Deficiencies
Traditional Ski Gloves	Burton Gore-Tex Series Gloves	Attached	Waterproof, windproof, thermal insulation	Mature technology, stable protection performance	Heavy structure, restricts hand mobility
Intelligent Heating Gloves	Override Heated Gloves	Attached	Electric heating, multi-gear temperature control	Improve adaptability to low-temperature environments	Increased weight, limited battery endurance
Professional Outdoor Gloves	Black Diamond Guide Series Gloves	Attached	Ergonomics, reinforced protection	High fitting degree, suitable for long-duration sports	Lack active adjustment functions

3.2.2. Summary of Deficiencies in Competitive Products

Competitive product analysis shows that although a mature product system has formed for current winter sports gloves, the following deficiencies remain:

1. Contradiction between basic thermal insulation and sports mobility. Traditional products enhance cold resistance by thickening thermal insulation materials yet reduce finger freedom of movement. This indicates that simply upgrading thermal insulation performance cannot fully satisfy user demands; future design needs to balance thermal insulation and mobility.

2. Conflict between intelligent product functions and portability. Intelligent heating gloves resolve low-temperature problems, yet added electronic modules increase product weight and impair long-duration wearing experience. Thus, intelligent functions must balance lightweight design while meeting user demands.

3. Insufficient satisfaction of users' latent experience demands. Most current products only solve the basic problem of "hand protection", with inadequate attention to user latent demands such as temperature feedback, intelligent adjustment and sports assistance. Therefore, future product innovation should shift from single function satisfaction to comprehensive experience promotion.

In conclusion, winter sports gloves on the market possess sound basic protection functions but retain optimization space in active temperature control, flexible structures and intelligent interaction. Hence, this study further extracts product demands based on user research and competitive product analysis, and classifies demand attributes via the KANO model to clarify the influence degree of different functions on user satisfaction.

3.3. Division of Demand Attributes Based on the KANO Model

Preliminary user research and competitive product analysis reveal that although current winter outdoor sports gloves are equipped with basic cold-proof and waterproof functions, problems including hand temperature drop, restricted sports operations and insufficient intelligent interaction persist during practical usage. Especially in dynamic sports scenarios such as skiing and ice skating, users require gloves to deliver basic protection while balancing sports mobility, wearing comfort and usage experience. Therefore, traditional function analysis methods alone cannot judge the actual influence of different demands on user satisfaction; scientific user demand evaluation methods must be adopted to classify and prioritize various design demands.

Based on extraction results of user problems and pain points from previous behavioral analysis, this paper transforms user troubles into evaluable product design demands. For instance, aiming at cold hands under low temperatures, demands including basic thermal insulation, active heating and temperature feedback are proposed; targeting heavy traditional gloves that restrict finger mobility,

lightweight design, flexible joint structures and ergonomic fitting design are raised; for insufficient intelligent experience, intelligent temperature control adjustment, sports data recording and mobile APP connection demands are put forward. After demand transformation, 10 functional evaluation indicators of winter outdoor sports gloves are formed: basic thermal insulation function, waterproof & windproof function, lightweight design, flexible joint structure, ergonomic fitting design, active heating function, temperature display function, intelligent temperature control adjustment function, sports data recording function and mobile APP connection function.

To further clarify the influence degree of various functional demands on user satisfaction, questionnaires are designed based on the KANO model. Each function includes forward and reverse questions, evaluating user satisfaction under two scenarios: "product equipped with the function" and "product without the function". This method can comprehensively reflect users' real perception of different functional attributes, providing data support for subsequent demand classification. A total of 139 questionnaires were distributed, 134 valid questionnaires recovered; all demands are classified according to the KANO evaluation table (Table 4).

Table 4. Summary of KANO Model Analysis Results.

Function/Service	A	O	M	I	R	Q	Classification Result	Better Coefficient	Worse Coefficient
Basic thermal insulation function	0	0	104	10	20	0	Must-be attribute	0.00%	-91.23%
Waterproof & windproof function	0	0	98	18	18	0	Must-be attribute	0.00%	-84.48%
Lightweight design	0	0	76	40	18	0	Must-be attribute	0.00%	-65.52%
Flexible joint structure	0	0	66	48	20	0	Must-be attribute	0.00%	-57.89%
Ergonomic fitting design	0	0	58	60	16	0	Indifferent attribute	0.00%	-49.15%
Active heating function	34	22	6	46	14	12	Indifferent attribute	51.85%	-25.93%
Temperature display function	18	12	6	72	14	12	Indifferent attribute	27.78%	-16.67%
Intelligent temperature control adjustment function	34	18	4	58	6	14	Indifferent attribute	45.61%	-19.30%
Sports data recording function	32	16	2	60	8	16	Indifferent attribute	43.64%	-16.36%
Mobile APP connection function	22	16	0	68	12	16	Indifferent attribute	35.85%	-15.09%

Analysis results of Table 4 reveal obvious differences in the influence of various functional demands on user satisfaction. Basic thermal insulation function, waterproof & windproof function, lightweight design and flexible joint structure are categorized as must-be attributes. For basic thermal insulation function, 104 users selected "taken for granted", with a Worse coefficient of -91.23%, indicating that although this function is a basic condition users deem mandatory, the absence of this function will drastically reduce user satisfaction. Therefore, thermal insulation performance remains the core must-be demand in winter outdoor sports glove design under low-temperature environments. The waterproof & windproof function also carries high necessity, with a Worse coefficient of -84.48%, proving that protection capacity in ice-snow environments directly determines user usage experience. In addition, lightweight design and flexible joint structures are also regarded as basic demands by users, with Worse coefficients of -65.52% and -57.89% respectively. This result illustrates that alongside the popularization of mass ice and snow sports, users' demands for sports equipment have evolved from single cold-proof protection to integrated upgrades of function and experience. Traditional winter gloves enhance cold resistance by thickening thermal insulation

materials yet create bulky structures that restrict finger mobility, reducing convenience of movements including holding ski poles and adjusting equipment. Hence, optimizing material selection and structural design to improve hand mobility during sports while meeting thermal insulation demands becomes a critical direction for future winter sports glove design.

Ergonomic fitting design, active heating function, temperature display function, intelligent temperature control adjustment function, sports data recording function and mobile APP connection function are classified as indifferent attributes in this research. The active heating function carries a Better coefficient of 51.85%, demonstrating that partial users hold strong interest in intelligent heating functions; yet unresolved defects of current intelligent products including increased weight, insufficient endurance and complex operation prevent such functions from becoming mandatory demands for most users. This aligns with the development status of current intelligent wearable products: intelligent functions can elevate product experience yet still require solutions for lightweight design, portability and operational convenience [9].

Synthesizing KANO model analysis results, young ice and snow sports users' demands for winter sports gloves concentrate on two layers: basic protection and sports experience. Basic thermal insulation, waterproof & windproof performance, lightweight construction and flexible structures are must-be demands that must be prioritized in product design; intelligent temperature control, temperature feedback and other functions fail to form rigid current demands yet possess great potential to boost product competitiveness. Therefore, subsequent design practice must prioritize satisfying must-be demands, and integrate moderate intelligent functions under the premise of ensuring lightweight and comfortable products, realizing the transformation of winter sports equipment from traditional protection-oriented products to experience-optimized products.

4. Design Practice

4.1. Transformation of Design Strategies Based on KANO Demand Analysis

Previous KANO model analysis proves that user demands for winter outdoor sports gloves do not equal simple function stacking but present a progressive hierarchy from basic protection demands to sports experience optimization demands. Basic thermal insulation, waterproof & windproof functions, lightweight design and flexible joint structures fall under must-be attributes that constitute core factors determining user satisfaction; active heating, temperature feedback and intelligent adjustment functions, though not mandatory current demands, carry potential to create differentiated product experience. Therefore, this research takes KANO analysis results as design foundations and further transforms user demands into product functional and structural design strategies.

Existing studies demonstrate that product design based on the KANO model should avoid blind pursuit of more functions, but confirm design priorities according to different demand attributes, transforming user demands into concrete design elements to improve matching degrees between products and actual sports scenarios [10]. Aiming at the core pain points of winter outdoor sports: "hand stiffness under low temperatures", "restricted finger mobility from traditional gloves" and "insufficient comfort for long-duration sports", this design sets "optimizing hand sports experience in cold environments" as the core objective and forms a three-tier design strategy: "basic protection guarantee — sports mobility improvement — intelligent experience optimization".

Firstly, at the basic protection tier, targeting users' high demands for thermal insulation, waterproofing and windproofing, high-performance thermal insulation materials and protective structures form the design foundation. Traditional winter sports gloves increase filling thickness to boost thermal insulation yet create bulky gloves that hinder sports mobility. Thus, this design adopts multi-layer composite structures to control overall thickness while guaranteeing thermal insulation effects, adapting to dynamic sports scenarios such as skiing and ice-snow hiking.

Secondly, at the sports experience optimization tier, in line with the high importance of lightweight design and flexible joint structures identified via KANO analysis, hand movement biomechanics serve as the basis for structural design. Partitioned treatment is applied to finger bending zones;

flexible materials connect finger joints, allowing gloves to deform naturally alongside hand movements and reducing restrictions on gripping and equipment adjustment imposed by heavy traditional gloves. Studies on sports equipment design point out that beyond meeting safety protection standards, wearable sports products must prioritize human ergonomics and comfort during sports; otherwise, sports performance will be negatively affected [11].

Finally, at the intelligent experience tier, addressing the status that active heating functions hold high latent value but have not become must-be user demands, intelligent modules are integrated in a concealed layout rather than acting as prominent visual elements. The heating system is combined with wrist control zones, allowing users to adjust hand temperatures voluntarily based on ambient temperature and personal demands, transforming the glove from a passive cold-proof device to an active environment-adaptive device. Meanwhile, a wrist-mounted temperature display module enables users to monitor real-time temperature status and enhance controllability during usage.

4.2. Design Scheme of Winter Outdoor Sports Gloves

Based on the above design strategies, this research completes an intelligent winter sports glove design scheme targeting young ice and snow sports users. Positioned as "integrating lightweight protection and intelligent temperature control", the overall design meets basic sports demands while enhancing the product's technological texture and usage experience. Renderings of this product design scheme are shown in Figure 7.

Figure 7 Glove Renderings Four groups of images are attached:

1. Front, back and side wrist strap renderings with annotated functional components: fingertip touch sensitivity enhancement, touchscreen-compatible fingertip anti-slip design, special joint fabric, palm anti-slip texture, intelligent constant-temperature heating wires, lightweight exoskeleton, adjustable wrist strap, dual-layer cold-proof inner & outer construction, dual-layer tightness adjustment, built-in micro sensors, micro vibration motors & main control board, day buckle wrist strap.

2. Exploded view of glove layers, heating circuit, wrist control module and shell components.

3. On-body wearing rendering under snowy outdoor environment, showing dual adjustable wrist straps.

4. Single glove rendering placed on snow rock terrain, highlighting modular wrist control panel and double strap design.

In terms of appearance design, the product adopts a concise streamlined styling language, eliminating excessive decorative elements common in traditional outdoor equipment to deliver a more professional and modern visual effect. Continuous curved surfaces are applied on the back of the hand to fit human hand structures and reduce visual bulkiness. Meanwhile, zoning via different material textures strengthens functional expression, allowing users to intuitively perceive the product's sports attributes.

In terms of structural design, finger and wrist zones with frequent sports movements are optimized as key priorities. Flexible connecting structures are adopted at finger joint zones to boost bending freedom; anti-slip textures are added on palm zones to strengthen gripping stability, enabling users to manipulate ski poles and other sports equipment precisely during skiing. Modular control structures are set on wrist zones, integrating temperature display and function adjustment into wrist straps to avoid extra wearable burden from standalone devices.

In terms of intelligent function design, distributed heating elements are embedded inside the glove to form an active heating system, improving hand comfort under low-temperature environments. Combined with temperature feedback functions, users can conduct targeted adjustment to realize more precise human-computer interaction experience.

In summary, this design does not simply stack intelligent functions, but transforms demands of different tiers into corresponding design strategies after screening user demands via the KANO model. Basic thermal insulation and protection functions guarantee product reliability; flexible structures upgrade sports experience; intelligent temperature control functions enhance product innovation,

ultimately forming an integrated sports glove design scheme matching winter outdoor sports scenario demands.

5. Conclusion

Taking young winter outdoor sports users as research objects, this paper conducts product design research based on the KANO model targeting mismatches between functional demand matching and user experience promotion in sports gloves. This research first extracts major demands of young users during winter sports through user research and competitive product analysis, and constructs a demand evaluation system covering functional indicators including basic thermal insulation, waterproof & windproof performance, lightweight construction, flexible joints and intelligent temperature control. Subsequently, KANO model questionnaires are distributed; positive and reverse demand evaluations are adopted to classify attributes of each function, and design priorities are confirmed based on the influence degree of each function on user satisfaction. As a vital user demand analysis method, the KANO model can effectively identify different demand attributes and provide a basis for product function optimization and design decision-making.

Research results indicate that basic thermal insulation, waterproof & windproof performance, lightweight design and flexible joint structures constitute core demands of young users for winter sports gloves, serving as must-be attributes that must be prioritized in product design; intelligent functions including active heating and temperature feedback, though not mandatory demands at present, act as important directions to elevate product experience and differentiated competitiveness. Based on the above research results, this paper further completes the design practice of intelligent winter sports gloves, realizing a full research workflow from user demand analysis to product scheme transformation.

Certain limitations exist in this research. Restricted by research duration and sampling conditions, the sample size of user surveys and verification under real sports environments leave room for improvement. Future research can carry out experience tests under authentic skiing and ice skating scenarios, and optimize product functions and structural design through long-term usage feedback to enhance the reliability and application value of research findings.

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