

## Research on the Application of Perceptual System to Support the Structural Design of Baby Clothes

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### **Abstract**

With the continuous advancement of social civilization, the benign lifestyle advocated by the green concept has caused a new wave in the world. However, consumers' definition of children's wear design often conflicts with designers' ideas. In this study, a green children's wear design system is proposed. The researchers try to understand the emotional response of consumers to the design, and apply the results obtained from perceptual evaluation and analysis to the structural design of baby clothes. The system may be very important to support the green and people-oriented children's wear design process, and can realize effective communication between consumers and designers. In this study, through the implementation of perceptual engineering, consumers' perceptual images are analyzed at multiple levels to realize the green, practical, comfortable and safe design of baby clothes. In the research process, questionnaire survey and quantitative analysis are mainly used. The researchers classify the perceptual factors of children's wear into 18 clusters. Through the analysis of 145 valid questionnaires, the four perceptual factors that consumers are most interested in are "environmental protection, practicality, comfort and safety", and finally the corresponding baby clothing structure is designed. The system plays an important role in the design of green baby clothes, which enables designers to better design clothing styles that meet the market demand.

**Keywords:** Kansei Engineering; Structural Design; Baby Clothes; Design System

## 1. Introduction

With the improvement of people's living standards and the implementation of the three-child policy in China, as well as the deepening of consumers' concept of "prenatal and postnatal care", the children's clothing market in China has ushered in a new development opportunity. Infants are in a period of rapid growth and development, and have no safety awareness, hygiene awareness and self-care ability. Therefore, structure is an important design point in infant clothing design. The buyer of baby clothes and the actual wearer are completely different individuals. The buyer's demand for products is conscious, which is known as explicit user demand, while the actual wearer's demand for clothes is unconscious and implicit user demand. Although there are a wide variety of baby clothing products available in the market, the design of baby clothing is more complicated than that of adult clothing. It not only requires designers to make great efforts in the coordination of styles and colors and fabrics, but also requires designers to fully understand the psychological and emotional needs of buyers and wearers of clothing, mainly involving subjective aspects such as preferences, purposes and possible social behavior levels of different consumers. Consumer desire is very important in designing a product in order to be widely accepted by the market (Janari & Rakmawati, 2016). Product design is done to create quality products and can meet the wishes of consumers so that products can be accepted and compete with competitors (Hasibuan, 2020). The design circle constantly advocates consumer-centered design to meet and improve consumer satisfaction, and the clothing industry gradually realizes that the best way to stay ahead of competitors is to standardize and customize clothing. In the design process, designers explore information in the positioning of consumers' emotions, themes, concepts and product types, and then process and transform the information into product ideas that combine clothing contours, materials and colors. In short, to design high-quality products, consumers need to participate in the design process. Therefore, the structural design of baby clothes should be based on the consumer's perceptual image, and the baby clothes should be analyzed by using the principle of perceptual engineering, and the corresponding points between the consumer's perceptual needs and the designer's design elements should be obtained, and the baby should be designed according to its physiological, psychological and behavioral characteristics. In addition, it is necessary to design specific functional points such as accessibility, intelligence, safety and hygiene.

Through investigation, it is found that the research on functional baby clothes in academic circles involves safety, comfort, intelligence, protection and structural functionality, etc. As the breakthrough point of baby clothes design research from different angles, it broadens the horizons for designers in children's wear industry. When designing children's wear styles, fashion designers can try their best to prolong the service life of clothes, such as making some intimate designs at cuffs, trousers corners and trousers waist to solve the problems brought by children's growth, so as to better extend the service life of children's wear (Cui, 2014). When parents buy clothes for their children, they are more concerned about whether the clothes their children wear are healthy, safe and comfortable. Considering this, factors such as fabric quality and the choice of chemical-free fabrics must be considered when choosing clothes (Zhu, 2016). In addition, some scholars have discussed the design elements of infant functional clothing from three aspects: structural functionality, fabric functionality and color and pattern functionality (Liu & Liu, 2018).

However, there are still many shortcomings in the design of baby clothes at present. For example, in the design of structure and function, it is mostly limited to sleeping bags, antishock clothes and some simple detachable designs, and less efforts are made in the structural function of daily clothes, ignoring the substantive needs of parents in the design. In other words, the baby clothes sold in the market lack the perceptual needs of both babies and parents to some extent. The design of functional clothing should be based on the market demand, trend analysis, application prospect and user demand analysis, and then determine the clothing style and structure, define the design elements, identify and finalize the clothing fabrics, and finally evaluate the products (Hu et al., 2013). Therefore, how to integrate the emotional value of consumers into the design process is a task for children's clothing professionals, which can not only make consumers become "co-creators", but also enable designers to better understand children's clothing.

## **2.Methods**

In this paper, the design of baby clothes is studied by the method of Kansei Engineering. Kansei Engineering introduced by Mitsuo (Nagamachi, 1995) as a consumer-oriented technology in developing products. It is a method of product development that interprets customer feeling to be the element of product design. Kansei in Japanese is translated as entire feeling or emotion that experienced by a person through his senses on certain thing, Environment or Situation (Schütte, 2002). It defines the past as an emotional reaction that is difficult to quantify, qualitative, irrational and illogical, and quantifies it with modern computer technology, so as to develop a new generation of design technology and products. In layman's terms, it is a customer-oriented product development technology, a translation technology that transforms customer feelings and intentions into design elements. Sansheng Nagamachi defines Kansei Engineering as: "The technology that transforms consumers' feelings or images about products into design elements. (See the picture below) "In other words, Kansei Engineering is a technology of human factors discussion, which mainly aims at exploring the factors of people's perception levels. The Kansei engineering aims to develop a relationship between customer's sentiments and product design parameters (Li et al., 2020). This will help the product to achieve maximum customer satisfaction, which in turn uploads the company's business in the market (zhong et al., 2019). Therefore, when it is applied to consumer-oriented product design and development, it can better reflect its unique importance.

A customer-oriented approach to product development with particular consideration of emotions is represented by Kansei Engineering, characterized by the possibility to capture customer perceptions and to translate them into product features. As one of the new methodology which aimed at making simpler the product/market fit process, Kansei become one of user-centered approach that advocate for customization of products guided by users' expectations (Alonso et al., 2014). Kansei Engineering can be simply defined as using engineering methods to study consumers' emotional intentions and transform them into design elements, so as to design products that satisfy consumers. This method is widely studied and applied in the fields of artificial intelligence, automobiles, household products, electronic products, mechanical equipment and clothing because of its strong scientific nature. Sansheng Nagasamachi, the originator of Kansei Engineering, once successfully applied this design method to the research and development of school uniforms for female college students, so the famous Wacoal Company successfully developed a "Good-up bra" and

won the highest sales volume of underwear products at that time. Kansei engineering methods mainly include quantitative inference and qualitative inference. Quantitative inference methods mainly include Kansei Engineering System and Kansei Engineering Modeling. Kansei Engineering System includes three kinds of Kansei Engineering System: forward inference Kansei Engineering System, backward inference Kansei Engineering System and mixed Kansei Engineering System, while Kansei Engineering Modeling includes Kansei Engineering Mathematical Model(As shown in Fig.1), Simulated Kansei Engineering and Cooccurrence Kansei Engineering Design. Qualitative inference refers to perceptual vocabulary classification. This method takes perceptual image vocabulary evaluation data as dependent variables and design elements as independent variables. It is widely used in the related research of design industry, including fashion design, because it does not need to use complicated mathematical methods and statistical methods. Therefore, this paper chooses the qualitative inference kansei engineering method to design baby clothes.

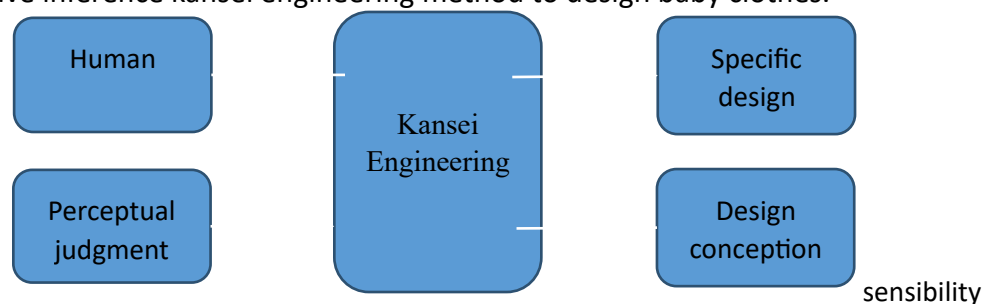


Fig.1 Kansei Engineering Model

### Multidimensional Analysis:

Fashion design is a comprehensive and interdisciplinary applied discipline, and it is also the unity of culture, art and science and technology. It is different from other art design disciplines, and its particularity lies in that it is shaped by different consumers. Fashion design includes elements such as style structure, color, fabric and technology. If designers want to integrate Kansei Engineering into fashion design, they need to make multi-dimensional analysis by various means. First of all, clothing modeling is the main element of clothing, and different clothing modeling will convey different subjective feelings. Therefore, clothing designers should actively investigate and study consumers' wearing psychology and purchasing needs, identify the important elements of perceptual design of modeling, and show the differences in consumers' psychological or physiological needs with different clothing modeling, so as to realize the unique development of personal modeling style. Secondly, clothing color, as the first element to capture people's eyes, is an important element to convey people's psychological characteristics. Different colors will give people different emotional tendencies because of the differences in saturation, lightness and hue. When designing clothing colors, we should fully consider the psychological characteristics and emotional needs of consumer groups and formulate targeted design schemes. Clothing fabric is also an important part of perceptual design, and the softness and concave-convex texture of the fabric will separate different tactile feelings and visual feelings. In addition, clothing technology is the process of the integration of the external form and the internal quality of clothing. Exquisite technology will often promote consumers' desire to buy and bring people a good consumption and wearing experience. Fashion design is a people-oriented design, and its ultimate goal is to meet people's own needs. The application of Kansei Engineering in the field of fashion design

is to make our design targeted and move towards a more reasonable and perfect direction. The combination of perceptual engineering and clothing design aims at designing clothing according to customers' feelings and intentions. Perceptual clothing design aims at the lifestyle of the wearer, and establishes a new design model from three aspects: objective physiological reflection measurement of human muscle activity, skin temperature change, cold, heat, sweating and fatigue when wearing clothing; The psychological reflection of human beings is measured by human vision, touch, language and expression; The material characteristics such as texture, concave and convex surface, light reflection and hand feel of fabric are evaluated by human physiological and psychological reflection. Therefore, designers should also attach great importance to the perceptual design of clothing technology.

### **Vocabulary collection of perceptual images:**

#### **Card classification**

As we all know, there are many perceptual adjectives used to describe clothing, but it is obviously impossible to list all these words and then explore the mapping relationship between them and design elements one by one. Therefore, on the basis of extensive vocabulary collection, we must invite experts in the field of children's wear design to screen and classify perceptual image vocabulary, and finally form the required perceptual image space. In order to achieve this goal, a very effective method is card classification.

Card classification comes from George Kelly's personal construction theory, which is a method of information induction and classification by sorting information according to certain standards, thus establishing the relationship between classes (Ge, 2012). Card classification is a method of writing the information that needs to be classified on cards, and then giving it to the respondents for classification. It is a quantitative information analysis method. After collecting users' expectations of information structure, it is quantitatively processed by cluster analysis, and finally expressed in a tree diagram for designers' reference (Dong, 2007). Card classification can be divided into two types: open and closed. The essential difference between them is whether the classification is provided in advance when grouping. For example, open card classification is to provide some cards to the respondents, which show the contents that need to be grouped, without providing classification in advance. Instead, the respondents classify the cards according to their own feelings, describe the characteristics of each group with one word, then merge the groups with similar meanings, and summarize the final classification with a new word. Using card classification, we can find the differences and connections between words and meanings simply and intuitively. After gradual classification and arrangement, the corresponding perceptual image space can finally be formed.

#### **Semantic difference method**

semantic differential scale (SD) is developed based on Kansei attributes. The scale consists of some arbitrary points to get the respondent's degree of satisfaction to evaluate the Product Design (Yan & Nakamori, 2010). Semantic difference method is the basis and tool for implementing image scale measurement, which was founded by the team of American psychologist Osgood in 1942. It is an experimental technique to measure people's subjective feelings about things by using adjectives. The semantic difference method consists of three elements: the evaluated object, the ruler and the subject. By describing the semantic vocabulary of the perceptual image of the subject, a five-point or seven-point psychological

scale is established to express the continuous psychological changes of the subject to different degrees. Among them, the grades of evaluation must be odd and cannot be divided too finely. Usually, the classification of grades is between 3 and 7, and the measurement of 5 grades is the most common. At the same time, the number of effective samples in each experiment should be at least 30 to obtain stable data. In order to reduce and avoid the difficulty in effectively distinguishing too many evaluation grades, this study selected a fivepoint scale to measure the image perception (Zhou,2016).

The specific implementation steps of obtaining intentional vocabulary of perceptual engineering are as follows:

The first step is to target a certain age group; The second step is to collect the clothing pictures circulating in the market extensively, sort them out after removing similar pictures, analyze the perceptual factors of clothing, and invite 10 experts in children's wear design industry to classify perceptual vocabulary through card classification; Step 3, according to the sorted perceptual words, select a group of most representative pictures and make a questionnaire. The pictures are numbered in the questionnaire, and the content design includes the information of the age, gender and occupation of the testee. Descriptive words are used to express all possible perceptual images, and intentional words such as "agree and disagree" are appropriately added. Each image vocabulary uses multiple levels to distinguish its preference degree, that is, they are used to reflect the feelings and preference degree of the testee on clothing. The fourth step is to establish a comparative version of perceptual image vocabulary. Because everyone's understanding of perceptual image vocabulary is biased, individual errors will occur in the evaluation. In order to reduce the error, make an intention kanban to unify the understanding of the subjects; The fifth step is to select a certain number of subjects, and reasonably distribute the target groups based on the principle of "popularization", including different regions, different professional positions, different identities, different salary and treatment levels, fashion design professionals and ordinary consumers who have not received professional training; The sixth step is to sort out the results of the questionnaire survey, and take adjectives describing consumers' perceptual images as zero-degree sensibility, and then gradually decompose them into primary sensibility, secondary sensibility and n-degree sensibility until various design elements of the product can be clearly defined. The implementation procedure of perceptual vocabulary classification is shown in Figure 2.

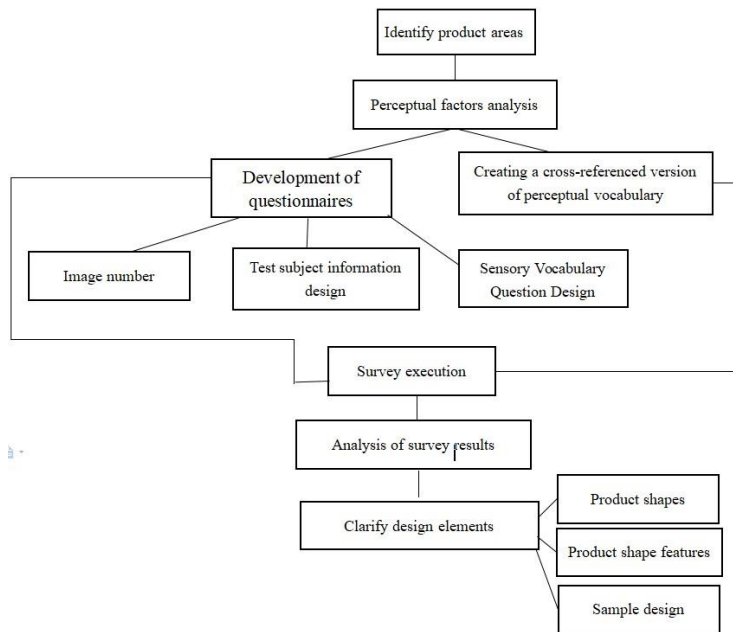


Fig.2 Procedure for implementing the taxonomy of perceptual discourse

### 3. Implementation process Pre-research preparation:

Through market analysis and research, this study collected 197 popular baby clothing styles. After interviewing 10 experts in children's wear design industry, the pictures are classified by card classification, and the most representative baby clothes pictures are sorted out and numbered, and each picture is marked with the corresponding perceptual factor. The sorted pictures and perceptual factors are made into a questionnaire. This questionnaire first collects the information of the respondents' gender, age, occupation and city, and then uses the second person to state the above perceptual factors and the corresponding pictures, such as "soft clothing fabric is the primary reason for you to choose baby clothes"; The choice uses five grades to distinguish the preference degree of the respondents: 1- strongly disagree, 2- disagree, 3- make do, 4- agree and 5- strongly agree. In order to ensure the accuracy of the survey results, intentional kanban was made for 18 perceptual factors for the reference of the respondents, as shown in Figure 3.

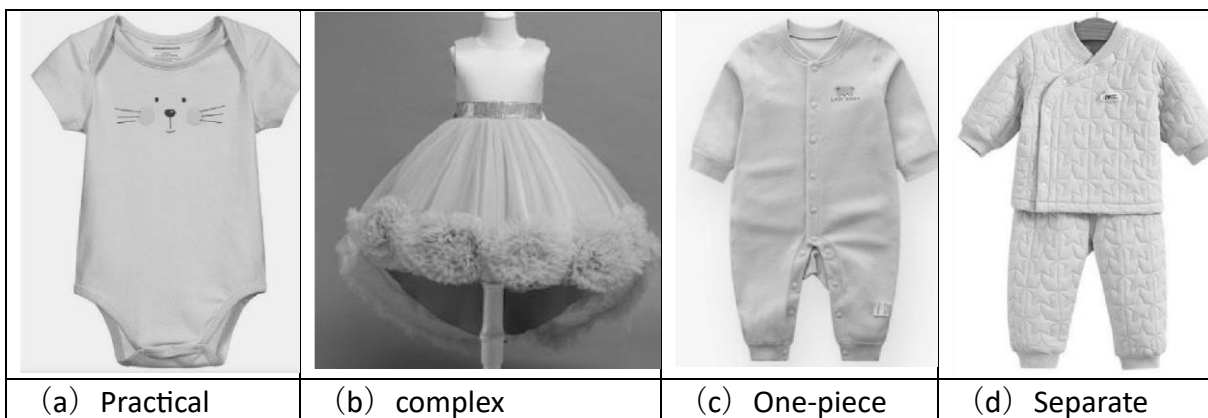


Fig.3 Reference diagram of the Perceptual Factor Intentional Kanban section

**Investigation and implementation:**

After completing the questionnaire, the parents of infants aged 25-40 are targeted as the main subjects for online questionnaire distribution. The questionnaire was distributed mainly in the form of online distribution. With the help of friends and relatives, we distributed 150 questionnaires, 50 of which were distributed in various cities in Guangdong Province and 100 were from provinces outside Guangdong Province. Participants volunteered to participate in this research, and their participation was not paid, and they were guaranteed anonymity, and they were told that they could freely terminate their participation at any time without punishment. After agreeing, they completed the online questionnaire. The respondents mainly involved: fashion designers, doctors, teachers, corporate executives, ordinary employees in the workplace, people in the Internet industry, stay-at-home mothers and selfemployed. In the end, 147 questionnaires were recovered, but 3 were not recovered, of which 2 were invalid, that is, the final valid questionnaire was 145, with a recovery rate of 96.7%.

**Questionnaire analysis:**

The results of data collection will be processed by SPSS26.0 system to determine the level of effectiveness and reliability. In SPSS software, the accuracy of data input is confirmed by frequency command. The statistical values of all continuous variables (using the 5-point Likert scale) are within this range, which does not indicate any problems about the data input program. In addition, there is no abnormal value or over-limit value in the data of other variables (demographic information) involved in the questionnaire or the experiment.

**4.Results and Discussions** The design process of baby clothes is determined through interviews and questionnaires. Emotional words come from direct interviews with 10 children's wear designers. The main purpose of the interview is to let the designers of baby clothes separate representative perceptual words from many perceptual words, and the selected perceptual words are determined by the assumption of 90% reliability level. Through sorting, 18 most representative pictures of baby clothes are obtained, and their perceptual words are matched, as shown by table below:

Table1:Eighteen perceptual words come from expert classification

No.	Kansei Word	No.	Kansei Word	No.	Kansei Word
1	environmental	7	terse	13	mature
2	individuality	8	practical	14	complicated
3	safe	9	child's interest	15	leisure
4	intellectual	10	comfortable	16	sports
5	luxurious	11	fashion	17	Siamese
6	originality	12	honest	18	fission

Questionnaire survey is to determine the basic needs of users.



**Perceptual hierarchy analysis:**

In this research design, the perceptual factor of "structural functionality" of baby clothes is taken as the overall goal and requirement, that is, "zero sensibility". Through the results of questionnaire survey, it is concluded that among the 145 valid questionnaires, the four perceptual factors of "environmental protection, practicality, comfort and safety" are very much agreed, that is to say, most consumers think that structural and functional baby clothes should have the characteristics of environmental protection, practicality, comfort and safety, and thus four "primary perceptual factors" are obtained. According to consumers' perceptual needs, combined with the design rules of baby clothes, it is subdivided from "primary sensibility" to "n sensibility", and finally a multi-level tree diagram is obtained, as shown in Figure 4.

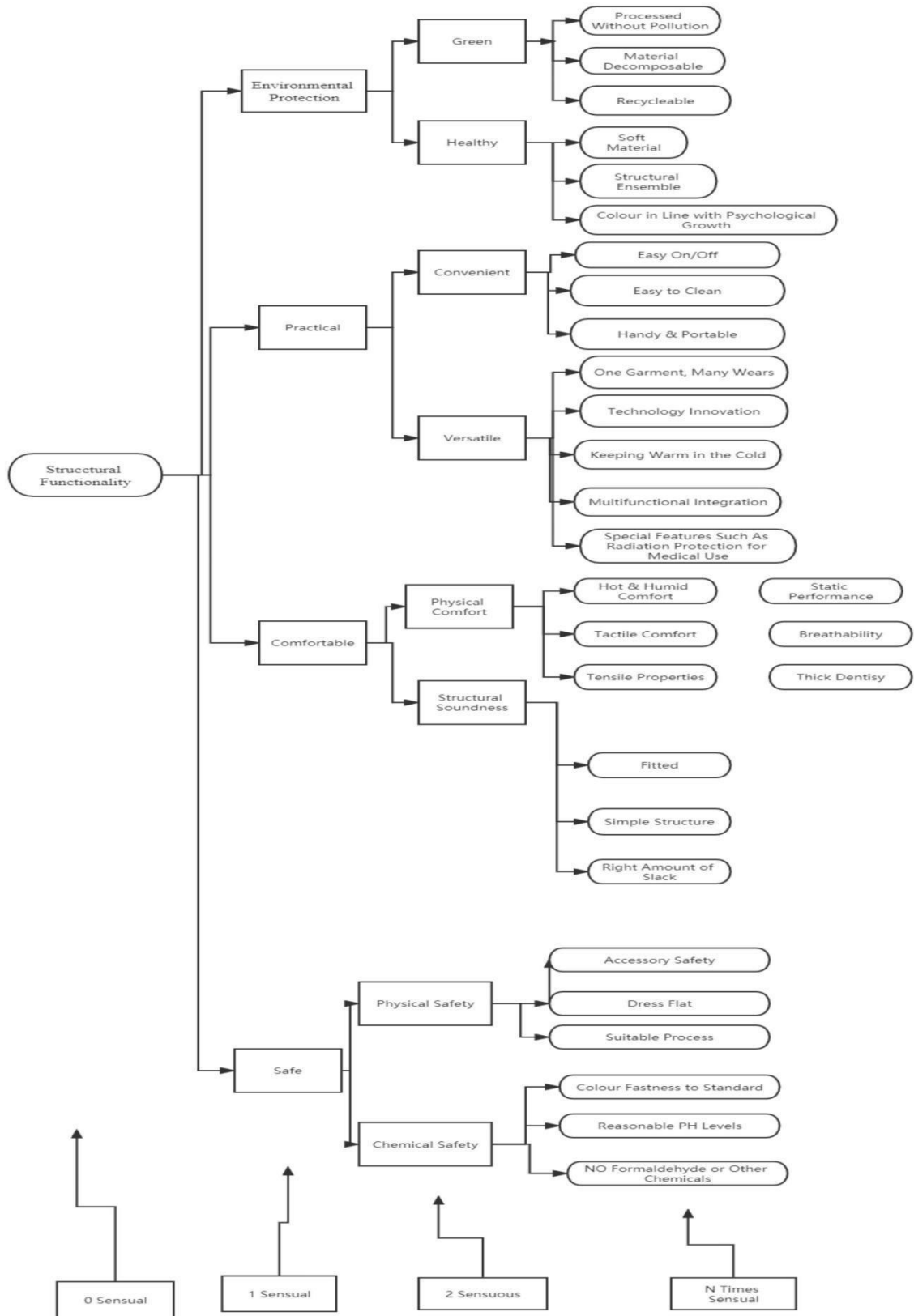


Fig.4 Multi-level tree relationship diagram

Define the elements of style and structure design:

According to n times of perceptual analysis, the perceptual factors related to the style and structure of baby clothes are structural fit, easy to put on and take off, multi-wearing, multifunctional integration, proper looseness, fit pattern and simple structure. According to the principle of design methodology, combined with the related perceptual factors of clothing structure obtained above, the outline requirements of baby clothing should be mainly loose and comfortable straight H-type and O-type; The design is simple and easy to put on and take off, and the collarless design is used as far as possible for daily clothes. If the clothes are needed for special occasions, the collar should not be too high, and flat lapels, bionic or cartoon lapels can be used as decoration. Considering the growth characteristics of babies, clothing should meet a series of behavioral changes such as lying flat, turning over, sitting, crawling and learning to walk. Therefore, the style design should be based on the style that is easy to stretch the limbs, and the combination of bibs, jumpsuits, long-sleeved tops and highwaisted pants is more suitable. In addition, the use of diapers should also be considered in the design of trousers. Babies lie or lie down most of the time. In order to ensure the smoothness of clothing, clothing can be made into one-piece or less than three-piece design, using the design of door placket, hidden button or side tie rope.

Through investigation and feedback, it is concluded that most caregivers encounter the following relatively prominent problems in the process of taking care of babies: 1. The baby is held in the arms of parents except sleeping, and the most frequent care is to change diapers. However, most of the common jumpsuits on the market at present connect the hidden buttons from the front of the door to the inner seams of the two trouser legs, and there are too many hidden buttons. Although the process is simple, it will undoubtedly take a lot of time in the long run, as shown in Figure 5; 2. The warm-keeping work of the baby's feet plays a very important role in cold protection, such as a series of problems that the trouser legs are exposed when the caregiver holds the baby vertically, and socks are easily rubbed off by the baby; 3. The baby's knees are easily damaged during crawling.

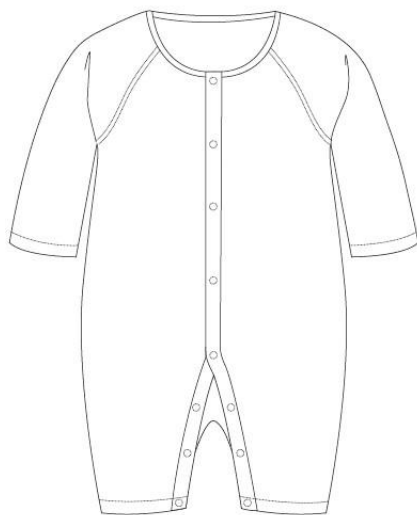


Fig.5 Common baby onesies

After the investigation of the existing products in the market and my own nursing practice, I designed the baby clothes scheme, which has multiple functions. First of all, in order to simplify the complicated procedure of changing diapers, under the condition of not affecting the appearance, the use process of the designed clothes is simplified, and the buttons on both sides of the trouser legs are replaced with unilateral hidden buttons to connect with the placket; Secondly, the cartoon design is added to the knee, which on the one hand increases the interest of the clothing, and on the other hand, cotton padding can be added between the two layers of fabric, which can effectively prevent the knee from being damaged, as shown in Figure 6; In addition, when the baby is held by the nursing staff, the problem that the trouser legs are shortened upwards is inevitable. However, by sewing two optional tiny stitches at the outer thigh suture, the matching warm socks can be fixed well, thus forming the use function in various occasions, as shown in Figure 7.

Fig.6 Simplified buttoned, knee pads jumpsuit

Fig.7 Breathable fixable foot sock.

**Conclusion**

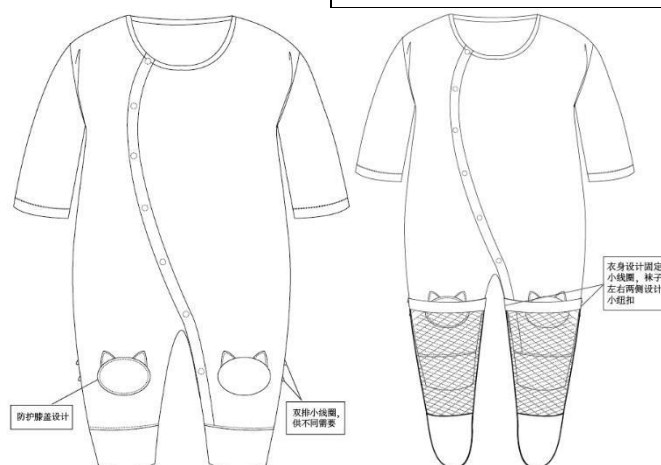
According to the previous research results, on the basis of trying to optimize the structural design of baby clothes, the following conclusions are drawn: Guiding clothing design through the principle of Kansei Engineering is a way to start from the perspective of "people", stop

Small loops on the body and small buttons on the left and right sides of the socks

Protected knee design at "things" and finally bring benefits to

Double row of small coils for different requirements

people. As the most direct embodiment of human emotions and personality, clothing should pay more attention to personalization when designing clothing. When designing, people's needs must be taken as the premise, and the close combination of sensibility and fashion design can be reflected in fashion design in a unique way. Baby clothing is a special product. When designing products, designers should realize that the wearing group of this kind of clothing is still in the stage of rapid growth and development, and this group has no safety awareness and self-care ability. Therefore, the design of clothing style and structure of this group should take into account not only the physical needs of the actual wearer, but also the emotional needs of caregivers as the starting point. By analyzing the perceptual images of caregivers, we can guide the design of structural and functional baby clothes, determine various design elements associated with them, and truly realize people-oriented design.



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