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**Article**

# An Evaluation Method for Hand-held Tactile Emotional Design

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**Abstract:** Based on the theory of Kansei Engineering, the relationship between the tactile feel of the remote control and the emotional response of the tester was studied. Research on hand-grip perception provided a further understanding of consumers' emotional response to products, which is a key factor influencing consumers' decision to purchase. 35 perceptual adjectives for touch were screened, and then based on the tactile sensory vocabulary, a remote control grip sample screening experiment was conducted. The semantic difference analysis was conducted using perceptual adjective vocabulary, and the measurement results were used to design a new remote control shape and compare the hand-held tactile feeling with commercially available remote controls. The touch and emotion were used for the best remote control grip design. The hand-held tactile remote control was a new type of hand-held remote controller that provided users with a new way of interacting with the environment and emotions based on the tactile feeling of the hand. For more than ten years, user experience (UX) has been used to describe the emotions and reactions of users when using products in usage environments. In this study, 20 men and women participated in experiments according. The results showed that the newly designed remote control was appropriate for one-handed operation and the most comfortable tactile sensations. Tactile performance was better than that of commercially available products. By comparing the improvement rates of products, designers can obtain a better reference for modifying product details or making design decisions from the result of this study.

**Keywords:** Product image, Form design, Usability evaluation, UX introduction

## 1. Introduction

In new product development, the process and results of design features and concept realization are important to success. Kansei Engineering focuses on customers' emotional or perceptual needs. Jiao et al. (2006) believed that using customers' sensibilities or feelings was necessary to design product differentiation means and find the design elements corresponding to the product image. Therefore, customers' perceptual needs are converted into the shape design characteristics of the target product and used to establish a database for evaluating interface design. Smith and Dunckley (2002) proposed using prototypes for synchronous design and iteration during the design process so that designers could obtain user evaluation feedback earlier.

Designers must allocate limited resources to the development of key design features, so it was important to find out the key styling elements that met the psychological needs of customers. Norman (1988) pointed out that designers needed to be more familiar with the conceptual design model and less familiar with the customer's mental model regarding the function, use, and terminology of system imagery. Therefore, establishing a good mapping between the user's mental model and the designer's conceptual design model is important in creating excellent products. The design concept model shows the concept of the product in the designer's mind and how the designer thinks the system should operate. The user's mental model refers to the user's understanding of the product system on how to function, operate, predict, and explain the product system. This is developed from the user's experience, training, and teachings. Wang and Chao (2010) used old anthropometric data to update. They proposed a method to obtain new data using Pairwise Body Dimension ratios (PBD ratios) to find Constant Body Ratio benchmarks (CBR benchmarks) that were least affected by gender and age. In addition to human dimension measurement, designers used different methods in the design stage to evaluate whether the product met customer needs and comfort to select the most appropriate design. The most commonly used method is usability evaluation in which user questionnaires are used based on preset evaluation criteria.

Kansei Engineering is a recent and effective customer-oriented human factor engineering method. There is a communication medium between designers and the needs of market customers. Among them, the term "sensibility" represents the customer's psychological needs for the product, while "sensibility engineering" is considered to be the understanding, analysis ability, and experiential response to the sensory information of the product. Nagamachi (1989) pointed out that the purpose was to develop new products based on customers' perceptual needs and to quantify and transform customers' feelings into the shape elements of new products. Therefore, the purpose of the design was to explore the relationship between customers' sensibility and product design characteristics and quantitatively analyze customers' subjective intentions. It needs to be discussed which styling elements were better to cater to customers' emotional needs.

Hand-based interactions with haptic devices become increasingly common. However, there are few empirical studies, especially on the use of hand-grip haptics for remote control. The use of remote control gripping haptics triggers a series of research activities to understand and define user experience (UX). UX is a multidimensional concept. The UX is a term used to describe users' perceptions and reactions to a product, system, or service in a specific context of use. Perceptions and reactions are physical, psychological, or both, while situations are temporary. Hassenzahl and Tractinsky (2006) believed that the concept of user experience attempted to transcend the task-oriented approach of traditional human-computer interaction and integrate aspects such as beauty, fun, happiness, and personal growth to meet the needs of ordinary people, but there were few tools.

Therefore, in this research, a set of "evaluation methods for the design of hand-held tactile emotional response remote controls" was developed including the application of human measurement and usability evaluation and operational calculations to evaluate the product. At present, the design of existing remote controls is mainly based on simple and thin shapes, and most remote controls only focus on the delivery of the blowing function and relatively little on the appearance design. Generally speaking, remote controls are considered a long-term product of electronic products and are often ignored in the product design process. However, the remote control is the most important communication medium when users hold tactile products and have the closest and most frequent contact with users. Therefore, using the remote control hand-holding haptics as a case study, a design method was proposed to conduct design and hand-holding tactile evaluations to select new designs with the best comfort and haptics.

## 2. Research Methods

### *2.1. Semantic Difference Method in Kansei Engineering*

In Kansei engineering, the interpretation of human perceptual responses is emphasized as the most direct expression of human psychology after receiving external stimulation is expressed in adjective vocabulary. Therefore, in many studies on Kansei Engineering, many scholars regarded this adjective vocabulary as an important factor for designers, consumers, and products. In the studies, adjective vocabulary was collected from relevant research literature, magazines, and advertising catalogs. These collected adjective vocabularies had similarities as well as ambiguities. Finally, the semantic difference method and other statistical analysis methods were used for further classification. The semantic difference method was used to explore the differences in the psychological cognition of target products among different user groups (Mondragon et al., 2005), and factor analysis was used to define the semantic axis. At the same time, the semantic space was constructed using the semantic difference method (Alcantara et al., 2005).

### *2.2. UX Measurement*

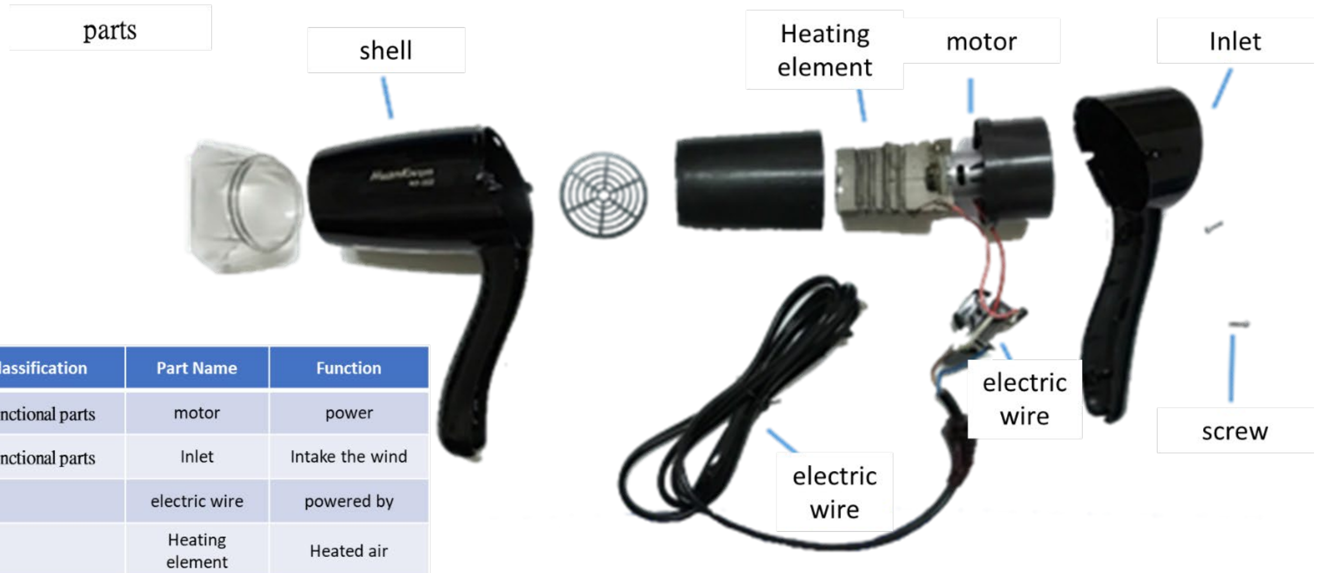
The UX tool for UX measurement was developed by Laugwitz et al. (2008) using data analysis methods. There was a validated tool to measure the user experience of interactive products (Cota et al., 2014). The process of the measurement is as follows.

Step 1: Deciding the target product;
Step 2: Collecting reference materials related to the target product;
Step 3: Measuring the human body dimensions for reference when designing the target product;
Step 4: Selecting the target product for comparison and filter the tactile adjective vocabulary;
Step 5: Designing new products by referring to the body measurements and operating conditions of the target product;
Step 6: Conducting a design evaluation of the new products and target products;
Step 7: If the user experience improvement of the new product is better than that of the target product, the design process ends. If the improvement is not satisfactory in operating efficiency, detailed modifications are made and compared with the target product. If redesign is required, Step 5 is repeated;
Step 8: The design process ends. This design process is only the end of the handheld tactile emotional user experience evaluation phase, and further decisions are made based on other methods according to the designer's needs.

UX testing requires performing defined tasks to test each product for approximately 20 minutes (including 5 minutes for questionnaire responses). The total testing time is approximately 2 hours per project. Before the UX test, the experimenter provides a summary of the procedure. Each subject is asked to perform 8 designated tasks with the chosen one. After the test task is completed, it is immediately given to the participant. Participants are instructed to answer questions based on their experience and feelings using product samples.

*2.3. Experimental Design and Materials*

The tactile feel of the remote control was designed based on the perceptual vocabulary and the measurement of the UX of these alternative products. User experience experiments were conducted to reveal how target users perceived the tactile feel of a remote control after interacting with it. The product for UX testing is shown in Fig. 1.




| Classification | Part Name | Function |
|---|---|---|
| Functional parts | motor | power |
| Functional parts | Inlet | Intake the wind |
| | electric wire | powered by |
| | Heating element | Heated air |
| operating parts | switch | Control power |
| Beautiful parts | shell | beautiful |
| Combine parts | screw | Assembly and combination |

**Fig. 1.** Remote control product description.

## 3. Results and Discussions

*3.1. Screening Tactile Adjectives*

In this research, tactile-related adjectives were collected and referred to tactile-related literature. After the first stage of screening, a total of 60 adjective words were obtained. After the visual words were eliminated, the number of independent tactile words decreased. The words included emotional vocabulary and material tactile vocabulary. After eliminating the emotional adjective vocabulary, 35 adjectives were left. An experimental questionnaire survey was conducted to screen 10 different remote controls. 4 suitable adjective words were chosen for each type of remote control. Finally, there were 8 independent tactile vocabulary left (Table 1).

**Table 1.** Glossary of tactile adjectives.

| | Average Filter Results | Final Screening Results |
|---|---|---|
| 1 | rough | rough |
| 2 | firm | firm |
| 3 | Detailed | Detailed |
| 4 | dry | strong |
| 5 | Tough | hard |
| 6 | hard | soft |
| 7 | soft | Smooth |
| 8 | Smooth | tight |
| 9 | flexible | |

**Table 1.** *cont.*

| | |
|---|---|
| 10 | cold |
| 11 | Warm |
| 12 | tender |
| 13 | Sticky |
| 14 | strong |
| 15 | tight |
| 16 | Moderate |

The result of the touch adjective words using the average method showed that 16 words were rough, solid, fine, dry, tough, hard, soft, smooth, solid, elastic, cold, warm, smooth, sticky, hard, tight, and gentle. As a guide for designing the remote control, different remote control sketch styles were designed as shown in Fig. 2.

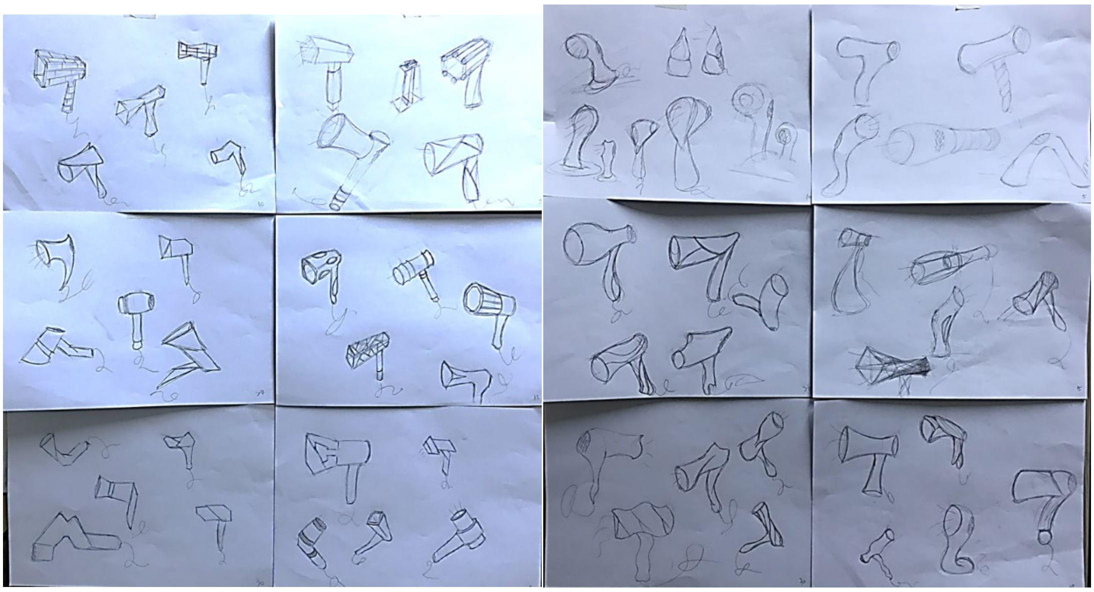


**Fig. 2.** Vocabulary sketches of tactile adjectives filtered by averaging method.

After filtering out the perceptual words, the rough, solid, delicate, strong, hard, soft, smooth, and tight design sketches were selected as they were related to the touch feeling of the hand. The following 4 different remote controls with the grip and appearance are shown in Fig. 3.

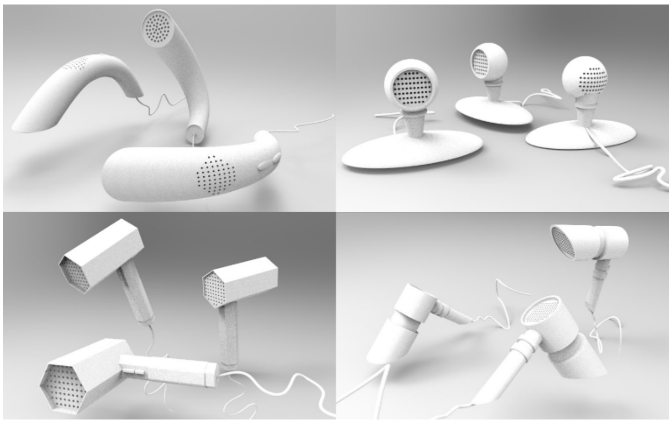


**Fig. 3.** Appearance entity design.

Through the design sketches, the following four different remote control grips and physical entities were created for comparison, as shown in Fig. 4. Fig. 5 shows the modified model for later use as a test.

**Fig. 4.** Comparison of physical appearance design and graphics.

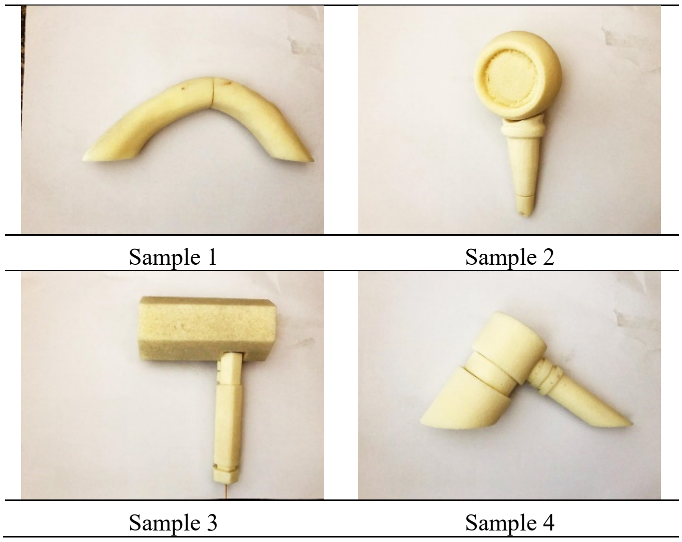



**Fig. 5.** Test model production.

The UX tool for UX measurement was developed by Laugwitz et al. (2008) through data analysis methods. There was a validated tool that was widely used to measure the user experience of interactive products (Cota et al., 2014; Rauschenberger et al., 2013; Schrepp et al., 2014). A layered structure based on UX structure consists of 8 dimensions of UX aspects as shown in Table 2 (thermal conductivity and rigid strength).

**Table 2.** Tactile characteristics of remote control grip.

| 1 | Tactile characteristics | Description of tactile characteristics |
|---|---|---|
| 2 | The circumference of the circle where the middle finger touches | The length of the place where the middle finger can touch |
| 3 | The middle finger grip angle | Whether the middle finger grip point has an inclination angle mainly depends on the surface change of the object. |
| 4 | thermal conductivity | How does the human body dissipate heat? |
| 5 | Rigid strength | Depends on the softness and hardness of the grip |
| 6 | Concave-convex drop | Concave-convex drop variability |
| 7 | Texture unit size | Texture unit size |
| 8 | Smoothness | Be easy |

There was a randomized order of positive and negative vocabulary for each item in the questionnaire. A 7-point scale was used to collect respondents' ratings of each perception item and supported instant responses to express feelings, impressions, and attitudes about using the product. Finally, testers used two testing methods: straight grip and flat grip Fig. 6).

A. straight grip B. Flat grip

**Fig. 6.** Hair dryer grip test.

*3.2. Example Verification and Discussion*

Product samples were classified based on the statistical results of user experience testing and the judgments of respondents. The benchmark comparison of the 4 product samples was compared as shown in Table 3. Further analysis of the benchmark comparison results showed that in terms of the subjects' UX perception of the tactile remote control grip, the best example was the straight grip sample 1, and the worst was the flat grip sample 2 as a whole. This result was reasonable and credible because the straight-grip sample 1 was a unique remote control grip and shape developed by remote control users for optimal performance in grip product design applications.

**Table 3.** Remote control grip tactile measurement using weights.

| Straight Grip | Sample 1 | Sample 2 | Sample 3 | Sample 4 |
|---|---|---|---|---|
| The circumference of the circle where the middle finger touches | 0.95 | 0.93 | 0.83 | 0.92 |
| The middle finger grip angle | 0.94 | 0.87 | 0.82 | 0.88 |
| thermal conductivity | 0.9 | 0.8 | 0.95 | 0.83 |
| Rigid strength | 0.86 | 0.41 | 0.72 | 0.98 |
| Concave-convex drop | 0.91 | 0.84 | 0.92 | 0.72 |
| Texture unit size | 0.92 | 0.73 | 0.78 | 0.83 |
| Smoothness | 0.98 | 0.84 | 0.94 | 0.89 |
| total value | 6.46 | 5.42 | 5.96 | 6.05 |
| Weights | 0.92 | 0.77 | 0.85 | 0.86 |
| Total weight value | 0.85 | | | |

**4. Conclusion**

The purpose of this study was to establish a model of optimal product image design and convert customers' perceptual needs into product design elements, using personal digital assistants as a case study. The implementation procedure of this study consisted of 8 steps. In this study, through morphological analysis of product modeling, the morphological shaping elements and categories of remote controls were summarized. The level of the designed remote control according to the perceptual model corresponding to the perceptual vocabulary was different from the products on the market, indicating the prediction ability of the perceptual model was trustworthy. The deduced shape design principles of the remote control provided designers with a way to combine specific shape elements to enhance the effectiveness of the overall product shape image. The perceptual design model can be used to identify customers' perceptual needs and product styling elements. By finding the correlation between the two, the key points of product design can be effectively and quickly obtained to establish a communication channel with customers and reduce the number and cost of design changes. Customer satisfaction was improved being compliance with the design principles and knowledge of human factor engineering, which is important in designing high-quality products.

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**Data Availability Statement:** Not applicable.

**Conflicts of Interest:** The author declares no conflict of interest.

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