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A CASE STUDY OF THE MULTI-FUNCTION HOUSEHOLD IRONING-TABLE BASED ON KANSEI ENGINEERING

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Abstract: The research aims to solve the space conflict between the development trend of small-sized housing and oversize professional ironing-table with a view of achieving innovative design of multi-functional household ironing-table. The paper discusses how to blend multi-function into the practice of design by taking household as the carrier in combination with the research approach of kansei engineering and evaluation. In terms of technological means, axial flow fan, PTC heating panel and other ironing products are ingeniously included in household products to achieve self- induced draft, drying and other functions. As regard to design method, the prototype is designed and produced through the experiment of two steps and emotional evaluation. Comparative evaluation is performed between the prototype and other household ironing tools, which realizes the significance of multi-functional ironing-table's ironing effect and the conception of space saving and provides optimized idea for the research of household ironing-table.

Keywords: *kansei engineering, multi-function, household ironing-table*

1. Introduction

Due to a continuous increase of consumers' requirements for high-quality life, the innovative research on products has become increasingly important. The ironing tool, which improves the flatness of clothes, has drawn unprecedented attention. The volume of professional ironing table is too large and unsuitable for the household, while small-sized ironing tool can not meet the requirement of higher standard. Along with the rapid development of multiple purposes and small-sized housing, much attention has been paid to the development of multi-functional household integration tool with a high potential and target market (Viswanathan, et al., 2016; Alexander, et al., 2016).

In academics, scholars began to conduct researches on functional breakthrough for ironing tool by using the method of module integration ten years ago (Jiang, et al., 2008). In recent years, scholars have focused on optimizing the function of ironing tool and obtaining prominent result (Liang, et al., 2016; Rosa, et al., 2016; Massey, 2017; De Leeuw, 2017; Friedrich, et al., 2017). However, most researchers neglect consumers' feeling and use background. The demand of consumer is constantly

evolving, while reconfigurable and multi-functional product is the one that can meet consumers' diversified demands (Lewis, 2011).

In the industry, ironing tool has constantly evolved. The cutting-edge ironing technology was rolled out by Laurastar during AWE exhibition in 2017, which achieved the effect of ironing nearly similar to professional ironing table. However, it does not solve the contradiction between the effect of ironing tool and the ratio of space occupied. Therefore, to ingeniously use family space and realize ironing effect is the key content and adirection in the research and development of the current household ironing table so as to improve consumers' satisfaction.

2. Research Aim

By reducing the space conflict between small-sized housing and large ironing table and taking consumers' demand into consideration, the multi-functional household ironing table with high utilization value and professional ironing effect has been developed. Household ironing table mainly focuses on catering to the household environment and space-saving, while multi-functional ironing table can achieve the ironing effect with high speed, quality and efficiency. Multi-functional household ironing table is designed to combine the advantages of both of them. Such design concept of superiority combination is widely concerned because multiple purposes and space saving conform to the current development trend Research idea refers to Fig.1.

Understand the problem. Through the analysis of previous research, the demand and expectation of consumers for household ironing tool has been preliminarily understood. It is known that they pay more attention to the specialty, volume, lying idle, time-saving and convenience of household ironing tool.

Analyze the problem. It is explored that multi-functional ironing table has similar technological function and ironing effect to professional ironing table, which makes consumers satisfied with the development trend of small-sized home appliances.

Solve the problem. In combination with the design angle and rigorous mechanical engineering of the product, the development trend of home appliances for small-sized housing is integrated with professional ironing effect in the manner of innovative expression.

Follow-up problem. On the basis of professional ironing product's effect and the development trend of home appliances for small-sized housing, the research and development factors of future multi-functional household ironing table are analyzed. According to the research idea, we have developed and designed new multi-functional household ironing table while adopting the method of emotional evaluation to conduct the experiment of designing multi-functional household ironing table as demanded by the consumer .

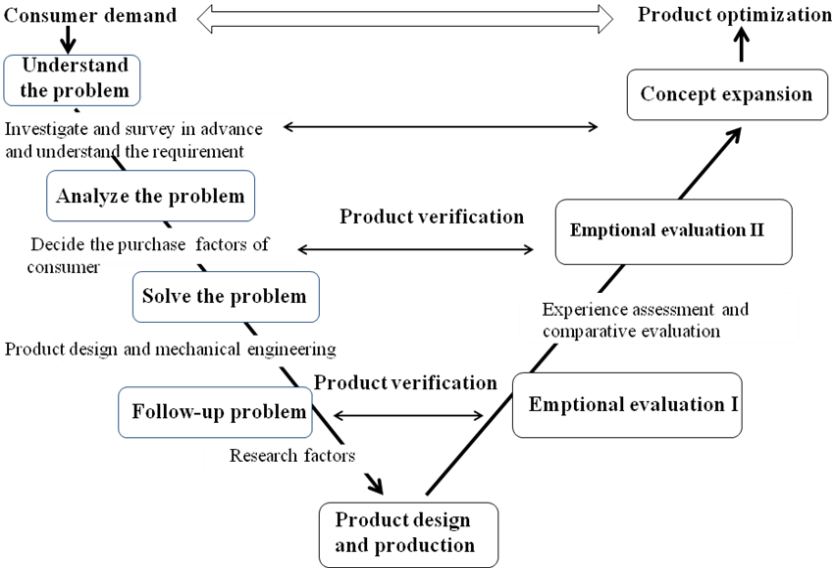

Figure 1. Research idea

3. Hypotheses and Methodology

3.1 Hypotheses

The research and development of ironing tool has developed rapidly in recent years. However, people's pursuit of life quality increases along with the progress of the times, hence it is necessary to discuss upgrading direction of household ironing tool in the future.

H1: Multi-functional household ironing-table can achieve two or more ironing functions owned by professional ironing-table.

Currently, most household ironing tools focus on achieving simple functions, while consumers have new pursuit of ironing effect. Therefore, the research on the principle and feature of professional ironing-table and the transfer of its function to household ironing-table will make the ironing effect more perfect.

H2: Multi-functional household ironing-table realizes function expansion with its volume intensified.

In order to achieve the effect of professional ironing-table, required accessories of products will increase correspondingly, resulting in oversize volume. Therefore, rapid conversion of iron-table and other household products should be made by adopting the multi-purpose concept, and the multi-functional household ironing-table with high utility rate of space and professional ironing effect shall be produced.

3.2 Design methodology

To meet diversified market demands, the manufacturing industry must provide more products and services for consumers (Kaneko, et al., 2017). Product design mainly considers how to use the multi-purpose concept to enhance the coupling of design variable controlled by stakeholders of different subjects and perfectly convert functional mode with different attributes so as to improve ironing effect (Panchal, et al., 2005; Kleinsmann, et al., 2017; Dong, 2017). In combination with both of them, the prototype with more professional ironing function and higher utility rate of space is researched and developed. The above analysis is corresponding to "Solve the problem" in Fig. 1.

4. Experimental method

The experiment includes two steps. The first step is to design and produce the multi-functional household ironing-table and complete preliminary emotional evaluation while the second step is to conduct comparative evaluation for the multi-functional household ironing-table with the rest of household ironing-tables existing in the market.

4.1 Function design

4.1.1 Function design

Clothing is still moist after it is ironed by an ordinary ironing tool, while the rate of evaporation depends on environmental conditions (temperature, speed and humidity). Relative air humidity has the greatest influence on the rate of evaporation (Lecoq, et al., 2017). In addition, pressure and cooling rate of the surface during ironing may have independent or coupled influence on the progress and final result of textile fabric ironing (Liang, et al., 2016; Benusiglio, et al., 2012).

Due to poor suction of traditional ironing-table, there are some disadvantages such as residual water and clothes sliding, etc. The centrifugal motor rapidly revolves and cooperates with the self-induced draft system with "V" funnel type wind force principle. Then, the airflow is produced and flows downward. It can better cling to clothes. Therefore, the self-induced draft system and drying system are the preferred functions of prototype design. The above functions are ingeniously applied to household appliances with high daily -using ratio so as to increase the utility rate of space.

4.1.2 Limit of main part

To achieve multiple purposes of the product in confined space, a program is designed to solve relevant problems in small-sized housing (Kim, et al., 2011; Wu and Lee, 2014). Ironing-table is not used every day, but writing desks and storage boxes are often used in daily life. Furthermore, the auxiliary space during drying shall be considered. Therefore, the writing desk with storage function shall be chosen as the main part.

4.2 Selection of materials

At present, researches on draught fan mainly concentrate on its noise, volume, revolving speed and stability (Choy, et al., 2017; Mao, 2017; Trabelsi, 2017). Fast revolving speed, small volume and quick installation are criteria in selecting induced draft system. Consequently, 200FZY6-S8S220V axial flow fan is used.

PTC thermistor, used as a drying device, is a ceramic part with barium titanate as the main ingredient. Its resistance-temperature characteristic is applied.

The surface of induced draft ironing-table, which uses the iron plate with venthole, is seamlessly connected to the operation shelf, creating a confined space. By cooperating with "V" funnel made of PVC, it ensures that the pressure transformed by wind energy of draught fan can make clothes more smooth.

The above contents and the following emotional evaluation are corresponding to "Analyze the problem" in Fig. 1.

5. Result and Discussion

5.1 Realization of function

5.1.1 Multi-functional ironing-table can achieve two ironing functions owned by professional ironing-table.

Connection of intelligent switch is as shown in Fig. 3-a. Press button 1 of remote control, and draught fan comes into operation as Fig. 2-b-A. The function of self-induced draft is achieved by ironing the plate's air hole, which can perfectly fix the clothes to be ironed on the ironing-table. Meanwhile, the combination of hot iron with cold airflow plays the role in shape-setting. When button 1 and button 2 are respectively pressed, heating element and draught fan work at the same time (as Fig.2-b-B) to achieve drying function and accelerate the process water evaporation water of the clothes after ironing.

5.1.2 Realization of the multi-purpose effect

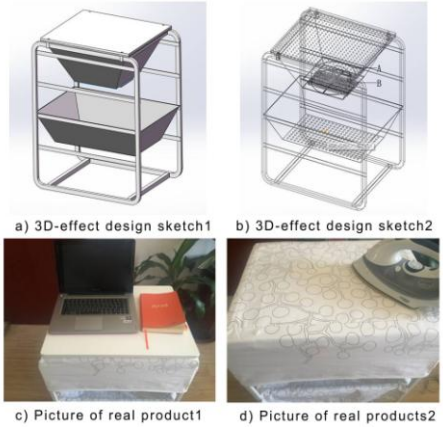

Fig. 2 3D-effect design sketch and Prototype

Fig. 3 Fittings Installation Procedures

It caters to the development trend of small-sized housing and improves the utility rate of space. By installing connection fittings (Fig.3-b) to main part (Fig.3-d),along with mutual covering and inserting through the connecting hole (Fig. 3-c) in the table board, the writing desk (Fig.2-c) and ironing-table (Fig.2-d) are rapidly transformed.

5.2 Emotional evaluation I

In view of eight-way split model developed by Larsen and Diener (1992), it is applied to the test analysis of consumers' feeling when the function is in on-state and off-state. Vocabulary test is set as: a, modern; b, kind; c, rich; d, professional; e, traditional; f, indifferent; g, dull; h, amateur. The eight-way split model is adopted as the evaluation reference, and fuzzy evaluation value is 1-10.

The experiment of emotional evaluation is respectively conducted for a multi-functional household ironing-table when its function is in on-state and off-state. Experimental subjects: 20 young women who are capable to receive new things.

The experiment concludes two steps: Test is conducted for experimenters of group I when the board is dismantled and the function is in off-state (the board is equivalent to an ordinary ironing board). Experimenters of group II shall work on the writing desk and then dismantle the board, and the test shall be conducted through the opening function of remote control. The two groups respectively give scores to affect the scale.

Table 1. Average value of emotional evaluation when the function is in on-state and off-state. (a, modern; b, kind; c, rich; d, professional; e, traditional; f, indifferent; g, dull; h, amateur.)

	a	b	c	d	e	f	g	h
Group I Function in off-state	4.29	3.57	4.86	4.76	5.00	3.81	4.62	4.76
Group II Function in on-state	6.19	6.67	6.67	6.95	6.71	4.76	5.43	5.48

Table 2 One-way ANOVA between two group （the function is in on-state：group1; off-state：group 2.）

		modern-g1/ modern-g2	kind-g1/ kind-g2	rich-g1/ rich-g2	professional-g1/ professional-g2	traditional-g1/ traditional-g2	indifferent-g1/ indifferent-g2	dull-g1/ dull-g2	amateur-g1/ amateur-g2
Factor	df	1	1	1	1	1	1	1	1
	MS	38.095	100.595	34.381	50.381	30.857	9.524	6.881	5.357
Error	df	1	1	1	1	1	1	1	1
	MS	0.638	0.395	0.681	30.761	0.557	0.376	0.452	0.526
	F	59.7	254.52	50.49	65.51	55.38	25.32	15.21	10.18
	P	0	0	0	0	0	0	0.003	0.004

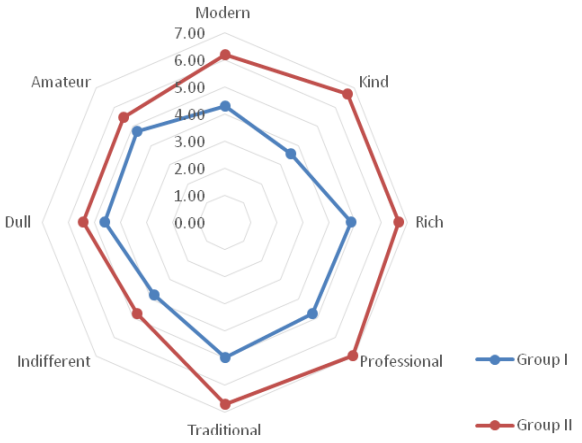

Fig. 2 Equipartition radar graph of emotional evaluation result when the function is in on-state and off-state.

According to the Table 1, person that perceives give obvious different data when the function is respectively in on-state and off-state. Table2 displayed the experiencing person gives data analysis to score according to his/her feeling and in combination with evaluation wordings. Fig. 4 is the Equipartition radar graph of emotional evaluation result. Combine fig. 4 and Table 2 we found it is observed that a remarkable difference exists between the two groups for different evaluation wordings, The scores of Item modern, kind, rich, professional and traditional in Group II are greatly higher than Group I. Pared-samples t-test shows P=0.000≤ 0.05. It is observed that testers obviously give different scores for the two products, and the scores for the Group II is higher than Group I. According to the result of emotional evaluation I, participants' emotional response can be motivated when the function is in on-state, and higher scores can be obtained. Therefore, the necessity of hypothesis 1 and 2 can be proved, which is corresponding to "Follow-up problem" in Fig.

5.3 Emotional evaluation II

With the emotional value assessed, there will be subsequent experiment for comparative evaluation.
Comparative evaluation is made for the prototype and ironing board in the market. Observation method is used for analysis. The rating scale is a questionnaire that consisting of seven classes. Participants give different evaluations in accordance with their own subjective feeling by looking at the pictures of ironing tools.
participants give different evaluations in accordance with their own subjective feeling.
Participants: As it involves related issues about product design and mechanical engineering, interviewees include housewives (i.e., consumer group),and the group of designers and machinists. Each group consists of 6 people to conduct comparative experiment.
experiment.
Evaluation objects: Prototype as Fig. 5-a; 2 Ordinary household foldable ironing board as Fig. 5-b; 3 Ironing board with shoulder blade as Fig. 5-c; 4 Mirror ironing board as Fig. 5-d.
Evaluation words: Function, practicability, intelligence, efficient utilization, appearance style and specialty.

a) Prototype b) Ordinary household foldable ironing board c) Ironing board with shoulder blade d) Mirror ironing board

Fig. 5 Evaluation objects

The a, b, c, d in the above figures respectively represent prototype, ordinary household foldable ironing board, ironing board with shoulder blade and mirror ironing board. according to the Average value of emotional evaluation between three group for four kinds of ironing boards draw the line chart. In general, Fig. 6 shows that the average score of multi-functional ironing table is obviously higher than the scores of other three kinds of household ironing boards. As the product in this research obtains the highest evaluation, we need to respectively extract three groups to respectively analyze the details of prototype evaluation.
By integrative observation of Fig. 7, 8 and 9, it is discovered that the designer group, machinist group and consumer group agree that the advantages of multi-functional ironing-table is efficient utilization and specialty, while intelligence is its shortcoming. From the perspective of product design and development, the main development direction of multi-functional household ironing-table is to continue maintaining and promoting the competitive advantages of efficient utilization and specialty

in order to keep ahead of competitors. Furthermore, intelligence is the disadvantage of prototype. To make it reach or surpass the level of competitors, its intelligence is to be enhanced., which will greatly improve the competiveness of prototype.

With simple efficient utilization does not bring strong sense of identity to consumers. Only when the function with more professional ironing effect is combined, it is more in line with the demand of consumers. These are influence factors for consumers deciding to use multi-functional household ironing-table. Meanwhile, it is the key content of optimal design of future multi-functional household ironing-table, which is corresponding to the follow-up problem aforementioned.

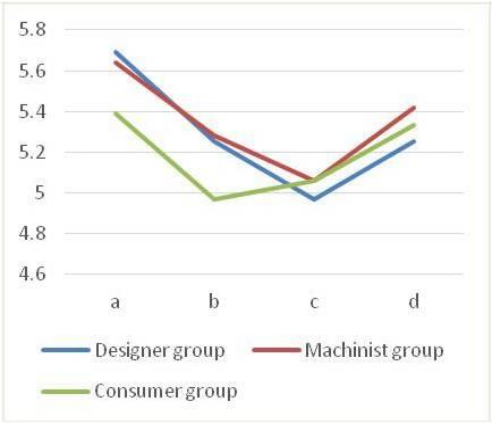

Fig. 6 Comparison in the average value among designer, machinist and consumer groups

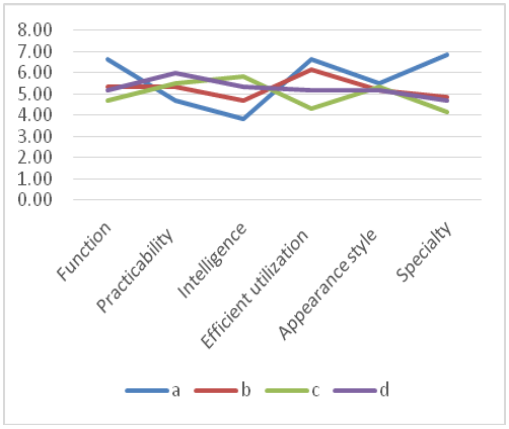

Fig. 7 Comparison in the average value between designer group for four kinds of ironing boards

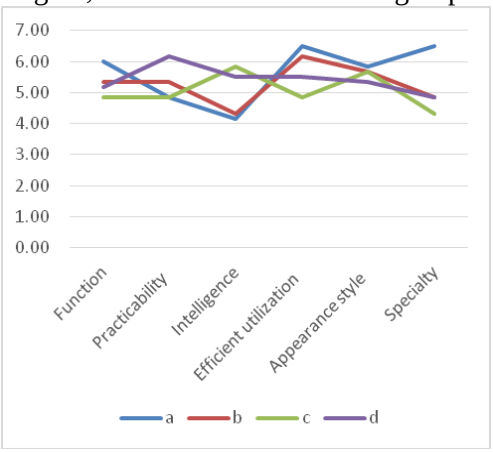

Fig. 8 Comparison in the average value between machinist group for four kinds of ironing boards

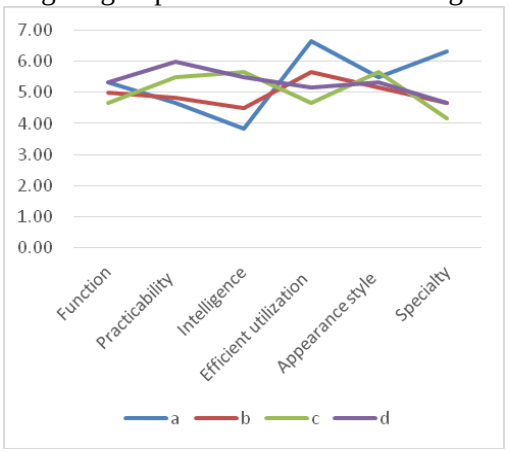

Fig. 9 Comparison in the average value between consumer group for four kinds of ironing boards

6. Conclusion

The research conducts an experimental test for housewife using new multi-functional household ironing-table, and the method for emotional evaluation is used to evaluate consumer's recognition degree for the product. Thus, it is found that the primary research for the prototype on the future development trend has been completed to some extent. At present, the research of ironing tool concentrates on enhancing the function achievement of ironing effect, which makes the household ironing products occupying a large market share neglected. The research focuses on solving the conflict between the ironing effect of ironing products and the ratio of space occupied.

In the research and development of multi-functional household ironing-tables, the thought of product design shall be combined with mechanical engineering. The thinking mode of product design focuses on how to apply the machine parts that can improve ironing effect to household products and the free convertion of two or more roles. The objective of mechanical engineering lies in how to achieve the ironing technology with high quality and efficiency. By combining these two modes, the concept of

multi-purpose product design is realized so as to better cater to the space constitution of small-sized housing.

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