

Study on the Reusability of Design Information for Leather Goods

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Abstract: The content of design information for leather goods was introduced in brief. It included information of design principles, design requirements, design process and design results. The factors that influenced reusability of design information for leather goods were discussed in detail. The fuzzy comprehensive evaluation on the reusability of design information for leather goods was studied at length. Then the method of reusing design information for leather goods, decomposing and then matching, was brought forward. The ways of reusing process of design information for leather goods were introduced. The reusable design information was organized and managed by computer technology. Designers can obtain helpful information rapidly, accurately, and efficiently, and the design efficiency can be greatly improved.

Key words: design information for leather goods, reusability, fuzzy comprehensive evaluation

1 Introduction

With the increasing global competition and the rapidly developing information technologies, modern companies have to face the difficult problem to promptly meet the market requirements with lower cost and higher qualities. At present, the competition among enterprises has changed to the digital applications between enterprises of the competition, as well as the enterprises of leather products. Reuse technology applied to product design has become one of the important methods to improve the competitiveness of enterprises.

2 Theoretical Basis of Reusability of Design Information for Leather Goods

2.1 Contents of Design Information for Leather Goods

Design information for leather goods refers to all design knowledge, design methods, design process and geometry structure of leather goods. It includes information of design requirements, design principles, design processes, and design results.

1) Information of design requirements

The information of design requirements for leather goods mainly contains popular trend and customers' demands of leather goods, such as their functions, the lasts, the soles, the heels, the styles, the patterns, the materials, the colors, and packaging requirements.

2) Information of design principles

The design principles run throughout the whole design process of products, and guide designers to design products that meet customers' demands and have some functional properties. They contain the knowledge of ergonomics, aesthetic principles, general characteristics of leather products, methods of making patterns, manufacture technology, design experience, industry norms, and so on.

3) Information of design process

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The information of design process mainly refers to the course how designers select the structure of products, the appropriate lasts and materials based on customers' requests, and their corrections and improvements of products' design. Information of design process records problems arising in the design process and the corresponding solutions, which will be useful for new designs in the future.

4) Information of design results

The information of design results is the information presented by products that have been successfully manufactured. The information of design results for leather goods includes information of their components (such as the heel, the sole, the upper, decorative items, etc.), the information of structure, technical requirements, materials, patterns, styles, and other information.

2.2 *The Reusability of Design Information for Leather Goods*

The reusability of design information for leather goods refers to their ability to be reused in the design of new products. The reusability is an indication used to measure the ability. The design information reuse for leather goods, contains two aspects: a) reuse of high-level conceptual design information of leather products, including information of design principles, design requirements, products' function, and design experience; b) reuse of design information of specific components, such as heels, soles, and decorative pieces.

3 Evaluation on the Reusability of Design Information for Leather Goods

3.1 *The factors that should be considered*

Design information of a certain leather product can be characterized by a number of items. The items and the value of their characteristics should be first determined when we decide whether the design information will be reused in the design of new products.

1) Conceptual design

The conceptual design is the initial idea in the process of product design, where designers express originality using design elements and some design approaches. The ratio of superposition in design ideas decides whether it will be reused. Reuse of this design information can be carried out on a higher level when the way of thinking has been more abstracted.

2) Functions

The function of products meets customers' particular requirements. In general, it is realized through materials and structures. Take sport shoes for example, in order to achieve their good wearing performance, wear-resistant soles, appropriate pattern of outsoles, or high-strength material used in parts easily worn out can be adopted in the design. If the functional demand for a leather product is similar, this method of function design can be reused.

3) Manufacture technology

The manufacture process is a key factor to leather products' quality. A different technology represents a different style of leather products, whether delicate or free.

4) Structure

There are various structures of leather products, and each structure corresponds to a specific function and a theme. Demand information of structure comes from the design requirement, when the basic positioning of new products is given out, a specific analysis can determine whether to reuse a previous design.

5) Materials and colors

Materials play a significant and direct role in the quality and style of leather products. Collecting and categorizing different materials and colors, marking their style and purpose and recording the source and

price information can help to make color cards. Whether and how to reuse the design information will be determined according to the product style and features of components during reuse designing.

6) Last

Last determines the basic design of shoe style, and style of last mainly changes in the front of the last, the position before the first metatarsal phalangeal joint. In order to save production costs and simplify the production process, reuse of last back is put forward. Based on different customers' needs, different toe thickness, different toe width, and different head style such as square, round, flat, or sharp head can be matched with a standard last back body. This will not only save costs of last design and production, but also help to form a number of standardized parts, so that assembly of shoes might become true.

The following two aspects should be considered when reusing the back of shoe last:

①Types of shoes

It has been known that leather shoes, rubber shoes, cloth shoes, and plastic shoes have different shrinkage and deformation when wearing because of their different materials, so their last arrangement cannot be the same. For different types of leather shoes, the last arrangement is not exactly the same either. Take women's round-head shoes and plain-head shoes for example, the round-head shoe upper doesn't cover most of foot-face and has no upper constraint, in order to make the shoe fit and catch the heel, its last should ascend in the waist, descend at the heel, and get a little narrow at the bottom.

②Heel height of shoes

The heel height of women's shoes could be divided into seven levels as 20, 30, 40, 50, 60, 70, 80 mm, the men's shoes into four levels as 25, 30, 35, 40 mm. Look at the main sizes of women's round-mouth shoe last and men's Balmoral shoe last, which are in Table 1.

Shoe Type	Heel Height	Bottom-line Length	Ball Girth	Base Width	Front Rising Height
Women's round-mouth shoe 23(2)	20	240	213	78.9	16
	30	240	213	78.9	15
	40	240	215	76.3	14
	50	240	215	76.3	13
	60	240	217	75	12
	70	240	217	75	11
	80	240	217	75	10
Men's Balmoral shoe 25(3)	25	270	239.5	88	18
	30	270	239.5	88	17
	35	270	236	86.7	16
	40	270	236	86.7	15

It can be seen from the table that the main characteristic sizes and arrangement of last change when the heel height changes. The heel height should be taken into account when reusing the back of last.

3.2 Fuzzy comprehensive evaluation on the reusability

The enterprise makes production according to customers' demand, which reflects requested performance of products, as well as customers' subjective desire and expectation. This demand and subjective will are often uncertain and ambiguous. Before reuse of design information for leather goods, we should find the design information that is the same or similar to the design requirement of a new product, then directly reuse or modify to reuse, avoiding repeating of design. Prior to design information reuse, it is necessary to determine the degree of similarity between them. Leather products industry is a

very empirical industry. There are many features of leather goods, but generally not described precisely and completely enough. The fuzzy comprehensive evaluation has been introduced to determine the extent of their similarity and decide whether or not to reuse.

1) Theory of fuzzy comprehensive evaluation

Firstly some of the characteristics are selected to represent the leather products, then use the cut-off level λ to roughly filter the candidate set of previous design, then use close-degree to judge the closeness between the new product design that customers request and the previous design, and then decide which candidate as a reuse design.

a) Characteristics description

$$U = \{u_1, u_2, \dots, u_n\} \quad (1)$$

n pieces of characteristics are used to describe the features of leather goods. u_i refers to the i characteristic.

b) Favorably conversion

Fuzzy characteristics matrix will be converted into the subjection-degree matrix, $m_{ji} \in [0,1]$, so that the close-degree can be used to measure the similarity. It will be more favorable when more close to a constant. The converting formula is:

$$m_{ji} = \min(X_{ji}, u_0) / \max(X_{ji}, u_0) \quad (2)$$

μ_{ji} refers to the favorable subjection-degree of i characteristic of j scheme; X_{ji} refers to the value of i characteristic of j scheme; u_0 refers to the value of characteristic of the design scheme based on customers' requirement, different items have different values; $\max(X_{ji}, u_0)$ means the bigger of X_{ji} and u_0 ; $\min(X_{ji}, u_0)$ means the smaller of X_{ji} and u_0 .

(c) The weight

The weights measure the importance of various items, their values are between $[0,1]$, it is marked as:

$$A = A(a_1, a_2, \dots, a_n) \quad (3)$$

Where,
$$\sum_{i=1}^n a_i = 1$$

Each characteristic of items has different weight, due to their different contribution to the product, different evaluation of customers and manufacturers.

(d) Cluster analysis

The cut-off level λ is used for cluster analysis, $\lambda \in (0,1]$, the start value is 1, and then select an appropriate value for cut, any values greater than λ are changed into 1, any values smaller than λ become 0, so that it's easy to see which design schemes are more close to the design requirement of new product, then find candidates for the program.

(e) Calculating the close-degree

Inner plot and outer plot are used together to describe the degree of closeness of the two fuzzy sets. The larger the inner plot, the closer the two fuzzy sets; the larger the outer plot, the farther the two fuzzy sets. Suppose A, B are the fuzzy sets in the domain of U .

The inner plot:

$$\underline{A} \bullet \underline{B} = \max(\min(\underline{m}_A(u_i), \underline{m}_B(u_i))) \quad (4)$$

The outer plot:

$$\underline{A} \otimes \underline{B} = \min(\max(\underline{m}_A(u_i), \underline{m}_B(u_i))) \quad (5)$$

The close-degree:

$$d(\underline{A}, \underline{B}) = \frac{1}{2} [\underline{A} \bullet \underline{B} + (1 - \underline{A} \otimes \underline{B})] \quad (6)$$

Finally, after the close-degrees of all candidates and new design scheme with customer requirements are calculated, the candidate with largest close-degree will be reused in the new design scheme.

2) Example

In design of sport shoes, the customer has made a number of structural and functional requirements. In accordance with these requirements, 4 similar previous designs have been found; one design of them will be taken as reuse design information after analysis. Although there are many characteristics of sports shoes, several important factors will be chosen to measure. In this case, the structure, air and water vapor permeability, weight, shock absorption, reverse-resistance, slip-resistance, wear-resistance (respectively, M_1, M_2, \dots, M_7) are selected to compare.

First of all, optimize the characteristics of the property of sport shoes, and multiplied by the corresponding weight; then, use cluster analysis to screen a group of candidates sets, then the candidate matrix of characteristics is obtained, as shown in the following:

$$R_{7,4} = \begin{Bmatrix} \begin{matrix} & M_1 & M_2 & M_3 & M_4 & M_5 & M_6 & M_7 \end{matrix} \\ \begin{matrix} C_1 \\ C_2 \\ C_3 \\ C_4 \end{matrix} \begin{bmatrix} 0.8044 & 0.89 & 0.9411 & 0.9802 & 0.9139 & 0.9678 & 1 \\ 0.9661 & 0.9361 & 0.9844 & 1 & 0.8898 & 0.862 & 0.9294 \\ 0.4417 & 0.6099 & 0.7758 & 1 & 1 & 0.8214 & 0.8214 \\ 1 & 0.7857 & 0.6875 & 0.6875 & 0.6111 & 0.6471 & 0.7882 \end{bmatrix} \end{Bmatrix} \quad (7)$$

Assume that the value of characteristics of customer demand is 1, calculating out the candidate sets' close-degree with the customer demand, the biggest will be reused in the new design.

3) The actual reusability of design information

The actual reusability of design information refers to the frequency of its reuse at the given design level. It is measured by the percent that the times of all design information's reuse divided by the times of its reuse. In product design, the actual reusability will not be the factor that decides whether or not to reuse some design information, however, through the statistical analysis of reusability of product design information, some measures can be taken to increase the reusability of design information of lower reuse rate and phase out those design information with too low reuse rate.

4 Reuse Process of Design Information for Leather Goods

The reuse processes are shown in the following figures (Figure1~ Figure2). The reuse steps are: Firstly, match the design demand and restrict when receiving a new design (Figure 1), if customer demand is fully consistent with the previous design, you can reuse the product as a whole; if not completely match, it is necessary to break down the demand into the conceptual design, functions, sculpt and technology (Figure 2); sculpt can be divided into last, structure, materials and colors2; function can be broken down into specific comfort and mechanical features, then make match respectively, decide whether to reuse according to the match degree.

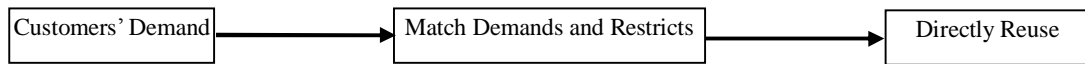


Fig.1 Match and reuse of requirement

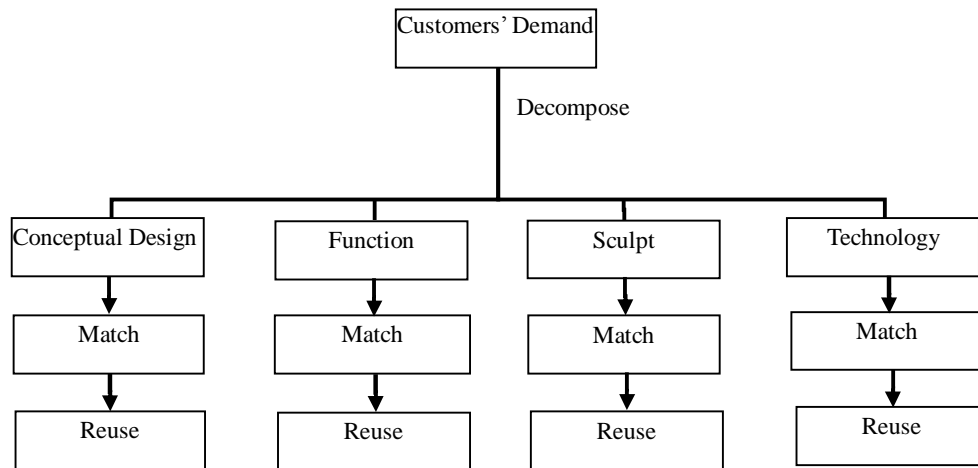


Fig.2 Decompose, match and reuse of requirement

5 Organization and Management of Reusable Design Information

The reuse of design information for leather goods is based on the repository of reusable design information. Now management of design information is integrated with computer technology, making the design information digital, formalized, and systematic. There are reasonable, mature and unified mechanism and environment to support and realize the automation of design information processing and decision making. After the repository has been built up, searching, matching and selecting of design information that is similar to the customers' demand become very convenient. Designers can obtain helpful information rapidly, accurately, and efficiently, and the design efficiency can be greatly improved.

6 Conclusion

The period of new leather product design is generally a little long, and there are many design work done repeatedly that causes high design and production costs. Reuse design will greatly simplify the design process of new products, improve efficiency and reduce design costs. We should attach more importance and make more effort in the research on reusability of design information for leather products.

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