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Product Design Based on Collaborative Kansei Engineering

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ABSTRACT

Collaborative Kansei Engineering is to achieve design optimization through multi-party collaboration and resource sharing, which can solve the problems of complex processes, large span of specialties, and long development cycles in each stage of design research. In this study, a collaborative design team was firstly formed based on the expertise, capability and working experience of different groups, and collaborative Conceptual Engineering was used to exchange and share knowledge on product design perceptual information and product attributes in order to speed up the decision-making process and improve design efficiency. Then, starting from the design task workflow, the tasks are decomposed and optimized according to certain logical relationships to achieve efficient design resource matching and improve the execution efficiency and controllability of collaborative design. Finally, the Design principles of Collaborative Kansei Engineering is constructed by considering the personal information of design resources, collaborative cooperation ability and other information. The results show that the approach to Internet product design based on Collaborative Kansei Engineering can improve the correct rate of decision evaluation in the product design process and improve the design efficiency.

Keywords: Collaborative Kansei engineering, Product design, Collaborative design team formation, Evaluation method

INTRODUCTION

Kansei Engineering originated in Japan in 1970 when the Department of Engineering at Hiroshima University introduced perceptual analysis into the field of engineering research. The term Kansei Engineering was first introduced by Mazda Japan in 1986. In the 1990s, Japanese industry introduced perceptual engineering in all aspects, applying its technical methods to the development of new products such as housing, automobiles, home appliances, household goods, and office supplies, etc. In 1993, in order to facilitate In 1995, the first "Symposium on Kansei Engineering" was held in Japan, and two years later, the "Japan Society for Kansei Engineering" was established. and the first global conference on sensual engineering was held in Japan.

Kansei Engineering is a comprehensive interdisciplinary discipline between design, engineering, and other disciplines, and belongs to the category of engineering. According to Akira Harada, Chair of the Department of Perceptual Cognition and Neuroscience and Professor of the School of Art and Design at Tsukuba University, although perceptual engineering belongs to engineering, it also involves art science, psychology, disability studies, basic medicine, exercise physiology, and other fields. It is now generally accepted that Kansei Engineering is the concretization of non-deterministic factors such as users' emotions or imagery into product design, and is used to describe, measure and statistically analyze the relationship between users' emotional preferences and product form, together with research theories such as ergonomics, design psychology, and user behavior, to build a theoretical system for industrial design research. Kansei Engineering focuses on the interrelationship between the user and the product, converting the imagery or concepts generated in the user's mind into quantifiable design parameters. In the context of perceptual engineering, "quantification" is the process of digitally presenting the relationship between the user's emotions and the design elements. In product design research, Kansei Engineering can be applied to express people's implicit perceptual factors in a quantified or semi-quantified form, and can establish a correlation with the design elements of the product, thus achieving a target product that meets the user's perceptual needs.

Collaborative Kansei Engineering emphasizes design optimization through multiparty collaboration and resource sharing, and is an open perceptual engineering system that solves the problems of complex processes, large span of specialties, and long development cycles in all phases of design research. Collaborative Kansei Engineering is one of the categories of perceptual engineering. Collaborative Kansei Engineering design process refers to the design goal that the complexity of a product's imagery or design attributes is beyond the designer's own working ability, and the design project involves more categories, which must be achieved with the deep participation of multiple groups, and through certain information exchange and interactive collaboration mechanisms to complete their respective collaborative tasks. The essence of Collaborative Kansei Engineering is that by exchanging and sharing perceptual information about product design, product attributes and other knowledge, the correct rate of decision making in the product design process is improved, the process of decision making is accelerated, and the efficiency of design is improved. In particular, with the development of diversified demands and the speed of product updates, companies must launch iterative and innovative products as soon as possible, while any complex project is completed in stages and according to certain steps, and there is an interdependent relationship between the tasks that make up each stage, and the completion of one task may require other tasks to provide the necessary information, which makes the personnel who undertake these tasks This makes it necessary for the people who undertake these tasks to also work with a Collaborative Kansei Engineering concept.

COLLABORATIVE DESIGN TEAM COMPOSITION

A collaborative team is essentially a team organization with limited resources, knowledge and concurrent behaviors. Team members need to have knowledge and capabilities in their respective fields, be able to self-organize and manage themselves, and work together to achieve team collaborative innovation tasks with a clear understanding of their roles. Due to the high complexity of the product form innovation design process and the variety of design tasks, multiple members need to work together to complete. Each group or each member in the collaborative team has different capabilities, and the collaborative objects can be classified according to each party's capabilities. The teams under the same kind of collaborative objects with different capabilities are called sub-teams, and the sub-teams can be cross-linked with each other, and a member can belong to more than one sub-team at the same time.

In the process of multiparty participation in collaborative design, the multiparty groups of the collaborative team mainly include users, designers, companies and experts. The user group can provide the original product experience information, demand information and evaluation information to effectively ensure the practicality of collaborative innovation; the designer group knowledge subject can provide feasible innovative design and technical solutions for the innovation process; the designer group knowledge subject can provide feasible innovative design and technical solutions for the innovation process; the company and enterprise are responsible for clarifying the design carrier; the expert group can effectively ensure the design and technical solutions through The expert group can effectively ensure the scientific and robustness of collaborative product innovation through scientific qualitative and quantitative analysis. The composition of each group in the collaborative team is shown in Table 1.

In addition, collaborative product design requires design subjects with different professional specialties distributed in different places, using different design tools, to discuss and modify the design plan repeatedly in a shared

Table 1. The composition of each group in the collaborative team.

Collaborative Group	Collaborators Object
user group	lead users
	creative users
	potential users
designer group	product appearance designer
	functional structure designer
	production process designer
expert group	design experts
	manufacturing experts
	development experts
composition	design company
	corporate departments

environment, and to complete the product design with the fastest speed and the best quality. It requires that all relevant members can be informed of relevant design solutions in time, can keep abreast of the progress status of the design process, can dynamically obtain information about the stage design results, can easily share design resources, and can effectively realize the collaborative communication of human intelligence. Generally speaking, when building collaborative design, the characteristics of the decentralized workplace of personnel from different departments and the problems of knowledge and information crossover between and within enterprises should also be considered. Therefore, collaborative design should satisfy the ability and efficiency that directly affects design, as well as the manageability of design.

COLLABORATIVE TASK ANALYSIS AND RESOURCE INTEGRATION

Building a collaborative task analysis and resource integration system is the basis for realizing collaborative innovation design. The relative sizes of task units under collaborative tasks are called task granularity, and there are clear boundaries between each granularity and clear information interaction or media transfer between them. How to reduce the complexity of tasks through reasonable task decomposition and optimal reorganization, and how to reasonably decompose the design tasks into design subtasks that are easy to accomplish collaboratively is the key to improve the collaborative efficiency. For a specific design task, choosing the appropriate design resources can maximize the resource potential and avoid the waste of resources.

In the process of collaborative innovation, in order to achieve the optimal matching of resources and tasks, the ability index evaluation of design resources is very important. With the matching principle of design task and resource's capability, the index capability evaluation of design resources is taken as the premise of design resource's preferential selection, and it is considered from both qualitative and quantitative aspects. On the basis of considering the individual capability and collaborative cooperation capability of design resources, the research is thought about the pursuit of resources' own interests, task weight, and quality threshold of resources, and the design capability required by the design task is carried out according to The decomposition and reorganization of tasks, and the use of resource matching methods to achieve the optimal matching of design resources and design tasks. The specific steps of collaborative task analysis and resource integration in this section are as follows: firstly, we start the collaborative design task decomposition and optimal reorganization, decompose the design tasks initially according to the standard enterprise product design process, analyze each design task according to the required design capability after the initial task decomposition is completed, and merge the tasks requiring the same design capability twice to form the design subtask group with the smallest granularity. group. Secondly, the design resources are integrated and selected, and the capability indexes of the design resources are aggregated, and the resources with the same design capability are formed into a temporary resource group. Finally, the matching of tasks and resources is completed, and the reorganized resource groups are matched with the task groups to obtain the

optimal solution for matching tasks and resources, taking into account the capabilities of group members and collaborative innovation capabilities.

In addition, collaborative task decomposition should follow certain principles, including process-first principle, user-first principle and management-first principle. The process-first principle means that the decomposition of the collaborative design task should be carried out in a top-down multi-layer decomposition until it is decomposed into non-divisible meta-tasks; the user-first principle means that the decomposition of the collaborative design task should be based on the user's requirements, and if the user finds the rules and special requirements of a design subtask, the user's requirements should be considered. It is easy to control and manage.

DESIGN PRINCIPLES FO COLLABORATIVE KANSEI ENIGINEERING

In order to effectively sort out the design method system of collaborative perceptual engineering and better guide the subsequent product design, the principles of collaborative perceptual engineering design are proposed. In the process of collaborative perceptual engineering system innovation, the composition of collaborative teams among knowledge subjects and under the classification of knowledge competence subjects is a subsystem of the collaborative perceptual engineering system, which also includes knowledge competence subsystem, product cognition subsystem and complex relationships among subsystems, so the composition and evolution of the collaborative perceptual engineering system is a complex system with many characteristics. These characteristics guide the principles of collaborative perceptual engineering design, which mainly include the principles of multilevel, holistic, openness, nonlinearity and dynamic evolution.

Multilevelness: The multilevelness of the synergetic design system is reflected in the composition of its elements, where the synergetic team, the synergetic task and the resource capability each form a level, and there are multilevel complex relationships between the synergetic team and the synergetic task, the synergetic task and the resource capability, and the synergetic team and the resource capability, such as crossover and affiliation. At the same time, the subjects of the collaborative team include both professional designers and collaborative users, and each of them has different knowledge backgrounds and different cognitive consciousness, thus constituting the diversity of collaboration. At least two groups should be involved in design activities, and these groups are usually independent of each other, and each has domain knowledge, experience and certain problem solving ability.

Holistic: For complex systems, the integration of the next layer will cause new functions to emerge from its upper layer, and these new functions are not simply the sum of the parts, but may converge with completely different characteristics. Synergistic perceptual engineering design system is closely connected between all layers, there is knowledge sharing and transfer between knowledge subjects, and the synergistic relationship between knowledge subjects will show gaining effect, which is the meaning and necessity of synergistic organization.

Openness: Complex systems are open systems, which are not only closely connected with the internal environment, but also have constant information and material circulation with the external environment. The synergistic sensual engineering design system can acquire more external resources and also complement their respective knowledge differences, strengthen the connection between each other or the close connection between each other and the outside, making the whole system process as an open subject system.

Nonlinearity: is the main source of complexity in complex systems. Nonlinearity implies diversity, variability and innovation. Complex systems can appear in different states only under nonlinear conditions, and it is the nonlinearity that gives rise to diversity. In the collaborative perceptual engineering design system, the interconnection and mutual constraints among multiple knowledge subjects and the interaction between each internal element also exist, and the spiral innovation of knowledge is realized through the knowledge sharing and communication of knowledge subjects. This determines the existence of complex non-linear roles and relationships between synergies.

Dynamic evolution: complex systems always keep changing from one state to another, the structure and function of complex systems are in change, and equilibrium and stability are a trend. In the collaborative sensual engineering design system, the dynamic changes of customer needs, the continuous development of advanced design tools and the independent learning of knowledge subjects make the collaborative system always in constant evolution.

In addition, the realization of system functions such as knowledge generation, dissemination and innovation in collaborative perceptual engineering product design as well as the management requirements such as identification, storage, integration and use of knowledge also require an authentic and comprehensive system principle. The specific principles of knowledge system modeling to be fully considered in conducting a complex product design system based on collaborative perceptual engineering include usability, authenticity, conciseness, relevance, systematicity and progressiveness. Practicality is the basic premise that the knowledge system model should be constructed to solve practical problems; authenticity is that the constructed knowledge system model should better reflect the actual knowledge system and accurately express the internal structure, composition and relationship of the collaborative perceptual engineering system; conciseness is that on the basis of truly reflecting the actual knowledge system, the modeling time and cost should be reduced and the system model should be expressed as concisely as possible; relevance is that the purpose of constructing. The purpose of the system is to meet the actual needs of the users, and it should respond to the objective facts in a targeted manner according to the actual needs; systematically, on the basis of meeting the targeted requirements, the internal structure, composition and relationships of the collaborative perceptual engineering design system should be expressed comprehensively, and the system composition should be considered systematically and deeply; progressively is that the process of people's understanding of the knowledge system is gradual, which means that the system modeling process in the collaborative perceptual engineering design. The system modeling process of collaborative perceptual engineering design should be carried out gradually from simple to complex.

CONCLUSION

Collaborative Kansei Engineering avoids the problem that traditional Kansei Engineering relies too much on the design ability and design experience of a single designer or a single group by exchanging and sharing knowledge about perceptual information and product attributes of product design, and improves the overall design quality and stability. This thesis forms a collaborative design team based on the areas of expertise and experience of different groups, which can effectively improve the efficiency of product form design. On this basis, the corresponding methods are used and requirements are collected using the characteristics of each group to obtain more accurate and comprehensive multiparty requirements. By decomposing and optimizing tasks according to certain logical relationships and efficiently matching tasks and resources, the execution efficiency and controllability of collaborative design can be improved. By applying the perceptual needs of multiple groups to the product design, we can design products that meet the perceptual needs of multiple groups.

At present, the research of product design for Collaborative Kansei Engineering is still in the initial stage, and it is necessary to continue to improve the team resource selection index and adopt more scientific weight determination methods to determine the weight of each collaborative group, so as to improve the efficiency of product design and promote the low-cost, high-efficiency and open innovation of related data and applications.

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