An Expert System to Support Clothing Design Process

Michele Santos[1] and Francisco Rebelo[2]

[1] Technical University of Lisbon, FA, Rua Sá Nogueira,
Pólo Universitário, Alto da Ajuda, 1349-055 Lisboa, Portugal
tmsantos@fa.utl.pt
[2] Technical University of Lisbon, FMH, Estrada da Costa,
Cruz Quebrada, 1495-688 Cruz Quebrada-Dafundo, Portugal
frebelo@fmh.utl.pt

Abstract. In the context of expert systems technologies and human computer interaction, the goal of this project is to construct an interactive design support to fashion designers when designing workwear or corporatewear clothes. This system will be fed by a semantic database that describes the relations between function and clothes specific context of use under the user's perspective. This application will contain relevant information for clothes designers and producers, alerting them to the user's clothes preferences adequate to a certain task, and hopeful, an added value to be included in the beginning of the design process. To gather all this information it will be studied the user's real work situation and preferences under Kansei Engineering and Rough Set methodology. The outcomes of this study could help clothing designers to suggest effective user centred design clothes.

Keywords: Expert system; Clothing design; Design process; Kansei; Rough Sets; Uniform / Workwear clothes.

1 Introduction

Fabric textiles are used in a wide range of applications in clothing design. However, due to the panoply of possibilities and materials quality of existing fabrics, the adequate choice, according to the usage context and other specific requirements, it is not an easy and rational process. Therefore, proposing an expert system that meets the requirements of a certain case could bring many advantages to the clothing industry and its inherent complexity. This can be achieved by a careful selection of inputs, but also by global or local tailoring properties of future potential users, condensed in a knowledge data base.

Clothes design developing process is surrounded by subjectivity, not only in uniform/workwear/corporatewear area, but also, in ready-to-wear. During the design process, firstly, information is explored in orientation ideas concerning moods, themes, concepts and product types. Secondly, all gathered data is processed and transformed into product ideas combining silhouettes, materials and colours [1]. Influences come from both external and internal sources, both from the environment and personnel related to the design process, directly or indirectly [2]. It is very

M.J. Dainoff (Ed.): Ergonomics and Health Aspects, HCII 2007, LNCS 4566, pp. 284–289, 2007.

common to forecast and to identify trends as key elements in the fashion industry, but the doubt remains—is this really a reliable source [3].

A design team members brief will usually initiate the process by defining "the garment type, age group, purpose, climate and price range ", a complete involvement in fashion ideas and different means of communication is also indispensable [1]. References on cultural, social and political events should also be regarded [2], as well as we suggest, the inclusion of the user's real work situation and preferences analysis study, to allow the development of adequate clothes subject to the context of use.

Therefore, the main purpose of this work is to present an interactive system concept based in an expert system to support clothing design process, making the design development process more objective. Simultaneously, the system will provide clothing designers the necessary elements for user centred design, subject to the context of use, throughout a user's preferences data base. There are three phases to achieve this purpose: (1) to define how data should be introduced in the knowledge data base of the expert system; (2) to define the data entry categories, according to the population target; (3) to define the data output type more useful for clothes designers, the potential users of this system.

Previous studies using expert systems have been applied in different design areas:

- Expert system conceptual design for computer software [4];
- Expert system for selection of coatings for metals [5];
- Expert system for composite laminate design [6].

In these studies the systems have proven to be effective, and better, when compared with previous ones [6]. According to Ichiko [4], it should be noted that, future intelligent man-machine interface, needs design aid technology to facilitate easy understanding of the design coverage, without distressing high level human intelligent activity.

Accordingly, we propose an interactive expert system to support the clothing design process under Kansei and Rough Set methodology development. For preferences analysis we will use Kansei Engineering to transform the evaluation data, of user's senses and feelings, in design elements for clothing design. Human Kansei and Rough Set methods have been used in previous studies to obtain decision rules on experimental data set and design elements [7, 8, 9]. In the system, user accessibility was taken into consideration due to the possibility of changing input and output parameters amongst others: garment type, age group, purpose, environment; through the graphic user interface.

2 A Concept Expert System to Support Clothes Design

Our proposed concept expert system to support clothing design process includes the following phases:

1. Knowledge data base collection
2. Data entry expert system categories
3. Data output expert system categories

In the following subsection, each phase will be described.

2.1 1st Phase – Knowledge Data Base Collection

This phase defines how data will be collected and introduced in the knowledge data base of the expert system.

We used Kansei Engineering and its semantic differential to ensure that user's perception and the entire surrounding environment are considered in the expert system.

Kansei Engineering is an ergonomic technology of customer-oriented product development, it focuses not on the manufacturer's intention of the product, but rather, on the customer's feelings and needs (*Kansei*) [10]. "*Kansei*" is a Japanese word that means the customer's feelings and needs relating to a product.

Kansei Engineering was developed in Japan, at Hiroshima University, in 1970, by Mitsuo Nagamachi and it has spread out, firstly in Japanese industries and them around the world. For many decades, manufacturers have provided hundreds of products which were developed from the manufacturer's intention. However, wise customers want products that fit their demands. This implies the need to incorporate the customer's needs and mind in the product, instead of manufacturer's objectives. To be able to do this, they should know what customer's needs have and what their feeling regarding the new product is. Kansei includes the customer's feelings about product design, size, colour, mechanical function, feasibility of operation, and price as well. We also propose to change some aspects of the Kansei methodology, introducing an Ergonomic Analysis before semantic variables definition, to be considered when deciding the semantics.

This methodology consists on:

Ergonomic analysis
This process starts with observation of the real work situation. An activity analysis of customer's working while interacting with their regular work environment is carried out with a camcorder and followed by a customer's behaviour survey, about their preferences and context of use. We will analyse and look for the influence of workwear in the interaction with other elements of the work system, evaluating and understanding if it causes problems.

Kansei semantics compilation
The collection of Kansei semantic variables is obtained though the selection of the compiled words from specialized bibliography and from potential user's and expert's opinions captured in different brainstorm sessions. All these words are then selected and reduced to a manageable number of relevant words for each characteristic and context.

Knowledge database
The previous ergonomic analysis and Kansei semantics compilation is condensed in a Kansei engineering knowledge database that responds to the user preferences market trend orientation. Consumer data can be inputted in the system depending on the users and context of use, every time it is required, or, when using the same data, adjusted every three or four years.

Rough Sets

Related to this point, we developed an expert system to build a systematic framework based on Kansei engineering technology. We utilized Rough Sets in the Kansei engineering system to construct the concerned database and computerized inference system.

Because Kansei has shown non-linear characteristics in the meaning statistics, usually it is used Neural networks measurement, Fuzzy Logics, Rough Sets and others without awareness of linearity or non-linearity of the Kansei. [11]. One of the problems found in Kansei is that human's Kansei concept does not have constant linear characteristics in statistical distribution. For example the Kansei big/small has a linear continuity, but the Kansei beautiful/not beautiful, has a curved aspect in physiological axis [11].

As verified by some experts, Rough Set theory enables to obtain more specific decision rules than traditional use of statistical regression analysis method in Kansei engineering, ensuring in better approaches to the characterization of design elements [7].

Rough Set theory is a mathematical approach to vagueness proposed by Pawlak in 1982. Its philosophy was set up on the assumption that we relate information to every object. Objects that we typify with the same information are indiscernible (similar) when we access any of them. This generated indiscernibility is the mathematical basis of the Rough Set theory [12]. The indiscernibility approach used in Rough Set is characterized in relation to a specified set of functions or attributes.

A set of indiscernible objects is entitled to an elementary set, and has a shape of a basic grain (atom) of knowledge about the universe; any combination of elementary set is described as crisp (precise) set – if not the set is rough (imprecise, vague). Subsequently, each Rough Set has boundary-line cases, i.e., objects that can not be classified with certainty as members of the set or of its complement; crisp sets do not have any boundary-line elements [12]. Thus, vague concepts, in contrast to precise ones, cannot be characterized in terms of information about their elements. Therefore, in Rough Set approach it is assumed that any vague concept is replaced by a pair of precise concepts – called the *lower* and the *upper approximation* of the vague concept. The lower approximation consists of all objects which certainly belong to the concept and the upper approximation contains all objects which may belong to the concept. Apparently, the difference between upper and lower approximation represents the boundary region of the vague concept [13].

An additional essential concept in Rough Set is that a minimal set of attributes can classify objects with the same accuracy as the original set of attributes. Exclusion of redundant attributes can help to recognize strong, non-redundant classification rules [14].

The most important advantage of Rough Set theory in data analysis does not require any initial or supplementary information about data, like probability distributions in statistics [12].

2.2 2nd Phase – Data Entry Expert System Categories

This section defines the data entry categories, according to the population target.

This expert system is primarily directed to clothing designers and clothes producers; they will use this platform as a design tool with all relevant users database

collected on the previous phase. To determine the important design inputs for designers we have made interviews to clothing designers with experience in workwear and corporatewear. From the interviews we have selected the main categories and respective options. This categories and options will enable designers to understand user's preferences and expectations related to the uniform they use to perform their tasks, in their work places, adequate to their basic use.

2.3 3rd Phase – Data Output Expert System Categories

The following part defines data output type more useful for clothing designers, the principal users of this system.

The given outputs, after the input selection, will give clothing designers a better understand of their work directions, based on user's requirements. These outputs will refer to design specifications to be considered from the beginning of the design phase, providing the base for a future user centred design uniform.

The system will facilitate designer's tasks by giving them a clear notion of potential user's needs, without trying to interfere or reduce their creativity. The interface was developed to provide effective and simple interactions between users and the system, with a human-centred design approach. We tried to give a positive experience to end users.

3 Conclusions

We have proposed a user centred technology to support clothing design process based on Kansei Engineering and Rough Sets. Kansei Engineering has been very useful for users, to select the fittest product to his/her Kansei, and even more useful, to designers [11], to understand the demands of the correct product whose specifications are suggested by the system. Rough Sets methodology appears to be of fundamental importance in artificial intelligence and cognitive sciences, particularly in machine learning, intelligent systems, decision analysis, and expert systems, along with other research areas.

The expert system prototype is being validated by a group of potential users – clothing designers. We are also trying to estimate user's and designer's satisfaction with this system outcome, as well as, how it can be improved and implemented in the future.

This interactive system simplifies the utilization of statistics data by clothing designers, who rather prefer to use a more specific design help tool, which provides specifications to be considered when designing.

We believe this system could be an additional value to the workwear and corporatewear industry.

Acknowledgments. The authors would like to thank to all the clothing designers that have participated in this study.

The research of Michele Santos has been supported by grant SFRH/BD/ 28621/2006 from Fundação para a Ciência e Tecnologia/Ministério da Ciência, Tecnologia e Ensino Superior.

References

1. Carr, H., Pomeroy, J.: Fashion Design and Product Development. Blackwell Scientific Publications, Oxford (1992)
2. Le Pechoux, B.: A Pattern Language Describing Apparel Design. Unpublished Doctor of Philosophy, North Carolina State University, Raleigh (2000)
3. Cayol, A., Bonhoure, P.: User pleasure in product concept prospecting. Theoretical Issues in Ergonomics Science, vol. 5, Taylor & Francis Ltd., pp. 16–26 (2004)
4. Ichiko, T.: An Expert System for Conceptual Design. In: Proceedings of the 2nd international conference on Industrial and engineering applications of artificial intelligence and expert systems, vol. 1, Tullahoma, Tennessee, United States, pp. 452–461 (1989)
5. Dobrzanski, L.A., Madejski, J.: Prototype of an Expert System of Coatings for Metals. Journal of Materials Processing Technology, vol. 175, Elsevier Science B.V., pp. 163–172 (2006)
6. Kim, J.S.: Development of a user-friendly expert system for composite laminate design. Computer Structures, vol. 79, Elsevier Science B.V., pp. 76–83 (2007)
7. Hirata, R., Nishino, T., Nagamachi, M.: Comparison between lower / upper approximations rough sets model for toddler shoes design. In: Proceedings of the 16th World Congress on Ergonomics. Elsevier Science B.V., pp. 738–743 (2006)
8. Nishino, T., Nagamachi, M.: Extraction of Design Rules for Basic Product Designing Using Rough Set Analysis. In: Proceedings of the 14th Triennial IEA Congress, pp. 515–518 (2003)
9. Nishino, T., Nagamachi, M., Ishihara, S.: Rough Set Analysis on Kansei Evaluation of Color. In: Proceedings of the International Conference on Affective Human Factor Design. Asean Academic Press, pp. 109–115 (2001)
10. Nagamachi, M., Imada, A.S.: Kansei Engineering: An ergonomic technology for product development. International Journal of Industrial Ergonomics, vol. 15, Elsevier Science B.V., p. 1 (1995)
11. Nagamachi, M.: Kansei Engineering and its Implications to Customer Satisfaction. In: Proceedings of the 16th World Congress on Ergonomics. Maastritcht, Nederlands. Elsevier Ltd (2006)
12. Pawlak, Z., Skowron, A.: Rudiments of rough sets. Information Sciences, vol. 177, Elsevier Science B.V., pp. 3–27 (2007)
13. Pawlak, Z.: Why Rough Sets? In: Proceedings of the IEEE International Conference on Fuzzy Systems, New Orleans, LA, USA. Springer, Berlin, pp. 738–743 (1996)
14. Jagielska, I., Matthews, C., Whitfort, T.: An Investigation into the application of neural networks, fuzzy logics, generic algorithms, and rough sets to automated knowledge acquisition for classification problems. Neurocomputing, vol. 24. Elsevier Science B.V., pp. 37–54 (1999)