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Intelligent Advisory System for supporting Aesthetic and Ergonomic Design

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Abstract: - When designing a product for every day use, designer has to consider various influential factors, among them aesthetics and ergonomics are very important. In the group of different products covering the same main function (purpose), those that look more attractive are usually more successful on the market. To be able to develop successful design solutions, designer has to possess expert knowledge and experience in many fields of engineering design including ergonomics and aesthetics. Such experts are rare. Teams of experts are usually established as alternative, yet it increases development costs of the product. The other possibility is to support designer with expert advices, given by the intelligent computer program. The paper presents a proposal for the intelligent advisory system with expert knowledge in fields of aesthetic and ergonomic design that would be able to offer expert help to the designer regarding of ergonomics and aesthetics of the product.

Key-Words: - design, styling, ergonomics, aesthetics, expert knowledge, intelligent advisory system

1 Introduction

In order to deliver suitable design solutions, designer has to consider a wide range of influential factors. Ergonomics and aesthetics certainly belong to the most complex ones. Less experienced designer could meet several problems in this design stage. Although ergonomic Computer Aided Design (CAD) software described in this paper can assure better ergonomic condition of the product, the designer has to have quite a lot of experience and knowledge in field of ergonomics to chose and carry out the appropriate redesign actions to improve the ergonomic value of the product in reasonable time. On the other hand, the aesthetic design phase still depends mostly on the designers' skill and experience and is not supported by any computer tool of practical value at all.

In this context, we are presenting a proposal for the intelligent consultative system that will be able to support designer trough the decision making process when defining the ergonomic and aesthetic parameters of the product.

2 Existing software

2.1 Ergonomic CAD software

In the field of CAD, development process has been focused toward the integrated tools that would enable the use of ergonomic data originating from various sources when performing ergonomic analysis of the product or working process.

The possibility to combine the ergonomic data from multiple sources would enable designer to use a single analysis tool to assess clearances, reach, visual requirements, and postural comfort at the earliest stages of design. It would make possible for designer to incorporate the important features into designs that would minimize the risk of injuries before a person ever physically encounters the product or workplace. These features include:

- three-dimensional modelling of the working place and equipment,
- three-dimensional human form modelling to represent various anthropometries and postures,
- evaluative techniques to assess reach, vision, fit and posture, etc [1].

Using an interactive interface, designers would be able to manipulate both, the human form and the working place design [2].

Two different approaches have been used to develop such software tools [3]. One approach is oriented into development of so called stand-alone ergonomic CAD software with ergonomic assessment capabilities and built-in tree-dimensional CAD module. The alternative approach is leading to development of the compatible ergonomic software based on the special modules that enable ergonomic analysis within commercially available CAD systems, which are used to provide the three-dimensional modelling and user interface. Some of the best-known representatives of the both groups of software are presented in the Table 1.

TABLE 1: REPRESENTATIVES OF BOTH GROUPS OF ERGONOMIC CAD SOFTWARE

Stand-alone ergonomic CAD software	Compatible ergonomic CAD software
SAMMIE	SAFEWORK
APOLIN	MINTAC
TADAPS	ErgoSHAPE
Deneb/ERGO	HUMAN
ERGOMAN	RAMSIS
ErgoSPACE	ANYBODY

2.2 Aesthetic CAD software

While the use of computer-aided technologies in the area of mechanical and ergonomic design is quite well established, the aesthetic design phase still represents a serious bottleneck in the computer-aided design process chain due to problem. Since the computer aided aesthetic design tools do not exist, designer have to trust to his or her aesthetic abilities and feeling in order to perform product design of complex-shaped products like car hoods, consumer appliances, toys, packaging, etc.

It is very hard to define a procedure that would assure acceptable results of the aesthetic design process. Currently, two European projects: FIORES and FIORES-II (FIORES - Formalization and Integration of an Optimized Reverse Engineering Styling Workflow) aim at building innovative CAD tools that adhere to the creative user mentality and at improving the cooperation between the main players involved in the product development process, by identifying shape properties directly affecting the aesthetic character, and by providing modelling tools for their evaluation and modification [4].

3 Intelligent advisory system

It is obvious, the expert advice is often needed and the application of the intelligent advisory system with expert knowledge could be very useful in the field of aesthetic and ergonomic design [5]. The system should be able to offer expert help – advice to the designer during the ergonomic and aesthetic design phase of a product. Since the aesthetic and ergonomic properties of the product are established at the early phases of the product development, the intelligent advisory system should be able to support this process with minimum data requirements.

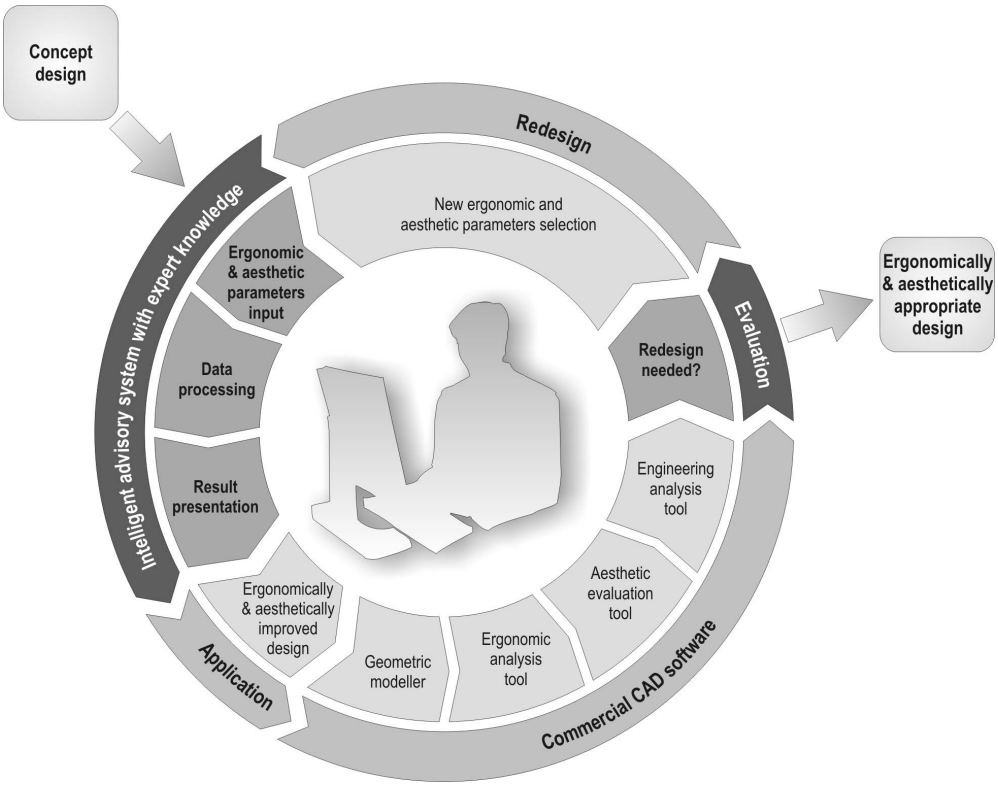

Fig.1. Design cycle using intelligent advisory system.

Our vision of the aesthetic and ergonomic design cycle supported by the intelligent system is presented in Figure 1.

It is anticipated that the product development cycle using intelligent advisory system would be very similar to the present conventional development cycle. The first main difference can be noticed in the concept design phase, where the intelligent advisory system should be used to improve the aesthetic and ergonomic value of the concept design solution. The ergonomic analysis and aesthetic evaluation should be performed on the CAD model with more precise geometry definition. After that, the intelligent system could be used again to advice the user which redesign changes are possible to improve the ergonomic and/or aesthetic value of the product if applicable.

4 Architecture of the proposed system

First of all, the appropriate formalism for the acquired knowledge representation will be defined. The commonly used formalisms for encoding knowledge are production rules, which are quite similar to the actual rules used in the design process. The collected rules will construct the knowledge bases of the system [6].

In order to have a proper control over each part of the system, it should have separate knowledge bases, containing the theoretical and practical knowledge about the design and redesign actions, for the ergonomic and aesthetic part of the system. When using only one part of the system, the inference engine will use only the knowledge base that belongs to the used part. On the other hand, when the complete system will be used, inference engine will use both knowledge bases and perform reconciliation when needed.

The redesign recommendations will be proposed to the user by using the expert knowledge collected in the knowledge base and the case-specific data given by the user. Explanation subsystem will provide all the information needed to understand the background of the proposed recommendations. Figure 2 shows the architecture and the expected data flow of the proposed intelligent advisory system.

4.1 Expert sub-systems

Proposed intelligent advisory system should increase the effectiveness and enable less experienced users to get qualitative results of the aesthetic and ergonomic design phase.

In order to ensure more effective use of the proposed system, it will be developed as self-standing software, divided in two separate sub-systems.

As mentioned before, sub-systems will use their own expert knowledge base to function independently. On the other hand, the proposed system will enable simultaneous usage of both sub-systems, where one sub-system will consider the results of the other sub-system and inversely. The result of the combined work of both sub-systems will be the selection of aesthetic and ergonomic design recommendation, which will lead to the aesthetic and ergonomic optimal design of the product.

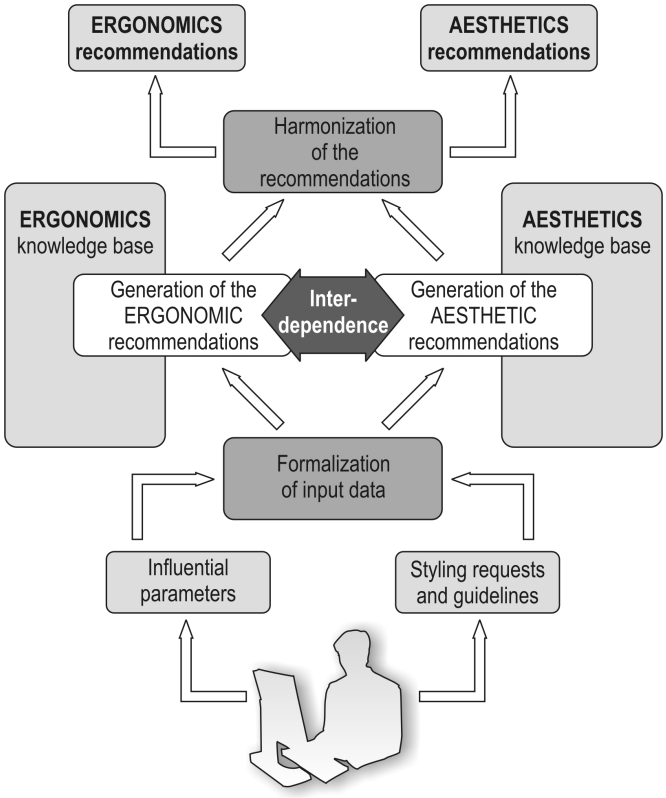

Fig.2. The architecture of the proposed intelligent system

4.1.1 Expert sub-system for ergonomic design

Expert sub-system for ergonomic design should help the user during enquiry, selection and application of the ergonomic recommendations [7] saved in its expert knowledge base. Appropriate anthropometrical data [8] will be collected and included in knowledge base.

4.1.2 Expert sub-system for aesthetic design

Expert sub-system for aesthetic design is meant to advise and guide the user during aesthetic design (styling) phase of a product development.

To ensure the proper expert knowledge in field of aesthetic design, knowledge base with rules and recommendations regarding aesthetic design will be build. Aesthetic elements proportion, harmony, direction, curvature and others will be investigated and included into the knowledge base.

4.2 User interface

The user interacts with the system through a user interface. Regarding the type of input and output data, two different styles of the interaction between user and the system are anticipated:

- question and answer,
- graphic interface.

The first one will be used mostly at the beginning, when first set of the parameters has to be presented to the system. During data processing phase, the inference engine may present additional questions or need for more parameters. In this case, the user interface will use both, question and answer and graphic style to present the problem to the user. In results' presentation phase, the user interface will present the solution in graphic style if possible.

To make the use of the system more comfortable, the user interface is being developed with a special attention.

5 Conclusion

We believe a development of an intelligent advisory system that would offer expert help and advice to the designer during the ergonomic and aesthetic design phase of a product has a great potential.

The use of the proposed system will enable even small companies to appear on the market with optimal designed products, at relatively low development costs, which will increase their competitive position on the market.

On the other hand, the proposed system is also meant to be used for education of the students of engineering and product design as typical representatives of inexperienced designers, who need support and advice in decision making process.

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