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A MODEL OF A KNOWLEDGE-BASED FMEA SOFTWARE SYSTEM

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Abstract:*The purpose of the Design Failure Mode and Effect Analysis is to detect and avoid the potential failures that may occur at a given part in the early stages of the manufacturing process. The procedure itself needs large amount of time and material support; therefore the practical application of the procedure is really paying off only when applied to very expensive components or to mass production.*

A way to make larger the field of application of this method with increased efficiency is using computer assistance. This enable a quick and intelligent reuse of the knowledge expressed in previous examinations. This paper presents the model of a case-based reasoning expert system. Here the stored FMEAs represent different cases. In the case of a new project the system searches for similar cases in its database and adapts the knowledge to the present situation.
Key words: *FMEA, expert system, quality management*

1. PRELIMINARIES

Starting from the requirements toward the quality system and also the welfare of the economy requires such a tool that is able to detect the possible failures in the earliest stage of the quality loop and to decrease or even stop the risks that the failures may represent. In some fields, where there are no adequate data about the failure possibilities and the probabilities of occurrence, in order that we can not apply the traditional methods of reliability, FMEA proved to be an effective tool for problem solving, which ensure the most properly platform for recognition of the problems in the early stages of the appearance (Johanyák, 1996). ISO 9004 also recommend the use of the above mentioned method.

The weak point of this method is in the traditional type realisation of it, where it proved to be time and money consuming and there are a lot of environmental effects (mood, atmosphere, personal recollection, etc.) which affect the recognition of certain failures and managing them. However the techniques, which apply a tabular documentation (form), ensure a perspicuous arrangement, the knowledge stored is hardly reusable. For this reason the team is constrained to complete the work again and again, when a similar design, process or system is analysed. Recently has arisen the idea of computer aided analysis. In the software market we can find many attempts but most of them are only passive participants in the analysis and however they have better and better user interfaces, the provided services are not more than simple word processing and database operations.

The propagation of the artificial intelligence generates the appearance of some knowledge-based applications (Hunt & Price, 1996)(Ormsby et al., 1991). These were prepared mainly for process analysis and are able to detect failures and suggest actions only for cases, which are the same with one registered in the past.

The purpose of the research work we are doing at the College of Mechanical Engineering and Automation in Kecskemét is to develop a complex software system which integrated with a CAD system and using its constructional designs besides the functional data providing from the designer is able to effectuate a knowledge-based design FMEA.

2. THE ROLE OF THE SYSTEM IN THE FMEA PROCESS

The system is not to work instead of the experts from the FMEA team, but to help and make easier their work. With this method, the process of the analysis suffers source changes. When starting the analysis, the system searches for similar constructions that already had been succeed. If there is such analysis, the system shows all the data and rules applied. The main advantage of the system is that based on similarities and past experience is able to give suggestions and point out the critical points that must be examined, and also gives the list of improvements and prevention methods that can be useful to apply (Kolodner, 1993).

The team members discuss the given list, they evaluate the different activities and complete it with new ideas. After this preparatory work, the system stores according to the quality documentation prescriptions in a hierarchical object structure the professional knowledge practical experience and the rules formulated by the team that appears during the FMEA execution.

3. SYSTEM STRUCTURE AND OPERATION

The software to be built up is a multiple module complex system (Figure 1). In the framework of the present research programme the module which establish the connection with the CAD system will enable only recognition of the parts from the structure that were constructed from element catalogue. Possible further research aim could be to work out such a knowledge-based system that can solve shape recognition problems as well, in order to identify in the CAD system not only the standard elements. The module interface must ensure:

- the necessary CAD data purchase for the case description;
- the possible controls of the adaptation of rules from similar earlier cases, during FMEA.

The arising failure possibilities and risks are influenced by data obtained from the CAD system, which relate to geometry, material and connection with other elements and information about the role of the construction and its function. These data are obtained interactively by the system with the help of the data acquisition module.

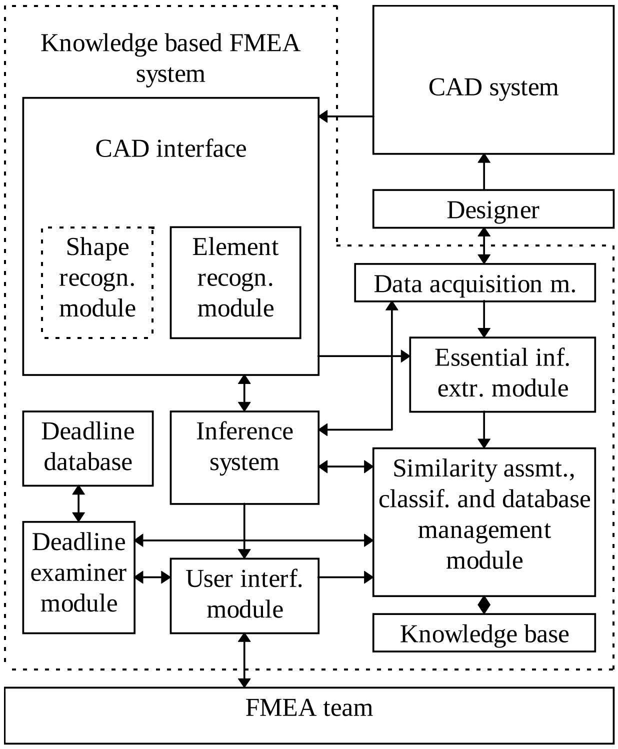

Fig. 1 The system and its relations

The starting data, which arrive from two sources, are analysed by a module, that extracts the essential information from it and in this way we can obtain the case description. The system forward the description to the similarity assessment/classification and database management module of which role is to find same or similar cases like the actual one from the knowledge base(Knauff & Schlieder, 1993)(Weß, 1993).

When is not the case of a sameness, the system effectuates the necessary abstractions on the case description, in order to find similarities. The construction of the knowledge base fits to the applied similarity assessment method and in this way the repeated searches are simple and fast. The knowledge base contains the so-called full descriptions, which include the descriptions of the cases for their easiest identification and also the past experience and rules. In order to reach the best for the user aims, a hierarchical object based construction seems to be the most efficient. In this system the cases are arranged according to the similarity characteristics in different levels in groups, and subgroups. The common characteristics are picked out and stored only once in the general description of the group.

The task of the inference system is - based on stored information and rules about cases that are the same or similar with the present one - to give the critical points, and necessary controls and to give an estimation for the risk numbers. To detect the potential failure possibilities more data may be needed. These can be provided either through the CAD interface from the CAD generated project (design) or from the designer itself through the data acquisition module. The user interface module displays the list generated by the inference system and makes possible for the team members that after discussion to be able to complete, to change, to simply or to reject it. There are further possibilities to enter new rules that are in connection with the given present case. These were useful in later analyses. The final form of the FMEA enters the knowledge base.

As a result of the analysis, action plans are built up containing the names of the responsible persons and the deadlines to complete the different activities. The team must recognise the success of this in a later analysis. The role of the deadline examiner module is to manage this activity. After the time interval for practical execution finishes, this is able to warn through the user interface module the team members about the necessity of the analysis and ask through the knowledge base module for previous analysis documentation. The deadline database is keeping in evidence all the data in a such a way that besides the ranked data there are indications for the corresponding accessible FMEAs from the knowledge base.

4. SUMMARY

The FMEA team, based on their professional experience tries to forecast and eliminate the failure possibilities. The effectiveness of this activity can be increased with the aid of complex knowledge-based software that can be built up upon the presented model.

The system fits the company's information and quality system - and due to the objective failure recognition and elimination in the early stages of possible occurrence - and makes effective it's activity. Contribute to the improvement of company's international estimation and serve as a tool for social and economical development

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