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Title of the paper: **KNOWLEDGE-BASED FMEA IN NETWORKING ENVIRONMENT**

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Summary

The Failure Mode and Effects Analysis is a proactive quality assurance method with the aim of eliminating all the failure possibilities before starting the practical accomplishment. An essential condition for success is the presence of the best specialists and their ability to call back their earlier similar cases at the time of the meeting.

This paper presents a research-development activity, which aims making Design FMEA more and more efficient with the help of network technologies, artificial intelligence and the modification of the original FMEA methodology.

1. Failure Mode and Effects Analysis

The FMEA is a systematic and analytical quality-planning tool for identifying what might go wrong either during the manufacture of a product or during its use by the end customer. The Design FMEA focuses on the consequences of a weakness in the design, and it also in the identification or confirmation of critical characteristics.

The FMEA requires a great deal of effort in time and money. Experts of the analysed domain should be available at all the time and be able to remember similar cases they have experiences with. The process of recognising potential failures is time-consuming, so if a design was analysed once it makes sense to cache the solution in such a way that it can be reused. In this circumstances the effectiveness of the teamwork can be increased considerably through an interactive aiding intelligent agent working with case-based reasoning.

The purpose of the research work done by the author at the College of Kecskemét, Department of Information Sciences making the Design FMEA more and more efficient with the help of 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 assist a knowledge-based design FMEA

2. The modified FMEA

2.1. Preparation work

In the new model a team member who is acquainted with the design divides the construction into its parts and prepares the description of the design and of the parts. This description contains the technical drawings and the functional analysis of the design.

During the functional analysis should be defined the external and internal functions of the design to be analysed and the parts which are up against these functions. External functions are those tasks that the analysed has to complete in the unit that contains the given part. To fulfil the external functions should be completed a lot of tasks inside the analysed part. These are the internal functions. Each external function depends on one or more internal functions. The internal functions depend on mating parts (Fig. 1).

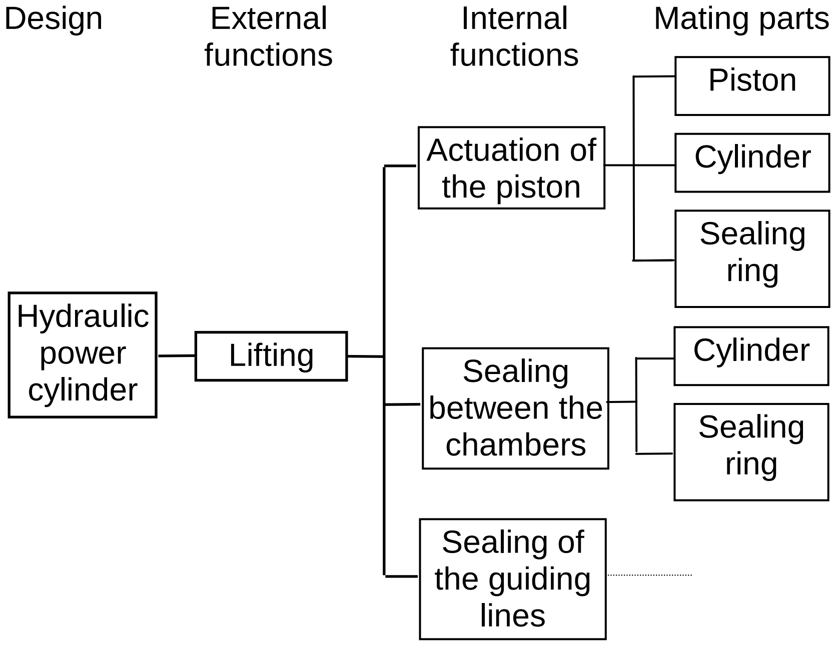

Fig. 1. Functional analysis of a Hydraulic power cylinder

This information will be transferred to a server-side database as a case to be analysed. The technical drawings are stored in form of CAD files, the additional information are stored in formatted text in XML format containing figures and parallel with this in a case description language required by the intelligent agent.

2.2.Teamwork

The team members are usually representatives of individual departments that make up most of the project work. During the analysis they are working in a virtual room, they are physically sitting at their workplaces in front of their computers equipped with multimedia accessories (web camera, microphone, speakers) and they are in communication with one another through the enterprise intranet or the Internet through secure protocols building a Virtual Private Network using a conference software. Each of the team members disposes of a web browser programme, which allows the communication with the server-side intelligent agent.

After logging on, the system automatically warns if there are expired completion dates of recommended actions of previous FMEAs. In that case the team can choose between starting a new analysis and reviewing the FMEA which completion dates are expired.

A new analysis starts by giving the code of the design to be reviewed. The Web browser than receives from the server the general overview of the design and the analysis of the parts. Parallel with this, through the conference connection the occurrent questions can be discussed, some features of the design can be explained in detail.

The parts are selected one by one for the analysis, giving in their identity code. The server-side intelligent agent outgoing from the CAD data and the functional description of the part seeks for previous similar cases in the knowledge-base. In case it founds one it will adapt to the present conditions and construct a list of potential failure modes, effects, potential causes and recommended actions for the prevention of occurrence, or when the prevention is not possible for diminishing the Risk Priority Number of the failure chain.

The group discusses the proposal of the system, seeks for additional failure modes and resolution possibilities on the traditional way. The scribe of the group notes these down and sends them to the system through XML forms. These data will be stored in the database as analysed and not closed cases.

In the course of returning analyses those experiences related to the suggested measures will be introduced in the database, and after evaluation if is necessary the team will suggest further actions. For these actions there will be set new deadlines. If the team consider that due to the actions effectuated the RPN value of the failure chain has been adequately reduced, they will close the analysis and the most effective actions will be stored. In the future the system will adapt these actions in similar cases. The whole case-description will be introduced in the knowledge-base as a closed case.

3. SYSTEM STRUCTURE AND OPERATION

The software to be built up is a multiple module complex system (Fig. 2). 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 part and its external and internal functions. These data are obtained partly from the formal description made in preparation phase and partly interactively from the team members with the help of the data acquisition module.

The starting data, which arrive from two sources, are analysed by a module that

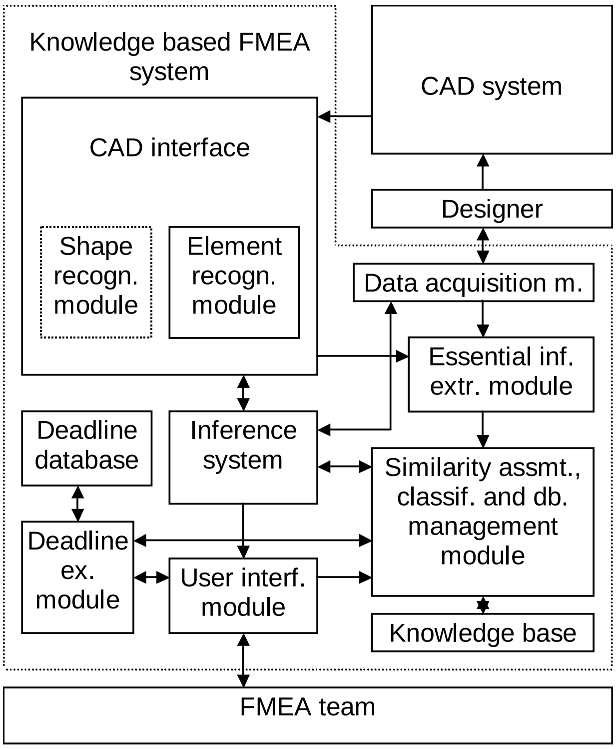

Fig. 2 The system and its relations

extracts the essential information from it and in this way can be obtained 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.

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 simplify 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 completion dates of recommended actions. 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 such a way that besides the ranked data there are indications for the corresponding accessible FMEAs from the knowledge base.

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