Expert System for Chose Material used Gears

E.V. Butilă, and F. Gîrbacia

Abstract—In order to give high expertise the computer aided design of mechanical systems involves specific activities focused on processing two type of information: knowledge and data. Expert rule based knowledge is generally processing qualitative information and involves searching for proper solutions and their combination into synthetic variant. Data processing is based on computational models and it is supposed to be inter-related with reasoning in the knowledge processing. In this paper an Intelligent Integrated System is proposed, for the objective of choosing the adequate material. The software is developed in Prolog – Flex software and takes into account various constraints that appear in the accurate operation of gears.

Keywords—Expert System, computer aided design, gear box design, chose material, Prolog, Flex

I. INTRODUCTION

THE choice of materials is particularly important in the gears box design. The judicious choice of materials depends, among other things, on two important dimensional characteristics of the gears: (i) the distance between wheel axle and (ii) wheel.

In the gear box design process choice of materials is done according to initial operating conditions. Often, the choice of materials is not an easy step, requiring consultation literature regarding their characteristics, data, usually tabular or chart form.

For this reason it was considered desirable to create a program of expert system for selection of material for gear. This paper presents the application program developed in Prolog – Flex for automated selection of gear box materials.

II. EXPERT SYSTEM FOR DESIGN

In the last years, based on achievements in the field of Artificial Intelligence (AI), were developed computer-aided engineering based on knowledge, which underlies the modern system of computer-aided design. Using AI tools in design processes, intelligent systems can be developed for the analysis and synthesis products.

Expert systems are applications of artificial intelligence, working with specialized knowledge and reasoning to solve real problems that normally require human experts. Building an expert system requires the extraction of relevant knowledge in the field (knowledge acquisition) in a suitable form to be introducing in the Knowledge Base (fig. 1). This activity is

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concern knowledge engineer [1, 4].

Expert systems are used to solve large problems in medicine, mathematics, engineering, geology, business, education, etc. Solved problems may involve activities of prediction, diagnosis, planning, monitoring, interpretation, etc. In the field of mechanical engineering and expert systems were created applications for product design, design for automated assembly, diagnosis, etc.

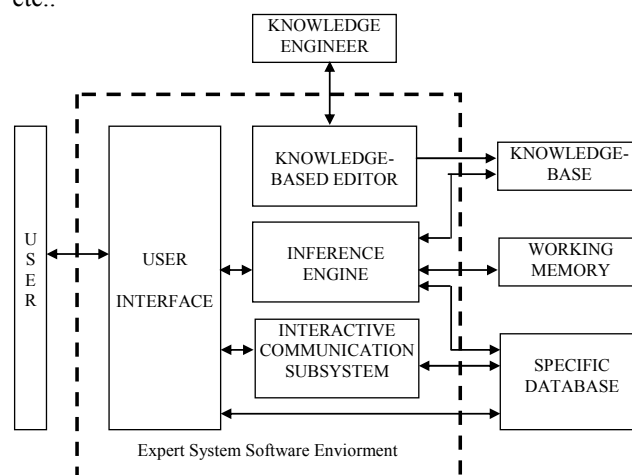Expert systems are specialized programs like Clips, Prolog, etc..

Fig. 1 The general structure of Expert System

III. PROGRAMING IN PROLOG - FLEX

Prolog - Flex is a software program specifically designed for developing expert systems and is implemented in Prolog.

Prolog - Flex is a high level language based on rules and allows unlimited access to technology. Flex is based on interactive questions and answers a mechanism that can be configured and extended by the programmer himself without a limit.

Prolog - Flex is a continuation of Knowledge Specification Language (KSL), which is very easy to read and understand. Prolog - Flex is a conventional language that can perform a number of procedures necessary for the construction and implementation of knowledge-based expert systems. A Prolog-Flex contains several statements KSL [4].

Flex programs are contained in ASCII files with file extension KSL and can be edited either using Prolog - Flex programming environment or a text editor such as Notepad [4].

IV. SELECTION OF GEAR MATERIAL

Choosing gears materials is generated according to several criteria of different operating conditions. In this application

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the following criteria are used by choice of materials:

- solicitation,
- peripheral speed,
- intern and extern stress,
- wheel dimension,
- required hardness,
- Flow and breaking limits,
- type of machinery and trained coach [2], [3].

  Algorithm associated application consists of three parts:
1) The questions posed by the application user and the possible answers that may be related to user data.
2) The rules for each possible answer.
3) The general rules (the set of rules) that will verify that each rule state.

Answers to questions can be cvasicuantificable, such as, for example, to ask "peripheral speed, they can be:

- Peripheral speed small,
- Peripheral speed high,
- Peripheral speed medium

or may be approximate, a range of values such as the question of "hardness required"," hardness between 175HB and 220HB". The source code for two examples is shown in Table 1.

TABLE I
CHOSE FROM HARDNESS

```
question speed
Select peripheral speed;
choose from speed_peripheral_small,
speed_ peripheral _big,
speed_ peripheral _medium.
```

```
question hardness
Choose the desired material hardness;
choose from hardness _170_200_HB,
    hardness _175_220_HB,
    hardness _190_235_HB,
    hardness _190_260_HB,
    hardness _200_260_HB,
    hardness _220_315_HB,
    hardness _200_300_HB,
    hardness _210_240_HB,
    hardness _220_280_HB,
    hardness _230_260_HB,
    hardness _235_257_HB,
    hardness _240_300_HB,
    hardness _250_270_HB,
    hardness _260_320_HB.
```
....

In fig. 2 is shown the user graphical interface to choose peripheral speed.
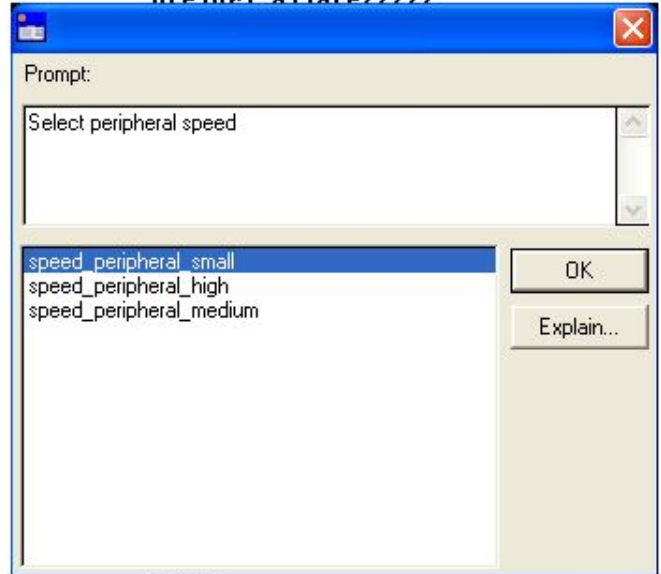

Fig. 2 Dialog box to select peripheral speed

In Fig. 3 is shown in the dialog box that the user must choose the desired material hardness.
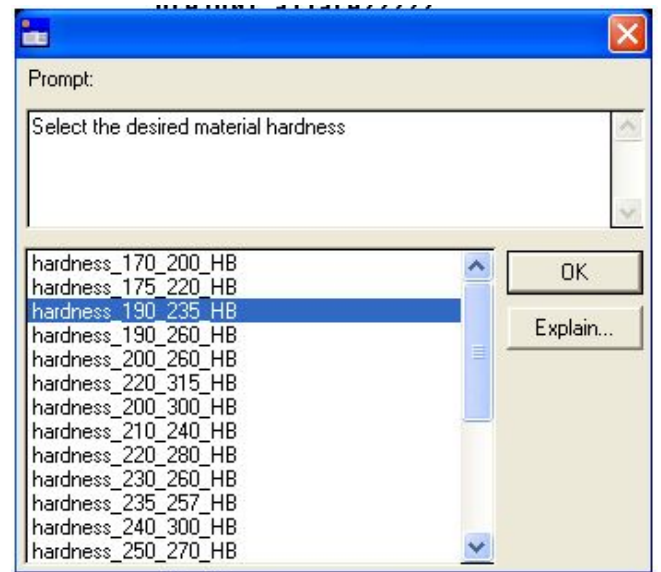

Fig. 3 Dialog box for choosing required hardness of the material

After the user answers a series of questions that is part of the above criteria, the program will analyze the responses by production rules implemented in the knowledge base. Such a rule is shown in Table 2. For each possible response will create such a rule. The rules presented in Table 2 are "carbon steel: quality XC 45"

The rules of the type above are combined in the above general rule, presented in Table 3, which helps run the program.

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TABLE II
RULE STEELS CARBON

rule steels_carbon
    if X is a question and not checked(X) and
    the answer to solicitation is less_solicitation and
    the answer to speed is speed_peripheral _small and
    the answer to stress is without_sock and
    the answer to dimension is normal and
    the answer to yield_point2 is   limit_higher_than_610 and
    the answer to hardness is hardness_190_260_HB and
    the answer to machinery is light machinery and
    the answer to dimension is less than 16_mm and
    the answer to yield_point is limit_between_700_850 and
    the answer to yield_point is limit_500
    then echo ('carbon steel: XC 45 ')
    and remember that checked(X).

TABLE III
RULESET MATERIALS

Rule set materials
    contains all rules.

The check command can launch the program. These procedure (Table 4) show all questions and summarizes the responses.

TABLE IV
ACTION CHECK

action check;
    do
    ask stress and
    ask speed and
    ask load and
    ask dimension and
    ask hardness and
    ask yield_point2 and
    ask machinery and
    ask dimension and
    ask yield_point and
    ask yield and
    invoke rule set material.

The program, after analyzing all the questions, answers user and all rules, displays a dialog window (Fig. 4) material resulting inference reasoning mechanism running. The material that resulted in this case meets the conditions set out in Table2.

Fig. 4 Dialog box with the result

V. CONCLUSION

In this paper are presented integrated design structures, based on the principles of total design (design, setup, breakdown, processing), that can be used to reduce product development time and costs.

Another benefit of expert design structures is given by increased flexibility regarding the modification modules and is taking into account the needs of beneficiaries and the restrictions imposed by the specifications of other parts or components.

Using the developed expert system package program contribute to develop "subiectivism" in the design, especially when the information is not cvasicuantificable.

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