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Piotr OCIEPKA*, Aleksander GWIAZDA

Institute of Engineering Processes Automation and Integrated Manufacturing Systems,
Faculty of Mechanical Engineering, Silesian University of Technology, Gliwice, Poland
*piotr.ociepka@polsl.pl

CONCEPT OF HYBRID SYSTEM FOR COMPUTER AIDED OF MACHINES DESIGN PROCESS

Abstract: This paper presents a method, basing on the engineering knowledge and experience, for aiding the design process. In this method, the system is built using the hybrid architecture that combines the advisory system and the CBR method. In the paper the structure of the advisory system and the functioning of the CBR system have been described. Attention was drawn to the problem of an "empty database" in relation to systems basing on the CBR method. It was also discussed the area of engineering activities for which the proposed method is dedicated.

1. Introduction

The current market trends require rapid development of new products. The time required for project elaboration, design process, technology preparation and product manufacturing is getting shorter. This determines the need for efficient and productive tools that can speed up the process, maintaining at the same time the high quality and low price of the product. With regard to the manufacturing processes this task is realized by flexible manufacturing systems that enable quick and efficient adaptation of the production system. In the process of designing and constructing are applied advanced and specialized tools like the CAD/CAE systems that significantly accelerate the process of designing. However, the time required to develop the correct construction is still too long. Therefore, it is the need for new methods and tools that will further accelerate this process. An important aspect of the designing and constructing processes of a new product is the ability to use the engineering knowledge and experience, gathered during previously realized projects. Therefore, there are some attempts to create tools basing on engineering knowledge and experience that would enable the effective support of the designing process and accelerate the realization time of the designing process [1,4,6,8,9,10]. This paper presents the method basing on engineering knowledge and experience, adding the engineering design process.

2. Description of the method

Designing and constructing are intellectual and creative processes. The process itself and its outcome is very much dependent on the talent, imagination, and creativity of an engineer.

In addition to these natural, often inherited factors, the quality of the generated design and construction are also affected by tools that skilfully applied can accelerate and facilitate engineering activities. Therefore it is reasonable to seek effective computer methods adding the design-construction activities. In the proposed method for adding the designing and constructing the advisory system and the method of case-based reasoning (CBR) were used. The advisory system can facilitate this process utilizing the knowledge acquired from experts. Its work relates to supporting the decision-making process at various its stages. In Figure 1 are shown the main elements of a typical advisory system.

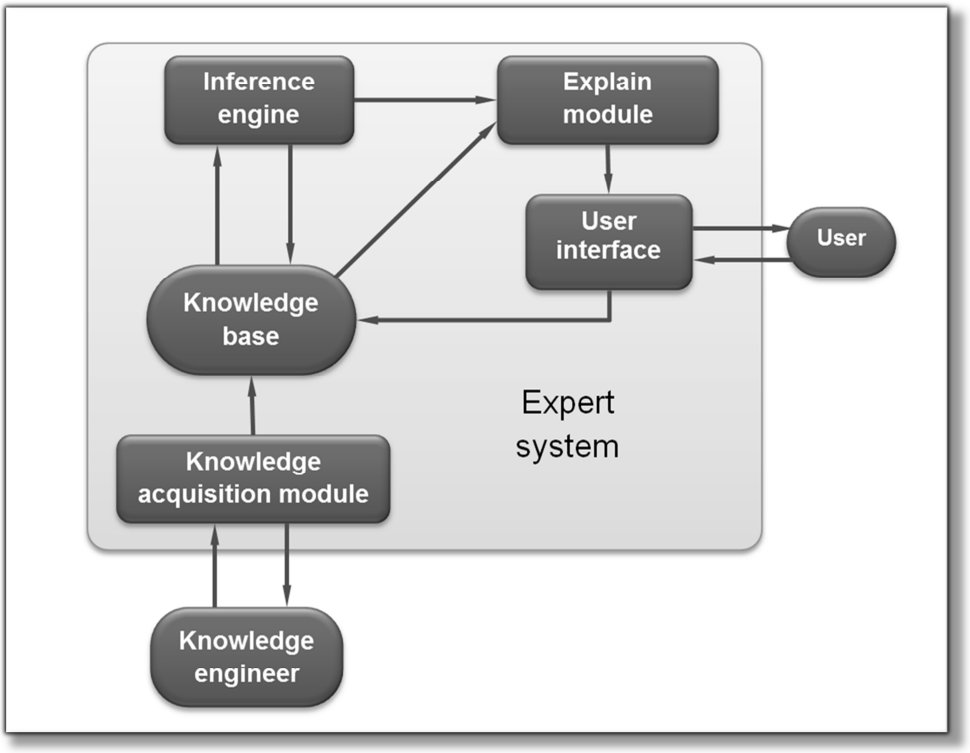

Fig. 1. Main components of an advisory system

The use of an advisory system in the process of designing and constructing is difficult because this system requires a constant process of acquiring the knowledge from experts, what is not a simple task. This limitation could be eliminated by the application of the CBR method. The CBR method uses the engineering knowledge and experience gathered during the realization of particular design projects. The CBR itself is a problem solving method basing on the searching analogies (similarities) between the present design problem and the earlier project cases [5]. They are adequately described and stored in dedicated databases. The software tool that solves problems using this method must be equipped with the mechanisms for collecting, processing and accumulating the knowledge and experience, and the efficient algorithms to search databases and to determine the similarity between the current design situation, and the cases stored in the databases. In Figure 2 is shown the classic operating cycle of the CBR method.

During utilization the CBR method there is the problem of “empty cases database”. This problem occurs in the initial phase of the system functioning when its database is empty,

causing that the design and construction process is not supported, and even delayed by procedures of recording new cases in the CBR database . The method proposed by the authors solves this problem by utilization the hybrid architecture of the system by combination an advisory system and the CBR method. The important element of the proposed system is the common database that can be used both by an advisory system and by the CBR application. This database is initially prepared during the process of creating the advisory system and then progressively updated with the cases recorded using the CBR method.

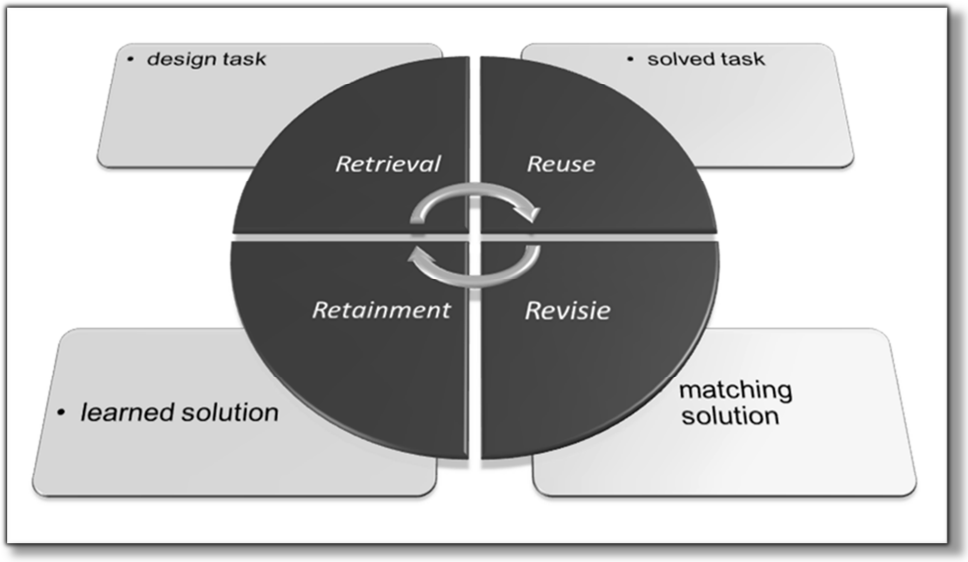

Fig. 2. R^4 model of the CBR cycle

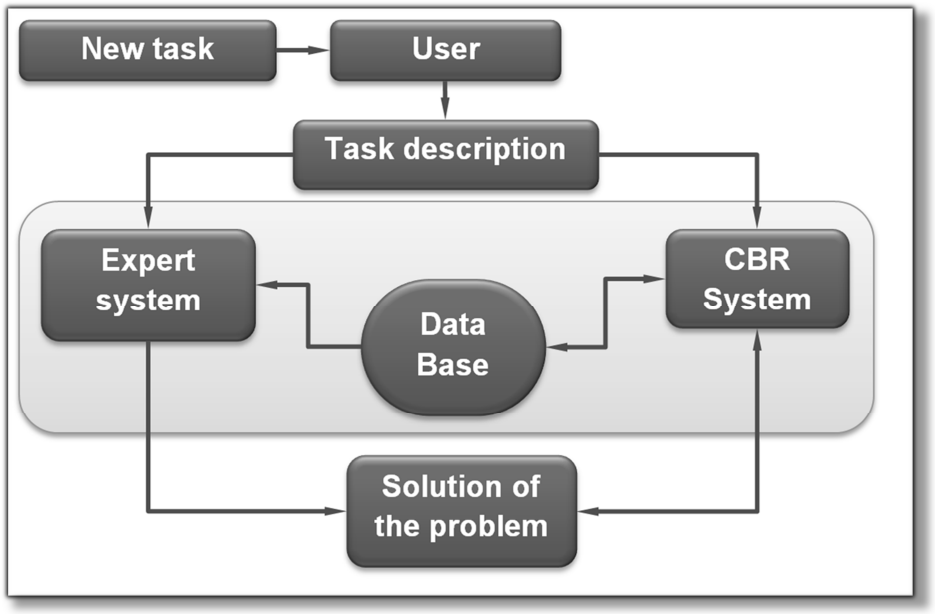

Fig. 3. Structure of the hybrid system

Throughout the application of the CBR technique the whole system has the ability to enlarge the accumulated design knowledge by recording “new design cases”. In other words it can be said that the system has the ability to “learn”. Here it is possible to discern a certain analogy with the work in the design office, where an experienced designer (advisory system) communicates their knowledge to a younger colleague (CBR system) while solving a common design task. On the basis of jointly realized project tasks younger engineer expands his knowledge and experience that can be used in next, analogous design tasks.

3. Area of functioning of the elaborated method

Due to the amount of time that must be devoted to the implementation of the project and to the needed intellectual effort of the designer, it could be distinguished three basic types of the design process:

- creative design, which results in the construction of a new technical mean,
- innovative design, which results in the construction of an adapted technical mean,
- routine design, which results in the construction of a multi-variant technical mean.

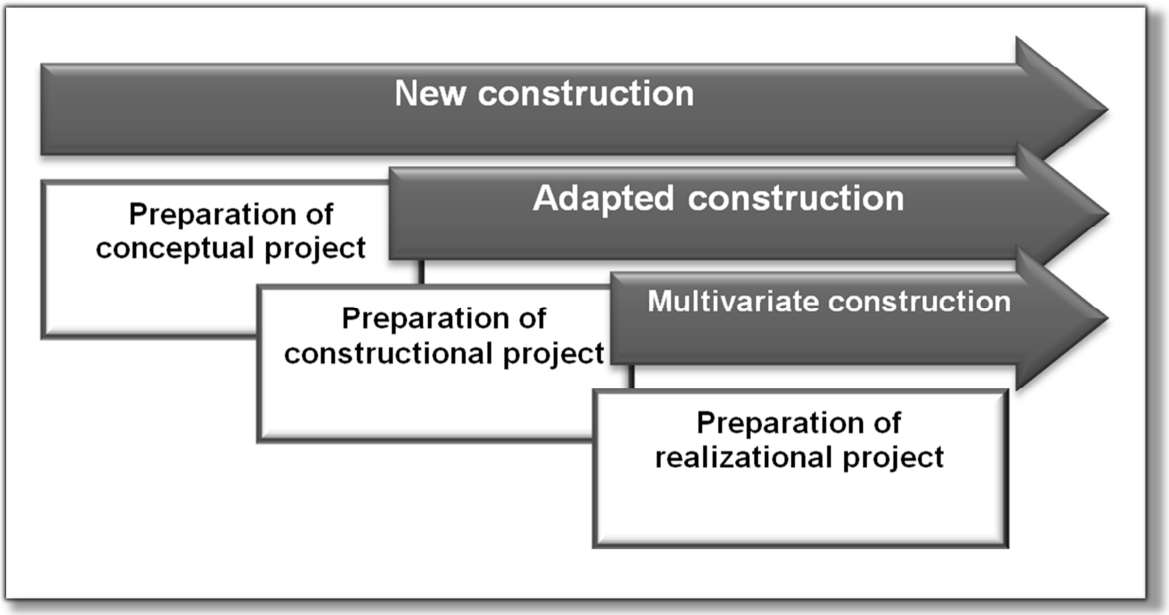

Fig. 4. Types of the design processes

The developed method, taking into consideration the nature and complexity of adding processes, may be the most effectively used to facilitate of elaboration the design of adapted technical means (innovative design). The design of this type, predominatingly basing on the selection of appropriate design documentation of an already developed technical mean and making the necessary modifications. During this type of project activities solving are tasks similar to those that have already been solved. So during this design process usually are adapted fragments or even whole constructions of known technical means. The action and the principles of a technical solution remains unchanged. As the result of this type of design are created variants (often dimensional) of previously developed design solutions.

4. Functioning of the elaborated method

In Figure 5 are shown the object-oriented organization and the method of functioning of the system basing on the proposed method. The actions realized by the system are carried out in two working areas, in the **WPK** area (the area of realization of the design and constructional nodes) and the **ZPK** area (the area of realization of the design task).

In the **WPK** working area the advisory system, basing on the design and constructional knowledge stored in the system database, proposes the design objects R_{fs} and the constructional objects K_{fs} that perform specific component functions stored in the model of a structure **MF** and fulfill the design and construction establishing **ZPK**. Then, the selected and approved by the system user individual component functions are used by the advisory system to create combinations of possible solutions K_{Fs} performing the main function of designed technical mean.

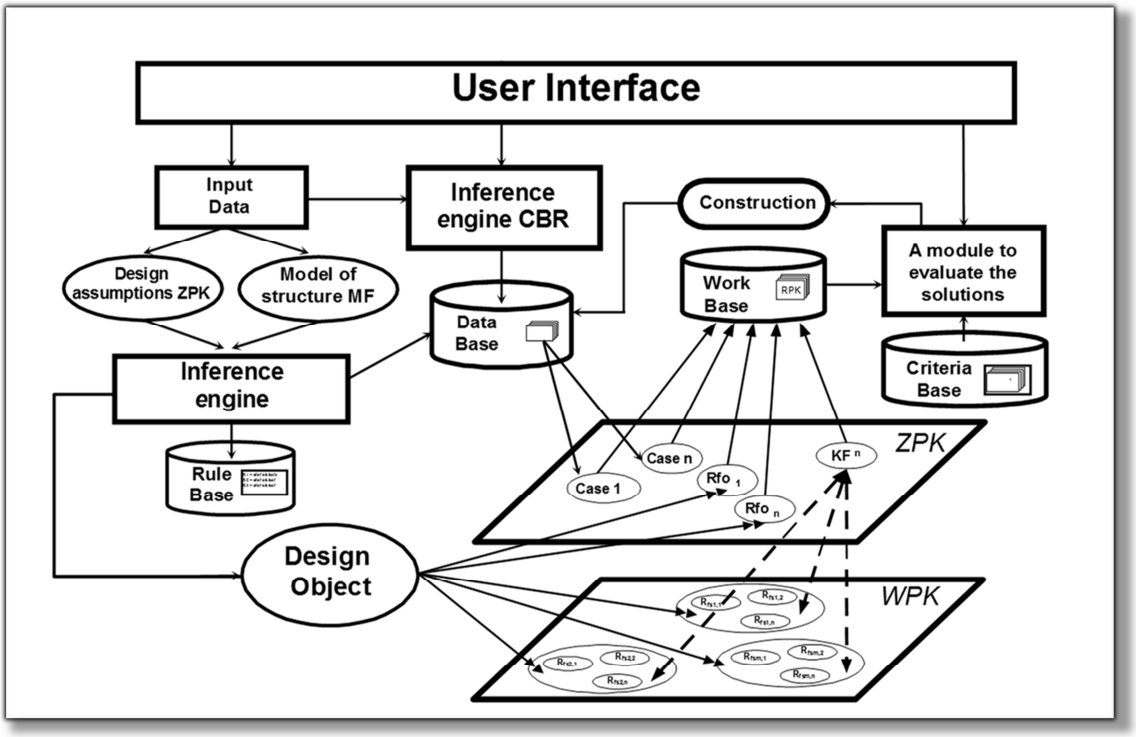

Fig.5. Functioning of the system basing on the proposed method[1,2,3,7]

At the **ZPK** working area are collected conceptions and the corresponding to them constructions of the future technical mean. These are the design objects R_{fo} and corresponding to them design solutions K_{fo} proposed by the advisory system, the combinations of component functions solutions KF^n and the conceptions $Cases_n$ found by the CBR application.

5. Conclusion

The paper discusses the possibility of using artificial intelligence methods for aiding the design and constructional process. The proposed method combines the advantages of advisory systems and the CBR techniques. The proposed hybrid structure eliminates the problem of an

"empty case database" by the solution basing on the application of the CBR method. The common database determines the consistent method of knowledge representation in respect of the advisory systems and the experience with regard to the CBR method.

The use of the developed system in the process of design and construction generation extends the range of design and constructional processes, which are considered by the designers, and reduces the time required to solve the particular design task especially in the case of the innovative design process.

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