

Development of expert systems for modeling of technological process of pressure casting on the basis of artificial intelligence

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Abstract. In article the main component of expert system of process of casting under pressure which consists of algorithms, united in logical models is considered. The characteristics of system showing data on a condition of an object of management are described. A number of logically interconnected steps allowing to increase quality of the received castings is developed

1. Introduction

In the field of casting under pressure in order to solve problems, which are targeted to achieving high-quality castings and exclusion of defects in the design phase, and the formation of optimal technological processes, automated information systems do not exist.

In recent years, the question of the application of expert systems (ES) in the production process in the simulation based on artificial intelligence increasingly began to be considered. [1]

At modeling phase of technological process an expert system must take into account the state of machinery during the operational phase, material, labor and financial resources of the enterprise [2].

The structural model of the system consists of realized elements (main line), modules and connections (dashed lines) as well as external plug projecting and modeling modules (dashed line) (Figure 1) This expert on the basis of the defect model system allows you to group and synthesize the information flow between the elements. The knowledge base of the expert system is based on a model of the casting considering verifying inference rules.



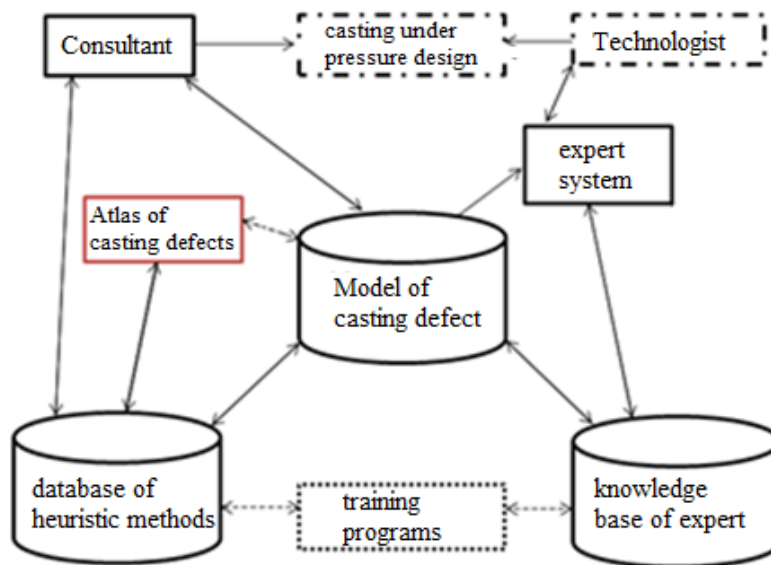


Figure 1 Structural model of expert system

2. Main part

The selection of knowledge representation model shall be based on predetermined objectives and peer review in the form of a set of heuristic techniques, interconnected logical chain.

The database of heuristic techniques takes an important place in the scheme, i.e. virtually on all of them, logical inference process is based. Defect model provides full description of heuristic methods and their relation to the withdrawal procedures.

The integrated expert system for solving problems of casting quality improving along with the proposed information model takes one of the central places.

The most rational for pressure casting process is the use of the productive expert systems with reverse output chain. This is due to the fact that the analysis or simulation of pressure casting process involves the use of physical laws describing the casting process parameters such as temperature distribution, pressure, fluid motion, the phase transition material. In this process, these components operate simultaneously on the final result, so the theoretical description and prediction of the influence of process parameters on the final result is a complex task requiring specific data of practical tests and experiments that make up a specific knowledge base of pressure casting process. Знания в экспертной системе прописываются в виде продукций (правил) вида «ЕСЛИ условие ТО вывод». The knowledge in the expert system are prescribed in the form of productions (rules) of the form "If the condition the conclusion". So, one of the most important rules of pressure casting process is the following: if you increase the temperature of the melt, then received casting will have a reduced strength; if lower temperature of the melt, then received casting will have emptiness in its entirety. Components of the rules of "condition" and "output" are facts that can be recorded using the components of the "object-attribute-value".

As the object acts obtained casting or any particular parameter of the resulting casting, such as porosity or strength, and the attribute is some parameter of pressure casting, that are directly or indirectly affects the object, i.e. melt temperature, mold temperature, pressure, speed of pressing, the material of melt and the mold, the number of the forming mold nests, cooling and other kinds. On the basis of practical data the choice of specific attribute values allows to get the object with predetermined properties. Выбор поставленной задачи задается формулировкой цели консультации, которая решает определенную проблему какого-либо параметра качества реальной отливки. The choice of the task is given by the formulation of advice objective, which solves a specific problem of a quality parameter of real castings. To set goals of the consultation

technologist selects a pair of «object - the attribute» from the list on the basis of information from the knowledge base of the expert system.

The logical conclusion is performed by the expert system after the user sets the goal of consultation. At this moment in the knowledge base there is a search for the first hypothesis included in the homogeneous group of hypotheses that corresponds consultation purpose.

However, it is necessary to take into account the correct installation of facts sequence to create a knowledge base [3]. In case of error there is a lengthening of the output chain and the emergence of the issues which are not resolved, that will eventually lead to a mismatch of problems of expert systems – a design of expert arguments. After determining the first hypothesis, the logical conclusion is performed in accordance with the algorithm of feedback chain of arguments to prove the current hypothesis. These steps are performed for all hypotheses designed to advice target as long as one of them has been proved. Proven hypothesis is defined as a recommendation. It is important to note that in the expert system one recommendation is equivalent to a group of recommendations (action algorithm) the subject area. If there is no evidence of any of the hypotheses the hypothesis with a large measure of posterior probability is accepted in the form of a recommendation. The expert system may include a large variety of different questions, which are set depending on the user's skill [4]. If the fact coefficient is less than the user's skill level, the expert system must identify its probability, based on experience. Otherwise, to fix the fact the expert system finds the relevant rule in the knowledge base and makes a calculation on the Bayes formula, inserting the values of the rules found in it.

The selection of knowledge representation model is characterized by a specified task and knowledge of experts [5]. Experts are presented as a set of heuristic techniques, interconnected among themselves with the logical chain. The choice is determined based on the used model of knowledge representation, the reality of the output of external calculation modules using the context file, as well as the availability of the source software modules for variety and adaptation expert system regarding the problems to be solved.

Допустим, Заданная цель – минимизировать количество брака при ЛПД. Учитывая, неясность формализации цели, необходимым является использование методов искусственного интеллекта. For example, a given target - to minimize the number of rejects at casting under pressure. Considering the uncertainty of formalization goals it is necessary to use methods of artificial intelligence. However, in the process of inference several subtasks appear which must be solved by standard computational methods [6, 7]. But for these tasks, there is already a clear algorithm and prepared programs.

In order to realize the expert system in the area of issues and logical inference it is necessary to adapt it to achieve the goal [8]. In this regard, it was approved additional types of questions, which allows more quickly and accurately retrieve data.

In addition to the generally established issue on the assessing the degree of statement factuality there reveals the possibility of excluding hypotheses, hard selection of hypotheses (e.g., selection of color defects), some hypotheses matching (for example, production can be two types of defect only). Sophisticated production rules are shown in the hierarchical graph. The graf has a clear structure of consideration of substantive rules (P) and recommendations (R) under the control and forecasting of the causes that lead to the appearance of defects in the casting and possible recommendations of their reduction and elimination (Figure 2). A fragment production rules is presented in Table 1.

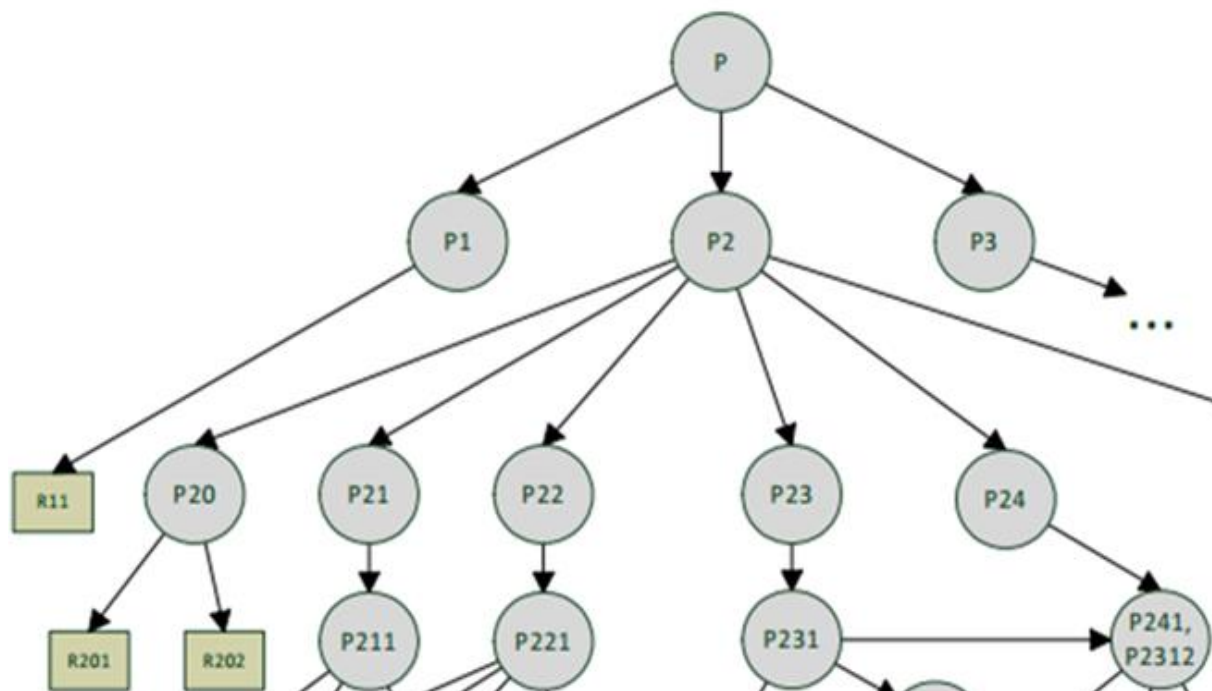


Figure 2 – Graf of production rules and recommendations (fragment)

Table 1 - production rules (fragment)

Symbol	Имя правила Rule name	Content of rule	
		Condition «If»	Action «then»
1	2	3	4
P2	Cold seam	Too low injection rate. Too small wall thickness	Raise the temperature of the melt and form (P20), if necessary, change the location of the gate (P211) in order to improve flow conditions and to increase the injection rate (P22) and equalize the wall thickness (P23) and improve air removal from the mold (P24).

3. Conclusion

Thus, the use of fuzzy logic in intellectual superstructure of the expert system allows to predict the quality of the castings, depending on the main parameters of die-casting process specified by the technologist and molds designer. Thus, in case of lack of experience, knowledge or proficiency of such specialists in any particular case, it is possible to carry out optimization of existing or new forecasting process by introducing linguistic variables, defining the main parameters of the production of castings, such as melt and mold temperature, locking piston pressure, pressing speed, the complexity of the mold and the casting configuration.

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