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# THE METHOD OF BUILDING A KNOWLEDGE MANAGEMENT SYSTEM IN A MANUFACTURING COMPANY

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***Abstract:*** The knowledge transformation processes are in line with the strategy of knowledge codification, which goal is the identification of resources, the creation of organizational knowledge bases and the use of information systems in the knowledge management. The research methodology bases on the use of the artificial intelligence usage in the knowledge management. First of all, the problems of a heuristic decision making are analyzed. This paper presents a method of the knowledge production processing, which is aimed at building a knowledge base in a manufacturing company. This method includes the processes related to the identification, conceptualization, formalization and implementation of knowledge in the system. Elaboration of a method begins with the identification of the basic steps and decision problems in the area of production technological preparation and ends with building of the design rules. The article contains examples of the method application for the preparation production in selected machine elements. A further step in the production knowledge implementation is the record of elaborated design rules in the knowledge base. The presented method aims at computer aided construction of the production knowledge management systems. The main emphasis was highlighted on the use of the knowledge based systems that allows obtaining selected information related to the design of technological processes.

***Key words:*** production knowledge, knowledge management system, production preparation, knowledge processing, design rules.

## 1. INTRODUCTION

Knowledge management is defined as the set of actions shaping the proper form and direction of the processes taking place in the knowledge resources of the organization. The objectives of the knowledge management are dependent on their relationship with the overall strategy of the organization. Objectives included in the current strategy determine whether it can be used regarding existing knowledge resources in the organization. Goals that are formulated independently of the strategy, in turn influence the emergence of new, previously non-existent strategic opportunities. Firstly, it determines the strategy of knowledge management, and secondly – the knowledge management determines a future strategy. In the area of knowledge management key processes are discerned, such as: locating, acquiring, developing, distribution, usage and retention of knowledge [1, 2, 3].

There is a term existing in the manufacturing companies which is called the knowledge production. It contains such sets of information thanks to which the basic objectives of production preparation may be implemented. Production knowledge resources contribute to the improvement of production processes and make the product meet the market requirements. Depending on the sources, the knowledge resources may be divided into basic groups of knowledge about the processes, systems and products [4, 5].

The starting point for the construction of a knowledge management system is the analysis of knowledge resources in a manufacturing company. Ongoing research in this area includes attempts to implement elements of artificial intelligence in the knowledge management systems [6, 7]. The research is focused primarily knowledge codification strategy and are based on methods of the expert systems elaboration [8, 9]. The rationale for the selection of such methods is the nature of the knowledge production itself, which is embedded in the reality of the company. It is necessary to use in such a case, the specialists-experts knowledge dealing with the production preparation. It allows mapping the way of experts reasoning, solving selected decision problems that require detailed knowledge resources. Within the knowledge codification there are some steps implemented, associated with: acquiring knowledge, elaboration of its representation and the record of the expert system knowledge base. An example of these activities is elaborated methods of manufacturing data acquisition for production management [10]. Another

example within the elaboration of the knowledge representation is the use of the hybrid systems CAPP [11].
It was noted that an approach based on the experts knowledge concerning the construction of knowledge management systems is quite general, in practice it is possible to proceed directly to the implementations. To be seen is a shortage of strict construction methods of which enable building of knowledge management systems in manufacturing companies. Therefore it becomes necessary to develop such a method of knowledge processing that will allow the construction of a dedicated knowledge base of the knowledge management system.

## 2. PROCESS STAGES OF THE KNOWLEDGE PRODUCTION PROCESSING

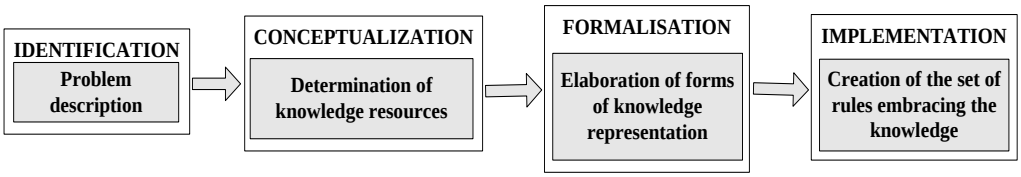



Fig. 1. Process stages of the knowledge production processing

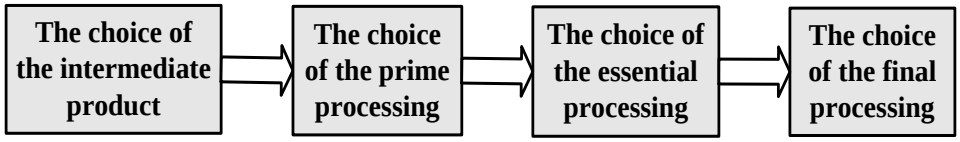



Fig. 2. Stages of knowledge identification in designing of technological processes

The knowledge resources gathered in a company are subject to the process of transformation. It is possible to distinguish firstly the input form of knowledge which is constituted by expertise knowledge. The output form of the knowledge is constituted by the system knowledge, which is recorded in the knowledge base system with the use of a software tool. This knowledge is presented according to the accepted knowledge representation. The knowledge transformation processes are in line with the strategy of knowledge codification, which goal is the identification of resources, the creation of organizational knowledge bases and the use of information systems in the knowledge management. The elaboration of the knowledge management system requires conducting of stages of the knowledge of the production process as shown in Fig. 1.
As part of the knowledge identification stage, the decision problems are selected and the extent of their solutions is determined. The conceptualization stage is based on a detailed analysis of selected problems in terms of determining the required knowledge resources. The knowledge formalization is to translate key concepts, rules and relationships into formal. It is associated with the creation of the proper knowledge presentation, which is used in the recordings of the system knowledge base. During the implementation phase, the design rules are created that stand for the knowledge components.

## 3. IDENTIFICATION OF THE PRODUCTION KNOWLEDGE

The identification stage of the production knowledge is based on the analysis of the fundamental problems in the area of production preparation. These problems depending on the way of solving can be divided into two types:
-*algorithmic problems* - these are the problems of known algorithm solutions (e.g.: choice of machining parameters, determination of time assigned to technological operations),
-*heuristic problems* - the solution of these problems depends on the specific conditions related to the company and is based largely on the experience of experts; they constitute the essence of decision making associated with the selection of the optimal variants in the view of adopted criteria; examples of such problems are: the elaboration of the basic plan of the technological process, designing elements of the operations structure, etc.
The identification of knowledge concerning the analysis of the problems of a heuristic character leads to an elaboration scheme associated with the design processes of selected machine components (Fig. 2). As a part of the decision stages, heuristic problems are determined that affect the distribution of knowledge resources for the implementation of specific sub-targets.

## 4. KNOWLEDGE CONCEPTUALIZATION

The conceptualization stage of knowledge requires the elaboration of the knowledge resources on the basis of which the decision problems are solved, determined at the level of knowledge identification. Taking into account the aspects of pre-production, the following sets of knowledge production in the

company were discerned:
-knowledge about the structure of selected machine components - this set includes details such as e.g. the workpiece material, the shape and geometrical dimensions, surface hardness,
-technological characteristics of the production system - is elaborated on the basis of the production capacity of manufacturing company; those are such knowledge components as: technical data of the machines, cutting tools and of the technological equipment, etc.,
-knowledge of the technological process design - these are general and specific rules for creating relationships between the construction of a given component and the structure of the technological process; an example of such knowledge is information about technological operations to be used to achieve specific design features of the component.
The knowledge conceptualization leads to the formation of acceptable decision solutions of problems from the point of view of the technological capcity of the production system and minimize production costs. While creating variants, specific criteria and limitations existing in the selected company, are analyzed. The number of possible solutions variants grows as the level of detail of the technological design process increases. In contrast, the degree of variants diversity depends on the level of complexity of the construction form of the component. The options available to choose from should be evaluated on the basis of which priority hierarchy and conditions of applicability are determined.
At the stage of the knowledge conceptualization, decision trees, that graphically reflect the decision-making, are elaborated. As an example of the selection variant based on the priority hierarchy, the selection of the machine in the technological process was shown. The starting point is the analysis of the machine technological capabilities. This leads to the creation of a set of possible variants of application. The basic procedure for the machines selection is shown in Fig. 3. The procedure scheme is based on the decision tree structure, in which nodes, machine names are placed on which the process takes place. The tree nodes are variants placed in the order of a fixed hierarchy of importance - the first node: Machine 1, the second node: Machine 2. In the case of nodes equivalence, variants were used as such: Machine 3, Machine 4, ..., Machine n. On the branches of the tree, Boolean values are placed, related to the adoption or rejection of the tree nodes data.
The decision problem solving process starts from the top of a tree and applies in passing through the various tree nodes, according to the accepted logic values of its branches, up to the base of the tree. The output value of the tree is the relationship between the type of technological operations and the name of the machine.

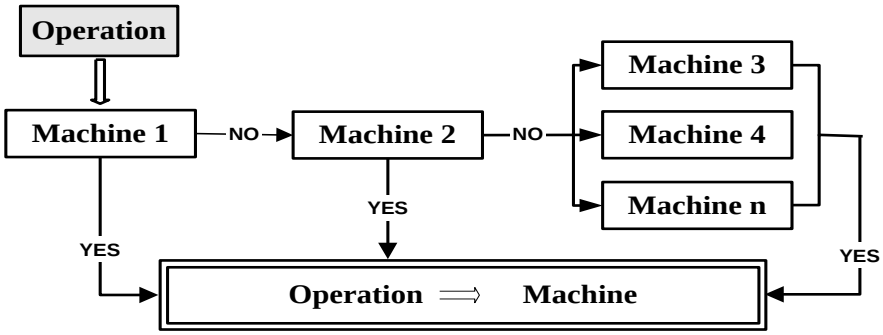



Fig. 3. The decision tree scheme for the machines selection

## 5. THE STAGE OF KNOWLEDGE FORMALISATION

The primary objective of the production knowledge formalization stage is its adequate preparation for recording in the knowledge system base. Knowledge is shown in the form of presentation that allows the gathering of knowledge components about ways how to solve the problems of decision-making. The condition of proper knowledge formalization is to present the relationship between input information about the products design and output information about the structure of the technological process. To meet this condition, appropriate methods of symbolic representation have been elaborated.
The process of creating a symbolic representation of the design is carried out in stages. First the characteristic dimensions are established, which are usually dimensions of the component. The next step is to divide the construction into elementary objects (*features*). These objects describe group of surfaces or an individual surface of the component. Features have been characterized by geometric construction features. In order to record the elementary objects symbols are used, with which the name of the construction feature and its dimensions is associated.
The application of the symbolic method for the machine construction representation is shown on the example of the pipes of hydraulic cylinders. Fig. 4

shows an exemplary embodiment of a construction component with the selected elementary objects. A symbolic representation of the technological process structure which constitute the information represented by the symbols that allow generating the technological process of the selected component of the machine.

The record of the structure symbol of the technological process is based on the formula:

{<OPERATION>, <STAND>, < FIXING m>, <TREATMENT n>,
<MACHINING HANDLES>, <TOOLS>}

where: m – means m-th item fixing in the given operation

n – means n-th machining treatment in the given operation.

Basing on the structure of the operation symbol within the technological process, information is obtained, presented in the form of the description and the operation drawings. An example of the elaboration of a symbolic representation of a technological process for the selected item of a type of cylinder tube is shown in Table 1.

## 6. IMPLEMENTATION OF THE PRODUCTION KNOWLEDGE

The implementation stage of the production knowledge focuses on the elaboration on design rules, which determine the selection rules of the technological process for the particular production item. The rules represent the relationship between the input information about the characteristics of structural and technological products, and the output information about the structure of the technological process.

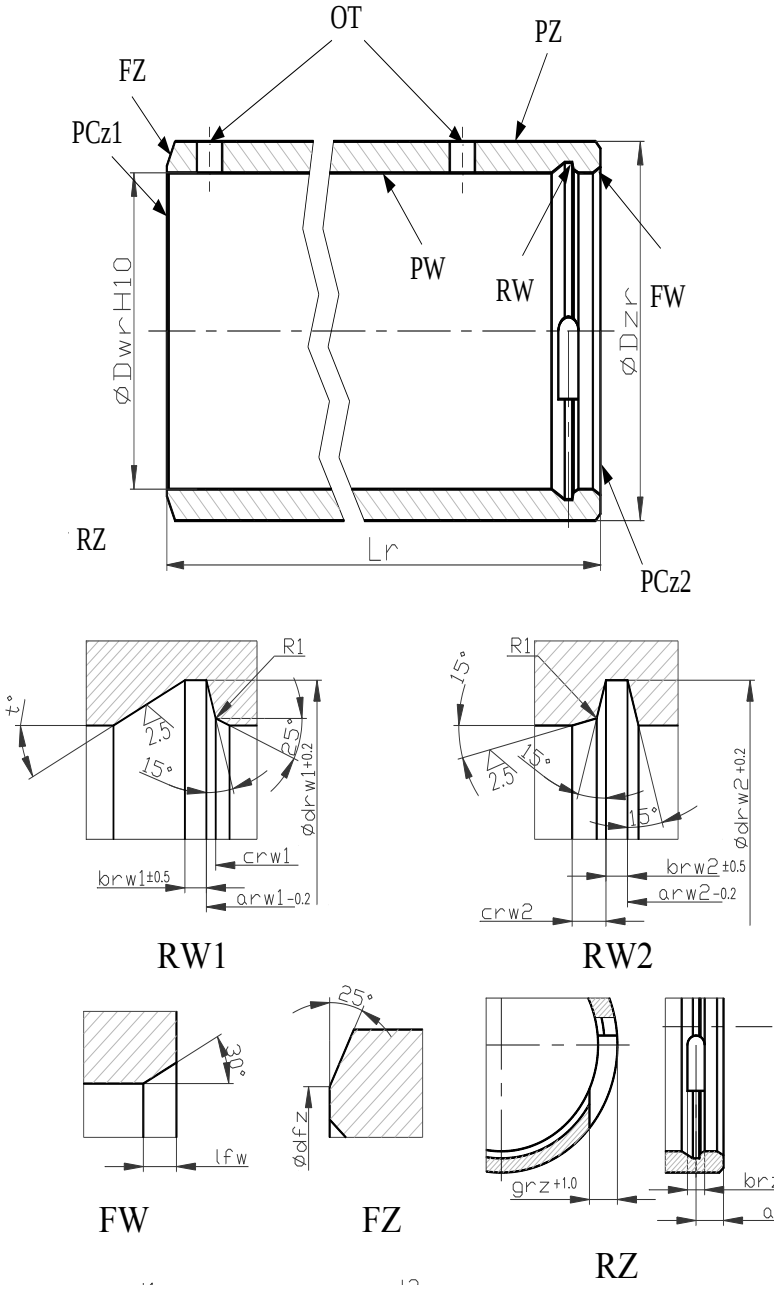
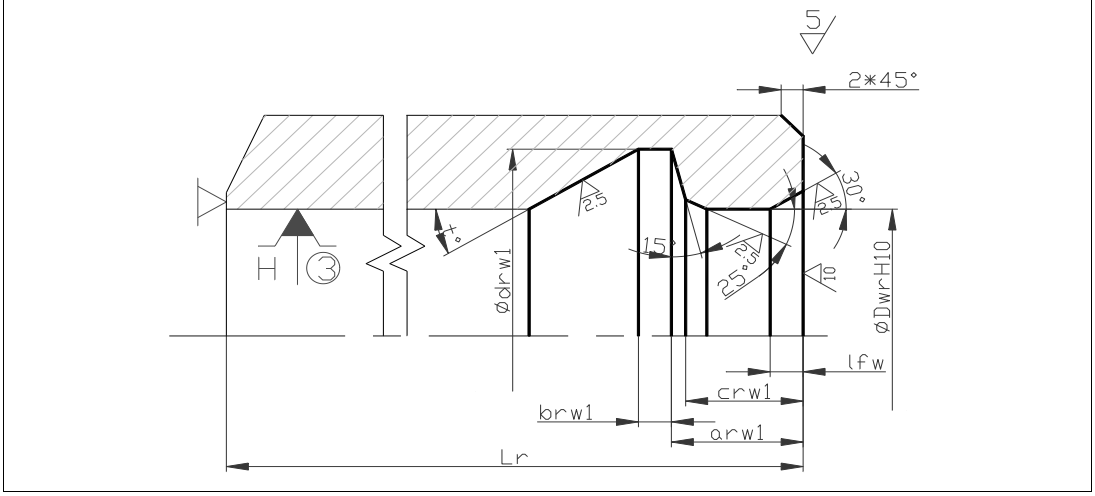



Fig. 4. Geometric design features of selected pipes elementary objects

Table 1. An example of the elaboration of a symbolic representation of a technological process

| Operation symbol |
| --- |
| {TURNING, 350NC, Z1, TKPCz2(Lr), WTKRW1(brw1, drw1, arw1), WTLRW1(t°, drw1), WTP1RW1(crw1, 15°), WTP2RW1(25°), TFW(lfw), TFZ(2, 45°), (M-325), (hR111.26 2525//r0.8, N-331, N-691/P, N-335)} |
| Operation drawings |
|  |



In the knowledge implementation, the methods of symbolic representation have been used: of a machine design components and the structure of the technological process. Research was conducted about the links between the elementary objects of selected cylinder pipe and procedures necessary for the fundamental processing of these objects.
Elaborated relationships between symbolic representations of knowledge allow creating the design rules in the following form:

IF <*object symbol*> THEN <*symbol of the process structure* >

On the basis of the form exemplary rules of design procedures in the process structure may be generated e.g.:

-complex rule:

R1: IF *RW1 (arw1, brw1, crw1, drw1, t)* THEN *WTKRW1 (brw1, drw1, arw)* and *WTLRW1 (t°, drw1)* and *WTP1RW1 (crw1, 15°)* and *WTP2RW1 (25°)*

-simple rule:

R2: IF *FW (lfw)* THEN *TFW (lfw)*

A further step in the production knowledge implementation is the record of elaborated design rules in the knowledge base of the production knowledge management system. For this purpose, appropriate software tools are used, for example the shell expert systems. Design rules are recorded according to a syntax and semantics of the used tool. An introduction of explanatory components regarding the symbols associated to the knowledge representation is required, which may be found in the rules. This can be accomplished through the elaboration of a suitable symbols base and its record in the knowledge management system.

## 7. CONCLUSIONS

The elaborated method aims at computer aided construction of the production knowledge management systems. These systems should effectively support designing of production processes associated with the knowledge processing, especially in the engineering industry. It is possible to integrate this system with enterprise management via the creation of a common knowledge base. It is a condition to make the computer systems of manufacturing companies operate properly. Taking into account the specific activity of such a system, the results of its work can be bound to with the following benefits for the company:
-improvement of processes and products,
-minimization of production costs,
-improvement of the information flow in the process.
The research methodology bases on the use of the artificial intelligence usage in the knowledge management. Decision problems of a heuristic nature were analyzed. The main emphasis was highlighted

on the use of the expert systems concept that allows obtaining selected and condensed information related to the design of technological processes.

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