Architecture and Simulation for Knowledge Management in Engineering

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Abstract: Today, information has become more important. Even data, information and knowledge are often used as if they have same meaning. This problem raises difficulties in engineering. It is necessary to exist a knowledge management (KM) system to avoid increased costs, waste of time and increased errors. In this paper the model of the knowledge management of the mechanical engineering was proposed. The model can be used by the manager for the choosing of competitive orders.

Key-Words: - knowledge management, mechanical engineering, information technology, machining system, marketing knowledge, competitive management.

Received: October 18, 2019. Revised: February 19, 2020. Accepted: March 21, 2020. Published: March 31, 2020.

1 Introduction

The market dynamics is further passed to the mode of operation and management. In a knowledge-based society and economy, operations such as determining the relevant information and aggregating them into pieces of knowledge must be automated, because in such a complex and unpredictable environment, they are indispensable tools for creating, searching and structuring knowledge.

The interaction between the economic environment and the manufacturing system is a major source of knowledge about the economic environment and the manufacturing system themselves [14]. Consequently, it is necessary to exist a knowledge management system to avoid increased costs, waste of time and increassed errors.

The recognition of the Knowledge Management (KM) imperative will provide an impetus for enterprise to understand and nurture their knowledge resources and activities.

KM has assumed a broad range of meanings from its inception; however, most of the published material remains ambiguous and provides little empirical evidence to support a specific definition for the knowledge management concept. KM has been acknowledged as being important to competitive advantage and organizational progress.

Thus, a clear understanding and agreement about KM should prove to be of great value for enterprises. As enterprises strive to create a competitive advantage with their products and services, they continue to contemplate the KM concept and the impact on organizational success.

In a effort to define KM, enterprises must determine which corporate knowledge should be harvested organized, managed and shared.

A general definition has been 'getting the right information to the right people at the right time' in order for them to make better decisions.

Knowledge management implementation is an advantage for the enterprise from viewpoint of the competitiveness. The new knowledge will be used both in the enterprise management and to develop new products and new services or make important changes in the business decisions.

By means of learning, the enterprise which uses the knowledge able to adapt and respond continuously to the changes of the business environment.

An important goal of KM is seen to be the sharing of best practice. So, by the improving the flow of knowledge through the enterprise can be obtained the following benefits:

- the sharing of the best practice around business processes;
- the ability to respond more effectively to customer demands.

Due to technology facilitates the rapid exchange of information, the pace of acquisition is growing exponentially in both large and small enterprises. The vast amounts of knowledge possessed by the enterprises are spread across countless structured and unstructured sources.

To improve processes and bring new products to the market faster and more cheaply, the enterprises have to identify, make available and apply this knowledge.

Thus, information must be understood, organized and

transformed for problems solving. Consequently, information transformed in product is knowledge and coordination of this kind of knowledge is made by means of knowledge management.

As shown above, the manufacturing industry faces the challenge of responding quickly to the ever-changing requirements of customers. It is necessary that in these high competitive environments, enterprises to control production system dynamics of such as:

- change in the product types and variants;
- change in the production quantities.

Enterprises have to develop and implement more responsive and flexible manufacturing systems based on knowledge. By this way, they can respond to outgoing and difficult to predict change in production requirements and make products with high quality, low cost and fast delivery.

Paper has the following structure: section 2 presents related literature, section 3 explains knowledge management in engineering, section 4 contains a case study and section 5 summarizes the main conclusions achieved.

2 Related Literature

The paper is related to several strands of literature.

To be competitive organizations should react adequately, interpret non-standardized information for problem solving and decision making, as well as change their infrastructure and management strategies [8]. Usually there are a lot of information and knowledge within organizations, but at the same time many of them (service organizations, in particular) are "information rich and knowledge poor." The information and knowledge assets, often called an "intellectual capital," i.e., knowledge that can be converted into value, make a great potential for organizations if utilized well [1].

Knowledge management (KM) has become an effective way of managing organization's intellectual capital or, in other words, organization's full experience, skills and knowledge that is relevant for more effective performance in future.

Studies in KM mainly focus on organizational knowledge captured in corporate and/or organizational memories [2], [9], [19] and on the development of knowledge management systems (KMS). However these initiatives in organizations have often run into difficulties mainly because the expansion of individual's personal tacit knowledge to knowledge of organization as a whole causes implementation problems.

In the paper [8] there are defined tacit knowledge and explicit knowledge. Tacit knowledge is personal knowledge gained through experience. It may be shared and exchanged through direct communication with others. Explicit knowledge is represented in documents, emails, knowledge repositories (data and knowledge bases), etc. Explicit knowledge can be formalized in words and numbers and it is easy distributed and shared.

Acquisition of explicit knowledge is indirect because it must be encoded and decoded in one's mental models where it is kept as tacit knowledge.

In [11] it is shown that the concept of managing knowledge has become increasingly popular both in the practical and in the academic discussion in the fields of engineering and management. Successful management of knowledge-related resources of companies has been recognized as a key basis for acquiring competitive advantage and other organizational success and the acquisition and application of knowledge has even been argued to constitute the focal role of organizations in the society [4].

The paper [13] is concerned with a application of knowledge management on the mechatronic system. The Internet –based CNC machining center has been considered and its knowledge management model has been prepared. The model prepared has been analyzed for machining performance of the manufacturing system.

The architecture of KM model of internet – based mechatronic system is presented in the figure 1.

The system presented in this paper consists of KM model (PC), mechatronic system (CNC machining center), user unit (PC, SMS) and data, information converter unit. KM model consists of knowledge bank compare, internet and network connection, commentary and management units. Operations of CNC Machining Center which is the main production unit of the system can be controlled both by the machine tool control panel and by e-mail, network from distant places. Also, the machine tool equipped with a lot of sensors so that the machine tool performance can be monitored and unexpected conditions can be controlled.

Motivated by the literature discussed above, this paper presents a knowledge management structure of the machining system to provide competitiveness of the enterprise.

3 Knowledge Management in Engineering

Knowledge-based engineering is an engineering methodology in which knowledge about the product, the techniques used in design, analysis, and manufacturing, is stored in a special product model [23].

Knowledge discovery in databases (KDD) is the non-trivial process of identifying valid, novel, potentially useful, and ultimately understandable patterns in data.

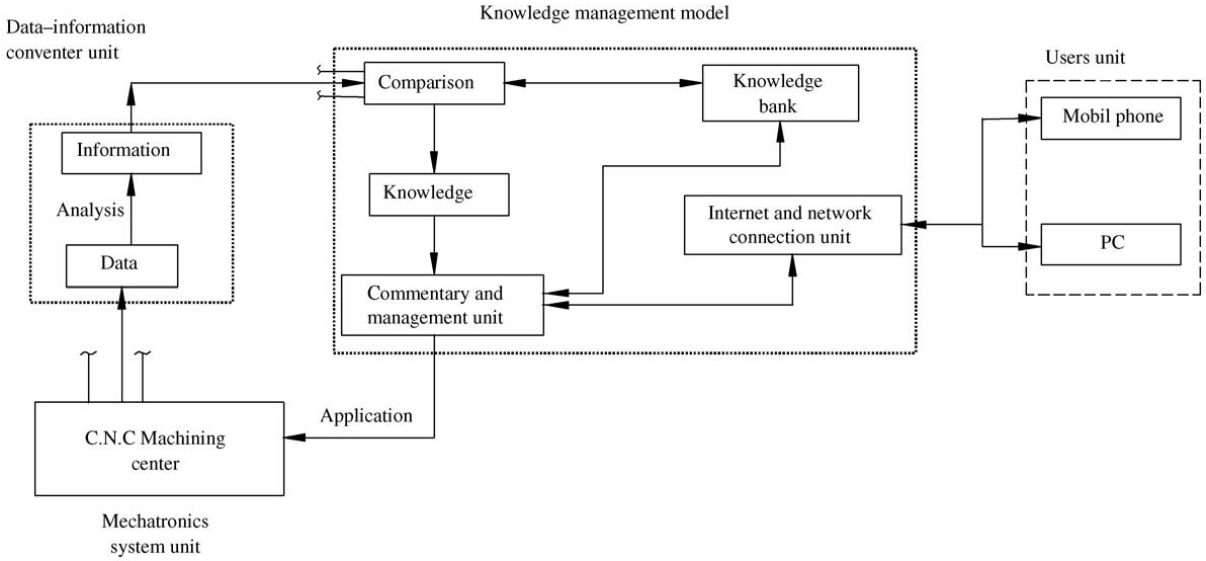

Fig.1 System diagram of KM of internet – based mechatronic system

It can acquire implicit and useful knowledge in large scale datasets, and involves an integration of multiple disciplines such as statistics, artificial intelligence, machine learning, pattern recognition, etc. KDD has had great success in commercial areas, and has begun to be used in knowledge acquisition of engineering disciplines.

The overall KDD process includes data selection, data preprocessing, data transformation, data mining, interpretation, and evaluation, as shown in Fig. 2 [21].

Defining data, information and knowledge is difficult. It is possible to distinguish between data, information and knowledge on base of external means or from the perspectives of the user.

In [13] it is shown that, data are considered as raw facts, information is regarded as an organized set of data, and knowledge is perceived as meaningful information.

Data consists of symbols that represent objects, events, and their properties. Information is data that has been made useful. Information answers who, what, where, when, and how many questions. Information is helpful in deciding what to do, not how to do it.

Knowledge consists of instructions and know-how. Knowledge answers how questions. Knowledge is more than information. Information is data organized into meaningful patterns. Information is transformed into knowledge when a person or an intelligence system reads, understands, interprets and applies the information to a specific work function.

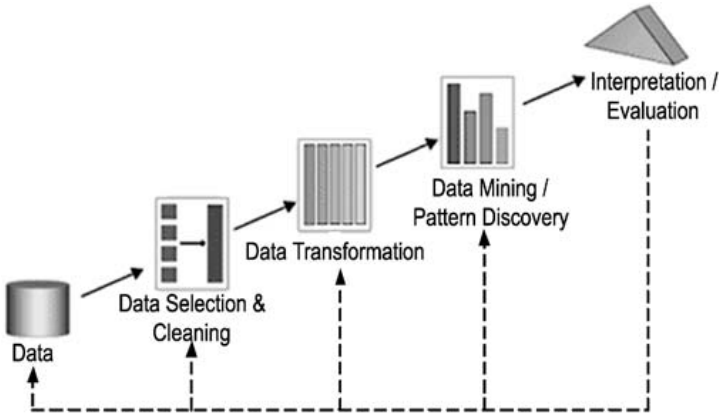

Fig. 2 The process of knowledge discovery

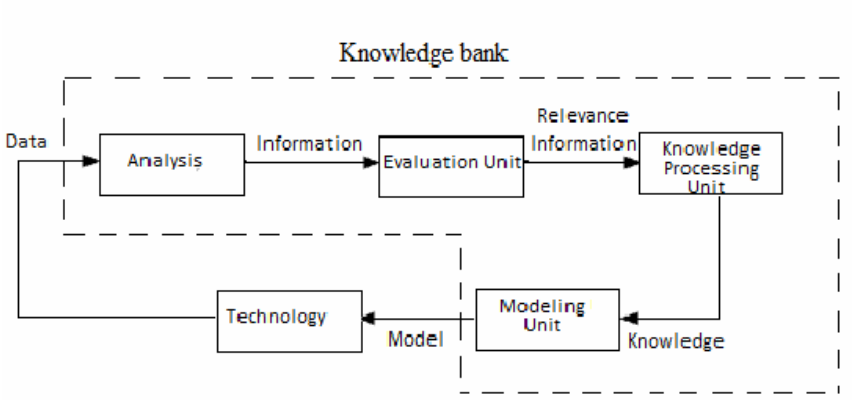

Fig. 3 KM model

One person's or one intelligence system's knowledge can be another person's or intelligence system's information.

If the information can't be applied to anything, it remains just information.

However, a person can take that same information, understand it and interpret it in the context of previous experience, and apply to anything, it is transformed to knowledge [15].

Information is becoming ever more important in engineering. It is not suitable to use data, information and knowledge conventionally. That is there is conceptual confusion. Also, today's technological products need interaction between different disciplines.

So the confusion increases more. At the multidisciplinary engineering system, any discipline contains some information peculiar to system. However, most of the information mean essentially same even if they are expressed in different terms in different disciplines. Therefore, the available information must be evaluated, simplified and transformed into usable form that is knowledge.

Next, the knowledge is coordinated and connected with the system. So, a kind of know-how is acquired for the technological product. This case is generally based on a model, while it has special characteristics. An example of machining system has been analyzed in the following section. The model produced by technical knowledge which is acquired by the interaction of data, information and knowledge, by the coordination and the application of them on engineering system. KM model is presented in Fig. 3.

KM is a comprehensive process of knowledge creation, knowledge validation, knowledge presentation, knowledge distribution and knowledge application [15]. When KM model is applied by the enterprise into its production process it is obtained increasing competitiveness of the product in the market.

That is KM model can be used for every stage of the engineering works such us design, manufacture, maintenance and repair.

4. Application of the knowledge management on machining system

4.1 Knowledge Management architecture of the Machining System

The architecture of KM model of machining system is presented in Fig. 4. The system showed in Fig. 4 consists of KM model, CNC Machining System, Marketing Knowledge.

KM model contains very important features of the system.

KM model consists of knowledge bank, compare, modeling and control units. The knowledge bank is formed according to the characteristics of the system.

It is very important that information which concerns with subject, correct, update, concordant must be converted knowledge and they must be stored in this unit. It is necessary that this unit becomes a flexible structure because it can be updated depending on the market dynamics and technical characteristics of the new manufacturing products.

The information coming from the Marketing Knowledge-unit are diagnosed by the comparison unit. Also the comparison unit has information-receive ability from knowledge bank. The essential function of the comparison unit is to compare the information and knowledge with each other. The output information from the comparison unit is a new knowledge. This new knowledge has been sent to modeling unit.

Not only does the modeling unit receive information from the comparison unit, it also interacts with the knowledge bank. The output of the modeling unit is the model which is analyzed in control unit. This unit sends the manufacturing instruction for to the CNC

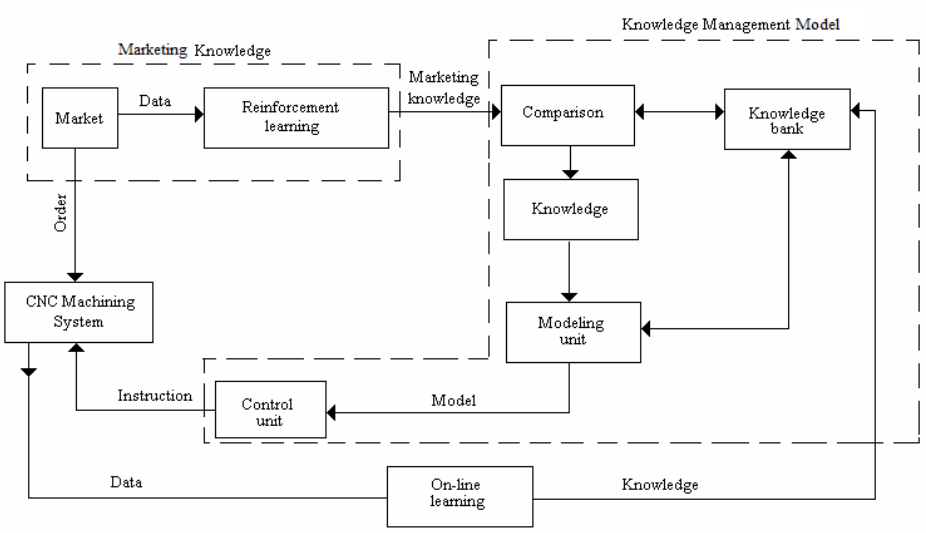

Fig. 4. Knowledge Management architecture of the Machining System

Machining System. Through on-line learning, the output information from CNC Machining System unit becomes the new knowledge and has been sent to knowledge bank.

The machining system receives contracts after the tenders (competitions) generated by the market offer quatations. The competitive control means competitiveness assessment, and based on it, an intervention on the machining system through instructions regarding the progress of the machining process in order to obtain maximum competitiveness. On the other hand, after assessing competitiveness, the management system should enable to develop competitive offer for the tenders. To achieve these two objectives, the competitive control uses the reinforcement learning to get to know the market and the non supervised on-line learning technique to get to know the machining system.

The learning process, in general, is an action in which the machining system can improve its ability to react so that, during subsequent requests, this should take actions more efficiently.

Devising a real-time modeling methodology, based on reinforcement learning (which is a specific non supervised learning technique) of the machining system relationship with the economic environment means that the machining system 'learns' what actions to perform in certain situations, based on the data supplied by the economic environment, so that such actions increase the possibilities of achieving the aim pursued. The system should 'exploit' what it already knows to get profit, but at the same time it must 'explore' the possibility of finding other suitable actions for the future. The machining system should try a variety of actions and then choose those that seem best.

According to the competitive management, regarding the market- machining system relationship by reinforcement learning, from the data supplied by the marketing section of the enterprise (auctions situation), an evolution of the economic environment for a period of time is carried out and an overall modeling is provided on the basis of past events.

Reinforcement learning is to be understood as the machining system capacity to 'learn' in permanent interaction with the economic environment, to inform and update the information about the auctions and to anticipate, before deciding to conclude a contract, the level of costs, profit and what is the best way to act.

Modeling the market- machining system relationship simulates, based on a state of the environment and an action of the machining system, the behavior of the assembly and can predict what will be the next state and the result obtained.

The relationship is used for planning, to take decisions regarding the behavioral modeling of the machining system – market assembly while considering possible future cases before such situations are experimented.

After each possible situation, the machining system will adapt its behavior, so that it tends towards its next most favorable state. By the learning process, the machining system will be allowed to execute a number of actions in accordance with the instructions from the behavioral model operation of the assembly and that action will be selected likely to bring it to the maximum competitiveness state.

4.2 Behavioral modeling

As shown above, on based of behavioral modeling, the unit control elaborates the necessary instructions to adjust the machining process and the manager can elaborate the management policies.

The term of behavioral modeling is introduced by

the authors of this paper and, for presenting this notion, we shall consider two elements H1 and H2, which interact with each other (Fig. 5. a). Model H1 of the first element establishes a connection between the input x and output y. If x and y are at the same time input and output of another element, whose model is H2, then the two elements interact with each other.

Modeling their interaction (behavioral modeling) means setting the pairs of values (x, y) which satisfy the transfer functions H1 and H2. The multitude of solutions which satisfy both transfer functions H1 and H2 represent the behavioral model because they describe the behavior of the elements during their interaction.

For instance, under the theme concerned, H1 could stand for the machining system while H2, for the market.

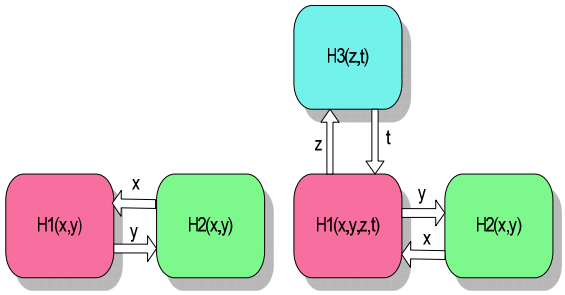

Fig. 5. Behavioral modeling

Behavioral modeling becomes increasingly complex as the number of interacting elements is

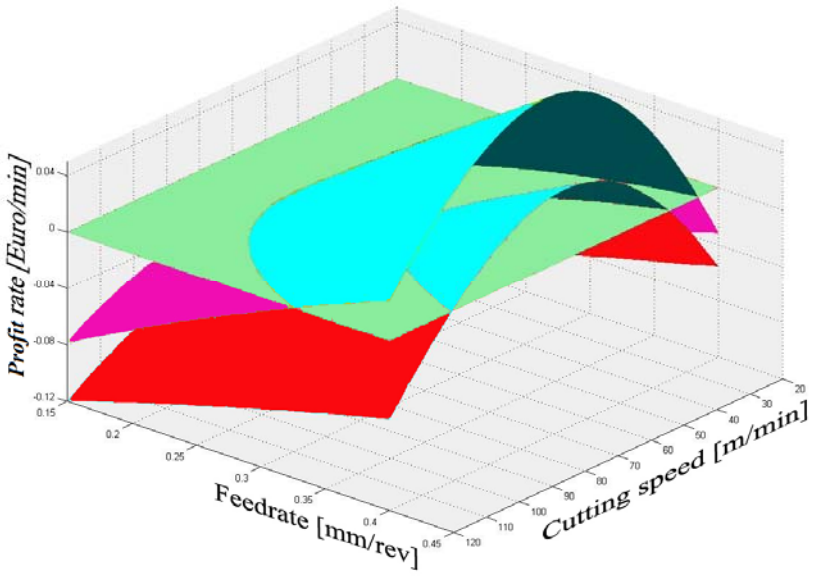

Fig. 6 Maximum profit rate of the manufacturing

system growing too.

For example, in case of Fig. 5.b, three elements interact and behavioral model represents the relationship between the values of x, y, z and t for which the three elements can interact.

Considering elements H1 and H2 with the following transfer functions:

$$\begin{cases} H1(x,y)=0 \\ H2(x,y)=0 \end{cases} \quad (1)$$

then, the solutions of the system (1) represent the behavior model of H1-H2 assembly. If the solution is unique, then the behavioral model is reduced at one operational point.

5. Case Study

Let us assume that in market there are more offers quotations for a certain product. Using reinforcement learning, the information from market becomes marketing knowledge and they are compared with the ones from knowledge bank.

After the comparison, knowledge unit send the technical-economic parameters to the modeling unit. Also, modeling unit interacts with the knowledge bank to achieve the machining model.

On basis of generated model, simulations are made and analyzed in control unit. This unit sends to the CNC machining system the manufacturing instructions that satisfy the customer demands in the competitive

conditions of the enterprise.

For example, from the simulations (fig. 6) it can see what is the maximum profit rate depending on the cutting speed and the federate of the machining process. The control unit sends to the CNC machining system the manufacturing parameters: cutting speed v'_{op}, feed rate *s*, depth of cut *t*.

On basis of these simulations the manager can decide if the order is accepted or rejected.

6. Conclusion

Knowledge management (KM) has become an effective way of managing organization's intellectual capital or, in other words, organization's full experience, skills and knowledge that is relevant for more effective performance in future.

Knowledge-based engineering is an engineering methodology in which knowledge about the product, the techniques used in design, analysis, and manufacturing, is stored in a special product model.

The paper proposes a knowledge management to achieve a competitive control of the machining systems. Then an application of Knowledge Management in engineering has been attempted to explain

Using and comparing marketing knowledge with stored and updated ones the machining model is carried out, analyzed and on its basis are generated instructions regarding the progress of the machining process in order to obtain maximum competitiveness.

By modeling and simulations, the manager can decide if the order is accepted and control the machining system to satisfy the customer demands.

To achieve these objectives, the competitive management uses the reinforcement learning to get to know the market and the unsupervised on-line learning technique to get to know the machining system.

Note that we propose to give managers a knowledge management model, so that they can interact with the economic environment (market). This knowledge management model represents a technical-economic model that can be used for competitive management of the manufacturing process without requesting experiments and based on the extraction of the knowledge from the previous experience.

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