

Knowledge Management in Machining Processes

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Abstract— In today's society, where access to data and information is more easily achieved thanks to the rate of development of information and telecommunication technologies, the problem is to know more and more, to know how to use the immensity of information that we can have at one time.

To a new global challenge the scientific community responds by a new conceptual paradigm, which in this case is the knowledge-based economy (KBE).

Knowledge, like information, is worthless if not applied in decisions on necessary actions in the context of economic activity of the company. Many companies have worked hard to store information on available knowledge, but did not give enough attention to the chase how to apply, are used not only actual work but also to generate new ideas for future activity.

In the paper we aim to offer a strategic vision of knowledge management (KM) that takes into account the synergy between technological and behavioural issues so necessary for progress in the current economic context.

Index Terms— knowledge, knowledge management (KM), knowledge-based economy (KBE), manufacturing process

I. INTRODUCTION

All over the world, companies are faced with increasingly accelerated and unpredictably dynamic changes.

This is influenced by the scientific and technical progress, the dynamics of customers' demands, the scientific approach to management and the mathematical focus on economy [1]. Changes lead to aggressive competition on a global scale, which calls for the establishment of new balances between economy, technology and society. The characteristic aspects of the present-day market, in particular case of mechanical components market, are the following: continuously decreasing of the current orders, leading to the design of small series production; strong tendency to personalize the products leads to a pronounced diversity of shapes, sizes and other characteristics of the mechanical components required on the market; flexibility, responsiveness and especially an efficient system management tend to become the characteristics that determine competitiveness on the market

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of components manufacturers and mechanical constructions. The current dynamics of the industrial and business environment is the great global challenge which must be faced.

To a new global challenge the scientific community responds by a new conceptual paradigm, which in this case is the knowledge-based economy (KBE), [2].

Knowledge, innovation and creativity are keys to success with the globalization of the Knowledge Economy in the new millennium. The winners in today's knowledge-based economy will be companies that consistently leverage and increase their intellectual capital: knowledge of an organization's workforce, documented processes, methodologies, patents, guidelines and software [3].

In order to progress in the present-day complex and unpredictable environment, the company must feature abilities of quick response [4] and favorably reposition itself on the market. Acquisition and preservation of this capacity is the most difficult step for companies as it involves many endogenous and exogenous factors and the process is continuous, dynamic and hardly predictable.

In this context, three elements are highlighted by their relevance: competitiveness, the manufacturing system and the knowledge system.

According to the literature, a company is competitive on a certain market when it succeeds to reach, up to an acceptable level, some economic indicators: turnover, profit, market share comparable or superior to that of other competing companies acting on the same market.

Many approaches to the problem of competitiveness [5], [6] show that, today, competitiveness is defined by the economic factors and indicators obtained and is more a suggested/induced notion than a numerically valued one. Approaches are of economic and managerial nature, while the relationship with the technical aspects of competitiveness is less noticeable.

At this point there is no defined algorithm to evaluate the technical and economic competitiveness, moreover, the technical factors are not considered at a practical level, when defining competitiveness, although consumption and costs incurred by the technological processes are generated by technical actions.

In this context, the notion of competitiveness gains new valences, including factors and policies that determine the ability of the enterprise to get a favorable place on the market, to hold that place and to continuously improve its position. Only in this way can competitiveness fully and synthetically characterize the enterprise viability.

In the paper, competitiveness will be understood as the capacity (potential) to provide performance (compared with other similar elements), in a very punctual way, within a

macroeconomic concrete context and at a certain time.

Within this paper, by manufacturing system we understand all the technological systems that are used to produce a specific product. Each of these technological systems is composed of machine-tool, tools, devices, parts, operator and carries out one of the operations of the technological process of making that product.

The manufacturing system is complete when the product is released for manufacture and remains there only until the end of the product completion. After this, when another product is released, the problem of structuring the manufacturing systems is taken from the beginning. This ad hoc structure of the manufacturing system is always present with manufacturing lots, but not in mass manufacturing, when all of the technological components of manufacturing system remain unchanged for a long time.

The manufacturing system performance depends on how it is run. In more specialized papers, [10], reference is made to the relationships between the parameters of the cutting processes and the technical performance of the manufacturing system (purely technical aspects), while in others, equally numerous references [1], [2] are made to the relationship between the product made by the manufacturing system and the market (economic relations).

In the literature no attempt to approach the whole manufacturing system–market assembly is reported; therefore, there are significant resources to improve performance which are not used because the technical and economic aspects are dealt with separately. Also, it is not known an algorithm for the management of the manufacturing system–market assembly, but only algorithms for the technical control of the technological systems-components of the manufacturing system [7], [8] and tools of economic management of the relationship between the enterprise as a whole and the market [9].

Nowadays, the manufacturing systems are controlled by means of numerically programmed machine tools which are part of the system [10].

The control is exclusively technical because there is no economic variable, although this is actually the ultimate goal of any processing process.

The dynamic changes and the overall progress of society are reflected at company level by many orders in number, small in volume, very diverse, obtained through frequent auctions with short-term response, which leaves no time for a relevant analysis of said orders. As a result, a long-term management is no longer possible.

The paper has the following structure: section 2 presents the problem formulation, section 3 illustrates KM on machining system and section 4 summarizes the main conclusions achieved.

II. PROBLEM FORMULATION

Knowledge, like information, is worthless if not applied in decisions on necessary actions in the context of economic activity of the company.

Many companies have worked hard to store information on available knowledge, but did not give enough attention to the chase how to apply, are used not only actual work but also to generate new ideas for future activity.

The application and use of knowledge requires that they be communicated from person to person, although this transfer is accomplished smoothly, without effort. In fact, in the company there is "market" of knowledge, with an evaluation system of exchanges, with sellers, buyers and intermediaries. In many companies the transfer of knowledge is made difficult because there is not time to transfer and therefore the exchange "price" of knowledge grows.

In today's society can get access a immense volume of information from almost anywhere. But only information is not sufficiently. The feature of knowledge society is not that it has large amounts of information, but inside always it has to know more.

To this information to become useful, it must be transformed into knowledge and then used efficiently in

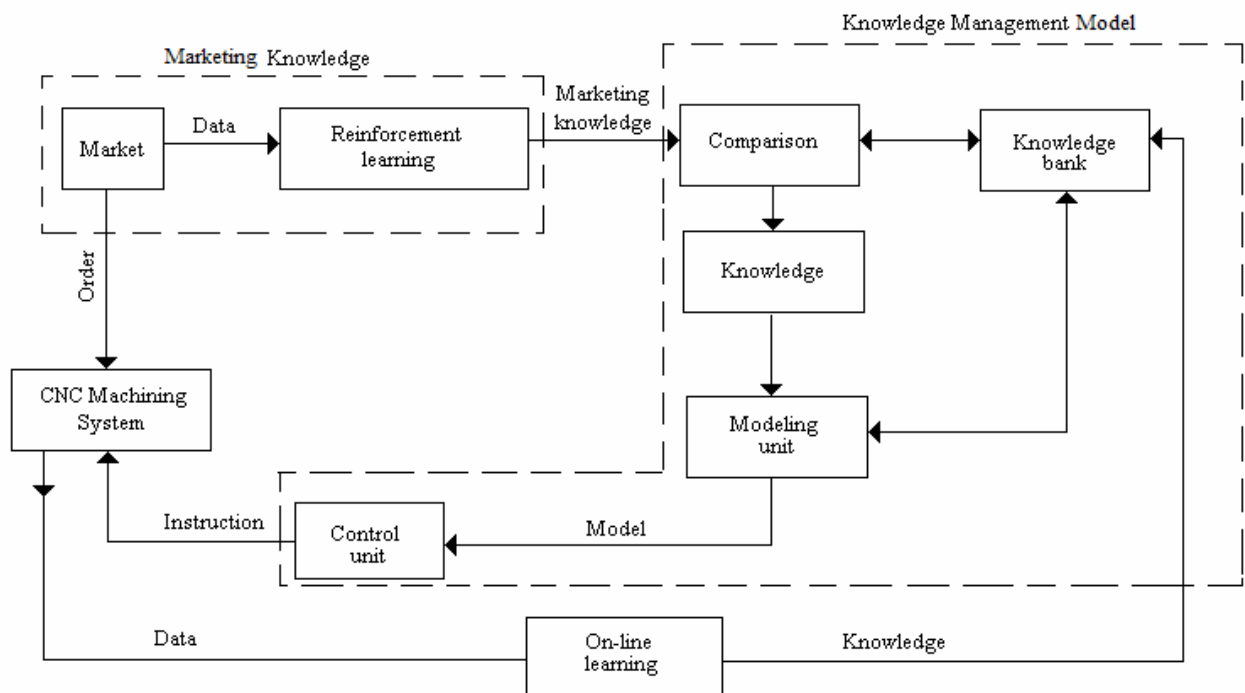


Fig. 1. Knowledge Management architecture of the Manufacturing System

company management. What we propose in this paper is to provide manager, based knowledge he has, (economic and technical knowledge) a model of KM (knowledge management) to his enterprise to be competitive. When there is a model that interconnects data and information, the model has the potential to be knowledge. Such model, which is knowledge, provides when the model is well understood, a high level of certainty or prediction regarding how less static models will evolve over time. We intend to offer one such of model at the manager of an enterprise.

KM provides the necessary information for solving the problems of adaptation, progress and competence of enterprise to cope with changes occurring in the environment.

III. APPLICATION OF THE KNOWLEDGE MANAGEMENT ON THE MACHINING SYSTEM

A. Knowledge Management Architecture of the Machining System

The architecture of KM model of machining system is presented in Fig. 1. The system showed in Fig. 1 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 is 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 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 quotations. 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.

B. 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.

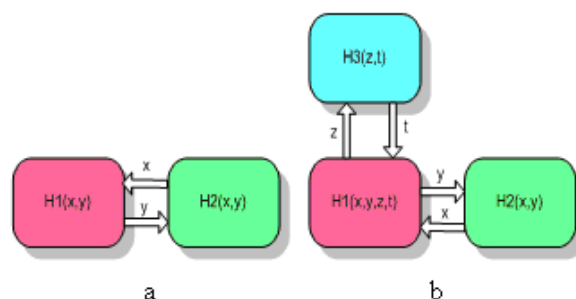


Fig. 2. Behavioral modeling

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. 2. 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 .

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

For example, in case of Fig. 2.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.

Considering $H1(x,y)$ and $H2(x,y)$ as being two lines, then the solution of the system is the intersection point H_0 (Fig. 3).

If there is a values string x_0 and y_0 as solutions of the system (1), then the behavioral model includes all these points (Fig. 4): (x_0', y_0') , (x_0'', y_0'') , (x_0''', y_0''') .

If the system (1) is incompatible, then there isn't any behavioral model that meets H1 and H2 assembly. In the case of Fig.2.b, the case of the interaction of three elements H1, H2, H3, the behavioral model is given by (x_0, y_0, z_0, t_0) , the system solution:

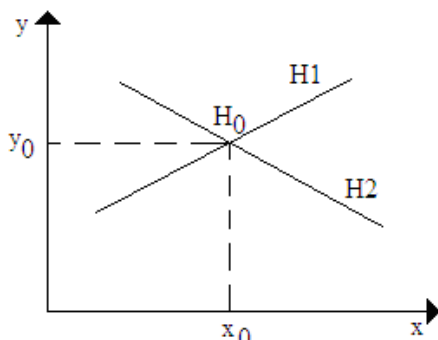


Fig. 3. Behavioral model with unique solution

$$\begin{cases} H1(x, y, z, t) = 0 \\ H2(x, y) = 0 \\ H3(z, t) = 0 \end{cases} \quad (2)$$

As the number of variables is more than equations, we expect the system (2) is indeterminate. The model will include an infinite number of points.

The behavioral modeling method of the machining system-market assembly is developed on these assumptions:

- elements H1 (machining system) and H2 (market) operate and are monitored on-line;
- during operation, elements H1 and H2 pass through different states, that means they operate with various values of the state parameters. For example, H1, the machining system, processes various products with various machining parameters and with various time, materials consumptions. Element H2, market, operate similarly, selling various products with various prices in various supply conditions.

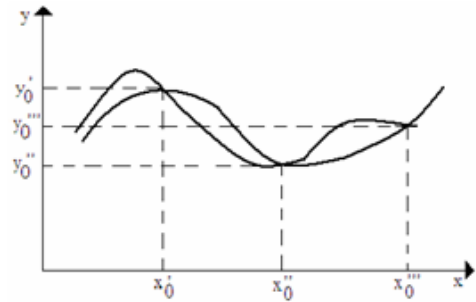


Fig. 4. Behavioral model with multiple solution

- elements H1 and H2 interact, but not throughout their operation (the machining system can interact with another markets).

Models currently used in the management of the machining systems, whether analytical, numerical or neural (or, in general, algorithmic), refer to the components of the systems. Building of models in all cases is based on off-line experimental investigation of an element, making up a set of experimental data and using it to select, out of a given family of data, the most appropriate model.

There are no cases reported in literature of behaviorally modeled systems where, by monitoring the current operation of the machining system concerned, to extract on-line knowledge which relates to the interactions taking place in said machining system, although, for a competitive management, it is in fact required to model the interaction between the system components. The concept of competitive management of the machining systems will be developed based on behavioral modeling, which will describe the interaction between elements (technological system, machining products, market).

IV. CONCLUSION

In this paper the architecture of the knowledge management of the machining system was achieved. Using and comparing marketing knowledge with stored and updated ones the manufacturing model is carried out, analyzed and on its basis are generated instructions regarding the progress of the manufacturing 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 control 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 control of the manufacturing process without requesting experiments and based on the extraction of the knowledge from the previous experience.

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