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MANUFACTURING SYSTEM STRATEGIC CONTROL

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ABSTRACT

In order to progress in the present-day complex and unpredictable environment, the company must feature abilities of quick response and favorably repositioning 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.The competitiveness based strategic control of the manufacturing systems as ability to perceive the environment, to make decision in time, as a result of the manufacturing system-market interaction, with no specific procedures. The manufacturing system environment provides on-line data on the actions undertaken which, properly analyzed and correlated, will further generate solutions in order to develop the control decision. The aim of this work is the achievement of a modern and general approach of technical-economic competitiveness of the manufacturing systems taking into consideration the dynamic of the interaction factors from the economic environment.

KEYWORDS: competitiveness, on-line learning, manufacturing system, adaptive control, competitive management.

1. Introduction

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. In the world there are prestigious competitiveness research centers , such as: Center for International Development-USA Harward University, European Institute of Technology with its research center in Cambridge, Geneva, Oxford and Organizational Competitiveness Research Unit of Sheffield University Halle-UK which deals with competitiveness at the global, regional down to enterprise/company level. However, 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 on 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 meanings, 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 this way can competitiveness fully and synthetically characterize the enterprise viability. In concordance with the specialty literature, an enterprise is competitive on a certain market when it obtains, on an acceptable level, certain economic indicators: cipher of business, profit, market segment comparable or superior to have another competitors on the same market.

In the paper, competitiveness will be understood as the capacity (potential) to provide performance (compared with other similar elements), in a very strict way, within a macroeconomic concrete context and at a certain time. Moreover, according to a matter of competitiveness (considered as an essential performance indicator) it will be assessed the extent to which the company achieves the purpose for which it has been created. Therefore, the paper aims at making a numerical and on-line evaluation of the

technical-economic competitiveness and the management of the manufacturing system is performed to obtain maximum competitiveness. Whence, it follows, on the current level, that the competitiveness is defined by the economic factors and indicators obtained. In this moment the algorithm for technical-economical competitiveness evaluation is not defined and, moreover the technical factors are not taken into account, also consumptions and expenses caused by the technological processes are generated by the technical actions. In this context, competitiveness notion has new meanings, because it assembles the factors and politics which determine the enterprise capacity to occupy a favourable place on the market, to keep that place and to improve the position. It isn't known an algorithm of management of ensemble manufacturing system - market, but just algorithm of technical management of the manufacturing system and the economic element of the relation with the market [4]. Today the manufacturing systems are managed through the programs of the machine tools on numerical program. Management is exclusive technique because an economic variable does not exist which in fact is an ultimate consequence. Dynamic changes and the general progress of society translated on the level of the enterprise through many orders as the small volume, of a great variety, obtained through frequent auctions with answers in short terms, carry it doesn't offer the times for analysis pertinence statements. Consequently, it can not be managed for a long time. It is enforced a method of the fluctuant on-line, prompt reaction, speeder management [3], [4]. The dynamism from the market is transmitted into the management.

2. The development of the strategic and control concept of manufacturing systems

The development of the concept will be based on the obtained results by the paper's authors, concerning the rigorous analytical and general description of econometric of technological system, made up machine tool, apparatus, part and tool. In Figure 1, a summary of a research studies on the cutting process is presented. From an analysis of these conclusions: in the *ZOY* plane, presents cost curve, *c*, and the productivity curve, *q*, depending on the process intensity, *R*, it is observed that c is minimum in the point where the value of the process intensity is *Rc* and the productivity curve, *q*, is maximum in the point where the value of the process intensity is *Rp*. Because analytically, *Rc* is different from *Rp*, it

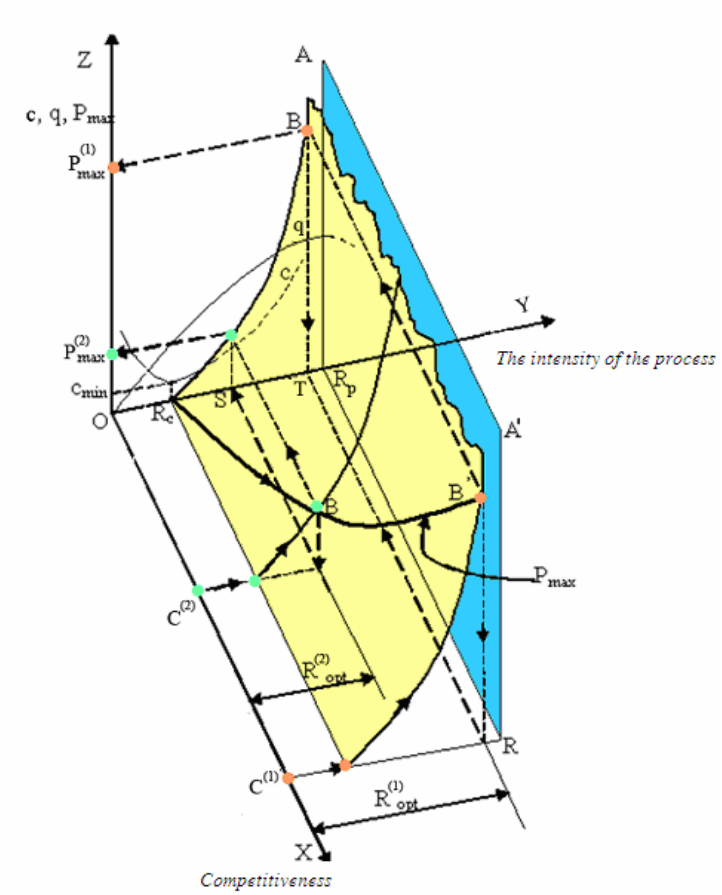

Fig. 1 Curve of maximum profit

follows that it is never possible to simultaneously achieve a minimum cost and a maximum productivity.

For a better understanding, the case of the cutting process will be presented. Thus, in the Figure 2, we presented the productivity *q* and the cost of the cutting process *c* dependence on durability of the cutting tool. An important parameter in the technical and economic defining is considered the specific price *p* as:

$$p = \frac{selling\ \ price}{surface\ \ area} \tag{1}$$

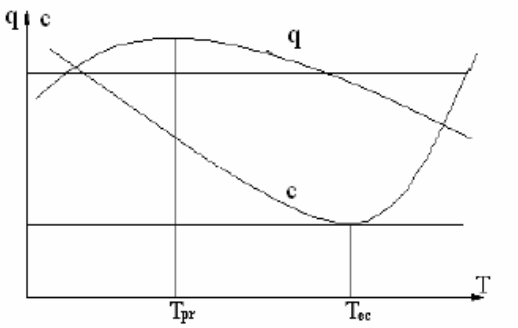

Fig. 2 Productivity q and cost c charts function of tool durability T

The specific margin (euro/min) is defined by the expression:

$$P = (p - c)q \tag{2}$$

It is obtained the margin formula:

$$P = \frac{c \cdot p \cdot s^{1-x} \cdot T^{1-m} - c_\tau \cdot T - c_s}{T + \tau_s} \tag{3}$$

Making null the derivative of the P from (3) with respect to T, it is calculated the optimum durability T_{op}. The optimum durability T_{op} is given by expression [3]:

$$T_{op}^{m} - \frac{(1-m) \cdot c \cdot p \cdot s^{1-x}}{c_r} \cdot \frac{T_{op} - T_{pr}}{T_{ec} - T_{pr}} = 0 \tag{4}$$

Using the cutting behavior in order to lead to a durability of the tool $T=T_{op}$ it can be computed the maximum margin.

The question is: how should we manufacture more and more expensive or cheaper and cheaper to obtain some the profit. To answer this question, let's see the spatial evolution of the maximum profit (P_{max} curve), depending on the competitiveness, *C*, and the process intensity, *R*. Let's consider to levels of competitiveness $C^{(1)}$ and $C^{(2)}$. From the researches of the specialist in the field, resulted that, during the competitiveness *C*, the productivity (*q* curve) increases, becoming more important than the cost (c curve) and the optimum intensity of the process, *Rp*, tends asymptotically to the point *Rp* (see the path $C^{(1)}$-E-B-$P^{(1)}$max).

For the value of the competitiveness $C^{(2)}$ the cost becomes more important and optimum intensity of the process tends to the point *Rc* which represents process intensity for the minim cost c_{min} (see the path $C^{(2)}$-D-V-$P^{(2)}_{max}$). In a limit case, when the competitiveness is null, (all auctions are lost at limit), than the maximum profit that can be obtained is null and this situation is valid only if the process intensity is *Rc*. It is obviously that the working with minimum cost is a limit that we don't want to touch it. As a conclusion, the process intensity modifies depending on the competitiveness between the limits *Rc* and *Rp* without without touching any of them. The competitiveness will determine, for each element of the manufacture system, the optimum level of the process intensity. As shown before, by competitive management, the adaptation of the management system is made to a maximization of the profit. To achieve the adaptation, it is necessary the modelling of the interaction within the ensemble: manufacturing system-market. We consider two elements H_1 and H_2 which interact between them (Figure 3). The model H_1 of the first element establishes a connection between input *x* and output *y*. If *x* and *y* are, at the same time input and out put of the other element H_2, then the two elements interact. Their interaction modelling means establishment of the values couple (*x,y*) which satisfy the transfer functions H_1 and H_2. The multitude of solutions which satisfy the both functions H_1 and H_2 represents the model, because it describes the elements behavior, during their interaction. *H1* could be represented the manufacturing system and H_2 – the market.

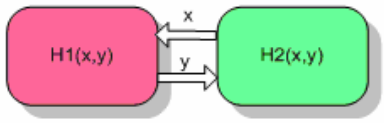

Fig 3 Interaction modeling of the elements of the strudied ensemble

3. The application of the strategic and control algorithm of the manufacturing systems for the manufacturing systems of the mechanics buildings

In a competitive market, the incapacity of the company to quickly and adequately and successfully request for a quotation that can echo severely on its capacity to survive economically. Indeed, an underestimated cost will result in losses while an overestimated cost will prevent the company from remaining competitive. So, there is a strong need expressed by industry to have sound cost estimating solutions, both in terms of design and quotation, that can improve the performance of these strategic functions. To face this need, and to replace the analytical-based methods commonly used in the manufacturing process planning, many companies apply parametric and analogous cost estimation methods. These methods are really fast because they are essentially synthetic; they provide the total cost

of the product according to some of its characteristics. Through application of the competitiveness management for the manufacturing system of the mechanic buildings, we can release a management of these systems. The manufacturing system receives contracts after auctions on the market. The competitive management system means the competitiveness evaluation and, on the basis of the auction the manufacturing system receives instructions about carrying on a made of the mode of the manufacturing process to obtain maximum competitiveness. On the other hand, as a result of the competitiveness evaluation, the management system must give the competitive offers which will enter in the auctions. To realise these two objects, the competitive management system uses reinforcement learning method to know the market and of the on-line unsupervised learning method to know the manufacture system. The modelling algorithm of the market-manufacturing system relation includes using the data base from the economic environment (auctions), the extraction of the knowledge through data mining and the realisation of the model through reinforcement learning; for obtaining of the punctual competitiveness indicators the data bases will be constituted from the competition environment and it will extract knowledge to evaluate the competitiveness; the offers on the market enter the competition environment to generate contracts for the manufacturing system; the modelling algorithm of the manufacturing system is realised leaving from the contract specifications and identifying the system. Using data mining a data set of functional and economic parameters will be obtained, the dates which will be used for the development of the model through unsupervised learning methods. On a basis of the above learning processes the strategic and control modelling will be realised of the ensemble of the manufacturing system – market and a possible implementation of the management system. The manufacturing system will receive instructions about the way of development of the manufacturing processes to achieve the maximum level of efficiency (maximum profit). The algorithm follows conceptual materialized through the system of relations between the value measures of exogenous and endogenous factors of the manufacturing system from the reality through a relation of modelling the manufacturing system – economic environment and functional modelling of the manufacturing system. The stages of the algorithm are: the determination of the relations of the manufacturing system with economic environment through the reinforcement learning; the determination of the relations results from a functional modelling of the manufacturing system; the determination of the system of relations among the groups of endogenous and exogenous factors of the manufacturing system. For the verification of the accuracy and applicability of the concept of competitive management of the manufacturing systems it is necessary to obtain results on a concrete example. In this sense, it is simulated and modelled a real manufacturing system of a pilot enterprise which works in real conditions on a real market with values of parameters taken from the economic reality.

4. Conclusions

The paper develops the notion of competitive management of the manufacturing system through modelling and on-line learning. Increasing competitiveness is not a process of exploit of a short-time advantages but it appears as a complex process and constitutes the support of an economic structure based on capital investments, on scientific research, development and innovation. It is necessary to put in obviously the correlations among the economic environment (the market, competition) and the manufacturing system and to study the role which they have in the acquirement and the increase of enterprise competitiveness. This becomes still more pressing due to the fact that the special literature consigns studies about competitiveness at least to the level of the enterprise and studies about the process and technology of the manufacturing system not making any connection between the two entities in the context of the technical economic competitiveness. In this context, the competitive management can offer solutions for development and competitive enterprises. Through this type of management the technical phenomenon is associated with the economic phenomenon.

This paper proposes a modern approach about manufacturing system competitiveness because: manufacturing system competitiveness is approached in a new manner, original by using investigation modern methods, which take into account all the factors which influence the realisation, keeping and increasing of industrial enterprise competitiveness; it is proposed a mathematical evaluation methodology of technical-economic competitiveness of the manufacturing system; it is proposed a new management concept of manufacturing systems, based on modelling of ensemble of manufacturing system-market and implement of this concept into the level of the manufacturing systems.

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