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AN EVALUATIVE STUDY OF THE COMPETITIVE MANAGEMENT

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ABSTRACT

In this paper, competitiveness, will be understood as the capacity (potential) to provide performance (compared with other similar elements), in a very exact way, within a macroeconomic concrete context and at a certain time. The competitive management of the manufacturing systems will be developed relying on behavioral modeling, which will describe the interaction between elements, namely machining system, manufactured products and the market. The paper presents a study about on-line evaluation of the competitive management efficiency.

KEYWORDS: competitive management, manufacturing process, efficiency, econometric model.

1. Introduction

Nowadays, the manufacturing systems are controlled by means of numerically programmed machine tools which are part of the system [1], [2]. The control is exclusively technical because there is no economic variable, although this is actually the ultimate goal of any manufacturing 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 those orders [3], [4]. As a result, a long-term management is not appropriate. A sort of fluctuating (just like the market) on-line, fastly responsive, prompt and rapid, however, ephemeral management is called for [5], [6].

The above considerations underline the relevance of introducing of the new concept - the concept of competitive management – proposed by this paper. This concept will have the following core features:

1. an *essential character, promptness, accuracy and completeness* in assessing how the manufacturing system operates at the current moment so as to ensure responsiveness and dynamism in its current relationship with the market;

2. behavioral modeling of the market-manufacturing system assembly to substantiate the strategic component of the competitive management thus ensuring the extension in time of the current performance;

3. possibility of changing consumptions in terms of level and structure (cost-productivity - process relationship), under equivalent technical conditions, by the intervention on the technology components to implement the *tactics component* of the competitive management, thus tailoring manufacturing system to the current market requirements;

4. use to the full, of the amounts invested in the system operation to ensure *the management optimization*;

5. possibility to act proactively on the manufacturing system to ensure *the management adaptability;*

6. possibility to anticipatorily evaluate the manufacturing system to ensure *the management predictability.*

It is obvious that, when applied to manufacturing systems, the concept of competitive management can offer solutions to make it more competitive and develop even the enterprise as a whole.

Models currently used in the management of the manufacturing systems, whether analytical, numerical or neural (or, in general, algorithmic), refer to the components of the systems [7], [8]. Building 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 models, the most appropriate one [9],[10].

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

In the model proposed by this paper, the market behaviour is considered unchanged. The manufacturing system receives contracts after the tenders (competitions) generated by the market requests and antreprised offer.

In this paper, it is proposed a numerical study of the competitive management efficiency by comparison to the conventional management.

The paper has the following structure: section 2 presents the proposed econometric modelling, section 3 contains the results of simulation and section 4 summarizes the main conclusions achieved.

2. Competitive Management Efficiency

The conventional management is based on the minimum cost, while the competitive management is based on the success of manufacturing product on the market.

The competitive management is more efficient as the profit increases. This management exploits the efficiency resources of the manufacturing system. In this context, the model of the competitive management efficiency was carried out.

The econometric model has as input the process characteristics, as output the "service" characteristics, while as parameters the machining system-market relationship characteristics. In figure 1 it is presented the generic econometric model, where the cutting speed *v* is the process characteristic, the cost *c*, the time *τ*, the profit rate *r* (for three levels of the price - P_1, P_2, P_3) are the service characteristics while the machining operation price *P* is the model parameter.

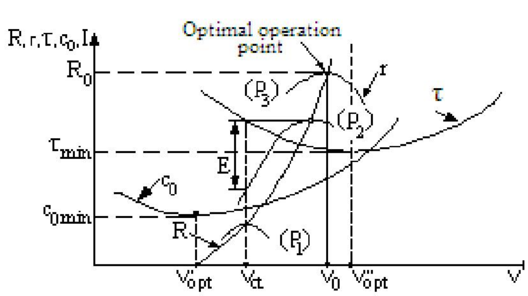

Fig. 1. Econometric model of the manufacturing system

In this figure, *R* curve is the maximum profit rate versus the price *P*.

Service characteristics of the econometric model developed in this paper are:

- cost *c*;
- time *τ;*
- profit rate *r*;

The *cost, c,* is defined as

$$c = \frac{C}{S}\ [\text{Euro/cm}^2] \qquad (1)$$

where:

C – it is the expenses of manufacturing process: salaries, tool cost, tooling allowance cost, energy cost and machine-tool cost;

S - the machined surface area.

Consequently, the cost is given by the following relation:

$$c = \frac{c_\tau}{10vs} + \frac{\tau_{sr}c_\tau + c_s}{10Tvs} + \frac{t \cdot c_{mat}}{10} + \frac{K_e c_e}{10000vs} + \frac{C_M}{10K_M} v^{\alpha-1} s^{\beta-1} t^{\gamma}\ [\text{Euro/cm}^2] \qquad (2)$$

where:

c_τ – means the sum of all expenses directly proportional to the time;

τ_{sr}- time needed for the tool change and adjustment of the tool [min];

c_s- tool cost between two successive reshaping;

c_{mat} – tooling allowance cost;

c_e – cost of 1Kwh electric energy;

K_e- energy coefficient [wh/min];

K_M - machine-tool coefficient;

C_M - machine-tool cost [Euro];

v – cutting speed [m/min];

s – feed rate [mm/rot];

t – depth of cut [mm];

α, β, γ – coefficients;

T – tool durability, given by the Taylor relation.

The necessary *time, τ,* for 1 cm^2 surface area machining is calculated on the formula:

$$\tau = \frac{T + \tau_{sr}}{10Tvs}\ [\text{min/cm}^2] \qquad (3)$$

Another service characteristic is the *profit rate, r,* and it is defined by the following relation:

$$r = \frac{p - c}{\tau}\ [\text{Euro/min}], \qquad (4)$$

where *p* is specific price, [Euro/cm^2].

As shown in figure 1, if the cutting speed *v* is constant in time, getting the value v_{ct}, then it will be optimum for a certain price (P_1) because the obtained profit will be maximum. For another price (P_2 or P_3), $v = v_{ct}$ is not optimum, resulting a profit difference *E,* which represents the competitive management efficiency.

Applying the competitive management, we'll take into consideration that the product price is P_3 and changing the value of the cutting speed $v = v_{ct}$ with $v = v_0$, then an additional profit E will be obtained.

3. Simulations and discussions

By means of relations presented above, an example of updated econometric model was carried out (Fig. 2).

In figure 2, a it is represented the curve of cost c.

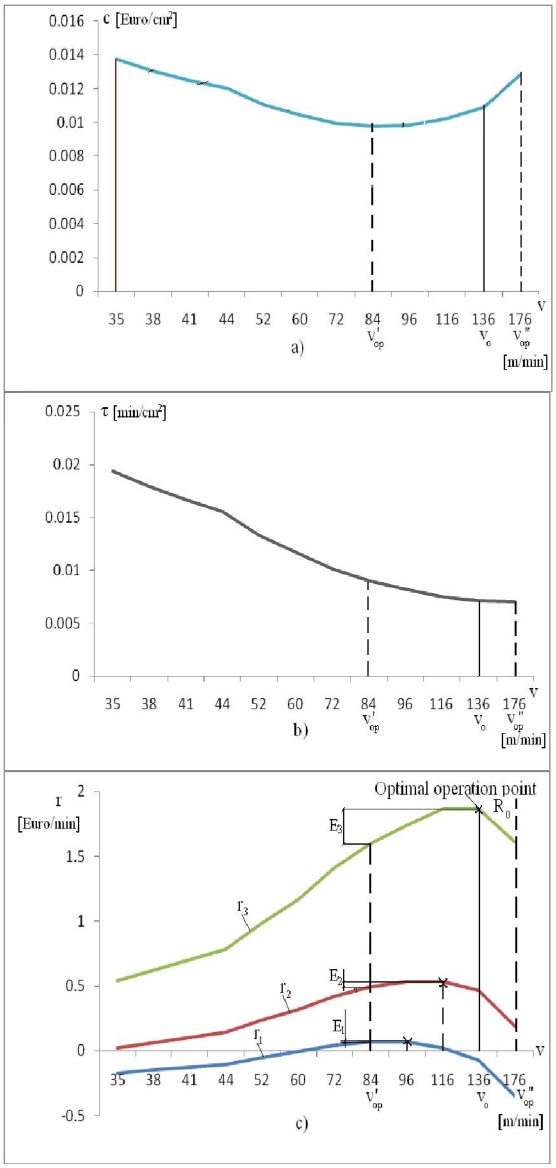

Fig. 2. Econometric model for a turning process and system: a) cost c; b) time τ; c) profit rate r, where: $p_1 = 0.0104$ Euro/cm^2, $p_2 = 0.0142$ Euro/cm^2, $p_3 = 0.0242$ Euro/cm^2, $c_\tau = 0.45$ Euro/min, $\tau_{sr} = 10$ min, $c_s = 20$, $c_{mat} = 0.008$ Euro/cm^3, $c_e = 0.23$ Euro/Kwh, $K_e = 150$ wh/min, $K_M = 5400000$ min$^{1/3}$cm, $C_M = 100000$ Euro, $s = 0.15$ mm/rot, $t = 3$ mm, $\alpha = \beta = \gamma = 0.5$.

It is important to note that the minimum cost $c_{min} = 0.00978$ Euro/cm^2 is obtained for the optimum cutting speed $v'_{op} = 84$ m/min.

Based on the relation (3), in the figure 2, b it is represented time τ. The minimum value of time $\tau_{min} = 0.007$ min/cm^2, corresponds to a cutting speed $v''_{op} = 176$ m/min.

Figure 2, c presents the curves of the profit rate r calculated on the relation (4) for three levels of the price.

As shown in figure 2, c, there is a maximum $R_0 = 1.8679$ Euro/min for the specific price $p_3 = 0.0242$ Euro/cm^2 and corresponds to a cutting speed $v_0 = 136$ m/min (optimal operation point). Also, on the diagram, there are negative values of the profit rate r.

The cutting speeds associated with maximum profit rates are situated between $v'_{op} = 84$ m/min and $v''_{op} = 176$ m/min.

According to the price increases, the maximum of the profit rate goes to the right, as shown in figure 2, c. On the basis of the econometric model and above considerations, the comparative numerical study of the competitive management efficiency reported to the conventional management was carried out.

We have considered a reference case having a cutting speed v = 84 m/min. As it can be seen in figure 2, a, the cost c is minimum for that cutting speed. We may say that, from the viewpoint of the conventional management, that cutting speed is even optimum cutting one.

Analyzing figure 2, c and table 1, it can be noticed that for a cutting speed of v = 84 m/min, for a specific price $p_1 = 0.0104$ Euro/min, the profit rate $r_1 = 0.068646$ Euro/min is very close to the maximum profit rate (0.069486 Euro/min), the difference E_1 is approximate by null, but the profit rate is different from the maximum one for the specific prices $p_2 = 0.0142$ Euro/min and $p_3 = 0.0242$ Euro/min. In those cases, the cutting speed can not be considered as being an optimum one. The competitive management efficiency is given by the differences E_1, E_2, E_3 (Fig. 2).

Table 1

v [m/min]	r_1 [Euro/min]	r_2 [Euro/min]	r_3 [Euro/min]
35	-0.17255	0.02397	0.541124
38	-0.14798	0.064659	0.624231
41	-0.12445	0.104101	0.705548
44	-0.10203	0.142205	0.784925
52	-0.04813	0.236645	0.986052
60	-0.00355	0.319586	1.169942
72	0.04438	0.420172	1.409101
84	0.068646	0.490351	1.600102
96	**0.069486**	0.529687	1.740743
116	0.023281	**0.530565**	1.865522
136	-0.07147	0.462569	**1.867933**
176	-0.34678	0.192472	1.611568

On the basis of the data from the table 2, in figure 3, it is represented the curve of the competitive management efficiency depending on the specific price *p*.

Six product prices were considered in simulations (column 1 of the table 2) and the corresponding profit rates (columns 2, 3).

Table 2

P [Euro/ cm^2]	r [Euro/ min]	r_{max}[Euro/ min]	E=r_{max}-r Euro/min	E/r [%]
0.010	0.068646	0.069486	0.000840	1.22
0.014	0.490351	0.530565	0.040214	8.20
0.024	1.600102	1.867933	0.267831	16.73
0.034	2.709853	3.273298	0.563445	20.79
0.044	3.819604	4.678662	0.859058	22.49
0.054	4.929355	6.084027	1.154672	23.42

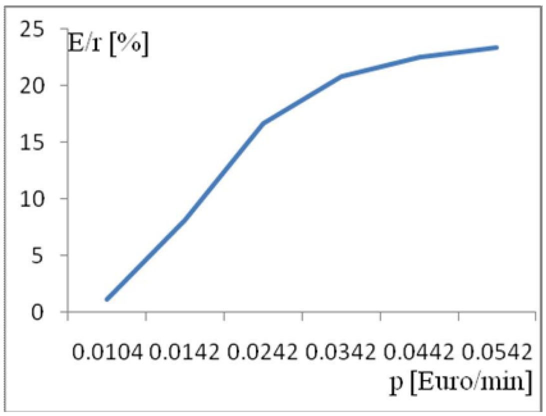

Fig. 3. Competitive management efficiency

As it may be seen, in figure 2, as the price increases, the competitive management efficiency becomes higher. Note that, it can begin from zero.

The management is considered efficient, as the competitiveness is higher. As seen in figure 3, the competitive management efficiency can reach 23.4 %.

4. Conclusions

In this paper, a numerical study of the competitive management efficiency by comparison to the conventional management has been achieved.

In the case of the products which do not have market success, the decrease of the cost is the most efficient method, applying the conventional management.

If the market success of the products is important, then the cost minimization does not provide maximum efficiency. In this case, the increase of the productivity is more important than the decrease of the cost.

As the market success of the products increases, the competitive management efficiency will also increase continuously. So, in the simulation case presented in this paper, the management efficiency reaches 25%.

References

[1] **H'nida, F., Martin, P. Vernadat, F.** - *Cost estimation in mechanical production: The Cost Entity approach applied to integrated product engineering*, International Journal of Production Economics, pp. 103, 17-35, 2006.

[2] **Wooldridge**, **J.** - *Introductory Econometrics: A Modern Approach*, Mason: Thomson South-Western, 2003.

[3] **Tharumarajah, A.** - *Self-Organising View of Manufacturing Enterprises*, Computers in Industry, Elsevier Science B.V., 2003, pp. 185-196, 2003.

[4] **Morel, G., Panetto, H., Zaremba, M., Mayer, F.** - *Manufacturing Enterprise Control and Management System Engineering: Paradigms and Open Issues*, Annual Reviews in Control, Elsevier Ltd., pp. 199-209, 2003.

[5] **Rooney**, **A.** - *Handbook on the Knowledge Economy*, Cheltenham: Edward Elgar, 2005.

[6] **Epureanu, A., Virgil**, **T.** - *On-Line Geometrical Identification of Reconfigurable Machine Tool Using Virtual Machining*, Enformatica, vol. 15, Spain, 2006.

[7] **Paladini, E. P.**- *A Pattern Recognition and Adaptive Approach to Quality Control*, WSEAS Transaction on System and Control, Vol. 3, pp. 627-643, 2008.

[8] **Epureanu, A., Marin, F.B., Marinescu, V., Banu, M., Constantin, I.**- *Reconfigurable Machine Tool Programing- A New Approach*, WSEAS Transaction on System and Control, Vol. 5, pp. 463-472, 2008.

[9] **Marinescu, V., Constantin, I., Epureanu, A., Banu, M., Marin**, **F.B.** - *Online Adaptive Learning System for Reconfigurable Machine Tool*, WSEAS Transaction on System and Control, Vol. 3, 2008, pp.473-482, 2008.

[10] **Ozbayrak**, **M.** - *Activity – Based Cost Estimation in Push/Pull Advanced Manufacturing System*, International Journal of Production Economics 87 (1), pp. 49-65, 2006.

[11] **Steven, L.Y., Rogelio, H. L., Landers, G. R.** – *Machining Processes Monitoring and Control: The State- of- the- Art*, Journal of Manufacturing Science and Engineering, DOI 10.1115, 2004

[12] J. M. Simao, P. C. Stadzisz, G. Morel,. Manufacturing Execution Systems for Customized Production, *Journals of Materials Processing Technology*, Elsevier B.V., 2006, 268-275.

[13] **Huang, B., Gou, H., Liu, W., Li, Y., Xie**, **M.** - *A Framework for Virtual Enterprise Control with the Holonic Manufacturing Paradigm*, Computers in Industry, Elsevier Science B.V., pp. 299-310, 2002.

[14] **Wang, D., Nagalingam, Sev. V., Lin, G.C.I.** - *Development of an Agent-based Virtual CIM Architecture for Small to Medium Manufacturers*, Robotics and Computer-Integrated Manufacturing, Elsevier Ltd., 2005

[15] **Valckenaers, P., Van Brussel**, **H.** - *Holonic Manufacturing Execution Systems*, Annals of the CIRP 2005, Elsevier Ltd., 2005.

[16] **Zhang, J., Gao, L., Chan, F.T.S., Li**, **P.** - *A Holonic Architecture of the Concurrent Integrated Process Planning System*, Journal of Materials Processing Technology, Elsevier Science B.V., pp. 267-272, 2003.

[17] **Jarvis, J., Ronnquist, McFarlane, R. D., Jain**, **L.** - *A Team-Based Holonic Approach to Robotic Assembly Cell Control*, Journal of Network and Computer Apllications, Elsevier Ltd., pp. 160-176, 2004.

[18] **Shao, X., Ma, L., Guan**, **Z.** - *A Market Approach to Decentralized Control of a Manufacturing Cell*, Chaos Solitons & Fractals, Elsevier Ltd. 2007

[19] **Leitao, P., Restivo**, **F.** - *ADACOR: A Holonic Architecture for Agile and Adaptive Manufacturing Control*, Computers in Industry, Elsevier B.V., pp. 121-130, 2005.