Modeling of the Competitive Management Efficiency

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Abstract: - 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 not appropriate. A sort of fluctuating (just like the market) on-line, fastly responsive, prompt and rapid, however, ephemeral management is called for.
In this paper it is considered that a solution for this situation is competitive management. The conventional management is based on the minimum cost, while the competitive management is based on the market success of manufacturing product. The paper presents a numerical study of the competitive management efficiency by comparison to the conventional management.

Key-Words: - Competitive management, manufacturing system, management efficiency, cutting process, econometric control, market-manufacturing system assembly.

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.

Many approaches to the problem of competitiveness [1], [2] show that, today, competitiveness is defined by the economic factors and indicators and is more a suggested/induced notion than a numerically evaluated one.

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 algorithm to evaluate the technical and economic competitiveness, moreover, the technical factors are not considered, although consumption and costs incurred by the manufacturing 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 maintain that place and to continuously improve its position. Only in this way the competitiveness fully and synthetically characterizes the enterprise viability.

In this 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.

The manufacturing system performance depends on how it is controlled. In more specialized papers [3] references are made to the relationships between the parameters of the cutting processes and the technical performance of the manufacturing system (i.e. purely technical aspects), while in others, equally numerous [4], references are made to the relationship between the product made by the manufacturing system and the market (i.e. economic relations) [5].

In the literature no attempt to approach the whole *market - manufacturing system assembly* is reported, despite 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 market – manufacturing system assembly, but only algorithms for the technical control of the manufacturing system [6] and tools of economic management of the relationship between the enterprise as a whole and the market.

Nowadays, the manufacturing systems are controlled by means of numerically programmed machine tools which are part of the system [7], [8]. 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 said orders. 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 [9], [10].

The above considerations underline the relevance of introducing of the new concept - the concept of competitive management – it is 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. behavioural 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 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 obviously that, when applied to manufacturing systems, the concept of competitive management can offer solutions to make it more competitive and develop even the enterprises 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. 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 model.

There are no cases reported in literature of behaviorly 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 Modeling of the 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 according 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 outut 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. In this figure, R curve is the maximum profit rate versus the price P.

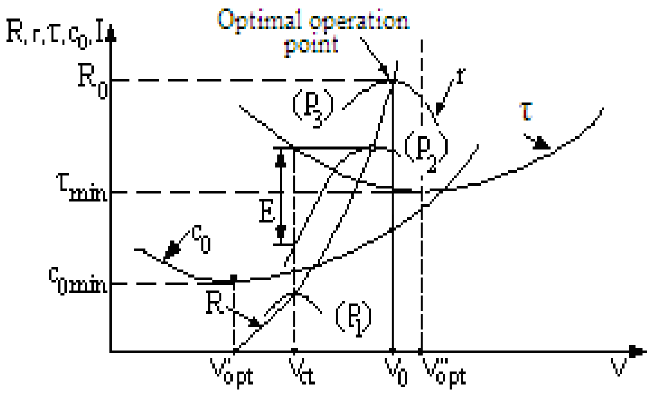

Fig. 1 Econometric model of the manufacturing system

Service characteristics of the econometric model developed in this paper are:
- cost c;
- time τ;
- profit rate r;

The *cost, c*, is defined as

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

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:

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

where:
c_τ – it is the sum of all expenses directly proportional with 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 with the formula:

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

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

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

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.
Appling 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

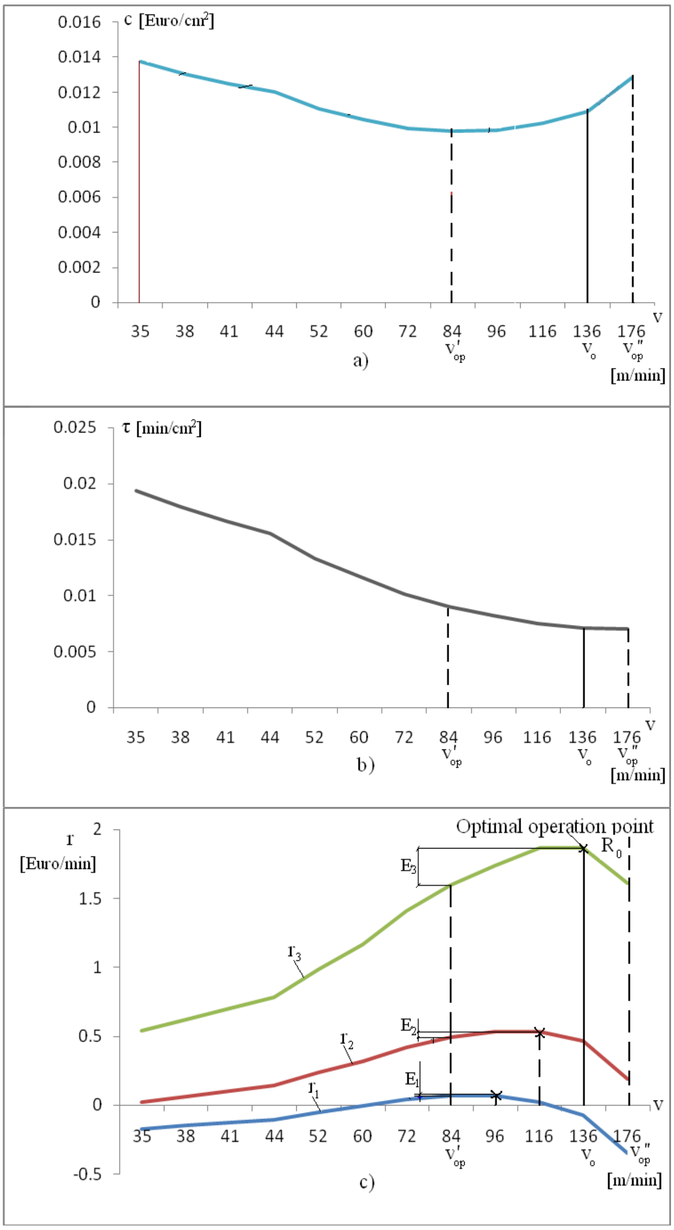

Fig. 2 Econometric model for a turning process and system: a) cost *c*; b) time τ; c) profit rate r, where: p_1 = 0.0104 Euro/cm^2, p_2 = 0.0142 Euro/cm^2, p_3 = 0.0242 Euro/cm^2, c_τ = 0.45 Euro/min, τ_{sr} = 10 min, c_s = 20, c_{mat} = 0.008 Euro/cm^3, c_e = 0.23 Euro/Kwh, K_e = 150 wh/min, K_M = 5400000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

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*.
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 τ_{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 with 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 as the price increases, the maximum of the profit rate goes to 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.

We have considered a reference case having a cutting speed v = 84 m/min. As it can see 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 observe that at cutting speed v = 84 m/min, for specific price p_1 = 0.0104 Euro/min, the profit rate r_1 = 0.068646 Euro/min is very closed to maximum profit rate (0.069486 Euro/min), the difference E_1 is approximate null, but the profit rate is different of 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 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 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 [%]
0.0104	0.068646	0.069486	0.000840	1.22
0.0142	0.490351	0.530565	0.040214	8.20
0.0242	1.600102	1.867933	0.267831	16.73
0.0342	2.709853	3.273298	0.563445	20.79
0.0442	3.819604	4.678662	0.859058	22.49
0.0542	4.929355	6.084027	1.154672	23.42

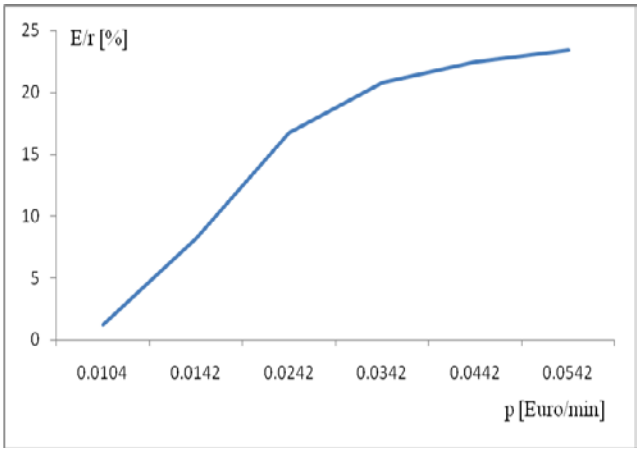

Fig. 3 Competitive management efficiency

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

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

4 Conclusion

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

In the case of the products which have't market success, the decrease of the cost is the most efficient method, appling the conventional management.

If the market success of the products is important, then the cost minimization don't provide maximum efficiency. In this case, the increase of the productivity is more important then the decrease of the cost.

According as the market success of the products increases, the competitive management efficiency increases continuously. So, in the simulation case presented in this paper, management efficiency reaches 25%.

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