About the Order Fulfillment Stage of the Manufacturing System

Part 2

DASCHIEVICI LUIZA, GHELASE DANIELA
"Dunarea de jos"University of Galati
ROMANIA

Abstract: - The paper aims, in the field of manufacturing technologies, at approaching issues of manufacturing systems, in order to develop a new concept of management, which is in line with the current market dynamics: the concept of competitive management. The concept of competitive management can offer solutions even to make competitive and develop enterprises as a whole. However, improving competitiveness is not a short-term process of exploiting advantages, but appears as a complex process of establishing and sustaining an economic structure based on capital investment, on research and knowledge, on development and innovation.

Key-Words: - competitiveness, manufacturing system, behaviour modelling, competitive management, knowledge based economy, on-line learning.

1 Behavioral modeling, instead of element modeling

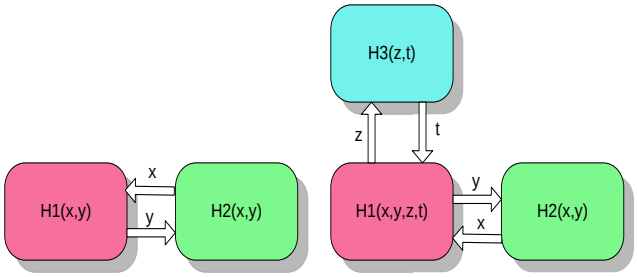
Behavioral modeling, instead of element modeling, to get quintessence and completeness, hence simplicity and robustness in the act of management/control

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 data , 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 new concept of control/management of the manufacturing systems will be developed based on behavioral modeling, which will describe the interaction between elements (technological system, manufactured products, the market).

2 Behaviour modelling of the manufacturing system

As shown above, by competitive management adaptation takes place, according to the principle of the exclusion to be found in Biology, of the manufacturing system for the purpose of profit maximization. To achieve adaptation, it is necessary to achieve modelling of the interaction between all elements of manufacturing system - market assembly, which shall be called behaviour modelling from now on. The term of behaviour modelling is introduced by the authors and, for presenting this notion, we shall consider two elements *H1* and *H2*, which interact with each other (Fig. 1.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. Modelling their interaction (behaviour modelling) 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 behavioural model because they describe the behaviour of the elements during their interaction.



a. b.

Fig. 1. Behaviour modelling

For instance, *H1* could stand for the manufacturing system while *H2*, for the market.

Behaviour modelling becomes increasingly complex as the number of interacting elements is growing too. For example, in the case of Figure 1.b, three elements interact and behavioural 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:

$$\begin{cases} H1(x,y)=0 \\ H2(x,y)=0 \end{cases} \quad (4)$$

then, the solutions of the system (4) represent the behaviour model of *H1-H2* assembly. If the solution is unique, then the behavioural 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. 2).

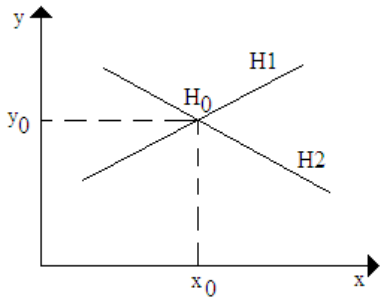


Fig. 2. Behaviour model with unique solution

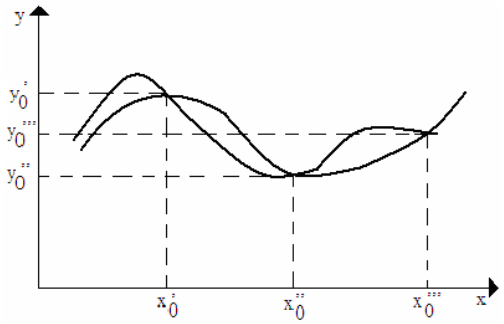


Fig. 3 Behaviour model with multiple solution

If there is a values string x_0 and y_0 as solutions of the system (4), then the behavioral model includes all these points (Fig. 3): (x_0', y_0'), (x_0'', y_0''), (x_0''', y_0''').

If the system (4) is incompatible, then there isn't any behavioral model that meets *H1* and *H2* assembly. In the case of Figure 1.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:

$$\begin{cases} H1(x,y,z,t)=0 \\ H2(x,y)=0 \\ H3(z,t)=0 \end{cases} . \quad (5)$$

As the number of variables is more then equations, we expect the system (5) is indeterminate. The model will include a infinite points number.

The behaviour modelling method of the machining system-market assembly is developed on these assumptions:

- elements *H1* (manufacturing system) and *H2* (market) operate and are monitored on-line;

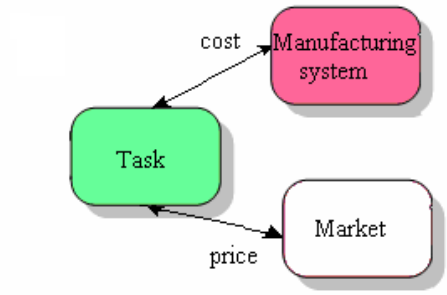


Fig. 4 The interaction between task - manufacturing system and between market - task

- 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.

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

Because *H1* and *H2* elements are evolutionary in terms of behavior, mathematical models can not be sustainable. For this reason, behaviour modeling of all the two elements, we use unsupervised on-line learning.

For construction of the task-profit model, which describes the interaction between manufacturing

system and market, authors achieved the task-cost manufacturing operation model and the task – market model (fig. 4).

The method proposed for achievement of the three models consists in monitoring and recording the relevant state variables of the manufacturing system in a database.

3 Competitiveness based management algorithm to be applied to the manufacturing system

By applying the concept developed under 4.1 to the mechanical construction manufacturing systems, the competitive management algorithm for these systems shall be developed.

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

The behavioural system modelling is to be achieved, based on which the company management may intervene in order to elaborate the necessary instructions to adjust the technological process and elaborate the management policies.

It can be noticed:

i) the algorithm for modelling the relationship market-manufacturing system implies using the data base from the economic environment (auctions), extraction of knowledge through data mining and model elaboration by reinforcement learning techniques;

ii) to obtain the concrete indicators of competitiveness, database from the competitive environment shall be provided and knowledge shall be extracted in order to assess competitiveness;

iii) the market offer quotations enters the competitive environment to generate the contracts for the manufacturing system;

iv) the modelling algorithm of the manufacturing system is designed starting from the contract specifications and system identification.

Using data mining techniques, data sets on the functional and economic parameters shall be obtained to be further used to obtain the model of non supervised learning techniques.

Based on the above learning processes the behaviour modelling of the manufacturing system - market assembly and the management system implementation are achieved. The manufacturing system receives instructions on the development of the manufacturing processes in order to achieve the maximum level of efficiency (maximum profit).

4 Experiments and simulations

During the experiment, first the data resulted over the last 6 months have been collected, with regard to the manufacturing machines that had been used for manufacturing some important parts in the construction of dump truck bins, namely the attachment plate of the supplementary chassis of the dump truck bin. Data regarding the actual work times, data referring to the modes of operation, data regarding the amounts of resulted wastes, data regarding all types of consumption, as well as data regarding the orders for delivered products were collected.

The case study under consideration is the one where the customer has requested an offer referring to both the manufacture of the part named “Attachment plate of the supplementary chassis of the dump truck bin” shown in Figure 5, and to its welding onto the supplementary chassis of dump truck bins.

The number of ordered parts is 80 and the total time for making them is 4.87 hours. The part will be welded on a length of 2x175 mm to the supplementary chassis (three-layer tee weld according to the drawing). The material to be used for making the parts is OL 37.

For the purpose of performing these operations, we will describe the technological flow along with the required processing, tools, equipment and devices to be used and we will present the resulted data hereinafter:

1) Cutting to dimension from the semi-finished product:

a - cutting to the length of 2x350 mm

b - cutting to the width of 2x180 mm

Equipment: Plasma jet cutting equipment PLASMA Jackle

Verifying tools and devices**:** Plasma nozzle 1.5 to 1.7;

Compressed air; Acetylene

2) Drilling holes having the diameter of 16.4 m

a - drilling one hole after another

b - positioning for every hole

Equipment: general purpose drilling and milling machine FUS 32

Verifying tools and devices: 16 mm diameter drill.

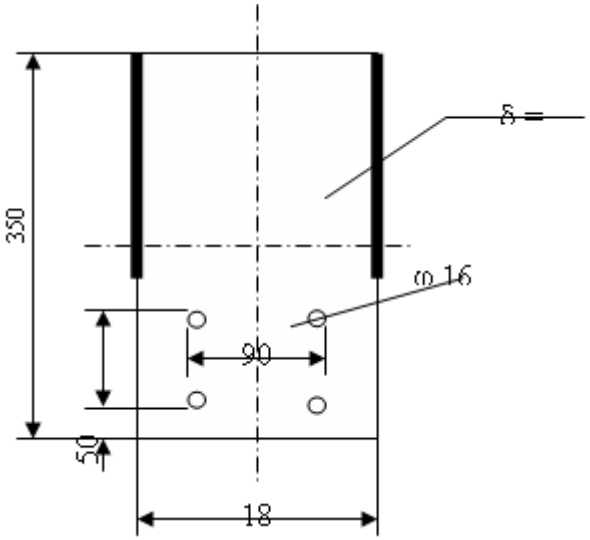


Fig. 5. Attachment plate of the supplementary chassis of the dump truck bin

Table 1- Example of experimental data regarding the process variables collected for the welding process

3) Weld on the length of 175 mm on both sides, on the
a - positioning and fixing
b - 4-pass tee weld
Equipment: welding equipment MAG Jackle
Verifying tools and devices**:** wire of 1.6 mm.

In order to succeed in demonstrating the viability of the solution to the problem of continuous identification and of competitive management of the modelled manufacturing systems, a practical data base resulted from process measurements was obviously required.
For this, some determining, measuring and monitoring of the welding processe was made (Table 1).

For the experimental implementation of the modelling method proposed, an IT product was developed and designed in the Visual FoxPro programming environment, using the function libraries in Matlab and C++.

The simulation implies two data input sequences: a sequence referring to entering the customer's requirements and the second sequence referring to entering the work restrictions.

Item nr.	Type of material	Type of weld	Length of welding seam	Number of passes	Amperage (A)	Rate of welding (mm/s)	Amount of welding wire (m)	Number of pieces	Welding time (sec.)	Energy Conumption (kwh)	Cost of operation (Euro)	Product Price (Euro)	Profit Rate (Euro/min)
-	v1	v2	v3	v4	v5	v6	v7	v8	v9	v10	v11	v12	v13
1	OL 52	Tee	501	3	200	10.2	4.2	63	1375	10.52	3156.29	3787.5	27.543
2	OL 52	Tee	562	2	198	9.2	5.25	43	3075	5.31	1611.06	1933.2	6.2856
3	OL 42	Tee	498	10	185	8.2	3.25	57	3705	29.17	9461.99	11354.3	30.644
4	OL 42	Tee	589	9	211	10.25	6.2	92	3467	57.16	16256.3	19507.5	56.265
.						.							
.						.						.	
.						.						.	

The behaviour model of the manufacturing system and market is presents for welding task.

5. Conclusions

The advantage of the competitiveness based management compared to the present day management of manufacturing system

1. The competitiveness based management has the advantage of being applicable to any manufacturing system; regardless the physical nature of the process and the product features;
2. Develop a methodology for the technical-economic competitiveness of the manufacturing system;
3. Develop a new concept of manufacturing systems management based on behaviour modeling of the market-manufacturing system assembly and on the implementation of the management to the manufacturing system, which is generally applicable and appropriate to the current market demands;
4. This type of management provides managers: the possibility of rapid price quotations of its products, a software representing the company model and which generates instructions in the progress of manufacturing processes the possibility of discovering the 'black holes' in the system and substantiating the investment policies. This new generation of enterprises based on the concept of competitive management will be able to achieve, in an economic environment, customized products at the quality level required by the market.

References

[1] D. Ghelase, L. Daschievici, V. Marinescu, A. Epureanu – "Method for control of the make-to-order manufacturing system on the base of earning power assessment", IJAMT, 2012.
[2] L. Daschievici, D. Ghelase – "Order earning power assessment of make to order manufacturing system", ModTech International Conference – New face of TMCR, 2012.