DYNAMIC MANAGEMENT OF MANUFACTURING ORDERS

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ABSTRACT

A key requirement for the make-to-order (MTO) manufacturing companies to remain competitive is the ability to assess incoming orders in terms of performance and to determine the best orders that they should accept.

In this paper, we propose a method to control the entire production process, from customer enquiry up to product delivery, for the MTO manufacturing systems. In practice, decisions on order acceptance and on production planning are often made separately. Sales department is responsible for accepting orders, while the production department is in charge of production planning for implementation of accepted orders.

The system environment provides on-line data on the actions undertaken which, properly analyzed and correlated, will further generate solutions in order to develop said system and make it competitive.

KEYWORDS: competitiveness, manufacturing system, dynamic management

1. INTRODUCTION

Order acceptance problem is usually treated in the literature considering the single resource case with deterministic processing time [1,2]. The acceptance criterion is based mostly on capacity-driven approach. We cannot take into consideration that company performance is essentially dependent on the manner in which accepted orders are appropriate to all characteristic elements of the manufacturing system. In accordance with the method proposed in this paper, order acceptance is Earning Power-driven, while work-load, due-date and price are considered as restrictions.

In present, machine control is made independently to of order features, such as price. This is why, although the local control of the machine is optimal, the order performance level is not maximum. The method presented in this paper removes the disadvantage in that the machine control is based on simultaneous optimization of all manufacturing processes caused by order fulfillment.

Finally, in the present order acceptance, planning and scheduling of the production process, and machine control can be solved separately. In this paper, we propose an integrated control method for the three aspects where Earning Power is used as decision criterion when accepting or rejecting the order.

One customer’s order can include several jobs. Knowing the price \( P_i \) (2), the cost \( c_{ijk} \), the asset \( A_{ijk} \) and the time \( t_{ijk} \), we can build the order modeling, meaning the \( EP \) for each order (1).

\[
EP_i = \frac{P_i - \sum_j \sum_k c_{ijk} \left( P_{jk} \right)}{\sum_j \sum_k A_{ijk} \cdot t_{ijk} \left( P_{jk} \right)} \left[ \frac{\text{Euro}}{\text{Euro} \cdot \text{min}} \right]
\]  

The price of order, \( P_i \) (2) can be distributed on each job, \( j \), then each operation that composes the job.

\[
P_i = \sum_j \sum_k P_{ijk}
\] 

Based on \( EP \), determined for each order, the order can be accepted or rejected the order.
Therefore, there are going to be accepted only those orders that can bring significant profit and can increase the market share. This modeling can provide a better order management and increase the company’s competitiveness.

2. CASE STUDY

We consider that we have to manufacture the part in Fig. 1 and the manager must decide whether to accept this order. The technological process needed to process the part consists of the following operations: turning, drilling and welding.

In order to evaluate the order EP we have to calculate job EP and operation EP. To do this, the order will be divided in job 1 (rod 1, Fig. 1) and job 2 (plate 2, Fig. 1). To perform job 1 it is necessary to use the turning operation. For job 2 we need drilling and welding operations.

In order to evaluate the order EP we will use the relation (1) and if this is adapted to order i it becomes:

\[
EP_i = \frac{P_i - \sum c_{ijk}(p_{jkn})}{\sum A_{ijk} \cdot t_{ijk}(p_{jkn})} = \frac{(P_{i11} + P_{i21} + P_{i22}) - (c_{i11} + c_{i21} + c_{i22})}{A_{i11} \cdot t_{i11} + A_{i21} \cdot t_{i21} + A_{i22} \cdot t_{i22}} \left[ \frac{\text{Euro}}{\text{Euro} \cdot \text{min}} \right]
\]

where:

- \(P_{i11}\) - is the price of turning operation;
- \(A_{i11}\) - the asset of turning operation;
- \(t_{i11}\) - is the time to perform a turning operation;
- \(P_{i21}\) - is the price of welding operation;
- \(c_{i21}\) - the cost of welding operation;
- \(A_{i21}\) - the asset of welding operation;
- \(t_{i21}\) - is the time to perform a welding operation;
- \(P_{i22}\) - is the price of drilling operation;
- \(c_{i22}\) - the cost of drilling operation;
- \(A_{i22}\) - the asset of drilling operation;
- \(t_{i22}\) - is the asset of drilling operation.

These data are given in Fig. 2 and Fig. 3.

By numerical simulations (Fig. 2, Fig. 3), for the cases of 14 cutting speed values, 11 drilling speed values and 13 rate of welding values were obtained 2002 EP’s values of order i. Maximum value for EP was obtained for a turning speed, \(v=50\) m/min, drilling speed, \(v=200\) rev/min and welding speed, \(v=5.2\) mm/s. Maximum value for EP is

\[7.25 \cdot 10^{-8} \left[ \frac{\text{Euro}}{\text{Euro} \cdot \text{min}} \right].\]

We can calculate the EP for the other orders in the order entry pool in a similar manner. In the end, all EP values of all orders are ordered in a decreasing sequence.

The orders with a maximum calculated EP that brings economical effect to the company would be kept.

The other orders will be outsourced to other manufacturing companies.

It results that the manager will have an overview of the order EP to make an order acceptance. Order acceptance will be made after evaluation of maximal EP values and after selecting only those orders that may bring profit to the company.

Analyzing data in table 1 according to the maximum value of EP, the manager can decide whether or not to perform all jobs necessary to achieve order in the company.

Table 1. Order EP maximum

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<tr>
<td>150</td>
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<tr>
<td>136.25</td>
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<td>x</td>
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<tr>
<td>22.5</td>
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<td>x</td>
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<tr>
<td>141.25</td>
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<td>x</td>
</tr>
<tr>
<td>127.5</td>
<td>x</td>
<td>x</td>
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<tr>
<td>8.75</td>
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<tr>
<td>13.75</td>
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</table>
Fig. 2. Order EP sequence

Fig. 3. Order EP sequence
If obtaining an unsatisfactory value of EP for the company, the manager may choose to outsource those operations. Thus, if the company run only drilling and outsourced the other two operations, it would be observed that this case is the most profitable ($EP = 57.5 \times 10^{-8}$ Euro/Euro·min).

If they perform the welding operation, the worst EP ($EP = 6.09 \times 10^{-8}$ Euro/Euro·min) is obtained.

3. CONCLUSION

Order acceptance will be made only after evaluating the maximal values of EP and selecting those orders that could be positive for the company.

As far as the order is concerned, if the company only performed the drilling operation and outsourced the other two operations, the effect on the company would be a positive one ($EP = 57.5 \times 10^{-8}$ Euro/Euro·min). If the company would only performed the welding operation it would have the worst EP ($EP = 6.09 \times 10^{-8}$ Euro/Euro·min). Therefore, the manager will have an overview of the order EP in order to perform the order acceptance.

This analysis will help the manager of a make-to-order companies, on one hand, to accept an order, and on the other hand, to perform an optimal control of the processing system.

In other words, the paper suggests a method for integrated control for a make-to-order manufacturing system where EP is used as a decision making criterion.

REFERENCES


