Considerations on the Make-to-Order Manufacturing System Control

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Abstract: - In practice, decisions on acceptance of order and production planning are often considered separately. Sales Department is responsible for accepting orders, while the production department in charge of production planning for implementation of orders accepted. Acceptance decisions are often made without involving the control of the production department or incomplete information on the basis of available production capacity. Method for integrated control of the job shop type manufacturing system proposed in this paper aims to facilitate the connection between the two departments and to achieve integrated control of job shop type manufacturing system on the basis of Earning Power (EP) evaluation. It gives a more accurate picture of a firm's profitability than gross income.

Key-Words: - Earning Power, control of manufacturing system, order acceptance.

1 Introduction
Manufacturing companies differ in how they respond to customs demands. Some, called make-to-stock (MTS) companies, anticipate customer needs, producing series standard products, and deliver the products when customer order occur. At these companies, all given products are usually used for general purpose, and therefore does not cover the exact customer needs. The estimated delivery periods required by customers can be easily observed. On the other hand, as there is repetitive production, the products can be manufactured on manufacturing systems as single production line. Therefore, manufacturing systems (and even workstations forming these manufacturing systems), are product dedicated. Changing a product that one MTS manufacturing system performs is time consuming. In additions, inventory costs are high. Others, called make-to-order (MTO) companies, start the manufacturing process only after the order content was acknowledged and accepted. Compared to MTS companies, these have a better responsiveness, because they can deliver products more varied and even customized. As a result, customer’s requirements are fully satisfied and inventory costs are low. However, these advantages can be realized only if the lead times can be reduced enough so that the delivery period required by the customers is respected. In additions, MTO manufacturing must be job shop and its workstations must be process dedicated. Lately, the problem of developing a system that offers advantages to both approaches appeared. S. Hemmati and M. Rabbani [1], who propose a hybrid MTS/MTO production system, report one solution. At this, a portion of the production system operates as MTS system and makes certain products, and the other operates as MTO system and makes other products. Moreover, some products first will be partially manufactured in MTS mode, reaching to the semi-finished product. In this state, the products are kept in stock until the arrival of customer order. Then, product manufacturing continues in MTO mode, until its delivery. The point where there is a shift from a mode to another is called order penetration point in the production line. A proper combination of MTO and MTS can exploit the advantages of the lower inventory, short delivery time, and good responsiveness. The authors present a decision-making structure to determine the appropriate position of the order penetration point for different products in a manufacturing system. In this way, you can use in a greater extend the advantages of both types of manufacturing systems. However, the disadvantages remain unchanged. Other researchers try solving the problem by improving one of the two systems. Since the high inventory and low responsiveness of the MTS manufacturing system are hard to improve, most researchers propose improvement of MTO
manufacturing system, considering that it’s easier to have sufficiently reduced disadvantages. In this paper, this approach will be considered. In order to implement this approach, we believe that production process consists in carrying out the following general activities:

- a) cost and time estimation,
- b) price and due date quotation,
- c) manufacturing process planning (where manufacturing operations are established, including workstations that will run, execution order of operations, and requirements for proper performance for each operation),
- d) production process scheduling (which establish the moments of time when all workstations will perform these operations),
- e) production process dispatching (correcting deviations from schedule), and
- f) manufacturing process control (correcting deviations from plan).

These activities can be grouped into two stages, namely: order entry stage, which is completed or not with an order acceptance, and order fulfillment stage, which is completed with product delivery. Then, upon studying each activity, we propose solutions for improvement of MTO manufacturing system, in order to increase performance.

The customer enquiry stage has a strong impact on the production workload of small and medium enterprises (SMEs). At this stage, customer enquiries are to be transferred to customer orders and planned for in the next production run. If a firm cannot achieve enough customer orders, its production capacity would be underutilized, and waste occurs. A key objective for SMEs is to maximize profits and minimize waste while processing customer requirements. Generally, such a decision will endeavor to accept or maybe reject an enquiry and could even attempt to negotiate with customers in order to protect the interest of both parties. This process, if not carefully handled, could affect a firm’s credibility and reliability in the market. Customer enquiries therefore play a major role in the business and operations of enterprises, and for SMEs, it is often difficult manage in a proper manner this essential part of their business.

2 Problem Formulation

In order to better represent the specified goal of manufacturing process we propose (as a novelty) as a criteria the Earning Power (EP). It is both synthetic (because it reflects the essential motivation of manufacturing process) as compliant with the most important five performance aspects, namely: profitability, conformance to specifications, customer satisfaction, return on investment and materials/overhead cost, selected by researchers in order of importance.

By definition, Earning Power is an operating income divided by total assets. Here, operating income is an income resulting from a firm's primary business operations, excluding extraordinary income and expenses. It gives a more accurate picture of a firm's profitability than gross income. It is calculated by the formula:

\[ EP = \text{Sales revenue} - (\text{Cost of sales} + \text{Operating expenses}) \]  

Asset is something that an entity has acquired or purchased, and that has money value (its cost, book value, market value, or residual value). An asset can be: something physical, such as cash, machinery, inventory, land and building; an enforceable claim against others, such as accounts receivable; right, such as copyright, patent, trademark or an assumption, such as goodwill.

For determination of EP it must be estimated: cost, time, asset, and price.

Current methods for estimating the cost and time are based on breakdown of the product into elements, cost estimation of each element and summing of other costs. As an element, we can consider one product component, one manufacturing component or one activity component. To estimate the cost for each element there are used element’s different features that are closely related to cost. With few exceptions, estimation methods lead to cost estimation without a mathematic model describing relation between cost and element’s different features. As a plus, those methods have a slight adaptation capacity to different specific situations because the information that is provided in order to estimate is general and does not adapt to specific case.

Price estimation goes from costs and represents the company mission in relation to the market.

Order acceptance problem is usually treated in the literature considering the single resource case with deterministic processing time. 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.
Fig. 1 Method flowchart
In present, machine control it is made independent to 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 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 it is used as decision criterion when accepting and rejecting the order.

3. Method Flowchart
The method proposed by us is described in Fig.1. Each customer enquiry is included in an enquiries pool. Periodically, these enquiries pool are downloaded in orders breakdown. Here, each order breaks in jobs and each job in operations in order to evaluate the $EP$ of the order. In order to evaluate the $EP$ of the order we need time and cost models at job level and operation level. Order acceptance decision will be made after $EP$ and lead time estimation for each order. The order acceptance is in descending $EP$ order. This is actually an order level control. Thus, all accepted orders go to processes planning from where resulting manufacturing documents for accepted orders.

Next step is production scheduling developing production documents for all orders accepted. They go to order entry pool waiting order release. For job level control it is established which of the jobs are going to be manufactured and non-manufactured. This selection is made by evaluating job $EP$. All manufactured jobs go to manufacturing jobs pool waiting order release.

Next step is in manufacturing operations level control with manufactured parts resulting. Here it is establish the optimal work parameters for operation $EP$ is maximum. Manufacturing parts will be assembled with non-manufactured parts in assembling operation level resulting order product delivery. In addition to achieving an integrated control of a job shop, this method develops a tactic and strategic control of investments.

4. Conclusion
There were not reported in the literature any attempts to address the whole system of manufacturing-market as a result, there is significant performance improvement resources that are not used, because it addresses the technical and economic aspect separately. In addition, there is no known algorithm for management of the entire manufacturing system-market, but there are technical management algorithms that make manufacturing systems and economical management tools in the overall relationship with the market.

The authors propose a new method of management of MTO manufacturing system. The method is based on earning power used as an evaluation criterion for accepting and rejection orders that have favorable economic effect.

References: