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THEORETICAL APPROACH FOR THE CONTROL OF THE MAKE TO ORDER MANUFACTURING SYSTEM
Part 2

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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 planns 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. The paper is a review of make-to-order (MTO) manufacturing system control.

KEYWORDS: control of manufacturing system, order acceptance, MTO manufacturing system.

1. ORDER ACCEPTANCE AND SCHEDULING

Order Acceptance (OA) is a managerial activity that deals with translation of the customer enquiries into orders. It may also deal with related decisions, such as due date and price determination. The order acceptance strategy has a large influence on the performance of a company. However, many enquiries only request a delivery time or a delivery quantity for a product without really committing them. This is especially true in today’s e-marketing environment. For example, a customer often makes a similar enquiry to several companies through the Internet simultaneously. The final selection depends primarily on the response to the initial enquiry. In these circumstances, one quick and accurate response to customer enquiries is very important.

Today, the procedure responding to an enquiry is approached as a multistage-multicriteria decision-making process. The most common support for this process is to develop an appropriate decision support system (DSS). In this kind of decision-making structure, the initial decision is to determine whether to accept the order based on a prescreening process. Another decision is to make a quote to customer enquiries, which includes the response to the three basic enquiry elements: due date (DD), quantity, and sales price. Generally, if the customer has imposed a DD, the next task is to determine whether sufficient materials and production capacity is available or can be provided to complete the new order in addition to other jobs that have already been confirmed.

If the enquiry specifies a flexible DD, a feasible DD should be determined.

The approach to processing customer enquiries varies widely. There are two common cases: sequential enquiry processing and concurrent enquiry processing. In the first case, only one enquiry is considered at a time. Generally, an enquiry requesting a large quantity or short delivery time needs to be treated in this sequential enquiry processing style. In the second case, a set of enquiries jointly at periodical intervals is concurrently processed. For enquiries that are processed concurrently, an optimization model is built to evaluate them against limited capacity in order to select a subset which will be fulfilled.

Gharehgozli et al. [1] present a comprehensive decision-making structure composed of two phases and dedicated to manage incoming orders. In the first phase, the incoming orders are checked for acceptance based on their due dates. For this purpose, they apply the backward method proposed by Kingsman and Hendry [2] and calculate the completion date, earliest release date and latest release date of the orders. In the second phase, the accepted orders are ranked according to a multiple criteria decision-making (MCDM) methodology, which combines two techniques, analytical hierarchy process (AHP) and technique for order performance by similarity to ideal solution (TOPSIS). The ranked orders are there finally accepted based on manufacturing system capacity.

Xiong et al [3] propose a decision support system (DSS) approach that helps SMEs to make appropriate responses to customer enquiries. There are three phases in the workflow for processing enquiries. In the first, those enquiries that are obviously unsuitable to be produced by the company are rejected. The remaining enquiries are evaluated against limited available capacity (both materials availability and production capacity) in the second phase. If necessary, capacity is adjusted by planning for over-time (OT) and/or subcontracting as well as by modifying production and materials supply plan. In the third, the feasibility of a specific DD, price, and delivery plan is to be checked with regard to a specific customer enquiry. For this, an available-to-promise (ATP)-based heuristic approach is developed for determining a feasible delivery date and for checking its feasibility. For enquiries that are processed concurrently, an optimization model is built to evaluate them against limited ATP quantities in order to select a subset which will be fulfilled. The optimization criteria depend on the company’s policy and business philosophy. The presented example is both to increase revenue and minimize inventory cost.

In today’s highly customer-centric competitive market, improving customer service level would be crucial for firms to increase their competitiveness. On the other hand, Oduoza and Xiong [4] have shown that none of the existing decision support systems had the capability to instantly relate customer enquiries at the enquiry stage with capacity, process capability, inventory, potential profit to be derived and material requirement planning. This is why they propose a decision support system which links profit maximization with to screening customer/order enquiries. As criterion to measure the firm’s capability to meet customer requirements, they propose the available-to-promise (ATP) which is a packetized quantity capable of being produced during a time period (typically one week), based on material availability of all components that assemble or manufacture the requested product. Under limited ATP quantities, it is imperative to evaluate a set of enquiries in order to select a subset to fill so that to maximize company’s revenue from processing customer enquiries.

Ebadian et al [5] propose a new comprehensive decision structure for the order entry stage in order to improve the production planning framework in MTO environments, by taking into account all affected parties of the supply chain: customers, the MTO company, suppliers and subcontractors. Four main decisions are taken on the new arriving orders by the proposed structure: a) identifying and rejecting undesirable orders; b) computing prices and delivery times (if delivery times of the new orders are negotiable) of non-rejected orders; c) quoting prices and delivery times to the customers and negotiating with them; d) selecting the best set of suppliers and subcontractors to provide the required material and workload for the new accepted orders. To make the four decisions are supposed two models: one to determine the prices of the new orders for different delivery times and the other one to select the best set of suppliers and subcontractors. The proposed structure leads to better management of the arriving orders. Applying the proposed decision structure requires knowledge of a large number of data.

2.MANUFACTURING PROCESS PLANNING

Many articles discuss the problem of integrated process planning and scheduling, defined as: giving the N jobs which are to be processed on M machines, finding an operations-machines sequence and schedule for each job, which is optimal with respect to some criteria. The main approaches of this problem are agent –and algorithm-based. The goal is always implementation of CAD/CAPP/CAM integration [6].

One example is provided by Q. Lihong and L.Shengping [7] that propose an algorithm-based solution, consisting in a) development of a representation of flexible process plans, generated by machine, operation and sequencing substitutability, b) formulation some objective functions to evaluate the performance of each plan, c) formulating specific restrictions, and d) development of an improved genetic algorithm, to select de best plan.

In representation of a process plan, R. Raman and M. M. Marefat [8] proposed an interesting idea**.** According to this idea, recognition of part features is based on these tool/process capabilities on wich is based the generation of each feature. In this way will be avoided the large number of topological structures which result by combining some geometrical elements that are not going to be manufactured.

Another interesting idea proposed by de H. C. Chang and F.F. Chen [9] consists in the fact that process planning and scheduling take into account that when job release just a part of floor is available. Therefore, just a part of the alternative process plans set can be taken into consideration. In addition, besides current optimization criteria, is also considered another one, namely machines utilization index.

The problem of alternative process plans generation in the integrated manufacturing environment is solved by D. N. Sormaz and B. Khoshnevis [10] by selection of alternative machining processes, clustering and sequencing of machining processes, and generation of a hierachical process plan network. Two procedures are proposed for process plan optimization, namely based on state space search using artificial intelligence technique and based on network flow theory.

3. PRODUCTION ACTIVITIES SCHEDULING

In the papers [11,12] the authors studied single-machine scheduling problems with past-sequence-dependent setup times and time-dependent learning effect. They proved that the makespan minimization problem, the total completion time minimization problem, and the sum of the quadratic job completion time's minimization problem could be solved by the SPT (processing time first) rule.

The paper [13] considers a single machine scheduling problem with setup times and learning considerations. The setup times are proportional to the length of the already scheduled jobs. The learning effect is also investigated in the scheduling environments; it is assumed a learning process reflects a decrease in the process time as the function of the number of repetitions.

The paper [14] is a review of scheduling research involving setup times or costs. The majority of the studied papers addressed sequence-independent setup times because dealing with sequence-dependent setup times is more difficult. The common solution methods are branch-and-bound algorithms, mathematical programming formulations, dynamic programming algorithms, heuristics, and meta-heuristics.

Scheduling problems with deteriorating jobs and learning effects including proportional setup times are studied in the paper [15]. The authors considered a new scheduling model in which job deterioration, learning and past-sequence-dependent setup times exist simultaneously. Under the proposed model, they showed that the single-machine scheduling problems to minimize the makespan, total completion time, and sum of square of completion times are polynomiall solvable.

The objective of the paper [16] is to find a schedule to minimize the total completion times. The authors developed a branch-and-bound algorithm for the optimal solution. Then they proposed a simulated-annealing heuristic algorithm for a near-optimal solution. Finally, they conducted a computational experiment to evaluate the performances of the proposed algorithms.

4. PERFORMANCE MEASUREMENT

Frequently performance measurement systems of manufacturing companies arebased on cost evaluation. In present manufacturing environment, these systems do not capture the relevant performances issues. Assessment results are used for monitoring, controlling and improving manufacturing operations. So, many researchers suggested new performance measurement approaches in order to provide to managers and operators with relevant information to support daily activities. However, there are few papers referring to performance measurement of manufacturing systems. most researchers focused research on financial and managerial accounting measures in order to determine organization performance.

Performance measures are tools to assess as good as possible the process outputs and allows to achieve a specified goal. For those performance measures to be as relevant as possible, the specified goal must represent as completely as possible the process of production and new operating philosophies of the companies. For this, researchers selected several performance indicators to better represent the specified goal. For example, in [16] a new performance measurement model is proposed. It includes four indicators with an appropriate weight. These indicators are: Cc for customer compliant, Od for on-time delivery, Ee for equipment effectiveness, Cq for cost of quality. The decision on how to weight the performance criteria is the most important decision made during manufacturing performance measurement system design [16]. In a practical example, the level of weights can only be the result of a qualitative analysis.

The paper [17] is specific to manufacturing systems and supposes a methodology, where dependability, flexibility, speed, quality, and cost are taken as manufacturing performance factors. They contribute to the profitability of the competitive strategies, which are identified as innovation, customization, product proliferation and price reduction. The performance evaluation model presented in this paper uses fuzzy analytic hierarchical process and approximate reasoning. The proposed fuzzy AHP approach consists of constructing an AHP comparison matrix with default pairwise evaluation of factors using fuzzy numbers. Their study shows that the performance difference between normal AHP and fuzzy AHP is affected by the confidence level and the attitude of Decision-Makers’ (DMs).

A. Haskose et al. [18] take as consistent for make-to-order environment the following performance measures: work in progress, manufacturing lead time, and utilization of workstations (%).

Chi-Wen J. Lee et al. [19] study the relation between the managed earnings (defined as an illegal practice in which a company will project a higher profit margin to attract investors) and the firms’ earnings performance and propose a new performance measure, namely earnings quality defined as the proportion of true economic earnings in the total reported earnings.

Ratore et al. [20] take into consideration the total productivity as an important measure of performance. They all think that maximization of total productivity drives to increased profitability and enterprise competitiveness.

4. CONCLUSION

In conclusion, the main disadvantage of methods of acceptance or rejection decision of an order is that this decision shall be based on time factor and capacity factor and takes too little account of performance that could be obtained if a particular order was be accepted. The performance for each level of operation will not be evaluated. Thus the operation structure and tool used in the process must be properly selected from a number of options so the that operation performance be maximized. In addition, there aren’t established any alternatives for situations where the technological flow is affected by bottleneck.

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