Integrated Supply Chain Model of Advanced Planning and Scheduling (APS) and Efficient Purchasing for Make-To-Order Production

Chan Seok Jeong • Young Hae Lee
Department of Industrial engineering, Hanyang University

Abstract

This paper considers that advanced planning and scheduling (APS) in manufacturing and the efficient purchasing where each customer order has its due date and multi-suppliers exit. We present a Make-To-Order Supply Chain (MTOSC) model of efficient purchasing process from multi-suppliers and APS with outsourcing in a supply chain, which requires the absolute due date and minimized total cost.

Our research has included two states. One is for efficient purchasing from suppliers: (a) selection of suppliers for required parts; (b) optimum part lead-time of selected suppliers. Supplier selection process has received considerable attention in the business-management literature. Determining suitable suppliers in the supply chain has become a key strategic consideration. However, the nature of these decisions usually is complex and unstructured. These influence factors can be divided into quantitative and qualitative factors. In the first level, linguistic values are used to assess the ratings for the qualitative factors such as profitability, relationship closeness and quality. In the second level a MTOSC model determines the solutions (supplier selection and order quantity) by considering quantitative factors such as part unit price, supplier’s lead-time, and storage cost, etc.

The other is for APS: (a) selection of the best machine for each operation; (b) deciding sequence of operations; (c) picking out the operations to be outsourcing; and (d) minimizing makespan under the due date of each customer’s order. To solve the model, a genetic algorithm (GA)-based heuristic approach is developed. From the numerical experiments, GA-based approach could efficiently solve the proposed model, and show the best process plan and schedule for all customers’ orders.

Key words: Make-To-Order Supply Chan (MTOSC), Advanced Planning and Scheduling (APS), Outsourcing, Due date

1. Introduction

Supply chains, which manufacture investment goods, consist of many successive business units, such as purchasing from suppliers, delivery, fabrication and assembly. In a supply chain environment, one manufacturing problem is that a number of customer-specific orders must be manufactured in a multi-project type of environment. Multiple customer-specific orders are subject to tight due dates, while at the same time there are long makespans, which result from order-specific parts that have to be manufactured in-house or produced outside. Capacity is generally scarce because fixed-cost has been reduced by outsourcing in recent years (Kolisch, 2000).

In a flexible industrial process, each order involves a different set of jobs in the fabrication and assembly process. The operations involved in a job are interrelated by precedence constraints, and can use alternative machines. Capacity adjustment is also possible through outsourcing with subcontractors when due dates cannot be kept. Timely and reliable delivery of products is an important factor in the manufacturing supply chain to ensure that manufacturing companies remain competitive. In some industries, meeting due dates is the bottom line for survival (Chung et al., 2000).

APS is very important in this environment, because it is at the leading edge of manufacturing management application technology. APS includes a range of capabilities, from finite-capacity scheduling at the shop floor level through to constraint-based planning (Turbide, 1998).

The appeal of APS to manufacturers is obvious, because companies can optimize their supply chains to reduce costs, improve product margins, lower inventories, and increase manufacturing throughput. APS necessitates deciding when to build each order, in what operation sequence, and with what machines to meet the required due dates.
In the competitive environment at the twenty-first century, executive management has been looking to purchasing to provide cost reductions, improve supply chain quality, gain across to new sources of technology, improve cycle time, involve suppliers in product and process development, and streamline processes.

Purchasing must perform a number of activities to satisfy the operational requirements of internal customers, which is the traditional role of the purchasing function. More often than not, purchasing supports the needs of operations through the purchase of raw materials, components, subassemblies, repair and maintenance items, and services.

Purchasing may also support the requirements of physical distribution centers responsible for storing and delivering replacement pans or finished products to end customers. Purchasing also supports engineering and technical groups, particularly during new product development.

Today many industries are moving away from vertical integration and relying increasingly on external suppliers. Purchasing must support this movement by providing an uninterrupted flow of high-quality goods and services that internal customers require. Supporting this Row requires purchasing to (a) Buy items at the right price; (b) At the required specification; (c) In the right quantity and (d) For delivery at me right time.

One of the most important objectives of the purchasing function is the selection, development, and maintenance of supply. This is what strategic supply management is all about. Purchasing must select and manage a supply base capable of providing performance advantages in product cost, quality, technology, delivery, or new product development (Monczka, Trent and Handfield, 2002)

2. Problem definition

Since production in a flexible industrial process is on a massive scale and requires long operating times, it is very important to make a production schedule that meets the due dates. Specific characteristics of a flexible industrial process include small lot size and operations that take a long time. If a customer order exceeds the due date, alternative machines, including outsourcing, should be used for operations related to the job. The makespan should be minimized to keep the due date for each customer order.

The structure of the supply chain in a flexible industrial process is shown in Figure 1. This chain has a four-level (supply, fabrication, assembly, customer) structure.

![Figure 1. Make-to-order supply chain in a flexible industrial process](image)

At the customer level, there are multiple orders with specific due dates. The product for each order is assembled after the required parts have been fabricated. Assuming that each product is produced in a specific assembly process, a product might need several parts, produced in related jobs at the fabrication level. Each assembly process can begin only after all the fabrication jobs have finished, and each assembly process is interrelated with the other assembly processes. Each job at the fabrication level produces a specific part for a product in an order, and may consist of several operations. At this point, the operations forming a fabrication job may include precedence constraints.

In reality, some of the operations involved in a job do have precedence constraints, and some of the operations required to complete the job are interrelated. Therefore, the operations-sequencing problem can be formulated as the well-known Traveling Salesman Problem (TSP) with precedence constraints. The manufacturing system under study consists of k machines (1, 2, …, k) and n different jobs (1, 2, …. n). All the jobs are loaded and processed continuously as a lot, according to a predetermined technological sequence given in the process plan (Nasr & Elsayed, 1990). Each job requires a number of operations, and each of these operations can be performed on a number of alternative, non-identical machines, which include outsourcing machines. A machine should be selected from among alternates for the operation sequence of each job. For a given production order, which involves a mix of jobs and machines, the operation sequence should be selected to maximize the production efficiency of all the jobs.

In this study, we focus on the fabrication and assembly level, because they are bottlenecks in the process and essential to satisfying the due date. Figure 2 shows a schematic diagram of the MTOSC model, with outsourcing.