INTEGRATING MANUFACTURING PLANNING AND CONTROL SYSTEMS INTO THE SUPPLY CHAIN

Track: Operations Planning, Scheduling and Control

Abstract

Manufacturing planning and control (MPC) systems play a vital internal role in manufacturing organizations, helping to develop overall and detailed material and capacity plans and schedules. When elements of a manufacturing organization's planning and scheduling are made known to supply chain partners, the linked companies can improve their respective supply chain performances.

This paper reviews the basic elements of MPC systems, discusses how knowledge of these elements can assist supply chain partners, and describes methods for sharing MPC data. Examples of applications are given to illustrate the methods and results of integrating MPC systems into the supply chain.

by

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Consider an organization—XYZ—that has limited information links with members of its supply chain. For downstream customers, XYZ must estimate (forecast) what demands are going to be for future periods. Most of the forecasting will be based on historical data, with some qualitative adjustments made for anticipated socio-cultural and economic environmental changes. Orders will be placed, but the timing and quantities of the orders will surely vary from the forecast. XYZ's customers will also lack information about stock on hand that would be useful in preparing orders. For upstream suppliers, the same uncertainty will exist (with the positions vis-à-vis XYZ reversed). Even if XYZ employs sophisticated planning and control systems internally, the risks of demand and supply uncertainties will affect operations and results. In this paper, we will begin by describing manufacturing planning and control (MPC) systems. The possible inputs to the MPC system from customers and outputs from the system to customers and suppliers, and how to share this information, will be discussed. Finally, applications of supply chain information sharing, and results, will be presented.

Manufacturing Planning and Control (MPC) Systems

MPC has been defined as a system that "provides information to efficiently manage the flow of materials, effectively utilize people and equipment, coordinate internal activities with those of suppliers, and communicate with customers about market requirements." (Vollmann, Berry, and Whybark, 1997) The MPC system undertakes several activities to fulfill the information requirements of this definition. These activities are linked internally through various departments and hierarchies.

See Figure 1

Within the "front end," demand management includes activities to determine external (customer) demands and internal demands: forecasting, order entry, order promising, and determining branch warehouse requirements, interplant orders, and service parts requirements (APICS Dictionary). Forecasting supports planning at all planning levels—long-, mid-, and short-term. Within the short-term planning horizon, orders entered into the system "consume" the forecast. Basically, until a firm order is placed by a customer or a firm requirement is made known for an internal need, all demands are estimated. Demand management is combined with resource planning to create aggregate production plans, and that planning data is disaggregated to create the master production schedule (MPS).

The MPS then drives the materials requirement planning (MRP) and capacity requirements planning (CRP) by exploding demand requirements through product specifications, like bills of materials (BOM) and routing files. Material needs are determined by netting the gross requirements for an item against inventory records containing on-hand balances and scheduled receipts. In time-phased planning, net requirements are used to determine when an order needs to be received and, based on lead-time data, when it needs to be released to the shop floor or to a supplier. The material plans are sent to capacity requirements planning (CRP) to determine how much and when capacity is needed to carry out required manufacturing activities.

The outputs of MRP and CRP planning are schedules that are executed (in the "back end") by sending orders to the shop floor (to make) and to suppliers (to buy). Fulfillment of orders by suppliers depends on their ability to meet the requirements of the order such as quantity, quality, and due date.

External Inputs to/Outputs from the MPC System

The supply chain concept links an organization's domain with suppliers (upstream) and customers (downstream). What internal MPC information can the organization share with these linked units to improve supply chain performance? Assuming the keystone premises of supply chain relationships—information, communication, cooperation, and trust—are met, knowledge about planned orders and inventory status can be as valuable externally as it is internally.

Two-way information sharing is valuable between the buying organization and the supplying organization. One useful information exchange would be for the customer to share "planned order release" information from its requirements planning system with the supplier. Typically, the supplier will forecast demands to prepare for future orders from the customer. In a make-to-stock environment, finished goods are scheduled to meet that forecast. These goods are then consumed by orders. In an assemble-to-order environment, modules are stocked so that orders can quickly be filled through execution of the final assembly schedule. And in a make-to-order environment, common components are ordered/built to reduce the cumulative lead time from order placement to shipment of the order. In all cases, having knowledge about the quantities and timing of customer requirements—in advance of receiving the order—would greatly improve the accuracy of the input to the supplier's MPC system. The MPS would start with order information that was much firmer than forecasts, although still susceptible to planning changes. However, experience with the stability of the customer's system and continuous updates would help peg the degree of certainty to accord to the system.

Another useful information exchange would be for the supplier to share inventory information with the customer. Suppose customer ABC is preparing to place an order for a specialized product from supplier XYZ. The configuration of the order must be set before the order can be placed. The components for desired configuration must be available at the time the order is processed if the order is to be acknowledged, built, and shipped on time. An alternative configuration, using available materials, might be agreed upon when the customer is notified about the delay created by material unavailability. However this communication between marketing, engineering, and materials with the customer may take a long time. A possible solution would be to create an on-line file, accessible to the customer, that gives the available-to-promise quantities of key components common to most configurations. The customer could then determine in advance whether he wished to submit an order for an alternative configuration or wait for the missing materials to become available.

A third information exchange would be for the customer to share inventory information with the supplier. Order placement for stock replenishment could become the responsibility of the supplier. By monitoring the customer's on-hand balance and considering historical use, logistical data, and other inventory data, the supplier could trigger orders and send them to the customer. This could eliminate the customer's need to place purchase orders and minimize demand management activities such as forecasting by passing these responsibilities on to the supplier. This process is usually referred to as vendor- or supplier-managed inventory (VMI or SMI).

Most of these exchanges can be effected by using electronic data interchange (EDI). The best alternative would be to establish data linkages through a common system, such as the Internet. In some cases, the host organization might break down its "firewall" and share its internal system. Additional training might be necessary for organizations using the host's system(s).

Benefits of information-sharing would be gained through reduction in the uncertainty that exists in system inputs, such as using knowledge of probable orders rather than forecasting. An additional benefit would be cost savings from automating purchasing and related transactions through the system interfaces, such as a reduction in personnel needed to prepare and monitor purchase orders. The improved flow of information should also result in better customer service based on measures such as on-time delivery.

Examples

Compaq Computer made a major strategic change by shifting from make-to-stock to a make-to-order process. (Teresko, 1998) Their new business model is called the Optimized Distribution Model, in which they build their desktop computers to channel or customer orders instead of producing products to a forecast. Channel partners can place orders through a shared EDI system, although Compaq is planning to change systems to use Internet/web-based transactions in the near future. Suppliers also use EDI to report on their delivery capability and status, allowing Compaq access to component availability. Compaq is reducing the number of suppliers by about 50%, and engaging the remaining suppliers in development processes to shorten the new-product development cycle. Some suppliers are on-site at various Compaq facilities providing SMI capabilities.

Some results of the changes include improving inventory turns from 5 to 14 (1997), and targeting future measures of 25 turns by the end of 1998 and 30 turns by the end of 1999. Reduced inventory increased customer service metrics by 33%--due to the decrease in cycle time gained from decreased inventory. Financial data (1997) included a 23% growth in revenues, 188 new products introduced, and a 90% increase in stock value.

Many software providers are improving the IT infrastructure in order to allow better connectivity between an organization and its supply chain associates: suppliers and customers. (Bartholomew, 1999) **Inland Paperboard & Packaging, Inc.** manufactures paperboard and packaging products, operating 6 paper mills and 46 processing facilities globally. They plan to use Internet systems by *Logility, Inc.* to handle planning, forecasting, and replenishment with their suppliers and to manage liaisons with their customers. **Whirlpool Corp.** is planning an e-commerce plan to connect with 600 suppliers using an Internet program called *Easy EDI*. They will be exchanging information on orders, inventory, shipments, and parts; and they expect to significantly reduce paper-based transactions and cut operational expenses.

Other manufacturers that have implemented online linkages among supply chain partners are Hewlett-Packard, Lubrizol Corp., and Ford Motor Company. (Stevens, 2001) **Hewlett-Packard** found that changing demand/supply requirements caused one of their suppliers to airfreight 100,000 pounds of plastic resin to its molder. So HP has connected the supply chain members, through the Internet, so that changes in requirements are communicated to all members of the chain—contract manufacturer, component supplier, molder, and plastics vender. HP has seen its costs decrease 3-5% due to implementing the information exchange. **Lubrizol Corp.** manufactures chemical and lubricant components. It has included some of its “trading partners” by using a software system to link the separately employed enterprise-resource planning (ERP) systems. Purchase orders and acknowledgements were the initial online documents created within the system. They have already begun to see business process improvements. **Ford Motor Company** is integrating its tier-one metal suppliers on a private exchange; these suppliers include steel suppliers, service centers, and stampers. The IT infrastructure will link member MRP/ERP systems allowing automation of business processes "such as purchasing and logistics transactions, material specifications, claims adjustments, and audit reporting throughout its global manufacturing and assembly operations." Ford expects to realize savings from operational efficiencies, to share feedback with its suppliers, and to integrate various functions into the system including product development.

Summary

The examples presented above clearly illustrate the advantages of integrating MPC systems within an organization's supply/value chain. It all starts with final customer—the end user. Having the knowledge of an order, versus estimating demand through a forecast is the first necessary step. This knowledge enables the organization to provide the exact product that the customer wants, rather than hoping to meet demands through on-shelf inventory. Using electronic processes in place of paper processes speeds purchasing transactions, and it leads to a reduction in cycle time. Tracking orders from placement through production and logistics to receipt allows everyone that is linked to the information system to be updated on the current status and changes that occur. Obviously the information systems must safeguard proprietary data form those outside of the system.

Production practices such as lean manufacturing and continuous improvement should contain initiatives that integrate appropriate information sharing into the supply chain. Customer expectations regarding competitive priorities have gravitated to flexibility, delivery, and service. The only way to meet those expectations is to quickly and accurately communicate requirements throughout the supply chain.

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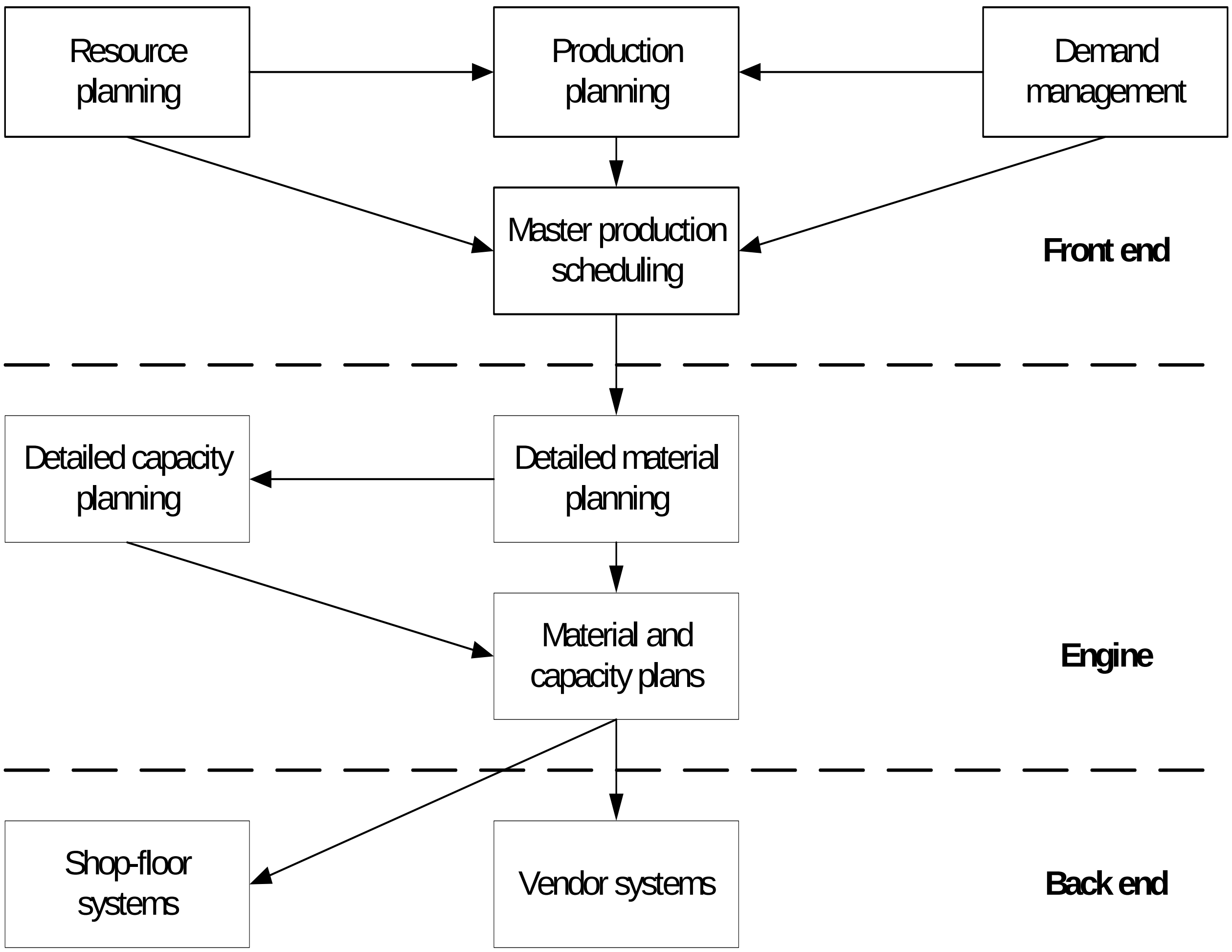
Figure 1. MPC Diagram[1]



[1] Vollmann, Berry, and Whybark, p.5.