Chapter 3.14
An Agent-Based Information Technology Architecture for Mass Customized Markets

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ABSTRACT

This chapter presents a Web-enabled, agent-based information system model to support mass-customized markets. We present a distributed, real-time, Java-based, mobile intelligent information system that interfaces with firms' existing IT infrastructures, follows a build-to-order production strategy, and integrates order-entry with supply chain, manufacturing, and product delivery systems. The model provides end-to-end visibility across the entire supply chain, allows for a collaborative and synchronized production system, and supports an event-based manufacturing environment. The system introduces four general-purpose intelligent agents to support the entire mass customization process. The adoption of this approach by a semiconductor manufacturing firm resulted in reductions in product lead time (by half), buffer inventory (from five to two weeks), and manual transactions (by 80%). Similarly, the adoption by a leading automotive manufacturer resulted in a 51% total inventory reduction while increasing plant utilization by 30%. These results verify that the successful adoption of this system can reduce inventory and logistic costs, improve delivery performance, increase manufacturing facilities utilization, and provide a higher overall profitability.

INTRODUCTION

The globalization of businesses and the infusion of information technology (IT) into every aspect of operations have introduced a strong demand for product variety and transformed business environments from a production-centric model to one that is information- and customer-centric (Arjmand & Roach, 1999). Although the Internet

has strengthened business with its convenience and 24-7 global accessibility, it has also dramatically shifted the traditional business model to a new, competitive market space. People can now purchase anything, anywhere, at any time, and both product customization and customer requirements are increasing exponentially, making sales and inventory prediction a challenge. Meeting the wants and needs of such a heterogeneous customer population, in a global market, inevitably calls for product variety, while every efficiency-seeking supply chain prefers to process as few "flavors" as possible.

Mass customization seeks an economical resolution of this fundamental conflict. Taking mass production as a foil implies that a mass-customized product should not cost end customers much more than a mass produced near-equivalent, and that the customization process should not create too much of a delay. We believe that this can be realized with consistency and at scale only with a *customer-centric production system*. This is one that enables an end-customer to configure (partially design) the product online and provides real-time visibility of the resulting order directly to the manufacturing floor and throughout the supply chain. In such a production system, businesses focus on their core competencies and outsource activities that are not essential to this core. Improvements in information technology infrastructures and worldwide acceptance of the Internet have strengthened this transition. As a result, complex products in the market can be the result of collaborative efforts of many companies (Anderson & Lee, 1999). The auto industry is an excellent example of such a collaborative effort. A car can have over 10,000 parts, with multiple stages of production, many suppliers, a high degree of product complexity, and a high degree of customization. The manufacturing operation of such a business often requires a high production rate, time and space constraints, and often long cycle times. High technology is another example. Fabrication-less firms that design new components are common. These firms now concentrate on their core business of designing a new component and outsource the manufacturing to specialized semiconductor and PC-board manufacturing contractors. Transportation and logistic systems are additional examples in which the Internet and online commerce have facilitated rapid movements of products and material in a time-sensitive production environment.

The participants in these markets include suppliers, retailers, and transportation services providers. The efficient operation of such markets requires extensive collaboration among its many members.

There are several common themes that characterize these markets. The first theme is the time-sensitive nature of the demand in such markets. The order stream for these markets can change in a short period of time. For example, for the semiconductor manufacturing system described later in this chapter, the order stream can arrive multiple times per day, creating a turbulent production environment requiring adjustments to production schedules. Similarly, transportation and delivery systems need to account for last-minute changes in orders, cancellation of existing orders, addition of new orders, breakdowns in the actual transportation facilities, and complications due to weather or traffic conditions, all within just a few hours (Dorer & Calisti, 2005). Most mass-customized production environments are time-sensitive and therefore exhibit such behavior. Traditional production systems cannot efficiently address these needs.

The second theme associated with such markets is the complexity of the supply chain system. The auto industry is an example of such a production environment. The supply chain is often multilayered with complex arrangements. Supporting mass customization of products in these markets can have a major impact on inventory levels for the suppliers that are located downstream from the final production vendor. If timely demand data reflecting the latest change in final product is not