Chapter VIII
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 dramati-
cally 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 require-
ments 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 reso-
lution of this fundamental conflict. Taking mass
production as a foil implies that a mass-custom-
ized 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, busi-
nesses 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 de-
gree 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 move-
ments 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 charac-
terize 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 pro-
duction 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 mar-
kets is the complexity of the supply chain system.
The auto industry is an example of such a produc-
tion environment. The supply chain is often mul-
tilayered 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
available to all suppliers, the inventory bullwhip
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