

# Agent-based e-commerce in case of mass customization

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## Abstract

The Internet has created a tremendous opportunity to conduct business electronically. Innovative business concepts like virtual enterprises, supply chain management, one-to-one marketing, and advanced competitive strategies such as mass customization (MC) are supported by the Internet. In this paper, an approach is proposed to support distributed, logically integrated inter-company business processes, wherein complex and hard to standardize data occur, by applying e-commerce techniques paired with agent technology. Inter-company data exchange, procurement, and coordination of production in MC are improved by means of a multi-agent system. The specific business requirements of companies that cooperatively produce a specific good or service are discussed. Next, it is demonstrated that automated inter-company communications are necessary and that an agent-based system can automate procurement and inter-company coordination of production. Last, the system's implementation is described. © 2002 Elsevier Science B.V. All rights reserved.

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## 1. E-commerce as a means to enable innovative competitive strategies

*E-commerce* may be defined as “any form of business transaction in which the parties interact electronically rather than by physical exchanges or direct physical contact” [1, p. 2]. It “refers to business activities involving consumers, manufacturers, service providers, and intermediaries using computer networks such as the Internet” [2, p. xi]. The scope of e-commerce reaches from simple *world wide web* (WWW) presence to shared business processes connecting different companies. E-commerce saves time and reduces the costs of

business transactions. E-commerce makes virtual enterprises, supply chain management, one-to-one marketing, and advanced competitive strategies, like *mass customization* (MC), more practicable and efficient.

MC requires a synthesis between mass production and the production of highly specialized, individualized products. MC aims to produce individual products with high quality at a cost typical for mass production and to achieve comparable, short delivery times [3, p. 48]. Originally, MC was portrayed as a marketing concept which, following the paradigm of customer orientation, automatically results from constant market segmentation [4, p. 13]. Products for specific market segments are offered to satisfy the needs of those special customer groups. A further differentiation of markets leads from micro

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markets and niche markets to individual markets that are comprised of a single customer. Small and medium manufacturers were forced to follow a strategy of differentiation, as the production of small quantities was predominant. The level of output was insufficient for cost leadership. Small and medium enterprises, opted to pursue MC, focus on a more efficient production process, and become more customer-oriented. Large manufacturers, on the other hand, sought higher flexibility and a higher level of customer orientation.

Empirical studies suggested five instances of MC, cf. [5]: service customization, self-customization, splitting of the production process, speed management, and modularization. A variety of cases concerning companies pursuing MC may be found in [6].

MC as a *competitive strategy* requires (dependent from its concrete instance) that different production types be employed simultaneously—especially single-item production with its normally high requirements for inter-company interactions. The approach presented herein aims at improving the (mandatory) business to business interactions required for MC. The problem of automatic inter-company collaboration involving (legacy) application systems of manufacturers and suppliers, that are often incompatible, is addressed. Data exchange between manufacturers and their suppliers can be handled efficiently and in a timely manner using e-commerce techniques paired with agent technology. This approach can further help to coordinate distributed production processes.

### 1.1. The business process that requires support

The description of the underlying business process is fundamental to understand the proposed approach. It is first explained at a macro level. Next, a specific scenario is used to explain improvements possible with the proposed approach.

The lower part of Fig. 1 depicts the MC macro process as introduced in [7, pp. 25–26]. It starts with the *configuration* of the desired product by the customer. It is necessary, next, to check which parts or assemblies can be produced by the manufacturer and which parts must be *acquired*.

For parts that must be acquired, individual attributes will likely have to be taken into account. The manufacturer then becomes a customer for some of its suppliers. The same is likely for the suppliers of the suppliers. This leads to a nesting of procurement activities, and finally, to a networked production process that covers multiple companies and plants. Procurement follows the *production* of individual products by flexible, partly-automated groups. Data is produced from ad hoc generated bills of materials and work schedules, suggesting that long- and mid-term overall planning in the usual sense is impracticable for MC—realistic parameters cannot be determined due to high uncertainties with regard to the products that must be produced in a longer planning period. Production must include quality assurance. The process culminates with the physical *distribution* of products.

The upper part of Fig. 1 illustrates a concrete instance of the MC macro process. It depicts the main interactions between customer, retailer, manufacturer, and suppliers necessary to sell, produce, and distribute a custom product. For this example, it is assumed that the manufacturer splits the production process to produce customer neutral standardized products and individualized (custom) products. The customer is integrated into the portion of the system that produces the individualized products, e.g. customer specific production of utility vehicles. In the interest of simplicity, suppliers of suppliers are omitted, and interactions are depicted with one supplier only.

The business process starts with a customer who is willing to buy an individualized product contacting a retailer. The customer then (guided by the retailer) customizes the product. As soon as the product is individualized, the retailer sends an order to the manufacturer. With expensive products, or when time is critical, the customer may demand an offer before launching an order. If this happens, the manufacturer must be able to assure a certain delivery date, a certain price, or a certain quality. To do so, the manufacturer has to process the data received from the retailer concerning the configuration of the product. The manufacturer then calculates which parts must be produced, which parts must be purchased, and how long it

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