

# Production planning and order acceptance in business to business electronic commerce

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## Abstract

Following the exponential growth of the Internet and the increasing number of software solutions enabling business-to-business electronic commerce, we study negotiation processes in a make-to-order (MTO) environment. In many industries, the value chain is fragmented both horizontally and vertically and manufacturing firms operate upon a MTO basis. In this application domain, the main decision process consists of interfirm negotiation upon requests-for-quotation distributed by customers and upon bids submitted by suppliers. At the same time, the negotiation process is tightly integrated with production planning and requires appropriate decision-support techniques. This paper discusses in detail the structure for a standardised negotiation process occurring in a multi-enterprise setting and presents three mixed-integer linear programming models that may be used by the different parties involved.

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## 1. Introduction

It is an obvious proposition to state that the management of manufacturing operations is currently undergoing a true revolution, with the widespread diffusion of novel industrial structures and the related enabling technology. Among the former, one can list supply chains, extended and virtual enterprises (Jagdev and Thoben, 2001) and ecosystems (Moore, 1997). Enabling technology is generally centred around the Internet and includes

supply chain management software, electronic marketplaces and the related communication infrastructure.

Most of the change process has up to now viewed the largest companies as first adopters and, through them, it has gradually diffused to their smaller suppliers and customers. In fact, the diffusion of novel organisational forms and technological solutions among small and medium enterprise (SMEs) has been fairly slow. The European Information Technology Observatory 2000 (EITO, 2000) reports: '... At the turn of the millennium the SME segment remains the biggest untapped market [for IT] in the European economies'. In other words, SMEs are undergoing the risk of being kept out of the IT revolution,

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despite the fact that the economies of advanced countries are solidly based on the value produced by such firms. For example, in the European Union, SMEs with less than 50 employees provide jobs for around 56 million people with a turnover of around 11,500 Billion €. A significant proportion of these companies belong to traditional manufacturing industries. When discussing e-business solutions for manufacturing SMEs, it must also be remembered that only 30% of European SME output goes to the consumer market. This implies that the focus should be on business-to-business (B2B), rather than business-to-consumer relations.

If one looks at the steps being undertaken within B2B electronic commerce by the larger companies, who often act as customers to SMEs, such companies currently pay great attention to e-procurement solutions. Apart from a few signs of change that are now starting to arise, e-procurement practices have up to now focused on customer benefits in terms of reduced transaction costs, and especially on price reductions. For example, reverse auctions (Engelbrecht-Wiggans, 1980)—in which customers force suppliers to outbid each other by lowering price—have become, to the eyes of many observers, the quintessence of Internet-based B2B electronic commerce. This business model certainly is not beneficial to supplier SMEs, and explains much of their reluctance to join the ‘Internet revolution’ (Counsell, 2001). One may therefore draw the conclusion that there is substantial space for research in e-business solutions that may become a truly—and not only rhetorically—“win-win” proposition for suppliers as well as for customers, large and small alike. Such research should cover aspects related to:

- Information and Communication Technology, so as to develop enabling systems,
- industrial organisation, that may help to set fair ‘rules of the game’ and to foresee and manage the resulting structural transformation of industrial value chains,
- manufacturing management, in order to support the operational decision-making activities performed by SMEs involved in such electronic commerce networks.

In the context of the latter stream of research, this paper proposes the basis for decision support systems which may support SMEs in their electronic negotiation processes. The paper originates from a wider research project (Cantamessa et al., 2001), whose objective is the development of an electronic platform enabling B2B electronic commerce for SMEs with make-to-order (MTO) operations. As clearly presented by Hendry and Kingsman (1989), the characteristics and strategic priorities of MTO companies are significantly different from those operating on a make-to-stock basis. Smaller MTO firms are also characterised by low product and process complexity and generally restrict themselves to performing processing and assembly operations upon standardised designs, or using order-specific designs directly provided by customers. By referring to the taxonomy by Amaro et al. (1999), the former would fall into the categories MTO-3–MTO-5, while the latter would more appropriately be considered engineering-to-order companies. However, the absence of design responsibility makes the order negotiation and fulfillment processes very similar in both of these cases. Many examples of such SMEs can be found in industrial clusters, in industries such as textile, furniture, ceramic tiles, etc.

In operations of this kind, the critical issue generally shifts from the management of materials to that of managing manufacturing capacity, since raw materials are often provided by customers or purchased using unsophisticated approaches, while the product bill-of-materials is relatively simple. In many instances, it can therefore be stated that the commodity being traded with customers is not physical goods, but rather, machine-hours. This leads to the critical need of integrating the order negotiation and production planning processes or, from an organisational perspective, of integrating the marketing and production functions (Muda and Hendry, 2002). To date, order negotiation and production planning processes are generally performed by human decision-makers, eventually supported by industry-standard information systems, such as MRP. However, for networked SMEs using the Internet in order to trade goods and manufacturing services, the frequency with which business

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