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MULTI-ECHELON PRODUCTION PLANNING PROCESS WITH NO TIME COORDINATION

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Abstract: The purpose of this paper is to study decentralized planning processes with no time coordination, performed within a whole supply chain. Distributed production and business units which compose the network, are considered as economically independent and autonomous in decision making, they define and update their production plans according to their own planning dynamic and strategy. Reactivity within these supply chains being quite dependent of this planning processes coordination, we try to assess the impact of this phenomenon on supply chain performance through a series of simulation, based on a generic linear programming model supporting the production, replenishment and delivery planning.

Keywords: Manufacturing systems, Production control, Planning Process, synchronisation, Simulation, Performance evaluation.

1. INTRODUCTION

Supply Chain Management (SCM) is defined as a global approach to coordinate information and materials flows between business entities in fulfilling customer's demand. Even if flows exchange among partners is defined by contract, coordination is nevertheless quite difficult due to the economic independency and decision-making autonomy of each one. *A key issue in SCM is then to develop mechanisms that can align the objectives of independent supply chains members and coordinate their decisions and activities so as to optimize system performance* (Li and Wang, 2007).

Related literature traditionally opposes different approaches in response to this scientific issue: centralized control architectures which ensure the optimal performance along the supply chain (SC), or decentralized decisional structures which model more realistic industrial situations and put individual performances optimization forward supported by efficient information exchange. Distributed decision making processes that are studied, explain the actual growing interest for information sharing (Huang et al., 2003; Chu and Lee, 2005; Li and Woo, 2004), notably since many authors and companies realized its beneficial impact on supply chain efficiency (D'Amours, et al., 1999; Fiala, 2004; Trkman, et al., 2005). However, main scientific results in this domain turn on information uncertainty without systematically coping with the problem of no time coordination in decentralized decisions processes.

The purpose of this paper is to study and simulate decentralized planning processes with no time coordination performed within production and business units distributed along supply chains, in order to assess their impact on the whole performance. The paper is organized as follows. The problem statement is proposed in section 2 and some current researches on supply chain planning are reviewed. Section 3 analyses the phenomenon of delayed information treatment induced by asynchronous planning processes. Section 4 describes a simulation based on a generic planning

model and tries through numerical experimentations to estimate the sensitivity of planning solutions quality to period values which characterize a regular updating for each production plan calculated by SC partners. The last section concludes on the problem relevance and perspectives

2. PROBLEM STATEMENT

SCM includes many key aspects on planning and control of operations. Authors working on this domain classically structure their analysis in relation with the different concerned business processes. (Lee and Whang, 2001) discuss on planning synchronization and workflow coordination implying the procurement, order fulfilment, Product Design and post sales support Processes. Considering the procurement, production, distribution and sales processes, (Rhode, et al., 2000) cited in (Dudek, et al., 2005) proposes a hierarchical organization of the various planning tasks of interest (see figure 1).

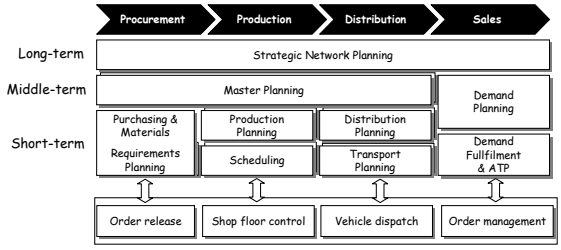

Fig. 1. SC planning matrix (taken from Rhode and al., 2000)

According to these points of view, planning problems studied in this paper are those concerned by the master planning. However, we consider they take part in a distributed managerial approach which supports decisions intending to elaborate in a dynamic way the most efficient solutions on SC replenishment, production and delivery operations performing.

Dynamic aspects of planning calculation are then based on the period and horizon concepts. The horizon defines the time interval on which planning decisions are considered as relevant to plan further activities. The planning period (or period) is the time interval on which decisions are temporally fixed and should not be questioned and modified before its end. Values of planning period are usually expressed on a timescale obtained by dividing the entire planning horizon into time slices, according to the smallest operating time of activities performed in the production system.

Planning dynamically computed are then based on the rolling horizon principle, which allows to countering the demand uncertainty by periodically updating information on customer's demand and products quantity in stock, production and delivery.

Rolling horizon planning is well-studied in literature, since many years. (Simpson, 1999) has performed some experimentation with specific heuristics to reduce the nervousness, and characterizes the relationship between rolling horizon and fixed horizon. (Millart, 1998) mentions the rolling horizon principle as an efficient mechanism for coping with demand uncertainty, and applies it to an industrial fish firm production planning. By defining the best ratio between the planning periods and frozen horizons, he has obtained a performance gain of 10% in comparison with a non rolling horizon plan. Recently, (Galasso, et al., 2006) uses the same mechanism to develop a planning system applied to a single customer – supplier relationship, which supports decision makers in their choice of frozen horizon / planning horizon position and length.

However, periodic production plans updating does not only present many advantages. The most inconvenient lies in the fact that unexpected events, when occur, are not instantaneously detected. Their treatments are then delayed at the planning period end, leading to increase the events perturbing aspect and gravity (Deschamps, et al., 2004). Synchronization of decision processes reduces this phenomenon but not completely excludes the case where information is treated with latency (Giard, 2004).

Our study differs from the previous mentioned approaches by considering the planning problem extended to the whole supply chain and not reduced to a Customer – Supplier relationship as it is often proposed in the literature. Planning solutions are dynamically calculated on finite-horizon, in a distributed way (multi-echelon system), according to each SC partner's decision updating periodicity. Assuming that an enterprise is not only involved in a unique SC, we consider that the period value the firm uses to update its production plans is chosen as a compromise providing an efficient planning for all activities it performs (for all SC) without guarantying an optimal solution.

This situation inevitably induces difficulties for synchronizing local processes composing a multi-echelon planning system (in the following section, we mention this problem as 'desynchronization phenomenon' or as 'no time coordination') and information treatment waiting times appear leading to degrade supply chains reactivity.

3. DESYNCHRONIZATION PHENOMENON

Planning synchronization refers to the joint design and execution of plans for product introduction, forecasting and replenishment. Planning synchronization defines what is to be done with the information that is shared; it is the mutual agreement among members as to specific actions based on that information (Lee and Whang, 2001). This definition implies that making synchronized replenishment and production planning represent a real effort which is often hard to achieve in reality: imposing a synchronous rhythm of planning for all the SC partners is quite difficult, especially when each of them considers itself free to draw its own policy and define its rules.