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Multi-echelon supply chain network design in agile manufacturing

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Abstract

In this paper, we consider a supply chain network design problem in an agile manufacturing scenario with multiple echelons and multiple periods under a situation where multiple customers have heavy demands. Decisions in our supply chain design problem include selection of one or more companies in each echelon, production, inventory, and transportation. We formulate the problem integrating all decisions to minimize the total operational costs including fixed alliance costs between two companies, production, raw material holding, finished products holding, and transportation costs under production and transportation capacity limits. A Lagrangian heuristic is proposed in this paper. Optimizing a Lagrangian relaxation problem provides a lower bound, while a feasible solution is generated by adjustment techniques based on the solution of subproblems at each iteration. Computational results indicate the high quality solutions with less than 5% optimality gap are provided quickly by the approach in this paper. Further, compared to initiative managerial alternatives, an improvement of 15% to 25% is not unusual in certain cases for the proposed approach.

Keywords: Agile Manufacturing, supply chain network design, multi-echelon, Lagrangian heuristic

1 Introduction and Motivation

Companies today are faced with a competitive environment which brings challenges, such as how fast products are designed, manufactured, and distributed, while simultaneously having to consider improving production efficiency and total operational cost. The concept of Agile Manufacturing was proposed as a novel manufacturing paradigm in response to these challenges. An agile company is capable of operating in a competitive environment with market opportunities that are continually emerging and changing with uncertainty. Virtual organization, according to Goldman *et al.*, (1995), is defined as “an organizational tool for agile competitors who are integrated by sharing core competencies and resources to accomplish a particular product which could not be done solely by each of the competitors.” A virtual organization is formed opportunistically, and disbanded when its objective is attained. Companies in a virtual organization share core competencies, resources, skills, and costs, which make them able to respond to global market opportunities which each individual member is not able to on its own.

Therefore, the concept of the virtual organization has emerged as a new organization model within Agile Manufacturing. Virtual organizations reflect and facilitate three major aspects of agile competition (Goldman *et al.*, 1995):

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