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Decision support system for product variety management

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ABSTRACT

This paper presents an approach of cost-based analysis of product variety by using modeling product families as logical bill-of-materials trees and assigning attributes to each component. By combining the product structure information with volume, cost and replenishment time, the proposed decision support tool can help to answer questions related to product family design, e.g. cost of adding a new variant into a product, benefit of replacing a specialized component with standardized one, how inventory replenishment time affects to total cost. This tool provides a mechanism to connect product family design with cost analysis.

Introduction

Product variety management is an important issue in many industries, as is evidenced by an ever-increasing product variety and a request for shorter product development life-cycles in dispersed manufacturing networks (Cooper and Griffiths, 1994). In order to cope with the challenges inherent in high-variety production and the stringent time constraints, companies need to take an integrated viewpoint of product design, production, and supply chain management (Forza and Rungtusanatham, 2002). Traditionally, product variety management seldom accounts for the production issues (Fixson,

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2005). On the other hand, studies in supply chains focuses largely on the back-end process of planning, i.e., implementing and managing flows and storage of raw materials, work-in-progress (WIP), finished goods from the point of origin to the point of consumption for the purpose of fulfilling customer requirements (Su et al., 2005). As management of supply chains becomes more complex and distributed, a knowledge-intensive approach of design for product variety is needed, which can enhance a company's operational capacities (Lee and Sasser, 1995). There is a need for cross-disciplinary applications that could help coordinating decisions related to products, processes and logistics.

There are a number of issues related to the management of the product variety in dispersed global manufacturing networks. Among them, practical yet fundamental questions asked by product and production managers include: (1) How to integrate product design with supply demand network design, (2) What is the cost and revenue of adding a new variant into a product? (3) How much is the benefit of replacing a specialized component with standardized one (i.e., cost vs. benefit tradeoffs)? (4) How much inventory replenishment time affects to total product cost? These questions could not be answered without a holistic viewpoint that accounts for product design, production systems, and supply. Decision making in this field is characterized by coordinated and synchronized flows of information about products and production processes among various supply chain members.

In order to address the questions, one must be aware of two fundamental technical issues, namely (1) designing a product structure that facilitates enhanced decision-support to logistics management (van der Vlist et al., 1997), and (2) analyzing the cost implications of product variety through rational cost modeling (Thyssen et al., 2006). In this regard, this paper proposes the cost-based analysis approach for dealing with the variety issues on top of product platforms and product portfolios. Product platform is understood in this paper as "*a set of subsystems and interfaces forming a common structure*" for product development (McGrath, 1995). Product portfolio is understood as the offering consisting of all product platforms. Use of product platforms, modular design and parameterization are tools for mass customization.

This approach proposes a key characteristic-based hierarchical product structure that integrates production cost and logistics information such as transport cost, inventory holding cost, lead-time and on-time-delivery percentage into low level components of the structure. Accordingly, a comprehensive cost model is developed, which accounts for the multiple variants of the product family, as well as the demand information. The cost model establishes the foundation for an optimization process in seek of an optimal tradeoff between cost and benefit. To implement and verify the method, the ASDN Product Variety Analysis (PVA) software is developed and is used to analyze product structures from a cost analysis point-of-view and support decision making at the product portfolio design phase. The described PVA features have been tested in real design project environments other than the example case discussed in this paper. The features have been developed during a product development project in a company that manufactures electrical industrial appliances for its launching of the next generation product family.

Related work

Maximizing external product variety to provide product customization at near mass production efficiency is the goal of mass customization (Pine, 1993). In that case, the increased commonality (components, modules, product platforms, product families, process platforms) is pursued to balance cost, revenue, and performance effects when selecting product architecture from a set of candidates (Fixson, 2005). Production cost is then estimated after identifying a set of production activities and resources related to produce a family of products.

A more accurate estimation of product cost considers the effect of product design variables to production process efficiency and sensitivity of production process variables against product design variables (Park and Simpson, 2005). Activity-based costing (ABC) is one alternative for relating resources consumed by activities to estimate the production cost of the product family design. Once resources used for four levels of production activities (unit-level, batch-level, product-sustaining level, and facility-sustaining level) have been identified, ABC method could be used to eliminate unnecessary activities, to reduce the amount of resources, to select less expensive activities and to

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