Available online at www.sciencedirect.com
ScienceDirect
Expert Systems with Applications 32 (2007) 1132–1140
Expert Systems with Applications
www.elsevier.com/locate/eswa

An integrated model for supplier selection decisions in configuration changes

H.S. Wang, Z.H. Che *

Department of Industrial Engineering and Management, National Taipei, University of Technology, 1, Sec. 3, Chung-Hsiao E. Road, Taipei 106, Taiwan, ROC

Abstract

Configuration change management provides a way for a manufacturer to become more competitive. Because of the short life and the large variety involved in commercial products, they must be configured accordingly. It is a task for the configuration change management. This paper presents an integrated model for modeling the change behavior of product parts, and for evaluating alternative suppliers for each part by applying fuzzy theory, T transformation technology, and genetic algorithms. The proposed model is based on the concepts of part change requirements, fuzzy performance indicators, and the integration of different attributes, to allow the part supplier selection of a specific commercial product to be explored and modeled. The application of this approach is illustrated through a case study of a TFT-LCD product for part change optimization. In terms of change performance, experimental analyses with different genetic parameters allowed the potential alternative suppliers for the product parts to be evaluated. The results of the experimental analyses show that this proposed methodology is a suitable approach and provides a quality solution for products with a complex configuration. In addition, the numerical results obtained from the new approach were compared with the results obtained by linear programming. The result shows that the proposed algorithm is reliable and robust.

Keywords: Configuration change; Supplier selection; Fuzzy theory; Genetic algorithms

1. Introduction

Mark and Reidelbach (1991) believed that a high customization strategy makes for a closer relationship between business and consumers, and Zhang and Li (1999) stated that product design is reduced to the determination of an appropriate configuration. Many companies today are putting more and more effort into modifying and improving existing products in order to satisfy customer demand and/or processing requirements. If a configuration needs to be changed then it must be done efficiently based on the specifications of the customer, production conditions and source constraints, etc. This has simply become a must for any commercial product that wants to make it and stay in today's market with its razor sharp competition. In order to enhance customer's satisfaction, part changes in product configuration are required so as to improve a product's functions and increase added value.

In a real-life production situation, manufacturers must invest a lot of time and capital to carry out these product part changes. When making changes, in order to save resources and costs, the first impulse of producers is to adopt existing product design patterns. Thus the manufacturer must research and develop a new technology with lower costs to design and produce new parts to improve his product.

The term 'product configuration' refers to the fact that many individual suppliers are involved, and that appropriate parts are provided and assembled so as to substantially improve the value of the product or service sin order to meet the requirement of the customer. Therefore, in today's rapidly growing and changing environment, the main challenge for the configuration management group is to

* Corresponding author. Tel.: +886 2 2771 2171x2346; fax: +886 2 7317168.
E-mail address: zhche@ntut.edu.tw (Z.H. Che).

0957-4174/$ - see front matter © 2006 Elsevier Ltd. All rights reserved.
doi:10.1016/j.eswa.2006.02.015

respond as quickly as possible to the uncertain and forever changing customer requirements.

In order to increase the competitiveness of a product in the commercial environment, companies focus on building up their core competencies, and on selecting the appropriate part suppliers, in order to decrease the level of risk in their business, and to improve the efficiency of any required product configuration change. Fulfilling customer requirements means the need for part change planning, including the resolving of issues of optimal cost and quality, etc. of the end product. Consequently, supplier selection is an essential part of the efficient management of configuration change, which is necessary for the effective operation of the organization. Hence, in this paper, we focus on the development and assessment of a model to determine the optimal configuration change strategy using the most suitable part suppliers.

This paper develops an innovative optimization algorithm designed specifically for supplier selection in a configuration change. The proposed optimization algorithm adopts the optimization concept of genetic algorithms (GAs), and the uncertainty decision making method of the Fuzzy theory. This proposed algorithm is capable of considering cost and quality attributes with uncertainty values in determining an optimal solution.

The remainder of this paper is organized as follows: In the next section, the literatures of product part changes are reviewed. The problem is defined in Section 3, and in Section 4 the mathematical model for the product configuration change is developed. The proposed model and procedures for solving the configuration change problem is described in Section 5. In Section 6, a real product example is provided to illustrate the practicability of the proposed model, and a comparison of the computational results obtained from linear programming (LP) with the proposed algorithm is analyzed. Finally, a brief summary is presented and we draw our conclusions in Section 7.

2. Literature review

To enhance the value of a commercial product, configuration change is a critical task, since in the life cycle of a product the changing of parts can create product functions that can enhance the competitive advantage of that product. Product configuration change refers to a component(s) that needs to be changed during its life cycle in order to increase its market value. Many scholars and engineers usually refer to it as 'part change management' or 'engineering change management' instead of 'configuration management'. Configuration management establishes and maintains the consistency of a product's performance and its functional and physical attributes (Christiansen, 1972). Barkan (1992) referred to the parts of a product that are modified or changed as an engineering design change. Furthermore, Wright (1997) pointed out that engineering changes are components of a product that are modified in the production phases, and that one has to find the appropriate parts to assemble the finished products. Subin and Weigel (1998) indicated that product configuration is a special case of design activity, i.e., selecting components from a predefined component library and connecting these components according to customer requirements. The goal of the configuration process is to find feasible solutions which satisfy customer requirements and product constraints Zhang, Wang, Wan, and Zhong (2005).

In order to carry out a product configuration change, much prior research has been done on this problem and many quality results have been proposed, such as Turner (1990) who formulated a mathematical approach to find the optimal assembly configuration, Chen (1995) developed a management system to perform these engineering changes through an actual product manufacturing process, Yeh (1997) proposed a framework for an automatic configuration design system using the database of the mechanical components, Chao and Chen (2001) proposed an approach for selecting proper components before actually completing the product assembly, Jonghoon and Lee (2002) considered manufacturing feasibility, production as well as outsourcing costs when analyzing the change assessment among different factories, and Zhang et al. (2005) discussed configuration-oriented product modeling and knowledge management for made-to-order manufacturing enterprises. In this paper, our focus is also on modeling the product configuration change problem, which makes that we have to take into consideration two different attributes, cost and quality. In addition, the fuzzy characteristics of these attributes are also brought into our model.

3. Problem description

In product configuration, the finished product is usually composed of many parts. Each of those parts can be provided by various suppliers from different geographical locations. In order to enhance the product functions, the challenge of the configuration change is to find suitable part suppliers that provide quality components, and can effectively fulfill both engineering and customer requirements. Therefore the producers need a model to assess which parts supplier can fulfill these requirements the best. The objectives and the constraints must be considered in the supplier selection process, and they are as follows:

(1) Minimize the value of the (operational cost–part quality).
(2) Assess all candidate part suppliers based on the defuzzied cost and quality data.
(3) Determine the near-optimal suppliers that can provide a lower cost and quality parts for completing the finished product.

In other words, based upon consumer or engineering requirements, an appropriate part supplier combination is required for a specific product in order to decide which supplier will provide which component. The question is, what combination of parts suppliers will best fulfill the requirements of both, low cost and high quality? It is the