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Int. J. Production Economics 75 (2002) 305–322

international journal of
production
economics

www.elsevier.com/locate/dsw

The evolution of a cellular manufacturing system – a longitudinal case study

Eric Molleman[a,*], Jannes Slomp[a], Samantha Rolefes[b]

[a] *Faculty of Management and Organization, University of Groningen, P.O. Box 800, 9700 AV Groningen, Netherlands*
[b] *Exticity Software, Redwood Shores, CA, USA*

Received 10 April 2000; accepted 20 February 2001

Abstract

This paper describes the evolution of a cellular manufacturing system in a medium-sized company over a 13-year period. The objective of this paper is to analyze the arguments that gave rise to the nearly continuous readjustment of the design of the cellular manufacturing system of this company and the direction in which these adjustments took place. The study indicates that two interrelated factors played an important role in the decision to change the system: the market and manufacturing technology. Analysis of these factors offers important insights into the aspects that need to be taken into account in cell formation. It is argued that a cellular system should reflect market characteristics. New technology, furthermore, demands specialized cells, producing in a multi-shift situation. These two developments point in the direction of market-oriented, reasonably sized, functionally organized manufacturing units. It is argued that market developments, new manufacturing technology and modern production control systems will probably constrain the application area of cellular manufacturing.

Keywords: Cellular manufacturing; Longitudinal case study; Market; Manufacturing technology; Performance; Management strategy

1. Introduction

A cellular manufacturing (CM) system is defined here as the grouping of workers and machines into relatively independent cells, which are responsible for the complete manufacturing of a set of part types. Many firms have adopted CM as a strategy for improving performance. Case studies (e.g., [1–14]) and survey articles (e.g., [15–17]) show important advantages of CM such as shorter throughput times, better product quality, and lower material handling costs. An important flaw of these studies is that they consider the success of CM only in the short term.

Cell formation is likely one of the most researched topics in the field of cellular manufacturing [18]. A large number of cell formation techniques have been developed through the years. All techniques require nearly the same information: number and types of machines, volume, routings, and processing times of part types [19–21]. A topic related to cell formation that has gained little attention in the literature concerns the stability of a CM system through the years. Some authors have investigated the effect of volume and

*Corresponding author. Tel.: +31-503633846; fax: +31-503632032.

E-mail address: h.b.m.molleman@bdk.rug.nl (E. Molleman).

0925-5273/02/$ - see front matter
PII: S0925-5273(01)00139-6

mix changes on the performance of a cellular manufacturing system (e.g., [22,23]) and conclude that these changes may necessitate the redesign of a CM system. Others indicate the inferior ability of a CM system to cope with volume and mix changes (e.g., [24,25]). Marsh et al. [26], however, found in an empirical study that major changes in the design of a cell, such as its termination, are relatively infrequent because management has several alternative, less radical and less expensive interventions to cope with declining cell performance. These actions to cope with altering circumstances include, for instance, working overtime, cross-training, set-up time reduction, alternative routings, outsourcing, anticipating inventory, adding workers and allowing intercell movements. March et al. [26] report that 26% of the 185 cells they studied in 15 metal machining firms were dismantled in the average six-year existence of the CM system. Their study is focused on individual cells and does not deal with the impact of cell changes on the entire CM system.

The study presented in this paper concerns a longitudinal case study covering 13 years of experience with a CM system. Our main objective is to gain insight to the reasons why parts of the CM system were redesigned in the course of this time span. Furthermore, we focus on the impact of redesign decisions on the entire CM system. More specifically, we discuss three factors which may drive a redesign of the CM system: (i) the market, (ii) manufacturing technology, and (iii) managerial choices. The market determines the demand for products of each cell and is therefore an important factor affecting the need for a cell's resources. New manufacturing technology is another factor that may provide an argument for redesign. A new and advanced technical system may be able to, for example, do more work, manage a larger variety of processes, cross the boundaries of cells or even make cells redundant. Finally, the functioning of a CM system is the continuous concern of management, and management policy may be an important determinant in the redesign of a CM system. These three factors are interrelated. Major elements of management strategy concern choices with respect to markets and technology investment. On the other hand, changes in markets and technological development may shape and mold strategy and force management to intervene to preserve or enhance performance.

Interventions to improve performance may or may not involve the redesign of cells. Besides coping strategies that concern design issues, management may opt for interventions that focus on altering processes or environmental conditions which may improve cell performance. Although we suppose that management will have decision latitude, the organizational and physical environment of a CM system will direct the choices made by management. In this longitudinal case study we follow the gradual change of a CM system and address all the major actions taken by management to keep or improve the performance of the system. Our main interest is the stability of the CM structure and, therefore, our primary concern is changes to the design of the CM system. However, to gain a full understanding of the modifications and developments, we will also highlight non-design interventions.

Section 2 of this paper gives an introduction to the firm in which we conducted our longitudinal study of the evolution of a CM system. Section 3 presents the major changes that took place in the cell design during the period 1987–2000. Section 4 relates these modifications to the factors presented above. In the final section, we discuss the impact of our findings in a more general way. In this section we also provide suggestions for further research.

2. The firm

Holec Algemene Toelevering (HAT; in English: Holec General Supplies) is an independent business unit of Holec Systems and Components (HSC). HSC produces systems for the distribution, protection and conversion of electricity. The founding of HAT was the result of a reorganization that took place in 1987 within HSC. The reorganization led to the establishment of five independent business units: Low Voltage, Medium Voltage, High Voltage, Industrial Systems and General Supplies. General Supplies delivers parts, tools and services to the other business units, which are responsible for end products and deal