Journal of Operations Management 19 (2001) 307–333

JOURNAL OF OPERATIONS MANAGEMENT

www.elsevier.com/locate/dsw

An evaluation of the relationship between management practices and computer aided design technology

Manoj K. Malhotra [a,*], Michelle L. Heine [b,1], Varun Grover [a,2]

[a] *Department of Management Science, Darla Moore School of Business, University of South Carolina, Columbia, SC 29208, USA*

[b] *Department of Management, College of Business Administration, Bowling Green State University, Toledo, OH 43403, USA*

Received 20 July 1999; accepted 23 August 2000

Abstract

Technology has been the engine of growth for the United States economy over the last decade, and it is reasonable to expect that appropriate selection and management of technology within the firm would continue to be highly critical to its success well into the future. Operations managers constantly struggle to seek answers to the right set of managerial actions that can be used to leverage technology for process effectiveness. This study takes a step in that direction by empirically examining the management of computer aided design (CAD) technology and outcomes of the product design process within manufacturing firms. In particular, the level of functionality and sophistication of the CAD system are examined with respect to the use of several structural and infrastructural management levers such as the degree of a firm's formalization and decentralization, the extent of the use of teams, the extent of training of CAD designers, and the equity of the incentives within the product design process. The influence of these management levers upon the CAD system performance is analyzed through the use of moderated regression analysis conducted on a cross-sectional data of 143 firms representing the vehicular industry in the USA. Our findings indicate that CAD functionality and sophistication are positively related to product design quality, flexibility, and overall performance. The impact of management levers on this relationship is a mixed one. Decentralization has no impact on the CAD technology–performance relationship, formalization has some positive effects, and the use of teams is helpful only in moderating the influence of sophistication on overall performance. Equity of incentives enhances design quality, while training is very important in improving performance across the board. In general, sophisticated "state of the art" CAD systems require much more proactive management than highly functional ones. Recommendations emerging from this study hopefully provide insights into a better management of not only CAD systems, but other process level technologies as well that are relevant to firms in the manufacturing sector. We also discuss implications of technology management provided by this research for creating leading edge enterprises.

Keywords: Computer Aided Design (CAD); Technology management; Management levers; Interdisciplinary

1. Introduction

In order to compete well in world markets, organizations have been forced to reengineer, empower employees, get lean, and become increasingly flexible while maintaining low prices. The paradigm for competing is no longer the simple dichotomy of low price-high volume or high price-customized products.

* Corresponding author Tel.: +1-803-777-2712; fax: +1-803-777-6876.

E-mail addresses: malhotra@darla.badm.sc.edu (M.K. Malhotra), mlheine@cba.bgsu.edu (M.L. Heine), vgrover@darla.badm.sc.edu (V. Grover).

[1] Tel.: +1-419-372-9512.

[2] Tel.: +1-803-777-5923; fax: +1-803-777-6876.

0272-6963/01/$ – see front matter

PII: S0272-6963(00)00063-2

Customers demand high quality products that are delivered on time in small lots with the capability for frequent engineering changes on short notice. Yet, the intense competition in a worldwide marketplace simultaneously mandates low prices. One way to achieve so many different objectives, which at times conflict with one another, may be to effectively use technological advances. Thus learning to manage technology has become an extremely important issue for both practitioners and academics alike as we move into the next millenium. This study is focussed on examining these issues within the context of computer aided design (CAD) technology, and its effective deployment within manufacturing firms in the US.

In general, firms have been looking for ways to get the most out of their current technology and thereby sustain their competitive advantage. Many manufacturing related technologies such as CAD, computer aided manufacturing (CAM), flexible manufacturing systems (FMS), and computer integrated manufacturing (CIM) have been acquired and implemented. Unfortunately, with reports of insignificant flexibility or productivity gained through their adoption and implementation (O'Leary-Kelly and Vokurka, 1998; Grant et al., 1991; Meredith and Hill, 1987; Jaikumar, 1986), the benefits of these technologies have not been commensurable with their large investments. Since it has been discovered that installing new technologies in USA has not always insured improved performance, better management practices that can leverage investments in technology and provide a competitive advantage need to be examined.

It has been shown that in many cases the application of new technologies to replace existing manual or mechanical systems yield meager performance improvements (Benjamin and Levinson, 1993; Schnitt, 1993; Jaikumar, 1986). The design of jobs, social structure, and organizational infrastructure often need to be changed significantly to fully exploit the capabilities of the new technology (Shani et al., 1992; Grant et al., 1991; Hayes and Jaikumar, 1988). Yet, research shows that these infrastructural and social changes are often overlooked (MacDuffie and Fisher, 1996; Maffei and Meredith, 1995; Meredith, 1987).

Management within manufacturing firms has begun to recognize this balance within the firm. The work force or human issues have been shown to be important, and have significant impact on strategic success (Boyer et al., 1997; Malhotra et al., 1996; Kelley, 1994; Hayes and Jaikumar, 1988; De Meyer and Ferdows, 1987; Fine and Hax, 1985). In two recent studies, the organization structure and use of human resources in manufacturing firms were found to be stronger contributors to flexibility than the technology itself (Upton, 1995; Zammuto and O'Connor, 1992). Firms are thus reorganizing to become decentralized, democratic organizations, where versatility and continuous change are the goals (Pasmore, 1995; Kelley, 1994; Ferdows and Skinner, 1986). If a firm can address all organizational elements and keep them in balance, it will potentially develop a distinctive competence that can set it apart from its competition.

This study has been motivated by two major limitations in prior work. First, although several models testing the impact of management levers on performance have been presented in the management literature, few of these technology models examine the impact of individual management levers upon the performance of the technology. Often, the researchers examine clusters of policies that commonly are found together, using constructs such as 'control' versus 'commitment' human resource systems (Arthur, 1994), 'progressive' human resource management (Delaney and Huselid, 1996), worker empowerment (Boyer et al., 1997), 'human capital enhancing systems' (Youndt et al., 1996), 'lean production policies' (MacDuffie and Fisher, 1996), and 'management committees' (Kelley, 1994) on technology performance. These levers are unique combinations of variables that fit the specific situation addressed by the researcher. This combination of variables, while providing a concept that is understandable and aesthetically appealing, does not provide an understanding of the individual impact of each variable. This limits the generalizability of the findings.

The second motivating factor for this study is that in general there has been a lack of research in manufacturing at the process level. Technology research has generally focused at the individual operator level (Swamidass and Kotha, 1998; Robertson and Allen, 1993; Collins and King, 1988), or at the organizational level with plant-based or strategic business unit (SBU) level-based performance measures (Boyer et al., 1997; Miller and Roth, 1994). The technology–process level is positioned in between the individual and organizational level. Technological systems often overlap