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Advanced manufacturing technologies and strategically flexible production

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Abstract

This paper deals with the role of advanced manufacturing technologies (AMT) within the context of changes in the basic principles to organize and manage manufacturing systems. In particular, the use and effectiveness of various technologies and their computer-based integration are investigated in the light of three emerging principles: (i) strategic multi-focusedness, (ii) process integration across functions, and (iii) process ownership. Together, these principles are referred to as Strategically Flexible Production (SFP). In an international sample of 392 manufacturing units from the metal-working industry, the use of AMT is analyzed in three groups: core adopters, partial adopters or non-adopters of SFP. Data show that while core adopters do not use stand-alone AMT more than the other groups, they have a higher level of computer integration (CI), in particular in their forefront departments. However, the use of integrating technologies varies much within the core adopters, suggesting that SFP does not necessarily require massive information technology (IT) support. This is further confirmed by the analysis of performance improvements. The mere adoption of stand-alone AMT per se does not provide companies with superior improvements in performance. On the contrary, SFP alone or combined with a higher level of integration of stand-alone AMT fosters increased time responsiveness.

Keywords: Computer integrated manufacturing; Operations strategy; Empirical research; Job design; Process design

1. Introduction

During the 1980s, Western manufacturers were attracted by the potential of computer technology to increase productivity through the improvement of quality and the reduction of costs and lead times. However, most investments aimed at exploiting the benefits of Computer Integrated Manufacturing (CIM) led to only partial results, and were often abandoned or scaled down. At the same time, a number of *soft* organizational and managerial approaches and improvement programs, mostly derived from Japan, began to spread in response to the dramatic changes in the competitive environment that seemed to require new rationales to organize and manage production systems. However, the compatibility and coherence between changing organizational paradigms and CIM approaches were not extensively explored nor understood. This paper aims to investigate the interactions between the implementation and integration of Advanced Manufacturing Technologies (AMT) and the adoption of new managerial and organizational principles.

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The study is organized as follows. Section 2 presents research background, including the decline of CIM, the shift in the rationales of production management, and the need to rethink the use of AMT; Section 3 details research hypotheses; Section 4 illustrates the methodology and the sample; and Section 5 reports the data analyses and discusses the major findings. Finally, Section 6 summarizes and considers future research.

2. Research background

2.1. The rise and fall of CIM

The introduction into manufacturing of computers as a source of competitive advantage has received scholarly attention for quite some time now. Early interest focused on the cost advantages of AMT — see e.g., Gerwin (1982), Zuboff (1982), Rosenthal (1984) — including various hardware-based and software-based approaches ranging from numerical control machine tools (NC) to machining centers, flexible manufacturing cells and systems (FMC/FMS), computer-aided design (CAD), computer-aided manufacturing (CAM), computer-aided process planning (CAPP), automated storage and retrieval systems (AS/RS), material resources planning (MRP II) and others. Once stand-alone AMT could be integrated into unified systems, the concept of CIM arose and was credited with the potential to provide not only improvements in efficiency, but also greater operational flexibility, higher quality products, a shorter time-to-market, and a faster response to changing customer needs (see e.g., Nemetz and Fry, 1988; Somers and Gupta, 1991).

The quest for such benefits caused CIM to evolve in order to integrate new applications and enlarge the set of business processes involved. Its turbulent growth in the 1980s and the perspective of a company-wide integrated information system also contributed to the creation of the myth of the so-called *unmanned factory*. In the early 1990s, however, this myth started to decline, as CIM had not kept its promises. Many CIM projects yielded only partial results (Jaikumar, 1986; Babbar and Rai, 1990), while others were given up completely, at times because of the difficulties in paying back the huge investments that were often required (Kaplan, 1986). Initially, two reasons were given to explain these failures. First, it was argued that, due to their poor understanding of the strategic potential of information technology (IT), most companies missed the opportunity to shift strategy from mere cost-leadership to differentiation based on quality, flexibility and service (Scott Morton, 1991). Second, the poor implementation of CIM projects, particularly in managing cultural and organizational change, was cited as a major cause of failure (Hirschhorn, 1984; Beatty and Gordon, 1988). In particular, firms often failed to understand that the implementation of CIM considerably alters organizational structure, even to the extent of changing reporting channels and responsibilities (Meredith, 1987).

These arguments basically refer to the poor understanding and use of CIM approach, which was, however, still considered to be effective. In addition, inherent and structural shortcomings of CIM were also identified. Duimering et al. (1993) observed that CIM may simply automate bad practice and institutionalize poor business processes, and thus suggested that the redesign of organizational structures and coordinating mechanisms should precede the implementation of technology. Gunn (1987) remarked on the lack of coherence between CIM projects and other approaches to manufacturing innovation that were becoming popular in industry, e.g., Just-in-Time, Total Quality Management, Concurrent Engineering, and Business Process Re-engineering (BPR). In general, it has been recognized that the concept of CIM as a multi-layer and hierarchical model to integrate AMT is inconsistent with the new rationales for production systems (Boer et al., 1990; Spina and Verganti, 1993).

2.2. Changes towards Strategically Flexible Production (SFP)

In response to environmental changes, there have been dramatic changes over the last two decades in the basic ideas of production system design, organization and performance indicators. Evident examples are the current emphasis on empowerment, learning organizations and local autonomy (rather than the mere automation of narrow tasks and the use of information systems to enforce hierarchical control);