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The content and process of automation strategies

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Abstract

If automation is to support the competitiveness for a manufacturing company, strategic as well as operational issues need consideration. To best support competitiveness, decisions concerning automation should be treated as one of several decisions in a manufacturing strategy. Furthermore, to fully utilize the advantages from automation, the manufacturing strategy content and process needs refinement. In this paper, improvement of the manufacturing strategy theory is suggested, mainly based on employment of human factors engineering.

Keywords: Semi-automated manufacturing systems; Automation strategies; Manufacturing strategy; Content and process; Human factors engineering

1. Introduction

Considering the increasing global competition and the threats of e.g. outsourcing and off-shoring to low-cost countries, competitive manufacturing capability is a critical and urgent matter for manufacturing companies. Automated manufacturing systems are often regarded as highly efficient, potentially improving the competitiveness of manufacturing companies. In the manufacturing domain abundant literature addresses the concept of automation (e.g. Chang et al., 2005; Mehrabi et al., 2000; Yu et al., 2003). The literature deals with different types of technical solutions, such as advanced manufacturing technology (AMT), and different ways of implementing automation. In the area of AMT, focus is on manufacturing process technologies that include for example computerized storage of information (Dean et al., 1992) or completely automated manufacturing solutions such as the SMART-cells (Fujimori, 1990; Makino and Yamafuji, 1988). The major problem with the technology oriented literature is that it focuses on the specific applications and the potential improvements but, unfortunately, fails to explain how to select technological investments that support a business (Hill, 2000).

Many studies indicate that most automation decisions emanate from the top, and often the outcome is not what was expected when making the investment. When top management initiates automation, often with the aim to reduce manufacturing cost, the decision on automation tends to be the only concern, i.e. automation is the manufacturing strategy (Winroth et al., 2007). If the decision is pushed on the organization, without linkage to the

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manufacturing capabilities, such investments may become real failures. An automation decision formulated together, and in congruence, with the other decisions in a manufacturing strategy, i.e. automation strategy as part of the manufacturing strategy, has shown to be more successful (Boyer et al., 1996; Winroth et al., 2007). Within the manufacturing strategy domain, decisions concerning automation, as well as other decisions affecting manufacturing resources and providing competitive advantages through support of the overall strategic initiative of the firm, have been described (Maruchek et al., 1990). Level of technology is one of several decisions constituting the manufacturing strategy content (e.g. Skinner, 1969; Hill, 2000). Here, however, the question is automation or not, and the appropriateness of different levels of automation in different situations is not treated. This view of automation is also noticed by Sheridan (2002) as the "all-or-none fallacy", especially common among the non-technical public.

When planning and implementing automated manufacturing systems, there are numerous issues to consider. In contrast to the process industries, systems in the manufacturing industry are rarely fully automated. A common solution is to integrate manual and automated operations into semi-automated manufacturing systems. Automation can involve automation of activities both at facilities level and on support systems level (Groover, 2001), i.e. physical issues as well as decision and control tasks can be automated (Frohm, et al., 2005). In order to fully utilize the capabilities of both humans and machines in a semi-automated manufacturing system, the interaction between them needs to be well conceived. Such interaction has traditionally been described in human factors engineering in the terms of function allocation, implying a system design process where functions are allocated to humans or to machines, respectively. The resulting function allocation may be described as the level of automation, ranging from entirely manual operations to full automation (Sheridan, 2002). Function allocation between human systems and technical systems is a far from trivial issue, and has been treated within areas where risks are extremely high, such as in aerospace and process industries (e.g. Sheridan, 2002; Inagaki, 2003). The applications of function allocation within the manufacturing industry are so far limited, although some initiatives have been undertaken (e.g. Fallon, 2001; Granell et al., 2006).

Automation decisions need to be made as a part of the other manufacturing strategy decisions. Existing models about the content and process of manufacturing strategy, emanating mainly from Skinner (1969) and Hayes and Wheelwright (1984), deal with automation very briefly as a question that is included in the process technology decision.

The view on automation on a strategic level tends to be an "all-or-none" decision. To fully utilize the possible advantages of automation as supportive for manufacturing competitiveness, the strategic decisions concerning automation need to be linked to the operational issues of task allocation between human systems and technical systems, a problem addressed within the human factors engineering domain. This paper elaborates on the possibilities of refinement of manufacturing strategy content and process with support from the human factors engineering domain in order to improve the support from automation on manufacturing competitiveness.

2. Methods and materials

Research presented in this paper was carried out as part of an ongoing Swedish research project, DYNAMO[1]—Dynamic Levels of Automation. DYNAMO is a 3-year project that ended in 2006. The DYNAMO project aims at dynamic levels of automation, i.e. a possibility to vary the level of automation according to the specific situation and the thereby associated requirements. DYNAMO is to provide industry with design, measurement, visualization, and management tools for dynamic levels of automation in manufacturing. Dynamic levels of automation are useful during multiple phases of the product realization process and are expected to increase manufacturing system's overall robustness. This paper focuses on aspects mainly related to the management of dynamic levels of automation on a strategic level, i.e. formulation and use of automation strategies within the area of industrial manufacturing. The results presented in this paper are based on both theoretical and empirical material.

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