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Aligning manufacturing strategy and levels of automation: A case study

Veronica Lindström [a,*], Mats Winroth [b]

[a] Department of Management and Engineering, Production Economics, Linkoping University, SE-581 83 Linkoping, Sweden
[b] Department of Technology Management and Economics, Chalmers University, Göteborg, Sweden

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ABSTRACT

Research has shown that alignment between manufacturing strategy and decisions regarding automation are often of an ad hoc nature, i.e. the support for automation decisions is poor. Support tools to find an appropriate level of automation are thus needed in order to achieve more efficient and robust production systems. The methodology presented in this paper contains five sub-processes where the chosen level of automation is aligned with the manufacturing strategy. Together they form an automation strategy, which secures a desired direction of the firm and also supports robustness and reliability of the manufacturing system due to the holistic approach chosen.

1. Introduction and background

Research has shown the importance of integrating humans and technology in manufacturing automation, thus supporting sustainable and robust manufacturing systems. Evidence from U.S. companies indicate the importance of including human aspects when implementing advanced manufacturing technology (Chung, 1996). A balanced and holistic approach to automation makes it easier to find an appropriate level of automation for best system performance (Martin et al., 1991). The relationship between humans and technology can be viewed as a continuum from fully manual to fully automatic by approaching the sharing of tasks between the human and technology (Frohm, 2008). This concept is called levels of automation (LoA). This is a concept which refers both to mechanized and cognitive tasks allocated between the human and technical equipment and ranges from 1 to 7 on a reference scale (Granell et al., 2007; Frohm, 2008).

* Corresponding author.
E-mail address: veronica.lindstrom@liu.se (V. Lindström).

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Empirical findings indicate correlation between a high extent of automation and increased extent of complexity and flexibility of social factors (Lin and Chen, 2000). However, there is a difference between the content and process of manufacturing strategy according to traditional manufacturing strategy framework (Anderson et al., 1989; Leong et al., 1990). Studying manufacturing strategy process show that decisions regarding automation tend to be rather of an ad hoc nature than planned activity (Winroth et al., 2007a), i.e. the level of automation is decided from product to product depending on volume (Granell, 2007) and there are no support systems guiding decisions. Thus, there is a need for developing tools which support alignment of both strategy and operational levels for reconfiguration of automation levels (Lindström, 2008).

Within the manufacturing strategy literature, decisions regarding automation and more specifically, levels of automation have traditionally been viewed as a structural decision category within the manufacturing strategy literature. On the other hand, decisions regarding human resources are considered as an infrastructural decision within the traditional manufacturing strategy formulation (Hill, 2000; Slack and Lewis, 2002; Miltenburg, 2005). The decision category for automation is named "process technology" and refers to equipment for production (Hill, 2000; Slack and Lewis, 2002; Miltenburg, 2005). This view is however technical as it does not take into consideration the integration of humans and technology and fails to explain the selection of appropriate technological investments that support a business (Hill, 2000). However, in Slack and Lewis (2008), automation is viewed as one dimension of process technology which consists of a mix of process technology and humans and stretches between high acuity and judgement and low acuity and judgement.

Thus, an alternative and newer approach in viewing automation is the task sharing approach (Satchell, 1998), which considers that a specific task is shared between both the human and technology. A survey conducted in Sweden during 2005 among production experts showed that 53 of the 62 respondents believed that policies regarding choice of manufacturing processes should be considered to a very high or high degree when formulating manufacturing strategies (Granell et al., 2006). Policies are here understood as modification of the manufacturing system. Moreover, the need for regular review of manufacturing strategies has been emphasized by Hayes and Wheelwright (1984) as well as by Platts and Gregory (1990), who state:

> "Manufacturing strategies must not only be consciously developed but they must also be subject to regular review; otherwise there exists the danger that the elements of the strategy fail to develop, as the business develops, leading to both internal and external inconsistencies often with serious manufacturing implications" (Platts and Gregory, 1990, p. 5).

To review and guide the manufacturing strategy formulation process, Platts and Gregory (1990) suggest several audits and an audit process to formulate manufacturing strategy. This audit process identifies manufacturing objectives, measures current manufacturing performance, determines the effects of current manufacturing practices, and identifies where changes are required (Platts and Gregory, 1990). The current manufacturing performance identifies existing practices from a traditional approach with viewing processes as technical entities and human resources as human processes. Hence, the integration of humans and technology is not considered in the work of Platts and Gregory (1990) and therefore there is a need to deepen and to embed human centred approaches to automation in manufacturing strategy. Also in the implementation of advanced manufacturing technology other aspects are important such as organizational culture and systematic practices (Lewis and Boyer, 2002).

Research on levels of automation presented in this paper has been done in an exploratory form, developing a methodology for measuring levels of automation (Granell et al., 2007) and a methodology for analysing and choosing levels of automation (Lindström, 2008). The purpose with the methodology for formulation of automation strategy is to choose an appropriate level of automation which is aligned with the manufacturing strategy of the firm where the measurement takes place. Further, research has shown that alignment between manufacturing strategy and decisions regarding automation are often of an ad hoc nature, i.e. the support for making automation decisions is poor. In summary, there is clearly a need for developing support tools to find an appropriate level of automation for more efficient and robust production systems. The aim of this paper is to present a