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Manufacturing strategy analysis and manufacturing information system design: Process and application

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Abstract

This paper specifies the structure of a manufacturing strategy analysis (MSA) to manufacturing system design (MSD) interfacing model. In particular, it addresses the link between manufacturing strategic initiatives and the requirements of manufacturing information system (MIS), and proposes a structured approach to help a company identify the key MIS requirements that are needed to effectively support the company's future manufacturing strategic aims. The proposed method has been successfully applied in a precision engineering company, resulting in an integrated MIS that was given *The UK Machinery Award for Innovation in Production Engineering*, for being "the most innovative application of computer technology in the manufacturing environment". © 2000 Elsevier Science B.V. All rights reserved.

Keywords: Manufacturing strategy; Manufacturing system; Manufacturing information system

1. Introduction

A unified framework has been proposed that aims to set systems thinking into the context of manufacturing systems management [1]. *Manufacturing systems management* (MSM) here is defined as a functional domain that involves all of the activities, such as design, implementation, operations and monitoring, etc., that are needed to regulate and optimise a manufacturing system as it progresses through its life cycle. Following the key principles of systems theory, this framework provides a unified framework which identifies the main MSM functional areas, specifies their generic functionality and contents, and then logically integrates

them into a closed loop to provide the basis for effective systems management. This paper focuses on the manufacturing strategy analysis (MSA) and manufacturing system design (MSD) interfacing function within this framework at the information and control level. It will first provide a brief overview of the structure of this MSM framework. Then, following a description of the structure, processes and tools specified along its MSA/MSD cycle, various new features regarding the specification of information system requirements will be discussed.

Various approaches have been developed to enable companies to identify manufacturing strategic direction, with the aim of satisfying corporate objectives. The implementation of a manufacturing information system (MIS) within a manufacturing organisation often forms part of the strategic approach to satisfying these objectives. This paper

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first introduces the concept of manufacturing strategically driven analysis of MIS system requirements. It is pointed out that in order for a MIS to be able to satisfy manufacturing strategic needs, a structured approach needs to be followed which provides the system's development with a strategic direction. A framework with a set of procedures is specified for such purposes, starting from the initial identification of objectives, through to the "develop-or-buy" decisions, and system design and implementation.

The paper also describes how the proposed approach has been effectively applied to the case of a typical modern precision engineering company, which heavily utilises computer numerically controlled (CNC) facilities and specialises in the making of aerospace and telecommunication components. Through an analysis of the company's manufacturing strategic requirements, the proposed procedures revealed a number of MIS related issues and features that helped to ensure a competitive edge.

2. Overview of the MSM framework

In order to deal with the complexity involved in the design and operation of modern manufacturing systems, attempts have been made to adopt a more systems approach to the problems concerned. For example, Wu [2] suggested an overall framework of manufacturing systems design and evaluation, with particular emphasis on systems analysis, systems design, and systems methodology. It consists of the following keywords that relate to the main areas of concern: *systems* (concepts and principles), *manufacturing* (structures, technologies and operations), *systems engineering* (problem-solving and structured decision-making) and *manufacturing systems* (design and evaluation). Of particular interest from the above is a prototype system model that is based on a range of key concepts of systems thinking, and a set of conditions necessary for the effective operation and control of manufacturing organisations. If one relates these well-proved systems principles to the area of MSM, it becomes apparent that certain key elements are lacking in the current theory and practice. In order to fill in the gaps, a conceptual MSM framework has been proposed that logically link a number of new and

previously established techniques together. Its overall structure closely follows that of the prototype system model to satisfy the prerequisite conditions for the effective control and operation of a system. This conceptual MSM framework specifies the key functional areas of MSM, outlines the contents and relationships within them, and then logically integrates these into a closed-loop to provide the basis for the development of a set of consistent parameters and procedures. It consists of three main functional areas: manufacturing strategy analysis (MSA), manufacturing system design (MSD) and manufacturing operations management (MOM), as shown in Fig. 1.

Generally speaking, the nature of MSA approaches can be summarised as a method of helping a company analyse its products, market and operations to identify areas of concern, and then setting objectives for these to be improved. However, the implementation of strategic initiatives will rely on the management of change through MSD projects. The general aim of a MSD project can therefore be defined as the determination of the best structure of a manufacturing system in order to provide the competence needed to support strategic objectives, and this must be achieved within the resource and other constraints. In addition, the complete MSM cycle should also include the aspects of manufacturing to plan, monitor and control the production processes once the system is implemented and in operation. Finally, the overlapping between these main areas identifies three additional MSM functions: MSA/MSD interfacing, manufacturing system implementation and manufacturing system status monitoring. The proposed framework reflects the view that a systems approach should be adapted to the design, implementation and management of manufacturing systems. A systems thinking in the management of manufacturing requires the development of a set of coherent strategic objectives and goals. A hierarchy of compatible system structures should then support this hierarchy of objectives.

As can be seen, three principal manufacturing architectures have been specified through MSD activities within this framework [3]:

- The *physical (or manufacturing) architecture* represents the 'hard' elements of the manufacturing

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