MANAGING THE FLEXIBILITY OF
FLEXIBLE MANUFACTURING SYSTEMS FOR COMPETITIVE EDGE

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ABSTRACT

Flexible Manufacturing Systems (FMS) are believed to be a major means for improving both production flexibility and productivity. If well managed, FMS can be a formidable competitive weapon for manufacturing firms. However, there exists confusion concerning how to define the concept of flexibility. One result is the misconception that flexibility may cause the decline of productivity. This paper reviews the existing studies on flexibility and presents a "flexibility map" which clarifies the relationship between various flexibility concepts and measures. This map also provides a foundation for exploring the issue of how flexibility can contribute to the firm's competitiveness. We further point out the importance of a Total System Flexibility (TSF) concept which considers two important flexibility factors: quickness of response to a change and economic response to the change. A numerical example of routing flexibility is used to demonstrate how flexibility can enhance the competitive or strategic value of FMS. Indeed, total system flexibility can increase rather than reduce productivity, and therefore enhance the firm's competitiveness.
1. INTRODUCTION

The United States has encountered formidable competitive challenges in the international trade arena in recent years. Some researchers see the loss of manufacturing as a natural consequence of the economic evolution around the world and claim that we should pay attention to services and deemphasize manufacturing. However, other researchers feel that the loss of manufacturing capability will severely reduce the standard of living of the United States, and will impair the ability to conceive and develop new products and technologies (Bitran et al. 1988).

Furthermore, customers' requirements have become more diversified and product life cycles have become much shorter. The focus of international competition has changed from cost to quality, reliability, and the ability to respond quickly and accurately to customer needs. The latter is what is called flexibility.

The flexible manufacturing system (FMS), which is an important class of automated manufacturing, was developed in the early 1970's to provide manufacturing firms with the ability to cope with dynamic demand patterns and the capability to achieve cost savings, quality improvements, and productivity gains. A U.S. Department of Commerce (1987) study estimates that as of 1981, there were 4500 Computer Aided Design (CAD) installations in the U.S. The number of CAD installations is expected to reach an astonishing level of 190,000 installations by 1995, a forty-fold increase in just 14 years. This study also estimated that the world market for industrial automation, including CAD, Computer Aided Manufacturing (CAM), Computer Aided Engineering (CAE), Computer Integrated Manufacturing (CIM), and computer based systems for production planning and control, which was about 15 billion dollars in 1983, is expected to grow to a level of 65 to 70 billion dollars by 1989 (see also Economic Commission for Europe 1986). All these massive investments are linked in one way or another to the attempt to enhance manufacturing flexibility (Swamidass 1988). No doubt, flexibility has become an important competitive weapon. More and more FMS's are expected to be installed in years to come.

Flexibility is the raison d'etre of the flexible manufacturing