Chapter XXIII
Modeling and Analysis for Production Performance:
Analysis of U.S. Manufacturing Companies

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ABSTRACT

Modeling is a great approach to analyze long-term consequences of policy options in manufacturing. In this chapter two modeling approaches are discussed for understanding the intertwined relationships among factors which influence the performance and competitiveness of manufacturing: the system dynamics approach and the quantitative survey approach. The system dynamics approach is used to develop a conceptual model of the strategic issues that influence the performance and competitiveness of manufacturing, and the results of a quantitative survey are used to understand the actual extent of the influences of various factors in the current situation.

INTRODUCTION

The world of manufacturing has changed dramatically over the last decade. Increasing competitive pressures are being experienced in both domestic and international manufacturing markets; rapid advancement of information technology has opened the door to global markets. Indeed, one of the most important changes affecting manufacturing is the globalisation of business, which has affected the nature and rules of competition for nations as well as for firms. The competitiveness of a country is being linked to the performance of its firms in global competition (Porter, 1991).

Trading nations in the world economy have become increasingly interdependent. Consequently, integration with world industry and the use of international rather than domestic benchmarks is a fundamental determinant for company success.

Manufacturing companies wanting to compete in global markets must acquire the ability to become globally efficient and nationally responsive. Technological innovation and leadership is a major requirement at the company as well as at the national level. During the last decade, however, the manufacturing industry in many industrialized countries has experienced a sharp decline in productivity and manufacturing competitiveness. This has been exacerbated by a high degree of under utilized capacity, low productivity, high costs, and technological and social obsolescence. The decline in productivity suggests that the economic and work practices of the past may no longer be adequate to sustain living standards or provide employment for a new generation of workers (Love & Gunasekaran, 1997; Petzall, Selvarajah, & Willis, 1996).

The literature suggests that there are a variety of ways by which a manufacturing system can become competitive and several different kinds of solutions to the problem of achieving competitiveness have been proposed. Samson (1991) suggests that the formulation and implementation of a manufacturing strategy that focuses on a strategic manufacturing mission (SMM) and the definition of the relationship between manufacturing and other functions should be undertaken to improve competitiveness. But before the SMM can be developed, it is necessary that an understanding of the factors and relationships that influence the performance and competitiveness of manufacturing be obtained.

This chapter discusses two modeling approaches: the system dynamics approach and the quantitative survey approach. These two approaches are very useful for understanding the intertwined relationships among factors which influence the performance and competitiveness of manufacturing. The system dynamics model is very powerful in conceptualizing the strategic issues, whereas the quantitative survey is useful in understanding the actual extent of the influences of various factors in the current situation.

SYSTEM DYNAMICS MODELING

Essentially, system dynamics is the result of the cross-fertilization between the elements of traditional management, feedback control theory, and computer simulation. Feedback control provides a structure for building a model and a way of selecting the most appropriate information for decision making. Indeed, system dynamics has been principally developed as a methodology for improving the effectiveness of the decision-making process (Graham, Morecroft, Senge, & Sterman, 1992; Morecroft, 1988; Senge, 1990). During the 1950s system dynamics was known as *industrial dynamics*. Forrester (1958) applies this technique to production-inventory problems.

Understanding Causal Relations

To assist the decision maker a technique known as causal loop diagramming is used in system dynamics to show the relationships between various factors. Senge (1990) has undertaken interesting work in the area of causal relations. Senge (1990) has used this concept to show why certain process or patterns develop over time. He theorizes that there are patterns of causal behavior (or archetypes) that can explain why events happen in certain ways. For example, one archetype defined by Senge (1990) is the *vicious circle* as illustrated in Figure 1. This is interpreted as "A implies an increase in B which implies an increase in A which implies an increase in B……" and so on. For instance, population growth rate will increase population, and population will