Chapter 26
Equipment Replacement Decisions Models with the Context of Flexible Manufacturing Cells

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ABSTRACT

The main problem of establishing equipment replacement decisions rules under specific conditions is to find decision variables that minimize total incurred costs over a planning horizon. Basically, the rules differ depending on what type of production type is used. For a batch production organization the suitable criterion is built on the principle of economies of scale. Proposed econometric models in this chapter are focused on a multiple machine replacement problem in flexible manufacturing cells with several machines for parts' processing, and industrial robots for manipulation and transportation of manufactured objects. Firstly, models for a simple case multiple machine replacement problems are presented. Subsequently, the more complicated case is considered where technological improvement is taken into account.

INTRODUCTION

Historically, development of production processes has passed from production structures in automatic rigid flow lines, efficient for mass and wide-range production, to flexible structures, especially efficient in low and medium-range production. Because manufacturing firms has to be flexible towards new market requirements, flexible production forms are increasingly seen as one of the most important manufacturing concepts. Currently, the trend in flexible manufacturing systems is toward small flexible manufacturing structures,

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called flexible manufacturing cells (FMC). In this sense, two or more CNC machines are considered a flexible cell and two or more cells are considered a flexible manufacturing system (Groover, 2001). Flexible manufacturing cell, in general, allows the processing of pieces which are different in terms of shape and dimensions, in a determined range. This creates prerequisites for the accomplishment of variable products, under high yield conditions. Considerable savings are made because the utilizations increases, the processing time is shortened, the handling distances are reduced, intermediate storage expenses decrease, the area required for production is reduced, the process may be systematized, proper conditions for continuous work are created and direct expenses are reduced. However, the real occurrence of failures during the exploitation stage can markedly modify the FMC performances (Corbaa et al, 1997). For this reason, downtime of FMC has to be analyzed and its influence on the processing cost has to be pondered over. In addition, to ensure that manufacturing process is held to be competitive, upgrading or replacing of equipment due to rapid innovations in technology also has to be considered. In this context often encountered issues in production planning are: Should this equipment be replaced? If not now, then when? Usually, written equipment replacement policy, in which units are scheduled for replacement based on age and expected condition, contains answers on such questions. In this chapter we wish to show several econometric models that could inspire managers to develop their own specific tools in building of an effective equipment replacement policy.

THE PROBLEM STATEMENT

Theoretically, any equipment replacement decision would be made based on thorough modeling equipment deterioration and projected remaining life. Practical approaches to equipment replacement decisions are mostly based on subjective appraisal. But it is generally accepted that tools for equipment replacement decision create important element of repair/replacement policy. Such a policy provides guidance to production and economic manager regarding when to replace existing equipment or its part; how to conduct the acquisition process; and what should be done with the equipment being replaced. Then, the main importance of developing of equipment replacement decision models in production planning consist in establishing rules for the replacement of old equipment or its part(s) by new. The main problem of establishing the rules is to find decision variables that minimize total incurred costs over a planning horizon (Dehayem Nodem et al 2009). Basically, the rules differ depending on what type of production type is used. For batch production organizations suitable criteria are built on the principle of economies of scale, where the large fixed costs of production are depreciation-intensive because of huge capital investments made in high-volume operations and are spread over large production batch sizes in an effort to minimize the total unit costs of owning and operating the manufacturing system (Sullivan, 2002). When solving equipment/parts replacement problem within a flexible manufacturing cell, it is necessary to consider the impacts of the replacement decisions on all of the components of the system. Therefore, possible equipment stoppages due to wrong decision results at least in diminishing capacity or stopping the operations in a manufacturing cell. Accordingly, proposed methods are dedicated for a multiple machine replacement problem that is also characterized as a flexible flow shop problem. A parallel flow shop production concept is consisting of a number of production lines. Jobs in such work shop may be composed of a series of works, each requiring several machines (Jianhua and Fujimoto, 2003).

Firstly we will model a simple case multiple machine replacement problem that is characterized for a parallel flexible flow shop environment, in which no technological improvement in equipment is in concern. Then we will consider the more

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