

Chapter 10

Appropriate Evolutionary Algorithm for Scheduling in FMS

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ABSTRACT

The diffusion of flexible manufacturing systems (FMS) has not only invigorated production systems, but has also given considerable impetus to relevant analytical fields like scheduling theory and adaptive controls. Depending on the demand of the job there can be variation in batch size. The change in the jobs depends upon the renewal rate. But this does not involve much change in the FMS setup. This paper obtains an optimal schedule of operations to minimize the total processing time in a modular FMS. The FMS setup considered here consists of four numbers of machines to accomplish the desired machining operations. The scheduling deals with optimizing the cost function in terms of machining time. The powers Evolutionary Algorithms, like genetic algorithm (GA) and simulated annealing (SA), can be beneficially utilized for optimization of scheduling FMS. The present work utilizes these powerful approaches and finds out their appropriateness for planning and scheduling of FMS producing variety of parts in batch mode.

1. INTRODUCTION

With the increasing sophistication of production practices there has been a corresponding increase in the importance and profitability of efficient production scheduling. The global nature of the present manufacturing environment has necessitated an improvement in the way companies

manufacture their products. This increase in demand has been matched by an increase in theoretical findings. The current state of production scheduling is a mixture of approaches from different areas. The intractability of the problem also lends itself to making the developments widely varied. Since the scheduling problem is not amenable to any particular solution, it is treated as NP-hard problem, and it can be treated as a subset of operational research (Buyurgan,

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Saygin, & Kilic, 2004; Moon, Kim, & Gen, 2004; Lee, Kim, & Choi, 2003). Production scheduling concerns the efficient allocation of resources over time for the manufacture of goods. The objective of the present scheduling problem is to find a way to assign and to sequence the activities of these shared resources such that production constraints are satisfied and production costs are minimized. FMS is designed to combine the high efficiency of a transfer line and the flexibility of a job shop to best suit to the batch production of mid-volume and mid-variety products. It may be realized that for an industry it is possible to reach for high flexibility by making innovative technological and organizational efforts. There has been a paradigm shift in manufacturing industries over the years which can be attributed to this idea (Vieira, Herrmann, & Lin, 2003; Lee, Jeong, & Moon, 2002). Flexibility is a property of a system and a system has a definite purpose to carry out. So flexibility is defined with reference to a particular task set (Mandelbaum & Brill, 1989). Manufacturing flexibility may be defined as the ability to cope with changing circumstances or instability caused by the environment (Gupta, 1993; Primrose & Verter, 1996). The intangible parts of flexibility that cannot be quantified in monetary terms are measured by a surrogate value (usually, the scoring method is applied) (Demmel & Askin, 1992; Stam & Kuula, 1991; Son, 1991; Suresh, 1991; Troxler & Blank, 1989; Venk, 1990; Zahir, 1991).

Given the part types and their volume in each batch FMS Scheduling is concerned with the real time operation of the system and the allocation of tools to the machine and allocation of operations to machines and is concerned with the following:

- a. Releasing of part types to the system: Only a subset of the part types constitutes a batch. Releasing rule priorities the part type of the batch leading to their ordered entry to the system.
- b. Assignment of operations of part type to machines: Routing flexibility provides alternate machines for an operation of a part type. Operation assignment rule is used to assign an operation to one amongst the alternate machines available for the purpose.
- c. Dispatching of part types waiting for processing before a machine: At any given point of time several part types wait in the local buffer for their turn to get service in a machine. Dispatching rules are used to prioritize them.

The present work is envisaged to work out the optimal scheduling process for modular FMS setups. The scheduling deals with optimizing the cost function in terms of machining time. The search space includes a number of feasible combinations and out of these; the best fit solution is derived with help of Genetic Algorithm (GA) and Simulated Annealing (SA). In order to accomplish the objective, the methodology is split into the following:

- Detailing the machining processes involved in the manufacture of the parts
- Application of GA and SA for scheduling
- Optimization of scheduling time with alternate assignments within FMS.
- Comparison of results obtained from the scheduling optimization methods and recommending the appropriate one.

2. MODEL FORMULATION

2.1. Description of the Parts

FMS has the capability to process a large number of part types. However, in the present study, the parts to be processed in the selected setups are so chosen that they are almost similar in their functions with differences in their physical and

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