ABSTRACT

Manufacturing industries of today should be flexible to meet the changing market environments. The technological breakthrough in manufacturing evolved with the application of computers and precise control has led to the development of flexible manufacturing systems (FMS), the systems that are capable of achieving both flexibility and productivity. The Operational Management System (OMS) that controls the shop floor activities still requires a great effort to fully exploit the benefits of flexible automation. The primary concerns of the OMS are: production scheduling; material handling system (MHS) scheduling; automated storage/retrival system (AS/RS) operation and control; and tool management. In this context, this thesis concentrates on scheduling problems that arise in flexible manufacturing scene. The concern of this thesis is the design and analysis of algorithms that generate schedules or control programs for the different sub systems (Work Cells 'WCs', MHS and AS/RS) in FMS.

There are different types of FMS and their operation differs with configuration. In this thesis, two systems are modelled. They include:

1. Set-up constrained FMC, the operational mode of which is analogous to conventional twin-table planners/plano-millers (System 1)
2. General job shop type FMS, in which the flow of parts follows pure job shop pattern (System 2).

Various algorithms have been employed to solve the scheduling problems of FMS. Heuristic, evolutionary search (genetic algorithm 'GA') and artificial intelligence (knowledge-based search) techniques are evolving largely for FMS scheduling problems. In this study, a few heuristics (including GA) and knowledge-based schemes are proposed for the models considered.

In this thesis, a GA has been proposed to provide an optimal sequence of jobs visiting FMC model for makespan criterion. The methodology to derive the control program for the operation of hardware components is also addressed. The proposed GA procedure has been validated by comparing it with the results of a few processing time-related priority dispatching rules (pdrs).

Three heuristic algorithms (including GA based heuristic) that employ Giffler and Thompson algorithm in conjunction with pdrs in different manners are proposed for the FMS model and compared. The GA based heuristic, which evolves optimal WCwise-pdr set that
controls the flow of parts, is proven efficient in providing near optimal solutions with reasonable computational time.

However, the computational time grows exponentially with problem size and requires a fast algorithm to handle reschedules. In this concern, irrespective of the size of the problem, two knowledge-based scheduling schemes to provide schedules faster than the GA are developed and experimented.

Further, the problem of automated guided vehicle (AGV) schedule to agree with optimal production schedule is addressed for FMS model. A heuristic algorithm that employs vehicle dispatching rules (vdrs) for conflict resolution is proposed and the performance of few vdrs is analysed with makespan criterion. The proposed heuristic provides the revised production schedule along with AGV schedule.

Besides this, a few heuristic algorithms (including GA) are proposed for the operation and control of AS/RS to improve its performance. The proposed methodologies allocate the materials that need to be stored during production run with minimum movement of the shuttle, and provide control programs that enable to link the operation of AS/RS with production schedule.

The integration of production schedule with AGV schedule and AS/RS control program provides a time-table for the entire operation and control of the FMS (System 2) to effect the smooth flow of parts through the system.