ABSTRACT

To cope up with increasing manufacturing competition in today's global market, many companies are going in for more of Flexible Manufacturing Systems (FMS). The very objective of FMS is to have the manufacturing flexibility, that is, the capability to produce simultaneously, a wide variety of part types from low to mid volume quantities at a low cost through reduced work-in-process inventory, reduced throughput time and increased machine utilization, but with the ultimate aim of an improved quality of finished products. The operational efficiency of the capital intensive FMS largely depends on how well the manufacturing flexibility is maintained. The FMS flexibility depends on not only the flexibility of hardware, e.g., Computer Numerical Control machines, automated material handling devices, but also on the flexibility of software, e.g., scheduling strategies. This research mainly aims at increasing FMS efficiency through FMS scheduling mechanisms.

There are different types of FMS and their operations differ with configuration. Owing to the complexity of FMS scheduling and the need for real-time control, many heuristics have been developed for reducing the complexity and computational burden. In this thesis, a few search heuristics (which are developed based on Genetic Algorithm, Simulated Annealing Algorithm, Tabu Search Method and Scatter Search Algorithm), have been proposed to schedule the FMS with the objective of optimizing two performance measures of FMS viz., (1) Maximizing the system utilization and (2) Minimizing the total penalty cost for tardiness of all the parts produced. All the proposed heuristics are evaluated by testing them on a more generalized FMS model and problem environment modeled in this work, and comparing with the results produced by a few dispatching rules commonly employed in practice. The proposed search heuristics are
further validated by testing them with a few benchmark FMS layouts and standard problems found in the literature.

For the Genetic Algorithm (GA) based search heuristic procedure, a few secondary population implementation schemes are suggested, basically to improve the searching power of the GA mechanism. Feeding of preferred set of solutions stored in the secondary populations, back into the generational population of the GA for subsequent genetic operation, is found to be more effective. Also, to speed up the search process of the GA, two parallelization schemes are also developed in this work.

In the Simulated Annealing Algorithm (SAA) based search heuristic proposed, a dynamic variation in the neighborhood construction mechanism is introduced, which exhibited its superiority over the standard SAA template.

In the proposed Tabu Search (TS) method based search heuristic, the basic TS template is equipped with a few advanced features such as critical event memory and restarting criterion, whose performance is better than the dispatch rules.

In the Scatter Search (SS) based search heuristic developed, advanced design features viz., Reference set rebuilding, Dynamic reference set updation and Tabu memory implementation are incorporated, whose performance is found to be better than the standard SS algorithm.