ABSTRACT

High degree of flexibility and quick response times have become essential features of modern manufacturing systems where customers are demanding for a variety of products with reduced product life cycles. Flexible manufacturing system (FMS) is proved to be the right answer to meet these challenges of global competition.

The performance of an FMS is highly dependent on the selection of the right scheduling policy for the control system. Traditionally scheduling problems consider machines as the only constraining resources but this is no longer correct as material handling equipment is becoming more and more valuable resource in an FMS. Hence its operations should be optimized and above all synchronized with machine operations. Scheduling of an FMS is a well known NP-hard problem which is very complex, due to additional considerations like material handling and alternative routing. Literature reveals that, in many of the cases scheduling of both the machines and material handling system was addressed independently. Hence in this work an attempt has been made to schedule both of them simultaneously.

Evolutionary algorithms have proved themselves as a better alternative for many of the optimization problems like scheduling. In this work, different evolutionary algorithms like genetic algorithms (GA), particle swarm optimization (PSO) and differential evolution (DE) are simulated to generate the sequence of operations. A heuristic is
developed for vehicle assignment, which selects a vehicle for every operation. This is hybridized with the evolutionary algorithms to solve the simultaneous scheduling problems.

New strategies are proposed in case of DE, which have shown promising results. Performance of all the evolutionary algorithms is evaluated by conducting about 4000 simulation experiments, on 82 benchmark problems. Effect of operators, parameters and hybridization, on the performance of evolutionary algorithms is also included in experimentation. It is observed that the hybrid algorithm, PSO-DE outperformed all the algorithms studied and it also yielded better results than those existing in the literature.

The flexibility of an FMS, to perform an operation on any of the alternative machines, which further increases the complexity of its scheduling, was not considered in most of the earlier works, especially on simultaneous scheduling. Hence an attempt has been made in this direction, through this work. Once evolutionary algorithms are proved to be better, these algorithms are applied to solve simultaneous scheduling problem, including alternative machines flexibility and sequence flexibility. Effect of number of alternative machines and vehicles on makespan and also on the utilization of machines and vehicles is studied. A machine selection heuristic is developed which takes care about balancing the load of individual machines while minimizing the makespan and it is integrated with the evolutionary algorithms to address the benchmark problems.