ABSTRACT

Manufacturing industries are under intense pressure from the increasingly competitive global market. Shorter product life cycles, time-to-market and diverse customer needs have challenged manufacturers to improve the efficiency and productivity of their production activities. Manufacturing systems must be able to yield products with low production costs and high quality as quickly as possible in order to deliver the products to customers on time. In addition, the systems should be able to adjust or respond quickly to changes in product design and product demand without major investment. Traditional manufacturing systems, such as job shops and flow lines, are not capable of satisfying such requirements. As indicated above, job shops and flow lines cannot meet today's production requirements where manufacturing systems are often required to be reconfigured to respond to changes in product design and demand. As a result, cellular manufacturing (CM), flexible manufacturing systems (FMS) and group technology (GT) have emerged as promising alternative manufacturing systems.

Nowadays, there is a strong tendency towards the effectiveness of manufacturing system. Proper scheduling of jobs is indispensable for the successful operation of a shop. Mostly, the term ‘scheduling’ in the context of manufacturing systems is used to refer to the determination of the sequence in which the jobs are to be processed over the production stages, followed by the determination of the start-
time and finish-time of processing of jobs, so as to meet the objective or set of objectives. It is also interesting to note that most problems of scheduling require horrendous computational effort for solving them optimally. In fact, it is most unlikely that the problem of scheduling has been termed as ‘NP-hard’ or ‘NP-complete’ problems, implying that the use of heuristic or approximate methods is resorted to solving the large sized problems. This complexity of scheduling problems makes them really challenging in the sense that smarter optimization techniques have to be developed, guaranteeing near-optimal solutions. Many optimization problems from the industrial engineering world, in particular manufacturing systems, are very complex in nature and quite hard to solve by conventional optimization techniques. There has been an increasing interest to apply metaheuristic methods to solve such kind of hard optimization problems.

Many researchers have employed the traditional techniques for solving the scheduling problems for different manufacturing systems. But, it is observed that the traditional techniques are not robust and it yields a local optimal solution. Moreover, it takes much computational time. In this work, a metaheuristic approach is applied for scheduling optimization of various manufacturing systems by considering single and multiple objectives i.e. minimizing the makespan, idle time of the machine, total penalty cost for not meeting the due date, earliness and tardiness penalties and combined objective of minimizing the weighted sum of makespan and total flow time.
In this research work, different non-traditional techniques such as Genetic Algorithm, Simulated Annealing Algorithm, and Ant Colony Optimization Algorithm are implemented for solving scheduling problems of various manufacturing systems. In addition to the above methods, a novel metaheuristic approach called Scatter Search (SS) is used as a common method for solving the scheduling problems of different manufacturing systems. A software framework has been developed to find out optimum schedules for the scheduling problems in various manufacturing systems to meet out the objective(s). The main aim of this research is to explore the potential of Scatter Search for scheduling problems of various manufacturing systems. The inherent weakness of many search procedures is that they often get trapped in a region around some local minima. Their ability to breakout of such entrapments and achieve better, ideally global minima, is based on their capacity to provide a suitable mixture of intensification and diversification. Scatter search also provides unifying principles for joining solutions based on generalized path constructions and by utilizing strategic designs where other approaches resort to randomization. The Scatter Search algorithm is tested on standard problems adopted for various manufacturing systems in the literature and developed problems. The results obtained by scatter search method are compared with other metaheuristic methods used and available in the literature. The effectiveness and efficiency of the scatter search algorithm over other metaheuristic methods are verified by the experimental observations. Among these techniques Scatter Search approach emerged as an efficient tool for the scheduling problems of various manufacturing systems.