Chapter 17
Application of Standard Deviation Method Integrated PSO Approach in Optimization of Manufacturing Process Parameters

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ABSTRACT

Multi-objective optimization is one of the most popular research areas in the world of manufacturing. It concerns the manufacturing optimization problems involving more than one optimization simultaneously, but in this present scenario, it is becoming very tough to solve a manufacturing-related multi-objective problem as no logical method has been developed in assignment of response individual weight. Therefore, to tackle this problem, this chapter proposes a new integrated approach by combining Standard Deviation Method with Particle Swarm Optimization. Two examples of optimizing the advanced manufacturing process parameters are performed to test the proposed approach. The examples considered for this approach are also attempted using other established optimization techniques such as Desirability-based RSM and SDM-GA. The results verify the effectiveness of the proposed approach during multi-objective manufacturing process parameter optimization.

INTRODUCTION

Manufacturing is the process of turning of raw material into finished product. Manufacturing of any product involves various aspects, such as designing of product, economic analysis of product or process and controlling of quality of product during production.

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The designing of product based upon the functional requirement, material available which best suits the application and manufacturing process available for them. Monitoring and controlling of product quality is performed before and during operation to ensure robustness of product to customer. Further, economic analysis of manufacturing process is a very important consideration.

Manufacturing process is the fundamental subject since it is of interest not only to mechanical engineers but also to those forms practically every discipline of engineering. It is so because engineering as a whole meant for providing various material for human consumption. For various products such as plant machineries of civil, mechanical, chemical, textile industries, etc, the manufacturing process forms a vital ingredient (Rao, 2011). However the entire process has been slow and costly, requiring substantial human and material resources. In order to make the process fast, now-a-days many large industries use highly automated and computer-controlled machine which enhances the capital as well as manufacturing cost of the product. Therefore, to obtain the required payback it is necessary to operate these machines as efficiently as possible. For this purpose a number of parameters are needed to be satisfied. The success of the manufacturing process depends on the selection of appropriate process parameters. The selection of optimum process parameters play an important role to ensure quality of product, to reduce the manufacturing cost and to increase productivity in computer controlled manufacturing process.

Modeling and optimization of process parameters of any manufacturing process is generally a difficult job where the following aspects are required: knowledge of manufacturing process, empirical equations to develop realistic constrains, specification of machine capabilities, development of effective optimization criteria, and knowledge of different mathematical and numerical optimization techniques. A human process planner selects proper parameters using his own experiences of from related handbooks. However, because of the many variables, complexity and stochastic nature of the process, achieving the optimal performance, even for a highly skilled operator is rarely possible. Therefore an efficient way to solve this problem is to develop the relationship between the performance of the process and its controllable input parameters by modeling the process through suitable mathematical techniques and optimization using suitable optimization algorithm (Raj, 2012).

Optimization is the method of getting best results subjected to various resources constrains. This can be broadly classified into two categories: Conventional optimization technique and Non-conventional optimization technique. The conventional optimization algorithms are deterministic algorithms with specific rules for moving from one to another solution. The example of these algorithms includes non-linear programming, geometric programming, quadratic programming, dynamic programming etc. But, the optimization problems related to the manufacturing are generally complex in nature and characterized by mixed continuous-discrete variables and discontinuous and non-convex design spaces. Hence, conventional optimization techniques fail to give global optimum solution, as they are usually trapped in the local optima. Also the convergence of these techniques is very slow. In order to overcome these problems, researchers have proposed non-conventional techniques for optimization of process parameters of various manufacturing processes.

In the previous days a lot of investigations have been initiated to obtain the best operating levels of manufacturing systems by using these non-conventional optimization techniques. The optimization techniques typically used by these researchers are: Simulated Annealing, Threshold Acceptance Algorithm, Genetic Algorithm, Particle Swarm Optimization, Bat Algorithm, Ant Colony Algorithm, Artificial Bee Colony Algorithm etc. All these methods mainly based on biological, molecular or neurological phenomenon that imitate the metaphor of biological evaluation or social behavior of species. These algorithms are comparatively new and gaining popularity due to certain properties, which the conven-