CHAPTER 2

LITERATURE SURVEY

2.1 INTRODUCTION

This chapter offers an general idea of the optimization of advanced manufacturing processes attempted by researchers. The literature covers a wide range of models and algorithms developed to optimize the advanced manufacturing processes are also addressed.

2.2 ADVANCED MANUFACTURING PROCESSES OPTIMIZATION

Akhilesh Kumara (2006) discussed about the continuous flow scheduling algorithm in resolving problems in experts systems. This article encloses the psycho-clonal algorithm for better utilization of systems. Alireza Akbarzadeh (2011) describes about the plastic injection moulding using statistical models and Invasive Weed Optimaization (IWO) algorithm. Invasive weed optimization algorithm is a nature motivated optimization procedure which is developed based on the r/k selection theory. This simple algorithm selects the solutions based on the k selection strategy and r selection strategy.

Altan (2010) depicts the injection moulding through the Taguchi method and neural network methods. ANOVA techniques were employed to examine the influences and parameters based on the cooling time on the shrinkage of the High Density Polyethylene (HDPE) material. Anandrao (2013) gives the detailed description about the optimization parameters for
plastic injection moulding for enhanced productivity in reduced time. In this trial on error based approach is used to determine the injection moulding parameters. Polymer is the material used in the moulding with high precision and minimum cycle time and high productivity.

Blanco (2001) has used Genetic Algorithms (GA) have been widely used to optimize the performance criteria. Holland (1975) has first introduced genetic algorithms as a highly robust search algorithm. This may be viewed as evolutionary or population based algorithms.

Chang Yu (2007) has first attempted to propose the behavioural model for flocking of birds. Osman & Potts (1989) have suggested a simple simulated annealing algorithm using a shift neighbourhood and a random neighbourhood search. Osman and Potts have also used simulated annealing with the objective of minimizing the maximum completion of time and have compared the results with constructive heuristics.

Bharti (2011) reviewed the research of the practical use of Taguchi method in the optimization of processing parameters for injection moulding. Taguchi method has been employed with great success in experimental designs for problems with multiple parameters due to its practicality and robustness. However, it is realized that there is no single technique that appears to be superior in solving different kinds of problem. Improvements are to be expected by integrating the practical use of the Taguchi method into other optimization approaches to enhance the efficiency of the optimization process. The review will shed light on the standalone Taguchi method and integration of Taguchi method with various approaches including numerical simulation, Grey Relational Analysis (GRA), Principal Component Analysis (PCA), Artificial Neural Network (ANN), and Genetic Algorithm (GA). All
the features, advantages and connection of the Taguchi-based optimization approaches are discussed.

Changyu Shen et al. (2007) proposed inverse model of manufacturing platform for determining the optimal parameters in injection moulding. Through the integration of inverse model based on MANFIS and Taguchi method, inversely, the optimal manufacturing parameters can be found by using the product requirements. The effectiveness and feasibility of this proposal is confirmed through numerical studies on a real case example.

Chen (2002), have used the Design Of Experiment (DOE) to identify causes of defects associated with plastic injection moulding processes at the early phases of designing processes and operations. A detailed eight-phase methodology is offered through which an identification of defects and effective solutions for their removal could be done. The paper also shows how the parameters of the problem could be established and how DOE could be applied to achieve the stated objectives by using the results of only 18 and 10 DOE test runs. The results of the initial experiments are subjected to a verification procedure to determine their viability and accuracy. As a result of this experiment, the company was able to make the changes needed to reduce the cycle time required to produce products and thus, increase productivity while maintaining high quality standards. In conclusion, an assessment of the results is provided and the necessary conditions and prerequisites for the effective utilization of the methodology are presented. Ogbu & Smith (1990) have proposed a simulated annealing approach to initialization of heuristics. The choice of a large neighbourhood and an acceptance probability function independent of the change in the make span of the schedule resulted in near optimal schedules for the problems tested. In a later work, Ogbu & Smith (1990) have compared this simulated annealing with that of Osman and Potts.
The results show a tie between the two heuristics with a slight advantage on the part of Osman and Potts.

Chen (2009) has developed a genetic algorithm. He stated that application of genetic algorithm for solving non parametric hard problems have revealed their efficiency to obtain good solutions in relatively shortest times. In this case, the offspring generated in each step of the algorithm do not replace their parents but individuals form the generation that have a fitness value below average. The algorithm uses a shift mutation which simply changes the position of one job. Reeves (2009) also choose to seed the initial population with a good sequence among randomly generated ones. This good sequence is obtained with the neighbourhood heuristic. Deng Chyn Shu (2005) has presented two simulated annealing algorithms characterized by having robust performance with respect to the temperature cooling schedule. Their results showed that their algorithms were comparable to the simulated annealing of Osman and Potts. Later, Deng (2010) have used SA with a problem specific knowledge that is given in the form of “Move desirability of jobs”. Zegordi et al. (1995) have demonstrated a hybrid technique by introducing problem domain knowledge into a Simulated Annealing (SA) algorithm. Their algorithm used a “Move desirability for jobs” table which incorporates several rules that facilitate the annealing process. This way, fewer control parameters are needed. Later Kennedy & Eberhart (1995) developed and presented Particle Swarm Optimization (PSO) depicting the behavior of swarms to solve optimization problems.

Farshi (2011) in their paper considered the two stage bicriteria flow shop scheduling with the objective of minimizing the total flow time subject to obtaining the optimal make span using genetic algorithm based approaches. In recent years, the supply chain design problem has been gaining
importance due to increasing competitiveness introduced by the market globalization (Feng Chung 2006). Firms are obliged to maintain high customer service levels while at the same time they are forced to reduce cost and maintain profit margins. Fernandes (2010) have developed a genetic algorithm for flow shop scheduling with multiple objectives (i.e. makespan, flow time and machine idle time). These three measures are considered to be equally important and thus the weighting factors of all of them in the fitness of the chromosomes were set to 1/3. Their procedure used the operation for crossover and neighbourhood crossover. The obtained solutions were excellent in terms of the quality of the solutions.

![Diagram](image)

**Figure 2.1 Various methods used in injection moulding process**

Forouraghi (2002) have presented a simulated annealing for sequence dependent flow shop environment. The simulated algorithm presented by them is used in the present study for permutation flow shop

A supply chain represents a system of services and distribution alternatives, which carries out the purposes of material procurement, converting this materials to transitional and completed goods while distributing the completed goods to customers. Conventionally, manufacturing, marketing, planning, purchase and distribution, concerns alongside the supply chain functions separately. These concerns possess have their peculiar goals and are frequently contradictory. Though, it is required to develop a procedure by way of which this dissimilar utilities can be put together. Supply Chain Management, known as the SCM, is a line of attach in which such combination can be attain (Shapiro 2000). Kennedy & Eberhart (2001) has devised and announced the swarm intelligence. Jayaraman & Pirkul (2001) built up a method of heuristic rooted in Lagrangean relaxation intended the distinct-basis, multi-good, multi-space, Supply Chain Network (SCN) pattern drawback. One more heuristic method routed in lagrangean relaxation as well as simulated annealing was build up Syam(2002) to tackle the situation for a muti-basics, multi-good, multi-position structure. Jang et al. (2002) offered a joint replica of system strategy, production with distribution development for a SCN. Whilst the employed a Lagrangean heuristic ta tackle the design problem for the SCN, a Genetic Algorithm (GA) was put forward to amalgamate production with distribution planning. Wodecki & Bozejko (2002) put forward a SA procedure that follows in a parallel computing situation. The scholars weighted the put forward procedure against the neighbourhood heuristic. The previous reveals superior outcomes. Syarif et al. (2002) built up a straddling tree-rooted GA method with solve problem in a multi-basis, sole-good, multi-phace planning contest rooted on prefer
numbers. Jayaraman and Ross (2003) put forwarded a heuristic method based on simulated annealing to design of distribution system and administration in supply chain situation. As the distribution design drawbacks in supply chains are known to be complicated and needs novel solution methods to tackle them (Hu et al. 2003).

Altiparmak et al. (2006) put forward a novel clarification process rooted in genetic procedures to obtain the group of Pareto-optimal result for manifold-goal Supply Chain Network planning drawback. To treat manifold-goal and permit the choice maker to appraise a superior amount of substitute answers, two dissimilar weight methods are put into practice in the put forward solution method. An investigational research employing real data from an organization that produces plastics goods in Turkey, was conducted in two phases. Although the influences of weight methods on the accomplishment of the put forward solution process are studied in the primary phase, the put forward solution process as well as simulated annealing is weighed against each other consistent with the quality of Pareto-optimal result in the phase. Sensi et al. (2006) found the most advantageous supply chain direction employing discrete event simulation while been tested by means of artificial intelligence. Chan (2007) put forward a choice making method to solve the distribution centre positioning problems for a supply chain arrangement by employing the fuzzy-rooted hierarchical idea. The supply chain is appraised by means of suppliers, customers, as well as distribution centers. The outcomes are weighed against ant colony optimization.

Chan et al. (2007) put forward a manifold ant colony optimization to plan a balanced as well as well-organised supply chain system, which upholds the most excellent equilibrium of transfer customer service. They directed attention to the well-organised allotment of the customers to the Distributed Centers (DC’s) by means of the dual goal of minimizing the
transfer time and level of disequilibrium of the DC’s. The put forward approach revels superior accomplishment bearing in mind both pessimistic and optimistic reaction looking for the most advantageous outcomes. Gunawan (2007) put forwarded the least cut sets technique to upraise the Interconnection network distribution system. Shi et al. (2007) has presented a novel method based on PSO for traveling salesman problem. An uncertain strategy is added in the approach for optimizing the TSP and GTSP (Generalized Traveling Salesman Problem). The nodes are derived based on ranking of random numbers generated. A Mixed Integer Linear Programming (MILP) model has been proposed to describe the optimization problem. A case study for the coatings business unit of a global specialty chemicals manufacturer is used to demonstrate the applicability of the approach in a number of scenarios (Panagiotis Tsiakis et al. 2008).

Huang et al. (2008) have designed a supply chain network in uncertain environment, in which the demands of the customer are taken as random variables and the operation cost involved are programmed using fuzzy neural network and optimized by particle swarm optimization to solve the established model. From the above discussion, it was observed that particle swarm algorithm is successfully applied in various supply chain optimization problems. Jeff Ferrio & John Wassick (2008) have presented a single period network design MILP model for multi-product supply chains. The network is comprised of production plants, an arbitrary number of echelons of distribution centers and customer locations.

Hussin et al. (2012) have proposed a hybrid approach incorporating simulation, Taguchi method, robust multiple non-linear regression analysis and the Psychoclonal algorithm. The Psychoclonal algorithm is an evolutionary algorithm that inherits its traits from Maslow
need hierarchy theory and the Artificial Immune System (AIS). The results obtained using the proposed hybrid approach is compared with those found out by replacing Psychoclonal algorithm with the Artificial Immune System (AIS) and Response Surface Methodology (RSM). Lazaros and Papageorgiou (2009) have presented a critical review of methodologies for enhancing the decision-making for process industry supply chains towards the development of optimal infrastructures and planning. The presence of uncertainty within supply chains is discussed as an important issue for efficient capacity utilization and robust infrastructure decisions. The incorporation of business or financial and sustainability aspects is also considered and future challenges are identified.

Lei et al. (2009) analyzed variations of mechanical characteristics that depend on the injection moulding techniques during the blending of short glass fibre and polytetrafluoroethylene reinforced polycarbonate composites. A hybrid method including Back-Propagation Neural Network (BPNN), Genetic Algorithm (GA), and Response Surface Methodology (RSM) are proposed to determine an optimal parameter setting of the injection moulding process. The specimens are prepared under different injection moulding processing conditions based on a Taguchi orthogonal array table. The results of 18 experimental runs were utilized to train the BPNN predicting ultimate strength, flexural strength, and impact resistance. Simultaneously, the RSM and GA approaches were individually applied to search for an optimal setting. In addition, the analysis of variance was implemented to identify significant factors for the injection moulding process parameters and the result of BPNN integrating GA was also compared with RSM approach. The results show that the RSM and BPNN/GA methods are both effective tools for the optimization of injection moulding process parameters.
Mohd. Muktar Alam et al. (2013) used trial and error approach to determine process parameters for injection moulding is no longer hold good enough. Since plastic is widely used polymer due to its high production rate, low cost and capability to produce intricate parts with high precision. It is much difficult to set optimal process parameter levels which may cause defects in articles, such as shrinkage, warpage, line defects. Determining optimal process parameter setting critically influences productivity, quality and cost of production in Plastic Injection Moulding (PIM) industry. In this paper optimal injection moulding condition for minimum shrinkage were determined by the DOE technique of Taguchi methods. The various observation has been taken for material namely Polypropylene (PP). The determination of optimal process parameters were based on S/N ratios.

Naishun Noor Rahbar et al. (2015) studied about the process parameter that affect the injection moulding process like injection time, injection pressure, packing pressure, packing time, cooling time, coolant temperature mould temperature, melt temperature which are then compared. The design of experiment approach to find out optimal parameter setting. The comparison shows effect of parameters on injection moulding process.

Nik Mizamzul Mehat et al. (2011) in their study found the optimal injection moulding conditions for minimum shrinkage during moulding by DOE technique (Taguchi method). Different observations were taken for a material namely Low Density Polyethylene (LDPE). Taguchi method is used to investigate the effects of melting temperature, injection pressure, refilling pressure and cooling time on the shrinkage of LDPE. Taguchi method has two main instruments, which are Signal-To-Noise (S/N) ratio and orthogonal arrays. S/N ratios were used for determining the optimum combinations of the process conditions for shrinkage. The S/N ratio takes both the average and the
variability of the quality characteristics into consideration. The results showed that the cooling time was the most effective factor for LDPE followed by refilling pressure and injection pressure was the least effective factor.

Packianather et al. (2013) used the soft computing platform to optimize the procedure for plastic injection moulding. Arrange of process parameters for plastic injection moulding for instance, injection pressure, mould temperature, injection time, and melt temperature are contemplated. The policy of hybridization contemplated on a joint action of a genetic algorithm, numerical simulation software and a neural network (i.e multilayer), which determine the most favourable process parameters. An estimated representation, which is analytical based, was built up using a back propagation neural network for the purpose of side-tracking the use of costly calculation outcome from the numerical simulation software.

Based on the feature of the optimisation problem, a non binary genetic procedure is used to resolve the optimisation representation.

2.3 SUMMARY

Most of the literature review reported in this chapter optimization of advanced manufacturing and moulding process related problems were dealt with. Largely, heuristic and extremely less non-traditional methods for solving the advanced manufacturing process optimization problem were considered. The integration of GA with SA approach was not dealt with in detail by most of the authors, for instance. But most of the authors, Packianather et al. (2013) have used soft computing platform for the optimization of the plastic injection moulding process, Rahbar et al. (2015) have applied DOE approach for studying the process parameters that affect the injection moulding process, Alam et al. (2013) have adopted the DOE
technique of Taguchi method for the material polypropylene for determination of optimal process parameters and finally Chen (2009) has developed a GA for solving non parametric hard problems which reveals the efficiency to obtain good solutions in the shortest time.

Considering the above fact this thesis concentrates more thrust on the GA and SA approaches to deal in various parameters during the injection moulding process.