Chapter 1 - Introduction

The cost of machining amounts to more than 20% of the value of manufactured products in industrialized countries. It is therefore imperative to investigate the machinability behavior of different materials by changing the machining parameters to obtain optimal results. The machinability of a material provides an indication of its adaptability to manufacturing by a machining process. Good machinability is defined as an optimal combination of factors such as low cutting force, good surface finish, low tool tip temperature, and low power consumption.

Process modeling and optimization are the two important issues in manufacturing products. The selection of optimal cutting parameters, like depth of cut, feed and speed, is a very important issue for every machining process. In workshop practice, cutting parameters are selected from machining databases or specialized handbooks, but the range given in these sources are actually starting values, and are not the optimal values. Optimization of machining parameters not only increases the utility for machining economics, but also the product quality to a great extent.

In today’s manufacturing environment, many industries have attempted to introduce flexible manufacturing systems (FMS) as their strategy to adapt to the ever changing competitive market requirements. To ensure quality of machined products to reduce the machining costs and to increase the machining effectiveness, it is very important to select appropriate machining parameters when machine tools are selected for machining.

1.1. Optimization

The design objective preceding most engineering design activities is simply to minimize the cost of production or to maximize the production efficiency. An optimization algorithm is a
procedure which is executed iteratively by comparing various solutions till the optimum or satisfactory solution is found. Accepting the best solution after comparing a few design solutions is the indirect way of achieving optimization in many industrial design activities. There is no way of guaranteeing an optimal solution with this simplistic approach. Optimization algorithms on the contrary, begin with one or more design solutions supplied by the user and then iteratively check new design solutions, relative search spaces in order to achieve the true optimum solution.

In optimizing the economics of machining operations, the role of cutting conditions such as feed rate, cutting speed and depth of cut have long been recognized. F.W.Taylor (1907) showed that an optimum or economic cutting speed exists which would maximize material removal rate.

Gilbert (1950) studied the optimization of machining parameters in turning taking maximum production rate and minimum production cost as criteria. Armarego & Brown (1969) investigated unconstrained machine-parameter optimization using differential calculus. Brewer & Rueda (1963) carried out simplified optimum analysis for non-ferrous materials. For Cast Iron (CI) and steels, they employed the criterion minimum machining cost.

Some of the widely used techniques in optimization are conventional Genetic Algorithm, Particle Swarm Optimization and Simulated Annealing which will be illustrated in the forthcoming chapters.

1.2. Surface roughness

Surface finish is an essential requirement in determining the surface quality of a product. Surface roughness in metal cutting is defined as irregularities on any material resulting from a machining operation. Average roughness Ra is the arithmetic average of departure of the profile from the mean line along a sampling length. Surface finish has a great influence on the reliable functioning of two mating parts. In this work optimum machining parameters for minimum
surface roughness on the machining of SS420 material is investigated. It has a large number of applications in industries such as the aerospace, petrochemicals, forging, medical, dental and surgical equipment industries, electrical and electronic components, food industries, tractor and tool production and automotive industries, where surface quality is an important factor.

During the initial period of the past century, tactual standards were used to measure the surface roughness; this involved the use of a series of specimens that had different finishes. The man in the shop used these specimens by running his fingernail first across standard tactual surface and then across the surface he was producing. The work piece was considered to be smooth enough when the two surfaces were felt to have the same roughness. In the modern times however stylus instruments are used with a diamond stylus which traverses a surface. These utilize transducers to convert the vertical and horizontal motions of the diamond stylus into recorded traces.

Surface roughness is usually measured in characteristic peak-to-valley roughness ($R_c$) or arithmetic average roughness ($R_a$). Arithmetical average (AA) roughness ($R_a$) or centerline average (CLA) is obtained by measuring the mean deviation of the peaks from the centerline of a trace, the centerline being established as the line above and below which, there is an equal area between the centerline and the surface trace.

### 1.3. Thesis Outline

The thesis is organized in nine chapters.

Chapter 1 gives an introduction to the Thesis.

Chapter 2 contains literature survey, motivation and objectives of the thesis.

Chapter 3 contains the experimental setup, Design of Experiments and analysis using Signal to Noise ratio (S/N) and Analysis Of Variance (ANOVA).
Chapter 4 contains the formulation of mathematical model using Response Surface Methodology (RSM) and its analysis.

Chapter 5 presents the Simulated Annealing based optimization of machining process.

Chapter 6 presents the Particle Swarm based machining process Optimization.

Chapter 7 presents the Genetic and Improved genetic algorithm based optimization of machining process.

Chapter 8 Results and Discussions

Chapter 9 presents conclusions.