A Project Report

on

OPTIMIZATION OF PROCESS PARAMETERS TO IMPROVE SURFACE ROUGHNESS OF PROPELLER SHAFT (SM45) BY USING TAGUCHI METHOD

By

MR. SRIJITH PRASAD DIVATE PRN NO 72175759G

MR. SAURABH SANJAYRAO JAPE PRN NO 72175788L

MR. VIVEK KIRAN PATIL PRN NO 72175782M

MR. GOPINATH SUBHASH LOHAKARE PRN NO 72175773B

Guide

Prof. Shrikant Jadhav

SINHGAD TECHNICAL EDUCATION SOCIETY-PUNE

तमसो मा ज्योतिर्गमय

Sinhgad Institutes

Department of Mechanical Engineering

Sinhgad Technical Education Society's

RMD Sinhgad School of Engineering

[2022-23]

Sinhgad Technical Education Society's

RMD Sinhgad School of Engineering

Sinhgad Institutes

CERTIFICATE

This is to certify that MR. SHRIJEET PRASAD DIVATE PRN NO 72175759G

MR. SAURABH SANJAYRAO JAP PRN NO 72175788L

MR. VIVEK KIRAN PATIL PRN NO 72175782M

MR. GOPINATH SUBHASH LOHAKARE PRN NO 72175773B

have successfully completed the Project Report entitled "**optimization of process parameters to improve surface roughness of propeller shaft (sm45) by using taguchi method**" under my supervision, in the partial fulfillment of *Bachelor of Engineering - MechanicalEngineering* of Savitribai Phule Pune *University.*

Date: -

Place: - Pune

Prof. Shrikant Jadhav
Guide

Prof…………….
External Examiner

Dr. Sachin Kulkarni
Head of Department

Dr. V.V.Dixit
Principal

ACKNOWLEDGEMENT

I take this opportunity to thank all those who have contributed in successful completion of this Project Stage -1 work. I would like to express my sincere thanks to my guide **Prof.Shrikant Jadhav**who have encouraged me to work on this topic and provided valuable guidance wherever required. I also extend my gratitude to **Dr. Sachin Kulkarni(H.O.D Mechanical Department)** who has provided facilities to explore the subject with more enthusiasm.

I express my immense pleasure and thankfulness to all the teachers and staff of the **Department of Mechanical Engineering of Smt. Kashibai Navale College of Engineering** for their co-operation and support.

Mr. Srijith Prasad Divate Sign……………….

Mr. Saurabh Sanjayrao Jape Sign……………….

Mr. Vivek Kiran Patil Sign……………….

Mr. Gopinath Subhash Lohakare Sign……………….

ABSTRACT

Metal cutting process is the most complex process which has many factors contributing towards the quality of the finished product. Turning is one among the metal cutting process in which quality of the finished product depends mainly upon the machining parameters such as speed, depth of cut, feed rate, type of coolant used, types of inserts used etc. Similarly the work piece material plays a vital role in metal cutting process. In turning process achieving a good surface quality and minimum cutting forces are the most importance. It involves many process parameters which directly or indirectly influence the surface roughness and cutting forces of the product in common. A precise knowledge of these optimum parameters would facilitate to reduce the machining costs and improve product quality. In this project turning of Steel SM45 work piece sample of propeller shaft and carbide insert tool will be performed on lathe machine. SM45 steel is used as the work piece material for carrying out the experimentation to optimize the Material Removal Rate. The bars will be use of diameter 50 mm and length 300 mm. There will be three machining parameters i.e. Spindle speed, Feed rate, Depth of cut. Different experiments will be carryout by varying two parameters and keeping other one fixed. Taguchi orthogonal array is designed with three levels of turning parameters with the help of software Minitab 18. Nine experiments are performed and material removal rate (MRR) is calculated. Taguchi method stresses the importance of studying the response variation using the signal–to–noise (S/N) ratio, resulting in minimization of quality characteristic variation due to uncontrollable parameter. The metal removal rate was considered as the quality characteristic with the concept of "the larger-the-better". The S/N ratio for the larger-the-better The S/N ratio values are calculated by taking into consideration with the help of software Minitab 18. The MRR values measured from the experiments and their optimum value for maximum material removal rate are identified.

Keywords: propeller shaft, Material Removal Rate, Minitab, surface roughness testing machine, S/N ratio

CONTENTS

Sr. No.	Chapter	Page No.
1.	Introduction	**1**
2.	Literature review	**13**
3.	Problem Idantification and Objectives	**19**
4.	Minitab Software	**22**
5.	Experimantial Procedure	**24**
6.	Steps Carried Out by Minitab Software	**25**
7.	Analysis of Taguchi Design	**31**
8.	Graphs obtained	**33**
9.	Final Data Obtained	**34**
10	Test Report For Workpiece	**35**
11.	Result and Conclusion	**40**
12.	Plan Of Proposed Work	**42**
13.	References	**43**

LIST OF FIGURES

Sr. No.	List Of Figures	Page No.
1.	Turning Process	**6**
2.	Driling Process	**7**
3.	Boring Process	**7**
4.	Milling Process	**8**
5.	Workpiece	**9**
6.	Basic Minitab	**22**
7.	Medium Duty Lathe Machine	**23**
8.	Surface Roughness Tester	**39**

CHAPTER 1

INTRODUCTION

Optimization of process parameters to improve surface roughness of propeller shaft (SM45) by using Taguchi Method

An automobile may use a longitudinal shaft to deliver power from an engine/transmission to the other end of the vehicle before it goes to the wheels. A pair of short drive shafts is commonly used to send power from a central differential, transmission, or transaxle to the wheels. Drive shaft (Propeller shaft) is a mechanical part of transmission system which is used to transfer the power from engine to the wheel. The movement of vehicles can be provided by transferring the torque produced by engines to wheels after some modification. The transfer and modification system of vehicles is called as power transmission system and have different constructive features according to the vehicle's driving type. Most automobiles today use rigid driveshaft to deliver power from a transmission to the wheels. A pair of short flexible driveshaft is commonly used in cars to send power from a differential to the wheels. In automobiles, axle shafts are used to connect wheel and differential at their ends for the purpose of transmitting power and rotational motion. In operation, axle shafts are generally subjected to torsional stress and bending stress due to self-weight or weights of components or possible misalignment between journal bearings.

1.1 Types of Drive Shafts There are different types of drive shafts in Automotive Industry:

- One-piece driveshaft
- Two-piece driveshaft
- Slip in Tube driveshaft

The slip-in-tube drive shaft is a new type that improves Crash safety. It can be compressed to absorb energy in the event of a crash, so is also known as a collapsible driveshaft.

Four types of materials SCM420, SCM420H, SCM440 and SM45C

Materials	Chemical composition (wt. %)									
	C	Si	Mo	Cr	Mn	Ni	S	P	Cu	Fe
SCM420	0.195	0.316	0.152	1.110	0.834	0.075	0.028	0.027	-	Bal.
SCM420H	0.210	0.210	0.180	1.020	0.770	0.060	0.024	0.020	0.110	Bal.
SCM440	0.390	0.180	0.200	0.940	0.740	0.10	0.012	0.017	0.110	Bal.
SM45C	0.410	0.250	-	0.020	0.700	0.030	0.050	0.030	-	Bal.

Materials	SCM420	SCM420H	SCM440	SM45C
Young's modulus (GPa)	517	733	655	569
Yield Strength (MPa)	365	470	415	343
UTS (MPa)	210	200	200	207
Density (g/cm^3)	7.85	7.7	7.85	7.7

Table 1. Material properties of work pieces

Turning is the most basic machining processes. The part is rotated while a single point cutting tool is moved parallel to the axis of rotation. Turning can be done on the external surface of the part as well as internally (boring). The starting material is generally a work piece generated by other processes such as casting, forging, extrusion, or drawing. Turning can be done in two ways whether manually, in a traditional form of lathe, which usually requires continuous supervision by the operator or by using a Computer-controlled and automated lathe which does not requires continuous supervision. In turning operations, vibration is a frequent problem, which affects the result of machining, in particular, the tool wear. Vibration can be defined as an object being repeatedly displaced at a very high frequency. In turning process, three types of mechanical vibrations are present. They are free, forced and self-excited vibrations. They occur due to lack of dynamic stiffness/rigidity of the machine tool system comprising tool, tool holder, work piece and machine tool. Machining vibrations, also called as chatter, correspond to the relative movement between the work piece and the cutting tool. These vibrations affect typical machining processes, such as turning, milling and drilling. Relative vibration amplitude between the work piece and cutting tool influences the tool life. Cutting tool and tool holder shank are subjected to dynamic excitation due to the deformation of the work material during the cutting operation. The dynamic relative motion between the cutting tool and work piece will affect the quality of the machining, in particular, the surface finish. Furthermore, the tool life is correlated with the amount of vibration . In turning, the presence of tool vibration is a major factor which leads to poor surface finish, cutting tool damage, increase in tool wear and unacceptable noise. With the production and productivity increasing in modern society, the manufacturing energy consumption is increased with intensifying the energy crisis and global warming [1]. According to International Energy Agency [2], manufacturing is responsible for nearly 1/3 of the global energy consumption and 36% of carbon dioxide emissions [3]. Increasing energy price and requirements to improve energy efficiency are the severe challenges faced by modern manufacturing enterprises. Increase in manufacturing production is characterized by technological development, which is driven by increased competitiveness. Machining processes must therefore also undergo changes in order to meet market requirements in order to guarantee the expected quality, reduce production costs, and increase productivity.

Today the standard procedure to avoid vibration during machining is by careful planning of the cutting parameters. The methods are usually based on experience and trial and error to obtain suitable cutting data for each cutting operation involved in machining a product. Machining vibration exists throughout the cutting process. While influenced by many sources, such as machine structure, tool type, work material, etc., the composition of the machining vibration is complicated. However, at least two types of vibrations, forced vibration and self-excited vibration, were identified as machining vibrations. Forced vibration is a result of certain periodical forces that exist within the machine. The source of these forces can be bad gear drives, unbalanced machine-tool components, misalignment, or motors and pumps, etc. Self-excited vibration, which is also known as chatter, is caused by the interaction of the chip removal process and the structure of the machine tool, which results in disturbances in the cutting zone. Chatter always indicates defects on the machined surface; vibration especially self-excited vibration is associated with the machined surface roughness [2]. A large number of theoretical and experimental studies on surface roughness of machined products have been reviewed where cutting conditions (such as cutting speed, feed rate, depth of cut, tool geometry, and the material properties of both the tool and work piece) significantly influence surface finish of the machined parts . The surface roughness can be affected by built up edge formation. The analysis of tool vibration on surface roughness is also investigated by some authors the purpose of these paper is to investigate the effects of tool vibration on the resulting surface roughness in the dry turning operation of carbon steel [5,6,7]. From the above literature reviews it is observed that many factors affect performance of the turning process and affecting surface quality. There are some differences concerning the influence of few factors on the surface finish. This may be due to different ranges of process parameter as well as different tool job machine combination. In machining operation, the quality of surface finish is an important requirement for many turned work pieces. Thus, the choice of optimized cutting parameters becomes very important to control the required surface quality. The aim of this research is to investigate the effects of cutting tool vibration on the resulting surface roughness in the dry turning operation of medium carbon steel. To achieve such objective, the research should have completed a fractional experimental design that allows considering a different level interaction between the cutting parameters (cutting speed, feed rate, depth of cut and tool length) on the two measured dependant variables (surface roughness and cutting tool vibration).

1.2 Machining:

Machining is any of various processes in which a piece of raw material is cut into a desired final shape and size by a controlled material-removal process. The processes that have this common theme, controlled material removal, are today collectively known as subtractive manufacturing, in distinction from processes of controlled material addition, which are known as additive manufacturing. Machining is a part of the manufacture of many metal products, but it can also be used on materials such as wood, plastic, ceramic, and composites. A room, building, or company where machining is done is called a machine shop. Much of modern-day machining is carried out by computer numerical control (CNC), in which computers are used to control the movement and operation of the mills, lathes, and other cutting machines.

During the Machine Age, machining referred to (what we today might call) the "traditional" machining processes, such as turning, boring, drilling, milling, broaching, sawing, shaping, planning, reaming, and tapping. In these "traditional" or "conventional" machining processes, machine tools, such as lathes, milling machines, drill presses, or others, are used with a sharp cutting tool to remove material to achieve a desired geometry.

Since the advent of new technologies such as electrical discharge machining, electrochemical machining, electron beam machining, photochemical machining, and ultrasonic machining, the retronym "conventional machining" can be used to differentiate those classic technologies from the newer ones. In current usage, the term "machining" without qualification usually implies the traditional machining processes.

1.2.1 Types of machining:

There are many kinds of machining operations, each of which is capable of generating a certain parts geometry and surface texture. Some of them are:

1. **Turning**: A cutting tool with a single cutting edge is used to remove material from a rotating work piece to generate a cylindrical shape. The primary motion is provided by rotating the work piece, and feed motion is achieved by the moving cutting tool slowly in a direction parallel to the axis of rotation of the work piece.

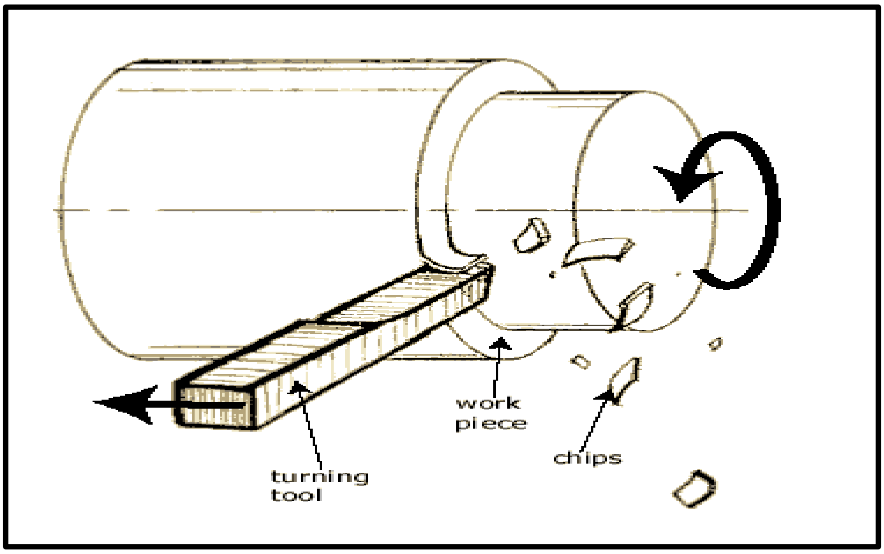


Fig 1. Turning Process

2. **Drilling:**

   It is used to create a round hole. It is accomplished by a rotating tool that typically has two or four helical cutting edges. The tool is fed in a direction parallel to its axis of rotation into the work piece to form the round hole.

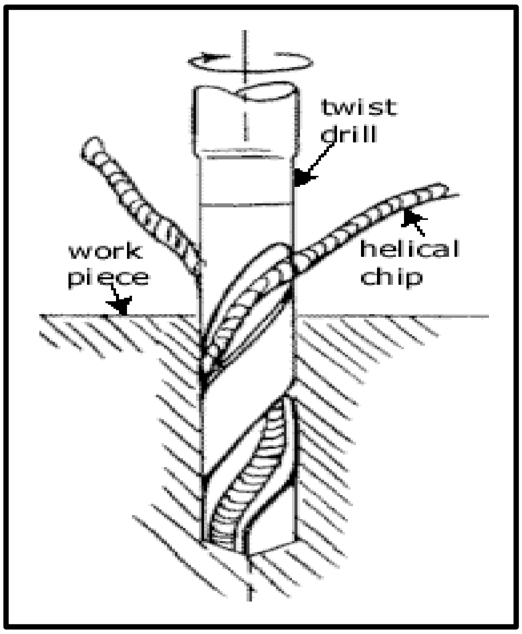


Fig 2. Drilling Process

3. **Boring:**

   A tool with a single bent pointed tip is advanced into a roughly made hole in a spinning work piece to slightly enlarge the hole and improve its accuracy. It is a fine finishing operation used in the final stages of product manufacture.

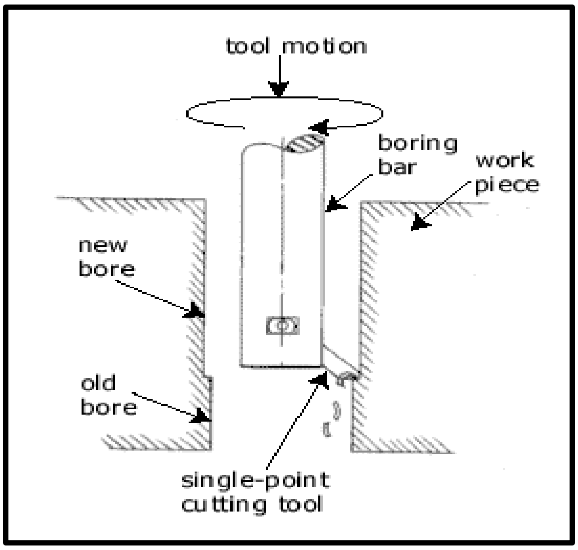


Fig 3.Boring Process

4. **Milling:**

   A rotating tool with multiple cutting edges is moved slowly relative to the material to generate a plane or straight surface. The direction of the feed motion is perpendicular to the tools axis of rotation. The speed motion is provided by the rotating milling cutter.

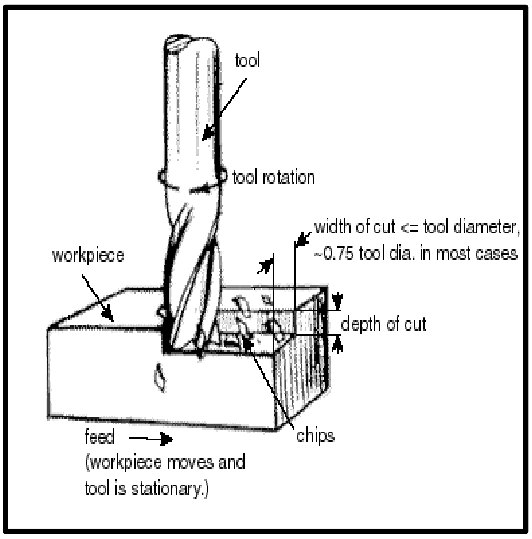


Fig 4..Milling Process

1.3 TURNING:

Turning is a form of machining, a material removal process, which is used to create rotational parts by cutting away unwanted material as shown in figure.

The turning process required a turning machine or lathe work piece, fixture and cutting tool.

It is the machining operation that produces cylindrical parts. In its basic form, it can be defined as the machining of an external surface:

¾ With the work piece rotating.

¾ With a single-point cutting tool, and

¾ With the cutting tool feeding parallel to the axis of the work piece and at a distance that will remove the outer surface of the work

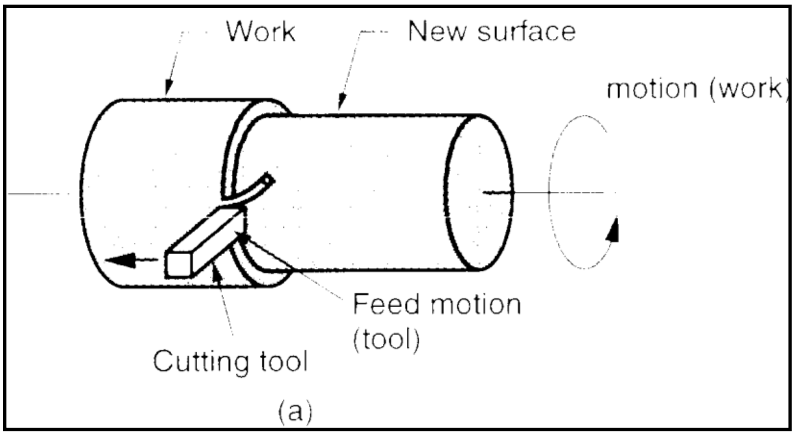


Fig 5. Workpiece

The work piece is a piece of pre-shape material that is secured to the fixture, which itself is attached to the turning machine, and allowed to rotate at high speeds. The cutter is typically a single point cutting tool that is also secured in the machine. The cutting tool feeds into the rotating work piece and cuts away material in the form of small chips to create the desire shape.

Machining parameters in turning process In the process of metal cutting, there are many factors who relate the process planning for machining operations. These factors can be classified as follows:

i. Type of machining operations (turning, facing, milling, etc.),
ii. Parameters of machine tools (rigidity, horse power, etc.),
iii. Parameters of cutting tools (material, geometry, etc.),
iv. Parameters of cutting conditions (cutting speed, feed rate, depth of cut, etc.),
v. Characteristics of work pieces (material, geometry, etc.).

1.4 Basic Parameters :

• **Cutting speed -** The cutting speed of a tool is the speed at which the metal is removed by the tool from the work material. In a lathe it is the peripheral speed of the work part in m/min.

V = лDN/1000 (m/min)

Where D, N are diameter of work piece (mm) and cutting speed (rpm) respectively.

• **Depth of cut (d):** The depth of cut is the perpendicular distance measured from the machined surface to the uncut surface of the work piece in mm.

• **Spindle speed -** The rotational speed of the spindle and the work piece in revolutions per minute (RPM). The spindle speed is equal to the cutting speed divided by the circumference of the work piece where the cut is being made

• **Feed rate –** It is the speed of the cutting tool's movement relative to the work piece as the tool makes a cut. The feed rate is measured in inches per minute (IPM) and is the product of the cutting feed (IPR) and the spindle speed (RPM). b) Response Parameters

• **Material removal rate:** This is a production term usually measured in cubic inches per minute. Increasing this rate will resulting get a part done quicker and therefore probably for less money, but increasing the material removal rate is often increases in tool wear, poor surface finishes, poor tolerances, and other problems. Optimizing the machining process is a very difficult problem.

• **Tool wear rate:** The rate at which the cutting edge of a tool wears away during machining. It is usually measured in cubic inches per minute. As the rate will increases the production rate will automatically goes down. It will result in the wear of the tool.

• **Surface Finish:** The degree of smoothness of a part's surface after it has been manufactured. Surface finish is the result of the surface roughness, waviness, and flaws remaining on the part. Surface roughness plays a vital role as it affects the fatigue strength, wear rate, coefficient of friction, and corrosion resistance of the machined components. In actual practice, there are various factors which can affect the surface roughness, i.e., tool variables, workpiece hardness and cutting conditions

1.5 Closure

"Comparison between Taguchi Method and Response Surface Methodology (RSM) In Optimizing Machining Condition." Research paper conclude Two techniques of DOE has been compared i.e. Taguchi method and RSM. From research paper it concluded that Taguchi method requires less data to find the optimum condition than RSM. Therefore it is recommended to use Taguchi method if the experimental run is time consuming and costly.so for turning of Steel SM45 work piece sample of propeller shaft used Taguchi method over RSM.

1.6 Introduction to taguchi methodology

Taguchi Method was proposed by Genichi Taguchi, a Japanese quality management consultant. The method explores the concept of quadratic quality loss function and uses a statistical measure of performance called signal to noise (S/N) ratio. Taguchi method is usually used in an analysis that uses a number of factors. When the total factors have been more than two, the number of experiment also will increase, and then the solution will be used Taguchi method. Taguchi Methods is a system of cost driven quality engineering that emphasizes on the effective application of engineering strategies rather than advanced statistical technique. It includes both upstream and shop floor quality engineering. Upstream methods efficiently use small scale experiments to reduce variability and find cost effective, robust designs for large scale production and the market place. Shop floor techniques provide cost based real time methods for monitoring and maintaining quality in production. Taguchi Methods allow a company to rapidly and accurately acquire technical information to design and produce low cost, highly reliable products and processes. Its most advanced applications allow engineers to develop flexible technology for the design and production of families of high quality products, greatly reducing research, development and delivery time. The DOE with Taguchi approach is divided into three main phases

1. Planning phase,
2. Conducting phase, and
3. Analysis phase

1.7 Background

Mankind has always had a fascination with quality. Today's technology is testimony to man's incessant desire to provide a higher level of quality in products and services to increase market share and profits. Sometimes quality is essential. A pacemaker that controls heart action must operate continuously and precisely. An erratic pacemaker is valueless, useless, and dangerous. Driven by the need to compete on price and performance and to maintain profitability, quality-conscious manufacturers are increasingly aware of the need to optimize products and processes. Quality achieved by means of design optimization is found by many manufacturers to be cost effective in gaining and maintaining a competitive position in the world market.

1.8 Design of experiments—the conventional approach

The technique of defining and investigating all possible conditions in an experiment involving multiple factors is known as the design of experiments (DOE). In the literature, this technique is also referred to as factorial design. Design of experiments concepts have been in use since Sir Ronald A. Fisher's work in agricultural experimentation during the late 1920s. Fisher successfully designed experiments to determine optimum treatments of land for agriculture to achieve maximum yield. Numerous applications of this approach, especially in the chemical and pharmaceutical industries, are cited in the literature. A thorough coverage of this subject is beyond the scope of this study, but the method and its advantages and disadvantages from an engineering point of view are illustrated by a simple example.

1.9 Design of experiments—the taguchi approach

To make the DOE easier and more attractive to industrial practitioners, Dr. Taguchi proposed the following considerations for application of the technique:

1. Definition of quality – Taguchi defined quality in terms of minimum loss to society, which in measurable engineering terms translates into consistency of performance. Regardless of application, whether it is a product or a process, or how the results are measured, consistency in performance is considered as a primary attribute. Consistency is achieved when performance is close to the target with least variation. To improve

quality, Taguchi proposed a two-step optimization approach: a. Find the factor-level combination that reduces performance variability. b. Adjust the factor levels that bring performance closer to the target.

2. Standardized DOE – For designing experiments, Taguchi utilized a special set of tables, called orthogonal arrays (OAs), which represent the smallest fractional factorials and are used for most common experiment designs.

3. Robust design strategy – To make products and processes insensitive to the influence of uncontrollable (noise) factors, Taguchi incorporates a formal way to include noise factors in the experiment layout. This new structure (called outer array design) facilitates the use of experiments of smaller size to study the effects of a larger number of noise factors, which leads to a favorable performance with the mean close to the target and reduced variation around the mean.

4. Loss function – The mathematical formula associated with the concept of the loss function proposed by Taguchi allows a simple way to quantify the improvements in monetary units. The concepts can be easily used to express predicted improvement from DOE results in terms of expected cost savings.

5. Signal-to-noise (S/N) analysis – For analysis of results from multiple-sample tests, use of signal-to-noise ratios instead of the results makes the analysis of DOE results much easier. In addition, the logarithmic transformation of the results in terms of S/N ratios empowers the prediction of improvement in performance from the analysis

CHAPTER 2

LIRERATURE SURVEY

Jakhale Prashant P, Jadhav B. R. studied higher value of surface roughness generates on the machining parts and due to rework or scrap results into increase in cost and loss of productivity. Surface roughness is a major factor in modern Computer Numerical Control (CNC) turning industry. optimization researches for CNC finish turning were either accomplished within certain manufacturing purposes, or achieved through various equipment operations. Therefore, a general optimization of surface roughness is deemed to be necessary for the most of manufacturing industry. In this paper author investigate the effect of cutting parameters(cutting speed, feed rate, depth of cut) and insert geometry(CNMG and DNMG type insert) on surface roughness in the high turning of alloy steel. The experiments have been conducted using L9 orthogonal array in a TACCHI lathe CNC turning machine. The optimum cutting condition was determined by using the statistical methods of signal-to-noise (S/N) ratio and the effect of cutting parameters and insert type on surface roughness were evaluated by the analysis of variance (ANOVA) [1]

Youcef ABIDI mentioned in paper hard machining is a process that has become highly recommended for replacing grinding in the manufacturing industry. This is due to its ability to machine complex shapes with reduced production costs by reducing the machining time and being an ecological process. Three technological parameters determine the quality and productivity generated from this process: cutting vibration, surface roughness and tool wear. Therefore, the analysis of the correlation between them is very important. Also mentioned neutralize the effect of cutting parameters, a combination of parameters such as cutting speed, feed rate and depth of cut to be used in the experimental tests is selected from the literature based on a quality-productivity optimum performance. The novelty of this work lies in the fact that we consider the cutting vibration as a response generated the during cutting process and not as a variable affecting the other technological parameters. This was rarely studied in previous researches [2]

Martoni took the topic of "Analysis and Repair of Latitude Sledge Lathe GHB-1340G". For the process of improving latitude slashes so that the composer can be reused to make improvements in the latitude slashes. After that, the composer conducts an experiment by turning the work piece sample. The next stage after testing the work piece samples by making a reduction, holes, and threads obtained a good, smooth, and even turning. The machine does not experience damage or problems anymore and can be used for a good turning process. [3]

Ng Chin Fei represent determining the optimal processing parameter is routinely performed in the plastic injection moulding industry as it has a direct and dramatic influence on product quality and costs. Taguchi method has been employed with great success in experimental designs for problems with multiple parameters due to its practicality and robustness. 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. [4]

Melesse Workneh Wakjira mentioned in research paper to analyze the machinability of CSN 12050 carbon steel bars using carbide insert tool in order to utilize the optimum cutting parameters by employing Taguchi approach. Experiments have been performed under dry cutting condition using an optimization approach according to Taguchi’s L9 (34) orthogonal arrays; signal-to-noise ratio tests are designed. Analysis of variance (ANOVA) was performed to determine the importance of machining parameters on the material removal rate (MRR). The results were analyzed using signal-to-noise ratios (S/N); 3D surface graphs, main effect graphs of mean, and predictive equations are employed to study the performance characteristics. [5]

Mahesh Gopal studied DSS material is very difficult to perform machining operations due to high austenite, nitrogen content, alloy composition, high strength, work hardening rate and toughness. High hardness requires high cutting force which tends to reduce machinability characteristics such as tool wear, surface finish, low MRR, etc. This review article researcher provides an overview of the research conducted during last one decade by the researchers and the optimization methods used to examine the machinability characteristics of DSS to predict surface unevenness wear in tool, machinability, MRR and chip volume ratio. Furthermore, this article indicates an efficient means of machining behavior, future scope and the fruitful methodology for the successful machining of duplex stainless steel. [6]

Arun Kumar Parida concluded Results of the main effects plot indicate that depth of cut is the most influencing parameter for MRR but cutting speed is the most influencing parameter for surface roughness and feed is found to be the least influencing parameter for both the responses. The confirmation test is conducted for both MRR and surface roughness separately. Finally, an attempt has been made to optimize the multiresponses using technique for order preference by similarity to ideal solution (TOPSIS) with Taguchi approach. [7]

Ahmet Hasçalık mentioned in his paper thesis the effect and optimization of machining parameters on surface roughness and tool life in a turning operation was investigated by using the Taguchi method. The experimental studies were conducted under varying cutting speeds, feed rates, and depths of cut. An orthogonal array, the signal-to-noise (S/N) ratio, and the analysis of variance (ANOVA) were employed to the study the performance characteristics in the turning of commercial Ti-6Al-4V alloy using CNMG 120408-883 insert cutting tools. The conclusions revealed that the feed rate and cutting speed were the most influential factors on the surface roughness and tool life, respectively. The surface roughness was chiefly related to the cutting speed, whereas the axial depth of cut had the greatest effect on tool life. [8]

Xianzhen Huang studied in this paper, dynamic model of regenerative chatter in turning process is established to predict the limited cutting width and derive the stability lobe diagram. This study addresses the influences of uncertain factors on the turning process, and a reliability based optimization model is established to obtain optimal turning parameters. In the optimization model, the maximum material removal rate is taken as the objective function and the reliability of turning stability, surface precision, and cutting power is defined as the constraint function. The sequential optimization and reliability assessment (SORA) is utilized to solve the optimization model. Finally, a discussion of the practical application of this method is presented. [9]

T. Tamizharasan mention the Effect of turning parameters on chip generation during machining aluminum composite is studied in this work. Turning of Al–4%Cu–7.5%SiC composite material prepared through powder metallurgy procedure was chosen as the work piece, machined using uncoated carbide insert TNMG 120404. Chips produced during machining were studied by measuring the thickness and were used along with uncut chip thickness to determine the chip thickness ratio. 99.85% pure aluminum was added with 4% volume fractions of copper and with silicon carbide particulates of 7.5%. To visualize the distribution of reinforcement phases in matrix, scanning electron microscope is used. Taguchi's methodology of design of experiments was adopted for designing a L9 (Latin square) orthogonal array for experimental investigation, and from analysis of variance, cutting speed influencing the formation of chip by 64.13%, continuing with depth of cut by 35.26%, was identified. Confirmation test accomplished with ideal conditions produces a better chip condition. [10]

Pardeep Saini carries out investigation on the impact of end milling parameters has been attempted for rough and finish machining conditions. Two case studies taken for study (a)rough machining i.e., 100% weightage to material removal rate (MRR) (b) finish machining i.e., 80% weightage to surface roughness, and only 20% weightage to MRR have been investigated. Full factorial design with 3-factors at 3-level each has been used as the design matrix for conducting the milling experiments. Taguchi-based grey relational analysis(TGRA) has been adopted for the bi-objective optimization for finish machining. The significance of process parameters has been checked with analysis of variance (ANOVA). [11]

H. Akkus investigated the consistency between the results obtained from the turning operation. To this end, Ti 6Al-4V alloy work piece was machined using CNC lathe. In addition, surface roughness (Ra), vibration, and energy consumption values were determined through turning. Experimental results were then analyzed statistically. Response Surface Method (RSM) and grey relational analysis were employed for statistical analysis. According to RSM analysis, grey relational analysis, and ANOVA and regression analysis, the feed rate was found the most Effective parameter that negatively affects surface roughness, energy consumption, and vibration.

GAP IN LITERATURE

The above literature review clearly indicates that the study of feed, speed and depth of cut on cutting force and surface roughness has been very active since the past several decades, but there has been a continuous need to extend this study for the different combinations of tool and work material. The literature review also shows that there is no much of work undertaken with mixed lathe machine tool and Steel SM45c, despite the fact that it is a widely used combination owing to its industrial applications. Input parameters preferred - speed, feed rate, depth of cut, coolant used, and Output parameters preferred- surface roughness, MRR, tool etc. Material preferred - Steel SM45c

CHAPTER 3

PROBLEM IDENTIFICATION AND OBJECTIVES

3.1 Problem Definition:

- The turning process in an automobile industry plays an important role in the production department, which in turn contributes to the profit of the industry. To get the better results from the machining process it is important to know the contribution level of different cutting parameters like speed of spindle, rate of feed and depth of cut to the machine. This study aims to determine and analyze the effect of the cutting tool edge geometry and cutting parameters (speed, feed, depth of cut) on surface roughness in turning of Steel SM45C work piece sample of propeller shaft.

3.2 Objectives:

1. To Develop Taguchi model for experimentation to analyze the parameters of surface roughness.
2. To analyze the effect of process parameters viz. speed, feed depth of cut on surface roughness of propeller shaft.
3. To find optimum combination of parameters in order to get the minimum surface roughness of propeller shaft.
4. To statistically analyze the response parameters.
5. Experimental testing and correlating results.

CHAPTER 4

MINITAB SOFTWARE

4.1 Minitab

Minitab is a software product that helps you to analyze the data. This is designed essentially for the Six Sigma professionals. It provides a simple, effective way to input the statistical data, manipulate that data, identify trends and patterns, and then extrapolate answers to the current issues. This is most widely used software for the business of all sizes - small, medium and large. Minitab provides a quick, effective solution for the level of analysis required in most of the Six Sigma projects.

4.2 About Minitab Inc.

MiniTab Inc. is one of the dominant providers of the statistical software for quality improvement. A huge number of companies trust Minitab, thousands of colleges use Minitab software for teaching. MiniTab Inc. is a company headquartered in State College, Pennsylvania, with subsidiaries in the United Kingdom, France, and Australia.

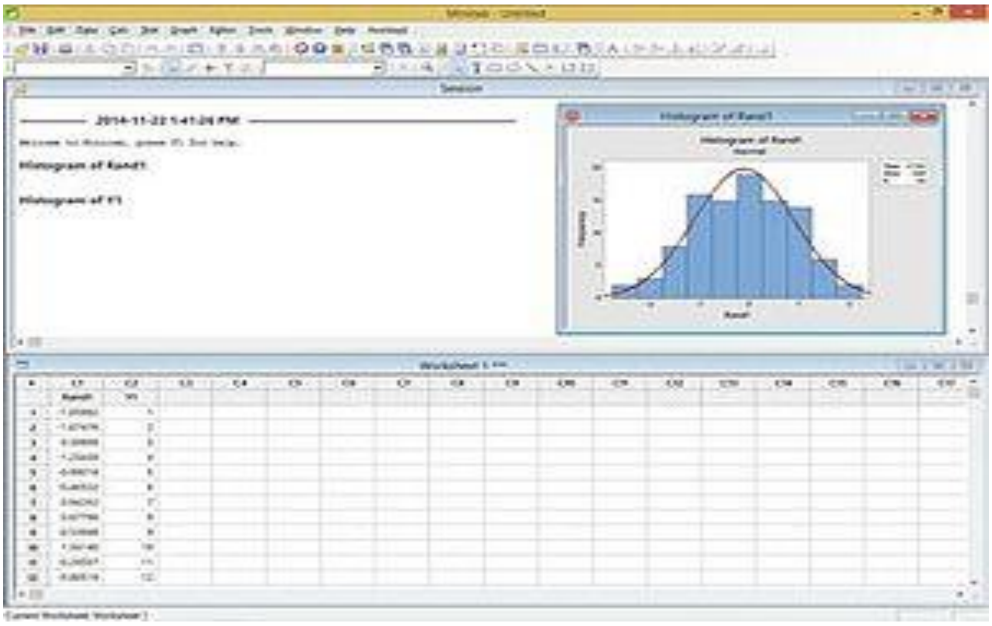


Fig. Basic Minitab

4.3 Lathe machine :

Medium Duty Lathe Machine

ID	Paricualars	Vasu-1	Vasu-2	Vasu-3
1	Length of Bed	1350 mm./ 4' – 6"	1600 mm./ 5' – 3"	1800 mm./ 6'
2	Admit Between Centre	522 mm.	750 mm.	978 mm.
3	Height of Centre	215 mm.	215 mm.	215 mm.
4	Width of Bed	270 mm.	270 mm.	270 mm.
5	Spindle Bore	52 mm.	52 mm.	52 mm.
6	Spindle Nose Dia/Threads	74.3 x 6 TPI	74.3 x 6 TPI	74.3 x 6 TPI
7	Taper Bore in Spindle	MT – 6	MT – 6	MT – 6
8	No of Spindle Speed/Range	6/40 to 470 mm.	6/40 to 470 mm.	6/40 to 470 mm.
9	Swing over Cross Slide	230 mm.	230 mm.	230 mm.
10	Swing over Bed	415 mm.	415 mm.	415 mm.
11	Tail Stock Spindle Morse Taper/DiaM.	MT – 4/50 mm.	MT – 4	MT – 4
12	No of Threads / Pitch	TPI 2 to 48	TPI 2 to 48	TPI 2 to 48
13	Electric Motor	2 HP.	2 HP.	2 HP.

Table of technical specification of lathe machine

CHAPTER 5

EXPERIMENTAL PROCEDURE:

Base readings:

C1	C2	C3	C4	C5	C6	C7	C8
Depth of cut (mm)	**Spindle speed (rpm)**	**Feed rate (mm/min)**	**Cuttting velocity(m/min)**	**MMR (mm^3/min)**	**SNRA1**	**Mean 1**	**Surface Roughness**
1.0	244	0.10	38.3274	3832.7	71.6702	3832.7	0.3
1.0	314	0.25	49.3230	12330.8	81.8198	12330.8	8.0
1.0	424	0.50	66.6018	333000.9	90.4499	333000.9	3.5
1.5	244	0.25	38.3274	14372.8	83.1508	14372.8	1.0
1.5	314	0.50	49.3230	36992.3	91.3622	36992.3	2.0
1.5	424	0.10	66.6011	9990.3	79.9915	9990.3	1.5
2.0	244	0.50	39.3274	38627.4	93.6702	38627.4	0.4
2.0	314	0.10	49.3230	9864.6	79.8816	9864.6	3.5
2.0	424	0.25	66.6011	333000.9	90.4491	333000.9	5.5

Table base readings

The following Procedure were carried –

- The specimens are turned on lathe machine .
- The Speed, Feed & Depth of Cut Required for Turning operation were first decided.
- We decided 3 speed, feed & depth of cut values.
- After that the Orthogonal Array was formed with the help of MINITAB Software.
- According to that Orthogonal Array, nine Turning Operations were carried out on CNC machine.
- The Surface Hardness testing was carried out for all the specimens.
- Then all the values of Surface roughness were put down in MINITAB software &Analyzed as the TAGUCHI design.
- After getting the graph, the optimum Solution was drawn.

5.1 Steps carried out in minitab:

Before using Minitab, we need to choose Independent factors such as Speed. Feed & Depth of Cut for the inner array and Dependent factors such as Surface Roughness for the outer array. Independent factors are factors we can control to optimize the process. Dependent factors are factors that can affect the performance of a system but are not in control during the intended use of the product.

Engineering knowledge should guide the selection of factors and responses. Minitab can help us design a Taguchi experiment that does not confound interactions of interest with each other or with main effects.

5.2 Experimental setup :

An experiment was conducted using work piece material SM45C. The bars used are of 20 mm diameter and 100 mm length. The cutting tool used was Cubic Boron Nitrite. CBN is the second only to diamond in the hardness. The tests were carried in a Conventional lathe. Three levels of cutting speed, feed and depth of cut were used and are shown in the following table:

Code	Process parameter	Levels		
		1	2	3
A	Cutting Speed, Vc	244	314	424
B	Feed, f	0.10	0.25	0.50
C	Depth of Cut, d/ t	1.0	1.5	2.0

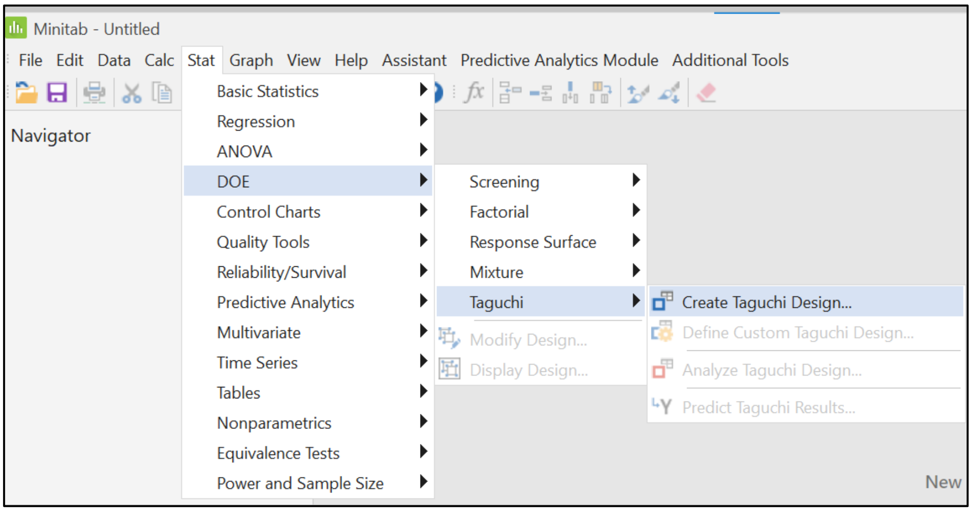
Table process parameters

5.3 Conducting a Taguchi designed experiment can have the following steps:

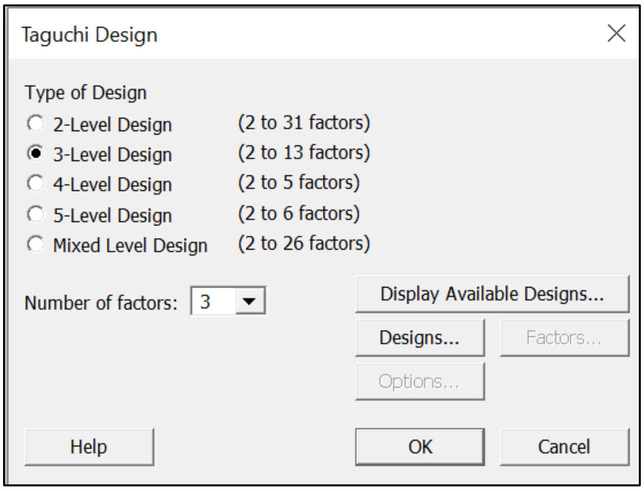
1. Choose **Stat** > **DOE** > **Taguchi** > **Create Taguchi Design** to generate a Taguchi design (orthogonal array). Each column in the orthogonal array represents a specific factor with two or more levels. Each row represents a run; the cell values identify the factor settings for the run. By default, Minitab's orthogonal array designs use the integers 1, 2, 3, to represent factor levels. If we enter factor levels, the integers 1, 2, 3, will be the coded levels for the design. We can also use **Stat** > **DOE** > **Taguchi** > **Define Custom Taguchi Design** to create a design

from data that we already have in the worksheet. **Define Custom Taguchi Design** lets specify which columns are our factors and signal factors. We can then easily analyse the design and generate plots.

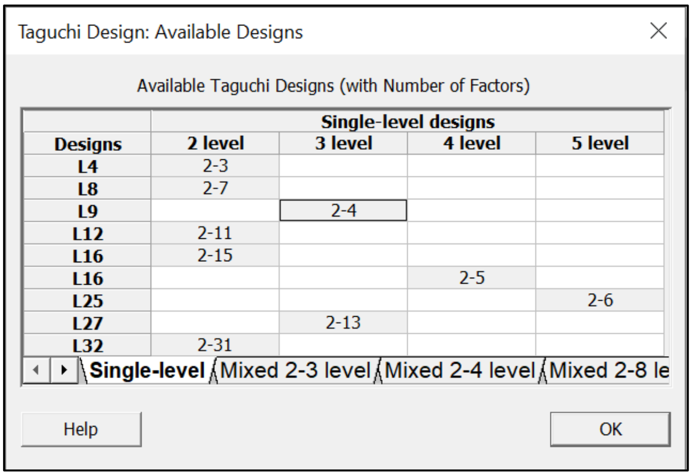
Step 1



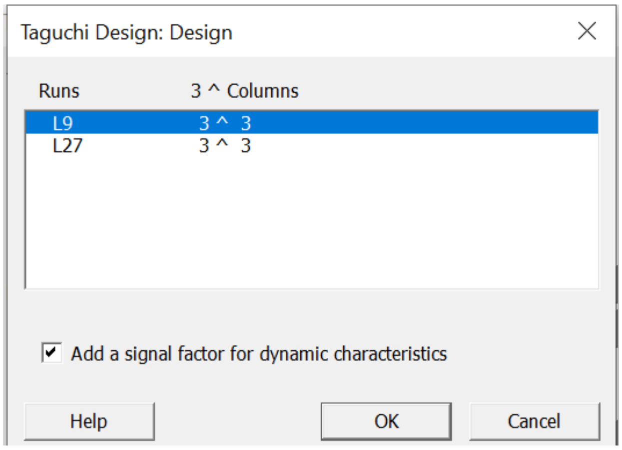
Step 2



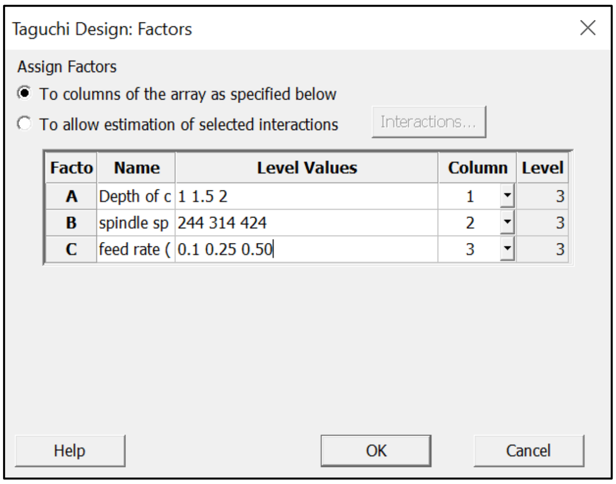
Step 3



Step 4



Step 5



Step 6

Taguchi Design

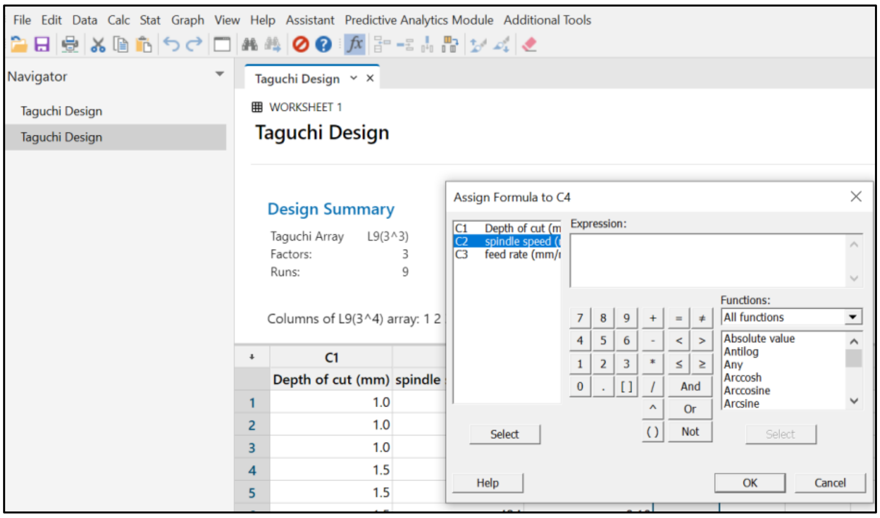
Design Summary

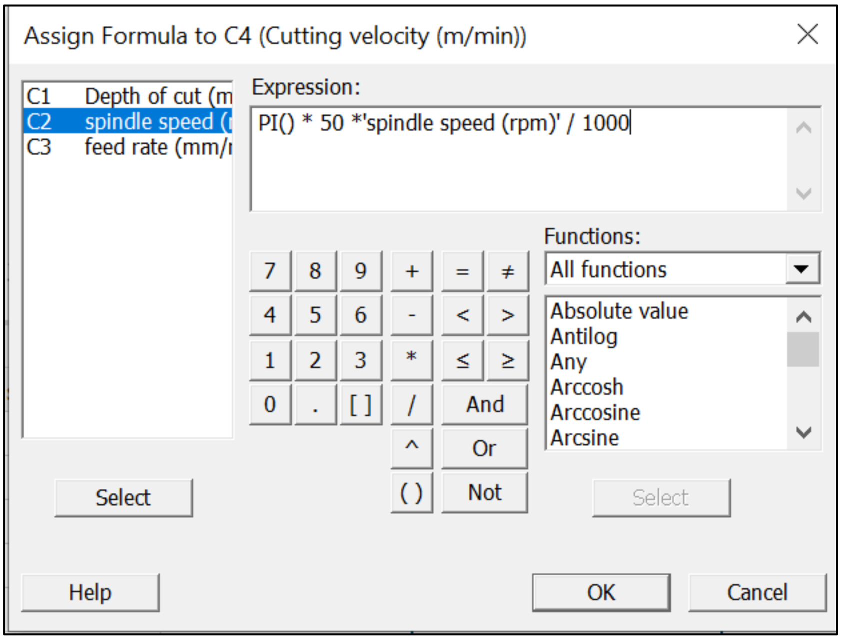
Taguchi Array	L9(3^3)
Factors:	3
Runs:	9

Columns of L9(3^4) array: 1 2 3

	C1	C2	C3
	Depth of cut (mm)	spindle speed (rpm)	feed rate (mm/min)
1	1.0	244	0.10
2	1.0	314	0.25
3	1.0	424	0.50
4	1.5	244	0.25
5	1.5	314	0.50
6	1.5	424	0.10
7	2.0	244	0.50
8	2.0	314	0.10
9	2.0	424	0.25

Calculation of Cutting Velocity & MRR





C1	C2	C3	C4
Depth of cut (mm)	spindle speed (rpm)	feed rate (mm/min)	Cutting velocity (m/min)
1.0	244	0.10	38.3274
1.0	314	0.25	49.3230
1.0	424	0.50	66.6018
1.5	244	0.25	38.3274
1.5	314	0.50	49.3230
1.5	424	0.10	66.6018
2.0	244	0.50	38.3274
2.0	314	0.10	49.3230
2.0	424	0.25	66.6018

Parameters

MRR = v f d

MRR = Material Removal Rate

v = Cutting Speed

f = Feed

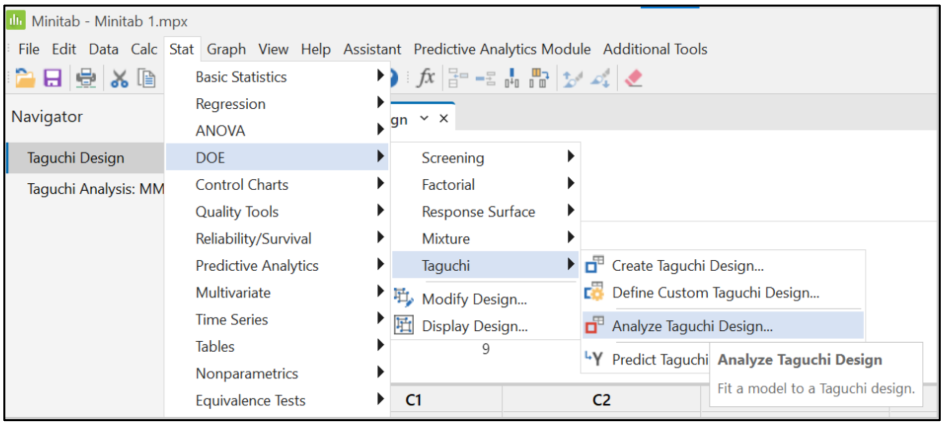
d = Depth of Cut

5.4 Results:

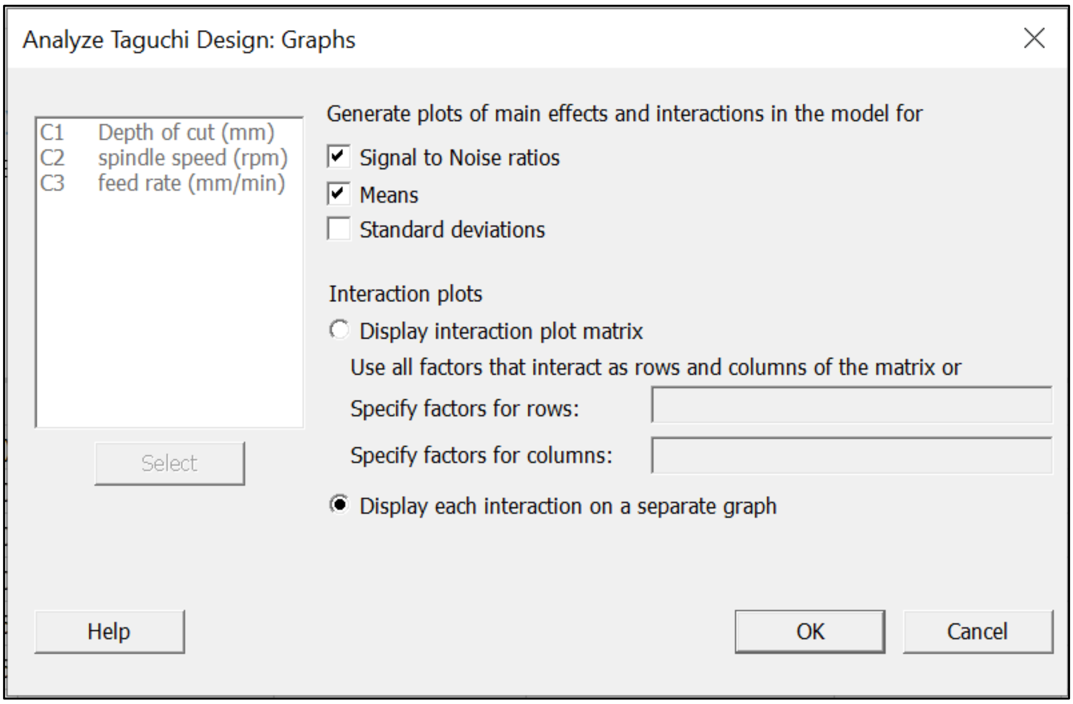
	C1	C2	C3	C4	C5
	Depth of cut (mm)	spindle speed (rpm)	feed rate (mm/min)	Cutting velocity (m/min)	MMR (mm^3/min
1	1.0	244	0.10	38.3274	3832.7
2	1.0	314	0.25	49.3230	12330.8
3	1.0	424	0.50	66.6018	33300.9
4	1.5	244	0.25	38.3274	14372.8
5	1.5	314	0.50	49.3230	36992.3
6	1.5	424	0.10	66.6018	9990.3
7	2.0	244	0.50	38.3274	38327.4
8	2.0	314	0.10	49.3230	9864.6
9	2.0	424	0.25	66.6018	33300.9

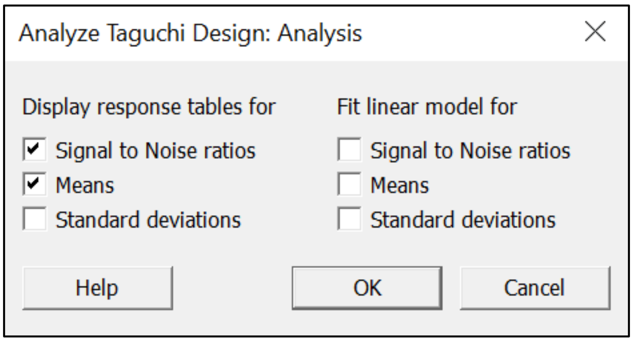
Table of results

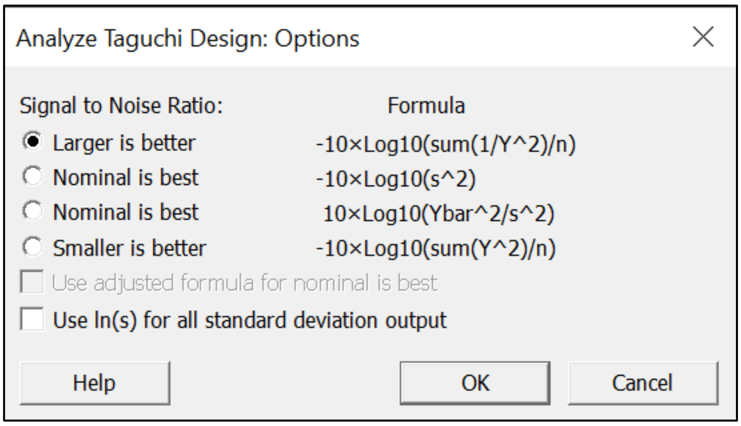
5.5 Analyze Taguchi design:

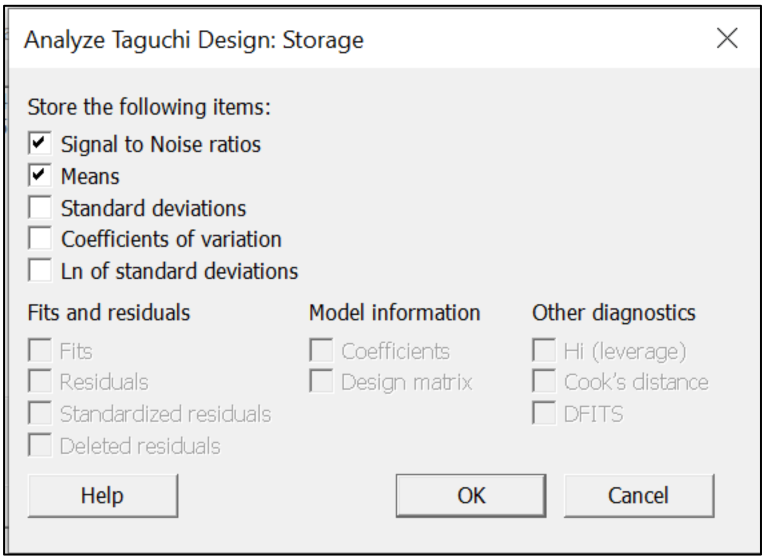


Enter the required settings by selecting Graphs, Analysis, Options and storage buttons

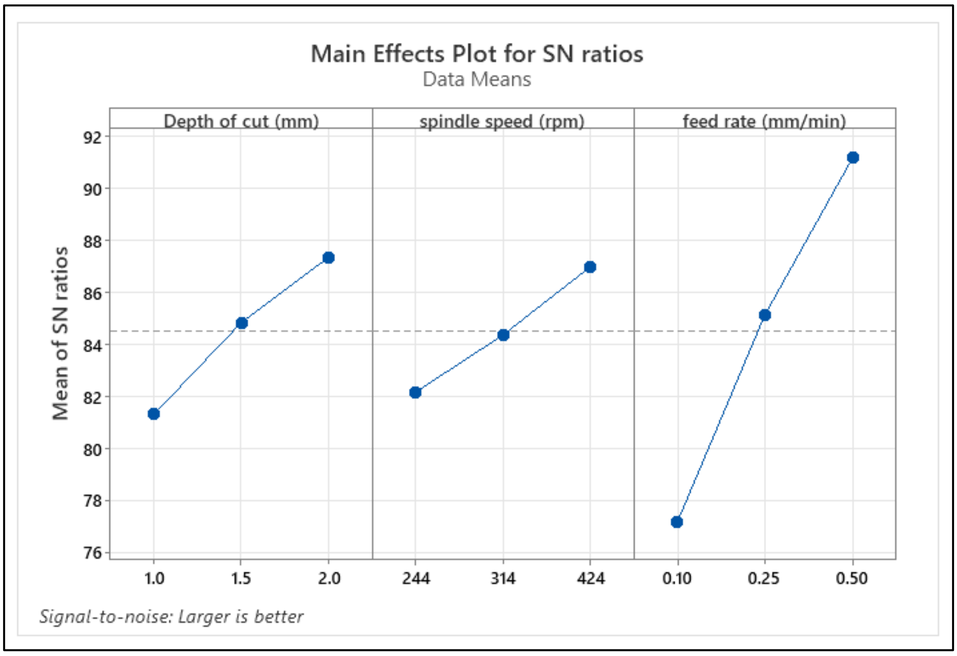



Analyze Taguchi Design: Analysis
Display response tables for
Signal to Noise ratios
Means
Standard deviations
Fit linear model for
Signal to Noise ratios
Means
Standard deviations
Help
OK
Cancel


Analyze Taguchi Design: Options
Signal to Noise Ratio:
Formula
Larger is better
-10×Log10(sum(1/Y^2)/n)
Nominal is best
-10×Log10(s^2)
Nominal is best
10×Log10(Ybar^2/s^2)
Smaller is better
-10×Log10(sum(Y^2)/n)
Use adjusted formula for nominal is best
Use ln(s) for all standard deviation output
Help
OK
Cancel


Analyze Taguchi Design: Storage
Store the following items:
Signal to Noise ratios
Means
Standard deviations
Coefficients of variation
Ln of standard deviations
Fits and residuals
Fits
Residuals
Standardized residuals
Deleted residuals
Model information
Coefficients
Design matrix
Other diagnostics
Hi (leverage)
Cook's distance
DFITS
Help
OK
Cancel

5.6 Graphs Obtained:



Graph of Main effects plot for SN ratios

By this graph, Depth of cut at 2 mm, Spindle speed at 424 rpm and Feed Rate at 0.50 mm/min gives largest S/N Ratio value and can be considered as least affected by uncontrolled factors.

5.7 Data obtained:

C1	C2	C3	C4	C5	C6	C7
Depth of cut (mm)	spindle speed (rpm)	feed rate (mm/min)	Cutting velocity (m/min)	MMR (mm^3/min	SNRA1	MEAN1
1.0	244	0.10	38.3274	3832.7	71.6702	3832.7
1.0	314	0.25	49.3230	12330.8	81.8198	12330.8
1.0	424	0.50	66.6018	33300.9	90.4491	33300.9
1.5	244	0.25	38.3274	14372.8	83.1508	14372.8
1.5	314	0.50	49.3230	36992.3	91.3622	36992.3
1.5	424	0.10	66.6018	9990.3	79.9915	9990.3
2.0	244	0.50	38.3274	38327.4	91.6702	38327.4
2.0	314	0.10	49.3230	9864.6	79.8816	9864.6
2.0	424	0.25	66.6018	33300.9	90.4491	33300.9

Table of data obtained

CHAPTER 6

TEST REPORTS FOR WORKPIECE

- **Work piece 1**

SAMVINSAN ENGINEERING

SAMVINSAN ENGINEERING Pvt Ltd

TEST REPORT

Company Name : Student 1	**REPORT NO :**	B- 036
	DATE OF RECEIPT	19.05.2023
	YOUR REF:	Letter
	TESTED DATE	19.05.2023
	DATE OF REPORT	19.05.2023
CLIENT:	**PAGE NO.**	1 of 1
TESTING AGENCY: SAMVINSAN ENGINEERING Pvt Ltd	**MALT. SPECIFICATION**	
LOCATION : SAMVINSAN ENGINEERING Pvt Ltd	**JOB NAME**	**MS Test Piece - 1**

Surface Roughness in Micron (Ra)

Make - Mitutoya	Model No - SJ-201	Instrument No. 730553
Sr No - 730553	Code No - 178-930-2D	Precision Ref. Specimen Code No : 178-601

Sr . No.	**Description**	**Surface Roughness in Micron (Ra)**	
		Observed Value	**Unit Of Measure**
1	**MS Test Piece - 1**	0.3	µm

Authorized Sign

SAMVINSAN Engineering Pvt. Ltd.
CIN: U74999PN2018PTC175036

Address: SR No. 363/1 Near Mahaveer Kunj Society, Santosh Nagar, Katraj
Pune - 411046. Maharashtra, India. Email - info@samvinsan.com

- **Work piece 2**

SAMVINSAN ENGINEERING

SAMVINSAN ENGINEERING Pvt Ltd

TEST REPORT

Company Name : Student 1		REPORT NO :	B-036
		DATE OF RECEIPT	19.05.2023
		YOUR REF:	Letter
		TESTED DATE	19.05.2023
		DATE OF REPORT	19.05.2023
CLIENT:		PAGE NO.	1 of 1
TESTING AGENCY: SAMVINSAN ENGINEERING Pvt Ltd		MALT. SPECIFICATION	
LOCATION : SAMVINSAN ENGINEERING Pvt Ltd		JOB NAME	MS Test Piece - 1

Surface Roughness in Micron (Ra)

Make - Mitutoya	Model No - SJ-201	Instrument No. 730553
Sr No - 730553	Code No - 178-930-2D	Precision Ref. Specimen Code No : 178-601

Sr . No.	Description	Surface Roughness in Micron (Ra)	
		Observed Value	Unit Of Measure
1	MS Test Piece - 1	8	µm

Authorized Sign

- **Work piece 3**

SAMVINSAN ENGINEERING Pvt Ltd

TEST REPORT

Company Name : Student 1	**REPORT NO :**	B- 036
	DATE OF RECEIPT	19.05.2023
	YOUR REF:	Letter
	TESTED DATE	19.05.2023
	DATE OF REPORT	19.05.2023
CLIENT:	**PAGE NO.**	1 of 1
TESTING AGENCY: SAMVINSAN ENGINEERING Pvt Ltd	**MALT. SPECIFICATION**	
LOCATION : SAMVINSAN ENGINEERING Pvt Ltd	**JOB NAME**	**MSTest Piece - 1**

Surface Roughness in Micron (Ra)

Make - Mitutoya	Model No - SJ-201	Instrument No. 730553
Sr No - 730553	Code No - 178-930-2D	Precision Ref. Specimen Code No : 178-601

Sr . No.	Description	Surface Roughness in Micron (Ra)	
		Observed Value	Unit Of Measure
1	MS Test Piece - 1	3.5	μm

Authorized Sign

SAMVINSAN Engineering Pvt. Ltd.
CIN: U74999PN2018PTC175036

Address: SR No. 363/1 Near Mahaveer Kunj Society, Santosh Nagar, Katraj
Pune - 411046. Maharashtra, India. Email - info@samvinsan.com

- **Work piece 4**

SAMVINSAN ENGINEERING

SAMVINSAN ENGINEERING Pvt Ltd

TEST REPORT

Company Name : Student 1	**REPORT NO :**	B- 036
	DATE OF RECEIPT	19.05.2023
	YOUR REF:	Letter
	TESTED DATE	19.05.2023
	DATE OF REPORT	19.05.2023
CLIENT:	**PAGE NO.**	1 of 1
TESTING AGENCY: SAMVINSAN ENGINEERING Pvt Ltd	**MALT. SPECIFICATION**	
LOCATION : SAMVINSAN ENGINEERING Pvt Ltd	**JOB NAME**	**MS Test Piece - 1**

Surface Roughness in Micron (Ra)

Make - Mitutoya	Model No - SJ-201	Instrument No. 730553
Sr No - 730553	Code No - 178-930-2D	Precision Ref. Specimen Code No : 178-601

Sr . No.	**Description**	**Surface Roughness in Micron (Ra)**	
		Observed Value	**Unit Of Measure**
1	**MS Test Piece - 1**	1	μm

Authorized Sign

SAMVINSAN Engineering Pvt. Ltd.
CIN: U74999PN2018PTC175036

Address: SR No. 363/1 Near Mahaveer Kunj Society, Santosh Nagar, Katraj
Pune - 411046. Maharashtra, India. Email - info@samvinsan.com

- **Work piece 5**

SAMVINSAN ENGINEERING

SAMVINSAN ENGINEERING Pvt Ltd

TEST REPORT

Company Name : Student 1	**REPORT NO :**	B- 036
	DATE OF RECEIPT	19.05.2023
	YOUR REF:	Letter
	TESTED DATE	19.05.2023
	DATE OF REPORT	19.05.2023
CLIENT:	**PAGE NO.**	1 of 1
TESTING AGENCY: SAMVINSAN ENGINEERING Pvt Ltd	**MALT. SPECIFICATION**	
LOCATION : SAMVINSAN ENGINEERING Pvt Ltd	**JOB NAME**	**MS Test Piece - 1**

Surface Roughness in Micron (Ra)

Make - Mitutoya	Model No - SJ-201	Instrument No. 730553
Sr No - 730553	Code No - 178-930-2D	Precision Ref. Specimen Code No : 178-601

Sr . No.	Description	Surface Roughness in Micron (Ra)	
		Observed Value	Unit Of Measure
1	MS Test Piece - 1	2	μm

Samvinsan Engineering Pune

Authorized Sign

SAMVINSAN Engineering Pvt. Ltd.
CIN: U74999PN2018PTC175036

Address: SR No. 363/1 Near Mahaveer Kunj Society, Santosh Nagar, Katraj
Pune - 411046. Maharashtra, India. Email - info@samvinsan.com

- **Work piece 6**

SAMVINSAN ENGINEERING

SAMVINSAN ENGINEERING Pvt Ltd

TEST REPORT

Company Name : Student 1		**REPORT NO :**	B- 036
		DATE OF RECEIPT	19.05.2023
		YOUR REF:	Letter
		TESTED DATE	19.05.2023
		DATE OF REPORT	19.05.2023
CLIENT:		**PAGE NO.**	1 of 1
TESTING AGENCY: SAMVINSAN ENGINEERING Pvt Ltd		**MALT. SPECIFICATION**	
LOCATION : SAMVINSAN ENGINEERING Pvt Ltd		**JOB NAME**	**MS Test Piece - 1**

Surface Roughness in Micron (Ra)

Make - Mitutoya	Model No - SJ-201	Instrument No. 730553
Sr No - 730553	Code No - 178-930-2D	Precision Ref. Specimen Code No : 178-601

Sr . No.	**Description**	**Surface Roughness in Micron (Ra)**	
		Observed Value	**Unit Of Measure**
1	**MS Test Piece - 1**	1.5	μm

Authorized Sign

SAMVINSAN Engineering Pvt. Ltd.
CIN: U74999PN2018PTC175036

Address: SR No. 363/1 Near Mahaveer Kunj Society, Santosh Nagar, Katraj
Pune - 411046. Maharashtra, India. Email - info@samvinsan.com

- **Work piece 7**

SAMVINSAN ENGINEERING

SAMVINSAN ENGINEERING Pvt Ltd

TEST REP0RT

Company Name : Student 1		**REPORT NO :**	B- 036
		DATE OF RECEIPT	19.05.2023
		YOUR REF:	Letter
		TESTED DATE	19.05.2023
		DATE OF REPORT	19.05.2023
CLIENT:		**PAGE NO.**	1 of 1
TESTING AGENCY: SAMVINSAN ENGINEERING Pvt Ltd		**MALT. SPECIFICATION**	
LOCATION : SAMVINSAN ENGINEERING Pvt Ltd		**JOB NAME**	**MS Test Piece - 1**

Surface Roughness in Micron (Ra)

Make - Mitutoya	Model No - SJ-201	Instrument No. 730553
Sr No - 730553	Code No - 178-930-2D	Precision Ref. Specimen Code No : 178-601

Sr . No.	**Description**	**Surface Roughness in Micron (Ra)**	
		Observed Value	**Unit Of Measure**
1	**MS Test Piece - 1**	0.2	µm

Authorized Sign

SAMVINSAN Engineering Pvt. Ltd.
CIN: U74999PN2018PTC175036

Address: SR No. 363/1 Near Mahaveer Kunj Society, Santosh Nagar, Katraj
Pune - 411046. Maharashtra, India. Email - info@samvinsan.com

- **Work piece 8**

SAMVINSAN ENGINEERING

SAMVINSAN ENGINEERING Pvt Ltd

TEST REPORT

Company Name : Student 1	**REPORT NO :**	B- 036
	DATE OF RECEIPT	19.05.2023
	YOUR REF:	Letter
	TESTED DATE	19.05.2023
	DATE OF REPORT	19.05.2023
CLIENT:	**PAGE NO.**	1 of 1
TESTING AGENCY: SAMVINSAN ENGINEERING Pvt Ltd	**MALT. SPECIFICATION**	
LOCATION : SAMVINSAN ENGINEERING Pvt Ltd	**JOB NAME**	**MS Test Piece - 1**

Surface Roughness in Micron (Ra)

Make - Mitutoya	Model No - SJ-201	Instrument No. 730553
Sr No - 730553	Code No - 178-930-2D	Precision Ref. Specimen Code No : 178-601

Sr . No.	Description	Surface Roughness in Micron (Ra)	
		Observed Value	Unit Of Measure
1	MS Test Piece - 1	3.5	µm

Authorized Sign

SAMVINSAN Engineering Pvt. Ltd.
CIN: U74999PN2018PTC175036

Address: SR No. 363/1 Near Mahaveer Kunj Society, Santosh Nagar, Katraj
Pune - 411046. Maharashtra, India. Email - info@samvinsan.com

- **Work piece 9**

SAMVINSAN ENGINEERING

SAMVINSAN ENGINEERING Pvt Ltd

TEST REPORT

Company Name : Student 1	**REPORT NO :**	B- 036
	DATE OF RECEIPT	19.05.2023
	YOUR REF:	Letter
	TESTED DATE	19.05.2023
	DATE OF REPORT	19.05.2023
CLIENT:	**PAGE NO.**	1 of 1
TESTING AGENCY: SAMVINSAN ENGINEERING Pvt Ltd	**MALT. SPECIFICATION**	
LOCATION : SAMVINSAN ENGINEERING Pvt Ltd	**JOB NAME**	**MS Test Piece - 1**

Surface Roughness in Micron (Ra)

Make - Mitutoya	Model No - SJ-201	Instrument No. 730553
Sr No - 730553	Code No - 178-930-2D	Precision Ref. Specimen Code No : 178-601

Sr . No.	Description	Surface Roughness in Micron (Ra)	
		Observed Value	Unit Of Measure
1	MS Test Piece - 1	5.5	µm

Samvinsan Engineering Pune

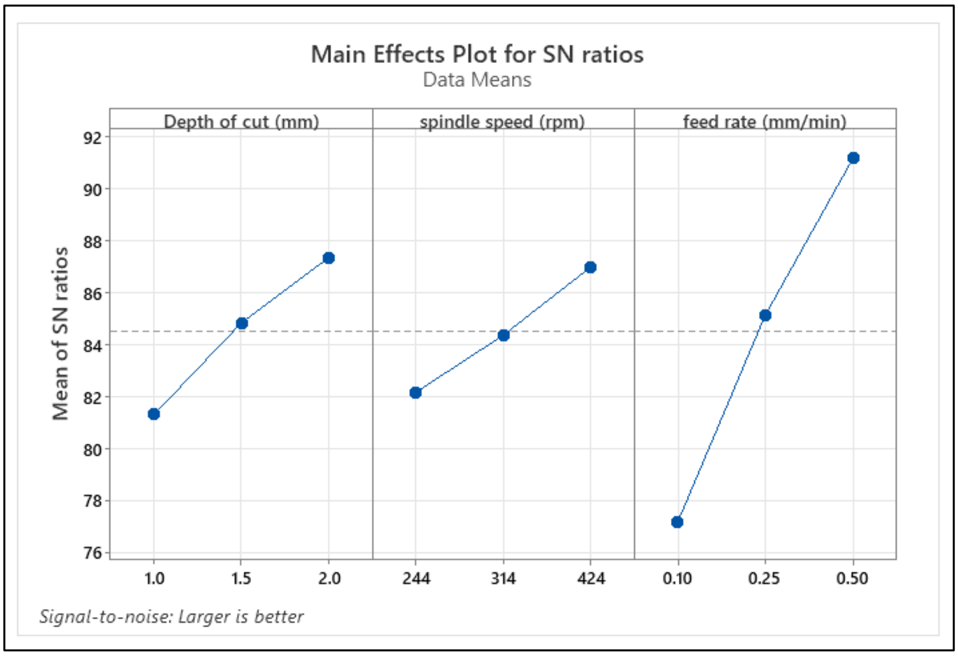
Authorized Sign

SAMVINSAN Engineering Pvt. Ltd.
CIN: U74999PN2018PTC175036

Address: SR No. 363/1 Near Mahaveer Kunj Society, Santosh Nagar, Katraj
Pune - 411046. Maharashtra, India. Email - info@samvinsan.com

CHAPTER 7

RESULT AND CONCLUSION:



Graph of mean of SN ratio

By this graph, Depth of cut at 2 mm, Spindle speed at 424 rpm and Feed Rate at 0.50 mm/min giving MRR 38327.4 mm3 /min gives largest S/N Ratio value and can be considered as least affected by uncontrolled factors.

C1	C2	C3	C4	C5	C6	C7	C8
Depth of cut (mm)	**Spindle speed (rpm)**	**Feed rate (mm/min)**	**Cuttting velocity(m/min)**	**MMR (mm^3/min)**	**SNRA1**	**Mean 1**	**Surface Roughness**
1.0	244	0.10	38.3274	3832.7	71.6702	3832.7	0.3
1.0	314	0.25	49.3230	12330.8	81.8198	12330.8	8.0
1.0	424	0.50	66.6018	333000.9	90.4499	333000.9	3.5
1.5	244	0.25	38.3274	14372.8	83.1508	14372.8	1.0
1.5	314	0.50	49.3230	36992.3	91.3622	36992.3	2.0
1.5	424	0.10	66.6011	9990.3	79.9915	9990.3	1.5
2.0	244	0.50	38.3274	38327.4	91.6702	38327.4	0.2
2.0	314	0.10	49.3230	9864.6	79.8816	9864.6	3.5
2.0	424	0.25	66.6011	333000.9	90.4491	333000.9	5.5

- **Conclusion:** The goal of the project was to improve the surface roughness of propeller shaft (SM45) by parameter optimization using Taguchi method. Before optimization the surface roughness value was 0.3 microns for operating parameters, depth of cut 1.0, spindle speed 244 rpm, feed rate 1.10 mm/min, MRR 3832.7 we have opted Taguchi method (L9) array to find out optimum parameters. After study we are able to improve surface roughness by 67% (successfully achived surface roughness of 0.2 microns) with optimized parameters; depth of cut 2.0mm, spindle speed 244 rpm, feed rate 0.5 mm/min and MRR 38327.4 mm^3/min.

Photograph of finalized specimen

PLAN OF PROPOSED WORK:

Sr. No	Activity/month	June/July	Aug	Sept	Oct	April
1	Search of topic					
2	Selection of topic and research papers					
3	Literature review					
4	Problem Identification And Objectives					
5	Study of Taguchi method & MINITAB Software					
6	Specimens are turned on lathe machine					
7	Surface roughness testing of all specimen					
8	MINITAB software &Analyzed as the TAGUCHI design					
9	Optimum Solution was drawn					
10	Rough draft of report					
11	Final report & paper					

REFERENCES

1. Jakhale Prashant P, Jadhav B. R. Prashant et al, " OPTIMIZATION OF SURFACE ROUGHNESS OF ALLOY STEEL BY CHANGING OPERATIONAL PARAMETERS AND INSERT GEOMETRY IN THE TURNING PROCESS International Journal of Advanced Engineering Research and Studies E-ISSN2249–8974
2. Youcef ABIDI "Correlation Analysis between Tool Wear, Roughness and Cutting Vibration in Turning of Hardened Steel "Engineering Transactions, 69(4): 403–421, 2021, doi: 10.24423/EngTrans.1263.20211210
3. Martoni "Analysis Of Damage And Improvement Of Sledge Cross On Ghb-1340g Lathe Machine "Turkish Journal of Computer and Mathematics Education Vol.12 No.8 (2021)963-972
4. Ng Chin Fei, " Practical Applications of Taguchi Method for Optimization of Processing Parameters for Plastic Injection Moulding: A Retrospective Review"Volume 2013 | Article ID 462174 | https://doi.org/10.1155/2013/462174
5. Melesse Workneh Wakjira "Analysis of CSN 12050 Carbon Steel in Dry Turning Process for Product Sustainability Optimization Using Taguchi Technique" Hindawi Journal of Engineering Volume 2019, Article ID 7150157, 10 pages https://doi.org/10.1155/2019/7150157
6. Mahesh Gopal " Factors Affecting and Optimization Methods used in Machining Duplex Stainless Steel - A Critical Review "Journal of Engineering Science and Technology Review 14 (2) (2021) 119 - 135
7. Arun Kumar Parida " Multiresponse Optimization of Process Parameters in Turning of GFRP Using TOPSIS Method " Hindawi Publishing Corporation International Scholarly Research Notices Volume 2014, Article ID 905828, 10 pages http://dx.doi.org/10.1155/2014/905828
8. Ahmet Hasçalık " Optimization of turning parameters for surface roughness and tool life based on the Taguchi method" Int J Adv Manuf Technol (2008) 38:896–903 DOI 10.1007/s00170-007-1147-0

9. Xianzhen Huang " An approach for optimization of turning parameters considering uncertainty parameters "Int J Adv Manuf Technol DOI 10.1007/s00170-017-0748-5
10. Tamizharasan, T., Senthilkumar, N., Selvakumar, V. *et al.* Taguchi's methodology of optimizing turning parameters over chip thickness ratio in machining P/M AMMC. *SN Appl. Sci.* **1**, 160 (2019). https://doi.org/10.1007/s42452-019-0170-8
11. Pardeep Saini " Optimization of end milling parameters for rough and finish machining of Al-4032/3%SiC metal matrix composite " by Pardeep Saini Eng. Res. Express 3 (2021) 045009 https://doi.org/10.1088/2631-8695/ac2e11
12. H. Akkus " Experimental and statistical investigations of surface roughness, vibration, and energy consumption values of titanium alloy during machining using response surface method and grey relational analysis "Scientia Iranica B (2022) 29(1), 109{119 doi: 10.24200/sci.2021.57548.5296