Experimental And Optimization of CNC Lathe Machine By Using Taguchi Method

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Abstract - *In order to maintain a competitive edge, modern firms depend on their production staff and assembly architects to precisely and quickly set up assembly procedures for new products. When it comes to improving the efficiency and quality of assembly operations, Taguchi Parameter Design is both a powerful and effective method and a competent tool. performing tasks that entail fine-tuning the CNC machine's input or process settings for improved output. Technologically, economically, and intellectually, it has been fine-tuned. In the course of this work, we reviewed a number of scholarly investigations on the use of CNC machines for a wide variety of materials and machining processes. I chose MILD STEEL (MS) as the material under operation for my project because of its accessibility, low cost, and wide variety of uses across many different sectors. Using Minitab 2015, I will analyse my findings statistically by calculating the means and signal-to-noise ratios for each turning action. For each turning operation, MILD STEEL (MS) will employ a L9 orthogonal array to select a set of values. In my project, I will optimise the feed rate, depth of cut, and spindle speed by examining these process parameters in millimetres per revolution, millimetres, and revolutions per minute, respectively. I will select a range of values for the inquiry process parameters that will lead to an optimised surface roughness using a L9 orthogonal array.*

Keywords: **CNC, Mild Steel, Taguchi method, Minitab.**

1. INTRODUCTION

Machines that use computer numerical control (CNC) technology include plotters, vinyl cutters, 3D printers, milling machines, and welding equipment. Computer Numerically Controlled, or CNC for short, means that the machine's actual motions are dictated by data sent from a computer, like coordinate locations. In common parlance, a "CNC Machine" is a piece of machinery that uses a cutting tool that spins on at least three axes (X, Y, and Z) to carve out shapes or patterns in a variety of materials. The focus here is on what are officially known as "CNC Routers," but the details covered should be useful for any CNC milling or engraving equipment as well.

2. OBJECTIVE

➢ The primary goal of this project is to create a data model for the interface of the CNC for turning interface. Because a preliminary analysis revealed that many manual interactions obstruct the automatic flow of data and that the process reliance of data is extremely high, technology grinding was ruled out.

➢ The prototype implementation of the developed interface for the other technologies should be tested at the CAM and CNC levels, and the prototypes should be tested and validated on real machines with appropriate workpieces (s). The data model should be fixed in an international standard after validation.

➢ The current study examines how different CNC parameters, including feed rate, depth of cut, and speed, impact the surface roughness of final components. Using a CNC lathe and Taguchi's method, the experiments were carried out on MILD STEEL (MS) material. One of the parameters that is output is surface roughness.

3. DESIGN OF EXPERIMENT

3.1 Different Techniques of DOE

1. Factorial design
2. Response Surface Method
3. Mixture Experiments
4. Taguchi Design

3.2 Objective of Taguchi Method

To improve process and product design, Taguchi is looking for easily controllable factors and their settings that reduce product response variability while maintaining a desired mean response. By adjusting those parameters to their sweet spots, we may make the product more resistant to variations in both operating and environmental circumstances. Removing the bed effect rather than the cause of the bed effect allows for more stable and high-quality goods to be obtained during the Taguchi parameter design stage. In addition, the method can save money and eliminate wasted goods by systematically applying it at the pre-production stage (off line), which means fewer tests are needed to determine cost-effective process conditions.

Input parameters

- Factor A : Speed (rpm)
- Factor B : Feed Rate (mm/min)
- Factor C : Depth of Cut (mm)

Output Parameter

Surface Roughness (Ra)

Table-1: Process Parameter Level

Parameters	Level1	Level2	Level3
Speed (rpm)	600	1100	1600
Feed Rate (mm/min)	0.11	0.16	0.21
Depth of Cut (mm)	0.4	0.6	0.9

Table-2: Taguchi Design Factor

Ex. No.	Speed (rpm)	Feed Rate (mm/min)	Depth of Cut (mm)
1.	600	0.11	0.4
2.	600	0.16	0.6
3.	600	0.21	0.9
4.	1100	0.11	0.6
5.	1100	0.16	0.9
6.	1100	0.21	0.4
7.	1600	0.11	0.9
8.	1600	0.16	0.4
9.	1600	0.21	0.6

4. EXPERIMENTAL WORK AND RESULTS

Fig-1: CNC Machine

Fig-2: Workpiece after turned

Table-3: Results Table

Ex. No.	Speed (rpm)	Feed Rate (mm/min)	Depth of Cut (mm)	Surface Roughness (μm)
1	600	0.11	0.4	0.714
2	600	0.16	0.6	0.546
3	600	0.21	0.9	1.886
4	1100	0.11	0.6	0.553
5	1100	0.16	0.9	0.894
6	1100	0.21	0.4	2.189
7	1600	0.11	0.9	0.727
8	1600	0.16	0.4	1.075
9	1600	0.21	0.6	1.452

Table-4: SN ratio for surface roughness

Ex.No.	Surface Roughness (μm)	S/N Ratio
1	0.714	2.92604
2	0.546	5.25615
3	1.886	-5.51083
4	0.553	5.14550
5	0.894	0.97325
6	2.189	-6.80492
7	0.727	2.76931
8	1.075	-0.62817
9	1.452	-3.23933

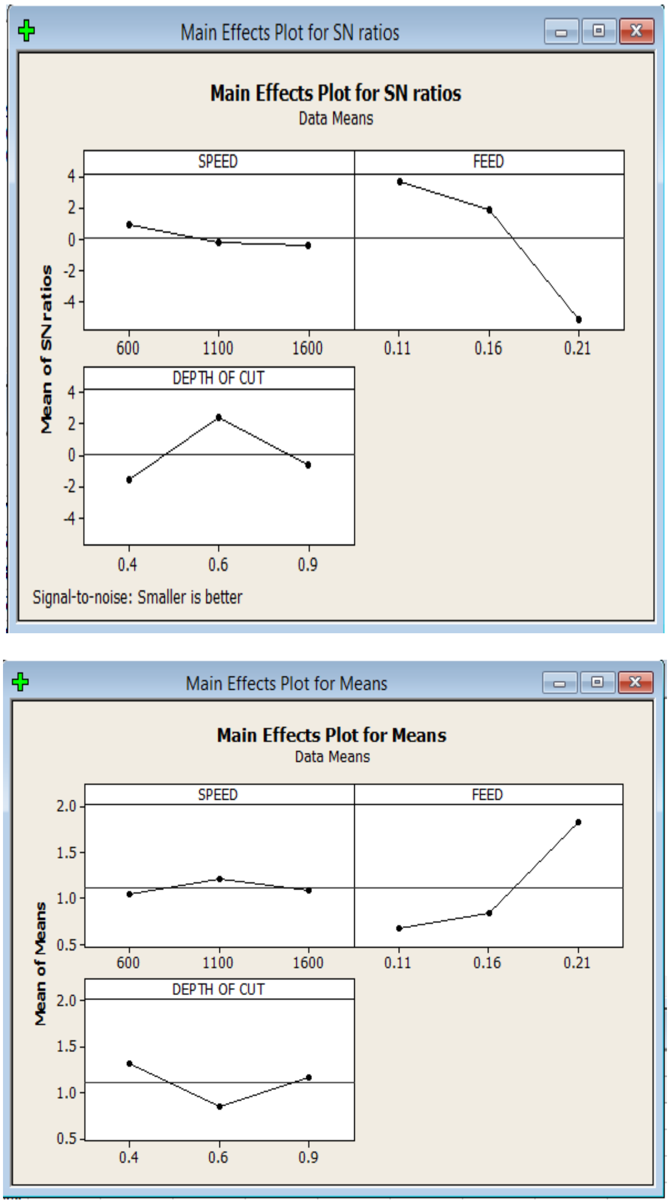

Fig-3: Minitab-16 Analysis Surface Roughness

Surface roughness is the output parameter of the tests that were planned using a CNC lathe machine. The input parameters are feed rate, depth of cut, and speed.

Minitab generates a response table for every response metric, including the mean, signal-to-noise ratio, and others. The response table shows which factors have the biggest influence on the response and which level of factors are associated with greater or lower response characteristic values.

First place goes to factor B because of its high value, second place goes to component C because of its second-highest value, and third place goes to factor A because of its low value relative to the other factors.

Graphs are created from the values in the answer tables. The S/N ratio and factor levels are displayed on the Y-axis of this graph. The goal of these graphs is to achieve the S/N ratio values displayed in the figure above to the best of our ability.

Level 1 (600 rpm) has a better signal-to-noise ratio for factor A (speed), as seen in the previous figure.

At level 1 (0.11 mm/min), the signal-to-noise ratio is higher for factor B (feed rate). The signal-to-noise ratio is higher at level 2 (0.6 mm) for factor C (cutting depth).

5. CONCLUSION

The following inferences are possible from the current experimental investigation's results:

A study was conducted to analyse the surface roughness of MILD STEEL (MS) material. By changing the feed rate, depth of cut, and speed, we may conduct experiments with the L9 orthogonal array. In order to analyse the experimental data, Minitab 16 was utilised. The analysis has led to the following conclusion. When compared to other characteristics, feed rate is the most important one. Experimental results show that the optimal combination of speed (1100 rpm), feed rate (0.21 mm/rev), and depth of cut (0.4 mm) produces the roughest surface, while the optimal combination of speed (600 rpm), feed rate (0.16 mm/rev), and depth of cut (0.6 mm) yields the smoothest surface. To achieve the best results, we ran the experiment on a CNC machine set to 600 rpm, with a feed rate of 0.11 mm/min and a depth of cut of 0.6 mm.

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