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Optimization of Cutting Parameter for Non-ferrous Materials through Taguchi Technique for CNC Turning

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ABSTRACT

The surface quality provided by machining techniques is one of the most important variables in determining the components' functional performance and, as a result, their fatigue life time. The results of surface characterization of a part produced by high-speed turning with the best combinations of input parameters such as spindle speed (rpm), feed rate, depth of cut, material removal rate, adequate coolant flood, tool geometry, work piece clamping, material composition, chip formations, and the corresponding output size precision, circularity, and better surface finish will be presented in this project. The significance of machining parameters in the study was determined by a series of machining tests on specimens, and the Taguchi technique (orthogonal array) was modified for the trials. A confirmation test was carried out using the best possible combination of cutting parameters. The surface damages and other surface flaws caused by the machining operations were evaluated on the machined samples. The link between turning parameters and surface roughness is investigated in this study in order to identify the impact of various parameters on the machined surface quality. By doing so, real production time is saved, processing efficiency is implemented, and resource consumption in the actual production process is lowered, resulting in increased process capability.

Keywords- Taguchi, Turning, Cutting factor, Optimization,Surface roughness

INTRODUCTION

Taguchi's parameter design is a systematic approach for optimising numerous parameters in terms of performance, quality, and cost in order to achieve optimal machining parameters for CNC turning.Surface roughness is an important indicator of a product's technological excellence and a component that has a significant impact on manufacturing costs. The quality of the surface has a substantial impact on the turning performance, since a high-quality turned surface improves fatigue strength, corrosion resistance, and creep life. Surface roughness also has an impact on surface friction, light reflection, lubricant retention, and electrical and thermal contact resistance. As a result, the intended surface roughness value for a particular part is usually specified, and specific techniques are used to attain the given finish.Ra, Rz, and Rq measurements are used to estimate surface roughness. There have been numerous research advancements in surface roughness modelling and machining parameter optimization in recent years.

OBJECTIVE OF WORK

The aims in this study are attention on

- To optimize the process cutting parameters viz. Cutting Speed, feed rate Spindle speed as well as depth of cut.
- To see the influencing contribution of each process parameter over the surface quality.
- To reduce the variations in dimensional geometry and achieve improvement in surface roughness along with better dimension conformance in CNC turning operation.
- To establish the redundant manufacturing system so that to improve the process capability after finalizing the optimized process parameters.

METHODOLOGY

To investigate the effect of the selected factors on the surface roughness of nonferrous material specimen Taguchi L9 OA (Orthogonal Array) Design Of Experiment method has been selected. We run experiments for this goal and analyse the results in order to improve the plan. Steps in Taguchi's Single-Objective Optimization Methodology Experiment Preparation, Identify the issue, Selection of factors and level, Orthogonal Array Selection (OA), Experimenting with the Results Experiment Results Analysis, Statistical Analysis and Interpretation of Experiment Results Then there's the Optimal

Condition Determination and the Confirmation Run.

DATA COLLECTION AND ANALYSIS OF DATA

Table 4.1 Orthogonal Array (Design Matrix) of Al

Worksheet 1 ***

↓	C1	C2	C3
	SPEED	FEED	DEPTH OF CUT
1	80	0.100	0.5
2	80	0.050	1.0
3	80	0.012	1.5
4	160	0.100	1.0
5	160	0.050	1.5
6	160	0.012	0.5
7	660	0.100	1.5
8	660	0.050	0.5
9	660	0.012	1.0

Response Table for Signal to Noise Ratios
Smaller is better

Level	SPEED	FEED	DEPTH OF CUT
1	-4.275	-2.380	-3.402
2	-4.051	-4.545	-6.611
3	-7.317	-8.719	-5.630
Delta	3.266	6.339	3.209
Rank	2	1	3

Main Effects Plot for SN ratios

Worksheet 1 ***

↓	C1	C2	C3	C4	C5	C6	C7
	SPEED	FEED	DEPTH OF CUT	SURFACE ROUGHNESS	SNRA1	SNRA2	
1	80	0.100	0.5	1.99	-5.9771	-5.9771	
2	80	0.050	1.0	2.00	-6.0206	-6.0206	
3	80	0.012	1.5	1.10	-0.8279	-0.8279	
4	160	0.100	1.0	2.49	-7.9240	-7.9240	
5	160	0.050	1.5	1.55	-3.8066	-3.8066	
6	160	0.012	0.5	1.05	-0.4238	-0.4238	
7	660	0.100	1.5	4.10	-12.2557	-12.2557	
8	660	0.050	0.5	1.55	-3.8066	-3.8066	
9	660	0.012	1.0	1.97	0.2646	-5.8893	
10							

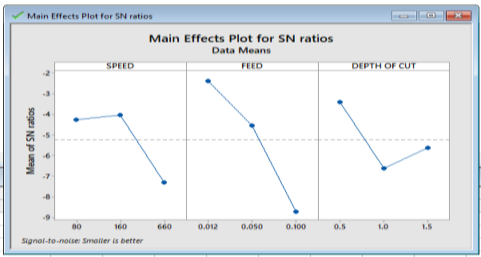


Figure 4.1 ANOVA for Aluminium

Table 4.2 Orthogonal Array (Design Matrix) of Brass

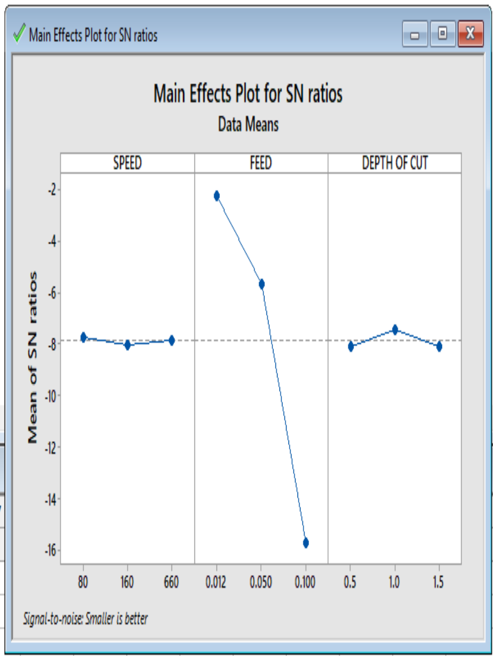
Worksheet 1 ***

↓	C1	C2	C3
	SPEED	FEED	DEPTH OF CUT
1	80	0.100	0.5
2	80	0.050	1.0
3	80	0.012	1.5
4	160	0.100	1.0
5	160	0.050	1.5
6	160	0.012	0.5
7	660	0.100	1.5
8	660	0.050	0.5
9	660	0.012	1.0

Response Table for Signal to Noise Ratios
Smaller is better

Level	SPEED	FEED	DEPTH OF CUT
1	-7.711	-2.199	-8.082
2	-8.044	-5.662	-7.451
3	-7.854	-15.748	-8.076
Delta	0.333	13.549	0.631
Rank	3	1	2

Main Effects Plot for SN ratios



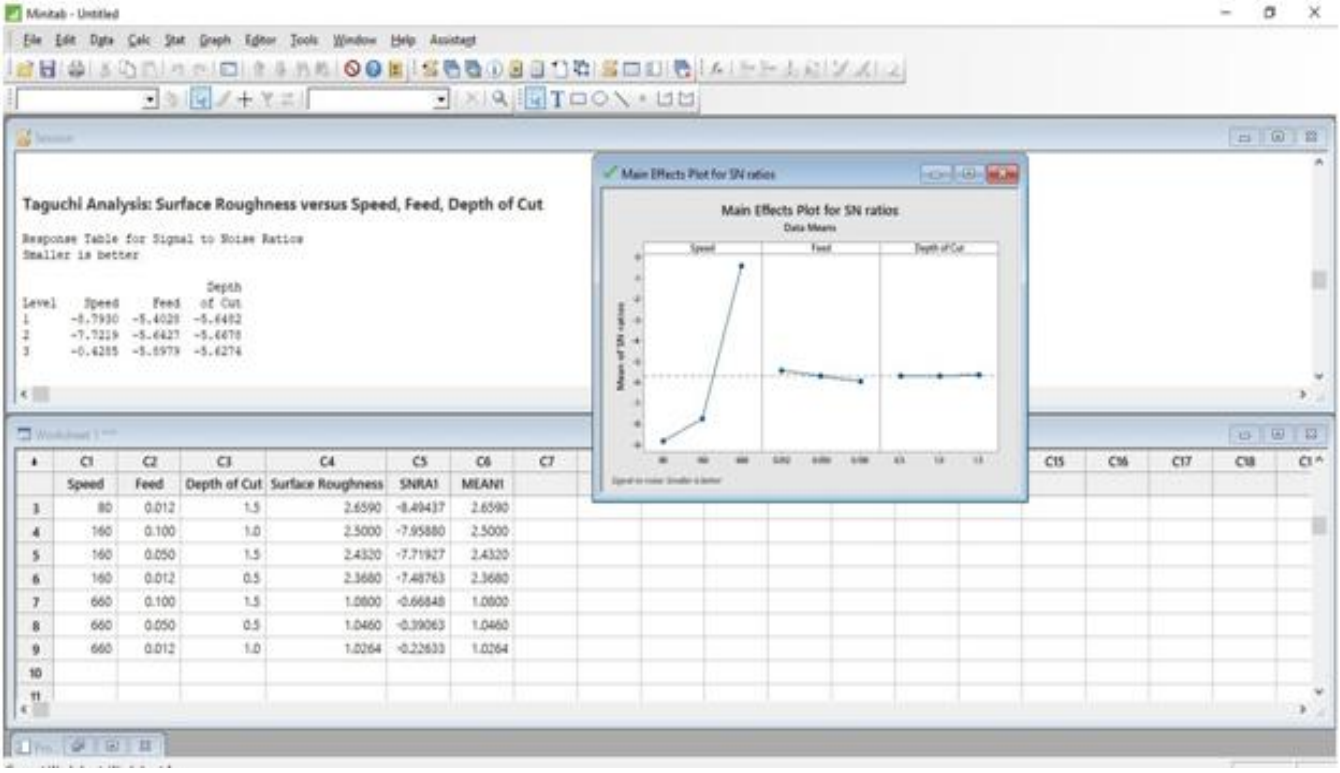
Worksheet 1 ***

↓	C1	C2	C3	C4	C5
	SPEED	FEED	DEPTH OF CUT	SURFACE ROUGHNESS	SNRA1
1	80	0.100	0.5	6.09	-15.6923
2	80	0.050	1.0	1.84	-5.2964
3	80	0.012	1.5	1.28	-2.1442
4	160	0.100	1.0	5.89	-15.4023
5	160	0.050	1.5	1.98	-5.9333
6	160	0.012	0.5	1.38	-2.7976
7	660	0.100	1.5	6.42	-16.1507
8	660	0.050	0.5	1.94	-5.7560
9	660	0.012	1.0	1.21	-1.6557

Table 4.3 Orthogonal Array (Design Matrix) of Copper

Worksheet 1 ***

↓	C1	C2	C3
	SPEED	FEED	DEPTH OF CUT
1	80	0.100	0.5
2	80	0.050	1.0
3	80	0.012	1.5
4	160	0.100	1.0
5	160	0.050	1.5
6	160	0.012	0.5
7	660	0.100	1.5
8	660	0.050	0.5
9	660	0.012	1.0



CONCLUSION

This study concludes optimized process parameters such that cutting speed, feed and depth of cut in CNC turning operation of non-ferrous materials (Al,Cu & Brass) for getting better surface finish and geometrical dimensional conformance. In this experimental study spindle speed, feed rate and depth of cut taken as Control (input) Parameters and the surface roughness was treated as Response Parameter.

1) Input parameter setting of spindle speed 160 rpm, feed rate 0.012 mm/rev , and depth of cut 0.5 mm has been given the optimum result for **aluminium.**

2) Input parameter setting of spindle speed 80 rpm, feed rate 0.012 mm/rev, and depth of cut 1.0 mm has been given the optimum result for the **brass** material.

3) Input parameter setting of spindle speed 660 rpm, feed rate 0.012 mm/rev , and depth of cut 1.0 mm has been given the optimum result for the **Copper** material was turned on CNC lathe.

The better combination of levels and factors (cutting parameters) – for Aluminum A2 B1 C3 for Brass A3 B1 C2 and for Copper specimen A1 B2 C3.

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