An Investigation Effect of Machining Parameters on CNC ROUTER

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***Abstract* - In this paper we have study on CNC Router, influence of various machining parameters like, tool speed (rpm), tool feed (mm/min), and depth of cut (mm). In the present study, experiments are conducted on Composite material of Acrylic resin and Aluminium TriHydrate with three levels and three factors to optimize process parameter and surface roughness. An L9 (3*3) Taguchi standard orthogonal array (OA) is chosen for design of experiments and the main influencing factor are determined for each given machining criteria by using Analysis of variance (ANOVA). The surface finish have been identified as quality attributes and are assumed to be directly related to productivity. In this experiment we were found that order of significant of main parameter decreasing order is Tool feed, Tool speed and Depth of cut.**

***Keywords* - CNC Router, Surface roughness (SR), Taguchi methodology, ANOVA**

I. INTRODUCTION

A CNC router is a computer controlled machine used to cutting, engraving, carving etc. for various materials, such as wood, composites, aluminium, steel, plastics, and foams. A CNC router will enable the cutter to be placed at any point guided by 3 axes of motion simultaneously. That means it can move the cutter left-right, from-to, or up-down all at the same time. A CNC router is very similar in concept to a CNC milling machine. The tool paths can be controlled via computer numerical control.

The composite material of Acrylic resin and Aluminium TriHydrate which is known as corian has much application in Furniture and decorative product making industries. Also now a day companies need to replace wood with lighter and good appearance material like Corian. So it is important to know the machining behaviour of Corian material.

Fig.1 CNC Router Machine

Increasing the productivity, the quality of the machined parts and good appearance are the main challenges of Furniture making industry. There has been increased interest in monitoring all aspects of the machining process. Quality of machining can be judged by surface roughness. Higher the surface finish higher will be the quality. Surface finish depends on 1.Cutting speed 2. Depth of cut 3.feed mostly. Speed, Feed and Depth of cut are the parameters that can be adjusted in machining operation. Most of the operators use trial and error method to find the appropriate cutting condition. It is not the effective way to find out optimal cutting parameters. So the main objective of the study is to find the optimum parameters (speed, feed, depth of cut) so that surface roughness is optimized. Taguchi technique is easy to understand and also easy to implement amongst all the techniques.

II. LITERATURE REVIEW

Siripen Supadarattanawong and Supasit Rodkwan[1] has studied series of machining processes of parawood were carried out on a CNC router to investigate the effect of various machining parameters such as spindle speed, feed rate and depth of cut on the surface quality of parawood machined surface using the Design of Experiment (DOE) and statistical methodologies. Hiren et

al.[2] discussed taguchi's robust design method is suitable to optimize the surface roughness of Aluminium material on CNC end milling and find out tool feed is most significant factor for surface finish. Pinki Maurya et al [3] implement the Taguchi methodology for milling on AL6351 –T6. taguchi design to optimize surface quality in a CNC face milling operation. PATEL K. P [4] used taguchi design to optimize surface quality in a CNC end milling process. Amit et al [5] has studied and discussed an application of the Taguchi method for investigating the effects of cutting parameters on the surface finish in CNC end milling for aluminium cast heat-treatable alloy material.

II. METHODOLOGY

Taguchi Method

Taguchi Method is developed by Dr. 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. The S/N ratio takes both the mean and the variability into account. The S/N ratio is the ratio of the mean (Signal) to the standard deviation (Noise). The ratio depends on the quality characteristics of the product/process to be optimized. The standard S/N ratios generally used are as follows: - Nominal is Best (NB), Lower the Better (LB) and Higher the Better 68 (HB). The optimal setting is the parameter combination, which has the highest S/N ratio. In this study lower the better is used.

Experimental Detail

- Workpiece Material: Composite of Acrylic Resin and Aluminium TriHydrate(ATH) Tool Material: HSS End milling cutter (6 mm Dia)
- The test is performed on work piece of 254mm x 40 mm. 9 grooves of 6mm x 3mm are cut on wokpiece using 6mm dia HSS End mill cutter as per the DOE.
- Surface roughness measurement is done offline with is done at INDO-GERMAN TOOL ROOM, Ahmedabad by Handy Surf E 35-A roughness tester.
- Process parameters and their levels

Table 1: Factors and Levels

	LEVEL		
FACTOR	**1**	**2**	**3**
Spindle Speed (rpm)	8000	10000	12000
Feed (mm/min)	1000	2000	3000
Depth of cut (mm)	0.75	1	1.5

Experimental Procedure

Taguchi method is used to optimize the machining parameters. There are 3 variables speed, feed and depth of cut and each variable are at 3 levels. Total number of degree of freedom for above experimental design is 7. For 7 degree of freedom system Taguchi array L9 is used (Table 2).

Table:2 Taguchi's L_9 Orthogonal Array

Sr. No	Spindle Speed (rpm)	Tool Feed (mm/min)	Depth of cut (mm)
1	8000	1000	0.75
2	8000	2000	1
3	8000	3000	1.5
4	10000	1000	1
5	10000	2000	1.5
6	10000	3000	0.75
7	12000	1000	1.5
8	12000	2000	0.75
9	12000	3000	1

In figure 2 the arrangement of the work piece on the CNC Router (LX 1325) before the machining of the grooves shown. The surface roughness is measured by surface roughness tester Handy Surf E 35-A is shown in figure 4.
In Table 3 the value of Ra measured by surface roughness tester is shown.

Fig. 2 Workpiece on CNC Router before machining

Fig. 3 Workpiece on CNC Router after machining

Figure 4: Surface finish measurement

Table: 3 Experimental Results

Exp. no	Spindle speed (rpm)	Feed (mm/min)	Depth of Cut (mm)	Surface Roughness (µm)	S/N Ratio
1	8000	1000	0.75	1.24	-1.86843
2	8000	2000	1.00	1.09	-0.74853
3	8000	3000	1.50	1.71	-4.65992
4	10000	1000	1.00	0.93	0.63034
5	10000	2000	1.50	1.63	-4.24375
6	10000	3000	0.75	1.77	-4.95947
7	12000	1000	1.50	0.79	2.04746
8	12000	2000	0.75	1.05	-0.42379
9	12000	3000	1.00	1.17	-1.36372

After performing experiment parameter are optimized by using Minitab software. Here Minitab 16 is used to optimize cutting parameter. Step by step procedure of Minitab is presented below.

1. Stat → DOE → Taguchi → Create Taguchi Design. In first step enter the number of factors, number of variables. Inner array will be created automatically. Enter the responses (outer array) correspondingly.
2. Stat→ DOE→ Taguchi → Analyse Taguchi Design. In second step, the design is analysed. Here generate the graphs for main effects and interaction in model for S/N ratio and for Means. Also generate the response table for S/N ratio and response table model for means.
3. Stat→ DOE→ Taguchi→ Predict Taguchi results.

After completion of the process for ANOVA table, response table for signal to noise ration and graph of main effects for S/N and for Means are generated.

Analysis Of Variance for Means(ANOVA)

The output characteristic, surface finish is analysed by software Minitab 16 and ANOVA is formed, which shows the percentage contribution of each influencing factor on surface roughness. This also signifies that which factor is more predominant in CNC ROUTER. Main effect plots for means and Main effect plots for SN ratios are plotted by help of software Minitab 16.

Table 4: Analysis of variance for means

Source	DF	Seq SS	Adj SS	Adj MS	F Value	P Value
Spindle Speed	2	0.3208	0.3208	0.1604	10.45	0.087
Tool Feed	2	0.4762	0.4762	0.2381	15.52	0.061
Depth of Cut	2	0.1828	0.1828	0.0914	5.96	0.144
Error	2	0.0306	0.0306	0.0153		
Total	8	1.0106				

From above table it can be seen that all the three factors are significantly affects the response. Feed has highest effect on response, speed has second highest effect on response and depth of cut has effect on output response.

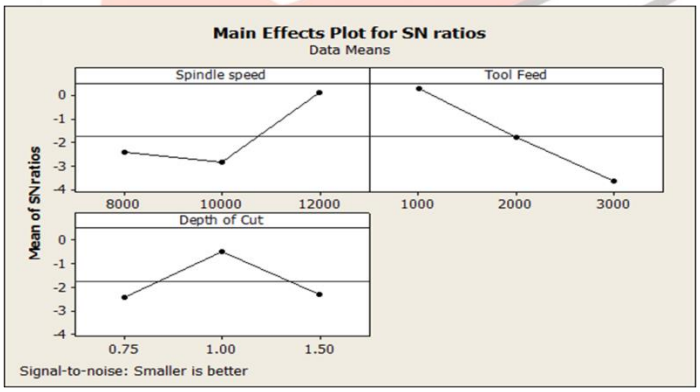

Figure 5: Main effect plot for S/N ratio

The above graph represents the main effect plot for signal to noise ratio. The type of plot is "smaller is better."

Table 4: Response Table for S/N Ratio

Level	Spindle speed	Tool Feed	Depth of Cut
1	-2.42563	0.26979	-2.41723
2	-2.85763	-1.80536	-0.49397
3	0.08665	-3.66103	-2.28541
Delta	2.94428	3.93082	1.92326
Rank	2	1	3

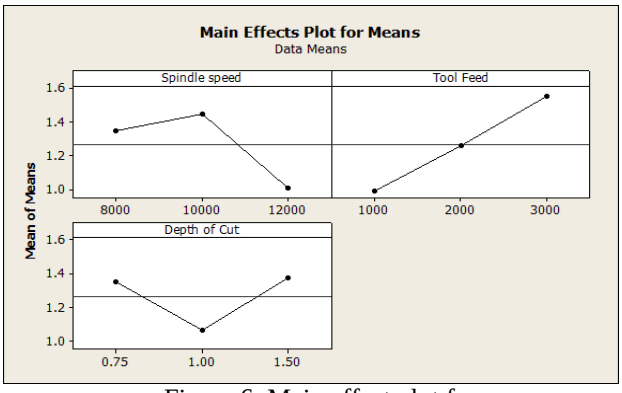

Figure 6: Main effect plot for means

The above graph represents the main effect plot for means.

Table 5: Response table from Mean

Level	Spindle speed	Tool Feed	Depth of Cut
1	1.3467	0.9867	1.3533
2	1.4433	1.2567	1.0633
3	1.0033	1.5500	1.3767
Delta	0.4400	0.5633	0.3133
Rank	2	1	3

IV. RESULTS AND DISCUSSION

1. From the graph of S-N ratio it can be observed that optimal value of surface finish is obtained at first level of Tool feed, third level of Spindle speed and second level of Depth of cut.
2. Optimal value of surface finish is 0.79 µm.
3. From the ANOVA it can be seen that percentage contribution of feed rate is maximum and it means Feed rate is the most dominating factor for modelling surface finish.
4. Taguchi robust design is suitable for modelling surface finish in CNC Router.

REFERENCES

[1] Siripen Supadarattanawong and Supasit Rodkwan, "An Investigation of the Optimal Cutting Conditions in Parawood Machining Process on a CNC Wood Router"-Kasetsart J. (Nat. Sci.) 40 : 311 - 319 (2006)

[2] Prof. Bharat S Patel , Mr Hiren Pal "Optimization of Machining Parameters For Surface Roughness In Milling Operation" International Journal of Applied Engineering Research, ISSN 0973-4562 Vol.7 No.11 (2012)

[3] Maurya, Dr. Pankaj Sharma, Bijendra Diwaker- "Implementation of Taguchi methodology to Optimization of CNC end milling process parameters of AL6351 –T6" International Journal of Modern Engineering Research (IJMER) Vol. 2, Issue. 5, Sep.-Oct. 2012, pp-3530-3533

[4] Patel K. P. "Experimental analysis on Surface Roughness of CNC End Milling process using Taguchi Design Method"-Vol. 4 No.02 February 2012

[5] J.Pradeep Kumar, K.Thirumurugan "Optimization of machining parameter for Titanium using Taguchi Method" International Journal of Advanced Engineering Technolog, E-ISSN 0976-3945, IJAET/Vol.III/ Issue II/April-June, 2012/108-113