Literature review and Optimization of Process parameters for machining different materials with CNC

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***Abstract*—This paper discuss of literature review of different materials on CNC. Today CNC technology has major contribution in industries. CNC machines are main platform in the contribution of good quality products in industries [15]. Basically CNC machines are automated operating machines which are based on code letters, numbers and special characters. The numerical data required for manufacturing a part provided by machine is called CNC (Computer Numerical Controlled).**

***Keywords*— CNC, SR, MRR, Taguchi, optimization.**

I. Introduction

The development of computer aided design and manufacturing system is evolving to the phase of integrated manufacturing systems, which is oriented towards the need of 21st century. Efforts are made to maintain and improve the vitality of manufacturing system. Keeping it as center stone of all economic activities and ensuring that manufacturing remains an attractive industrial area.Optimization of corporate activities in computer integrated manufacturing (CIM) and CAPP in one of the greatest targets of the system. Since it has been believed that only those industries capable of effective manufacturing would withstand international and global competition. A CNC (Computer Numerical Controlled) machine is controlled by motors by using computers. In the modern machining the challenge is mainly focused on quality in terms of surface finishing. Surface texture is concerned with geometric irregularities. The quality of surface is most significant for any product. The surface roughness is main affecting thing such as for contact causing surface friction, wearing, holding the lubricant etc. There are many factors which affect the surface roughness (SR) and material removal rate (MRR), i.e. tool (material, nose radius, geometry, tool vibration), work piece (hardness, mechanical properties), cutting condition (speed, feed, depth)etc. New products have been generally designed to be produced on three axis CNC machining centers from cubical billets. It is not sufficient to device a feasible procedure for manufacture of desired component. The procedure must be economically justified. Cutting conditions may be established which give satisfactory results.

II. LITERATURE REVIEW

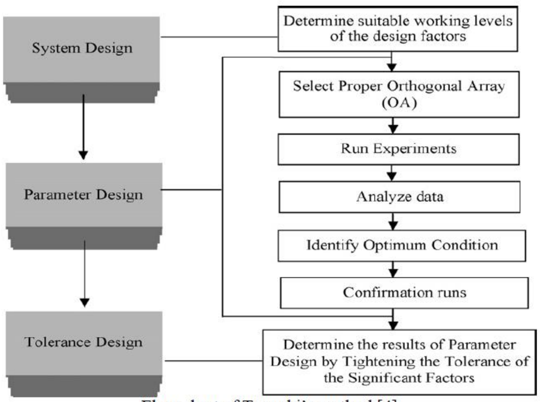
Prajapati et al. [1]have optimized the machining parameters for SR and MRR in CNC turning.SS 316 (austenite steel) work material of Ø 45 mm and length 35 mm was used in turning in dry environment conditions.In this study, the effect and optimization of machining parameters (cutting speed, feed rate and depth of cut) on SR and MRR is investigated. An L27 Orthogonal array, analysis of variance (ANOVA) and grey relation analysis is used. Chandrasekaran et al.[2] studied the machinability of AISI 410 on CNC lathe for SR using taguchi method. The effect and optimization of machining parameters on SR is investigated. L27 Orthogonal array, analysis of variance (ANOVA) are used in this investigation. The experiment was conducted on FANUC CNC lathe. Work material of Ø 32 mm and length 60 mm was used. Benardos et al. [3] studied a neural network modelling approach for the prediction of surface roughness in CNC face milling. Taguchi design of experiments method is used and MATLAB version 5.3.0.10183 (R11) program was used to create, train and test the ANNs.. Zhang et al. [4] investigated the Taguchi design application to optimize surface quality in a CNC face milling operation. An orthogonal array of L9 was used and ANOVA analyseswere carried out to identify the significant factors affecting surface roughness. CNC Mill: Fadal VMC-40 vertical machining centre was used for this experiment and 19.1×38.1×76.2 mm aluminium blocks as a work piece. The experimental results indicate that in this study the effects of spindle speed and feed rate on surface were larger than depth of cut for milling operation.

III. Cutting Process variables

Cutting speed and cutting feed: The process of metal cutting or machining of metal work-piece is influenced greatly by the relative velocity between the work-piece and the edge of the cutting tool. The relative movement in the machining operations is produced by the combination of rotary and translator movement either of the work-piece or of the cutting tool or both. Thetranslator displacement of the cutting edge of the tool along the work surface during a given period of time is called 'feed', while the rate of traverse of the work surface past the cutting edge is designated as 'cutting speed'. The presence of these motions e.g., feed and cutting speed permits the exertion of the process of cutting continuously. In machine tools with rotary priming cutting motion, the cutting speed is given by: $V = \pi DN$ m/min. 1000 where D is diameter of the milling cutter(mm) N is the cutter rotational speed in rpm.

IV. TAGUCHI METHODOLOGY

Traditionally design methods are too complex and difficult to use. A large number of experimental works has been done when the process parameters are increased with their levels. To solve this problem Taguchi method is used with a design of orthogonal arrays to study the all parameters. Taguchi Method is developed by Dr.Genichi Taguchi, a Japanese quality management consultant. It is an efficient tool for the design of high quality manufacturing system. The main advantage of this method to reduce the experimental time and find out significant factor. Taguchirobust design method is a most powerful tool for the design of a high quality system. He considered three steps in a process's and product's development: system design, parameter design, and tolerance design. In system design, the engineer uses scientific and engineering principles to determine the fundamental configuration. In the parameter design step, the specific values for system parameters are determined. Tolerance design is used to determine the best tolerances for the parameters [17].Taguchi's orthogonal array provides the set of experimental data (less number of experimental runs) and Taguchi's S/N ratio is the logarithmic function of desired output. The objective of using S/N ratio as a performance measurement is to develop products and processes insensitive to noise factors. The steps suggested by Taguchi are:



Flow chart of Taguchi's method [4]

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

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

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.

Material Removal Rate (MRR): Material removal rate (MRR) is defined as the material is removed per unit time. Its unit is mm3/sec. MRR = V*f*d mm3/sec V = Cutting Speed (in mm/sec) f = Tool feed (in mm) d = Depth of cut (in mm)

Surface Roughness: Surface roughness is defined as a group of irregular waves in the surface, measured in micrometers. It is produced by the fluctuations of short wavelengths characterized by asperities (local maxima) and valleys (local minima) of varying amplitudes and spacing. Surface roughness is defined by various characteristics of the surface profile such as center-line average R. peak-to-valley height Hand average roughness depth, but these have limitations. The randomness of the profile is no measured by any of these parameters. The randomness of the surface profile causes the roughness value to vary under the given cutting conditions and is caused by the random nature of the mechanism of formation of the built-up edge, side flow and tool wears.There are various methods used for the roughness measurement such as stylus profilometry, light sectioning and taper sectioning methods, scanning electron microscopy and transmission electron microscopy etc.

V. CONCLUSION

From the above discussion we found that most of the researchers had taken input parameters (speed, feed, depth of cut) and in some cases other parameters such as nose radius, environment etc. and facing output parameters SR, MRR. From the literature review it is found that for surface roughness the most significant parameters are speed, feed and nose radius and least significant parameter is DOC and for MRR the most significant parameters are DOC, feed and speed and least significant parameter is nose radius.In this paper, studied the different approaches for the machining parameters with the optimum utilization of these parameters. Now these days these parameters play a very vital role for the machining and utilized in the industries.

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