A literature review on machining of different materials with CNC

Er. Manpreet Singh[1], Er. SanjeevVerma[2], Dr. Sanjiv Kumar Jain[3]
[1]M.Tech. Student, Punjab, Technical University, India
[2]Asstt. Prof., PCET, Lalru, India
[3]Prof. & Head of Department, Ambalacollege of Engg., Devsthali, India

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 21stcentury. 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.

Gologlu et al. [5] studied about pocket milling which is often encountered in plastic mould manufacture. The implementation and selection of cutting path strategies with appropriate cutting parameters have significant effect on surface roughness. The aim of this study is to investigate optimum cutting characteristics of DIN 1.2738 mould steel using high-speed steel end mills.

Joshi et al.[6] Investigated the SR response on CNC milling by Taguchi technique. Analysis of variance (ANOVA) was used in this investigation. The material used for the experiment is (100 x 34 x 20 mm) 5 blocks of aluminium cast heat-treatable alloy. The output characteristic, surface finish is analysed by software Minitab 15 and ANOVA is formed, which shows the percentage contribution of each influencing factor on surface roughness.

Kothiyal et al.[7]performing experiment for optimized the parameter for MRR using Taguchi methodology and ANOVA. The L9 Orthogonal array is used in MINITAB 15 which shows the percentage contribution of each influencing factor on MRR.The material used for the experiment is (100 x 34 x 20 mm) blocks of aluminium cast heat-treatable alloy.

Yang et al. [8] studied the surface roughness on end milling with gene expression programming. In this research, a method based on gene expression programming (GEP) has been proposed to construct the prediction model of surface roughness. GEP combines the advantages of the genetic algorithm (GA) and genetic programming (GP).

Reddy et al.[9]optimized the parameters forsurface roughness using response surface methodology and genetic algorithm.The work piece material used for the present investigation is P20 mould steel of flat work pieces of 100mm ×100mm ×10mm.Pre-hardened steel (P20) is a widely used material in the production of moulds/dies due to less wear resistance and used forlarge components.The experiments were conducted using Taguchi's L50 orthogonal array in the design of experiments by considering the machining parameters such as Nose radius, Cutting speed, feed, axial depth of cut and radial depth of cut.

Kromanis et al. [10]studied to develop a technique to predict a surface roughness of part to be machined. 3D surface parameters give more precise picture of the surface, therefore it is possible more precisely to evaluate the surface parameters according to technological parameters. In result of the study, the mathematical model of end-milling is achieved and qualitative analysis is maintained. Achieved model could help technologists to understand more completely the process of forming surface roughness.

Bajic et al.[11] performed the machining process for optimized the parameters for SR in face milling. Test samples made of carbon steel St 52-3 with dimensions 230x100x100 mm were used in experiments. The parameters cutting speed, depth of cut and feed on machined surface roughness in face milling process have been examined. The results of the performed research show that both feed and cutting speed influence on surface roughness but the feed is the most influential factor.

Chockalingam et al.[12]studied the effect of different coolant conditions on milling of AISI 304 stainless steel.Cooling methods used in this investigation were flooding of synthetic oil, water-based emulsion, and compressed cold air. Cutting forces and the surface roughness were studied and tool flank wears observed. In this study, the comparison between different coolants effect to the milling of AISI 304 stainless steel is done.

Routara et al.[13] investigated the optimization of parameters using response surface method. For this research three different materials 6061-T4 aluminium, AISI 1040 steel and medium leaded brass UNS C34000 were used. For this research he used the ANOVA approach and F test. Thakkar et al.[14] optimized of Process Parameters for Surface Roughness and Material Removal Rate for SS 410 Material.All experiment conduct on CNC turning and the output parameters are MRR & SR is predicted by ANOVA.

Newman et. al [15] studied the CNC places the most important place in industries. CNC has an efficient role in production. He studied that CNC is basically platform of industries, which is basic function of CAD/CAM/CIM. In this research author shows the CNC and working of CNC in manufacturing system.

III.   CUTTING PROCESS VARIABLE
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:

$$V = \frac{\pi DN}{1000} \text{ m/min.}$$

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:
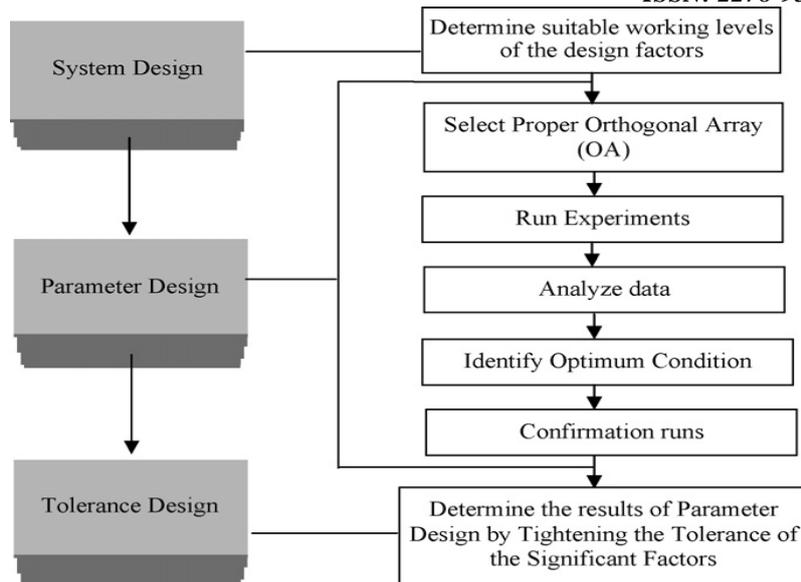
Flow chart of Taguchi's method [4]

Material Removal Rate (MRR): Material removal rate (MRR) is defined as the material is removed per unit time. Its unit is mm^3/sec.

MRR = V*f*d mm^3/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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