MANTECH Publications

Journal of Advance Manufacturing System and Technology
Volume 2, Issue 1, January-June, 2017

Review Paper on Optimization of Process Parameters for CNC Turning

Swapnil Jagade[1], Pankaj Patole[2], Sumit Patil[3], Suraj Pawar[4], Shalaka kulkarni[5], Omkar Kulkarni[6]

Research Scholars[1, 2, 3, 4], Assistant Professor[5, 6]

Department of Mechanical Engineering

Zeal College of Engineering & Research,

Savitribai Phule Pune University, India

Corresponding Authors: *swapniljagade96@gmail.com[1], pankaj14patole@gmail.com[2], psuraj091@gmail.com[3], patil.sumit007@gmail.com[4], omkar.kulkarni@zealeducation.com[5], Shalaka.kulkarni@zealeducation.com[6]*

Abstract

The main purpose of today's manufacturing industries is to produce low cost, high quality products in short time. They mainly focused on achieving high quality, in term of part accuracy, surface finish, high production rate etc. So, the selection of optimal cutting parameters is a very important issue for every machining process in order to reduce the machining costs and increase the quality of machining products. This paper shows the literature review of a detail study on process parameter optimization in turning process using CNC. This study will help in understanding how the input process parameters of CNC affect on the response variables. One of the technique widely used for optimization of machining parameters is Taguchi and ANOVA approach help to determine which parameters are most significant.

Keywords: *Optimization, Taguchi method, ANOVA, Surface roughness, Material removal rate.*

1. INTRODUCTION

Turning is the removal of metal from the outer diameter of a revolving cylindrical work piece. Turning is used to reduce the diameter of the work piece, usually to a specified dimension, and to produce a smooth finish on the metal. Cutting speed, feed rate, depth of cut, tool-work piece

material, tool geometry and coolant conditions are the turning input parameters which highly affect the response variables. In CNC turning, various response variables like surface roughness, material removal rate, chip methodology etc. are involved. It is necessary to increase tool life, to improve surface finish, to reduce cutting force in turning operations through an optimization study. Among these all, surface roughness and material removal rate plays the most important role in the performance of a turning process. The settings of turning parameters depend on the experience of operators. It is difficult to achieve the greatest performance of a machine because there are so many adjustable machining parameters. In order to minimize these machining problems, there is a need to find optimum cutting conditions for CNC turning. Meanings of the important parameters are as follows-

1.1 Input parameters-

Cutting speed-The cutting speed is the speed at which the circumference of the work part moves along the cutter and is normally given in mm/min.

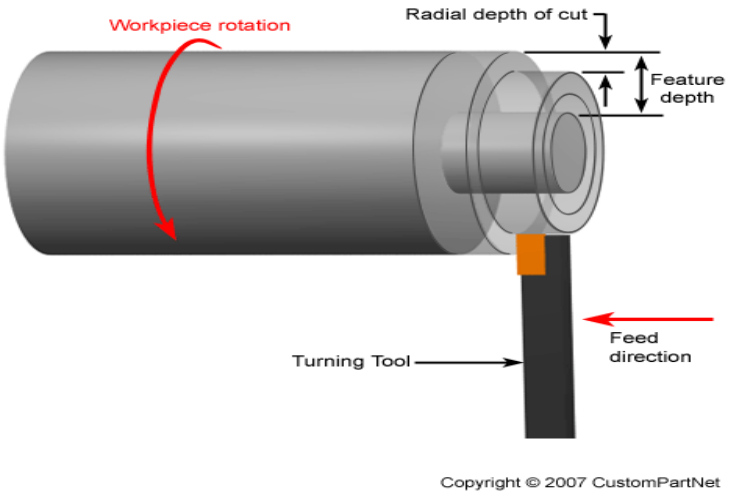

Figure 1

Feed rate-The feed of a lathe can be defined as the distance the cutting tool advances along the length of the work for every revolution of the spindle. A finer feed is required for better finishing.

Depth of cut-The measurement (normally in inches or millimeters) of how wide and deep the tool cuts into the work piece.

1.2 Response variables-

Surface roughness-surface roughness often shortened to roughness, is a component of surface texture. It is obtain by the deviations in the direction of the normal vector of a real surface from its ideal form. If these deviations are large, the surface is more rough and if they are small, the surface is smooth.

Material removal rate (MRR)- MRR is defined as the material removed per unit time. Speed, feed and depth of cut together determine the material removal rate.

2. TAGUCHI METHOD

Taguchi is a new method of conducting the design of experiments which are based on well defined guidelines. Taguchi method uses a special set of arrays called orthogonal arrays. These standard arrays stimulate the way of conducting the minimal number of experiments which gives the full information of all the factors that affect on the performance parameter. The use of the orthogonal arrays method result in choosing the level combinations of the input design variables for each experiment.

2.1 Orthogonal array

While there are many standard orthogonal arrays available, every array is meant for a specific number of independent design variables and levels. For example, if one wants to perform an experiment to understand the influence of 4 different independent variables with each variable having 3 set values that is level values, then an L9 orthogonal array might be the right choice.

The L9 orthogonal array is use for understanding the effect of 4 independent factors each having 3 factor set or level values. This array assuming that there is no interaction between any two factors while in many situations, no interaction model assumption is valid, there are some other cases where there is a clear evidence of interaction.

2.2 Designing of experiment

The design of an experiment includes the following steps-

1) Selection of proper independent variables.

2) Selection of number of levels setting for each independent variable.

3) Selection of proper orthogonal array.

4) Assigning the independent variables to each column.

5) Conducting the experiments.

6) Analyzing the data.

3. ANALYSIS OF VARIANCE

Analysis of variance (ANOVA) is an analysis technique used in statistics that splits the aggregate variability found into a data set in two parts: systematic factors and random factors. The systematic factors having a statistical influence on the given data set, but the random factors do not. Operator uses the analysis of the variance test to determine the result independent variables have on the dependent variable amid a regression study.

How to use **-** The type of ANOVA run depending on a number of factors. It is applied when data needs to be experimental. Analysis of variance is used if there is no access to statistical software resulting in computing ANOVA by hand. It is simple to use and best suited for small samples. In many experimental designs, the sample sizes must be the same for the various factor level combinations.

Analysis of variances is helpful for testing three or more than three variables. It is similar to multiple two sample t-tests. ANOVA groups differences by comparing the meaning of each group and includes spreading out the variance into diverse sources. It is employed with test groups subjects, between groups and within groups.

4. LITERATURE REVIEW

Pranav R. Kshirsagar, DuradundiSawant. Badkar, Somesh R. Pise, Sunil A. Pokalekar, Mahindra Goudadaba [1] have studied the characteristics of surface roughness in turning of EN8 steel by optimization of machining parameters using taguchi method and ANOVA. The machining parameters selected were three level parameters such as speed, feed and depth of cut. A total of 9 experiments were

performed which included codes values and observed responses. These experiments were done in CNC machine using coated carbide tool inserts.

The statistical methods of signal to noise ratio that is S/N ratio and the analysis of variance (ANOVA) are applied to investigate effects of cutting speed, depth of cut and feed rate on surface roughness. The analysis of variance (ANOVA) is used to study the optimization of the process parameters affecting the surface roughness was achieved with the Taguchi orthogonal test design. It was found that feed rate is the most significant factors affect on the surface roughness Ra for turning of EN8steel material. The quality of machined surface decreases with increase in feed rate.

D Kanakaraja et al.[2]have studied the cutting parameters in turning operation of SAE 8822 alloy steel with respect to surface roughness in CNC lathe. Carbide tool is used for machining. In this optimization technique used is Taguchi method and L9 orthogonal array was used to conduct experiments. The result shows that the influence of surface roughness is depend on feed and next is followed by speed and depth of cut.

Ranganath M S1, Vipin2, Harshit3 [3] in this study prediction model of surface roughness has been developed for turning EN-8 steel with uncoated carbide inserts using RSM that is Response surface methodology. The model was developed in the form of multiple regression equations correlating dependent parameter surface roughness, with cutting speed, feed rate also the depth of cut, in a turning process. The box behnken design process was used to plan the experiment. It was found that Cutting speed has the strongest effect on the surface roughness among the selected parameters.

P. Surulimani, A.karthikraja et al. [4]have studied optimization of CNC turning parameters on EN36B steel using Taguchi method. The Taguchi's L9 orthogonal array is used to formulate the experimental layout. The ANOVA and signal-to-Noise ratio are used to study the performance characteristics in turning operation. They worked on surface roughness and MRR. It was found that the primary factor affecting the material removal rate is feed rate, subsequently followed by speed and depth of cut and also primary factor affecting the roughness is feed rate, subsequently followed by depth of cut and speed.

N Ganesh1*, M Udaya Kumar1, C Vinoth Kumar1 and B Santhosh Kumar1 [5]have established the characteristics of surface roughness in turning of EN-8 steel by optimization of machining parameters using Genetic Algorithm. This work focuses on CNC turning using Cemented Carbide tool for varying Spindle speed, Feed rate and Depth of cut. The experiment is designed for Second order linear model using RSM. Mathematical formulation is carried out by correlating the values of responses Machining time and Surface Roughness with the contribution of Feed, spindle speed, and Depth to develop the Empirical models for the responses. The Optimization of cutting parameters is carried out using Genetic Algorithm (GA). It was found that the minimum value of surface roughness (Ra) obtained from GA is 2.51 µ. Genetic Algorithm is best modeling as it learns the best fit of even linear models.

Krupalpawar et al. [6] have worked on the effect of insert nose radius and machining parameters on surface roughness and MRR in a turning of HSS(M2) using Taguchi method and ANOVA. A four parameter design of experiment, three level, L9 orthogonal array using Minitab software, the (S/N) ratio is employed to study the response variables in the turning of high speed steel that is HSS (M2) by taking nose radius of tin coated carbide inserts tool of 0.4, 0.8 and 1.2 mm on CNC turning centre. It was found that feed rate and nose radius are the most significant factors in case of MRR and surface roughness for turning of HSS (M2) material.

R Ramya1*, T T M Kannan1, S Giridharan1, R Baskaran1 and J Madhan1 [7] They applied Taguchi orthogonal design to optimize the setting of cutting parameters in surface roughness. The experiments were conducted in CNC machine taking the cutting parameters as cutting speed, feed and depth of cut using coated tool insert. The material taken for experiment was EN-8 steel. For three levels three factors L9 orthogonal array was used. ANOVA and signal to noise ratio were examined using MINITAB 16 software. It was found that Spindle speed is a dominating parameter for achieving lower surface roughness during turning of EN-8 steel rods. The optimum parameter achieving lower surface roughness values of EN-8 steel rod are 225 m/min of cutting speed, 0.2 mm/rev of Feed and 0.5 mm Depth of cut.

K.Pradeep Kumar Mouli et al. [8] have studied optimization of cutting tool geometry by CAE Approach for Titanium Alloy. The cutting tool geometry was optimized by design of experiments (DOE) techniques and a machining simulation and the analysis (Deform 3D) software by defining required material properties of titanium alloy , tool geometry , cutting parameters etc. The influences of tool geometries such back rake angle, side rake angle and nose radius while cutting titanium alloy (Ti-6AI-4V) has been studies thoroughly through design of experimental (DOE) techniques, computer aided engineering (CAE). The tool radius found to be has higher influence in generating cutting force among the cutting tool rake angles while machining titanium alloy.

ChintanKayastha en al. [9] has studied on optimization of process parameter in turning of Copper by combination of Taguchi and principal component analysis method. For optimization of material removal rate that is MRR and surface roughness PCA method coupled to grey based Taguchi method is implemented as multi response optimization problem cannot solved by other optimization methods. They conclude that, based on accountability proportion (AP) and cumulative accountability proportion (CAP), PCA analysis can reduce the number of response variables to be taken under consideration in optimization. This is very helpful in situations were large number of responses have to be optimized simultaneously.

K. G. Nikam1, S. S. Kadam2 [10] have investigated the effects of process parameters on surface finish. The surface quality is influenced by cutting speed, feed rate and depth of cut and many other parameters. In the present study attempt has been made to investigate the effect of cutting parameters(feed rate, cutting speed, depth of cut) and insert geometry(CNMG and TNMG type insert) on surface roughness in the finish turning of EN 8 steel. The experiments have been performed using L9 orthogonal array in a SPEED LX 200 MAJOR CNC lathe machine. Turning process carried out on the EN 8 steel. The optimum cutting condition was determined surface roughness were checked by the analysis of variance (ANOVA).It was found that Highest surface finish (lowest Ra) is obtained at a cutting speed of 200 m/min, feed rate of 0.2 mm/revolutions and a depth of cut of 0.5mm. Best surface roughness is

obtained from CNMG 120412 FC insert than other two type of insert.

Basil M. Eldhose et al. [11] have worked on optimization of the cutting parameters of SS304 for CNC turning operation. In this research, optimization method used is Taguchi method. They investigated the effects of various parameters such as speed, depth of cut and feed on the material removal rate and surface roughness of the SS304 in a CNC turning machine. It was found that the most effecting factors on MRR is depth of cut, on surface roughness is speed and depth of cut , machining time is feed and speed , tool wear is speed and feed.

Arshad Qureshi 1, Madhukar Sorte2, S.N. Teli3 [12] have studied Optimization of Cutting parameters for Surface roughness in CNC turning of P20 steel. They optimized the cutting parameters such as feed rate, depth of cut and cutting speed for the turning process of AISI P20 steel for better surface finish. Taguchi's technique has been used to accomplish the objective of the experimental study. L-9 Orthogonal array, Signal to noise (S/N) have been used for conducting the experiments. They concluded that the combination of the high level of cutting speed (200m/min) and low level feed of (0.1mm/rev) and a middle value of depth of cut 0.1mm yield the optimum result.

Shunmugesh K.1, Panneerselvam K.1 and Pramod M.2 and Amal George2 [13] have investigated on Optimization of CNC Turning Parameters with Carbide Tool for Surface Roughness Analysis Using Taguchi Analysis. This experimental study concentrates on the understanding of machining process in turning of 11smn30 using carbide tip insert under dry condition. The experiment was carried out using three input parameters namely cutting speed, feed rate and depth of cut. The main objective of the current work is to find out the optimum cutting conditions that affect the surface roughness values Ra and Rz. Tool used for the study was Taguchi analysis. From the Taguchi analysis it was found that the feed rate is the most affecting factor on the surface roughness Ra and Rz followed by cutting speed and depth of cut respectively.

S.N.Naik1, J.S. Sidhu2, S.S.Kulkarni3 [14] have studied Optimization of cutting parameters of SS316 using different cutting tools on CNC lathe. Taguchi optimization methodology is applied to optimize cutting parameters in turning ofSS316.The turning

parameters were cutting speed in rpm, feed rate in mm/rev, depth of cut in mm. It was found that For material removal rate (MRR), Depth of cut is most dominant factor for ceramic, carbide& CBN tool. The Surface Roughness (Ra) mainly depends on feed rate as concluded from the delta values of S/N ratios with Ceramic, Carbide where as for CBN tool, it depend on speed.

1Dalip kumar, 2kulbhushan sharma[15]have studied optimization of CNC turning parameters for surface roughness by using Taguchi method on en-24.In this study, optimization of machining parameters (cutting speed, depth of cut and feed rate) on surface roughness is investigated. The analysis found that feed rate and cutting speed are the main factors affecting more the surface roughness and vibration. Principal cutting edge angle and depth of cut are the least affecting factors.

Prof. Sushil Kumar Sharma Er. Sandeep Kumar [16] have worked on Optimization of Surface Roughness in CNC Turning of Mild Steel (1018) using Taguchi method. There are a number of parameters like cutting speed, feed and depth of cut etc. Which must be taken into consideration during the machining of this alloy. It was found that surface roughness increases when feed rate increases, however cutting speed also the influencing parameter followed by depth of cut.

P. Madhava Reddy, P. VijayaBhaskara Reddy, Y. Ashok Kumar Reddy and N. Naresh[17] have studiedoptimization of machining parameter for turning of en 16 steel using grey based Taguchi method. A plan of experiments based on Taguchi's L27 orthogonal array and turning experiments were conducted with prefixed cutting parameters for EN 16 steel bar using tungsten carbide tool. The turning parameters are feed rate, cutting speed and depth of cut and the responses are surface finish and material removal rate.

It was found that The optimal 'process parameters' based on grey relational analysis for the turning of EN 16 steel include a 200 m/min cutting speed, 0.1 mm/rev feed rate and 0.6mm depth of cut. From ANOVA, it is identified that the interaction parameter between cutting speed and feed rate (60.71%) influences more on turning of EN 16 steel followed by depth of cut (20.04%) and feed rate (10.49%).

CONCLUSION

From above literature review it shows that most of the researchers have worked on the input parameters like cutting speed, feed rate, depth of cut and response variables like surface roughness, material removal rate etc. Very few researchers have studied on parameters like nose radius, tool life, tool material, coolant type etc. Most of the researchers have used Taguchi method for experimentation and also ANOVA and signal-to-noise ratio are used to study the performance characteristics in turning operation. It was found that the primary factor affecting the material removal rate is feed rate, subsequently followed by speed and depth of cut and also primary factor affecting the surface roughness is feed rate , subsequently followed by depth of cut and speed.

ACKNOWLEDGEMENT

We want to wish special thanks to Dr. Sunil G Dambhare, Head of mechanical department, Zeal College of engineering & research, for their guidance and attention. We have to appreciate the guidance given by other professors as well as the panels especially in our project presentation that has improved our presentation skills thanks to their comment and advices.

REFERENCES

[1] Pranav r. Kshirsagar, somesh r. Pise, sunil a. Pokalekar, mahindragoudadaba, duradundisawant. Badkar, " optimization of surface roughness of en8 steel in cncturning operation by taguchiconcept",International conference on recent innovations in engineering and management dhananjaymahadik group of institutions (bimat0) kolhapur, Maharashtra,23rd march,2016 isbn:978-81-932074-5-1.

[2] D Kanakaraja, D Anjan Kumar Reddy, M Adinarayana, and L Vamsi Krishna Reddy2 , "optimization of cnc turning process parameters for prediction of surface roughness through Taguchi's parametric design approach", ISSN 2278 – 0149 ,Vol. 3, No. 4, October 2014 © 2014 IJMERR. All Rights Reserved.

[3] Ranganath M S, Vipin, Harshit, " Surface Roughness Prediction Model for CNC Turning of EN-8 Steel Using Response Surface Methodology", International Journal

of Emerging Technology and Advanced Engineering, Website: www.ijetae.com (ISSN 2250-2459, ISO 9001:2008 Certified Journal,Volume 5, Issue 6, June 2015)

[4] P.Surulimani, A.Karthikraja, V.Sivaganesan, J.Gowthaman ,M.Yojiith, " Optimization of CNC Turning Parameters on EN36B Steel Using Taguchi Method", ISSN(Online): 2319-8753 ISSN (Print) : 2347-6710 International Journal of Innovative Research in Science, Engineering and Technology (A High Impact Factor, Monthly Peer Reviewed Journal) Vol. 5, Issue 2, February 2016.

[5] N Ganesh, M Udaya Kumar, C Vinoth Kumar and B Santhosh Kumar, "optimization of cutting parameters inturning of en 8 steel using responsesurface method and genetic algorithm",Int. J. Mech. Eng. & Rob. Res. 2014 ISSN 2278 – 0149 www.ijmerr.com,Vol. 3, No. 2, April 2014 © 2014 IJMERR. All Rights Reserved.

[6] Krupal Pawar1 and R. D. Palhade2, " Multi-objective Optimization of CNC Turning Process Parameters for High Speed Steel (M2) Using Taguchi and ANOVA Method", International Journal of Hybrid Information Technology Vol.8, No.4 (2015), pp.67-80 http://dx.doi.org/10.14257/ijhit.2015 .8.4.09.

[7] R Ramya, T T M Kannan, S Giridharan, R Baskaran and J Madhan, " optimization of turning parameters ofen-8 steel cylindrical rods using Taguchimethodology", Int. J. Mech. Eng. & Rob. Res. 2014 ISSN 2278 – 0149 www.ijmerr.comVol. 3, No. 4, October 2014 © 2014 IJMERR. All Rights Reserved.

[8] K. Pradeep Kumar Mouli, SrinivasaRaoNandam, P. Vijay Kumar Raju, G.AppalaRajuand A.Chandrakanth, " Optimization of Cutting Tool Geometry by CAE Approach for Titanium Alloy", 5 th International & 26th All India Manufacturing Technology, Design and Research Conference (AIMTDR

2014) December 12th–14th, 2014, IIT Guwahati, Assam, India.

[9] ChintanKayastha, Jaivesh Gandhi, "Optimization of Process Parameter in Turning of Copper by Combination of Taguchi and Principal Component Analysis Method",International Journal of Scientific and Research Publications, Volume 3, Issue 6, June 2013 1 ISSN 2250-3153.

[10] K. G. Nikam, S. S. Kadam, "Optimization of Surface Roughness of EN8 Steel byChanging Cutting Parameters and Insert Geometry in Turning Process", International Journal of Science and Research (IJSR), ISSN (Online): 2319-7064, Impact Factor (2012): 3.358

[11] Basilm.Eldhosecijomathew, dr. Binumarkose, " optimization of the cutting parameters of SS 304 FOR CNC turning operation", international journal OF innovative research IN advanced engineering (ijirae) issn: 2349-2163volume 1 issue 8 (september 2014) .

[12] Arshadqureshi, madhukarsorte, s.n. Teli, "Optimization of cutting parameters for surfaceroughness in CNCturning of P20 steel",international journal OF scientific & engineering research, volume 6, issue 12, december-2015,issn 2229-5518.

[13] Shunmugesh k., panneerselvamk.andpramod m. and amal George, " Optimization OF cnc turning parameters WITH carbide tool FOR surface roughness analysis using taguchi analysis",research journal OF engineering sciences issn 2278 – 9472vol. 3(6), 1-7, june (2014) res. J. Engineering sci.

[14] S.n.naik, j.s. Sidhu, s.s.kulkarni, "optimization of cutting parameters of SS316 using different cutting tools on CNC lathe", international journal OF scientific research and management studies (ijsrms), issn: 23493771 volume 1 issue 9, PG: 275-282.

[15] Dalipkumar, kulbhushansharma, " optimization of cnc turning parameters for surface roughness by

using taguchi method on EN-24", international journal OF mechanical and production engineering, issn: 2320-2092, volume- 4, issue-8, aug.-2016.

[16] Prof. Sushilkumarsharma,er. Sandeepkumar, "optimization OF surface roughness IN cnc turning OF mild steel (1018) usingTaguchi method", international journal of engineering research & technology (ijert) issn: 2278-0181Vol. 3 issue 1, january– 2014.

[17] P. Madhava Reddy, P. VijayaBhaskara Reddy, Y. Ashok Kumar Reddy and N. Naresh, "optimization of machining parameter for turning of EN16 steel using grey based Taguchi method vol. 9, no. 3, march 2014 issn 1819-6608, ARPN Journal of Engineering and Applied Sciences ©2006-2014 Asian Research Publishing Network (ARPN). All rights reserved.