A Review Paper on Optimization of Process Parameter for CNC Lathe on Steel Alloy with Carbide Insert

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Abstract— Machining is an important production technique to develop highly accurate and quality products. It is required for finishing of many industrial components manufactured by casting, welding and powder metallurgy processes. Machining is usually the final stage of product development and can be performed by using conventional as well as non conventional machining methods. Quality and requirements of the client are the two main objectives that any manufacturing industry in the world tries to achieve. Machining is one of the main operations of metal processing in any manufacturing industry. The quality of the metal cut obtained depends on many parameters of the process. These process parameters affect the output response or performance characteristics The important machining parameters such as type of material, spindle speed, feed and depth of cut that affecting the responses as surface roughness, cutting time and MRR are reviewed in this research work. This review paper presents a detailed study of the past research on machining parameters that affects the turning operation.

Key words: Machining, Feed, Depth of Cut, Surface Roughness and MRR

I. Introduction

Manufacturing industry is dependent on various production techniques but machining is one of the basic needs for manufacturing industry because of its application. High quality machining is required for soft to hard industrial materials and this machining process can improve or decrease production costing and also selling of products. So improvement in machining is all time requirement of industry and that’s why in present era computer controlled machining is desired need for industries and important research topic for researchers. Machining has various factors which are responsible for quality production like design of product, material selection, machine selection, operator knowledge, environmental selection etc. A number of input factors that are involved in high quality machining process such as type of material, spindle speed, feed and depth of cut that affecting the responses such as surface roughness, cutting time and MRR.

II. Literature review

In this chapter, the major contributions to the field of machining optimization related to this research have been reviewed. The Machinability study of different industrial materials reviews the relationship between various machining process parameters related to input and output and the economics of machining. The available cutting tool materials for different grades of steel and their effects on parameters like cutting force, surface roughness, material removal rate, power consumption, tool wear mechanisms and tool life have been discussed. The mathematical model development for various modelling methods and its effectiveness are discussed. In case of conflicting output parameters, there is no single combination of input parameters that provides the best output performance may be obtained.

M. Vijay Kumar et. al [*1*] advocated the research work on EN 19 stainless steel material using turning on a CNC lathe and to investigate the parameters that influence the surface roughness and material removal rate . the CNC turning parameters are feed, depth of cut, spindle speed / rotational speed, lubricant and responses are MRR and surface roughness. Carbide tipped tool used as experimental cutting tool. Experimental Design of Taguchi's L18 Mixed Orthogonal Array is to be studied. The optimization is performed using Taguchi's method and to find out the significance of process parameters for response variables ANOVA technique is applied.

In a study presented by P Bhanuprakash et. al [*2*] using Taguchi's experiment design method as an experiment plan. The L27 orthogonal array is chosen to perform experiments. The input parameters are Spindle speed, feed rate, and depth of cut. In the following experimental investigation the important characteristics and desired performance attributes are removal rate of material and surface roughness. Taguchi's “S / N ratio analysis” is used to analyze the effect of process variables that are independent is used to obtain better multifunctional machining characteristics Gray Relational Analysis is used in the following experimental exercise. By the results of the present experimental study it is revealed that proposed method of multi objective optimization considerably improves machining characteristics.

G.Rajkumar et. al [*3*]studied on machining improvement of Inconel-718 using carbide tool for different process materials. Two different tool materials are used for this research work which is following Titanium and Carbide. Taguchi method is used for design of experiment table. Total nine experiments are performed for three factors and three levels for this research work. The process parameters are Spindle Speed, Feed rate and Depth of cut (DOC). Surface roughness is the response parameter for this research work. Regression model equations are present and verified using ANOVA analysis. GA based optimization is performed for this research work.

R. Karthikeyan et. al [*4*] studied on the turning process of expelling the overabundance material or undesirable material from the work piece utilizing cutting apparatus. The quantity of turning tests was led on EN24 as recommended by Taguchi's L9 symmetrical cluster for three components and three dimensions. The target of this work is to advance the process parameters, for example, cutting speed, feed and profundity of slice to accomplish least surface roughness and least cutting power separately and combined by utilizing Taguchi – Gray examination. From this examination, it was discovered that the joined least surface roughness and cutting power could be accomplished under the states of 900 rpm of axle speed, 0.2 mm/rev of feed and 0.25 mm of profundity of cut.

Niranjan D B et. al [*5*] an endeavour is made to streamline the cutting framework. Cutting speed, feed rate and profundity of cut are the cutting parameters in the turning activity of Aluminium Alloy 6061 T6 round and hollow poles utilizing Taguchi technique and ANOVA. Better nature of the surface complete is acquired with cutting speed 429 m/min, feed rate 0.05mm/min and profundity of cut 1mm.

A Saravanakumar et. al [*6*]examined to locate the ideal framework for turning amid machining of aluminium amalgam 6063 with carbon nitride embed. In this research process parameters considered are feed, speed and profundity of cut and were inspected with the assistance of plan of examinations to acquire better surface finish and limit roundness mistakes. Investigations were led dependent on Taguchi strategy L27 symmetrical exhibit and broke down with less the better idea. This examination demonstrates the critical and predominant attributes that impacts the reactions of the turning task. The present study affirmed that the reactions were extraordinarily affected by the feed rate, trailed by speed.

Grynal D'Mello et. al [*7*]By considering machining parameters such as cutting spindle speed, expense ratio and cutting depth in high-speed dry turning of TI - 6Al - 4V and roughing parameters such as flank wear and vibration of the cutting machine, the surface roughness Manage the demonstration of parameters Ra and Rt. Three artificial neural network (ANN) strategies, especially multilayer perception (MLP), radial basis function neural network (RBFNN) and sum wavelet - extreme learning machine (SW - ELM) are used for turning tests with uncoated carbide embed.

Sathiya Narayanan et. al [*8*] experimentally concentrated on augmenting material removal rate (MRR) and limiting surface roughness (Ra) by picking the ideal turning parameters. L27 Orthogonal cluster based trials were directed in CNC Supertech 6.2 turning focus utilizing carbide embed CNMG 120408. The individual and collaboration impacts of feed rate (f) and profundity of cut and cutting velocity on MRR and Ra is dissected in Design Expert 9.0 Software. Exact models are encircled which uncovers the connection among the turning parameters and yield reactions. Unconventional advancement strategy hereditary calculation is utilized with multi target capacity to discover the ideal parameters in turning AISI H13 steel materials.

C Moganapriya et. al [*9*]experimental investigated to optimize the material removal rate and surface roughness for three factors which are cutting speed, feed rate and depth of cut. Taguchi method is used for development of experiment table. Object material TiAlN/WC-C is used for cutting analysis. The most important factor is depth of cut for surface roughness which is equal to 50%, where as for MRR the most important factor is speed which is equal to 55% importance. The best outcome for this research work has 555 m/min cutting speed, 1 mm depth of cut and 0.05mm/rev is feed rate.

Abhijit Saha et. al [*10*]demonstrates three process inputs viz. shaft speed, feed and profundity of cut has been decided for process capacity study in plain turning task following Taguchi's L27 symmetrical exhibit. "Process Capability Index" was assessed for two machining qualities recurrence of hardware a vibration and normal surface roughness. Single reaction enhancement was applied for these two machining characteristics, which could streamline turning process capacity. The optimum parameters for recurrence of hardware vibration and normal surface roughness were observed to be shaft speed: 240 rpm, feed: 0.16 mm/rev, profundity of cut: 0.2 mm.

Hemant Jain et. al [*11*] demonstrates the another methodology for the enhancement and assessment of machining parameters for turning activity on Inconel-625 on CNC machining with the assistance of Taguchi Methods is introduced. The fundamental target of this examination is to acquire an ideal setting of process parameters in turning for boosting the material expulsion rate of the made part, the MRR has been researched by the investigation while machining for all intents and purposes utilized segment. According to Taguchi 'DOE', the quantity of tests to be directed in this examination exceptionally deliberate and all around determined, the turning tasks are executed according to the machining conditions appeared in the symmetrical cluster. The outcomes from affirmation runs demonstrated that the decided ideal blend of machining parameters enhanced the execution of the machining process.

Laxman Abhang et. al [*12*] in their paper improves numerous qualities (surface roughness and instrument wear) in turning of EN-31 steel using tungsten carbide embeds. Five controllable elements of the turning procedure viz. cutting speed, feed rate, profundity of cut, tool nose range and diverse convergences of strong fluid ointments, were considered. A factorial composite structure (25 +8) was utilized for experimentation. Reaction surface philosophy was utilized for displaying the reactions. Attractive quality capacity was utilized for concurrent improvement of different quality reactions

M.Sayeed Ahmed et. al [*13*]experimental investigation to streamline Feed and Radial powers and highlight the impact of cutting parameters in turning on MS work material. Here in this experimental study working condition were dry and HSS tool was used. Cutting parameters are Cutting Speed, Feed rate and Depth of cut. The experimentation was carried out using Taguchi's L9 Orthogonal Array (OA) and Minitab-16 measurable programming. Ideal estimations of process parameters for wanted execution qualities are acquired by Taguchi plan of investigation.

Sayak Mukherjee et. al [*14*] in this study, they proposed an optimization technique using orthogonal array to maximize MRR. This research work also generated a prediction formula for determining MRR using a set of parameters in CNC turning. Therefore, by using the optimum process variables, it is possible to increase the efficiency of machining in the automatic manufacturing environment and to decrease the total production cost.

Carmita Camposeco- Negrete [*15*]their paper indicates an experimental investigation identified with the advancement of machining parameters in rough turning of AISI 6061 T6 aluminum. Experimental runs were arranged utilizing a "Central Composite Design" and the "Response Surface Technique" was used to optimize the lathe turning operation. The experiment highlighted that for minimizing specific energy and for minimizing surface roughness the significant factors responsible were depth of cut and feed rate respectively.

Hari Vasudevana et. al [16] optimized process parameters using MOGA optimization technique for experimental table made by Taguchi method. Four different process input parameters are selected for this research work which is following: cutting speed, feed rate, depth of cut and tool nose radius. Each factors have four levels. Three different response parameters are selected f or this research work which are MRR, surface roughness and cutting power on tool. Total 27 experiments are designed for this research work using Taguchi method. MMC is used as test material and made at laboratory levels. The optimal solution for this research work is A2B1C1D3, i.e. apparatus nose sweep of 0.8 mm, cutting speed of 120 m/min, feed rate of 0.05 mm/rev and profundity of cut of 1.6 mm, is assessed as the ideal mix. The corroborative examination at these settings gave greatest estimation of MPCI, approving the outcomes.

P. Jayaramana et. al [17] introduced a novel methodology for the advancement of machining parameters on turning of AA 6063 T6 aluminium composite with various reactions dependent on symmetrical cluster with dark social investigation. In the present work, turning parameters, for example, cutting speed, feed rate and profundity of cut are enhanced considering the different reactions, for example, surface roughness (Ra), roundness (Ø) and material evacuation rate (MRR). A dark social grade (GRG) is resolved from the dim examination. Ideal dimensions of parameters have been distinguished dependent on the estimations of dark social review and afterward the huge commitment of parameters is dictated by ANOVA. To approve the test outcome, affirmation test is performed.

SNo	Author	Work-Piece Material	Tool Material	Machining Parameters	Responses	Methodology	Optimization Technique	Remark
1	M. Vijay Kumar et al. [2018]	EN 19 stainless steel	Carbide tip	feed rate, depth of cut spindle speed lubricant	surface roughness Material Removal Rate	Taguchi's L18 mixed type	Taguchi	only Taguchi Optimization is Performed
2	P Bhanuprakash et al [2018]	AlSi7Mg	tungsten carbide	Spindle speed feed rate depth of cut	Surface Roughness Material Removal Rate	Taguchi method L27 orthogonal array	Grey Relational Analysis	Two Response Optimization
3	G. Rajkumar et al [2018]	INCONEL 718	Titanium (DNMG 15-06-04) Carbide (TNMG 15-06-04)	Spindle Speed Feed depth of cut	surface roughness	Taguchi's L9	GA	Single optimization Is Used
4	R. Karthikeyan et al [2018]	EN24	Carbide tool	cutting speed feed depth of cut	surface roughness cutting force	Taguchi's L9 orthogonal array	taguchi – Grey analysis	only Taguchi Optimization Is Performed
5	Niranjan D B et al [2017]	Aluminium Alloy 6061 T6	Carbide tool	Cutting speed Feed rate Depth of cut	Surface Roughness	Taguchi method	Taguchi method	Single optimization Is Used
6.	A Saravanakumar et al [2017]	aluminum alloy 6063	carbon nitride	Cutting speed Feed rate Depth of cut	Surface Roughness	Taguchi method L27 orthogonal array	Taguchi	Two Factor Only
7.	Grynal D'Mello et al [2017]	Ti-6Al-4V	TiN Coated carbide	Cutting speed Feed rate Depth of cut	Surface roughness	Radial Basis Function Neural Network		Only Comparison
8.	Sathiya Narayanan et. al [2017]	Oil Hardened Non-Shrinking Die Steel (OHNS/AISI H13)	carbide insert CNMG 120408	Cutting speed Feed rate Depth of cut	Surface Roughness Material Removal Rate		GA	only Two Response optimization
9.	C. Moganapriya et. al.[2017]	AISI 1015 mild steel	TiAlN coated tool	Depth of cut	Surface Roughness	Taguchi method (L-9)	Taguchi method	only two response optimization

				Feed rate Spindle speed	Material Removal Rate			
10.	Abhijit Saha et al (2016)	ASTM A36	Cemented Carbide Insert	spindle speed feed rate depth of cut	tool vibration surface roughness	Taguchi method L27 orthogonal array	process capability index	only two response optimization
11	Hemant Jain et al [2015]	Inconel-625	Tungsten Carbide	Spindle Speed Feed Rate Depth Of Cut	Material Removal Rate	Taguchi Method L9 Orthogonal Array	Taguchi	Single Optimization Is Used
12	Laxman Abhang et al [2015]	En-31steel	Tungsten Carbide	Cutting Velocity Feed Rate Depth Of Cut Tool Nose Radius	Surface Roughness Tool Wear	Response Surface Methodology	Composite Desirability	Two Response Optimization
13	G.M.Sayeed Ahmed et al [2015]	Mild Steel	HSS Tool	Cutting Speed Feed Rate Depth Of Cut	Feed force	Taguchi's L9 Orthogonal Array	Taguchi Design	One Response Optimization
14	Sayak Mukherjeea et al [2014]	Sae 1020	Carbide Cutting Tool	Speed Feed Depth Of Cut	Material Removal Rate	Taguchi Method L25 Orthogonal Array	Taguchi Method	Single Optimization Is Used
15	Carmita Camposeco-Negrete [2014]	AISI 6061 T6 Aluminum	Silicon Carbide, Reinforced Ceramic Grade.	Feed Rate Depth Of Cut	Energy Consumption Surface Roughness Material Removal Rate	Response Surface Method	Composite Desirability	No Moga Used
16	Hari Vasudevana et al [2014]	GFRP (Glass Fibre Reinforced Plastic) Composites,	PCD Cutting Tool	Tool Nose Radius Cutting Speed Feed Rate Depth Of Cut.	Surface Roughness Cutting Force Material Removal Rate	Taguchi's Orthogonal Array L27	Taguchi Method	No Moga Used
17	P. Jayaramana et al [2014]	AA 6063 T6 Aluminium Alloy	Carbide Tool	Cutting Speed Feed Rate Depth Of Cut	Surface Roughness Material Removal Rate	Taguchi Method	Grey Analysis	No Moga Used

III. CONCLUSION

A. From the above literature review we found that the researcher have taken

- Input parameters (controllable factors): Researcher taken input parameters: speed (16 research papers out of 17 mentioned above research cases), feed (17/17) and depth of cut (17/17).
- Output parameters (uncontrollable factors): Researcher taken output parameters: material removal rate (9/17), surface roughness for turning (14 research paper out of 15 research cases).
- Response optimization: Single responses were (8/17) and multiple responses were (9/17).

B. From the above review it is also found out that:

- Increases feed rate gives higher material removal rates (MRR) consequently surface roughness increase or surface finish is decreased.
- Increase depth of cut increase material removal rates and decreases surface finishing of machined surface.
- but increasing the cutting speed not only improves surface finish but also the material removal rates.

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