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# A review on the optimization of process parameters in turning operation

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## Abstract
***The purpose of this research paper is to make an attempt to review the research work which has been done previously on the turning operation for the required quality characteristics of material removal rate and surface roughness. There are various optimization techniques which have been employed to optimize the process variables or parameters.***

## Keywords
***Cutting parameters, Material removal rate, Optimization techniques, Surface roughness.***

## 1.Introduction
Turning is the process of removing material from the outer diameter and to produce cylindrical objects. In this process the work piece is rotating held in the chuck and tool advances, which is being held in the tool post, into it parallel to the axis of work piece and perpendicular to the work piece. The movement of the tool parallel to the axis of w/p is termed as feed and the movement of the tool perpendicular to the axis of the work piece is termed as depth of cut. The effect of the combination of these parameters removes the material from the outer surface of the w/p. Turning, generally used to decrease the radial dimensions of the work piece, to indicate dimension, and to give satisfactory surface finish and material removal rate. Many a times the turning process on the work piece is done in such a way that the neighbouring segments have different radial dimensions.

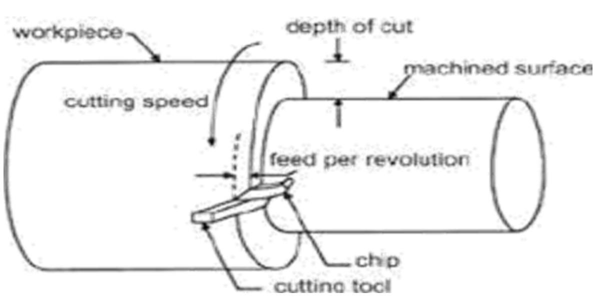


Figure 1 Turning operation

Surface roughness is the measure of surface texture i.e the deviation of the surface from the reference plane. Greater the deviation greater is the roughness.
Material removal rate is the removal of thickness of the work piece in the turning operation.
There are many process parameters which are affecting the process.

- Cutting Speed
- Depth Of Cut
- Feed Rate
- Insert radius
- Lubricating Condition etc.

The objective is to attain a combination set of the parameter set so that the desired response factor can be optimized.

## 2.Literature review
Sujit Kumar Jha (2014) [1] conducted an experiment through the turning Mild Steel specimen by the tin coated carbide as tool with feed rate, spindle speed and depth of cut as cutting parameters. Explored feed is the greatest relevant parameter for mrr using Taguchi method.

Ali Abdallah et al. (2014) [2] has investigated on turning of Aluminium alloy i.e. AL 6061 by Taguchi method with feed, depth of cut and spindle speed as cutting factors, using uncoated inserts for tool.

Kamal Hassan(2012) [3] conducted an experiment using medium Brass alloy (C34000) as the work piece . The cutting parameters are feed, cutting speed and depth of cut. The study explores the main effects of parameters on the Material Removal Rate (MRR) in the turning of C34000.MRR can be optimized by using Taguchi methodology. MRR is optimized by using 27 experiments based on L27 orthogonal array of the Taguchi methodology. The optimized levels of the process parameters for optimization of MRR have been recognized. Best results were confirmed through validation experiment. Parameters which are making important effect on material removal rate are feed rate, also the interaction between cutting speed feed rate was found to be significant to Material removal rate for reducing the variation.

Ramesh N et al. (2016) [4] conducted a study for the optimization of the process parameters which are feed, Cutting Speed and Depth of Cut and minimizing Surface Roughness (Ra) also maximizing material removal rate (MRR) of AA 6061 using PSO. Taguchi methodology was used with an orthogonal array L9 to conduct the experiments. The tool used was Carbide cutting tool. This study reveals that the technique known as PSO can be applied for different expected Ra values that are modeled by different conventional methods (such as RSM and DP) and non-conventional methods (such as PSO and ANN). It is thus very important for the researchers to give several alternatives by using various matching approaches between optimizing approaches and modeling to give the top result of MRR and Ra value in the problem of optimization.

Sidda Reddy et al. (2009) [5] has investigated on the turning of Aluminium alloy by the usage of carbide cutting tool. The cutting parameters focused on this work are cutting speed, depth of cut and feed, the response is roughness of surface. The methodology used was Adaptive Neuro Fuzzy Inference System (ANFIS) and Response Surface Methodology (RSM).

Surlimani et al. (2016) [6] investigates the machining of EN36B steel to find the optimal parameters for CNC turning process. The Taguchi's methodology was used and L9 Orthogonal array was employed. Cutting parameters are Depth of cut, Speed and Feed. Analysis of Variance (ANOVA) and Signal-to-Noise ratio were used to study the main perform characteristics in turning operation. The results tell that the main factor affecting the MRR is feed rate, then followed by depth of cut and speed. (ii) Results disclose that the main factor affecting the roughness of surface is feed rate, then followed by speed and depth of cut.

S S Mahapatra (2006) [7] conducted an experiment using Taguchi method and Genetic Algorithm. The cutting parameters taken were spindle speed, depth of cut and feed rate. Work piece used is of material S45C. The utmost optimal parameter which is influencing surface roughness is cutting velocity followed by feed rate. Also feed rate and cutting velocity is having high influence on tool life.

D. Philip Selvaraj et al. (2010) [8] examined that in turning of AISI-304 austenitic steel with TiCS and TiCN coated tungsten carbide tool and the cutting factors are feed rate, cutting speed, and depth of cut, feed rate followed by the cutting speed are the prime affecting parameter for surface roughness.

Shivam Goyal et al. (2016) [9] conducted an experiment. Work piece used was AISI 2010 mild steel. Cutting tool as WNM G32 RP carbide insert with a nose radius 0.8. Cutting parameters used in the investigation are depth of cut, feed rate, cutting speed,. Taguchi methodology was employed. Cutting speed and then feed rate are the highest optimal value which are affecting surface roughness and depth of cut, followed by cutting speed are the highest optimal value for MRR.

Vishal Francis et al. (2013) [10] performed an experiment using mild steel 0.18%C. Tool used was mild steel. The Cutting parameters used were depth of cut, feed rate and spindle speed. The methodology used was Taguchi. The chief optimal parameter for surface roughness and MRR is feed rate and speed of spindle respectively.

W. Bouzid Sai. [11] have investigated, a commercially available insert is used to turn an AISI 4340 steel in a speed range of 325 and 1000 m/min. Cutting time was used to measure the flank wear. This is to give the tool life, defined as the operational time that has passed before the flank wear has touched the criterion mark. It is revealed that an increase in cutting speed causes a larger decrease of the time of the second gradual stage of the wear process. The reason behind this is the thin coat layer which is quickly peeled off during high-speed turning. The study includes the realization of a wear model in relation to time and cutting speed. An empirical model has been established for tool life determination in connection with cutting speed. On the basis of the results obtained it is possible to give optimal cutting speed to attain the maximum tool life. Thamizhmanii, S., et al. (2007) [12] analysed the best cutting conditions to achieve the minimum surface roughness in turning SCM 440 alloy steel with the use of coated ceramic tool. Taguchi's mixed level L18 orthogonal array was used. The results were analysed in Design-Expert software. It was investigated from the study that depth of cut is a significant factor then feed in consideration of lowest surface finish.

Natarajan, C., et al. (2010) [13] planned an Artificial Neural Network (ANN) to forecast the surface roughness through back propagation network with the help of Matlab 7 software. Cutting parameters evaluated were feed rate, spindle speed and depth of cut.Tests were performed in dry condition on C26000 metal in a CNC turning center with a CNMG 120408 insert. A total of 36 specimens were experimented. The actual roughness values were matched with the predicted roughness values by using Matlab 7. The percentage of deviation between the roughness values was found to be 24.4%.The interactions between the parameters were also obtained through the model. It is found that feed rate is having huge effect on surface roughness then the other parameters.

Sharma, N., et al. (2012) [14] applied L18 orthogonal array to optimize the surface roughness during turning operation. ANOVA and Signal to Noise ratio were applied to investigate the performance characteristics during turning of AISI 410 steel bars using TiN coated P20 and P30 as cutting tool. The cutting parameters considered were depth of cut, insert radius, feed and cutting speed. It was found that the insert radius and feed rate is having important effect on surface roughness with 1.91% and 92.74% contribution respectively.

Somashekara, H M, and Swamy, N L., et al. (2012) [15] obtained an optimal setting for turning Al6351-T6 alloy for best surface roughness. A model was created for optimal surface roughness using regression technique. The turning parameters considered is feed, speed and depth of cut with 3 levels each. L9 orthogonal array was applied for the experiment. The roughness measure was done with three repetitions. The results found between regression model and experimental values were having error less than 2%. From ANOVA and S/N ratio, cutting speed was established to be uppermost significant parameter followed by feed & depth of cut.

Yadav, U. K., et al. (2012) [16] investigated the effect of machining parameters (feed, speed and depth of cut) on optimization of surface roughness while turning AISI 1045 steel alloy. The experiments were conducted on stallion 100HS CNC lathe using Taguchi's L27orthogonal array. From ANOVA it was found that feed is having the supreme contribution of 95.23% on the surface roughness than cutting speed. Using the predictive equation the predicted value of optimum surface roughness at the optimal conditions was found to be 0.89µm whereas the calculated response was 0.93µm. Therefore the error between them comes out to be only 4.4%. As a result a good agreement was achieved between them. The results were evaluated by MINITAB 16 software.

Bala Raju, J, et al. (2013) [17] investigated effect of cutting parameters such as feed, cutting speed and depth of cut in the turning of mild steel and aluminium with the help of HSS cutting tool. It was carried out to attain better surface finish and to reduce power required by flattening the cutting force in machining. The experiments were carried based on 2k factorial techniques. ANOVA was the tool used to find out the effect of cutting parameters in surface finish. And multiple regression analysis was used to develop cutting forces required for machining. It was establish that feed is having significant effect on surface roughness as well as cutting force.

## 3.Conclusion

From the literature review it is observed that various methods are used to minimize surface roughness and maximize MRR. For this various combination of factors are studied and on the analysis the process factors such as speed, depth of cut, tool angle, nose radius etc. are being optimized. Further other levels of factors and combination of factors can be considered in future for the study. This review helps to overview the previous study on turning which has been done.

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