

Predetermination of Surface Roughness by the Cutting Parameters Using Turning Center

¹N.MANOJ, ²A.DANIEL, ³A.M.KRUBAKARA ADITHHYA, ⁴P.BABU, ⁵M.PRADEEP

Assistant Professor, Dept. of Mechanical Engineering, Jay Shriram Group of Institutions, Tiruppur, Tamilnadu, India, ¹

U.G Student, Dept. of Mechanical Engineering, Jay Shriram Group of Institutions, Tiruppur, Tamilnadu, India ^{2,3,4,5}

ABSTRACT: The increase of customer needs for quality in metal cutting has driven the metal cutting industry to continuously improve quality of metal cutting processes. Within these metals cutting processes, the CNC turning process in one of the most fundamental metal removal operations used in the modern manufacturing industries. It is an important parameter in the highly Automated Manufacturing engineering industries which has significant influence on the performance of mechanical parts and products. This work focuses on developing an empirical model for the prediction of surface roughness in CNC turning. The following machining parameters are considered for deriving the new model: Tool Material, Work Material, Feed, Spindle speed and Depth of cut. The existing methods used for predicting the surface roughness value are only data mining techniques, computational neural network techniques and application of Taguchi techniques. This paper presents a new algorithm to establish a statistical model for predicting the surface roughness value, which is a simple monogram like procedure.

KEYWORDS: Tool Material, Work Material, Feed, Spindle speed and Depth of cut.

I. INTRODUCTION

Metal cutting involving metal through machining operations. Machining traditionally takes place on lathes, drill presses, and milling machines with the use of various cutting tools. There are many machines that have been designed to perform specific types of machining operations. In a modern machine shop, most of these machines would be computer controlled (numerically controlled) and capable of running automatically according to a program set by the operator. Power-operated tool used for finishing or shaping metal parts, especially parts of other machines.

Basic machining operations are (1) turning, the shaping of a piece having a cylindrical or conical external contour; (2) facing, the shaping of a flat circular surface; (3) milling, the shaping of a flat or contoured surface; (4) drilling, the formation of a cylindrical hole in a work piece; (5) boring, the finishing of an existing cylindrical hole, as one formed by drilling; (6) broaching, the production of a desired contour in a surface; (7) threading, the cutting of an external screw thread; and (8) tapping, the cutting of an internal screw thread. In addition there are operations such as sawing, grinding, gear cutting, polishing, buffing, and honing.

Surface roughness is the measure if the finer surface irregularities in the surface texture. These are the result of the manufacturing process employed to create the surface. Surface roughness Ra is rated as the arithmetic average deviation of the surface valleys and peaks expressed in micrometers.

There are numerous analytical methods for establishing the surface roughness as well as the visualization of surface texture.

II. LITERATURE REVIEW

Kopac et al. [1] utilized a Taguchi experimental design to determine the optimal machining parameters for a desired surface roughness for traditional truingin. Taguchi design method was used to identify the impact of various parameters on an output and determine the combination of parameters to control them to reduce thevariablility in that output. They chose a design for five factors; cutting speed, cutting material, workpiece

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 3, March 2017

material, cutting depth, and consecutive cut. In addition to these factors, they also specifically considered seven second order interactions between these factors. According to their analysis, the most significant influences on surface quality are cutting speed, cutting material, cutting depth, and consecutive cut. They also found that the interactions between cutting speed and cutting depth, cutting speed and consecutive cut, and cutting material and consecutive cut were all significant. Feng and Wang [2] conducted testing and used regression analysis to develop a complete empirical model of surface roughness for traditional turning. They created a resolution V design using feed, workpiece hardness, tool point angle, depth of cut, and spindle speed.

Azouzi and Guillot [3] examined the feasibility of neural network based sensor fusion technique to estimate the surface roughness and dimensional deviations during machining. This study concludes that depth of cut, feed rate, radial and z-axis cutting forces are the required information that

Lay:

Lay represents the direction of predominant should be fed into neural network models to predict the surface roughness successfully.

In addition to those parameters, Risbood [4] added the vibrations of the tool holder as additional parameter to predict the surface roughness. During their experiments they observed that surface finish first improves with increasing feed but later it starts to deteriorate with further increase of feed.

III. SURFACE ROUGHNESS TERMINOLOGY AND AFFECTING PARAMETERS

The quality of machined surface is characterized by the accuracy of its manufacture with respect to the dimensions specified by the designer. Every machining operation leaves characteristic evidence on the machined surface. This evidence in the form of finely spaced micro irregularities left by the cutting tool. Each type of cutting tool leaves its own individual pattern which therefore can be identified. This pattern is known as surface finish or surface roughness.

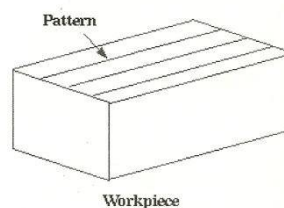


Fig 3.0 surface pattern of the work piece

3.1 TERMINOLOGY

Roughness consists of surface irregularities

which result from the various machining process. These irregularities combine to form surface texture. Roughness height:

It is the height of the irregularities with respect to a reference line. It is measured in millimeters or microns or micro inches.

Roughness Width:

The roughness width is the distance parallel to the nominal surface between successive peaks or ridges which constitute the predominate pattern of the roughness. It is measured in millimeters.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 3, March 2017

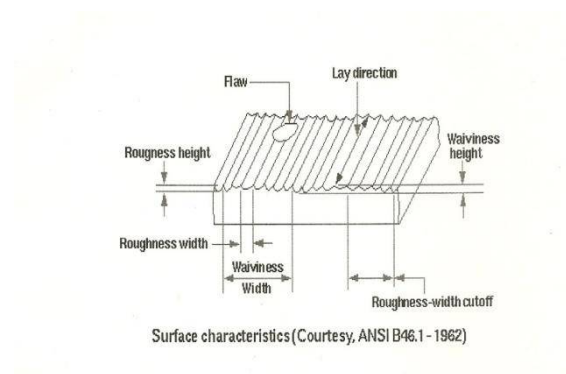


Fig 3.1 surface characteristics

surface pattern produced and it reflects the machining operation used to produce it.

Waviness:

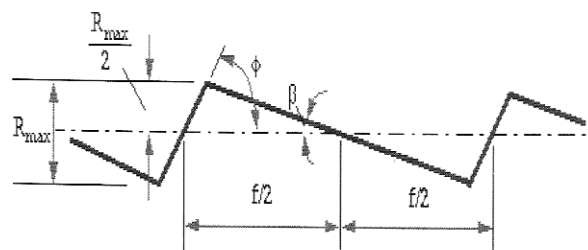
This refers to the irregularities which are outside the roughness width cut off values. Waviness is the widely spaced component of the surface texture. This may be the result of workpiece or tool deflection during machining, vibrations or tool run out.

Ideal surface roughness is a function of only feed and geometry. It represents the best possible finish which can be obtained for a given tool shape and feed. It can be achieved only if the built-up-edge, chatter and inaccuracies in the machine tool movements are eliminated completely. For a sharp tool without nose radius, the maximum height of unevenness is given by:

$$R_{MAX} = f / \cot\phi + \cot\beta$$

The surface roughness value is given by

$$R_a = R_{MAX} / 4$$



f feed

ϕ major cutting edge angle

β working minor cutting edge angle

Fig 3.3 Idealized model of surface roughness

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 3, March 2017

IV. EXPERIMENTAL ANALYSIS

Since turning is the primary operation in most of the production processes in the industry, Surface finish of the turned component has greater influence on the quality of the product. The present work aims to predict the cutting parameters that influence to surface roughness value using a combined approach of Multiple Quadratic Interpolation (MQI) and optimization technique.

4.1 EXPERIMENTAL WORKS:

The screening experiments examined the impact of the following parameters on surface roughness (Ra) in finish truing:

- Feed (F)
- Spindle Speed (N)
- Depth of Cut (D)

In this experiment work piece material and tool material are fixed.

Work piece material: En24

Tool Material: Tungsten Carbide (nose radius 0.4) The varying parameters are feed, spindle speed and depth of cut. Feed varying from 0.1 mm/rev to 0.15 mm/rev, Spindle speed varying from 2200 rpm to 2800 rpm, and depth of cut varying from 0.1mm to 0.3 mm. The above said data are considered by referring standard data book and operator's experience.

Table 4.1 Experimental Cutting Parameters

	Feed (MM/rev)	Speed (RPM)	Depth of Cut (mm)
Minimum	0.1	2200	0.0
Average	0.125	2500	0.2
Maximum	0.15	2800	0.3

MATRIX	RANGE
N – Ra	0.02 – 0.2
D – Ra	0.01 – 0.22
F – Ra	0.57 – 0.93

From the above said varying parameters a test chart is prepared for various combinations. This test chart is used for conducting the experiment in CNC turning center.

Feed and roughness value varies remarkably then the order combinations combination.

Quadratic fit is obtained for feed and roughness value. From the combination influencing nine quadratic equations were listed.

$$F1 = -9.4793 \times 10^{-3} Ra^2 + 8.5061 \times 10^{-2} Ra + 2.5081 \times 10^{-2}$$

During the course of operation cutting tool the insert was changed for each 9 component. The

$$F2 = -5.1466 \times 10^{-3} Ra^2 + 6.9067 \times 10^{-2}$$

Ra +

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 3, March 2017

following diagram shows the dimensional details of the machined component.

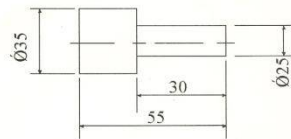


Fig 4.1 Component Drawing

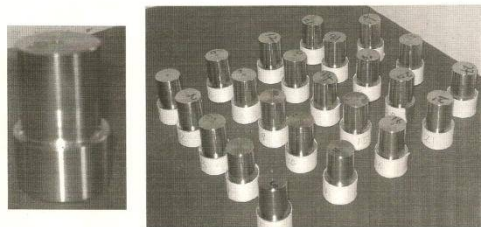


Fig 4.2 mechanical component

4.2 ORGANIZING THE DATA

The surface roughness value is measured for each component. The surface roughness data of the components were collected with surface profilometer Mitutoyo Surface Tester. Three measurements are taken along the component axis.

4.3 MULTIPLE QUADRATIC INTERPOLATION: Incident matrices were prepared for the following combination (N,Ra),(D,Ra) and (F,Ra). From these matrices computed range values are 3.7487×10

$$F3 = -2.8238 \times 10^{-2} Ra^2 + 0.1406 \times 10^{-2} Ra - 1.6511 \times 10^{-2}$$

$$F4 = -3.1461 \times 10^{-3} Ra^2 + 6.7137 \times 10^{-2} Ra + 3.6008 \times 10^{-2}$$

$$F5 = 1.0175 \times 10^{-2} Ra^2 + 3.0830 \times 10^{-2} Ra + 5.9506 \times 10^{-2}$$

$$F6 = 8.8456 \times 10^{-3} Ra^2 + 3.1343 \times 10^{-2} Ra + 5.9812 \times 10^{-2}$$

$$F7 = -4.8246 \times 10^{-3} Ra^2 + 6.7183 \times 10^{-2} Ra + 3.8794 \times 10^{-2}$$

$$F8 = 1.2230 \times 10^{-2} Ra^2 + 2.5840 \times 10^{-2} Ra + 6.2835 \times 10^{-2}$$

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 3, March 2017

$$F9 = -0.1154 Ra^2 + 0.4305 Ra - 0.2504$$

V. RESULT AND DISCUSSIONS

From the experimental analysis Ra values are measured for 27 components with varying cutting parameters and plotted in the table 1. From the tabular values the following graphs are plotted for different combinations of parameters.

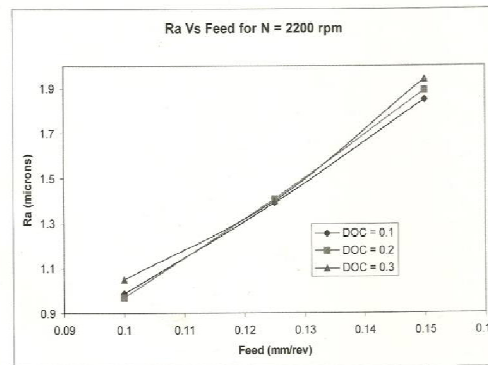


Fig 5.1: Ra Vs Feed chart for N=2200 rpm

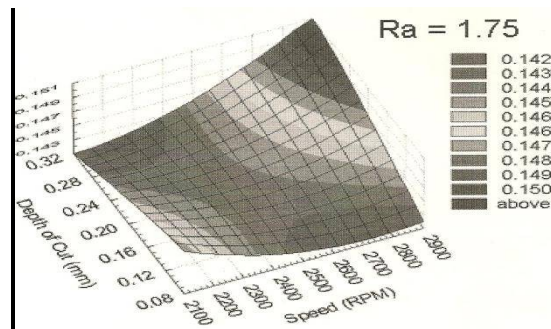


Fig 5.12: Response Surface for Roughness Value 1.75

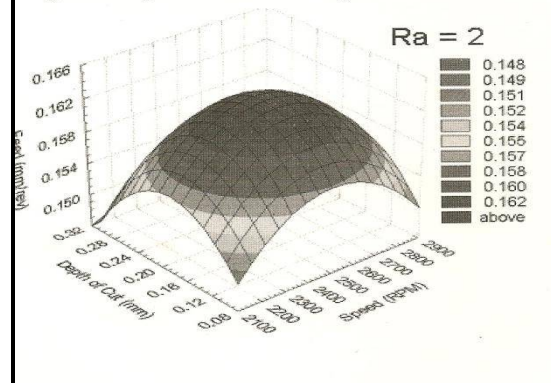


Fig 5.13: Response surface for roughness value 2

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 3, March 2017

VI. CONCLUSION

The MQI approach to study the impact of turning parameters on surface roughness was presented. It featured the following contributions.

- The depth of cut does not impact the surface roughness in the studied range, which could be used to improve productivity.
- Feed has a significant impact on the observed surface roughness.
- A systematic approach was provided to design and analyze the experiments, which is able to reduce the cost and time of experiments and to utilize the data obtained to the maximum extended.

The five components are machined using randomly selected cutting parameters. The roughness for the same combination was computed using MQI software and the roughness was measured for five experimental components the resultant value observed with 5% of error.

REFERENCES

1. Antony J., (2000), "Multi-response optimization in industrial experiments using Taguchi's quality loss function and Principal Component Analysis", Quality and Reliability Engineering International, Volume 16, pp.3-8.
2. Ahmed S. G., (2006), "Development of a Prediction Model for Surface Roughness in Finish Turning of Aluminium", Sudan Engineering Society Journal, Volume 52, Number 45, pp. 1-5.
3. 3.Abburi N. R. and Dixit U. S., (2006), "A knowledge-based system for the prediction of surface roughness in turning process" Robotics and Computer-Integrated Manufacturing, Volume 22, pp. 363-372.
4. 4.Al-Ahmari A. M. A., (2007),"Predictive machinability models for a selected hard material in turning operations", Journal of Materials Processing Technology, Volume 190, pp. 305-311.
5. Choudhury S. K. and Bartarya G., (2003), "Role of temperature and surface finish in predicting tool wear using neural network and design of experiments", International Journal of Machine Tools and Manufacture, Volume 43, pp. 747-753.