Analytical Investigation Of Turning Process Parameters By Using FEA Technique

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Abstract- *Turning process is one of the most fundamental machining processes used in the manufacturing industry. The process of turning is influenced by many factors such as cutting velocity, feed rate, depth of cut, geometry of cutting tool, and cutting conditions etc., to name a few. In machining operations, achieving the desired surface quality of the machined product is really a challenging job. This is due to the fact that quality is highly influenced by process parameters directly or indirectly. However, the extent of significant influence of the process parameters is different for different responses.*

In this thesis the effect of insert nose radius and machining parameters including cutting speed, feed rate and depth of cut on surface roughness in a turning operation are investigated by using the Taguchi optimization method.

3D modeling done by CREO parametric software. Analysis is done by ANSYS.

Keywords- Discrete Wavelet Transform, Singular Value Decomposition, Human Visual System.

I. INTRODUCTION

The challenge of modern machining industries is mainly focused on the achievement of high quality, in terms of work piece dimensional accuracy, surface finish, high production rate, less wear on the cutting tools, economy of machining in terms of cost saving and increase the performance of the product with reduced environmental impact. The ratio between costs and quality of products in each production stage has to be monitored and immediate corrective actions have to be taken in case of Deviation from desired trend. Surface roughness measurement presents an important task in many engineering applications. Many life attributes can bealso determined by how well the surface finish is Maintained. Machining operations have been the core ofthe manufacturing industry since the industrial revolution and the existing optimization researches for Computer Numerical Controlled (CNC) turning were either simulated within particular manufacturing circumstances or achieved through numerous frequent equipment operations. These conditions or manufacturing Circumstances are regarded as computing simulations andtheir applicability to real world industry is still uncertainand therefore, a general optimization scheme without equipment operations is deemed to be necessarily developed. Surface roughness is commonly considered asa major manufacturing goal for turning operations inmany of the existing researches. The machining process ona CNC lathe is programmed. Many surface roughness prediction systems were designed using a variety of sensors including dynamometers for force and torque.Taguchi and Analysis Of Variance (ANOVA) canconveniently optimize the cutting parameters with severalexperimental runs well designed.

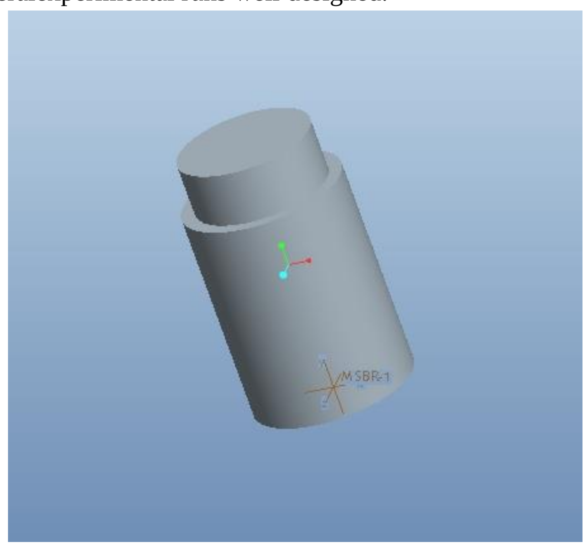


Fig: 1 turning

TAGUCHI TECHNIQUE

Taguchi defines Quality Level of a product as the Total Loss incurred by society due to failure of a product to perform as desired when it deviates from the delivered target performance levels.This includes costs associated with poor performance, operating costs (which changes as a Taguchi Methods

Help companies to perform the Quality Fix!, Quality problems are due to Noises in the product or process system, Noise is any undesirable effect that increases variability, Conduct extensive Problem Analyses, Employ Inter-disciplinary Teams, Perform Designed Experimental Analyses, Evaluate Experiments using ANOVA and Signal-to noise techniquesproduct ages) and any added expenses due to harmful side effects of the product in use.

SURFACE FINISH

Surface finish, also known a surface texture or surface topography, is the nature of a surface as defined by the 3 characteristics oflay, surface roughness, and waviness. It comprises the small local deviations of a surface from the perfectly flat ideal (a true plane).Surface texture is one of the important factors that control friction and transfer layer formation during sliding. Each manufacturing process (such as the many kinds of machining) produces a surface texture. The process is usually optimized to ensure that the resulting texture is usable. If necessary, an additional process will be added to modify the initial texture. The latter process may be grinding (abrasive cutting), polishing, lapping, abrasive blasting, honing, electrical discharge machining (EDM), milling,lithography, industrial etching/chemical milling, laser texturing, or other processes.

II. METHODOLOGY

In this work, experimental results were used for Optimization of input machining parameters speed, feed, and depth of cut using Taguchi Technique for the response Surface Roughness and stress

III. LITERATURE SURVEY

Using the Response Surface Method to Optimize the Turning Process of AISI 12L14 SteelBy Karin Kandananond, Faculty of Industrial Technology, Rajabhat University Valaya-Alongkorn, Prathumthani 13180, Thailand, Received 28 July 2010; Accepted 4 December 2010.The purpose of this paper is to determine the optimal cutting conditions for surface roughness in a turning process. This process is performed in the final assembly department at a manufacturing company that supplies fluid dynamic bearing (FDB) spindle motors for hard disk drives (HDDs). The workpieces used were the sleeves of FDB motors made of ferritic stainless steel, grade AISI 12L14. The optimized settings of key machining factors, depth of cut, spindle speed, and feed rate on the surface roughness of the sleeve were determined using the response surface methodology (RSM).

3D MODEL OF WORK PIECE &CUTTING TOOL

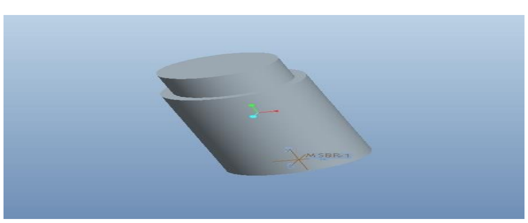


Fig:2 Work piece

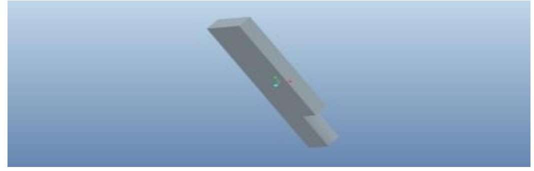


Fig: 3 Cutting tool

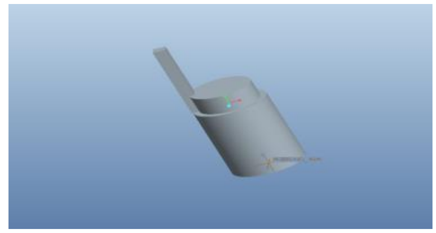


Fig: 4 Assembly of turning components

TABLE 1:PROCESS PARAMETERS AND THEIR LEVELS			
PROCESS PARAMETERS	LEVEL1	LEVEL2	LEVEL3
CUTTING SPEED(rpm)	600	1200	1800
FEED RATE (mm/rev)	200	250	300
DEPTH OF CUT(mm)	0.4	0.5	0.6

TABLE 2: ORTHOGONAL ARRAY WITH PROCESS PARAMETERS			
JOB NO.	**SPINDLE SPEED (rpm)**	**FEED RATE (mm/min)**	**DEPTH OF CUT (mm)**
1	600	200	0.4
2	600	250	0.5
3	600	300	0.6
4	1200	200	0.4
5	1200	250	0.5
6	1200	300	0.6
7	1800	200	0.4
8	1800	250	0.5
9	1800	300	0.6

CUTTING FORCE CALCULATIONS

The turning process parameters of spindle speed, feed and depth of cut are used to calculate the cutting force is by using this formula.

Cutting force (Ks) $=\frac{\text{Ne X60 X } 10^3 \text{ X Coefficient of Efficiency}}{\text{Depth of cut X Feed X Cutting Speed}}$

Here, Ne = power

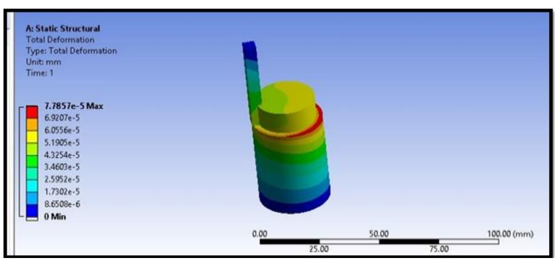
INTRODUCTION TO FEA

Finite Element Analysis (FEA) was first developed in 1943 by R. Courant, who utilized the Ritz method of numerical analysis and minimization of variational calculus to obtain approximate solutions to vibration systems. Shortly thereafter, a paper published in 1956 by M. J. Turner, R. W. Clough, H. C. Martin, and L. J. Topp established a broader definition of numerical analysis. The paper centered on the "stiffness and deflection of complex structures".

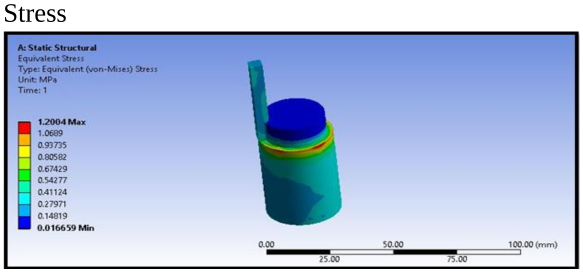
FEA consists of a computer model of a material or design that is stressed and analyzed for specific results. It is used in new product design, and existing product refinement. A company is able to verify a proposed design will be able to perform to the client's specifications prior to manufacturing or construction. Modifying an existing product or structure is utilized to qualify the product or structure for a new service condition. In case of structural failure, FEA may be used to help determine the design modifications to meet the new condition.

Analysis results

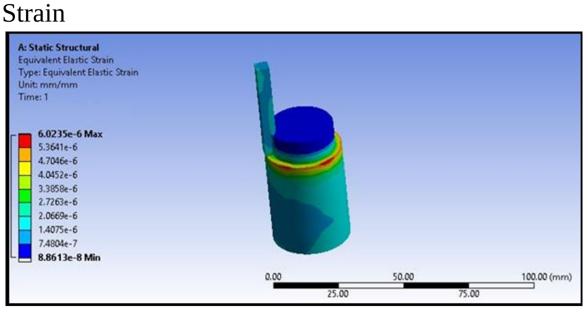
Deformation



Stress



Strain



Results table

FORCE(N)	Total deformation(mm)	Stress (N/mm^2)	Strain
1150	0.0004346	6.23	3.01e-05
992	0.0003749	5.78	2.90e-05
688	0.0002600	4.00	2.01e-05
550	0.00020787	3.20	1.608e-05
375	0.00014173	2.18	1.096e-05
270	0.00010205	1.57	7.89e-06
465	0.00017515	2.70	1.35e-05
297	0.00011225	1.73	1.42e-05
206	7.785e-5	1.20	6.0235e-06

EXPERMENTAL SETUP

The work piece material selected forinvestigation is the EN31 STEEL. The cutting experiments were carried out on Work piece by CNC Lathe under differentcuttingconditions are shown in Table 2.Experimental data of EN31 STEEL which was used in experiments as shown in the Table

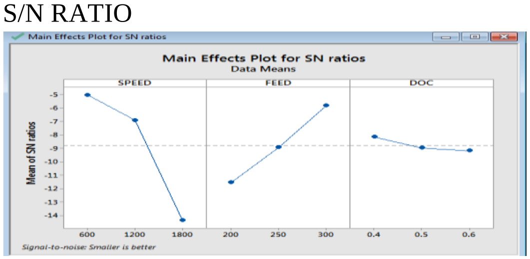
TABLE 3: EXPERIMENTAL DATA FOR 3 PARAMETERS ON Rz, FOR CARBIDE TOOL

JOB NO.	SPINDLE SPEED (rpm)	FEED RATE (mm/min)	DEPTH OF CUT (mm)	Surface finish (R_a) µm
1	600	200	0.4	0.62
2	600	250	0.5	0.78
3	600	300	0.6	0.91
4	1200	200	0.4	1.21
5	1200	250	0.5	1.46
6	1200	300	0.6	1.94
7	1800	200	0.4	2.41
8	1800	250	0.5	2.84
9	1800	300	0.6	3.12

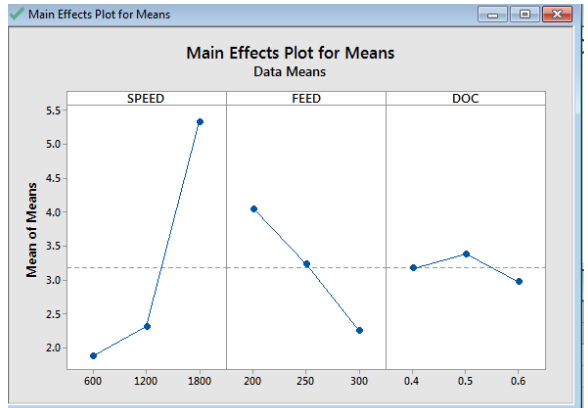
IV. RESULTS AND DISCUSSION

In the Taguchi method the results of the experiments are analyzed to achieve one or more of the following three objectives. To establish the best or the optimum condition for a product or a process. To Studying the main effects of each of the factors identifies the optimum condition (Figures 2 and 3). The process involves minor arithmetic manipulation of the numerical result and usually can be done with the help of a simple calculator. The main effects indicate the general trend of the influence of the factors. Knowing the characteristic, i.e., whether a higher or lower value produces the preferred result, the levels of the factors, which are expected to produce the best results, can be predicted. Estimate the contribution of individual factors. To estimate the response under the optimum conditions. The knowledge of the contribution of individual factors is the key to deciding the nature of the control to be established on a production process.

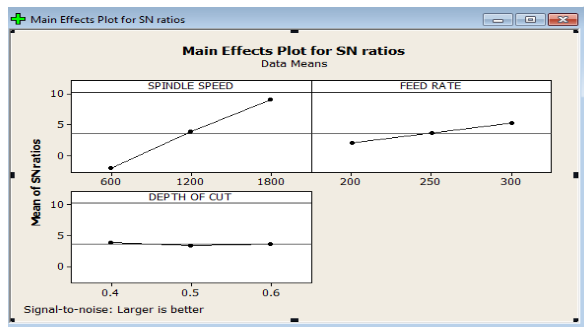
EFFECT OF TURNING PARAMETERS ON STRESS FOR S/N RATIO



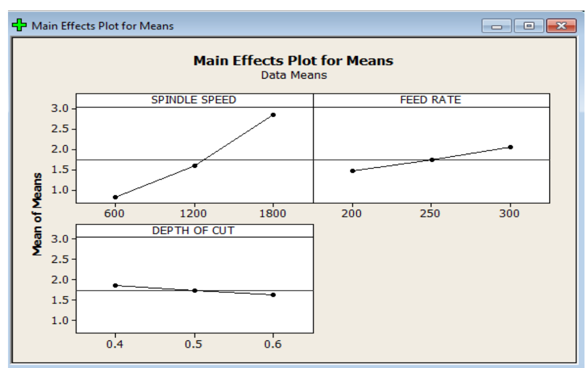
EFFECT OF TURNING PARAMETERS ON STRESS FOR MEANS



EFFECT OF TURNING PARAMETERS ON Surface finish FOR S/N RATIO



EFFECT OF TURNING PARAMETERS ON Surface finish FOR MEANS



Taguchi method stresses the importance of studying the response variation using the signal–to–noise (S/N) ratio, resulting in minimization of quality characteristic variation due to uncontrollable parameter. The cutting force is considered as the quality characteristic with the concept of "the smaller-the-better". The S/N ratio for the smaller-the-better is:

$S/N = -10 *\log(\Sigma(Y2)/n))$

Where n is the number of measurements in a trial/row, in this case, n=1 and y is the measured value in a run/row. The S/N ratio values are calculated by taking into consideration above Eqn. with the help of software Minitab 17.

The force values measured from the experiments and their corresponding S/N ratio values are listed in Table

V. CONCLUSION

The cutting parameters are cutting speed, feed rate and depth of cut for turning of work piece EN 31 tool steel. In this work, the optimal parameters of cutting speed are 600rpm, 1200rpm and 1800rpm, feed rate are 200mm/min, 250mm/min and 300mm/min and depth of cut are 0.4mm, 0.5mm and 0.6mm. Experimental work is conducted by considering the above parameters. Cutting forces, surface finish and cutting temperatures are validated experimentally.

By observing the experimental results and by taguchi, the following conclusions can be made:

To minimize the cutting forces, the optimal parameters are spindle speed – 600rpm, feed rate – 200mm/min and depth of cut – 0.4mm.

To get better surface finish, the optimal parameters are spindle speed – 1800rpm, feed rate – 300mm/min and depth of cut – 0.6mm.

To maximize material removal rate, the optimal parameters are spindle speed – 600rpm, feed rate – 200mm/min and depth of cut – 0.6mm.

The effects of these parameters on the cutting forces are calculated using theoretical calculations and using the forces stresses and displacements are analyzed using Ansys. 3D modeling is done in Pro/Engineer.

By observing the analysis results, the stress values are less than the yield stress values.

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