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Analysis of Surface Roughness in Turning Process by Optimizing Grade of Accuracy and Metal Removal Rate

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Abstract: *Turning method is one in every of the foremost elementary machining processes utilized in the producing business. the method of turning is influenced by several factors like cutting rate, feed rate, depth of cut, pure mathematics of cutlery, and cutting conditions etc., to call many. In machining operations, achieving the specified surface quality of the machined product is de facto a difficult job. this is often owing to the very fact that quality is extremely influenced by method parameters directly or indirectly. However, the extent of great influence of the method parameters is totally different for various responses. during this the result of insert nose radius and machining parameters as well as cutting speed, feed rate and depth of cut on surface roughness in an exceedingly turning operation area unit investigated by victimization the Taguchi improvement methodology with the assistance of CREO constant quantity software system and ANSYS.*
Keywords: *Cutting speed, CREO, Feed rate, Turning.*

I. Introduction

The challenge of recent machining industries is mainly centered on the accomplishment of top quality, in terms of labor piece dimensional accuracy,surface end, high production rate, less wane 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 prices and quality of product in every production stage should be monitored and immediate corrective actions got to be taken in case of Deviation from desired trend. Surface roughness mensuration presents a very important task in several engineering applications. Many life attributes are often additionally determined by however well the surface end is Maintained. Machining operations have been the core of the producing trade since the commercial revolution and also the existing optimization researches for pc Numerical Controlled (CNC) turning were either simulated within specific producing circumstances or achieved through varied frequent instrumentality operations. These conditions or producing Circumstances area unit thought to be computing simulations and their pertinence to globe industry continues to be unsure and thus, a general optimization theme while not instrumentality operations is deemed to be essentially developed. Surface roughness is often thought of as a significant manufacturing goal for turning operations in several of the prevailing researches. The machining method on a CNC shaper is programmed. several surface roughness prediction systems were designed victimization a variety of sensors as well as dynamometers for force and torsion. Taguchi and ANSYS will handily optimize the cutting parameters with many experimental runs well designed.

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 techniques product ages) and any added expenses due to harmful side effects of the product in use Surface finish, also known a surface texture or surface topography, is the nature of a surface as defined by the 3 characteristics of lay, 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. Literature Survey

The Effect of Tool Construction and Cutting Parameters on Surface Roughness and Vibration in Turning of AISI 1045 Steel Using Taguchi Method by Rogov Vladimir Aleksandrovich, GhorbaniSiamak This paper presents Associate in Nursing experimental investigation targeted on distinguishing the consequences of cutting conditions and power construction on the surface roughness and natural frequency in turning of AISI1045 steel. Machining experiments were distributed at the shaper mistreatment inorganic compound cutting insert coated with vellication and 2 kinds of cutting tools made from AISI 5140 steel. 3 levels for spindle speed, depth of cut, feed rate and power overhang were chosen as cutting variables. The Taguchi methodology L9 orthogonal array was applied to style of experiment. By the assistance of ratio and analysis of variance, it absolutely was finished that spindle speed has the numerous result on the surface roughness, whereas tool overhang is that the dominant issue moving natural frequency for each cutting tools. additionally, the optimum cutting conditions for surface roughness and natural frequency were found at totally different levels. Finally, confirmation experiments were conducted to verify the effectiveness and potency of the Taguchi methodology in optimizing the cutting parameters for surface roughness and natural frequency.

III. Methodology

In this work, experimental results were used for improvement of input machining parameters speed, feed, and depth of cut victimisation Taguchi Technique for the response Surface Roughness. multivariate analysis is additionally used for Predicting the influence of varied parameters on Rz.

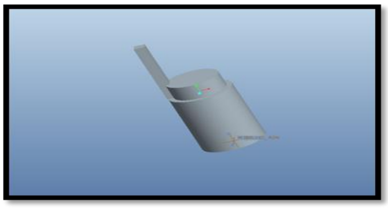

Figure 1: Cutting tool and Work piece assembly

To select associate degree applicable orthogonal array for the experiments, the entire degrees of freedom got to be computed.

Table I: Process Parameters

JOB NO.	SPINDLE SPEED	FEED RATE	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

IV. Experimental Setup

In the experimental setup, the folowing operations are done.

1. Set the speed management to minimum speed and switch on the shaper motor by moving the silver on/off switch to the FORWARD position. Advance the speed management knob to regarding the 10 O'clock position (around 400-600 RPM).
2. advance the cross slide crank regarding ten divisions or .010" Turn the carriage hand wheel counter dextrorotary to slowly move the carriage towards the headstoc Continue advancing the tool towards the support till it's regarding 1/4" far from the chuck jaws.
3. The power feed is engaged by the knurled tumbler gearstick on the rear of the support to vary the lever setting you want to pull back on the knurled sleeve with goodish force.
4. Just as in facing, you ordinarily can build one or additional comparatively deep (.010-.030) roughing cuts followed by one or additional shallow (.001- .002) finishing cuts.

5. The diameter of the work piece is decided by a caliper or micrometer. Micrometers ar additional correct, however less versatile. you may would like a machinist's caliper capable of activity right down to 0.001".
6. It ought to be obvious that you must ne'er decide to live the work whereas it's in motion
7. It’s an honest plan to require a minimum of 2 separate measurements simply to create positive you bought it right.
8. A shoulder may be a purpose at that the diameter of the work piece changes with no taper from one diameter to the opposite.
9. Advance the cross slide concerning .020 and use power feed to show down a couple of 1/2" length on the tip of the work piece. Repeat this a number of additional times till you've got reduced the diameter of the tip section to concerning 1/2".
10. To get a pleasant sq. edge we have a tendency to should switch to a tool with {a sharp|a purposey} point ground to associate angle of but 90 degrees
11. The work piece material selected for investigation is that the nut thirty one STEEL. The cutting experiments were distributed on Work piece by CNC shaping machine below completely different cutting condition.

Figure 2: Work pieces processed on CNC Lathe

Table II: Experimental Data For Three Parameters

JOB NO.	SPINDLE	FEED RATE	DEPTH OF	Surface
1	600	200	0.4	3.274
2	600	250	0.5	3.655
3	600	300	0.6	3.690
4	1200	200	0.4	3.480
5	1200	250	0.5	3.720
6	1200	300	0.6	4.000
7	1800	200	0.4	3.470
8	1800	250	0.5	3.070
9	1800	300	0.6	3.770

V. Results

Cutting tool and the metal rod are subjected to stress strain analysis using ANSYS at different depth of cuts and different rpms. Among the various depth of cuts and rpm some pictures of analysis are as follows.

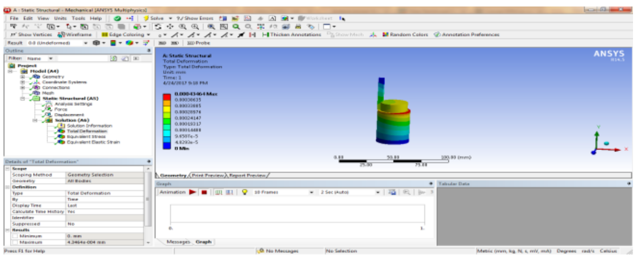

Figure 3: Total Deformation Shape at Force-1150N

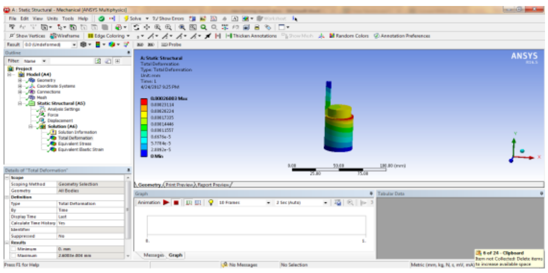

Figure 4: Total Deformation Shape atForce -688N

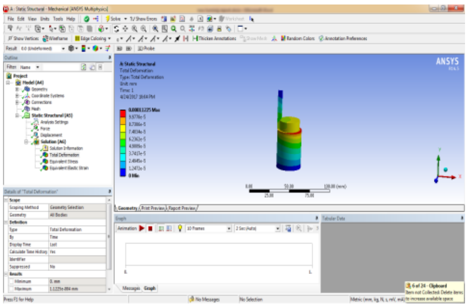

Figure 5: Total Deformation Shape at Force-297N

The stress and strain analysis results are tabulated as follows.

Table III: Structural Analysis Result 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

With the help of the Taguchi method the tested values are

Table IV: Taguchi Orthogonal Array

JOB	SPINDLE	FEED RATE	DEPTH	Surface finish
1	600	200	0.4	3.274
2	600	250	0.5	3.655
3	600	300	0.6	3.690
4	1200	200	0.4	3.480
5	1200	250	0.5	3.720
6	1200	300	0.6	4.000
7	1800	200	0.4	3.470
8	1800	250	0.5	3.070
9	1800	300	0.6	3.770

The worksheets for the results from the above tables using ANSYS and the Taguchi methd are well tabulated and they are plotte on graphs too as below.

Worksheet 1 ***

↓	C1	C2	C3	C4	C5	C6	C7
	speed	feed	doc	surface	surface 1	SNRA1	MEAN1
1	600	200	0.4	3.274	3.30	10.3358	3.2870
2	600	250	0.5	3.655	3.70	11.3106	3.6775
3	600	300	0.6	3.690	3.80	11.4662	3.7450
4	1200	200	0.5	3.480	3.50	10.8564	3.4900
5	1200	250	0.6	3.720	3.85	11.5575	3.7850
6	1200	300	0.4	4.000	4.10	12.1471	4.0500
7	1800	200	0.6	3.470	3.56	10.9164	3.5150
8	1800	250	0.4	3.070	3.12	9.8124	3.0950
9	1800	300	0.5	3.770	3.89	11.6608	3.8300

Figure 6: Worksheet

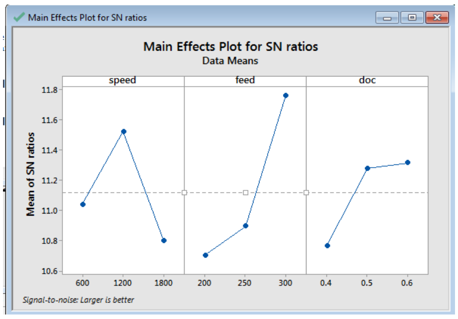

Figure 7: Effect of turning parameters on force for S/N ratio

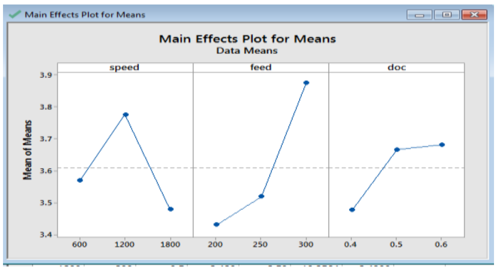

Figure 8: Effect of turning parameters on force for Means

Taguchi methodology stresses the importance of finding out the response variation victimization the signal– to–noise (S/N) quantitative relation, leading to minimisation of quality characteristic variation due to uncontrollable parameter. The cutting force is taken into account because the quality characteristic with the idea of "the smaller-the-better". The S/N quantitative relation for the smaller-the-better is:

$$\mathbf{S/N = -10 * \log(\Sigma(Y^2)/n))}$$

Worksheet 1 ***

↓	C1	C2	C3	C4	C5	C6	C7
	speed	feed	doc	surface	surface 1	SNRA1	MEAN1
1	600	200	0.4	3.274	3.30	10.3358	3.2870
2	600	250	0.5	3.655	3.70	11.3106	3.6775
3	600	300	0.6	3.690	3.80	11.4662	3.7450
4	1200	200	0.5	3.480	3.50	10.8564	3.4900
5	1200	250	0.6	3.720	3.85	11.5575	3.7850
6	1200	300	0.4	4.000	4.10	12.1471	4.0500
7	1800	200	0.6	3.470	3.56	10.9164	3.5150
8	1800	250	0.4	3.070	3.12	9.8124	3.0950
9	1800	300	0.5	3.770	3.89	11.6608	3.8300

Figure 9: S/N Ratio values and Force values

VI. Conclusion

In this thesis a shot to create use of Taguchi optimisation technique to optimize cutting parameters throughout high speed turning of linear unit thirty one alloy steel exploitation cemented inorganic compound cutter.

By perceptive the experimental results and by touchy, the optimum parameters for the minimizing the cutting forces, to get higher surface end and to maximize the material removal rate have to experimental calculated. The effects of those parameters on the cutting forces are calculated exploitation theoretical calculations and exploitation the forces stresses and displacements are analyzed with ANSYS and the 3D modeling is finished in CREO.

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

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