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Study of Performance of Machines for Optimum Surface Roughness

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ABSTRACT

all of the research was extensively based totally across the obtainment of the floor or surface roughness. The evaluation of the following has been performed on the premise of various parameters . Some analyses were greatly focused on Milling machines and its distinctive programs, even as some were based on CNC machines additionally.one-of-a-kind methodologies primarily based on special machines and had been used as a metric to determine the floor roughness. Majority of the studies done were based on the exercise of the Taguchi technique, which is widely considered as an excellent technique to engineering that emphasizes the jobs of studies and development (R&D), and product layout and improvement in reducing the incidence of defects and failures inside the manufacturing manner. Parameters like velocity of reducing, Feed, slicing depth, charge of material removal or MRR, time taken by using the system etc

Keywords : MRR, Taguchi Orthogonal array, Analysis of variance (ANOVA), Surface roughness

1. INTRODUCTION

Milling is a steel removal process. In milling operation, metallic is eliminated by means of a rotating multipoint cutter which is fitted on the arbor of the milling machine. The styles of capabilities are formed by way of a milling gadget on a part via cutting away the unnecessary material. Milling gadget has its major additives which are its column, saddle, base, desk, knee, overarm, arbor and spindle. inside the milling technique, certain elements play a totally important function including work-piece, fixture and cutter that are needed within the milling procedure. The workpiece is held within the fixture, connected to a desk of milling machines. 3 table movements are feasible in a milling device i.e crosswise, vertical, and longitudinal but rotational or swivel moves are also located with respect to the desk in some instances. In enhancing the method of milling, a totally critical function is performed with the aid of the exceptional floor. The fatigue strength, corrosion, resistance, creep existence is improved via improved surface. floor roughness influences a number of purposeful attributes of components along with friction among two contacted elements, components wearing, mirrored image of mild, transmission of warmth distributing capability of lubricant, conserving capacity of load bearing, coating or fatigue resisting and so forth. Therefore, the chosen system ought to be proper for the duration of the operation and favored finished floor is detailed. For optimum surface roughness, Taguchi method can be used to optimize the parameter

2. OBJECTIVE

The goal of this software is to examine the performance of milling machines for max surface roughness as it's miles one of the parameters which could in large part influence the overall output of the manufactured workpiece. The vital objective of the technology of metallic cutting is the solution of realistic issues related to the efficient and unique removal of metallic from workpiece. It has been diagnosed that the reliable quantitative predictions of the numerous technological overall performance measures, preferably inside the form of equations, are vital to broaden optimization techniques for choosing

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slicing situations in manner planning. The progress in the improvement of predictive fashions, primarily based on cutting theory, has no longer yet met the objective; the maximum important cutting overall performance measures, which include, tool lifestyles, reducing force, roughness of the machined floor, power intake, … and so on., need to be defined the usage of experimental studies. Consequently, further improvement and optimization for the technological and financial performance of machining operations rely upon a nicely based totally experimental methodology. Unfortunately, there is a lack of statistics handling. Take a look at methodology and information evaluation in metallic slicing experiments. The call for excessive first-class and completely computerized manufacturing focuses interest on the surface condition of the product, in particular the roughness of the machined surface, because of its impact on product appearance, feature, and reliability. For those reasons it's far critical to maintain consistent tolerances and floor ends.

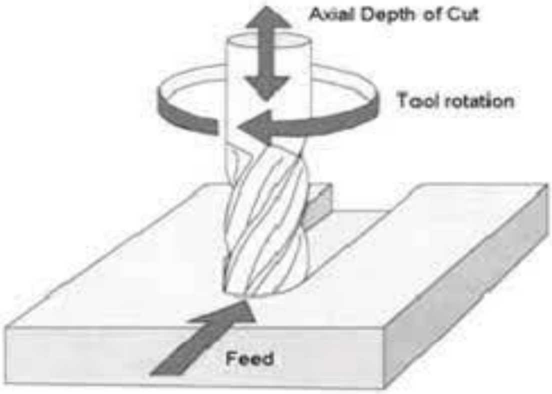
also, the high-quality of the machined surface is beneficial in diagnosing the stability of the machining manner, in which a deteriorating floor end might also imply workpiece fabric non-homogeneity, revolutionary device wear, reducing device chatter, and so forth. The multiplied application of computer aided manufacturing (CAM) to machining by using CNC machine gear has focused on growing dependable equipment information systems, to make sure top-rated manufacturing the usage of high priced equipment. amongst several commercial machining processes, milling is a fundamental machining operation. End milling is the most common steel removal operation encountered. It is extensively used in a variety of manufacturing industries together with the aerospace and car sectors, wherein excellence is an critical element in the production of slots and dies. The superiority of the surface plays a totally crucial role within the performance of milling as a great-quality milled surface appreciably improves fatigue power, corrosion resistance, and creep existence. floor roughness also influences several functional attributes of elements, including sporting, warmth transmission, capability of keeping a lubricant, coating, or resisting fatigue. Therefore, the favored finish floor is typically targeted and the appropriate tactics are selected to reach the specified fine. several elements affect the very last surface roughness in end milling operation. factors together with spindle velocity, feed price, and depth of cut that manage the slicing operation can be set up earlier. but, factors consisting of device geometry, device wear, and chip formation, or the material properties of each tool and workpiece are out of control. One must develop strategies expecting the surface roughness of a product before milling in order to examine the robustness of machining parameters which includes feed charge or spindle pace for retaining a preferred floor roughness and growing product first-rate. It is also essential that the prediction method needs to be accurate and reliable. Researchers on this site try to develop fashions that may expect floor finish of a steel for a ramification of machining situations which includes pace, feed, depth of cut, and so on. dependable fashions would no longer most effective simplify manufacturing procedure making plans and manage, but could assist in optimizing machinability of substances. therefore, the cause of this examine is (1) to observe the effect of machining parameters on the surface exceptional of the machined surfaces, (2) to expand one floor prediction approach which is termed the a couple of regression prediction version and (3) to assess prediction potential of model.

3. EXPERIMENTAL DESIGN

Experiments have been performed in order to investigate the effects of one or more factors of the process parameters (spindle speed, feed rate and depth of cut) on the surface finish of the machined surface. When an experiment involves two or more factors, the factors can affect the response individually or interactively. Often, the experimental design does not give an idea about the interaction effects of the factors as in the case of one factor at-a time experimentation, All possible factor level combinations experiments conducted in completely randomized designs are especially useful for testing the interaction effect of the factors. Completely randomized designs are appropriate when there are no restrictions on the order of the testing to avoid systematic bias errors due to the wear of the cutting tool. The procedure to define a model of the process includes the following steps:

1. Selecting the factors to be involved in the process and choosing the levels of these factors. 2. Conducting the experiment at all possible factor level combinations randomly. 3. Analyzing the collected data using parametric analyses of variance (ANOVA). 4. Building the multiple regression model. 5. Validating of the model.

Experimental Procedure: This experiment employed a Bridgeport end-milling machine. Eight ¾-inch four-flute high-speed steel cutters were used. The experiment has been done under a dry machining environment. The experimental setup is shown in figure. 1. The cutting parameters were set as: four levels of spindle speed (750, 1000, 1250, 1500 rpm), seven levels of feed rate (150, 225, 300, 375, 450, 525, 600 mm/min), and three levels of depth of cut (0.25, 0.75, 1.25 mm). The cutters used to execute the experiment were selected randomly. Surface roughness Ra measured in micrometers was the response variable. Several variables were put under close control including the machine on which milling operation was performed (the same machine was used for all experimental work), and the operator (the same operator machined all specimens). The surface roughness data were collected randomly for each of the 84 machining conditions defined by the levels of independent variables (4 spindle speeds ×7 cutting feeds × 3 depths of cut). The experiment was performed on aluminum workpieces.



Building the multiple Regression model : The proposed multiple regression model is a two-way interaction equation: Y = C + B1X1 + B2X2 + B3X3 + B12X1X2 + B13X1X2 + B23X2X3 (1) where Y: surface roughness in µm X1: spindle speed in rpm X2: cutting feed in m/min X3: depth of cut in mm In this model, the criterion variable is the surface roughness (Ra) and the predictor variables are spindle speed, feed rate, and depth of cut. Because these variables are controllable machining parameters, they can be used to predict the surface roughness in milling which will then enhance product quality. A commercial statistical package STATISTICA 6.0 was used to do the regression analysis. In order to judge the accuracy of the multiple regression prediction model, percentage deviation φi and average percentage deviation φ were used and defined as

$$\phi_i = \frac{\left|R_{aim} - R_{aip}\right|}{R_{aim}} \times 100\%$$

Where,

φi: percentage deviation of single sample data.

Raim: measured Ra .

Raip: predicted Ra generated by a multiple regression equation.

$$\overline{\phi} = \frac{\sum_{i=1}^{n} \phi_i}{n}$$

where,

φ : average percentage deviation of all sample data

n: the size of sample data This method would test the average percentage deviation of actual

Ra (measured by an off-line stylus type profilometer) and predict Ra (produced by the multiple regression model).

4. RESULTS

After 84 specimens were cut for experimental purposes, they were measured off-line with a stylus type profilometer to obtain the roughness average value Ra. All original 84 samples were randomly divided into two data sets, training set and testing set. The training set contained 60 samples which were used to build the model and the testing set contained 24 samples which were used to test the flexibility and the validity of the regression model as shown in Tables 1 and 2, respectively. The collected data were analyzed using parametric analyses of variance (ANOVA) with surface finish as the dependent variable and spindle speed N, Cutting feed F and depth of cut D as independent variables. The ANOVA model was modified to include the main effects of the independent variables and up to two-variable interactions only. The significance level was based on the P-value from ANOVA [13] as 0.05 and 0.05 0.10 0.10 < < < > Significant if P Mildly significant if P Insignificant if P (4) A statistical model was created by regression function in STATISTICA 6.0 from the training data set. The R Square was 0.83879, which showed that 83.879 % of the observed variability in Ra could be explained by the independent variables. The Multiple R was 0.9158, which meant that the correlation coefficient between the observed value of the dependent variable and the predicted value based on the regression model was high.

Table 1 Effect of cutting parameters on the surface finish of the machined surfaces (training data set)

No.	Cutting parameters			R_a, µm	No.	Cutting parameters			R_a, µm	No.	Cutting parameters			R_a, µm
	N rpm	F mm/min	D mm			N rpm	F mm/min	D mm			N rpm	F mm/min	D mm	
1	750	525	1.25	3.7	21	1500	450	1.25	2.6	41	1000	600	0.75	4.0
2	1250	300	1.25	2.4	22	750	600	0.75	4.5	42	1250	150	1.25	1.7
3	1000	375	0.25	2.6	23	1000	525	0.25	3.8	43	1000	375	0.75	2.6
4	750	600	1.25	4.4	24	750	300	1.25	2.4	44	1250	300	0.75	2.5
5	750	300	0.75	2.6	25	1500	225	0.75	1.9	45	1000	225	0.75	2.4
6	1500	375	1.25	2.5	26	1250	150	0.25	1.2	46	1500	300	0.75	2.1
7	1250	450	1.25	2.3	27	1250	525	1.25	2.5	47	1000	525	0.75	3.9
8	1000	300	1.25	2.3	28	1250	375	1.25	2.5	48	1250	225	0.25	2.1
9	750	150	1.25	1.9	29	1000	225	0.25	2.3	49	1000	150	0.75	1.9
10	1500	600	0.75	2.6	30	1000	450	0.75	3.0	50	1250	375	0.75	2.5
11	1500	450	0.25	3.2	31	1000	600	0.25	4.1	51	1000	150	0.25	1.6
12	1000	450	0.25	4.0	32	1500	150	0.25	1.3	52	1000	225	1.25	2.7
13	750	375	0.75	3.1	33	750	375	1.25	2.6	53	750	225	1.25	2.5
14	1250	600	0.25	3.8	34	1500	525	1.25	3.0	54	1250	450	0.75	2.2
15	1250	225	0.75	2.1	35	1250	300	0.25	2.6	55	1500	300	0.25	2.3
16	1000	150	1.25	1.6	36	1000	300	0.25	3.1	56	750	450	0.25	4.8
17	1000	300	0.75	2.1	37	1500	225	0.25	1.4	56	1250	600	0.75	2.6
18	750	450	1.25	3.3	38	750	225	0.75	2.6	58	750	525	0.25	4.5
19	1500	600	0.25	3.2	39	750	150	0.75	1.7	59	1250	225	1.25	2.4
20	1250	525	0.75	2.5	40	750	525	0.75	4.0	60	1250	150	0.75	1.7

Table 2 Effect of cutting parameters on the surface finish of the machined surfaces (testing data set)

No.	Cutting parameters			R_a, µm	No.	Cutting parameters			R_a, µm	No.	Cutting parameters			R_a, µm
	N rpm	F mm/min	D mm			N rpm	F mm/min	D mm			N rpm	F mm/min	D mm	
1	1000	450	1.25	2.1	9	1500	450	0.75	2.3	17	1500	525	0.75	2.6
2	1500	150	1.25	1.5	10	750	600	0.25	4.7	18	1500	525	0.25	3.1
3	750	300	0.25	3.0	11	1500	375	0.75	2.1	19	1500	600	1.25	3.2
4	750	450	0.75	3.7	12	750	375	0.25	3.2	20	750	150	0.25	1.6
5	1000	375	1.25	2.6	13	1250	600	1.25	3.1	21	1250	450	0.25	2.5
6	750	225	0.25	2.1	14	1250	375	0.25	2.7	22	1500	150	0.75	1.4
7	1500	375	0.25	2.7	15	1000	600	1.25	2.1	23	1000	525	1.25	1.5
8	1250	525	0.25	3.1	16	1500	300	1.25	2.4	24	1500	225	1.25	1.8

In Table , the coefficients for the independent variables were listed in column B. Using these coefficients, the multiple regression equation could be expressed as:

$$\bar{R}_a = 1.178854 - 0.000492N + 0.009897F - 0.17625D \\ - 0.000003N \times F + 0.000811N \times D - 0.003012F \times D$$

The scatterplot between the observed Ra and the predicted Ra of all 84 samples as shown in Figure 2 indicated that the relationship between the actual Ra and the predicted Ra was linear. The result of average percentage deviation (φ) showed that the training data set (n=60) was 11.645% and the testing data set (n=24) was 12.134%. This means that the statistical model could predict the surface roughness (Ra) with about 88.355% accuracy of the training data set and approximately 87.866% accuracy of the testing data set.

Table 3: included in the multiple regression model (α=0.05)

Factor	Effect (Beta)	Standard error of effect (SE Beta)	Regression Coefficient (B)	P-value
Intercept			1.178854	0.0000*
N	-0.166194	0.173971	-0.000492	0.0000*
F	1.792732	0.242093	0.009897	0.0000*
D	-0.086891	0.258455	-0.176250	0.0002*
N×F	-0.803242	0.258455	-0.000003	0.0017*
N×D	0.507176	0.242093	0.000811	0.0585**
F×D	-0.726007	0.173971	-0.003012	0.0000*

* : Strongly significant
**: Mildly significant

The analysis indicated that all main factors and their interactions were highly significant (P<0.05). The individual effects of various factors as well as their interactions can be discussed from the Pareto chart illustrated by Figure 3. The length of each bar in the Pareto chart is proportional to the absolute value of its associated regression coefficient or estimated effect. The effects of all parameters and interaction terms are standardized (each effect is divided by its standard error). The order in which the bars are displayed corresponds to the order of the size of the effect. The chart includes a vertical line that corresponds to the 95% limit indicating statistical significance. An effect is, therefore, significant if its corresponding bar crosses this vertical line.

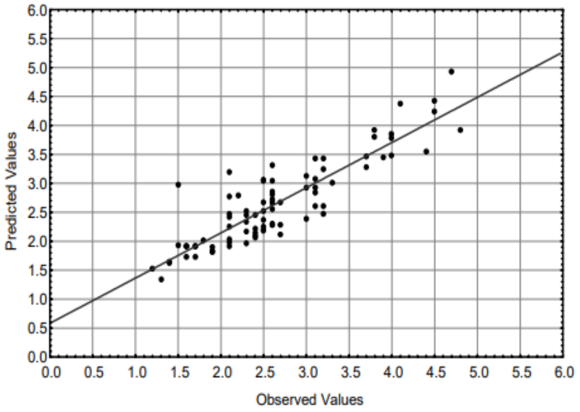


Figure 2:Observed vs. predicted values of surface roughness

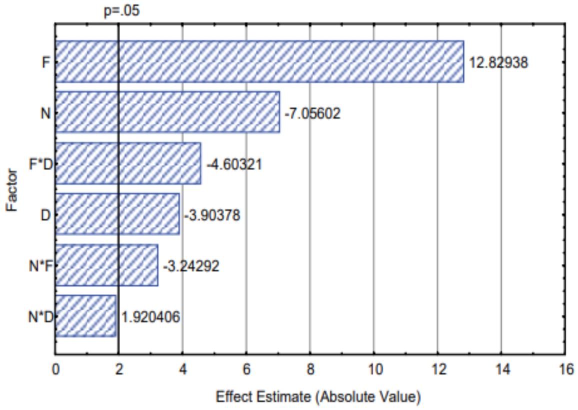


Figure 3: Pareto Chart of Standardized Effects for surface roughness R_a showing significant factors and interactions

The numerical estimates of the effects indicate that the effect of feed is the largest (12.82) and has positive direction. The positive direction means that the surface finish deteriorates with increasing the cutting feed. This is due to the increase in distance between the successive grooves made by the tool during the cutting action, as the cutting feed increases. Figure 3 shows the effect of spindle speed (-7.05). The negative direction means that increasing the spindle speed improves the surface finish. It is generally well known that an increase in cutting speed improves machinability. This may be due to the continuous reduction in the build up edge formation as the cutting speed increases. The interaction between the cutting feed and depth of cut significantly affects the surface roughness (-4.6). The interaction also suggests that to get a certain surface finish and maximum metal removal it is preferable to use a high cutting feed associated with depth of cut. The depth of cut also has a negative value (-3.9), which indicates that increasing the depth of cut improves the surface finish. The effect of the depth of cut is less significant on the surface finish. The interaction between the cutting feed and spindle speed is significantly affecting the surface roughness as shown in Figure 3. The figure shows that increasing the spindle speed improves the surface finish as the cutting feed decreases. This supports the earlier discussion about the effect of decreasing cutting speed on the surface roughness of the machined workpieces. The interaction between the depth of cut and spindle speed is less significant as shown in Figure. The interaction reveals that increasing the spindle speed and increasing the depth of cut deteriorates the surface finish.

5. CONCLUSIONS

As described in the text before, precision for surface roughness is highly dependent upon what sort of factors or parameters are being exploited.The machines need to be more powerful and economically efficient, as the main aspect of their usage is manufacturing, and manufacturing for a firm without faults and problems can be easily put to use with better functioning being used. The following includes numerous aspects, which are driven based on what harvests maximum profits, excluding wastage while manufacturing. Most of the papers were able to justify upto a manufacturing accuracy of about 12 per cent, nearly.

REFERENCES

https://www.researchgate.net/publication/321796166_Study_of_performance_of_milling_machine_for_optimum_surface_Roughness
https://www.researchgate.net/publication/321796179_Comparative_Study_of_Performance_of_Milling_Machine_for_Optimum_Surface_Roughness
http://www.isca.in/IJES/Archive/v6/i9/6.ISCA-RJEngS-2017-165.pdf
https://www.theijes.com/papers/v2-i1/R02101030113.pdf
https://cdn.ymaws.com/www.atmae.org/resource/resmgr/JIT/yang030101.pdf