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Enhancing the Surface Finish of Product Coming From High Precision CNC- Milling Center by Varaying the Machtine Parameters Through Taguchi Approach

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Abstract: ***The manufacturing process for products with high degree of precision is very critical and hence increasing the surface quality, wherever possible has been the prime motive, so many leading companies are working with high precision CNC-VMC series for operations such as Drilling, Tapping, Turning, Milling, etc.***
Surface roughness is the most important indicator of surface quality in machined items. So as to achieve that changing machine parameters as per product size and environment is necessary. In this research, the parameters which are taken into account are : spindle speed, feed rate, and depth of cut. Taguchi Design is utilized in this study to find the best combination of parameters to reach out to the maximum surface finish criteria. For various combinations of three parameters: spindle speed, feed rate, and depth of cut, experiments are carried out using the Taguchi orthogonal array. The surface roughness Ra is analyzed for each experiment run using Taguchi.
Keywords: Taguchi Method, Spindle Speed, Feed rate, Surface finish, Surface roughness, Depth of cut.

I. INTRODUCTION

To satisfy centered need of fastest mill-tap in Automobile, Surgical and Telecom industries, leading industries have adopted and developed high speed drill-tap center, milling center known as High precision Series. The series is outfitted with fast electro-mechanical type integral pallet changer, fast tool changer and dynamic rapid feed rate of nearly 60 m/min. This moving column drill tap centers ideally fit for small and mid-sized components for continuous drilling-tapping operations and the milling centers are fit for big sized contour shaped components.

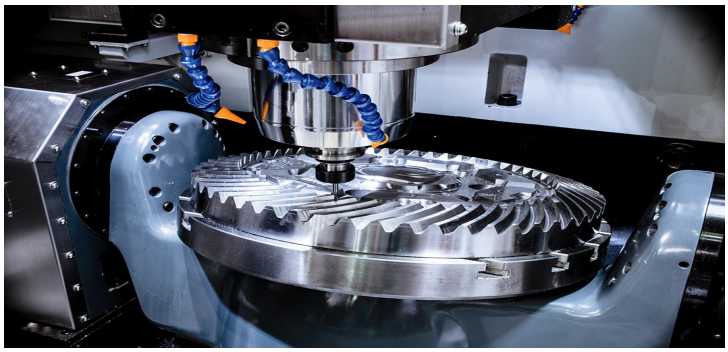

Fig (a) 3 axes Milling Center

The Methodology used in this research is Taguchi Methodology.
Taguchi has found a new method of conducting the design of experiments which are based on well-defined guidelines. This method uses a special set of arrays called orthogonal arrays. These standard arrays stipulate the way of conducting the minimal number of experiments which can give the full information of all the factors which affect the performance parameters. The main core point of the orthogonal array method lies in choosing the level combinations of the input design variables for each experiment, other than that ,The Taguchi method involves reducing the variation in a process through robust design of experiments. The overall objective of the method is to produce high quality product at low cost to the manufacturer.

Along with this we can check the Machining capabilities of such machines. Machining capabilities is a study in which the main aim of it is to detect and evaluate the machine related influences on the manufacturing process and to possibly understand them based on influences at certain area.

There are many parameters involved in this study which are likely to mentioned below :

1) Surface finish
2) Tools
3) Cycle Times
4) Coolant flow and temperature
5) Pressure
6) Performance
7) Current
8) Power

For all machining interactions ,it is critical to get precise measurements with greater surface finish and for accomplishing high production and better MRR. A machining process includes different parameters which has direct or indirect influence on surface roughness and material removal rate.

The influence of varied machining parameters (spindle speed, feed, and depth of cut) on material removal rate in end milling is demonstrated in this report. The requirement for high-quality, completely automated manufacturing focuses attention on the product's surface condition. The surface finish of the machined surface is very essential because it affects the product's look, function, and reliability. There are few things we need to understand about the surface roughness : Characteristics of Surface finish and Factors affecting the surface Roughness.

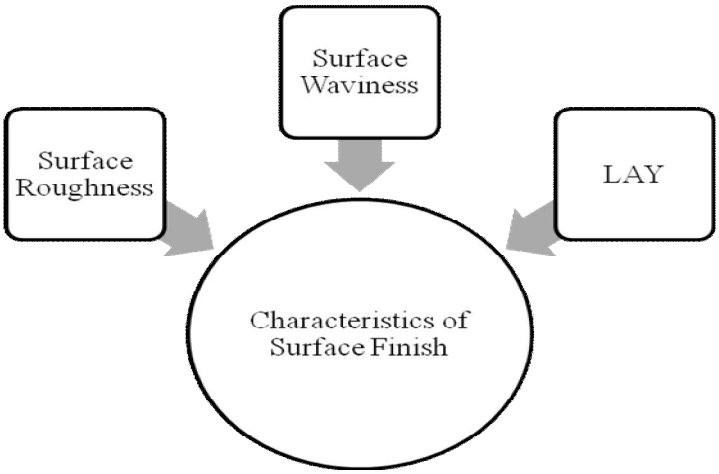

Fig (b) Characteristics of Surface Finish

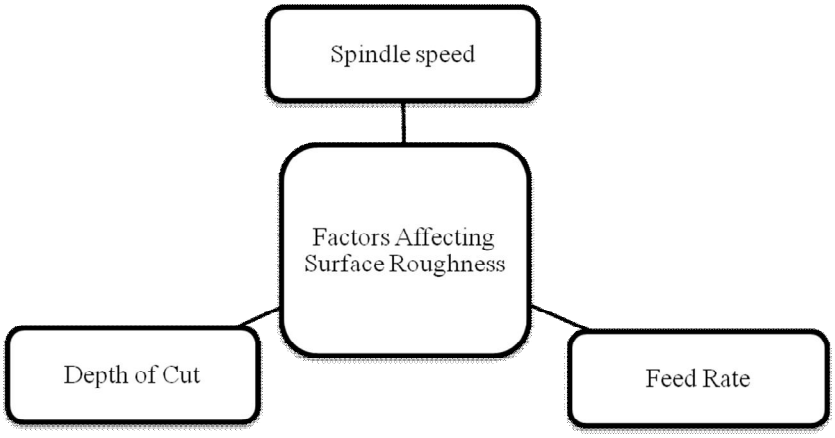

Fig (c) Factors affecting Surface Roughness

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II. FACTORS AFFECTING THE SURFACE FINISH

Now let's understand the individual effects of these parameters on surface roughness of high precision CNC milled work piece.

A. Effect of Spindle Speed

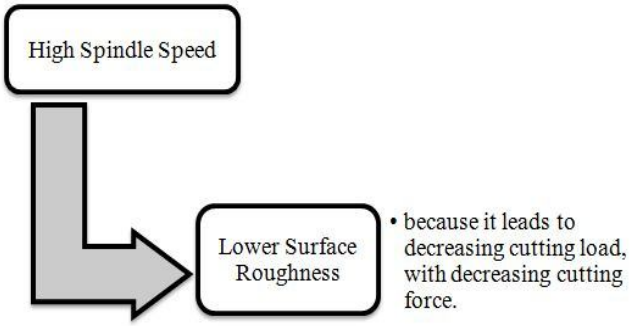


Fig (d) Effect of Spindle Speed on surface roughness

B. Effect of Feed Rate

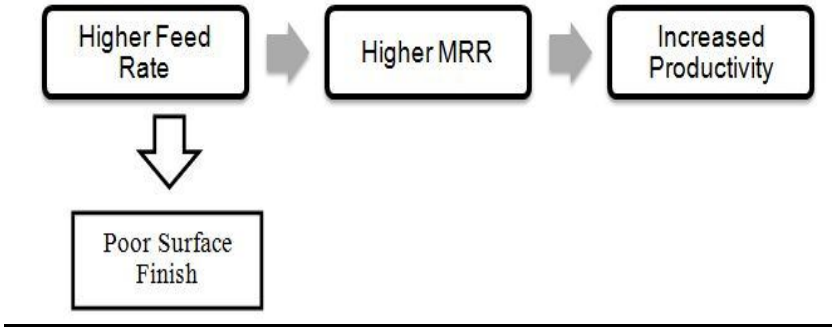


Fig (e) Effect of Feed rate on surface roughness

C. Effect of Depth of Cut

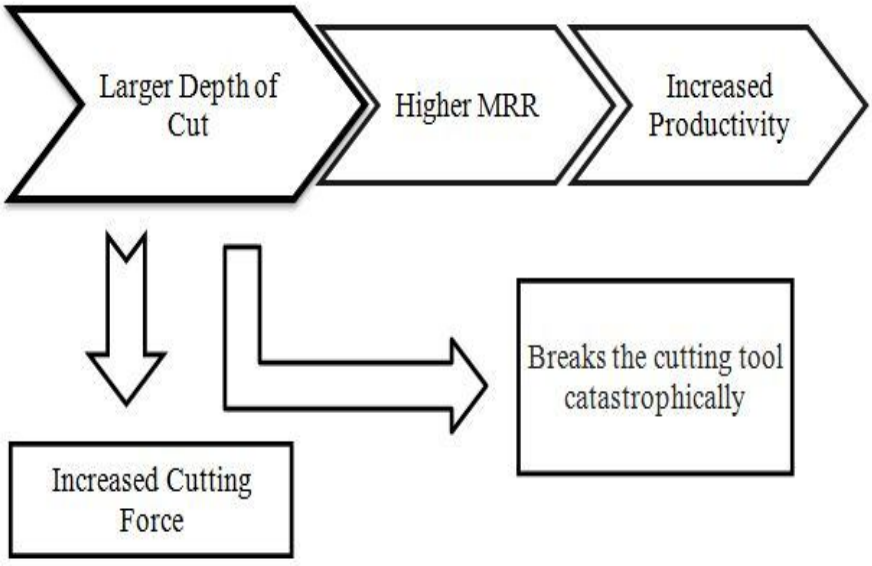


Fig (f) Effect of Depth of Cut on surface roughness

III. EXPERIMENTAL RESULTS

As per the experimental results were carried out on High precision CNC milling center, we got the following results to investigate the best possible combinations to increase surface finish through Taguchi approach. We have conducted 3 experiments based on given industrial data. We have taken these results with minitab 2019 software usage.

Control factors	Level 1	Level 2	Level 3	Unit
Factor A (Spindle Speed)	1500	2500	3000	rpm
Factor B (Depth of cut)	0.06	0.1	0.15	min/tooth
Factor C (Feed rate)	0.5	0.8	1	mm

Table (a) : Input Parameters

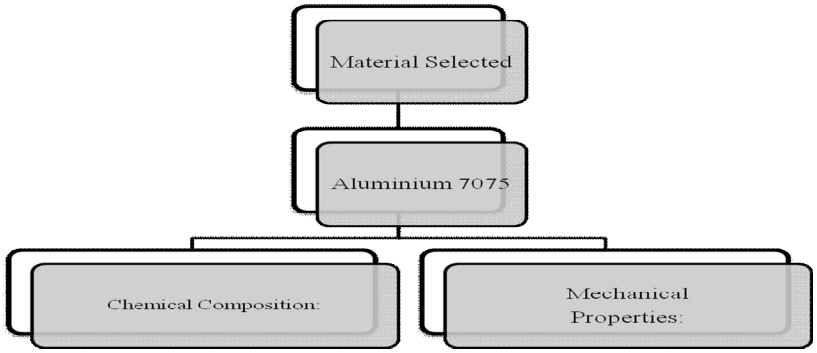


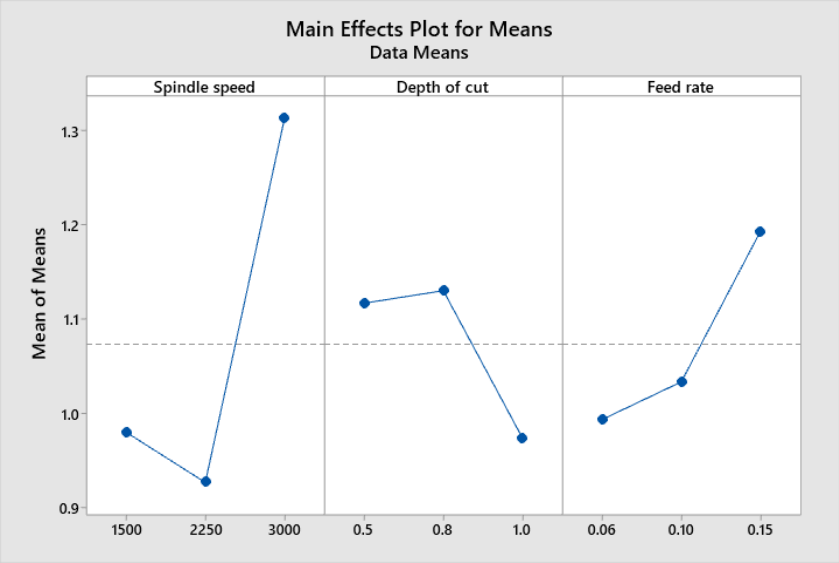
Fig (g) Material Used for experiment : Aluminium 7075

Experiment No.	Spindle speed	Feed Rate	Depth of cut	Surface Roughness
1.	1500	0.10	0.10	0.95
2.	1500	0.5	0.15	1.00
3.	1500	0.8	0.06	0.99
4.	2250	0.10	0.15	0.98
5.	2250	0.5	0.06	1.00
6.	2250	0.8	0.10	0.80
7.	3000	0.10	0.06	0.99
8.	3000	0.5	0.10	1.35
9.	3000	0.8	0.15	1.60

Table (b) : Results based on Taguchi array L9

Level	Spindle speed	Depth of cut	Feed rate
1	0.9800	1.1167	0.9933
2	0.9267	1.1300	1.0333
3	1.3133	0.9733	1.1933
Delta	0.3867	0.1567	0.2000
Rank	1	3	2

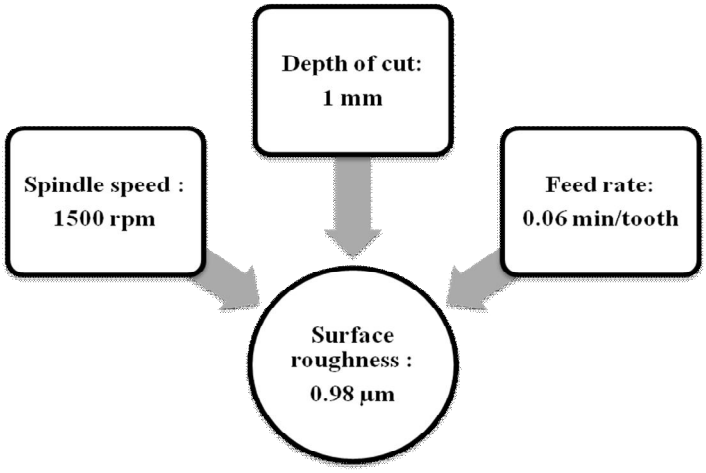
Table (c) :Response table for means



(Fig (h) : Main effects plot for means)

IV. CONCLUSION

From the Table (c) & Fig (h) we can analyze that lowest possible surface roughness we do get at spindle speed 2250 rpm but by considering all the 3 parameters, we get the less surface roughness or increased surface finish at 1500 rpm, 1 mm depth of cut and at 0.06 min/tooth feed rate and here the surface roughness is 0.98 micrometer, which is way too good. Thus the Taguchi approach suggests to manipulate input parameters to achieve high level of surface finish.



(Fig (h) : Conclusive experimental evidence)

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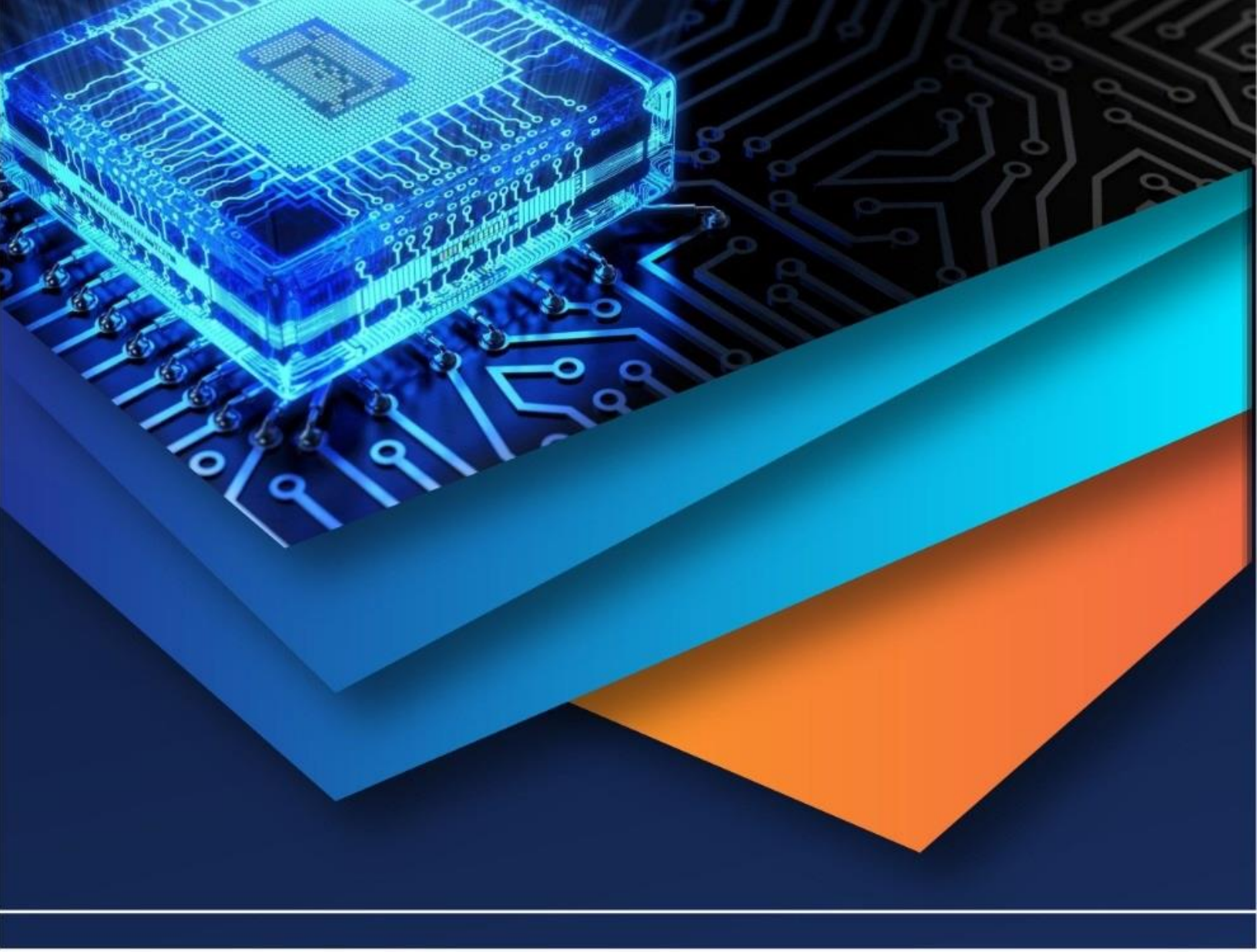

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