A Review on Multi Objective Optimization of CNC End Milling Parameters

Deepika Prasad[1], Aditya R. Prabhukhot[2], Vijay Kapre[3]
Department of Mechanical Engineering, SLRTCE, Thane, India
[1] *deepikaprasad363@gmail.com*, [2] *aditya.prabhukhot@slrtce.in*, [3] *vijaykapre@slrtce.in*

Abstract— This paper deals with the literature survey of the optimization of CNC end milling parameters. The process parameters which should be optimized in end milling are cutting speed, depth of cut and feed rate. Optimization of these parameters through various methods will minimize the surface roughness and increase in metal removal rate. Selection of proper machining operation and parameter is very essential for both quality and productivity of the product and also for the consumption of minimum time. In this paper we will study various methods used by the researchers for the same.

Keywords—End milling,taguchi,anova

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I. INTRODUCTION

Machining can be defined as a process of removing material to form chips.Nowadays,most of the modern machining is done by CNC(computer numerical control) in which computers are used to direct and progress of the mills,lathes and other cutting machines.Milling is a metal removal process which consists of a milling cutter to remove the material from the surface of the workpiece.The cutter is a rotary cutting tool,often with manifold cutting tools.The milling process requires milling machine,workpiece,fixture and cutter.Here the cutter moves perpendicular to its axis so that cutting takes place on the circumference of the cutter.

CNC end milling is the operation used extensively in industries to produce complex geometrical shapes with accountable accuracy and surface finish with flexibility and adaptability.In today's scenario in industries, quality and productivity are the most important factors to be taken into consideration for the manufacturing of a product.To optimally define the parameters for the machining of the product is a big challenge for the manufacturers to increase production.

The various factors such as surface roughness and material removal rate are responsible for the quality of the product which in turn are reliant on the process parameters such as cutting speed, feed, depth of cut etc. There are various optimizing techniques used to ring the optimal values of these parameters for better quality and machining.

II. LITERATURE SURVEY

Vishwajit.D.Patil [5] have studied and experimented to make an attempt to find out optimum process parameters of CNC end milling on Al (2024-T4) plates. He has used Taguchi L_9 orthogonal array. Anova is also been used and then comparison between the two has done. Process parameters considered are cutting speed, feed rate and depth of cut.

J.S.Pang studied and used taguchi parameter design phase to determine the optimal end milling parameters to achieve lowest surface roughness and cutting force values for HNT-AL/epoxy hybrid composite under varying end milling parameter conditions. A basic $L_{27}(3)^3$ orthogonal array was used.

Lohithaksha.M.Maiyar [3] investigated the parameter optimization of end milling operation for Inconel 718 super alloy with multi response criteria based on taguchi L9 othogonal array method with grey relational analysis. Additionally ANOVA is also applied to identify the most significant factor.Cutting velocity is the most significant factor followed by feed rate affecting the multiple performance characteristics.

M.Janardan [4] studied that three levels and three factors are used to design through L_{27} orthogonal array on EN24 steel.ANOVA is developed to.Increase in wheel speed tend to progress the surface finish and also increase in MRR. Best surface roughness is obtained by low table speed and low depth of cut.Best surface roughness is obtained by increasing table speed, wheel speed and depth of cut.

Process Parameters

Power :

The machining parameters should be selected so that the maximum machine power is used. The power consumed in milling is given by [1]

$$P = (F*v)/(6120*\eta)$$

Where F : peripheral cutting force,
v : cutting speed,
η : efficiency

Cutting force :

The cutting force F must not exceed a specific maximum value prescribed to prevent chatter.

Cutting tool deflection

Cutting tool deflection affects the accuracy of the machined components. Considering the cutting tool as a cantilever beam the deflection at the end of the cutting tool can be calculated by [2]

$$\delta = (F*L^3) / (3* I *E)$$

Where, F : cutting force
L : length,
E : module of elasticity of the cutting tool material,
I : moment of inertia.

Cutting conditions constrains

The feed rate and the cutting speed may vary between the lower and higher permitted values of the machine.

Influence of process parameters on MRR in end milling operation

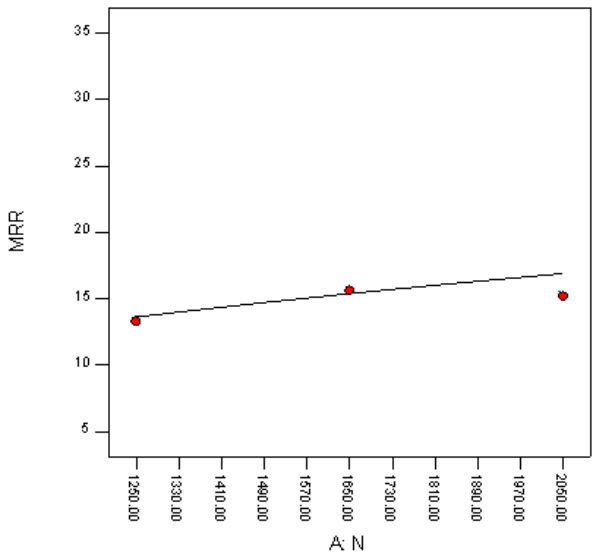

Figure 1.1. Direct effect of wheel speed on MRR

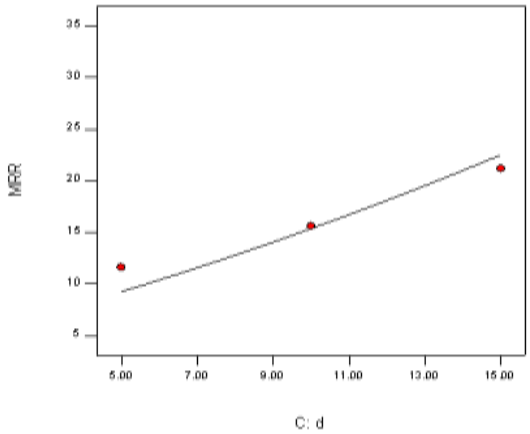

Figure 1.2. Direct effect of depth of cut on MRR

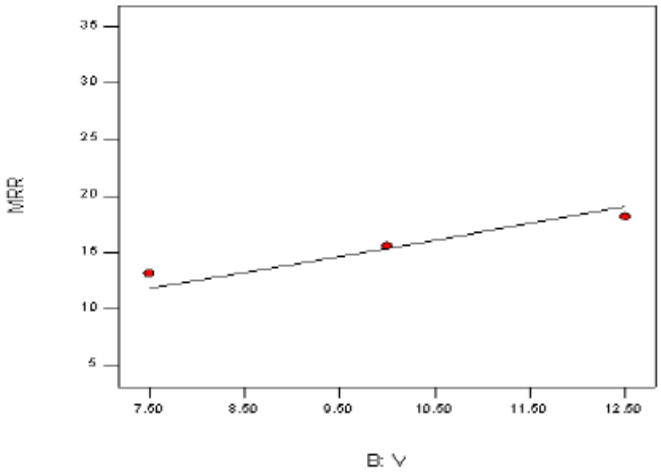

Figure 1.3. Direct effect of Table speed on MRR

M Janardan shows that the direct effect of process parameters on output response, surface roughness is shown in Figs 1.1 to1.3. From Fig. 1.1, it is observed that increase in wheel speed tends to increase the MRR; whereas the other two machining parameters were kept at its mid value. It was observed from the direct effects, depth of cut plays more vital role on MRR than other two parameters. Material removal rate in machining process was an important factor because of its vital effect on the industrial economy. Increasing the table speed, wheel speed and depth of cut leads to an increase in the amount of Material removal rate. But the most influential factors were table speed, and depth of cut. The highest value of MRR is obtained at the extreme range of the input parameters in all the interaction plots. Also the MRR

Influence of process parameters on surface roughness in CNC end milling operation

B. C. Routara studied roughness models for five different roughness parameters and for three different workpiece materials using response surface method. The second-order response models have been validated with analysis of variance. It was found that all the three cutting parameters (spindle speed, depth of cut and feed rate) and their interactions have significant effect on roughness parameters considered in the present study though the influences vary with the nature of workpiece material. Thus response surface models are specific with respect to the roughness parameter as well as the workpiece material.

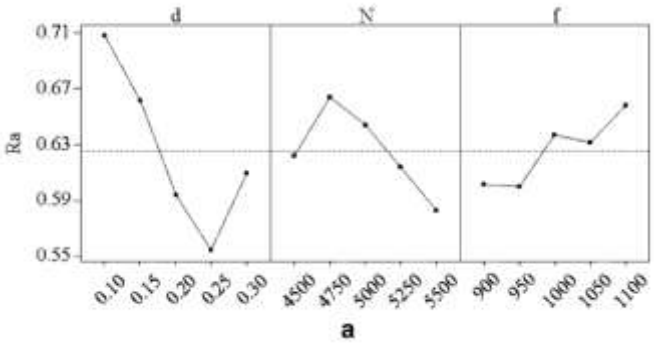

Figure 1.4. Direct effect of Ra on Speed Feed and Depth of Cut

III. CONCLUSION

Surface roughness and MRR parameters greatly depend on work piece material. Best surface roughness was obtained at the lowest depth of cut and low wheel speed combination. The surface roughness results also indicate a poor surface finish for a lower depth of cut at a lower wheel speed. This behavior is due to the plugging action of the tool on the work piece surface at lower depth of cut.

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