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Optimization of Cutting Parameters on Turning Process: A Survey Approach

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Abstract – In the current global competitive environment there is a need for the selection of the machining parameters is the most important task to the process planner to achieved the low cost as well as desired quality of machined components. This paper is study about to finding new approach to the optimized the cutting parameters for optimum outputs. The various method is used to optimized the process parameters for optimum solution like; Response Surface Method, Taguchi Method, Genetic Algorithm Method etc. In this paper review about various method are used for optimized the parameter for optimum solution. The cutting parameters is taken into consideration like; spindle speed (rpm), feed (mm/rev) and depth of cut (mm) etc.

Keywords- Cutting parameters, Optimization methods, Surface roughness, Materials Removal Rate (MRR) etc.

I.INTRODUCTION

The cost of machining amounts to more than 20% of the value of manufactured products in industrialized countries. It is therefore imperative to investigate the machinability behavior of different materials by changing the machining parameters to obtain optimal results. The machinability of a material provides an indication of its adaptability to manufacturing by a machining process. Good machinability is defined as an optimal combination of factors such as low cutting force, good surface finish, low tool tip temperature, and low power consumption. Process modeling and optimization are the two important issues in manufacturing products. The selection of optimal cutting parameters, like depth of cut, feed and speed, is a very important issue for every machining process. In workshop practice, cutting parameters are selected from machining databases or specialized handbooks, but the range given in these sources are actually starting values, and are not the optimal values. Optimization of machining parameters not only increases the utility for machining economics, but also the product quality to a great extent. In today 's manufacturing environment, many industries have attempted to introduce flexible manufacturing systems (FMS) as their strategy to adapt to the ever-changing competitive market requirements. To ensure quality of machined products to reduce the machining costs and to increase the machining effectiveness, it is very important to select appropriate machining parameters when machine tools are selected for machining.

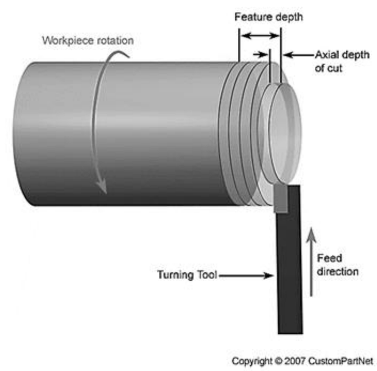

Fig 1. Turning process

II. NEED FOR OPTIMIZATION

Traditionally the choice of cutting condition for metal cutting is left to the machine operator. In such cases the expertise of the operator plays a serious role, however even for a talented operator it's terribly tough to realize the specified output values when by choosing the management parameters values on the premise of his information. Nowadays, several academicians & firms have an interest in optimizing producing method so as to scale back price, improve quality, & get high potency. To achieved this, analysis of knowledge to be manufacturing is needed to be carried out by using suitable statistical design. Statistical design of experiments refers to the method of designing the experiments so the suitable knowledge will be analyzed to succeed in the specified conclusion. Design & method like factorial design, response surface methodology and Taguchi method are wide use in place of one factor at a time experimental approach which is time consuming & incurs additional cost.

III. LITERATURE REVIEW

Makadia and Nanavati [1], Design of experiments has been used to study the effect of the main turning parameters such as feed rate, tool nose radius, cutting speed and depth of cut on the surface roughness of AISI 410 steel. A mathematical prediction model of the surface roughness has been developed in terms of above parameters. The effect of these parameters on the surface roughness has been investigated by using Response Surface Methodology (RSM). Response surface contours were constructed for determining the optimum conditions for a required surface roughness. The developed prediction equation shows that the feed rate is the main factor followed by tool nose radius influences the surface roughness. The surface roughness was found to increase with the increase in the feed and it decreased with increase in the tool nose radius. The verification experiment is carried out to check the validity of the developed model that predicted surface roughness within 6% error. Ashvin J. Makadia et.al [2], made efforts to find out the effect of cutting speed, feed, depth of cut & cutting geometry on the surface roughness. 81 no. of experiments were carried out with AISI 410 steel. (3^4) full factorial design of experiment was used. All the experiments were carried out on Jobbler X1 made by Ace design. In order to understand the turning process, the experimental results were used to develop the models using RSM. In this work Minitab 14 software was used for computation work. To verify the accuracy of the model 3 confirmation runs were performed. The goal was to minimize the surface roughness. Results found out were, feed rate as main influencing factor followed by tool nose radius & cutting speed. Depth of cut had no significant effect on the surface roughness. Interaction between most factors had no significant effect except feed rate & tool nose radius. Optimal combination of machining parameters found were (255.75m/min, 0.1mm/rev, 0.3mm, 1.2mm) for cutting speed, feed, depth of cut respectively.

Thirumalai and kumaar [3] The multi objective optimization based on NSGA-II used for optimizing the machining parameters and a set of non-dominated solutions are produced. The multi attribute decision making method is used to select the optimum machining parameters from the nondominatedsolutions. Cutting speed, feed and depth of cut have been considered as machining parameters. Surface roughness, tool life, cutting force, power consumption and material removal rate have been obtained as responses from the Inconel 718 turning process. The nonlinear regression models have been developed to map the relation between machining parameters and output responses. Finally, the optimal machining parameters have been selected from the nondominated solutions. Selvarajet. al, [4] have studied the Taguchi optimization method was applied to find the optimal process parameters, which minimizes the surface roughness during the dry turning of AISI 304 Austenitic Stainless Steel. A Taguchi orthogonal array, the signal to noise (S/N) ratio and the analysis of variance (ANOVA) were used for the optimization of cutting parameters. ANOVA results shows that feed rate, cutting speed and depth of cut affects the surface roughness by 51.84%, 41.99% and 1.66% respectively. A confirmation experiment was also conducted and verified the effectiveness of the Taguchi optimization method. Raoet. al, [5] presented a detailed overview of Taguchi Method in terms of its evolution, concept, steps involved and its interdisciplinary applications. It could be concluded that this method with its perfect amalgamation of statistical and quality control techniques was one of the effective and effi-cient methods of its kind to highlight the benefits of designing quality into products upstream rather than inspecting out bad products downstream. It offers a quantitative solution to iden-tify design factors to optimize quality and reduce cost. Also, the application of this method is not confined to a particular domain but also to other fields like product and service sec-tors. It thus is a powerful method as compared to the other intuitive and more cumbersome methods encompassing a large number of fields in terms of application. Asiltürket. al, [6], in this study Firstly cutting parameters namely, cutting speed, depth of cut & feed rate was designed using the Taguchi method. AISI 304 austenitic stainless-steel work piece was machined by a coated carbide insert under dry condition. The influence of cutting parameters on surface roughness is examined. RSM was used to create models for surface roughness. ANOVA was used to check the adequacy of model. Taguchi L27 array was selected, after every experiment surface roughness values were measured. In order to better understand the interaction effect of variables on roughness parameters, three-dimensional (3D) plots for the measured responses were created based on model equations. The control factors settings found for Ra was: V1 (cutting speed 50 m/min), f1 (feed rate 0.15 mm/rev), a2 (depth of cut 1.5 mm). The optimized control factors settings for Rz were: V3 (cutting speed 150 m/min), f1 (feed rate 0.15 mm/rev), a1 (depth of cut 1 mm). The results demonstrated that this optimization method was efficient and greatly reduced the machining cost and the design process. The prediction models can be applied to determine the appropriate cutting conditions, in order to achieve desired surface roughness. Neseliet. al, [7], worked to find out the effect of cutting geometry parameters such as tool nose radius, rake angle & approach angle on surface roughness values using RSM. Turning of AISI 1040 steel with Al2o3/Tic was carried out on Harrison M300 lathe. For finding optimum value of geometry parameters the quadratic model of response surface methodology was used. Tool manufacturer's catalogue was used to select the values of cutting parameters. In this study 3 factors were studied with their low-middle-upper levels. In all experiment depth of cut, speed, cutting speed, feed rate were taken as fixed values. It was found that, Tool nose radius was the most significant factor on surface roughness. Interaction between all factors had no significant effect. Optimal combination of machining parameters found were (0.4, 60, -3) for tool nose radius, approach angle & rake angle respectively.

Hornget. al, [8], worked to investigate the machinability of Hadfield steel in hard turning. The Hadfield steels have excellent wear resistance properties and are largly used in engineering applications. The cutting tool used was an uncoated Al2O3/TiC mixed ceramic. The combined effects of four machining parameters, including cutting speed, feed rate, depth of cut and tool corner radius, on the basis of two performance characteristics—flank wear (VBmax) and surface roughness (Ra), were investigated and the centered central composite design (CCD) and the analysis of variance (ANOVA) were used. The quadratic model of RSM associated with the sequential approximation optimization (SAO) method was used to find optimum values of machining parameters. Using the SAO method of RSM, the optimal setting of machining parameters were found, cutting speed of 209.29 m/min, feed rate of 0.08mm/rev., cutting depth of 0.25mm and nose radius of tool of 0.88mm. Nithyanandhan et al. [9] have investigated the effects of process parameters on surface finish and material removal rate (MRR) to obtain the optimal setting of process parameters. And the analysis of Variance (ANOVA) is also used to analyze the influence of cutting parameters during machining. In this work, AISI 304 stainless steel work pieces are turned on conventional lathe by using tungsten carbide tool. The results revealed that the feed and nose radius is the most significant process parameters on work piece surface roughness. However, the depth of cut and feed are the significant factors on MRR.

Noordinet. al, [10], worked to find out the performance of a multilayer tungsten carbide tool using response surface methodology (RSM) when turning AISI 1045 steel. Cutting tests were performed with constant depth of cut and under dry cutting conditions. The factors investigated were cutting speed, feed and the side cutting edge angle (SCEA) of the cutting edge. The main cutting force, i.e. the tangential force and surface roughness were taken as responses to study. Cutting tests were carried out on a 9.2kW Harrison M500 lathe machine under dry cutting conditions. The turning process was studied with a standard RSM design called a central composite design (CCD). Coated carbide tools have been known to perform better than uncoated carbide tools when turning steel, hence commercially available CVD coated carbide insert was used in this study. The work piece material used had a dimension of 300mm in length and 100mm in diameter. This material is suitable for a wide variety of automotive-type applications. The cutting performance tests involved 16 trials, for each experimental trial, a new cutting edge was used. Due to the limited number of inserts available, each experimental trial was repeated twice and each surface turned was measured at three different locations. The ANOVA revealed that feed was the most significant factor influencing the response variables investigated. The SCEA2 and the feed and SCEA interaction factors provided secondary contribution to the responses investigated. Additionally, the cutting speed

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also provided secondary contribution to the tangential force.

IV.CONCLUSION

After study of many literatures of researchers in the above mentioned have put by considering the different factors & such as cutting parameters which include cutting speed, feed, depth of cut. Some of them have considered the tool geometry parameters, different type of coated tools, mi-lubrication, and different type of work material. The different types of factors were varied over its range in order to find out their effect on the output such as surface roughness, material removal rate, cutting force, type of chips, power consumptions and temperature etc. From this study, it was concluded that response surface methodology techniques can help in reaching the desired outputs of the turning process or optimum parameter for turning process.

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