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OPTIMIZATION IN THE CUTTING PARAMETERS OF MILLING– A REVIEW

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ABSTRACT
Every day scientists are developing new materials and for these material, we need economical and efficient machining process. Optimum machining parameters are of great concern in manufacturing environments, where economy of machining operation plays a key role in competitiveness in the market. The present work deals with the review of optimization of milling process parameters.

INTRODUCTION
Machining involves the shaping of a part through removal of material. A tool, constructed of a material harder than the part being formed, is forced against the part, causing material to be cut from it. Machining, also referred to as cutting, metal cutting, or material removal, is the dominant manufacturing shaping process. It is both a primary as well as a secondary shaping process. The device that does the cutting or material removal is known as the machine tool. Nearly all castings and products formed by deformation processing [bulk or sheet metal] require some machining to obtain the desired final shape or surface characteristics. The material is generally removed in the form of chips. The primary reasons for selecting machining over the other two primary shaping processes are improved surface finish and dimensional tolerances, Produce complex geometries in low quantities economically because of more flexibility in tooling and fixturing, low operating costs and lower set up times time to prepare tooling for production.There is a wide variety of machining processes, which leads to numerous variables and relationships.
The optimization of milling process is often achieved by trial-and-error method based on the shop floor experiences by determining the certain parameters of the process. But this is timeconsuming and results in wastages and scrap. Therefore a method is required for quantitatively identifying the right inputs and parameter levels for making a high quality product or service. A branch of applied statistics dealing with planning, conducting, analyzing and interpreting controlled tests to evaluate the factors that control the value of a parameter or group of parameters is called optimization. DOE is an important tool for designing processes and products, an optimization tool. It helps us to understand process characteristics and to investigate how inputs affect responses based on statistical backgrounds. In addition, it has been used to systematically determine the optimal process parameters with fewer testing trials.

MILLING PROCESS
Milling is the process of removing extra material from the work piece with a rotating multi-point cutting tool, called milling cutter. The machine tool employed for milling is called milling machine. Milling machines are basically classified as vertical or horizontal. These machines are also classified as knee-type, ram-type, manufacturing or bed type, and planer-type. Most milling machines have self contained electric drive motors, coolant systems, variable spindle speeds, and power-operated and table feeds. The three primary factors in any basic milling operation are speed, feed and depth of cut. Other factors such as kind of material and type of tool materials have a large influence, of course, but these three are the ones the operator can change by adjusting the controls, right at the machine.

COMPUTER NUMERICAL CONTROL
Numerical Control is the automation of machine tools that are operated by precisely programmed commands encoded on a storage medium, as opposed to controlled manually via hand wheels or levers, or mechanically automated via cams alone. Most NC today is computer numerical control (CNC), in which computers play an integral part of the control.In modern CNC systems, end-to-end component design is highly automated using computer-aided design (CAD) and computer-aided manufacturing (CAM) programs. The programs produce a computer file that is interpreted to extract the commands needed to operate a particular machine via a post processor, and then loaded into the CNC machines for production. Since any particular component mightrequire the use of a number of different tools drills, saws, etc., modern machines often combine multiple tools into a single "cell". In other installations, a number of different machines are used with an external controller and

IJESMR
International Journal OF Engineering Sciences & Management Research

human or robotic operators that move the component from machine to machine. CNC (Computer Numerical Control) is the general term used for a system which controls the functions of a machine tool using coded instructions processed by a computer. The application of CNC toa manual machine allows its operation to become fully automated.
Combining this with the use of a part program enhances the ability of the machine to perform repeat tasks with high degrees of accuracy. Preparatory functions, called G codes, are used to determine the geometry of tool movements and operating state of the machine controller functions such as linear cutting movements, drilling operations and specifying the units of measurement. They are normally programmed at the start of a block. Miscellaneous functions, called M codes, are used by the CNC to command on/off signals to the machine functions. i.e. M03 - spindle forward (CW), M05 –spindle stop, etc. The functions allocated to lower M code numbers are constant in most CNC controls, although the higher M code number functions canvary from one make of controller to the next.

fig-1 VF-4 CNC milling machine

LITERATURE SURVEY

Literature review bridges the gap between two stages of a project execution i.e. problem definition and evolution of design configuration (Solution). Extensive literature review is carried out to explore the elements of the present review paper requirement.

SurasitRawangwonga et al. concluded that Cutting speed and feed rate significantly affected the surface roughness of semi-solid AA 7075 face milling. The result also indicated that higher value of speed and lower feed tended to decrease the surface roughness. Optimization done using full factorialdesign technique.[1], (2012).

MohamadSyahmiShahrom et al. concluded that MQL shows the better surface roughness compare with Wet machining. S/N noise ratio and Analysis of Variance (ANOVA) approve that parameter more significant affect the surface roughness is feed rate follow by cutting speed and depth of cut. Taguchi method have produced more accurate prediction values. during milling operation of AISI 1060.[2] (2012).

Reddy Sreenivasulu concluded that cutting speed and depth of cut are the most significant factors affecting the responses, their contribution in an order of 26.84% and 40.44% respectively. Confirmatory experiments show that 5.052µm for surface roughness and 1.682 delamination damage to validate the used approach after conducting with optimal setting of process parameters. Finally, artificial neural network has been applied to

IJESMR
International Journal OF Engineering Sciences & Management Research

compare the predicted values with the experimental values, the deviations are found in the range of 3.7%, it shows good agreement between the predictive model results and the experimental measurements. [3](2013)

TurgayKıvakIn concluded that Taguchi was a successful method to determine optimal machining parameters in the milling of Hadfield steel with PVD- and CVD-coated carbide inserts under dry milling conditions. The experimental results were evaluated using ANOVA. According to the results of statistical analyses, it was found that the feed rate was the most significant parameter for surface roughness with a percentage contribution of 82.38% and that the cutting speed was the most significant parameter for flank wear with a percentage contribution of 49.33%.[4] (2013)

Vijay s krishnarajthe most influencing parameter on surface roughness is the feed per tooth Which is followed by depth of cut and cutting speed the results of taguchi analysis and annova are in good agreement. During endmilling of TI-6Al-4V. [5] (2013)

Dinesh Kumar Chauhan et al concluded that while face milling of EN31. Out of four variables, depth of cut contribute the highest effect on MRR, followed by feed, interaction effect of feed and depth of cut and finally on coolant. The cutting speed has insignificant influence on the MRR. (Optimization done by using full factorial design technique) [6] (2014)

G.guruvaiahnaidu et al. observed that the surface roughness is high at low speed and certainly decreasing from moderate cutting speed to low speed conditions surface roughness is high at low feed rate and certainly decreasing from low feed rate to moderate feed rate conditions, but again from moderate to high feed rate, the surface roughness increases. it is observed that, the surface roughness is high at small depth of cut and certainly decreasing from small depth of cut to moderate depth of cut conditions, but again from moderate to high depth of cut, the surface roughness increases. While milling of EN31alloy steel using taguchi technique. [7] (2014)

G.HarinathGowda et al. had done the optimization of the force and Temperature which are the outputs in the turning process of lathe by adjusting the speed, feed, and depth of cut which are the influencing parameters in the turning process by applying ANN methodology for the EN31. It is found that the speed and the depth of cut have great significance on the force and Temperature, whereas the feed has less significance on both the outputs.

Harsh Y Valera and Sanket N Bhavsara concluded that spindle speed, feed and depth of cut significantly affect the surface roughness and power consumption while turning EN 31 alloy steel work material using coated carbide cutting tool. (only investigation of parameters) [8], (2014)

Kedare S. B. et al. in his research work, the effects of three parameters, namely, cutting speed, feed and depth of cut were studied upon Surface finish during milling operation. The end milling was performed under the Minimum Quantity Lubrication condition (900ml/hr)using end mill cutter and compared with conventional flooded lubrication (2liter/min). The comparative effectiveness was investigated in terms of surface finish. The surface finish was found to be improved by 27%. The findings of this study show that MQL may be considered to be an economical and environmentally compatible lubrication technique. [8] (2014)

Shahul Backer et al. concluded that based on minimum number of trials conducted to arrive at the optimum cutting parameters, Taguchi's method seems to be an efficient methodology to find the optimum machining parameters. [9] (2014)

Chintan. H. Patel et al. investigated the optimization of End milling of AISI 1018mild steel by various lubricants using the Grey relational analysis method. Quaker 7101, Blasocut strong 4000 and Velvex have been selected as lubricant. All the experiment are carried out at different cutting parameter (Number of Tool Flutes, Depth of cut, Spindle speed and Feed rate) in various lubricant assisted environment.Twenty Seven experiments runs based on an orthogonal array of Taguchi method were performed. Each nine experiments were carried out in Quaker 7101, Blasocut strong 4000 and Velvex lubricant. Surface roughness, cutting force andpower consumption selected as aresponse variable.An optimal parameter combination of the milling operation was obtained via Grey relational analysis. By analyzing the Grey relational grade matrix, the degree of influence for each controllable process factor onto individual quality targets can be found. The optimal parameter combination is then tested foraccuracy of conclusion with a test run using the same parameters. It is concluded that the

IJESMR
International Journal OF Engineering Sciences & Management Research

application of quaker 7101 cutting lubricant utilize in end milling process has proved to be a feasible cutting fluid with combination of water and chemical (Emulsions), if it can be applied properly. Whose results show that there is a considerable improvement in surface roughness and quality of product created.
[10] (2013)

Balinder singh et al. evaluated the machining performance of EN24 Steelusing CNC Milling Machine which employed carbide End Millcutting tool. All the experiments trials, planning and analysis wereexecuted using Taguchi design of experiment. The purposes ofDOE method applied in this study were to determine the optimumcondition of machining parameters and the significance of eachparameter to the performance of machining characteristics. Thetotal experiment runs performed in this study was 27 trials usingrandomized parameters which done by MINITAB 15 software.The following conclusion are drawn based on the performanceof machining characteristics studies in this research work namelysurface roughness (Ra) and material removal rate (MRR).

1. The pilot experiments were carried by varying the processparameters e.g. spindle speed, feed and depth of cut to studytheir effect on out parameter e.g. surface roughness andmaterial removal rate. In pilot study, only three parametersthat mainly affect the cutting speed and surface roughnessi.e. spindle speed, feed and depth of cut. These parametersare selected for this study.
2. From the all selected parameters, Feed Rate was significantlyaffecting the milling of EN24. The result showed that thefeed rate contributed 87.79%, cutting speed contributed only1.58% and depth of cut contributed was least with 0.003%for surface roughness (Ra).
3. In Material Removal Rate feed was the most significant input factor followed by Feed rate and cutting speed. The contribution for feed Rate, cutting Speed and depth of cut.[11] (2013)

Mr. Dhole N.S et al.concluded about Taguchi method which involves reducing the variation in a process through robust design ofexperiments. The overall objective of the method is to produce high quality product at low cost to the manufacturer. Taguchideveloped a method for designing experiments to investigate how different parameters affect the mean and variance of aprocess performance characteristic that defines how well the process is functioning. The experimental design proposed byTaguchi involves using orthogonal arrays to organize the parameters affecting the process and their appropriate levels.The experiments are conducted using L-18 orthogonal array on EN 33 material as suggested by Taguchi. Signal-to-Noise(S/N) ratio and Pareto Analysis of Variance (ANOVA) will be employed to analyze the effect of milling parameters oncutting force. Main effects of process parameters on the quality characteristics can be analyzed.It was observed that cutting speed & feed rate havethe major influence on the cutting force and as thecutting speed increases cutting force decreases, but asthe feed rate and depth of cut increases cutting forcealso increases particularly for this specific test rangeon specified materials. Use of Tin coated carbide toolproduces less cutting force than H.S.S. & uncoatedcarbide tools. Also it has been observed that cuttingforce is significantly reduced after using the selectedoptimum levels of parameters for all three workmaterials.It is a systematic and efficient approach fordetermining the optimum experimental configurationof design parameters for performance, quality, andcost. Principal benefits include considerable time andresource savings; determination of important factorsaffecting operation, performance and cost; andquantitative recommendations for design parameters,which achieve lowest cost, high quality solutions.Taguchi method is a powerful tool, which can offersimultaneous improvements in quality and cost.[12] (2012)

N.S. Pohokar and L. B. Bhuyarestimated the tool life selection of optimum parameters it is necessary to determine them at first for the given machining situation. There are several techniques available to determine the optimum values of these parameters, in this paper machining parameters, cutting speed, feed, depth of cut, and one geometric parameter rake angle are considered for optimization. The Genetic algorithm was developed for predicting the results. To validate the results experimentally trials are then carried out a CNC milling using HSS tool by continuous running condition under dry run on the AISI 1040 MS plate of 140 X 120 X 10 mm workpiece. The predicted results match 95 % including the errors. Thus proves the genetic algorithm is used for optimization of geometric and machining parameters for the estimation of tool life.The geometric and machining parameters are studied in order to optimize tool life to the greater extent. As per the handbook recommendation the parameters cause the tool wear which is directly proportional to tool life is studied and modified for better results. By understanding the concepts of establishing the values of geometric and machining parameters, the suitable optimization procedures for a wide variety of problem in the area of design and manufacturing was develop and implemented. The optimized values of geometric and machining parameters

IJESMR
International Journal OF Engineering Sciences & Management Research

directly used in the manufacturing industry. The tool life obtains using G.A. (theoretically) and experimentally when compared the 90% matching was found out because of errors that can again be control and again optimized up to 95 %. This set a correct optimization procedure for optimizing the parameters.
[13] (2013)

AbhishekDubey et al. in the paper presents the multiple response optimization of end milling parameter using grey based taguchi method. Experiments were designed and conducted based on L27 orthogonal array design The milling parameter were spindle speed, depth of cut, feed rate and pressurized coolant jet and the response was surface roughness. EN31, high carbon alloy steel which achieves a high degree of hardness and compressive strength and abrasion résistance. The present work is focused to study the effect of process parameter such as speed, feed rate, and depth of cut, pressurized coolant jet on surface roughness in end milling of EN31 steel. Surface roughness values were recorded for each experiment. The feed rate was identified as the most influential process parameter on surface roughness. The present work successfully demonstrated the application of Taguchi based Grey relational analysis for optimization of process parameters in end milling of EN31 steel. The conclusions can be drawn from the present work were as follows:

1. The highest Grey relational grade of 1.0000 was observed for the experimental Process, shown in response table (Table No. VI) of the average Grey relational grade, which indicates the combination of control factors.
2. The order of importance for the controllable factors to the minimum surface roughness, in sequence, is the feed rate, depth of cut, spindle speed and pressurized coolant jet.
3. However, it is observed through ANOVA that the spindle speed is the most influential control factor among the four end milling process parameters investigated in the present work, when minimization of surface roughness is considered.[14] (2013)

CONCLUSION

Optimization of milling parameters has been carried out in the literature by many researchers. A few works are based on simulations and other works are based on many experimental runs, collecting huge amount of data and processing it to achieve the result. Taguchi method is widely adopted in the literature for the improvement of quality and machining economics. Taguchi method uses the orthogonal array concept with small number of experimental runs to investigate the effects of parameters on performance measures reduces the sensitivity due to inherent variations present in the system. Moreover, Taguchi method does not consider the interactive effects of control factors.

Research work on Multi response optimization require attention.Very less work is done on MRPI. Also other methods of optimization should be used. Output parameter such as surface roughness is focused much other parameters such as tool life, toolwear, ,cutting force, torque, flank angle, approach angle, power generatedetc should be considered. Optimization technique such as genetic algorithm, artificial neural network are not used much.More work is required to be done on lubrication techniques which will enhance the output parameters. New materials as well as the material having lots of application in various sectors their machining parameters needs to be optimized. Optimization on various different process of machining require attention.

REFERENCES

1. G.guruvaiahnaidu, A.venkatavishnu ,G.janardhanaraju, “Optimization of process parameters for surface roughness in milling of EN-31 steel material using taguchi robust design methodology”, International Journal of Mechanical And Production Engineering sept (2014) , Volume- 2, Issue-9, pp: 2320-2092.
2. Harsh Y Valera, Sanket N Bhavsar, “Experimental investigation of surface roughness and power consumption in turning operation of en 31 alloy steel”,2nd International Conference on Innovations in Automation and Mechatronics Engineering, ICIAME , (2014),Vol.14 , pp:528 – 534.
3. SurasitRawangwonga, JaknarinChatthongaWorapong, BoonchouytanaRomadornBurapaa, “Influence of Cutting Parameters in Face Milling Semi-Solid AA 7075 Using Carbide Tool Affected the Surface Roughness and Tool Wear. 11th Eco-Energy and Materials Science and Engineering, Energy Procedia, (2013),Vol.56, pp:448 – 457.
4. MohamadSyahmiShahrom ,Nafrizuan Mat Yahya and Ahmad RazlanYusoff, “Taguchi Method Approach on Effect of Lubrication Condition on Surface Roughness in Milling Operation”, Malaysian Technical UniversitiesConference on Engineering & Technology , MUCET, (2012), pp:594 – 599.

IJESMR
International Journal OF Engineering Sciences & Management Research

5. Avinash A thakre, "Optimization of Milling Parameters for Minimizing Surface Roughness Using Taguchi'sApproach", International Journal of Emerging Technology and Advanced Engineering Vol 3, Issue 6, June 2013, pp:226-230.
6. Thakur paramjitmahesh and R. Rajesh , "Optimal selection of cncendmilling of AL7075 aluminium alloy using taguchi fuzzy approach", International conference on advances in manufacturing and material engineering,(2014),Vol.5, pp:2493-2502.
7. HMT "production Technology", Tata McGraw Hill, 2004.Phillip j.Ross "Taguchi Techniques for Quality Engineering",Tata McGraw Hill, Second Edition, 2005.
8. Dinesh Kumar et al., "Optimization Of Milling Process By The Effects Of Machining Parameters For High Carbon Alloy Steel",Journal of Engineering Computers & Applied Sciences ,(2014), Vol.3.
9. SurasitRawangwong et al., "Influence of Cutting Parameters in Face Milling Semi-Solid AA 7075 Using Carbide Tool Affected the Surface Roughness and Tool Wear",11th Eco-Energy and Materials Science and Engineering,(2014),Vol.56, pp: 448-457.
10. Lin, W. S; Lee, B. Y; Wu, C. L. (2001). Modeling the Surface Roughness and Cutting Force for Turning, Journal of Materials Processing Technology, Vol.108, Issue 3, pp. 286-293.
11. Abhang L B and Hameedullah M, (2011), "Modeling and Analysis for Surface roughness in Machining Aluminium Alloy using Response Surface Methodology", International Journal of Applied Research in Mechanical Engineering,Volume-1, Issue-1
12. Kamal, Anish and M.P.Garg (2012), "Experimental investigation of Material removal rate in CNC milling using Taguchi method "International Journal of Engineering Research and Applications (IJERA) Vol. 2, Issue 2,Mar-Apr 2012, pp.1581-1590