KEMENTERIAN PENDIDIKAN MALAYSIA

POLITEKNIK MALAYSIA

KOLEJ KOMUNITI MALAYSIA

PROCEEDING

CiE-TVET 2019

9th National Conference in Education Technical & Vocational Education and Training

20-21 AUGUST 2019

POLITEKNIK BANTING SELANGOR

THEME:

LEVERAGING TVET FOR A BETTER FUTURE

PROSIDING

CiE-TVET 2019

9th National Connference in Education

Technical & Vocational Education and Training

" LEVERAGING TVET FOR A BETTER FUTURE"

Anjuran

POLITEKNIK MALAYSIA BANTING

Diterbitkan oleh Jabatan Pendidikan Politeknik & Kolej Komuniti (JPPKK), Kementerian Pendidikan Malaysia
dengan kerjasama Politeknik Banting Selangor

Proceeding of the 9th National Conference in Education - Technical & Vocational Education and Training (CiE-TVET) 2019

eISBN: 978-967-11412-7-4

Cetakan Pertama : November 2019

Diterbitkan oleh

Politeknik Banting Selangor
Jalan Sultan Abdul Samad,
42700 Banting, Selangor
http://www.polibanting.edu.my

Diterbitkan oleh Jabatan Pendidikan Politeknik & Kolej Komuniti (JPPKK), Kementerian Pendidikan Malaysia
dengan kerjasama Politeknik Banting Selangor

MEC08

A Review on Optimization of Machining Parameters in Turning

Jeevana Jothi a/p Ramakrishna*1, Kogila a/p Muthusamy2, Maniyarasi a/p Munusamy3

123Politeknik Banting Selangor
Corresponding author: 1jeevanajothi@rocketmail.com

ABSTRACT

Optimum cutting parameters is essential to be determined in order to make the most use of the lathe in a limited time. It takes a considerable time to become skillful in operating lathe machine and to avoid it, the best and shorter way in using lathe by minimizing hazards and damage is to use the optimum parameters value to get desired shape and quality. Besides that, in this rapidly growing world, productivity and quality plays vital role either in customers or industries view. The qualities in the machined workpiece are the surface finish or surface roughness and also producing it with lesser time. This review compiles all the literature review of obtaining the optimum parameters in machining which includes input parameters (cutting speeds, feed rate, spindle speed, depth of cut,) and output parameters (tool life, flank wear, surface roughness, chip formation and material removal rate). Most of the studies find the optimum values through Taguchi method. Taguchi method is known as a powerful tool in optimizing process control and quality system in manufacturing which eliminates the need for repeated experiments in this study. Summary of tools, materials with optimum parameters in obtaining best surface finish is determined in this review.

Key Words: Cutting parameters, Taguchi method, surface roughness

1.0 INTRODUCTION

Manufacturing technology provides the productive tools that aids in the rising standard of living. The technology involves many processes such as grinding, sawing, shaping, drilling, turning, milling and broaching to form a usable type of metal. Processes in manufacturing industry emphasize the metal cutting as one of the main and basic process. Machined components are quite favourable because of their improved quality or accurate finishing operation and low cost. [1] Metal cutting is a process that causes a fracture of the workpiece that result in chips. The components are brought to the desired shape by machining which removes the unwanted workpiece from the parent workpiece. There are five types of machining which are single point cutting, multiple point cutting, grinding, electro discharge machining (EDM) and electrochemical machining. Single point cutting which is removal of metal by cutting tool is investigated in this study that is turning. Figure 1 shows single point cutting by boring, turning and shaping.

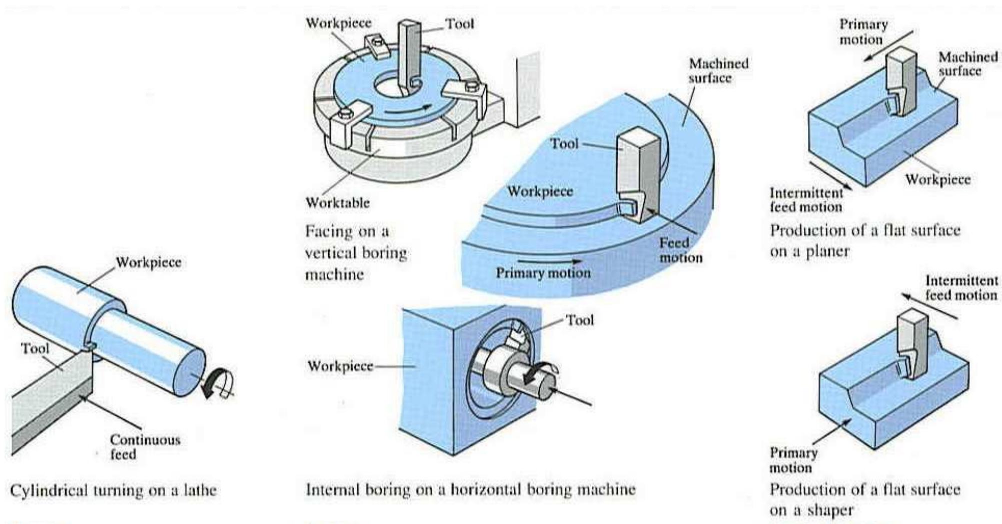

Figure 1: Single point cutting

2.0 LITERATURE REVIEW

Numerous studies have suggested several methods in determining the optimum cutting parameters in lathe machine that affects the output parameter such as surface roughness and tool life. Most of the studies use Taguchi method to find the optimization to reduce the number of experiments and also analysis of variance (ANOVA) which helps in analyzing which data need to be controlled. [16]

Mr. Jatinder Kumar, et al [1] and K. Senthil Kumar, et al [20] carried out a study on determining optimum cutting parameters for surface roughness by Taguchi method resulted that feed rate influenced the surface roughness most followed by cutting speed but depth of cut does not have any effect on it. H. Yanda, et al [5] researched in the effect of feed rate, cutting speed and depth of cut on surface roughness, material removal rate and also tool life in dry condition. When cutting speed and feed rate increases, material removal rate is optimum but if both parameters decreases, tool life is optimum. Sunday Joshua Ojolo, et al [3] carried out studies on parameters that effect tool life under dry machining, concluded that tool life is mostly influenced by spindle speed, feed rate and depth of cut. J.S Senthilkumar, et al [6] also investigated under dry condition the effects on surface roughness and flank wear. Based on Taguchi design of experiment, main factor affects surface roughness and flank wear is cutting speed.

Ajit Kumar Senapati, et al [8] carried out studies on cutting forces effect during dry turning by Taguchi method and found that parameters that influence tool life are depth of cut, feed rate and speed. According to M.Kaladhar, et al [10] and Mihir T Patel, et al [14] nose radius and feed influence surface roughness for both stainless steel and aluminium in turning operation. Another important consideration that results in better surface finish is the usage of fluid while machining compared to dry machining, M. Venkata Ramana, et al [15] in his study about “Experimental investigations on machining of titanium alloy under different machining environments”. Alaattin Kacal, et al [16] investigated in high speed turning of hardened material that is always hard to maintain without grinding process, concludes that CBN cutting tools gives better performance than ceramic tools in turning operations. Kaushal Pratap Singh, et al [17] studied on the selection of machining parameters in both dry and wet condition using tin coated carbide cutting tool which indicates depth of cut plays important role in surface roughness and material removal rate. Upinder Kumar, et al [22] described an approach predicting the surface roughness and material removal rate in dry condition using Taguchi orthogonal array and Grey Relational Analysis which reduced to single performance compared to multiple performance characteristics. Zeelan Basha N, et al [9] and Oquz Colak [23] both applied genetic algorithm in investigating the optimum cutting parameters on surface roughness and high pressure assisted turning respectively. Coated carbide was chose as the tool and the best tool life obtained when the pressure is at the highest.

3.0 LATHE MACHINE OPERATION

Lathes were developed as early as the fifteen century and were known as "bow" lathes. The operator rotated the workpiece by drawing a bow back and forth, either by hand or with the use of a foot treadle. Later, Bessons lathe introduced in 1568, which was driven by a cord passing over a pulley above the machine. This in turn drove two other pulleys on the same shaft which rotated the workpiece and a crude, wooden lead screw, which in turn allowed the operator to remove metal from the piece being machined. The screw cutting lathe originates in the seventeen century. Development and advancements continued until computerized controlled lathes are developed. Figure 2 shows typical centre lathe and the parts which are labelled. Two rigid supports that are known as centres, chuck or faceplate hold a piece of workpiece in the lathe machine. The spindle carrying the workpiece rotates while the cutting tool travels certain direction to cut the workpiece into desired surface or shape. There are different types of metal removal can be obtained from the cutting tools as shown in Figure 3.

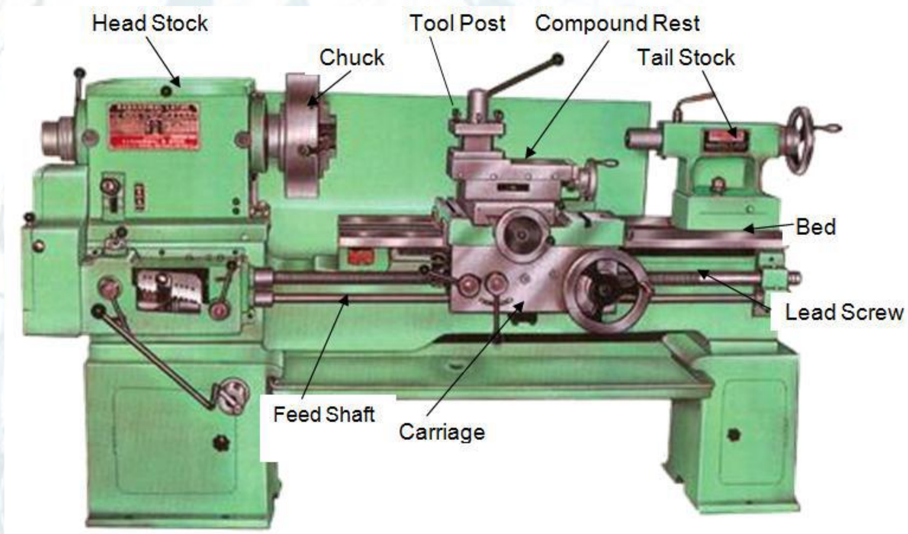

Figure 2: Typical centre lathe machine

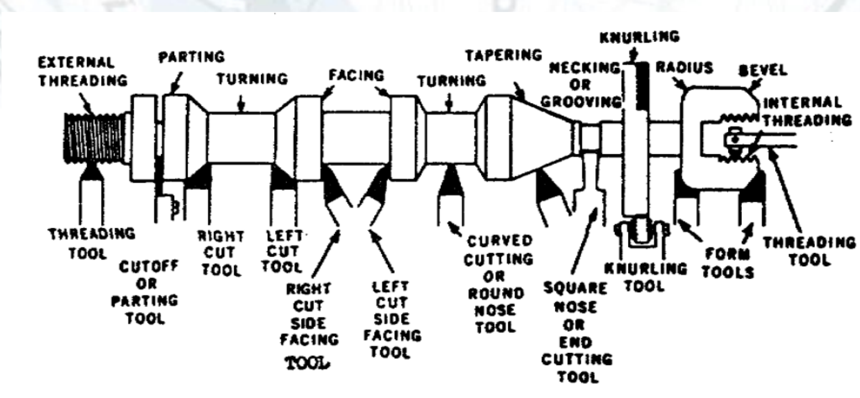

Figure 3: Common types of metal removal by cutting tools

Turning is a metal cutting process that is done using lathe machine [21] which is used for the generation of cylindrical surfaces. Typically the workpiece is held in the chuck and is rotated on a spindle to give the required surface and the direction of the feeding motion is predominantly axial with respect to the machine spindle[4]. For a given surface only one cutting tool is used. It does not imply on metal cutting but also surface and cost. [13]

4.0 CUTTING PARAMETERS

Performance of cutting tool is very important to design improvement.[2] Good machinability of a workpiece is obtained when these criteria's are taken into considerations which are tool life, cutting speeds, feed rate, spindle speed, depth of cut, flank wear, surface roughness, chip formation and material removal rate. Tool life is the capacity of tool from start up to failure in cutting workpiece or better known as the useful life of the tool.

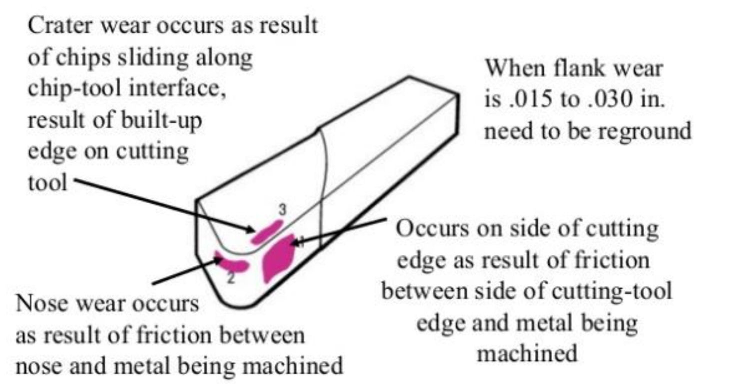

Figure 4: Effects on tool after tool life decreases

Other parameters in turning are cutting speed and feed rate which is always considered as pair in the effect of cutting process. Cutting speeds is the relative speed that removes metal when the tool passes the workpiece. It is expressed in meters per minute and the ideal cutting speeds always gives the best quality and productivity. Feed rate is expressed in inches per minute and is defined as velocity at which the cutter is fed against workpiece. It is also defined as how much a tool advances in one revolutional of workpiece. Spindle speed is derived based on cutting speed and is expressed in revolution per minute (RPM). Depth of cut indicates how much a tool digs or removes the metal component (millimetre) in the current pass. Figure 5 shows all the parameters involved in turning process in lathe machine. Material removal rate (MRR) is defined as the amount of material removed when machining. It is important in the turning operation to reduce the time taken to shape a material and at the same time to ensure the surface roughness and not affecting the cutting forces. [3] Cutting speed and feed rate should be high in order to obtain maximum material removal rate. [4] Figure 6 shows the contribution of input parameters for surface roughness and flank wear respectively.

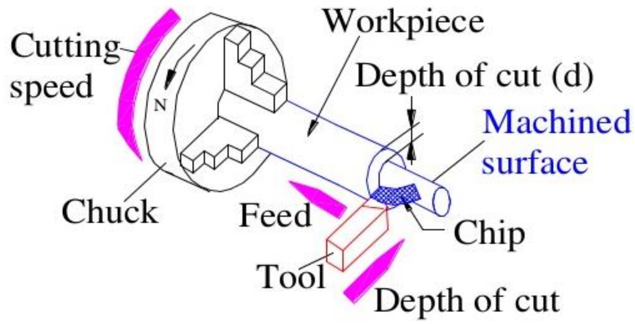

Figure 5: Parameters in turning

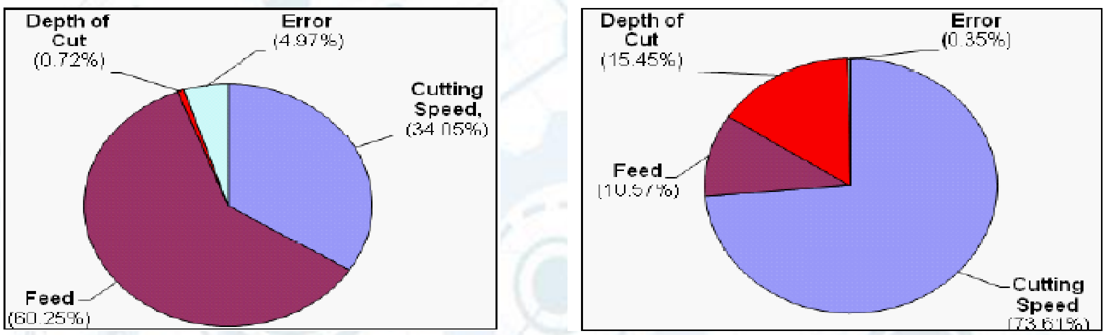

Figure 6: Contribution of input parameters for surface roughness and flank wear respectively [1]

The methodology used in almost all the journals are turning through conventional lathe machine in dry condition. Some used measurement of temperature to find out the heat distribution by using thermocouple [2,4].

5.0 RESULTS AND DISCUSSION

The results from all the type of turning using different parameters are output parameters cannot be minimized if using same combination of input parameters. Depth of cut plays no important role in influencing surface roughness compared to cutting speed. Surface roughness was influenced by cutting speed and federate. If there is heat distribution, it decreases from the contact edge to the farther when cutting speed is increased. The workpiece material plays important role in distributing the heat as in example, in metal the heat is carried away by chips but in composite, it is in the tool. The Taguchi method is the great tool in minimizing the number of experiments needed in order to get the results of the parameters that plays an important role in surface roughness and tool life.

Table 1: Summary of optimum parameters

Ref	Tools	Material	Roughness	Flank Wear	Cutting Speed	Feed Rate	Depth Of Cut	Tool Life
1	Multilayer coated carbide insert	Die steel (HCHCR)	Minimum		150m/ min	0.08rev/min	0.5mm	
				Minimum	125m/ min	0.14rev/min	0.3mm	
2	Carbide tool	Aluminium -based metal-matrix composites						
3	High speed steel(HSS) Tungsten carbide Dmng carbide	Medium carbon steel			1400 rev/min	0.3 mm/rev	1.5mm	161 s 480 s 782s
	High speed steel(HSS) Tungsten carbide Dmng carbide	Mild steel			1400 rev/min	0.3 mm/rev	1.5mm	321 s 726 s 864 s
	High speed steel(HSS) Tungsten carbide Dmng carbide	Brass			1400 rev/min	0.3 mm/rev	1.5mm	386 s 1028 s 1183 s
4		AISI 1020 steel			1400 rpm 1400 rpm	0.2mm/rev 0.1mm/rev	1mm 0.75mm	
6		Nickel base super alloy inconel 718	Optimum	Optimum	25m/min 25m/min	0.2mm/rev 0.1mm/rev	1.25mm 1.5mm	
9	Coated carbide tool	Aluminium 6063(combination of magnesium n silicon)	1.512µm		80m/min	0.18mm/rev	0.3mm	
10	Physical Vapour Deposition (PVD) coated cermet insert	AISI 304 austenitic stainless steel	Minimum		150m/ min	0.25mm/rev	2mm	
13	AITiN coated cemented carbide tool	NIMONIC 75	Optimum		175m/ min	0.02mm/rev	0.1 mm	
14		Aluminium 6082	Optimum		1235 rpm	0.142mm/rev	0.495mm	
15	CVD(chemical vapour deposition) coated tool	Titanium alloy	Optimum with palm oil(lubricant)		79m/min	0.026mm/rev	1mm	

16	Ceramic CBN-cubic boron nitride (better at surface performance)	Cold work tool steel	Minimum		225m/ min	0.05mm/rev	0.2mm	
17	Tin coated tungsten carbide	EN 36 steel	Minimum		500 rpm	o.5mm/reev	1mm	
18	Poly crystalline diamond (PCD) insert	Aluminium silicon carbide			100-600m/ min	0.108-0.2 mm/rev	0.25-0.75mm	
21		Medium carbon steel	1.007µm		188m/ min	0.1mm/rev	1.5mm	
22		Titanium alloy	Surface-0.89µm		71m/min 75m/min	0.141mm/rev 0.133mm/rev	2mm 2mm	Tool life-max
23	Uncoated cemenyed carbide cutting tool insert	Duplex stainless steel	Optimum		100m/ min	0.06mm/rev	0.75mm	
24	Coated carbide inserts (PVD ALTiN)	Inconel 625 alloy	Optimum		50m/min	0.103mm/rev	0.3mm	
25	Coated carbide cutting inserts	Titanium alloy	Optimum		175m/ min	0.05mm/rev	0.5mm	
26	Uncoated tungsten carbide tool	Aluminium alloy	3.89 micron		100rev/ min	0.2mm/rev	0.2mm	
27	Carbide cutting tool	Carbon steel,cast iron,stainless steel	0.7 µm		249.36 m/min	0.1mm/rev	1mm	

6.0 CONCLUSION

Finishing process is done by grinding before turning process is introduced. This process is best performed with configured turning centers. [1] The literature survey shows that there are numerous studies that are done in determining optimization of cutting parameters in turning whether in dry or wet condition using different tools and materials and also different types of approach. Surface roughness and material removal rate had been investigated in several studies as it is the vital parameters in industries and quality aspects. Turning process has been agreed as the way to achieve efficiency in machining in environmental manner. Surface roughness in turning operation by lathe influenced by cutting speed, the greater the value of cutting speed, the better it results in surface roughness. [1][6][14][18][24][25] Although cutting speed do affect in roughness, it does not affect other output parameters such as tool flank wear even in the same condition or environment. [1]Another studies stated otherwise, the increase in cutting speed increases flank wear. [16] Tool life and tool performance were also affected by flank wear. [1] Besides cutting speed, feed rate also influence roughness. [2][10][13-17][23][26] Tool life is one of the important aspects to reduce the cost in an industry that produce mass products. Ways to lengthen tool life is by using high pressure cooling which also lower the machining cost and maintain the cutting speed. [22] [27]. The summary of tools and materials used in turning in obtaining best surface finish and flank wear and the optimum parameters are as shown in Table 1.

REFERENCES

[1] J. Kumar and R. Joshi, "Determination of optimum cutting parameters for surface roughness and tool flank wear in hard turning taguchi method," *International journal of research in mechanical engineering & technology,* vol. 4, no. 1, pp. 19-25, 2013.

[2] P. Reddy and A. Sriramakrishna, "Analysis of orthogonal cutting of aluminium-based composites," *Defence science journal,* vol. 52, no. 4, pp. 375-383, 2002.

[3] S. J. Ojolo and O. Ogunkomaiya, "A study of effects of machining parameters on tool life," *International journal of materials science and applications,* vol. 3, no. 5, pp. 183-199, 2014.

[4] N. Ahmed, R. Atta and Y. M. Shariff, "Effect of changing turning parameters on the cutting forces," *Life science journal,* vol. 11, pp. 25-32, 2014.

[5] H. Yanda, J. Ghani, M. Rodzi, K. Othman and C. Haron, "Optimization of material removal rate, surface roughness and tool life on conventional dry turning of FCD700," *International journal of mechanical and materials engineering,* vol. 5, no. 2, pp. 182-190, 2010.

[6] J. Senthilkumaar, P. Selvarani and R. Arunachalam, "Selection of machining parameters based on the analysis of surface roughness and flank wear in finish turning and facing of inconel 718 using taguchi technique," *Emirates journal for engineering research,* vol. 15, no. 2, pp. 7-14, 2010.

[7] V. B. Magnum and V. R. Naik, "Evaluation and optimization of machining parameter for turning of EN 8 steel," *International journal of engineering trends and technology,* vol. 4, no. 5, pp. 1564-1568, 2013.

[8] A. K. Senapati, A. Bhatta, A. Senapati, O. Mishra and S. Mohanty, "Effect of machining parameters on cutting forces during turning of mild steel on high speed lathe by using taguchi orthogonal array," *Global journal of advanced research,* vol. 1, no. 1, pp. 28-35, 2014.

[9] Z. B. N, S. G. Kumar and E. Mosisa, "Determining the effect of cutting parameters on surface roughness using genetic algorithm," *Science, technology and arts research journal,* vol. 2, no. 4, pp. 98-101, 2013.

[10] M. Kaladhar, K. V. Subbaiah and C. S. Rao, "Determination of optimum process parameters during turning of AISI 304 austenitic stainless steels using taguchi method and ANOVA," *International Journal of lean thinking,* vol. 3, no. 1, pp. 1-19, 2012.

[11] C. Shoba, N. Ramanaiah and D. Rao, "Effect of reinforcement on the cutting forces while machining metal matrix composites -An experimental approach," *Engineering science and technology, an international journal,* vol. 18, pp. 658-663, 2015.

[12] A. Fathy, M. Abdelhameed and F. Shehata, "Effect of some manufacturing parameters on machining of extruded Al-Al2O3 composites," *International scholarly research network,* pp. 1-6, 2012.

[13] P. Subhash, C. Bose and C. S. P. Rao, "Evaluation of optimum cutting parameters in turning of NIMONIC 75 using RSM," vol. 2, no. 2, pp. 17-30, 2013.

[14] M. T. Patel and V. A. Deshpande, "Experimental investigation of effect of process parameters on MRR and surface roughness in turning operation on conventional lathe machine for aluminium 6082 grade material using taguchi method," *International journal of engineering research and applications,* vol. 4, no. 1, pp. 177-185, 2015.

[15] V. M. Ramana, G. K. M. Rao and D. H. Rao, "Experimental investigations on machining of titanium alloy under different machining environments," *Recent advances in mechanical engineeing applications*, pp. 137-145, 2013.

[16] A. Kacal and F. Yildirim, "High speed hard turning of AISI S1 (60WCrV8) cold work tool steel," vol. 10, no. 8, pp. 169-186, 2013.

[17] K. P. Singh, G. D. Gautam, R. Yadav, L. Bisht and G. Norkey, "Selection of optimum machining parameters for EN36 alloy steel in cnc turning using taguchi method," *International journal of scientific & engineering research,* vol. 5, no. 3, pp. 976-982, 2014.

[18] R. Venkatesh, A. Hariharan and N. Muthukrishnan, "Machinability studies of Al/Sic/ (20p) MMC by using PCD insert (1300 grade)," in *Proceedings of the world congress on engineering*, London, 2009.

[19] T. S. M. Babu and N. Krishnan, "Machinability behavior of PCD 1600 grade inserts on turning Al/SiC/B4C hybrid metal matrix composites," *International journal of engineering research and applications,* vol. 2, no. 3, pp. 1174-1180, 2012.

[20] K. S. Kumar, J. Senthilkumaar and A. Srinivasan, "Reducing surface roughness by optimising the turning parameters," *South african journal of industrial engineering,* vol. 24, no. 2, pp. 78-87, 2013.

[21] B. Das, S. Roy, R. Rai and S. Saha, "Studies on effect of cutting parameters on surface roughness of Al-Cu-TiC MMCs: An artificial neural network approach," *International conference on advanced computing technologies and applications,* pp. 745-752, 2015.

[22] U. Kumar and D. Narang, "Optimization of cutting parameters in high speed turning by grey relational analysis," *International journal of engineering research and applications,* vol. 3, no. 1, pp. 832-839, 2013.

[23] O. Colak, "Optimization of machining performace in high pressure assisted turning of Ti6Al4V alloy," *JOurnal of mechanical engineering,* pp. 675-681, 2014.

[24] K. Venkatesan, R. Ramanujam, . V. Saxena, N. Chawdhury and V. Choudhary, "Influence of cutting parameters on dry machining of inconel 625 alloy with coated carbide insert- a statistical approach," *ARPN Journal of engineering and applied sciences,* vol. 9, no. 3, pp. 250-258, 2014.

[25] J. Nithyanandam, S. L. Das and K. Palanikumar, "Influence of cutting parameters in machining of titatnium alloy," *Indian journal of science and technology,* vol. 8, pp. 556-562, 2015.

[26] G. Singh, M. P. Singh and G. Singh, "Optimization of the machining parameters for surface roughness during turning of Al/SiC/Gr Hybrid MMc," *International journal of engineering research & technology,* vol. 2, no. 11, pp. 1613-1617, 2013.

[27] J.N. King, "The power constant as a metal cutting parameter selection criterion," *The journal of the association of professional engineers of Trinidad and Tobago,* vol. 40, no. 2, pp. 73-80, 2011.

9th National Connference in Education

Technical & Vocational Education and Training

eISBN 978-967-11412-7-4

Diterbitkan oleh Jabatan Pendidikan Politeknik & Kolej Komuniti (JPPKK), Kementerian Pendidikan Malaysia
dengan kerjasama Politeknik Banting Selangor