ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 2, Issue 6, December 2012

Optimization of Turning Process Parameters by Using Tool Inserts- A Review

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Abstract— In this paper an attempt is made to review the literature on optimizing the machining parameters in turning processes by using tool inserts. Various conventional techniques employed for machining optimization include geometric programming geometric plus linear programming, Non-Linear Programming, goal programming, sequential unconstrained minimization technique and dynamic programming etc. The latest techniques for optimization include fuzzy logic, scatter search technique, ant colony technique, genetic algorithm, Taguchi technique and response surface methodology are being applied successfully in industrial applications for optimal selection of process variables in the area of machining. Taguchi methods is latest design techniques widely used in industries for making the product/process insensitive to any uncontrollable factors such as environmental variables.

Index Terms— **Machining Operation, Turning Process, Programming, Fuzzy Logic, Taguchi Methods.**

I. INTRODUCTION

Turning is the removal of metal from the outer diameter of a rotating cylindrical work piece. Turning is used to reduce the diameter of the work piece, usually to a specified dimension, and to produce a smooth finish on the metal. Often the work piece will be turned so that adjacent sections have different diameters. Turning is the machining operation that produces cylindrical parts. In its basic form, it can be defined as the machining of an external surface:-

- With the work piece rotating,
- With a single-point cutting tool, and
- With the cutting tool feeding parallel to the axis of the work piece and at a distance that will remove the outer surface of the work. The objective of this research is to study the effect of cutting speed, feed, depth of cut, machining time on metal removal rate, specific energy, surface roughness, volume Fraction and flank wear. Taylor showed that an optimum or economic cutting speed exists which could maximize material removal rate. Considerable efforts are still in progress on the use of hand book based conservative cutting conditions and cutting tool selection at the process planning level. The need for selecting and implementing optimal machining conditions and most suitable cutting tool has been felt over the last few decades. Despite Taylor's early work on establishing optimum cutting speeds in machining, progress has been slow since all the process parameters need to be optimized. Furthermore, for realistic solutions, the many constraints met in practice, such as low machine tool power, torque, force limits and component surface roughness must be overcome.

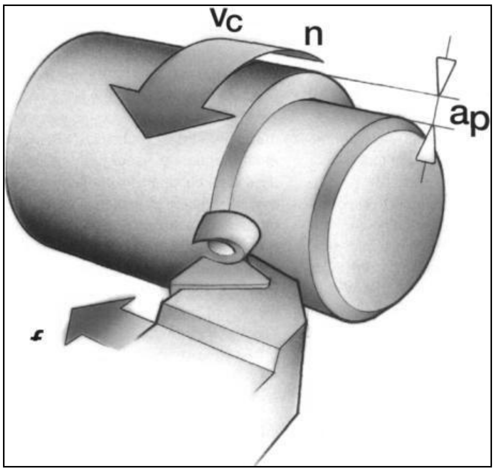


Fig 1. Turning process

II. WORK PIECE MATERIAL

1. Mild steel
2. Aluminum
3. Brass
4. Alloy steel
5. Cast iron
6. Ferritic steel
7. Non ferrite steel

III. TOOL MATERIAL

1. Carbon steel
2. High speed steels3. Cast Cobalt alloys
4. Carbides (Tungsten carbide & titanium carbide)
5. Carbide tool with CVD & PVD.
6. Silicon Nitride
7. Cubic Boron Nitride (CBN)
8. Diamond

IV. FACTORS AFFECTING THE SURFACE FINISH

Whenever two machined surfaces come in contact with one another the quality of the Mating parts plays an important role in the performance and wear of the mating parts. The height, shape, arrangement and direction of these surface irregularities on the work piece depend upon a number of factors such as:

A) The machining variables which include
a) Cutting speed
b) Feed, and
c) Depth of cut.
B) The tool geometry
Some geometric factors which affect achieved
Surface finish includes:

a) Nose radius
b) Rake angle
c) Side cutting edge angle, and
d) Cutting edge.
C) Work piece and tool material combination and their mechanical properties
D) Quality and type of the machine tool used,
E) Auxiliary tooling, and lubricant used, and
F) Vibrations between the work piece, machine tool and cutting tool.

V. LITERATURE REVIEW

Turning is used to produce rotational, typically axis symmetric, parts that have many features, such as holes, grooves, threads, tapers, various diameter steps, and even contoured surfaces. Parts that are fabricated completely through turning often include components that are used in limited quantities, perhaps for prototypes, such as custom designed shafts and fastener. Turning is also commonly used as a secondary process to add or refine features on parts that were manufactured using a different process. Due to the high tolerances and surface finishes that turning can offer, it is ideal for adding precision rotational features to a part whose basic shape has already been formed. The work piece rotates in the lathe, with a certain spindle speed (n), at a certain number of revolutions per minute. In relation to the diameter of the work piece, at the point it is being machined, this will give rise to a cutting speed, or surface speed (Vc) in m/min. The cutting speed is only constant for as long as the spindle speed and/or part diameter remains the same M.Khaladkar [1] The Experimental investigation conducted to turn AISI 304 austenitic stainless steel using PVD coated cermets by employing Taguchi technique to determine the optimal levels of process parameters. In case of MRR response, depth of cut is dominant one followed by feed. The optimal combination of process parameters parameter is obtained at 150 m/min cutting speed 0.25mm/rev, 2mm depth of cut and 0.4 mm nose radius. Saurav Datta [2] The study deals with optimization of multiple surface roughness parameters in search of an optimal parametric combination (favorable process environment) capable of producing desired surface quality of the MS turned product. The study proposes an integrated optimization approach using Principal Component Analysis (PCA), utility concept in combination with Taguchi's robust design methodology. Application of PCA has been recommended to eliminate response correlation by converting correlated responses into uncorrelated quality indices called principal components which have been as treated as response variables for optimization. Utility based Taguchi method has been found fruitful for evaluating the optimum parameter setting and solving such a multi objective optimization problem. The said approach can be recommended for continuous quality improvement and off-line quality control of a process/product. Mr. Ballal Yuvaraj [3] Taguchi method for find a specific range and combinations of turning parameters like cutting speed , feed rate and depth of cut to achieve optimal values of response variables like surface finish, tool wear, material removal rate in turning of Brake drum of FG 260 gray cast iron material. It is a scientifically disciplined mechanism for evaluating and implementing improvements in products, processes, materials, equipments and facilities. Wuyi Chen [4] The majority of Ra data collected during the tests were summarized by using histograms. The horizontal axis of the graphs represents the observed roughness readings and the vertical axis gives the frequency of the readings. The graphs are able to show the variations of surface roughness with the changing work piece hardness. From Fig. it is evident that the harder the work piece material, the lower is the surface roughness obtained for a given set of operating parameters. When finish cutting of hardened steel, the radial thrust force (Fy) became the largest among the three cutting force components and was the most sensitive to the changes of cutting edge chamfer, tool nose radius and flank wear. Lateral plastic flow of the work piece material in front of a cutting edge increased roughness of machined surfaces. Therefore, the harder, and hence less plastic, the work piece material, and the better the surface finish. Surface roughness could be improved by increasing cutting speed. Two possible reasons are :(i) work piece material presents less plastic behavior at higher deformation velocity and (ii)the flank wear scar becomes smoother at higher cutting speed. Araştırma Makalesi [5] The effect of turning parameters such as cutting speed, feed rate and depth of cut on machining characteristics of AISI 304 steel was investigated. The highest tool – chip interface temperature was measured 356 °C at 100 m/min cutting speed, 0.2 mm/rev and 2mm depth of cut conditions. The most effective parameter on the temperature rise was found depth of cut. The surface roughness increased when the depth of cut and feed rate were increased while the cutting speed have an inverse influence. E. Daniel Kirby [6] The use of a modified L8 orthogonal array, with three control parameters and one noise factor, required only sixteen work pieces to conduct the experimental portion, half the number required for a full factorial design. Feed rate had the highest effect on surface roughness, spindle speed had a moderate effect, and depth of cut had an insignificant effect. This would indicate that feed rate and spindle speed might be included alone in future studies, although the literature review would caution against ruling out depth of cut altogether. M. N. Islam [7] Feed rate has a dominant effect on surface finish; the interaction between cutting speed and feed rate also plays a major role which is influenced by the properties of work material. With the increase of material hardness the interaction effect diminishes. Surface roughness by itself is not a reliable indicator of machinability, due to non-optimal cutting conditions and interaction effects of additional factors. Karin Kandananond [8] The best cutting conditions for minimizing surface roughness in a turning process of ferrite stainless steel, grade AISI 12L14. The work pieces used were the sleeves of fluid dynamic bearing (FDB) spindle motors manufactured in the final assembly department at a factory which supplies FDB motors for hard disk drives

(HDDs). The effects of the depth of cut, spindle speed and feed rate on surface roughness were studied using the Taguchi design. The ANOVA shows that all three factors and the interactions depth of cut spindle speed and spindle speed, feed rate have significant effects on the response Viktor P. Astakhov [9] The notion of optimal cutting temperature resulting in the formulation of the first metal cutting law is very useful in the analysis of the influence of various parameters of the cutting process on tool wear, as it makes such an analysis simple and straightforward. At the optimal cutting temperature, the increase of the cutting feed leads to increased dimensional tool life. Influence of the depth of cut on the tool wear rate is negligibly small if the machining is carried out at the optimum cutting time. Kamal Hassan [10] There is a number of parameters like cutting speed, feed and depth of cut etc. which must be given consideration during the machining of medium Brass alloy. This study investigates the effects of process parameters on Material Removal Rate (MRR) in turning of C34000. The single response optimization problems i.e. optimization of MRR is solved by using Taguchi method. The optimization of MRR is done using twenty seven experimental runs based on L'27 orthogonal array of the Taguchi method are performed to derive objective functions to be optimized within the experimental domain When the MRR is optimized alone the MRR comes out to be 8.91. The Material removal rate is mainly affected by cutting speed and feed rate. With the increase in cutting speed the material removal rate is increases & as the feed rate increases the material removal rate is increase. Hari Singh [11] Models develop in this study can be used to predict the tool life of titanium carbide coated tungsten carbide inserts and surface roughness obtainable for turning En24 alloy steel provided variables within specified range. The predicted values of tool life and surface roughness are 26.8688 min and 79.8236 ru respectively. Pradeep Kumar [12] An optimal setting of turning process parameters (cutting speed, feed rate and depth of cut) resulting in an optimal value of the feed force when machining EN24 steel with Tic-coated tungsten carbide inserts ,have been accomplished using Taguchi's parameter design approach. Interaction between cutting speed and depth of cut is significant at 95% confidence level in affecting the mean and variation of feed force, while the interaction between feed and depth of cut affects only the variation in the feed force. Dr.S.S.Chaudhari [13] MQL is a technique that could reduce many cutting problems coming from high consumptions of lubricant, like high machining costs or environmental and worker health problems. Taguchi's robust orthogonal array design method is most suitable for analysis of the surface roughness and tool wear problem during turning operation. The cutting performance of MQL machining is better than that of conventional machining with flood cutting fluid supply. M Venkata Ramana [14] In this context, the synthetic oil as a cutting fluid in machining of Ti6Al4V alloy shows advantage in minimizing the surface roughness. G. H. Senussi [15] The interaction effect between cutting speed and feed rate on chip micro-hardness is reported easily so, chip micro-hardness is higher at high level of feed rate [0.20 mm/rev], but it is better when increasing in cutting speed [200 m/min]. P. Barman [16] Taguchi orthogonal array is employed to optimize the machining parameters with respect to the fractional dimension of surface topography produced in CNC turning of three different materials it has been observed that feed rate has the most significant effect on controlling the fractional dimensional characteristics of surface profile for all the three materials mild steel, aluminum and brass. LB Abhang [17] A reliable surface roughness model for steel turning was developed using RSM and incorporated cutting speed, feed rate, depth of cut, and the tool nose radius. The study was optimized by the LINGO-solver approach, which is a global optimization technique. This has resulted in a fairly useful method of obtaining process parameters in order to the required surface quality. The optimal parameter combination of the turning process corresponded to cutting speed of 189 miters/minute, a feed attain rate of 0.06 mm/revolution, a depth of cut of 0.2 mm, and a tool nose radius of 1.2 mm. Al-Ahmari [18] In this paper, empirical models for prediction of machinability models (tool life, cutting force and surface roughness) have been developed based on cutting experiments. Response surface methodology and neural networks are used to construct new machinability models. The developed neural networks predict the tool life, cutting force, and surface roughness together. Jitendra Verma [19] Experiment was designed using Taguchi method and 9 experiments were conducted by this process. Cutting speed is the only significant factor which contributes to the surface roughness i.e. 57.47 %. The second factor which contributes to surface roughness is the feed rate having 23.46 %. The third factor which contributes to surface roughness is the depth of cut having 16.27%. It is recommended from the above results that cutting of 18.30 to 15.78 m/min can be used to get lowest surface roughness.

VI. REVIEW OF CONVENTIONAL OPTIMIZATION TECHNIQUES

Traditionally, the selection of cutting conditions for metal cutting is left to the machine operator. In such cases, the experience of the operator plays a major role, but even for a skilled operator it is very difficult to attain the optimum values each time. Machining parameters in turning process are cutting speed, feed rate and depth of cut. The setting of these parameters determines the quality characteristics of turned parts. Following the pioneering work of Taylor (1907) and his famous tool life equation, different analytical and experimental approaches for the optimization of machining parameters have been investigated. Gilbert (1950) studied the optimization of machining parameters in turning with respect to maximum production rate and minimum production cost as criteria. Armarego & Brown (1969) investigated unconstrained machine-parameter optimization using differential calculus. Brewer & Rueda (1963) carried out simplified optimum analysis for non-ferrous materials. For cast iron (CI) and steels, they employed the criterion of reducing the machining cost to a minimum. A number of nomograms were worked out to facilitate the practical determination of the most economic machining conditions. They pointed out that the more difficult- to-machine materials have a restricted range of parameters over which machining can be carried out and thus any attempt at optimizing their costs are artificial. Brewer (1966) suggested the use of Lagrangian multipliers for optimization of the constrained problem of unit cost, with cutting power as the main constraint. Walvekar & Lambert (1970) discussed the use of geometric programming to selection of machining variables. They optimized cutting speed and feed rate to yield minimum production cost. Petropoulos (1973) investigated optimal selection of machining rate variables, viz. cutting speed and feed rate, by geometric programming. Sundaram (1978) applied a goal-programming technique in metal cutting for selecting levels of machining parameters in a fine operation on AISI 4140 steel using cemented tungsten carbide tools. Ermer & Kromodiharajo (1981) developed a multi-step mathematical optimization of machining techniques 701 model to solve a constrained multi-pass machining problem. They concluded that in some cases with certain constant total depths of cut, multi-pass machining was more economical than single-pass machining, if depth of cut for each pass was properly allocated. They used high speed steel (HSS) cutting tools to machine carbon steel. Hinduja et al (1985) described a procedure to calculate the optimum cutting conditions for machining operations with minimum cost or maximum production rate as the objective function. For a given combination of tool and work material, the search for the optimum was confined to a feed rate versus depth-of-cut plane defined by the chip-breaking constraint. Some of the other constraints considered include power available, work holding, surface finish and dimensional accuracy. Tsai (1986) studied the relationship between the multi-pass machining and single-pass machining. He presented the concept of a break-even point, i.e. there is always a point, a certain value of depth of cut, at which single-pass and double pass machining equally effective. When the depth of cut drops below the break-even point, the single-pass is more economical than the double-pass, and when the depth of cut rises above this break-even point, double pass is better. Carbide tools are used to machine the carbon steel work material. Gopalakrishnan & Khayyal (1991) described the design and development of an analytical tool for the selection of machine parameters in drilling. Geometric programming was used as the basic methodology to determine values for feed rate and cutting speed that minimize the total cost of machining SAE 1045 steel with cemented carbide tools of ISO P-10 grade. Surface finish and machine power were taken as the constraints while optimizing cutting speed and feed rate for a given depth of cut. Agapiou (1992) formulated single-pass and multi-pass machining operations. Production cost and total time were taken as objectives and a weighting factor was assigned to prioritize the two objectives in the objective function. He optimized the number of passes, depth of cut, cutting speed and feed rate in his model, through a multi-stage solution process called dynamic programming. Several physical constraints were considered and applied in his model. In his solution methodology, every cutting pass is independent of the previous pass; hence the optimality for each pass is not reached simultaneously. Prasad et al (1997) reported the development of an optimization module for determining process parameters for operations as part of a PC-based generative CAPP system. The work piece materials considered in their study include steels, cast iron, aluminum, copper and brass. HSS and carbide tool materials are considered in this study. The minimization of production time is taken as the basis for formulating the objective function. The constraints considered in this work include power, surface finish, tolerance, and work piece rigidity, range of cutting speed, maximum and minimum depths of cut and total depth of cut. Improved mathematical models are formulated by modifying the tolerance and work piece rigidity constraints for multi-pass turning operations.

VII. REVIEW ON LATEST TECHNIQUES

The latest techniques for optimization include fuzzy logic, scatter search technique, ant colony technique, genetic algorithm, and Taguchi technique and response surface methodology.

A. Fuzzy Logic

Fuzzy logic has great capability to capture human commonsense reasoning, decision-making and other aspects of human cognition. Kosko (1997) shows that it overcomes the limitations of classic logical systems, which impose inherent restrictions on representation of imprecise concepts. Vagueness in the coefficients and constraints may be naturally modeled by fuzzy logic. Modeling by fuzzy logic opens up a new way to optimize cutting conditions and also tool selection.

METHODOLOGY

Klir & Yuan (1998) fuzzy logic involves a fuzzy interference engine and a fuzzification-defuzzification module. Fuzzification expresses the input variables in the form of fuzzy membership values based on various membership functions. Governing rules in linguistic form, such as if cutting force is high and machining time is high, then tool wear is high, are formulated on the basis of experimental observations. Based on each rule, inference can be drawn on output grade and membership value. Inferences obtained from various rules are combined to arrive at a final decision. The membership values thus obtained are defuzzified using various techniques to obtain true value.

B. Genetic Algorithms (GA)

These are the algorithms based on mechanics of natural selection and natural genetics, which are more robust and more likely to locate global optimum. It is because of this feature that GA goes through solution space starting from a group of points and not from a single point. The cutting conditions are encoded as genes by binary encoding to apply GA in optimization of machining parameters. A set of genes is combined together to form chromosomes, used to perform the basic mechanisms in GA, such as crossover and mutation. Crossover is the operation to exchange some part of two chromosomes to generate new offspring, which is important when exploring the whole search space rapidly. Mutation is applied after crossover to provide a small randomness to the new chromosomes. To evaluate each individual or chromosome, the encoded cutting conditions are decoded from the chromosomes and are used to predict machining performance measures. Fitness or objective function is a function needed in the optimization process and selection of next generation in genetic algorithm. Optimum results of cutting conditions are obtained by comparison of values of objective functions among all individuals after a number of iterations. Besides weighting factors and constraints, suitable parameters of GA are required to operate efficiently. GA optimization methodology is based on machining performance predictions models developed from a comprehensive system of theoretical analysis, experimental database and numerical methods. The GA parameters along with relevant objective functions and set of machining performance constraints are imposed on GA optimization methodology to provide optimum cutting conditions.

IMPLEMENTATION OF GA

First of all, the variables are encoded as n-bit binary numbers assigned in a row as chromosome strings. To implement constraints in GA, penalties are given to individuals out of constraint. If an individual is out of constraint, its fitness will be assigned as zero. Because individuals are selected to mate according to fitness value, zero fitness individuals will not become parents. Thus most individuals in the next generation are ensured in feasible regions bounded by constraints. The GA is initialized by randomly selecting individuals in the full range of variables. Individuals are selected to be parents of the next generation according to their fitness value. The larger the fitness value, the greater their possibility of being selected as parents. Wang & Jawahir (2004) have used this technique for optimization of milling machine parameters. Kuo & Yen (2002) have used a genetic algorithm based parameter tuning algorithm for multidimensional motion control of a computer numerical control machine tool.

C. Taguchi Techniques

Genichi Taguchi is a Japanese engineer who has been active in the improvement of Japan's industrial products and processes since the late 1940s. He has developed both the philosophy and methodology for process or product quality improvement that depends heavily on statistical concepts and tools, especially statistically designed experiments. Many Japanese firms have achieved great success by applying his methods. Wu (1982) has reported that thousands of engineers have performed tens of thousands of experiments based on his teachings. Sullivan (1987) reports that Taguchi has received some of Japan's most prestigious awards for quality achievement, including the Deming prize. In 1986, Taguchi received the most prestigious prize from the International Technology Institute – The Willard F. Rockwell Medal for Excellence in Technology. Taguchi's major contribution has involved combining engineering and statistical methods to achieve rapid improvements in cost and quality by optimizing product design and manufacturing processes. Barker (1990) reported that since 1983, after Taguchi's association with the top companies and institutes in USA (AT & T Bell Laboratories, Xerox, Lawrence Institute of Technology (LIT), Ford Motor Company etc.), his methods have been called a radical approach to quality, experimental design and engineering. Sullivan (1987) reported that the term "Taguchi methods" (TM) refers to the parameter design, tolerance design, quality loss function, on-line quality control, design of experiments using orthogonal arrays, and methodology applied to evaluate measuring systems. Pignatiello (1988) identifies two separate aspects of the Taguchi methods: the strategy of Taguchi and the tactics of Taguchi. Taguchi tactics refer to the collection of specific methods and techniques used by Genichi Taguchi, and Taguchi strategy is the conceptual framework or structure for planning a product or process design experiment. Ryan (1988) and Benton (1991) reported that Taguchi addresses design and engineering (off-line) as well as manufacturing (on-line) quality. This fundamentally differentiates TM from statistical process control (SPC), which is purely an on-line quality control method. Taguchi's ideas can be distilled into two fundamental concepts:

(1) Quality losses must be defined as deviations from targets, not conformance to arbitrary specifications
(Benton 1991).

(2) Achieving high system-quality levels economically requires quality to be designed into the product. Quality is designed, not manufactured, into the product
(Daetz 1987; Taguchi 1989).

Lin et al (1990) stated that Taguchi methods represent a new philosophy. Quality is measured by the deviation of a functional characteristic from its target value. Noises (uncontrolled variables) can cause such deviations resulting in loss of quality. Taguchi methods seek to remove the effect of noises. Taguchi (1989) described that quality engineering encompasses all stages of product/process development: system design, parameter design, and tolerance design. Byrne & Taguchi (1987), however, pointed out that the key element for achieving high quality and low cost is parameter design. Through parameter design, levels of product and process factors are determined, such that the product's functional characteristics are optimized and the effect of noise factors is minimized. Kackar & Shoemaker (1986) observed that parameter design reduces performance variation by reducing the influence of the sources of variation rather than by controlling them, it is thus a very cost-effective technique for improving engineering design.

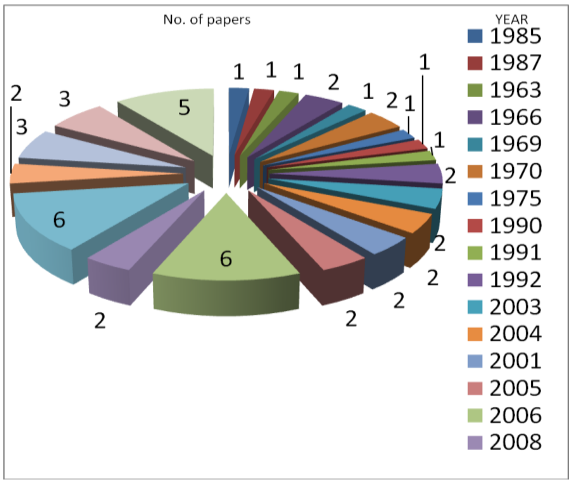
D. Response Surface Methodologies (RSM)

Experimentation and making inferences are the twin features of general scientific methodology. Statistics as a scientific discipline is mainly designed to achieve these objectives. Planning of experiments is particularly very useful in deriving clear and accurate conclusions from the experimental observations, on the basis of which inferences can be made in the best possible manner. The methodology for making inferences has three main aspects. First, it establishes methods for drawing inferences from observations when these are not exact but subject to variation, because inferences are not exact but probabilistic in nature. Second, it specifies methods for collection of data appropriately, so that assumptions for the application of appropriate statistical methods to them are satisfied. Lastly, techniques for proper interpretation of results are devised. The advantages of design of experiments as reported by Adler et al (1975) and Johnston (1964) are as follows:

- Numbers of trials are reduced.
- Optimum values of parameters can be determined.
- Assessment of experimental error can be made.
- Qualitative estimation of parameters can be made.

Inference regarding the effect of parameters on the characteristics of the process can be made. Cochran & Cox (1962) quoted Box and Wilson as having proposed response surface methodology for the optimization of experiments. Box & Hunter (1957) have proposed that the scheme based on central composite rotatable design fits the second-order response surfaces very accurately.

VIII. ANALYSIS OF LITERATURE REVIEW



Graph1. Number of Papers/ Journals Published In Yea

IX. SUMMARY OF RECENT MACHINING OPTIMIZATION TECHNIQUE

Techniques	*Authors*	*Tools used*
Multiple objective linear program	D.kim M.Ramulu (2003)	Analysis of variance (ANOVA)
Taguchi	Paulo Davim.Pedro Reis, Vitro Lapa, C.Conceicao Antonia (2003)	The Analysis of Variance (ANOVA) was performed to investigate the cutting characteristics of PEEK
Artificial Neural Network.	L.yu, L.Cheng, Yam, Yan, Jiang (2006)	An artificial neural network (ANN) is trained using simulated structural damage index to establish the mapping relationship between the structural damage index and damage status.
Taguchi analysis Orthogonal array - Grey relational analysis - ANOVA	Tsao, Hocheng (2004) Noorul Haq Marimuthu and Jeyapaul (2007)	Analysis of Variance (ANOVA) multiple responses based on orthogonal array with grey relational analysis. Based on the grey relational grade, optimum levels of parameters have been identified and significant contribution of parameters is determined by ANOVA
Taguchi	Palanikumar, Karunamoorthy, Karthikeyan, and Latha.	Fuzzy logic to optimize the machining parameters for machining of GFRP composites. A multi response performance index (MRP) was used for optimization
Taguchi Taguchi's experimental design method Taguchi's optimization technique Minimum machining costs criterian.	E. Kilickap (2010) Mustafa Kurt Eyup Bagci2 and Yusuf Kaynak (2008) Gaintonde, Karnik, Achuytha, & Siddeswarappa (2006) Milon brozek, Rostislav choteborsky, Miroslav muller , petr HRABE (2007)	ANOVA, analysis of signal-to-noise ratio Orthogonal arrays of Taguchi, the signal-to-noise (S/N) ratio, the analysis of variance (ANOVA), and regression analyses The fitness function is derived through mapping the objective function of the drill optimization problem. Cutting condition optimizations were calculated for the minimum machining costs criterion using the basic economic indexes of the workshop
Fuzzy Logic	Vimal sam singh , Latha and Senthilkumar (2009)	L27 orthoganal array, fuzzy based model is developed to predict thrust force and torque.
Design of Experiments	Dong-Woo Kim Myeong-Woo Cho 1,	ANOVA (Analysis of Variance) is carried out

	Tae-Il Seo and Eung-Sug Lee (2008)	Analysis of variance is used
Response Surface Methodology Taguchi Method	Palanikumar , Shanmugam , Paulo Davim (2010) Kishore,Tiwari.& Singh (2009)	for checking the validity of the model An attempt to investigate experimentally the significance of the drill point geometry and operating variables on the drilling forces and the drilling induced damage
Design of Experiments	Durãoa, Magalhãesa, Marquesb, João Manuel Tavaresb (2007)	Non Destructive inspection technique.

X. CONCLUSION

In most of the industries the turning process parameters and surface roughness on the job/work piece depends upon the skill, experience and mentality of the operators therefore it is very necessary to optimize the turning process parameters, so that minimum surface roughness can be attain to obtain the maximum surface roughness. The above review of literature shows that various traditional machining optimization techniques like Lagrange's method, geometric programming, goal programming, dynamic programming etc. have been successfully applied in the past for optimizing the various machining process variables. Fuzzy logic, genetic algorithm, scatter search, Taguchi technique and response surface methodology are the latest optimization techniques that are being applied successfully in industrial applications for optimal selection of process variables in the area of machining. In the recent optimization technique Taguchi methods is latest design techniques widely used in industries for making the product/process insensitive to any uncontrollable factors such as environmental variables. Taguchi approach has potential for savings in experimental time and cost on product or process, development and quality improvement.

XI. FUTURE SCOPE

From the above conclusion one can use the Taguchi method for optimizing the turning process parameters like speed, feed, and depth of cut, nose radius, and type of tool, materials of tool and work piece and cutting fluids etc for minimizing the surface roughness and maximize the tool life by experimental setup. Orthogonal array in the Taguchi technique will help to finalize the number of levels and thus finalize the number of experiments. Also the signal to noise ratio will help to observe the behavior of quality characteristics of work piece.

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