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Experimental Investigation and Analysis of Cutting Parameters in CNC Turning on Cast Iron

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ABSTRACT

In this study, the effect of the machining parameters like spindle speed, feed, depth of cut on material removal rate is investigated .Machining is the most important of the manufacturing processes which involves the process of removing material from a work piece in the form of chips. Machining is necessary where tight tolerances on dimensions and finishes are required. Being such an important process in manufacturing industry, a machining process is considered for investigation in the present work. This paper presents the experimental investigations on the effects of cutting variables like Spindle speed, Feed and Depth of cut on the Material removal rate and spindle load. The experiments were conducted on Cast iron on a CNC turning machine using ceramic insert. The experiments were conducted as per the design of experiments. Initial trial experiments were conducted to fix the ranges for the control parameters. After conducting the experiments the MRR measured and recorded. The effects were studied after plotting the graphs between the Input process parameters versus the responses using Design expert software. The results obtained in this study can by further used for optimizing the process parameters there by the optimized results help the operator to enhance the quality as well as machining rate. The experimental results are compared with predicted results in neural network software easy NN+, the parameters are considered as optimized parameters for better material removal rate. . There are several techniques available to determine the optimum values of these parameters, in this paper machining parameters cutting speed, feed, depth of cut, are considered for optimization. The neural networks were developed for predicting the optimized results theoretically. To validate the results experimentally trials are then carried out a CNC turning using carbide tool by continuous running condition under wet run on the Cast iron work piece. The predicted results match well with experimental values. Thus proves the neural network is used for optimization of machining parameters

.Keywords: Turning, Machining, MRR, Spindle speed, Depth of Cut, Feed rate, Spindle load, Experimental, CNC Lathe, ANN

1. INTRODUCTION

Every industry are trying to decrease the cutting cost and increased the quality of machined parts or components. The machining time reduces lead to reduce overall costs which depend on volume of material to be removed and machining parameters like speed, feed and depth of cut. 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. Turning is a Conventional machining process where 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 dimension, and to produce a smooth finish on the metal. Often the work piece will be turned specified so that adjacent sections have different diameters. In a global competitive environment every industry are trying to decrease the cutting cost and increased the quality of machined parts or components.So,it required to focus o material removal rate and surface roughness. The machining time reduces lead to reduce overall costs which depend on volume of material to be removed and machining parameters like speed, feed and depth of cut. The quality of surface roughness is also important properties of machined parts, the good quality machined parts improved fatigue strength, creep life. The surface roughness also on some functional attributes like surface friction, wearing, light reflection, ability of holding and distributing a lubricant, load bearing capacity, etc. Increasing the productivity and the quality of the machined parts are the main challenges of the based industry 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 cutting, metal cutting, or material removal, is the dominant manufacturing shaping process. It is both a primary as well as a secondary shaping process. Machining is the term generally used, rather than material removed or cutting. 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.

CNC TURNING

CNC turning Machine generally consists of the following parts: 1. A tool holder 2.A tool insert carrier3. One or several tool inserts 4. The tool holder must fit the main spindle of turret socket.5. The shape of the tools and insert depends on the Machining Methods and the dimensional tolerances of the work piece.6. Tool carriers are generally secured to tool holders by clamping dogs, set tool are laid down in a form that the control system can understand. For two-dimensional components with little geometric complexity 2 axis programming is used. screws or sleeves. In some cases, the tool carrier and a tool holder constitute a single part.7. Tool insert can be permanently brazed to the tool carrier. However, throw away index able tool tips are used in most cases and these are secured to the tool carrier by a clamping system. The insert can be indexed, inverted or changed completely when worn chipped. CNC programming refers to the methods for generating the instructions that drive the CNC machine tool. In a CNC program, the machining steps (operations) for producing a part on the machined

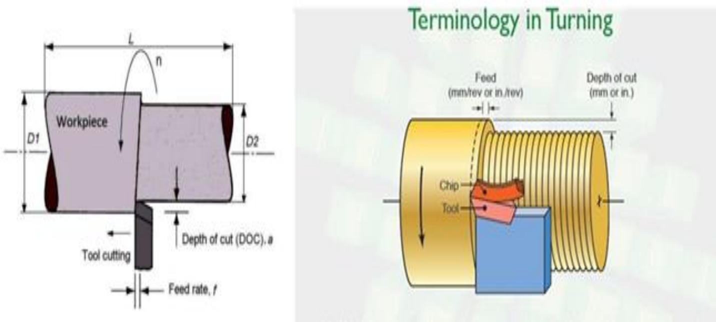


Fig.1. operation1 Basic

1.2 CUTTING TOOL&MATERIAL

A cutting tool can be defined as a part of a machine tool that is responsible for removing the excessive material from the work piece by direct mechanical abrasion and shear deformation There is a large variety of cutting tool materials that are available, each having its own specific properties and performance abilities. Examples of insert materials are Carbides, HSS, CBN, Diamond, Carbon speed steels etc.

1.2.1 Cutting Speed: Cutting speed may be defined as the rate at which the uncut surface of the work piece passes the cutting tool. It is often referred to as surface speed and is ordinarily expressed in m/min, though ft./min is also used as an acceptable unit. Cutting speed can be obtained from the spindle speed. The spindle speed is the speed at which the spindle, and hence, the work piece, rotates. It is given in terms of number of revolutions of the work piece per minute i.e. rpm.

1.2.2 Feed: Feed is the distance moved by the tool tip along its path of travel for every revolution of the work piece. It is denoted as f and is expressed in mm/rev. it is also expressed in terms of the spindle speed in mm/min as F = f N Where, f = Feed in mm/rev N = Spindle speed in rpm. Feed rate is the tool movement (traverse) in the machining direction. The feed rate is obtained by the programmer from the table book of the tool Manufactures manuals and from the experienced gained by the programmer. The unit of feed is "mm per revolution of the work piece or mm per minutes".

1.2.4 Depth of cut:

Depth of cut (d) is defined as the distance from the newly machined surface to the uncut surface. It is the thickness of material being removed from the work piece. It can also be defined as the depth of penetration of the tool into the work piece measured from the work piece surface before rotation of the work piece. The diameter after machining is reduced by twice of the depth of cut as this thickness is removed from both sides owing to the rotation of the work. d = D1-D2/2 where, D1 = Initial diameter of job D2 = Final diameter of job.

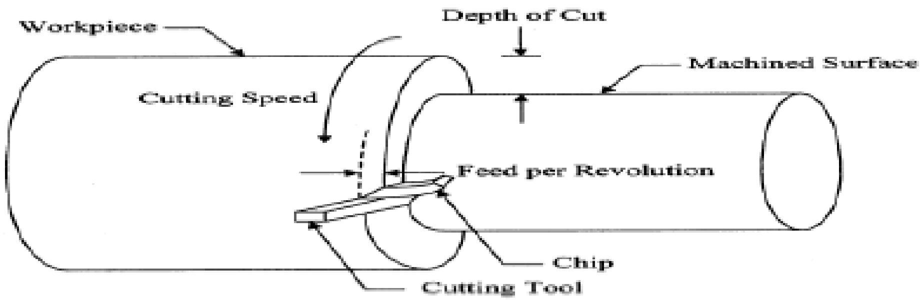


Fig.1.2 The adjustable machining parameters

1.4 objective of the project

The objective of the work is to study and discuss the various methods of Taguchi technique and strategies that are adopted in order to find the following parameters by both experimentally and Taguchi's techniques. The use of arrays to study the effect of machining parameters influence on Material Removal Rate.To develops relationships between the control parameters and response parameters during machining.

1.5 New Technology in Manufacturing Industry These day computers are widely used in Manufacturing Industries. The Engineering applications of computers fall mainly in to following areas.

1. Computer Numeric Control (CNC) 2. Computer Aided Drafting and design (CAD)

3. Computerized Materials Handling (Robotics) 4. Computer Aided Quality assurance (CAQA)

5. Computer Aided Production control and Management (CAPM) 6. Computer Integrated Manufacturing (CIM)

In this module only CNC machines are being dealt with.CNC involves the use of computers for the precise control of the physical movement of the machine tools by letters, numbers and symbols. A CNC Machine runs on a program fed to it. The program consists of precise instructions about the Methodology of Manufacture as well as the movements.

For example 1. Which tool is to be used? 2. at what cutting speed? 3. at what feed? 4. In which path will the tool move? 5. from which point to which point?

Technical Data Of The Machine ACE Designers LT-16XL Available at the Centre

Specifications		
Capacity		
Distance between centres	mm	425
Maximum turning dia	mm	270
Maximum turning length	mm	400
Swing over bed	mm	500
Swing over carriage	mm	250
Main Spindle		
Spindle nose		A2-5
Bore through spindle	mm	47
Bar capacity	mm	25
Chuck siZe (standard)	mm	165
Front bearing bore	mm	80
Spindle Drive		
Spindle motor rated power (continuous rating /15 min rating)	kw	5.57.5
Speed range (inf. Variable)	rpm	50-4000
Full power range	rpm	1000-3000
Axis Slides		
X axis stroke	mm	140
Z axis stroke	mm	400
Feed rate (inf. Variable)	mm/min	0-10.000
Rapid traverse rate X axis	m/min	20
Rapid traverse rate Z axis	m/min	20
Tailstock		
Quill diameter	mm	140
Quill stroke	mm	400
Taper in quill		M14
Thrust (adjustable Max.)	Kg.	500
Z axis base travel	mm	235
Turret		
Number of stations		8
Maximum boring bar dia	mm	40
Tool cross section	mm	25 x 25
Weight (approx.)	Kg.	4000
Dimension (approx.)	mm	2200x1750x1750

1.3 MATERIAL OF THE WORK PIECE

Cast iron is one of the oldest ferrous metals used in construction and outdoor ornament. It is primarily composed of iron (Fe), carbon (C) and silicon (Si), but may also contain traces of sulphur (S), manganese (Mn) and phosphorus (P). It has a relatively high carbon content of 2% to 5%. It is hard, brittle, non malleable (i.e. it cannot be bent, stretched or hammered into shape) and more fusible than steel. Its structure is crystalline and it fractures under excessive tensile loading with little prior distortion. Cast iron is, however, very good in compression. The composition of cast iron and the method of manufacture are critical in determining its characteristic.The most common traditional form is grey cast iron. Common or grey cast iron is easily cast but it cannot be forged or worked mechanically, either hot or cold.In grey cast iron, the carbon content is in the form of flakes distributed throughout the metal. In white cast iron, the carbon content is combined chemically as carbide of iron. White cast iron has superior tensile strength and malleability. It is also known as 'malleable' or 'spheroidal graphite' iron. Cast iron is still manufactured by much the same process as it was produced historically. Iron ore is heated in a blast furnace with coke and limestone. This process "deoxidizes" the ore and drives off impurities, producing molten iron. The molten iron is poured into moulds of the desired shape and allowed to cool and crystallize. Upon manufacture, cast iron develops a protective film or scale on the surface which makes it initially more resistant to corrosion than wrought iron or mild steel. Finishing may include bituminous coatings, waxes, paints, galvanizing and plating. In addition, there are a variety of treatments that can reduce rusting and corrosion caused by environmental factors. Factory preservative treatments are typically barrier coatings intended to prevent the castings from oxidizing (rusting) in the presence of humidity and oxygen in the air.

1.4 NEURAL NETWORKS

The simplest definition of a neural network, more properly referred to as an 'artificial' neural network (ANN),is:"a computing system made up of a number of simple, highly interconnected processing elements, which process information by their dynamic state response to external inputs. ANNs are processing devices (algorithms or actual hardware) that are loosely modeled after the neuronal structure of the mammalian cerebral cortex but on much smaller scales. A large ANN might have hundreds or thousands of processor units, whereas a mammalian brain has billions of neurons with a corresponding increase in magnitude of their overall interaction and emergent behaviour. Although ANN researchers are generally not concerned with whether their networks accurately resemble biological systems, some have. For example, researchers have accurately simulated the function of the retina and modeled the eye rather well. Although the mathematics involved with neural networking is not a trivial matter, a user can rather easily gain at least an operational understanding of their structure and function.

1.4.1 Easy NN plus neural networks: Easy NN-plus grows multi-layer neural networks from the data in a Grid. The neural network input and output layers are created to match the grid input and output columns. Hidden layers connecting to the input and output layers can then be grown to hold the optimum number of nodes. Each node contains a neuron and its connection addresses. The whole process is automatic. The neural networks learn the training data in the grid and they can use the validating data in the grid to self validate at the same time. When training finishes the neural networks can be tested using the querying data in the grid, using the interactive query facilities or using querying data in separate files. The steps that are required to produce neural networks are automated in Easy NN-plus. Easy NN-plus produces the simplest neural network that will learn the training data. The graphical editor can be used to produce complex networks.

2. LITERATURE REVIEW

The performance of hard turning is measured in terms of surface finish, cutting forces, power consumed and tool wear. Surface finish influences functional properties of machined components. Surface finish, in hard turning, has been found to be influenced by a number of factors such as feed rate, cutting speed, work material characteristics, work hardness, cutting time, tool nose radius and tool geometry, stability of the machine tool and the work piece set-up, the use of cutting fluids, etc.

[1].Hassan, K. et al. (2012) has done the experimental investigation of material removal rate (MRR) in cnc turning of C34000 using Taguchi method using L‟27 array. When the MRR is optimized alone the MRR comes out to be 8.91. The optimum levels of process parameters for simultaneous optimization of MRR have been identified. Optimal results were verified through confirmation experiments. It was concluded that MRR is mainly affected by cutting speed and feed rate.

[2].Sujit Das attempts to study the machine ability issues of aluminium-silicon carbide (Al-Sic) metal matrix composites (MMC) in turning using HSS cutting tool. Sic-reinforced metal matrix composites (MMCs) containing Sic particles (5wt%-20wt %) of 400mesh size were prepared by powder metallurgy (P/M) route and used as work material for turning. Experiments were conducted at various cutting speeds and depth of cuts at constant feed rate and parameters, such as cutting forces and surface roughness were measured. It was found that higher weight percentage of Sic reinforcement produced a higher surface roughness and needs high cutting forces during machining operation of MMCs. It was also observed that surface roughness and the cutting forces are also depending upon the depth of cut and the cutting speed at constant feed rate. [3]. Rodrigues L.L.R [3] has done a significant research over Effect of Cutting Parameters on Surface Roughness and Cutting Force in Turning of Mild Steel. [9].Gopalswamy et al (2009) used Taguchi method in determining the optimal process parameters in hard machining of hardened steel. They observed that the Cutting speed is the most influencing parameter on tool life and surface roughness.

[10].TugrulOzelet al. (2007) has conducted an experimental study on turning of AISI D2 steels (60 HRC) using ceramic wiper tool. The cutting parameters considered in this work are cutting speed, feed rate and depth of cut and the response are tool wear, surface roughness. Tool wear analysis using Neural Network Modeling. He suggested that for high feed rate maintaining good surface finish and best tool life was obtained in lowest feed rate and lowest cutting speed combinations [11].Diwakar Reddy et al. (2011) has conducted an experimental investigation on turning of medium carbon steel using uncoated carbide tool. This work dealt with cutting

parameters such as speed, feed and depth of cut and the response as surface roughness. ANN modeling is applied to find optimal cutting parameters. It is concluded that the model has been proved to be successful in terms of agreement with experimental results. [12]. Kagade and Deshmukh (2011) has investigated an experimentalstudyonturningof High Carbon High Chromium steel (HCHC) using CNMG 09 03 08-PF carbide insert tool. The cutting parameters focused in this work are cutting speed, depth of cut, feed rate and the outcomes considered are surface roughness, spindle load. This work has revealed a conclusion that speed has maximum effect and depth of cut has minimum effect on surface roughness [13].Sharma et al.(2012) has conducted an experimental study on Hard turning of EN8 steel using High speed steel tool. This work deals with prediction of tool wear with application of Image processing with considering are cutting speed, feed rate and depth of cut as cutting parameters. It was concluded with comparison of deviation of results for tool wear between conventional method and image processing. [14]. D.Rahul Davis 2013[14] The present work is associated with turning operation of En-19 steel. The paper represents the influences of five different cutting parameters like pressurized coolant jet, rake angle, depth of cut, spindle speed and feed rate on the surface roughness of the En-19 steel. In the experiment Taguchi technique was used to calculate the various readings by using MINITAB15 software. Orthogonal L16 array was used and signal to noise ratio and the analysis of variance (ANOVA) are employed to interpret the cutting parameters. The carbide tipped tool having negative and positive rake angle according to the combination of the experiment was used. The experiment setup included spindle speed of 780 and 1560 rev/min, pressurized coolant jet of 0.5 and 1 bar, rake angle 4 and 7 degrees, depth of cut of 0.5 and 1 mm and feed rate 0.16 and 0.8 mm/rev. At last confirmation test was done to compare the value with final outcome to confirm the effectiveness of the surface roughness of En-19 steel. [15].Ghani, M.U. et al. (2007) has presented results of an investigation into the tool life and the tool wear behavior of low content CBN cutting tools used in hard turning of hardened H13 tool steel using finite element thermal modeling. It involved measuring the cutting forces, cutting temperatures, tool wear and the contact area. [16]. Mohammad Reza SoleymaniYazdi and Saeed ZareChavoshi (2010) studied the effect of cutting parameters and cutting forces on rough and finish surface operation and material removal rate (MRR) of AL6061 in CNC face milling operation. The objective was to develop the multiple regression analysis and artificial neural network models for predicting the surface roughness and material removal rate. According to them, in rough operation, the feed rate and depth of cut are the most significant effect parameters on Ra and MRR and increases with the increase of the cutting forces. [17]. Richard Deweset al (2003) carried out the study on rapid machining of hardened AISI H13 and D2 moulds, dies and press tools.

3. METHODOLOGY To investigate the process parameters for MRR on cast iron the following experimental procedure is carried out. 1: The raw material (metal rods) is fed into the CNC Turning lathe Machine.2: The Metal rods are clamped in the machine.3: The program is written in the computer console according to the required cutting parameters i.e. spindle Speed, Depth of Cut and Feed Rate 4: The process of turning has been done in the following three cases. (i)Varying speed while keeping the Depth of Cut and Feed Rate constant.(ii) Varying Feed Rate and keeping the Spindle Speed and Depth of Cut constant and (iii) Varying Depth of Cut while keeping the Spindle Speed and Feed Rate constant. The machining of a work piece by a CNC program requires axis and a coordinate system to be applied to the machine tool.

Fig1.1 CNC Machine

Fig.3.1 Screen for CNC Programming

Fig. 3.2Principle of Machining

Fig .3.2 CNC L3.1 Axes of CNC Turning Machine

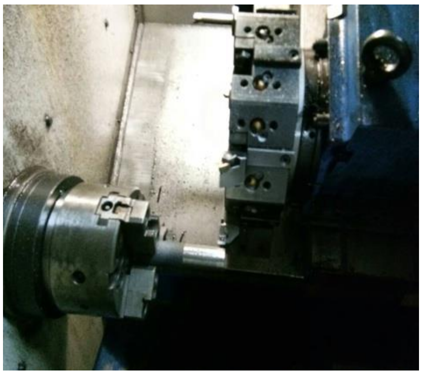
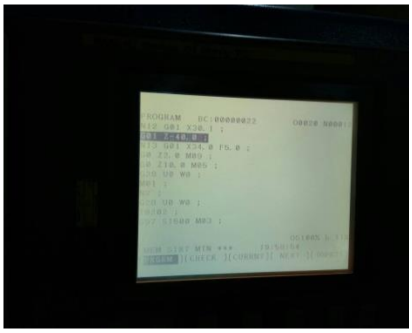
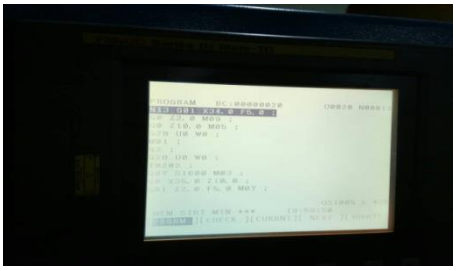


Fig.3.1 CNC Lathe used for Experimentation and codes





Programming of CNC

3.1DESIGN OF EXPERIMENTS (DOE) Experiments were conducted on a high precision CNC lathe machine of FANUC Series. Cast iron is taken as the work piece material for investigation. The specimen is prepared with the dimensions of 80 mm length and 32mm diameter for turning and carbide insert is used for experimentation. The control factors considered for experiments are spindle speed, feed and depth of cut while, Metal removal rate, as the output response.

Cast iron Specimens after Machining

Table.3.1Control Factor s & Levels

S.No.	Control Factors	Symbol	-1 Level	0 Level	+1 Level	Units
1	speed	N	1500	1600	1700	rpm
2	Feed	F	0.08	0.1	0.12	mm/min
3	Depth of Cut	DOC	0.6	0.8	1	mm

After conducting the experiments as per the design of experiments, the output responses were measured and recorded.MRR is calculated as the ratio of volume of material removed from work piece to the machining time. In order to determine the volume of material removed after machining, the weights of work piece before machining and after machining are measured. Machining time taken for each cut is automatically displayed by the machine. The output responses recorded for each set of process control variables are listed in Table .3.2.

3.1.1MATERIAL REMOVAL RATE (MRR): The material removal rate has been calculated from the difference of weight of work piece before and after machining by using following formula. MRR = Wi-Wf /ρst mm3/sec, Where, Wi = Initial weight of work piece in gm, Wf = Final weight of work piece in gm, t = Machining time in seconds, ρs= Density of work piece (7.8x10-3 g/mm3)

3.1.2 Parameters and levels for selection 1.Feed rate (0.08, 0.1, and 0.12 mm/rev): It is known from the fundamentals of metal cutting that feed rate influences the material removal rate. Various researchers have observed the effect of feed rate on the MRR, spindle force during machining of cast iron Thus, these feed rates are chosen based on the design of experiments at +1 and -1 levels 3. Spindle speed (1500, 1600, 1700 rpm): Previous studies have indicated that the MRR is influenced by the spindle speed. Therefore, to study the effect of spindle speed in detail, these values of spindle speed has been considered based on levels. 4. Depth of cut (0.6, 0.8, 1 mm): The depth of cut also influences the MRR, which in turn influences the tolerance and fit of the components.

3.2Design of Experiments (DOE) The experiments were conducted on a high precision CNC lathe machine of FANUC Series Oi Mate - TC in machining centre. Cast iron is taken as the work piece material for investigation. The specimen is prepared with the dimensions of 71mm length and 32mm diameter for turning and carbide insert is used for experimentation. The control factors considered for experiments are spindle speed, feed and depth of cut while, Metal removal rate, as the output response. The ranges of the process control variables are given in table 1. The experiments are conducted based on L18 orthogonal array as shown in Table 2.After conducting the experiments, the output responses were measured and recorded. MRR is calculated as the ratio of volume of material removed from work piece to the machining time. The spindle force is also recorded directly from the machine. In order to determine the volume of material removed after machining, the weights of work piece before machining and after machining are measured. Machining time taken for each cut is automatically displayed by the machine.

Table.3.2 DOE and Material Removal Rate

Work specimen No.	Speed (rpm)	Feed (mm/rev)	DOC (mm)	Weight before turning (grams)	Weight after turning (grams)	Cycle Time (sec)	MRR (mm^3/sec)
1	1500	0.8	0.6	800.00	790.00	78	0.0102
2	1500	0.1	0.8	790.00	785.30	68	0.0117
3	1500	0.12	1	785.30.	765.00	60	0.0166
4	1600	0.8	0.8	755.00	745.00	52	0.0153
5	1600	0.1	1	745.05	740.00	85	0.0117
6	1600	0.12	0.6	740.98	720.05	75	0.008
7	1700	0.8	1	785.00	775.00	45	0.0222
8	1700	0.1	0.6	775.00	765.00	63	0.0095
9	1700	0.12	0.8	765.00	758.00	73	0.0095
10	1600	0.1	0.8	745.00	738.00	70	0.0114
11	1700	0.1	0.8	758.00	750.00	45	0.0177
12	1600	0.12	0.8	766.00	758.00	68	0.0117
13	1600	0.1	0.6	720.00	690.00	65	0.0092
14	1500	0.08	0.8	765.00	755.00	57	0.0140
15	1500	0.1	0.6	755.00	740.00	55	0.0109
16	1700	0.1	1.0	750.00	745.00	38	0.0263
17	1600	0.08	0.6	690.00	682.00	62	0.0096
18	1600	0.12	1.0	682.00	670.00	60	0.0166

3.2. OPTIMIZATION USING NEURAL NETWORKS

A neuron is the basic element of neural networks, and its shape and size may vary depending on its duties. Analyzing a neuron in terms of its activities is important, since understanding the way it works also help us to construct the ANNs. Each processing element consists of data collection, processing the data and sending them to the relevant consequent element. Each processing element consists of data collection, processing the data and sending the results to the relevant consequent element. The whole process may be viewed in terms of the inputs, weights, the summation function and the activation function.

3.3 DYNAMIC MULTILAYER FEED FORWARD NEURAL NETWORK Designing and implementing intelligent system has become a crucial factor for the innovation and development of better performance in machining. A neural network is a parallel system, capable of resolving problem with sigmoid functioning and its variations are shown in Fig.3.4.The working model of Artificial Neural Network is as shown in Fig.3.3. The system implements ANN, where the data flows from input to output units is strictly feed forward created dynamically at runtime. The data processing can extend over multiple (layers of) units, but no feedback connections are present i.e., connections extending from outputs of units to inputs of units in the same layer or previous layers with weights adjustment.

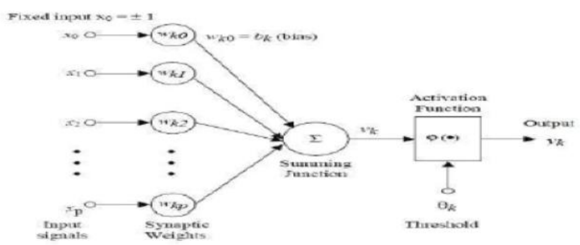


Fig.3.3 Model of Artificial Neural Network

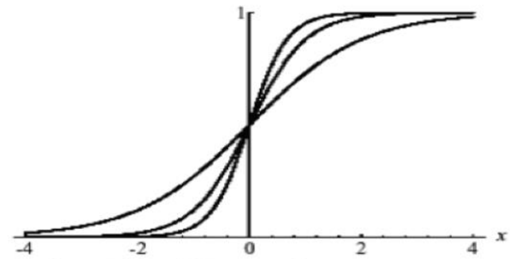


Fig.3.4 Three Sigmoid Network

3.4. RESULTS AND DISCUSSION BY ANN

A feed-forward three layered back propagation neural network is constructed with three layers including with input, output and hidden layers. The input neurons are cutting speed, feed, depth of cut, output neurons are MRR. Neurons in the hidden layers were determined by examining different neural networks. Easy NN plus software was used for training of this network and the ANN was trained with back propagation algorithm. Weights of network connections are randomly selected by the software. The learning of neural network is shown in fig 3.5.The red line is the maximum example error, the blue line is the minimum example error and the green line is the average example error. The orange line is the average validating error. Learning progress graph shows the maximum, average and minimum training error. The average validating error is shown if any validating examples rows are included .The neural network was trained with 18 examples and validated with 8 examples and tested for 8 examples. Predicted values of MRR are given in table 3.3 Percentage of error between experimental values and predicted values for the MRR, of work piece is calculated and error calculated results are shown in fig 3.7.it was found that the predicted values are very close to the experimental values. From these results, it can be deemed that the proposed network model is capable of predicting the MRR of the work piece. The network grid is used to run the program is shown in the fig 3.6

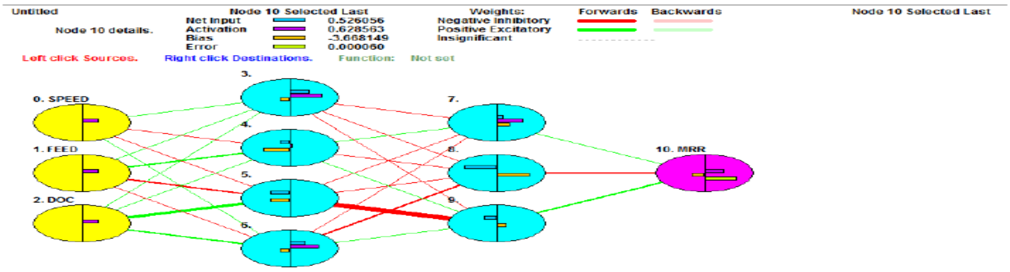


Fig 3.5 Neural Network Architecture

Table 4.10 experimental vs predicted values

Exp.No.	Experimental Value	Predicted Value	% of Error Value
1	0.0132	0.01319	0.0757
2	0.0213	0.02129	0.0469
3	0.048	0.04799	0.0208
4	0.0284	0.02839	0.0352
5	0.0586	0.05859	0.0170
6	0.0176	0.01759	0.0568
7	0.0306	0.03057	0.0980
8	0.0233	0.02329	0.0429
9	0.0499	0.04989	0.0200
10	0.0297	0.02969	0.0336
11	0.0297	0.02967	0.1010
12	0.0441	0.04409	0.0226
13	0.0208	0.02077	0.1442
14	0.0224	0.02239	0.0446
15	0.0214	0.02139	0.0467
16	0.0283	0.02829	0.0353
17	0.0154	0.01539	0.0649
18	0.0441	0.04409	0.0226

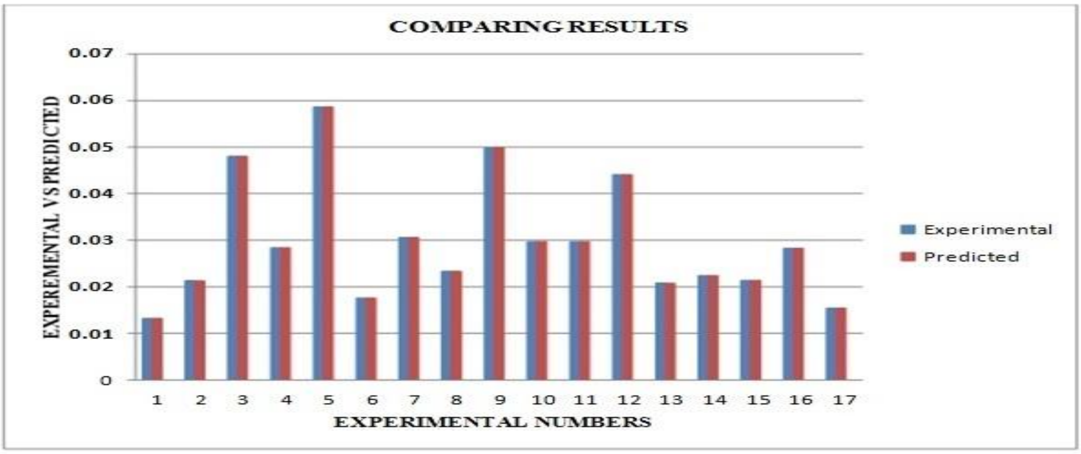


Fig 4.8 Comparison between Experimental & ANN

Aneural network (3-2-1) was used to learn the collected experimental data. The Neural network architecture obtained using easy NN+ software. The trained ANN was used to predict the MRR. It was found that there is agreement between experimental data and predicted values for MRR. Then it is possible to change the cutting tool at correct time in order to get good quality of products. The neural network can help in selection of proper cutting parameters to increase MRR and reduce machining time.

4. CONCLUSIONS

The parameters considered in the experiments are optimized to attain maximum material removal rate. As the spindle speed, feed rate and Depth of cut increases, the removal of material per unit time also increases. In this work, back-propagated single hidden layer neural network is a successful modelling tool for a CNC machining process. This work investigated the influence of the operating parameters like feed rate, depth of cut, clamping length and spindle speed. It was evident that each of these parameters studied contributed to the error in the dimensions of the machined component. Depth of cut and the feed rate had more effect on the accuracy than the other parameters. Based on this ANN prediction, the NC program could be corrected before commencing the actual machining operation, thus improving the accuracy of the component at less cost and time.

5. FUTURE SCOPE OF WORK

There is scope for work extending the study with various work materials like brass, magnesium, nickel, steel, thermo set plastic, titanium and zinc. The material of cutting tool used in the present project was carbide. The experiment can be performed with different cutting tools including Tungsten carbide electrode to assess the machining performance of CNC machine.

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