CHAPTER 2

LITERATURE REVIEW

This chapter deals with a review of boring process and the possibility of the development of boring tool equipped with impact dampers in engineering applications. The assessed cutting parameters, the method of testing the boring tool equipped with and without dampers and their effects on the cutting responses studied by various researchers is completely explored.

2.1 MACHINING PROCESSES

Tobias et al (1961) developed a graphical method for describing machine structure characteristics. Tlusty et al (1963) investigated the chatter phenomenon in machining which arises from the self excited vibrations through coupling mechanisms, both of which depend on the interaction between the machining process and the machine-tool system structure.

Merritt et al (1965) defined the lowest stability limit for the given feed and cutting speed independent of the spindle speed.

Marui et al (1995) concluded that the chatter vibration is suppressed by the regenerative effect in the cutting tool having small side cutting edge angle on the chatter vibration is excited by the regenerative effect in the case of a large side cutting edge angle.

Yves et al (1996) studied the effects of cutting parameters in a lathe dry boring operation. A full fractional design was used to evaluate the independent variables such as cutting speed, feed rate, depth of cut, tool
length and type of boring bar. The results revealed that using a long tool length may result in vibration that could be efficiently controlled by the use of a damped boring bar.

Thomas et al (1996) focused on the effect of tool vibrations on surface roughness during lathe dry turning process and also investigated the analogy of the effect of cutting parameters between tool dynamic forces and surface roughness and the results show that the depth of cut has not a significant effect on surface roughness except when operating within the built up edge range. They also revealed that cutting parameters not only have an effect on the amplitude of vibration, but also on the variation of tool’s natural frequency.

Choudhury et al (1997) presents a system for online vibration control on a turning lathe which is designed, developed and tested for controlling machine tool vibration, resulting in increased productivity and improved machining accuracy.

Kondo et al (1997) introduce a new criterion for detecting regenerative chatter by the application of spectral analysis and also examined the new criterion by using numerical simulations assumed to be orthogonal, and then experiments for verification of criterion validity using the regenerative chatter of a turning workpiece in orthogonal cutting.

Yang et al (1999) analysed the stability of the cutting system with an oscillating cutter which is used to suppress chatter in a cutting process and also it enhances the stability of the cutting system by properly increasing time varying magnitude and frequency of the oscillating cutter.

Pratt et al (1999) demonstrated that the boring bars for single point turning on a lathe susceptible to chatter and introduced a new biaxial vibration control system (VPI smart tool) for boring bars.
Pratt et al (2001) explored the dynamics and control of machine tool vibrations with particular attention to boring bar chatter and also developed a detailed model and simulations of the system by adapting concepts from experimental model analysis and signal processing.

Alpay et al (2002) introduced a new machine tool chatter suppression technique called multi level random spindle speed variation. These spindle speed variation methods serve for the avoidance of machine tool self excited vibration associated with existing depths of cuts.

Andren et al (2004) investigated the deflection shape and the resonance frequencies of a boring bar using three methods to determine the dynamic properties of a damped boring bar. The three methods used were a theoretical Euler-Bernoulli beam model, an experimental model analysis and an operation deflection shape analysis and also concluded that the boring bar vibrations are usually non-stationary and the dynamic response of the clamped boring bar has non-linear properties. The highest vibration level was in the cutting speed direction.

Mei et al (2005) designed a wave controller based on the real distributed cutting system model for the active regenerative chatter suppression during boring manufacturing process. Mei et al (2006) concluded that the regenerative chatter can be suppressed using an optimal controller designed on a dynamic model which includes the critical regenerative effect. The effectiveness of the controller can be verified in both time and frequency domains.

Othman et al (2006) proposed a machine vision system to identify the presence of chatter vibration in turning process since chatter is undesirable because it causes poor surface finish and machining accuracy which reduces tool life.
Emre et al. (2007) proposed an analytical model for a stability limit predictions in turning and boring operations resulting practical formulas for stability limit and conducted chatter experiments for both turning and boring operations.

Saffen et al. (2007) investigated that the acceleration of the cutting tool on surface roughness of the workpiece in dry turning operation increases with the increasing of the cutting tool overhang for difference conditions where the vibration of the cutting tool strongly depends on cutting tool overhang and also the increasing cutting speed leads to decrease in surface roughness of the workpiece and the effect of cutting tool vibration in feed direction can be neglected if compared with that in vertical direction.

Kebdani et al. (2008) develop a chatter model for predicting chatter stability conditions in hard turning based on the root locus method and harmonic balance method to determine a critical stability parameter and concluded that the linear chatter model well support to improve the productivity in many manufacturing processes.

Cemel et al. (2009) examines the effects of cutting parameters (cutting speed, feed rate and depth of cut) on to the surface roughness through the mathematical model developed by using the data gathered from a series of turning experiments to attain the desired surface quality. Bourdim et al. (2009) concluded that the dynamic instability of boring operation is a regenerative type and the optimum cutting width for a stable machining depends on the cutting speed, they also found that at low cutting speed the instability occurs at higher width of cuts and vice versa.

Fatih et al. (2010) explored experimentally about the mechanics of boring process on Cast Iron automotive Engine cylinders and concluded that by selecting proper cutting conditions, cutting forces can be controlled below
a threshold value, tool life and part quality can be increased. Murat et al (2010) described that the tool overhang is one of the important cutting tool parameter that has not been investigated much in detail and the deflection of the cutting tool increases with tool overhang.

Brecher et al (2010) presents the systematic approach of the integration of an active workpiece holder with two high dynamic axes controlled by piezo-electric actuators on a milling machine and concluded that the active workpiece holder offers possibilities to resent chatter vibrations.

Ahmed et al (2011) derived the mathematical model of the productivity rate a machine tool for multi tool machining processes. The new equations enabled the calculation of output of a machine tool in the cases of multi tool machining for simultaneous and separate process. Based on the new equations, the productivity rate of multi-tool processes for a machine tool is calculated as a function of the cutting speed changes. The new equations for the productivity rate enable the finding of the correct optimal machining modes that can give the maximum productivity rate of a machine tool.

Muhammad et al (2011) investigated the effect of rake angle to minimize surface roughness in boring operations using Taguchi method and concludes that high feed rate and low cutting speed produces low surface roughness.

### 2.2 MACHINING PROCESSES WITH DAMPERS

The research works on damping material in boring process were familiar in the 1990s. Some of the researchers carried out experimental work on boring process equipped with different type of dampers and analysed the characteristics of damping materials.
Moore et al (1995) had proven that the impact dampers played effectively in damping synchronous shaft vibrations in a cryogenic rotor bearing system. Wong et al (1995) considered an actively controlled electromagnetic absorber for reducing the chatter in a boring bar. The dynamic characteristic of the boring bar was modelled using tino shenko beam finite elements, while a lump parameter model was used for the absorber. Simulation results show that a significant increase on the boring bar damping ratio can be achieved by using the proposed electromagnetic absorber.

Ema et al (1995) investigated that the frequency of a vibrating system with an impact damper was approximately decided by the natural frequency of the system and the mass ratio they concluded that when the system vibrates in the direction of gravity the critical amplitude at which the functions of the impact dampers were decided by the natural frequency and the acceleration due to gravity, on the other hand when the system vibrates in the direction perpendicular to gravity the impact damper functions effectively until the amplitude of vibration reaches almost zero because the frictional force occurring between the main mass and the free mass acts as a damping force. They also suggested that the use of the impact damper can improve the damping capability at least eight fold or more compared with the damping capability of the main vibration system and also the possibility of applying the impact dampers to the actual cutting tools.

Yokomichi et al (1996) presented an approximate analysis for determining the damping characteristics of a multi body system that is provided with the short impact damper attached to some arbitrary point of the system. It was shown that good vibration reductions can be achieved when the damper is applied to the point where the modal amplitudes are relatively large
even under small mass ratio, the damping performance is improved with optimized clearance.

Ema et al (1996) studied the improvement of damping capability of boring tools and suppression of chatter vibration using impact dampers and also conducted experimental test by varying the method of applying an impact damper to a boring tool they also investigated about the effects of amount of free mass and clearance, the overhang length of the boring tools and the cutting conditions they suggested that by using an impact damper boring of deeper holes are possible and the efficiency of the boring operations can be improved.

Ema et al (1998) studied the effect of cutting conditions on the initiation boundary of chatter vibrations experimentally and the usage of impact damper to suppress the chatter vibration and also demonstrated that chatter vibration is hardly prevented by changing the cutting conditions in drilling operations.

Chung et al (2001) reviewed the materials for vibration damping including metals, polymers, cement, shape memory alloys, ferro magnetic alloys and composites and also suggested that metals and polymers can be used as dampers due to their viscoelasticity property.

Evita et al (2001) concluded that the friction damper was found successful to prevent high frequency chatter causing the problem of reduced tool life in fine boring operation and also introduced a typical design of friction damper with experimental proof by cutting test eliminating chatter in fine boring assuming normal tool life of cutting edge.

Rahman et al (2001) investigated and compared Tool wear of uncoated cemented carbide tool inserts during dry turning and focused on the
relationships between tool life and damping capacity and also concluded that tool life was higher when the cutting was performed on the ferrocement bed lathe which has higher damping capacity and also discussed on the effect of damping on Tool wear and tool vibration.

Cheng et al (2003) investigated the behaviour of an impact damper in free damped vibration and constructed a simple model of impact damper using spring mass and viscous damper. The important feature in the analysis of the model was that the deformation of an impact damper during the collision with the main mass can be formulated and therefore the contact time was taken into consideration and the results clearly depicts that the reduction of the vibration response depends not on the number of impacts but primarily on the collision that occurs while the impact mass and the main mass are moving towards each other in a vibratory system.

Duncan et al (2005) investigated the performance of a single particle vertical impact damper over a range of forcing oscillation amplitude and frequencies, mass ratios, structural damping ratios, impact dampers, lid heights and damper coefficients of restitution and suggested that increasing the lid height of the damper increases the amplitude at which maximum damping occurs and also in addition gravity plays less of a role in the damper dynamics at large amplitudes and vertical damper can be modeled as a horizontal damper.

Lonnie et al (2006) described a flexible tool holder which acts as a dynamic absorber for a boring bar and introduced flexibility into the holder which matches the fundamental natural frequency and also used finite element models to refine the design.

Shigeru et al (2006) proposed an analytical method for the response of the main system (any structure or mechanical equipment) with an impact
damper in which the motion of the auxiliary mass is limited by motion-limiting stop having hysteresis damping subjected to harmonic and random excitations.

Nam et al (2006) introduced a mechanical damper to reduce tool vibration during the high speed milling process and presented a numerical procedure for qualitatively estimating the amount of friction work in mechanical damper using finite element analysis.

Ganguli et al (2007) demonstrated the effect of active damping on regenerative chatter instability for a turning operation and also presented a relationship between regenerative chatter instability structural damping.

Hussien et al (2007) developed a mathematical approach to study the whirling motion of a boring bar workpiece system in a deep hole boring process. The whirling motion was reduced with the addition of external forces on the boring bar in the two directions. The validated experiment was concentrated mainly on the workpiece side and the computed natural frequencies of the boring bar-workpiece model were determined.

Moradi et al (2008) used dynamic vibration absorbers to reduce the undesirable vibration and in addition analysed the chatter stability in dominant modes of boring bar. The optimum design of a Tuneable Vibration Absorbers (TVA) was presented and applied to suppress chatter in boring manufacturing process.

Yanchen et al (2008) experimented the fine particle impact dampers (FPID) in boring operations and determined that it works well in controlling the vibration with a frequency lower than 50Hz and also suggested that FPID has a significant application in mechanical vibration with a range of low frequencies.
Fang et al (2008) analyzed the granular damping based on free vibration tests which was conducted on a cantilever beam and suggested that granular damping is highly dependent on vibration level and compared granular damping and impact damping then highlighted the unique features of granular damping.

Sanjiv et al (2008) discussed the performance of a harmonically excited vertical impact damper and their functions which are limited in predicting its dynamics and damping characteristics. Ehsan et al (2008) studied the analytical method which was used to investigate damping performance of a simple particle impact damper on amplitude and frequency of a system over a wide range of particle-to-structure mass ratio and clearance.

Henrik et al (2009) demonstrated that a standard clamping housing clamping a boring bar with damping screws improves a non-linear dynamic boring bar behaviour and also concluded that a boring bar is likely to exhibit different dynamic properties when clamped or mounted in the clamping housing with clamping screws.

Ashfak et al (2011) studied the application of Magneto-Rheological damper to vibration control and designed the vibration damper using Magneto-Rheological fluids, tested and evaluated its performance and their use on vibration control systems.

2.3 APPLICATIONS OF PREDICTION MODELING AND SOFT COMPUTING TECHNIQUES IN MACHINING

The applications of the statistical analysis and soft computing techniques in the prediction of the cutting process parameters and cutting responses in machining processes were introduced, based on previous research works carried out in the field of manufacturing processes.
Fisher (1921) studied the survey results of a statistical examination of the plots of Broad balk and suggested systematic procedure for ANOVA study. The application of conventional and non conventional optimization methods for machinability problems are explained in books (Rao (1996), Deb (2004)). The modeling and optimization using Response Surface Methodology (Gunaraj et al (1997)) for machinability problems provided the baseline to carryout study on boring processes. The prediction techniques, neural networks, Fuzzy logic and Genetic Algorithms were explained with the help of engineering problems by Rajasekaran (2006).

Viharos et al (1999) suggested that reliability process models are required for selecting optimal parameters during process planning, for designing and implementing adaptive control systems due to their model free estimation, uncertainty handling and learning abilities and also suggested that ANNs can be frequently used for modelling of machining processes.

Tugrul et al (2005) utilizes neural network modelling to predict surface roughness and tool flank wear over the machining time for variety of cutting conditions in hard turning and developed regression models to capture process parameters.

Petropoulos et al (2005) presents the development of a predictive model for cutting force components in longitudinal turning of constructional steel with a coated carbide tool and formulated a model in terms of cutting conditions and also used Taguchi method for the plan of experiments and performed the analysis using Response Surface Methodology.

Ezugwu et al (2005) developed an ANN model for the analysis and prediction of the relationship between cutting and process parameters during high speed turning and achieved a better performance of the neural network model in terms of agreement with experimental data.

Gaitonde et al (2005) presented the application of Genetic Algorithm (GA) for reduction of burr size in drilling process and models using RSM and the developed RSM models are then employed with Genetic Algorithm, which is a search algorithm based on natural selection, to minimize the burr size. Daniel et al (2005) worked on the spring back optimization of bending processes using the concept of Experimental design and RSM.

Onwubolu et al (2006) presented a mathematical model for correlating the interactions of some drilling control parameters such as speed, feed rate and drill bit diameter and their effects on some responses such as axial force and torque acting on the cutting tool during drilling by means of Response Surface Methodology. The results obtained revealed that the mathematical model was useful not only for predicting optimum process parameters for achieving the desired quality but also used for process optimization.

Kadirgama et al (2006) describes the application of neural network methods to predict the cutting force model in milling 618 stainless steel. Design of Experiments was used to reduce the number of the experiments and provide the optimum experiment condition and compared the predictive result between experimental results and neural network. The error from the neural network prediction result was acceptable since the value of the prediction was closer to the experimental result.

Palanikumar et al (2006) discussed the applications of the Taguchi method with fuzzy logic to optimize the machining parameters (workpieces,
cutting speed, feed rate, depth of cut and machining time) for machining of Glass fiber reinforced polymer composites with multiple characteristics.

Emre et al (2007) observed a satisfactory agreement between analytical predictions and the experimental results for turning and boring operations. Chern et al (2007) analyzed the effect of vibration in boring by investigating the surface roughness of the workpiece with the help of Taguchi method and analysis of variance.

Budak et al (2007) proposed an analytical model for the stability of turning and boring processes and compared the proposed stability model predictions with the experimental results and observed an acceptable agreement.

Nalbant et al (2007) investigated on the surface quality of steel workpieces and compared the experimental results using multiple regression analysis and artificial neural networks and suggested that the predictive neural network model shows better predictions than various regression models for surface roughness and insisted that both the methods can be used for prediction of surface roughness in turning process.

Tugrul et al (2007) investigated on finish turning of AISI D2 steels (60HRC) using ceramic wiper design inserts and developed multiple linear regression model and neural network model for predicting surface roughness and tool flank wear. They carried out neural network based predictions of surface roughness and tool flank wear and compared with a non-training experimental data and suggested that neural network models are suitable to predict Tool wear and surface roughness.

Natarajan et al (2007) presented the feed forward back propagation neural network (FFBPNN) for tool life prediction in turning operation and an
evolutionary technique namely particle swarm optimization was used instead of FFBPNN and proved that the experimental results match well with the predicted by both ANN with BP and the proposed method.

Palanikumar et al (2007) developed mathematical model to predict surface roughness and Tool wear in their works in order to study main and interaction effects of machining parameters by regression analysis and ANOVA techniques and suggested the best procedure for modeling and optimization of process parameters.

Qing et al (2008) used ANN and GA together to establish the parameter optimization model in Electrical Discharge Machining (EDM) process. The ANN model developed represents the relationship between metal removal rate and input parameters and GA was used to optimize the machining parameters.

Umbrello et al (2008) presented a predictive hybrid model based on the artificial neural networks (ANNs) and finite element method (FEM) which were used for both forward and inverse prediction and trained a three layer neural networks based on the selected data from numerical investigations in hard machining. The result shows that the hybrid ANN-FEM based approach provides a robust framework for machining analysis.

Karnik et al (2008) described the comparison of burr size predictive models in drilling operations based on Artificial Neural Networks (ANN) and Response surface Methodology (RSM) and the comparison clearly indicated that the ANN models provide more accurate prediction compare to RSM models.

Sidda et al (2008) deals with the development of surface roughness prediction model for machining aluminum alloys using multiple regression
and artificial neural networks and conducted experiments using full factorial design in the Design of Experiments on CNC turning machine with carbide cutting tool. The experimental results shows that ANN model predicts with high accuracy compared with multiple regression model.

Yu et al (2008) presented a method for predicting regenerative chatter in turning of uniform and stepped workpieces while considering the variations in natural frequency and confirmed that the predicted chatter on set conditions were in good agreement with the experiments.

Ambrogio et al (2008) presents a hybrid model based on the artificial neural network (ANNs) and finite element method (FEM) which was used to predict the residual stress profile and trained a three layer neural network and tested on the data obtained by numerical investigation of hard machining and concluded that the numerical results were consistent with experimental data. Mathew et al (2008) used acoustic Emission for monitoring manufacturing processes particularly metal cutting because monitoring the condition of the cutting tool in the machining process was very important and an unexpected tool failure may damage the tool, workpiece and sometimes the machine tool itself.

Vishal et al (2008) studied the machining variables such as cutting forces and surface roughness which were measured during turning at different cutting parameters and the data obtained by experimentation were analysed and constructed the model using neural networks and tested the model obtained with the experimental model.

Ramon et al (2008) investigates the prediction of Tool wear in hard machining using neural networks and carried out an experimental investigation to determine Tool wear for different values of cutting speed, feed and time. The parameters of the design and the training process for the
neural network were optimized using Taguchi method. Outcomes from the two models were analysed and compared where the neural network shows better capability to make accurate predictions of Tool wear under the studied conditions.

Shyan et al (2009) investigated the optimization of computer numerical control (CNC) boring operation parameters for aluminum alloy 6061 T6 using grey relation method. Additionally the analysis of variants (ANOVA) was also applied to identify the most significant factor.

Basim et al (2009) describes the selection of cutting speed and feed rate that depends on cutting force model for turning Hastelloy C-276 using response surface methodology. The model obtained was found to be accurate based on the variance analysis and also the predicted values were closer with the experimental results. It was recommended to decrease the feed rate and depth of cut with increasing the cutting speed to reduce the boring tool vibrations.

Tugrul et al (2009) presented the effects of insert design in turning of steel parts using conventional and wiper design inserts and developed a regression model and neural network model for predicting surface roughness, mean force and cutting power. Their results show that neural network models are suitable for predicting surface roughness patterns for a range of cutting conditions in turning.

Ridha et al (2009) implemented a wear prediction model in the finite element Code Abaqus in which Tool wear was a function of the normal pressure and the material properties on a blanked part.

Yang et al (2009) compared various wear forecast models in drilling operations based on artificial neural networks (ANN) and established a Back Propagation Wavelet Neural Network (BPWNN) combining the
prominent dynamic properties of Back Propagation Neural Network (BPNN) with the enhanced ability of a Wavelet Neural Network (WNN) in mapping nonlinear functions and investigated the effects of drill wear, cutting spindle speed, drilling depth and feed rate conditions on the thrust force and the cutting torque.

Venkatesan et al (2009) found that the Artificial intelligent tools like genetic algorithm, ANN and fuzzy logic were useful in modeling reliable processes in the field of Computer integrated manufacturing and ANNs were used as process models because they can handle strong non-linearity, a large no. of parameters and missing information when the dependencies between parameters become non-invertible, the input and output configurations used in ANN strongly influences on the accuracy and the Genetic Algorithm based ANNs were used to construct models which gives more accurate results in less time. They proposed that a Genetic algorithm – based ANN model can be used for turning process in manufacturing industry.

Sivasakthivel et al (2010) developed a mathematical model for Tool wear in end milling process by employing second order response surface methodology and verified the adequacy of the model using Analysis of Variance.

Abhang et al (2010) measured the tool-chip interface temperature experimentally during turning of EN-31 steel alloy with tungsten Carbide inserts using a tool-work thermocouple technique and developed first and second order mathematical model in terms of machining parameters using RSM on the basis of the experimental results.

Hamidreza et al (2010) proposed a new soft computing approach for drilling rate prediction with acceptable accuracy which was an important issue in minimizing drilling cost.
Majumder et al (2010) used two methods to predict the Surface roughness of Nd: YAG laser drilled mild steel specimens and compared the results of the two methods through RSM and ANN.

Gaitonde et al (2010) developed ANN based models to study the effect of process parameters such as cutting speed, feed, drill diameter, point angle on burr height and burr thickness during drilling of AISI 316L stainless steel. The input - output patterns required for training were obtained from drilling experimentation planned through Box-Behnken design and the simulation results demonstrated the effectiveness of ANN models to analyze the effects of drilling process parameters.

Kadirgama et al (2010) developed a tool life prediction model for P20 tool steel with aid of statistical method and find the optimization values with particle swarm optimization (PSO) using coated carbide cutting tool.

Saeed et al (2010) studied the influence of hardness and spindle speed on surface roughness in hard turning operation of cutting tool and used ANN and regression methods for modeling of surface roughness and indicated that the ANN model can predict hardness for the train data and spindle speed for the test data with a good accuracy.

Danko et al (2010) aims at the determination of a Tool wear regulation model using Radial Basis Function Neural Network (RBFNN) that can ensure the maximum allowed amount of Tool wear rate within a predefined machining time with experimentally adjusted parameters. Singh et al (2010) developed an analytical Tool wear model for the mixed ceramic inserts during the hard turning process and the proposed model was validated by conducting experiments and found that the model was capable of predicting the flank wear using the cutting parameters and tool geometry.
Chandrasekaran et al (2010) discusses the complexity and uncertainty of the machining processes and preferred soft computing techniques for predicting the performance of the machining processes and revealed that the major soft computing tools like neural network, fuzzy sets, GA, simulated annealing, ant colony optimization and particle swarm optimization can be applied for prediction and optimization. Moreover the article reviews the application of the soft computing tools to the machining processes like turning, milling, drilling and grinding.

Hazim et al (2010) introduced a special type of neural network, Radial basis Network (RBN) to the field of machining and simulation which was a feed forward three layer fully interconnected neural network successfully used to establish the relationship between the machining conditions (Input) and process parameters (output) for the case of ball end milling. A very good agreement was observed between the forces predicted by the new model and the experimental data.

Hyun et al (2010) shows that the cutting condition from RSM gives a better result than that from the Taguchi method during turning on CNC lathe.

Patricia et al (2010) developed different artificial neural networks for the prediction of Surface roughness values in Aluminium alloy after face milling process. The radial base (RBNN), feed forward(FRNN), and generalized regression (GRNN) network were selected and data used for training these networks were derived from experiments conducted using a high speed milling machining and FFNN achieved better results.

Yang et al (2010) used a differential evolution algorithm (DEA) based artificial neural network (ANN) for the prediction of Surface roughness in Turning operations. The result obtained from the DEA based ANN model
were compared with the Back propagation based ANN and found that the error percentage was very close and observed that the convergence speed for the DEA based ANN was higher than the BP-based ANN.

Miodrag et al (2011) concluded that soft computing techniques are artificial intelligence based techniques and they are very powerful tool for solving extremely complex, non linear processes and also presented that conventional metal cutting and plasma cutting are complex processes depends upon many input parameters and intermediate correlations. Precise mathematical modelings of these processes are almost impossible. Relationship among the process input parameters and corresponding outputs were established from the measured data. Modeling of the measured data was performed using response surface methodology, artificial neural networks hybrid network and neuro fuzzy system. All the models were trained and tested. In general, the results of the modeling are in good agreement with the experimentally obtained data.

Alwarsamy et al (2011) theoretically resolved the cutting forces in boring operation and developed a predictive theoretical cutting force model and discussed the influence of cutting parameters on force components which were predicted using MathCAD professional software.

Vinod et al (2011) in a review article concluded that the soft computing tools like neural networks and fuzzy logic were widely used by the researchers to predict the performance of machining processes like turning, boring, drilling, milling and electric discharge machining successfully and the scope of these soft computing techniques were not limited to machining processes only rather research work can be undertaken to apply these methods to manufacturing processes such as casting, welding and forming.
Yigit et al (2011) investigated the multi response optimization of the turning process for an optimal parametric combination to yield the minimum cutting forces and surface roughness with the maximum material removal rate (MRR) using a combination of Grey relational analysis (GRA) and the Taguchi method. Their objective functions were selected in relation to the parameters of the cutting process like cutting force, surface roughness and metal removal rate and finally concluded that the optimization of complicated multiple performance characteristics of the processes can be greatly simplified using the Grey-based Taguchi method.

Saeed et al (2011) describes the tool flank wear prediction in CNC turning of 7075 Al alloy sic composites using ANN and the comparison between the results of the presented model shows that the ANN with the average relative prediction error for flank wear values and can be utilized effectively for prediction of flank wear.

Saeed et al (2011a) investigated on the capability of Regression Analysis (RA), ANN and Coactive Neuro-Fuzzy Inference System (CANFIS) to predict the surface roughness, material removal rate and overcut in electrochemical drilling using different electrolytic solutions and the comparison of results indicated that CANFIS, gives the best result to predict the surface roughness and overcut while ANN was best for predicting MRR.

Mohammad et al (2011) presented a new approach to determine the optimal cutting parameters leading to minimum surface roughness in face milling operations by coupling artificial neural network (ANN) and harmony search algorithm (HS). The obtained results show that the harmony search algorithm coupled with feed forward neural network was an efficient and accurate method in approaching the global minimum of surface roughness in face milling.
SeHo et al (2011) studied on the response surface model for machining errors in internal lathe boring. The machining error prediction model was described by the Response Surface Method using tool overhang, feed per revolution and depth of cut as the factors for the analysis. The least square method revealed that tool overhang and depth of cut were significant factors with 90% confidence intervals.

Sukhomay et al (2011) presented a neural network based sensor fusion model for a Tool wear monitoring system in turning operations and validated in manual turning operations. Abuthakeer et al (2011) conducted the experiments on CNC lathe effect of cutting parameters such as cutting speed, depth of cut and feed rate and the testing results showed that the regression model and ANN model developed has a close proximity with the experimental results with accuracy.

Chinnasamy et al (2012) designed an artificial neural network (ANN) model to predict the surface roughness through feed forward back propagation network using MATLAB software for the experimental data obtained and compared the experimental data with ANN results and found that there was no significant difference and concluded the confidence level of ANN in CNC turning.

With the help of the above approaches, the present investigation has focused on the study of cutting parameters in boring process and their effect on cutting responses when the boring tool is equipped with and without dampers using ANN and RSM algorithms.