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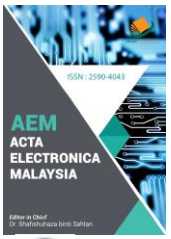


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***REVIEW ARTICLE***

# ROLE OF TAGUCHI AND GREY RELATIONAL METHOD IN OPTIMIZATION OF MACHINING PARAMETERS OF DIFFERENT MATERIALS: A REVIEW

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**ABSTRACT**

Now a day's quality of the product is highly concerned with production for the competition point of view. So, for enhancing the quantity and quality of the products with different machining like drilling, milling, grinding etc. must perform with their specific parameters. For optimizing the surface finish many approaches were used but among them taguchi and grey relational method is used repetitively. These methods are the best tools for optimizing of different machining parameters for improving surface finish and better MRR. In future for improving the machining rate we can also use other techniques like genetic algorithm and nature algorithm in manufacturing system.

**KEYWORDS**

Taguchi Method, Grey Relational Analysis, Engineering Materials

## 1. INTRODUCTION

Manufacturing: To fulfill the demand of customer or human need we have to convert one form of available material (Raw material) into other form (Desired form or Product).

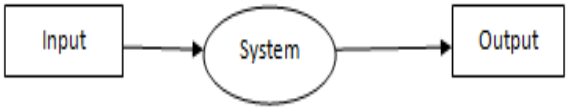


**Figure 1:** The System

The conversion of raw material by means of different processes into desired product is called manufacturing and the process which are performed on raw material known as manufacturing process. Manufacturing processes can be categorized as following

Casting: In casting process raw material in molten form is poured into mould and then solidifies. Mould is made in form of desired shape of the product.

Machining Process: In machining process to get desired shape of the product extra material is removed from the work piece in the form of chips. Ex- Drilling, Shaping, Planning, Turning, Milling etc.

Metal Forming Process: In metal forming process desired shape is obtained by forming raw material by means of compressive forces (except drawing operation). In forming process wastage of raw material is negligible

Fabrication Process: In this process all parts are assembled by different means of joining as welding, soldering brazing riveting etc.

Surface Treatment Process: Surface treatment processes are performed on work piece to improve the property and other working condition as life of product.

### 1.1 PROBLEMS IN MANUFACTURING IN MODERN ERA

As we all are familiar today's time is of huge completion to fulfill the demand of customer in market for the same product at lower cost in comparison of others as well as customer expectation is also high. In modern times to satisfy the customer a lot of factors are keep in mind during the production of the product. Which are listed as below:

- Need of customer should be fulfill.
- Customer demand should be fulfilled in minimum time
- Cost of product should be lowest.
- Life of product should be as much as possible
- Quality of product should be good
- Best service and repair of the product should be available easily etc.

#### *1.1.1 Manufacturing parameters to overcome above points of customers*

During the manufacturing of the product to overcome above mentioned point manufacturing parameters are taken into consideration

- Raw material should be of good quality and easily available.
- Production cost should be minimum
- Production time should be minimum
- Proper manufacturing process should be considered
- Proper machining parameters should be selected
- Production rate should be high.
- Tool life should be high
- Material removal rate should be high.
- Surface finishing should be high etc.

### *1.1.2 Methods for optimization*

There are many methods for optimization of machining parameters for different type's materials which are listed as below

- Nature algorithm
- Taguchi and Grey relational analysis
- Genetic algorithm
- Tabu search
- Ant colony algorithm etc

## 2. LITERATURE SURVEY

For optimization of machining parameters with different techniques are discussed in this section from some literatures as shown in Table 1:

**Table 1:** Literature Review

| Name of author | Area of Research | Method |
|---|---|---|
| A.Ranga Subbaiah et al. (2017) | Optimization of Milling Parameters | Taguchi method |
| Sangeetha.M. and Prakash.S. (2017) | Optimization of Drilling Parameters | Meta ModelingApproach |
| Sukhpal Singh Chatha et al. (2016) | Performance evaluation of aluminium 6063 drilling | Taguchi method |
| Arshad Noor Siddiquee et al. (2014) | Optimization of deep Drilling Parameters | Taguchi method |
| G. Vijaya Kumar and P. Venkataramaiah (2013) | Minimization of Burr Height and Tool Wear in Drilling | Desirable-Fuzzy Approach |
| Lohithaksha M Maiyar et al. (2013) | Optimization of Machining Parameters for End Milling | Taguchi Based Grey Relational Analysis |
| D. Biermann et al. (2012) | Thermal Aspects in Deep Hole Drilling of Aluminium Cast Alloy Using Twist Drills and MQL | Taguchi method |
| K. Kadirgama et al. (2009) | Surface Roughness Prediction Model of 6061-T6 Aluminium Alloy | Statistical Method |
| A. Noorul Haq et al. (2008) | Multi response optimization of machining parametersof drilling Al/SiC | Grey relational analysis in the Taguchi method |
| P. Narender Singh et al. (2004) | Optimization by Grey relational analysis of EDM parameters | Grey relational analysis |
| Eguia, I., et al (2013) | Cell formation and scheduling of part families | Tabu Search |

The cutting speed, feed rate and depth of cut and by using taguchi method and genetic algorithm examine that surface roughness can be improved at a particular cutting speed(4750 rpm), feed rate(1500 mm/min) and depth of cut(0.4 mm) [1]. The output response burr height is obtained using Profile projector and analyzed and this burr height is highly affected by feed rate and drill diameter. As the feed increases the burr height increased and it decreased as the spindle speed increased [2]. Experiment done in dry condition and with lubricant and the thrust forces and torques at the speed of 30 m/min and feed rate of 60 mm/min. is obtained and tool life increased [3]. The machining parameters (speed, cutting fluid, feed and hole-depth) and it is obtained that how much percentage of the parameters is affecting the surface roughness [4]. The burr height and tool wear are minimized successfully using Desirable-Fuzzy approach [5]. The grey relational analysis is an effective optimization tool for machining of Inconel 718 alloy in end milling. It has been also found that the optimal cutting parameters for the machining process lies at 75m/min for cutting velocity, 0.06 mm/tooth for feed rate and 0.4 mm for depth of cut. Further it has been observed that there is a 64.8%increase in material removal rate and at the same time a 9.52% decrease in surface roughness [6]. The feed rate is most considerable factor for heat generation during the operation [7]. To investigate the most dominant variables among the cutting speed, feed rate, axial depth and radial depth and to optimize the parameters. Response surface method based optimization approach was used in this study. It can be seen from the first order model that the feed rate is the most significantly influencing factor for the surface roughness [8].

Grey relational analysis in the Taguchi method for the optimization of the multi response problems is a very useful tool for predicting the surface roughness, cutting force and torque in the drilling of Al/SiC Metal Matrix Composites [9]. To optimize the multi response characteristics of Electric Discharge Machining of Al–10%SiCP composites employed orthogonal array with Grey relational analysis. The experimental result for the optimal setting shows that there is considerable improvement in the process. The application of this technique converts the multi response variable to a single response Grey relational grade and, therefore, simplifies the optimization procedure [10]. Tabu search method for scheduling of part family for manufacturing is used for optimization [11].

From above discussed literatures different used methods can be compare in the below Table 2.

**Table 2:** Number of Times Method Used

| S. No. | Methods | No. of times used |
|---|---|---|
| 1 | Taguchi method | 7 |
| 2 | Meta Modeling Approach | 1 |
| 3 | Desirable-Fuzzy Approach | 1 |
| 4 | Statistical Method | 1 |
| 5 | Tabu Search | 1 |

From the above Table.2 the comparison can be made how many times any methods used in this paper frequently as shown in graph A:

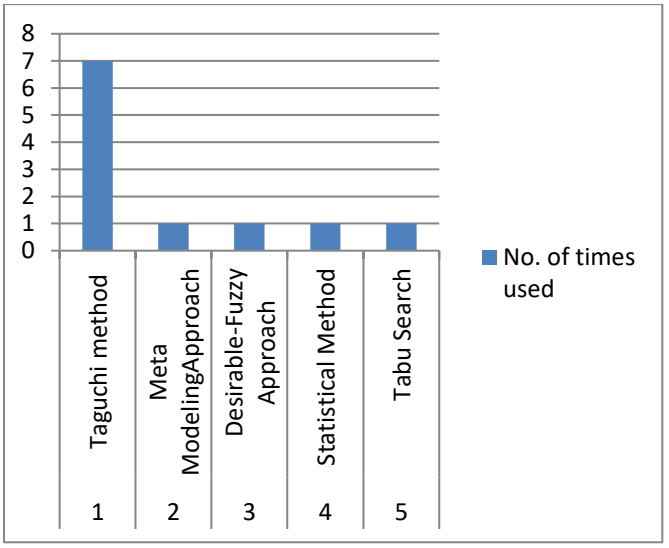


**Figure 2:** Graph A

## 3. HISTORY AND IMPACT OF TAGUCHI METHOD

The Taguchi method was first introduced by Dr. Genichi Taguchi to AT&T Bell Laboratories in 1980. Nowadays Taguchi method is commonly used continuously to improve the quality of the product in place of statistical process control (SPC), the Deming approach, and the Japanese concept of total quality control.

Following are the main advantages of taguchi method:

- It provides a base to determine the functional relationship between controllable product or service design factors and the outcomes of a process.
- It provides a method to adjust the mean of a process by optimizing controllable variables.
- It provides a procedure to examine the relationship between random noises in the process and product or service variability.

### 3.1 Steps for applying taguchi method

Following are the steps to apply the taguchi method

**Step 1: Problem identification**

First, the production problem must be identified. The problem may have to do with the product process or the service itself.

**Step 2: Brainstorming session**

Second, a brainstorming session to identify variables that have critical effects on service or product quality takes place.

The critical variables identified in the brainstorming sessions are referred to by Taguchi as factors.

These may be identified as either control factors (variables that are under the control of management) or signal factors (uncontrollable variation).

Once these factors have been identified, different levels or setting of the control factors are defined.

At least three levels should be used for each factor in order to identify functional forms (such as interactions) of the effects more clearly.

Noise factors can be measured at the time of the experiment and included in the analysis.

Once the decision variables are established, objectives of the experiments should be defined. These objectives are defined as follows:

- Less the better
- Nominal is best
- More the better

**Step 3: Experimental Design**

Using the factors, factor levels, and objectives from the brainstorming session, the experiment is designed. The Taguchi method uses off-line experimentation as a means of improving quality. This contrasts with traditional on-line (in process) quality measurement.

As with any experiment, care should be taken in selecting an appropriate number of trials and with the conditions for each trial.

The number of replications to be used in the experiment should be established beforehand.

**Step 4: Run Experiment**

There are different Taguchi analysis approaches that use quantitatively rigorous techniques such as analysis of variance (ANOVA), signal-to-noise ratios (S/N), and response charts. These approaches, although not always theoretically sound, are useful in engineering related projects involving engineered specifications, torques, and tolerances.

**Step 5: Analysis**

Experimentation is used to identify the factors that result in closest-to-target performance. If interactions between factors are evident, two alternatives are possible. Either ignore the interactions (there is inherent risk to this approach) or, provided the cost is not prohibitive, run a full factorial experiment to detect interactions. The full factorial experiment tests all possible interactions among variables

**Step 6: Confirming Experiment**

Once the optimal levels for each of the factors have been determined, a confirming experiment with factors set at the optimal levels should be conducted to validate the earlier results. If earlier results are not validated, the experiment may have somehow been significantly flawed. If results vary from those expected, interactions also may be present, and the experiment should, therefore, be repeated.

### 3.2 Why taguchi is most useful

There are some reasons why taguchi is most useful technique than any other technique.

- The Taguchi method is a standardized approach for determining the best combination of inputs to produce a product or service.
- This is accomplished through design of experiments (DOE). DOE is an important tool in the arsenal of tools available to the design and process engineer.
- It provides a method for quantitatively identifying just the right ingredients that go together to make a high-quality product or service.
- Taguchi approaches design from four perspectives: robust design, concept design, parameter design, and tolerance design.
- The Taguchi concept of robust design states that products and services should be designed so that they are inherently defect free and of high quality. The concept is not necessarily new.
- Taguchi's approach for creating robust design is through a three-step method consisting of concept design, parameter design, and tolerance design.
- Concept design is the process of examining competing technologies to produce a product.
- Concept design includes process technology choices and process design choices.
- Appropriate choices in these areas can reduce production costs and result in high quality products.
- Parameter design refers to the selection of control factors and the determination of optimal levels for each of the factors.
- Control factors are those variables in a process that management can manipulate.
- Control factors do not affect production costs.
- Optimal levels are the targets or measurements for performance.
- The goal is to fine the most efficient process and service design.
- These parameters can be determined through experimentation.
- Tolerance design deals with developing specification limits.
- Tolerance design occurs after parameter design has been used to reduce variation and the resulting improvement has been insufficient.
- This often results in an increase in production costs.
- Of these four design considerations, the Taguchi method primarily focuses on parameter design.

## 4. CONCLUSION

The number of methods have been used different researchers among all some are Taguchi method, Grey relational analysis, Genetic algorithm (GA), Simulation, Artificial Neural Network (ANN), Tabu Search (TS), Fuzzy logic etc are the most used techniques for optimization various manufacturing system. Evolutionary techniques such as Taguchi method, Grey relational analysis and Genetic algorithm (GA) are proved mostly effective in solving difficult production problems. Most of the researcher not been provided a clear reason in using different optimization techniques like taguchi and grey relational analysis etc. The literature recommends that taguchi and grey relational may be used for historical reasons because it was one of the best optimize approaches to be used for combinational problems, providing near-optimal solutions, in an acceptable amount of time. In future some different algorithms like nature and genetic algorithm may also be used for comparing the result with taguchi and grey relational method for best outcomes.

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