

DEVELOPMENT OF A MATHEMATICAL MODEL FOR PREDICTING OPTIMUM SETTINGS OF CONTROL FACTORS IN WIRE ELECTRICAL DISCHARGE MACHINING (WEDM) USING ROBUST DESIGN

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This work addresses a formulation and solution to a multi-objective optimization problem for the selection of the best control settings on a Wire Electrical Discharge Machine, as it is the special characteristics of WEDM devices that even a single factor can influence the machining results in complex ways. The measures of performance (Material Removal Rate (MRR) and Surface Finish (SF)) for the model are used to predict the measures of performance as a function of a variety of control settings. In selecting the best combination of control settings the concept of Robust Design is introduced.

It is known that to minimize the total cost, which consists of the Unit Manufacturing Cost (UMC) and quality loss, parameter design must be first carried out. Next, during tolerance design, tolerances should be adjusted to strike an economic balance between reduction in quality loss and increase in manufacturing cost. This strategy of minimization of the total cost is a precise statement of the fundamental principle of Robust Design.

Engineers and managers, unaware of the benefits of designing robust products and the Robust Design methodology, tend to use more costly parts, components, and manufacturing processes to improve quality without first gaining the available benefits of the parameter design. As a result, they miss the opportunity to improve quality without increasing manufacturing cost. This leads to the misconception that higher quality always leads to increased UMC.

The estimated effects of design parameters will be valid even when other parameters are changed during the subsequent design or when designs of related subsystems change. This can be achieved by employing the signal-to-noise (S/N) ratio to measure quality and orthogonal arrays to study many design parameters simultaneously. Orthogonal Arrays (OA) provide a set of well balanced (minimum) experiments and Dr. Taguchi's Signal-to-Noise ratios (S/N), which are log functions of desired output, serve as objective functions for optimization and also assist in data analysis and prediction of optimum results. After conducting a matrix experiment, the data from all experiments in the set taken together are analyzed to determine the effects of the various parameters.

In this research the mathematical model was developed and the predictions were made on the improvements of MRR and SF. The verification experiments were carried out and it is clear that the experimental results agree well with the predictions.

Finally, optimization of a process or a product need not be completed in a single matrix experiment. Several matrix experiments may have to be conducted in sequence before completing a product or process design.