# Multi-Objectives Process Optimization in End Milling Process of Aluminium Alloy 6061-T6 Using Genetic Algorithm

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**Abstract.** Manufacturing industries are business driven and profits are generated by increasing annual revenue and reducing total manufacturing costs. The cost involves multiple resources such as raw materials, manpower, equipment and even manufacturing time. Thus, every manufacturing process from the frontline to the backline must run up to the maximum capacity and effectiveness without compromising products' yield and quality. End milling is one of the crucial processes to produce geometry shape products mainly in the automotive and aerospace industries. Therefore, this paper aims to obtain optimum conditions of ethe nd milling process for three cutting inserts with multi-objective parameters using a combination of mathematical modelling and genetic algorithm. The responses studied are surface roughness, cutting temperature, cutting force and flank wear. The target is to obtain the lowest value of all the responses studied by considering both input and response parameters simultaneously at one time. The process involved multi parameters and responses, thus in this study, multi-objective optimization genetic algorithms (MOGA- II) were applied. The optimization process parameters of end milling were obtained using response surface methodology, mathematical models and the MOGA-II approach. The optimum parameters were determined according to the design flow, constraints value and mathematical algorithm. Based on MOGA-II analysis, every workflow generated 1600 feasible solutions for optimization that meet the design space requirement. However, only a final solution was selected according to the multi-objective optimization of each insert used in the experiments. Subsequently, multi-criteria decision-making is required to choose the final optimization of the machining performance. Based on the parallel coordinates plot in MOGA-II and the multi-criteria decision-making approach, the final iteration number representing a single combination of optimum parameters was obtained for each cutting insert. The results of end milling process parameters with optimised machining conditions are presented and discussed. In the confirmation analysis, all the results are less than 10% of marginal error, thus, indicating that the model that was developed for the response studied is reasonably accurate. All the actual values are within a 95% prediction interval. Therefore, it can be concluded that the process was optimized which regards the lowest value obtained for the responses studied. In addition, the process was enhanced significantly with a combination of the MQL technique and the application of tri-hybrid nanofluids in end milling even for the low-cost cutting insert like uncoated tungsten carbide. For future study, other methods or algorithms can be applied in other machining processes to obtain optimum machining parameters.

**Keywords:** End milling process, Process optimization, Tri-hybrid nanofluids, Decision making, Genetic algorithm

*The 5th International Conference on Automotive Innovation and Green Energy Vehicle*
AIP Conf. Proc. 2998, 050003-1–050003-17; https://doi.org/10.1063/5.0188871
Published by AIP Publishing. 978-0-7354-4793-6/$30.00