

Multi-Criteria Decision Making in CNC Turning Operations: Current Practices and Future Prospects

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Abstract: Computer Numerical Control (CNC) turning operations represent one of the most critical processes in modern manufacturing. The inherent complexity of optimizing multiple, often conflicting objectives—such as surface roughness, tool wear, production time, cost, and environmental impact—necessitates sophisticated decision-making approaches. This review paper synthesizes current knowledge on multi-criteria decision making (MCDM) techniques applied to CNC turning operations. We examine the theoretical foundations, implementation strategies, and empirical results from contemporary research. Our analysis reveals that Pareto-based evolutionary algorithms combined with fuzzy logic and machine learning techniques show the most promising results. We identify critical research gaps and propose future directions for advancing MCDM in CNC turning, emphasizing Industry 4.0 integration, sustainability considerations, and real-time adaptive optimization systems. This paper serves as a comprehensive guide for researchers and practitioners seeking to understand and implement MCDM strategies in precision manufacturing.

Keywords: CNC turning, multi-criteria decision making, Pareto optimization, fuzzy logic, machine learning, manufacturing optimization

