Chapter 4

Modelling and Optimization of End Milling Process Using TLBO and TOPSIS Algorithm:
Modelling and Optimization of End Milling Process

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ABSTRACT

To assure desire quality of machined products at minimum machining costs and maximum material removal rate, it is very important to select optimum parameters when metal cutting machine tool are used. Minimum Surface Roughness (Ra) is commonly desirable for the component; however Material Removal Rate (MRR) should be maximized. This chapter presents an approach for determination of the best cutting parameters precede to minimum Ra and maximum MRR simultaneously by integrating Response Surface Methodology with Multi-Objective Technique for Order Preference by Similarity to Ideal Solution and Teaching and learning based optimization algorithm in face milling of Al-6061 alloy. 30 experiments have been conducted based on RSM with 4 parameters, namely Speed, Feed, Depth of Cut and Coolant Speed and three levels each. ANOVA is performed to find the most influential input parameters for both MRR and Ra. Later the multi-objective attribution selection method TOPSIS and multi objective optimization method TLBO is used to optimize the responses.
INTRODUCTION

Milling is the metal removal process of using rotary multi point cutters hold on arbor and spindle to remove material from a work piece by advancing in a direction or at an angle with the axis of the tool. There are a wide variety of different milling operations and machines, on scales from small individual parts to large parts. It is one of the most commonly used processes in industry, today for machining parts to precise sizes and desire shapes. Application of Milling-

- Flat surface in horizontal, vertical and inclined planes.
- Generating slots or ribs or grooves at various sections.
- Slitting or parting of work piece.
- For producing surfaces of revolution.
- Generating helical flutes of the drills.
- Long thread milling on power screws, large lead screws, worms etc.
- Short thread milling for small size fastening screws, bolts etc.

The milling operation can be broadly classified according to their operation such as horizontal milling, vertical milling and inclined milling depending on the direction of cutter axis. End milling, face milling, slot milling, slab milling, saw milling, straddle milling, gang milling, etc. Face milling is mostly used for milling operations for high metal removal rate. Face milling is a combination of up cut and down cut milling operation. In face milling, the location of the cutter with respect to the work piece is of considerable significance. Face milling as shown in Figure 1 is usually preferred for rough machining of larger surfaces.

The production rate is also higher as the diameter of the cutter is large but quality and productivity are the two important sides which is usually required for any industry. In order to achieve that, the operating parameter parameters should be suitably adjust, but they are opposite in nature. Generally maximizing productivity is directly related to the machining cost. However, productivity can be expounded in term of MRR and quality can be many factor such as machining parameters, cutting phenomena, work piece properties and cutting tool properties, etc. The significant machining parameters are \( v, f, DOC, CS \) chosen by literature survey and experience. In automobile and aerospace industry, there is demand for materials that are tougher, lighter, harder, stiffer, and stronger, more corrosion and erosion- resistance properties and superior mach inability index. Al-6061 alloy possess all these properties, hence considered under this research as a work-piece material. Expounded in terms of product characteristics, i.e. dimensional accuracy, surface smoothness and form stability, etc. 6061 Al alloy is a precipitation hardened alloy, containing magnesium and silicon as their main alloying component. It has good thermal and mechanical properties and show better weld-ability property. It is one of the most useful and common alloys of aluminum for industrial purpose use. 6061 is commonly used for the following:

- Construction of aircraft planes structure, such as wings and fuselages, commonly in home built aircraft than military or commercial aircraft. Another alloy 2024 is certain stronger, but 6061 is more easily heat treated work and remains resistant to corrosion even when the surface is eroded, which is not in the case of 2024, which is commonly used for thin AL clad coating for corrosion resistance.