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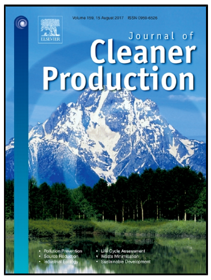

Experimental study for the effective and sustainable repair and maintenance of bars made of Ti-6Al-4V alloy. Application to the aeronautic industry

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Experimental study for the effective and sustainable repair and maintenance of bars made of Ti-6Al-4V alloy. Application to the aeronautic industry

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Abstract. This paper presents an experimental study of turning for repair and maintenance operations of Ti-6Al-4V bars for the aeronautic industry. Turning operations were analysed to establish adequate conditions to reach the expected dimensional tolerances, form and surface quality of the workpieces under sustainable conditions. As the main criterion, restoration of the parts to the components so that they can resume their normal activity is considered. Moreover, minimisation of the cutting forces is considered critical to reduce the power consumption and tool wear. A full factorial design with four factors (environment, feed rate, spindle speed and type of tool) was performed to evaluate their influence on the cutting forces, roundness and surface roughness. Low feed rates were found to produce the lowest surface roughness and cutting forces, while the spindle speed has limited influence on the results. The environment and type of tool were found to be significant only for the cutting force due to the interaction of these factors with the feed rate. Dry machining proved to be a suitable environment to conduct the experiments, reducing the cost of the process and the environmental impact.

1. **Introduction**

The aeronautic industry is one of the most important sectors of the world economy. Air transportation provides access to markets, developing commercial relations (Miller and Clarke, 2007) and facilitating the movement of people. Currently, the International Air Transport Association (IATA) includes nearly 260 airlines, which transported 3.5 billion passengers and 51 million tonnes of cargo in 2015 (Tyler, 2016). Aircraft have a substantial impact in terms of atmospheric emissions. They emit primarily CO_2, CO, H_2O, HC, NO_x and SO_x (Wasiuk *et al*., 2015). Although road transportation is the main cause of transportation-sector emissions, international aviation has shown a higher rate of increase (95%) from 1990 to 2014 than road transportation (69%) (OECD/IEA, 2016). In 2013, the transportation sector accounted for 23% of world CO_2 emissions (OECD/IEA, 2016), and petroleum consumption is expected to increase until 2030 (IEA, 2012).

Aeronautics is an industrial sector with a constant need to develop innovative solutions to reduce costs and diminish the drawbacks of flights, including emissions and noise. Thus, the reduction of fuel consumption is of great importance for aeronautical companies. To this end, strategies include eliminating unnecessary aircraft weight, using intelligent air traffic management procedures and providing better-performing flight procedures for aircraft (Turgut and Rosen, 2012). These changes are driven by internal motivations, *e.g*., efficiency and economic benefits, and by new policies and regulations (Hagmann *et al*., 2015). Currently, public sector bodies, such as the European Union, are encouraging these changes. For instance, the Flightpath 2050 report stated the following objectives for 2050: a 75% reduction in CO_2 per passenger kilometre, 90% reduction in NO_x emissions and 65% reduction in noise (M'Saoubi *et al*., 2015).

Aircraft manufacturing uses a wide range of materials and alloys, among them, carbon, ceramic and metal matrix composites, and aluminium, nickel, steel and titanium alloys (Ezugwu *et al*., 2003).