**Subject:** PhD at Mondragon University- Machining Laboratory, 3-4 years

**Starting date:** from June 2020.

**Title:** Knowledge based cutting for surface engineering of conventional and additive manufactured materials

**Summary:**
The study of the surface of machined parts has been always a goal for machined components as in many applications has certain characteristics to be accomplished (tribology, corrosion) or a component life will depend on it (fatigue). The surface integrity (SI) concept is usually defined as the inherent or enhanced condition of a surface produced in machining or in another surface operation. SI not only concerns the topological (geometric) aspects of surfaces, but also the whole assemblage of their physical, mechanical, metallurgical, chemical and biological properties and characteristics. In metallic materials, the set of surface properties included in the SI concept (roughness, state of residual stresses, surface hardness, microstructure, defects, etc) strongly influences the performance in-service (fatigue, corrosion resistance, tribology, etc) of the final component.
As a general rule, the surface condition generated in machining is considered to worsen material properties as compared to the base material, but this may not be the case if proper microstructures are generated in the machined surface layer using assisted machining or given machining working conditions. Moreover, it's well known that nanocrystalline microstructure can provide better strength or high-cycle fatigue resistance. While initially aspects related to stress resistance were attributed to certain roughness, now many other parameters are under consideration, particularly in critical parts made for automobiles and aircrafts. Fracture behaviour, fatigue life, tribology or corrosion resistance are considered in the design of finishing process for components on which transports safety is relevant. All this research has produced a large and consistent knowledge about the management of defects after processing. Until now, the main efforts for enhancing surface quality have been devoted to prevent material alteration during cutting. In this project we are making the next step in achieving the SI - we will control and use thermomechanical conditions at the tool/workpiece contact for generation of desired microstructure and thus desired mechanical properties of the final workpiece. To increase the knowhow about surface improvements/modifications, an extended experimental plan will be done, in which a general machining process will be approximated by an orthogonal cutting operation.
This will be attempted by multiscale experiments from in-situ micro-cutting in SEM to a macro scale orthogonal cutting cutting test bench where assisted machining techniques could be applied (hot machining, cryogenic machining). Multiscale simulation techniques will be further developed and utilised to reveal atomistic mechanisms involved in cutting, to give access to experimental variables not measurable experimentally and finally as a predictive tool for surface engineering. These approaches will be applied to a range of key materials such as steels for automotive industry (AISI 1045), aeronautical alloys (Inconel 718) and aluminium alloys (Al-7475), obtained through conventional routes (rolled, forged ) but as well by Additive Manufacturing (AM). Financiación: 50% MU-MGEP y 50% CIC Nanogune. http:// https://www.nanogune.eu/es. Nota: la tesis se desarrollará en inglés (documentación, presentación)

**Starting degree:** Master in Industrial Engineering (to be accredited in Spain)

**Lange:** English (if possible C1).