

## Research Topic 15 for the ParisTech/CSC PhD Program

FOR APPLICATION, PLEASE CONTACT ADVISOR(S) BY EMAIL WITH COPY TO:

[ali.siadat@ensam.eu](mailto:ali.siadat@ensam.eu) AND [yvon.velot@ensam.eu](mailto:yvon.velot@ensam.eu)

**Subfield:** *Mechanical Engineering*

**ParisTech School:** *SMI - Sciences des Métiers de l'Ingénieur*

**Title:** *Modelling residual stresses in milling operation using an efficient analytical-FE approach*

**Advisor(s):** *J. C. Outeiro, LaBoMaP, Arts et Metiers, Campus of Cluny.  
A. Moufki, LEM3, University of Lorraine, Metz.*

### **Short description of possible research topics for a PhD:**

*Machining residual stresses are caused by the non-uniform distribution of plastic deformation in the machined surface and subsurface. They play a critical role in the mechanical characteristics of machined components such as fatigue life and corrosion resistance [1]. Residual stresses can also cause part distortion after machining. Therefore, the relationship between the cutting process and the surface integrity has to be investigated deeply.*

*In the published literature, models are based on two approaches: (1) the semi-empirical modelling which requires several experimental data, (2) the Finite Element Method. However, it should be noted that FEM-based software are limited in terms of simulated times. Indeed, in most cases the simulations are limited to the orthogonal cutting and last few milliseconds which is not able to reproduce the heat diffusion process (this is a significant parameter for residual stress analysis) in the tool-workpiece system as in milling operations. In this work, residual stress will be investigated using both modeling and experimental study. For modelling, an existing hybrid Analytical-FE model [2, 3] will be extend to the residual stress calculation in milling operation. The purpose of this work is to develop a predictive model that significantly reduce the computational times when compared to the FE based models.*

### **Required background of the student:**

- *The candidate should have a knowledge of the finite element (FE) method, MATLAB programming language and continuum mechanics.*

### **A list of 5 (max.) representative publications of the group:** (Related to the research topic)

- [1] I.S. Jawahir, E. Brinksmeier, R. M'Saoubi, D.K. Aspinwall, J.C. Outeiro, D. Meyer, D. Umbrello, A.D. Jayal, "Surface Integrity in Material Removal Processes: Recent Advances", *CIRP Annals - Manufacturing Technology*, keynote paper, 60 (2), 2011, 603-626.
- [2] Y.Avevor, A. Moufki, M. Nouari, Analysis of the frictional heat partition in sticking-sliding contact for dry machining: an Analytical-Numerical modelling, *Procedia CIRP*, 58, 2017, 539 – 542.
- [3] A. Moufki, D. Dudzinski, G. Le Coz, Prediction of cutting forces from an analytical model of oblique cutting, application to peripheral milling of Ti-6Al-4V alloy, *International Journal of Advanced Manufacturing Technology*, 81 (1-4), 2015, 615-626.