

2023 CEMEF Internship

TITLE	Modelling of lubrication during aluminum rolling
Key-words	Strip rolling, Tribology, Mixed Lubrication Regime, programming
Global objective of work	Improve the understanding of the lubrication and the prediction of friction coefficient in aluminum rolling, through a comprehensive work of modelling, from the physical phenomena to advanced numerical simulations.
Context	Cold rolling of aluminum alloys is very dependent on friction and thus on lubrication. A multiphysics model of lubricated friction was developed in the 1990s. The internship aims at improving this first model from a physics point of view. It is focused on the existing software: it requires in-depth analysis of the physical phenomena in order to improve the program coding from speed and robustness points of view. This work program will be the basis of a PhD position starting in 2023.
Detailed presentation	The existing model couples several physical phenomena [1] : 1. Elastic-plastic strip deformation 2. Microplastic deformation of roughness 3. Formation and evolution of the lubricant film 4. Elastic roll deformation (2D plane) 5. Roll-strip coupled heat transfer (2D plane) The model thus includes a wide range of physical phenomena (non- linear solid mechanics, fluid mechanics, heat transfer, etc) intimately bound to one another. Therefore, once these phenomena have been understood and mastered, an efficient numerical coupling is a key step towards a high performance software. In the existing software, these couplings translate into nested loops (see figure 1 for a summarized resolution scheme). Certain equations are stiff ODEs, i.e. very sensitive to parameters and boundary conditions. The convergence process is therefore slow, and is not even assured in the most severe conditions of high stress and/or temperature gradients. The work program of the internship is an ambitious, two-face project: on the one hand, the understanding of the multi-physical phenomena, to be questioned and enriched from the physical point of view if needed ; on the other hand, the improvement of the numerical methods, e.g. spatial integration of ODE, or the management of transitions between sub-parts of the integration domain











Skills, abilities requested	Background in Materials Science, Physics and numerical methods. A taste for programming is necessary (software is written in Fortran 90). Rigor. Dedication to a project. Capacity for teamworking; oral and written reporting. English, level B2 minimum.
Location	Constellium C-TEC - Constellium Technology Center Parc Economique Centr'Alp, Voreppe, Isère (38) www.constellium.com Ecole des Mines de Paris, CEMEF, Sophia Antipolis, Alpes-Maritimes (06) https://www.cemef.minesparis.psl.eu/
Research team(s)	Constellium C-TEC : MAP (Modelling, Applications, Prototyping) MINES Paris-CEMEF : PSF (Processes, Surfaces, Fonctionnalities)
Supervisor(s)	Alexandre Barthelemy, R&D Engineer, Constellium 04 76 57 80 31 - alexandre.barthelemy@constellium.com Pierre Montmitonnet, Research Director, CNRS 04 93 95 74 14 – pierre.montmitonnet@minesparis.psl.eu Imène Lahouij, Assistant Professor MINES Paris 04 93 95 75 86 – imene.lahouij@minesparis.psl.eu

To apply : Your application can only be submitted online.

CEMEF has set up a form to be completed online: https://applyfor.cemef.mines-paristech.fr/internship/

