PhD Position: Optimization of deep-drawing processes through a better prediction of elastic spring-back for complex loading paths

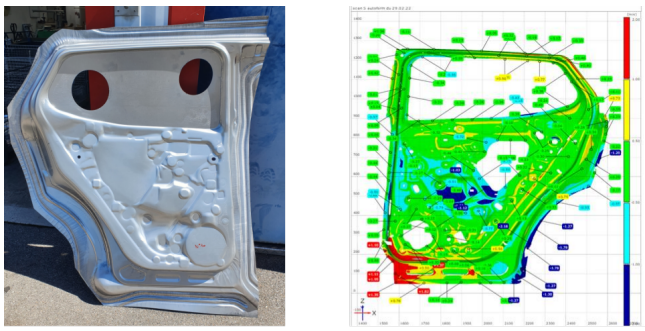
Context and goals of the PhD

Meeting European goals in terms of carbon emissions rises important challenges for the Automobile industry. Car must be lighter and therefore the use of lighter and/or thinner materials is fundamental. These metallic sheets often exhibit a strong anisotropic behavior and therefore it is always a challenge to design a forming process in order to fulfill the geometric and visual quality requirements of the parts.

Within this context, Renault, AutoForm and CEMEF have joined forces in order to propose an end-to-end predictive modeling tool that significantly speeds up the designing process of new parts. The key physical phenomenon that must be controlled concerns the material spring-back. Spring-back can be defined as the elastic deformation that is released once the part is removed from the tool. An example of the prediction of the spring-back phenomenon is shown in the figure below.
The elastoplastic behavior of the material is at the very heart of the problem and in order to accurately simulate the spring-back, different ingredients have to be combined:

- Identification of the material loading-path: A preliminary simulation of the existing process is required in order to precisely identify the loading path (often non-proportional) of the material.
- Material testing: Custom material testing should be designed in order to identify the mechanical behavior of the material at conditions close to the real thermo-mechanical conditions seen by the material during the manufacturing process.
- Material properties identification: The material properties used in the constitutive laws of the material should be identified by simulating the aforementioned custom experimental tests.

This project is at the cross-road between numerical modeling, experimental characterization and material parameter identification.



Final part (left) compared to the spring-back predicted by numerical simulation (right). Courtesy of Renault Group.

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It is important to highlight that the partners of this project represent all the chain of research and development since it goes from the research center (CEMEF), the finite elements Software editor (AutoForm) and the carmaker (Renault Group).

Keywords

Sheet metal forming – Anisotropic Plasticity – FE Method – Non-proportional experimental testing.

Candidate profile and skills

Degree: MSc or MTech in Computational mechanics, non-linear mechanics or related discipline, with excellent academic record. Considering the nature of the project, the candidate must be willing to also carry out advanced experimental work. Skills: Finite Element Method, continuum mechanics, proficiency in English, ability to work within a multi-disciplinary team.

Offer

The 3-year PhD will take place in CEMEF, an internationally-recognized research laboratory of Mines Paris located in Sophia-Antipolis, on the French Riviera. It offers a dynamic research environment, exhaustive training opportunities and a strong link with the industry. Annual gross salary: around 26k€. She/He will join the Computational Solid Mechanics (CSM) research team under the supervision of D. Pino Muñoz and P-O. Bouchard.

Industrial partners