

Research Topic for the Arts et Métiers ParisTech - CSC PhD Program

Subfield: Mechanical Engineering

ParisTech School: Arts et Métiers ParisTech

Title: Integrating reliability analysis in the simulation of sheet metal forming processes.

Advisor(s):

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Short description of possible research topics for a PhD:

Sheet metal parts have become widely used in various engineering areas, such as automotive and aeronautic industries, which explains the strong scientific interest in their forming processes. With the ever growing progress in computer science, numerical simulation of these processes has become very attractive and, in fact, necessary to overcome experimental issues. However, in spite of substantial progress in this direction, accurate modeling of actual sheet metal forming processes is still far from being achieved. Further research effort is needed to account for some key additional aspects, characterizing the actual forming process. One of these aspects, which is often disregarded in the analysis, is the inherent variability of the sheet metal mechanical properties. These mechanical and material properties are generally considered to be deterministic in the corresponding numerical simulations. However, due to several factors (e.g. presence of defects), their actual values are known to have a certain scatter around nominal ones. The present PhD thesis aims to study the effects of this variability aspect on the formability of sheet metals. First, a robust mechanical-reliability coupling between deterministic numerical approaches (e.g. Finite Element Method) and reliability methods (e.g. First and Second Order Reliability Methods) will be developed. This coupling will then be used to study the sensitivity of sheet metal formability to each material or process parameter. Finally, the most influential parameters will be considered in a reliability analysis for some appropriately selected case studies.

Required background of the student:

Computational mechanics, Reliability analysis, Sheet metal forming processes

A list of 5 (max.) representative publications of the group:

- [1] Bouktir, Y. and Chalal, H. and Haddad, M. and Abed-Meraim, F., *Investigation of ductility limits based on bifurcation theory coupled with continuum damage mechanics*, Materials & Design 90 (2016), pp. 969-978.
- [2] Ben Bettaieb, M. and Abed-Meraim, F., *Investigation of localized necking in substrate-supported metal layers: Comparison of bifurcation and imperfection analyses*, International Journal of Plasticity 65 (2015), pp. 168-190.
- [3] Akpama, H. K. and Ben Bettaieb, M. and Abed-Meraim, F., *A comparative study of Forming Limit Diagrams predicted by two different plasticity theories involving vertex effects*, Key Engineering Materials 651-653 (2015), pp. 21-26.
- [4] Mansouri, L. Z. and Chalal, H. and Abed-Meraim, F., *Ductility limit prediction using a GTN damage model coupled with localization bifurcation analysis*, Mechanics of Materials 76 (2014), pp. 64-92.
- [5] Abed-Meraim, F. and Peerlings, R. H. J. and Geers, M. G. D., *Bifurcation analysis versus maximum force criteria in formability limit assessment of stretched metal sheets*, International Journal of Applied Mechanics 6 (2014), pp. 1450064.

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