Computational strategy for machining simulation of large aeronautical aluminum parts

Katia Mocellin*, Pierrick Rambaud†

* MINES ParisTech, PSL Research University, CEMEF - Centre de mise en forme des matériaux, CNRS UMR 7635, CS 10207 rue Claude Daunesse 06904 Sophia Antipolis Cedex, France
Email: katia.mocellin@mines-paristech.fr
† Email: pierrick.rambaud@mines-paristech.fr

ABSTRACT

During machining operations, industrial workpiece can be deformed. These deformations can lead to non-conformity of the workpiece and thus a rejection of the workpiece in the final stage of manufacturing. The main mechanisms at work are residual stresses, generated during the thermo-mechanical history of the raw material and those induced by the tool action on the workpiece. Based on the framework of the software FORGÉ® [1], massive removal procedure and equilibrium computation are used to predict part deflection and non-conformities taking into account the first type of stress. The software is thus articulated in 3 main steps:

1. Identification of the removed material;
2. Cutting of the identified volume by removing the elements from the simulation;
3. Computation of the mechanical problem by using residual stresses maps to evaluate workpiece deformations.

The authors propose to improve the material removal procedure in order take into account the two phenomena. The main difficulty lies in producing an accurate mesh to handle the difference in magnitude of stress and affected depth in the material.

The solicitations require the development of new heterogeneous remeshing techniques to take into account the residual stresses induced by machining and reduce the computation time. Those modification need to be compatible with the massive material removal. This operation is realised by immersing the volume to be machined (called pockets) into the mesh using the topologic remesher FITZ [2]. Step 1 is then enriched with an automatic mesh fitting and local adaptation, step 3 is taking into account stress induced by machining. Those modifications have been integrated to the FORGÉ® solution in an automatic machining procedure to assist in the development of manufacturing sequences. This procedure is validated by comparing to experimental distortions of an academic workpiece.

FIGURE 1: (a) Vertical displacement after the machining of 10 pockets into an aluminium billet of raw aluminium (500x100x70 mm) simulated with (b) 10 processors

REFERENCES
