1st Esaform Mobility Grant: Modeling of Post Machining Distortions in Thin Walls Applied to Aluminum Parts compared to experimental results

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Abstract. Before machining, one of its final production step, workpiece have embedded residual stresses due to the manufacturing processes. On large and complex aluminium aeronautical parts, up to 90% of the raw material volume is removed by machining. During this operation, the mechanical equilibrium of the part is in constant evolution due to the redistribution of the initial stresses. This redistribution is the main cause for workpiece deflections during machining and for distortions - after unclamping -. Both may lead to non-conformity of the part regarding the geometrical and dimensional specifications and therefore to a rejection of the part or to additional conforming steps. In addition, the machining process itself adds residual stresses close to the surface of the part. For thin wall, those stresses can lead also to other distortion.

In order to improve the machining accuracy and the robustness of the process, the effect of the residual stresses has to be considered for the definition of the machining process plan.

In this study authors will use the software developed in CEMEF[1] based on a previous numerical[2] tool with enhanced remeshing and removal of material methods. It allows predicting deflections taking into account the residual stresses (induced by the heat treatment and the machining process), the fixture layout and the machining sequence. As a first application, results obtained by Madariaga & Al.[3] will be compared to the one obtained with this new approach.

Experimental set-up and measurements have been developed to machine a workpiece in controlled conditions. 3D deflections, initial and induced residual stress have been evaluated in order to be compared with the computational approach.

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Keywords: finite element, distortion, aluminum, distortion, Residual stresses
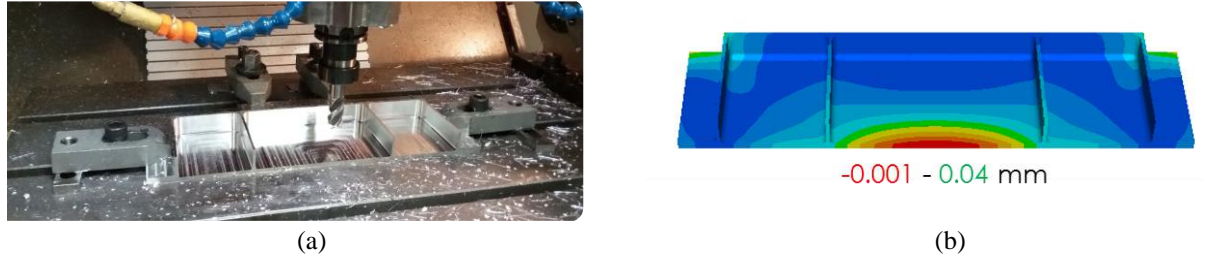
FIGURE 1. Description of the machined workpiece (a) after the machining of the finishing step and (b) result obtained for vertical displacement after unclamping for the same part with the software

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