Comparison of Design Approaches to Generate Tools for a Forming Process with a Six Degree of Freedom Press

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Abstract. This paper addresses tool design for multi-axial forming presses. These multi-axial forming tools are used for instance with Stewart platforms to mould in this case long fiber-reinforced thermoplastics (LFT) or glass mat thermoplastics (GMT) and induced material flow by tool motion path. The therefore used multi-axial forming tools differ from linear pressing tools, which are tightly defined by the workpiece geometry. These multi-axial tools also differ from incremental sheet forming tools, which have a universal shape and form the workpiece geometry by a complex tool motion path. The design of tools for multi-axial forming presses must take both the workpiece geometry and the tool motion path into account. The investigated tool designs are based on area-, line- and point-wise approaches to generate the shape of the tool from the workpiece geometry. In area-wise approach, the geometry is generated by moving the workpiece along an inverted tool path and shaping the surface of a generic tool with boolean operations. In line-wise approach, intersecting lines between workpiece and planes perpendicular to toolpath are transformed to a tool reference geometry generating a tool surface. In point-wise approach, the surface of the workpiece is tessellated and transformed to the tool surface by using reference layers depending on the tool motion path. All approaches are benchmarked by comparing the effort and the quality of the resulting tool surface. The tool surface quality is quantified by generating outputs, here a virtual workpiece, backward with the other two approaches and comparing the deviation of all outputs to the input, here the nominal workpiece. Finally, the tool design approaches, the results of the deviation between the virtual and the nominal workpiece geometry and the evaluation method are discussed.