A METROLOGY-BASED TECHNIQUE FOR AUTOMATED FIBRE PLACEMENT PROGRAMMING STRATEGY OPTIMISATION

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Dry fibre material has emerged as an alternative to pre-impregnated tapes for Automated Fibre Placement, promising higher conformability over steered paths and a more cost-effective manufacturing route. However, manufacturing components with complex geometries requires balancing conflicting requirements: minimum steering radius, maximum angle deviation and maximum tape gap width, see Figure 1.

Complex geometries often require steering to keep angle deviation and gap width of quasi-isotropic tapes at a required minimum. The optimisation process of curvilinear paths however, often does not take into account manufacturability [1]. It is current industrial practice to optimise the fibre paths based on nominal gap width, angle deviation and steering radii outputs of the programming software. However, since the software tool has a critical limitation in taking into account the material characteristics of the tape materials, a series of physical lay-up trials are carried out based on the programmed paths. The manufacturing quality of these paths are then judged by visual inspection and this highly subjective result is used for further program optimisation [2].

In this work, tapes were deposited on a complex geometry and the actual deposition quality was correlated with the result of the programming software tool. The actual path quality was measured utilising the surface topography of the preform captured by a laser line scanner, which was post processed in a commercial metrology software. This data was then compared directly with the quality prediction of the analysis tool provided by the AFP machine manufacturer, and the comparative results were used to understand the source of the deviations.

This work results in a database that guides the selection of the programming strategy based on preform quality instead on solely relying on nominal software output values. This will lead to less iterations between programming and deposition as well as enabling fine-tuning the programme software tool based on more realistic material behaviours. Enabling right-first-time programming for large composite structures will have a positive effect on wider adoption of Automated Fibre Placement.

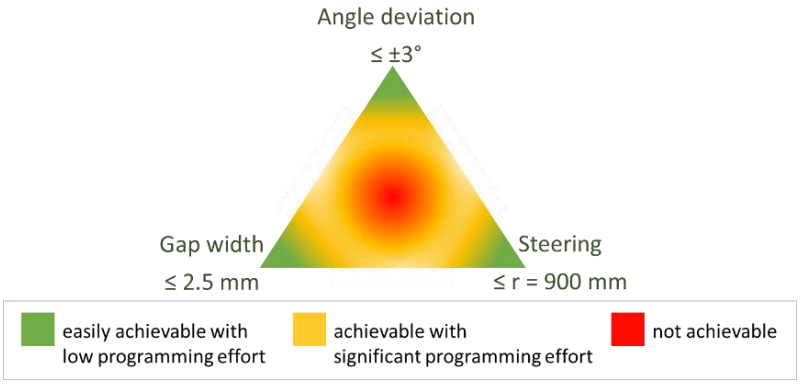

Figure 1: Contradicting requirements in the programming of AFP tape paths on complex parts

References

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