# *Distortion prediction in Fused Deposition Modelling: a case study using Finite Element Simulation*

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## *ABSTRACT*

Fused Deposition Modeling (FDM) is a 3D printing technology in which a thermoplastic material is extruded through a nozzle to build layer by layer the desired part. Within FDM technology, the filament is first heated to a semi-molten state and then extruded, while the nozzle moves following a predefined printing path.

During the printing process, the thermal energy of the thermoplastic polymer is dissipated through conduction (within and between the filaments) as well as convection and radiation (both between the filament and the external environment). The heating and the subsequent cooling phenomena, leading the semi-molten filament to re-assume a solid state, are characterized by high thermal gradients involving residual stresses that can induce part distortions, either during the printing process itself or after the component removal from the building plate. In this context, mechanical simulations aiming at predicting residual stresses and part deformation are attracting more and more interests from research institutions and industries.

Accordingly, in this study a simulation approach able to predict distortions of FDM components with non-trivial geometry and with reasonable computational times, is presented.

To this aim, a finite element scheme to simulate the FDM printing process is proposed. The simulation approach is based on an uncoupled thermo-mechanical analysis with sequential element activation. As a first step, a thermal analysis is used to evaluate the temperature field evolution during both the filament deposition process and the cooling, including conduction with previously deposited material, convection with the external environment and radiation. Subsequently, the results of the thermal analysis are used as forcing term in the structural one, where residual stresses and deformations are calculated. The importance of using temperature dependent parameters will be highlighted in this work.

The simulation results will be validated through a comparison with experimental test in terms of deformation; finally, the reversed deformed shape of the model will be used to print the component reducing the deviations from the original shape.

## *REFERENCES*

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