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Simulation for Additive Manufacturing 2017 Munich, Germany

Abstracts

11^{th}-13^{th} October, 2017

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Key Words: *AM process simulation, topology optimization, computation time*

Including detailed simulations of complex manufacturing processes in a design or optimization loop is gaining allot of attention, in particular with regard to additive manufacturing (AM). A key driving force behind AM is the geometric freedom granted to the designer, which enables innovative designs of high complexity. However, given (*i*) the high-energy input typically associated with AM processes, (*ii*) the multi-physics and multi-scale phenomena that need be accounted for, (*iii*) the necessity of support structures and subsequent machining steps and (*iv*) the complexity of the geometry itself; a human designer is no longer able to account for the sheer number and entanglement of design and manufacturing considerations. Therefore, in order to exploit the advantages of AM, large-scale structural optimization techniques—*i.e.*, topology optimization [1]—in combination with numerical process simulations, are required.

The feasibility of the automated avenue of design and manufacture, as outlined above, hinges first and foremost on the computational efficiency of the AM process simulation, and the associated design sensitivity computations. Moreover, AM process simulations in general follow the additive nature of the physical process itself, and therefore involve growing computational domains. In a finite element setting, new elements are added or activated in the FE model and the degrees of freedom increase in each time step of the process simulation. This aspect typically necessitates advanced computational implementations and has implications in terms of computational scalability of the simulation and, by implication, the optimization phase [3].

In this contribution, we consider options for reducing the computation– or wall-time of the AM process simulation part of the problem. The work is based on a layer-by-layer process model, with the energy input associated with the AM process simplified to thermomechanical loads [2]. Initially, geometric and material linearity is assumed, although the computational implications of including nonlinear phenomena and more complex loading conditions—including, for example, heat transfer simulations—are investigated as well.

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