Print-to-Perform: Additive Manufacturing Simulation as Essential Part of an End-to-End Workflow

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As more and more printing technologies, printable materials and processes emerge, the 3D printing or additive manufacturing industry and market continues to grow. Technological evolution has opened new possibilities, allowing for a shift from prototypes and demonstrators to high quality, fully functional end-use parts. In this process, simulation plays a vital role in enabling the engineer to assess the feasibility of a proposed design. From functional generative design to manufacturing planning to physics based, detailed simulations guide and assist during the development stages. Starting with creating optimal designs based on functional specifications, the designer can perform concept trade off studies and generate functionally validated final shapes. These designs are then completed with support structure strategies and part slicing, so that the part can be built. Before heading for the shop floor, the build process is simulated within a scalable simulation framework, ranging from melt-pool level physics for residual stresses and microstructures to part level distortions and validation of the part and support structures, thus covering a wide variety of processes and materials. This simulation solution serves to digitally accelerate the decision-making process and to meet product development needs for additive manufacturing.

Using full size industrial examples, the current presentation demonstrates how simulation can play an important role to support the engineering process to successfully create additively manufactured parts. Today, several different methods and technologies exist to simulate the build process of a part; all with their advantages and costs. Topology optimization is commonly using a traditional simulation approach, AM print simulation for the design phase is using an eigenstrain based approach and for a high fidelity print simulation a thermo-mechanical simulation approach is needed. The presentation will consider different approaches and their applications to assess the build process and show how and where these techniques fit into the development process. It is demonstrated how such a combination of numerical techniques can help to avoid costly trial and error design by eliminating infeasible design solutions well before starting the printer.