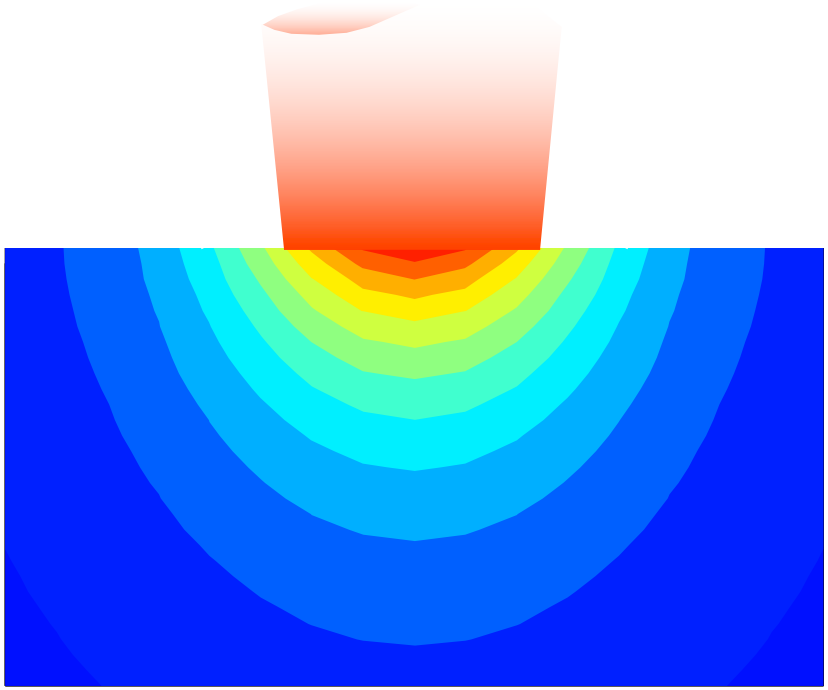
Carnegie Mellon University and Applied Optimization, Inc.

selected for awards under the

Modelling Challenge for Additive Manufacturing

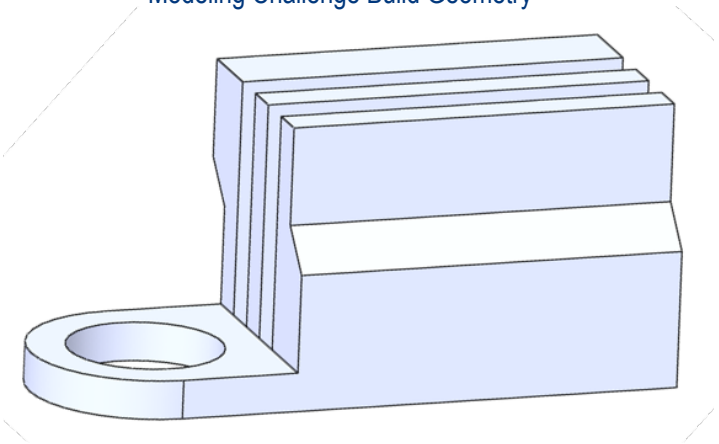


The Modeling Challenge

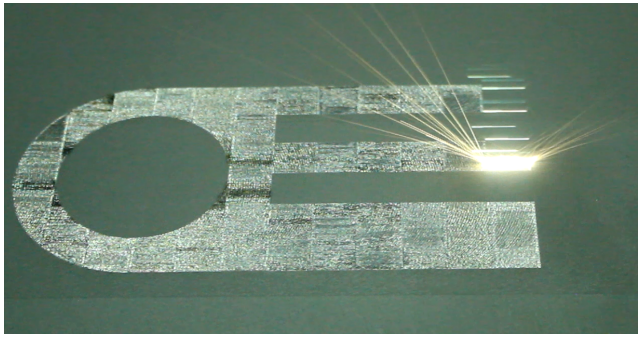
Under sponsorship of America Makes and the Defense Advanced Research Projects Agency (DARPA), the Center for Innovative Materials Processing through Direct Digital Deposition (CIMP-3D) at the Pennsylvania State University recently conducted a **Modeling Challenge for Additive Manufacturing**. The objective of the challenge was to identify the current accuracy of computational models for simulating the thermal and microstructural response of a material during the additive manufacturing process, with the ultimate goal of utilizing these tools as a means for accelerating the qualification of the additive manufacturing for critical applications.

The Challenge involved simulating the thermal and microstructural response of a relatively complex "build" using the powder bed fusion process and Inconel 718™ alloy. Ideally, this information would also be utilized to anticipate simple mechanical properties representing the build material, as well. Detailed process information, in the form of a Simulation Package, was provided to prospective modeling groups, and experimental data generated at CIMP-3D was used for direct comparison to the submitted simulation results. Modelers were provided eight weeks to submit their results, and the results of the simulations were judged on the ability to accurately describe the thermal, microstructural, and mechanical property responses of the material during processing, which were weighted at 50%, 30%, and 20%, respectively. Fourteen organizations requested the Simulation Package, and four organizations provided complete simulation results.

Modeling Challenge Build Geometry



Photograph of Process During Build



The Modeling Challenge Award Winners

Based on comparisons between the experimental data and the submitted simulation results, the team representing **Carnegie Mellon University** was awarded the highest ranking, followed by a team lead by **Applied Optimization, Inc.**

The Carnegie Mellon University team was comprised of: Professor Shi-Chune Yao of the Mechanical Engineering Department, Professor Anthony Rollett of the Materials Science & Engineering Department, Professor P. Chris Pistorius of the Materials Science & Engineering Department, and Mr. Patcharapit Promoppatum of the Mechanical Engineering Department.

The Applied Optimization team consisted of Dr. Anil Chaudhary of Applied Optimization and Dr. Suresh Babu of the University of Tennessee, Knoxville. The collaboration between Applied Optimization and the University of Tennessee was made possible through an NASA STTR program.

The two awardees were able to fairly accurately represent the complex motion of the heat source associated with the build, while providing thermal data that reasonably agreed with experimental results. The thermal data enabled the teams to ascertain the operable transformations associated with the nickel-based alloy and approximate the resultant microstructures. A technical publication of the results from the Modeling Challenge, along with experimental data, is being planned.