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CRADA/NFE-20-08285

# Validating Thermal Compensated Deposition using Computed Aided Manufacturing Software


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**CRADA FINAL REPORT**
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Manufacturing Science Division
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# *Validating Thermal Compensated Deposition using Computed Aided ManufacturingSoftware*

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**CONTENTS**

**LIST OF FIGURES**

## ACKNOWLEDGEMENTS

This CRADA NFE-20-08285 was conducted as a Technical Collaboration project within the Oak Ridge National Laboratory (ORNL) Manufacturing Demonstration Facility (MDF) sponsored by the US Department of Energy Advanced Manufacturing Office (CPS Agreement Number 24761). Opportunities for MDF technical collaborations are listed in the announcement "Manufacturing Demonstration Facility Technology Collaborations for US Manufacturers in Advanced Manufacturing and Materials Technologies" posted at http://web.ornl.gov/sci/manufacturing/docs/FBO-ORNL-MDF-2013-2.pdf. The goal of technical collaborations is to engage industry partners to participate in short-term, collaborative projects within the Manufacturing Demonstration Facility (MDF) to assess applicability and of new energy efficient manufacturing technologies. Research sponsored by the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Advanced Manufacturing Office, under contract DE-AC05-00OR22725 with UT-Battelle, LLC.

## ABSTRACT

DP Technology Corporation's flagship product, ESPRIT, is a highly adaptable computer-aided manufacturing system that's used across industries and continents to create nearly anything. ESPRIT is used to generate toolpath trajectories for traditional subtractive and additive manufacturing (AM) cycles. DP Technology and Oak Ridge National Laboratory have partnered together to improve the generated additive toolpath by means of API simulation. The potential impact of this research is the enhancement of toolpath planning for additive and hybrid manufacturing. Being able to simulate and compensate for various effects such as overheating, and distortion are critical components for the industrial adoption of hybrid manufacturing processes. Industrial applications include the mold & die, automotive, and aerospace industries


# 1. VALIDATING THERMAL COMPENSATED DEPOSITION USING COMPUTED AIDED MANUFACTURING SOFTWARE

This phase 1 technical collaboration project (MDF-TC-2021-08285) began on August 3, 2020 and concluded on March 1, 2021. The collaboration partner DP Technology is a small business. Due to DP Technology being acquired by Hexagon, the project was terminated during Phase I activities.

## 1.1 BACKGROUND

DP Technology's ESPRIT CAM software is sold globally for many types of machining applications. Recently, DP Technology created an Additive Manufacturing department to incorporate several additive technologies, including Direct Energy Deposition and Powder Bed Fusion, into ESPRIT.

DP Technology works closely with universities and research facilities to ensure ESPRIT offers the latest CAM features to its end-users, including additive manufacturing. In phase I, ORNL would evaluate the current capabilities of ESPRIT and assess the framework provided by the API for the implementation of simulation in toolpath generation.

This collaboration will help DP Technology to enhance Direct Energy Deposition cycles by validating and improving the toolpath trajectory as outlined in the project plan that will lay the foundation for a phase II collaboration to fully develop a simulation in the ESPRIT API. DP technology wants to improve ESPRIT software by integrating the result of this project research to provide better toolpaths that results in better additively manufactured components.

## 1.2 TECHNICAL RESULTS

All the time spent working with ESPRIT was been focused on training. DP Technology first hosted a weeklong training entitled "ESPRIT Basic Mill Turn Class", including lessons such as "ESPRIT Interface," "Introduction to Programming," "3-Axis Milling on Multiple Fixtures," and "Rotary Milling." By the end of this training, Oak Ridge National Laboratory (ORNL) staff members were comfortable navigating the software and had practiced programming several parts ranging in complexity from a simple flat component with 3-axis milled features to a mill-turn component utilizing two spindles and two turrets.

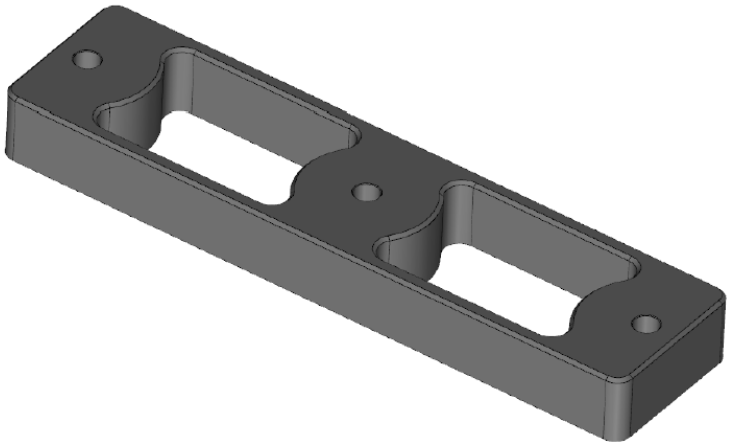

**Figure 1: 3-Axis Milled Component**

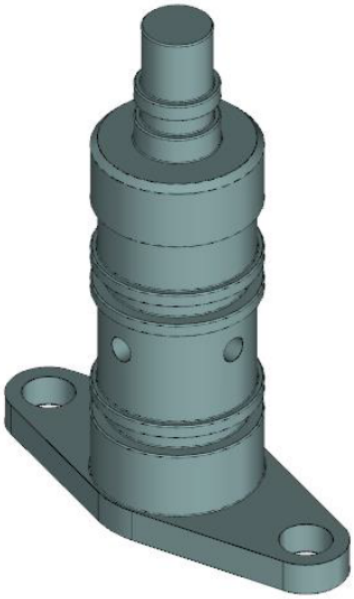

**Figure 2: Mill-turn Component**

ORNL employees were then offered the more specialized additive training on the ESPRIT software. This two-day training built on the knowledge from the basic mill-turn class to cover the additive capabilities of ESPRIT, which were not covered in the basic training. Several geometries were selected as examples for this training to cover all these capabilities, including Flat Deposition, Wrap Deposition, Fillet Deposition, and Auto Tool Inclination. The training also included the integration of additive and subtractive features, so the full process of importing a geometry, additively manufacturing the near net shape of that geometry, and post processing the additive component via machining was covered.

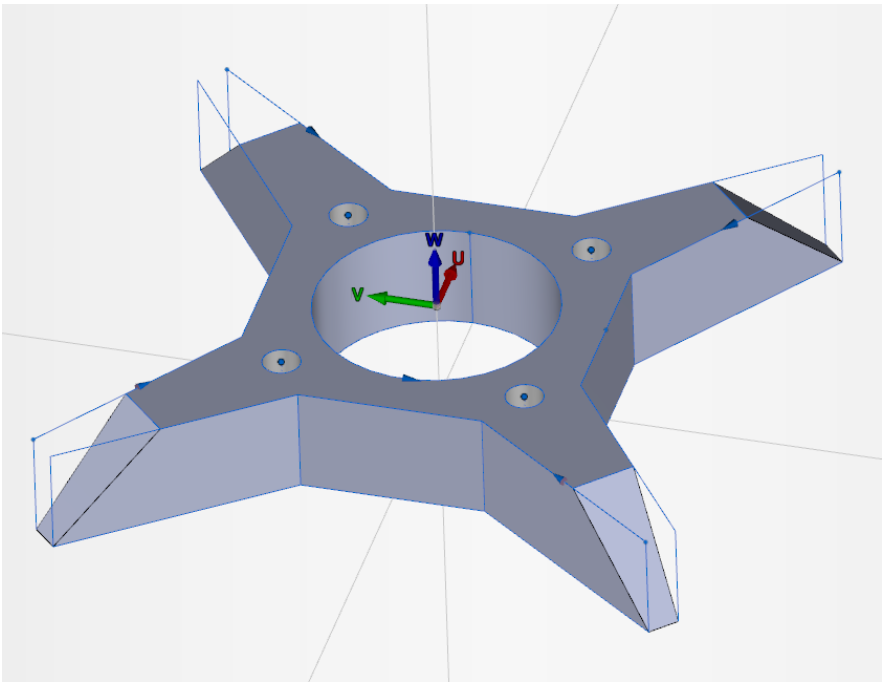


**Figure 3: Flat Deposition Component**

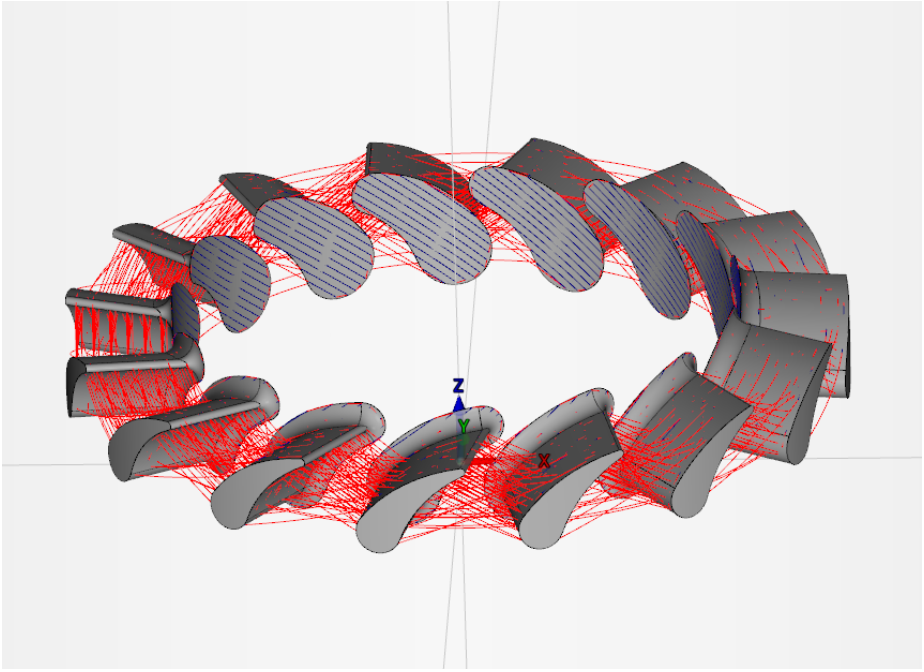


**Figure 4: Fillet Deposition Component**

## 1.3 IMPACTS

Due to this collaboration being cut short due to DP Technology being acquired by Hexagon, there was little to no impact seen. However, if this project is to continue, it has the potential for cost savings, increased performance of directed energy deposition processes, new processes and materials, and reduced GHG emissions.

## 1.4 CONCLUSIONS

Upon the termination of this collaboration, ORNL engineers have been trained to use the ESPRIT software for both additive and subtractive operations. Now that the engineers are trained, next steps in the next collaboration would be to begin the experimental tests outlined.

# 2. PARTNER BACKGROUND

DP Technology Corporation's flagship product, ESPRIT, is a highly adaptable computer-aided manufacturing system that's used across industries and continents to create nearly anything – but especially complex parts. It's not just about software, though. DP Technology's robust technical support offers users a true long-term partnership and ensures they're getting the most out of ESPRIT.

DP Technology's clients are mom-and-pop machine shops, multinational aerospace corporations, and everyone in between. They benefit from their innovative solutions and world-class support services.

Established in 1982 by industry veterans Dan Frayssinet and Paul Ricard, DP Technology has grown to approximately 280 employees in 21 offices across three continents.