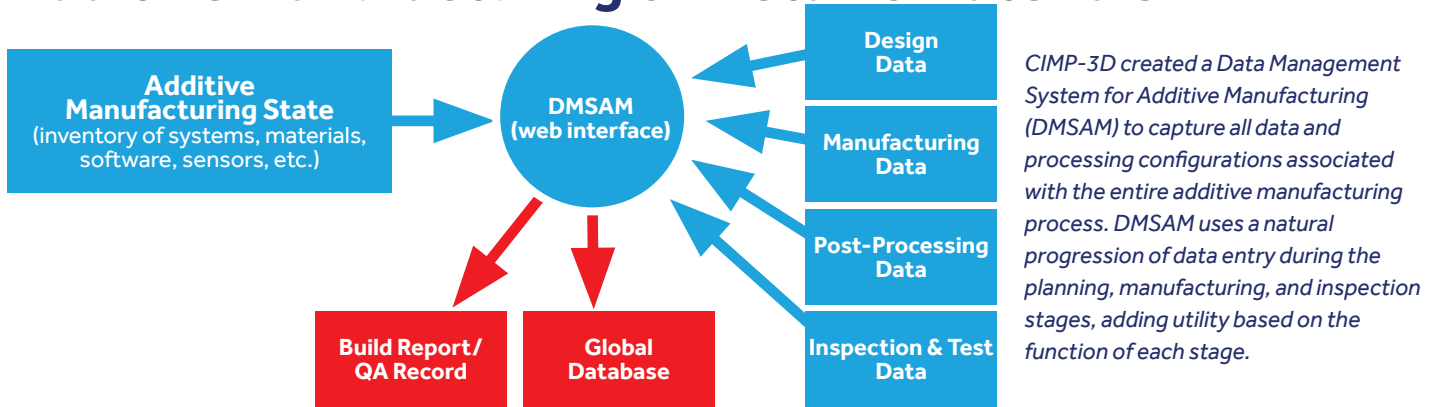


SUCCESS STORY

Support of America Makes Mission - Center for Innovative Materials Processing through Direct Digital Deposition (CIMP-3D)

Spurring Implementation of Additive Manufacturing of Metallic Materials



CIMP-3D created a Data Management System for Additive Manufacturing (DMSAM) to capture all data and processing configurations associated with the entire additive manufacturing process. DMSAM uses a natural progression of data entry during the planning, manufacturing, and inspection stages, adding utility based on the function of each stage.

PROBLEM

Additive manufacturing (AM) offers significant potential for improving the competitiveness of U.S. manufacturing through improved product design and performance, decreased manufacturing cost, and reduced lead time. There are, however, substantial challenges for implementation of AM when applied to metallic materials requiring a high degree of reliability. Manufacturing critical components in this environment requires a high level of process understanding to ensure consistency. A means to qualify the process for various applications and the ability to access and manage process data for quality assurance purposes are also important prerequisites. Other supporting actions include the ability to demonstrate the technology, especially to small and medium-size enterprises (SMEs), increased employment of simulation technology, and a greater physical understanding of the process.

OBJECTIVE

The objectives of this project were to bridge the gap between applied research and mature product development, to provide shared assets for the nation's industrial base, to further the adoption of AM technology, and to develop a rich environment for the education and training of technologists.

By providing key demonstrations, developing tools, and investigating AM methods, CIMP-3D aimed to increase the acceptance of AM as a viable manufacturing process, expanding opportunity and developing the AM supply chain.

TECHNICAL APPROACH

CIMP-3D conducted tasks with the focus on spurring implementation of AM technology of metallic materials. America Makes, the Defense Advanced Research Projects Agency (DARPA), and CIMP-3D developed several tasks to:

- Support the exploration of CIMP-3D as a potential spoke to the America Makes Innovation Factory Hub
- Create process, product, and technology demonstrations for the Department of Defense
- Develop AM data management and analysis methods
- Conduct outreach and engagement of SMEs in AM
- Support America Makes training and outreach activities
- Develop assessment and evaluation of methods for accelerating qualification of AM
- Sponsor a Modeling Challenge for AM



**AMERICA MAKES
TECHNOLOGY
DEVELOPMENT
ROADMAP**

This project aligns to:



VALUE CHAIN

**ASTM
PROCESS CATEGORY:**
Directed Energy
Deposition (DED)
Powder Bed Fusion

MATERIAL:
Titanium,
Inconel

ACCOMPLISHMENTS

The activities conducted under this program have broad technology transition implications. The local data management system, available to America Makes membership in March 2017, enabled small to large companies to supply documentation of processing conditions for AM. The acceptance and use of this system provides real-life data on AM parameters used at a company as an active, ever-growing database dedicated to simplifying the selection and use of machine specific parameters in Laser-Based Powder Bed Fusion (LB-PBF), Laser-Based Directed Energy Deposition (LB-DED), and Polymer Fused Deposition Modeling (FDM); tracking inventory for materials, system, post-processing requirements; providing a generic (XML) format for data exchange; and automatically generating build reports to document the complete AM process for parts.

The SME Challenge directly supported the application and adoption of AM for small companies with five SMEs participating in this project. This Challenge focused on concepts that use AM for improving a current product or developing a new product for these SMEs. The five selected companies received a stipend and access to the CIMP-3D & America Makes facilities and research personnel where they were able to validate, demonstrate, and showcase their AM-processed ideas.

Roadmap workshops guided the development of technology applicable to industry while technology exchanges were used to drive consensus, such as with qualification and standards, for the expanded adoption of AM technology.

The Modeling Challenge, supported by 3DSim, Applied Optimization, Carnegie Mellon University (CMU), and the University of Tennessee, Knoxville, provided validation of commercial codes. The challenge consisted of an integrated modeling approach with coupled thermal-mechanical modeling of the AM build process on a particular part to develop the thermal history and stress state; the microstructural evolution during deposition build and post-processing; and prediction of the mechanical properties and characteristics of the material. A total of fifteen organizations participated in this project.

Additionally, several tasks under this program supported training and education of the workforce in AM. This included co-hosting with America Makes in the National Forum on Additive Manufacturing Education and Training at University Park, Pa in October 2016; actively engaging in the America Makes Workforce and Education Outreach Working Group and assisting in their roadmapping efforts; supporting undergraduate students during execution of various tasks of the program and during a formalized summer internship; and expanding the outreach of America Makes to industry by conducting Roadmapping Workshops and Technology Exchanges.

PROJECT END DATE

March 2017

DELIVERABLES

- Process schemas for three AM processes for metallic materials and polymer materials, including the database structure for accepting data from the process and property schemas
- Report on the five SMEs engaged in the SME Challenge
- Report on the planning, discussions, and execution of five Roadmapping Workshops and two Technology Exchanges
- Report on the process and material performance within America Makes projects and recommendations for augmenting knowledge and/or validation
- Report on the Modeling Challenge, including the validation data generated and complete data sets

All downloadable deliverables are available to members of America Makes via the Digital Storefront.

FUNDING

\$2.3M total project budget

PROJECT PARTICIPANTS

Project Principal:

Penn State University – Applied Research Laboratory CIMP-3D

Public Participants:

U.S. Department of Defense
Defense Advanced Research Projects Agency

4038 Support of AM Mission – Center for Innovative Materials Processing through Direct Digital Deposition (CIMP-3D)

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