Reducing "Time to First Good AM Part" Through In-Situ Sensor Driven NDE

DART SLM powder cell at UDRI (left) and in-situ sensors installed on UDRI's DART SLM (right).

PROBLEM

Currently metal additive manufacturing (AM) is being utilized as an iterative trial-and-error printing process that requires time consuming post-inspection steps to inform each design/build iteration. In addition, components in aircraft and weapons systems operate under very demanding conditions, requiring stringent quality assurance procedures to detect and locate non-conformances that might compromise flight safety. Costly nondestructive evaluation (NDE) is required to identify these non-conformances. This project seeks to illuminate and enable a more focused NDE to reduce time/cost and eventually enable detection of data anomalies in-situ that can lead to identification of critical end part nonconformances.

OBJECTIVE

The objective of this project is to reduce the time and associated costs of obtaining the first good metal AM part. By correlating in-situ data to ground truth NDE data, the project aims to identify regions of interest or "points of concern" for a targeted/streamlined NDE approach. The goal is to demonstrate how in-situ laser powder bed fusion (LPBF) sensors coupled with effective data management/correlation can enable machine learning algorithms to identify part regions and resolution needed for inspection.

AMERICA MAKES TECHNOLOGY DEVELOPMENT ROADMAP

This project aligns to:

VALUE CHAIN

ASTM PROCESS CATEGORY	EQUIPMENT	MATERIAL
Powder Bed Fusion,	UDRI DART SLM Machine	AlSi10Mg

TECHNICAL APPROACH

The University of Dayton Research Institute (UDRI) is leading the program team which includes Northrup Grumman Corporation (NGC), ZEISS, Open Additive, and Macy Consulting. UDRI's DART selective laser melting (SLM) system with its open architecture 3D printing platform allows researchers to customize the printer's use of materials and monitor printing progress using a variety of sophisticated sensors.

NGC is providing a representative design of an aluminum heat exchanger that has been modified for AM fabrication. UDRI is printing the NGC identified heat exchanger parts utilizing their DART SLM machines. ZEISS is performing multi-resolution X-ray computed tomography (CT) on each correlation build. Upon finding the non-conformances in post inspection, the CT data can be used to correlate end part nonconformances to in-process anomalies. The technology demonstration plans to showcase how costly post inspection time can be limited by utilizing in-situ data to determine points of concern for inspection.

PROJECT START/END DATE

November 2020 - May 2021

EXPECTED DELIVERABLES

- Part CAD, past print history, and non-conformance criteria
- In-situ sensor data
- Flagged data anomalies
- Low resolution CT of all printed parts
- High resolution CT of selected regions
- Flagged non-conformances
- Correlation of in-situ flagged anomalies to NDE identified non-conformances
- Algorithmic determination of regions of interest for "point of concern" NDE inspection
- High resolution CT of MVP print in algorithmically defined "points of concern"
- Evaluation of the time savings and detection accuracy of this approach
- Final report

FUNDING

$255K total project budget
($170K public funding/$85K private funding)

PROJECT PARTICIPANTS

Project Principal:
University of Dayton Research Insititute (UDRI)

Other Project Participants:
Northrop Grumman Corporation
Zeiss
Open Additive
Macy Consulting

Public Participants:
U.S. Department of Defense

NCDMM Blairsville
Headquarters
486 Cornell Road
Blairsville, PA 15717
Phone: (724) 539-8811
NCDMM.org

NCDMM Chambersburg
Letterkenny Offices
4755 Innovation Way
Chambersburg, PA 17201
Phone: (717) 553-0068

NCDMM Youngstown
America Makes Offices
236 West Boardman Street
Youngstown, OH 44503
Phone: (330) 622-4299
AmericaMakes.us

NCDMM Huntsville
7027 Old Madison Pike, NW
Suite 108
Huntsville, AL 35806
Phone: (256) 929-6299