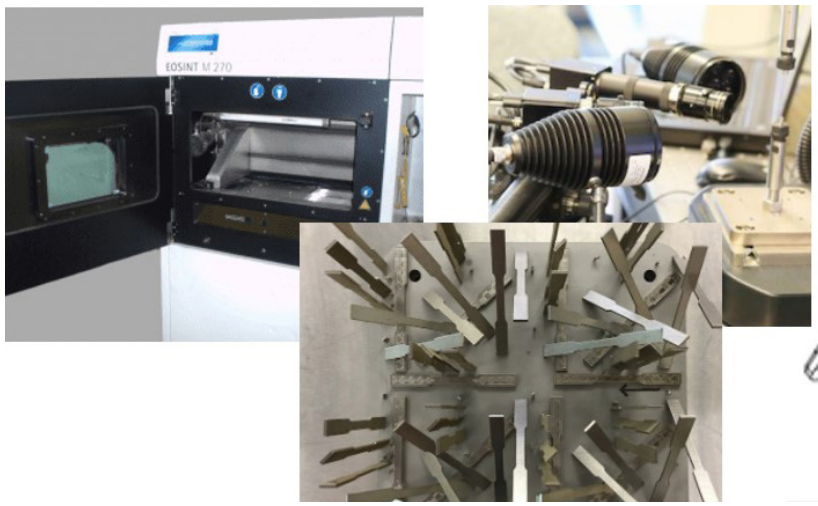
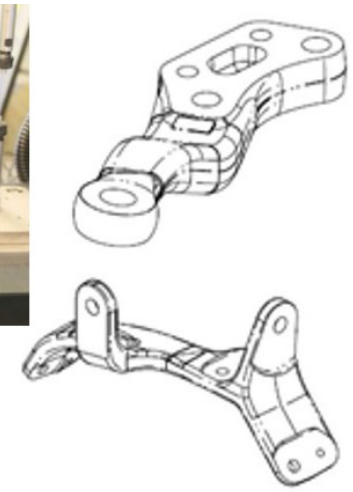
PROJECT SUMMARY 5514.001

Data Driven Qualification for Additive Manufacturing

This project seeks to enable robust (and potentially specific tool independent) data-driven qualification of AM parts using process monitoring and metallurgical insight.





This project involves comparing test specimens from multiple machines and multiple locations, as well as optimizing the geometry of some "real world" parts for additive manufacturing.

PROBLEM

A major limiting factor for the adoption of additively manufactured (AM) parts into structural applications is the challenge of qualification. The range of equipment suppliers that use their own proprietary feedstock formulations makes each AM system unique and thus subject to its own qualification protocol—even the same system model in a different location. This highlights the need for a qualification process that is dependent on material science rather than on individual manufacturing parameters.

OBJECTIVE

This project is developing a data-driven qualification process that allows relationships across instruments, platforms, suppliers, and even alloy systems to be inferred using intelligent machine learning algorithms informed by underlying physics-based modeling. This allows predictions to be made across AM systems which can reduce the amount of data needed to qualify a new machine and certify a new part, greatly speeding the adoption of AM parts into military vehicles without sacrificing the quality and reliability that drive the need for qualification. The goal is to enable qualification of AM parts with significantly reduced testing across various tools, vendors, and feedstocks by directly incorporating awareness of manufacturing issues such as melt pool scaling, powder reuse, and local thermal environment during a build.

AMERICA MAKES TECHNOLOGY DEVELOPMENT ROADMAP

This project aligns to: MATERIAL

ASTM PROCESS CATEGORY
Powder Bed Fusion, Directed Energy Deposition

EQUIPMENT
3D Systems DMP Flex 350, EOS M270, custom-built DED & PBF systems

MATERIAL
316L, 7000-series Al Alloys

TECHNICAL APPROACH

Working closely with collaborators at US Army Combat Capabilities Development Command (CCDC) Ground Vehicle Systems Center (GVSC), the Alliance for the Development of Additive Processing Technologies (ADAPT) Data-Driven Qualification for Additive Manufacturing (DDQ-AM) team at Colorado School of Mines is establishing baseline process-property data for select demonstration parts using laser powder bed fusion and laying the groundwork for a multi-year vision to develop a physics-based, data-driven approach to enable qualification of AM parts across multiple manufacturing platforms and feedstocks. Combining expansive process monitoring with extensive microstructural analysis and measured properties, the team is building an intelligent machine learning framework informed by underlying physical metallurgical principles to enable accurate prediction of printed part performance in conjunction with process monitoring data based on minimal input information.

PROJECT START DATE

December 2020

EXPECTED END DATE

June 2022

DELIVERABLES

- Economic impact estimates
- FEA optimization of candidate part
- Additive fabrication of candidate part
- Flow diagram for AM part qualification
- Detailed plan for in-situ monitoring and control necessary for qualification
- Preliminary reports on feedstock, defect formation, effect on material, and impacts on qualification
- Coupon testing and analysis summary reports
- Machine learning framework for baseline material
- Draft plan for transferring approach to other feedstocks and machines
- Demonstration of cyberphysical security approach

FUNDING

$2.5M total project budget

PROJECT PARTICIPANTS

Project Principal:
Colorado School of Mines

Other Project Participants:
Army Ground Vehicle Service Center
Colorado State University
University of Pittsburgh

Public Participants:
U.S. Department of Defense