National Aeronautics and Space Administration

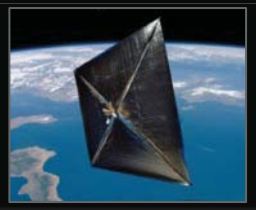
Marshall Space Flight Center

Additive Mfg for Propulsion Systems at MSFC: A Path to Flight

JANNAF: Additive Manufacturing for Propulsion Applications

03 September 2014



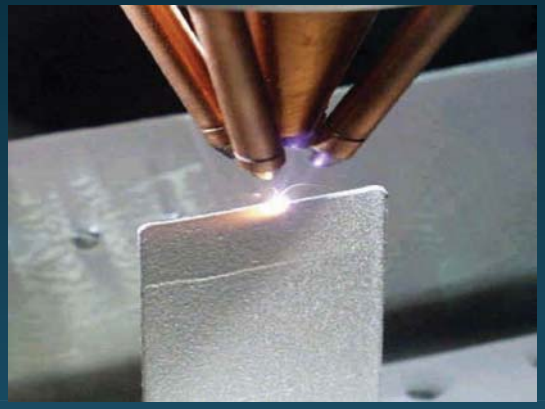



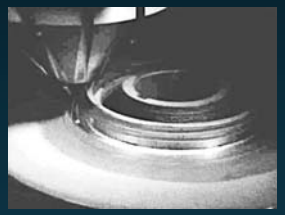
marshall

Kristin Morgan
Strategic Advisor

Additive Manufacturing at MSFC

20+Years of Experience





1991

2000

2010

Additive Manufacturing at MSFC

Near-Term

For Space

Long-Term

In-Space

Why Additive Manufacturing?

Affordability

Reduced part count
Fewer critical welds and brazes
Reduced tooling
Schedule and cost savings

Why Additive Manufacturing?

Performance

Optimized internal flow passages
Minimized leak paths
Lower mass

MSFC's Additive Manufacturing Laboratory

Recent AM Tests and Builds

MSFC's Role

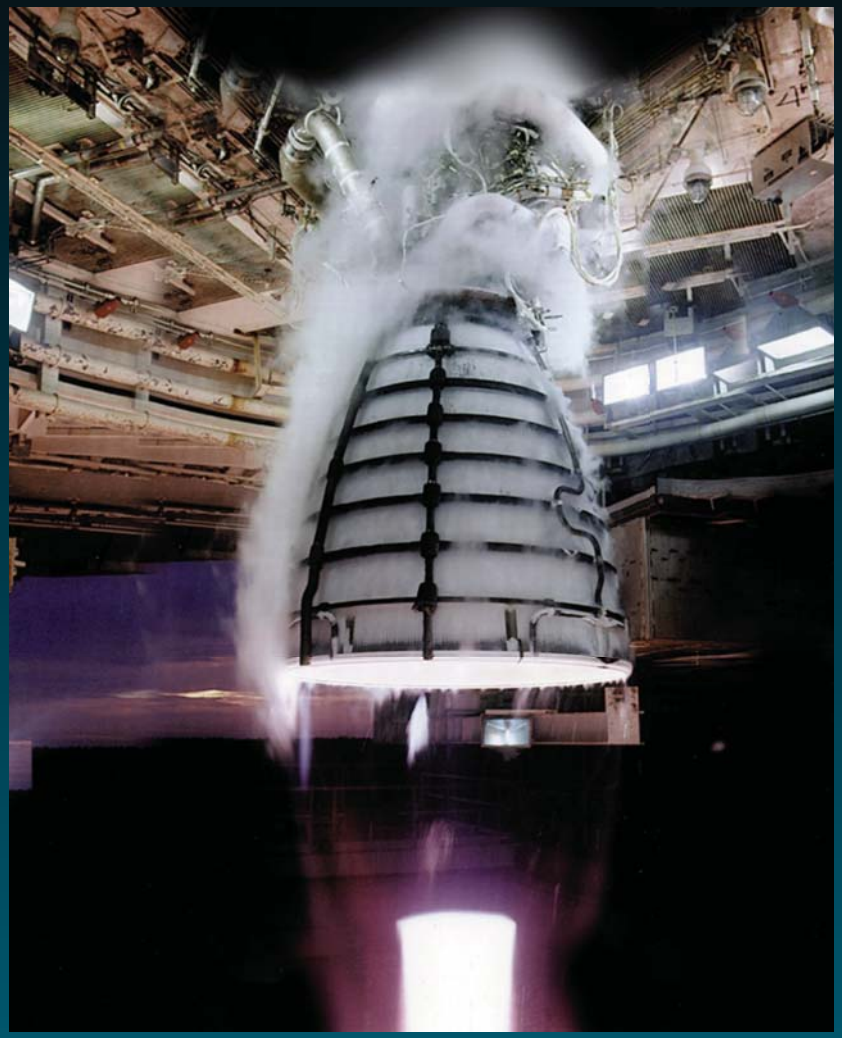


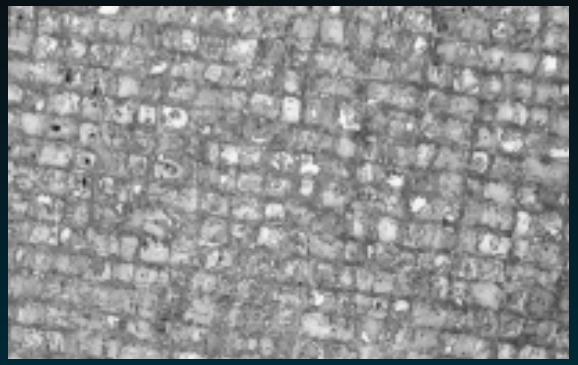
Image Credit: Aerojet Rocketdyne

Smart Buyer

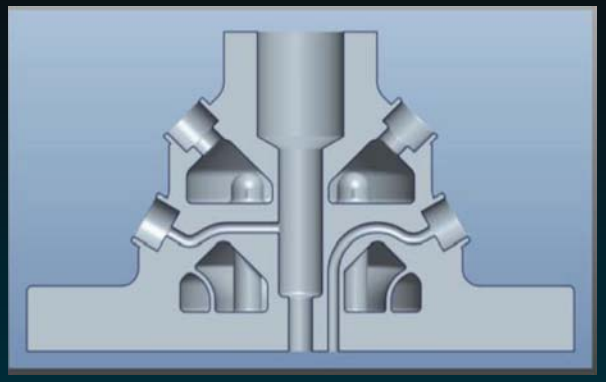
Tech Transfer

Anomaly Resolution

Primary Challenges in AM

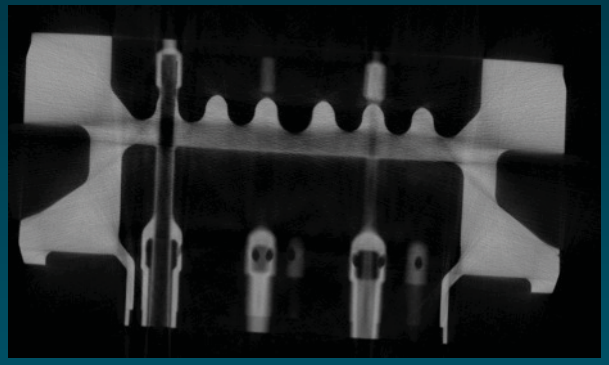


Materials Characterization



Standard Design Practices

Process Modeling, Monitoring, & Control



Flight Certification

MSFC's Goals in AM

Path to Flight

Establish flight certification logic

Near-term

- Interim MSFC guidelines and specifications for AM materials, processes, and design
- Provide recommendations to vendors and standard holders on allowable practices & specification limits.

Long-term

- Incorporate AM materials and processes into existing NASA standards.

MSFC Tasks and Objectives

Materials Characterization

1. Build Parameters
2. Powder Influence
3. Thermal Processing
4. Surface Improvement Effects
5. Applied Materials Characterization

MAPTIS Database

MSFC Tasks and Objectives

Design Practices

1. Optimized mechanical design
2. Compressed development cycles
3. Build strategies

Design Guidelines HDBK

MSFC Tasks and Objectives

Process Modeling, Monitoring & Control

- Collaboration with government, industry, and academia
- Modeling with MGI, Ames, and CIMJSEA
- Monitoring with University of Alabama

MSFC Tasks and Objectives

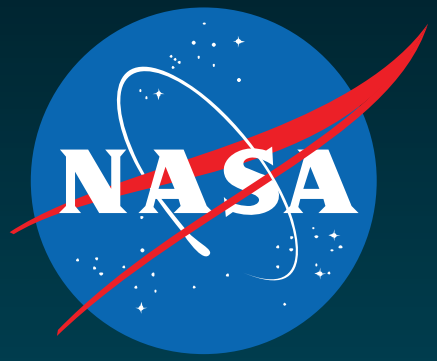
Flight Certification

1. Part Classifications
2. Part performance qualification
3. Governing process controls
4. NDE requirements
5. Lot acceptance requirements
6. Fracture control requirements
7. Machine and Operator cert and re-cert

MSFC Interim Spec

In Summary

- Additive Manufacturing offers tremendous promise for the rocket propulsion community.
- The ability to create customized, complex geometries on-demand is a dramatic shift in the design and manufacture of high-performance propulsion systems.
- Foundational work must be performed to ensure the safe performance of AM parts.
- Government, industry, and academia must collaborate for the characterization, design, modeling, and process control to accelerate the certification of AM parts for human-rated flight.



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