High Temperature Additive Architectures for 65% Efficiency DE-FE0031611

Joe Weber, GE Power
Lyndsay Kibler, GE Power

UTSR Project Review Meeting
Daytona Beach, FL
November 1, 2018

This material is based upon work supported by the Department of Energy under Award Number **DE-FE0031611**

Agenda

- Impact of Additive at GE
- Industrial Gas Turbine Terminology
- Turbine Vane Conventional Cooling Fundamentals
- Program Objectives
- Additive Modalities
- Next Steps

Impact of Additive at GE

Performance
- Removes traditional mfg. constraints
- Enables “near surface” cooling

Speed to Market
- Model to part directly
- ~18 month cycle

Cost
- Eliminate casting tooling
- Metal only where needed

Improving state-of-the-art

Processing sciences

Alloys

Design

Advanced Manufacturing Works - Greenville

Merging design and manufacturing technology to deliver better products

Additive

- >10,000 parts shipped
- 1st GT parts produced/fielded

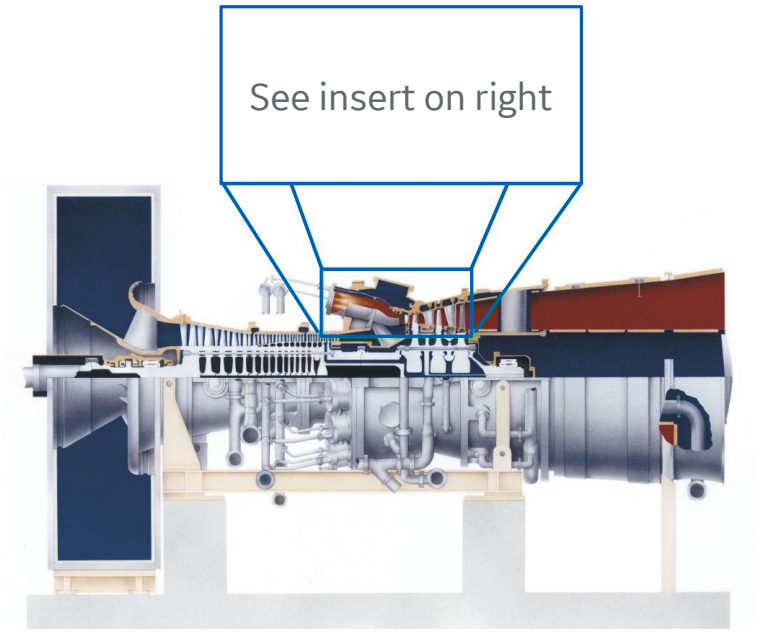
Ceramics

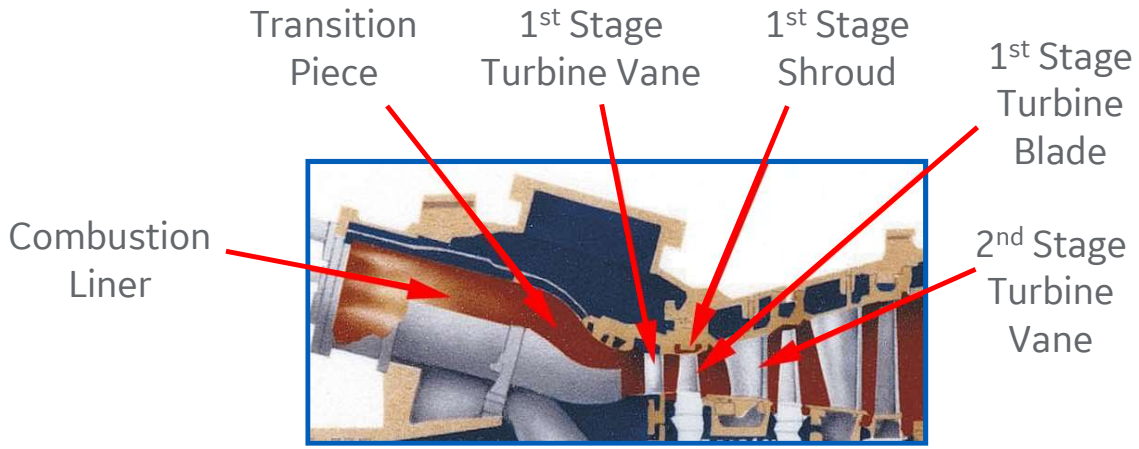
- 1st fielded CMCs
- Thermal coatings

Process optimization

- Automation/CMT/Digital
- HGP Special Processes
- Reduced cost and lead time

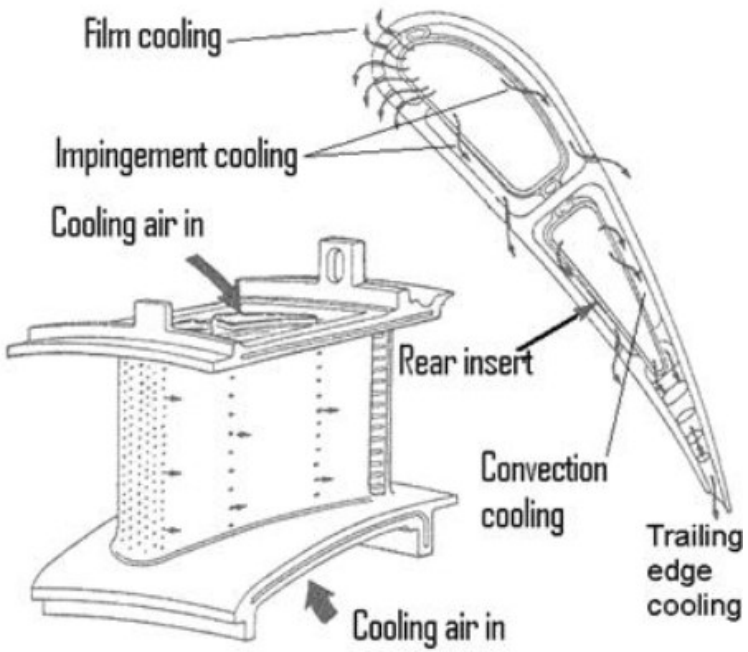
Industrial Gas Turbine Terminology



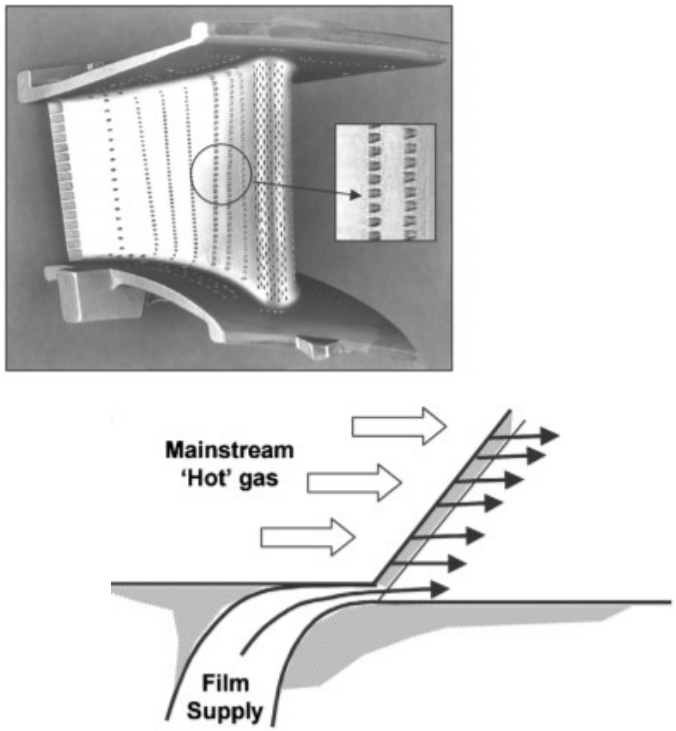


Turbine Vane Conventional Cooling Fundamentals

Internal Cooling Flow Circuit



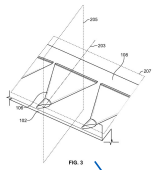
Surface/External Film Cooling



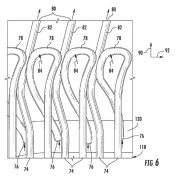
Program Objectives: Phase I – Discovery

Conceptual Design & Feasibility

Advanced Film Shapes



Near-wall Microchannels



Recirculating Trailing Edge

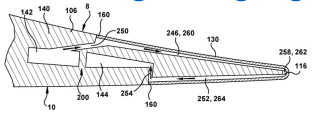


FIG. 6

Axial Film Flow for Leading Edge

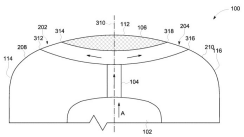


FIG. 3

Airfoil Compartmentalization & Impingement Reuse

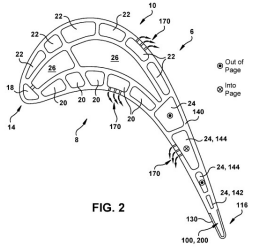


FIG. 2

Advanced H-Bumps

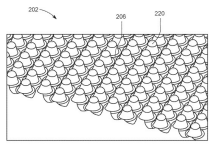


FIG. 3

Adaptive Cooling

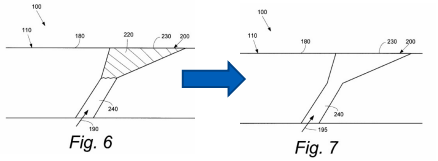
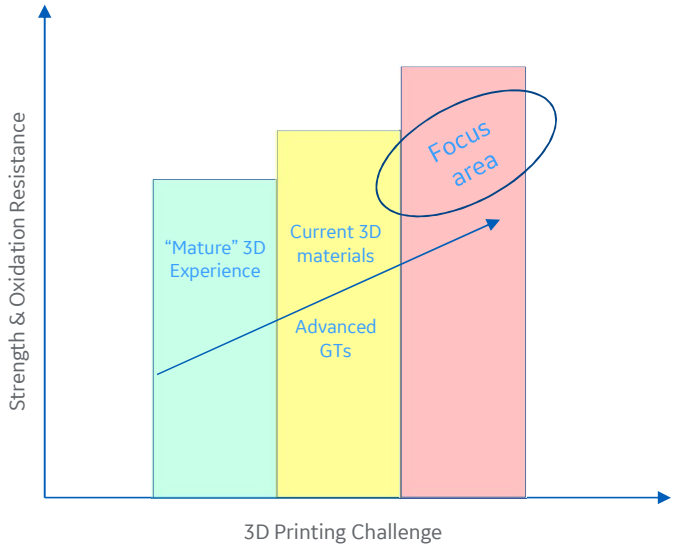


Fig. 6 Fig. 7

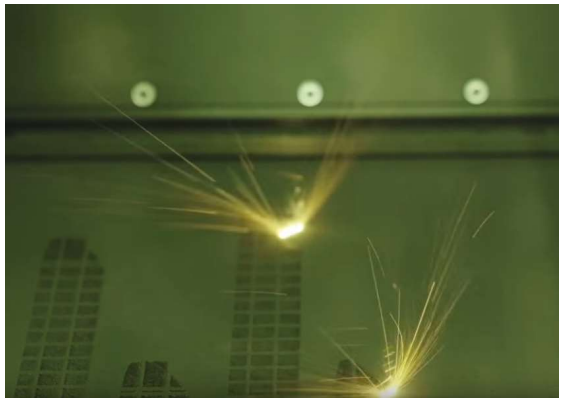
Additive Modalities & Materials



Program focus will be on high-temperature alloys, and additive modalities that enable their use

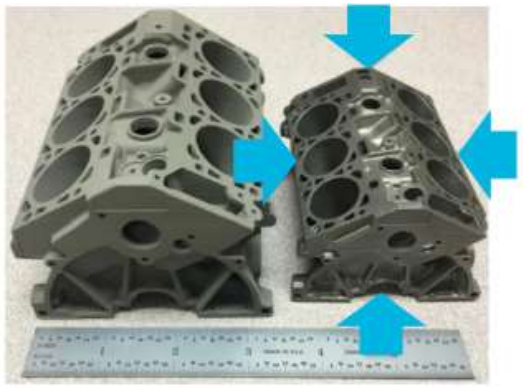
Additive Modalities

DMLM
Direct Metal Laser Melting



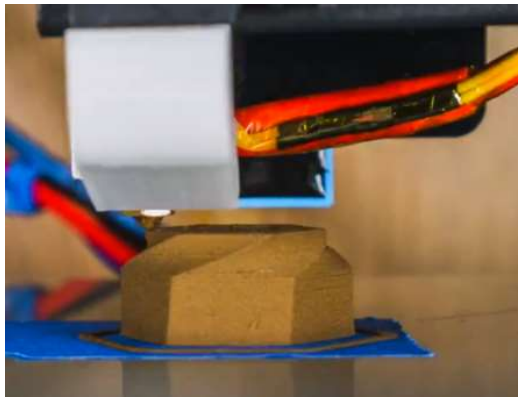
High-resolution laser sintering process; ideal for complex features and uncastable internal geometries

Binder Jet
The Original “3D Printing”



Powder bed method that uses polymer binder to hold layers together; results in fully dense part after sintering

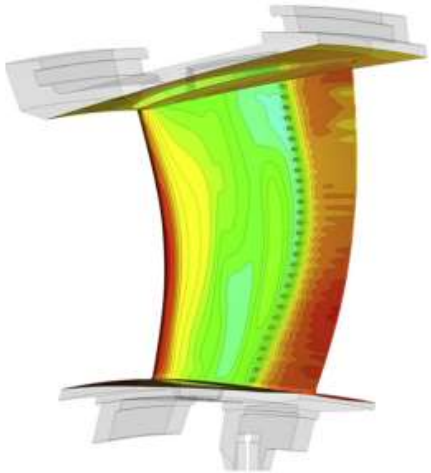
FDM
Fused Deposition Modeling

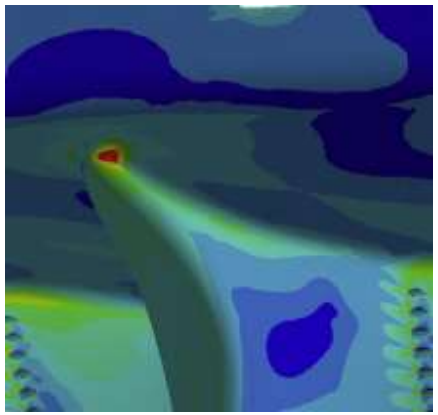


Metal-infused filament results in fully dense part after sintering

Next Steps

Conceptual Design & Feasibility
FEA Analysis: Heat Transfer & Structural





Additive Modalities & Materials
Coupon Print Trials