

Additive Manufacturing Ecosystem



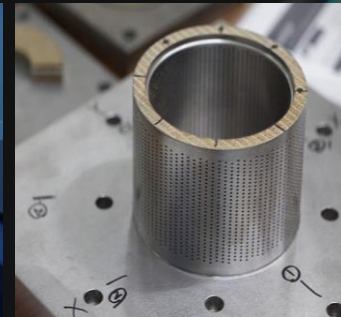
POWER



AVIATION



TRANSPORTATION



OIL & GAS



HEALTHCARE



MEDICAL

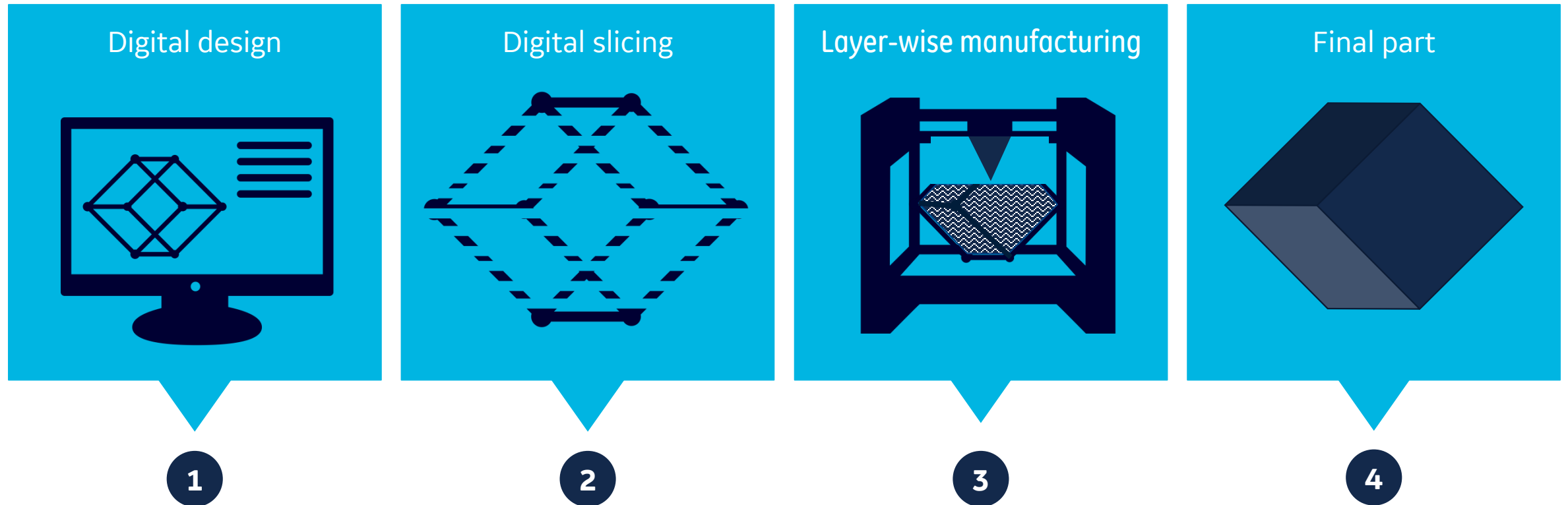


AUTOMOTIVE

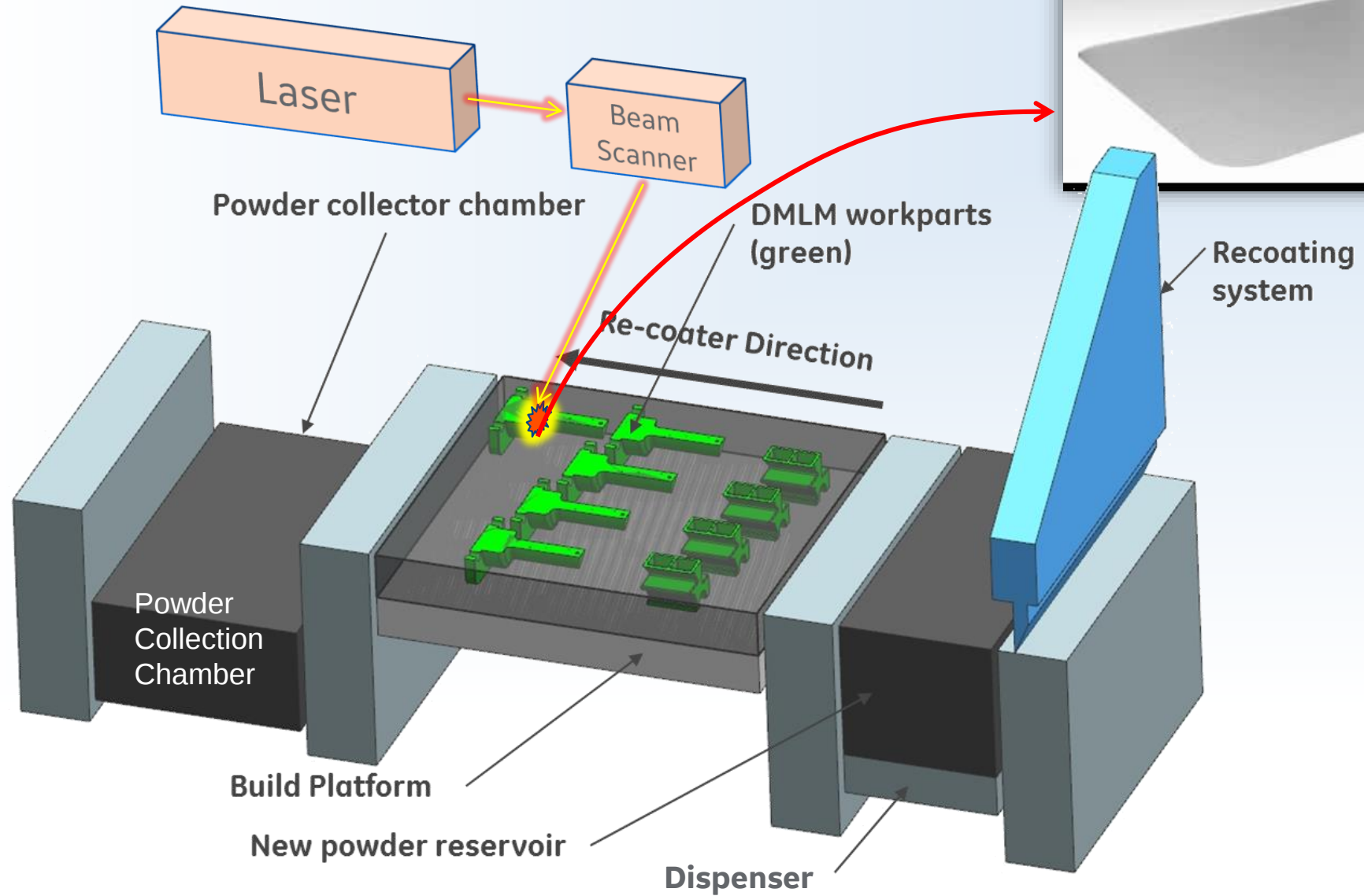


Luana Iorio, Ph.D
April 1, 2017

Additive Manufacturing ... a 4 step process



Direct Metal Laser Melting (DMLM)



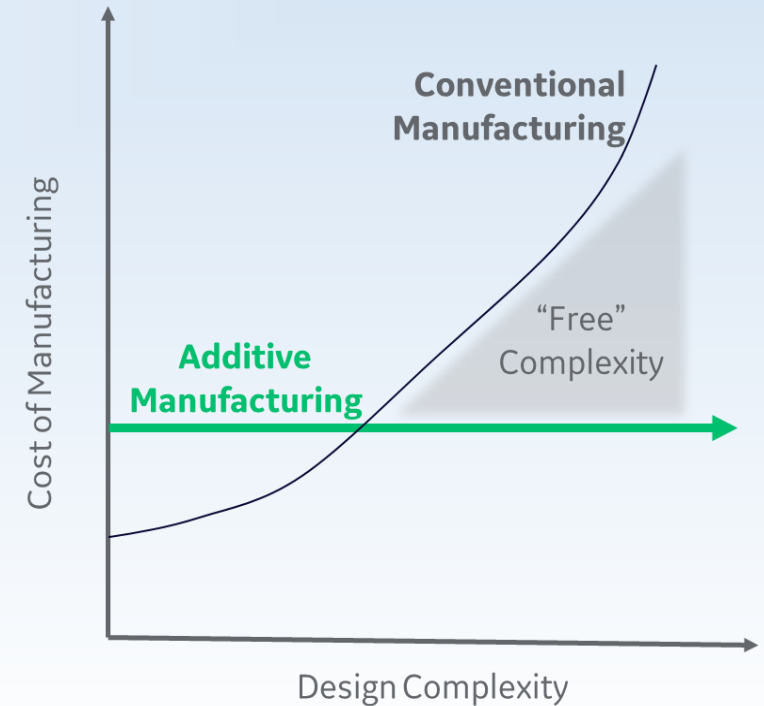
Transformational Power of Additive

The Additive Advantage

1 Expands What is Possible ... opens up new design capability to optimize part & system designs in a way we cannot with traditional manufacturing processes

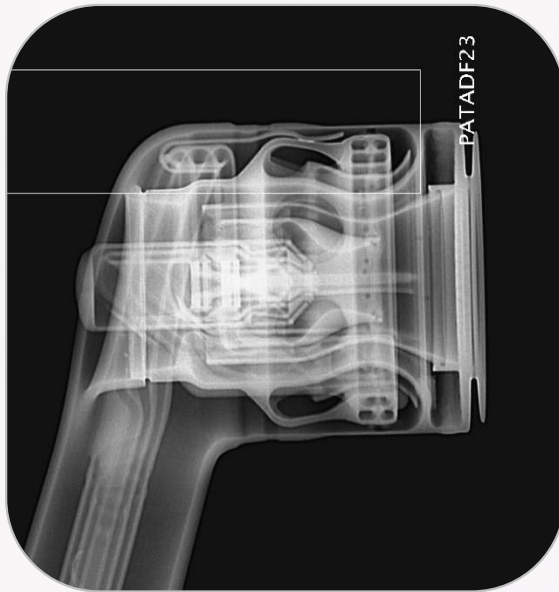
2 Improves Quality ... eliminates design trade offs; reduced cycle times, digital v. analog control, reduced braze/weld/rivet/bolted joints

3 Simplifies Systems... more robust designs, reduced part counts and assemblies; shortened supply chains



It started with 1 part ...

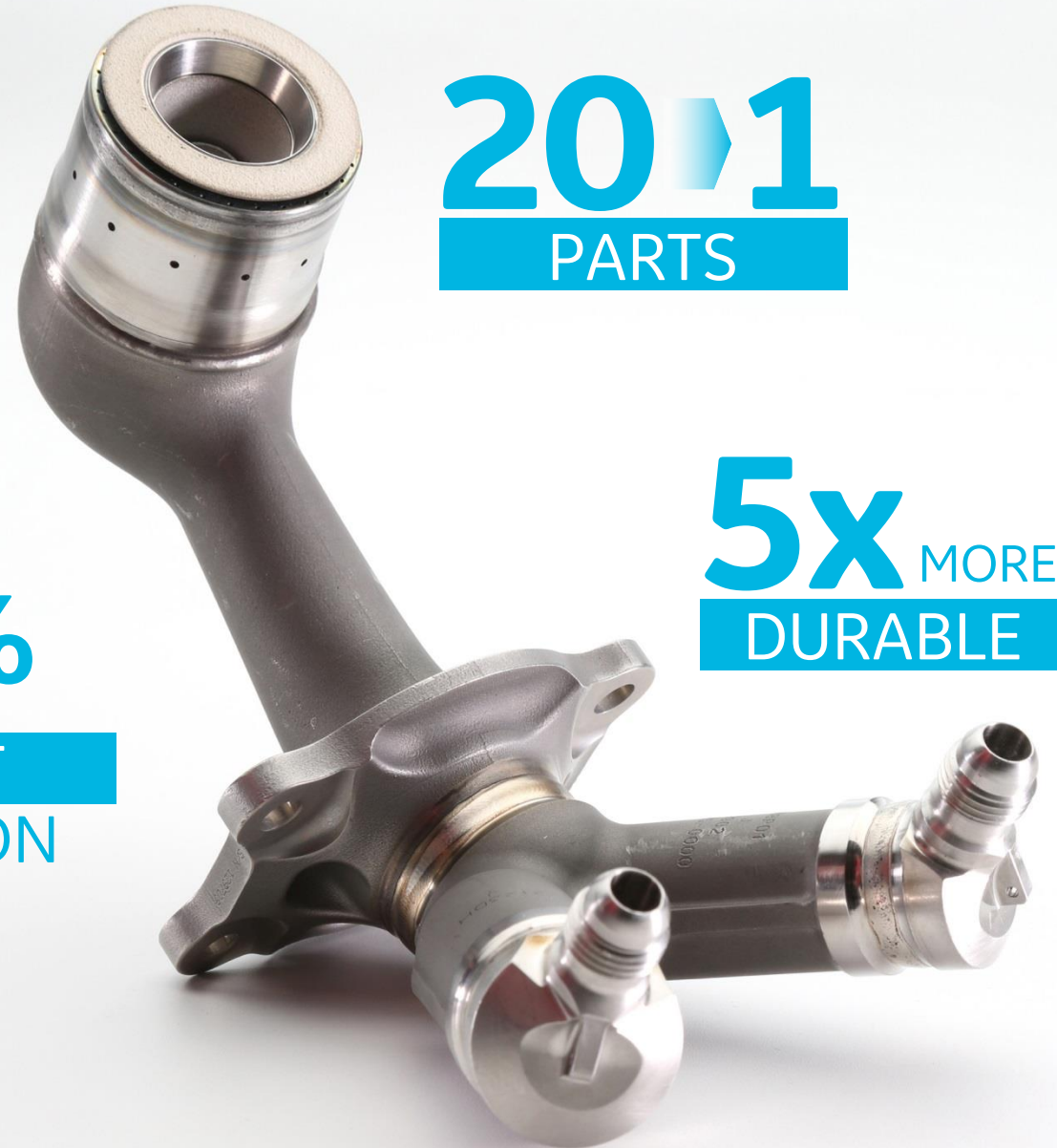
Capabilities of full production
35,000 – 40,000 per year



25%
WEIGHT
REDUCTION

20 → 1
PARTS

5x MORE
DURABLE



LEAP is a trademark of CFM International, a 50/50 JV between GE and Safran Aircraft Engines



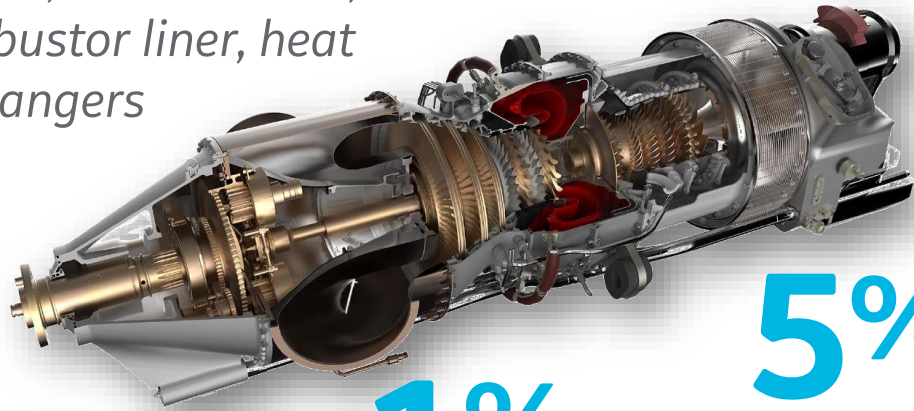
and now we're building an engine ... the Advanced Turboprop engine (ATP)

55% of major structures additively manufactured

ATP engine for new Cessna aircraft - Denali

*Sumps, bearing housings,
frames, exhaust case,
combustor liner, heat
exchangers*

855 → 12
PARTS



1%
FUEL BURN
REDUCTION

5%
ENGINE WEIGHT
REDUCTION

25%
PART WEIGHT
REDUCTION

50 → 1
PARTS

C-Sump



*Each major component
eliminates many sub-parts*





Acetabular Cup

Trabecular Structure

Tailored and **bespoke** designs

Additive Adoption Barriers & Opportunities

Barrier

Immature design-for-additive tools

Limited materials base

Uncertain material properties

Machine size and speed limitations

Post-processing complexity

Part qualification, evolving industry standards

Technical Opportunity

Topology optimization & analysis tools

Materials development

Process modeling

In-process monitoring

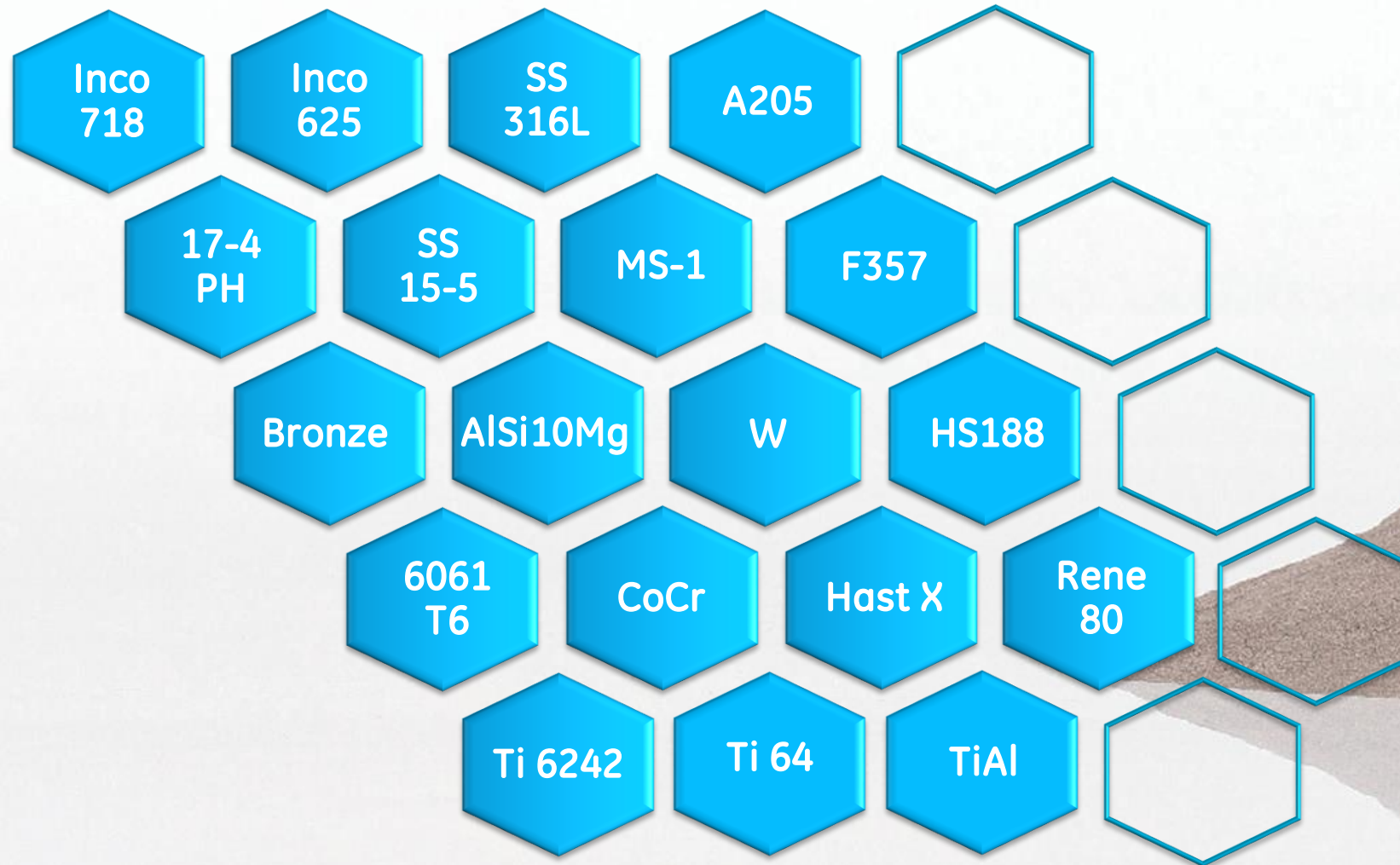
Rapid qualification techniques

Scaling machine capability – machine design, laser technologies, control systems

Non-destructive evaluation techniques

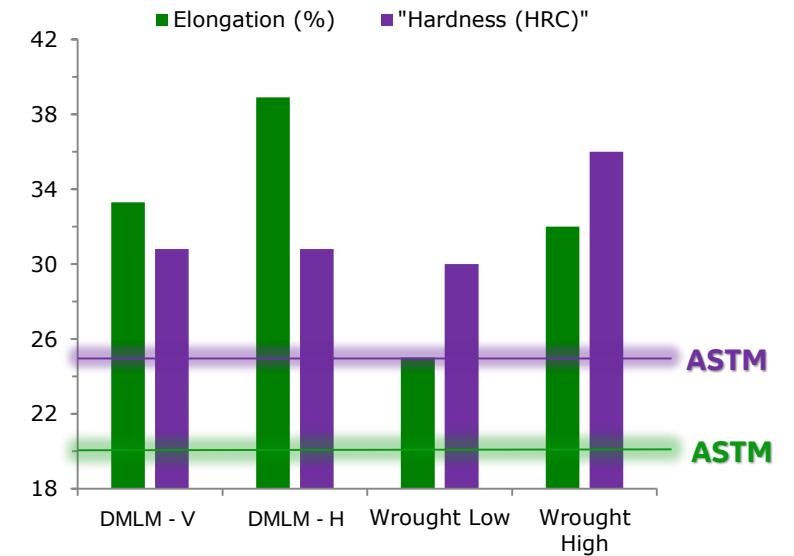
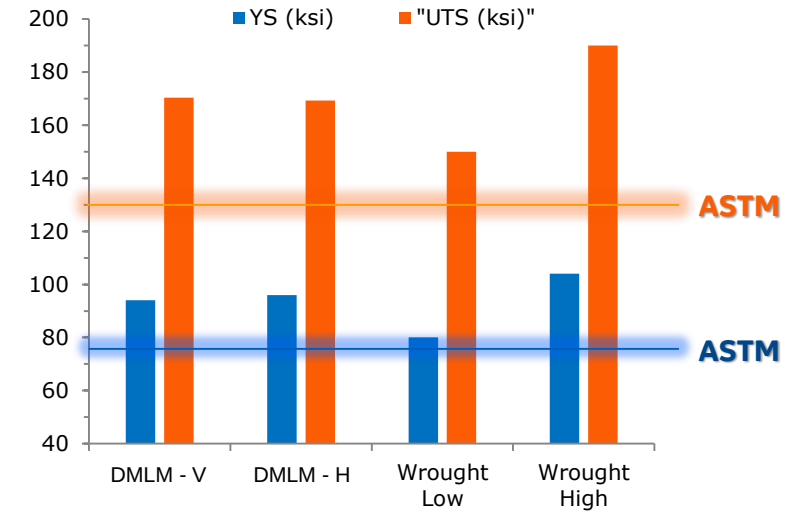
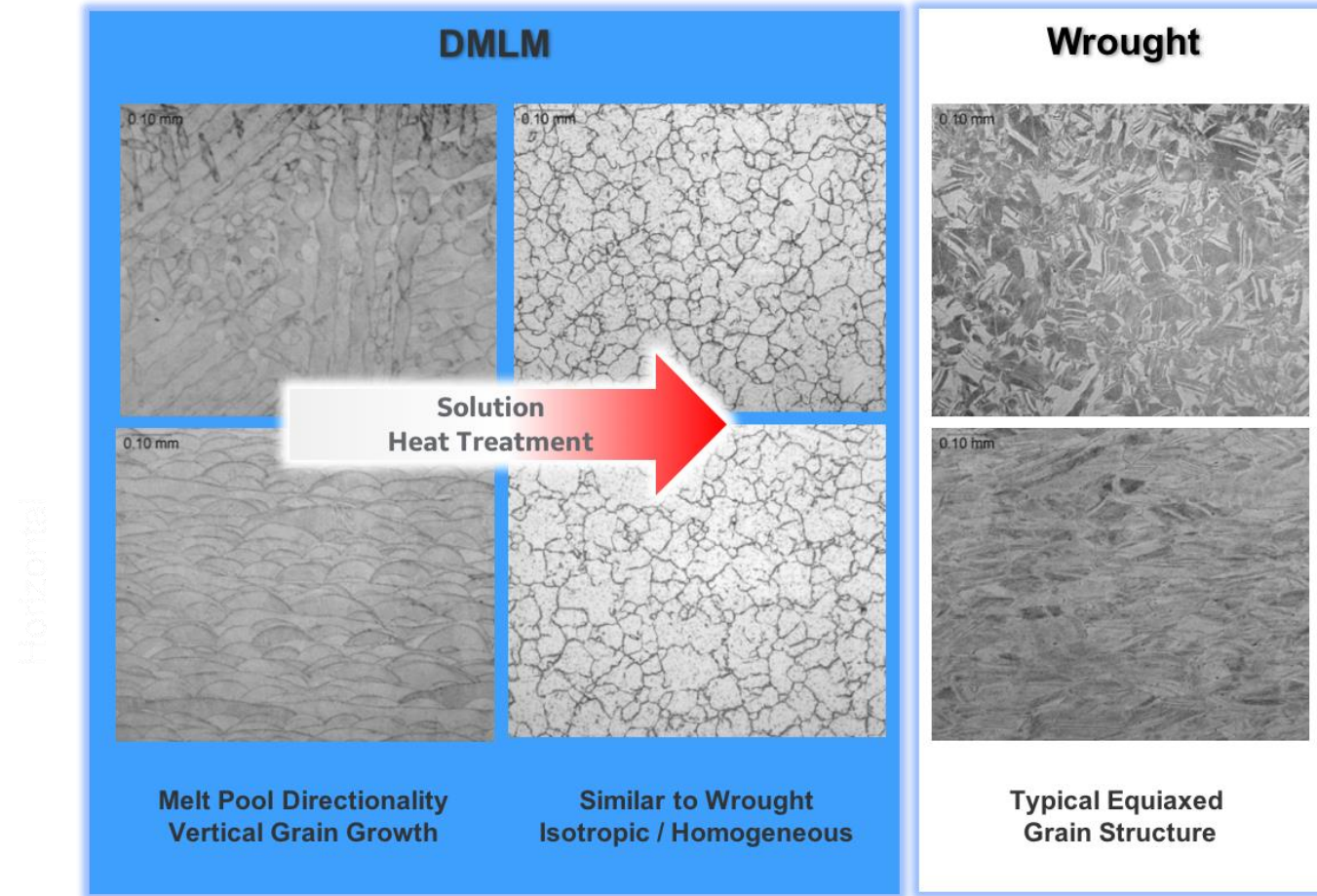


Rapidly Expanding Materials Capability



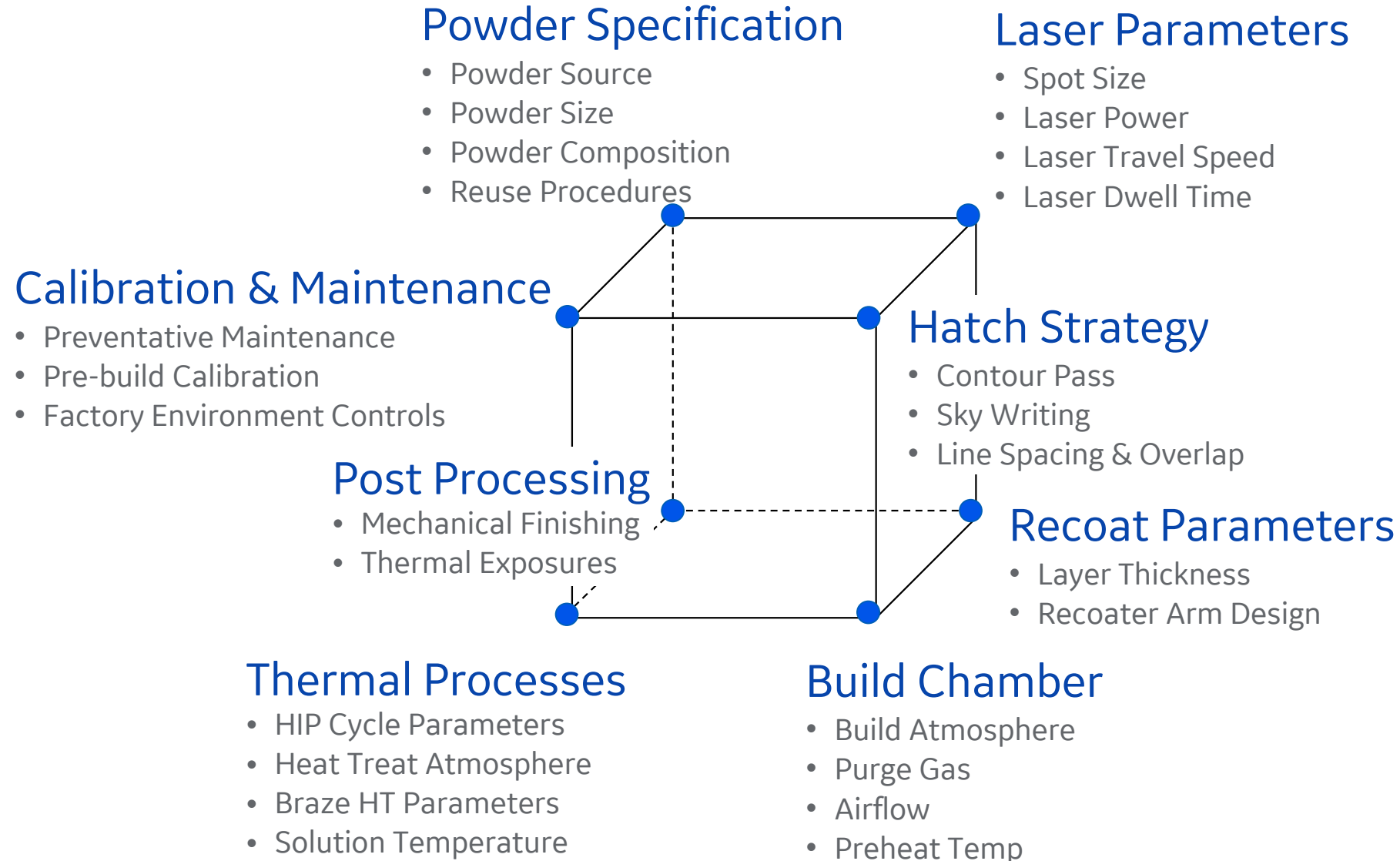
Understanding Structure-Property Relationships

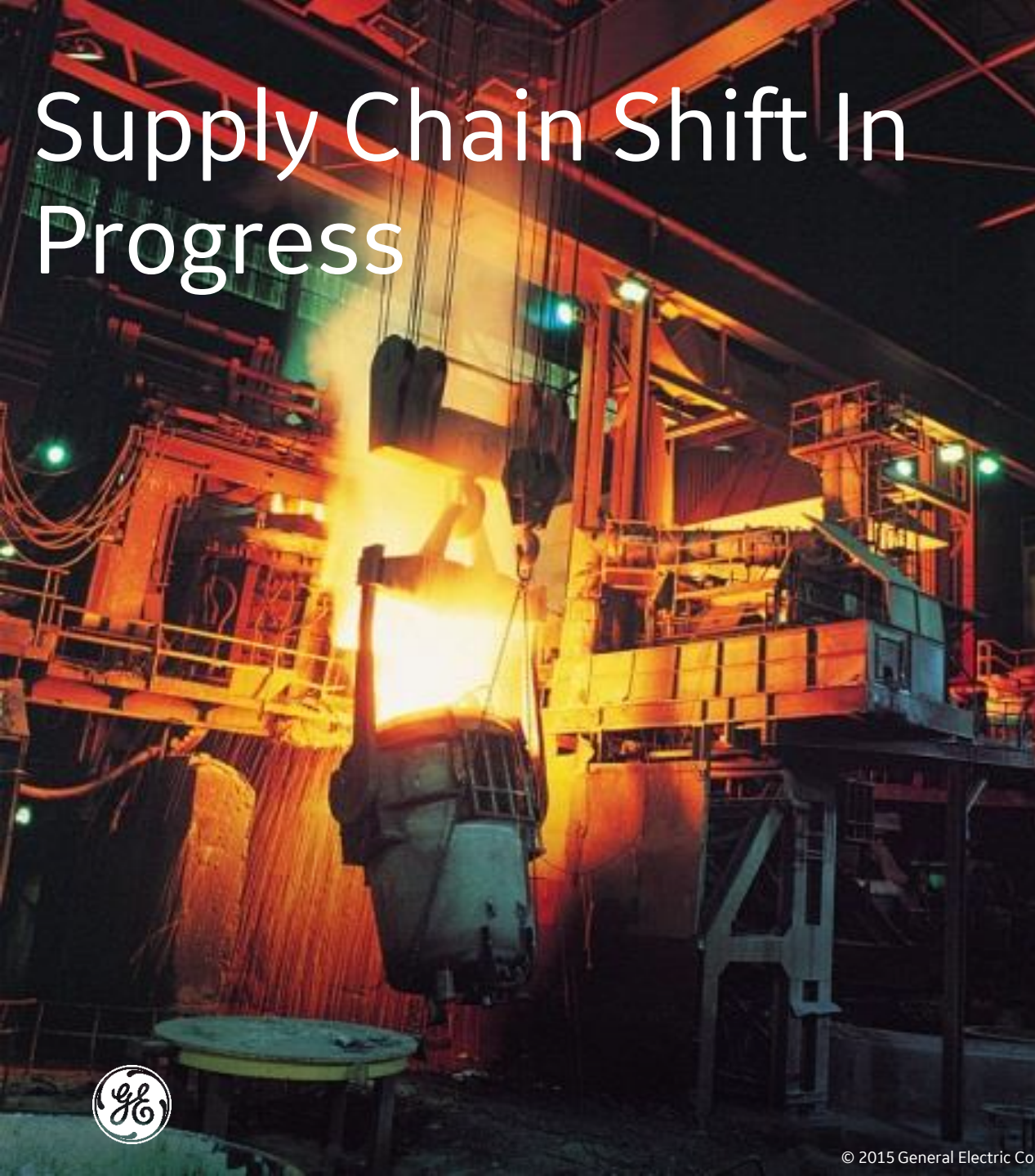
Co-28Cr-6Mo



Additive Manufacturing Development Process

100+ Material & Machine Parameters





Supply Chain Shift In Progress



Building the next generation workforce

Primary and secondary schools

\$2 million for 3D-printing equipment and curriculum

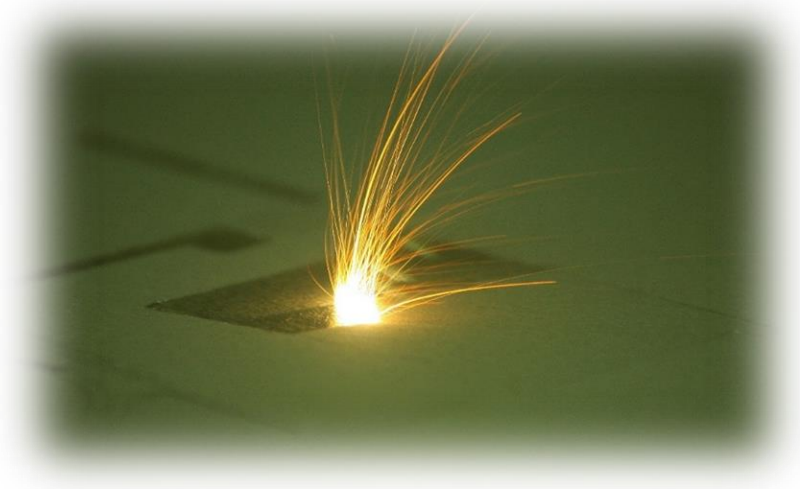
Focus on **STEM/STEAM** programs



Two- and four-year colleges and universities

\$8 million for metal additive manufacturing equipment

Focus on **additive learning** efforts



Supporting Industry Initiatives

Some of the opportunities ...

Specifications



American Welding Society



Industry Groups



GE Aviation Additive Technology Center

