

Pratt & Whitney

A United Technologies Company

OEM Perspectives on Additive Manufacturing

FAA Research, Engineering and Development Advisory Committee
Subcommittee on Aircraft Safety

March 9, 2017

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25 YEARS OF AM HISTORY AT P&W

AM Evolutionary Development

Resin & Wax Stereolithography



1989 1st P&W machine

Supported structures

Powder Based Non-metallic



Nesting

Unsupported structures

Tooling, prototypes

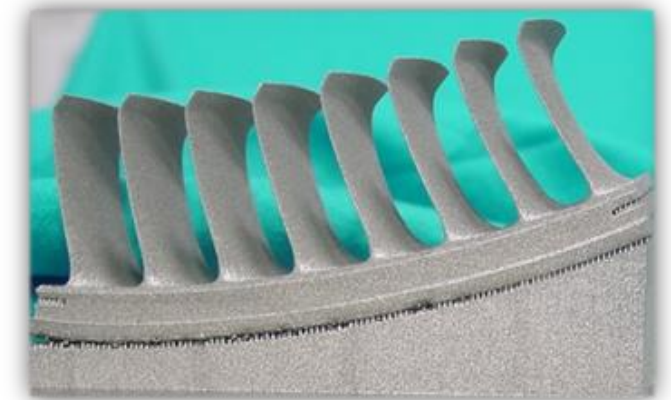
Powder Based Metallic



Prototype

Medical grade

Powder Based Aerospace Metallic



Tooling

Production

1980's

1990's

2000's

Today

EXPERIENCE IS IMPORTANT

Part count and variety teaches various aspects of the process

Visual



Rigs & Testing



Engine Development



Production

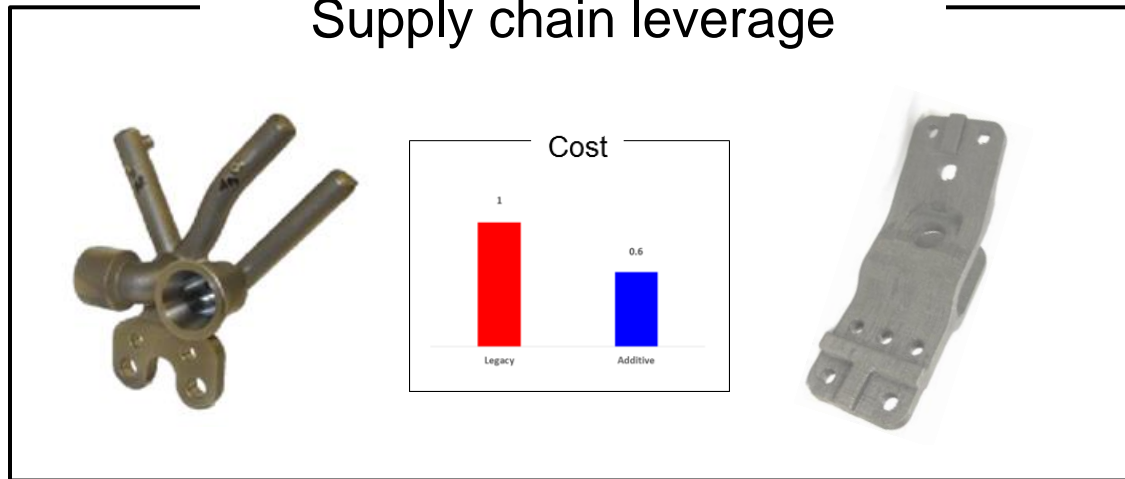


Over 3,000 metal parts builds experience and knowledge

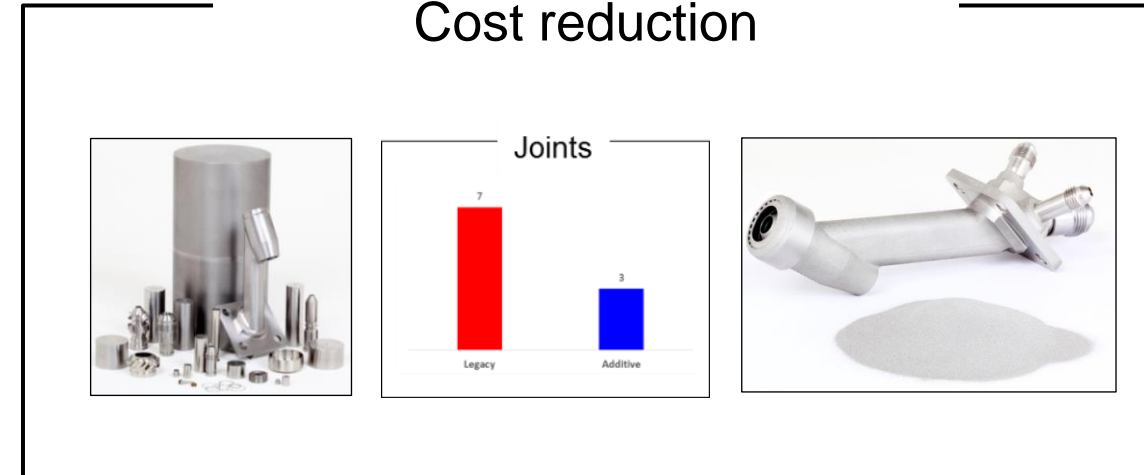
HOW DOES ADDITIVE GENERATE VALUE?

Specific categories of value generation

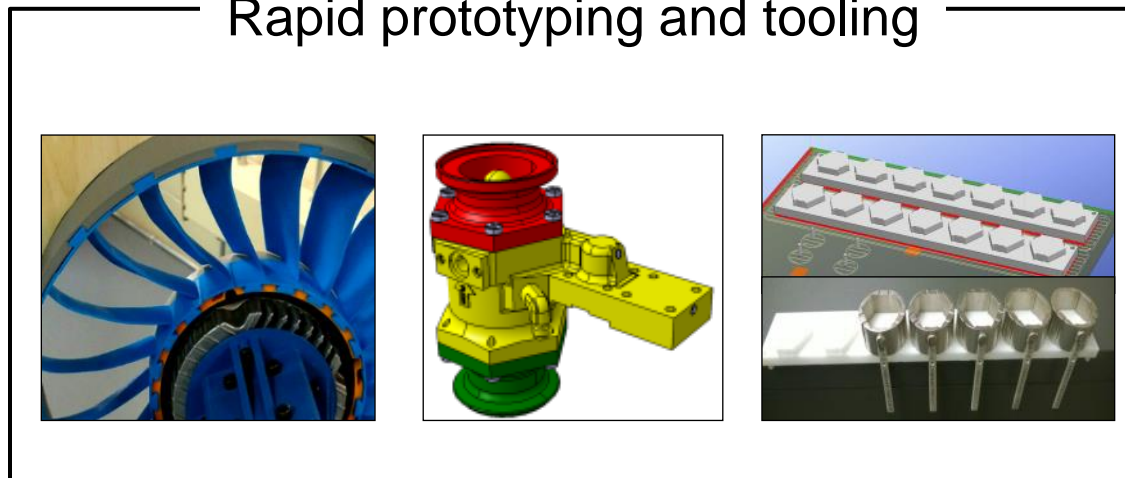
Supply chain leverage



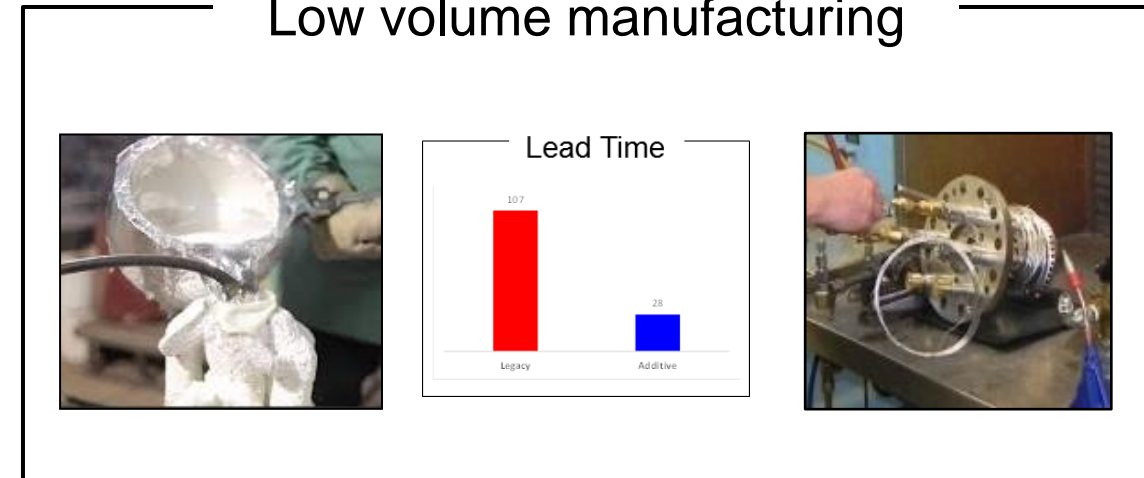
Cost reduction



Rapid prototyping and tooling



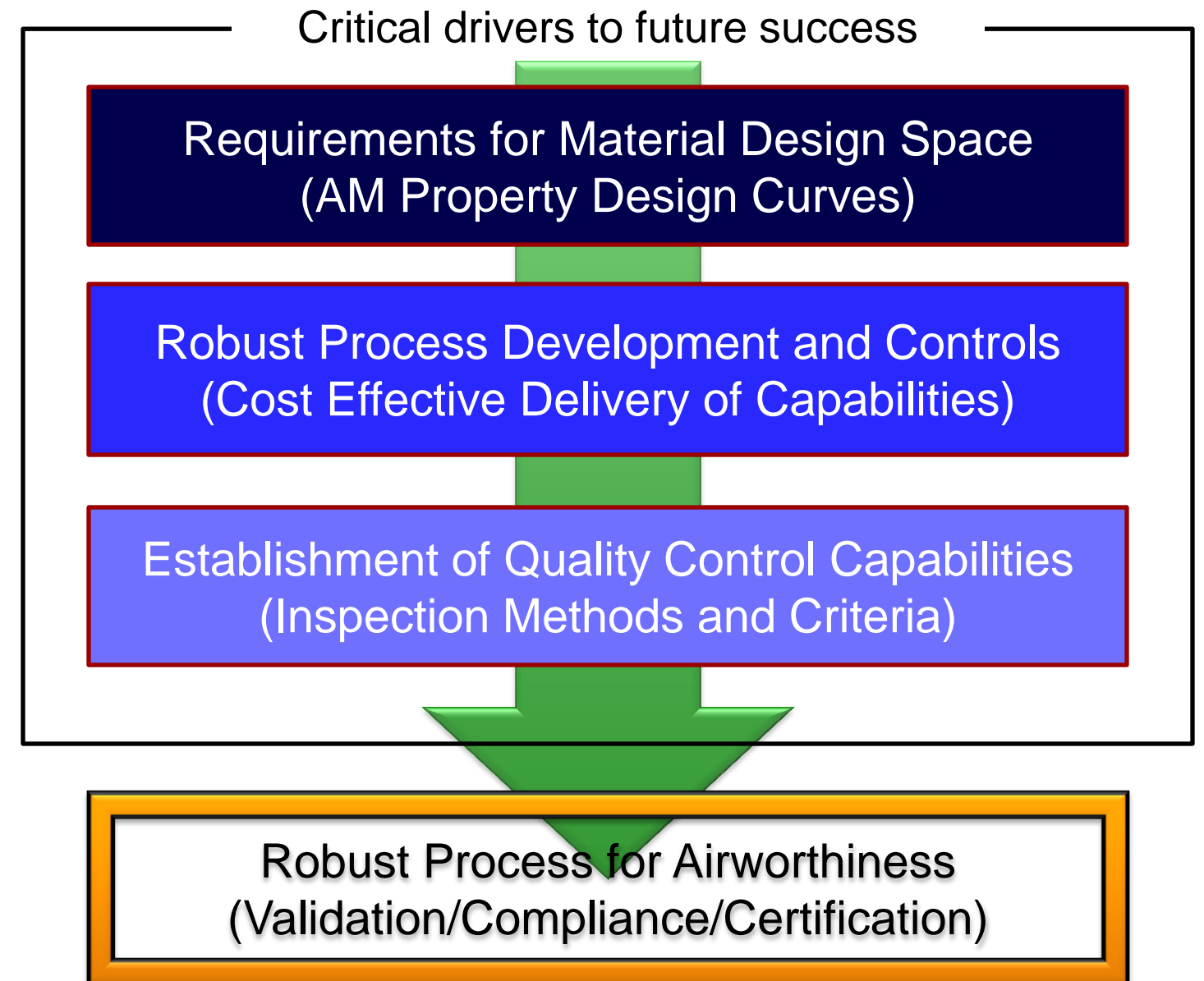
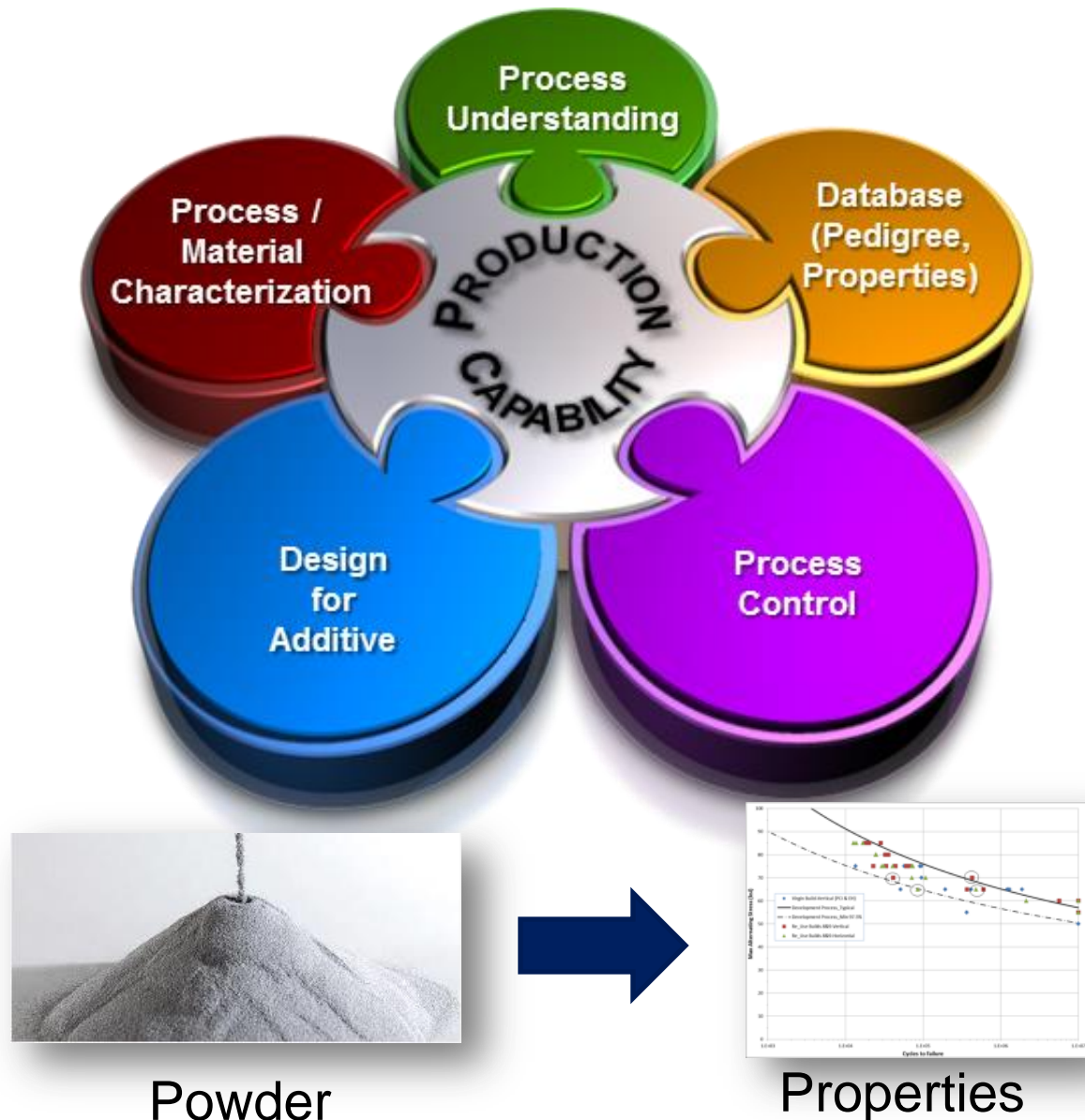
Low volume manufacturing



Ultimate opportunity – Unique designs enabled by Additive Manufacturing

ADDITIVE MANUFACTURING

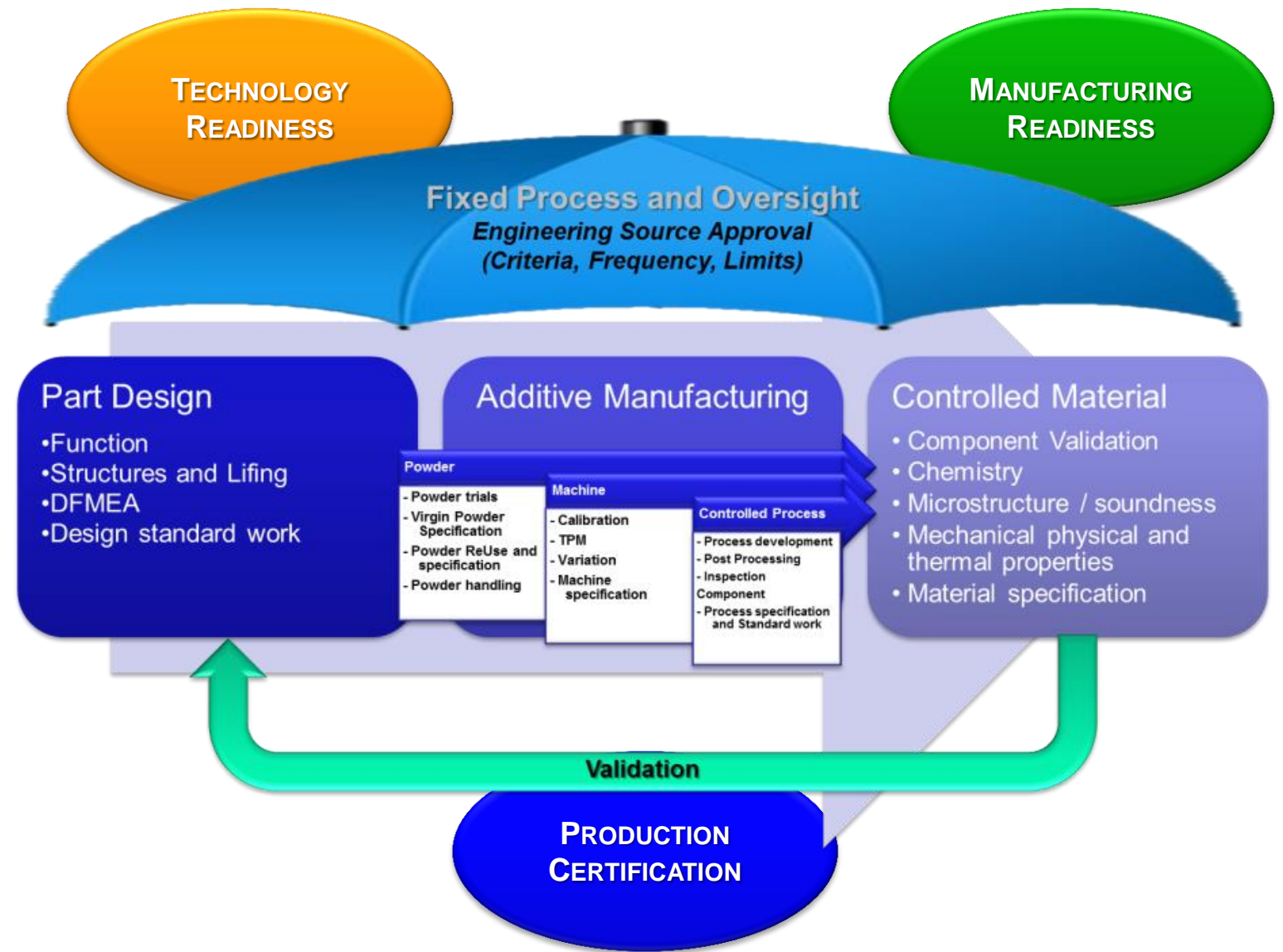
What we need to do to be good at this



COMPONENT DESIGN

Existing Design Standard Work is applied to AM component design

- AM standards and specifications are defined for the component.
- Relevant process features of AM are incorporated into the design process through a Design Guide.
 - Geometric features, Support Structure, Build Orientation, Build examples, etc.
- Mechanical properties required for Structural assessments are added to the “Materials Selection Activity” of Engineering Standard Work.
- Oversight including -- Source selection, Process evaluation, Process Approval, Approval of changes and variation
- Component level validation of properties.



PW1500G SYNCH RING BRIDGE BRACKETS

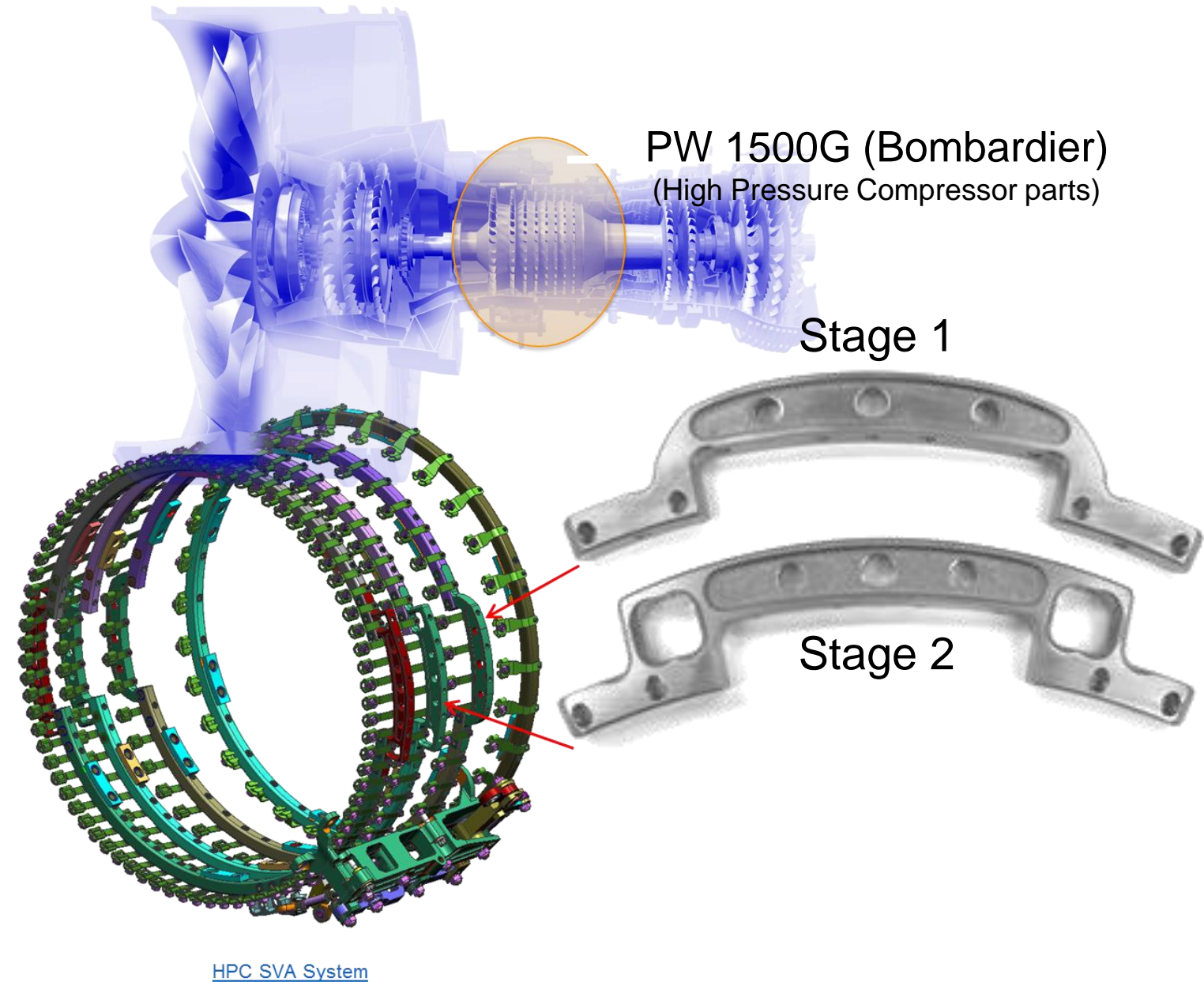
Electron Beam Ti6-4

Why?

- Can Minimize Significant Conventional Machining from Forging
- Optimized Utilization of Build Layout
- Good Ti6-4Al Material Candidate

Learning

- Teaming with Regulatory Agencies very beneficial.
- Leveraged learning from other difficult AM processes
- Powder/Process/Material specifications essential
- Technical challenges are prevalent and Drive Technology Readiness
- Procedure, traceability, documentation and certification become primary drivers of Manufacturing Readiness and dominate overall timeline



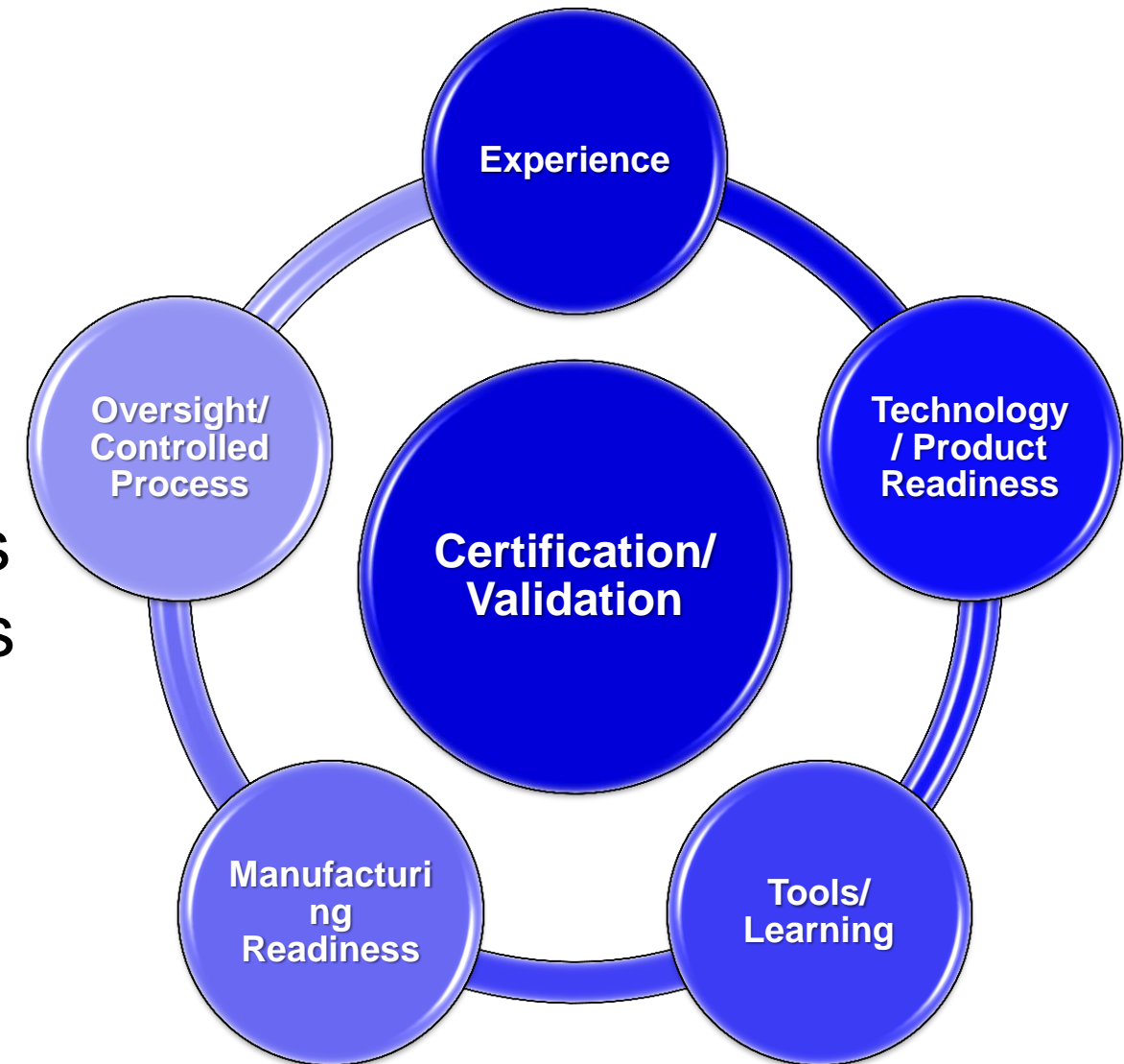
CONCLUSIONS

AM technology is ***PROGRESSING*** within UTC

EXISTING development and validation methodologies are utilized

EXTENSIVE characterization of the relevant Processes and Materials is a set of standards and specifications that provide Process Control

INVOLVEMENT with industry standards committees is key to future certification



THANK YOU

