Current Challenges for AM Volume Production

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Special Focus Group on Quality for AM

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Outline

- Introduction to HiETA Technologies
- NDT challenges at HiETA
- NDT for AM Volume Production – Route forward
- Conclusions

Who We Are

- Specialists in **thermal management** and **lightweighting** solutions enabled by Additive Manufacturing
- Established four years ago with approximately 25 staff
- Technology Centre with R&D and manufacturing cells at Bristol and Bath Science Park
- Number of past and current Innovate UK and CDE projects for automotive, motorsport, defence and aerospace sectors

Who We Are

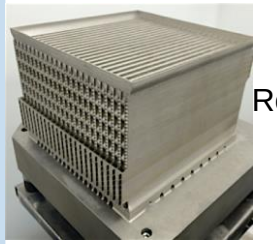
Realise CO2 reduction via light weighting and efficiency through the use of Additive Manufacturing

Product Portfolio

Customer requirements converted into innovative solutions

Micro Power Generation

Micro Gas Turbine

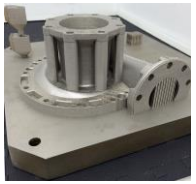


Cuboid Recuperator

Annular Recuperator

Waste Heat Recovery

Inverted brayton cycle system



Brayton cycle scroll engine

Highly Efficient ICE

Turbo machinery

Cooled turbine wheels (CM247)

Cooled compressor

Reciprocating engine

Hollow head valve

Cooled exhaust

Lightweighting and Optimisation

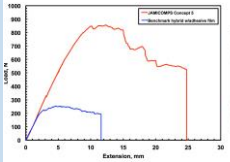
Lattice architectures

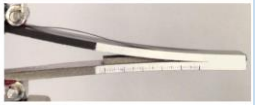
Turbine nozzle

Thrust nozzle

Hybrid Truss Structures

Novel composite-to-metal joints





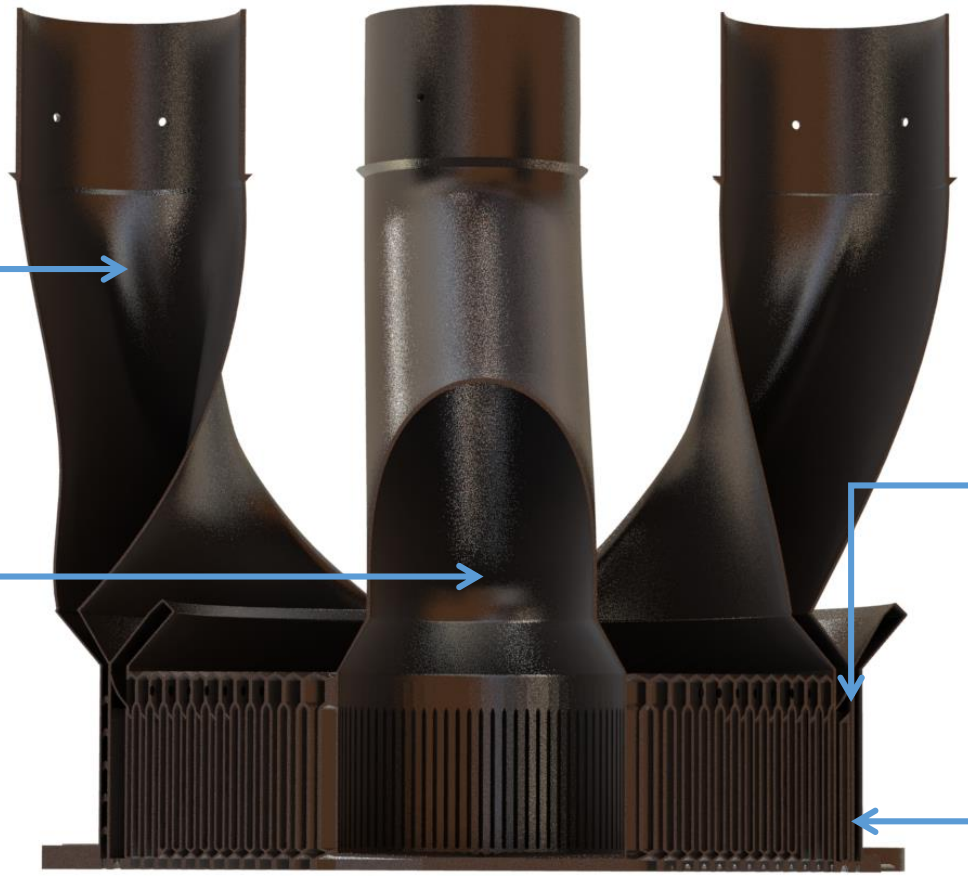
Why AM?

HiETA technologies

Component integration

Increased performance

Reduced leadtime

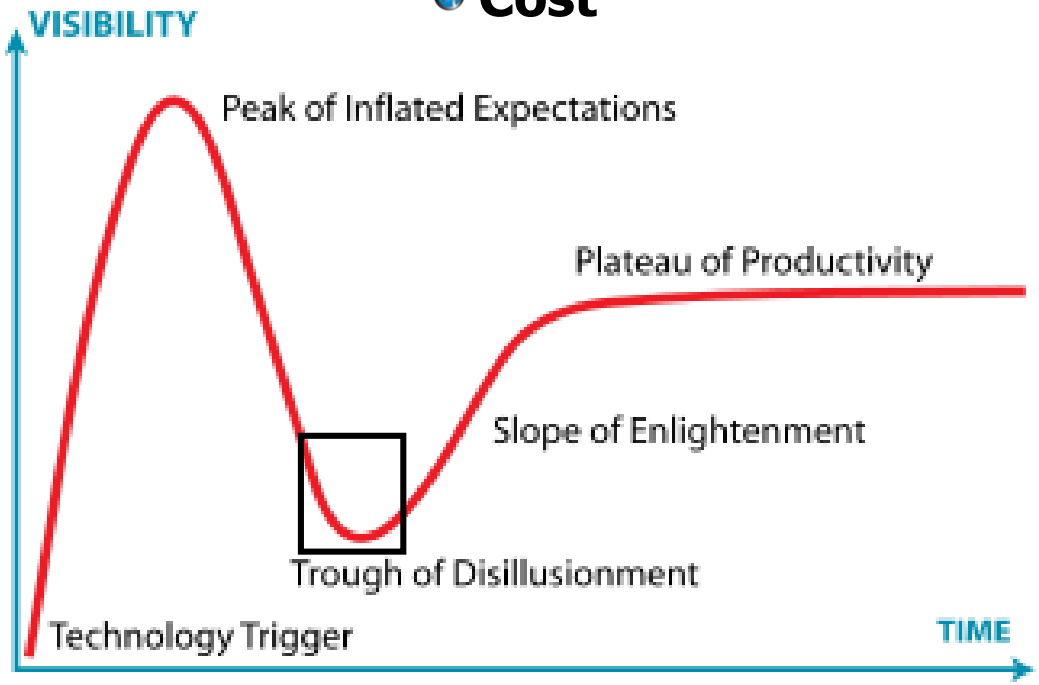


Improved packaging

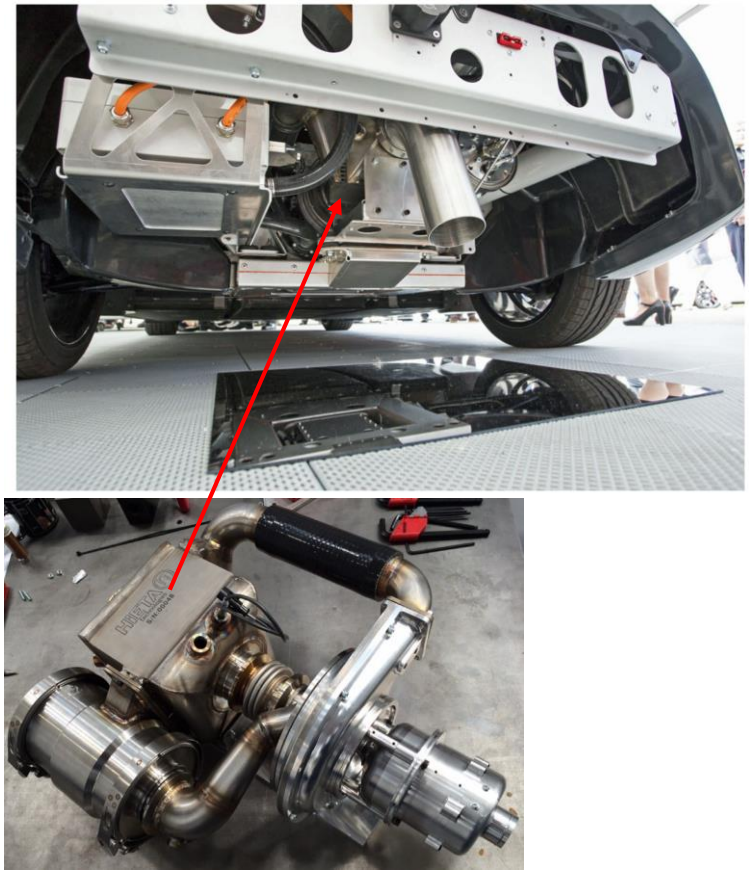
Reduced weight

Where we are?

- **Productivity**
- **Quality**
- **Cost**

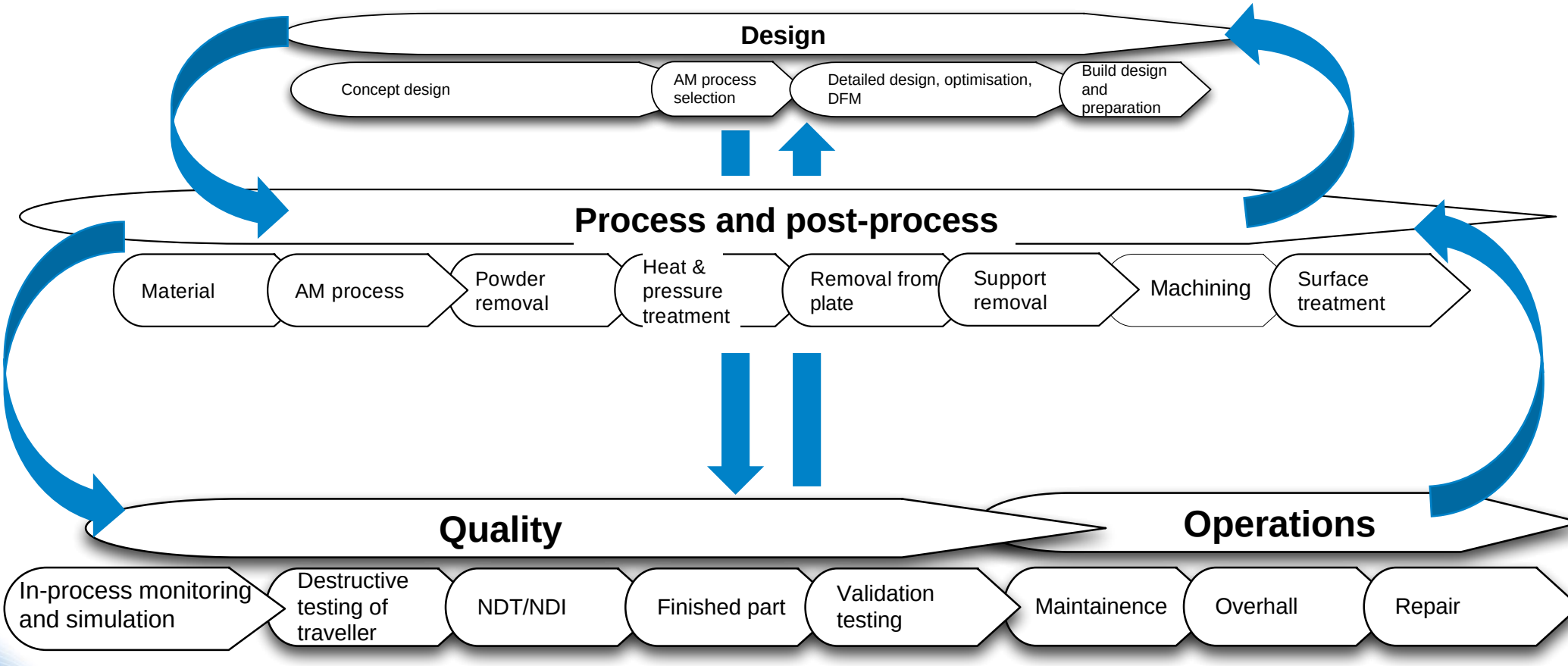


Delta Motorsport's range extended electric car at the LCV2016 event, 14 September 2016.



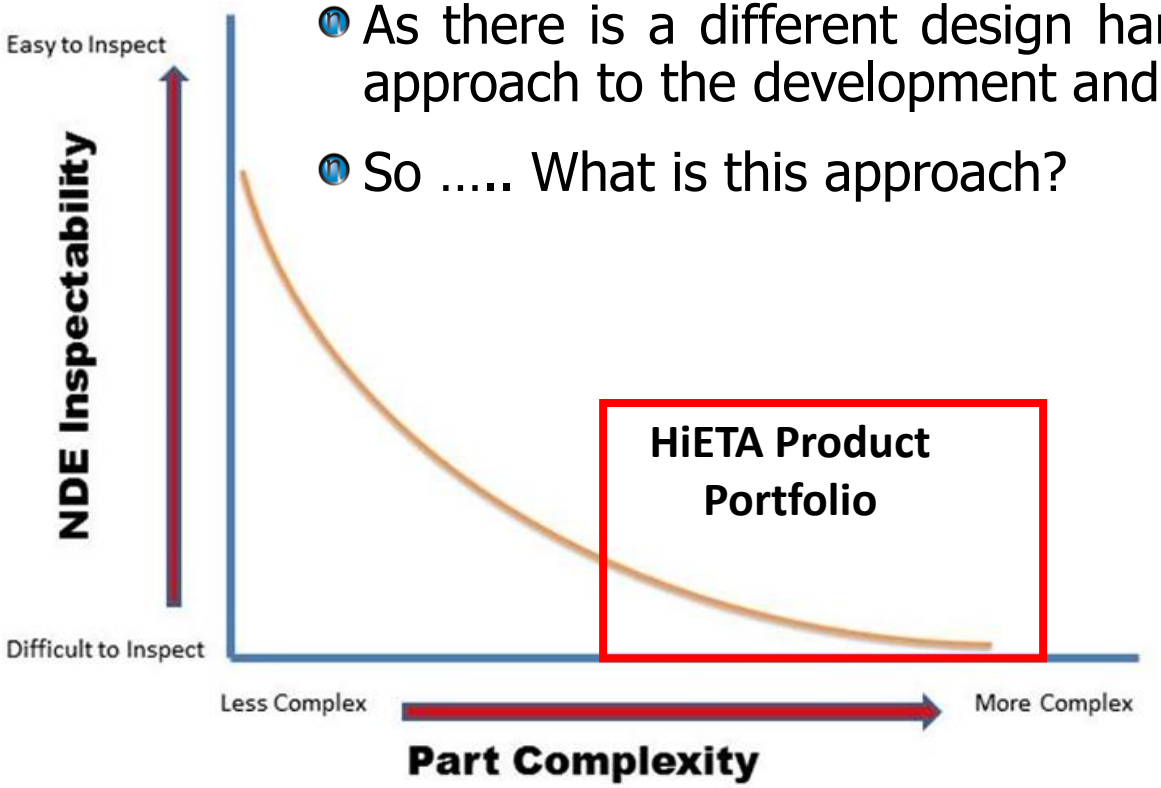
https://www.gov.uk/government/news/delta-motorsport-reveals-new-low-cost-micro-turbine-technology

HiETA AM Value Chain

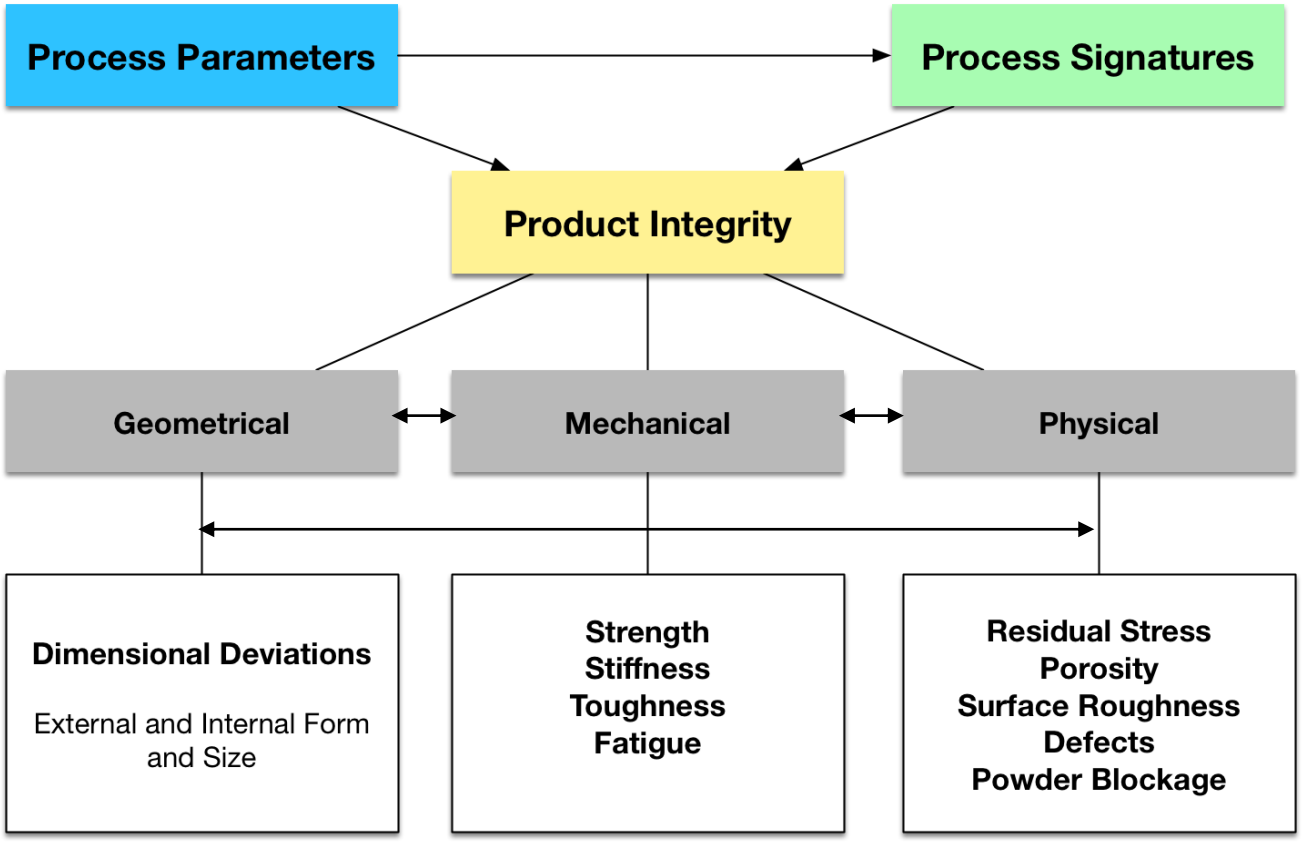


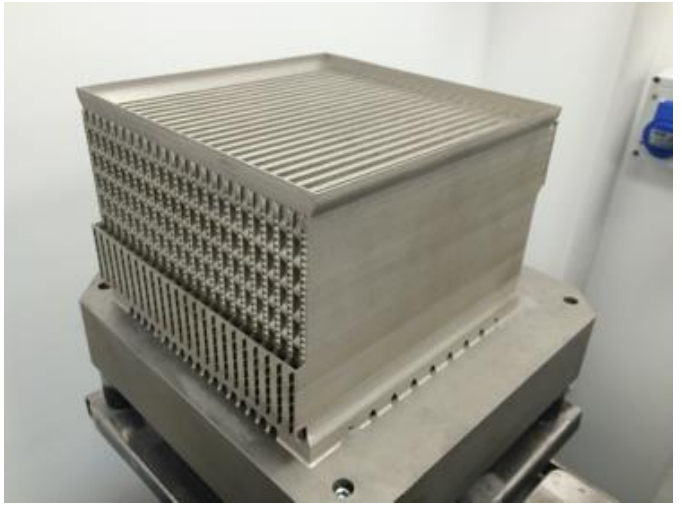
NDT Challenges

- Complexity has a significant effect on the inspectability of the part
- This includes integrated lattice structures (for structural and thermal performance), complex internal channels and thin walls (0.1-0.3 mm)
- As there is a different design handbook there is also a different approach to the development and inspection of AM components
- So ….. What is this approach?



Design for Metrology and NTD





NDT Methods for AM

- **NDT for Volume Production has different requirements from NDT for R&D**

- Design and process validation at a reduced scale but..

- We need to know that the parts we manufacture are produced to their design intent including dimensional stability, sufficient density, free of powder and internal stresses are eliminated

- Understanding ongoing capability and performance is essential for the development of our processes: methods we employ to prove quality and capability must be relevant, useful, in house, quick and simple to perform

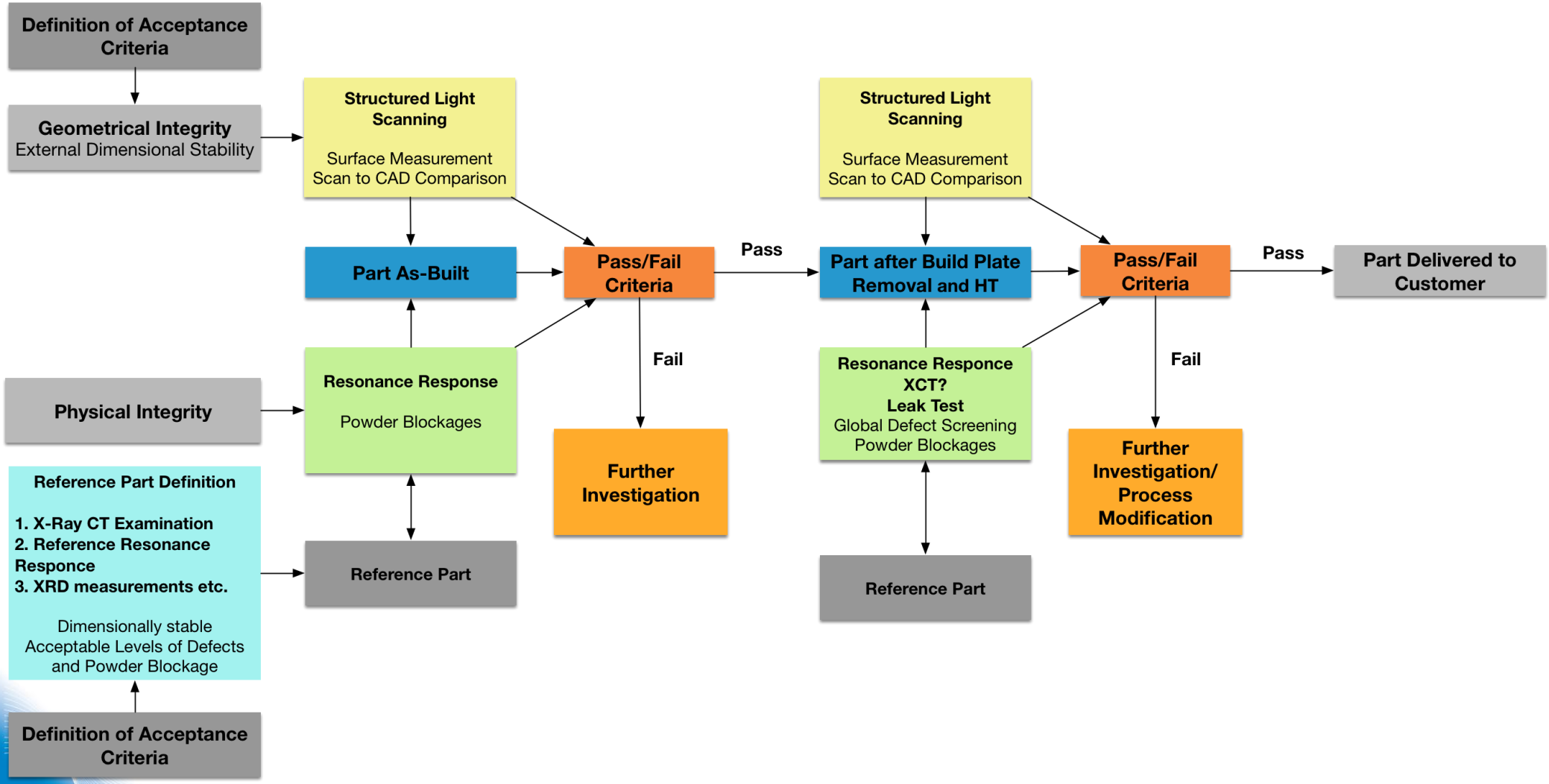
NDT Methods for AM

	Group Category				
	1	2	3	4	5
Visual Testing	Y	Y	P	NA	NA
Leak Testing	NA	NA	Y	Y	NA
Liquid Penetrant Testing	Y	Y	P	NA	NA
Process Compensated Resonance Testing	Y	Y	Y	Y	Y
Electrical Impedance Tomography	Y	Y	NA	NA	NA
Alternate Current Potential Drop	Y	Y	P	NA	NA
Eddie Current Testing	Y	Y	P	NA	NA
Array Eddy Current Testing	Y	Y	P	NA	NA
Phase Array Ultrasonic Testing	Y	Y	P	NA	NA
Ultrasonic Testing	Y	Y	P	NA	NA
Radiographic Testing	Y	Y	P	NA	NA
Radiographic Testing	Y	Y	Y	NA	NA
X-ray Computed Tomography	Y	Y	Y	Y	Y

- Group1: Simple tools and components
- Group 2: Optimised standard components
- Group 3: Embedded features
- Group 4: Design for AM
- Group 5: Lattice structures

AMERICA MAKES: NATIONAL ADDITIVE MANUFACTURING INNOVATION INSTITUTE (NAMII)
Nondestructive Evaluation (NDE) of Complex Metallic Additive Manufactured (AM) Structures, June 2014

NDT Flow



Conclusion

- **We need to understand the requirements for NDT for volume production**

  New design – New requirements?

- **We lack a factory making volumes of a similar product to give confidence to a customer that it can be done at volume**

  - With the exception of dental
  - This may change with components such as the GE Leap engine fuel nozzle

- **Do we know how we can do it?**


HiETA
technologies
THANK YOU