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## *Sponsors*



IHS Markit



Johnson Matthey  
Inspiring science, enhancing life



# Design for High Volume Additive Manufacturing

# Agenda

Design for High Volume Additive Manufacturing (HV-AM)

Ultra HV-AM [UHV-AM]: 500K to 1M units per annum (UPA)

About Us

UHV-AM  
Why?

UHV-AM  
Enablers

Summary  
and next  
steps

# Our Mission

As an independent institute, we collaborate with manufacturers, other academic institutes and solution providers to deploy innovative technologies, tools and methods to support the manufacturing sector.



**HSI** A Manufacturing  
Innovation  
Institute

# Our Vision

To lead in providing outstanding value and knowledge for sustainable manufacturing

Collaborate. Innovate. Deploy.



Virtual  
Engineering



Data Analytics for  
Resource Efficiency



Circular  
Value Chains



Manufacturing  
New Technologies



# UHV-AM - Why?

## Product



PRODUCT PERFORMANCE  
PART REDUCTION  
DESIGN FREEDOM

## Manufacturing Engineering



MANUFACTURING AGILITY  
INVESTMENT EFFICIENCY  
RAPID LAUNCH  
TIME TO MARKET

## Series Production



INCREASED PRODUCTIVITY  
INVENTORY REDUCTION  
LEAN MANUFACTURING  
SCHEDULE FLEXIBILITY  
CHANGE MANAGEMENT

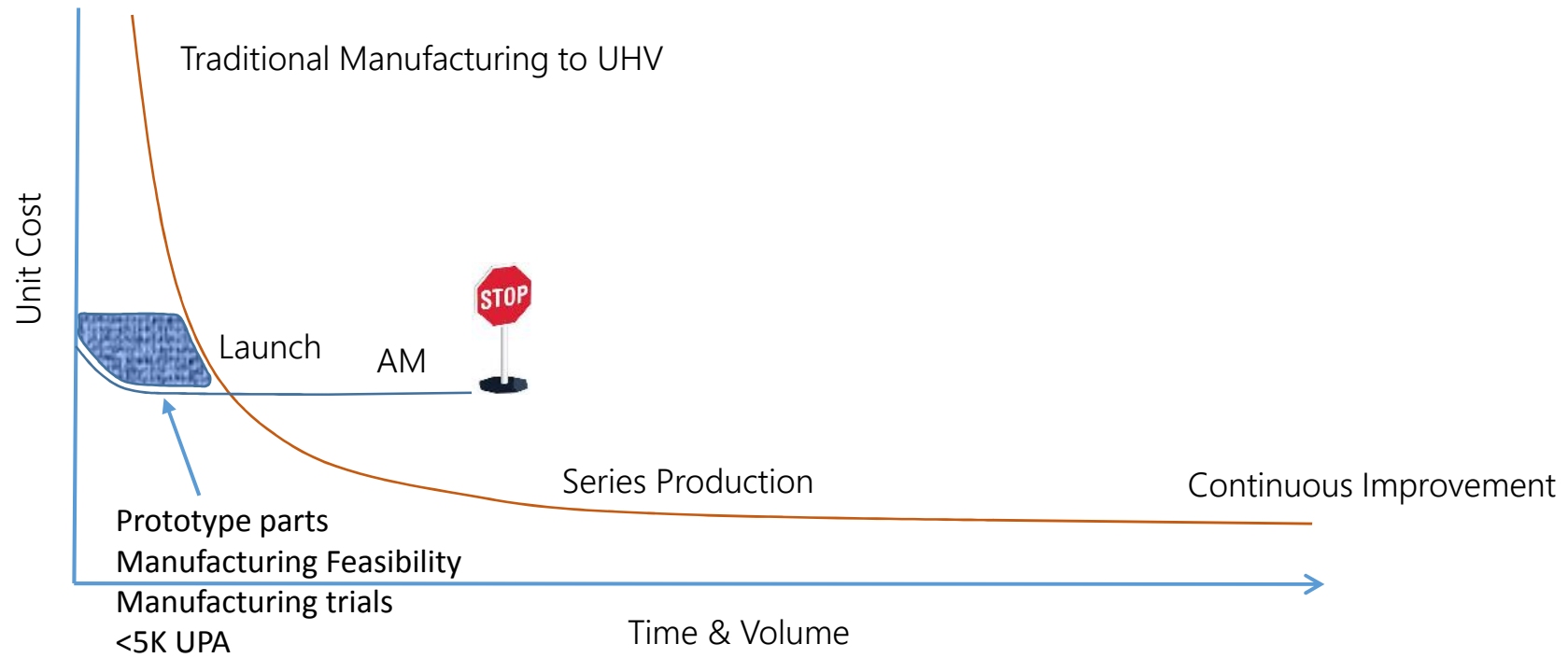
## Business Performance



COMPLEXITY FOR FREE  
CUSTOMER ENGAGEMENT

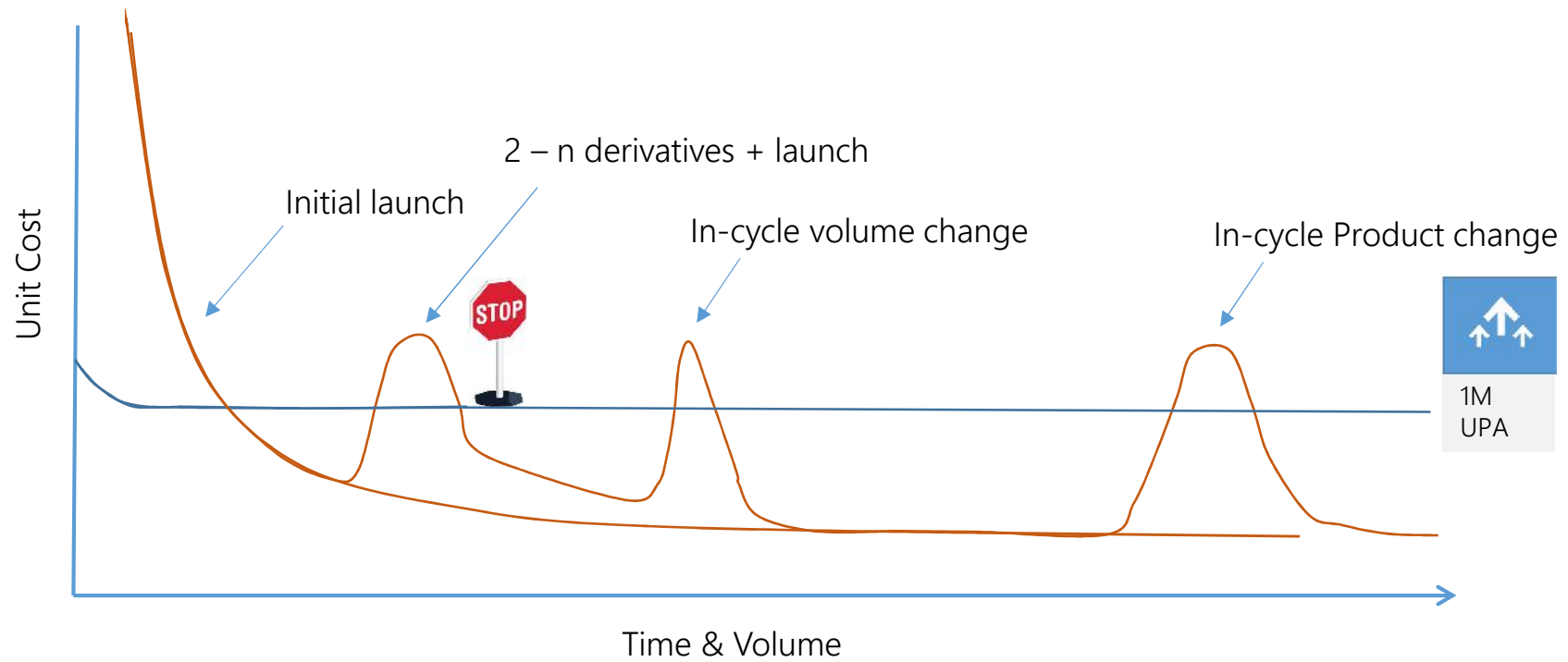


# Unit Cost v Time/Volume





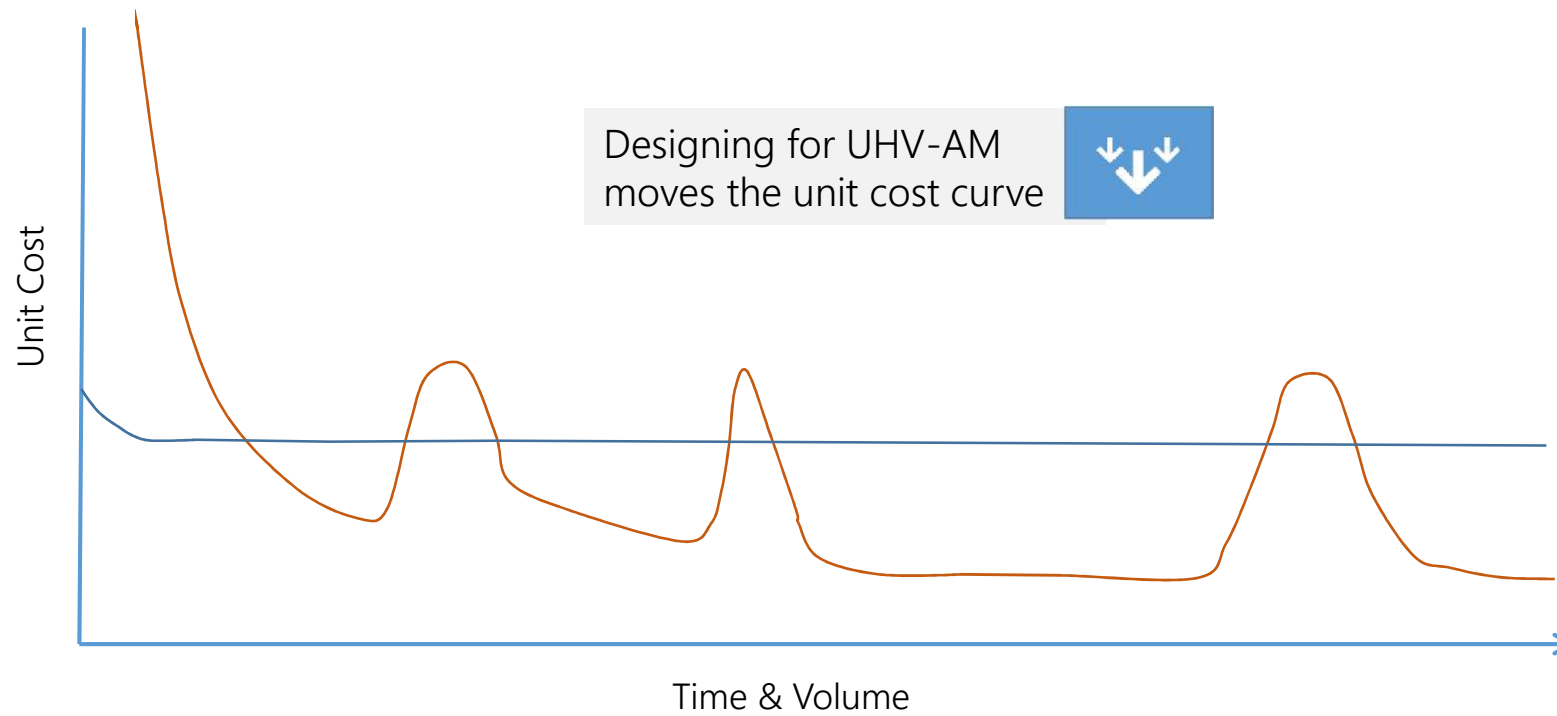
# Unit Cost v Time/Volume



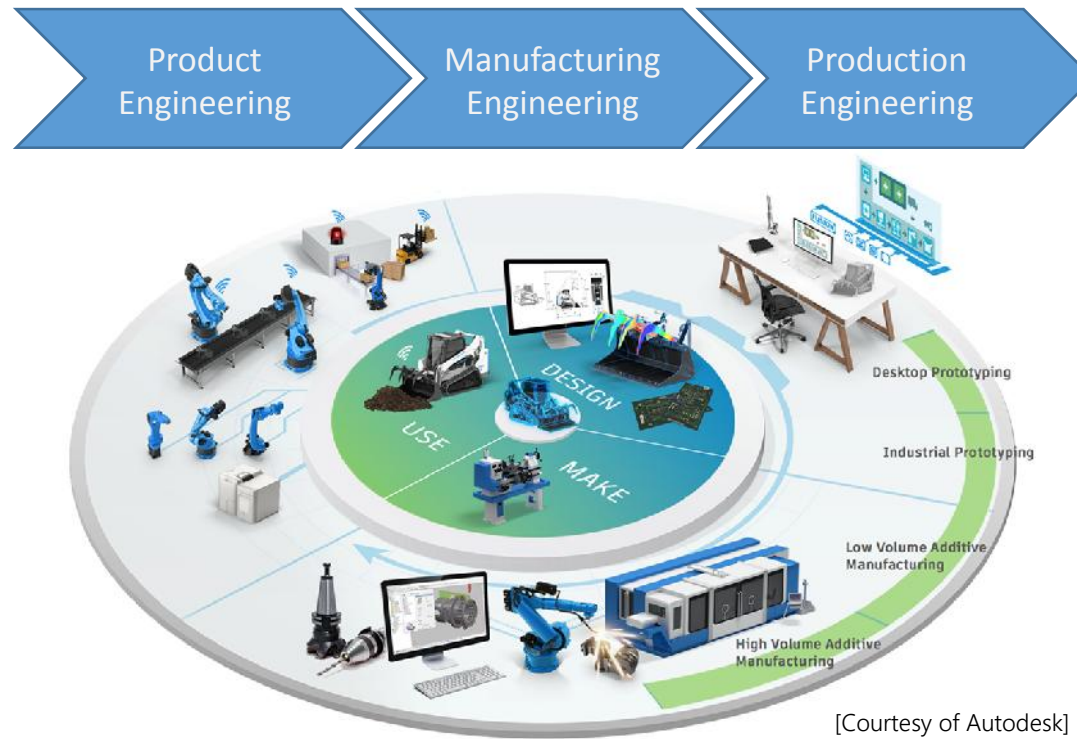




# Unit Cost v Time/Volume

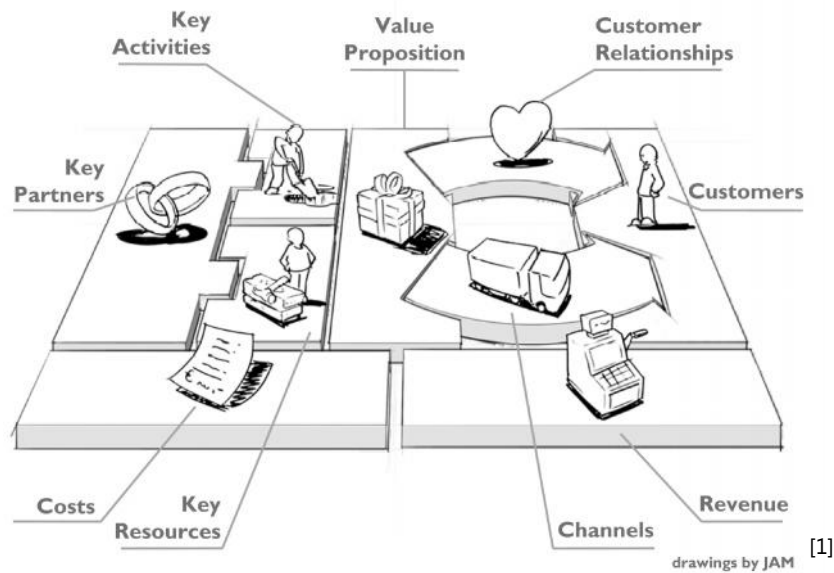


# Lowering the Unit Cost Equation – How?



# Recognise total cost/benefit?

For UHV-AM - Take another look at the Business Model



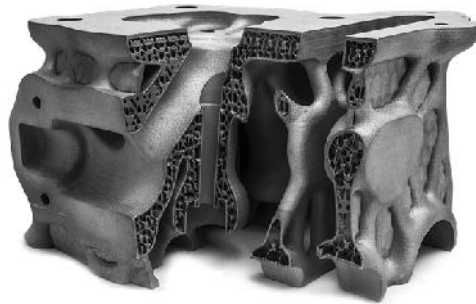
- Customer engagement
- Value proposition
- Resources required
- Partners
- Skills requirements
- Costs
  - £xxM in inventory?
  - £xxM in spare parts?
  - £xxM in launch costs?
  - £xxM in supplier tooling costs?
  - £xxM in capital investment?
  - £xxM in training/skills



[1] – Business Model Canvas, Osterwalder A, Pigneur Y, (2010)



# UHV-AM – Product Design Enablers



## Performance optimisation

- Change the Design Rules
- Remove a number of product design constraints

## Optisys Design Exercise [2]

- part count reduction from 100 discrete pieces to a 1 piece
- weight savings >95%;
- lead time reduced from 11 months to 2 months;
- production costs reduced by 20% to 25%;



[2] - <https://www.optisys.tech/>



# Design for UHV-AM – Product Engineering

UHV-AM Design Enabler	UHV-AM Impact to Manufacturing
Minimise number of components	Assembly costs reduction,
Minimise complexity	AM materials –Surface roughness and accuracy is impacted by grain size
Use open innovation materials	Cost and resilient sourcing strategy
Total facility cost	Net shape v near net shape processing
Tolerance within process capability	AM processing and post processing
Poke yoke Assembly by design	unambiguous assembly
Minimise the need to assemble flexible parts	minimise operator handling issues
Features to facilitate automated assembly	location points, clamping positions
Eliminate the need for adjustment/selective fit	in process measurement, customised dimensions to eliminate adjustment
Design for minimum waste	Material removal. AM support structures



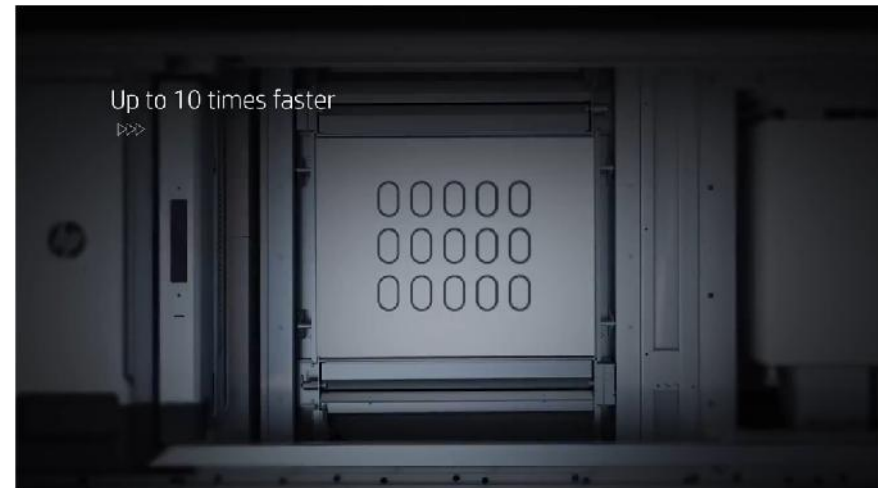
# Solving the Volume Problem

Faster Printing



[Adidas Futurecraft 4D]

Higher Productivity



[HP Jetfusion 3D Printing Solution]



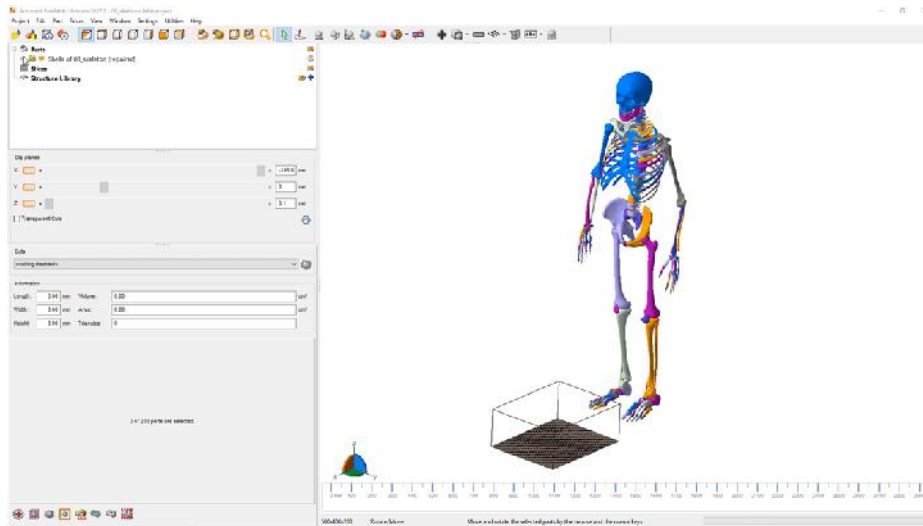
# Solving the Volume Problem – UHV-AM BoP

Fully Engineered Ultra High Volume Bill of Process



[Illustration Courtesy of Autodesk]

# Manufacturing Engineering



[Courtesy of Autodesk]



- Line side stock
- Kitting
- Inventory
- Spare Parts
- Manage the Change
- Scalable production





# Summary and Next Steps

UHV-AM  
Why?

## Next Generation Propulsion Systems

Significant Product and Manufacturing Opportunity

Weight reduction for electrified vehicle range

Modular volume expansion

Facilitate rapid and frequent product update

UHV-AM  
Enablers

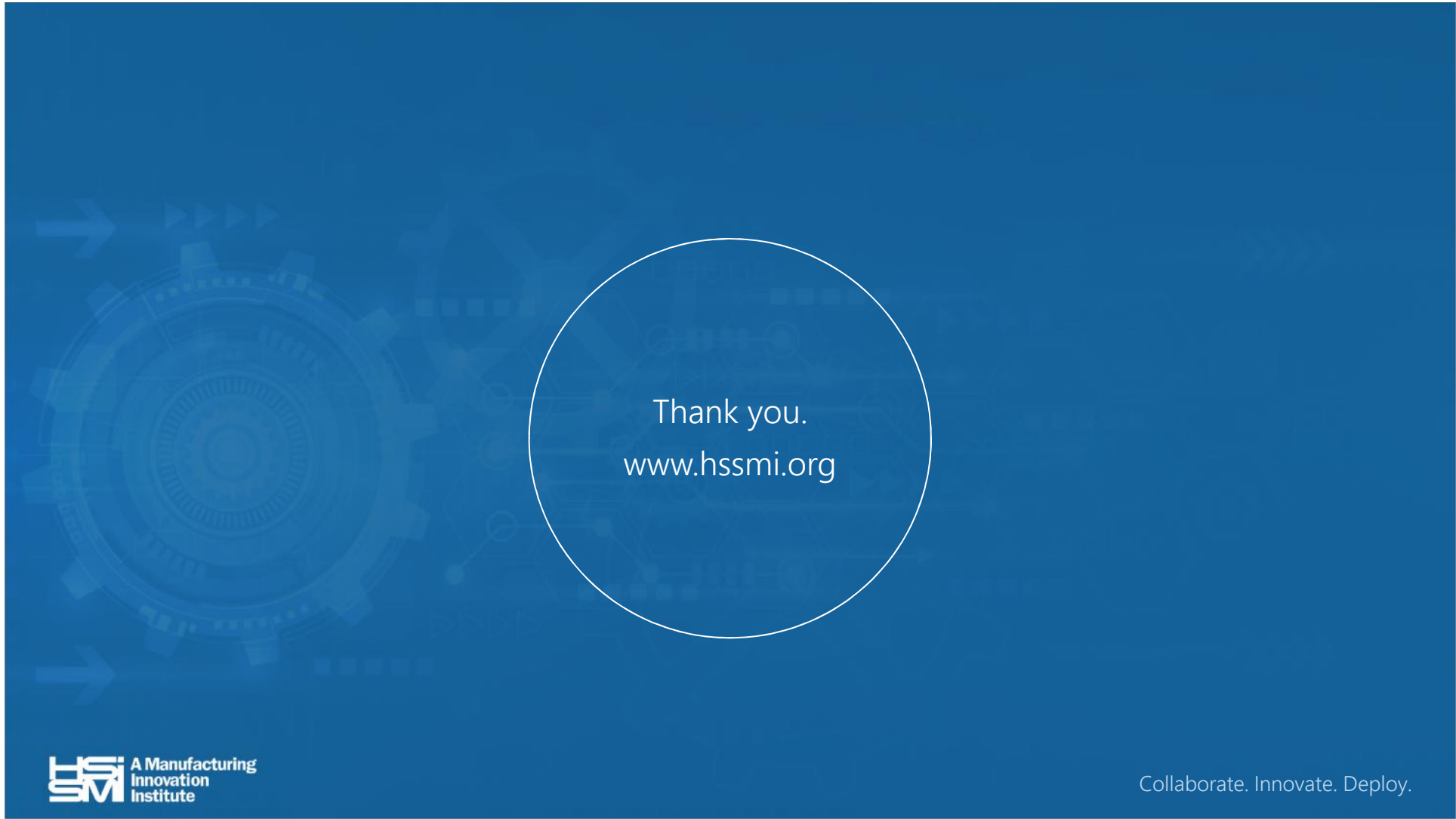
## Next Generation Propulsion Systems

Develop systems that can scale to volume

BoP design to lower the cost per unit

Design for UHV-AM - Product

Design for UHV-AM - Manufacturing



Thank you.  
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**cenex**