



# HP 500 Series Demo & Brunch and Learn

Jim Snodgrass, Sr Product Manager - Cimquest  
HP 3D Printing

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# But First...

## Who Is Cimquest?

- Serving design and manufacturing engineers since 1990
- 50 Employees
- Offices in MA, NJ, OH, PA, VA
- World leader in Mastercam CNC machining service, support and training
- 17 years working with additive systems
- Reverse engineering and inspection sales and service



All products supported in sales, service work, tech support and consulting / training



### CAD/CAM

Mastercam delivers CAD/CAM software tools for all types of programming, from the most basic to the extremely complex.



### 3D PRINTING

Take your 3D CAD designs from on-screen to in-hand with 3D Printing and Rapid Prototyping Solutions



### SCANNING & INSPECTION

Scanner hardware and software for reverse engineering, scanning and automated inspection.



### ENGINEERING SERVICES

Cimquest expert staff provides engineering services including design, program, 3D printing, scanning and reverse engineering services.



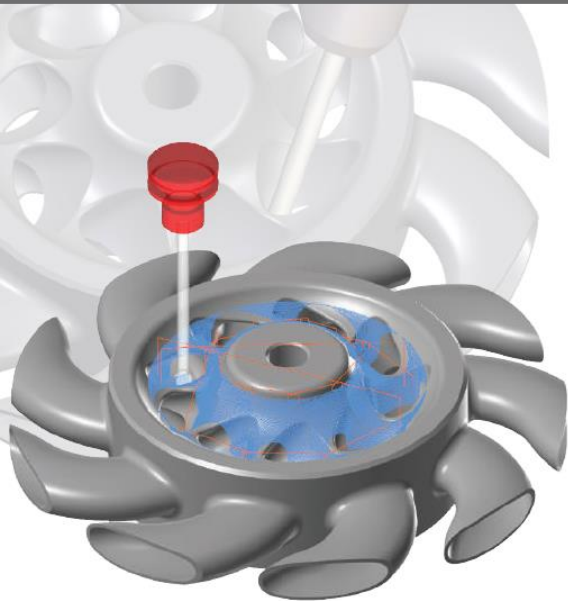


# Cimquest Tour (Branchburg, NJ Office)



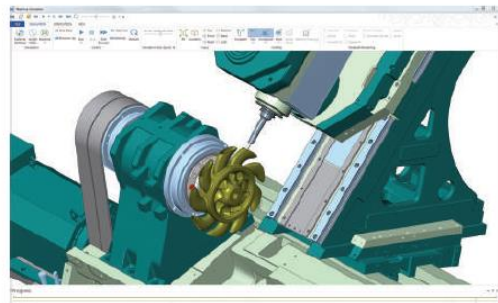


# World's Largest Mastercam Resource



## MASTERCAM

Our Mastercam CAD/CAM products offer remarkable application and budgetary flexibility. From basic to complex, these products enable you to achieve your goals effectively and efficiently. Our line comprises 2-axis machining, multiaxis milling and turning, wire EDM, router applications, free-form artistic modeling and cutting, 3D design, drafting, surface and solid modeling. The Mastercam suite of products programs more CNC machines than any other solution in the world – and is the most proven CNC programming system worldwide.



Smooth Tool Motion



Save Time & Money



Increased Tool Life



Cut Hard Materials

**20% - 75% faster cycle times.**

**Dramatically extended tool life.**

**Less wear on your machines.**

Mastercam's Dynamic Motion toolpaths deliver these powerful benefits while helping you get the most out of any machine - new or old. Mastercam has included Dynamic Motion technology for more than five years and they are constantly expanding it across the core of the Mastercam suite. That means the speed and efficiencies are built into the software.

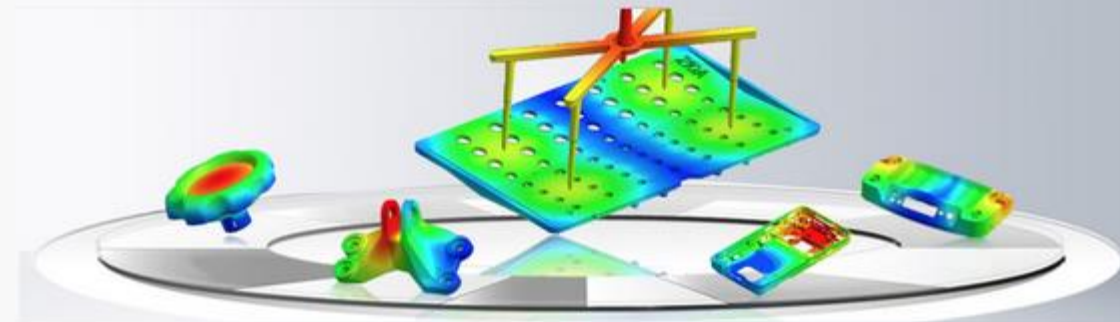
POWERED BY MASTERCAM'S  
DYNAMIC MOTION TECHNOLOGY



# 3D Scanning, Reverse Engineering, DfAM

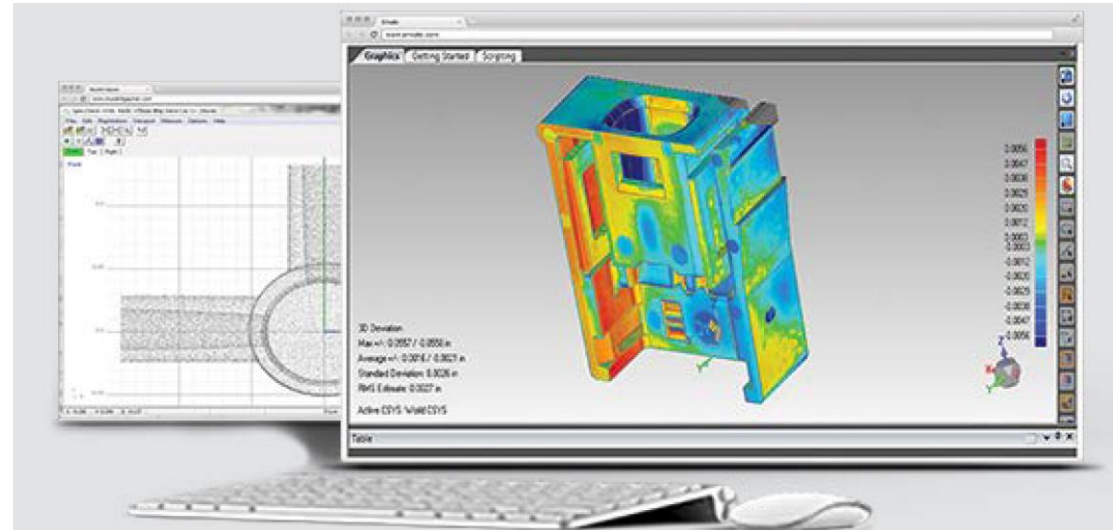
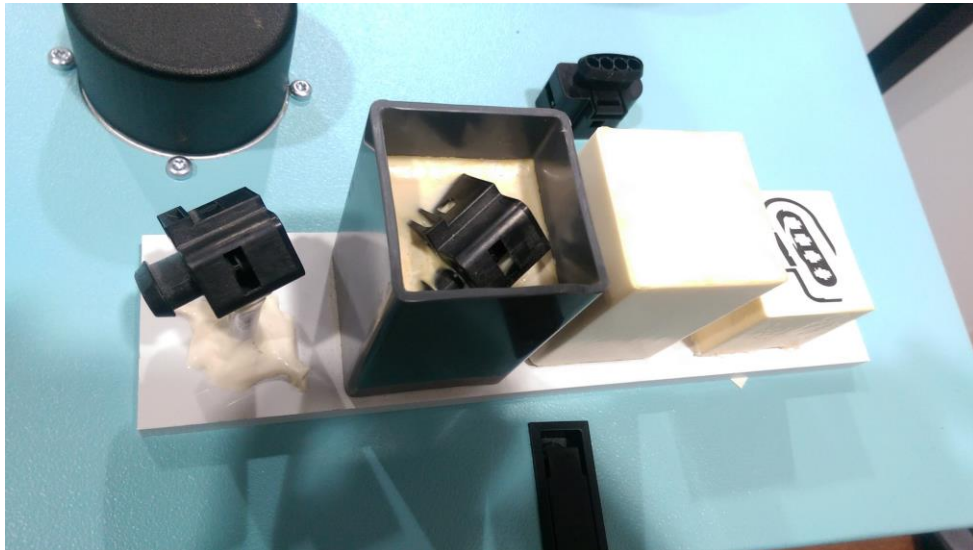
Practical functions include:

- Creating feature-rich, history-based CAD model from physical parts
- Generating 3D polygonal and surface models from point cloud data
- Metrology based inspection/reverse engineering
- Scan internal/external features of plastic parts and produce first article inspection reports

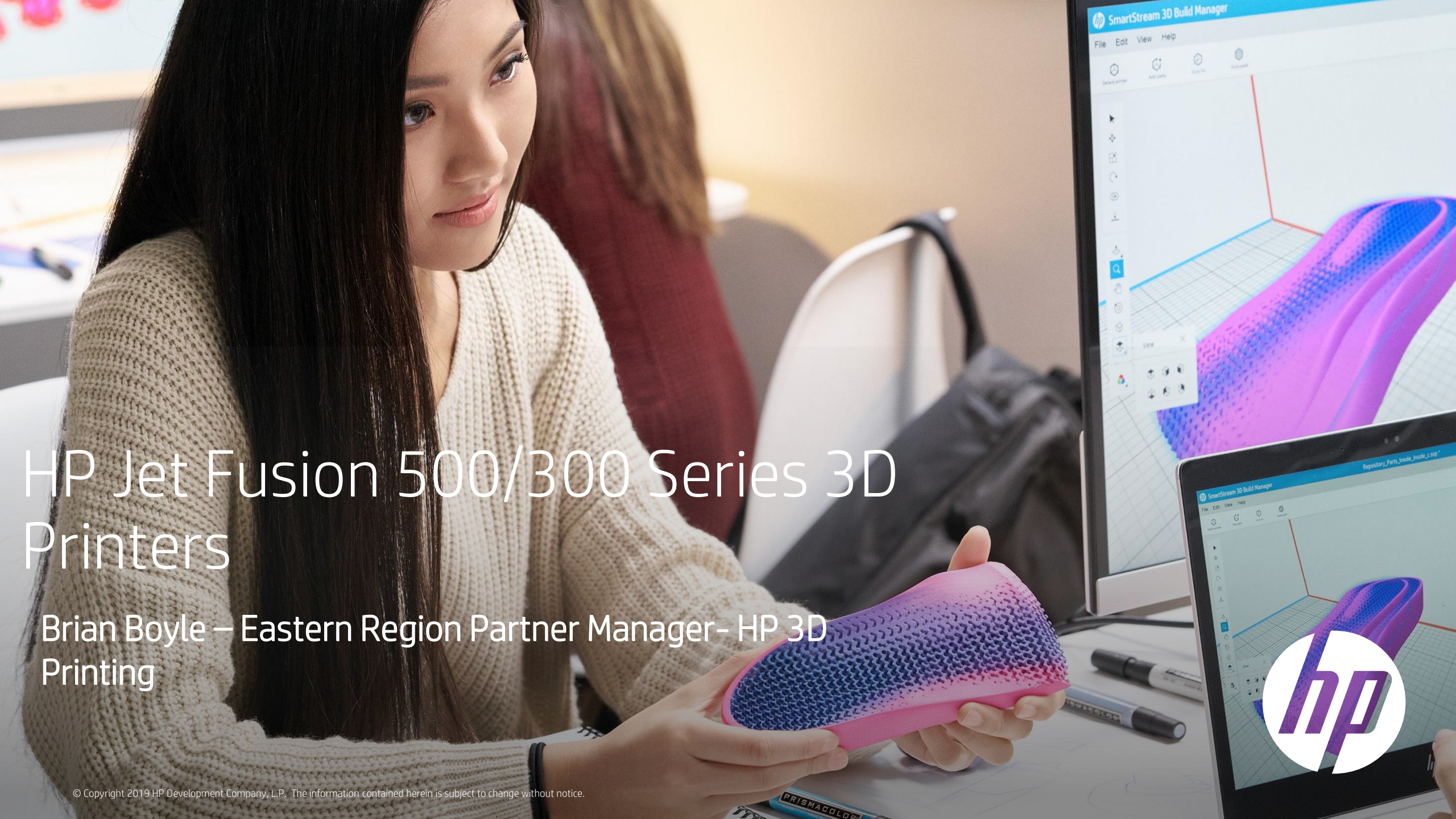




# IRIS 3D





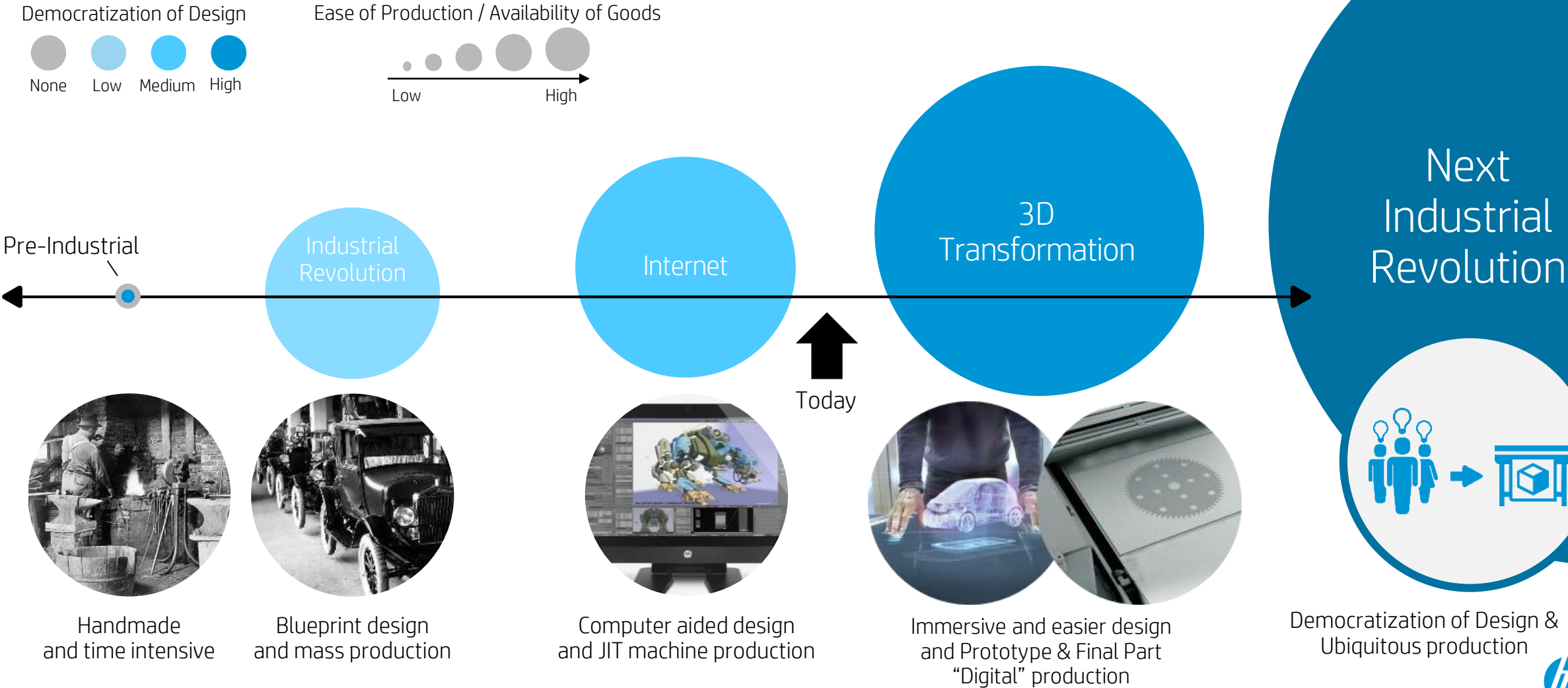


# HP Jet Fusion 500/300 Series 3D Printers

Brian Boyle – Eastern Region Partner Manager- HP 3D Printing



# Driving the next industrial revolution by reinventing 3D



# 3D Printing: Catalyst for the 4th Industrial Revolution

## DIGITAL INDUSTRIAL REVOLUTION



Artificial  
Intelligence



Industrial  
Internet  
of Things



Big Data and  
Analytics



Robotics



3D Printing

## TRANSFORMING \$12T MANUFACTURING MARKET



Rapid  
innovation



Shorter time  
to market



Less  
inventory



More efficient  
supply chains

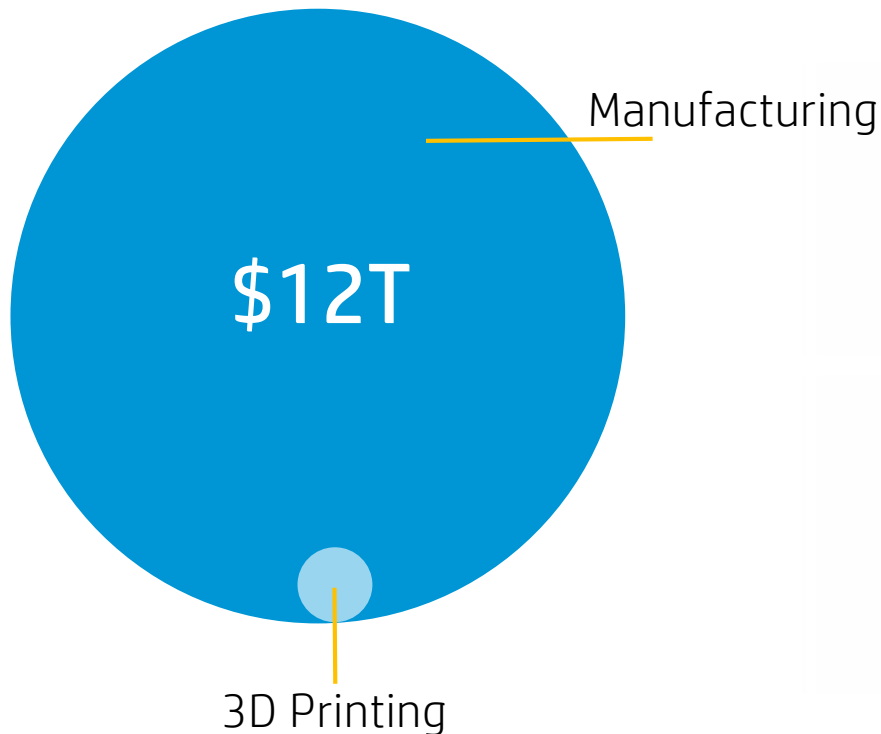


Higher capital  
efficiency



# Six levers to disrupt the \$12T manufacturing sector

MANUFACTURING SECTOR OFFERS  
GREAT POTENTIAL FOR 3D PRINTING

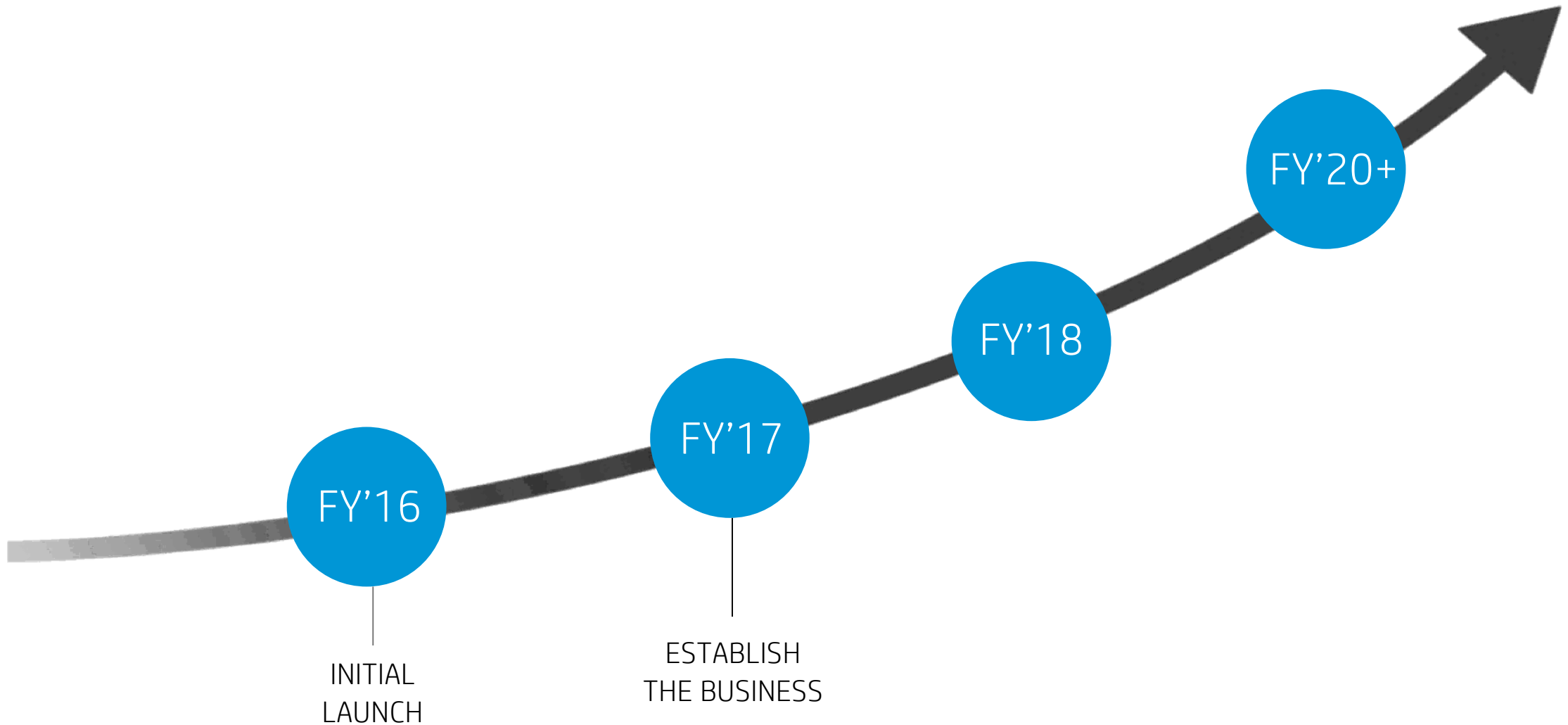


Source: Wohler's Associates

SIX KEYS TO TRANSFORM  
THE \$12T MARKET



# HP 3D Printing business roadmap



# HP Jet Fusion 3D 4200 Series Printing Solution

Functional parts

Up to 10 times faster<sup>1</sup>

At half the cost<sup>2</sup>

[1] Based on internal testing and simulation, HP Jet Fusion 3D average printing time is up to 10 times faster than average printing time of comparable fused deposition modeling (FDM) and selective laser sintering (SLS) printer solutions from \$100,000 USD to \$300,000 USD on market as of April, 2016. Testing variables for the HP Jet Fusion 3D 4210/4200 Printing Solutions: Part quantity: 1 full build chamber of parts from HP Jet Fusion 3D at 20% of packing density versus same number of parts on above-mentioned competitive devices; Part size: 30 cm<sup>3</sup>; Layer thickness: 0.08 mm/0.003 inches.

[2] Based on internal testing and public data, HP Jet Fusion 3D 4210/4200 Printing Solutions average printing cost per part is half the average cost of comparable fused deposition modeling (FDM) and selective laser sintering (SLS) printer solutions from \$100,000 USD to \$300,000 USD on market as of April, 2016. Cost analysis based on: standard solution configuration price, supplies price, and maintenance costs recommended by manufacturer. Cost criteria: printing 1 build chamber per day/5 days per week over 1 year of 30 cm<sup>3</sup> parts at 10% packing density under certain build conditions and part geometries using HP 3D High Reusability PA 12 material, and the powder reusability ratio recommended by manufacturer.

3D data courtesy of Invent Medical





# Driving the transformation to industrial-scale 3D manufacturing



Large build size  
for heavy production

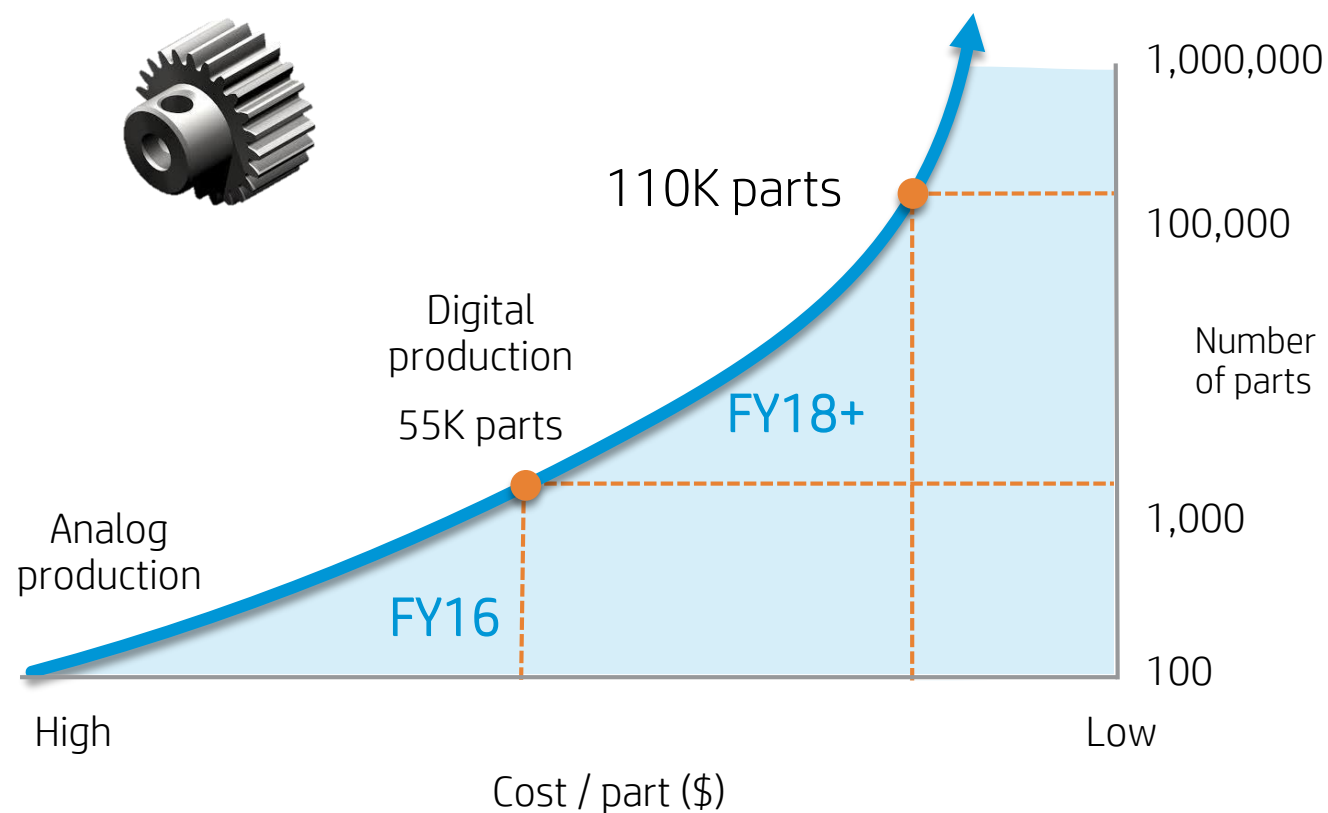


Continuous printing

Economics to disrupt  
manufacturing

# Significant momentum in the first year

Delivering breakthrough economics



Driving  
**material costs** down

Reducing  
cost-per-part (CPP)

Doubling  
break-even to **110K**



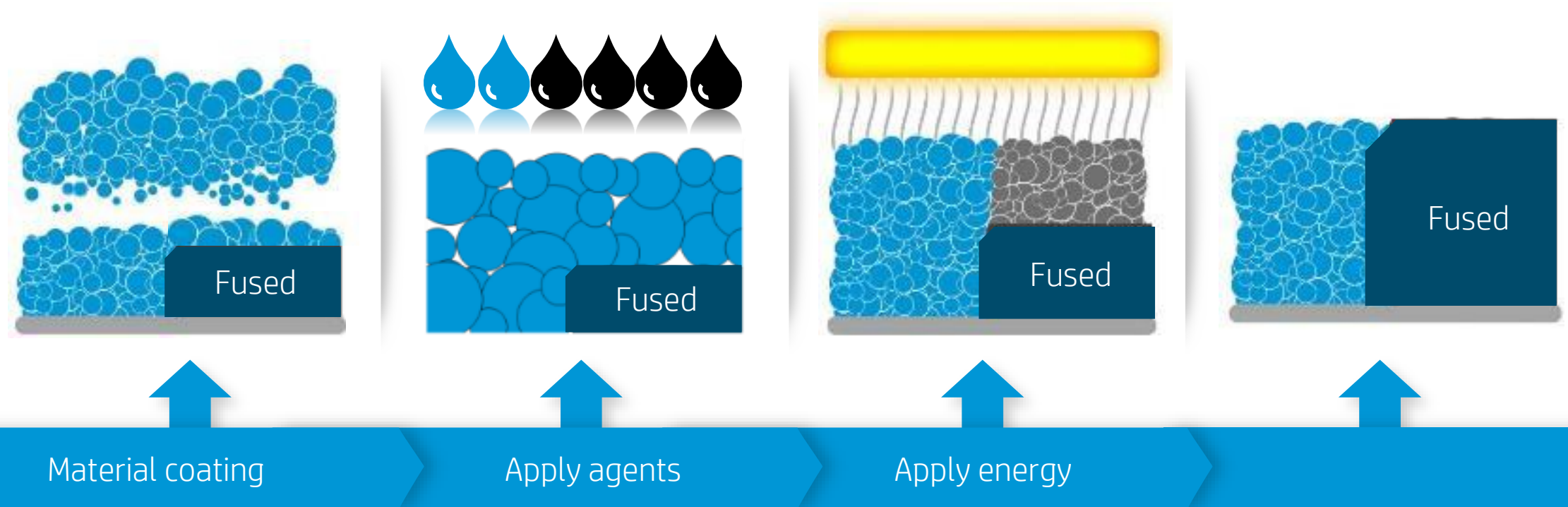
# HP MULTI JET FUSION TECHNOLOGY





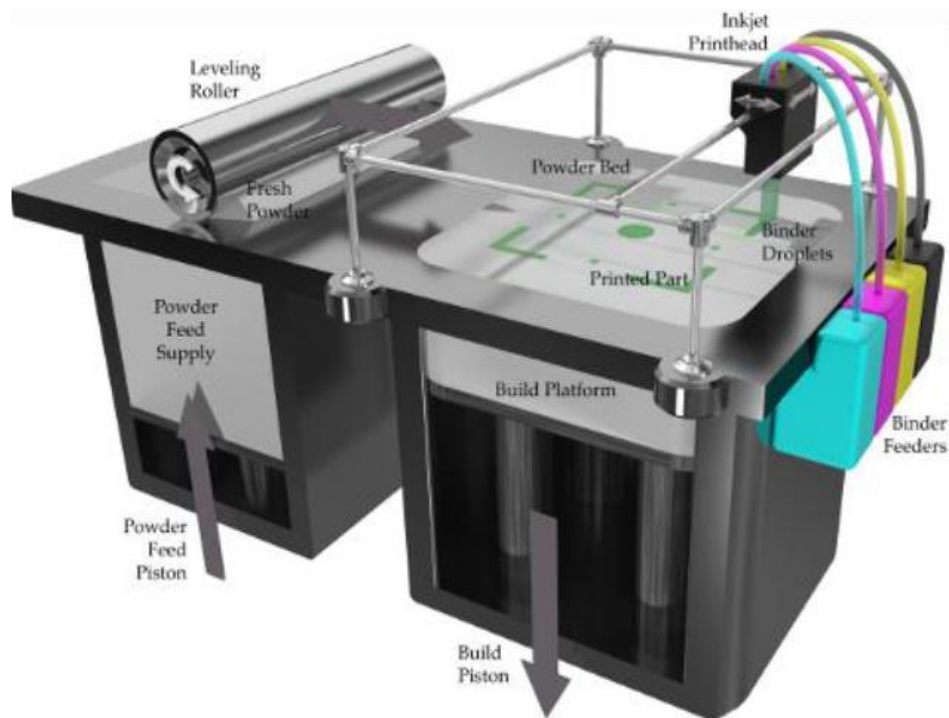
# HP Multi Jet Fusion platform

## Basic elements of the process

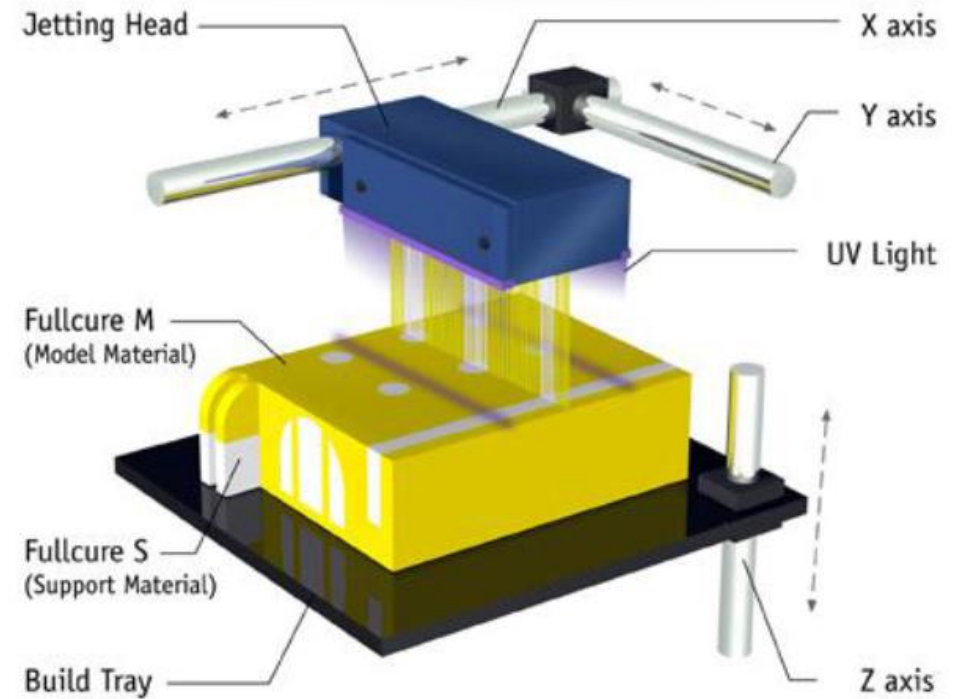


# Most common misconceptions about HP Multi Jet Fusion

This is **NOT**  
Binder Jetting!



This is **NOT**  
Material Jetting!







# INTRODUCING THE NEW HP JET FUSION 500/300 SERIES 3D PRINTERS





# HP Jet Fusion 580/380 Color 3D Printers

Produce functional parts in full color- with voxel control-in a fraction of the time<sup>1</sup>



The cost-effective HP 3D printing solution tailored small/medium-sized product development teams, design firms, and universities producing up to 100 parts per week.<sup>2</sup>

## Full spectrum color parts with voxel control

- Prototype and produce brilliant, full-color functional parts
- Optimal mechanical properties
- Up to 100 parts per week<sup>2</sup>
- Future-ready technology

## Accurate, functional parts with intricate detail

- Engineering-grade thermoplastic parts
- Fine detail, high dimensional accuracy
- Accurate, repeatable results

## Accelerate design—create, test, iterate in hours

- Multiple prototype iterations in the same time
- In-house, compact automated 3D printing
- Easy access to parts, reliable and predictable
- Prototype and final part production using the same technology.

# HP Jet Fusion 540/340 3D Printers

Accelerate your creation workflow—produce functional parts in a fraction of the time<sup>1</sup>



## Accurate, functional parts with intricate detail

- Optimal mechanical properties.
- Fine detail and high dimensional accuracy
- Accurate and repeatable results.
- up to 100 parts per week.<sup>2</sup>

## Streamline design—create, test, iterate in hours

- Multiple prototype iterations in the same time
- In-house, compact automated 3D printing
- Easy access to parts, reliable and predictable
- Affordable HP JF 3D Solution Service (incl. support and training)

## Print consistent white parts with voxel control

- Clean, white models.
- Future-ready technology.
- Prototype and final part production using the same technology.

The cost-effective HP 3D printing solution tailored small/medium-sized product development teams, design firms, and universities producing up to 100 parts per week.<sup>2</sup>



# Designed for convenient in-house automated production

Enclosed,  
automated  
material mixing,  
loading,  
and reclamation  
systems

Intuitive user interface



Full color with voxel-  
level control (580/380)

Designed for  
small/medium-sized  
product development  
teams, design firms, and  
universities producing up to  
100 parts per week<sup>1</sup>

## A fully integrated, compact design

A cleaner,<sup>2</sup> easy-to-use solution that integrates material mixing and loading, printing, and reclaiming material in one device.



# HP Jet Fusion 580/380 Color and 540/340 3D Printers



## Technical information

	Technology	HP Multi Jet Fusion technology
Printer performance	Effective building volume	580/ 540 printers: Up to 332 x 190 x 248 mm (13.1 x 7.5 x 9.8 inches) 380/340 printers: Up to 393 x 190 x 248 mm (10 x 7.5 x 9.8 inches)
	Layer thickness	0.08 mm (0.003 inches)
	Printhead resolution	1200 dpi
Dimensions (w x d x h)	Printer	61.6 x 37.6 x 59.3 inches (1565 x 955 x 1505 mm)
	Shipping	69.7 x 45 x 79.3 inches (1770 x 1143 x 2013 mm)
	Operating area	2785 x 2530 x 2440 mm (109.6 x 99.3 x 96 inches)
Software	Included software	HP SmartStream 3D Build Manager HP SmartStream 3D Command Center
	Supported file formats	3MF, STL, OBJ, VRML v.2
	Safety	NA (US & Canada): IEC 61010-1 compliant, NRTL certified; EU: Machinery Directive, EN 61010-1, EN 60204-1, EN ISO 12100 and EN ISO 13849-1 compliant
Certification	Electromagnetic compatibility	EN 55032:2012 Class A; CISPR 32:2012 Class A; FCC CFR 47 Part 15 Class A; ICES-003, Issue 6 Class A; EN 61000-3-12:2011; IEC 61000-3-12:2011; EN 61000-3-11:2000; IEC 61000-3-11:2000; EN 55024:2010; CISPR 24:2010
	Environmental	REACH compliant
Warranty & Service coverage included	One-year limited hardware warranty	

(1) Based on internal and third-party testing for HP Jet Fusion 580 Color and 540 3D Printers, printing and cooling time is a fraction of the time of the printing times of comparable plastic fused deposition modeling (FDM), stereolithography (SLA), and material jetting solutions from \$20,000 USD to \$120,000 USD on market as of June, 2017. Testing variables for the HP Jet Fusion 580 Color 3D Printer: Part quantity: 1 full build chamber of parts from HP Jet Fusion 3D at 10% of packing density versus same number of parts on above-mentioned competitive devices; Part size: 30 cm3; Layer thickness: 0.08 mm/0.003 inches. Competitor testing variables are comparable.



# Designed for...

## OEM R&D TEAM



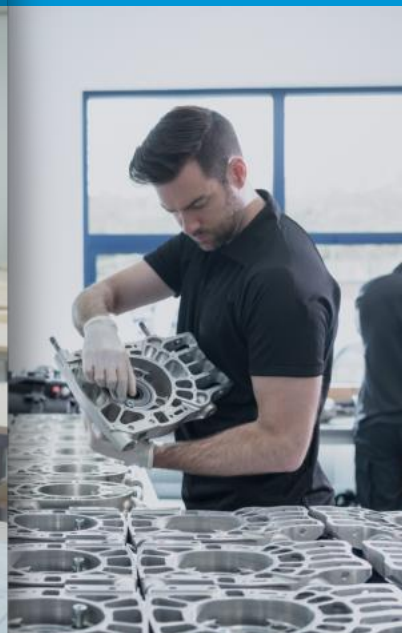
Accelerate time to market

## DESIGN FIRM



Refined printed parts  
that capture the  
client's vision

## CUSTOMIZED PART MANUFACTURER



An economical solution for  
short run end-use parts

## SERVICE BUREAU



Expand customer base  
with functional color  
part capabilities

## MANUFACTURING SUPPORT TEAMS



Robust jigs and assembly  
guides that maximize  
assembly line efficiency

## UNIVERSITIES



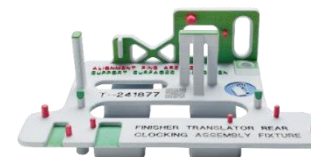
Expose students to a  
versatile and easy to use  
professional-grade system



Color presentation  
models



Visual aids



Color jigs  
and fixtures



Labels



Consumer goods  
Artwork / collectibles / jewelry



Thankyou!







Data courtesy of NACAR





keep reinventing





# HP 500 Series Demo

Neil Glazebrook - Sr Product Manager - Cimquest  
HP 3D Printing





# Applications

Jim Snodgrass- Sr Product Manager - Cimquest  
HP 3D Printing

# Nylon 12 Clip Supported 85 lbs under strict scientific conditions

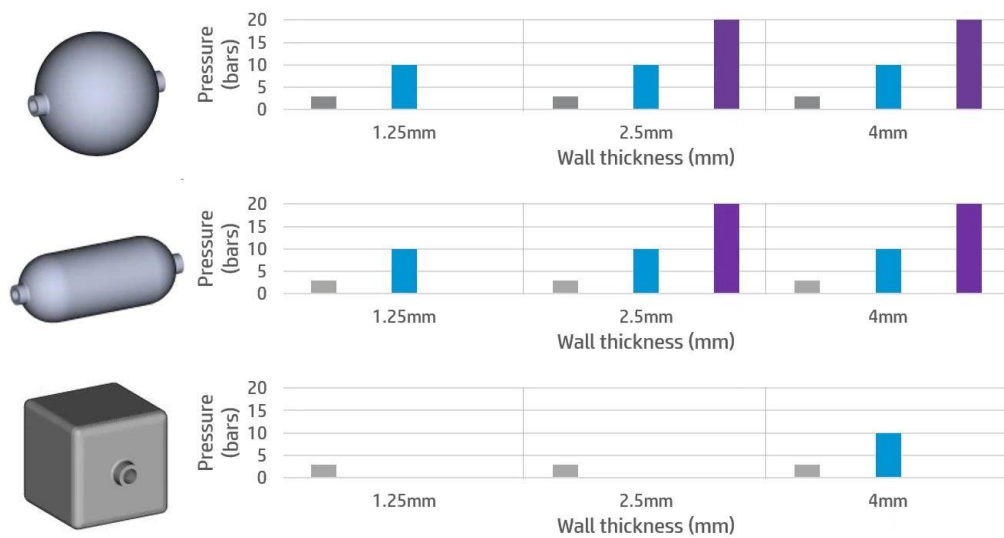




# Fluid Tightness / Pressure Testing

## Fluid tightness

### Water tightness results



Parts withstand pressure without breaking under the following conditions:

- Working time: 7h
- Temperature: 25°C
- Constant pressure

**NOTE:** Pressure range tested: 3-20 bars.



4mm Wall Sphere and Cylinder Held 20 Bar / 290 PSI

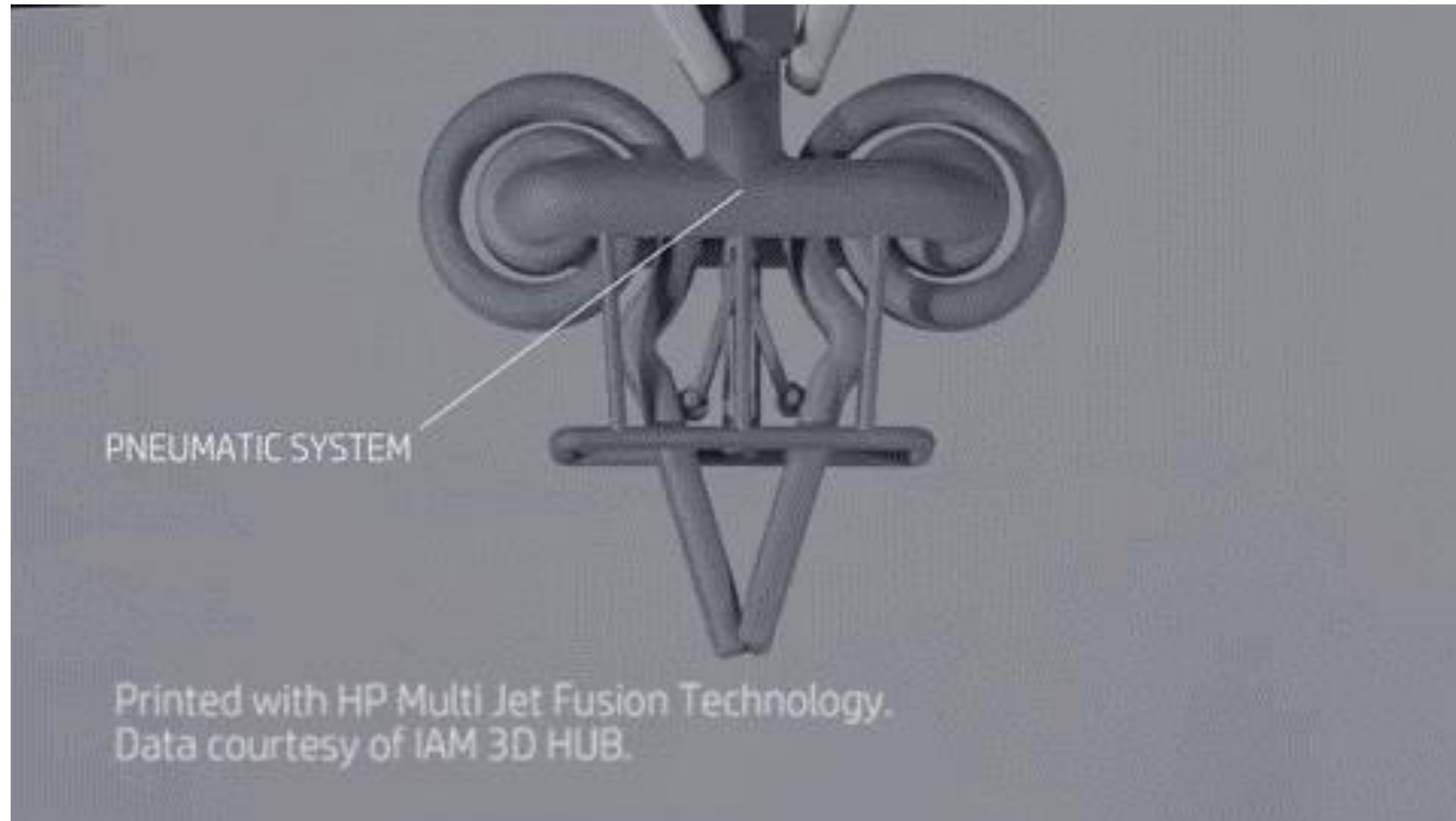


# Meta Materials

Stampato con HP Jet Fusion



## End of Arm Tooling



PA12 has high chemical resistance to a wide variety of commonly-used fluids in the industry. In the following table, the main groups of fluids that could be used with PA12 fluid vessels are listed:

Fluid	Chemical resistance
Diluted alkalis	Good
Concentrated alkalis	Good
Hot water	Neutral
Chlorine salts	Good
Alcohol	Good
Esters	Good
Ethers	Good
Ketones	Good
Aliphatic hydrocarbons	Good
Motor oil	Good
Aromatic hydrocarbons	Good
Toluene	Good
Unleaded petrol	Good
Dot 3 brake fluid	Good
Chlorinated hydrocarbons	Neutral
Trichloroethylene	Neutral



# HP MJF – Pre-series

Piusi



PIUSI K400 meter



Pro

Aluminum – original version for Gasoline, Diesel, and Kerosene.

HP MJF HR PA12 – redesigned parts for Adblue



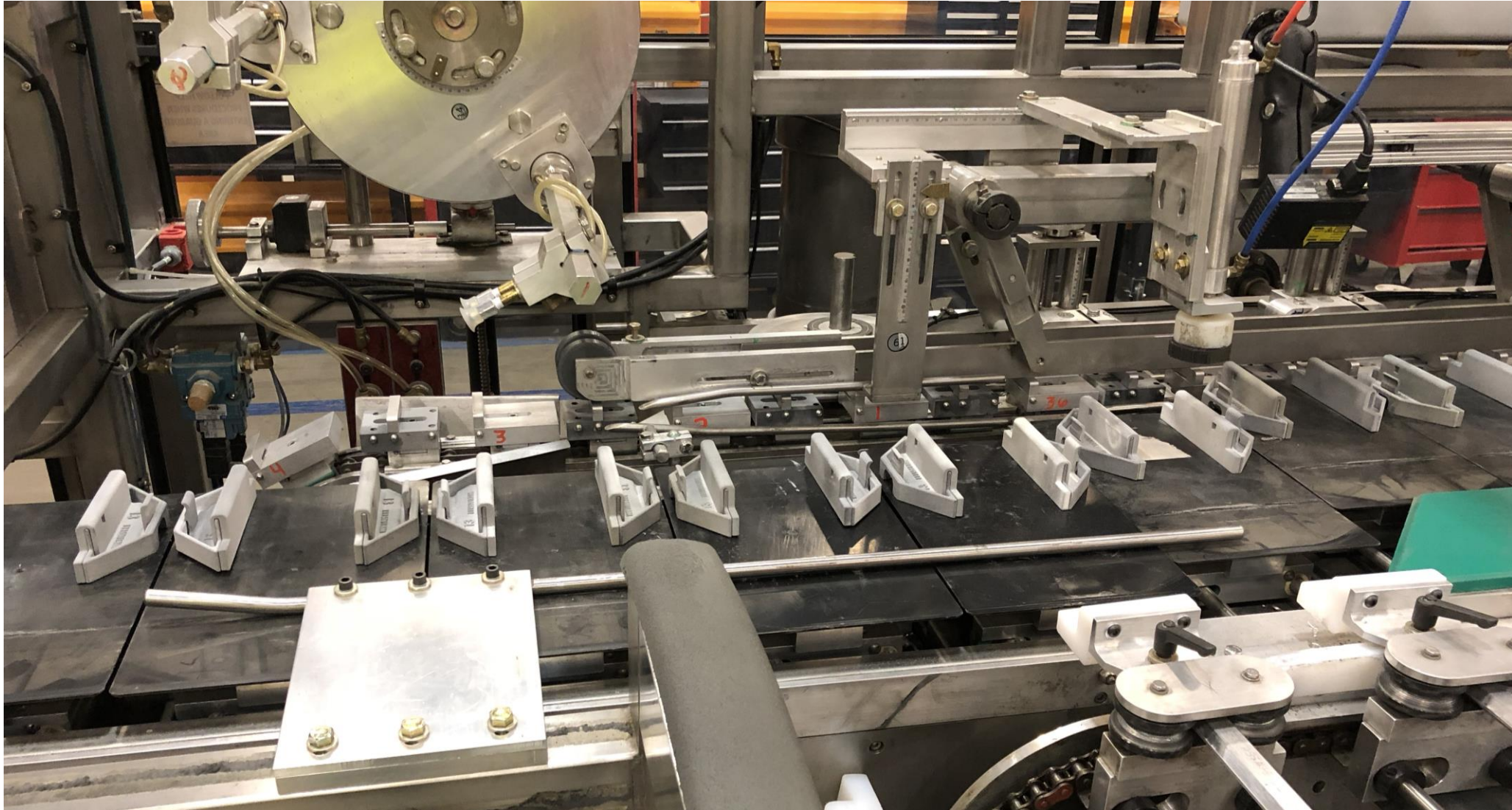
# HP 3D Printing Workholding for Matsuura 5 Axis CNC Machining 2019 (Youtube)





# Tooling Application

## Package insertion line



# HP Supplies packaging lines

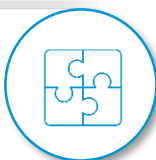
## Chain plate redesign

### Challenge



Combining 3 parts into 1

### Application



Chain plate redesign

### Benefit of MJF



Estimated 20% savings

Shorter lead time

Weight reduction (30%) (potential weight reduction on motor of 4 kg of 32 part)

Elimination of vibrations caused by screws

	Conventional	HP 3D print with MJF
PRODUCTION	PLASTIC CNC	HP MJF
COST SAVINGS		Est. 20%
LEAD TIME	30 days	3-5 days





# HP Supplies packaging lines

## Break/fix application: Part failure on a production line

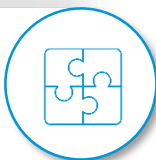
### Bearing

#### Challenge



A bearing failed on a label applicator causing two aluminum pulleys to be damaged beyond repair. These pulleys are not included in the normal spares inventory.

#### Application



Bearing. Fully functional spare parts on demand.

#### Benefit of MJF



Over 60% savings  
Production line back in operation two days faster, avoiding opportunity cost. Printed parts are exhibiting the same strength as conventional parts.

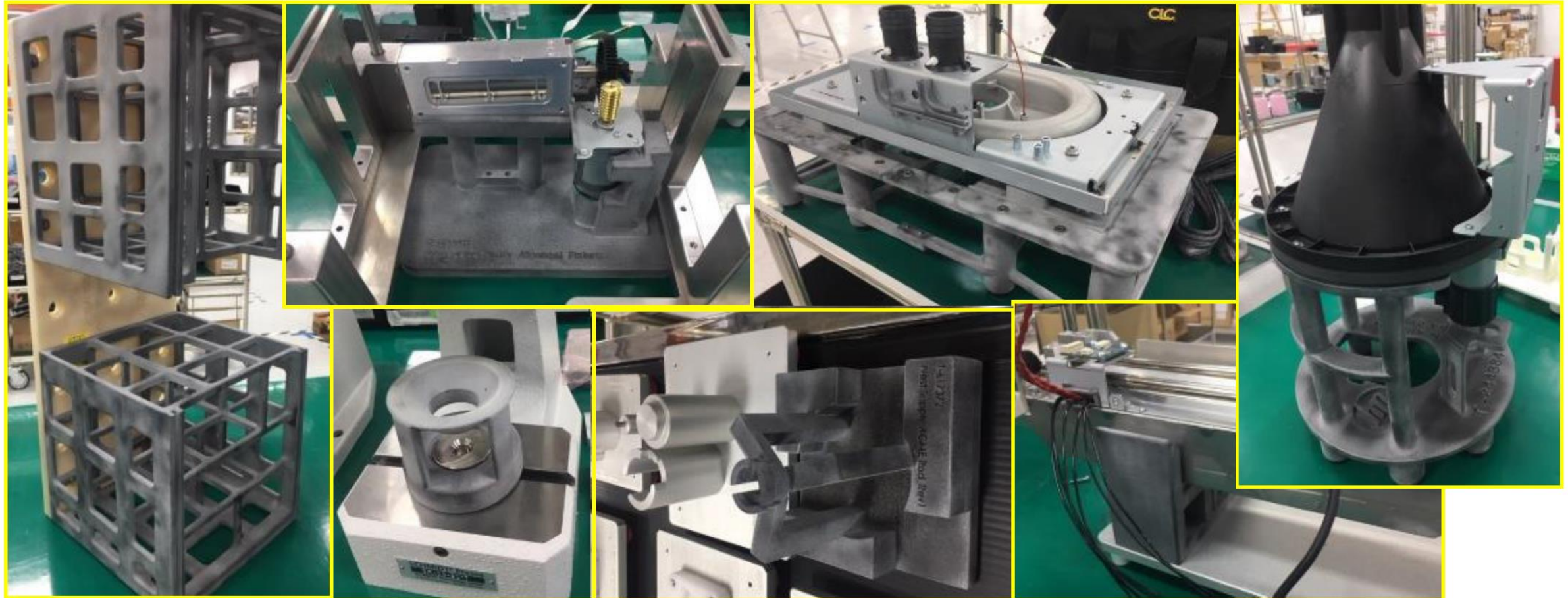
	Conventional	HP 3D print with MJF
PRODUCTION	CNC METAL	MJF
COST SAVINGS		Over 60%
LEAD TIME	3 days	16 hours



# Manufacturing Aids

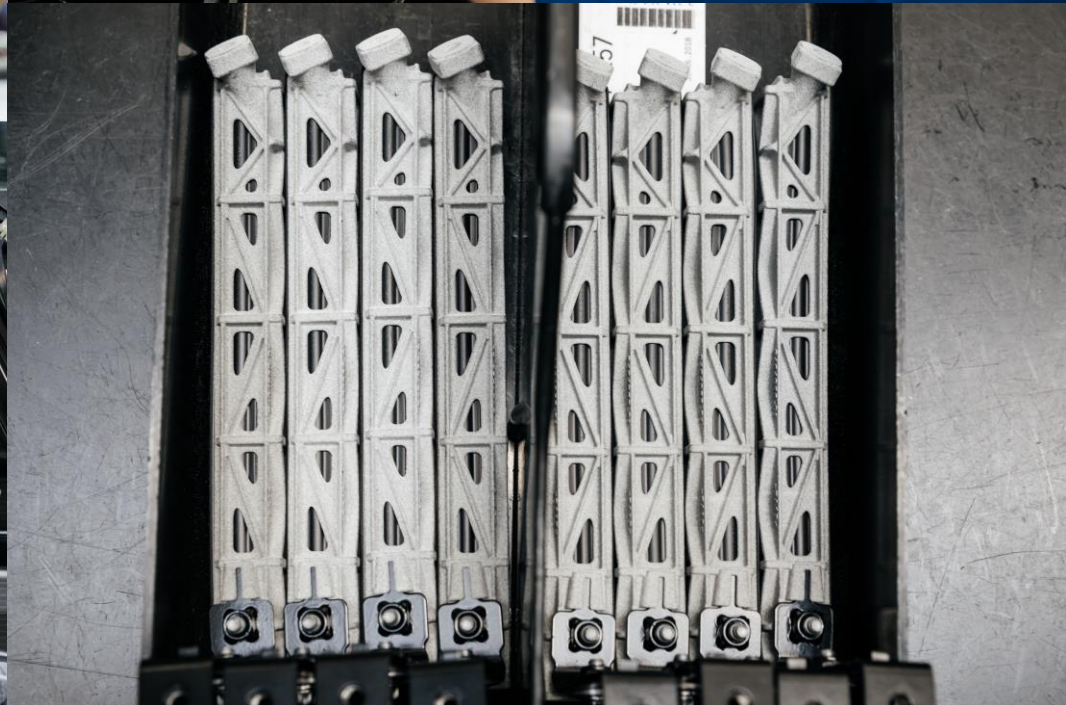
Specialized tools used in the manufacturing process

Over 80 manufacturing aids have been implemented into the multi-jet fusion machine production line.





# BMW i8 Two HP Production Parts



# HP Latex 1500 Large Format Printer





# HP Latex 1500 final part for color calibration

50%

Cost reduction<sup>1</sup>

93%

Weight reduction<sup>2</sup>

95x

Carbon footprint reduction<sup>3</sup>

## Design evolution

Aluminium machined  
Traditional design



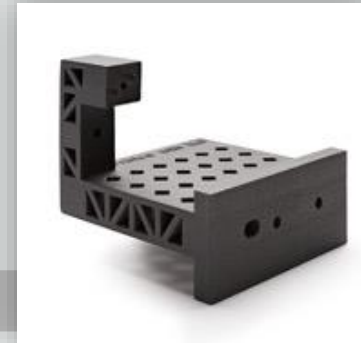
355g

Plastic 3D Printing  
Block design



80g

Plastic 3D Printing  
Light design



55g

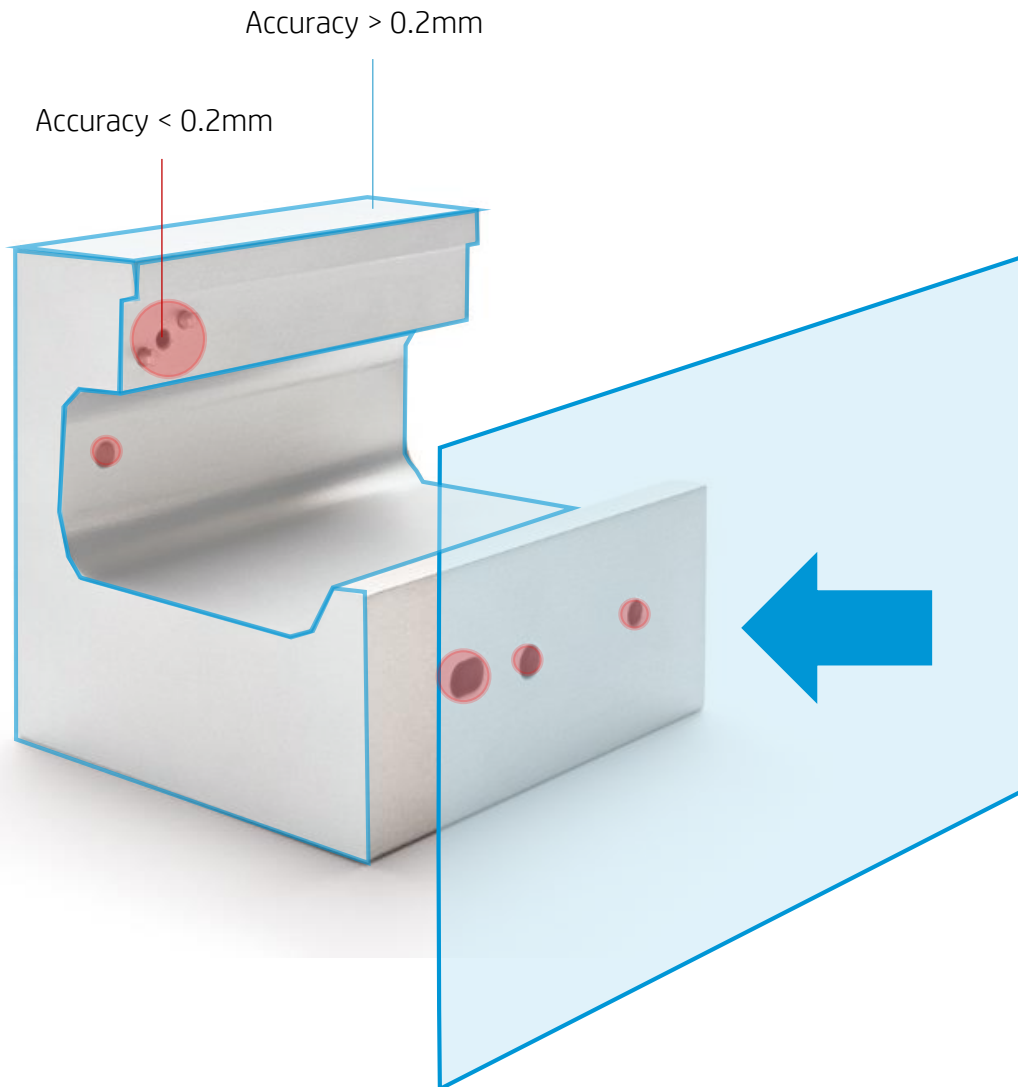
Plastic 3D MJF Printing  
Topological design



23g

1) Cost reduction calculated based on: Aluminium machined part = \$22, MJF part = \$11 (2) Weight reduction calculated based on: Aluminium machined part = 355g, MJF part = 23g

3) Carbon footprint reduction calculated based on: Aluminium machined part carbon footprint: 19.7 kg CO2 eq. MJF part carbon footprint: 0.97 kg CO2 eq



## High Dimensional Accuracy Hybrid Production

High Precision is  
frequently not  
required in all sides



# Three Areas Where 3D Can Respond

1 Forward Operating Base (FOB)

2 Army Field Service Battalion (AFSB)

3 HQ (Depot, DLA, APG...)

Example: If a wheel gets blown off:

- 1) Fast rough replacement to get vehicle out of there
- 2) Where wheel is properly replaced
- 3) Where they re engineer or re deploy to make sure wheel can't get blown off

# FOB to AFSB Coordination

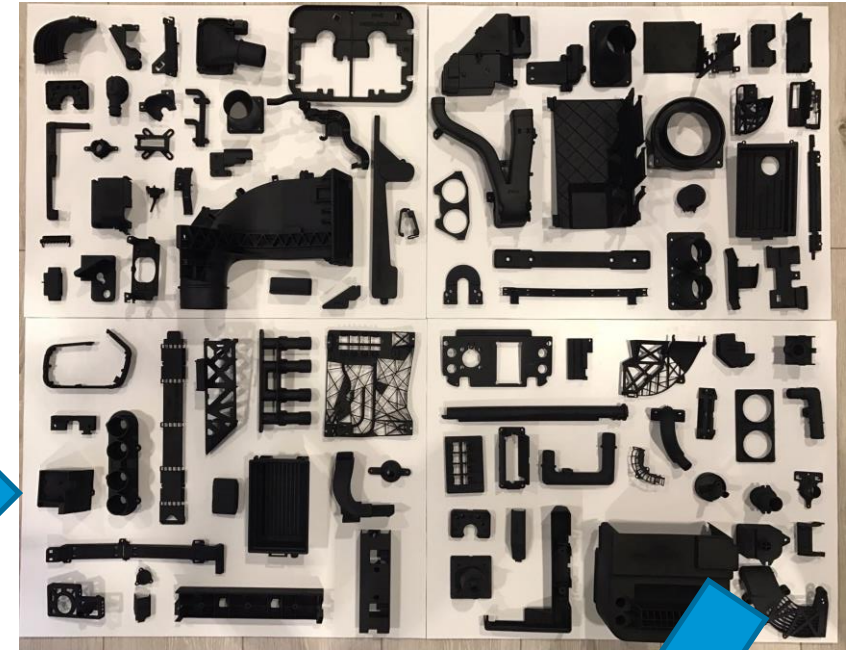
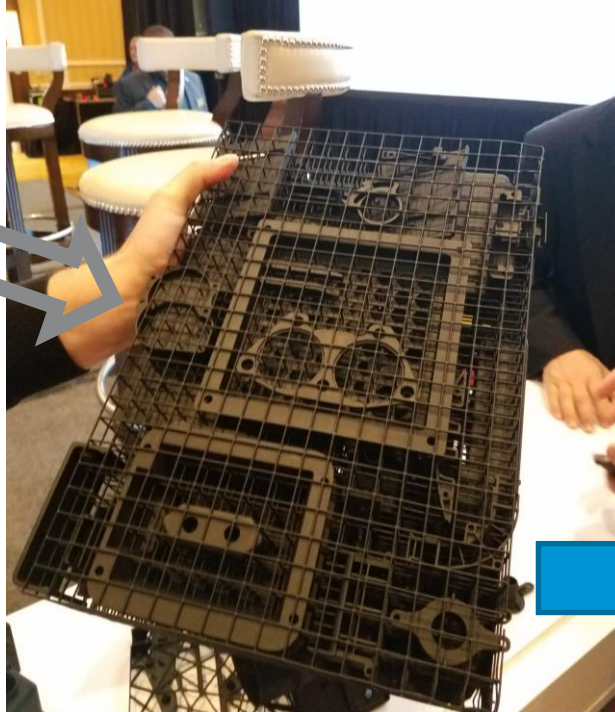
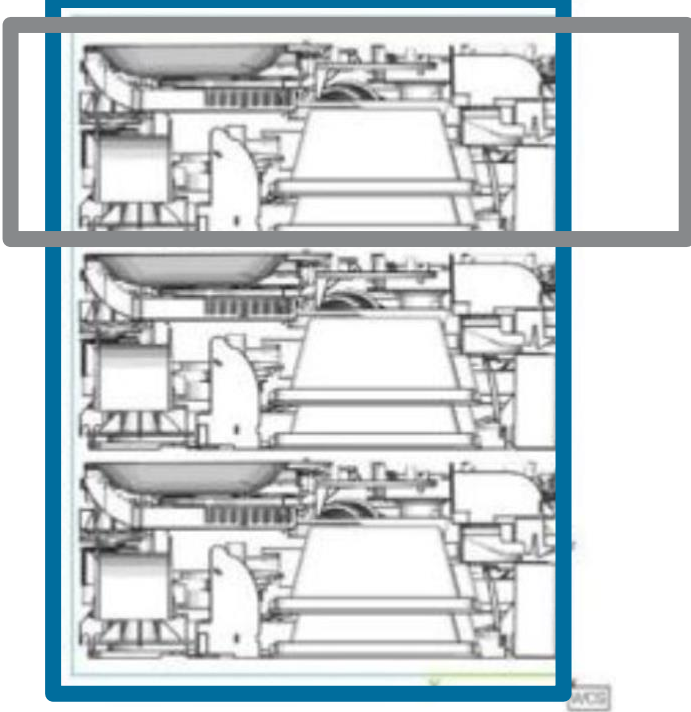
**Figure 5: Army Valve Stem Cover Additively Manufactured for Interim Solution**



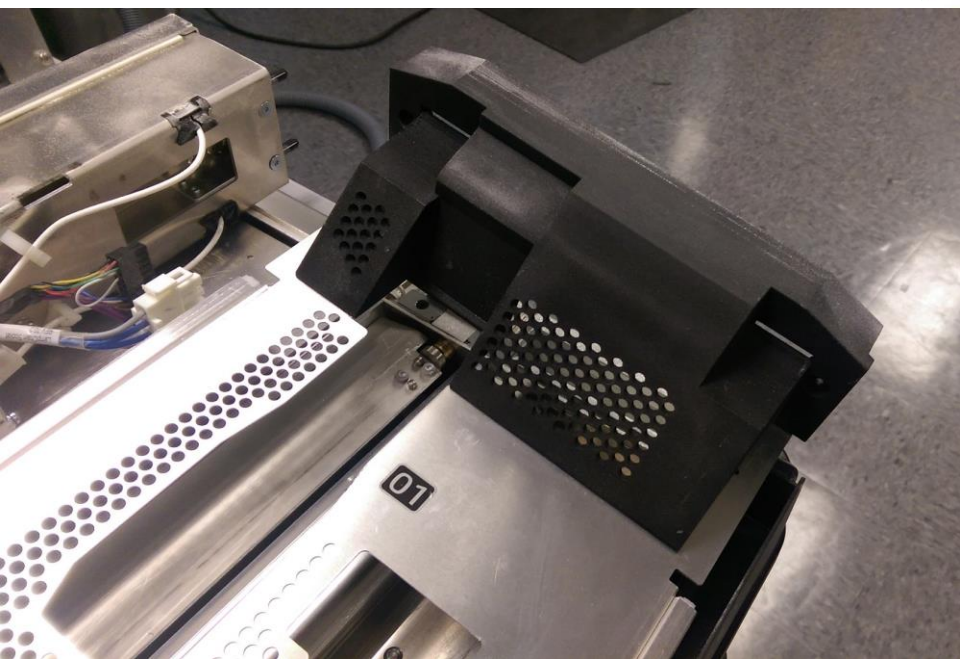
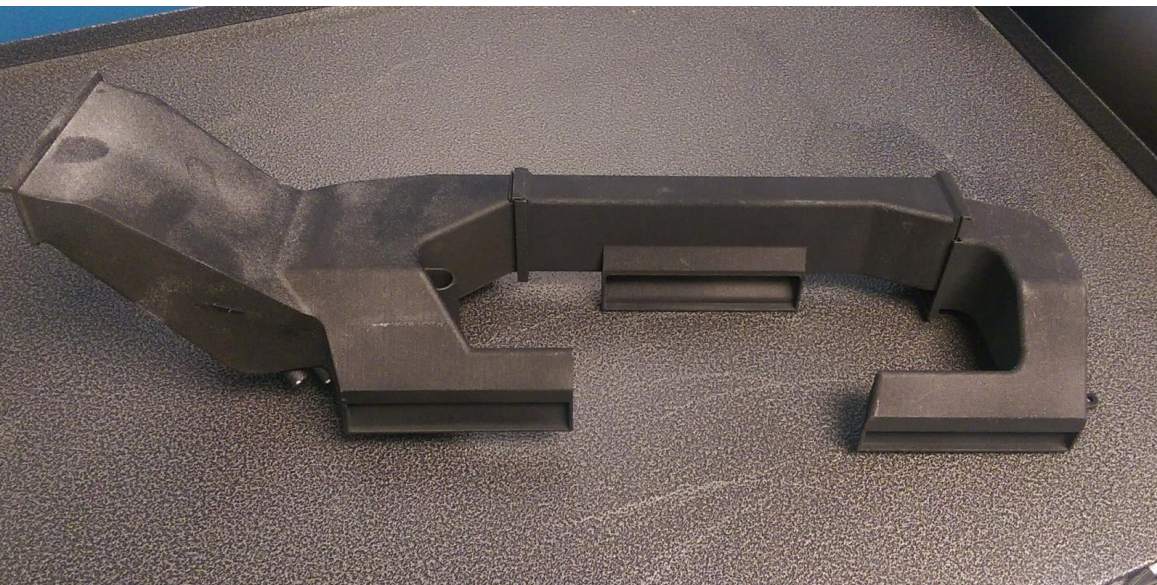
The Army additively manufactured versions 1 through 4 of the covers before a final part was produced through conventional manufacturing (shown in version 5).

Source: Department of Defense (DOD). | GAO-16-56











## Reduced cost using MJF

- MJF reduces lead time from 6 weeks (IM) to 3 days (MJF).
- New part design improves part functionality by increasing air flow (+22%)
- MJF “one part design” reduces the failure metrics on top line due to assembly and leakage issues.
- MJF manages the investment on mass production, equipment and tooling, enabling the pre serial or bridge part for end customer.

Cost comparison	Injection molding	MJF
Part components	6	1
Parts per year	3.000	3.000
Tooling cost	\$140,000	-
Leakage test equipment	\$50,000	-
Part cost	\$5.88	\$26.10
	\$ 2	NA
	\$0,80	NA
	\$29,79	\$26.10

## Injection molding



MJF



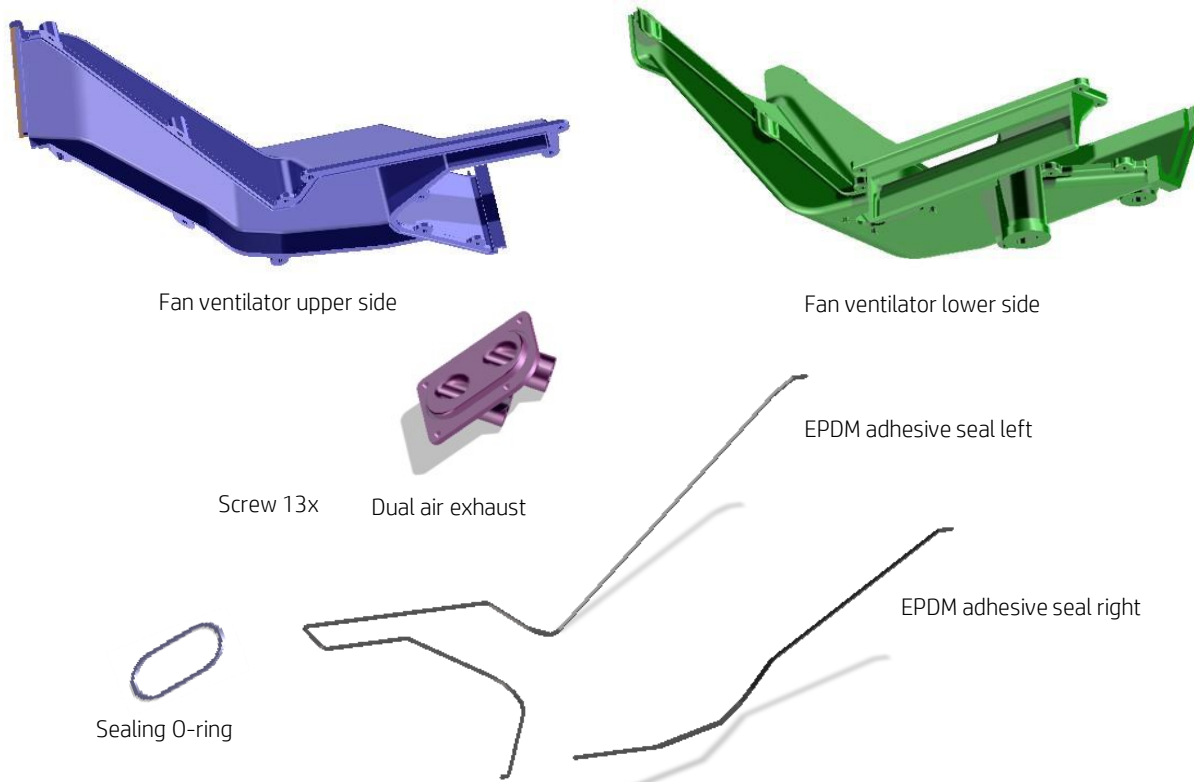
contained herein is subject to change without notice

# Jet Fusion Fan Ventilator: Traditional Design & Manufacturing vs. 3D printed

## Traditional Design & Mfg

6 parts + 13 screws + Assy & testing

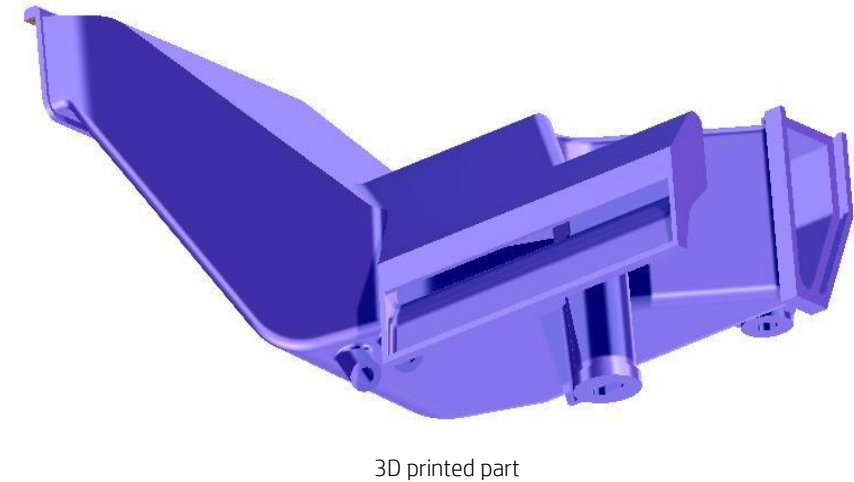
\$194 (600u/year, incl. tooling amort. in 1y)



## 3D printed integrated design

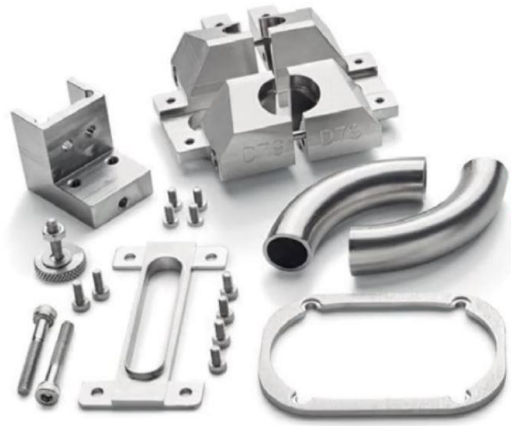
1 Part

\$96 (600u/year, HP 3D MJF)

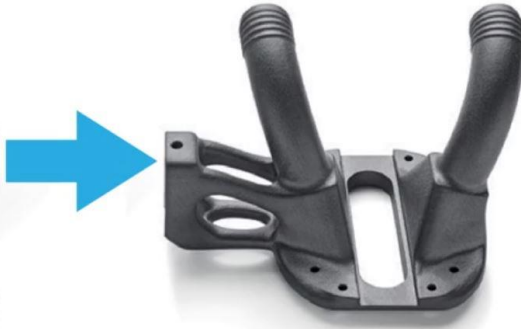




## CNC



## MJF



## Tooling - Tube Bending Tools

Company background:

Sag Tubi is an innovative company focused on pipe solutions since 1969.

Challenge:

They use a tube bending process to create fluid systems and pipes.

This process requires significant work, as well as:

- Tools to bend the tubes and make fixtures
- Moulds to check the tubes curvature and shape

These tools are usually made of metal, produced with CNC machines.

With HP MJF, they can:

- Create lighter tools and moulds
- Reduce their production costs and time



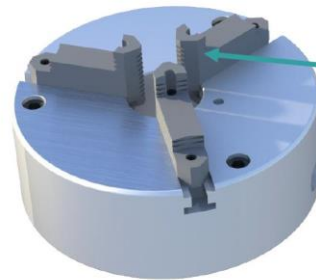
HP MJF bending mould



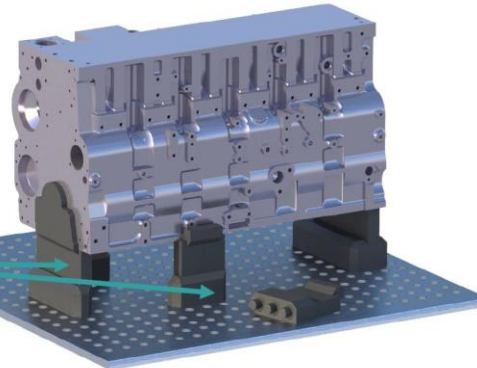
HP MJF checking fixture mould

## Additive Manufacturing in the Part Manufacturing Process

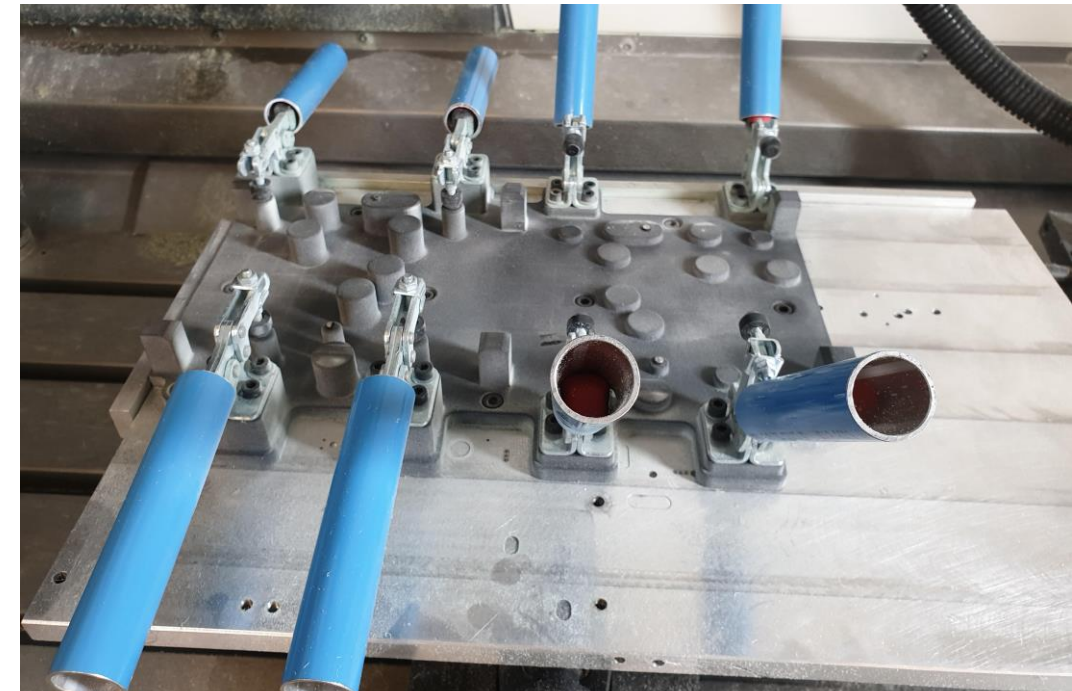
- Custom, exact sized grippers and holders
- Fixtures for machining and validation
- Solid hold without concern of marring work parts



A lathe chuck with 3D printed plastic grippers



3D printed mounts for part validation





THE CUSTOMER

# MOTOR L'ESCALA RACING TEAM

The Motor L'Escala Racing Team, is a motorsport team located in L'Escala, Girona (Spain).

The team is one of the participants at the yearly amateur Panda Raid rally competition. It is a long distance resistance rally, held yearly in March. More than 350 teams join the competition with an old school and customized Fiat Panda or Fiat Marbella racing car. It takes place from Madrid (Spain) to Marrakech (Morocco) in 7 stages.



INDUSTRY SEGMENT: Mobility & Transportation

INDUSTRY SUB-SEGMENT: Motorsports

3D PRINT MAIN BENEFIT

- Performance
- Customization
- Cost Reduction
- Time Reduction

WHY 3D PRINT CUSTOMIZATION

There were no other manufacturing alternatives to 3D Printing technology to create those customized and single run production parts. The team was able to design the parts just as they needed. Otherwise they would had to use original parts and apply too much modifications and tunnings to the got the parts that fulfill their needs.

WHY MJF AIR TIGHTNESS

As HP MJF has the best performance in fluid thightness, the team relied on this technology to ensure that the parts performed consistently well along the competition and the most weather and terrain extreme conditions.

CHALLENGE OF THE CUSTOMER

The team used a car configuration in previous editions of the competition that work well, but they wanted to upgrade the engine by changing the former one for

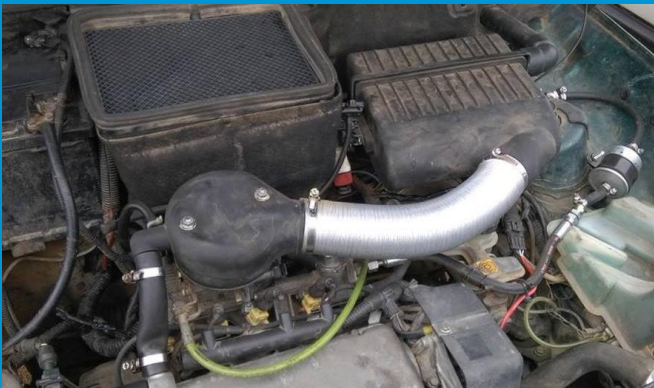
FINAL PART APPLICATION

# AIR FILTER SYSTEM (BOX & DUCTS)

- MATERIAL  
HP 3D HR PA 12
- POST PROCESSING  
Bead Blasting

Those new customized parts are the Filter Cover, the Filter Housing and the Collector.

The parts are required to perform under high temperatures as them are placed under the hood of a racing car facing extrem weather conditions along the whole competition, and in special during those stages crossing desartic areas of Morocco.



# THERMAL ANALYSIS

MESUREMENT CONDITIONS

- Engine temperature stabilized at 90°C (engine coolant), as per car's sensor measurement. No driving done in the car (no forced air circulation in engine compartment)
- Measurements taken with room temperature of 15°C
- For every picture, engine compartment was left with car bonnet closed for heating up, opening it just before the picture was taken
- Camara emissivity set to 1. Depending of the real emissivity of the materials, temperature might be slightly underestimated (dirty steel [engine] has emissivity value close to 1, MJF parts are supposed to have values close to 0,95 [test pending].



Measurements	
Sp1	67,6 °C
Sp2	68,6 °C
Sp3	68,7 °C
Sp4	71,5 °C
Sp5	39,3 °C
Sp6	32,1 °C
Sp7	37,0 °C
Sp8	38,0 °C
Sp9	37,6 °C
Sp10	38,6 °C
Sp11	39,9 °C
Sp12	37,3 °C
Sp13	34,4 °C



Measurements	
Sp1	69,0 °C
Sp2	49,1 °C
Sp3	78,6 °C
Sp4	55,2 °C
Sp5	78,6 °C
Sp6	55,4 °C
Sp7	81,5 °C
Sp8	33,9 °C
Sp9	35,5 °C
Sp10	23,2 °C
Sp11	24,6 °C
Sp12	24,7 °C

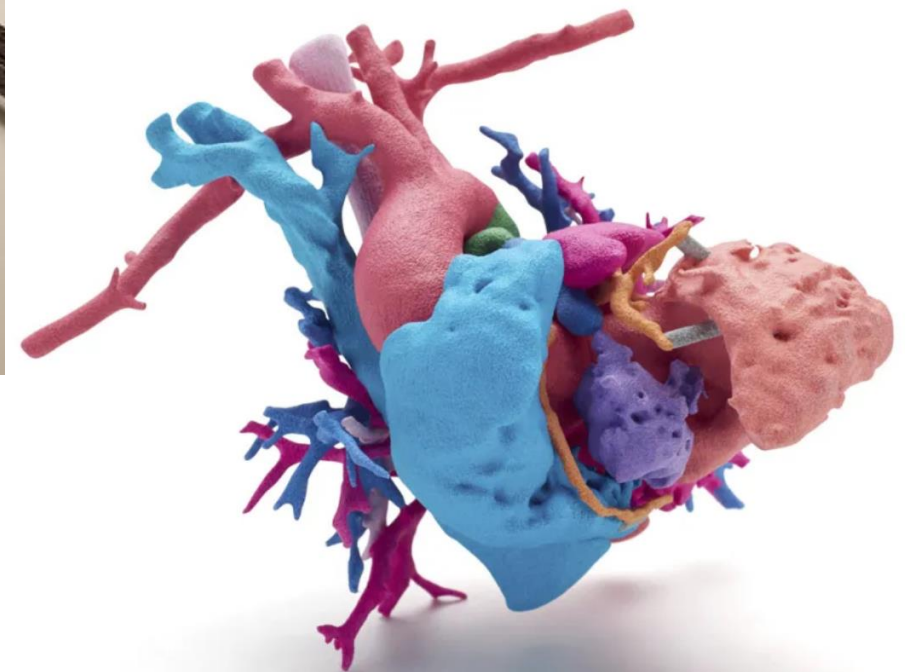
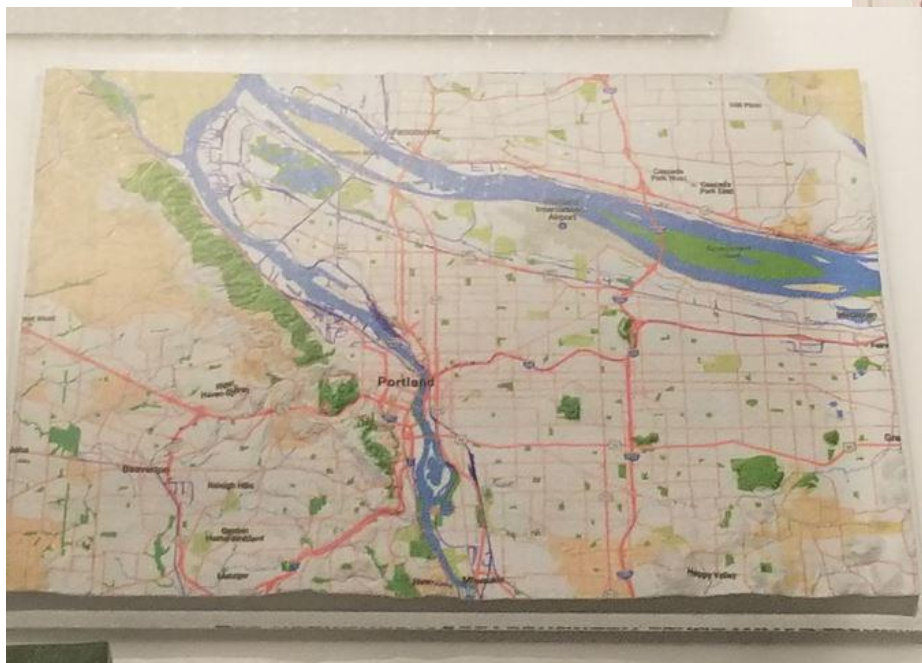
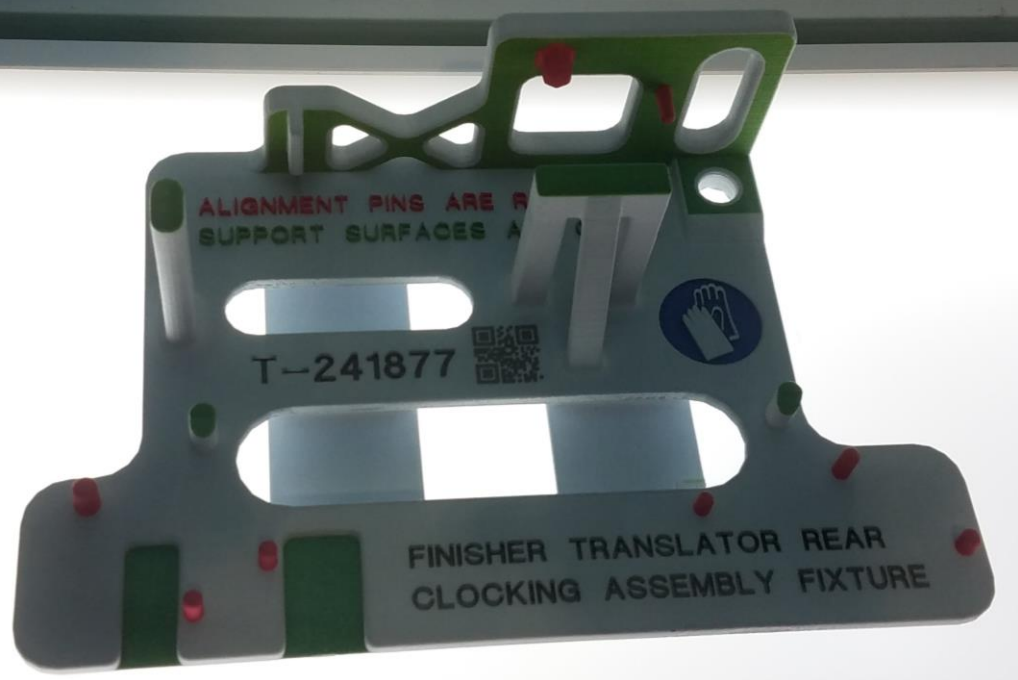
Thermal properties  
**Also Strong  
at Cryo  
Temps**

Heat deflection temperature (@0.45 MPa, 66 psi), XY, XZ, YX, YZ	174 °C/345 °F	ASTM D648 Test Method A
at deflection temperature (@0.45 MPa, 66 psi), ZX, ZY	175 °C/347 °F	ASTM D648 Test Method A
at deflection temperature (@1.82 MPa, 264 psi), XY, XZ, YX, YZ	114 °C/237 °F	ASTM D648 Test Method A
at deflection temperature (@1.82 MPa, 264 psi), ZX, ZY	120 °C/248 °F	ASTM D648 Test Method A



# Bowman Bearing: HP 3D Printed PA 11 Bearing Housing



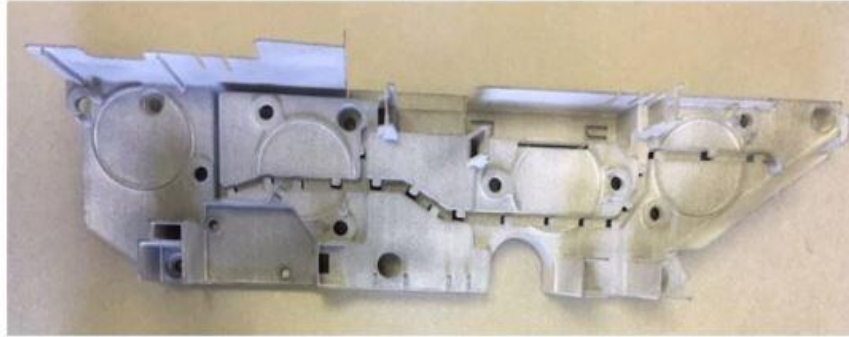






## MJF Version

- Delivery Time = 3 Days



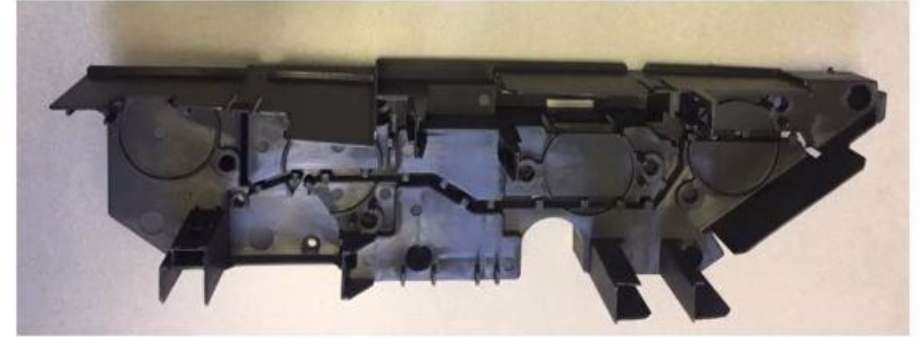
1. Reduce Risk of Tool Changes
  2. Validates Design During Tool Construction
- Augments Production Ramp



FORERUNNER  
3D PRINTING

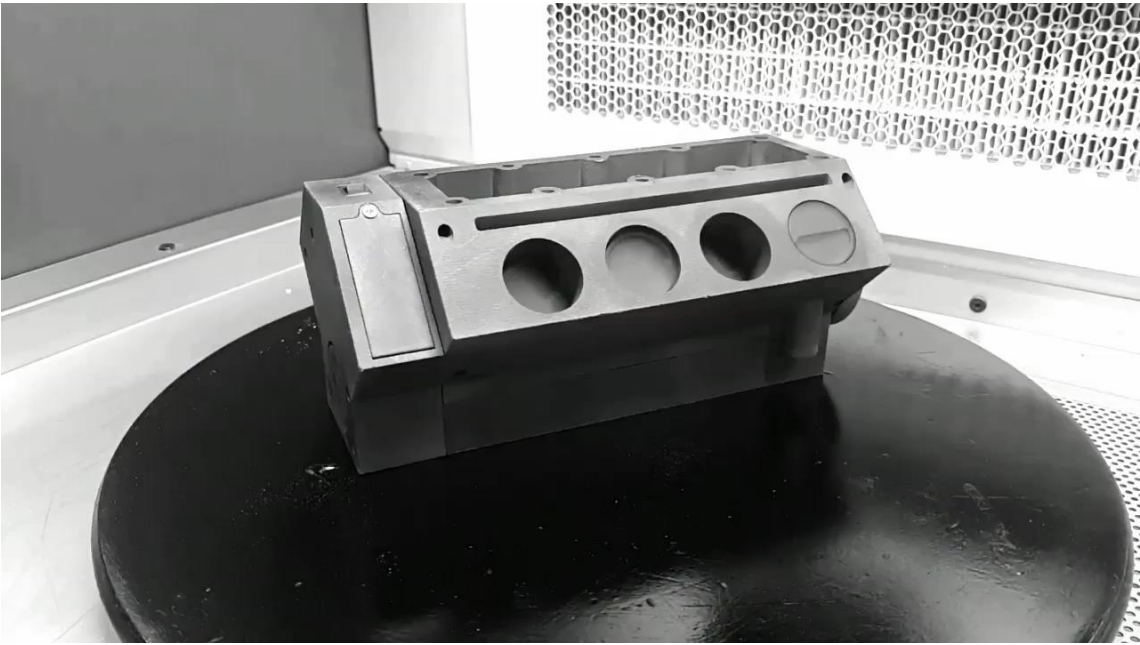
## Injection Mold Version

- Delivery Time = 42 Days



LINEAR  
AMS





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3D PRINTING

