

# Eaton Vehicle Group - DM Webinar



Sept 2020

# Company Profile

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- Eaton provides sustainable solutions that help its customers effectively manage electrical, hydraulic, and mechanical power – more safely, more efficiently, and more reliably. Eaton’s 2019 revenues were **\$21.4 billion**, and it sells products to **customers in more than 175 countries**. Eaton has approximately **93,000 employees** and **more than 100 locations** globally.
- Eaton’s Vehicle Group, which is part of its Industrial Sector, has facilities located on **six continents**.
- The Vehicle Group provides automotive and commercial vehicle manufacturers worldwide with products and systems that are designed to improve a vehicle’s overall efficiency, performance and power – such as emission control components, engine valves, valvetrain systems and superchargers – as well as offering driveline expertise through its transmission, clutch and torque management products and systems.

# The team leading Eaton Vehicle Group's Additive Manufacturing initiative



Alexandre Georgetti · 2nd

Snr. Manager, Manufacturing Strategy - Vehicle Group at Eaton at Eaton

Kalamazoo, Michigan · 500+ connections · [Contact info](#)



Alex Abernethy · 1st

Corporate Vehicle Group Mfg. Engineer / Additive Manufacturing Engineer at Eaton Corporation

Kings Mountain, North Carolina · 500+ connections · [Contact info](#)

# Additive Manufacturing at Eaton Vehicle Group

- Additive Manufacturing team supports our operations globally and we produce products for both Commercial Vehicle & Automotive markets.



# Key Challenges and Opportunities for Metal AM

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1. Produce prototypes to reduce product development cycles (time to market)
2. Produce tooling, fixtures, as well as quality and safety devices faster, in order to accelerate our time to market and be more competitive
3. Produce maintenance, repair and operations (MRO) components quicker to increase uptime/efficiency of our operations and reduce costs
4. Design freedom, components consolidation

# Business goals for AM: Reduce costs and accelerate time to market

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- The ability to reduce lead times to produce our manufacturing devices from by 70% from 3 - 4 weeks to 5 - 10 days
- Ability to reduce costs by up to 90% (function of design, size, etc.)

# How AM is changing our business

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- Challenging our teams to think differently when designing or addressing an issue
- Opening up different design possibilities, allowing us to address issues quicker
- Launching products faster by reducing the lead time needed to set up our internal manufacturing processes

# Our additive journey

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- Prior to Desktop Metal, we were already using polymer 3D printers
- Our team was searching for a metal printer to support activities on the shop floor. We visited the Additive Manufacturing trade show in Detroit and began conversations with Desktop Metal at that event
- Since then, expanded Studio Plus into three other regions

# Studio System focus: Manufacturing environment

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- The Studio System is a key part of our Industry 4.0 strategy, more specifically on our additive manufacturing space and we are expanding our printing capabilities globally.
- The Studio System is becoming part of the workflow for our global Manufacturing Engineering and tool room teams.
- The Studio System is used daily to support our operations globally. One of the top benefits is the ability to produce the manufacturing devices we need at a lower cost and with greatly reduced lead times.

# Metal AM is opening our minds to completely new design possibilities

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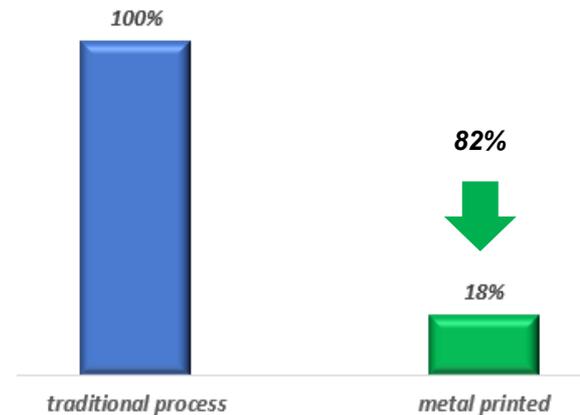
*“Before additive manufacturing I was afraid to fail, after additive manufacturing if you fail it happens quickly and you can also correct the error quicker.”*

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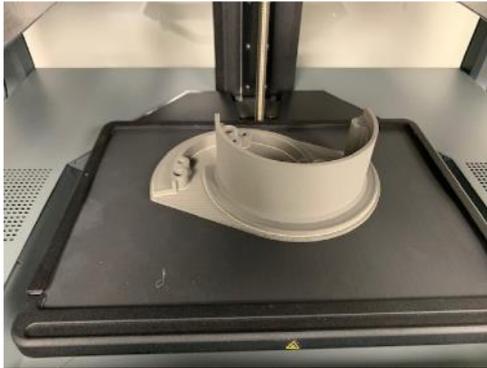
# Maintenance, Repair and Operations (MRO)

# Furnace chain guide

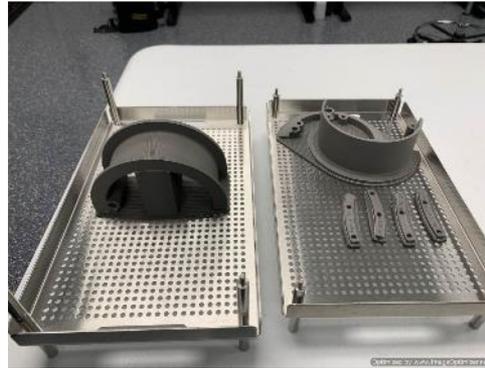
<b>What is the part? How/where is it used?</b>	<ul style="list-style-type: none"><li>• Furnace loading / unloading conveyor component</li></ul>
<b>How is it typically made?</b>	<ul style="list-style-type: none"><li>• Traditional machined and heat treatment</li></ul>
<b>What is the advantage/impact of 3D printing?</b>	<ul style="list-style-type: none"><li>• Lower cost to produce compared to buy from an external vendor done on traditional machining process</li><li>• Lower lead time to obtain MRO components and get asset back into operation</li></ul>
<b>Additional comments</b>	<ul style="list-style-type: none"><li>• Reverse engineering leveraging 3D scanner to build model as drawing was not available</li></ul>



# Furnace chain guide



Printed



Debound

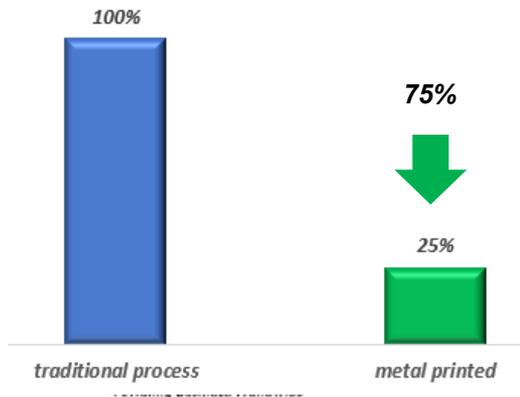


Sintered

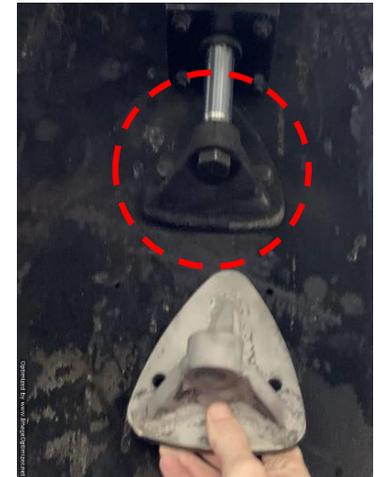


# Furnace door bracket

<b>What is the part?</b> <b>How/where is it used?</b>	<ul style="list-style-type: none"><li>• Furnace door bracket to attach cylinder (used to open / close furnace door) to the furnace door</li></ul>
<b>How is it typically made?</b>	<ul style="list-style-type: none"><li>• Traditional machined and heat treatment</li></ul>
<b>What is the advantage/impact of 3D printing?</b>	<ul style="list-style-type: none"><li>• Lower cost to produce compared to buy from an external vendor done on traditional machining process</li><li>• Lower lead time to obtain MRO components and get asset back into operation</li></ul>
<b>Additional comments</b>	<ul style="list-style-type: none"><li>• Reverse engineering leveraging 3D scanner to build model as drawing was not available</li></ul>

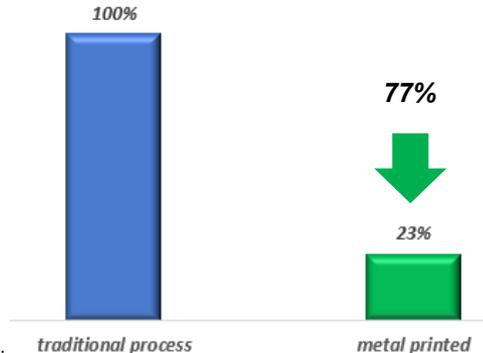


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# Furnace door stop

<b>What is the part? How/where is it used?</b>	<ul style="list-style-type: none"><li>Furnace door end stop</li></ul>
<b>How is it typically made?</b>	<ul style="list-style-type: none"><li>Traditional machined and heat treatment</li></ul>
<b>What is the advantage/impact of 3D printing?</b>	<ul style="list-style-type: none"><li>Lower cost to produce compared to buy from an external vendor done on traditional machining process</li><li>Lower lead time to obtain MRO components and get asset back into operation</li></ul>
<b>Additional comments</b>	<ul style="list-style-type: none"><li>Reverse engineering leveraging 3D scanner to build model as drawing was not available</li></ul>



# Furnace door stop

Part Setup Name: US-KINGS MOUNTAIN-TOOL\_IPSEN FUF

MATERIAL: 17-4 PH STAINLESS STEEL

SCALE: 100 %

LAYERS: 643

DIMENSIONS: 156.01 x 74.42 x 140.40 mm

FINAL PART WEIGHT: 856,46 g

**Total Consumed Material**

METAL: 1.19 kg

INTERFACE: 8.45 g

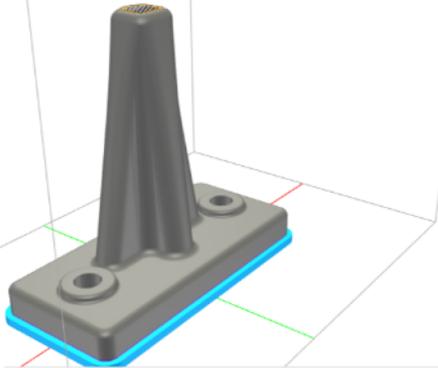
COST OF CONSUMED MATERIAL: \$135,71

**Fabrication Time**

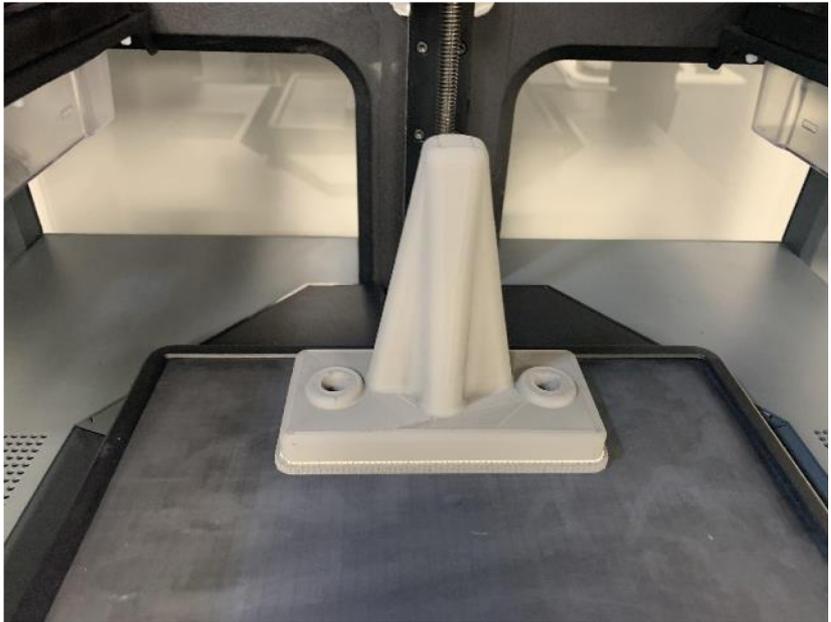
PRINT: 28h 58m

DEBIND: 41h 33m

SINTER: 48h 12m

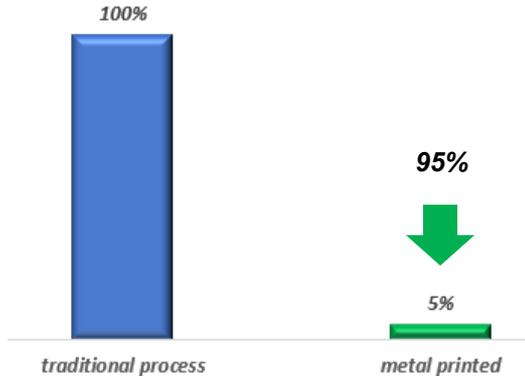


- UNPRINTED
- RAFT
- SUPPORTS
- INTERFACE
- OUTER WALLS
- INNER WALLS
- INFILL
- RAPID MOVES
- SINGLE LAYER



# Buss box safety device

<b>What is the part?</b> <b>How/where is it used?</b>	<ul style="list-style-type: none"><li>Engage buss box switch arm to turn buss box on and off</li></ul>
<b>How is it typically made?</b>	<ul style="list-style-type: none"><li>Traditional machined and heat treatment</li></ul>
<b>What is the advantage/impact of 3D printing?</b>	<ul style="list-style-type: none"><li>Lower cost to produce compared to buy from an external vendor done on traditional machining process</li><li>Lower lead time to obtain MRO components and get asset back into operation</li></ul>



# Buss box safety device

Part Setup Name: US KINGS MOUNTAIN TOOL\_T 80002 1

MATERIAL: 17-4 PH STAINLESS STEEL

SCALE: 100 %

LAYERS: 152

DIMENSIONS: 121.95 x 74.42 x 23.42 mm

FINAL PART WEIGHT: 71.60 g

Total Consumed Material

METAL: 208.10 g

INTERFACE: 1.41 g

OVER-ENGINEERED MATERIAL: \$23.64

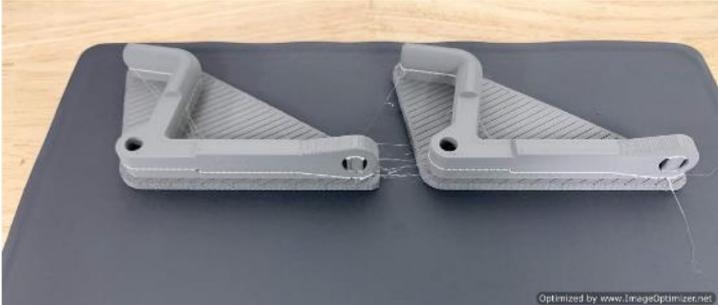
Fabrication Time

PRINT: 7h 21m

DEBIND: 27h 43m

CUTTER: 33h 2m

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<input checked="" type="checkbox"/> OUTER WALLS	<input checked="" type="checkbox"/> INNER WALLS	<input checked="" type="checkbox"/> INFILL	<input type="checkbox"/> RAPID MOVES
<input type="checkbox"/> SINGLE LAYER			

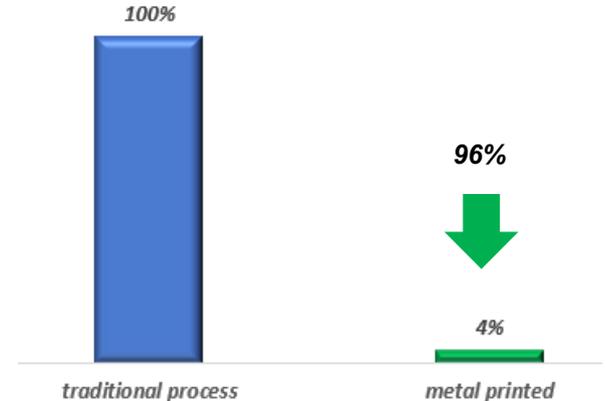


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# Fixturing and Tooling

# Test stand oil fill nozzle

<b>What is the part?</b> <b>How/where is it used?</b>	<ul style="list-style-type: none"><li>• Assembly end of line tester component to faster fill oil to product during tester process</li></ul>
<b>How is it typically made?</b>	<ul style="list-style-type: none"><li>• Traditional machined, welded and heat treatment</li></ul>
<b>What is the advantage/impact of 3D printing?</b>	<ul style="list-style-type: none"><li>• Lower cost to produce compared to buy from an external vendor done on traditional machining process</li><li>• Lower lead time to obtain the tooling (faster problem solving / back to operation)</li></ul>
<b>Additional comments</b>	<ul style="list-style-type: none"><li>• Internal complex geometry / features that are expensive to produce by standard machining processes</li></ul>



# Test stand oil fill nozzle



Part Setup Name  
**US-GALESBURG-TOOL-FILL\_NOZZLE\_1:**

MATERIAL  
17-4 PH STAINLESS STEEL - 100 %

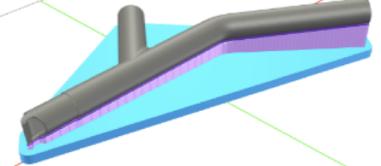
LAYERS:  
168  
DIMENSIONS  
150.20 x 89.76 x 25.82 mm  
FINAL PART WEIGHT  
65.61 g

#### Total Consumed Material

METAL  
215.16 g  
INTERFACE  
1.74 g  
COST OF CONSUMED MATERIAL  
\$24.97

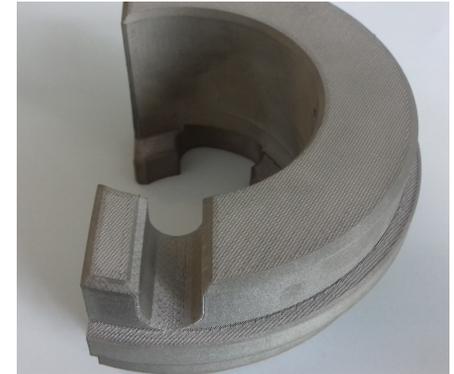
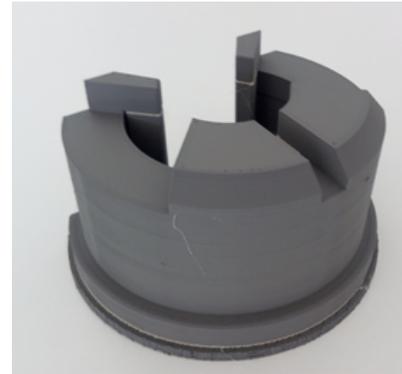
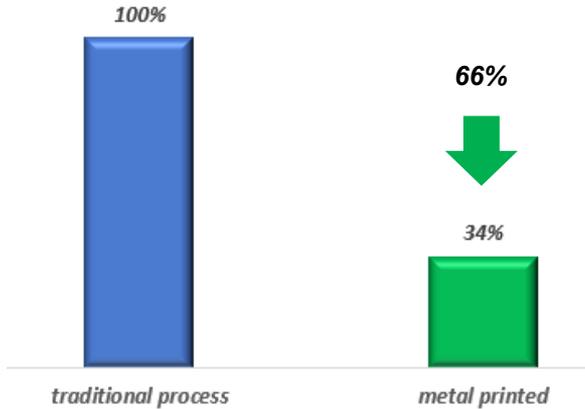
#### Fabrication Time

PRINT  
7h 40m  
DEBIND  
17h 23m  
SINTER  
39h 2m



# Part Carriers - loader cup

<b>What is the part?</b> <b>How/where is it used?</b>	<ul style="list-style-type: none"><li>• Loader cup for hobbing machine automation</li><li>• It is part of the carousel on a CNC hobbing machine used for rotor machining</li></ul>
<b>How is it typically made?</b>	<ul style="list-style-type: none"><li>• Traditional machined and heat treated for hardness (tool life)</li><li>• Due to the complicated design, item was purchased from an external vendor</li></ul>
<b>What is the advantage/impact of 3D printing?</b>	<ul style="list-style-type: none"><li>• Lower cost to produce compared to buy from an external vendor done on traditional machining process</li><li>• Lower lead time to obtain the tooling (faster problem solving / back to operation)</li></ul>



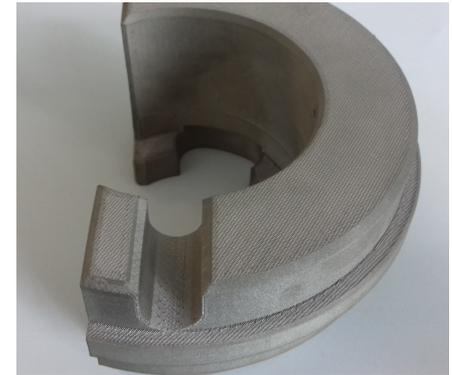
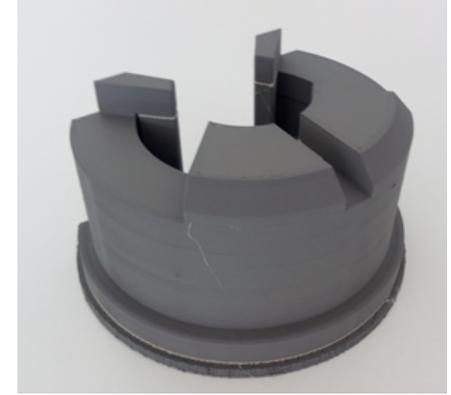
# Part Carriers - loader cup



Original  
(machined)

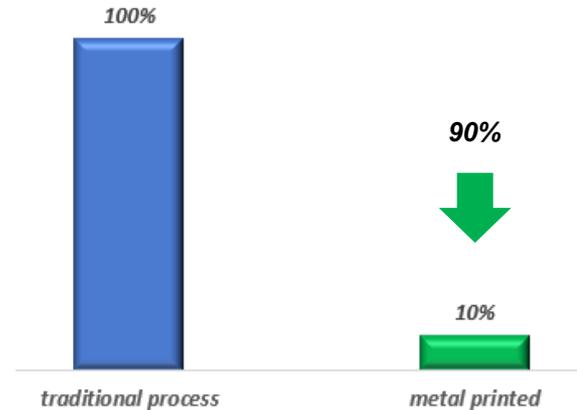


3D printed

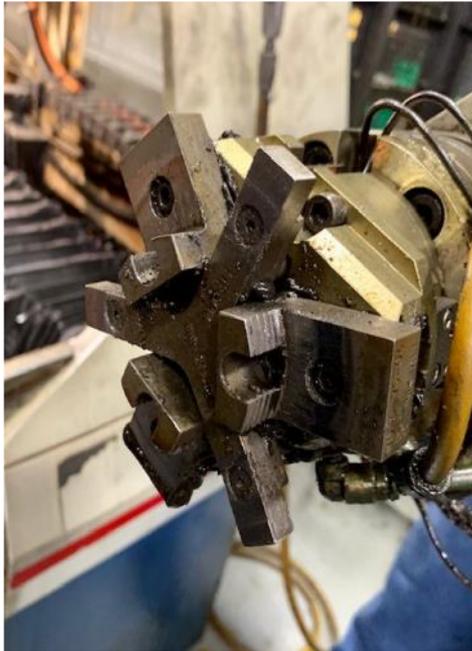


# Robot gripper

<b>What is the part? How/where is it used?</b>	<ul style="list-style-type: none"><li>• Gripper is used to automatically load a gear chamfering operation (gear machining processes)</li></ul>
<b>How is it typically made?</b>	<ul style="list-style-type: none"><li>• Traditional machined and heat treatment</li></ul>
<b>What is the advantage/impact of 3D printing?</b>	<ul style="list-style-type: none"><li>• Lower cost to produce compared to buy from an external vendor done on traditional machining process</li><li>• Lower lead time to obtain the tooling (faster problem solving / back to operation)</li></ul>
<b>Additional comments</b>	<ul style="list-style-type: none"><li>• Allow us a lower tooling inventory cost and people to manage it</li></ul>



# Robot gripper



Original (machined)

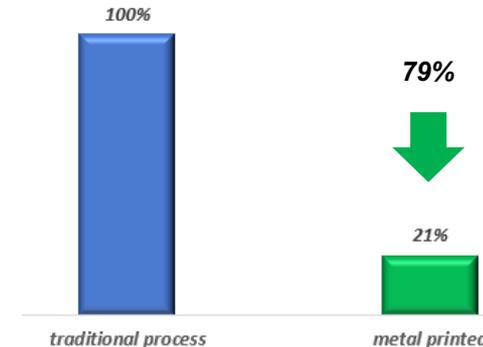


3D printed

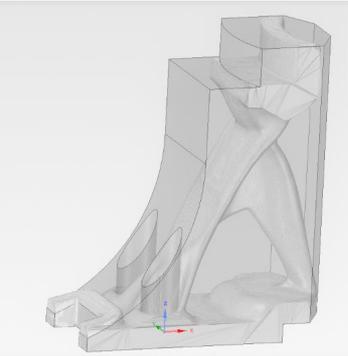
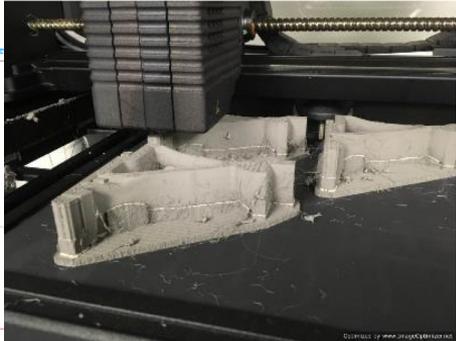
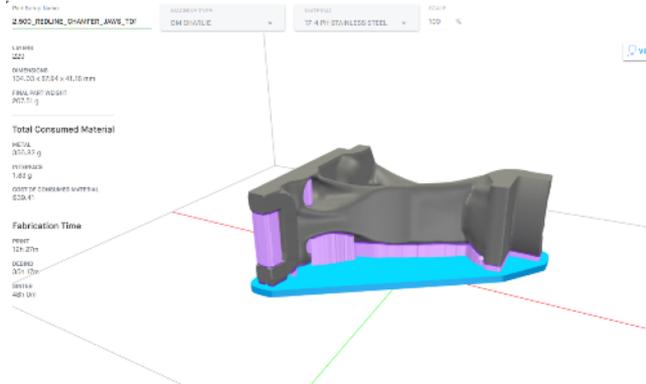
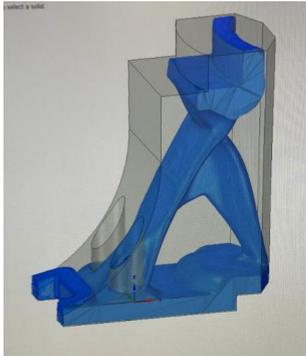


# Gear tooth chamfer chuck jaws

<b>What is the part?</b> <b>How/where is it used?</b>	<ul style="list-style-type: none"><li>• Pneumatic jaws for gear chamfering process</li></ul>
<b>How is it typically made?</b>	<ul style="list-style-type: none"><li>• Traditional machined and heat treatment</li></ul>
<b>What is the advantage/impact of 3D printing?</b>	<ul style="list-style-type: none"><li>• Lower cost to produce compared to buy from an external vendor done on traditional machining process</li><li>• Lower lead time to obtain the tooling (faster problem solving / back to operation)</li><li>• New design incorporating topology optimization process</li></ul>
<b>Additional comments</b>	<ul style="list-style-type: none"><li>• Allow us to lower tooling inventory cost and people to manage it</li></ul>



# Gear tooth chamfer chuck jaws

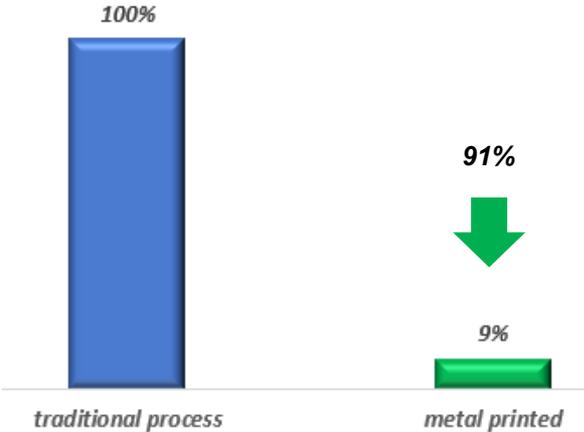
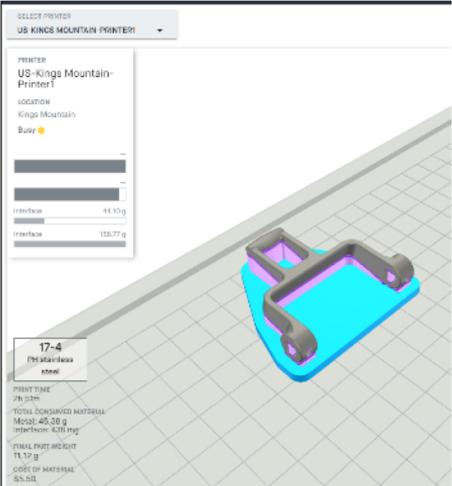


# Product testing fixtures for one of Engineering labs

<b>What is the part? How/where is it used?</b>	<ul style="list-style-type: none"><li>• Testing fixture device for product development prototypes</li></ul>
<b>How is it typically made?</b>	<ul style="list-style-type: none"><li>• Traditional machined and heat treatment</li></ul>
<b>What is the advantage/impact of 3D printing?</b>	<ul style="list-style-type: none"><li>• Lower cost to produce compared to buy from an external vendor done on traditional machining process</li><li>• Lower lead time to obtain the prototypes and get the test done (faster product development)</li></ul>
<b>Additional comments</b>	<ul style="list-style-type: none"><li>• First prototype developed for our business using DM metal printing technology</li><li>• Prototypes done on 17-4 material due to no availability on 4140 / H13 material driving lower prototype end of life</li></ul>

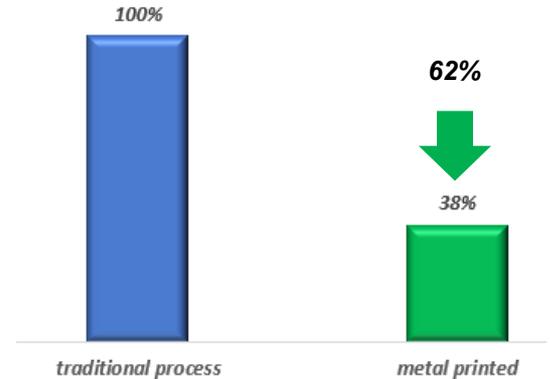


# Product testing fixtures for one of our Engineering labs



# Gear lab coupling fixtures

<b>What is the part?</b> <b>How/where is it used?</b>	<ul style="list-style-type: none"><li>• Fixture to allow parts to be measured at gear lab measurement machines</li></ul>
<b>How is it typically made?</b>	<ul style="list-style-type: none"><li>• Traditional machined and heat treatment</li></ul>
<b>What is the advantage/impact of 3D printing?</b>	<ul style="list-style-type: none"><li>• Lower cost to produce compared to buy from an external vendor done on traditional machining process</li><li>• Lower lead time to obtain the tooling (faster problem solving / back to operation)</li></ul>
<b>Additional comments</b>	<ul style="list-style-type: none"><li>• This was the first project mixing both metal and TPU printing material</li><li>• First interaction done 100% in polymer didn't last long due to wear</li></ul>



# Gear lab coupling fixture



Original  
(polymer 3D printed)

17-4 PH stainless steel



PRINTED		
<b>DIMENSIONS</b>	<b>Material</b>	<b>Weight</b>
PRINTED(GREEN PART) 76.13 x 64.50 x 70.52 mm	MATERIAL-METAL 591.21 g	PRINTED(GREEN PART) 595.11 g
DEBOUND(BROWN PART) 76.13 x 64.50 x 70.52 mm	MATERIAL-INTERFACE 3.91 g	DEBOUND(BROWN PART) 570.84 g
FINAL DIMENSIONS 60.96 x 50.80 x 56.51 mm	MATERIAL COST \$66.95	FINAL WEIGHT 378.53 g

MOST RECENT JOB  
1908201338PEPJ

PART SETUP  
US-KINGSMOUNTAIN-TOOL\_T-80107.st\_17-4\_PH\_stainless\_steel

MODEL  
US-KINGSMOUNTAIN-TOOL\_T-80107.stp



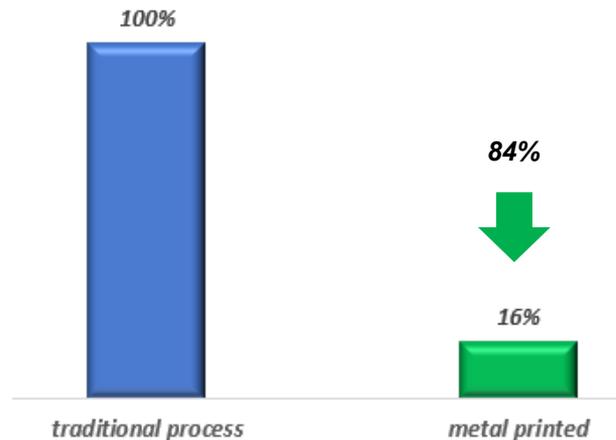
3D metal  
printed



3D metal  
printed + TPU

# Assembly bearing press tool

<b>What is the part?</b> <b>How/where is it used?</b>	<ul style="list-style-type: none"><li>• Assembly press tooling to press bearings into gear box housings</li></ul>
<b>How is it typically made?</b>	<ul style="list-style-type: none"><li>• Traditional machined and heat treatment</li></ul>
<b>What is the advantage/impact of 3D printing?</b>	<ul style="list-style-type: none"><li>• Lower cost to produce compared to buy from an external vendor done on traditional machining process</li><li>• Lower lead time to obtain the tooling (faster problem solving / back to operation)</li></ul>
<b>Additional comments</b>	<ul style="list-style-type: none"><li>• First tooling tested on a critical functional assembly operation</li></ul>



# Assembly bearing press tool

17-4 PH stainless steel

PRINTED

DIMENSIONS	Material	Weight
PRINTED(GREEN PART) 87.30 x 87.29 x 36.47 mm	MATERIAL-METAL 236.85 g	PRINTED(GREEN PART) 240.75 g
DEBOUND(BROWN PART) 87.30 x 87.29 x 36.47 mm	MATERIAL-INTERFACE 3.90 g	DEBOUND(BROWN PART) 230.68 g
FINAL DIMENSIONS 73.59 x 28.02 x 73.59 mm	MATERIAL COST \$31.27	FINAL WEIGHT 156.65 g

MOST RECENT JOB  
1908201425PTYM

PART SETUP  
US-KINGSMOUNTAIN-TOOL\_t-100057-  
e\_mod3.st\_17-4\_PH\_stainless\_steel

MODEL  
US-KINGSMOUNTAIN-TOOL\_t-100057-  
e\_mod3.stn



**Ergo issue:** Awkward hand position when removing heavy tooling from base creating an ergonomic stressor.



Tooling inside 1851 bearing tooling



2074 bearing inside new tooling



Bearing Press



Bearing completely on, new tooling successful



Tooling after x3 cycles, no damage.

# Assembly bearing press tool



Bearing completely on, new tooling successful



Tooling after x3 cycles, no damage.



# Metal AM: Business impact at Eaton Vehicle Group

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- Accelerate time to market by reducing time needed to industrialize a product
- Increased equipment uptime
- Reduce MRO costs on manufacturing floor
- Product optimization opportunities

# Future work

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- Continue to expand both our number of printers and the amount of different manufacturing devices produced globally
- Exploring binder jetting for production parts



**EATON**

*Powering Business Worldwide*