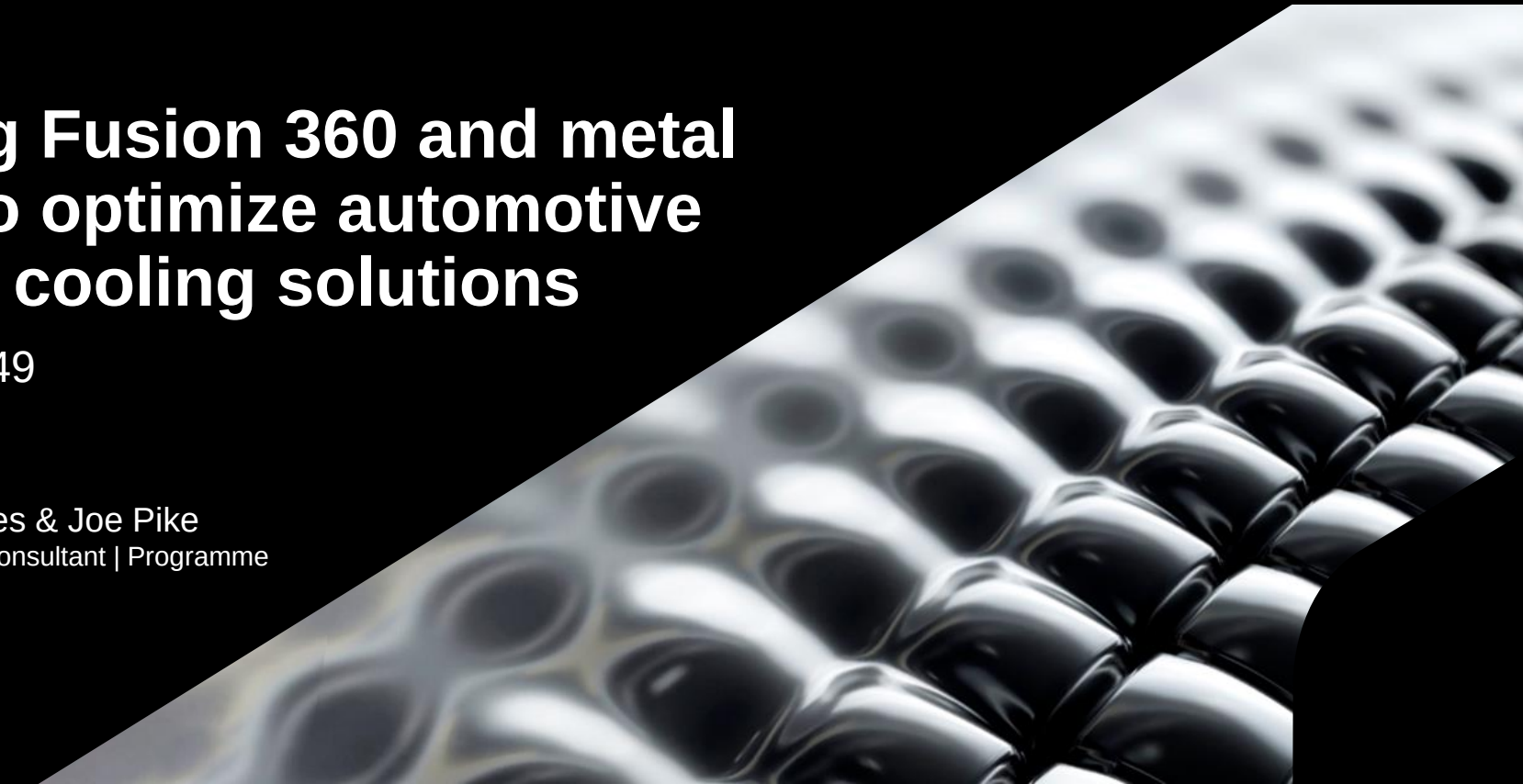
AUTODESK UNIVERSITY

Using Fusion 360 and metal AM to optimize automotive mold cooling solutions

TR501949

Jack Holmes & Joe Pike
Technology Consultant | Programme Manager



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Agenda

- Intros
- ITL Background
- Project Aim
- Project Steps
  - CFD Simulations
  - Design Iterations
  - Manufacturing
- Conclusions
- Next Steps
- Q&A

Introductions

Jack Holmes

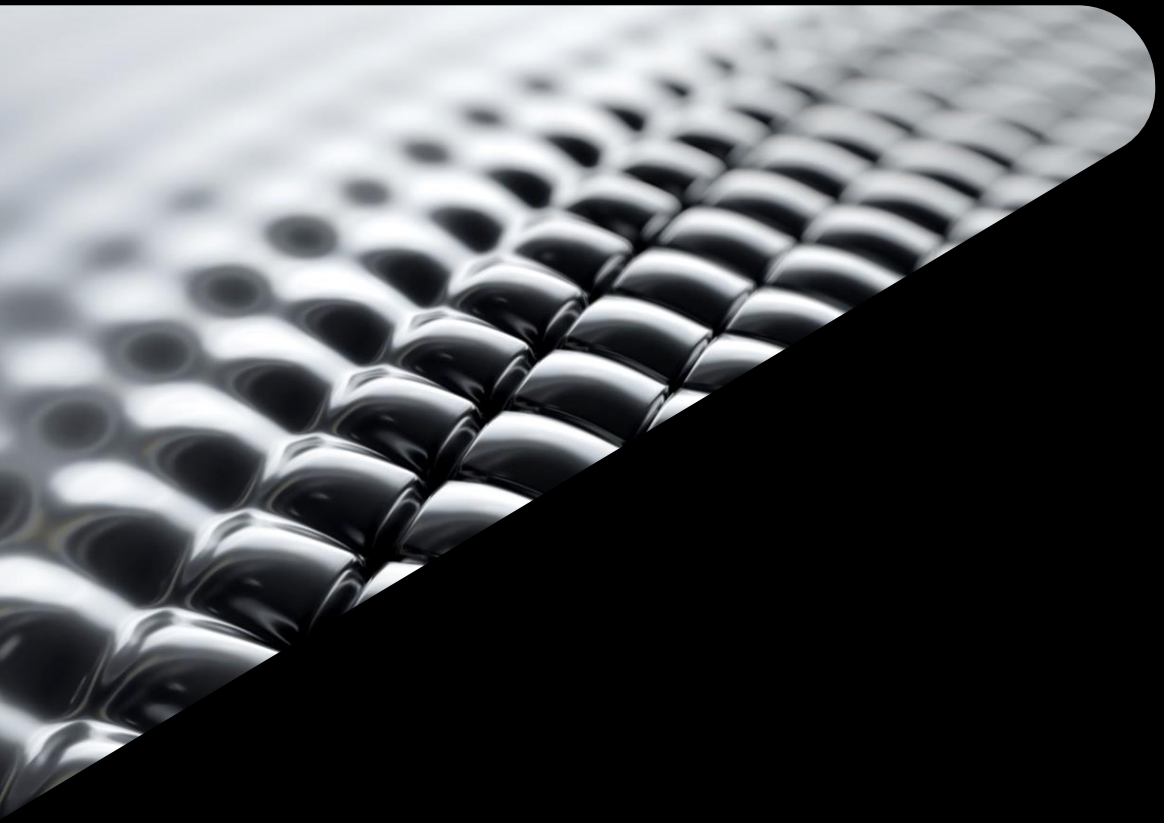


- Technology Consultant at Autodesk, working with customers and partners across all industries to innovate on solutions
- Focus on Fusion 360 manufacturing, including subtractive, additive and machine tool connections
- jack.holmes@autodesk.com

Joe Pike



- Programme manager at Impression Technologies with experience across various automotive sectors for OEM's including Ford, Jaguar Land Rover, Bentley & McLaren.
- Enables customers to complete projects in quick succession with cradle to grave support.
- J.pike@impression-technologies.com

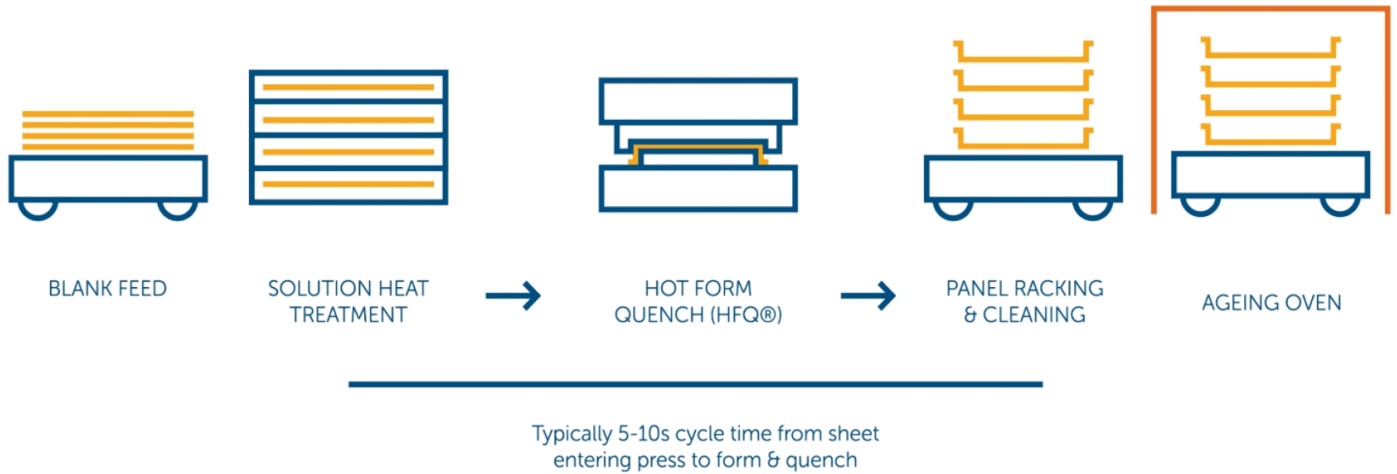


ITL

Background & Technology

Impression Technologies Ltd (ITL)

Background & Technology



HFQ is a proven scalable process similar to that of press-hardened steel

HFQ® - The Benefits

SUSTAINABILITY	Circular aluminium enabler – up to 95% emissions savings
COST REDUCTION	> 20% reduction in part cost & tooling
MASS REDUCTION	20-50% weight saving
VIRTUALLY NO SPRINGBACK	Dimensional conformance first time
RETAINED DUCTILITY	Improved energy absorption for crash
PART INTEGRATION	3 parts to 1: Lower assembly & tooling costs

ITL a Global Automotive Supplier



2012
ITL incorporated

2016
First commercial application

2017
Collaboration with aluminium suppliers

2019
First Tier signed

2021
Tier production capable

2022

- UK production volumes ramp up
- >25 new parts
- >$30m investment
- HFQ lines installed in EU and CN

The Latest -



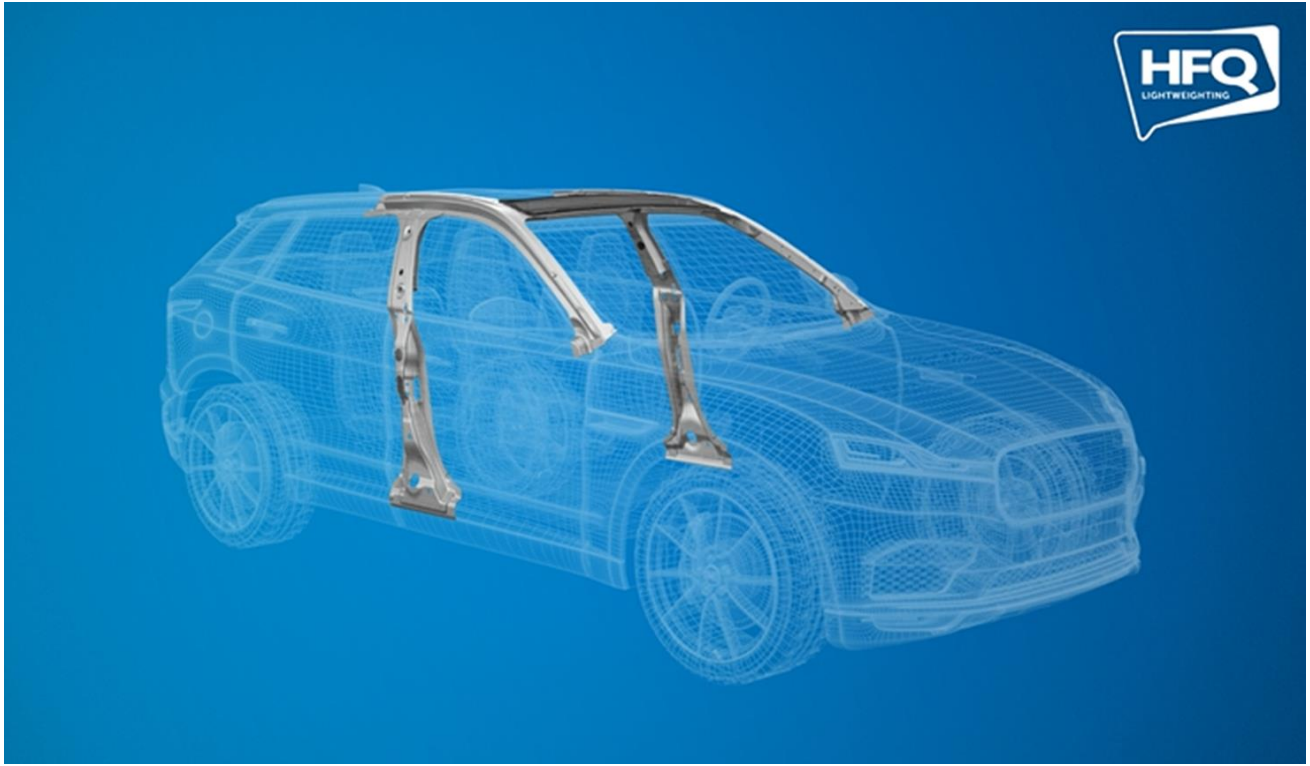
HFQ Technology & business model is now validated by the mass market

Electric vehicles and sustainability will drive increasing demand

Latest wave of nominations provide springboard for global scale-up

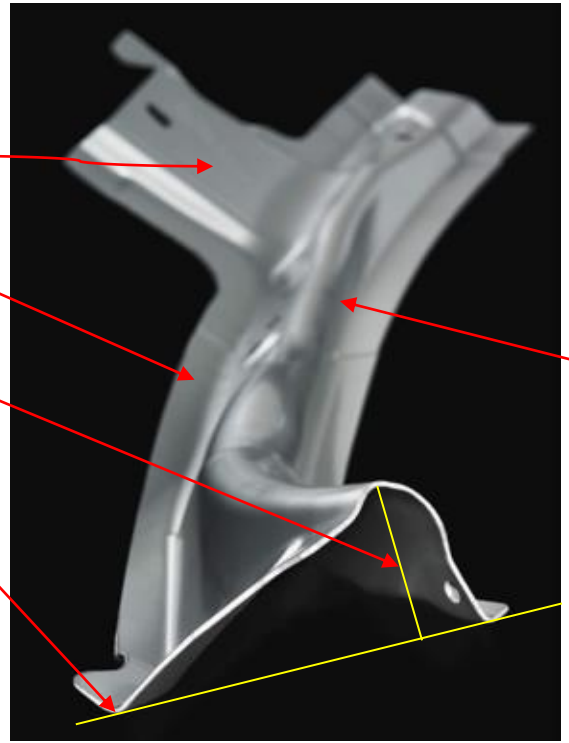
£5m raise to address automotive & aerospace market opportunity

World first - HFQ safety cell on DBX designed for side intrusion & roof crush



Applied Benefits of HFQ Technology versus Cold Forming

- **Integration** of front Header connection**, not possible** with **cold forming**
- **Minimum bond flange width,** for **improved occupant vision**
- **Deep draw capability, not possible** with **cold forming**
- **Extremely tight** internal bend radii, **not possible** with **cold forming**





- **Utilisation of high strength** aluminium to **reduce weight - circa 20% versus lower strength cold form grades**
- **Formed in a single HFQ draw operation to minimise investment**
- **Negligible springback**

Tool Cooling in HFQ

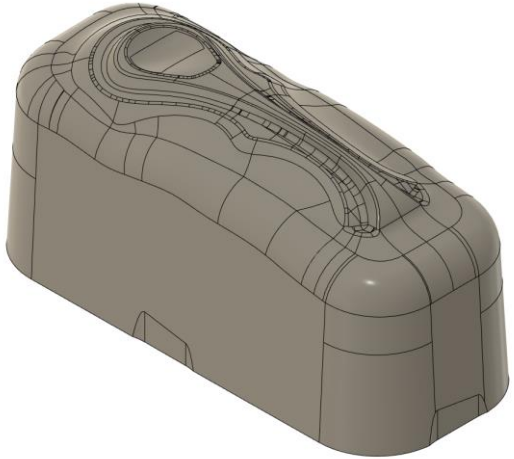
- Uniformity of temperature distribution across the tooling surface is key in ensuring an even quench rate
- By maintaining high cooling rates in the HFQ process we are able to provide parts with substantially better material properties when compared to other technologies
- Limitations in current tooling manufacture methods mean that cool tooling can create additional timing when producing tools for manufacture
- By utilising new methodologies, we can reduce tooling manufacture times as well as incorporate optimal cooling designs.



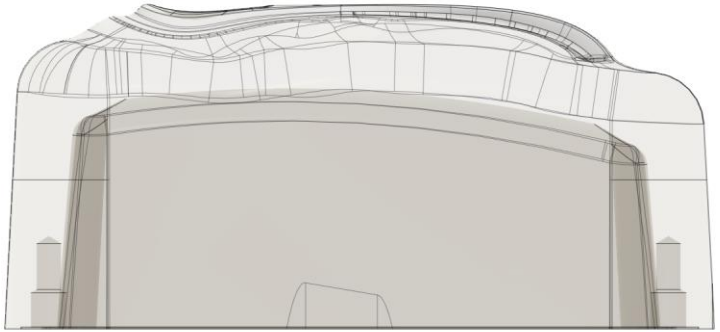
Project Aim & Feasibility

Project Aim

- Cooled Punch Tool
- Design Optimization
- Additive Technologies
- Alternative Design Techniques
- Comparison of D&M Techniques







Project Feasibility Study

- Attempt to prove out the capability and its functionality
- Tryout an uncooled printed part on ITL's smaller press
- Understand how the additive printed tool material interacts with the aluminum and other processes to improve development



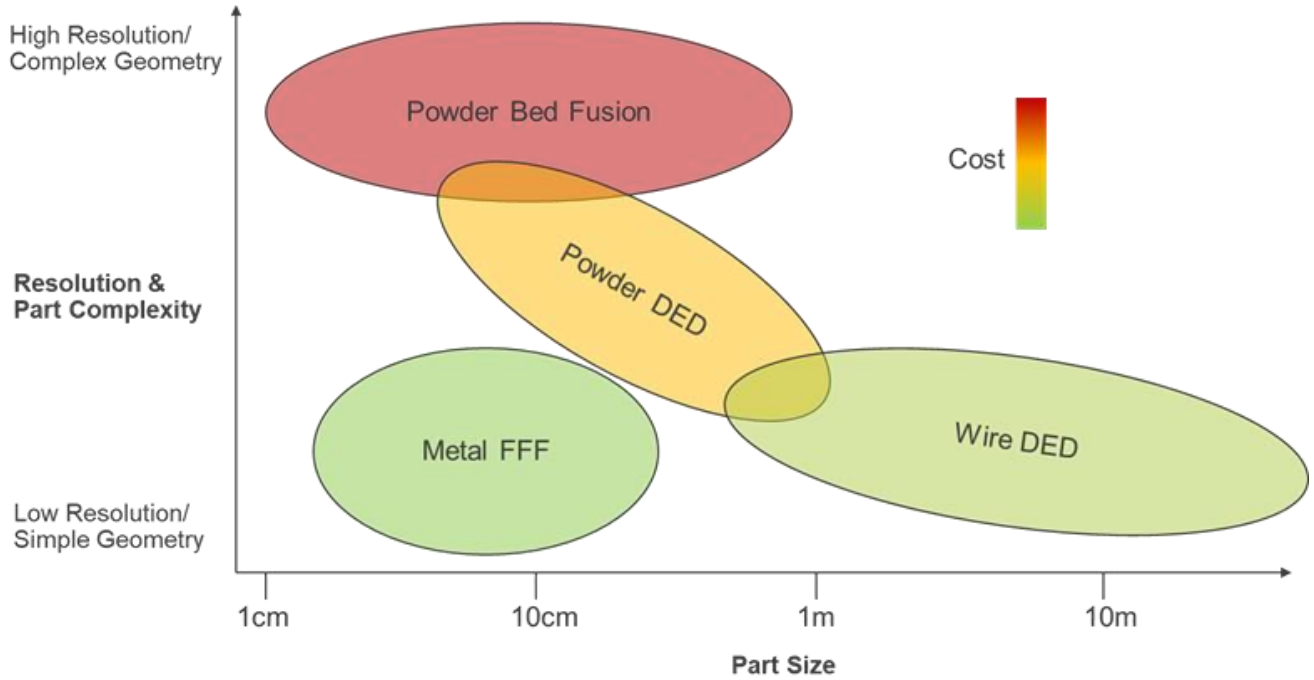




Manufacturing Methods

Manufacturing Methods

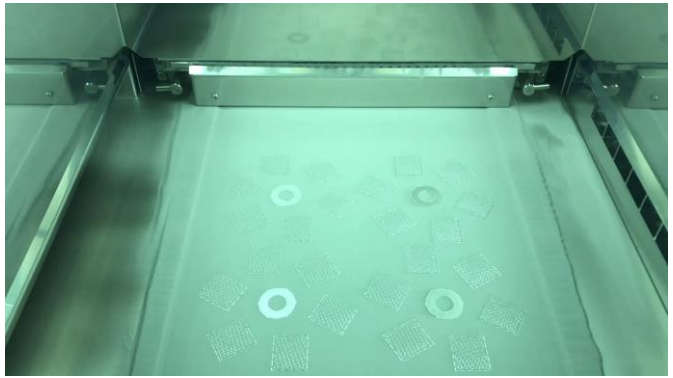
Metal Additive Manufacturing



Manufacturing Methods

PBF vs. DED

Powder Bed Fusion (PBF)



- Higher cost solution
- High resolution / complex geometry
- Internal lattice structure

Wire Directed Energy Deposition (DED)



- Lower cost solution
- Low resolution / simple geometry
- Internal cooling channels

Project Process Steps



CFD Simulation

Check current design’s performance



Design Iteration

Edit design, run simulation, iterate



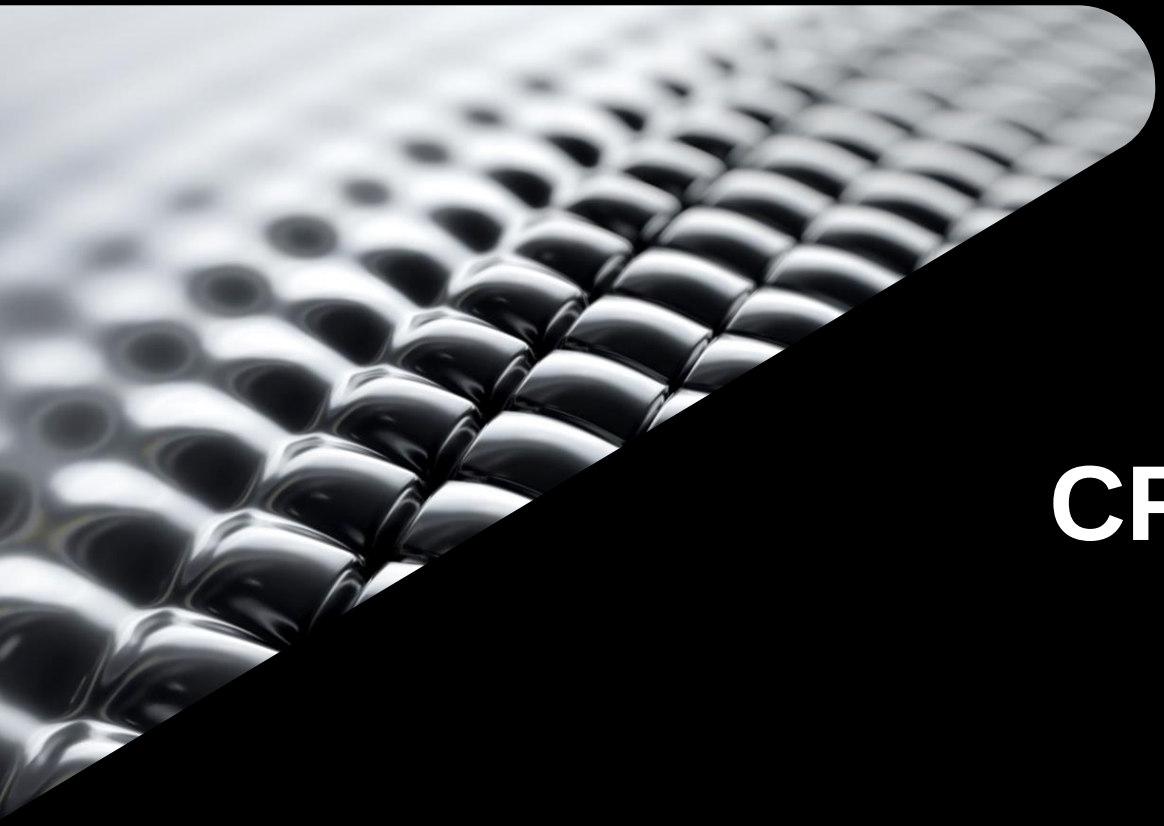
Manufacturing

Produce designs using alternative manufacturing methods



Testing

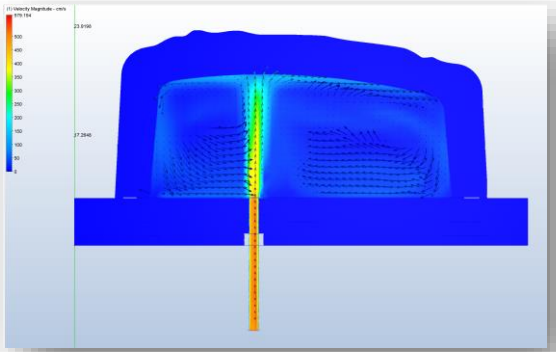
Test end components performance at ITL’s facility

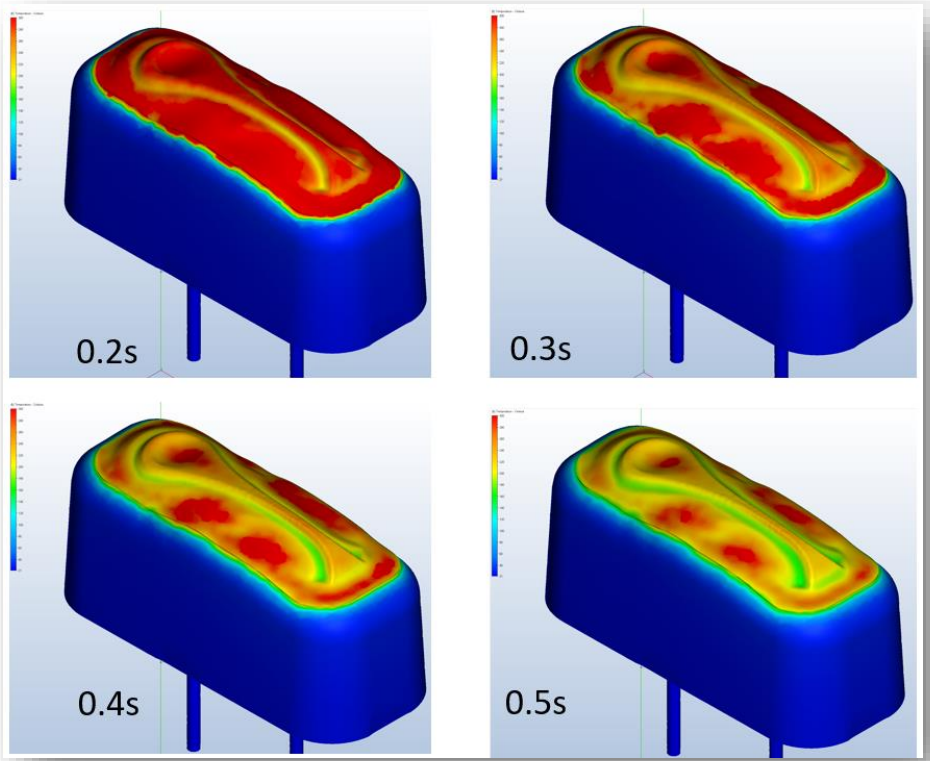


CFD Simulation

CFD Simulation

- Autodesk CFD checked heat transfer from current design
- Simulation model defined
- Non-conformal cooling displayed

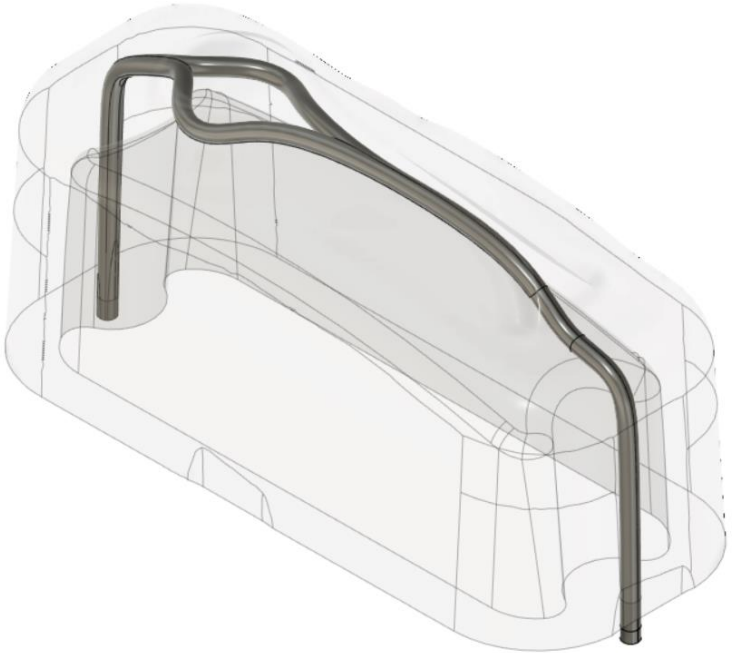


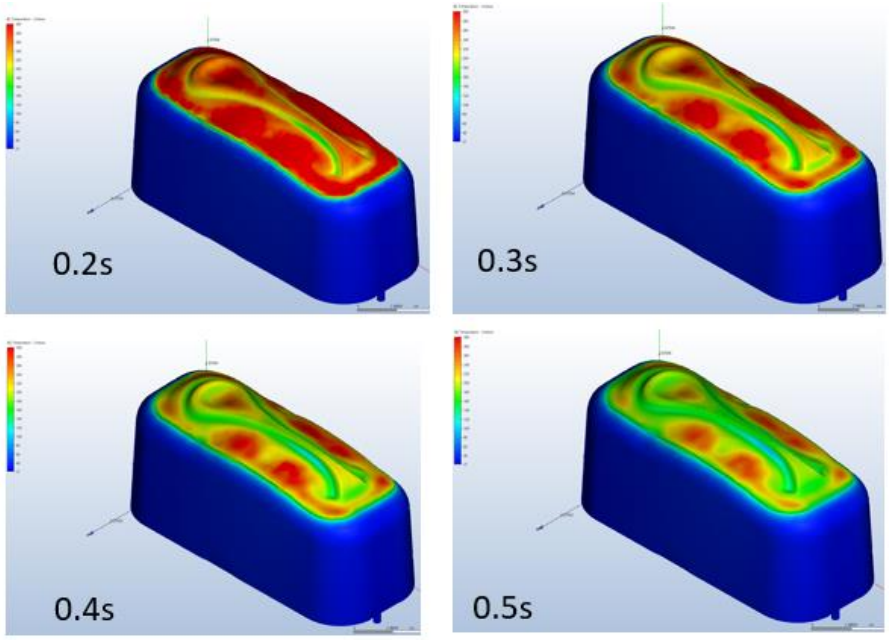


Design Iterations

DED Designs

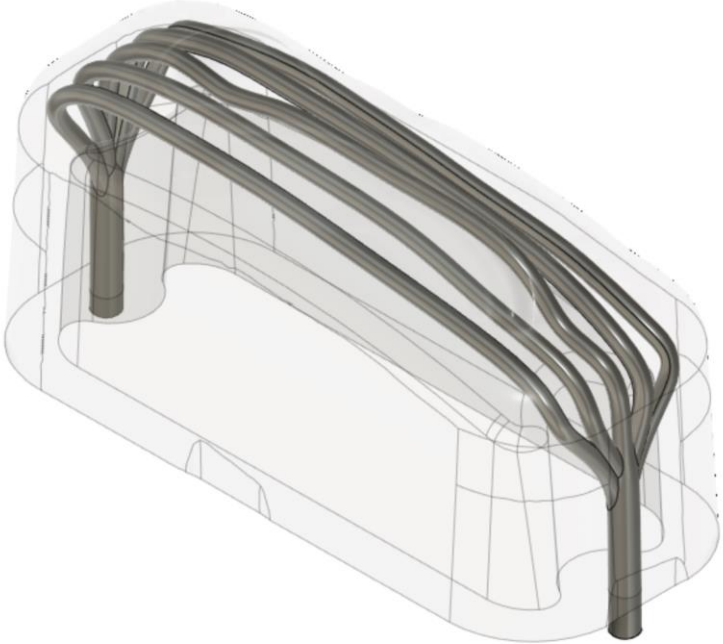
Iteration 1

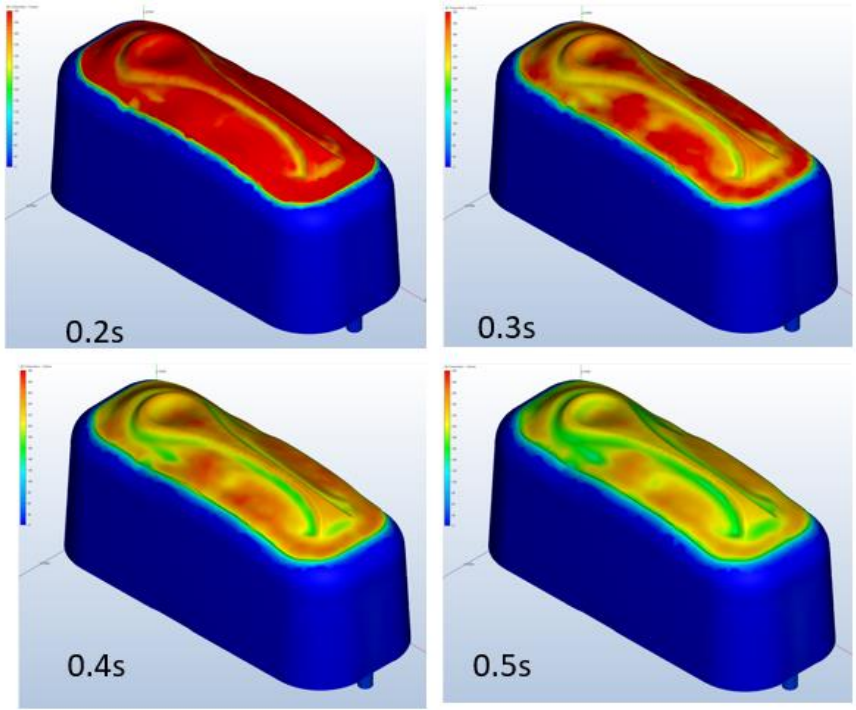




DED Designs

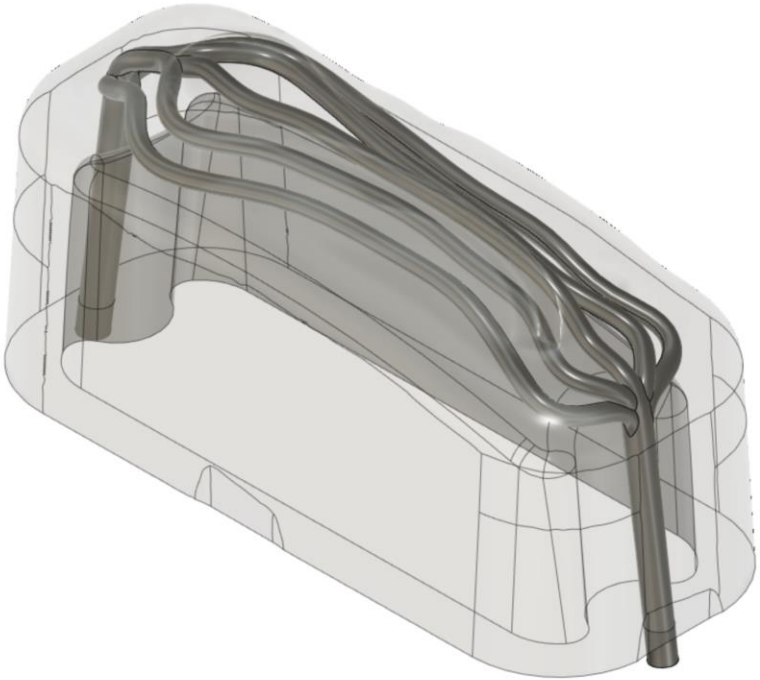
Iteration 2

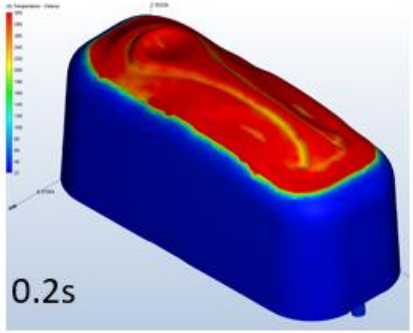


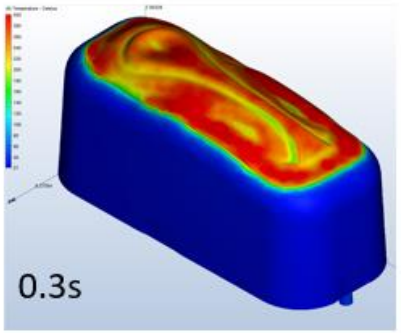


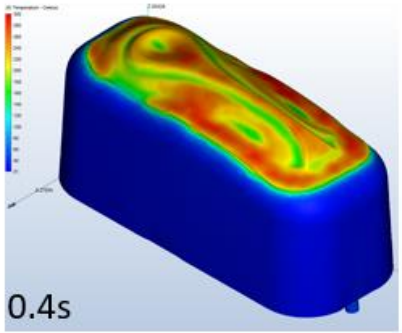
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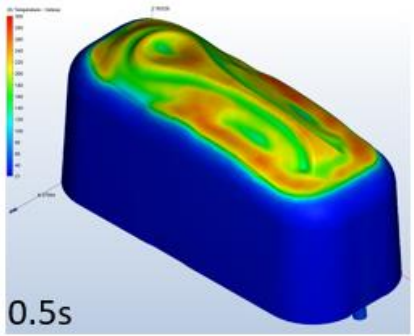
Iteration 3





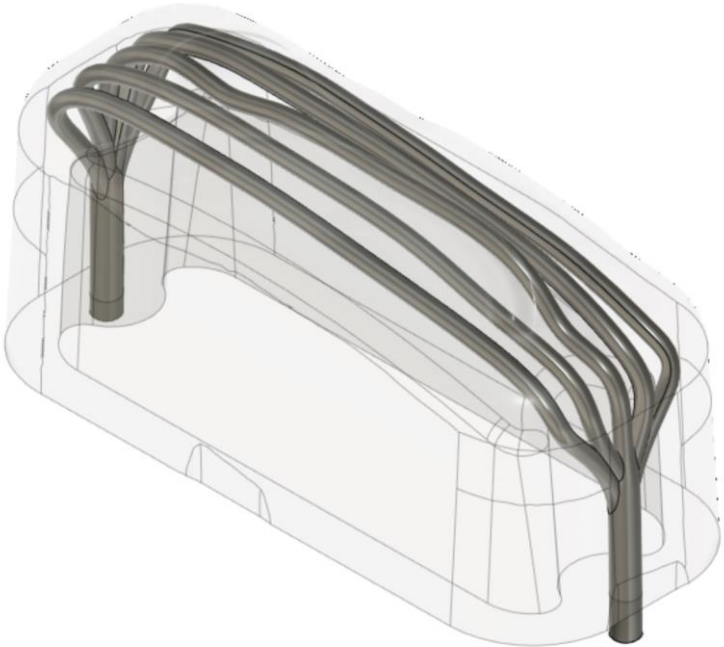




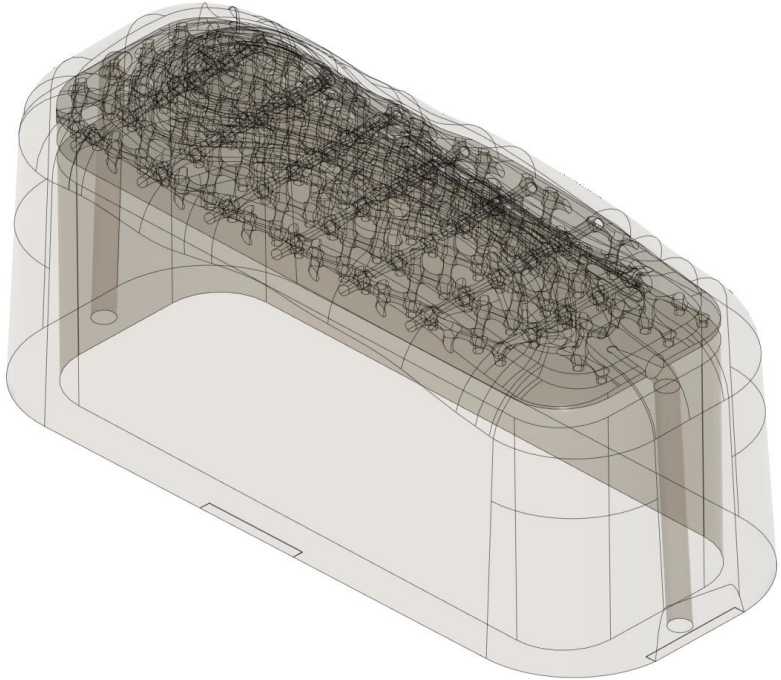


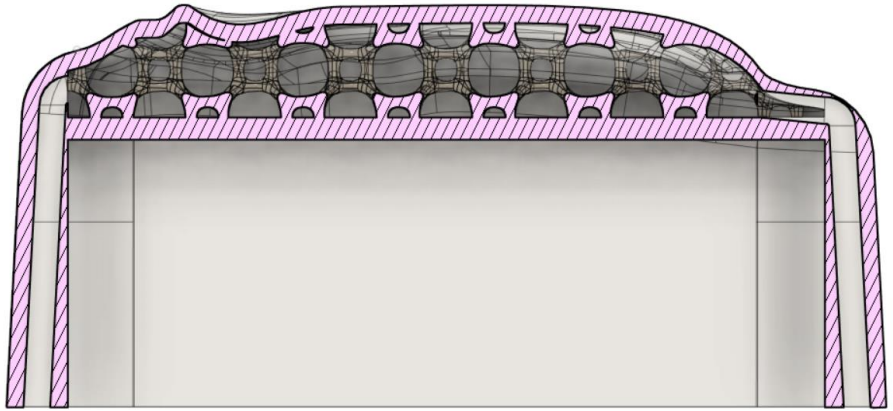
DED Designs

Selected Design

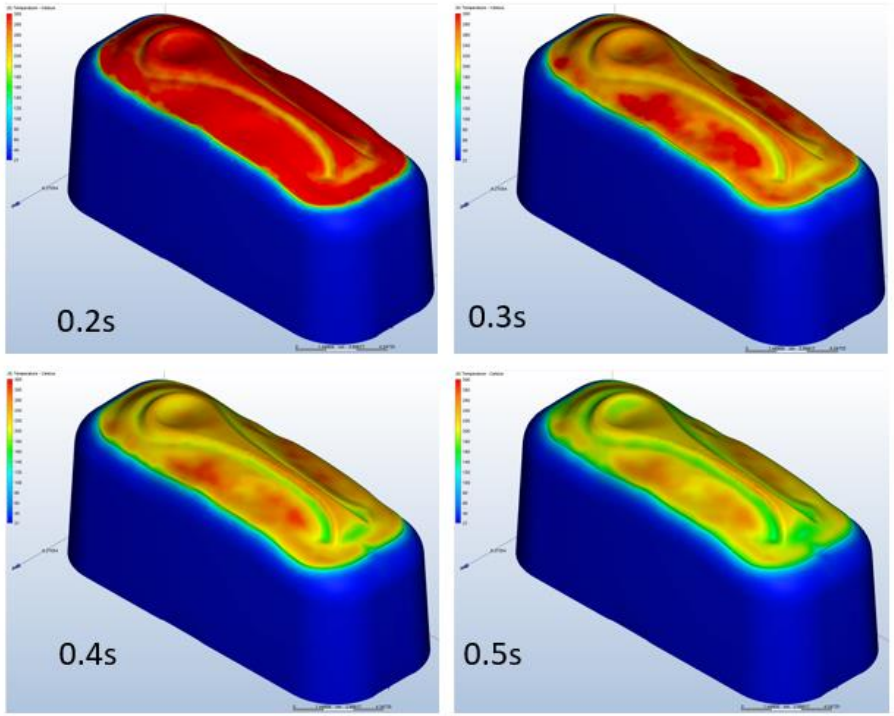


Lattice Design



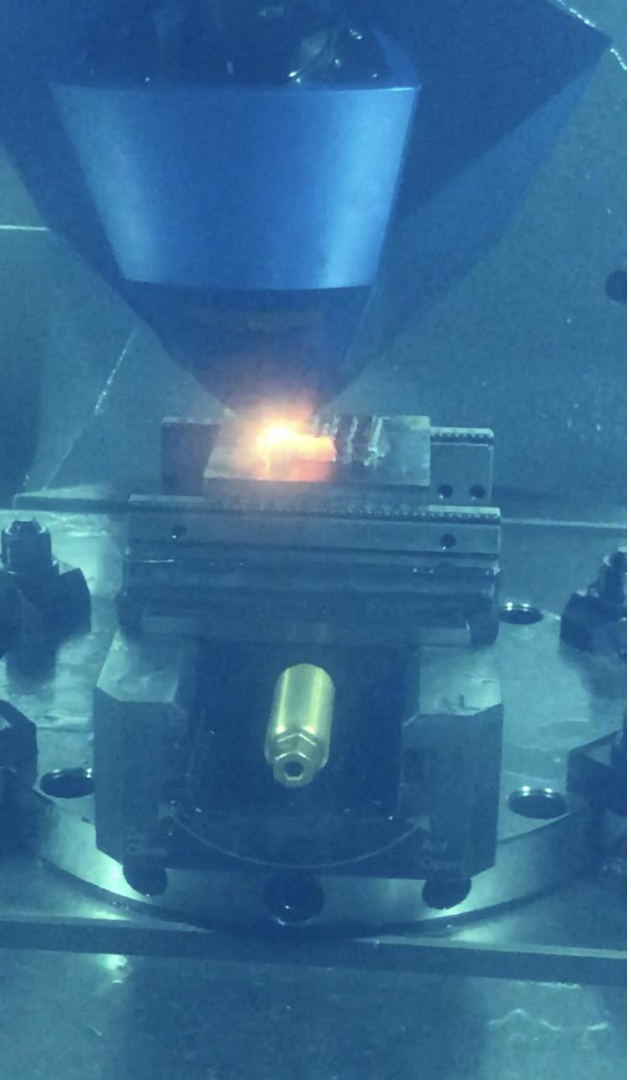


Lattice Design



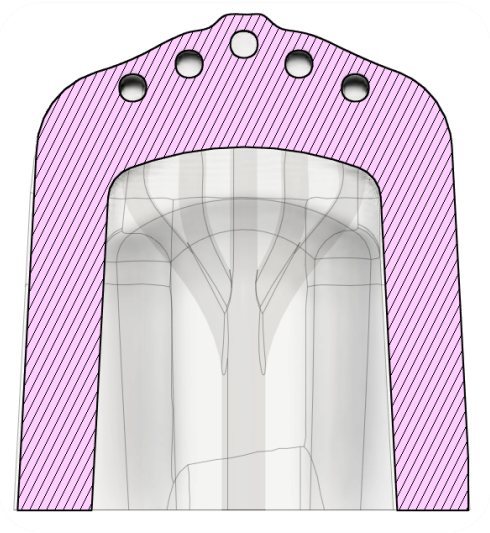


Manufacturing

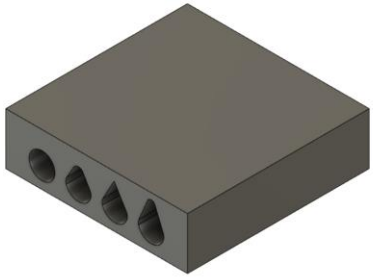


Build Preparation

- Design edits required for manufacturability
- Reduce overhangs
- Test pieces ran



Overhang Test Pieces

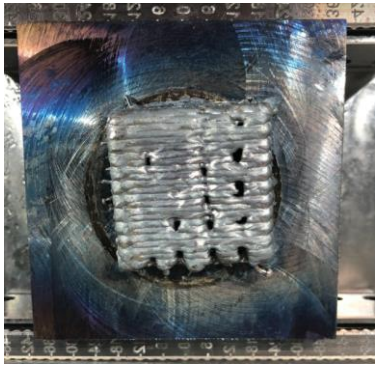




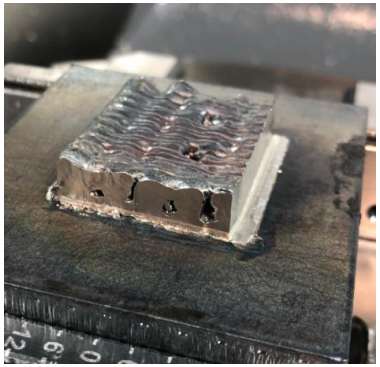
- 5mm radius
- 5mm, 60 degree overhang to rad
- 5mm, 60 degree overhang to point
- 5mm radius, 45 degree overhang tear drop to rad

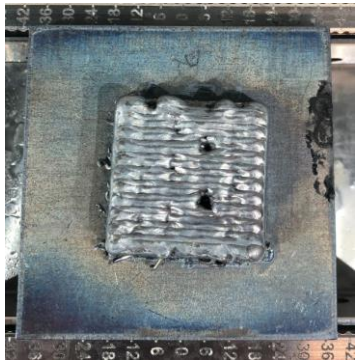
Test Piece 1:



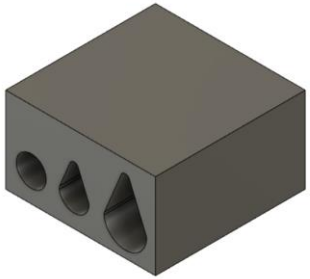


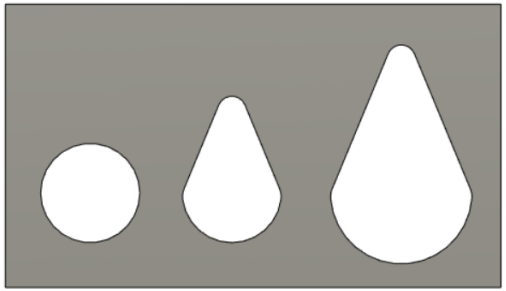
Test Piece 2:





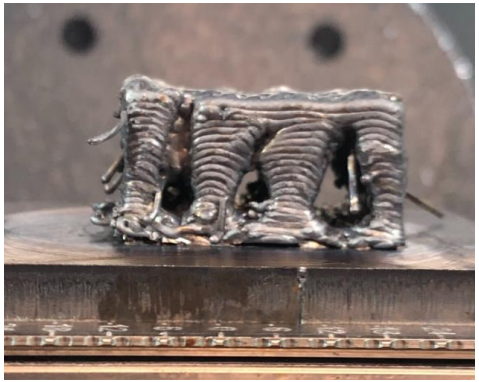
Overhang Test Pieces

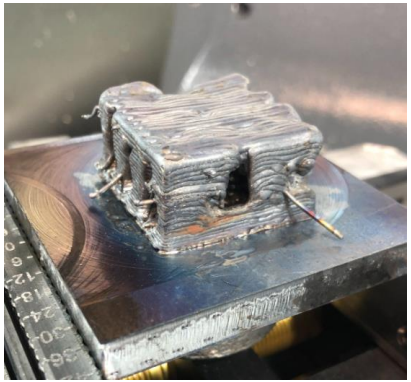


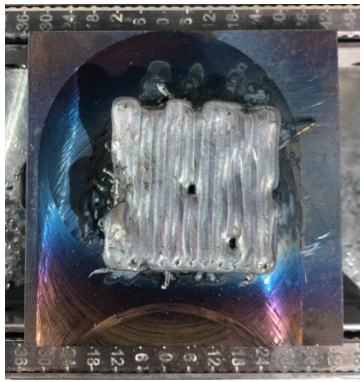


- 7mm radius
- 7mm radius, 45 degree overhang to 1mm rad
- 10mm radius, 45 degree overhang tear drop to 1mm rad

Test Piece 3:

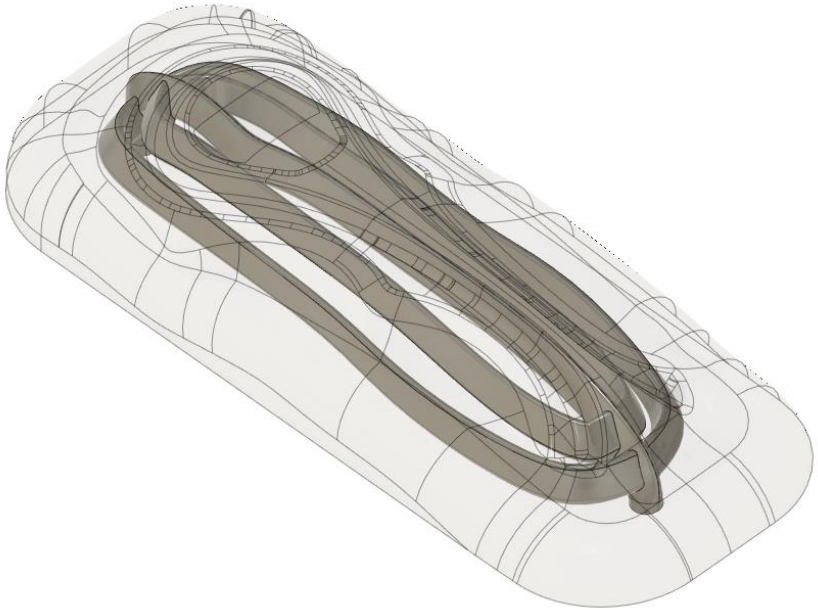


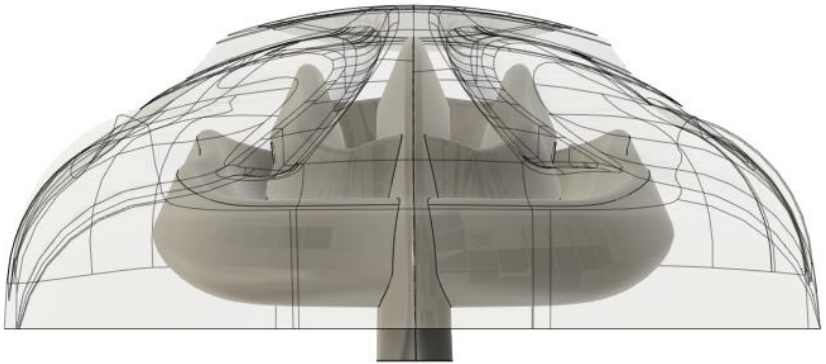




Design Edits

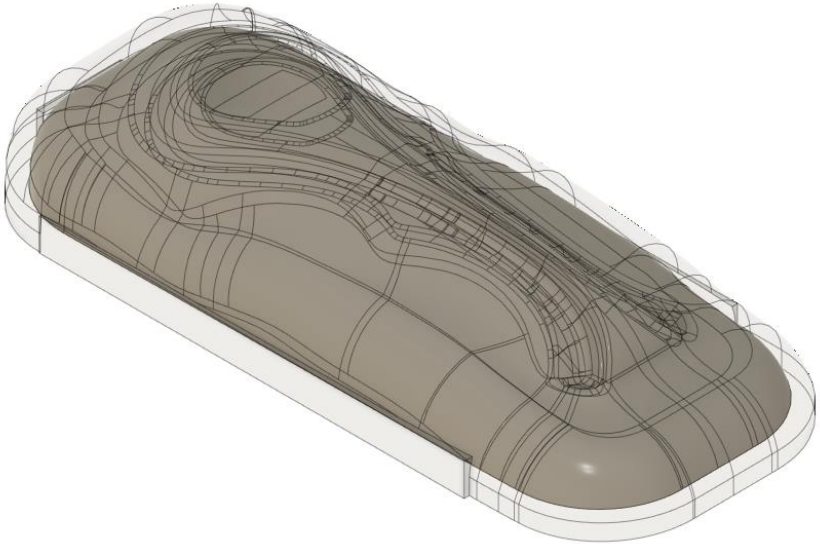
7mm channels applied:

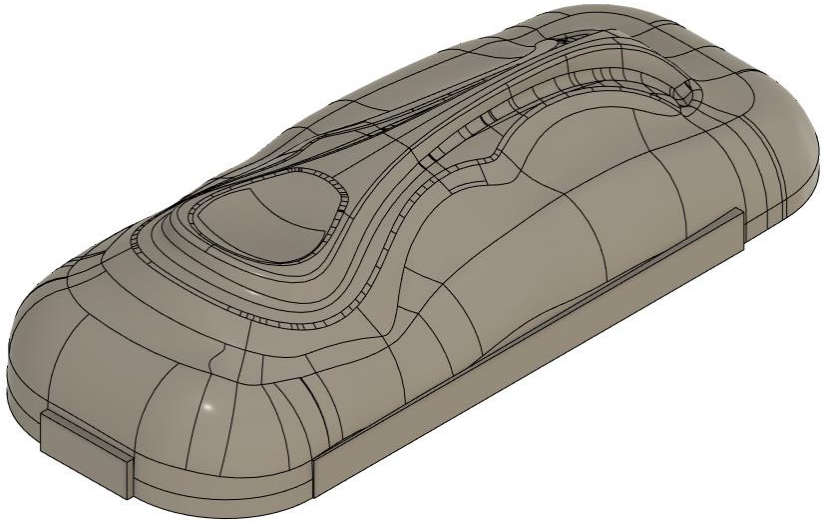




Design Edits

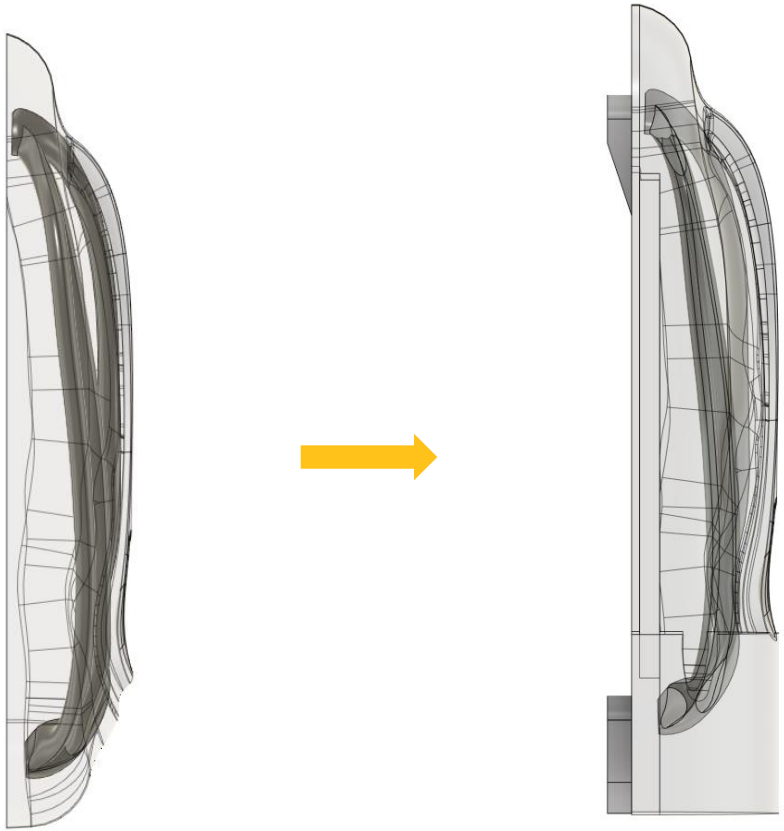
Excess material:





Design Edits

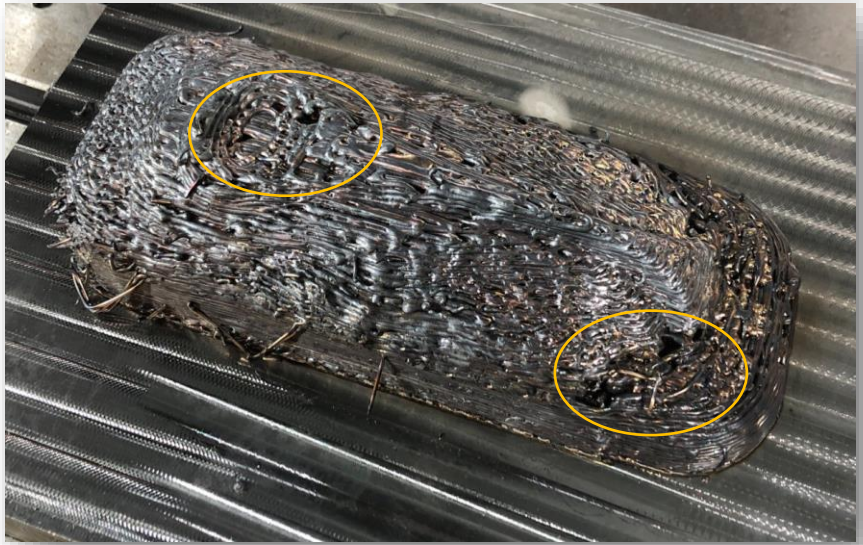
Vertical setup:

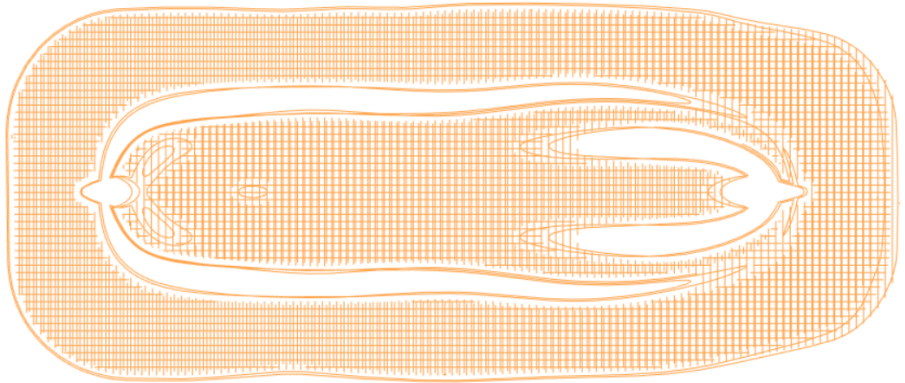


DED Builds

DED Builds

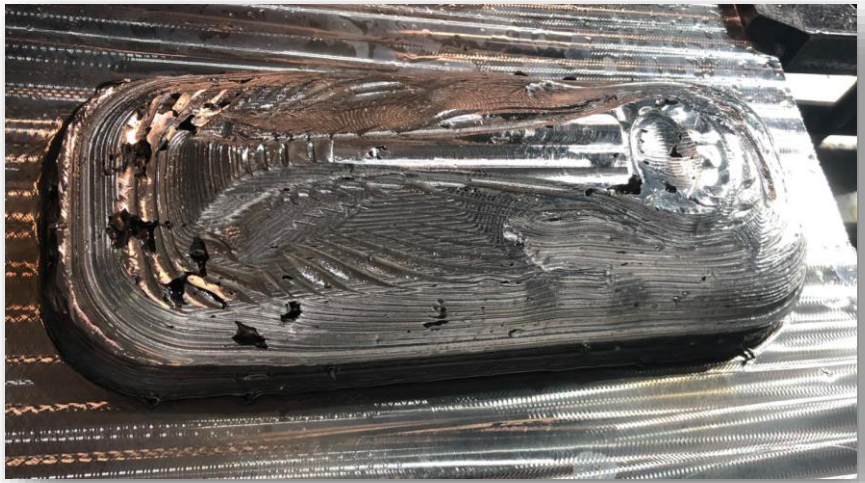
Horizontal Build:

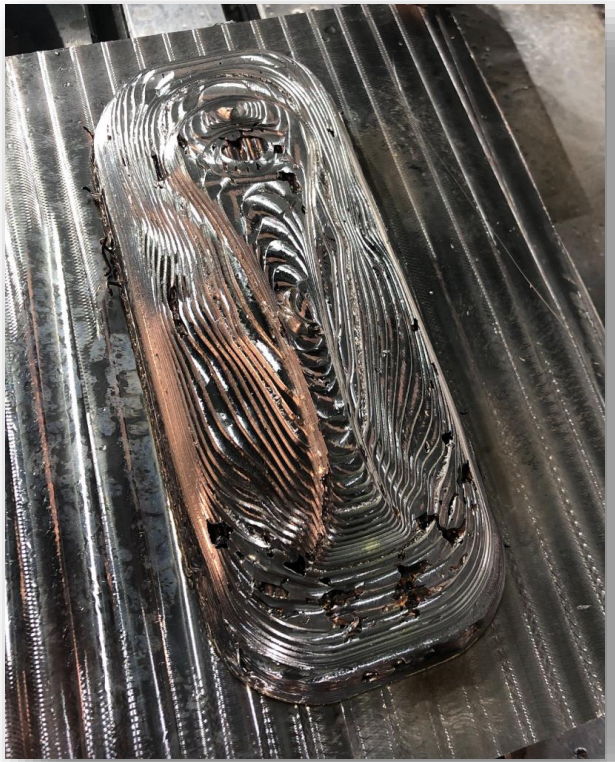




DED Builds

Horizontal Build:





Conclusion – technology with current design & setup not suitable. More optimisation needed

DED Builds

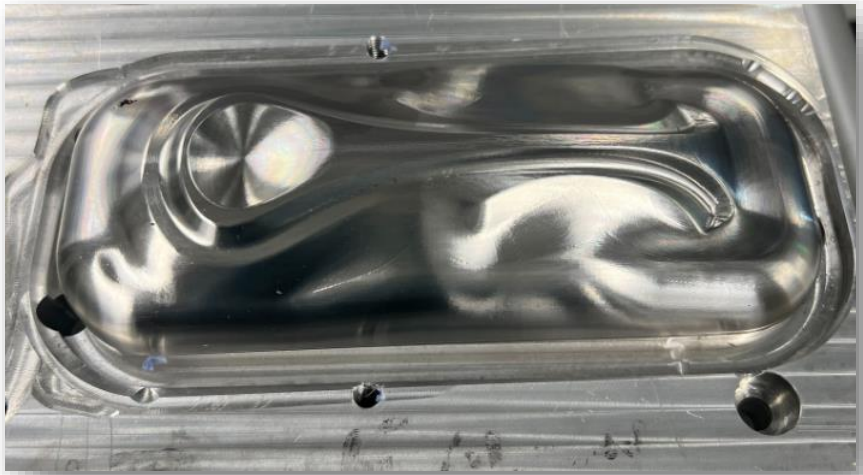
Vertical Build:



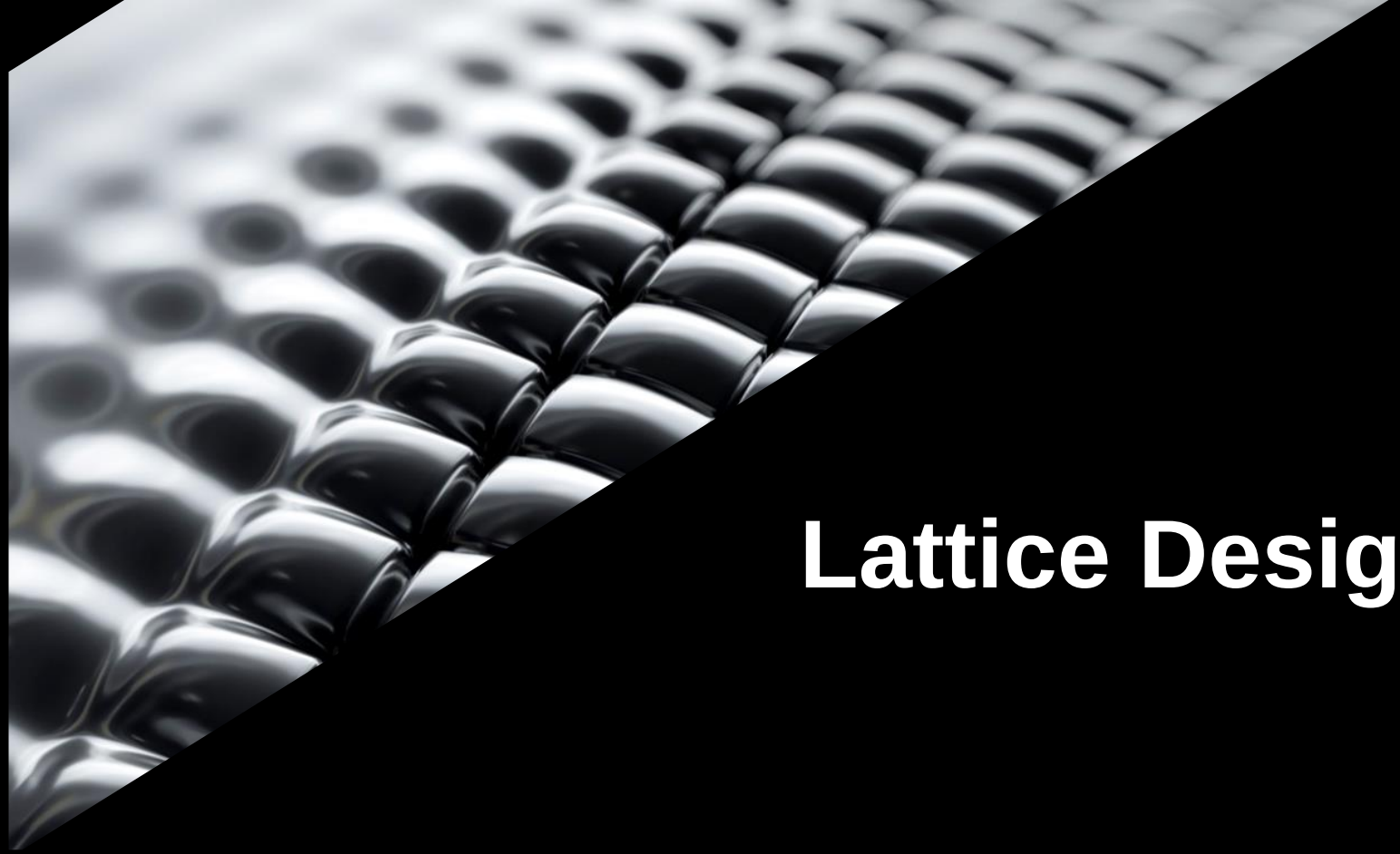


DED Builds

Vertical Machined:







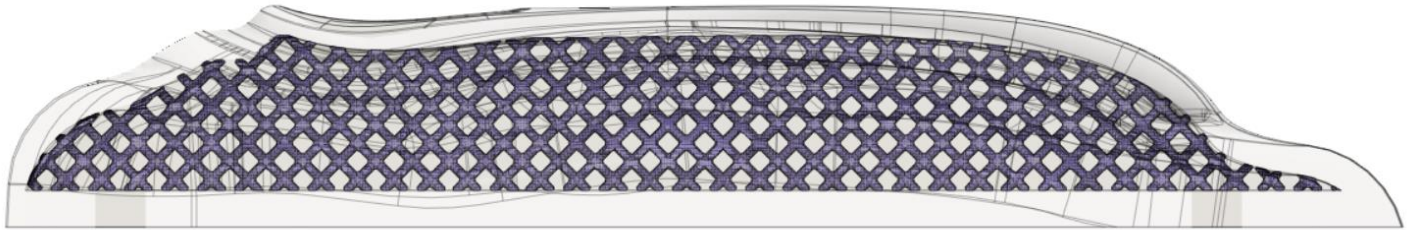
Lattice Design

Design Edits

Internal Lattice

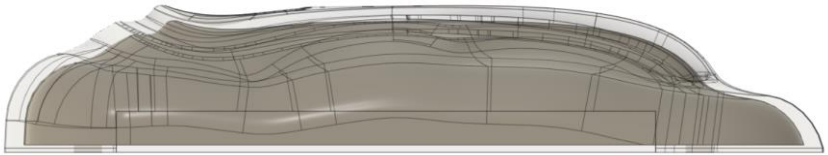
- Volumetric Lattice tool - Fusion 360 Product Design Extension

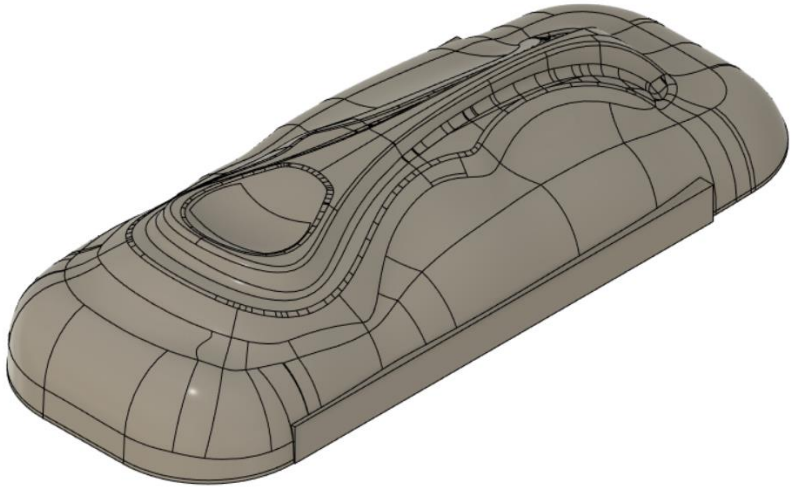




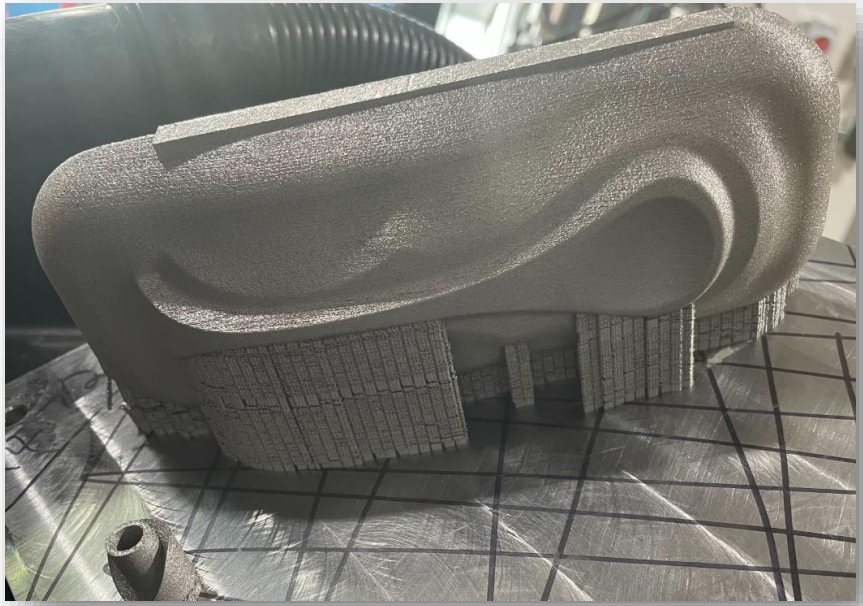
Design Edits

Excess material added:



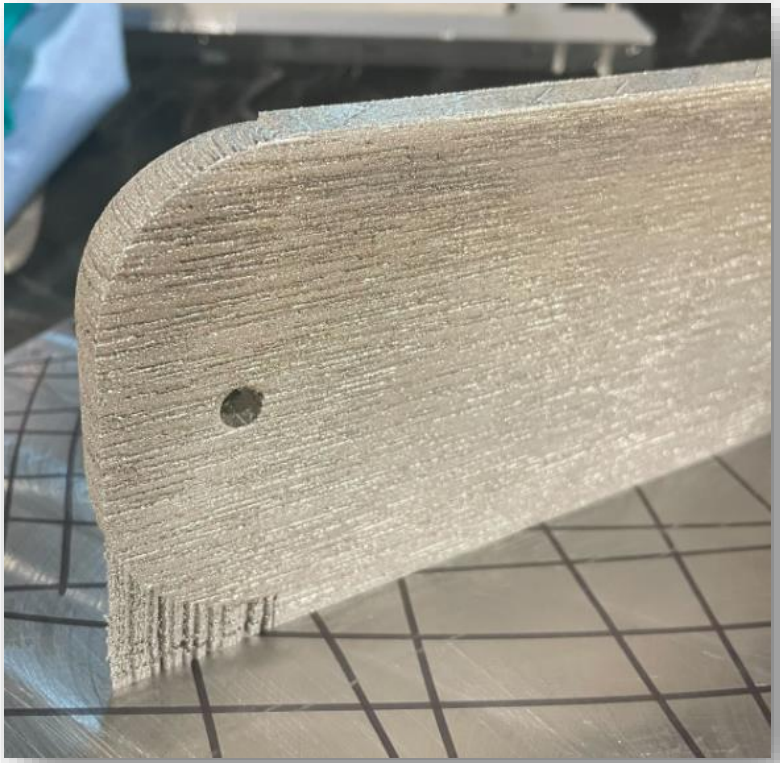


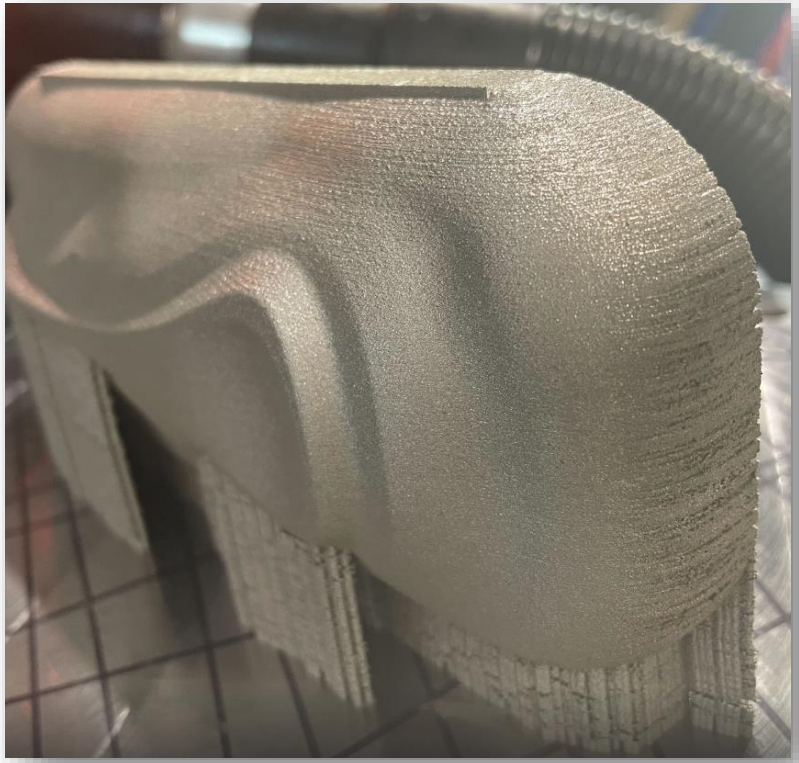
Build Results



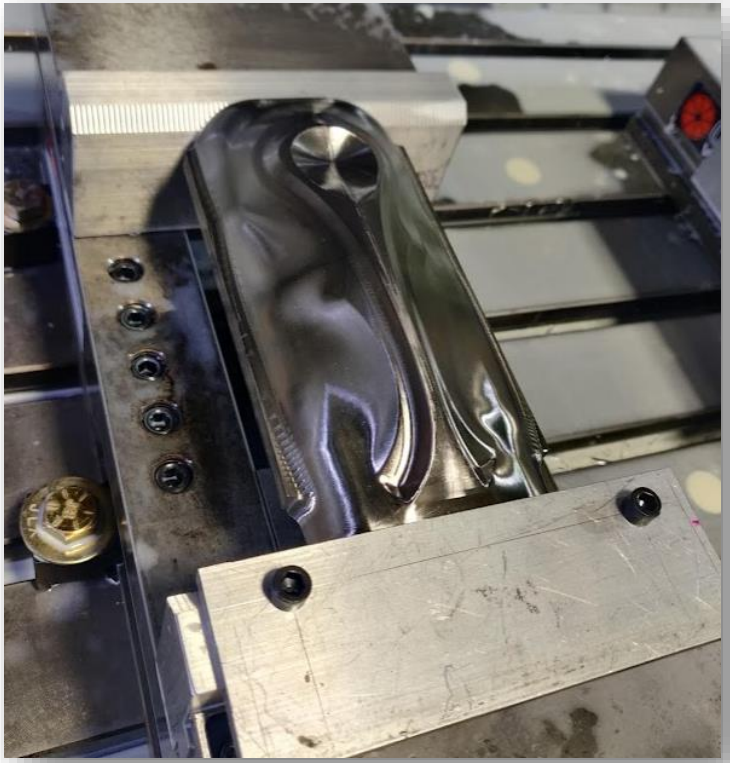


Build Results





Machining





Conclusions

Manufacturing Outcomes

- DED:
  - Orientation very important
  - Avoid overhangs as much as possible
  - Test as much as possible
  - Can get a working result
    - More accessible solution to achieve result
    - Worse surface finish
- PBF:
  - Can achieve more complex geometries
    - Less material required
  - Less accessible solution
    - Testing will determine benefits



Next Steps

- Test parts at ITL
- Compare results
- Laser cut parts





•Compare process v. benefits

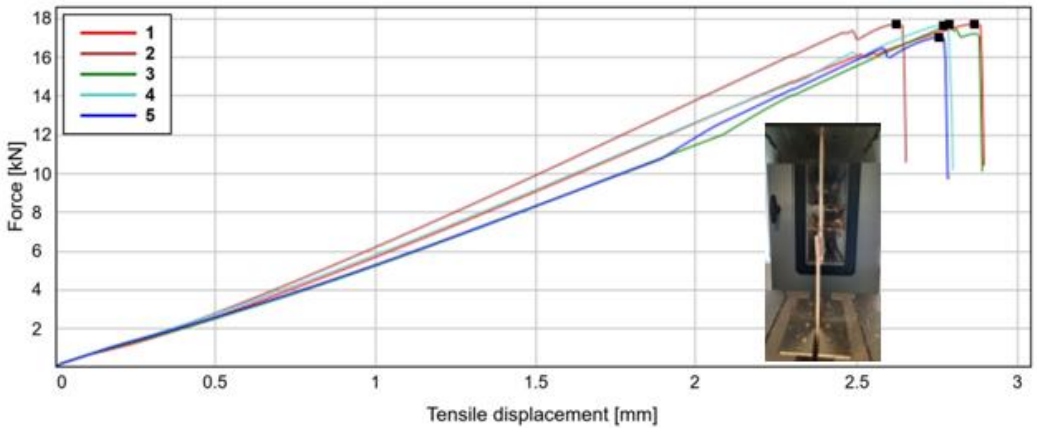
•Implement into industry applications

•Review and test material properties to quantify the benefits of the technology

Testing & Knowledge of Outcomes

- Once we have pressed components, we will be in a position to test the material.

- Tensile testing the material allows the ITL tech team to quantify the difference and advancement in final material properties.

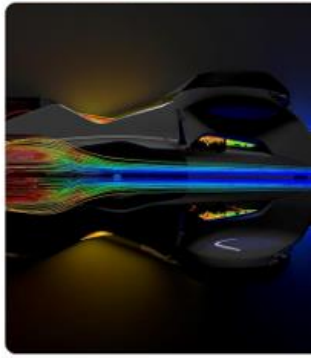


Implementation

- By validating the processes within the project between Autodesk and ITL, we have proven that new and future manufacturing techniques benefit HFQ.
- The current software has been critical in proving the theory whilst the hardware has enabled us to trial this on a small scale.
- The fast-paced nature of the automotive industry combined with these manufacturing techniques will allow HFQ to be delivered within prototype timing to production standards.
- Once the hardware/machinery advances in terms of size and cost, we are confident that prototype projects will be in a position to have significant timing reductions whilst maintaining critical material characteristics





Thanks to

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- James Neville
- Autodesk Technology Centre staff



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