Manufacturing Technology Centre

# Optimisation of a Fork Bottom for AM

**Andrew Triantaphyllou**

**Technology Lead , Design for AM**

TCT, 30 Sep 2015

Ketech

GRM OPTIMISED ENGINEERING DESIGN

Stand J21

CASiM CENTRE FOR ADVANCED SIMULATION & MODELLING

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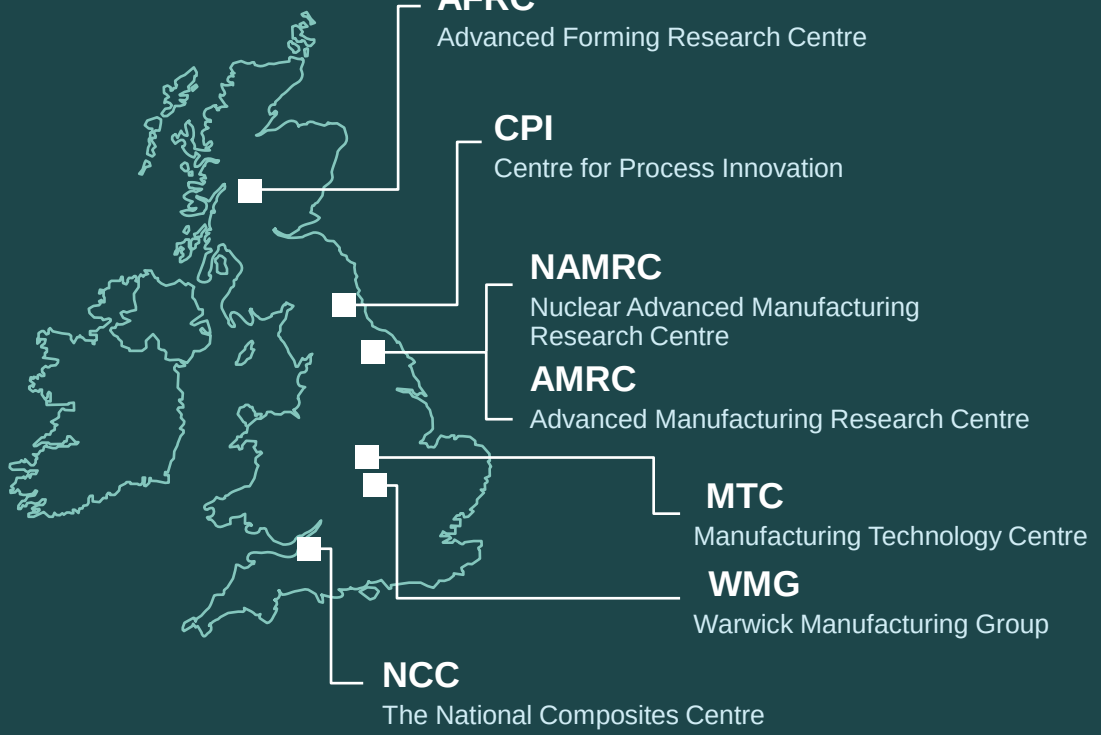
# HVM CATAPULT CENTRES

MTC is the lead centre for Net Shape & Additive Manufacturing in the High Value Manufacturing Catapult

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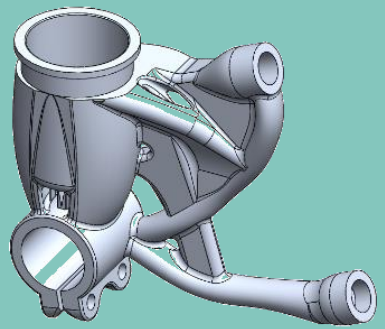
CATAPULT High Value Manufacturing

# Overview

## What we did



## Can an SME use AM?

£ ?

## Our role

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# GOAL: Understand rules for AM optimisation

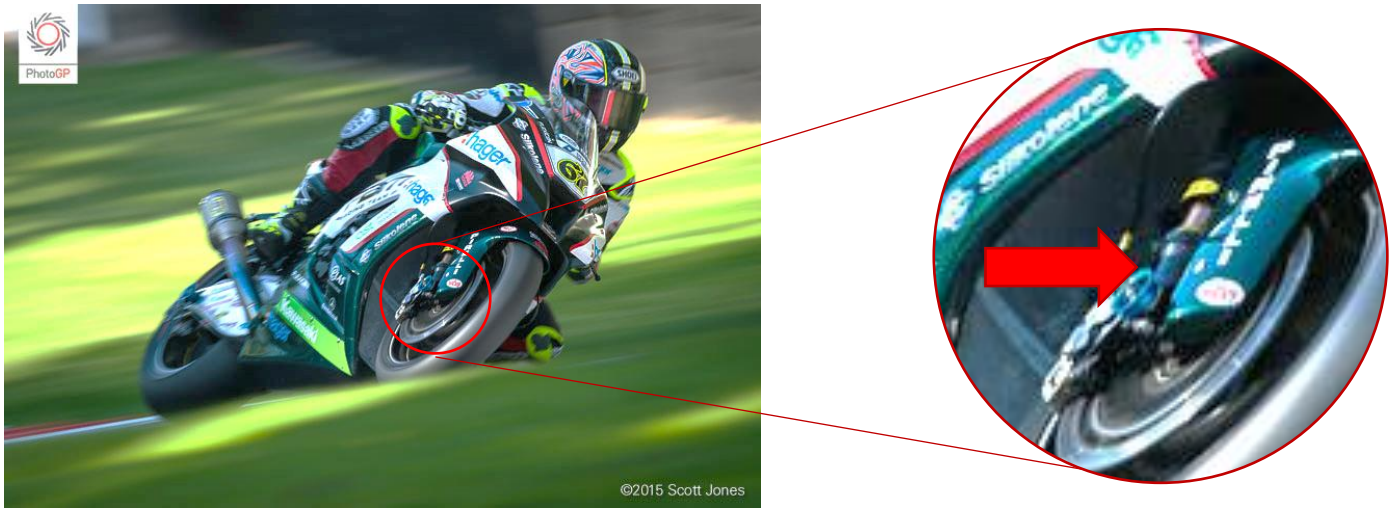
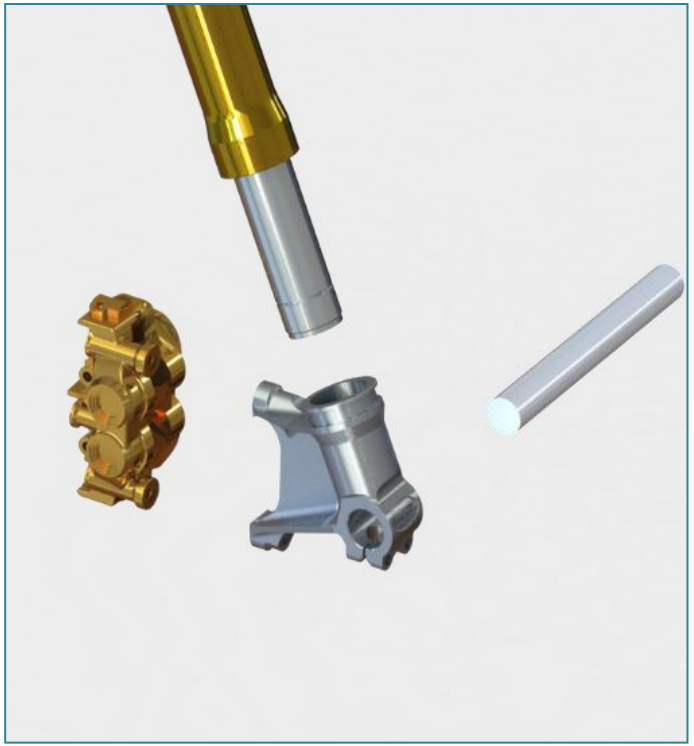


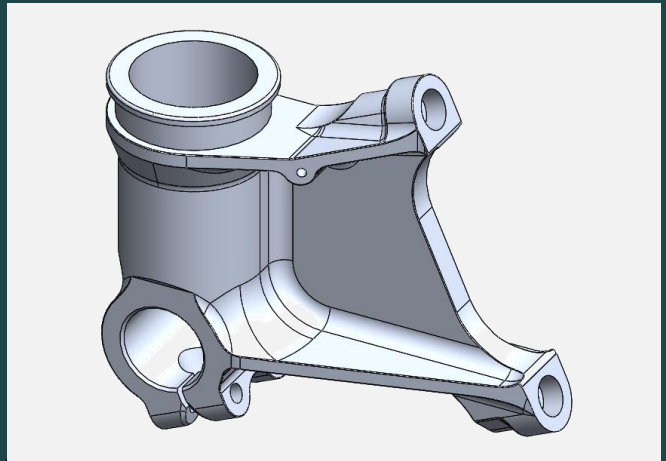

*Image: Copyright Scott Jones, via K-Tech*

# Component: Fork bottom



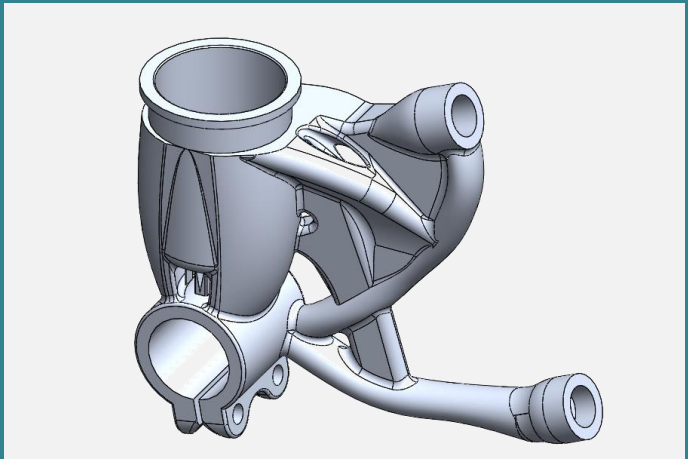
*Modelled by K-Tech using SolidWorks*

# BEFORE

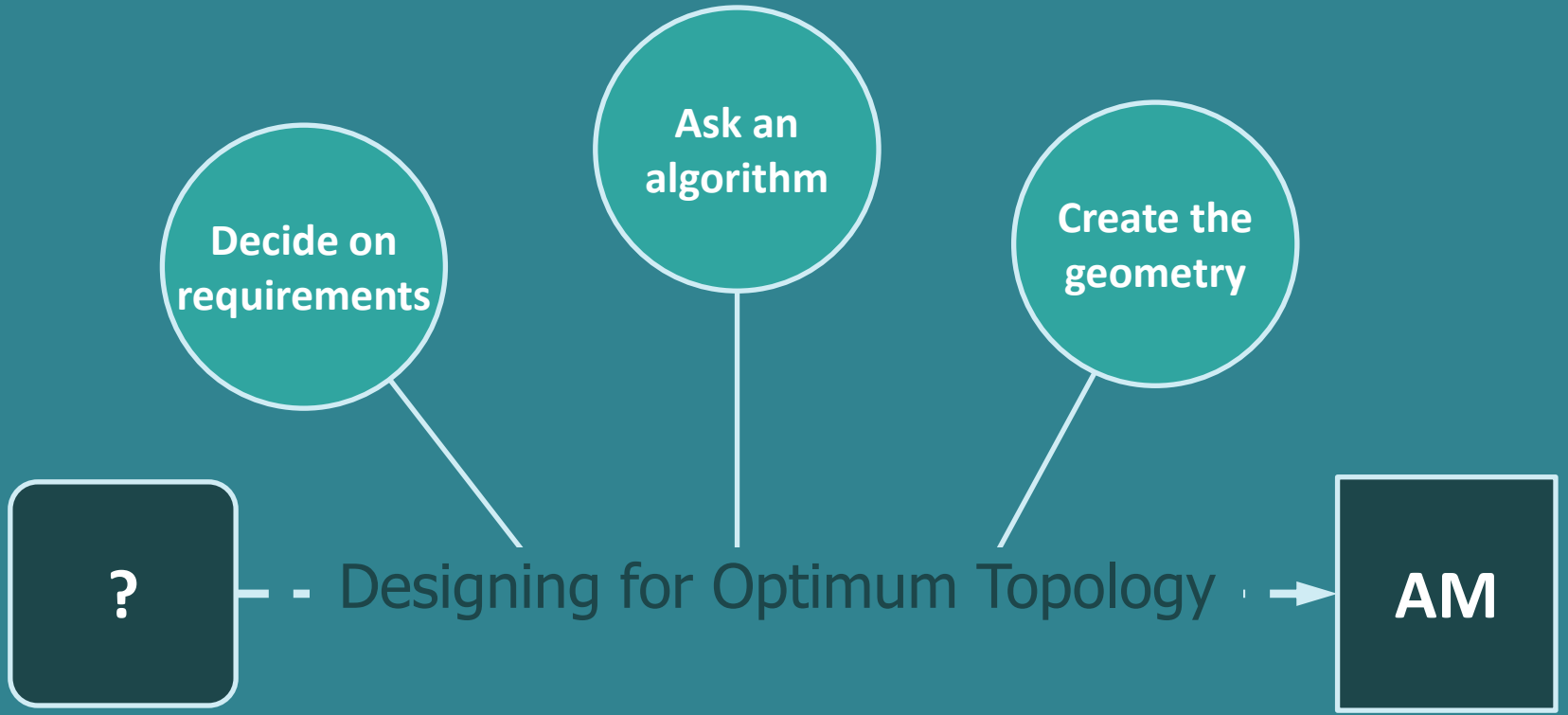


| | |
|---|---|
| Material | 6082-T6 |
| Mass | 570g |

# AFTER



| | |
|---|---|
| Material | AlSi10Mg |
| Mass | 419g |
| Saving (both forks) | -302g |

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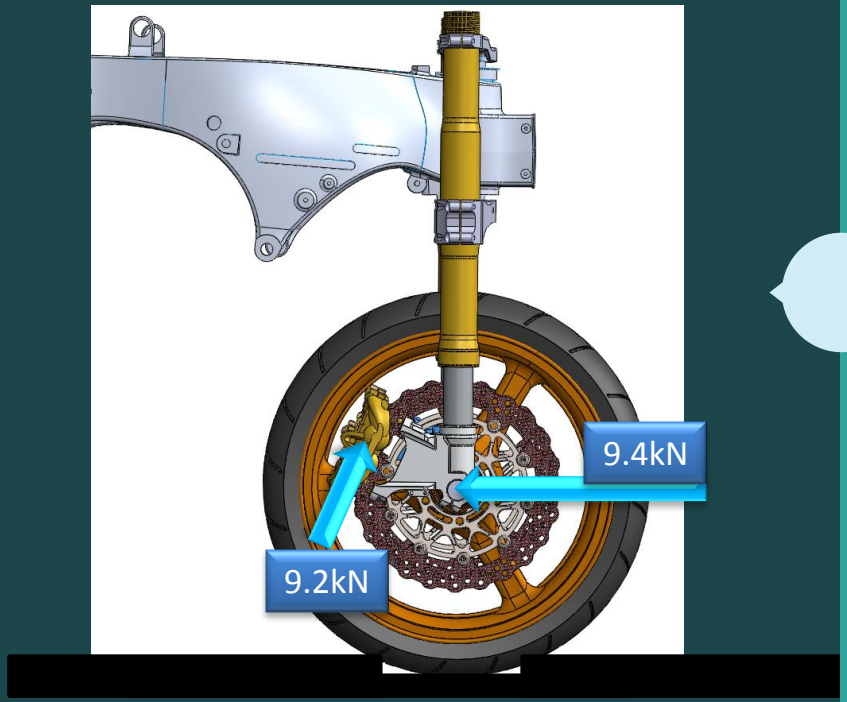
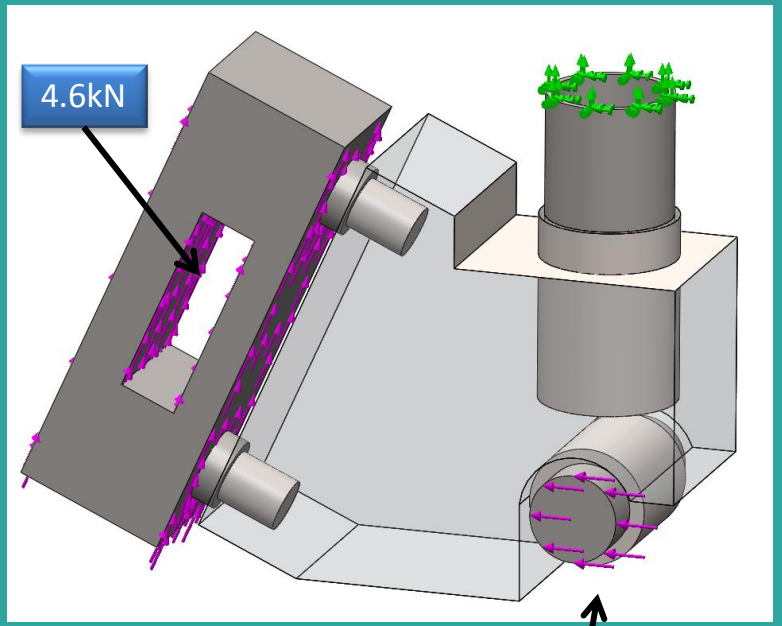
# 3g braking into a pothole




# Design volume




Repeated for alternative load cases

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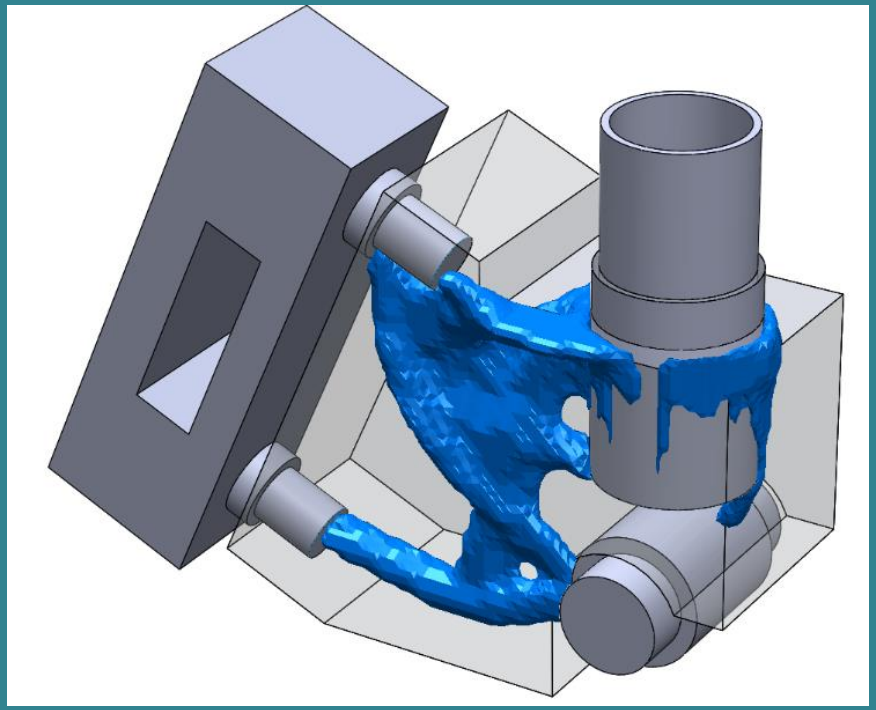
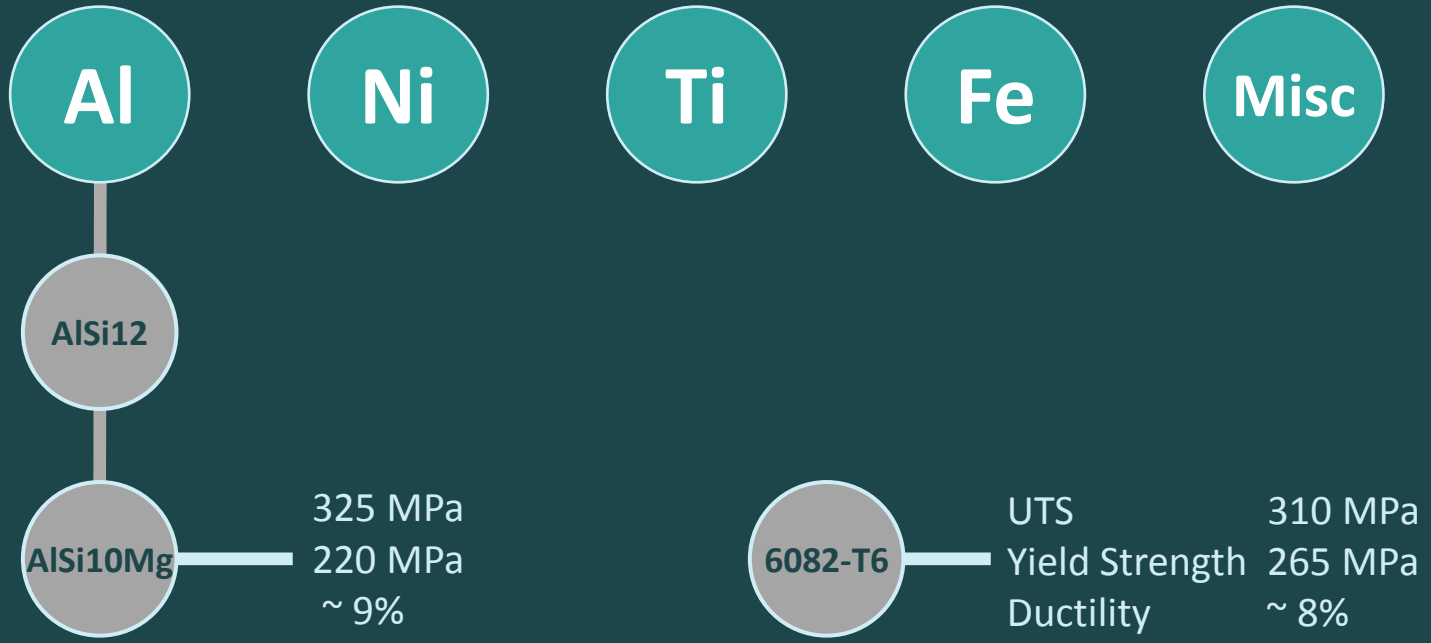
# The algorithm suggests a solution



*Generated in SolidWorks Premium with GRM TruForm SW Add-in*

# Selective Laser Melting material choices

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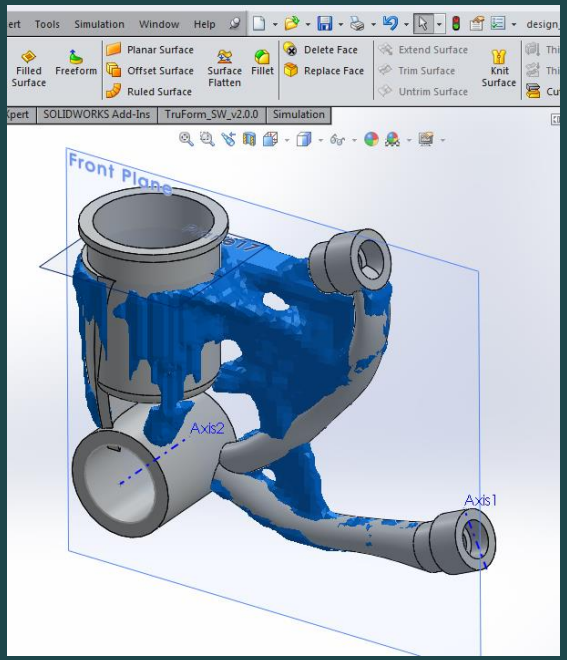
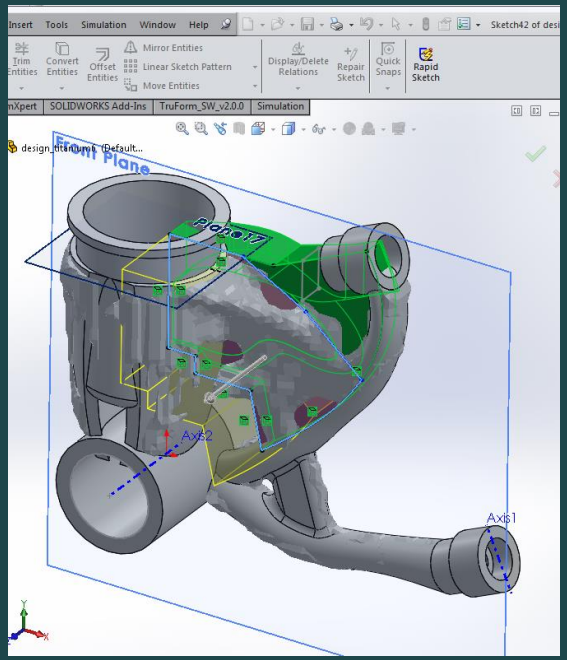
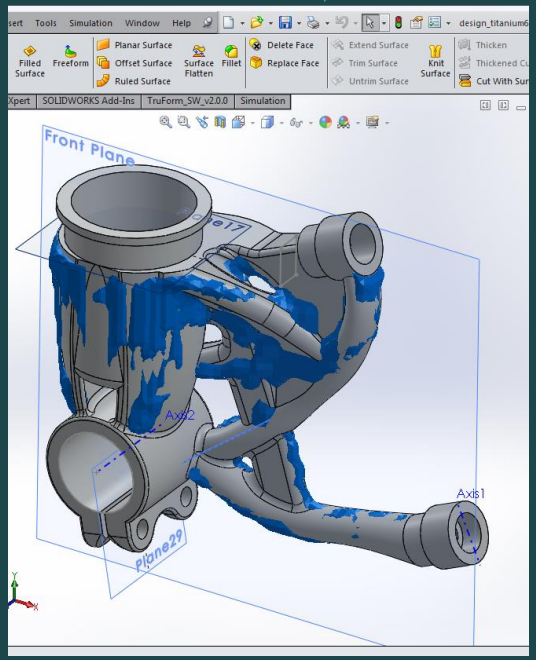
# Remodelling

1 2 3

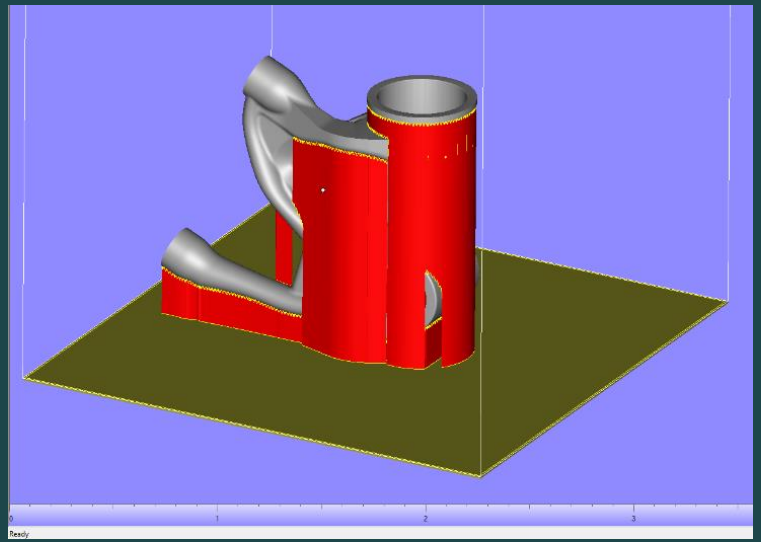


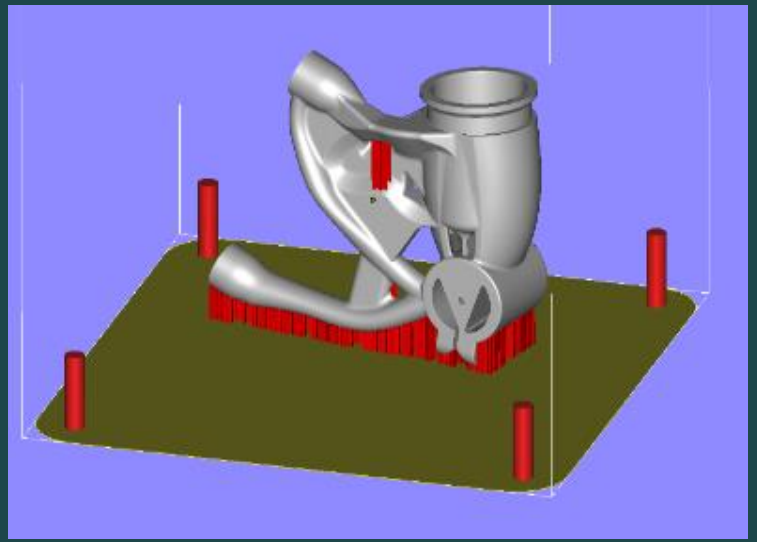




*Modelled by GRM using SolidWorks*

# Remodelling for supports





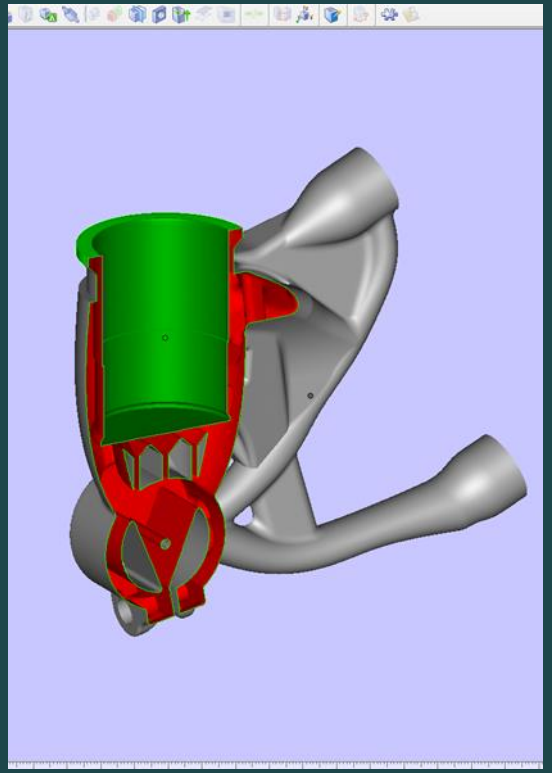
- Modelled for function
- Optimised for supports

*Supports added using Magics*

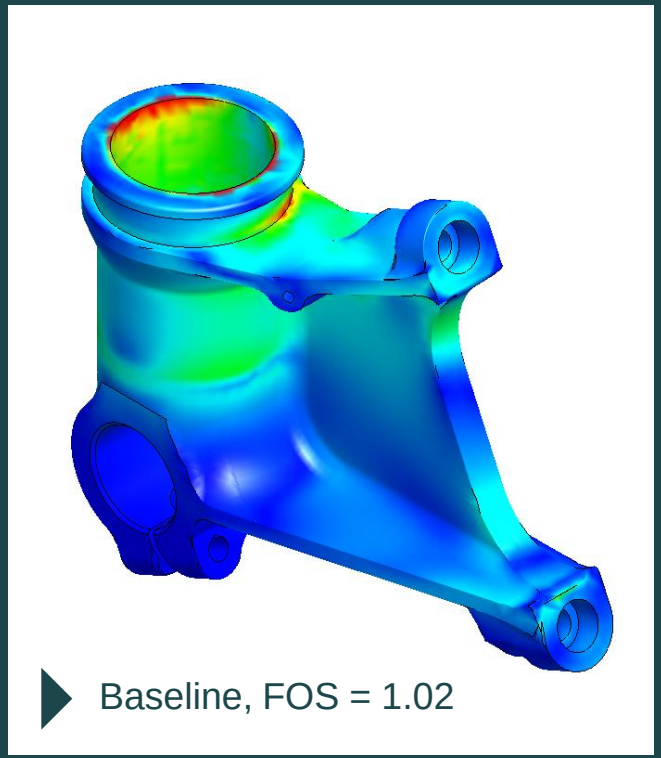
# Combat fatigue

Allow for improving surface texture by:

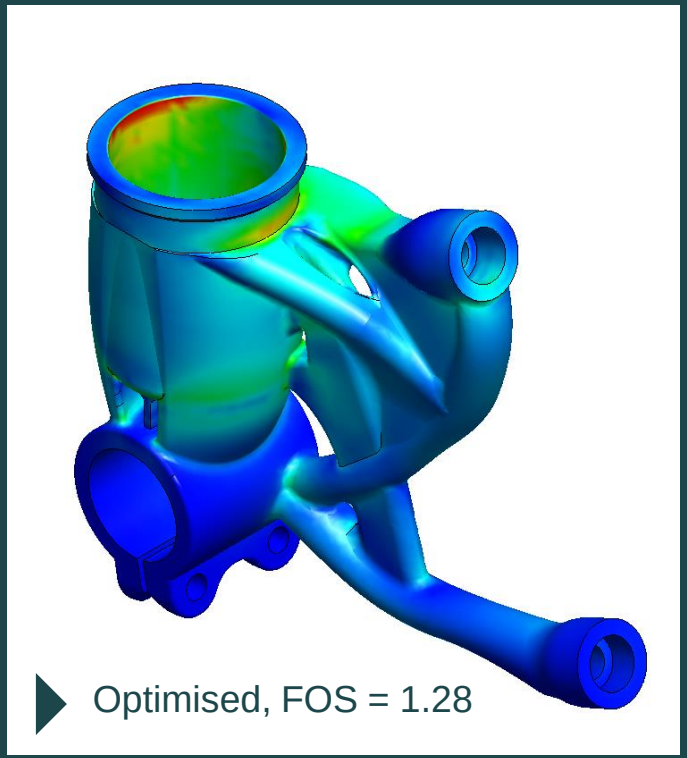
- Machining interior (green area)
- Grit blasting exterior (grey area)



# Validation and comparison - Stress



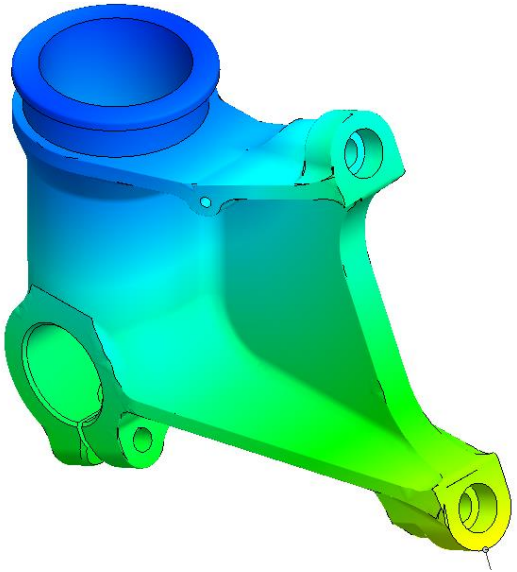
- Baseline, FOS = 1.02



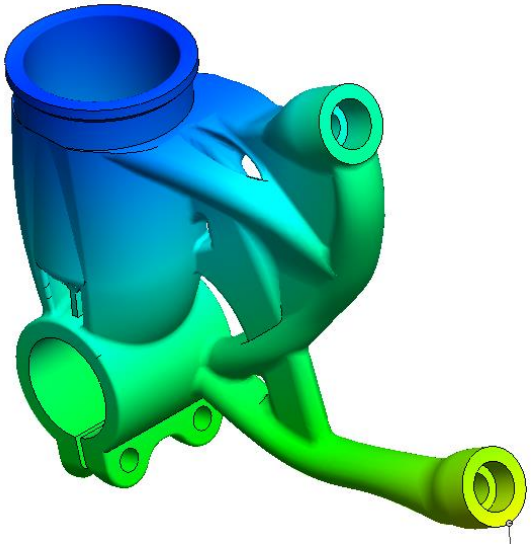
- Optimised, FOS = 1.28

*Simulation by GRM using SolidWorks Premium*

# Validation and comparison – Displacement

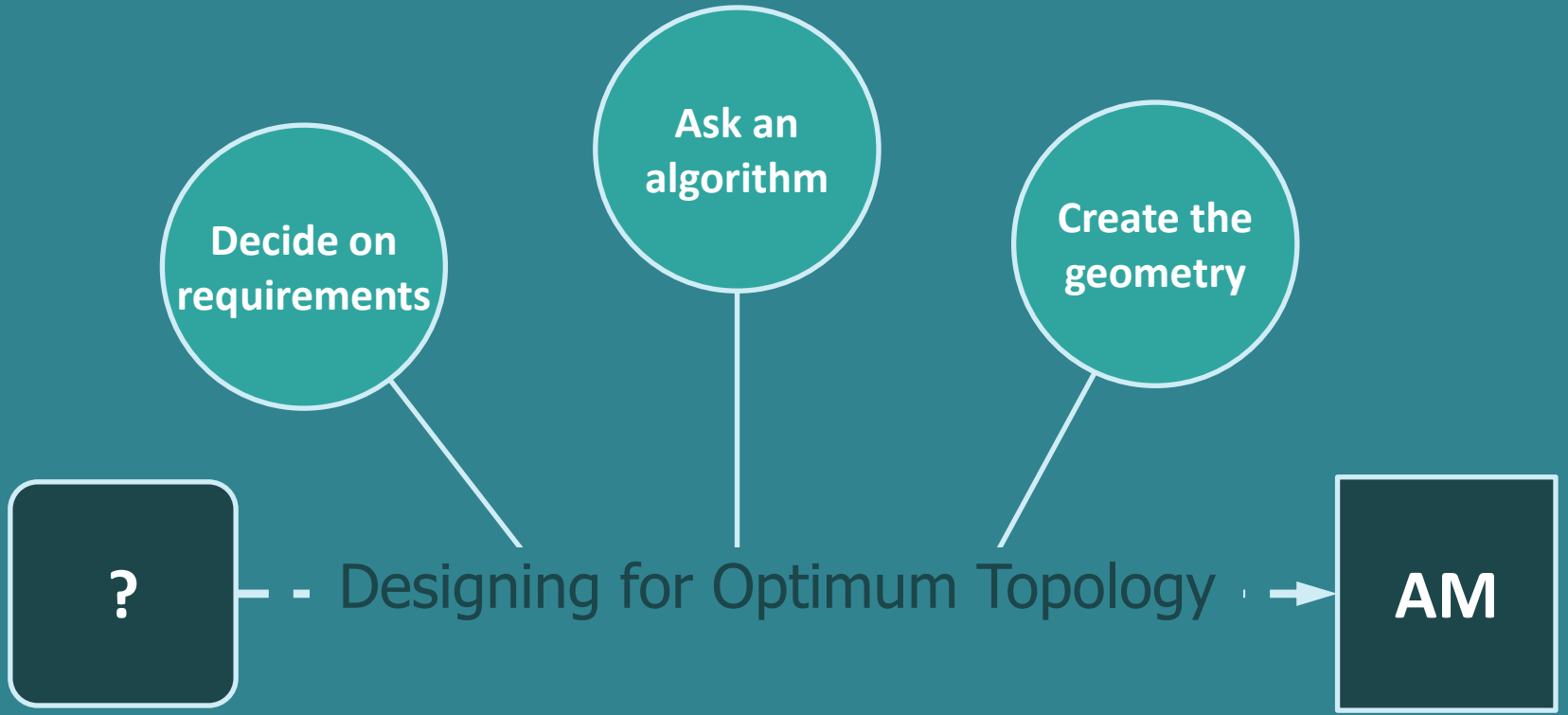


- Baseline, Max = 2.2mm



- Optimised, Max = 2.2mm

*Simulation by GRM using SolidWorks Premium*

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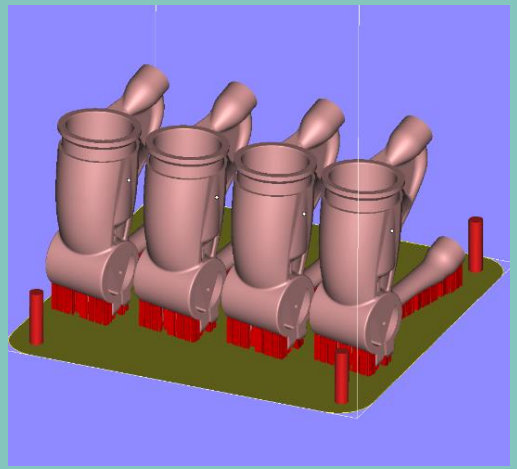
# What will it cost for AM build?

## Batch of 4



## Cost for build

| | |
|---|---|
| Pre-process files | 5 hrs |
| Operator for build | 5 hrs |
| Build (depreciation) | 65 hrs |
| Powder | @£80/kg |
| Post-process | £ 230 |
| *Per component* | *~£1,200* |

*~£2·5K /Kg*

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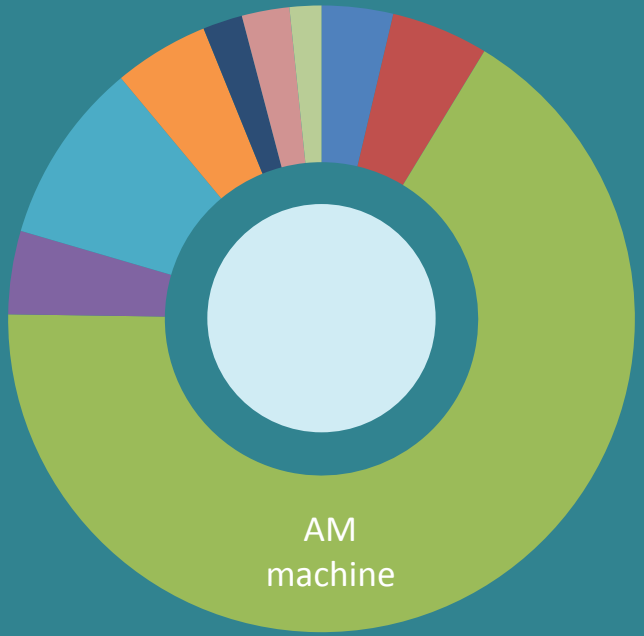
# Cost Factors

## Machine utilisation is the main factor

- Model prep
- Operator
- Machine
- Powder
- Residual stress HT
- EDM (removal)
- Fettle
- Blast

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# Conclusion

- Too expensive for mass production
- How about for race use?
- Race spec alloy is 7075-T6
- AlSi10Mg can't match those properties

# Future Work

- Investigate whether SLM  Ti can provide a better solution than machined Al.


*Image:  Courtesy of Jon Jessop photography, via K-Tech*

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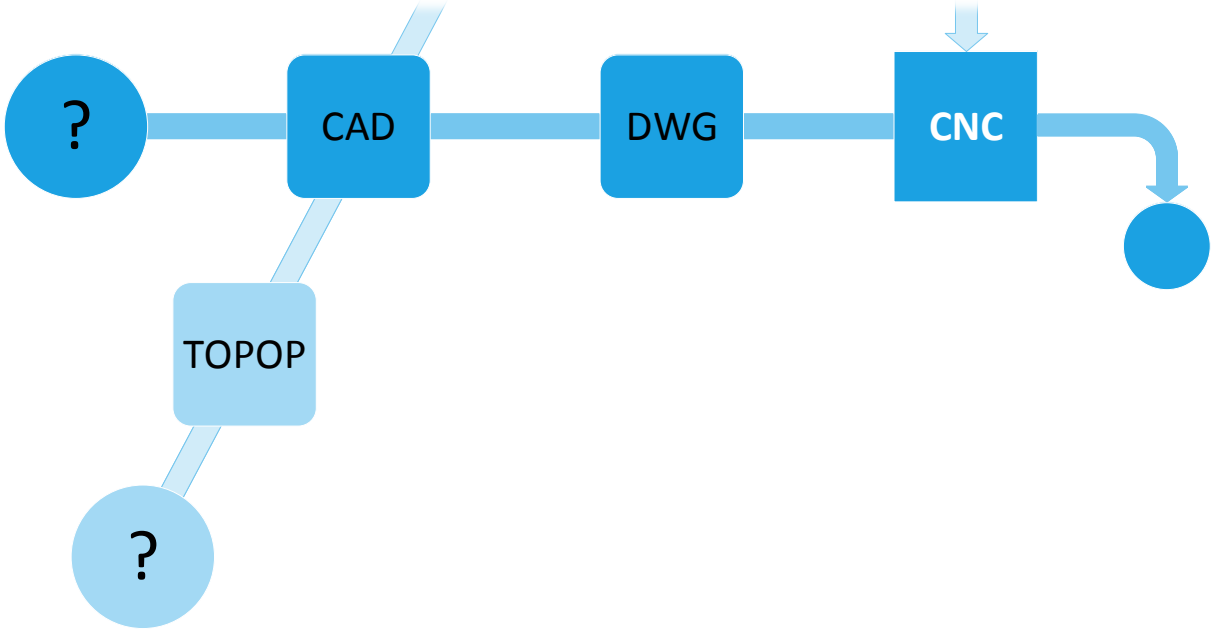
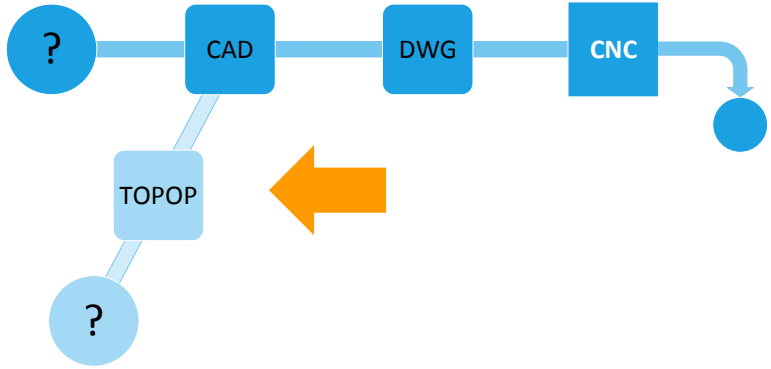
# How can an SME start taking advantage of AM topology optimisation?

# What do you need to Design for AM?



# Software investment

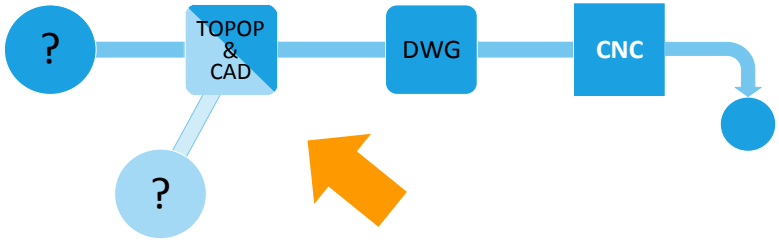



## Option 1 – High-end, Powerful

Eg:
- Altair Optistruct
- VR&D Genesis
- Simulia TOSCA

## Option 2 – Lightweight, Simpler

Eg:
- Altair INSPIRE




## Option 3 – Integrated into CAD

Eg:
- GRM TruForm (SolidWorks)
- Limitstate Form (SpaceClaim)

# How the project fits MTC strategy

## Design for AM

- User guides – DfAM
- Software comparison and advice
- Software tool improvement
- AM value proposition

# Project partners


- SME - Design and Manufacture motorcycle suspension units



- SME - Design Consultants
- Write optimisation tools


- Project to support West Midland SMEs in modelling and simulation

# Summary:

- The bar is still high in terms of process cost (what is -302g worth?)
- The bar is lower for access to designing complex forms - one of AM's value adds.
- The MTC works with SMEs to remove barriers to adoption of AM.

*Shopping list:*

- *Software*
- *Training*
- *AM Bureau Gift Voucher*

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# Thank-you

We would like to thank CASIM for part-funding this project.





**For more information please contact:**
Andrew.Triantaphyllou@the-mtc.org
**Manufacturing Technology Centre**
Pilot Way
Ansty Business Park
Coventry
CV7 9JU
www.the-mtc.org

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