

CU 36: Coordinating the AM Process (Pilot)

TOPIC 3: Design for AM -setting & meeting the design brief

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FOR SAM PILOT ATTENDEES AND TRAINERS ONLY

MM13

Topics covered include....

- Design for AM
- Benefits of AM versus commitment
- Business case
- Functional requirements
- Commercial requirements
- Standards & legislative requirements

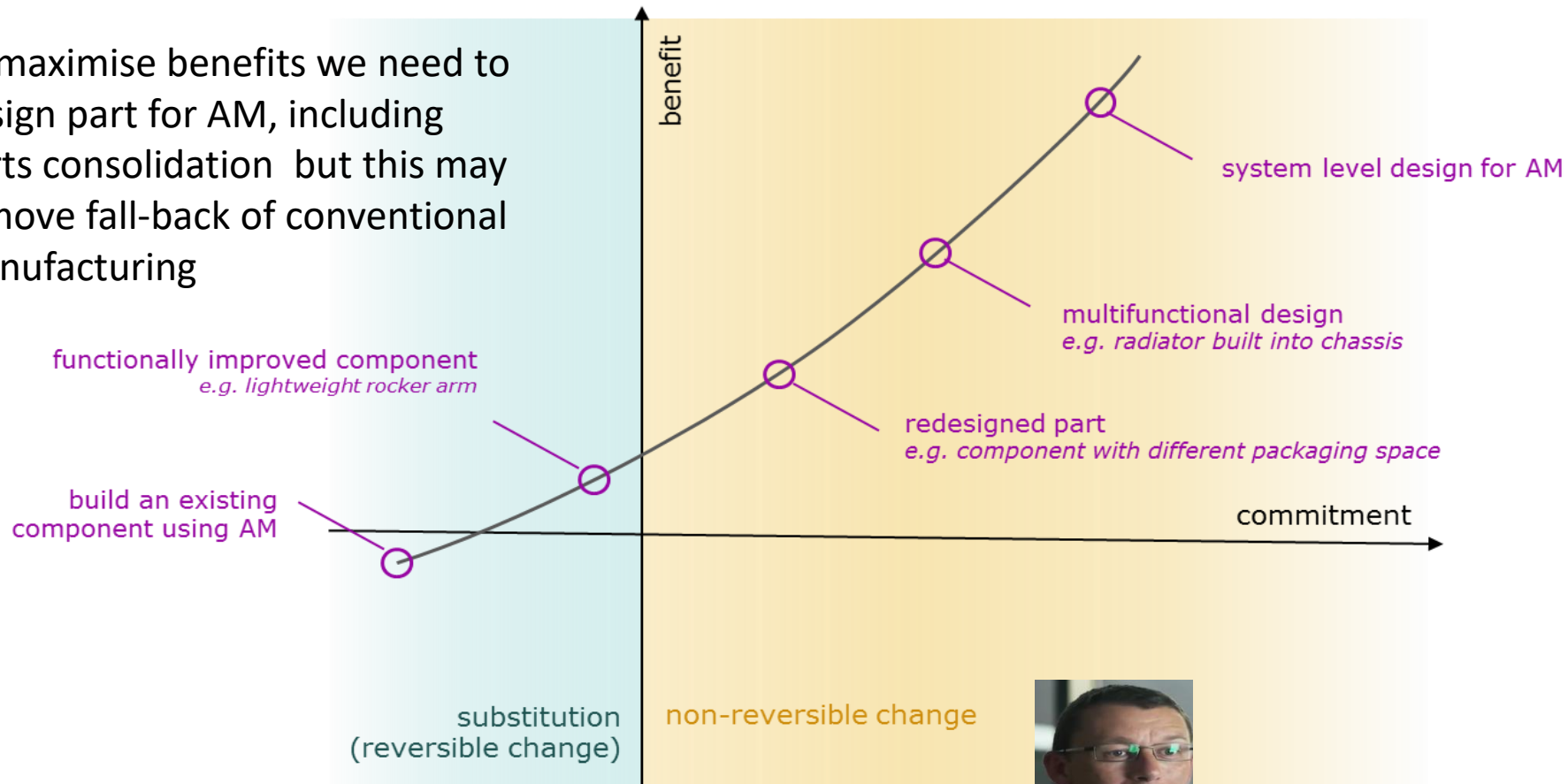
Design for AM (DfAM) - Requirements capture

To support Design for AM (DfAM) we need to get more detail than for standard AM requirements capture;

1. Business case for specifying AM
2. Part function
3. Commercial requirements
4. Standards & legislative requirements
5. Scope for redesign
6. Material requirements
7. Customer management requirements

Benefit/Risk vs commitment to AM

To maximise benefits we need to design part for AM, including parts consolidation but this may remove fall-back of conventional manufacturing



Based on a graphic by Neil Mantle, Rolls-Royce



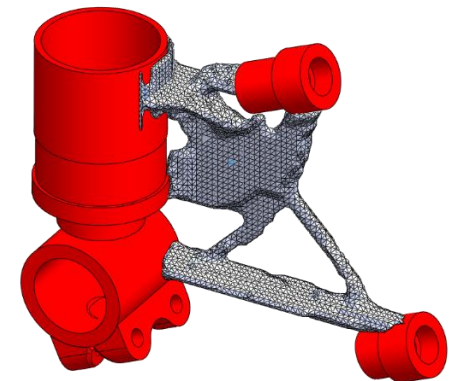
- **Why is the customer considering AM for this part:**

- *Reduced cost*
- *Reduced lead time*
- *Improved quality*
- *Better performance*



Sometimes for old* parts supply chain no longer exists

* Sometimes referred to as legacy or stranger parts



- **Current manufacturing process:**
 - *What is current manufacturing process?*
 - *Any steps after part manufacture?*
- Help to understand current design limitations and where AM can add value.
- Additional assembly or manufacturing steps?
 - *Potential for parts integration*
 - *Impact of downstream processing (e.g anodizing)*



- **Purpose of the component/assembly:**

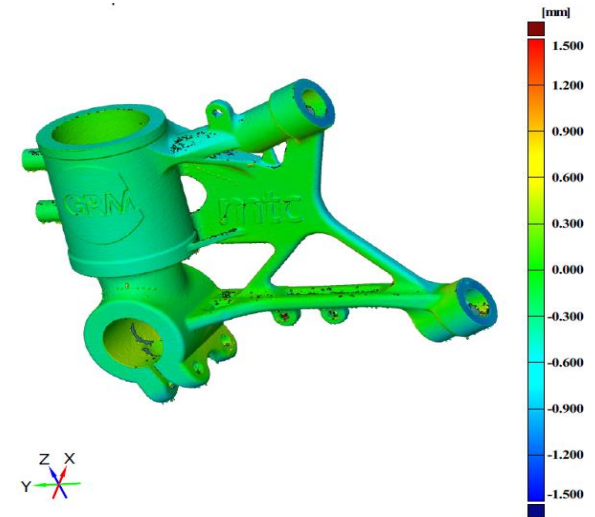
- *What does the part/assembly do?*
- *What are the critical functional requirements?*
- *What are the design drivers?*
- *How does it interact with adjacent components*



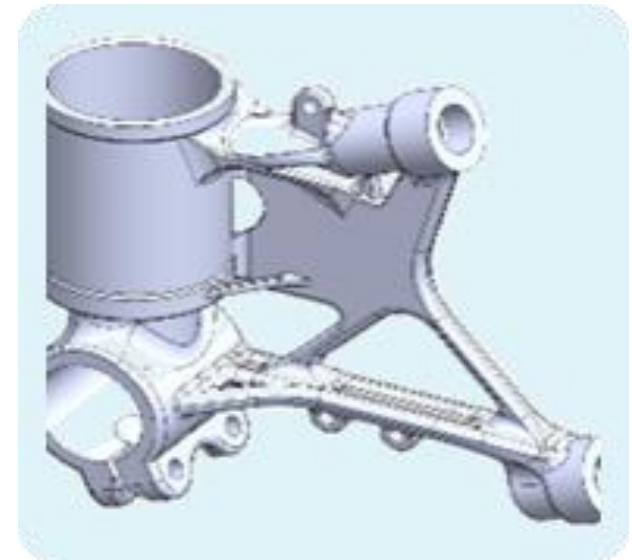
- Capturing this information will ensure that, if met, the final part will be fit for purpose.
- It also helps to identify where AM can add value.

Accuracy & Surface finish

- **Dimensional accuracy and tolerances:**
 - *What accuracy is required?*
 - *What surface tolerances are required?*
 - *Are all these essential, or only specific ones?*
- Accuracy and surface finish requirements affect AM process and post processing choices
- Understand if they are only required on critical surfaces, such as mating faces in assemblies
- Relaxing tolerances or surface finish requirements can reduce the cost/lead-time



- **CAD files/drawings of components/assembly and relevant adjacent files:**
 - *Size and complexity of files?*
 - *Individual part or the assembly ?*
 - *Function of parts in understood?*
 - *Are all the CAD files/drawings available?*
- Files may not be available.
- Reverse engineering will be required to generate data – this can be slow, costly and risky



- **Cost target:**

- *Does customer have cost target for the parts?*
- *Has customer considered all aspects of the AM process beforehand (design, simulation, printing, post processing, inspection, quality)?*
- *Potential to add value/ reduce costs (such as assembly) ?*



- Ensure parts are economically viable, and also help give the customer a better appreciation of the full AM process, as well as the value added to the part by using AM.

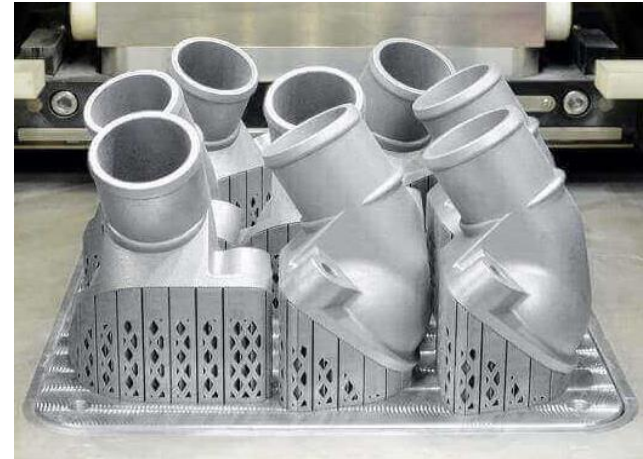
- **Lead time:**

- *Does customer have a target lead time for the part?*
- *Have they considered the full AM process?*
- *Is there time to redesign parts or simply recreate them?*

- Very easy to underestimate the lead-time
- Things can go wrong
- This should be considered when providing a lead time to the customer.

- **Production volume:**

- *How many parts does the customer need?*
- *Are there variations in the parts?*



- AM is best used for low volume production runs.
- If the customer requires a higher volume, AM may not be the best manufacturing method.

Q- Which metal AM process is potentially suited to larger production volumes ?

<https://www.menti.com/aloy9o5k2frf>



- **Legislative requirements:**

Different sectors have different legal requirements;

- *Have standards and compliances been clearly defined?*
- *Can AM meet the legislative requirements?*
- *Any health and safety requirements?*

- Information help avoid problems with part qualification and certification.
- These may impact several process steps



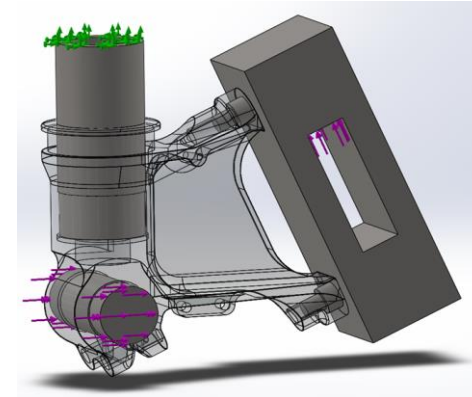
Scope for Redesign

- **Customer “openness” to redesign for AM:**

- *How much of the design is customer willing to change*

- Unless some redesign is possible it is likely that part cost, lead-times and quality will be impacted

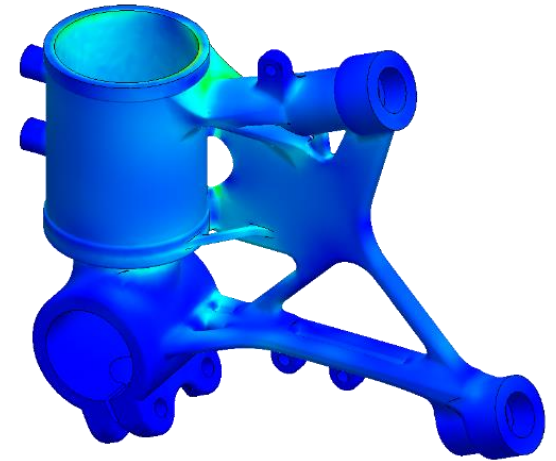
- In some cases alternative manufacturing routes may be more beneficial



Capture Scope for Redesign

- **Consider the impact of redesign:**

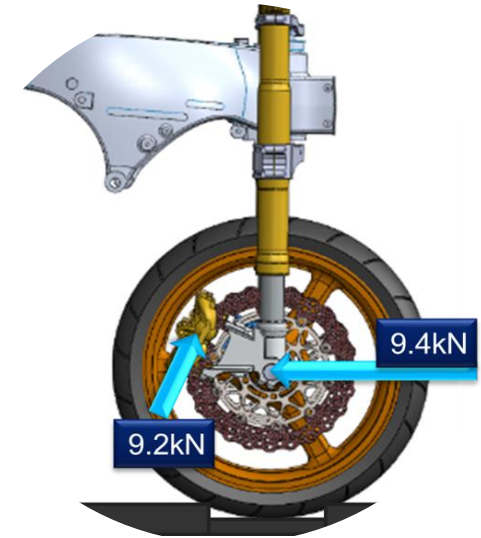
- *How to improve part performance ?*
- *How to reduce AM cost/difficulty?*
- *Essential interfaces?*
- *Part envelop ?*
- *Features which require access?*



- Some constraints are fixed (interfaces /envelop)
- Parts integration can reduce interfaces and widen envelop
- Lattices and organic surfaces difficult to inspect

• Material Requirements

- *Current component material(s)?*
- *Is material fixed ?*
- *Material needs to consider;*
 - *Mechanical requirements?*
 - *Chemical requirements?*
 - *Temperature requirements?*
 - *Fatigue requirements?*
 - *Loading requirements?*



- Helps to understand the part and identify AM equivalents.
- Not all the data on AM materials may be available, so testing may be required to validate suitability.

- Material used in the current part may not be available in AM. Therefore an equivalent AM material may have to be chosen and assessed for its suitability.
- **AM material equivalent suitability:**
 - *Is the current material available for AM?*
 - *What material equivalents are there?*
 - *Is that the best material for the job?*
- Some materials may require post processing to achieve the desired material performance. Such as heat treatment for fatigue, or coating for chemical resistance.



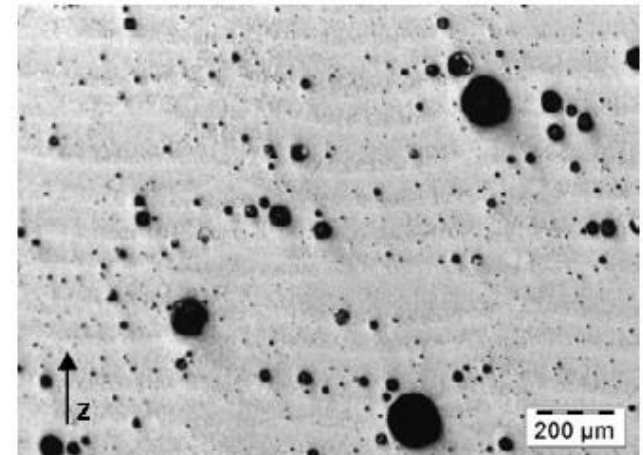
- **Any other AM value add:**
 - *Can AM add value through materials in any other way?*
- Some processes are able to manufacture in multi material, multi colour, or functional grading. These are unique to AM and may be available to the component/assembly to add value.



- **Material integrity requirements:**

- *What level of defects are acceptable?*
- *What is the target density?*
- *Can these be mitigated through post processing (e.g HIP)?*

- Many AM processes suffer from defects such as porosity, voids, and other defects. These need to be communicated and acceptable levels agreed.
- While some of these defects can be improved with post processing, that needs to be fully considered in the design stage, as well as cost.



- **Gate reviews and customer feedback:**
 - *How involved does the customer want to be in the process?*
 - *Should the customer approve design changes throughout?*
 - *Do prototypes need to be made?*
- The customer may want to be hands off or directly involved in the entire process.
- Visual or functional prototypes may need to be made for the customer to evaluate aesthetics, fit in an assembly, or performance.

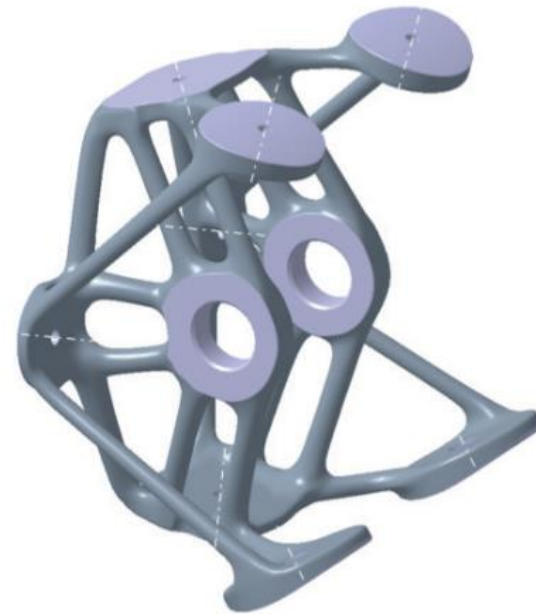
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Requirements Capture - Example

A customer has a visual prototype and a CAD file for a component designed for an AM process, what things can be skipped in the requirements capture?

Questions related to the part design

- Suitability of design for AM
- Potential for redesign





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Thank you & Questions ?

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