SECTOR SKILLS STRATEGY IN ADDITIVE MANUFACTURING

Co-funded by the Erasmus+ Programme of the European Union

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CU 36: Coordinating the AM Process (Pilot)

TOPIC 1: Capturing client requests and preparing quotations

David Wimpenny (MTC)

FOR SAM PILOT ATTENDEES AND TRAINERS ONLY

MM18-24

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- Sales order process
- Things to watch out for
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- Overview of requirement capture
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Information based on AM service bureau operation (ie making parts for an external customer)

but

even if you are making parts for internal use only you still need to manage the process

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Should help to answer questions …

Part okay for AM?

Which AM process ?

Can the part be redesigned for AM ?

What is the process chain ?

Cost/time of manufacture ?

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Sales-order process

1. Requirements capture
2. Quote
3. Receive order
4. Acknowledge order
5. Schedule build
6. Make, deliver and get paid……

Sounds easy !

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Dangers !

- Quote is wrong (incomplete, inaccurate, open to interpretation…)
- Order arrives months later (need to generate new price and timing)
- Purchase order does not match the quote
- Check customer Terms & Conditions (T&Cs) are acceptable
- Check part file received with order does not differ significantly from the part you quoted for

Not just about commercial considerations
you may not be able to make the new part !!!

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Keeping in mind the dangers….lets work through the process of requirements capture and quoting

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Effective communication is critical …

- Engagement with customer
- Adopt a consistent structured approach to requirements capture
- Avoid making assumptions
- Listen to the customer and make sure requirements are clear
- Get background information if possible

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Requirements Capture includes;

1. Part function
2. Commercial requirements/Business case
3. Scope for redesign
4. Material requirements
5. Customer management requirements

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First 3 questions ….

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Q1 – Has customer used AM before ?

Helps to understand the level of additional customer “education” and managing expectations you have to do

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Q2 – what do they want (hope to)to get out of the current project

- Improved part performance through;
  - Use of alternative material
  - Design for AM
- Reduced assembly operations by part consolidation
- Flexible production to enable low volume/customisation
- Reduced lead time
- Reduced cost

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Q3 – What do you want to make ?

- Name of part
- Function of the part
- Part geometry > fixed or redesigned for AM?
- Material > is this fixed or alternatives possible?
- Number of parts / when required > flexibility for scheduling ?
- Accuracy /surface finish requirements ?
- Any specific heat treatment/ infiltration/surface coating ?

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What is the perfect AM part …?

- Low production volume*
- Complex geometry*
- Small in size*
- Thin walled*
- Material which is difficult to process using conventional manufacturing methods but easy (and proven) in AM

*for most AM processes

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Educating & Managing Expectations

- AM can be slow and expensive
- To maximise benefits parts should be redesigned
- Accuracy (+/- 50µm up to +/-5mm!)
- Surface finish (PBF-LB typical RA 10-30µm but depends on machine, material, location orientation etc.)
- Limited range of proven materials for AM
- Properties are often anisotropic (vary in different directions)
- Choosing “cheaper” material may not reduce cost significantly
- Process failure and scrap parts are common
- Part requirements may have to change for AM

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"Level 2" questions include….

Is the part subject to particular security and export control issues ?

- Commercially sensitive
- Government national security classification
- Export control/ITAR

International Traffic in Arms Regulations (ITAR) establishes controls regarding the export and import of defense-related items and services that appear on the United States Munitions List (USML).

Needs to be a clear YES or NO

If YES then this may increase part costs or prevent manufacture

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Requirements Capture Guide -1

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1. Part / assembly information and functionality		
Component and project goals – high level requirements and AM benefits to be realised		
Component name		
CAD files of the component(s) and relevant assemblies and adjacent parts	Provide accurate information about the existing or proposed component or assembly. (e.g. size and complexity of the geometry)	If there is a possibility of consolidation, it's important to capture the requirements for the combined / consolidated part also.
Purpose/function of component or assembly	Describe the functionality of the component or assembly Identify and record critical functional requirements. Identify the design drivers of the component (e.g. load-driven, fatigue-driven, frequency-driven etc.)	This is a very important step. If we don't capture these we might end up designing a component which isn't fit for the purpose/application. In addition, we might miss the opportunity of getting the maximum benefit from AM
Goal of the AM build or redesign task and the priority of goals	Determine why Additive Manufacturing was chosen for this part? What is the value the customer is seeking by choosing the AM route? Determine openness to options of redesign for AM.	If we don't understand the value we're getting with AM we could risk proposing solutions that are not economical, or that don't deliver full value. In some cases an alternate manufacturing route might be cheaper and quicker than AM.
Legislative requirements	Legislative requirements are application and sector specific, and all legal standards and compliance requirements must be clearly defined at the start. e.g. CE mark, aerospace standards etc.	We need to ask: Can we demonstrate compliance using AM for this part? It is important to understand the legislative requirements beforehand especially for critical components to avoid problems with qualification and certification of the AM part.
Cost target	Determine whether the customer has a realistic cost target for the component, and how well the AM-specific elements have been considered in the overall cost goals.	Here we determine the likely possibility of meeting cost target with AM. Solutions and proposals need to demonstrate that they meet the cost target. Developing a superior AM part that is not viable economically is likely to be rejected.
Production volume	To verify if the intended production volume is suited to current AM economic models. Currently, AM is most suitable for low-volume production.	If the production volume is high it is challenging to provide a positive business case for AM. There might be alternate manufacturing methods which are more economical.

2. Material, functional and performance requirements		
Material considerations		
Component material	Identify the required material and the rationale for selecting it. Determine whether a suitable/ equivalent material can be used for AM.	The material used in an existing component may not be available to use with AM. Material choice can drive AM process decision, while material attributes and bulk material properties are important factors in AM part design.
Alternative/equivalent material acceptability	Determine whether a different material would be acceptable, if the original material proposed cannot deliver the required function, or cannot be used in AM.	Alternative materials may deliver better performance with AM, however, it is also likely that a redesign for that chosen material is necessary to achieve the added value that is required.
Linear or non-linear material **Plastic deformation**	For polymers, these properties may be critical for functionality or assembly.	AM can offer the option of functionally graded parts, where different materials are used for different parts of the component to optimise function, weight and cost
Dimensions & accuracy required.	Different AM processes have different capabilities in terms of dimensional accuracy. Determining dimensional accuracy is important for the machine as well as the build parameters used.	This is critical. If we don't capture this we may end up choosing wrong AM process or will need to spend a lot of time and effort on post-processing (finishing and machining) to reach acceptable tolerances.
Surface requirements and definition of surface functionality	Define the required Ra Define the reasons for the particular requirements.	Ra specifications may be difficult to achieve with AM on particular surfaces. Finishing and machining post-build steps can be costly for AM parts, so it's important to define where they are most critical so that the AM process and build steps can be optimised to meet cost targets.
Residual powder considerations	For established AM standards, it is necessary to record any specific requirements for powder recycling e.g. minimum percent of virgin powder vs. recycled.	Meeting required industry standards will ensure that the part can be certified/qualified. The level of powder control will have an impact on the production cost.
Functional requirements		
Material integrity requirements	Acceptable internal / external defects and levels of porosity, density, and anisotropy.	Some properties of AM parts may need defined that wouldn't apply in conventional manufacturing due to the effects of building in layers and from powder particles.
Fatigue and damage tolerance requirements	Determine extent to which fatigue properties are critical Define surface finish requirements that affect fatigue properties.	There is a possibility of improving the fatigue properties of a part with HIPing after part is manufactured with AM. This information is important to define the appropriate post-processing steps which are significant for overall cost.

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CAD files of the component(s) and relevant assemblies and adjacent parts	Provide accurate information about the existing or proposed component or assembly. (e.g. size and complexity of the geometry)	If there is a possibility of consolidation, it's important to capture the requirements for the combined / consolidated part also.

Q- Should you quote for part if you don't have CAD data or STL file ?

Go to

https://www.mentimeter.com/

Vote: 44474206

https://www.menti.com/alwa6w63g3mi

Click to download as image

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- CU36 -Topic 1-Q1 (should you still quote for a part if you don't have CAD data or STL file) - Mentimeter

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Internal job request system at MTC

- Semi-automated process for requirements capture
- Information feeds directly into the job quotation and scheduling system
- However, communication with customer is still essential

(particularly for metal parts)

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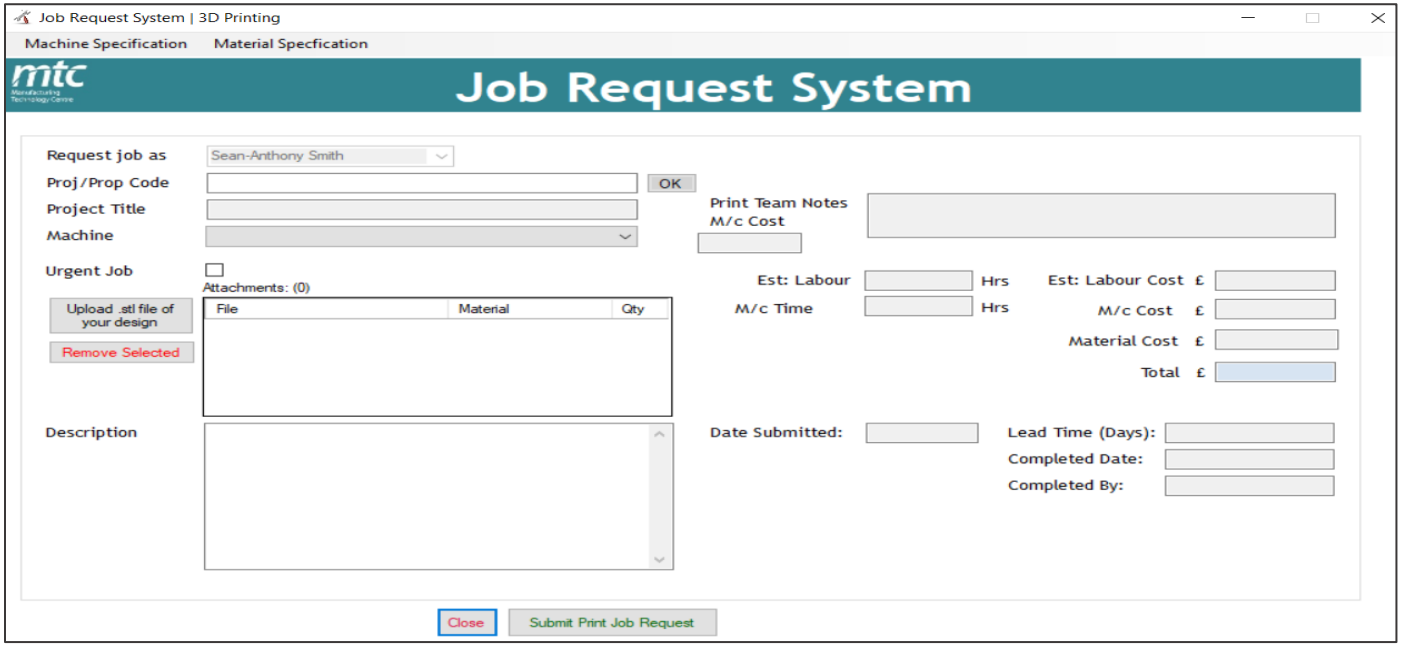
MTC Polymer AM Job Request System



Only provides AM build quotation

Talk to customer to understand what they want from the job.

Part may require redesign, and/or post processing operations.

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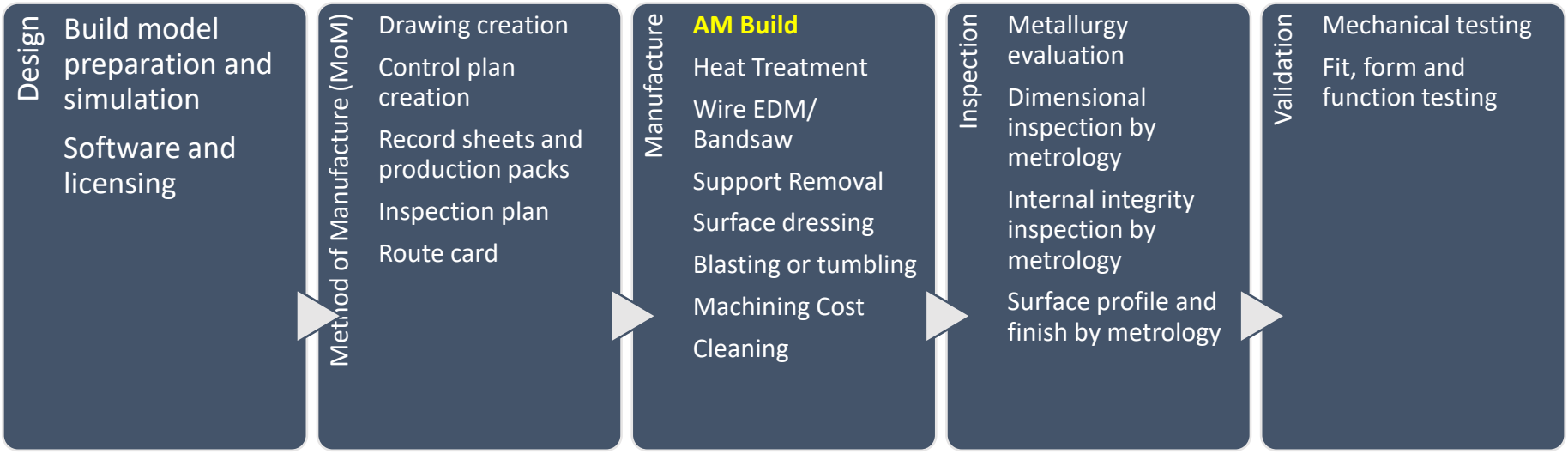
MTC's approach to metal part quotations…

- Comprehensive and risk adverse
- Involves all stakeholders within the process chain
- Slow, costly but reduces the risk of problem downstream



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AM quoting: Managing Risk

- Difficult process + difficult material + difficult geometry = high risk
- Identifying “problem” features and see if they can be designed out
- conduct process simulation and/or undertake test builds of these features

Failed builds/scrap parts are bad for customer and supplier

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Binder Jetting

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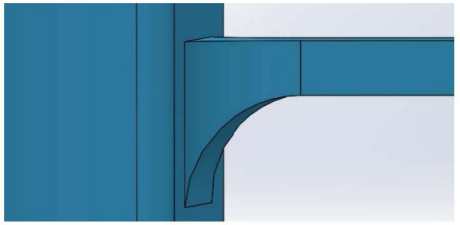
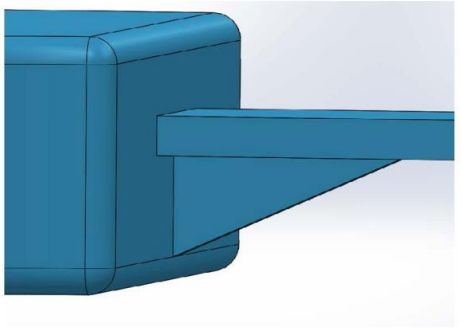
General guidelines

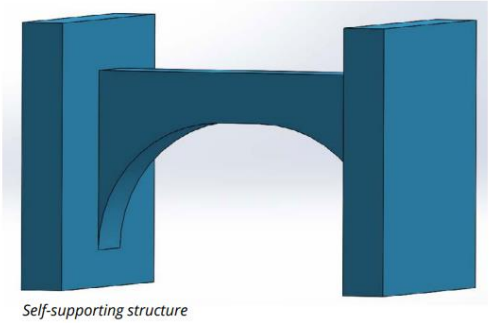
- Avoid walls below 1mm (increase for larger parts)
- Features below 0.75mm may need to be thickened
- Add radius or ribs to cantilevered features
- Avoid holes below 1mm diameter
- Provide access to internal channels to remove powder where possible
- Avoid sharp edges (add 1mm radius)



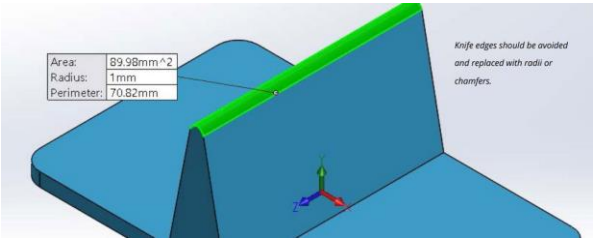
Fillets add strength to delicate features and reduces issues during the furnace stage.

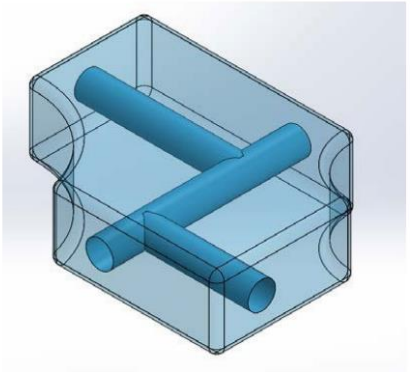


Ribs significantly increase the strength and survivability of cantilever features.



Self-supporting structure





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What sort of features are a problem with metal PBF-LB parts ?

https://www.menti.com/al6nkm5mi6u1

voting code **5682 2338**

https://www.mentimeter.com/

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- CU36-Topic1-Q2 (difficult features for PBF-LB parts) - Mentimeter

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Managing Risk

For high risk parts “time & materials” rather than a fixed price
or
“Best endeavours”

If not the price quoted needs to factor in the risk

Prototypes

low value material/ parts

- High risk x3
- Medium risk x2
- Low risk x1.5

Performance Critical Parts/ Supporting Production

high value material and /or parts

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AM Quoting: Cost Categories (Non-Exhaustive List)

Materials/Consumables:

- AM Machine Feedstock; powder/wire..
- Blasting and polishing media
- Material containers
- Machine consumables; base-plates, filters,
- Powder test consumables
- CNC fixture and tooling
- Hand tools; files, grit paper, dremmel tools..

Machine Time:

- Powder Lab/Test Equipment
- Blender and Sieve
- AM machine
- Furnace
- Wire EDM/Bandsaw
- CNC
- Blasting or polishing equipment
- Metrology equipment
- Metallurgy equipment

Labour:

- MoM creation and AM build model generation
- Material preparation
- AM machine operations
- Powder Removal
- Furnace operations
- Wire EDM/Bandsaw operations
- Support removal
- CNC operations
- Component surface dressing
- Blasting or polishing operations
- Metrology operations
- Metallurgy operations
- Visual inspection at each step

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Automated quotation system

- Quoting is time consuming, requires expertise, can be subjective and if not undertaken correctly losses work or loose money on jobs
- In recent year automated quotation systems have been developed which allow customer to receive quotes 24/7
- BUT these tend to be more reliable for simple polymer processing ….

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AM Quoting: Best in Class (Non-Exhaustive List)

- https://www.materialise.com/en/software/solutions-for-data-preparation/quoting
- https://www.protolabs.co.uk/services/3d-printing/
- https://amfg.ai/
- https://proto3000.com/3d-printing-rapid-prototyping-additive-manufacturing-services-quote/
- https://www.3tamp.com/polymer-ordering-portal

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www.skills4am.eu

Thank you & Questions

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