

Implementation success story

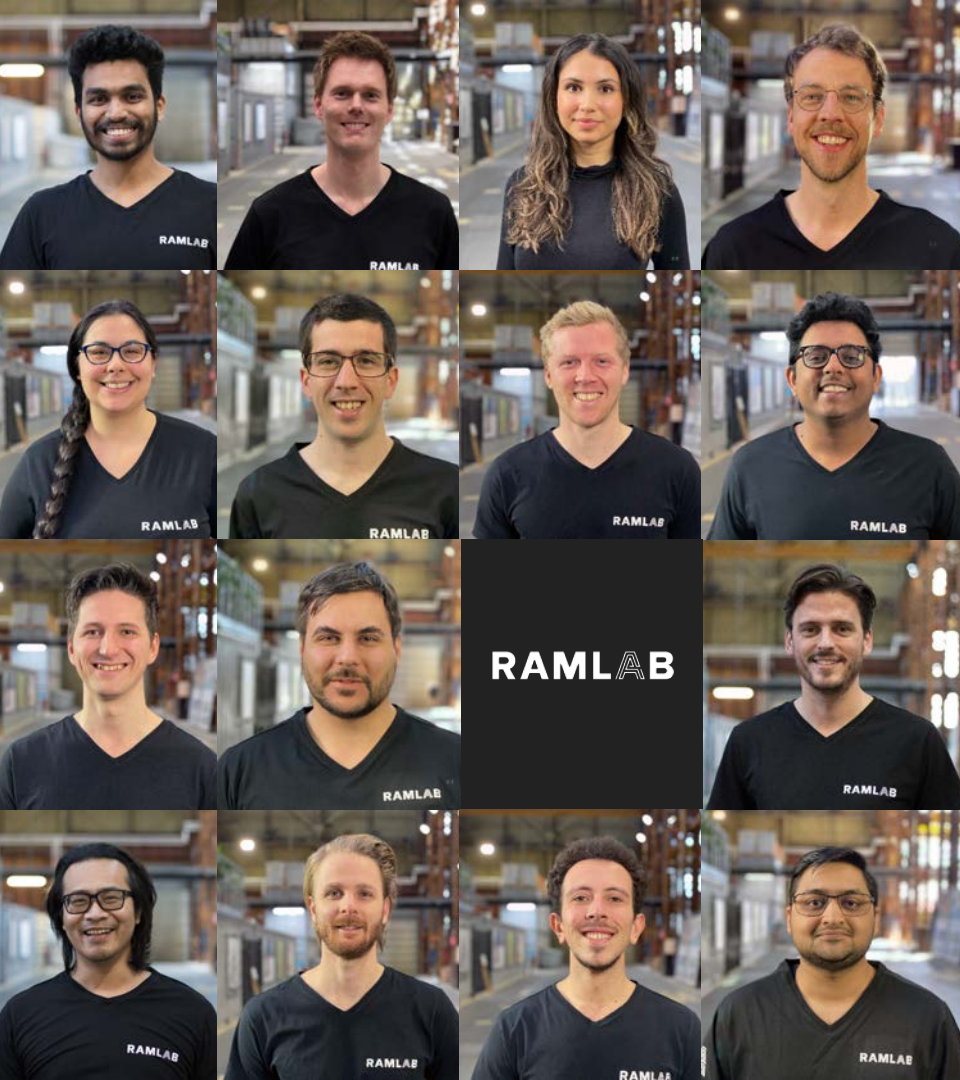
- metal parts on demand

RAMLAB

metal parts on demand



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Company

THE RAMLAB TEAM

ROTTERDAM,
THE NETHERLANDS

Competencies

**Materials science &
engineering**
Mechanical engineering
Robotics
Software development



**RAMLAB'S SOLUTION:
WIRE ARC ADDITIVE MANUFACTURING (WAAM)**





**RAMLAB DELIVERS:
WORLD'S FIRST CLASS APPROVED WIRE ARC ADDITIVE MANUFACTURED PROPELLER
- NOVEMBER 2017 -**





RAMLAB

Metal parts on demand

WAAM

Repair

Software development

Success stories

- Digital warehouse
- Custom design
- Multi-materials
- High-end alloys
- Monitoring and Control system

Digital Warehouse

Components as digital blueprints

The Digital Warehouse concept



The problem:

- Lock up of significant amount of resources in stock parts
- Long lead times cause delays in production

The Digital Warehouse concept



The solution:

- Digital inventory enables AM on demand
- The component can be customized prior to the manufacturing using design tools
- R&D can be centralized in high-tech centers, while production can be placed in critical locations



Material

X90

Application

Oil & Gas

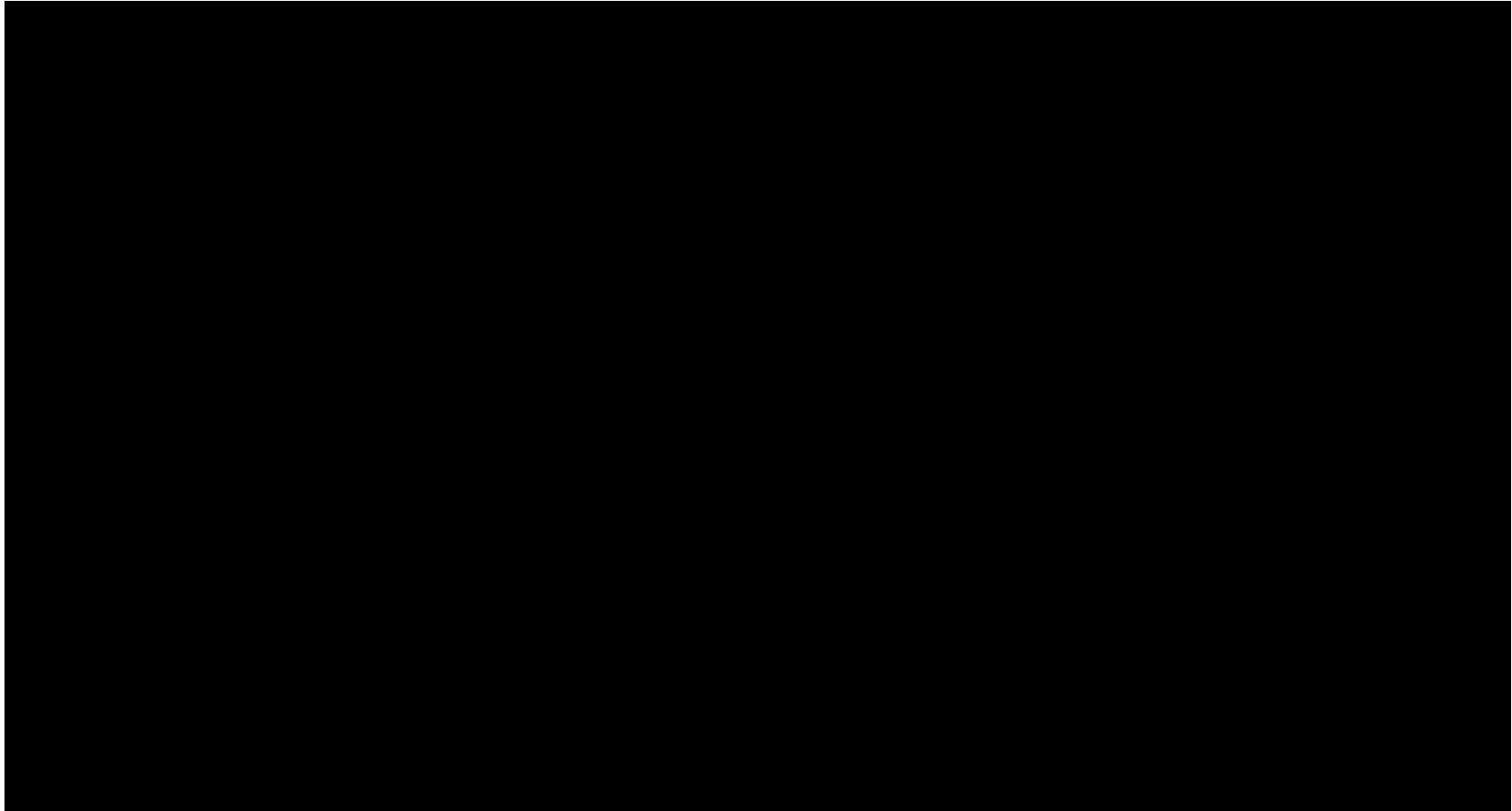
Why?

Shorter lead times

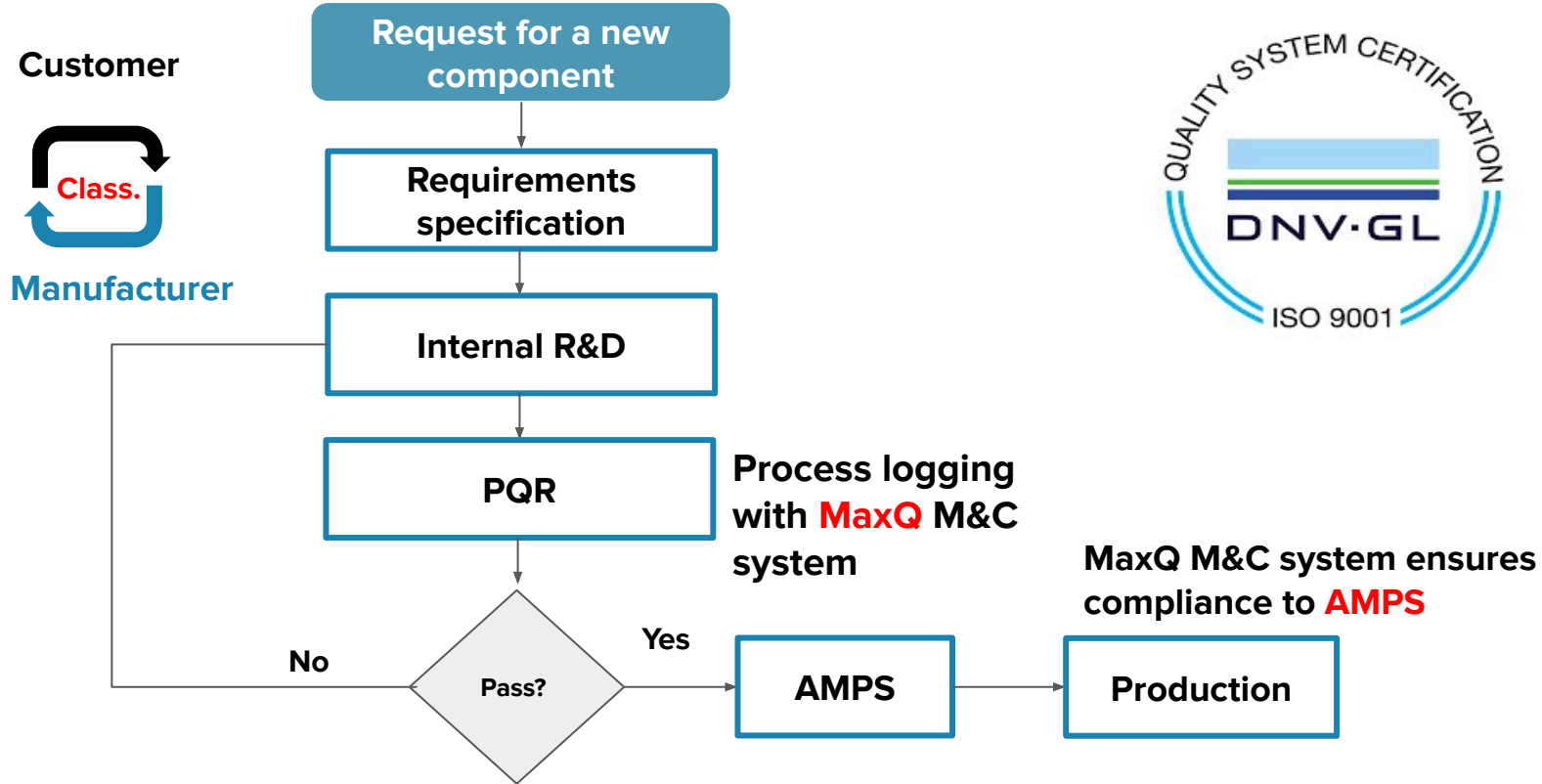
Innovative design

Weight optimization

RAMLAB's solution is distributed



Quality assurance



The Digital Warehouse concept

Custom design

Why WAAM can be a solution?



Hollow Blade

Material

AISI 316L

Application

Maritime sector

What's new?

Complex design



- Freedom in designing customized toolpath strategies
- Macro programming automates repetitive tasks



Blades

Material

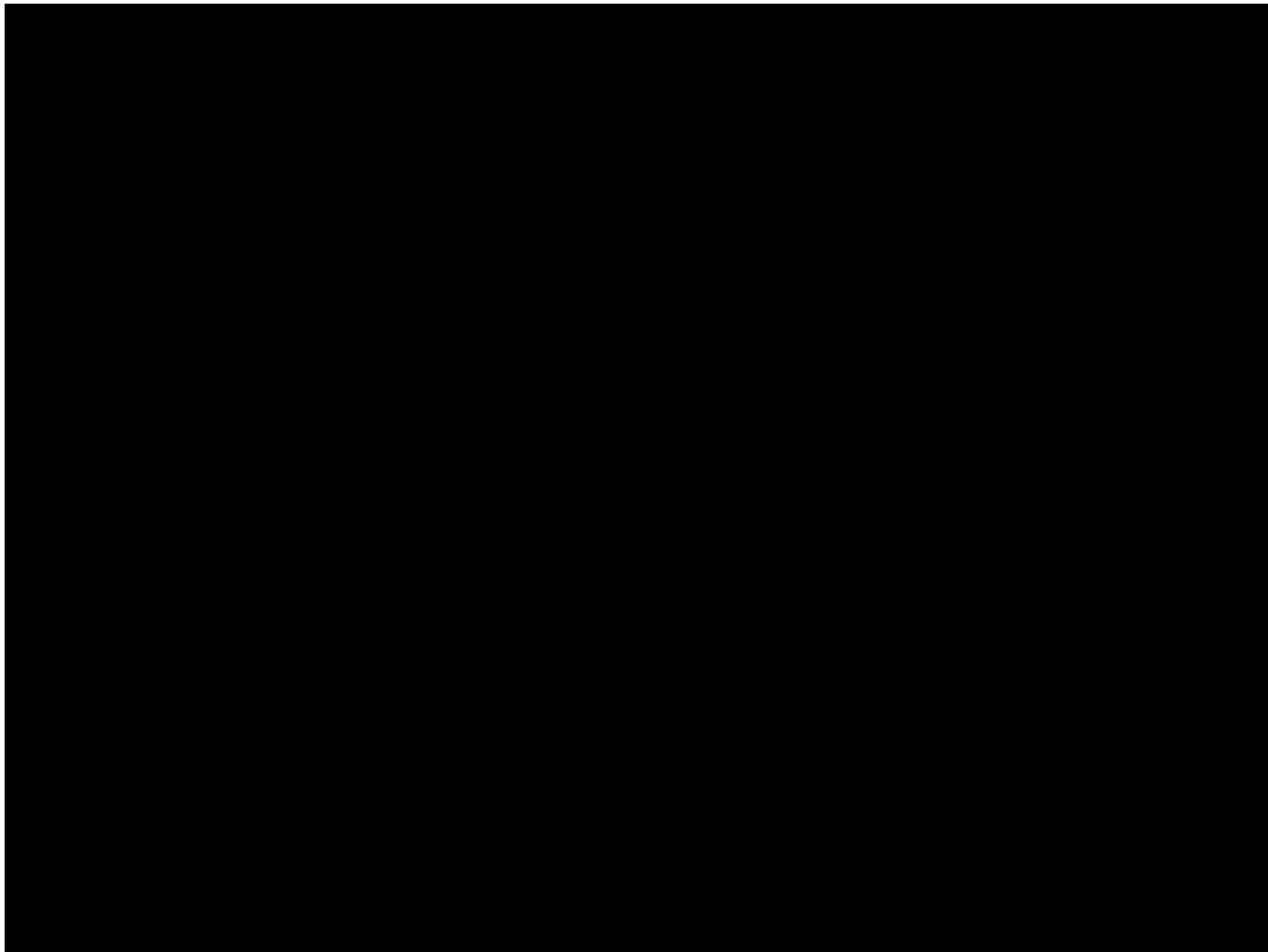
AISI 316L

Applications

**Maritime sector and
chemical industry**

What's new?

**Customized blade design
Fast prototyping**



Multi-materials



Multi-materials

Material

AISI 316L

Stellite 6

Applications

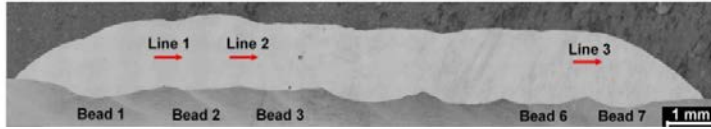
Chemical industry

What's new?

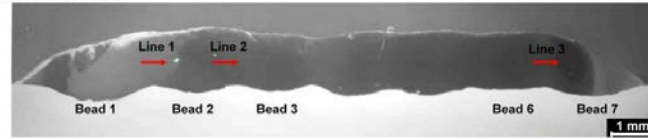
Functional materials


the next big thing

(a) S355+Stellite 6



(b) AISI 420+Stellite 6



Source: Deposition of Stellite 6 alloy on steel substrates using wire and arc additive manufacturing

AISI 316L

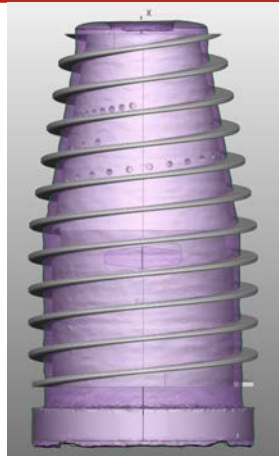
Turning

**Design
Control**

Stellite 6

Completion

Stress-relief



Cold cracking of Stellite 6

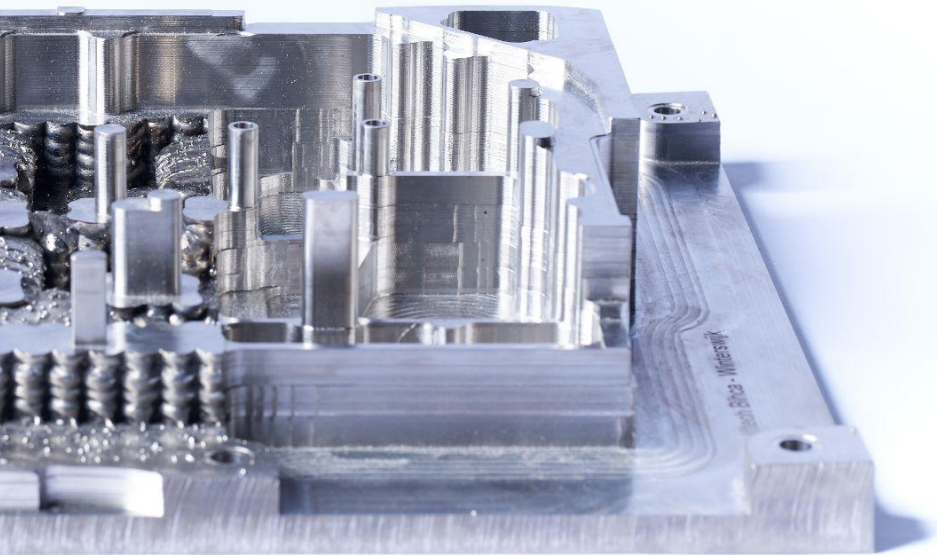
Cause: high welding speed (0.9 m/min)

Solution: Travel speed reduced from 0.9 m/min to 0.42 m/min



High-End alloys

What are the benefit of WAAM?



HIGH-END ALLOYS

Titanium alloy

Ti6Al4V

Applications

**Maritime, Energy and
Chemical industry**

Why?

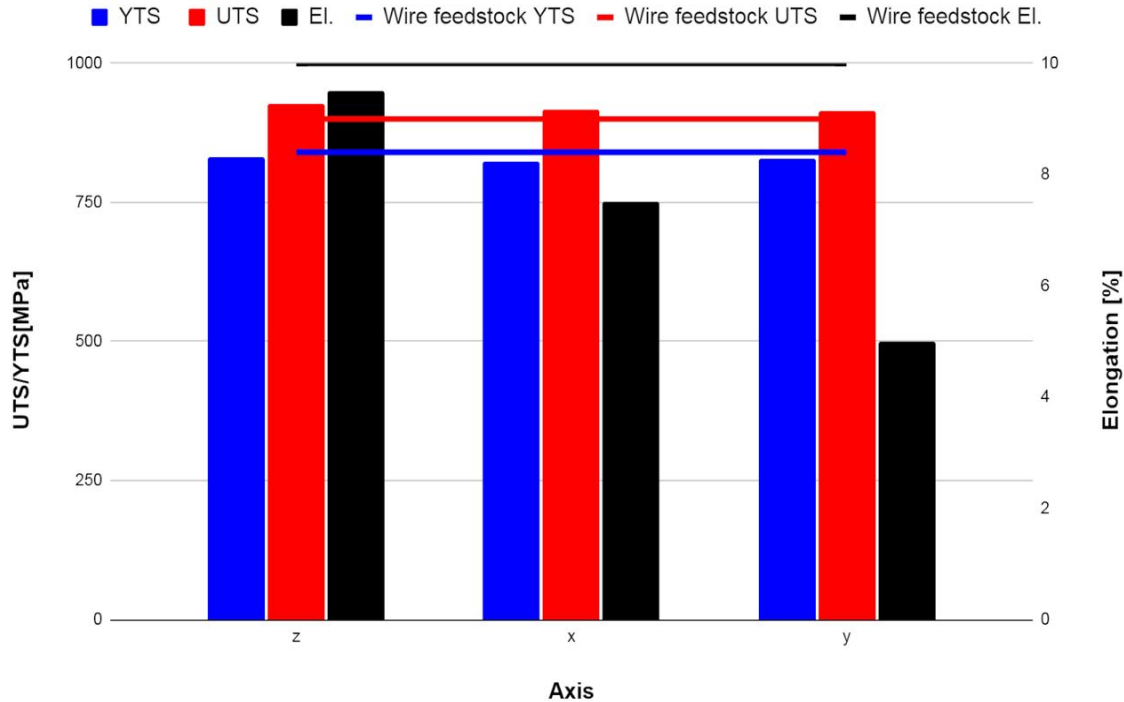
**High material savings
Short lead times**

Component for High-Tech

Machining material from Ti6Al4V forged blocks leads to high material waste and economic losses.

WAAM brings material usage to 30 kg from 120 kg.





- Traditional heat treatment does not affect the material properties.
- Currently we are performing research on innovative heat treatment procedures to improve the mechanical properties of Ti6Al4V

Monitoring and Control

How to assure quality?



MaxQ

**PRINT, WELD AND REPAIR
CERTIFIED HIGH QUALITY
PARTS**

- Process control
- Machine diagnostics
- Logging/traceability
- Anomaly detection
- Geometry monitoring & control

**First time right manufacturing
First time right certified parts**

MaxQ + WAAMApp

It provides an UI interface where the operator can configure and monitor the WAAM process.

The main features are:

- Printing job management
- WAAM workflow
- Process parameters dashboard
- Event handling

Process parameters give feedback on process stability.

Waveform features can be studied to obtain insights on anomalies



Geometry control

Several pictures are taken at different angles to produce a detailed 3D scan of the product.

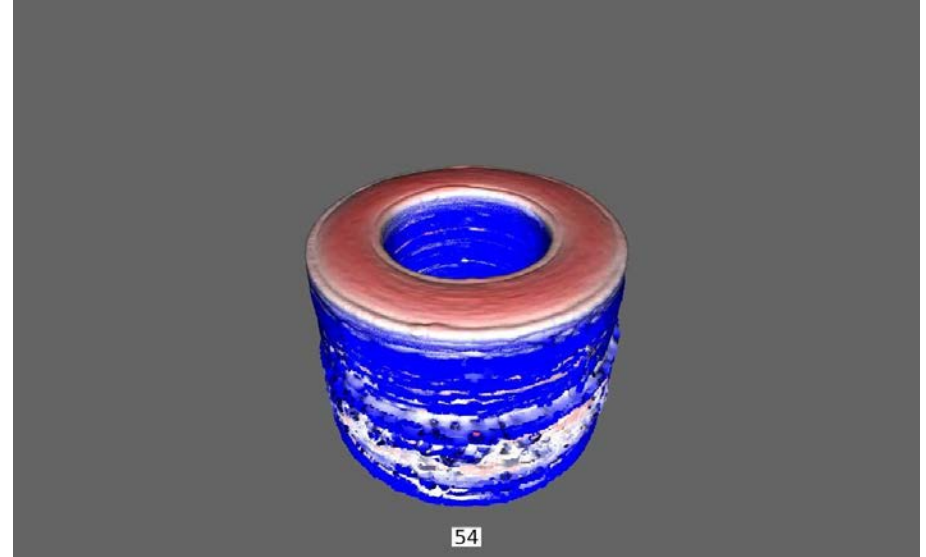
The pictures are then computed and stored in a safe database for further analysis.



Geometry control

Toolpaths are projected on the scanned surface to compensate for curved edges. In this way, a **constant stick-out** is guaranteed.

By stacking all the scans, the final product can be recreated and finally compared with the original design.

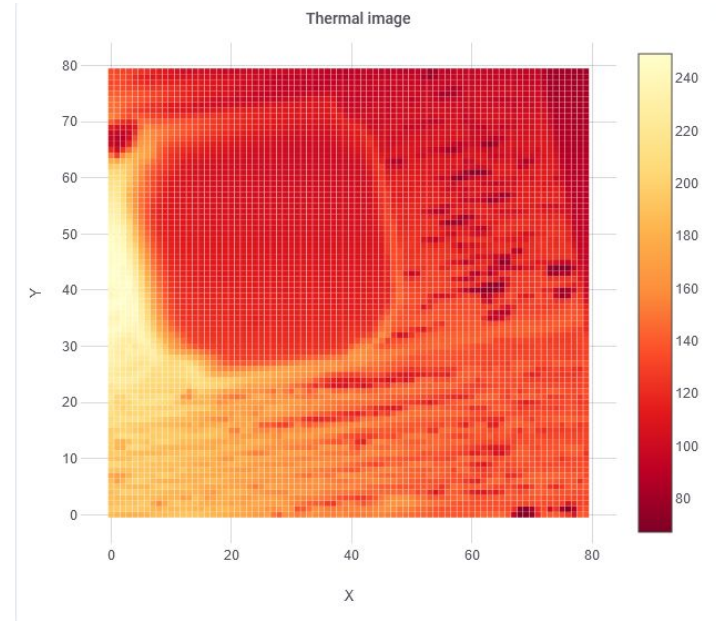


Temperature control

Control of interpass temperature is crucial for ensuring the required material properties.

Proper cooling promotes better mechanical properties and finer microstructure.

Heat accumulation can lead to increased surface roughness and promotes metal flow due to gravity



Coming Soon

- Anomaly detection
- Spectrometer data
- Audio sensor
- Melt pool segmentation
- Cobot solution



Thank you!

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