Enabling the circular economy with Additive Manufacturing

ADDILAN

WAAM TECHNOLOGY MACHINES

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CECIMO Webinar

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WHO WE ARE

- March 2017 (established)
- Outcome of business cooperation between 2 main machine tool manufacturers (2014-2017)

ADDILAN

Industrial Partner

ONA WE ARE EDM

MAHER HOLDING

Technology Partner

tecnalia
MEMBER OF BASQUE RESEARCH & TECHNOLOGY ALLIANCE

Public Investment

GRUPO spri

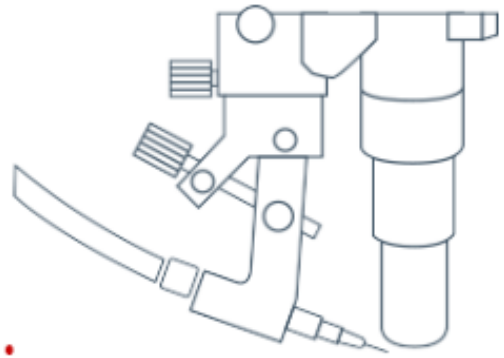
Bizkaia seed capital

ADDILAN DNA

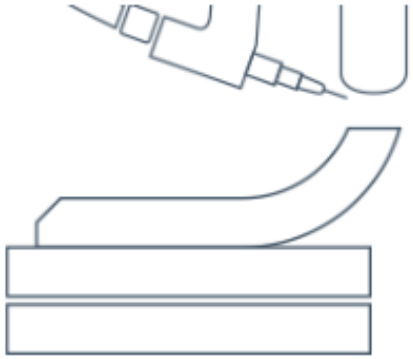
- **Deep materials knowledge:** wide portfolio of tested materials for real production
- **Own software:** time-saving developed program, suitable for all geometries/parts/parameters.
- **Collaborative approach:** collaboration experience with Tecnalia R&D center and other parties of the value chain
- **Reliable process:** integral solution with monitoring for best results. Industrial origins (ONA+MAHER holding)

WAAM technology (Wire Arc Additive Manufacturing)

How it works



1. Wire is melted using an arc welding process to create a bead.



2. Beads are overlapped to create layers.

3. The piece is created layer by layer.

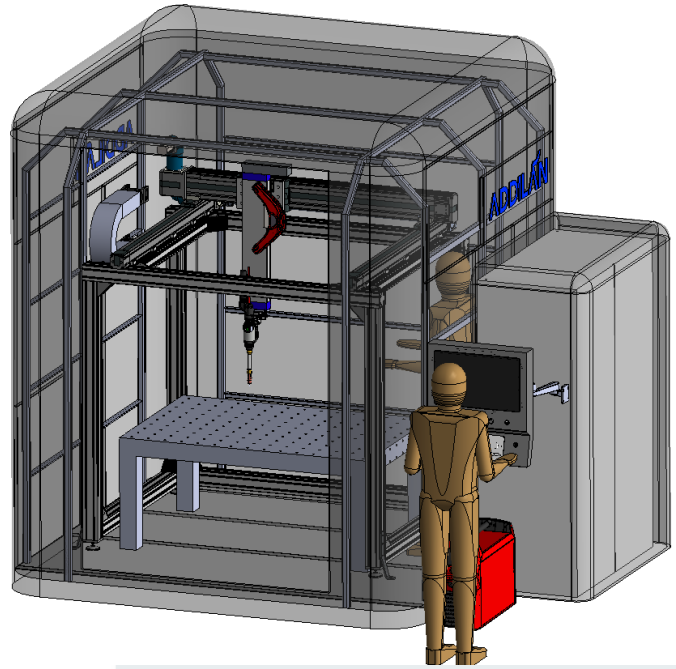
ARCLAN

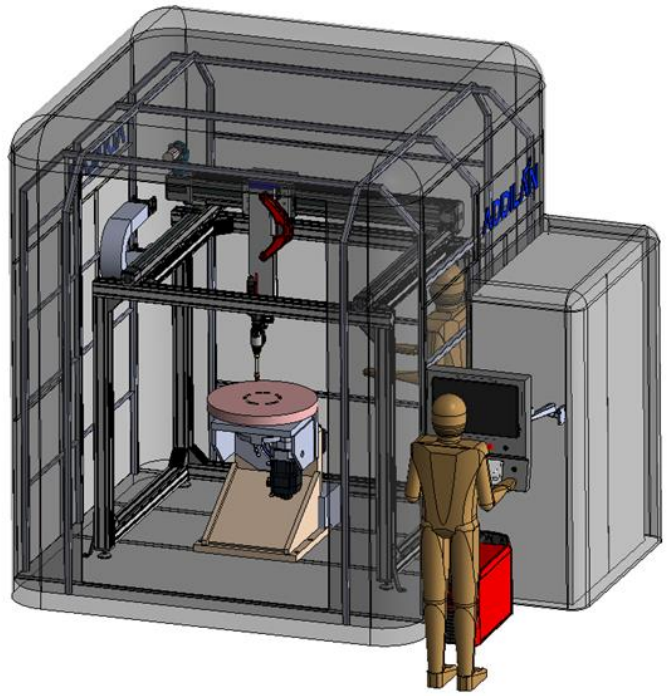
Modular solution

- **Printing volume**: 1000x1000x500mm/D600x700mm
- **Maximum part weight**: 300-500 kg
- **Axis**: 3-5
- **Technology**: PTA, MIG, CMT
- **Deposition rate**: 0,5-10 kg/h

Options

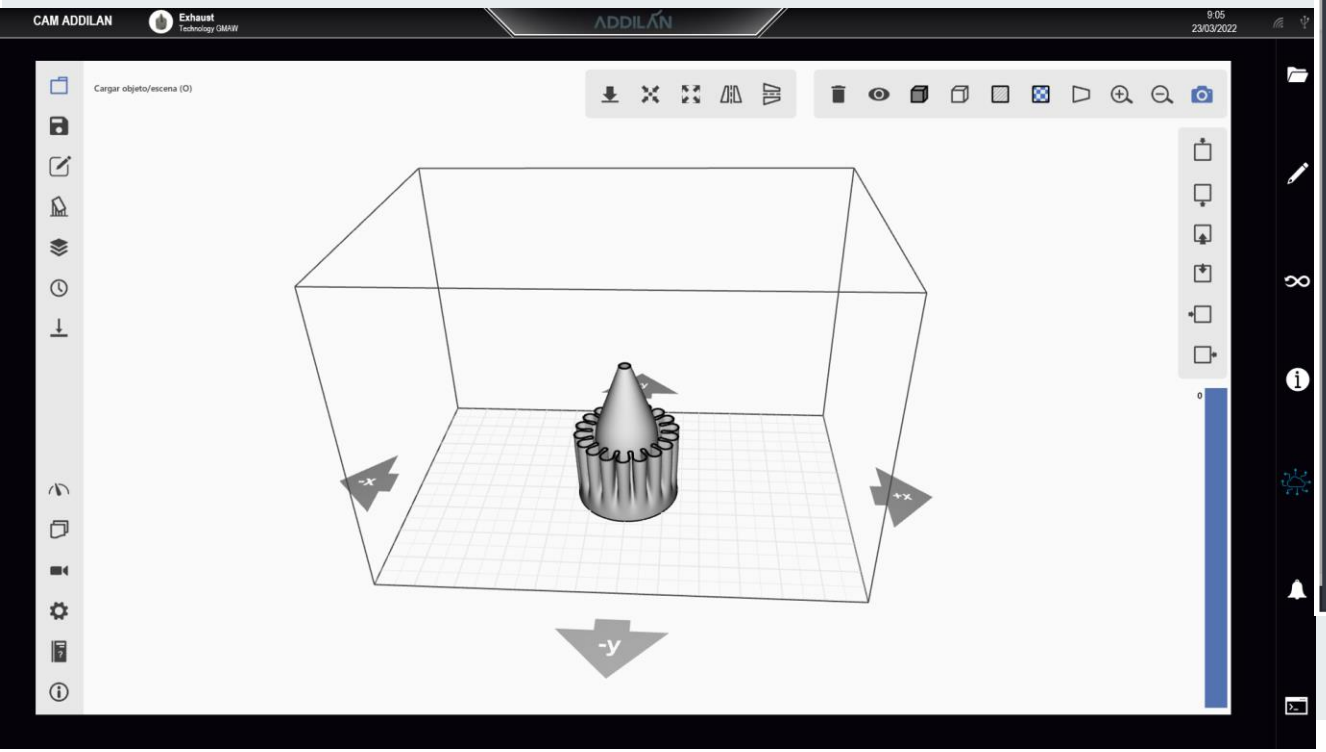
- **Inert atmosphere chamber:** (Ar, He or mixtures)

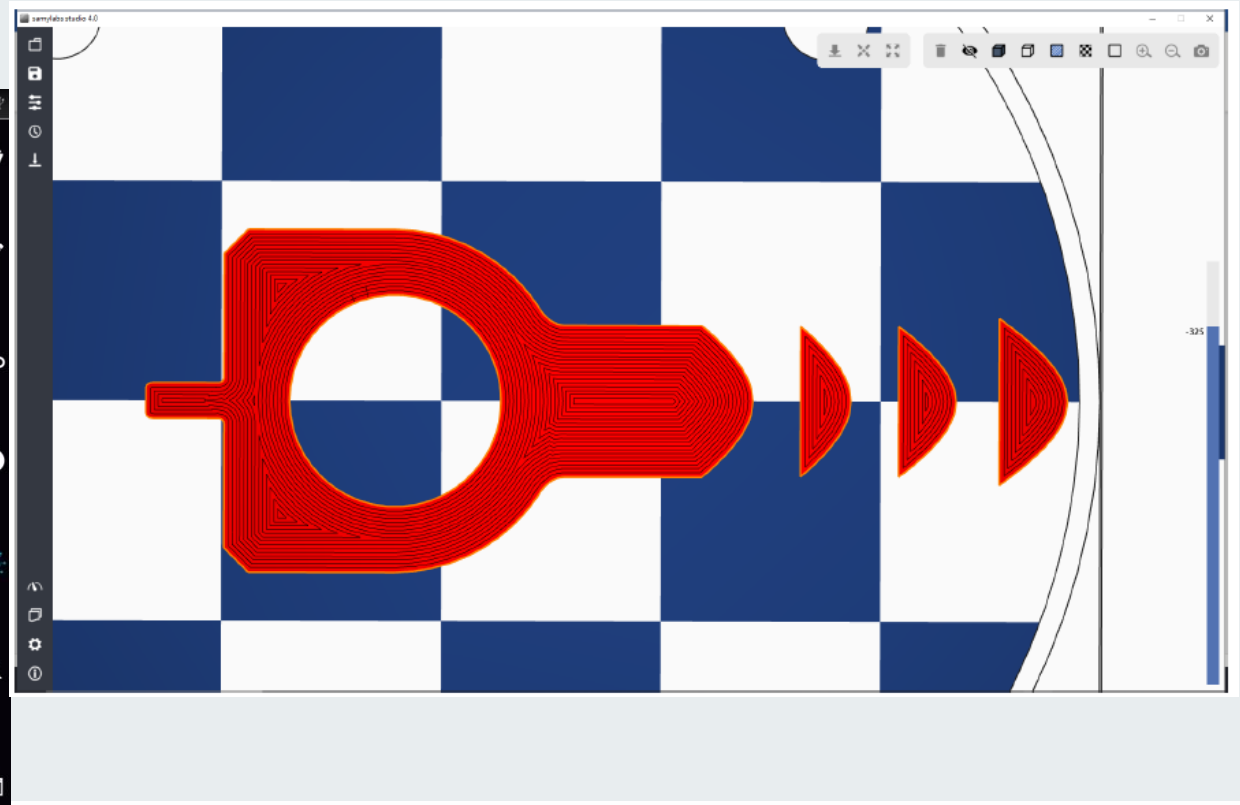




3DLAN

- Developed software solution for ADDILAN´s technology
- Compatible with standard commercial CAD/CAM based on G-code postprocessing (Siemens NX, Autodesk…)
- Monitoring system: temperature, position…

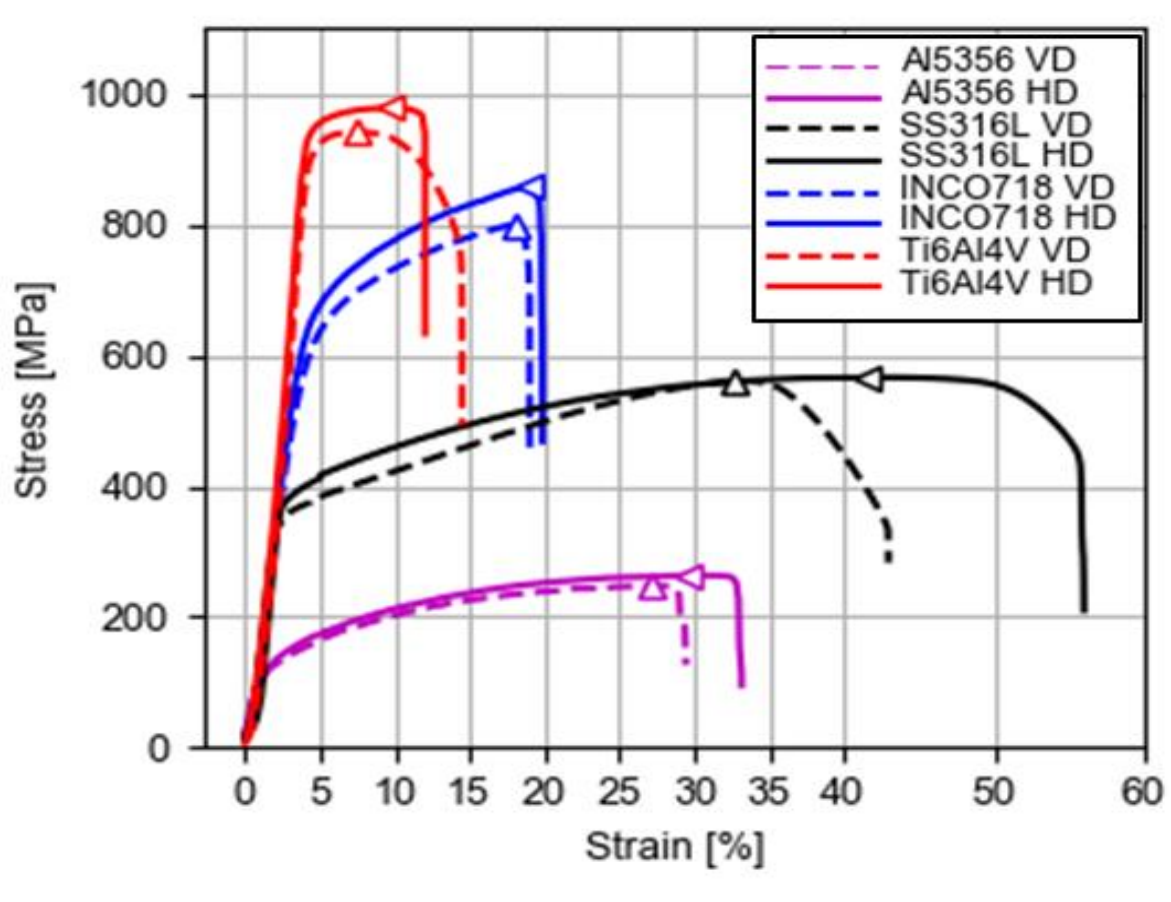




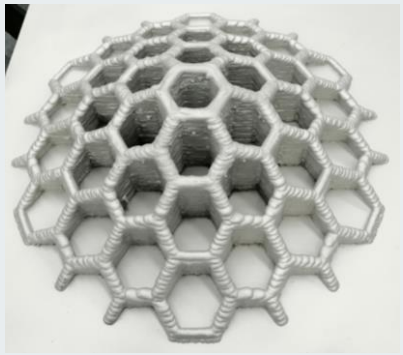
MATERIALS & TESTING

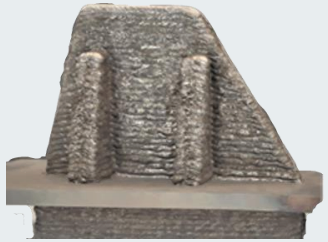
Tested materials by ADDILAN

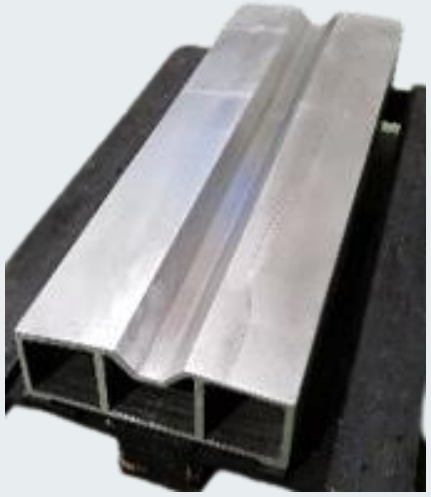
- Aluminum 5356 and Al 4040 (MIG)
- Low alloy steel (ER70) (MIG)
- 316L stainless steel (PTA/MIG)
- Titanium 6Al4V (PTA)
- Invar (PTA/MIG)
- Inconel 718 (PTA/MIG)



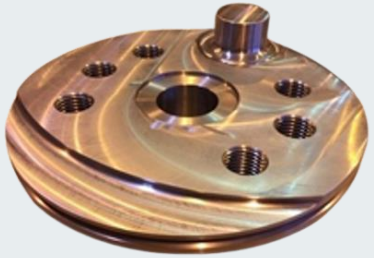
Aluminium

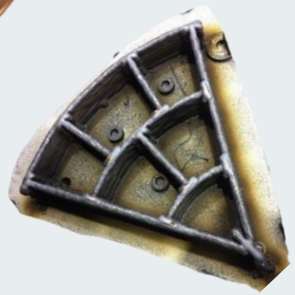




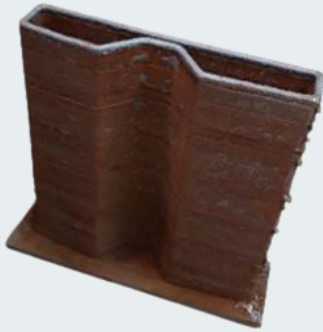


Stainless steel

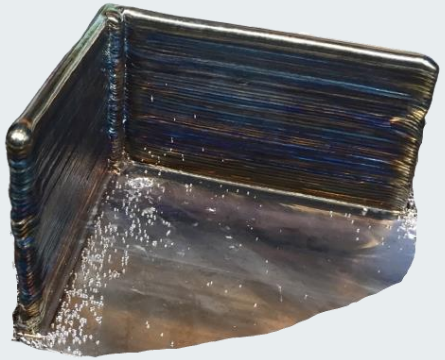


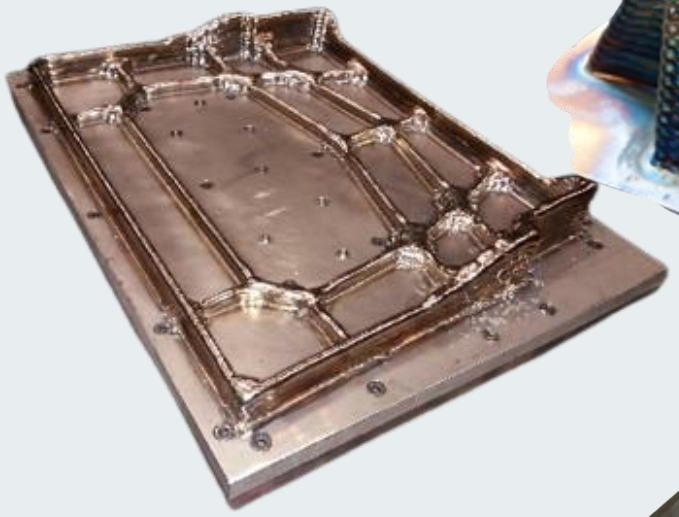


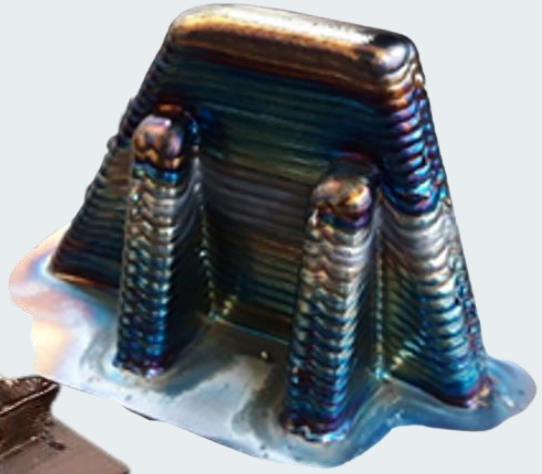
Invar

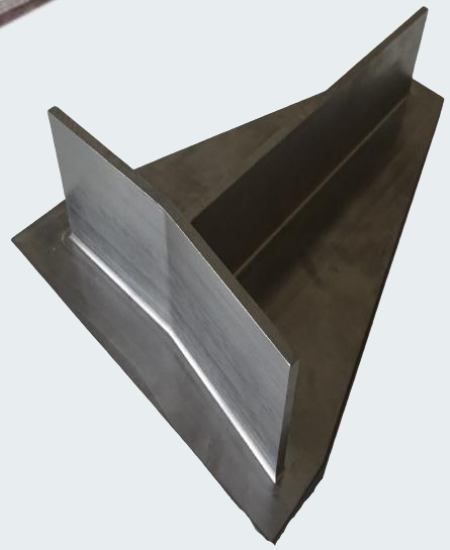


Titanium





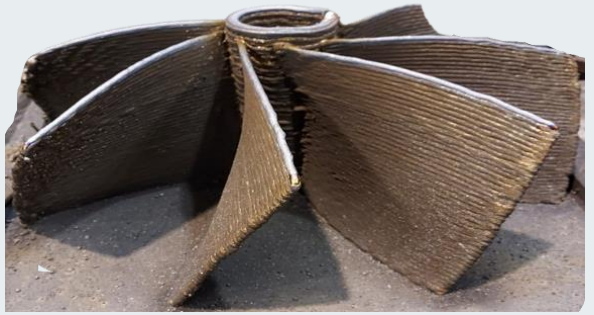




Low carbon steel

APPLICATIONS

- **Manufacturing of medium to large size**
- **High added value parts**
- **Highly demanding industrial sectors:**
  - Aerospace
  - Trains
  - Energy
  - Maritime
  - Oil & gas



BEST PRACTICE EXAMPLE

JIP program phase II

DNV

KONGSBERG

ADDILAN
WAAM TECHNOLOGY MACHINES

intertek
Total Quality. Assured.

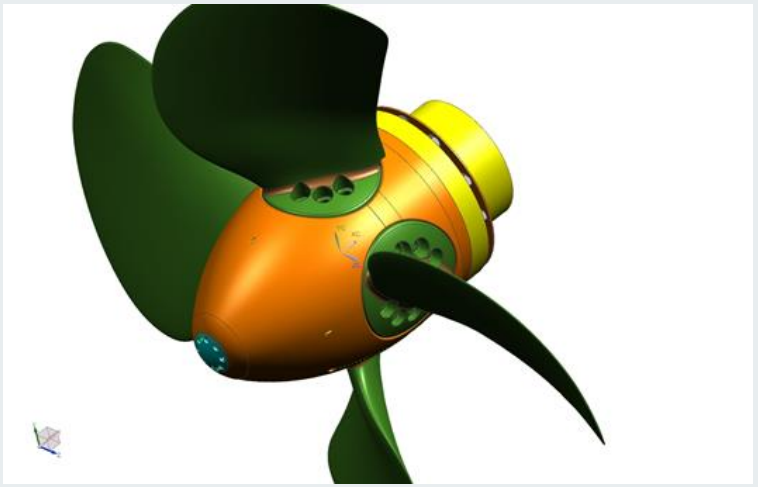
voestalpine

Guaranteed
Value the Future, Upgrade the Past

BEST PRACTICE EXAMPLE

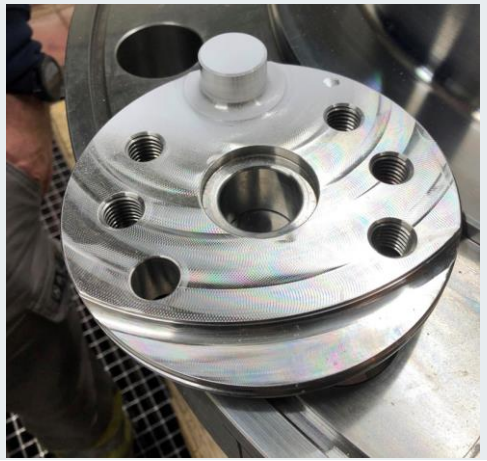
Part Characteristics

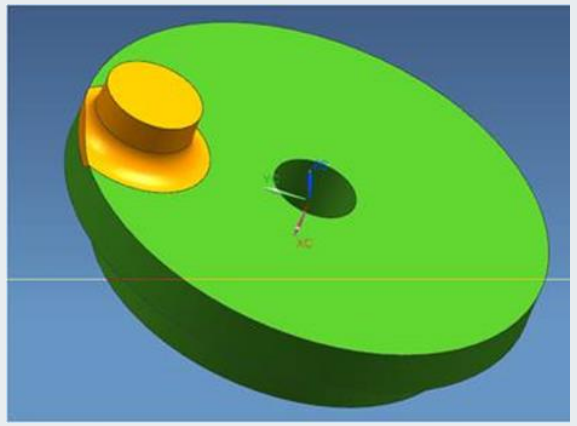
The crank disc is a component in a controllable pitch propeller



Functionality of the part:

- Pitching the propeller blade to the right pitch and transmitting the pitch related torque from the blade through the crank disk
- The crank disc transmits significant dynamic forces and is in most designs utilized close to the limit in terms of fatigue loads.
- Conventional crank-discs are most often in forged steel.





Reasons for selecting AM:

- Reduce cost
- Reduce lead time
- Improve Sustainability
- Repair

Operational improvements

Part functionality:

- Improved Mechanical propetries
- Improved Fatigue properties

Supply chain and economics:

- Material cost
- Part cost
- Production cost
- Reduce lead time

Sustainability (environmental impact):

Material use

- Use less material compared to conventional production methods

Energy use

- Reduced energy compared to conventional production methods

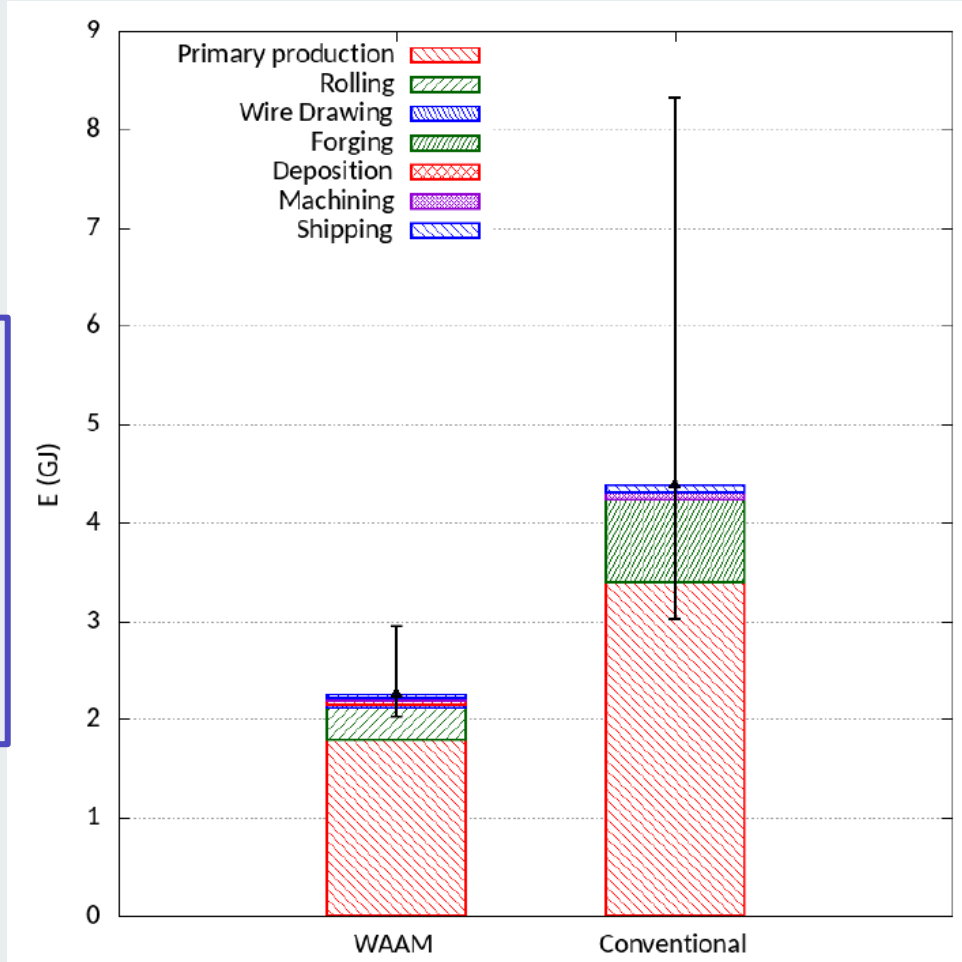
Repair

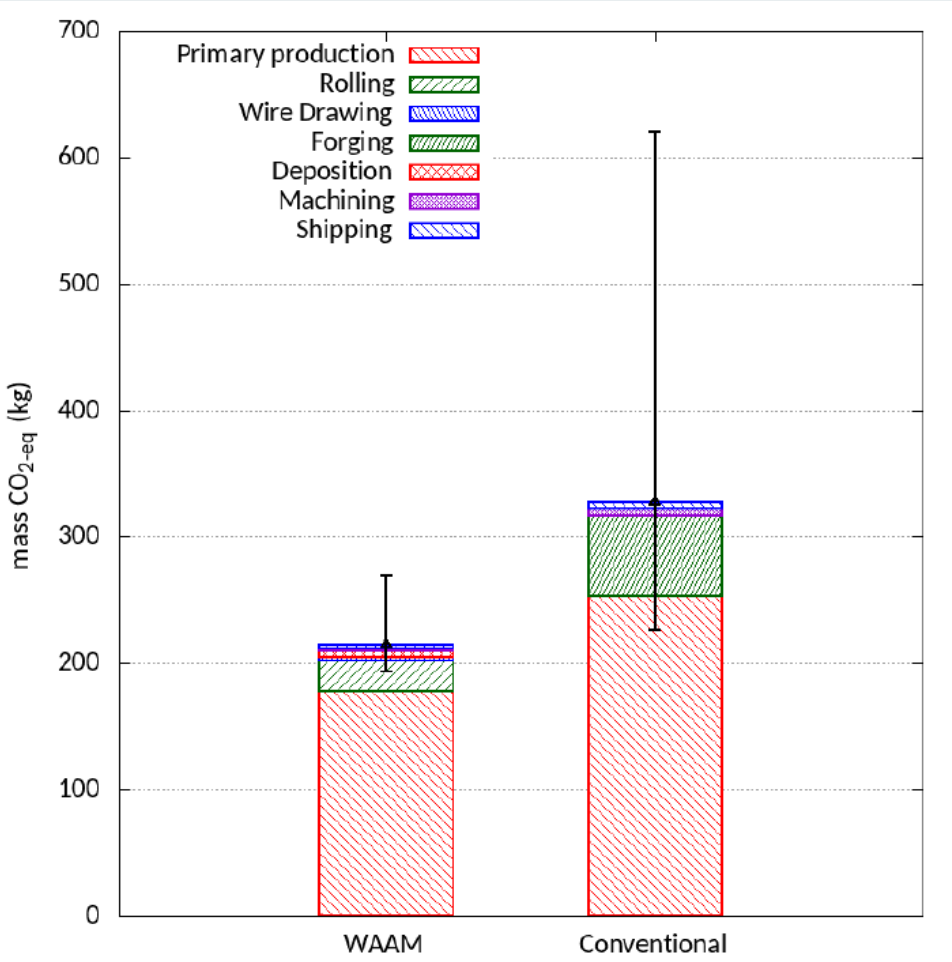
- AM gives new opportunities regarding repair and reuse

CO2e Calculations of Crank disk produced conventionally vs WAAM

Compared to conventional production, Hybrid WAAM allows to reduce:

- Energy consumption by approx. 50%
- CO2 emissions by approx. 33%



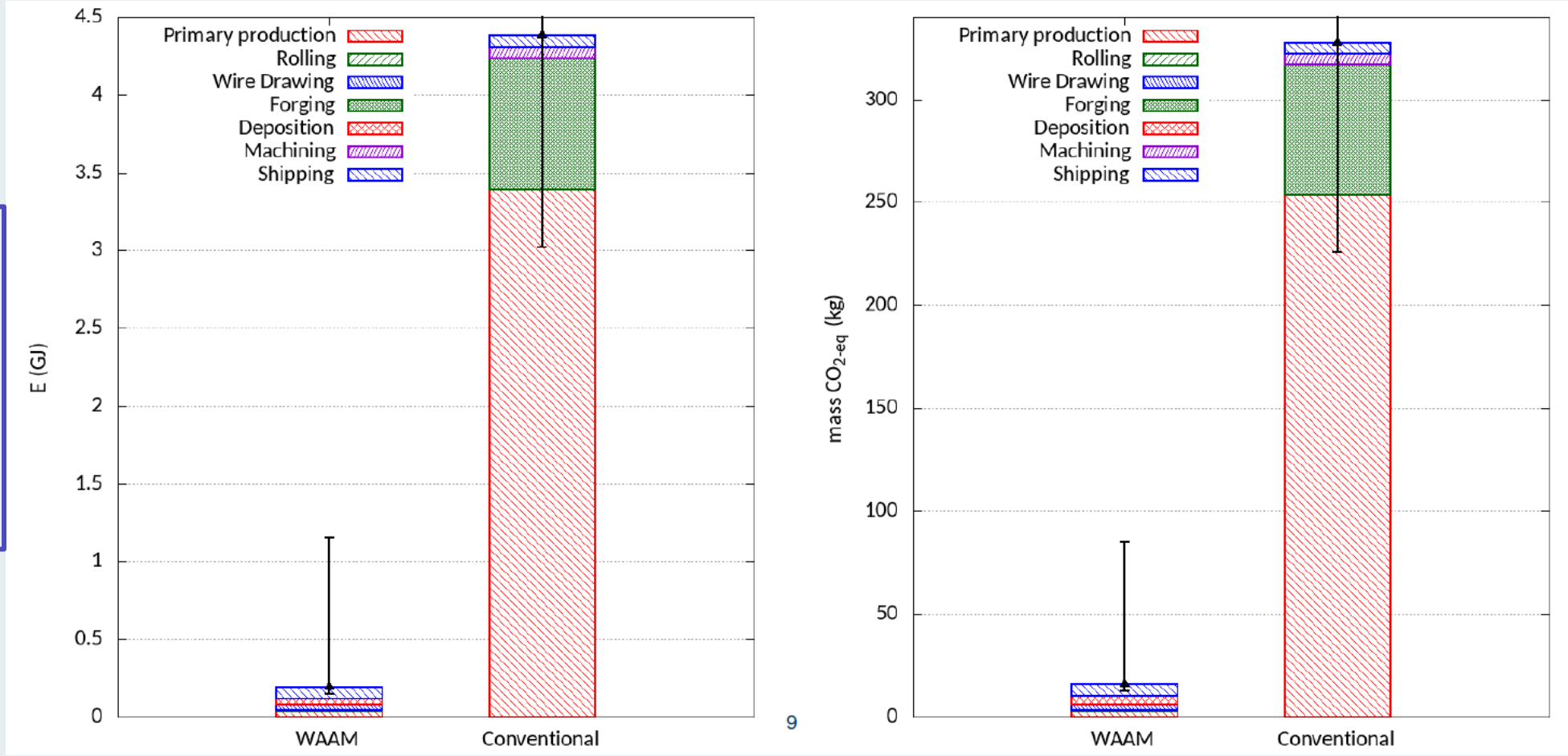


(Courtesy Guaranteed)

WAAM Repair Crank Disc Results

Compared to conventional production, WAAM Repair allows to reduce:

- Energy consumption by approx. 95%
- CO2 emissions by approx. 90%



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(Courtesy Guaranteed)

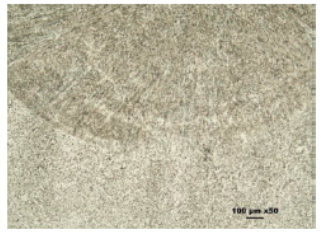
Material

High strength alloy steel

	Orient.	YS (MPa)	UTS (MPa)	Elong. (%)	F. T. room Tª (J)	Hardness (HV)
GMAW-WAAM*	Horizontal	599 ± 45	824 ± 43	21 ± 3	34 ± 21	-
	Vertical	652 ± 6	877 ± 8	16 ± 4	79 ± 14	
PTA-WAAM*	Horizontal	573 ± 17	761 ± 8	21 ± 3	54 ± 15	-
	Vertical	587 ± 4	791 ± 5	20 ± 1	59 ± 19	

*With HT —> Air stress relief at 570 ºC for 3h, after cooling in air

Microstructure:



Fatigue testing:

Test conditions: Standard NF EN 6072 (12)
- -Stress Ratio : 0.1
- -Frequency : 30 Hz
- -Temperature : Room T
- -Run out : 2.000.000

Load	Nº Cicles
660 MPa	$2*10^6$ (Not break)
700	$2*10^6$ (Not break)
750	$2*10^6$ (Not break)

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