

3DMP®

Fast | Simple | Economic

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GEFERTEC



R & D



Product
Development



Sales



Application
Center



Strong partners of GEFERTEC GmbH



Partner in the
Support Process



Partner for
Machine Production

Feb 2015
Founding

2015
Seed and Series A
Financing B.I.G./Scansonic

Sep 2017
Official Market Launch EMO

Nov 2017
Launch of arc40X series

Sep 2018
Series B/stake of
EMAG Group

Nov 2019
Delivery of the 20th arc-
Machine to Nordmetall
• • •

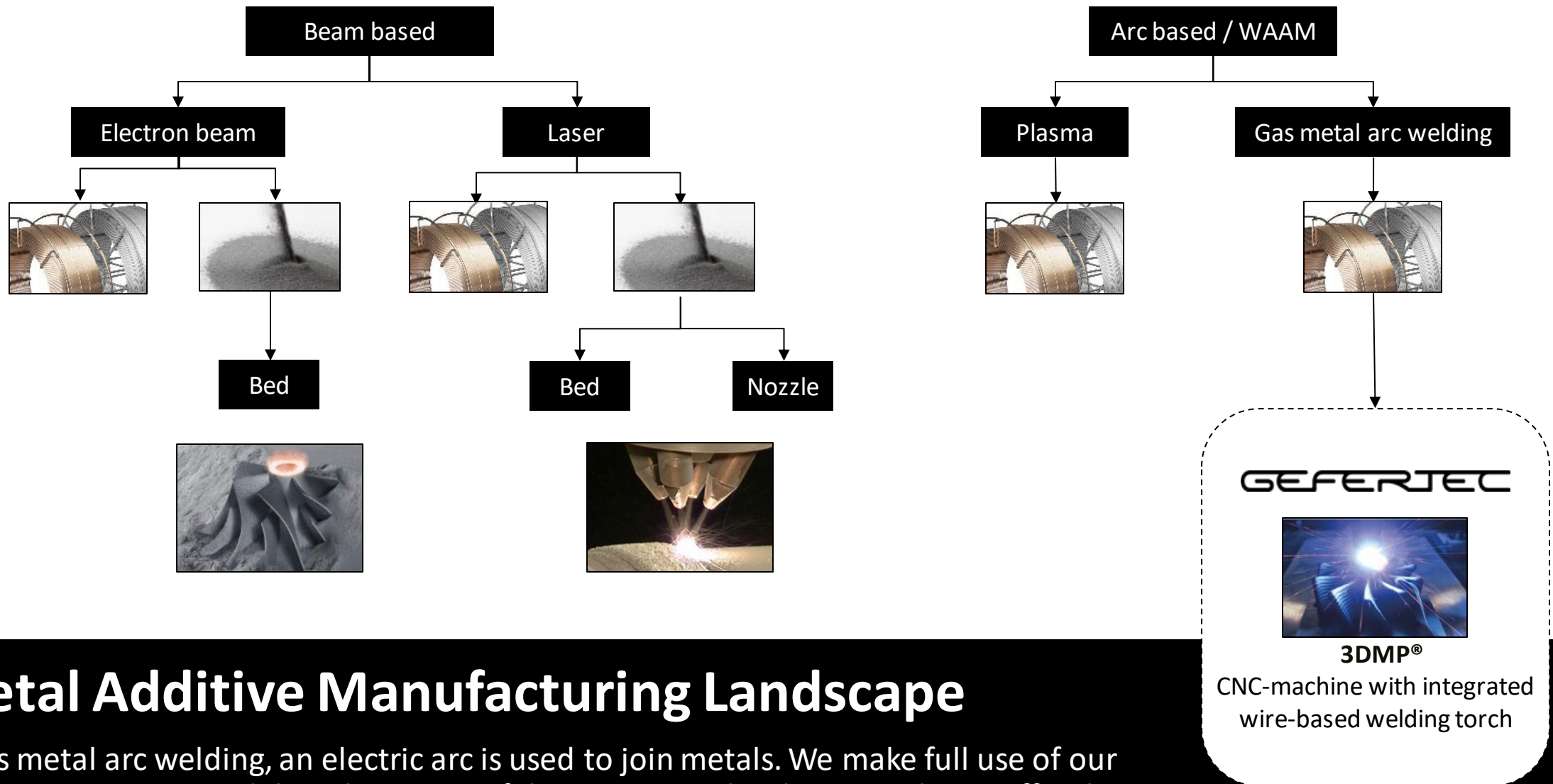
Dez 2016
1st Machine Sale

Mai 2018
1st International
Machine Sale

Aug 2019
Founding GEFERTEC LLC

	 arc403	 arc405	 arc603	 arc605
Job-shopper	 FLYINGPARTS	 FLYINGPARTS  Rolf Lenk Werkzeug-u. Maschinenbau GmbH		 FIT  Rolf Lenk Werkzeug-u. Maschinenbau GmbH
Job-shopper Aerospace		 MMT-DUNCHA		 FASTeCH LLC <small>A HARLOW GROUP COMPANY</small>  Aircraft Philipp NingBo XJ Aerotech Co., Ltd
R&D	 Instytut Metali Nieżelaznych Gliwice NORDMETALL <small>MATERIALS AND THERMAL ENGINEERING</small>	 DVS SLV HALLE 		 b.tu Brandenburgische Technische Universität Cottbus - Senftenberg
Energy	SIEMENS	 MH MITSUBISHI HITACHI POWER SYSTEMS		SIEMENS

Summary of our References

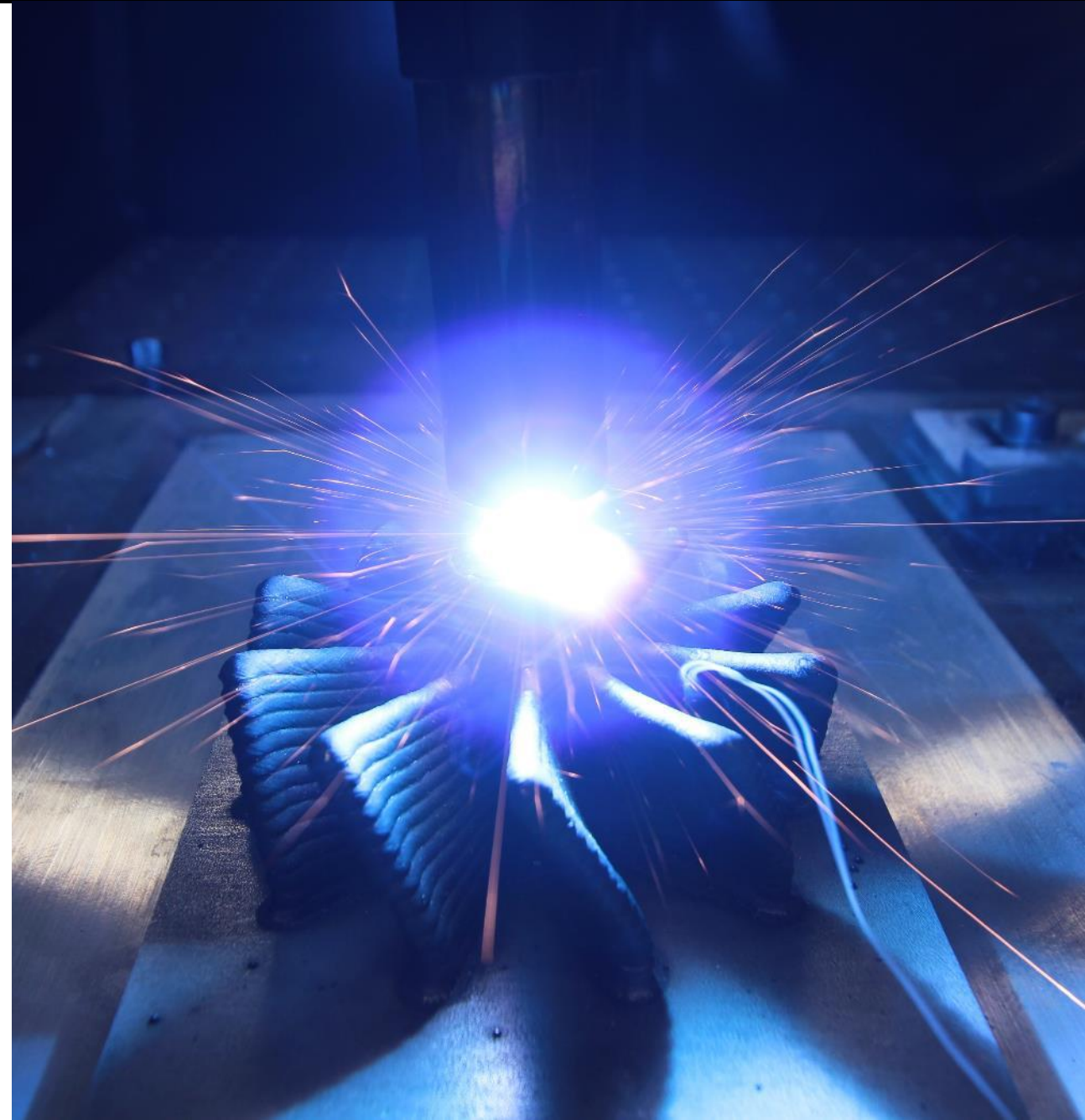


Metal Additive Manufacturing Landscape

In gas metal arc welding, an electric arc is used to join metals. We make full use of our extensive expertise and the advantages of this mature technology in order to offer the layered printing of several metal layers in a fully automated, digitally controlled and easy to use manner.

Arc instead of laser

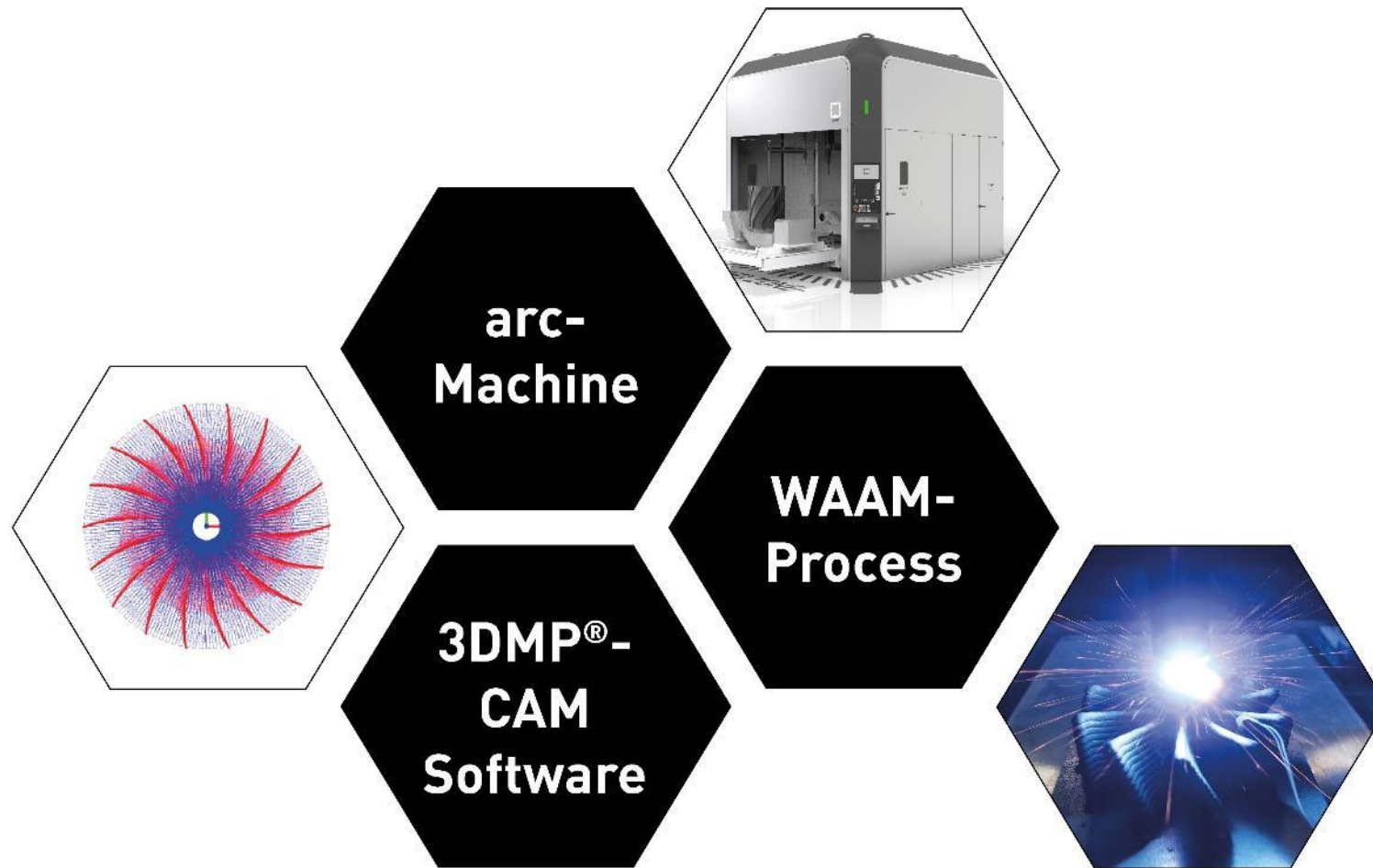
- No laser nor electron beam technology
- Matured process
- Digitally controlled and easy to use
- Fully automated





Wire instead of powder

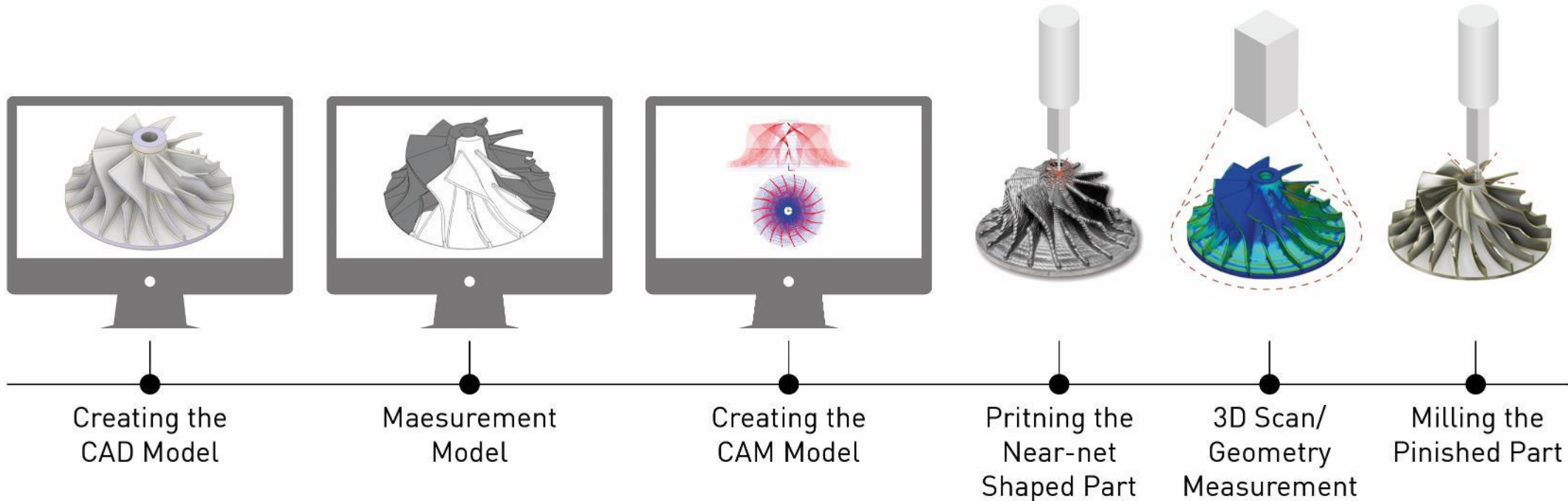
- Nearly 100 % material utilization
- Low material costs
- Easy handling
- Uncomplicated storage
- Extensive selection of materials



What Is 3DMP®?

Due to the integration of a simple WAAM process, an easy to use CAM software and the GEFERTEC machinery, a revolutionary as well as sustainable solution for manufacturing is provided.

3DMP® Process Steps



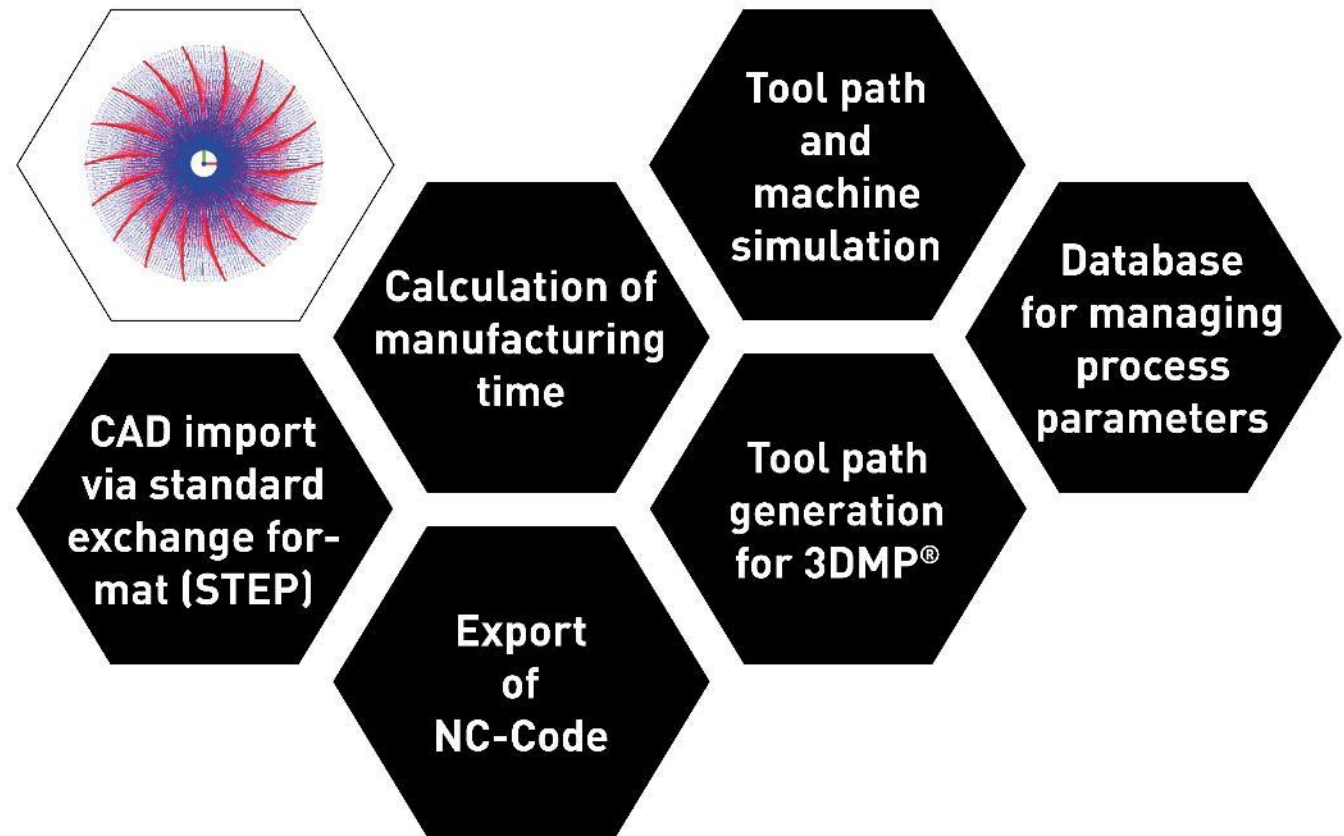
The 3DMP® Process Chain

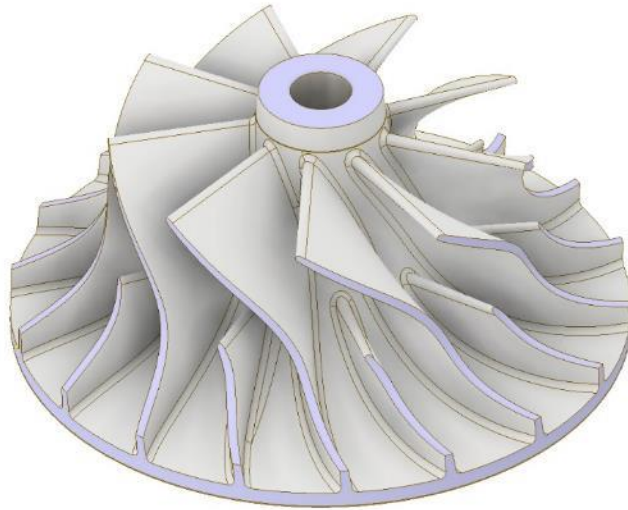
3DMP® combines the technically mature and highly reliable arc welding method with the CAD data of the metal parts that are to be produced. The CAD data will be converted into individual digital printing layers, the so-called CAM models. Then, the blank part is printed fully automatically and in a controlled manner. This step is followed by a 3D scan for quality control and finally the milling of the finished part.

CAM 3DMP®

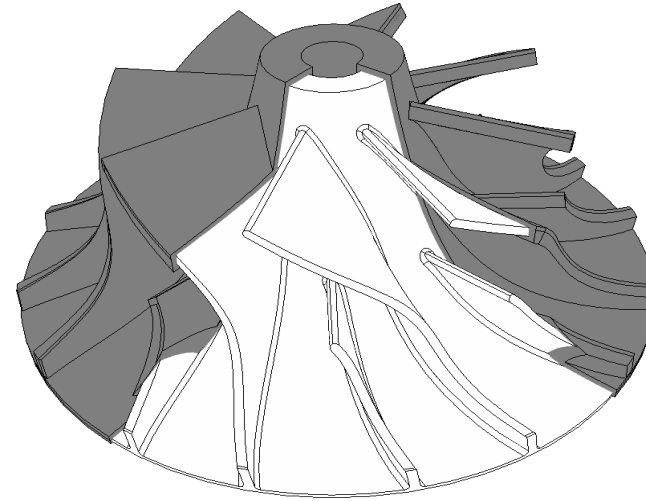
Offline programming system for path-controlled processes with CNC machines adapted to the 3DMP manufacturing process.

The CAM-3DMP® software allows to use multiple strategies for the generation of tool paths.





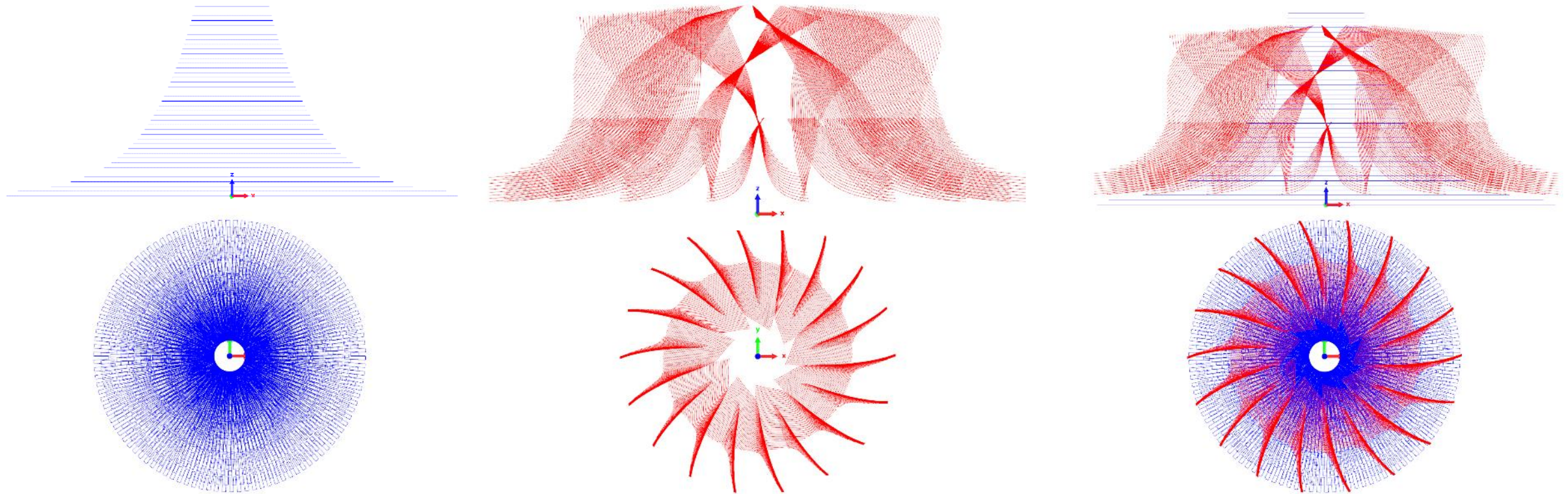
CAD model (final part)



Offset model vs. final part

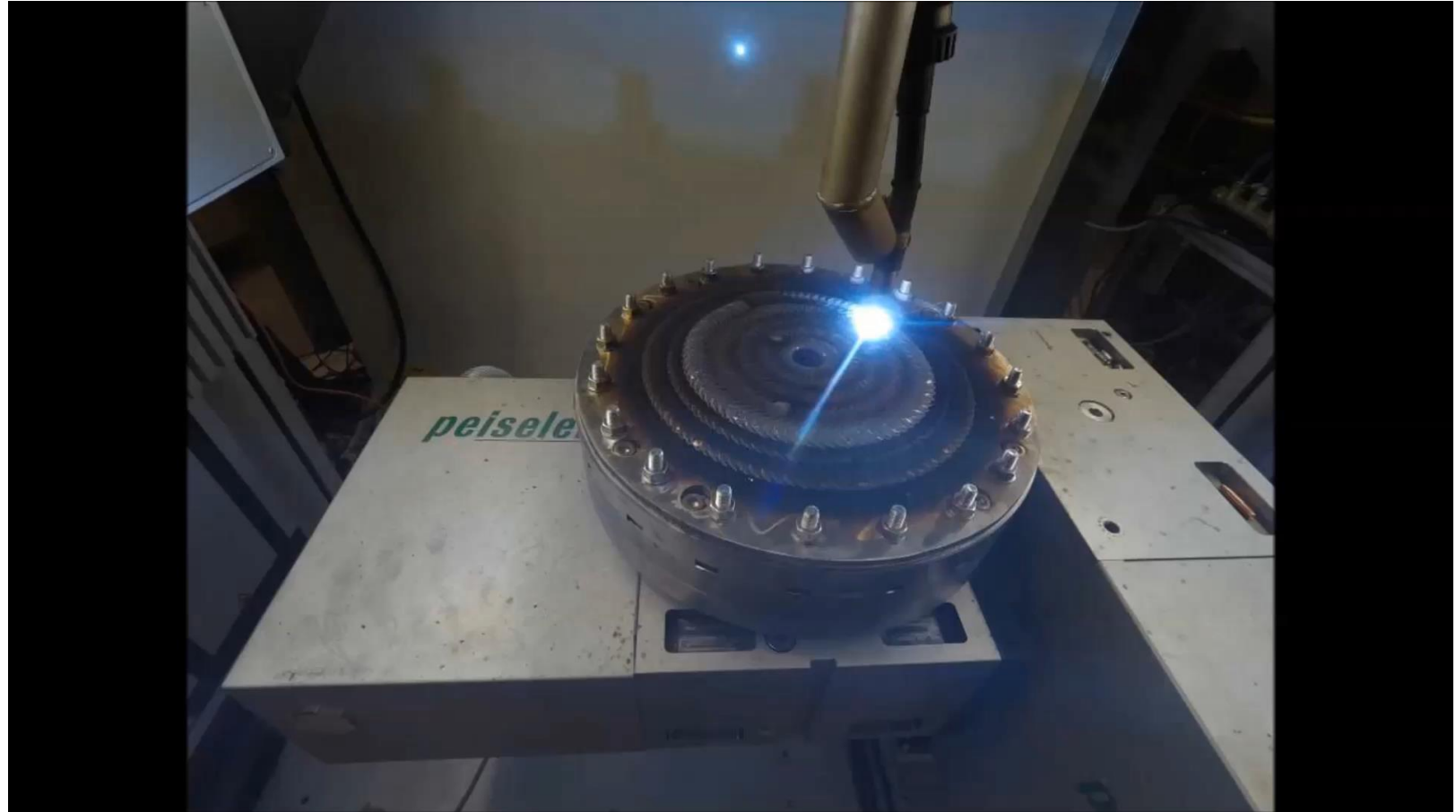
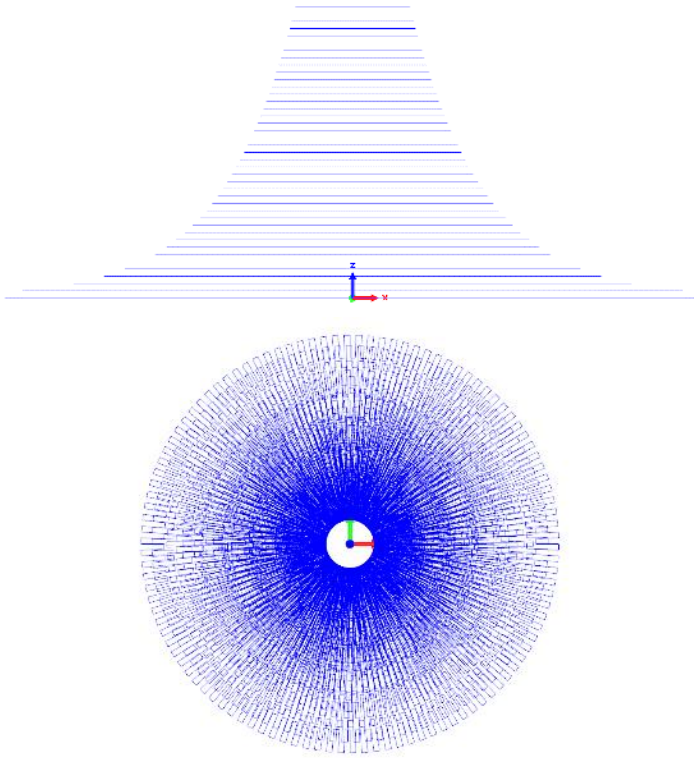
The 3DMP® Process Chain: The Offset Model

Due to the final milling operation and the clamping during the process a slightly oversized CAD model (offset model) is required. Compared to the raw material block in conventional manufacturing, 3DMP® leads to less wasted chipping material in the end.



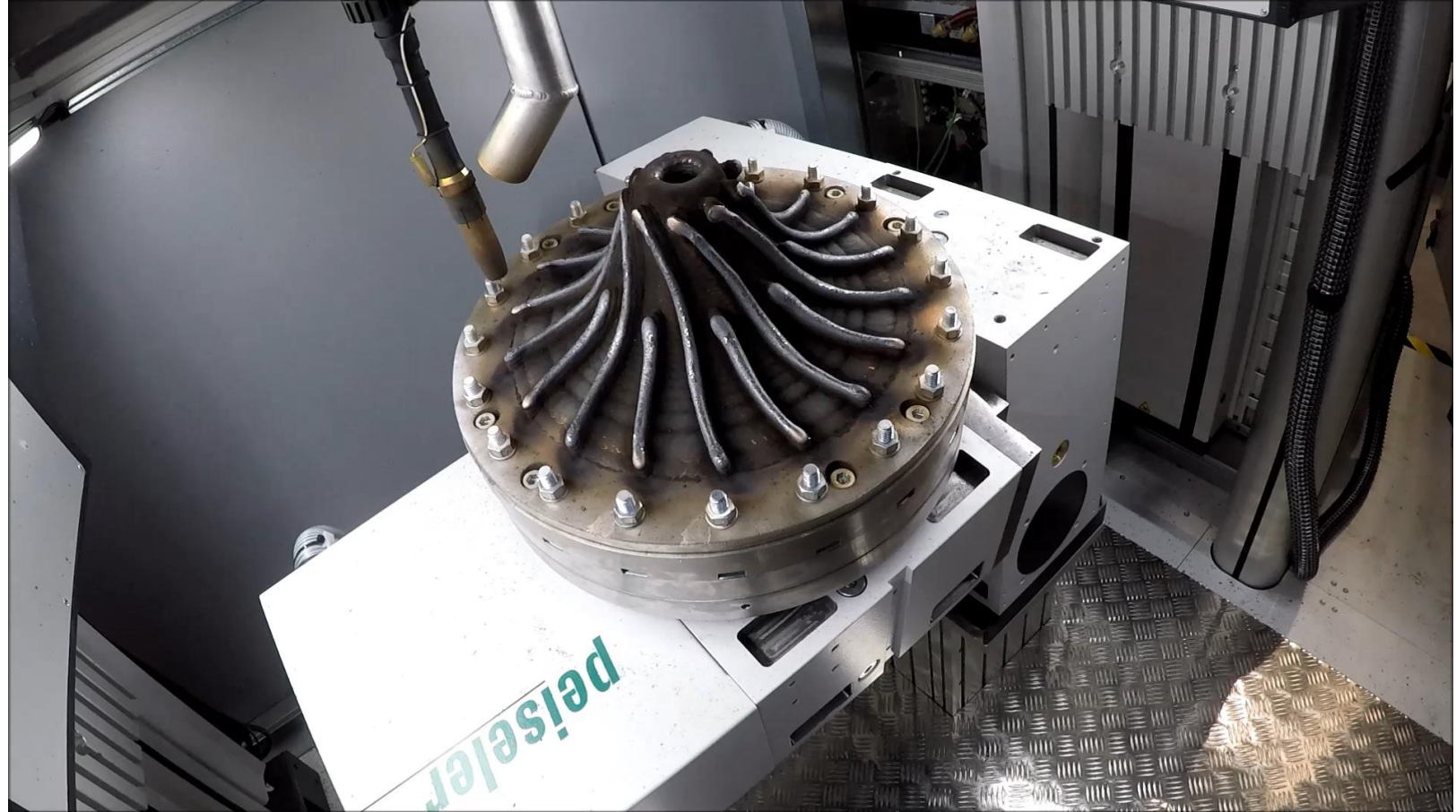
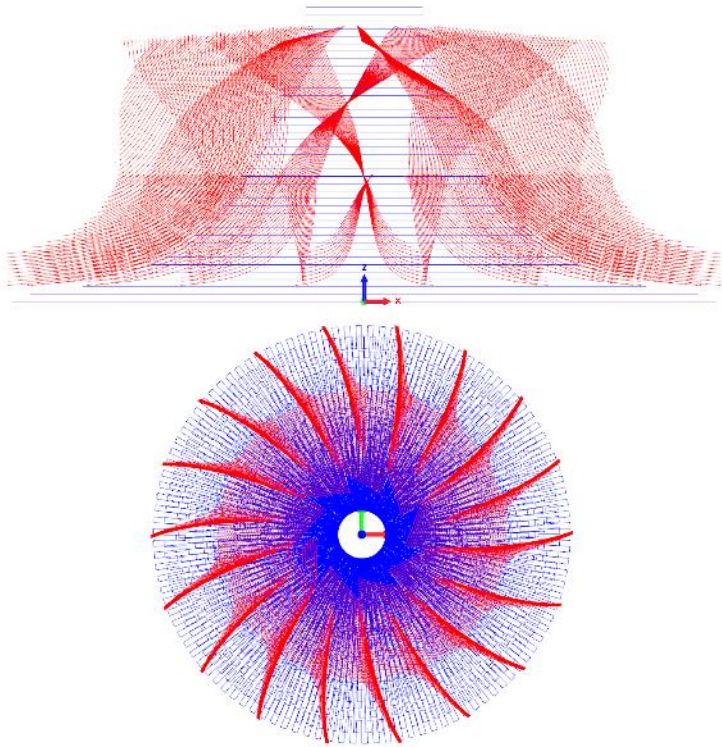
The 3DMP[®] Process Chain: Generating The CAM Model

In order to create a NC-Code, the offset model is converted into a CAM model by slicing layer by layer.



The 3DMP® Process Chain: Printing

First, the cone is printed in a 3 axis machine.



The 3DMP® Process Chain: Printing

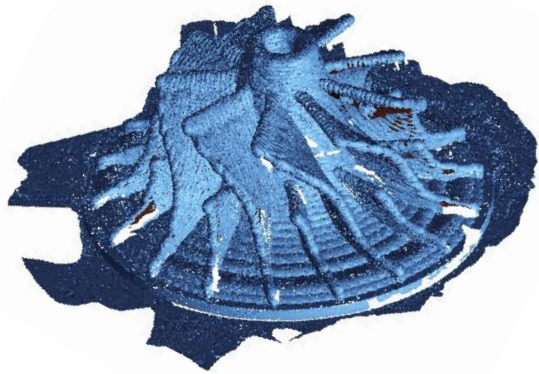
Afterwards, the impeller blades are printed onto the cone.



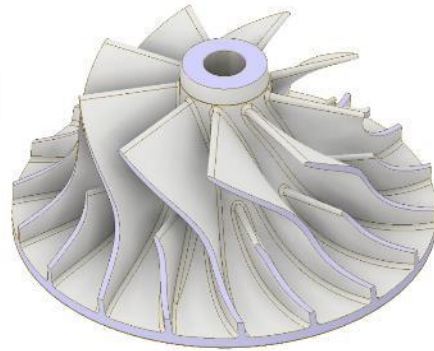
- Material: 1.4370
- Build-up rate: 350 cm³/ h (21 in³/ h)
- Printed volume: 2450 cm³ (150 in³)
- Printed mass: 19,4 kg (43 lb)
- Mass incl. base plate: 29 kg (64 lb)
- Printing time: 7 h
- Process time: 13 h

The 3DMP[®] Process Chain: Printing

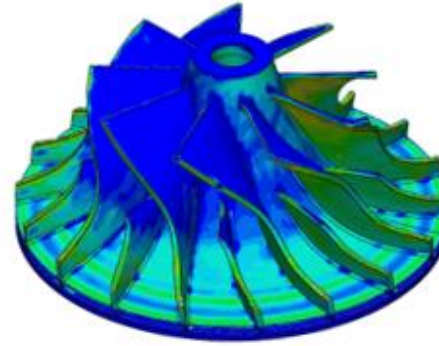
Printing the near net shape part by using a wire-based arc welding process. Build-up rate depends on material as well as geometry.



3D-Scan



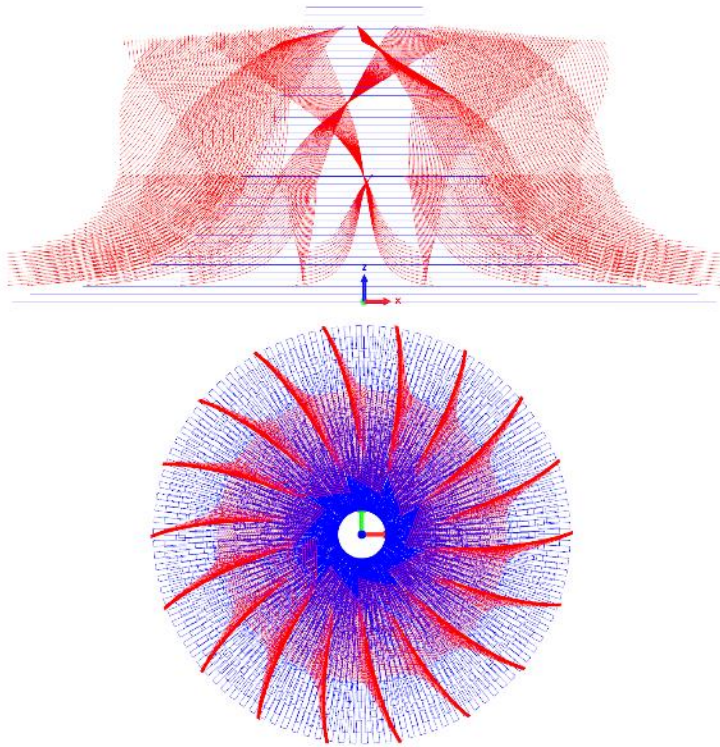
Target geometry

Comparison actual /
target geometry

Finished part

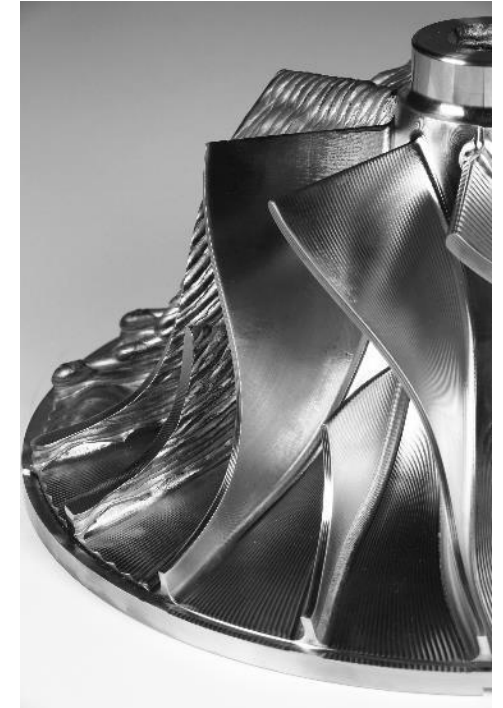
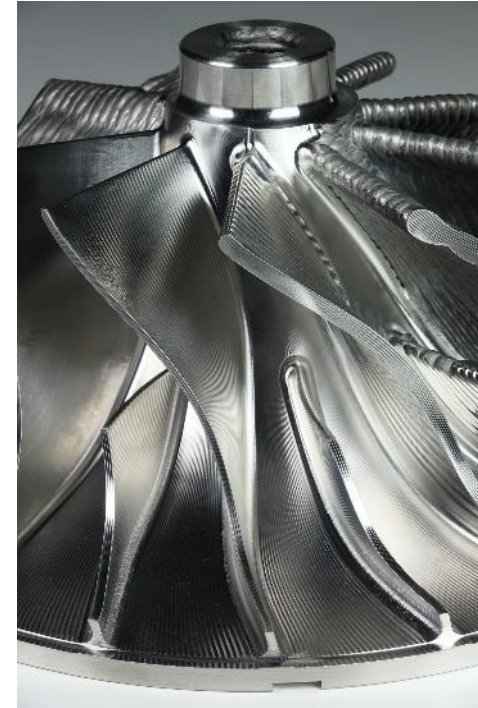
The 3DMP® Process Chain: 3D-Scan And Milling Operation

The printing operation is followed by a quality control in terms of 3D-Scan to measure the distortion. Therefore, the actual geometry is compared to the target geometry according to the drawing. Based on the geometry comparison the finished part is machined.



The 3DMP® Process Chain: Finishing

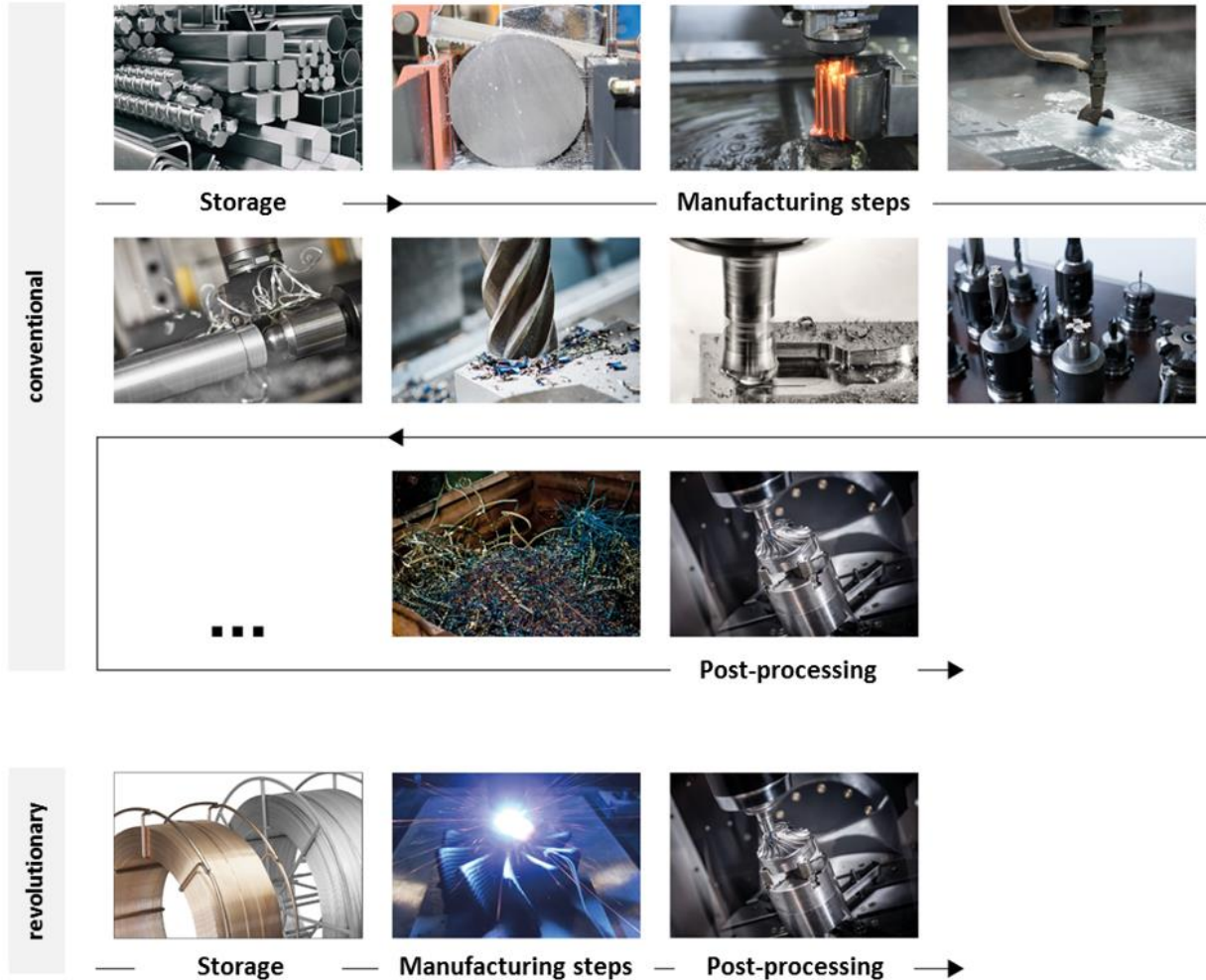
After the printing process the part is generally finished applying milling or turning operations.



Partly finished part as demonstration sample

The 3DMP® Process Chain: Finishing

After the printing process the part is generally finished applying milling or turning operations.



Conventional Manufacturing versus 3DMP®

- Reduced material storage facility
- Reduced number of manufacturing steps
- Lower handling costs
- Less tool wear and material waste
- Complementing conventional manufacturing
- Focusing on core competences

GEFERTEC Arc Series

Either 3 or 5 motion axes offer maximum flexibility in terms of component.

The machine scalability allows additive production of either small and large high-quality metal parts.

arc405



arc403



Machine	Max. printed volume	Axes
arc405	0,4 x 0,65 m (Ø - z)* 0,72 x 0,45 m (Ø - z)*	5
arc403	0,72 x 0,9 x 1,25 m	3

Outer dimensions: 3,0 x 2,3 x 3,1 m

arc605



arc603



Machine	Max. printed volume	Axes
arc605	0,9 x 0,7 m (Ø - z)	5
arc603	1,1 x 1,4 x 1,72 m*	3

Outer dimensions: 4,5 x 4,5 x 4,33 m

* Maximum values, depending on the variant & options selected, there may be deviations.

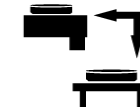


arc605



arc605
Control Interface

Retrofit Equipment Options



Flexible Table
Positioning



Automation Tool



Titanium Module

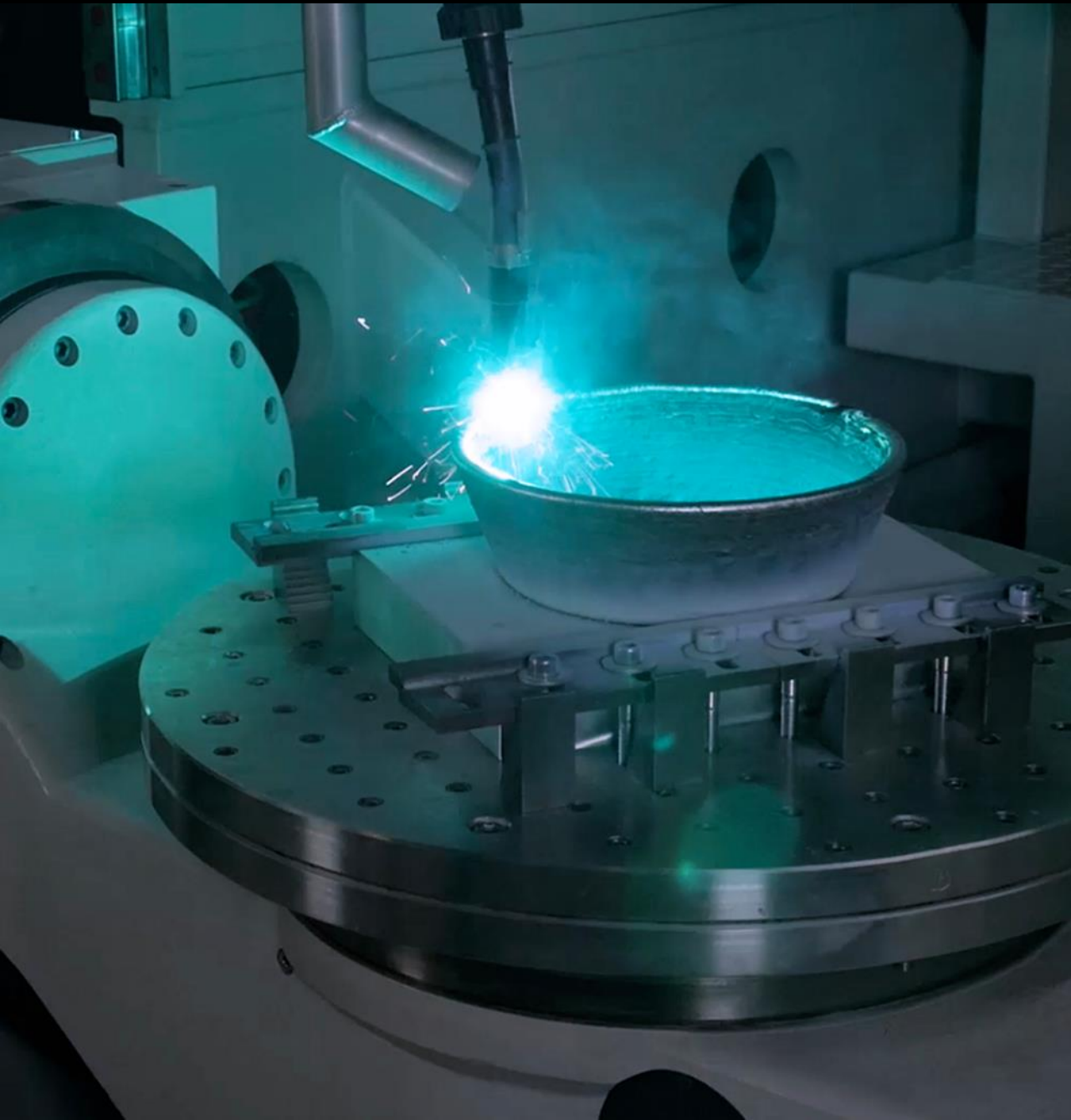


QM Feature



Temperature Tracking
and control

GEFERTEC Arc Machine Series



3DMP® is Fast

- Aluminum: 600 cm³/ h (1,6 kg/ h)
- Steel: 450 cm³/ h (3,5 kg/ h)
- Ni-Based: 450 cm³/ h (3,5 kg/ h)
- Titanium: 900 cm³/ h (4 kg/ h)

Process-oriented

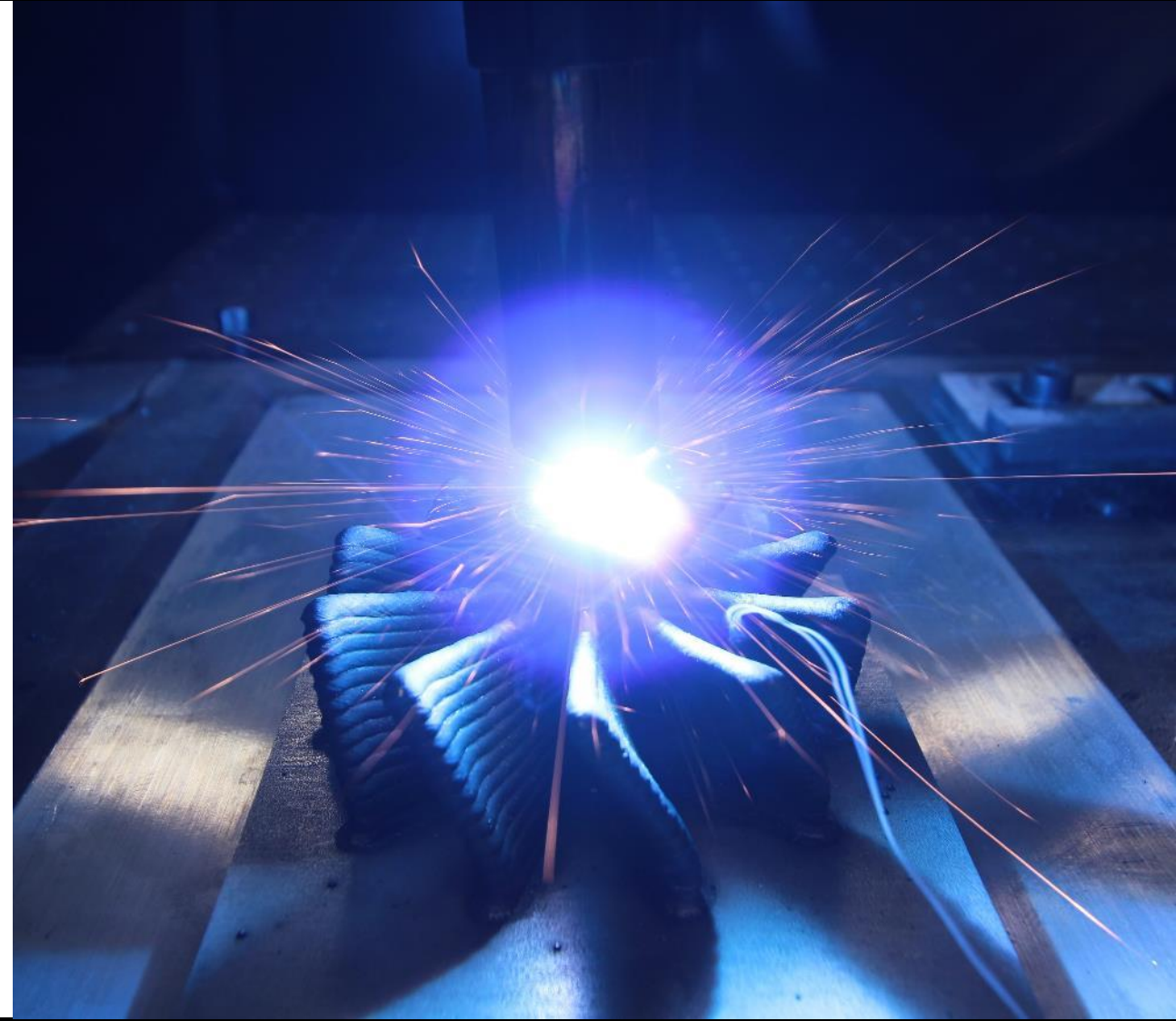
- High cost chipping
- Forging
- Ineffective Casting

Application-oriented

- Prototypes & Repair
- Small batches
- Tool making

Component-oriented

- Multi-materials
- Freedom of design
- Inner structures



3DMP® Application Scenarios Are Diverse

Replacing Milling Operations

- Reducing chip volume
- Saving high-cost materials
- Reducing tool wear
- Reducing lead time

Conventional Manufacturing

Material: 1.4305



Raw Material
85 kg
Blank costs: 1.000 €



Milling
Chips: 67 kg (80%)
Milling costs: 3.500 €



Finished Part
18 kg
Total costs: 4.500 €

3DMP®

Material: 1.4316



Printed Blank (6.5 h)
25 kg (printed volume: 17 kg)
Blank costs: 750 €



Milling
Chips: 7 kg (28%)
Milling costs: 1.250 €



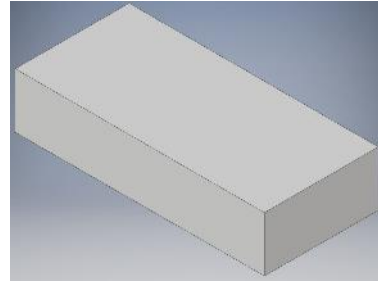
Finished Part
18 kg
Total costs: 2.000 €

AM of Titanium

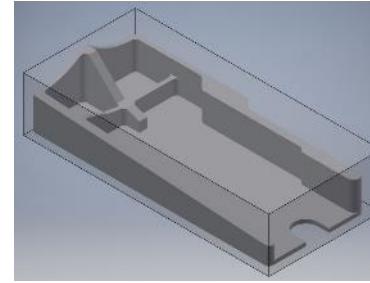
- Reducing high chip volume
- Saving high cost materials
- Reducing tool wear
- Reducing lead time
- Replacing forging operations

Conventional Manufacturing

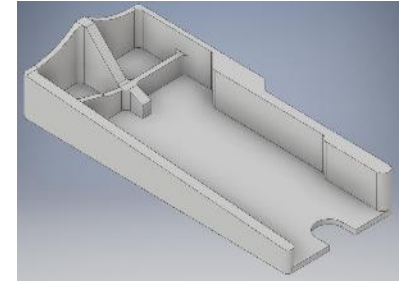
Material: Ti6Al4V



Raw Material
14.4 kg



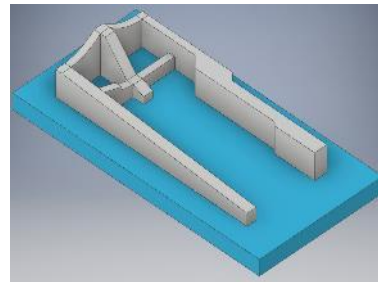
Milling
Chip mass: 12.3 kg



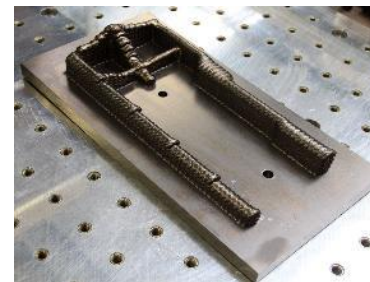
Finished Part
2.1 kg

3DMP®

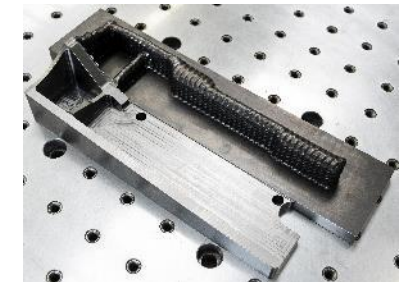
Material: Ti6Al4V



Offset model for 3D-Print
Mass Printing: 1.7 kg
Mass base plate : 2.8 kg



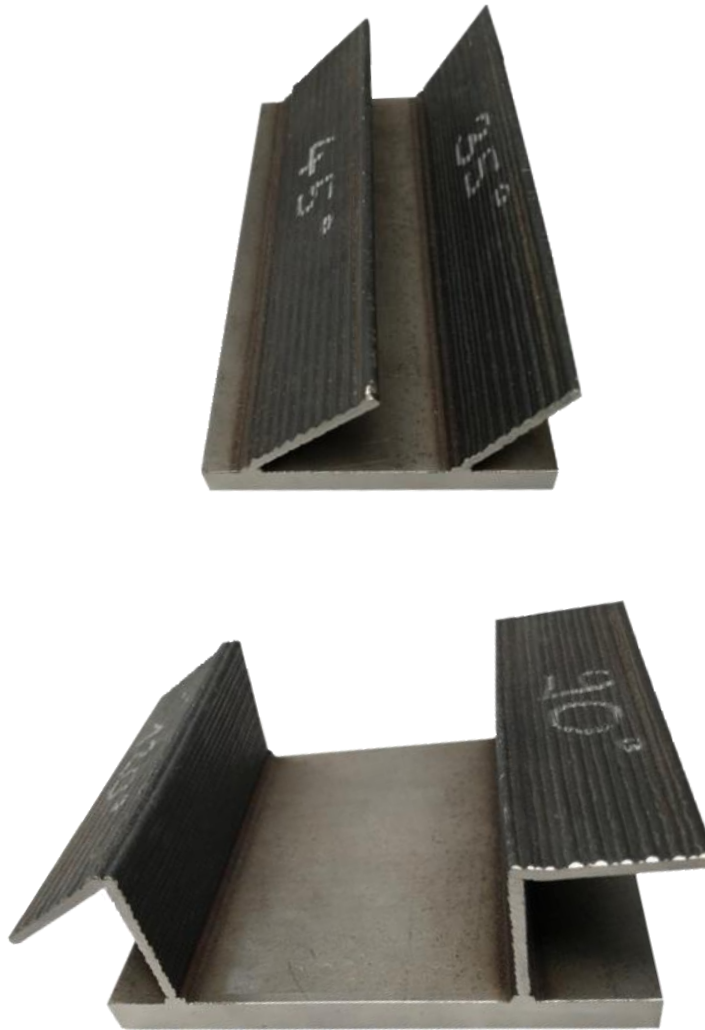
Milling
Chip mass: 2.4 kg



Finished Part
2.1 kg

3DMP® to Enlarge Design Freedom

- Manufacturing complex geometries
- Outstanding build-up rates
- Manufacturing bigger parts



1.2367 | X38CrMoV5 3
Hot Work Tool Steel

3DMP® for Small Batches and Prototypes

- Replacement of casting operations
- Cost savings
- No moulds and tools required
- Increase of flexibility
- Economically efficient as of a batch size of 1



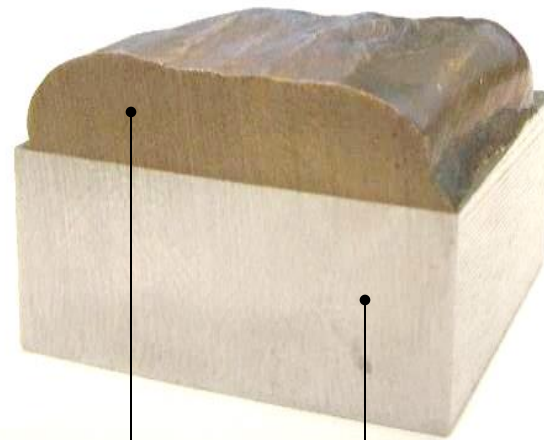
[1]



3.3548 | AL 5183 | AlMg4,5Mn0,7

3DMP® Tool Making

- Fast implementation of design changes
- Multi-materials
- Wear- resistant coatings
- Inner structures for cooling



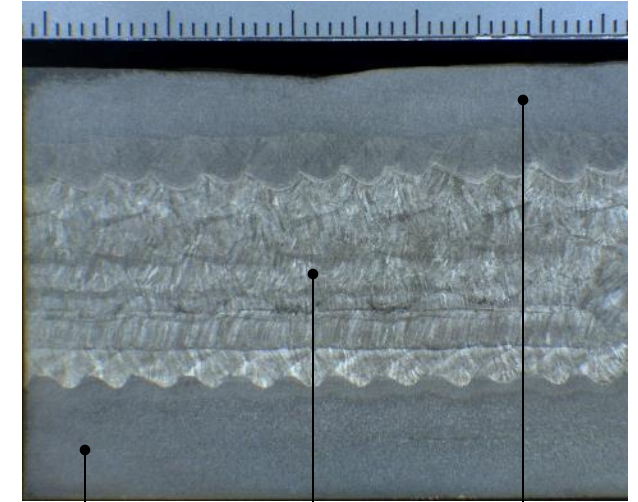
Copper
Base
(2.0921)

Stainless
Steel
(1.4301)



Duplex Steel
(1.4462)

Mild Steel
(1.0045)



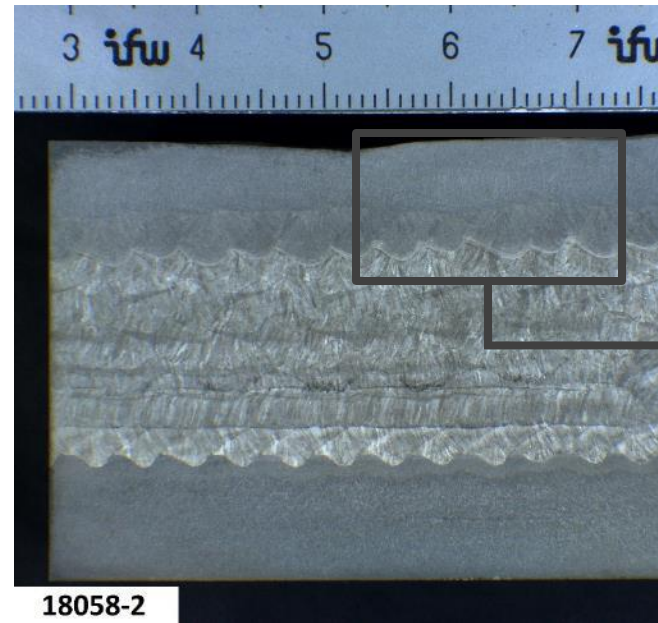
Mild Steel
(1.0045)

Stainless
Steel
(1.4370)

Hardfacing
(1.4718)

Tool manufacturing Hardness

- 1.4718 → 58 HRC
- 1.2343 → 55 HRC
- 1.2367 → 45 HRC

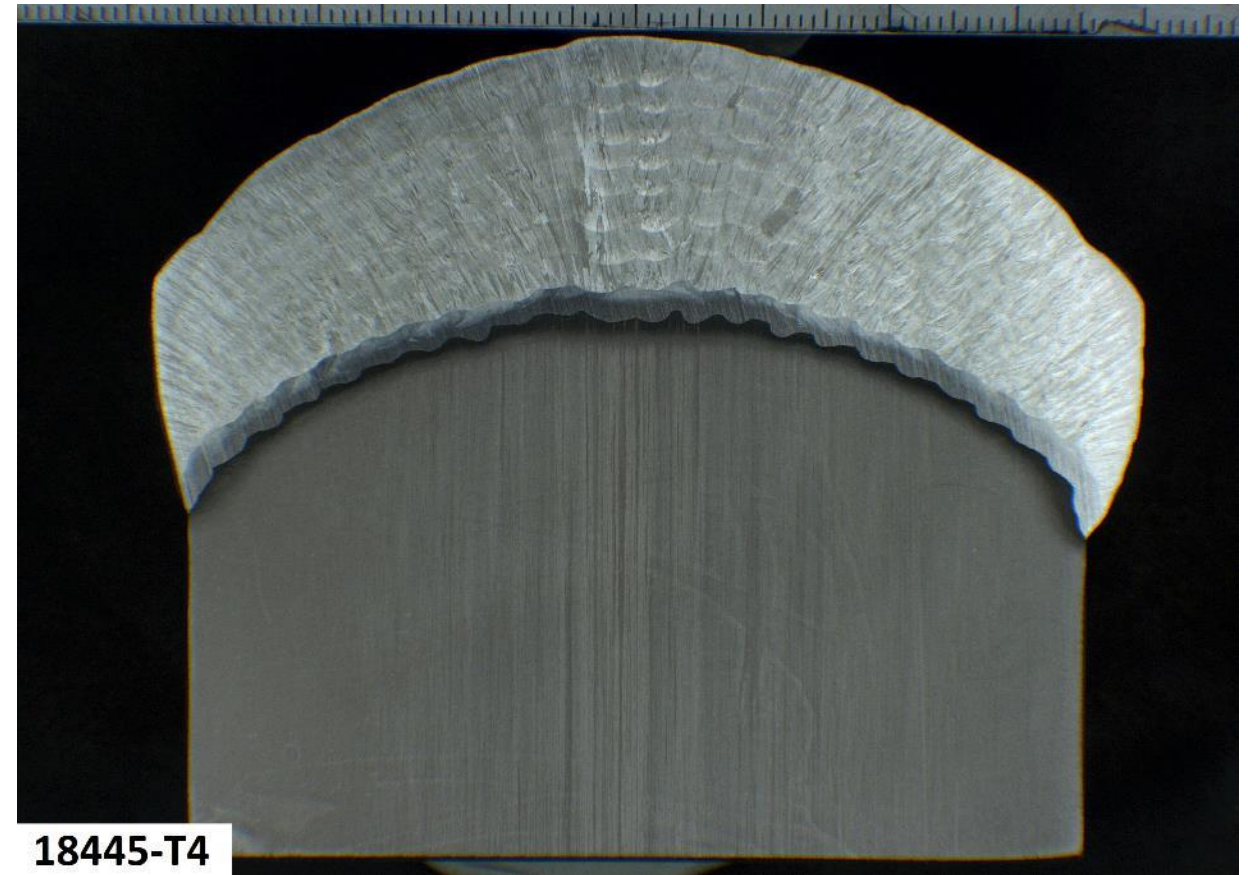


Photomicrograph of one layer 1.4718



Coating IN718 + IN625

- Coating material In718
- Buffer layer In625
- Base material 1.2842
- Coating 25mm
- No pre-heating necessary, Production at room temperature RT (20°C)



Coating of a mandril

Functional Structures

- Water cooling channels
- Circular channels (figure 1) extremely challenging
- Figure 2 and 3 ensure high process reliability due to the geometric structure

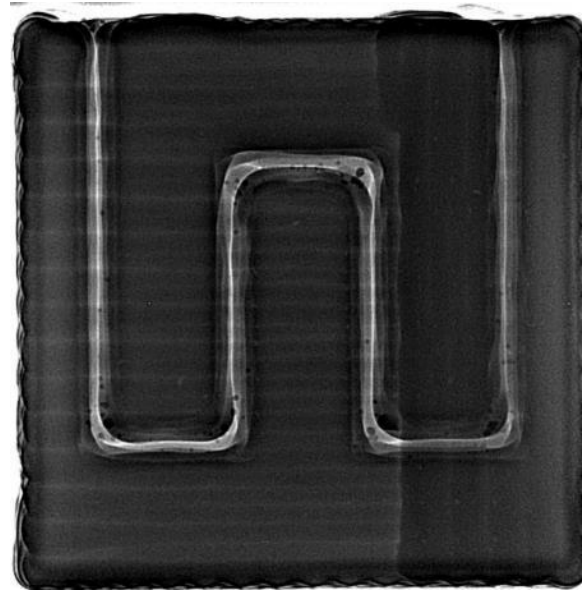


Figure 1

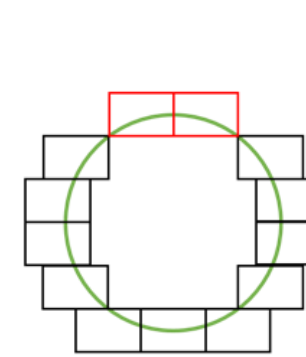


Figure 2

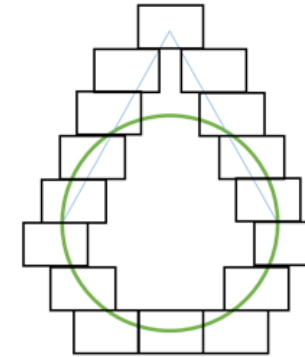
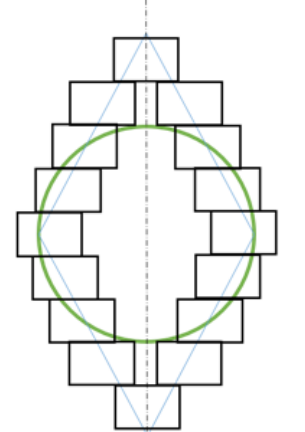


Figure 3



Cross section cooling channel



Alternative geometry

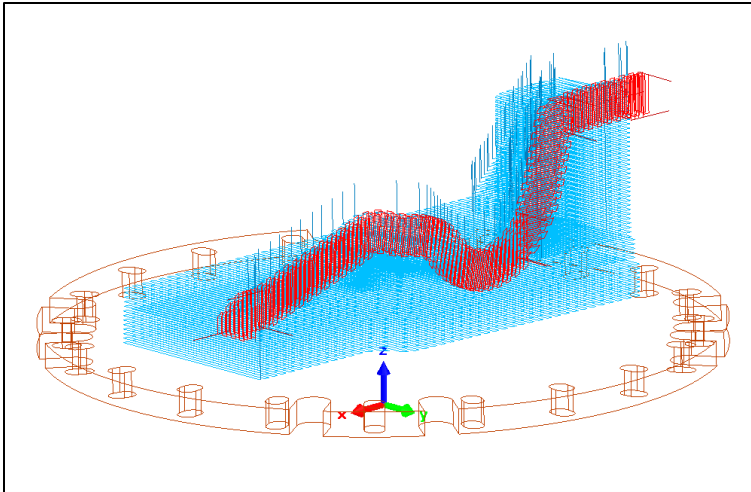


Cross section weld bead (simplified)

30°...45°



Sheet Metal Cutting and Forming Tool of the Automotive Industry



Technical Data

Machine: arc405

Dimensions [mm]:

L = 283 | H = 123 | B = 145

Wire: 1.4316 | Ø 1,0 mm

1.4718 | Ø 1,0 mm

Printing mass: 1.4316 | 14,1 kg

1.4718 | 1 kg

Printing time: 1.4316 | 8,00 h

1.4718 | 0,50 h

Benefits of 3DMP®



reduction of
manufacturing time



Cost savings



Small units



Material savings



Fast customization

Conventional Manufacturing – Casting & Milling

- Problems with the procurement :
 - Long delivery times of the cast part
 - During the development many adjustments are made, which have to be implemented quickly

Schuler – Hot Forming Die



Technical Data

Machine: arc405

Dimensions [mm]:

L = 400 | H = 187 | B = 214

Wire: 1.4370 | Ø 1,0 mm

1.2343 | Ø 1,0 mm

Printing mass: 1.4370 | 11,3 kg

1.2343 | 3,1 kg

Printing time: 7,00 h

Benefits of 3DMP®



Reduction of
manufacturing time



Cost savings



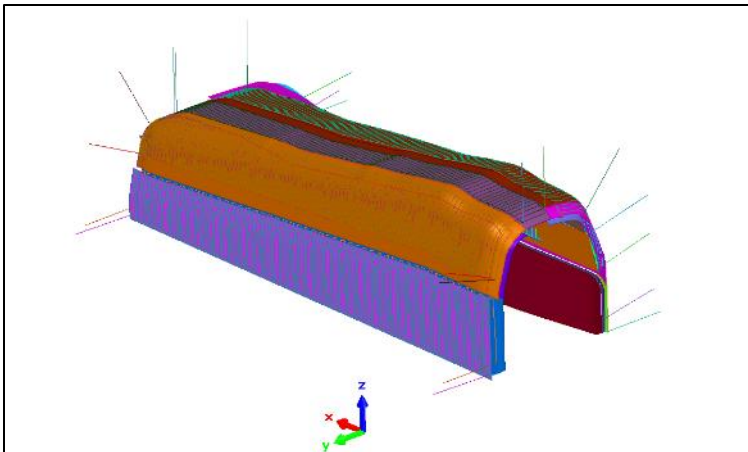
Multi-materials



Material savings



Extension of life-time



- Current challenge:
 - Segmentation of the die into single segments necessary
 - Why multiple segments?
 - Near-net-shape and under the surface running cooling channels must be drilled mechanically

EMAG GmbH – Gearbox Housing of a Powershift Transmission



Technical Data

Machine: arc405

Dimensions [mm]:

$D_{a, \text{Flansch}}$ = 324

$D_{a, \text{Segmente}}$ = 380

$D_{i, \text{Kühlkanal}}$ = 161

$D_{i, \text{Rohr}}$ = 248

H = 244

Wire: 1.4370 | \varnothing 1,2 mm

Printing mass: 35,0 kg

Printing time: 31,6 h

Benefits of 3DMP®



reduction of
manufacturing time



Cost savings



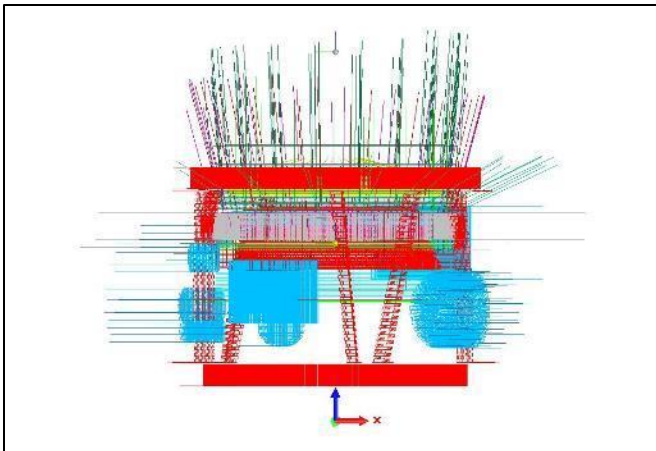
Small units



Material savings



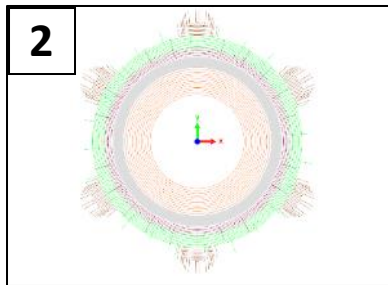
Fast customization



Conventional Manufacturing – Casting & Milling

- Problems with the procurement :
 - Weight-optimized component geometry cannot be produced due to production limits of conventional technology
 - Subsequent changes can only be realized by manufacturing new moulds

Deutsche Bahn – Wheelset Bearing Cover



Technical Data

Machine: arc405

Dimensions [mm]:

Da = 382 | Di = 147 | H = 70

Wire:

1.4430 | Ø 1,0 mm

Printing mass: 13,2 kg

Printing time: 7,00 h

Benefits of 3DMP®



Reduction of
manufacturing time



Cost savings



Small units



Material savings

Conventional Manufacturing - Casting

- Year Locomotive 1964-1974
- Wheelset bearing cover on the list of missing parts of Deutschen Bahn
- List of missing part = prio list of parts relevant to availability; the absence of these parts can cause a vehicle downtime
- Problems with spare parts requirement:
 - High minimum purchase quantities
 - Delivery times of the spare part: several months

Deutsche Bahn – Secondary Roll Stop



Technical data

Machine: arc405

Dimensions [mm]:

L = 250 | B = 216 | H = 312

Wire:

SW 100S NiMoCr | Ø 1,2 mm

Printing mass: 36,3 kg

Printing time: 26,00 h

Benefits of 3DMP®



Reduction of
manufacturing time



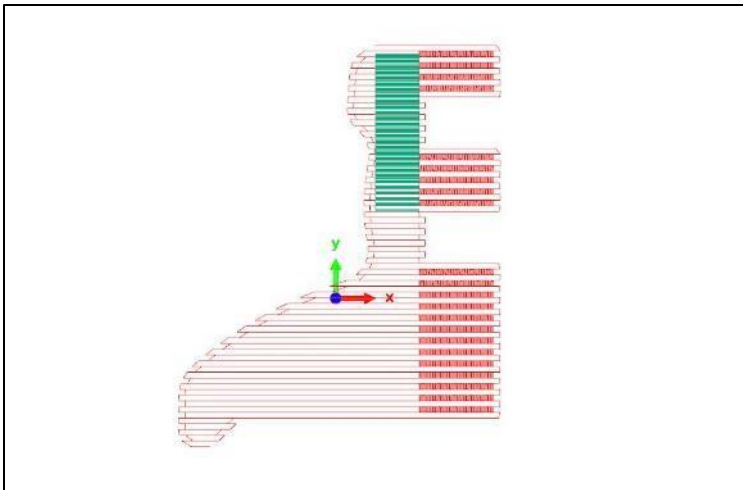
Cost savings



Small units



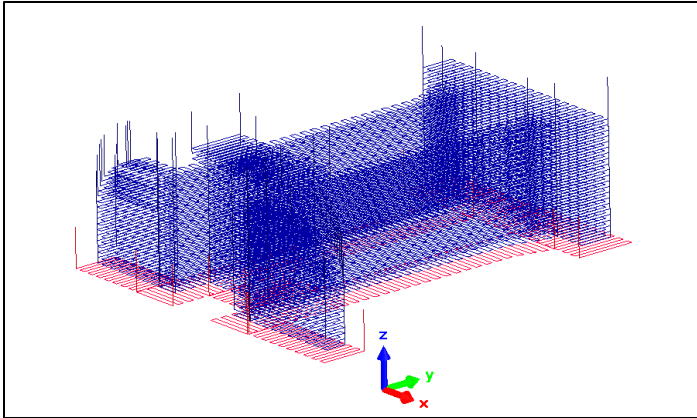
Material savings



Conventional Manufacturing - Casting

- Application: high speed ICE trains
- Mobility relevant component in the bogie area of ICE trains
- Ensures safe passage of trains in tight curves (the box gate limits the lateral play of the car body)
- Problems with spare parts requirement:
 - Delivery times of the spare part: min. 10 months

MMT-Duncha – Aircraft: Nacelle/Latch Housing



Technical Data

Machine: arc405

Dimensions [mm]:

L = 250 | H = 66 | B = 160

Wire:

3.7165/Ti6Al-4V | Ø 1,2 mm

Printing mass: 3,70 kg

Printing time: 3,25 h

Benefits of 3DMP®



Reduction of
manufacturing time



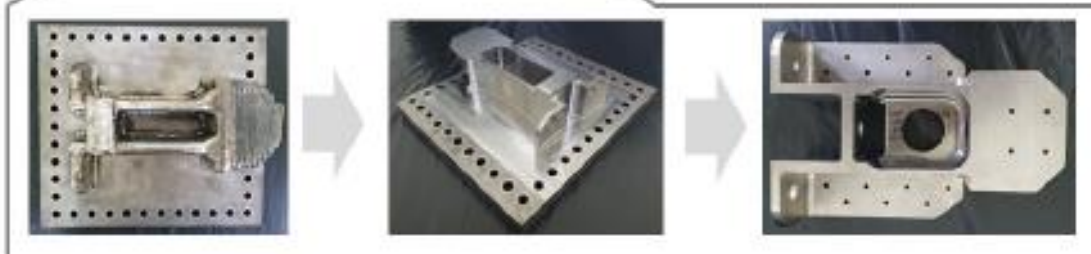
Cost savings



material savings



Quick lead time



Conventional Manufacturing - Milling

- Material savings: conventional – 25kg | 3DMP® – 3.5kg
- Component in approval
- Class-1 component: High tensile requirement

Aircraft Philipp – Spar



Technical Data

Machine: arc603

Dimensions [mm]:

L = 772 | H = 25,4 | B = 230

Wire:

3.7165/Ti6Al-4V | Ø 1,2 mm

Printing mass: 2,70 kg

Printing time: 2,25 h

Benefits of 3DMP®



Reduction of
manufacturing time



Cost savings



Material savings



Reduction of
Fly-to-Buy ratio

Conventional Manufacturing - Chipping

- Component in approval
- Spar on Bombardier CRJ aircraft → Part of the powerplant suspension
- Class 1 component = aircraft cannot take off if the component is missing
- Problems with spare part requirement:
 - Time-consuming roughing process
 - 96 % chipping effort: titanium block: 36 kg → Finished part: 2,5 kg

R&D Aerospace Project - REGIS

Subproject "3D metal printing
of large integral components
made of titanium and
aluminium
for aviation"

Project Partners

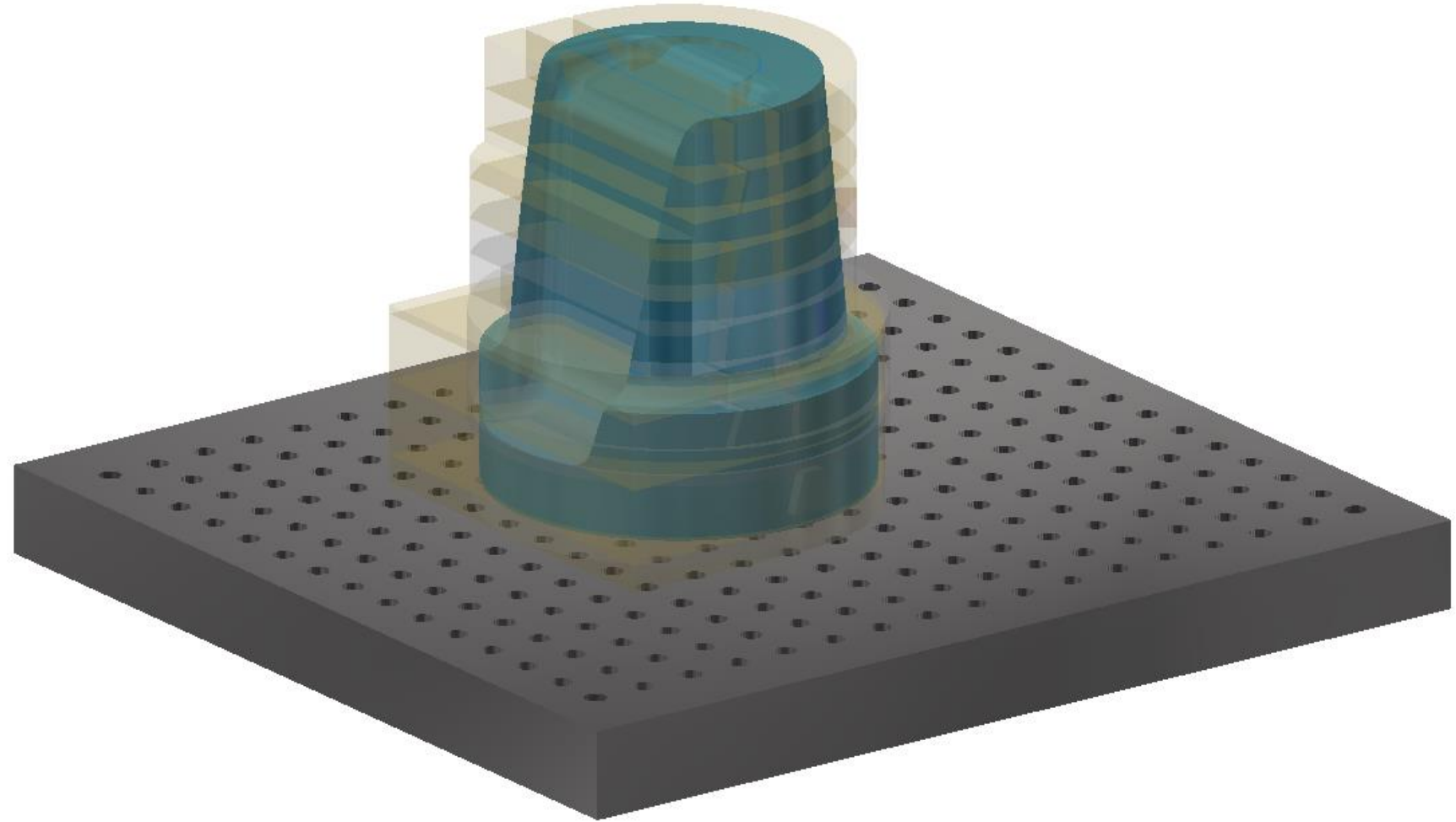
The Airbus logo, consisting of the word "AIRBUS" in a bold, black, sans-serif font.

Milestones

- Concept for 3D printing of components larger than 1m x 1m
- Process/design strategy for distortion minimization
- Process control according to aviation standard
- Requirements for component design
- Requirements for machine design

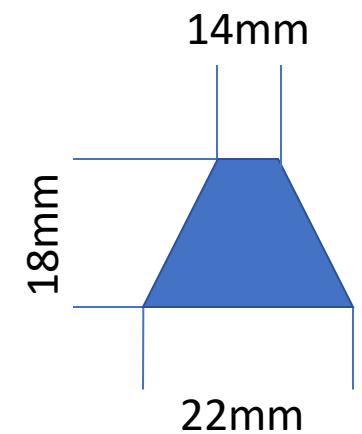
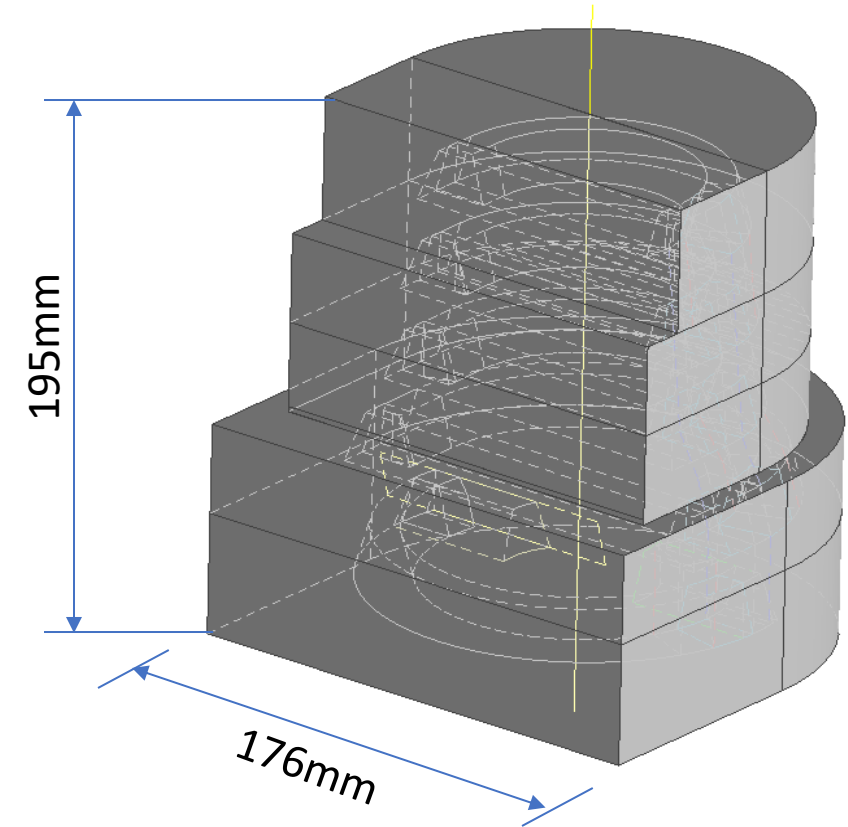
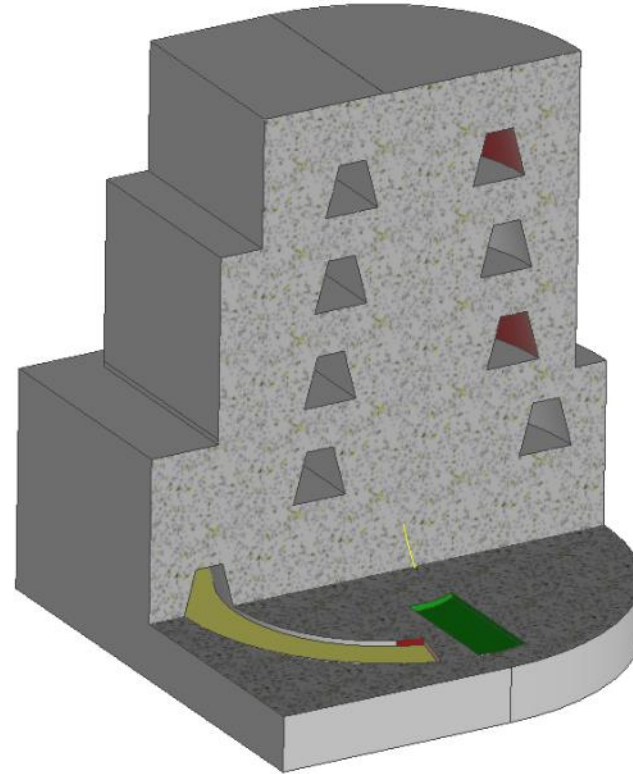
Functional Structures

- Aluminium pressure mold
- Material: 1.2343



Functional Structures

- Cooling channels
- Material: 1.2343



Processable Materials

There is an extensive selection of processable materials for 3DMP®. Basically every weldable material available as wire can be applied in GEFERTEC arc machine centers.

Steel

1.2343 (tool steel)
1.2367 (tool steel)
1.3346 (hard-facing steel)
1.4718 (tool steel)
1.4316 (stainless steel)
1.4370 (stainless steel)
1.4332 (stainless steel)
1.4430 (stainless steel)
1.4462 (high-alloyed CrNi - Duplex)
1.4551 (stainless steel)
1.4718 (hard-facing steel)
1.6834 (low-alloy)

Ni-Based

1.3912 (Nickel 36)
2.4856 (Alloy 625)
2.4668 (Alloy 718)*

Non Ferrous Materials

3.7165 (Ti6Al4V/ Grade 5)
2.0921 (Copper based)

Aluminium

3.0805 (Al99,5Ti)
3.2245 (4043 AlSi5)
3.2315 (6082 AlMgSi1)*
3.2371 (4018 AlSi7)
3.3206 (6063 AlMgSi0,7)
3.3536 (5754 AlMg3)
3.3548 (5183 AlMg4,5Mn)
3.3556 (5356 AlMg5)
3.3546 (5087 AlMg4,5MnZr)

* Under examination

Our Offer



Development
Partner



Training



Sample Part
Production



Service



CAM-Pro-
gramming



Process
Development



GEFERTEC – Your Partner in Technology!



3DMP® Potentials

- Higher deposition rates
- Greater diversity of materials
- Improved mechanical properties
- Large parts
- Economic from lot size 1
- Reduction of manufacturing costs by up to 60%
- Reduced number of manufacturing steps
- Maximum material utilization
- Outstanding design freedom ...

3DMP® Limitations

- Surface finish, Structure resolution
- Geometric complexity

Make 3DMP® Benefits Your Benefits!

Thank you for your attention!

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