3DMP®
Fast I Simple I Economic
Feb 2015
Founding

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

Dec 2016
1st Machine Sale

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

Aug 2019
Founding GEFERTEC LLC

Strong partners of GEFERTEC GmbH

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<td>Partner in the Support Process</td>
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<td>Partner for Machine Production</td>
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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.
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.
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.
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.
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.

- 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: 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.
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.

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<tr>
<th>Machine</th>
<th>Max. printed volume</th>
<th>Axes</th>
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<tr>
<td>arc405</td>
<td>0.4 x 0.65 m (Ø - z)*</td>
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<tr>
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<td>0.72 x 0.45 m (Ø - z)*</td>
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<tr>
<td>arc403</td>
<td>0.72 x 0.9 x 1.25 m</td>
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<td>Outer dimensions: 3.0 x 2.3 x 3.1 m</td>
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<tr>
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<tr>
<td>arc605</td>
<td>0.9 x 0.7 m (Ø - z)</td>
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<tr>
<td>arc603</td>
<td>1.1 x 1.4 x 1.72 m*</td>
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<td>Outer dimensions: 4.5 x 4.5 x 4.33 m</td>
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* Maximum values, depending on the variant & options selected, there may be deviations.
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)
3DMP® Application Scenarios Are Diverse

**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
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

3.3548 | AL 5183 | AlMg4,5Mn0,7

[1] © Fit AG
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)
- Hardfacing (1.4718)
- Stainless Steel (1.4370)
- Mild Steel (1.0045)
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)
Functional Structures

- Water cooling channels
- Circular channels (figure 1) extremely challenging
- Figure 2 and 3 ensure high process reliability due to the geometric structure
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 l 11,3 kg
  - 1.2343 l 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]:**
  - $D_{a,Flansch} = 324$
  - $D_{a,Segmente} = 380$
  - $D_{i, Kühlkanal} = 161$
  - $D_{i, Rohr} = 248$
  - $H = 244$
- **Wire:** 1.4370 | Ø 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]:**
  - $D_a = 382$ | $D_i = 147$ | $H = 70$
- **Wire:**
  - 1.4430 | $\varnothing$ 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

**Technal 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

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
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.

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<th>Steel</th>
<th>Ni-Based</th>
<th>Non Ferrous Materials</th>
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<td>1.2343 (tool steel)</td>
<td>1.3912 (Nickel 36)</td>
<td>3.7165 (Ti6Al4V/ Grade 5)</td>
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<td>2.4856 (Alloy 625)</td>
<td>2.0921 (Copper based)</td>
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Our Offer

- Development Partner
- Service
- CAM-Programming
- Training
- Process Development
- Sample Part Production

GEFERTEC – Your Partner in Technology!
Make 3DMP® Benefits Your Benefits!

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
Thank you for your attention!