3D-METAL PRINTING IN THE AUTOMOTIVE INDUSTRY – THE NEXT BIG THING?

VIRTUAL VEHICLE Research Center
Aldo Ofenheimer

Blade Chassis Assembly

https://www.youtube.com/watch?v=zXG17_RcrZQ

Divergent Microfactories‘ 3D printed Blade supercar

0-100 km/h in 2,5 seconds
Weight: 635 kg
700 horsepower Mitsubishi Evo engine

Kevin Czinger, Divergent’s entrepreneurial founder, had built a car with aluminum 3D printed joints, or “nodes,” which form the car’s chassis along with tubes of carbon fiber.

Czinger didn’t just want to produce a handful of cars; he wanted to fundamentally change the way the automotive industry worked, establishing so-called “microfactories” that could rapidly manufacture (and repair) cars like the Blade all around the world, drastically cutting down shipping time and costs and helping the environment in the process.

Over the last year, Divergent Microfactories has raised huge sums of money, won awards, and even partnered with SLM Solutions, one of the world’s premier metal 3D printing specialists.

Setting the scene

virtual vehicle

Additive Manufacturing

- **Binder Jetting**
  - **“3D-Printing”**
  - Many more
- **Direct Energy Deposition**
  - **Direct Metal Deposition**
  - Many more
- Material Extrusion
- Material Jetting
- **Powder bed Fusion**
  - **SLS** — **Most common technology for metal parts**
  - **SLM**
  - **EBM**
- Sheet Lamination
- Vat Photopoly-merization

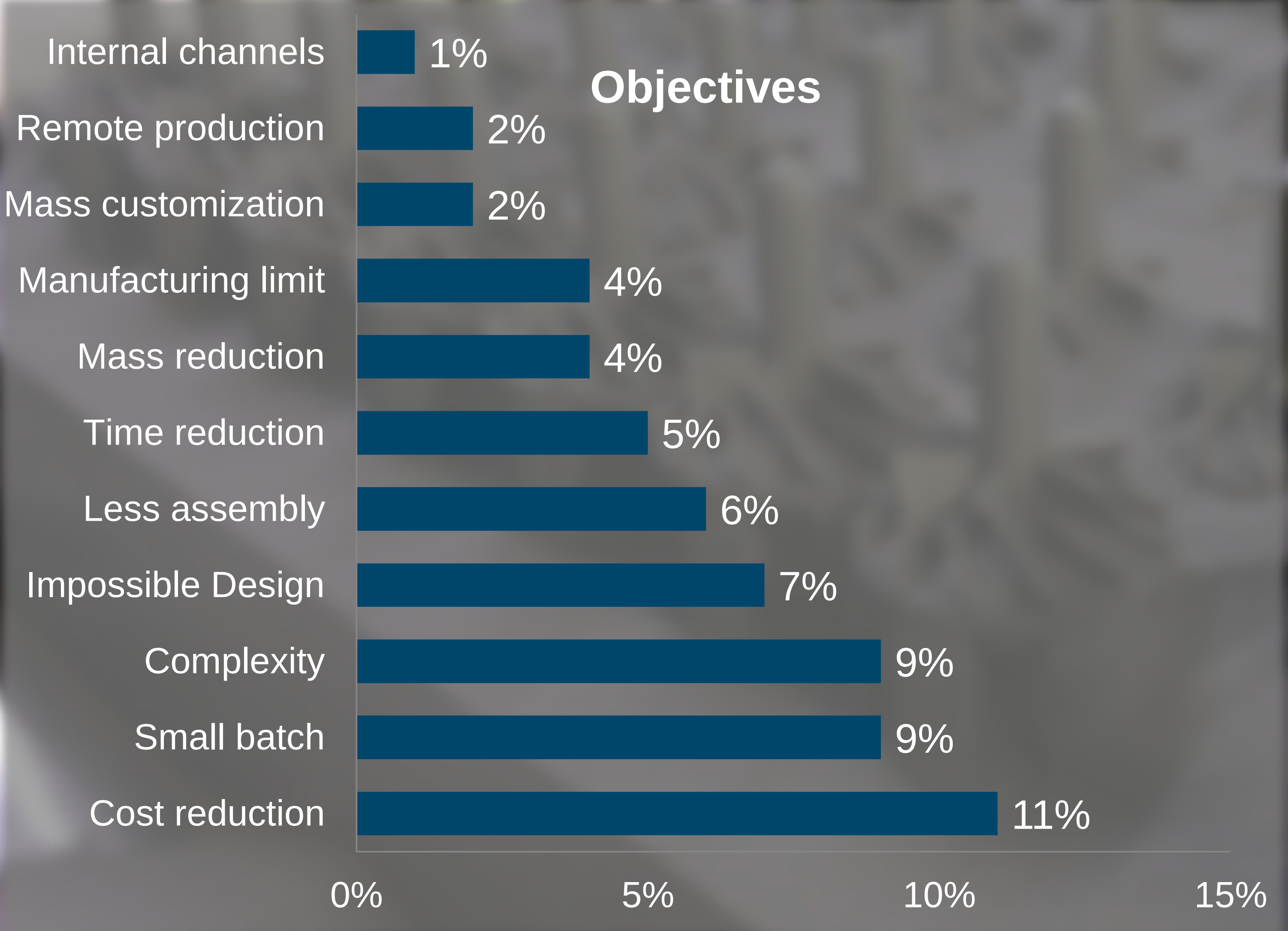
Bold: used with metal

Setting the scene

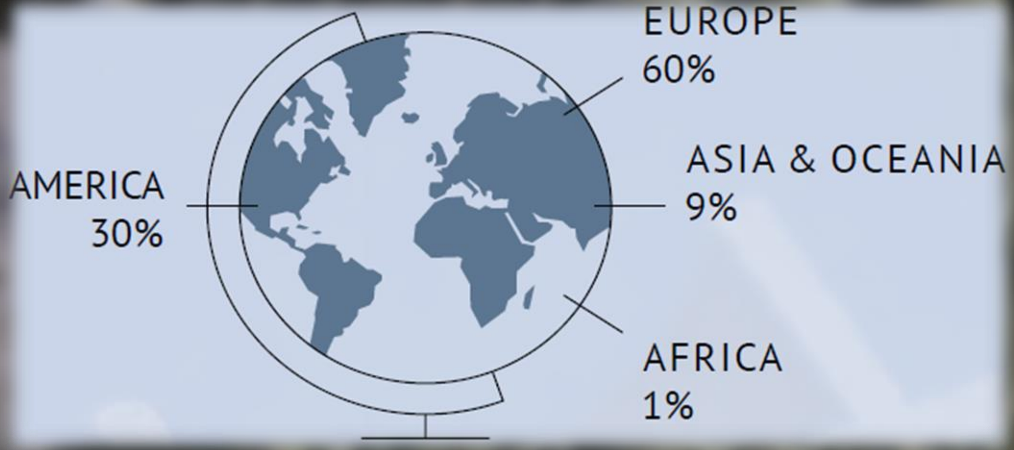
virtual vehicle

- **Binder Jetting**: The binder jetting process uses two materials; a powder based material and a binder. The binder is usually in liquid form and the build material in powder form. A print head moves horizontally along the x and y axes of the machine and deposits alternating layers of the build material and the binding material.
- **Direct Energy Deposition**: Directed Energy Deposition (DED) covers a range of terminology: ‘Laser engineered net shaping, directed light fabrication, direct metal deposition, 3D laser cladding’ It is a more complex printing process commonly used to repair or add additional material to existing components.
- **Material Extrusion**: Fuse deposition modelling (FDM) is a common material extrusion process and is trademarked by the company Stratasys. Material is drawn through a nozzle, where it is heated and is then deposited layer by layer. The nozzle can move horizontally and a platform moves up and down vertically after each new layer is deposited.
- **Material Jetting**: Material jetting creates objects in a similar method to a two dimensional ink jet printer. Material is jetted onto a build platform using either a continuous or Drop on Demand (DOD) approach.
- **Powder bed fusion**: The Powder Bed Fusion process includes the following commonly used printing techniques: Direct metal laser sintering (DMLS), Electron beam melting (EBM), Selective heat sintering (SHS), Selective laser melting (SLM) and Selective laser sintering (SLS).
- **Sheet Lamination**: Sheet lamination processes include ultrasonic additive manufacturing (UAM) and laminated object manufacturing (LOM). The Ultrasonic Additive Manufacturing process uses sheets or ribbons of metal, which are bound together using ultrasonic welding.
- **Vat polymerisation** uses a vat of liquid photopolymer resin, out of which the model is constructed layer by layer. (http://www.lboro.ac.uk/research/amrg/about/the7categoriesofadditivemanufacturing/)

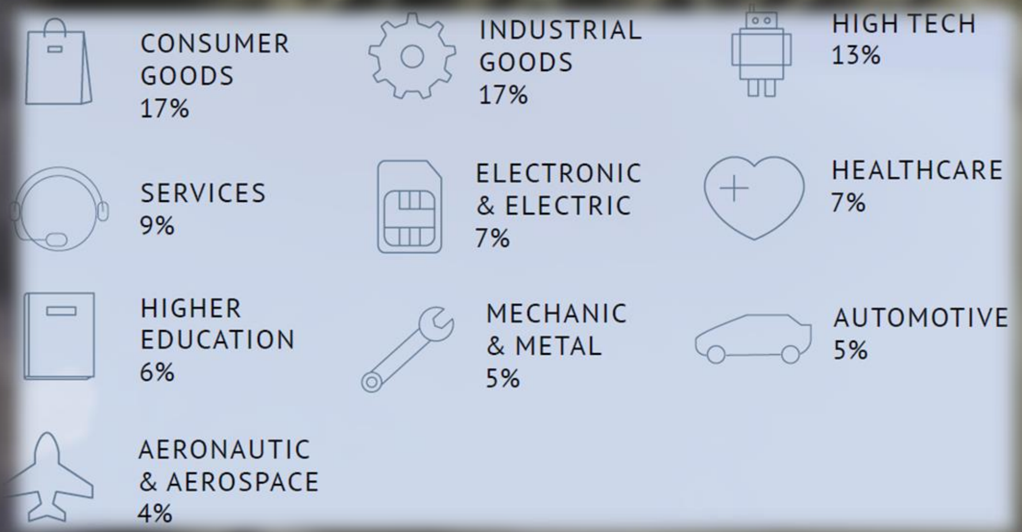
The state of AM – in general



Demographics
900+ respondents



Vertical Markets



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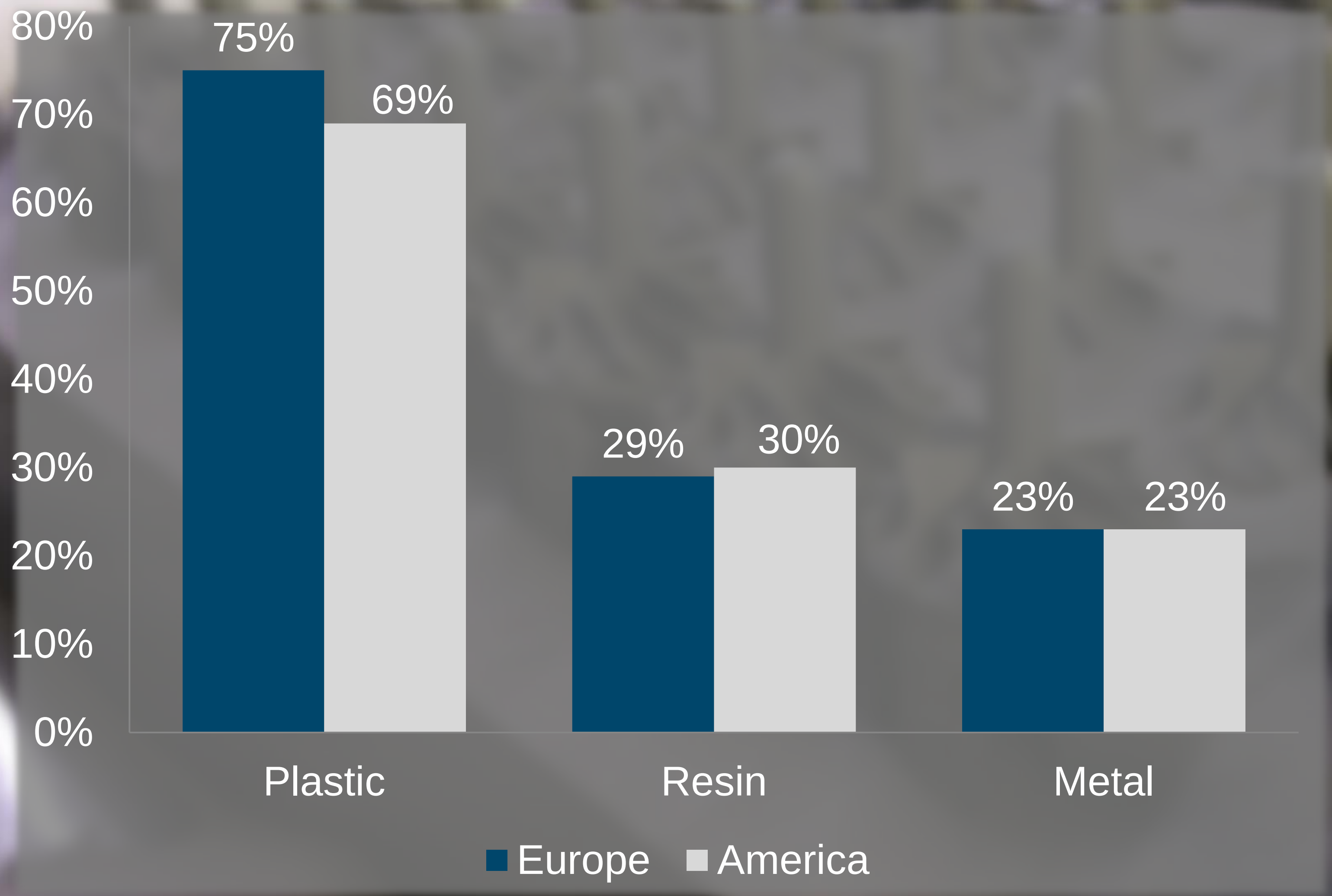
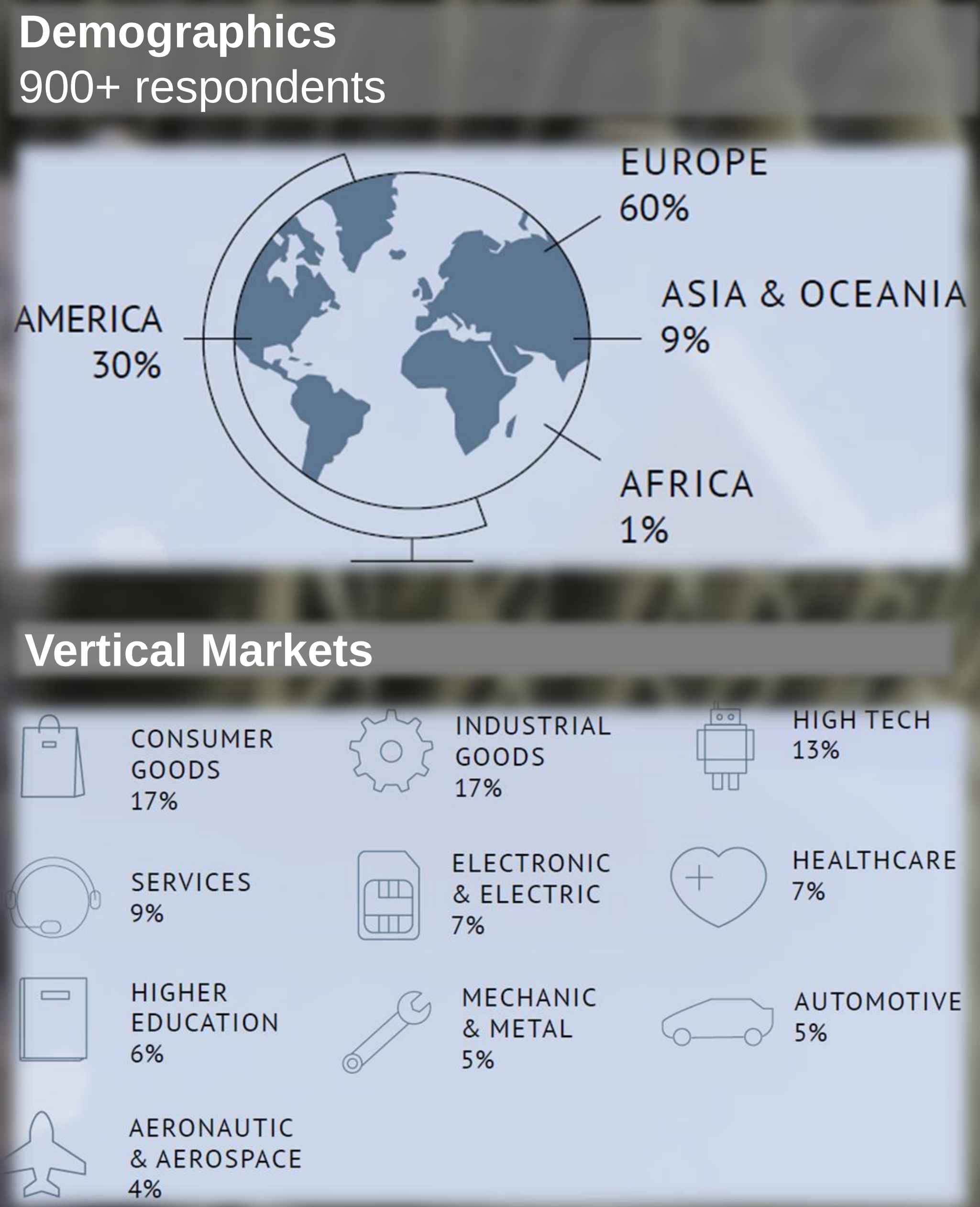
The state of AM – in general





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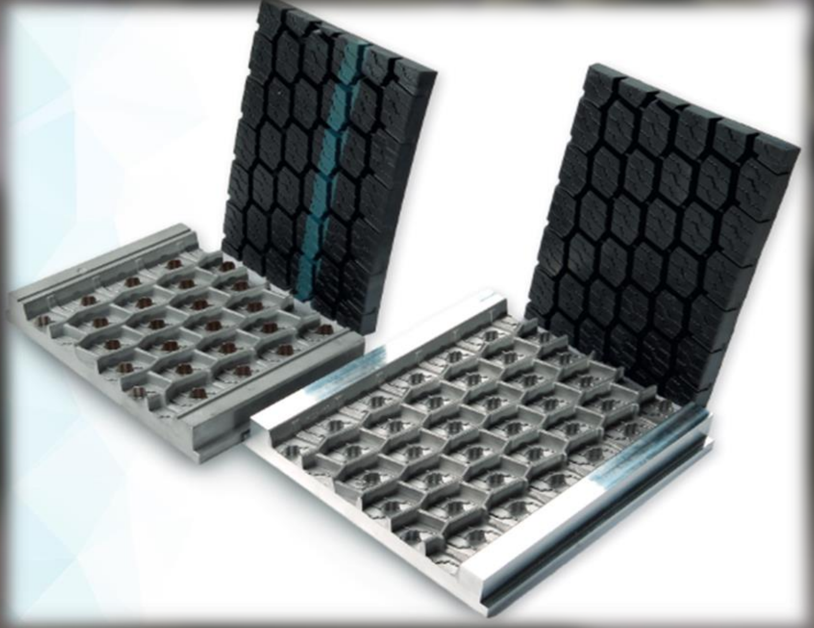
Applications – automotive

Housing and Bracket of Front-Axis-Differential

Turbocharger



Tire Molds

Transmission Plate

Applications – automotive

SLM Solutions Group

- has exposure to attractive end markets and has longstandig relationships with blue chip customers
- The market continues the shift from rapid prototyping to industrial applications
- is well positioned to capitalise on this trend given SLM Solutions‘ technology and customer base

Core industries:
Medical, dental, aerospace, automotive, tooling, energy

Printing metals

Introduction:

Materials, too then, are another aspect of car design and production that 3D printing will change. The aerospace industry, which like the automotive industry needs long-term reliable parts, has already begun that change. Kawola noted that because aerospace is an industry which makes lower volumes in terms of units, companies have been able to innovate on 3D printers before now. “Aerospace very much values the benefits 3D printing can bring, especially when it comes to designing things that are lighter weight,” he said, noting that companies typically only make a few dozen new planes a year, as opposed to hundreds of thousands of cars the automotive industry churns out.

https://eu.mouser.com/applications/3d-printing-change-auto-design/

Printing metals

virtual vehicle

	62% Al-Alloys	2% Co-Alloys	2% Ni-Alloys	8% Ti-Alloys	26% Tool Steel/ Stainless steel
Material Properties	• Light weight • Good alloying properties • Good processability • Good electrical conductivity	• High toughness • High strength • Good bio-compatibility • Good corrosion resistance	• High corrosion resistance • Excellent mech. Strength • High creep rupture strength up to 700°C • Outstanding weldability	• High strength, low weight • High corrosion resistance • Good bio-compatibility • Low thermal expansion • Good machinability	• High hardness and toughness • High corrosion resistance • Good machinability

Printing metals

virtual vehicle

	62% Al-Alloys	2% Co-Alloys	2% Ni-Alloys	8% Ti-Alloys	26% Tool Steel/ Stainless steel
Appli-cations	• Aerospace • Automotive • General industrial applications	• Dental • Medical implants • High temperature	• Aerospace • Gas turbines • Rocket motors • Nuclear reactors • Pumps • Turbo pump seals • Tooling	• Bio-material for implants • Aerospace • F1 motor sport • Maritime applications	• Plastic injection and dicasting moulds • Medical implants • Cutlery and kitchenware • Maritime • Spindles and screws

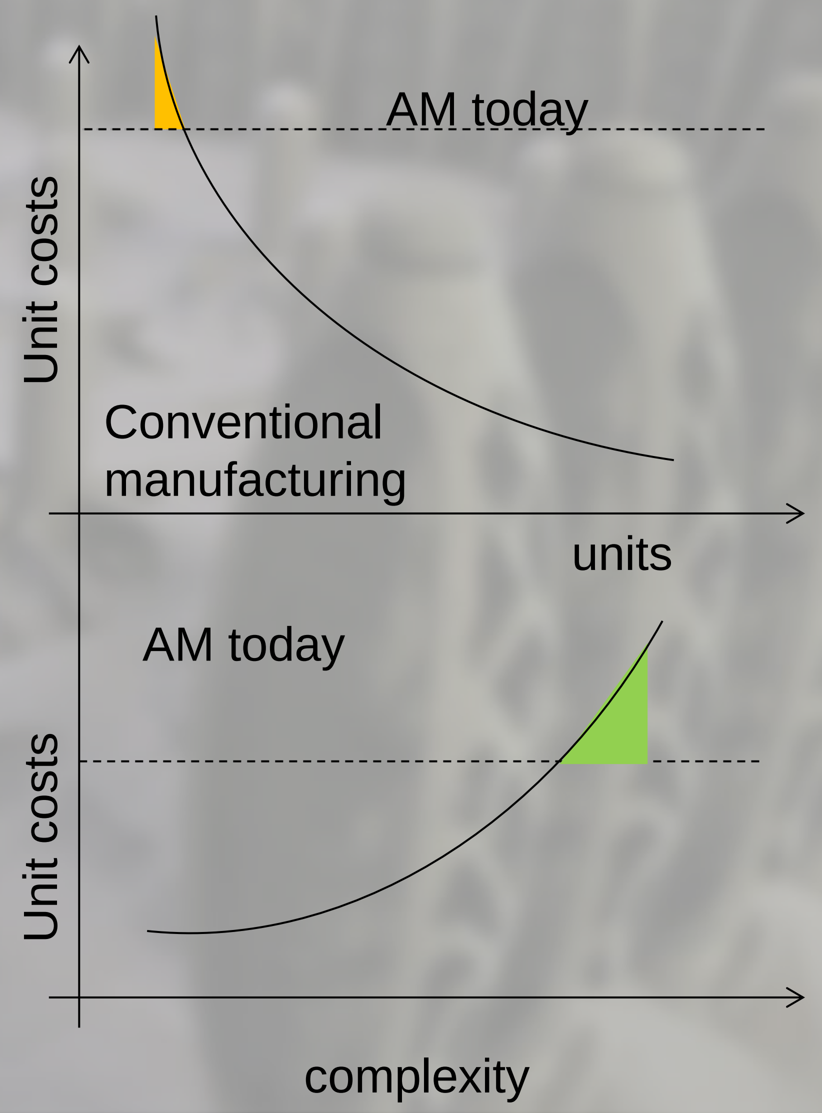
3D metal printing

virtual vehicle

Advantages:

- New geometric designs
- Individual components (mass-customization)
- Spare parts on demand
- Parallel manufacturing of different components
- Low maintenance costs
- „toolless“ production
- Possible reduction of stock costs

The gap needs to be closed: Unit costs should decrease, unit costs/complexity should be decreased
Only then 3D printing is financially more attractive

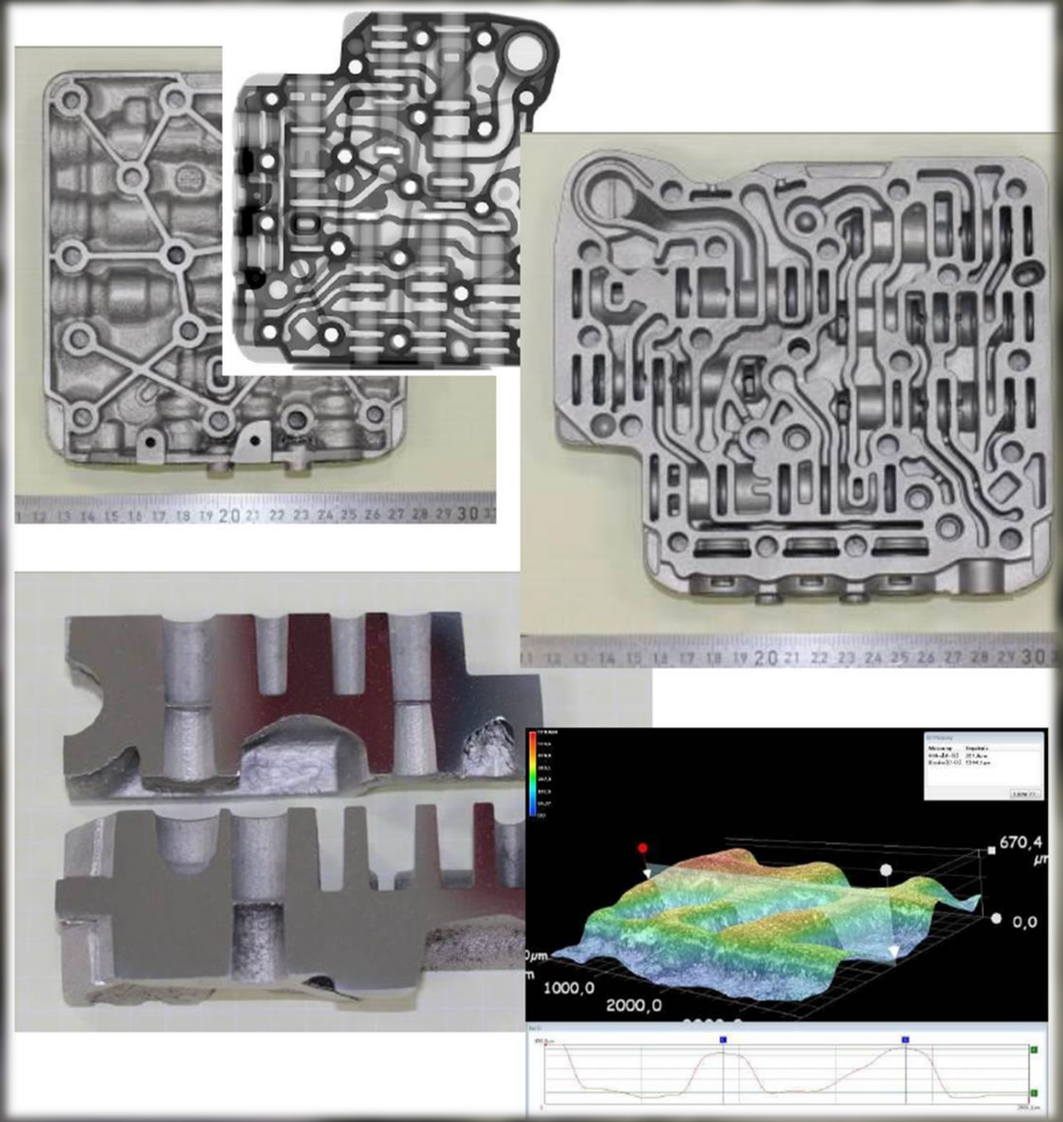


Applications - automotive

virtual vehicle

Transmission Plate

- Material: AlSi9Cu3
- Weight: 930g
- Building-time: 19h 25min
  - ✓ Surface roughness
  - ✓ Surface flatness < 0,4
  - ✓ Tolerances < +/- 0,2
  - ✓ X-ray analysis
  - ✓ Density
  - ✓ Hardness
  - ✓ Tensile strength



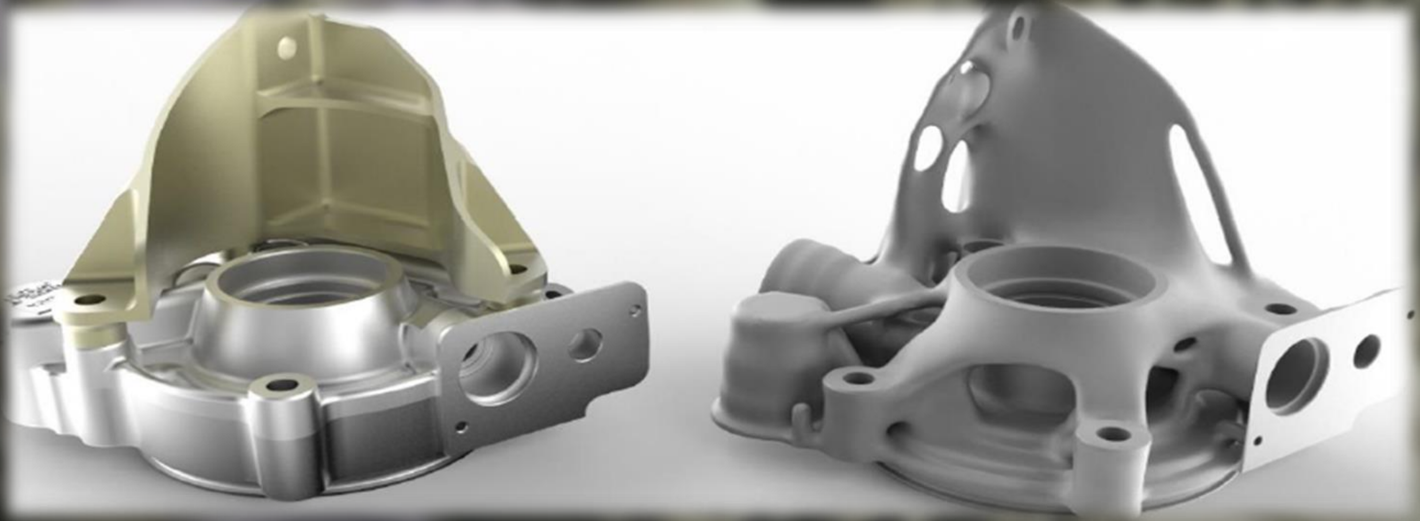
Applications - automotive

virtual vehicle

Housing and Bracket of Front-Axis-Differential

- ✓ Up to 1 year reduction in development time
- ✓ Flexible design changes – minimal hard tooling
- ✓ Vehicle structure weight reduced by > 50%
- ✓ Part count lowered by > 75%

Current 2 piece design Weight: 2,328 kg	**New 1 piece Bionic-design** Weight: 1,171 kg



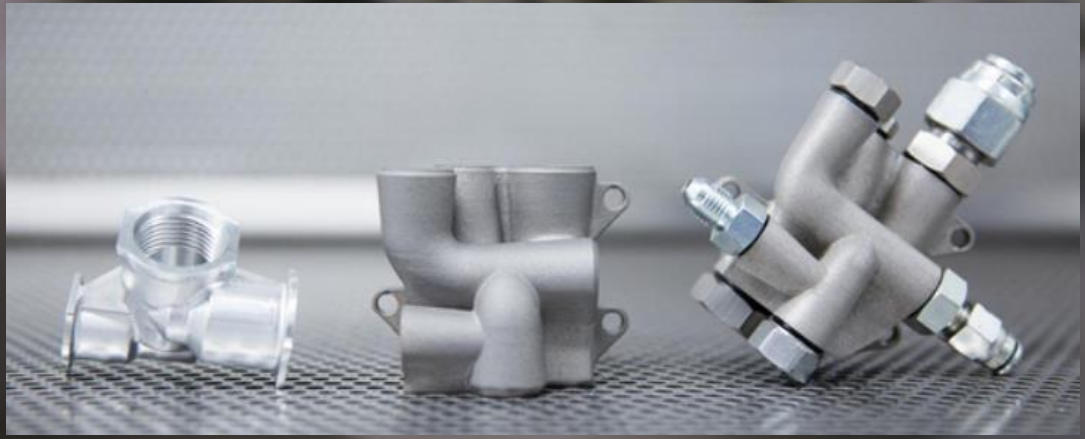
- 50,3 %

Applications - maritime

virtual vehicle

Submarine prototype for the U.S. Navy

Yacht Livrea



Spare parts for nautical racing

Boat propeller

https://www.3dnatives.com/en/3d-printing-maritime-applications230820174/

Applications - maritime

Submarine Prototype: 3D printing and the U.S. military are starting to become very good friends, such as seen with a recent collaboration between the Oak Ridge National Laboratory and the U.S. Navy, which saw the creation of a submarine hull prototype in only 4 weeks! In order to achieve such a big feat, the partners used the Big Area Additive Manufacturing technology (BAAM) to create the 30 foot, 6 carbon fiber composite material sections.
Because the cost of manufacturing a typical submarine hull is usually between $600,000 and $800,000 with building taking around 3 to 5 months to complete, it is expected that 3D printing will help to reduce these costs by 90%!

Boat Propeller: One of the great maritime applications of 3D printing this year was developed by Damen Shipyards Group, RAMLAB, Promarin, Autodesk and Bureau Veritas; companies who teamed up to print a premium boat propeller. WAAMpeller is the name of this new propeller, which is being designed to adapt to the Damen Stan Tug 1606 boat models.
The propeller, which weighs approximately 180 kg and measures 1,300 mm in diameter, will be printed from a bronze alloy using the WAAM (Wire Arc Additive Manufacturing) process. Subsequently, it must undergo numerous tests, including crash tests, in order to obtain certification. In May, the first prototype of the propeller was introduced and is expected to be tested in the coming months.

https://www.3dnatives.com/en/3d-printing-maritime-applications230820174/

Food for thought…

Mass-customization

Mini offers 3D printed car accessories for new levels of customization in 2018: ***Mini Yours***

MINI Yours, which is slated to launch in the UK in March 2018, will offer customization features such as side scuttles, interior trims, illuminated door sills, LED door projectors, and more. According to MINI, its clients will be able to select and personalize their car's features using a simple online tool.

https://3dprint.com/198469/mini-yours-customised-products/

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VIRTUAL VEHICLE Research Center is funded within the COMET – Competence Centers for Excellent Technologies – programme by the Austrian Federal Ministry for Transport, Innovation and Technology (BMVIT), the Federal Ministry of Science, Research and Economy (BMWFW), the Austrian Research Promotion Agency (FFG), the province of Styria and the Styrian Business Promotion Agency (SFG). The COMET programme is administrated by FFG.

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