

Successful business models with 3D printing

What does the technology really mean for the market?



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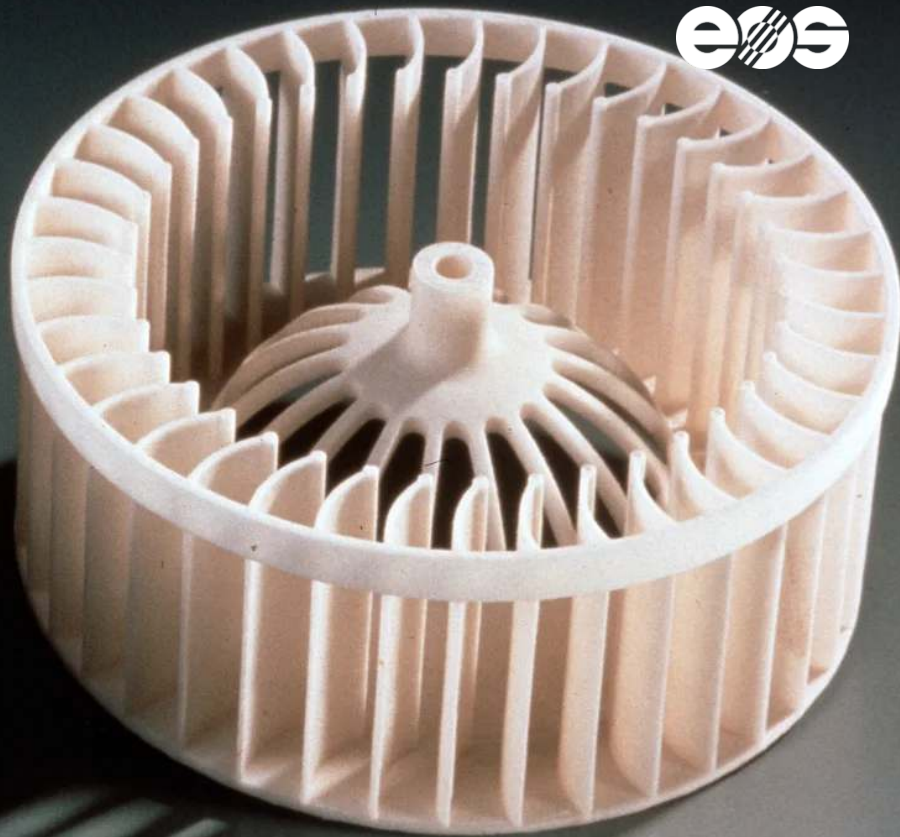
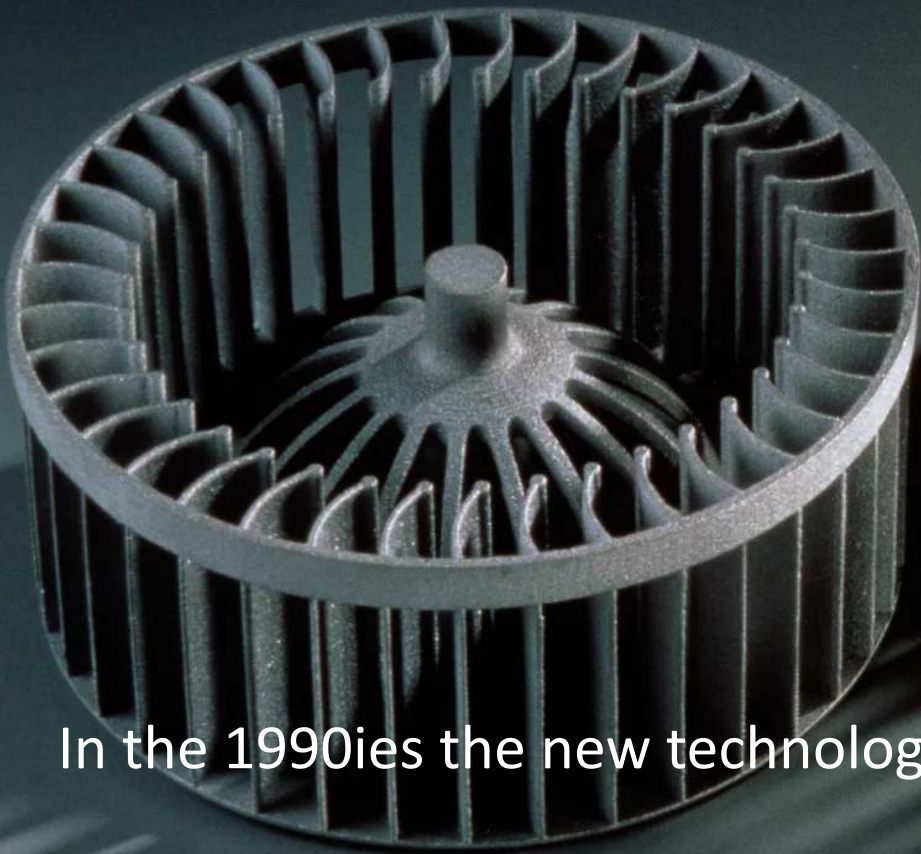
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3D Printing – A Star is Born



Dr. Hans J. Langer in 1989,
Pioneer of 3D Printing,
Founder of EOS.

3D Printing – A Star is Born



In the 1990ies the new technology was relevant for prototyping only

3D Printing – A Star is Born

A violin
3D printed
by enthusiastic
engineers at EOS



3D Printing – A Star is Born



February 2011

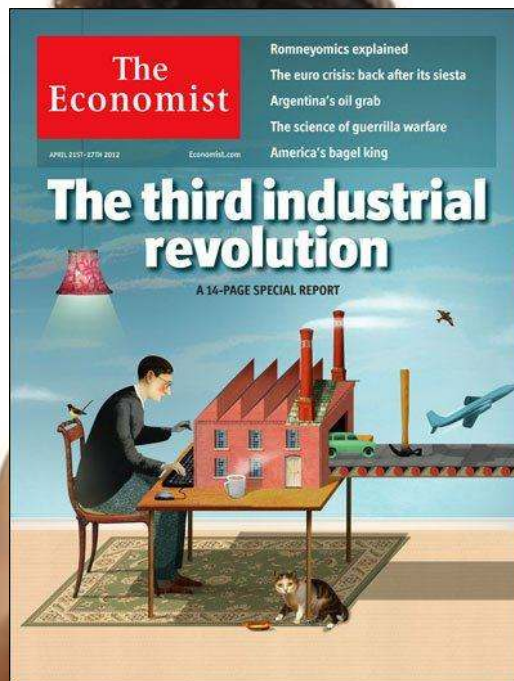


A violin
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3D Printing – A Star is Born



February 2011



April 2012

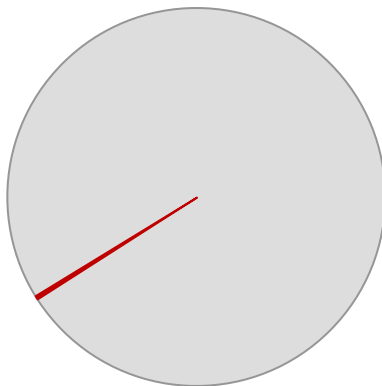


November 2012 The Economist

The hype is over! Welcome to reality!

US\$ 12,000,000,000,000 (Trillion)

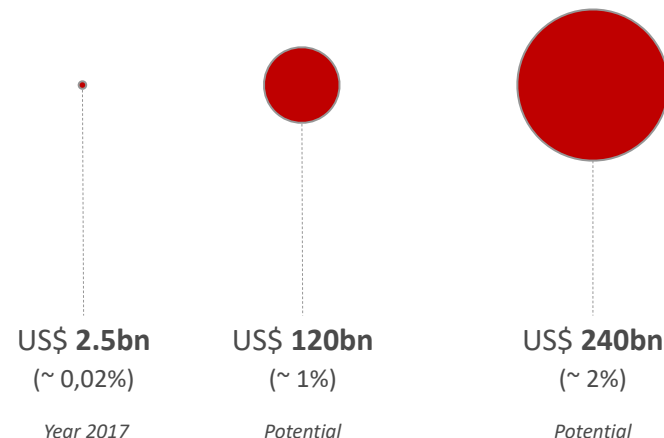
Market Size
Global Manufacturing
Industry



Market Size
Global 3D Printing
Industry

US\$ 2,500,000,000 (Billion)

Current and Potential
Global 3D Printing
Market Size



Is 3D Printing really so special?

Typcial Claims

- Distributed manufacturing still, minimum cost needs 24/7 production
- Supply chain simplification complex assemblies don't just *print*
- Digital manufacturing every machine can be computer controlled
- Freedom of design sure, but who will pay for it?
- Customization who needs it?

The Sceptic's Voice

Fact is, many people are extremely successful with it



Fact is, many people are extremely successful with it

1998

- Core business additive manufacturing
- 1 industrial polymer 3D printer from EOS



2020

- 21 polymer, 28 metal industrial 3D printers
- 280 employees in 7 sites



Siemens has invested Millions in the technology



Siemens has invested Millions in the technology

2014

- Idea of repairing gas burner tip
- Initial investments

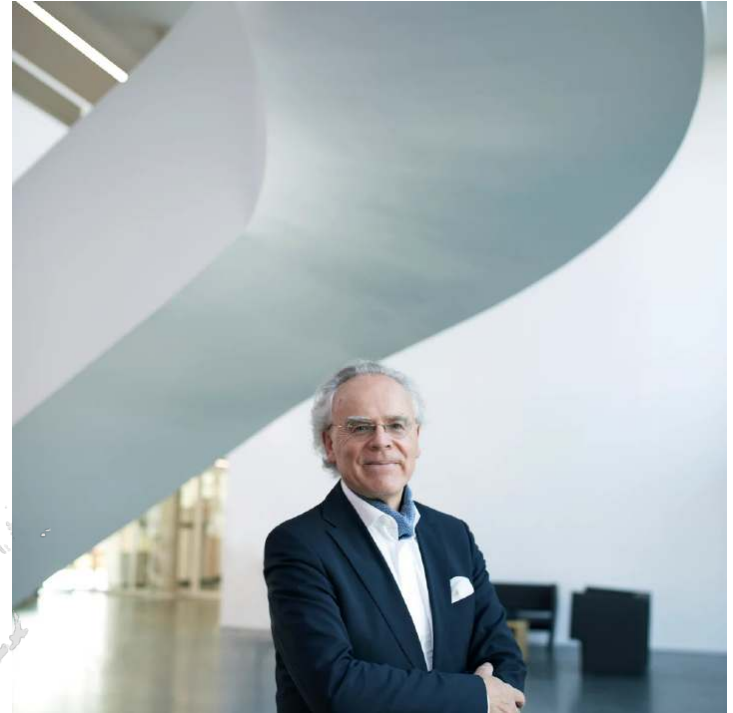
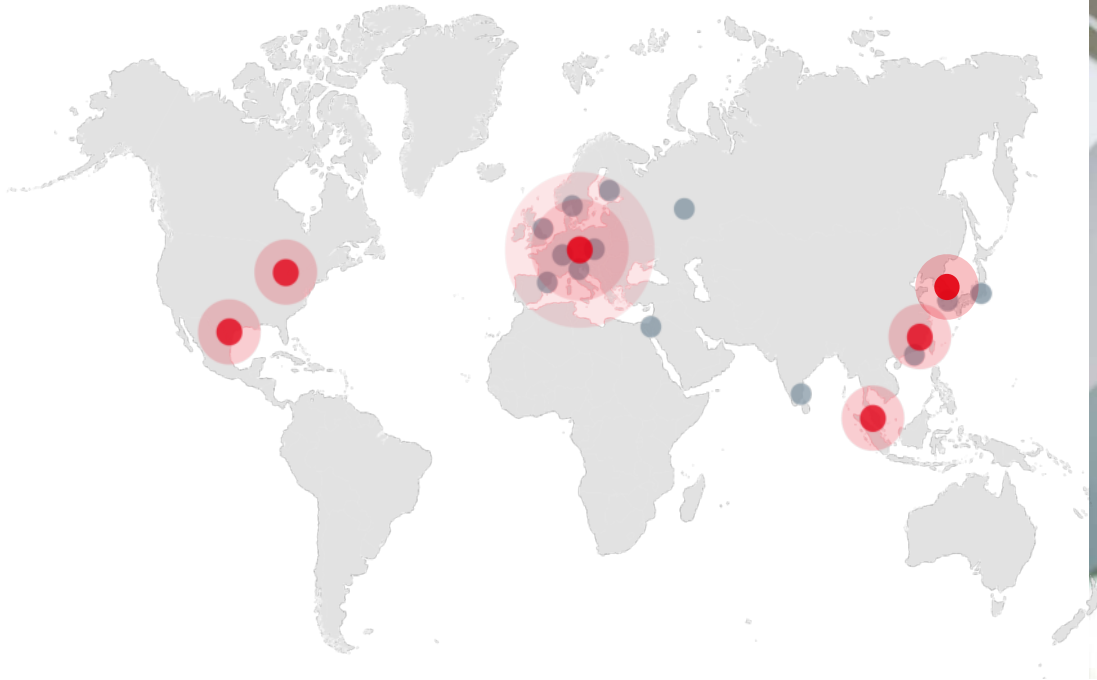


2020

- Extended operations and re-invented burner
- Targeting other parts, e.g. turbine blades



We only grew because our customers were so successful!



How to build a successful business with 3D Printing?

Where 3D Printing really makes a difference!

New design
possibilities

Waste disposal sites emit gases that need to be managed

waste disposal sites



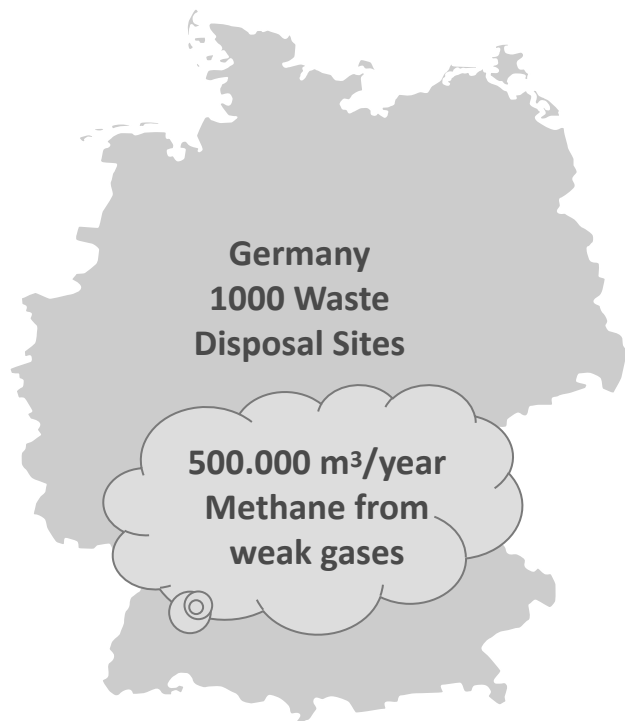
- Emissions due to decomposition of organic components
 - Gases with high level on Methane concentration that are easy to convert into energy
 - Gases with low concentration of methane called „weak gases“

weak gases



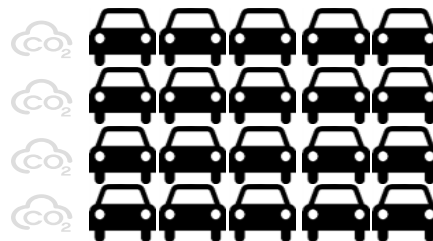
- Contain low concentrations of Methane
- Are released over long period of time in large amounts
- Are difficult to convert into energy - no universal and reliable solution yet
- **Have a high impact on climate**

Weak gases have a significant climate impact



If released

=

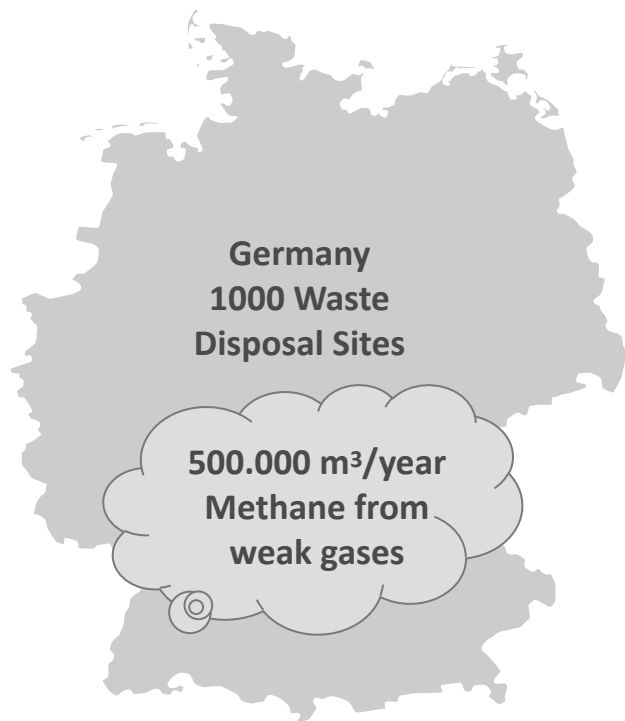


6.000.000 mid size cars⁽¹⁾

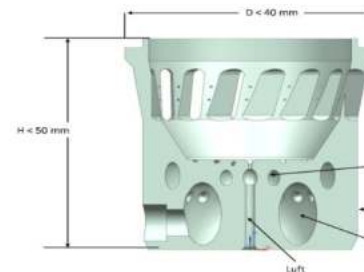


(1) Gasoline Consumption: 4l/100 km; 15.000 km/year

Weak gases have a significant climate impact



can now be
 converted
 into energy



Previously impossible design.
 Now additive manufacturing!

(2) Average household with 4 people; Energy consumption of 5.000 kWh/year

Where 3D Printing really makes a difference!

New design possibilities

- key: technology leadership -

Current limit of design possibilities: it's us!

The future:

Computer generated design.

Example:

Rocket engine by Hyperganic software
and built on EOS M290 system



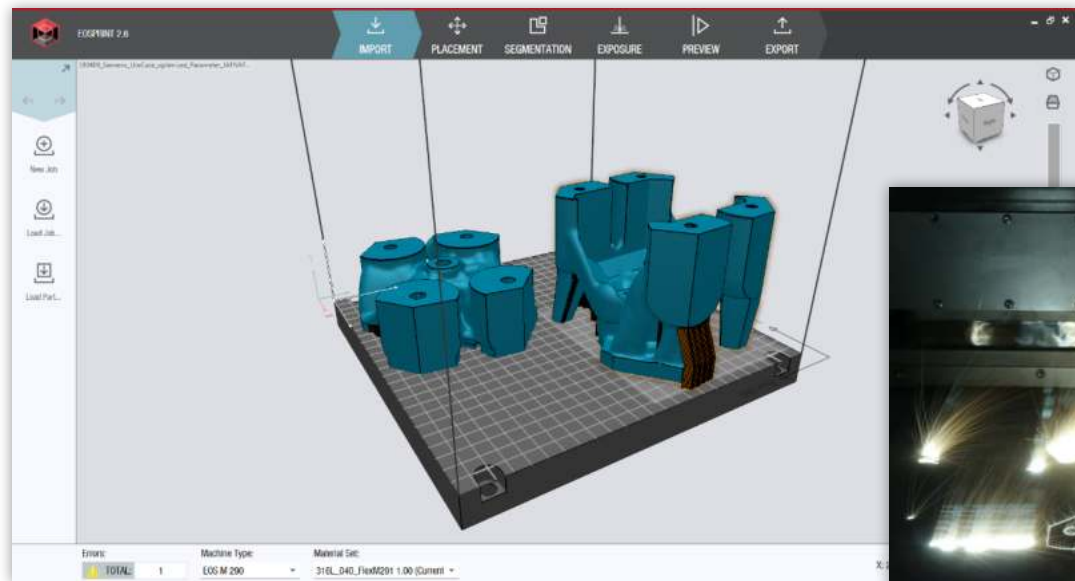
Where 3D Printing really makes a difference!

**New design
Possibilities**

- key: technology leadership -

**Fully digital
from CAD to physical part**

Mixed batch production from CAD to Part



Initial gain often speed and agility in R&D and fast piloting



Example:

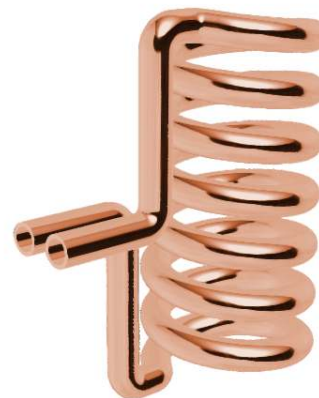
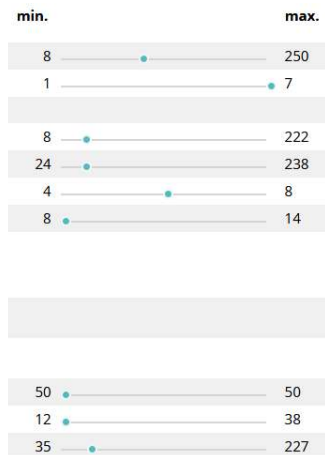
Protiq started with prototyping applications, one specialty is inductors

Digital production chain can improve customer intimacy

Inductor-Configurator

Select the desired basic form and configure it according to your requirements

Geometries



Where 3D Printing really makes a difference!

**New design
Possibilities**

- key: technology leadership -

**Fully digital
from CAD to physical part**

- key: closer to your customers -

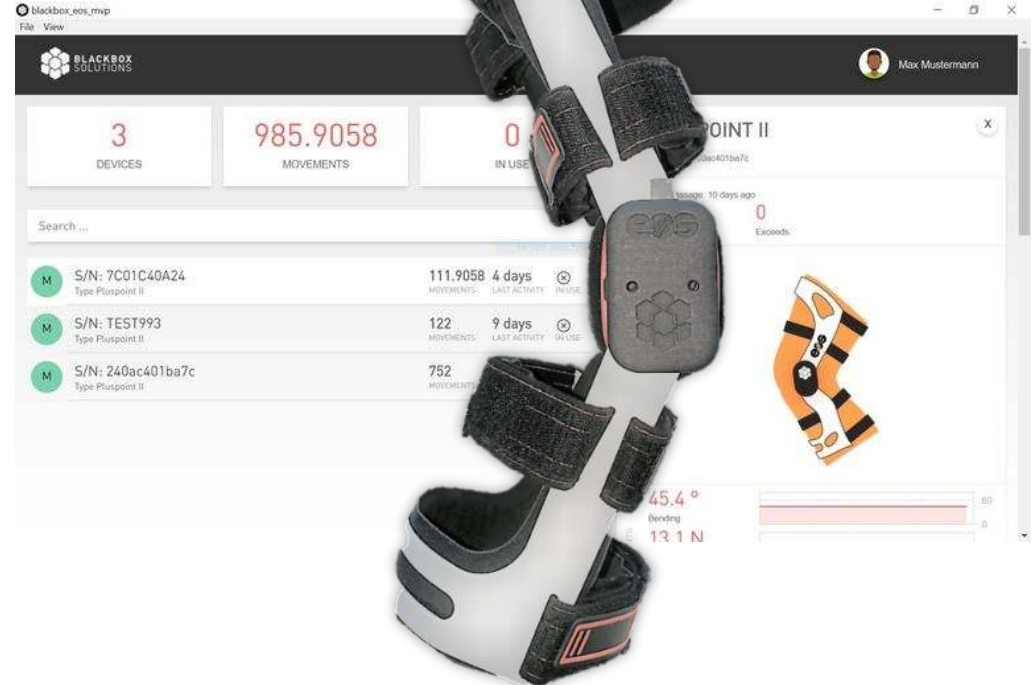
How could „digitalized products“ look like?

The future:

Products develop from experience

Example:

Sensor give feedback on usage,
could translate into improved product,
manufactured by flexible EOS technology



Where 3D Printing really makes a difference!

**New design
Possibilities**

- key: technology leadership -

**Fully digital
from CAD to physical part**

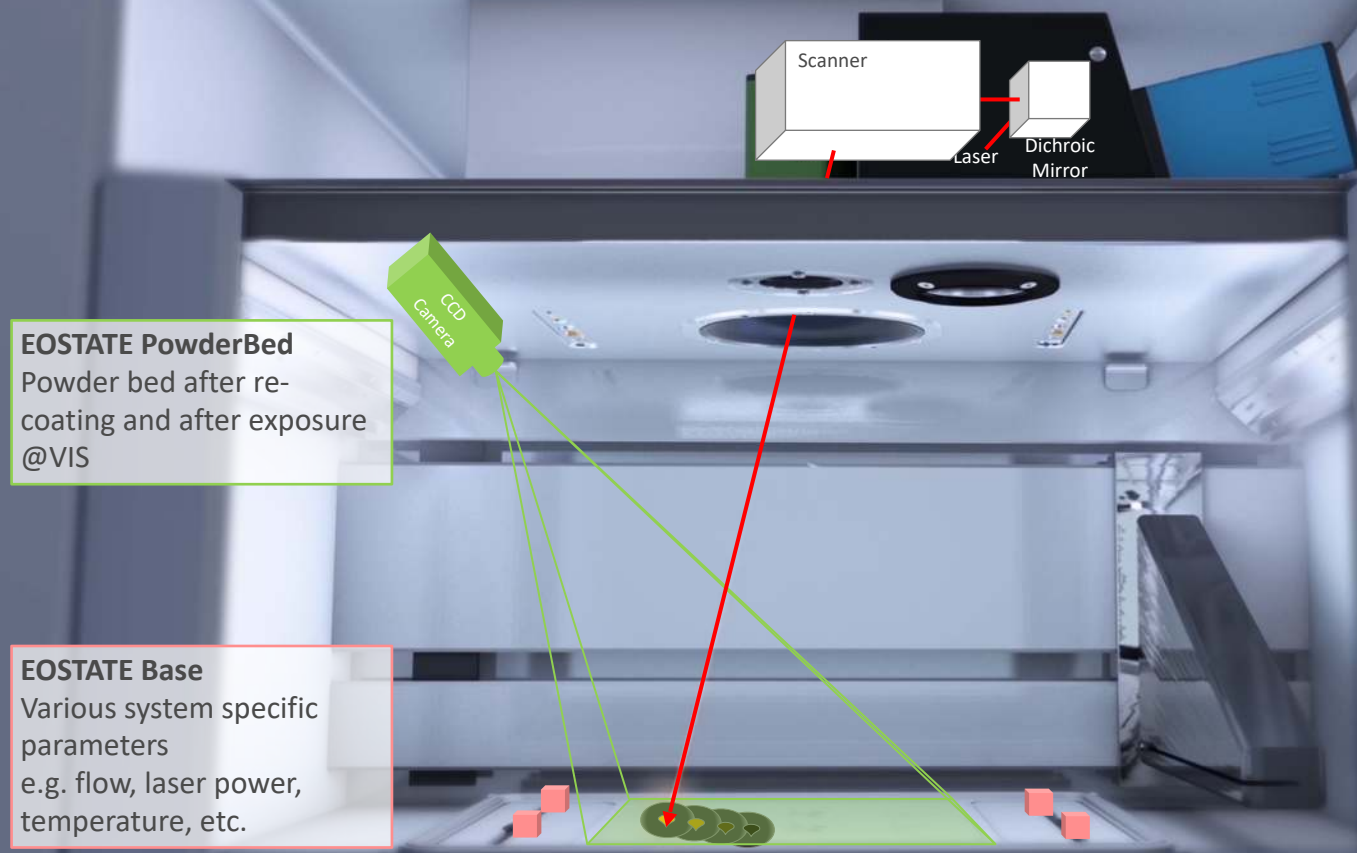
- key: closer to your customers -

**Looking inside the part
while it builds**

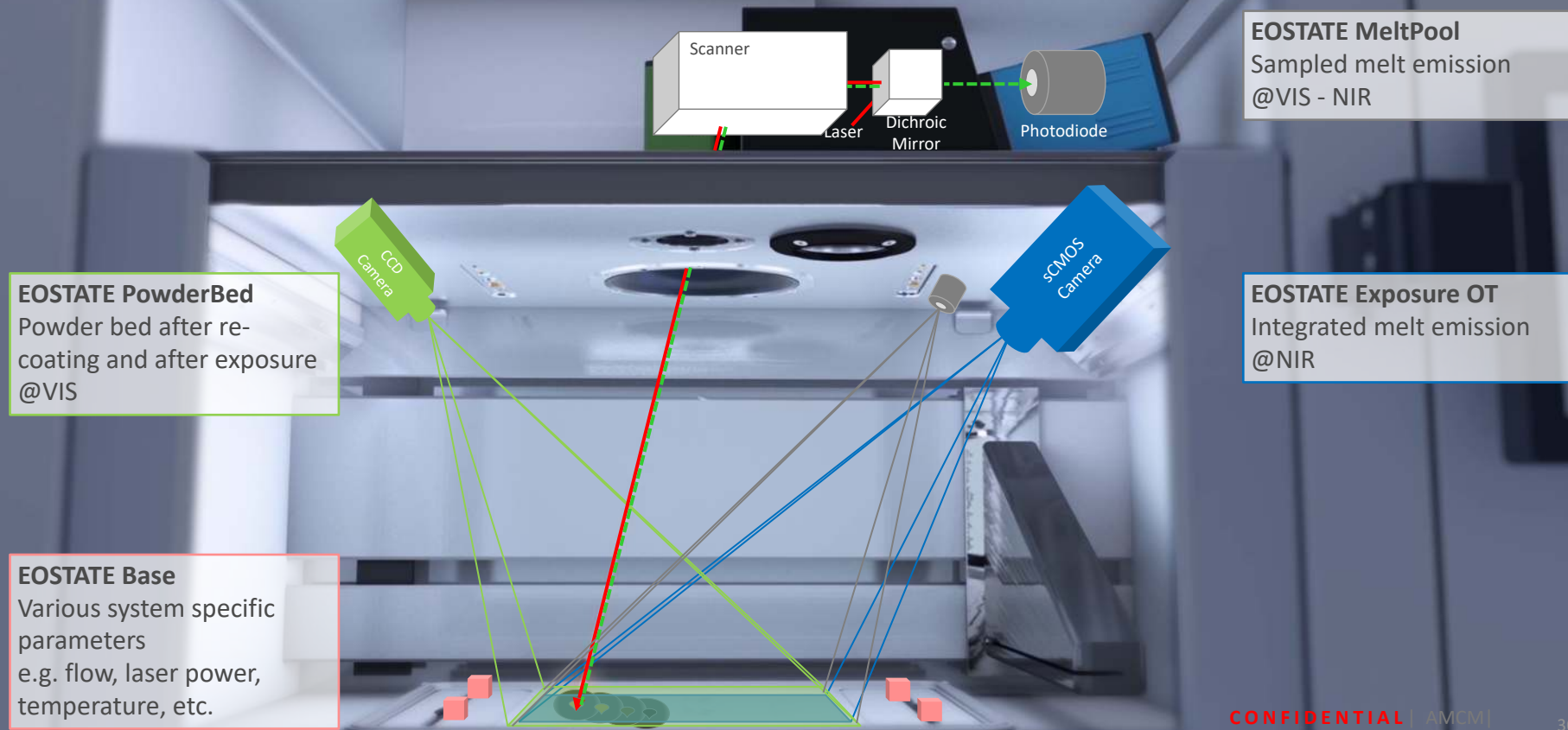
Four different monitoring tools in EOS systems



Four different monitoring tools in EOS systems



Four different monitoring tools in EOS systems

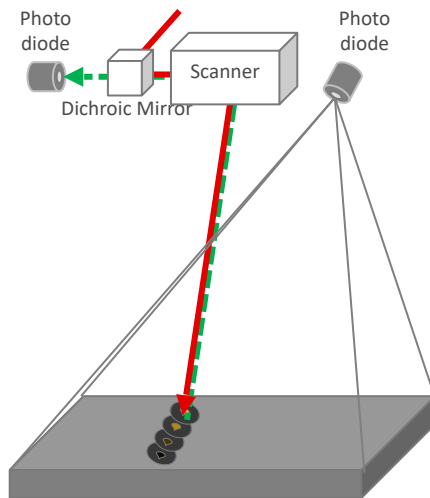


EOSTATE MeltPool Monitoring



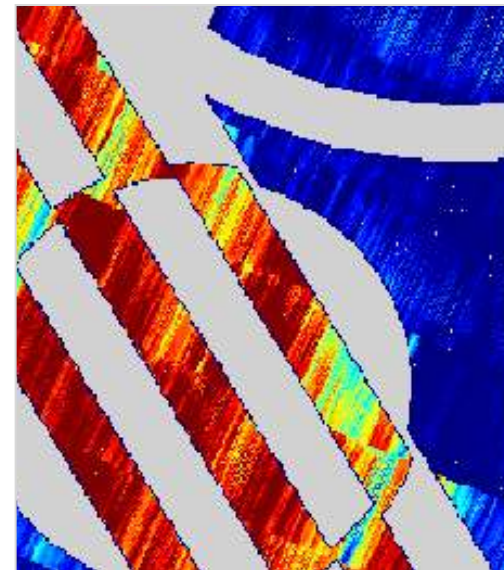
Short time measurement of emissions

→ blink of an eye



Thermal emission back-propagation and reference signal

→ using optical path



Displaying sequential melt pool information

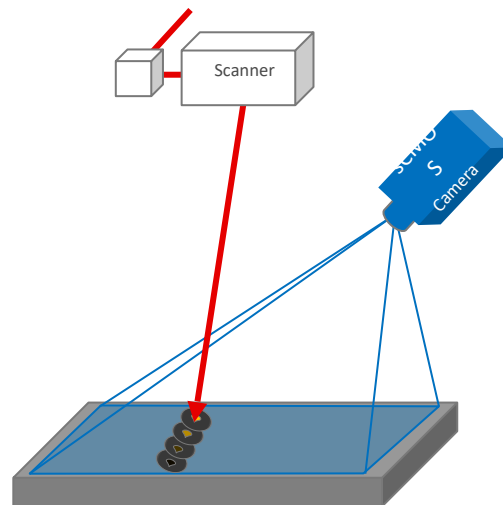
→ melt pool

EOSTATE Exposure OT



Long time exposure of
urban traffic

→ traffic volume



Measurement of radiance over time
for each pixel

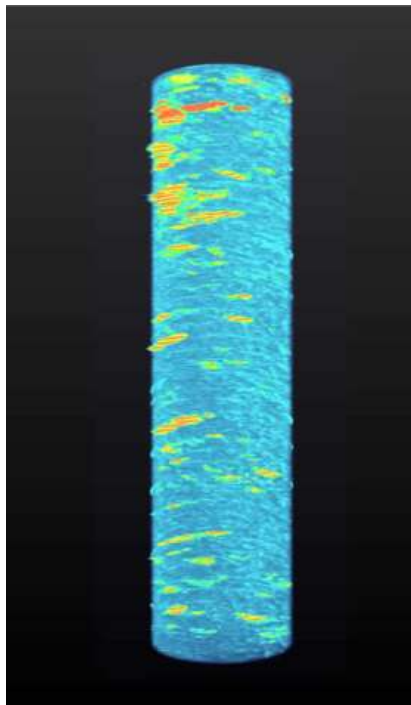
→ independent from beam path



Long time exposure in
additive manufacturing

→ amount of heat

Airbus A320neo boroscope manufacturing by MTU



Benefits

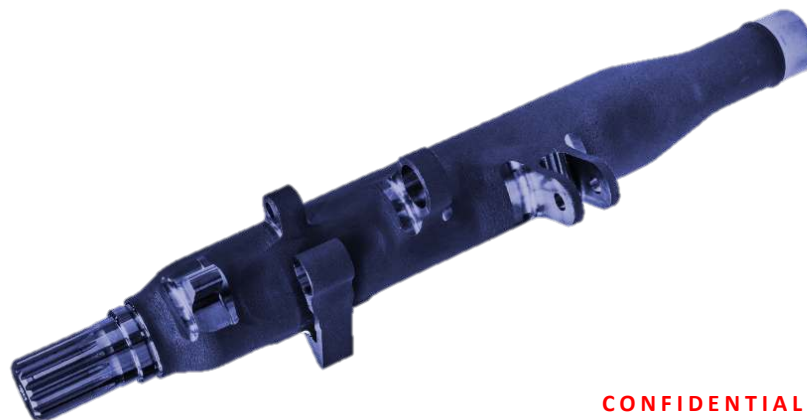
- 100% insight into the part
- part specific quality assurance
- X-Ray inspections completely removed
- detect scrap earlier

Airbus A350 XWB latch shaft manufacturing by Airbus



Benefits

- 10 traditional parts → 1 AM part
- 28 parts with 1 print job
- Reduced overall qualification effort



Where 3D Printing really makes a difference!

New design Possibilities

- key: technology leadership -

Fully digital from CAD to physical part

- key: closer to your customers -

Looking inside the part while it builds

- key: quality leadership -

Additive manufacturing is calling for the „digital twin“

The future:

Full interaction of simulation, sensing and reality

Example:

Amphyon software already predicts build process,
today we check and improve manually,
but the future could close the loop digitally



Where 3D Printing really makes a difference!

**New design
Possibilities**

- key: technology leadership -

**Fully digital
from CAD to physical part**

- key: closer to your customers -

**Looking inside the part
while it builds**

- key: quality leadership -

**Material properties
emerge for each spot**

Amorphous metals without size limitations

Most Metals



Crystalline structure

- Dislocations lead to permanent deformation
- Grain boundaries are weak spots

Metallic Glass



Amorphous structure

- Dislocations rebound elastically to initial shape
- Resistant to corrosion and wear

Additive Manufacturing



Partnering companies



AM VENTURES

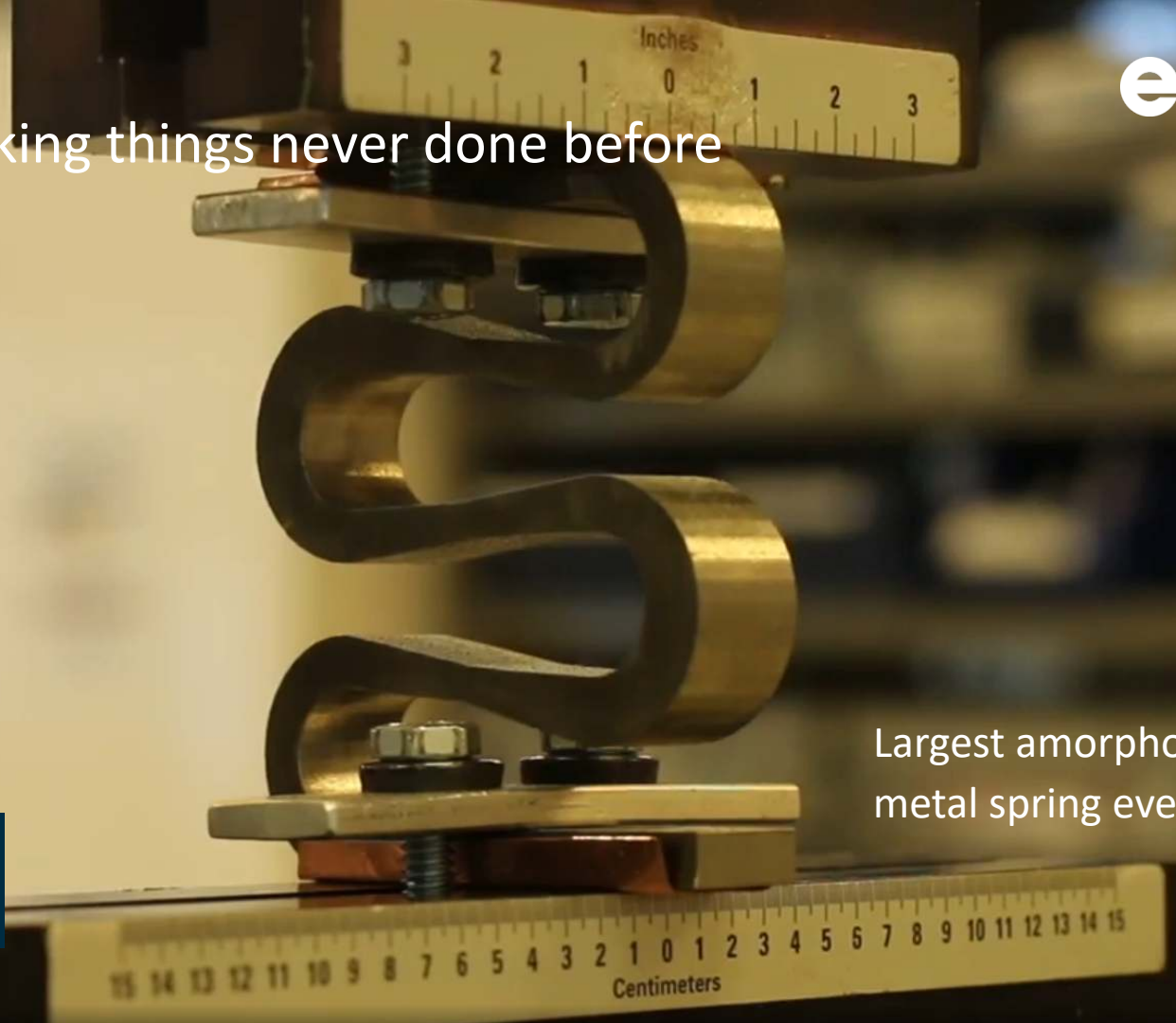


Blue Ocean: making things never done before

Heraeus

exmet

Largest amorphous
metal spring ever made



3D Printed Bridge - A Star is Born After All

Nik Huber Guitars:

"3D-printed amorphous metals are a promising material for guitar building because of their unique properties. Especially in our conservative guitar market, it is important to be open for further developments, but also for new materials and technologies."



NIK HUBER

GUITARS

Heraeus

Where 3D Printing really makes a difference
...and how to build a business on that!

New design Possibilities

- key: technology leadership -

Fully digital from CAD to physical part

- key: closer to your customers -

Looking inside the part while it builds

- key: quality leadership -

Material properties emerge for each spot

- key: blue ocean -

The one thing you cannot do,
no matter how rigorous your analysis or heroic your imagination,
is to make a list of things you never thought of.

- Thomas Schelling

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