Additive manufacturing

Antti Salminen

20.11.2020

Aamukahvit proffan johdolla -seminaarisarja

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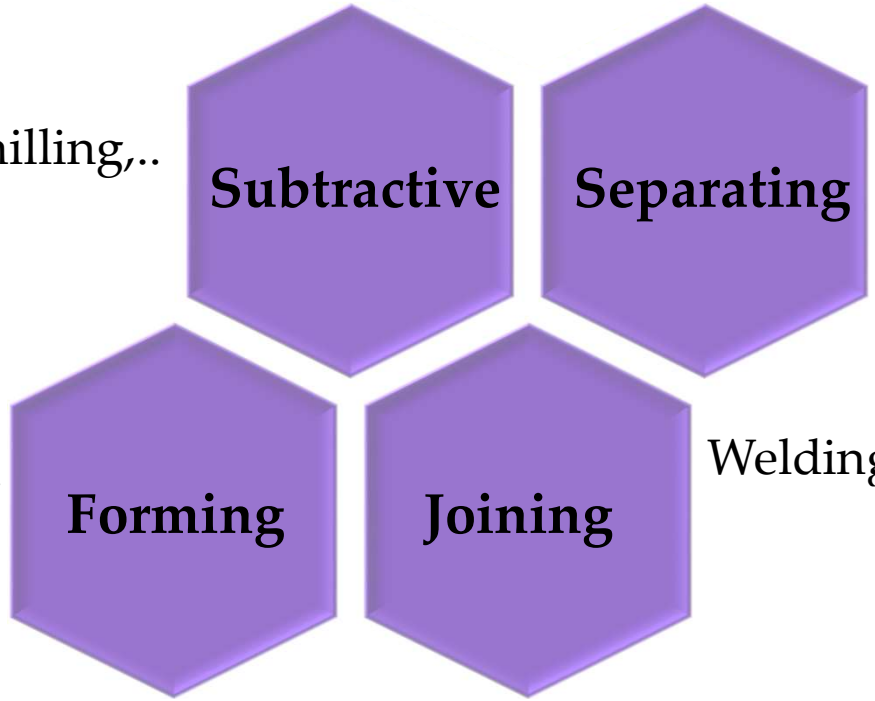
Material processing categories

Machining, drilling, milling,..

Oxygen cutting, sawing,…



Casting, forging, hardening,…

Welding, brazing, riveting…

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Terminology

ISO/ASTM 52900:2015 Additive manufacturing — General principles — Terminology

3D printing:

- Manufacturing of objects through the deposition of a material using a print head, nozzle, or another printer technology.
- Term has in particular been associated with machines that are low end in price and/or overall capability.

Additive manufacturing, AM

- process of joining materials to make parts from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing and formative manufacturing methodologies.

Suggestion is to use word **additive manufacturing** about industrial fabrication of this technology!

https://www.iso.org/standard/69669.html

ISO/ASTM 52900:2015

AM Technologies / Processes

1. Binder jetting
2. Directed energy deposition
3. Material extrusion
4. Material jetting
5. Powder bed fusion
6. Sheet lamination
7. Vat photopolymerization

https://www.iso.org/standard/69669.html

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2012

- Additive manufacturing got the media attention

THE WALL STREET JOURNAL.

SCIENTIFIC AMERICAN

Forbes

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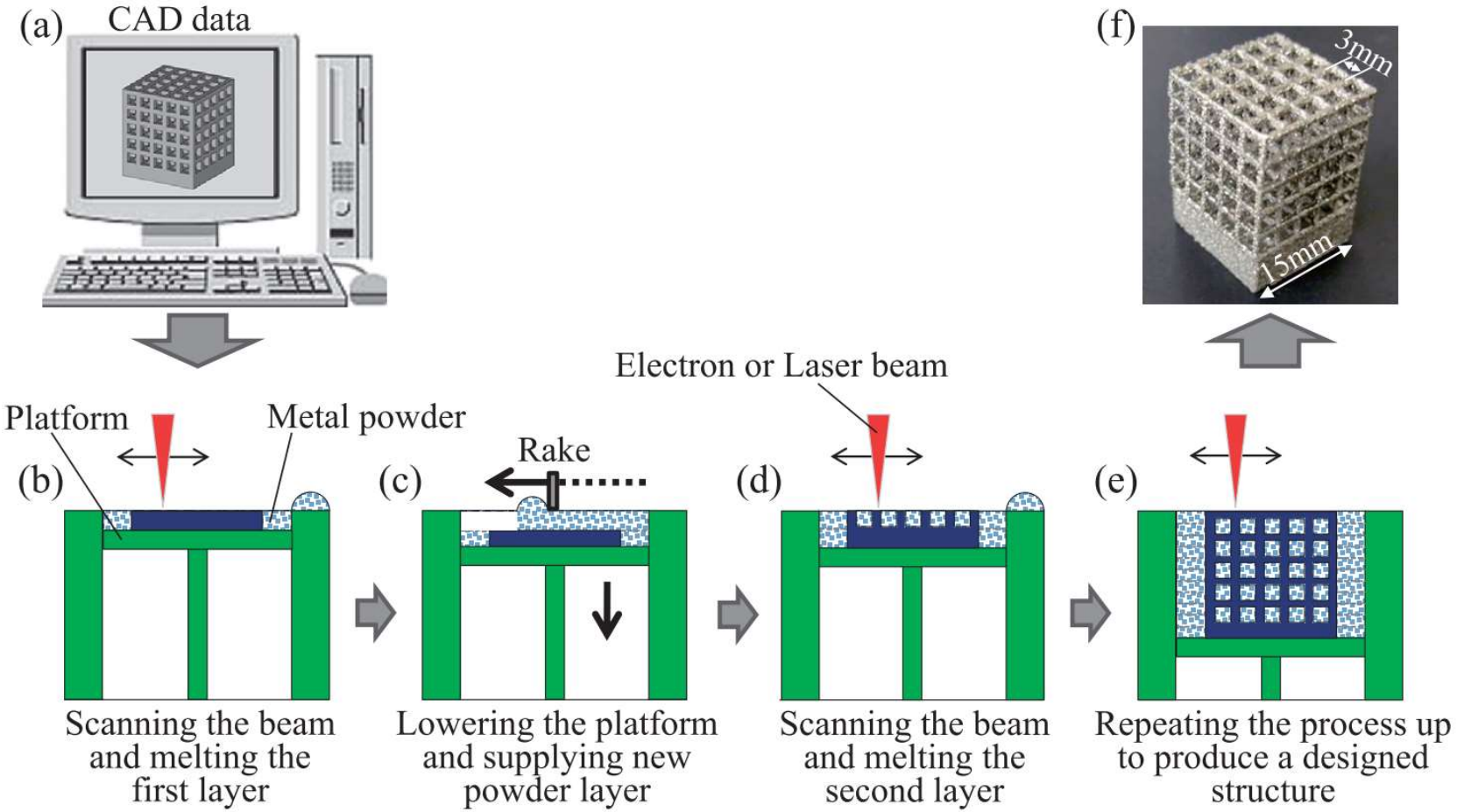
Powder Bed Fusion



2015 Nakano & Ishimoto

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17.9.2020

NASA

Future Rocket Engines May Include Large-Scale 3D Printing

NASA is developing new additive manufacturing techniques to fabricate very large and complex components. These techno...

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18.9.2020

EOS GmbH
@EOSGmbH

Atlantic Council

Global supply chains disrupted: Additive manufacturing, onshoring, and COVID-19 - Atlan...

Join us for another lively GeoTech Hour discussion as we consider how the future of supply chains is being shaped by ...

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19.9.2020

metal-am.com

World's fastest fan-driven HIP from Quintus Technologies supports AM post-production at...

World's fastest fan-driven HIP from Quintus Technologies supports AM post-production at PRES-X. Quintus Technologies,...

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20.9.2020

metal-am.com

ASTM International supports eight new standards projects for Additive Manufacturing

ASTM International supports eight new standards projects for Additive Manufacturing. Global standards developer ASTM ...

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21.9.2020

metal-am.com

SMS Group to supply Outokumpu's new stainless steel AM powder atomisation plant under s...

SMS Group to supply Outokumpu's new stainless steel AM powder atomisation plant under subscription contract. SMS Grou...

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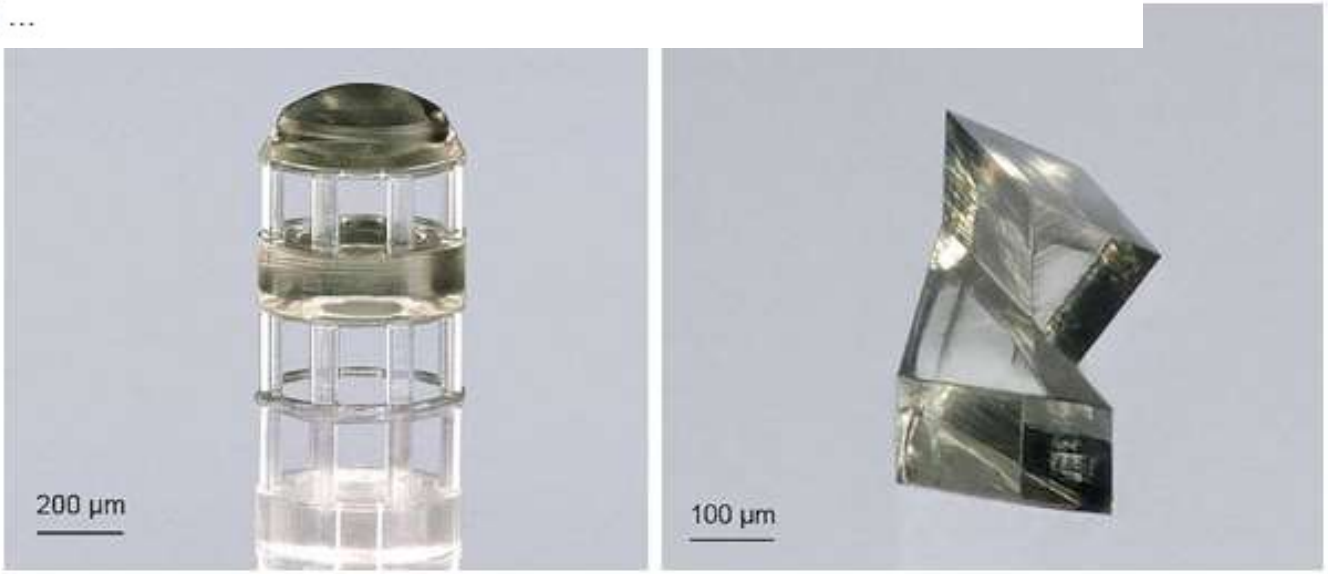
24.9.2020

Laser Focus World

New 3D-printing material for micro-optics has high refractive index

With both a high refractive index (1.62) and a low Abbe number (25), Nanoscribe's new IP-n162 photoresin enables new ...



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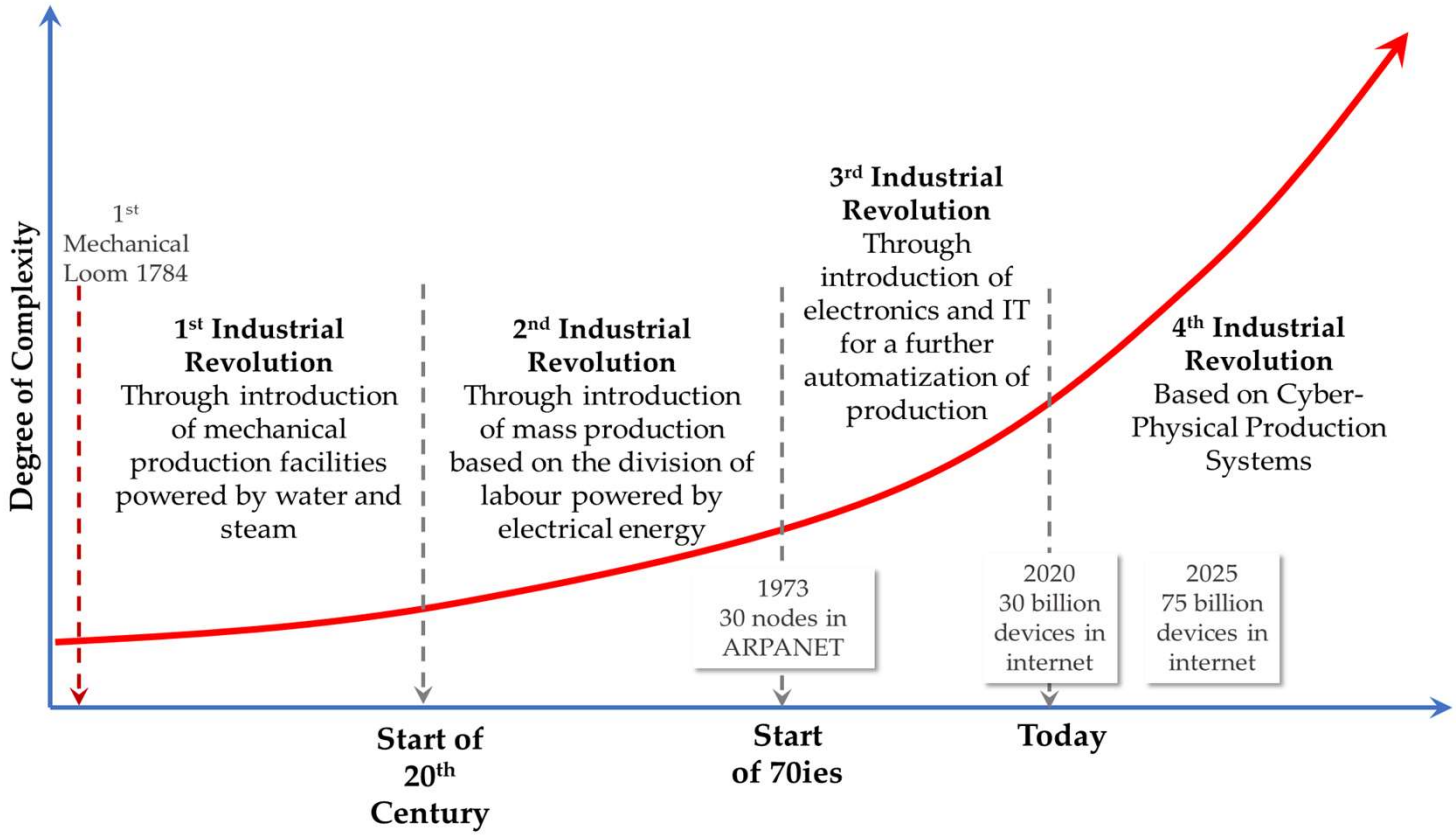
Is AM 4th Industrial revolution

No, but its essential part of it



Korpela et al., 2020

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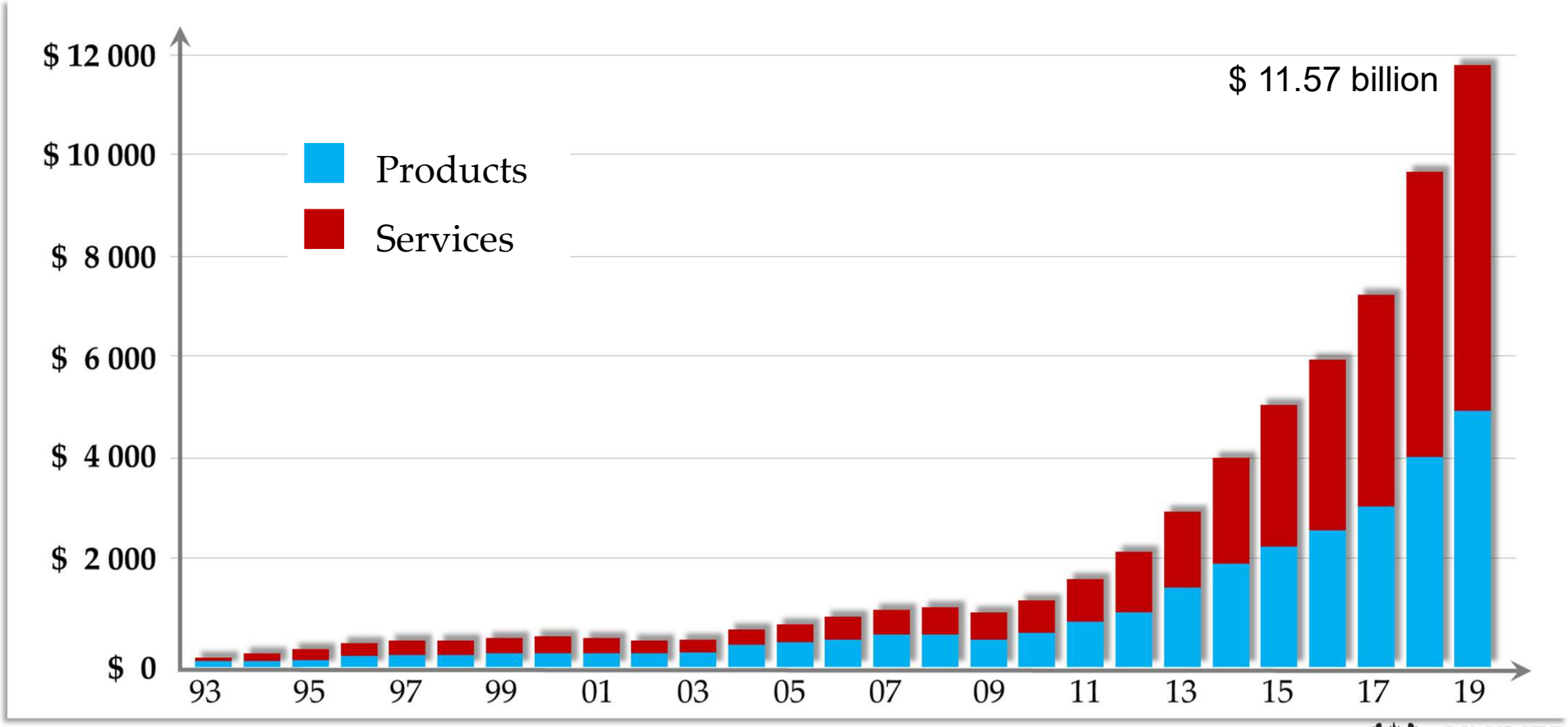
AM market in billion USD



WOHLERS ASSOCIATES

https://wohlersassociates.com/

Wohlers Report 2020

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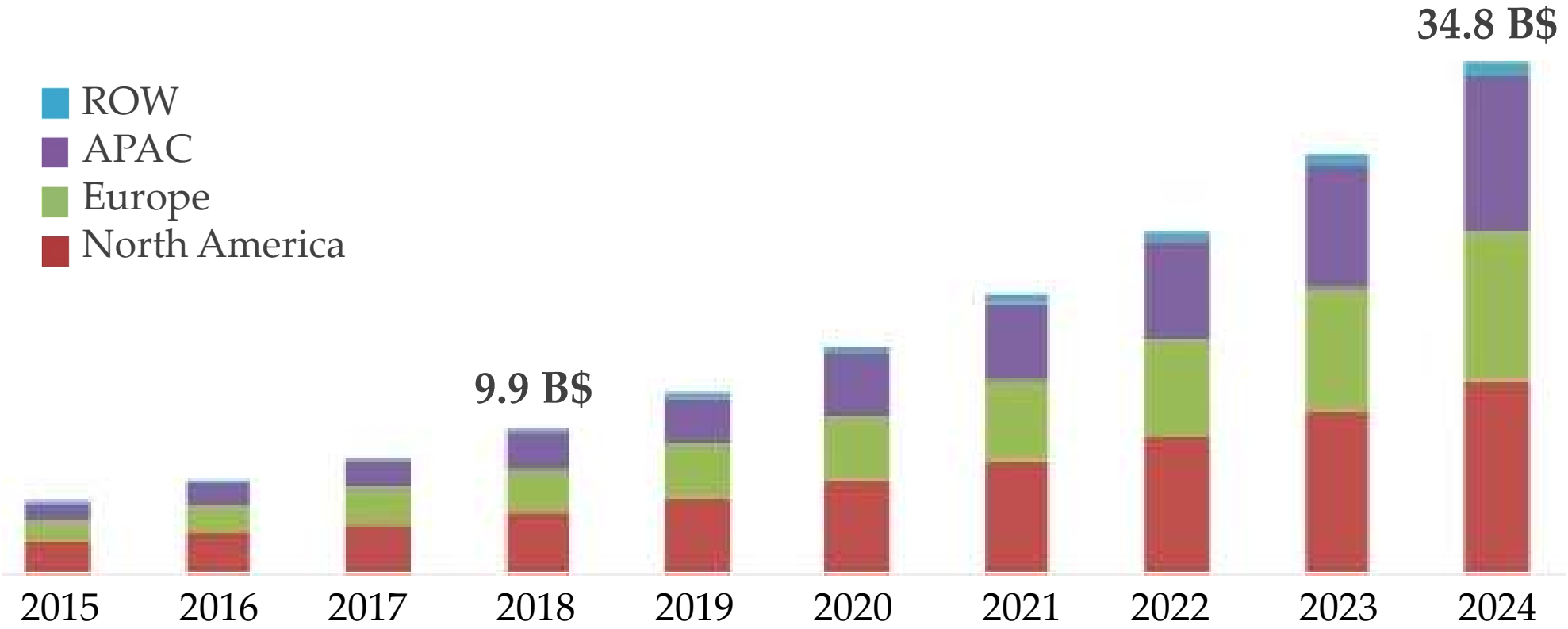
3DP market by region



Source: MarketsandMarkets press release
https://www.marketsandmarkets.com/PressReleases/3d-printing.asp

MARKETSANDMARKETS

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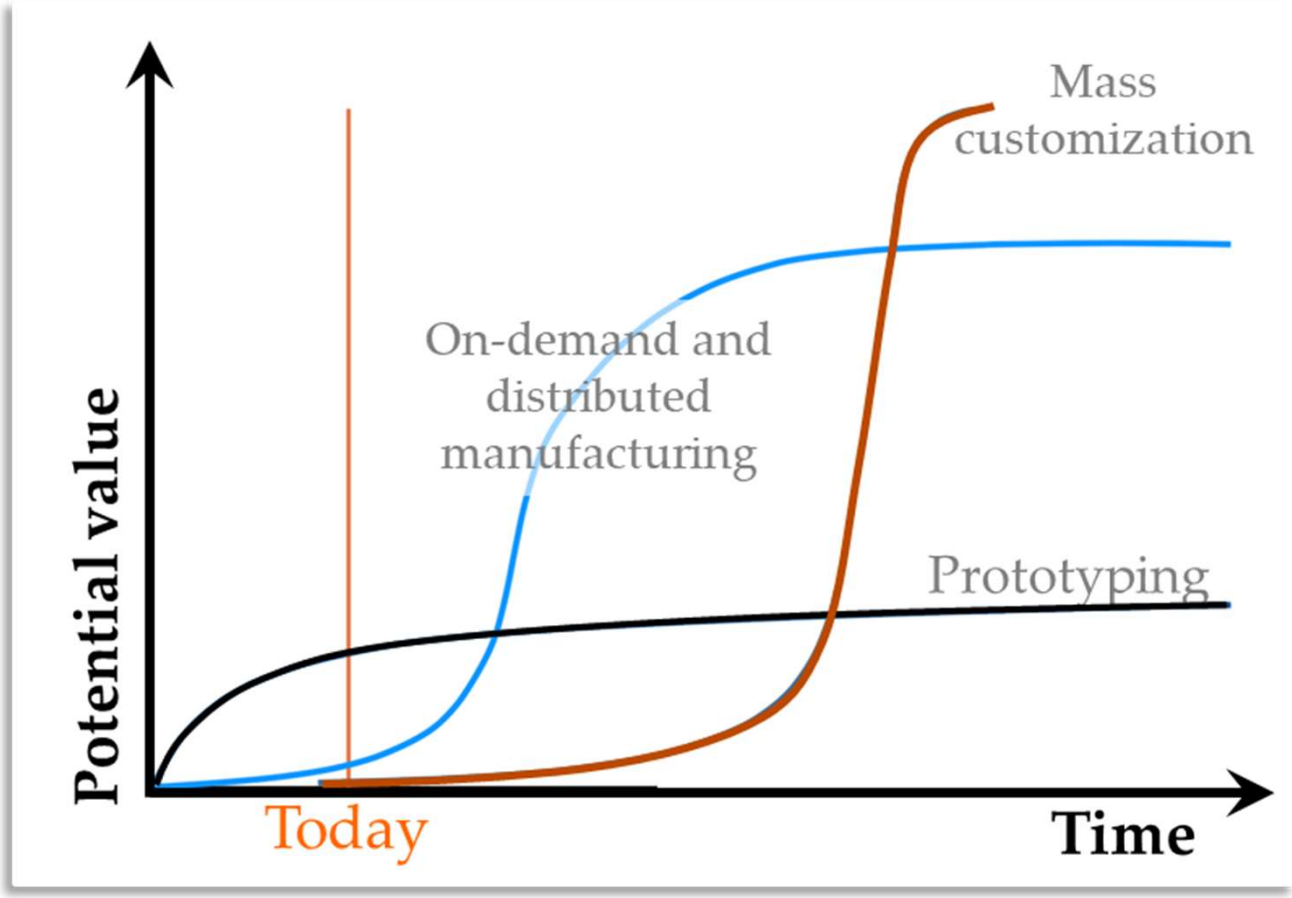
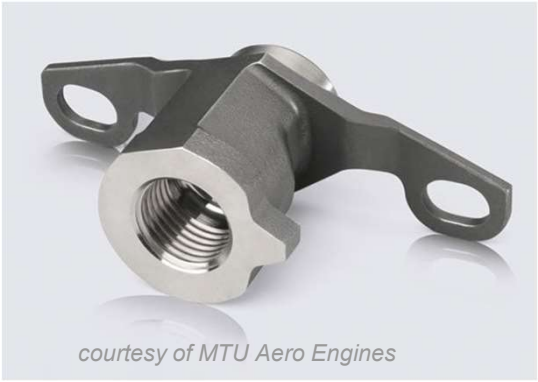
The Three Ages of Industrial 3D Printing





SpareParts3D
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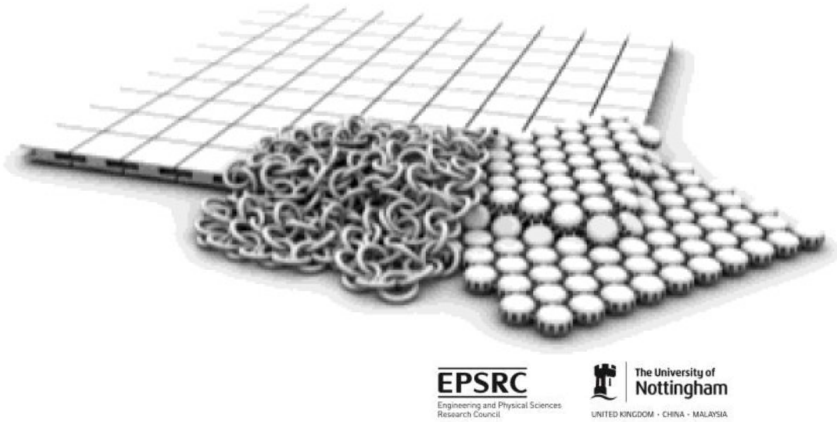
Advantages

Driving force

- Less restrictions to freedom of design

Advantages

- Ability to manufacture complex geometries
- Feasible small batch production
- Personal features to product
- More environment friendly (sustainability)
- New supply chain models
- More functions



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Weaknesses of the AM

- Price of product
- Building time, throughput time
- Mechanical properties unknown, availability of material data
- Restriction in part dimensions
- Surface quality not good enough always, post processing required
- Accuracy partly unknown
- Process variations, depends on design etc.
- Quality assurance and verification

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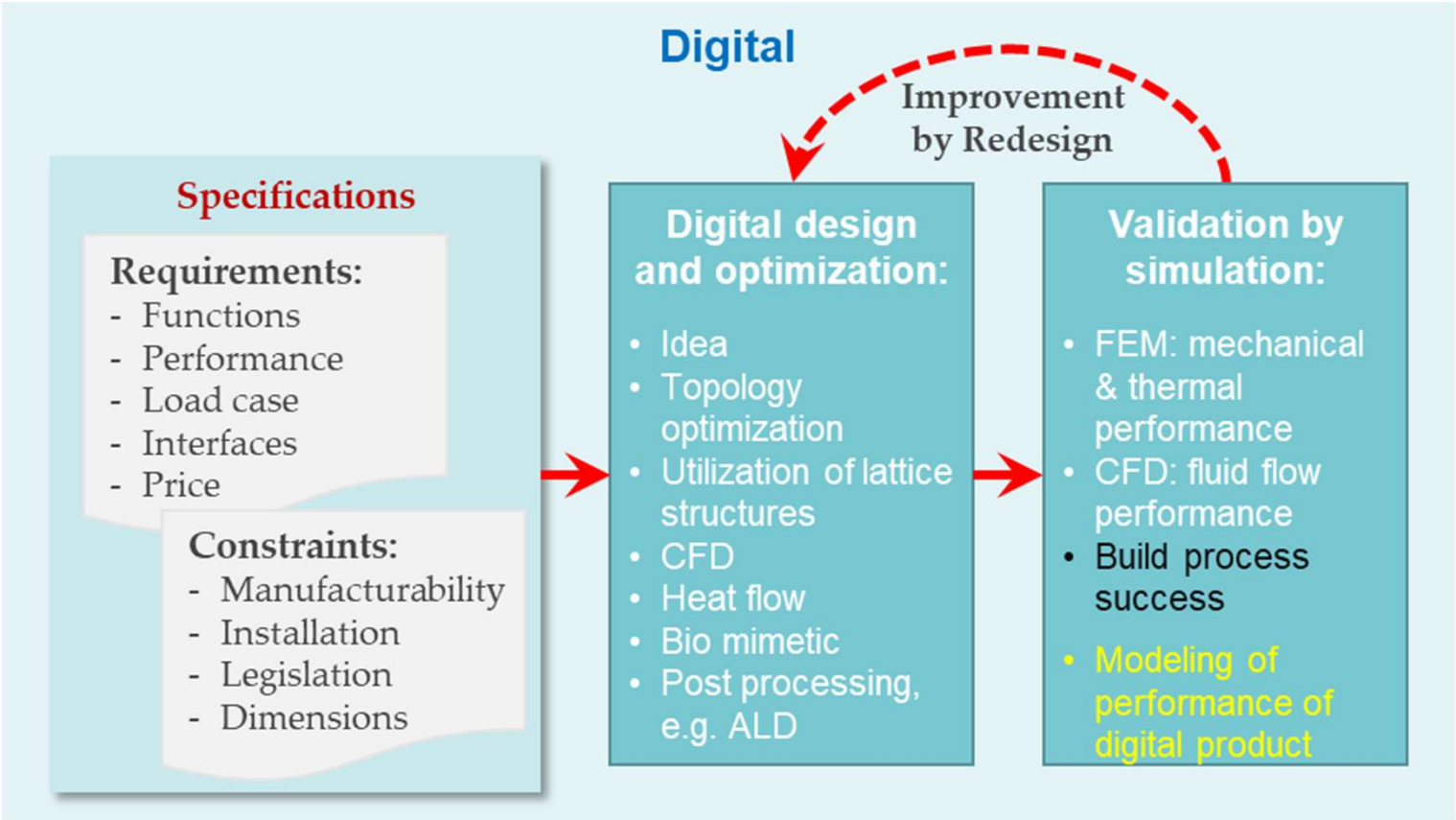
AM – Digital process



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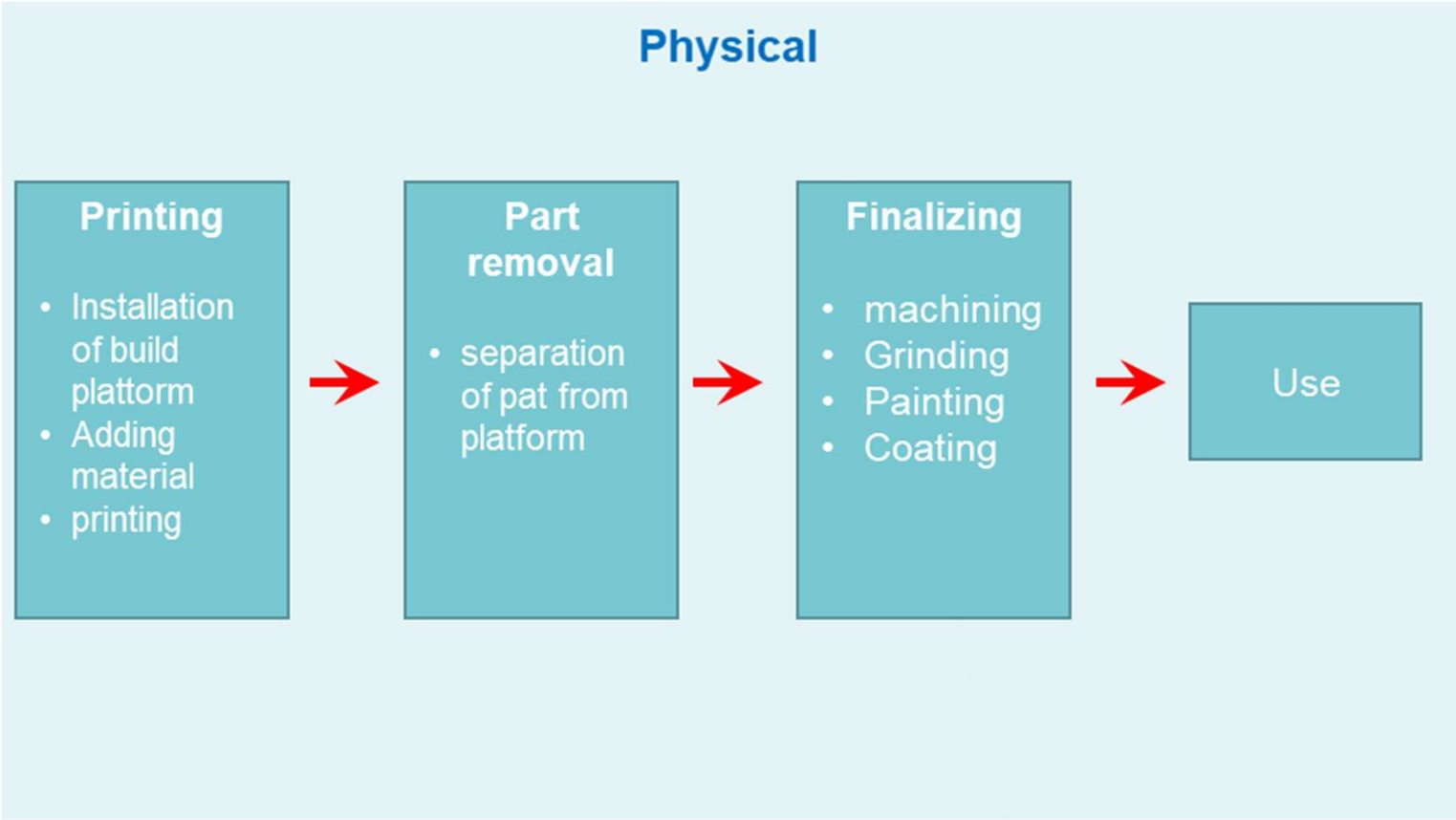
AM – physical process



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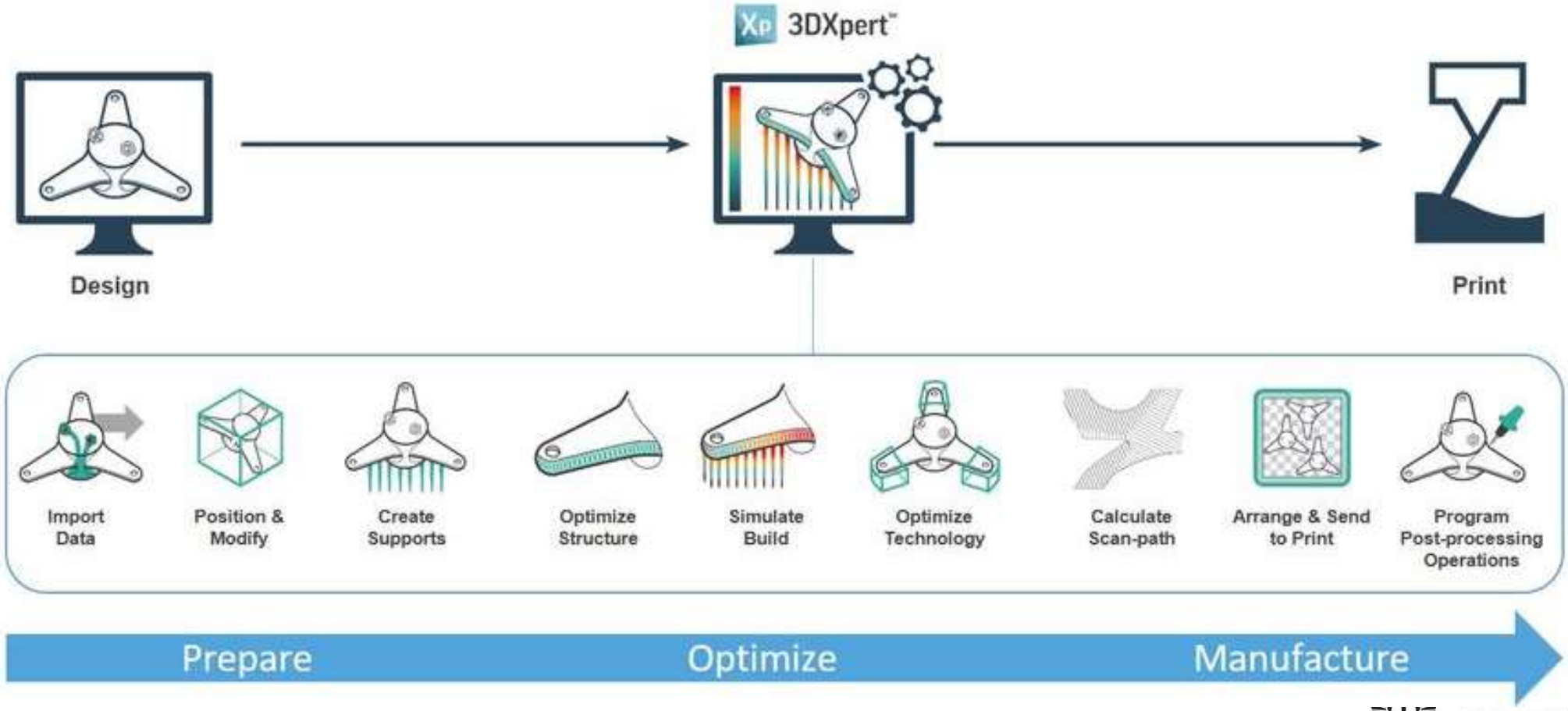
Real Digital Manufacturing



3D SYSTEMS

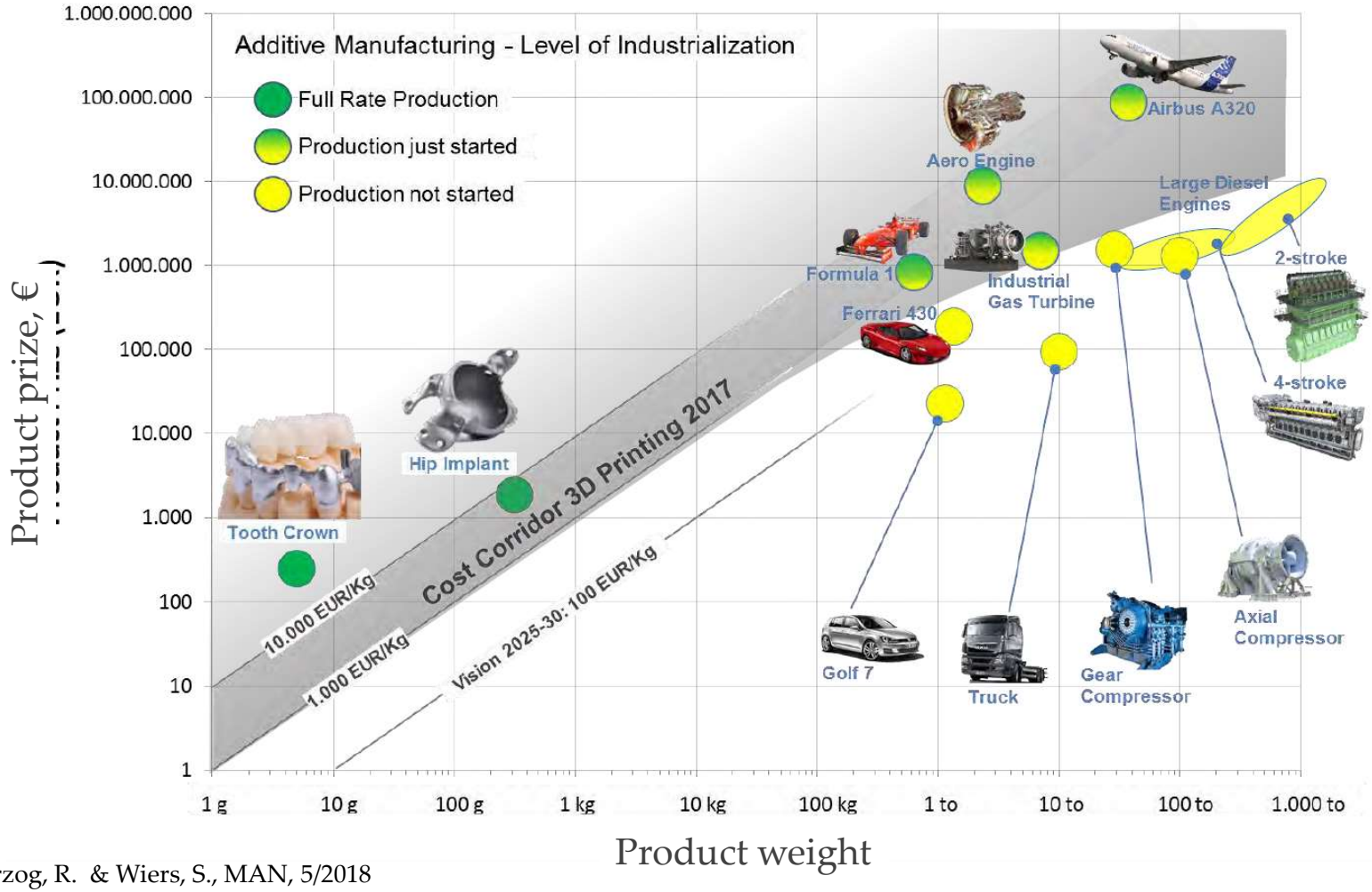
OF TURKU

Industrialization

CATEGORY 0	CATEGORY 1	CATEGORY 2	CATEGORY 3	CATEGORY 4	CATEGORY 5	CATEGORY n
▪ Bolts ▪ Small Sheets ▪ Levers ▪ Bosses ▪ Inserts	▪ Seal Carrier	▪ Outer Air Seals ▪ Shrouds	▪ Inner Air Seals ▪ Interstage Seals	▪ Var. Guide Vanes ▪ Blades ▪ Honeycombs	▪ Panels ▪ Fairings ▪ Bearing Cases	▪ New Design ▪ Gamma' strength-ening materials

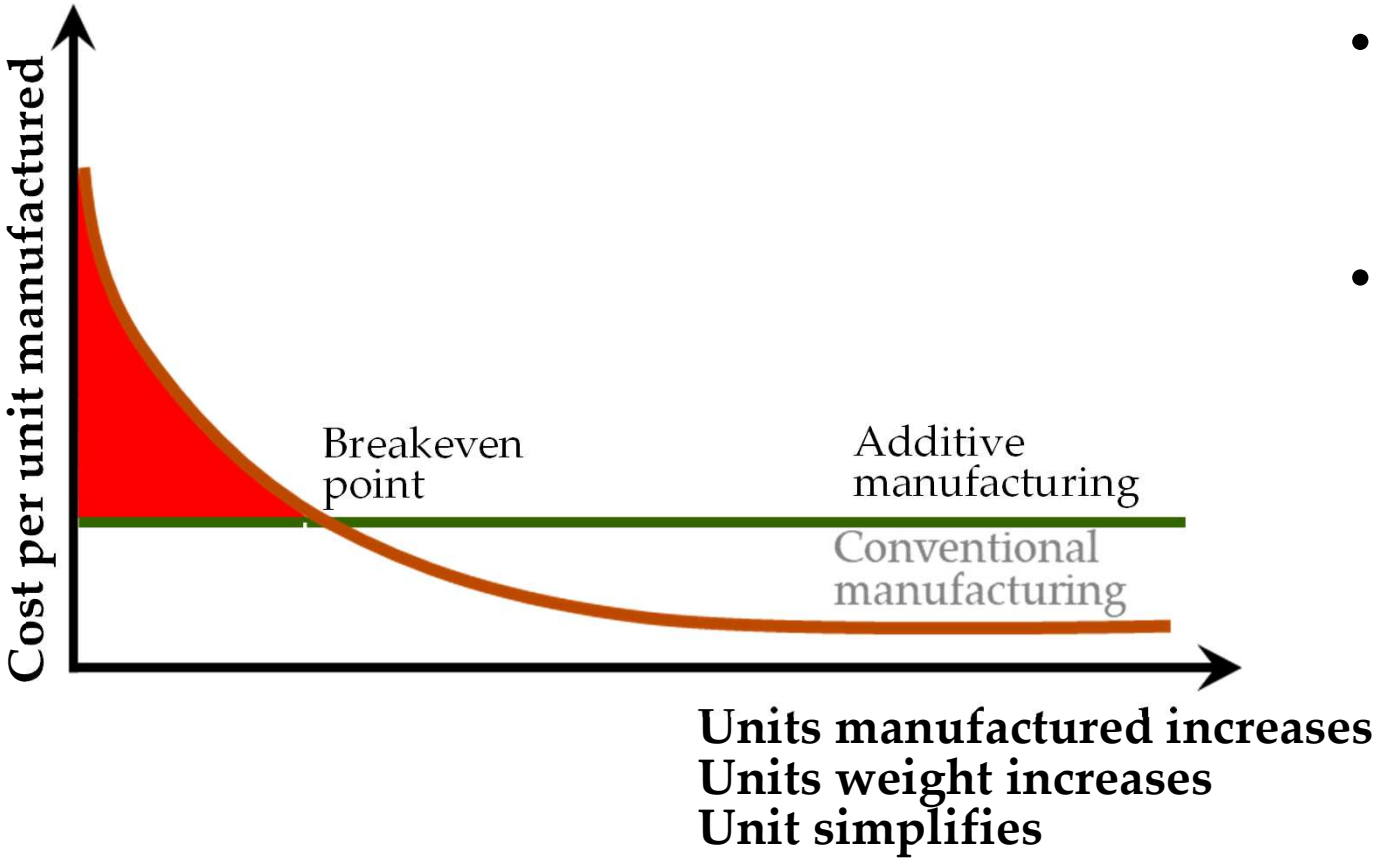
Karl-Heinz Dusel, MTU Aero Engines AG, May 2014

Industrialization



Herzog, R. & Wiers, S., MAN, 5/2018

Breakeven analysis



- 3DP changes the normal product paradigms
- Unit price don't have to degrease by volume, weight and simplicity

Reduction of number of components

From 16 parts to 1

Carlström 2016

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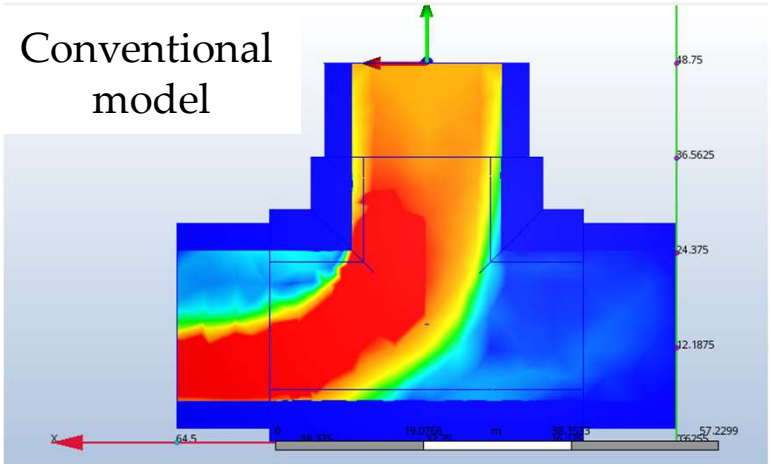
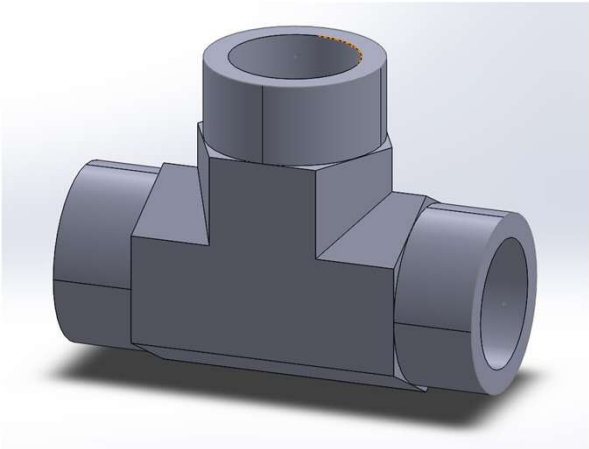
T-joint

- Conventional manufacturing:
  - Flow of hydraulic fluid is not optimized.
  - Conventional manufacturing method causes sharp edges.





LUT University
Student project

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LEAP fuel nozzle tip*

95%
INVENTORY
REDUCTION

20 ▸ 1
PARTS

5x MORE
DURABLE

30%
COST EFFICIENCY
IMPROVEMENT

25%
WEIGHT
REDUCTION

*LEAP is a trademark of CFM International, a 50/50 JV between GE and Safran Aircraft Engines.

Comparison versus TAPS fuel nozzle

Source: GE Aviation

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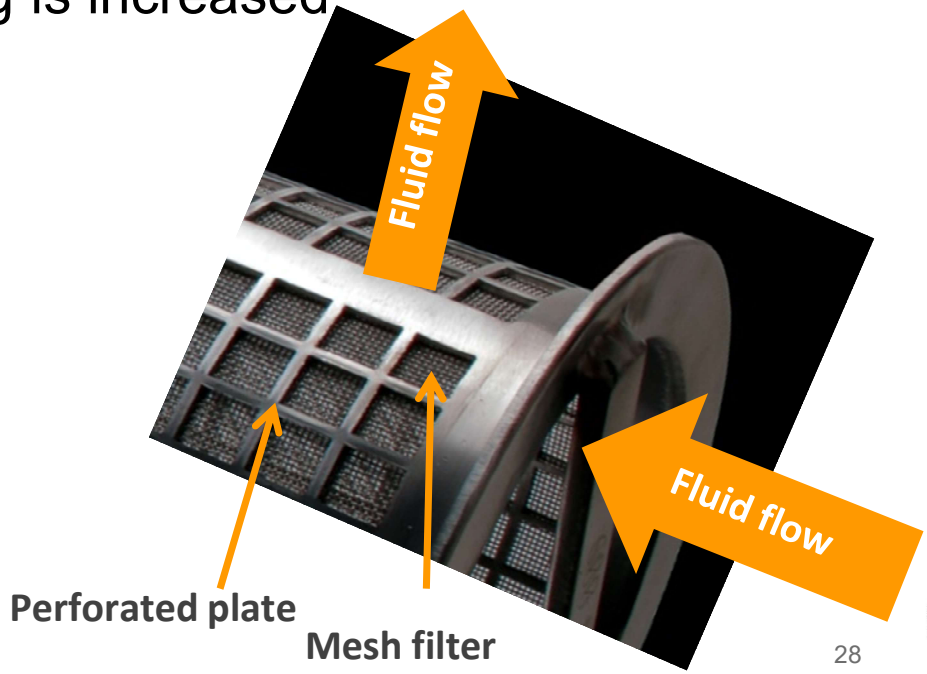
Use of AM in filtering

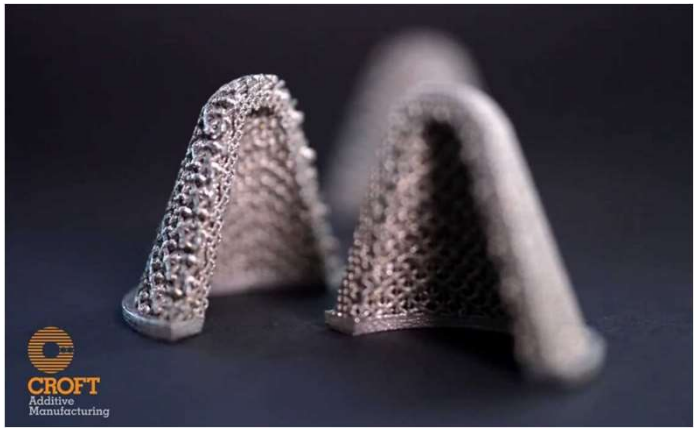
- Pressure difference between inlet flow and outlet flow determines the amount of energy needed for pumping.
- Turbulence in flow causes increase to resistance of filter i.e. filtering efficiency decreases → Amount of inlet flow has to be increased i.e. energy needed for pumping is increased

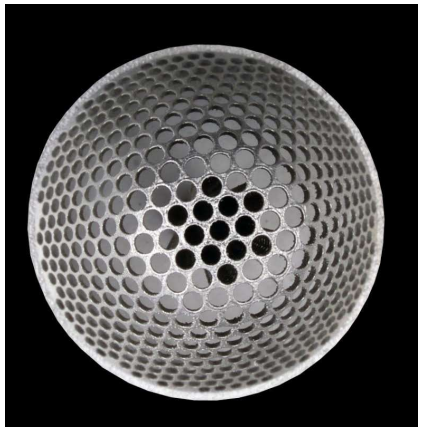


Source: Neil Burns (Croft Additive Manufacturing)

Use of AM in filtering

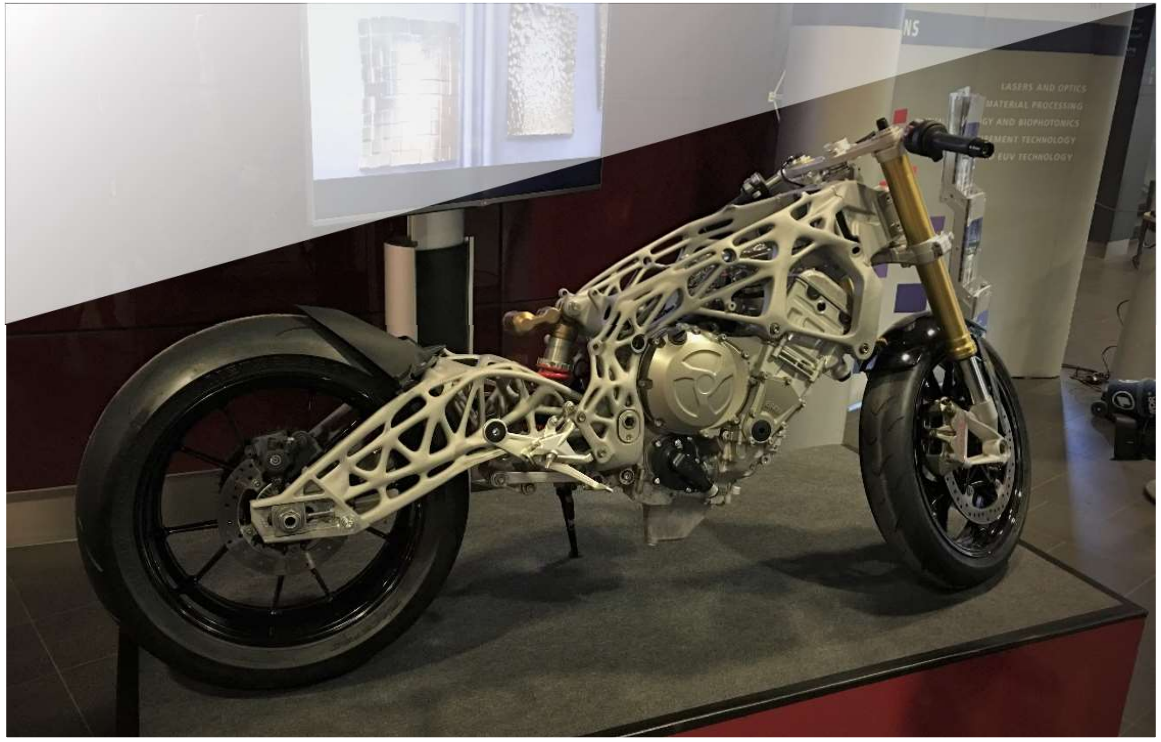
- Idea enabled by AM:
  - If the fluid channels and holes in the filter could be aligned with fluid flow, turbulence would decrease → pressure drop would decrease → less energy needed for pumping.
  - This structure is possible to manufacture only with AM.
  - Material: SS316L

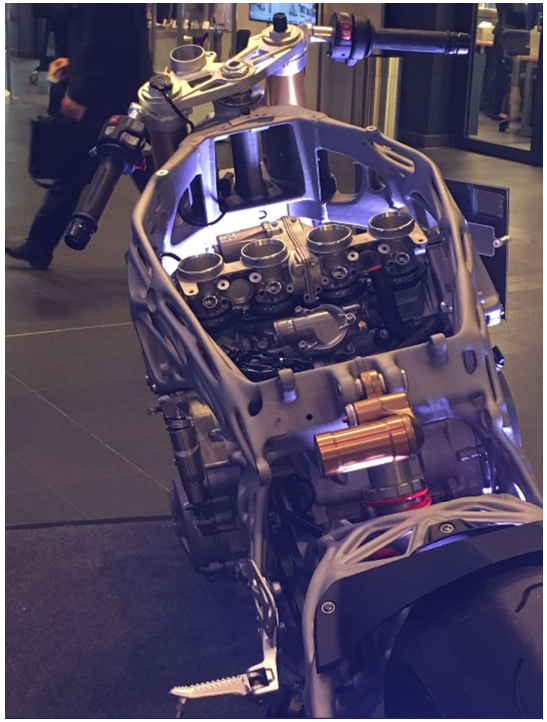




Source: Neil Burns (Croft Additive Manufacturing)

Motorcycle frame, BMW





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Electric Polymer Motorbike

bigrep

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3D printed tire

kupol

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AIRBUS Bastian Schäfer, 2014

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Thank you for your attention

Any questions ?

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