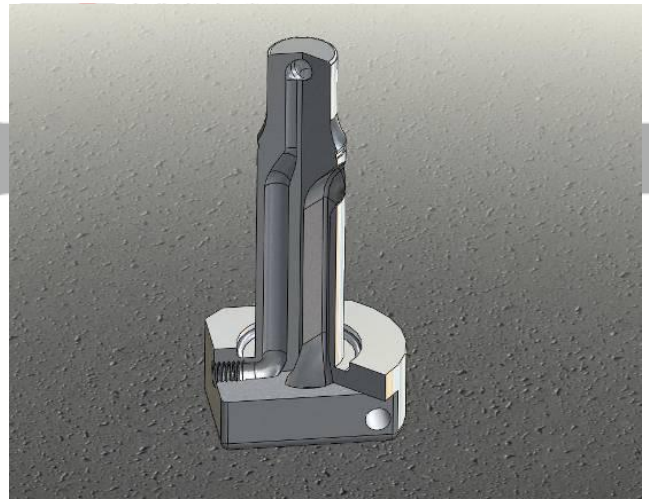

3D Selective Laser Melting (SLM)

- from the Drawing to the Part-

Denis Klemm*, Robert Taranczewski,
Romy Petters, Lukas Löber, Volker Hoffmann

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Dresden

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overview

- intro SLM Technology
- SLM research topics@ IFW
  - ~~materials research~~
  - design engineering
  - ~~technology development~~
- applications

introduction - SLM

State of the art

Rapid prototyping

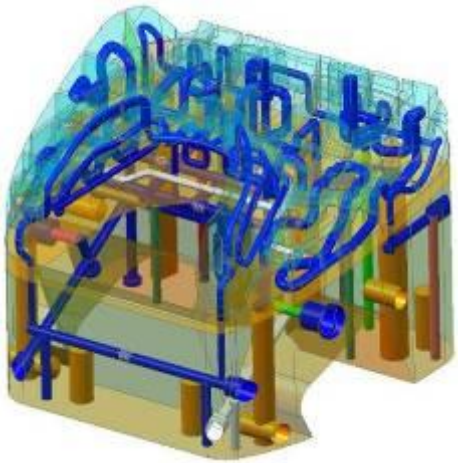
Rapid Tooling

Parts with complex geometry and/or inner volume

Source: FESTO

Materials used today:

- 316L (Stainless steel)
- Ti (cp), TiAl6Nb7, TiAl6V4,
- CoCrMo, H13 tool steel,
- aluminium, gold,
- polymers, …



Source: Concept Laser

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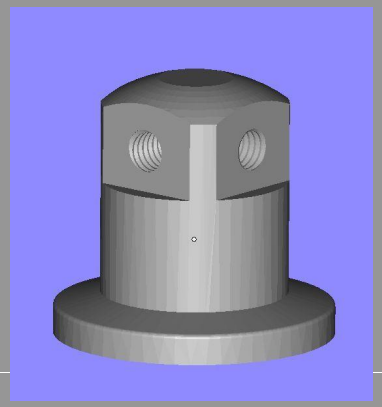
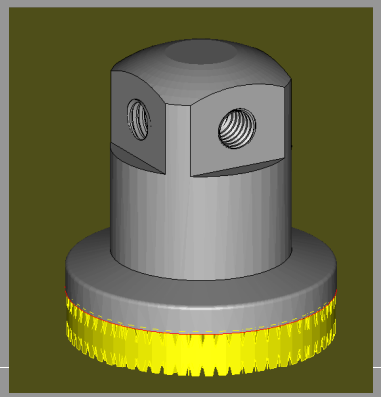
SLM process chain

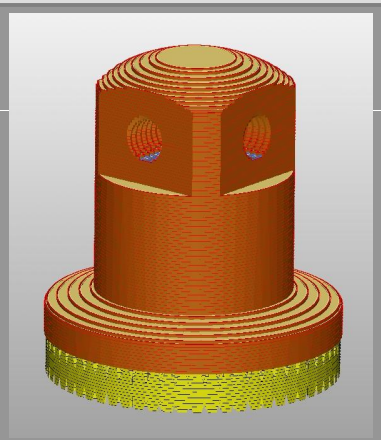
STL data



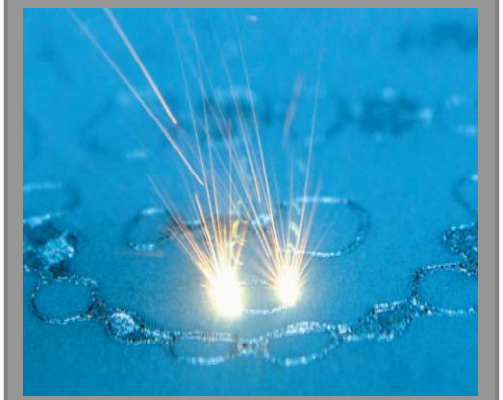
supports



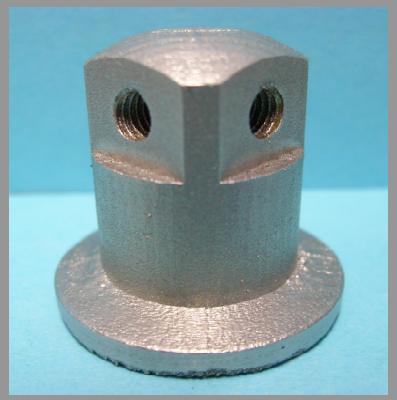
slicing



SLM process



finish



Laser Beam Melting

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research topics

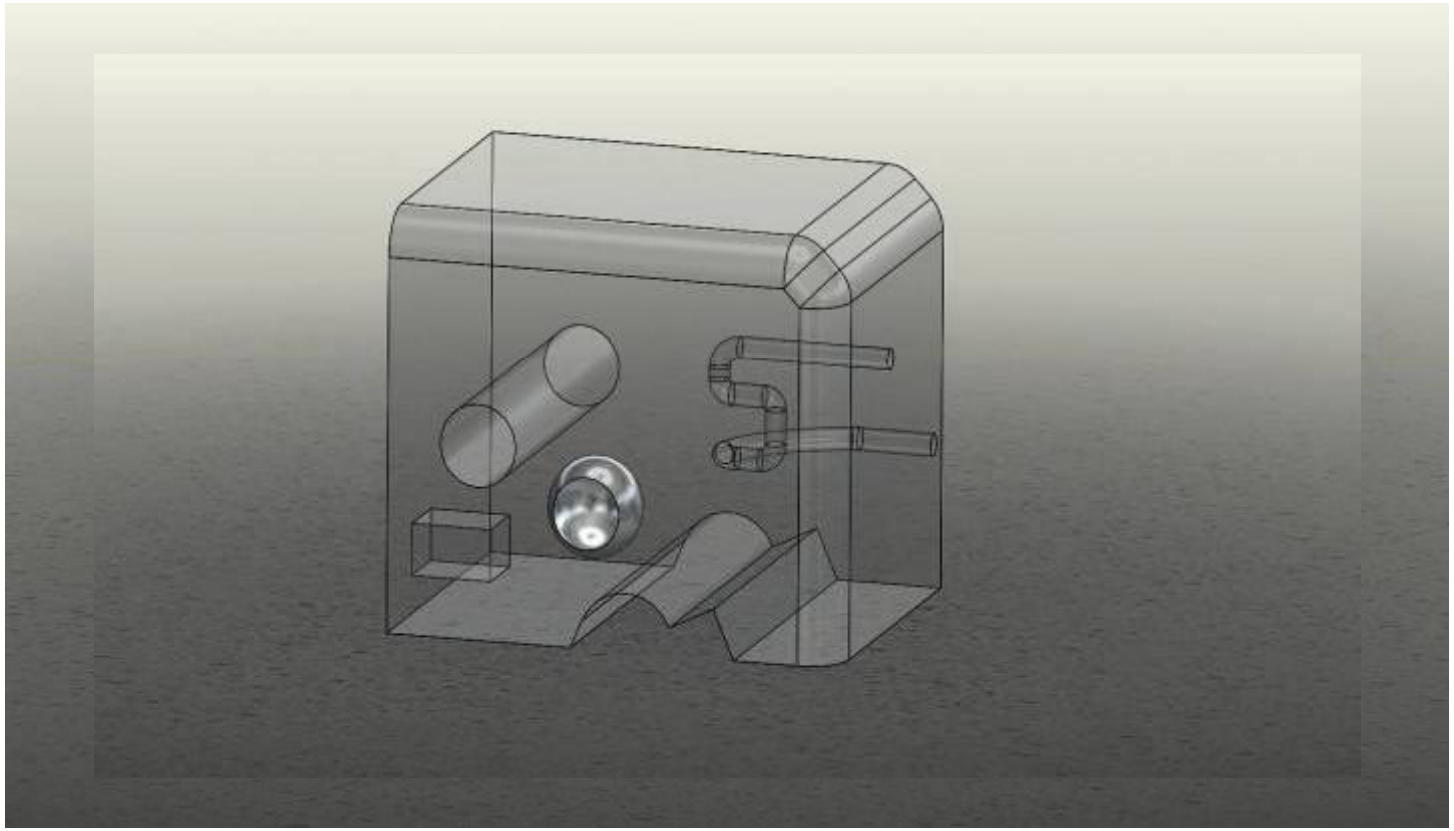
- design engineering -

conventional manufacturing techniques

- conventional fabrication techniques
  (casting +) Drilling, CNC machining, eroding etc.

SUBTRACTIVE Techniques

subtractive manufacturing



manufacturing techniques

- conventional fabrication techniques
  (casting +) Drilling, CNC machining, eroding etc.

SUBTRACTIVE Techniques

- generative moulding / manufacturing
  stereolithography, 3D printing, EBM, SLS, SLM, etc.

ADDITIVE Techniques

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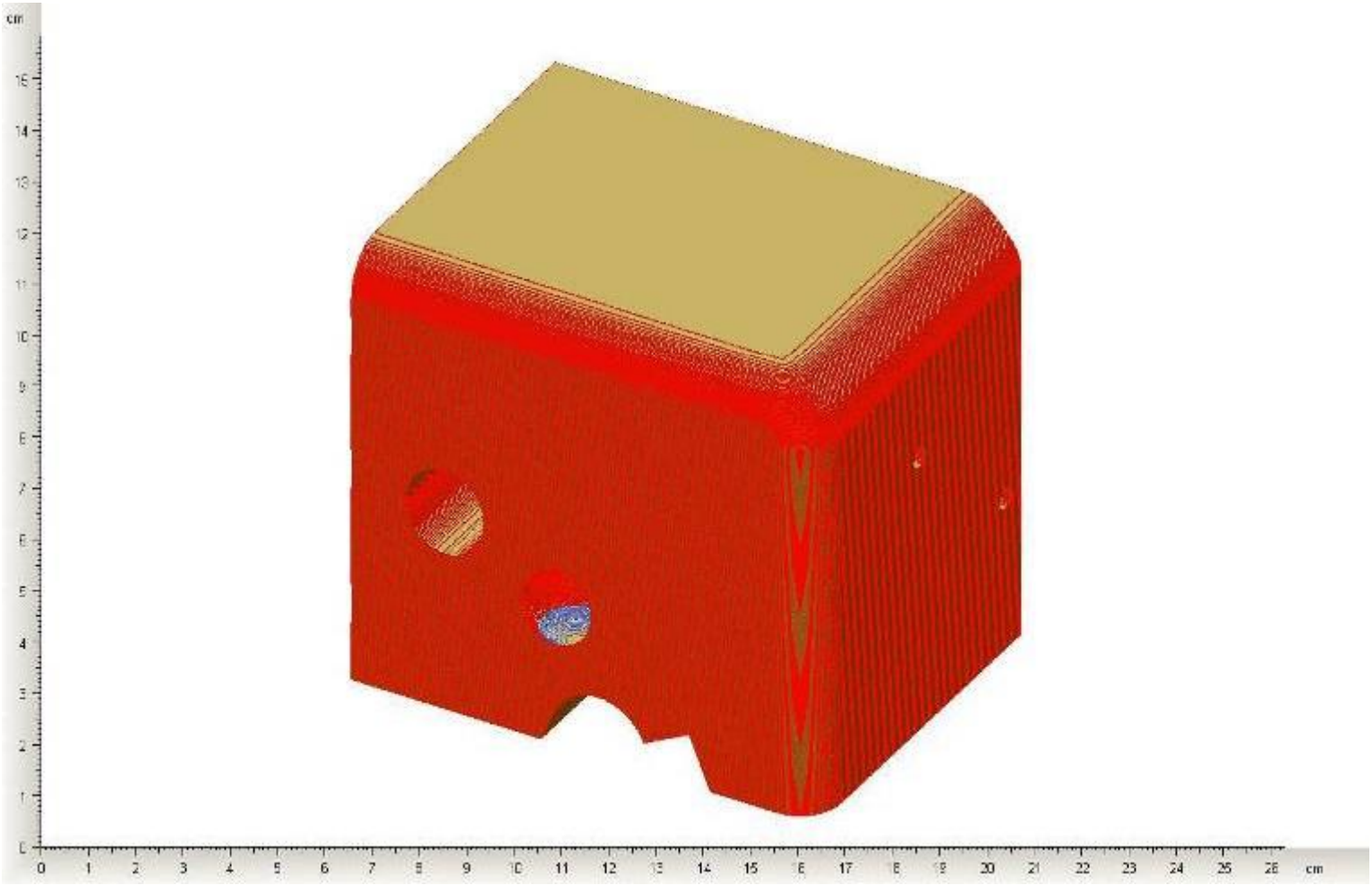
additive manufacturing



manufacturing techniques

- conventional fabrication techniques
  (casting +) Drilling, CNC machining, eroding etc.

SUBTRACTIVE Techniques

- generative moulding / manufacturing
  stereolithography, 3D printing, EBM, SLS, SLM, etc.

ADDITIVE Techniques

design engineering depends on manufacturing techniques!!!

complexity wanted
material use: as less as possible,
as much as needed
additive => bionic

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design engineering

A conventional CAD/CAO by engineer

B unconventional CAD/CAO

C solid freeforming

D inverse designing

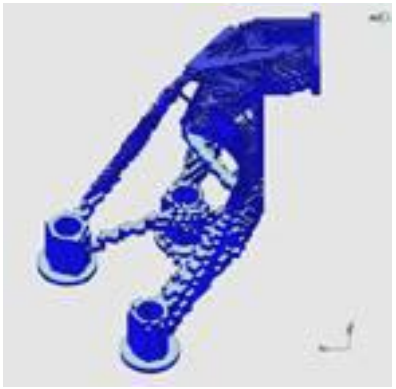
A

design engineering

example
CAD/CAO by engineer

Input for STL data

- *CT* — *copy*
- *CAD* — *re-engineering*
  re-design
- *CAO* — *optimize*



ability for modification

B

unconventional design engineering

example
CAD & Boolean operations

constructional elements

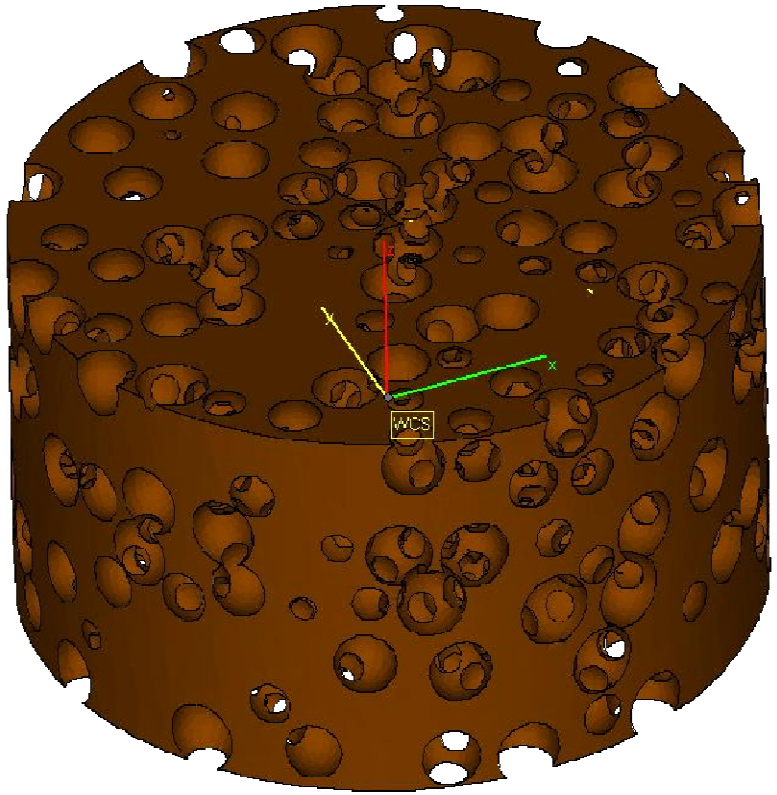
- porous core structure:

degrees of freedom

design space

# of pores

∅ offset



pore size

pore size
distribution

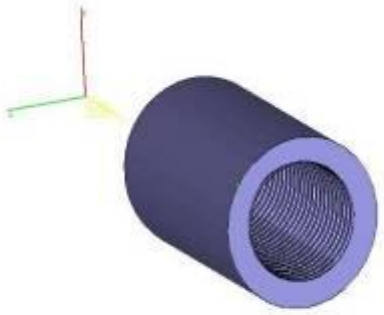
???

e. g. open cell porous structure
- CAD model -

constructional elements

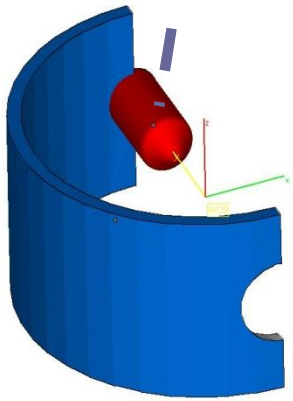
- peripherical elements:

- connection elements



e. g. M5 screw thread

- shell / frame structures

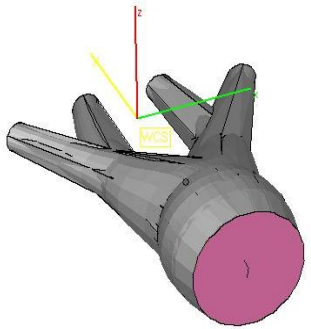


e. g. thin half shell

constructional elements

- peripherical elemen

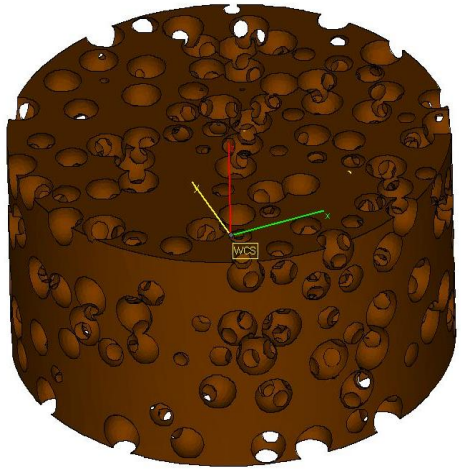
- delivery race

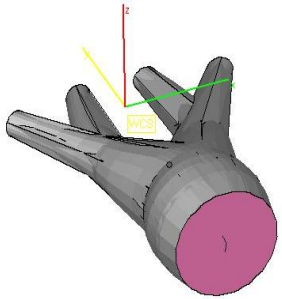


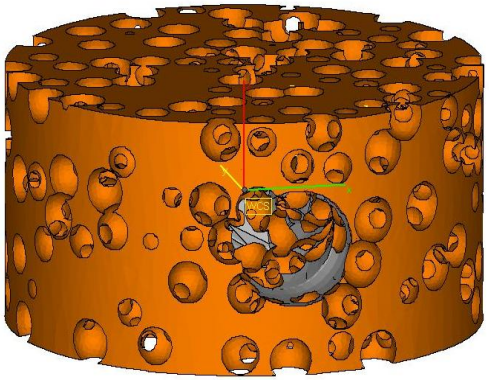
e. g. multiple bifurcation

- and so on

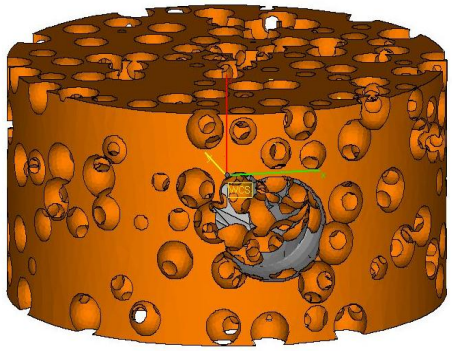
constructional elements







constructional elements



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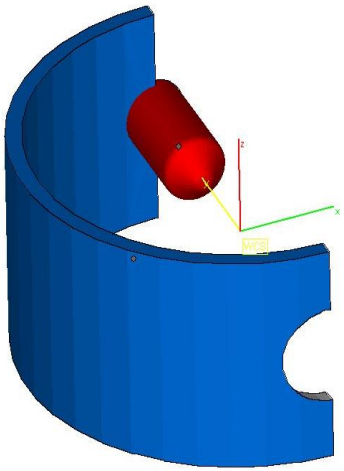
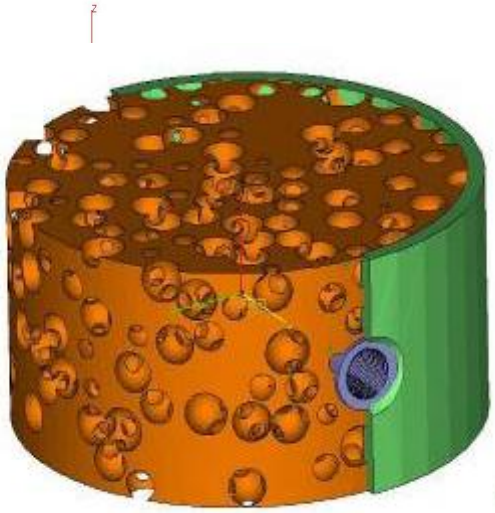




(180° twisted)

constructional elements

- further ideas:

- position dependent porosity

- sandwich structures

- anisotropic reinforcements

- fixations

patient individual SLM hull implant ($TiAl_6Nb_7$)

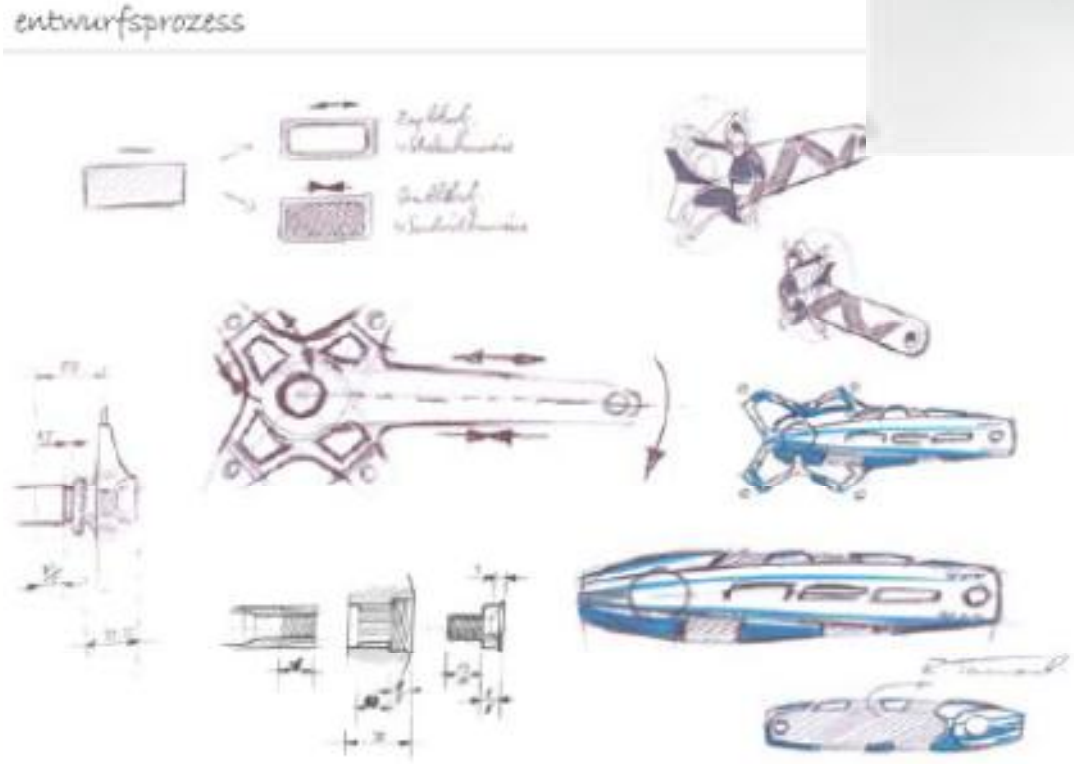
Source: MTT Technologies

C

design engineering

example
industrial design

neo crank set



Crank

D

inverse design engineering

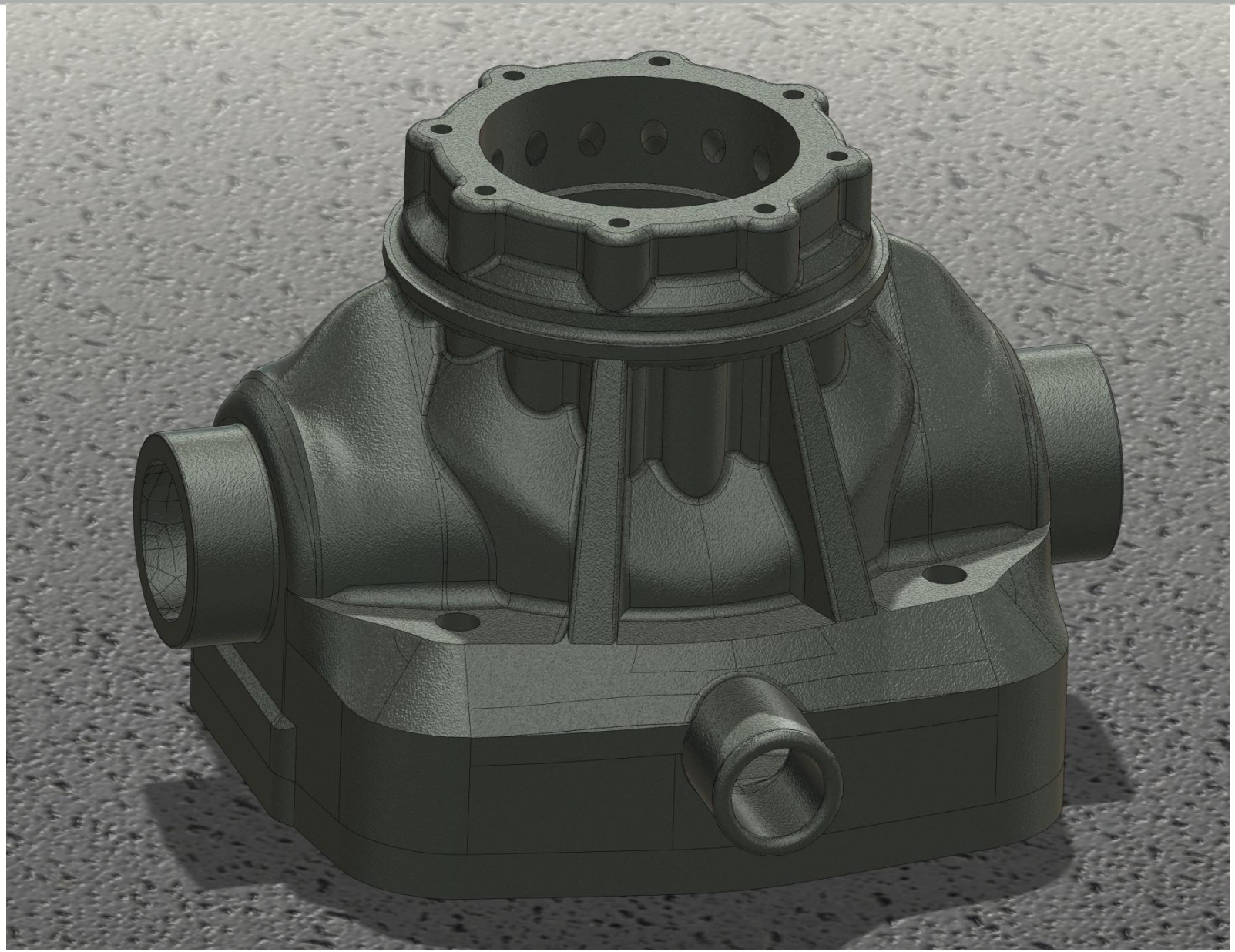
motor bike cylinder block
50 / 125 ccm

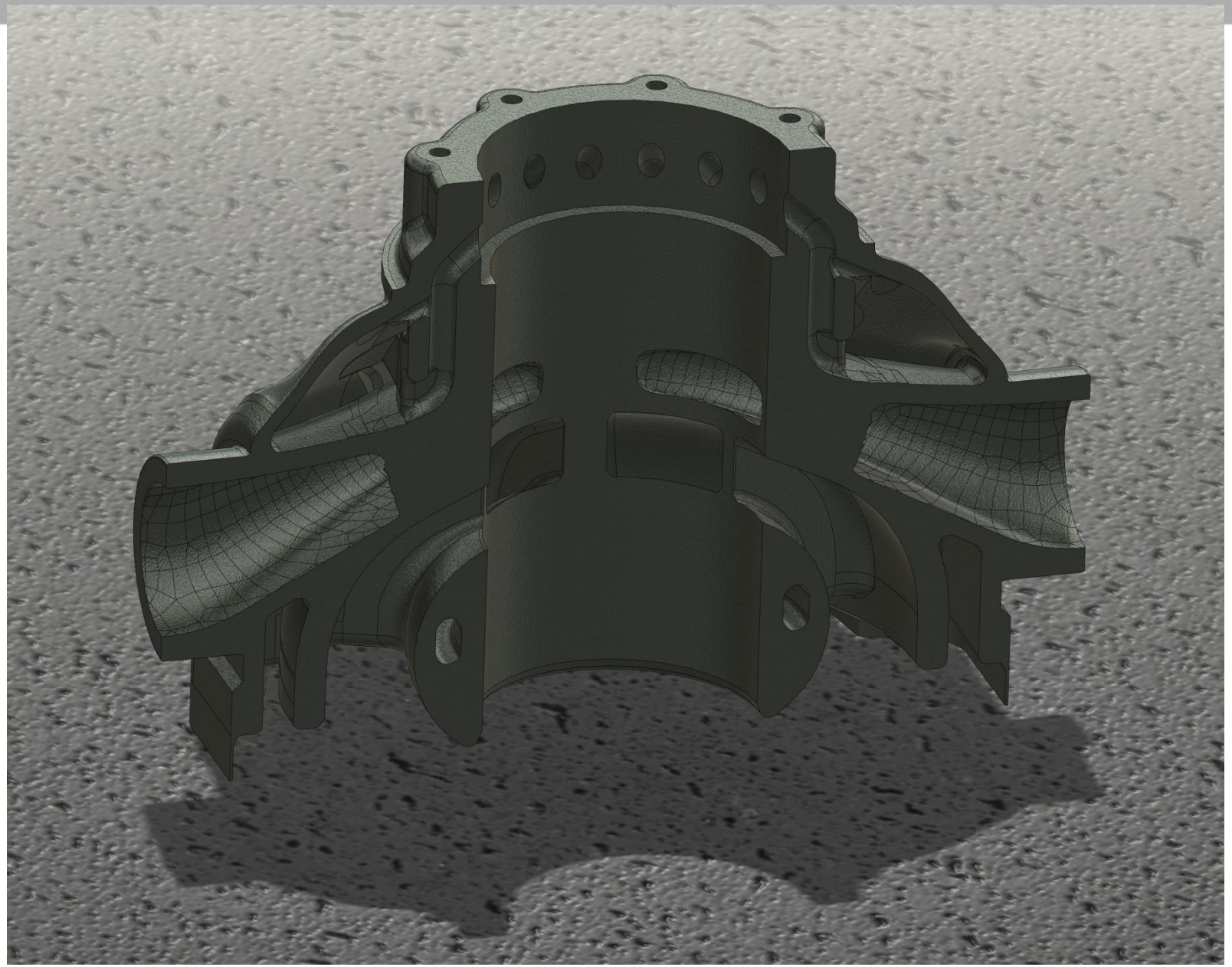
Design engineering

- aim: effective cooling

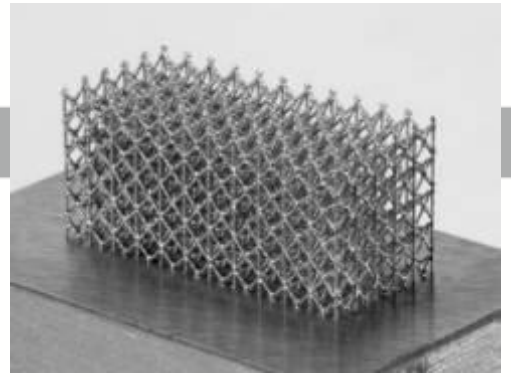
- conditions
  - outlet channels (x,y,z)
  - cylinder bore ∅ 54 mm (125 ccm)
  - wall thickness ≥ 4mm

- reverse approach
  - design of hollow features
  - ‚optimal' wall thickness
  - consideration of SLM limitations





conclusion



3D Laser melting

- innovative technique
- allows manufacturing of parts with complex geometry:
  - tools, parts with inner tubes, implants, lightweight parts

Laser beam technique

- Tool to combine rapid quenched µ-volumina
- allows well-defined local heat treatment

Materials

- some commercially available materials

Conclusion

Design engineering of complex geometry

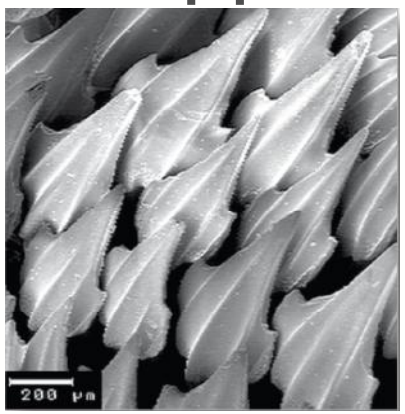
= knowledge to design (by software)

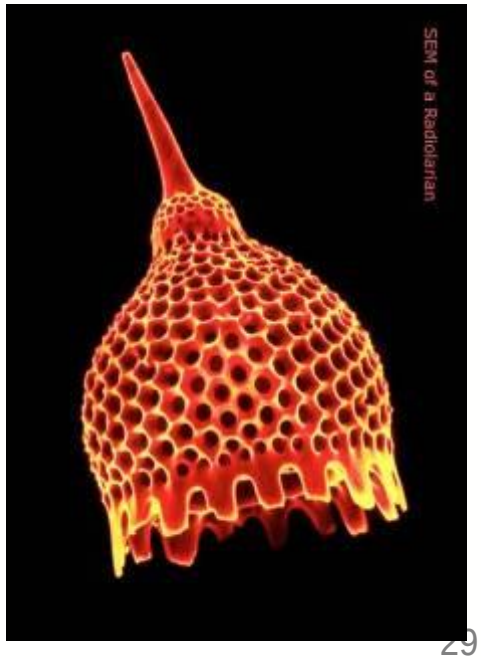
+ neglecting of common thinking

+ creativity

education!!!

Bionic approach





Thank you

contact:

materials research

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www

- Animation (die während des Vortrags aus technischen Gründen nicht gezeigt werden konnte)

http://www.ifw-dresden.de/institutes/ikm/research/metallische-glaser-und-komposite/laserstrahlschmelzen/maschine-de/institutes/ikm/organisation/dep-34/ausstattung/laserstrahlschmelzen/maschine-de/rapid_technologie_engl_640x480.avi

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