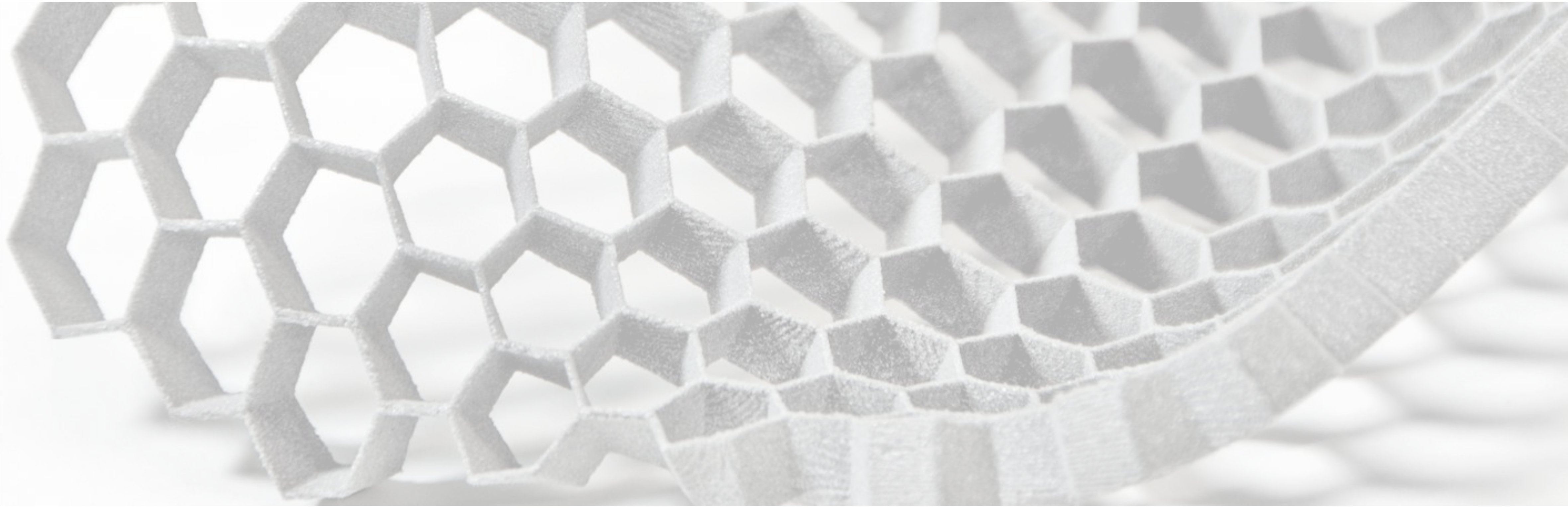
3D THINKING APPLIED TO A REAL WORKING ENVIRONMENT

SAM-Webinar: **3D Thinking and Design for Additive Manufacturing**

Online – March 16th 2021 – Dr. Georg Schlick, Matthias Schneck, Matthias Schmitt, Max Horn



Fraunhofer IGCV

Fraunhofer IGCV Locations

Augsburg and Greater Munich Area

Augsburg Innovationspark

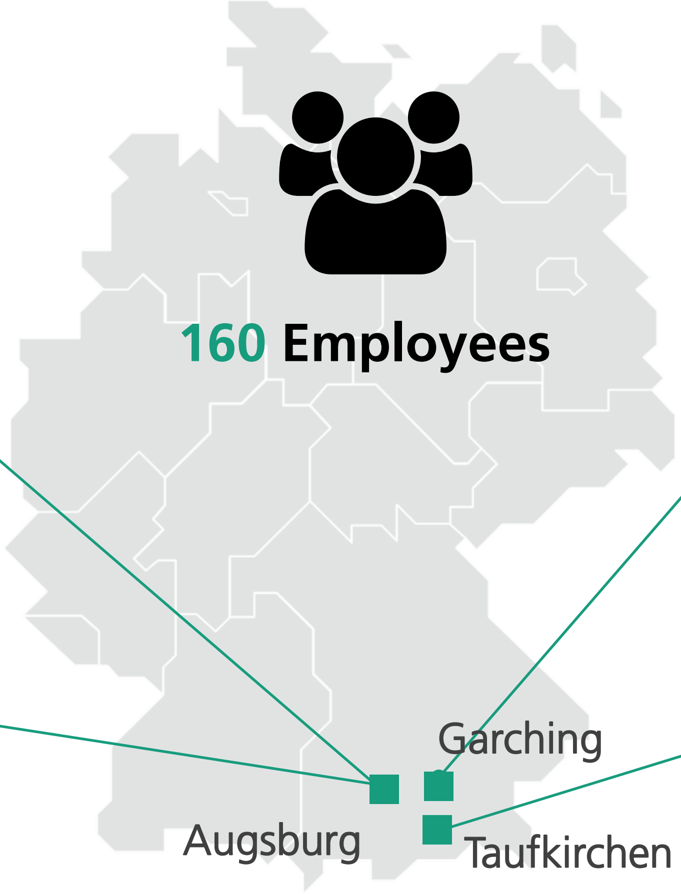
2 Buildings with more than **6 000 m²** office and workshop space

Composite Technology

Headquarters
Am Technologiezentrum 2
86159 Augsburg

Processing Technology

Am Technologiezentrum 10
86159 Augsburg



Research Campus Garching near Munich

Office: 300 m²
Workshop: 1,500 m²
(Completion: 2021)

Casting Technology

Zeppelinstr. 15
85748 Garching near Munich

Ludwig Bölkow Campus

Willy-Messerschmitt-Str. 1
82024 Taufkirchen

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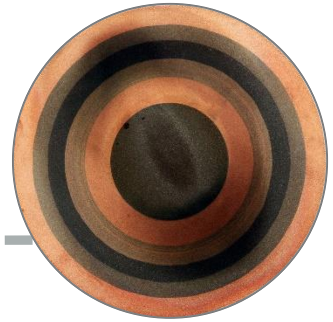
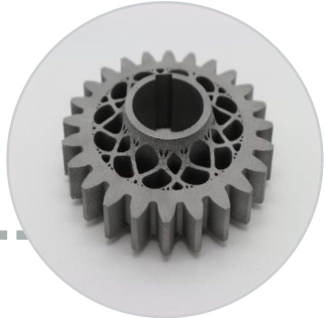
Engineering. Production. Multimaterial Solutions



Materials Engineering

Design Methods



Design

Processing Technologies

Production Plants

Factory

Across three scientific fields, 30 scientists are working on Additive Manufacturing.

30 Scientists, 60 Students

Head of Additive Manufacturing
Prof. Dr. Christian Seidel

AM@Sand/Tooling	AM@Polymer/Composites	AM@Metal
Dr. Daniel Günther	Prof. Dr. Iman Taha	Dr. Georg Schlick / Dr. Peter Barth / Prof. Dr. Johannes Schilp

Focus:

Additive Manufacturing of sand moulds and tools via **Binder Jetting**

Focus:

Extrusion-based technologies and **Liquid Deposition Modeling** (LDM) for processing of (fibre-reinforced) **Polymers**

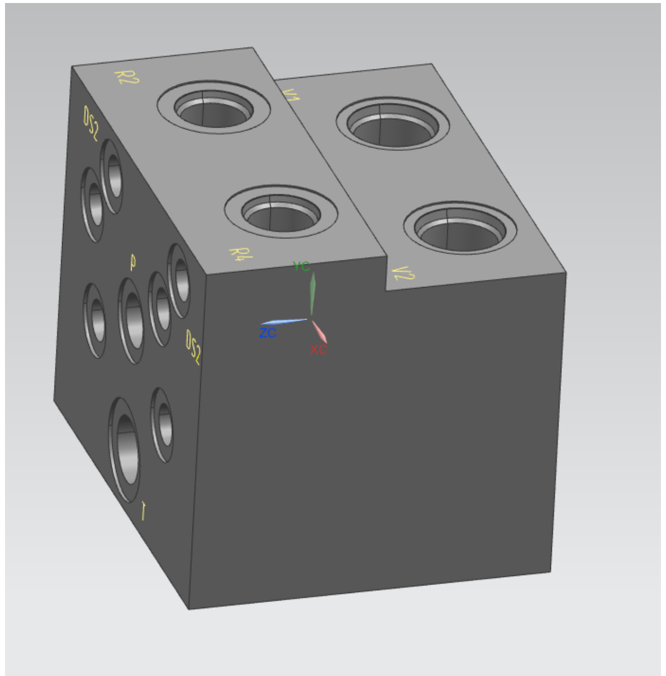
Focus:

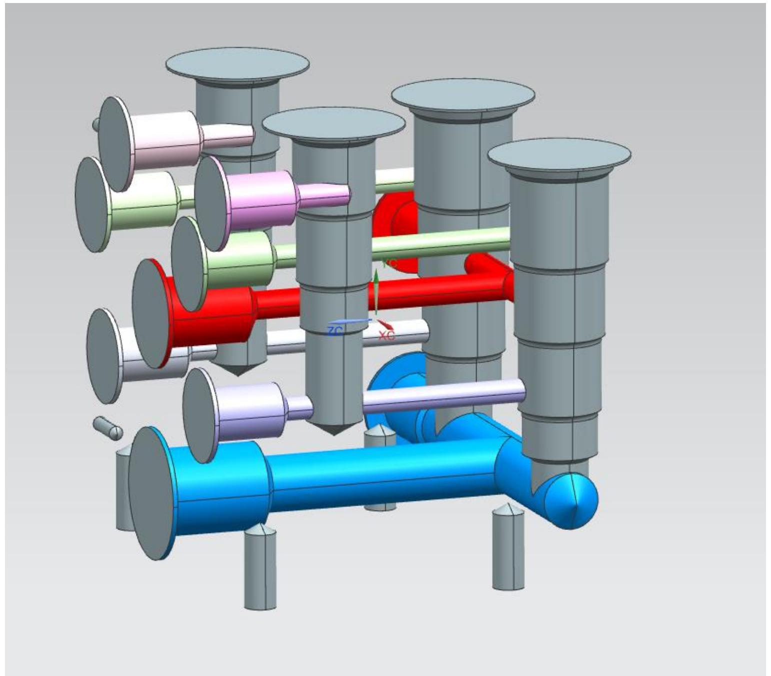
Laser-based Powder Bed Fusion and **Directed Energy Deposition** (High-Pressure Cold Gas Spraying) for **Metals** and **Multi-materials**

public

Optimization example: a hydraulic block

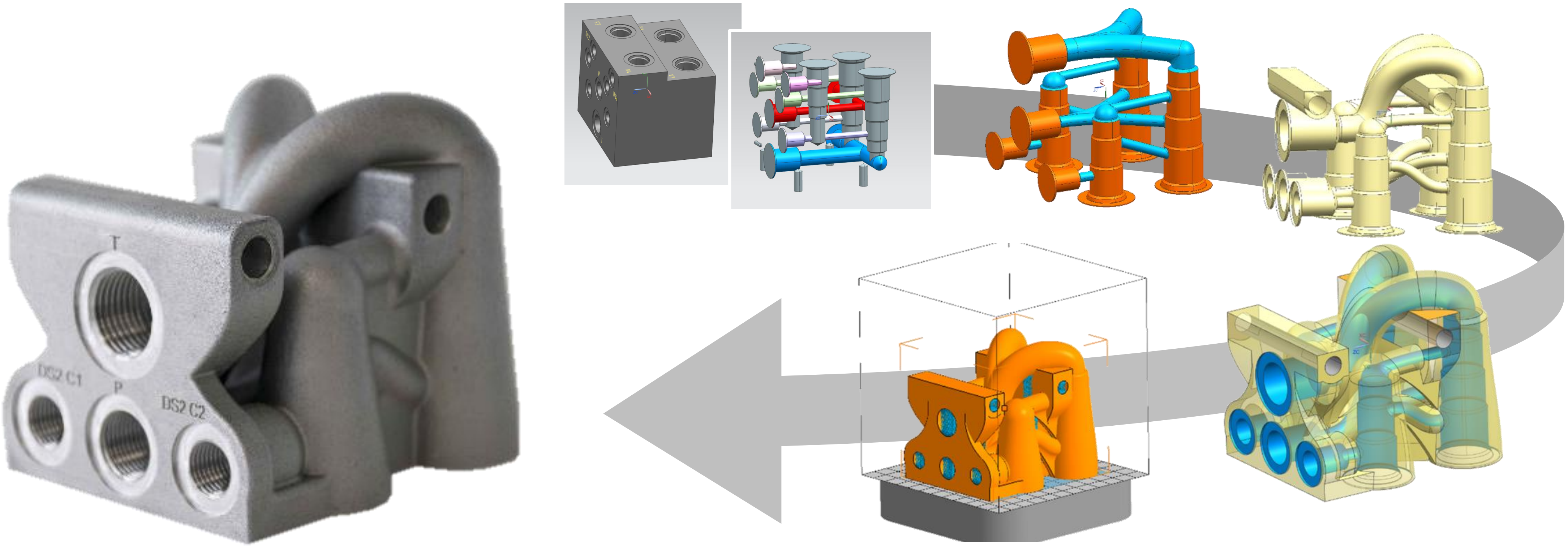
Boundary conditions and development goal





Optimization example: a hydraulic block

Optimization process – the low hanging fruit



→ AM hydraulic block offers 81% of weight reduction and holds a pressure of 300 bar (like conventional part).

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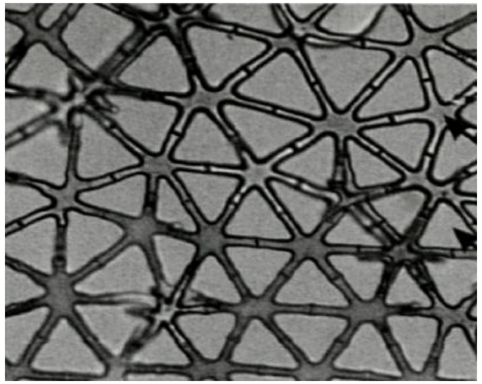
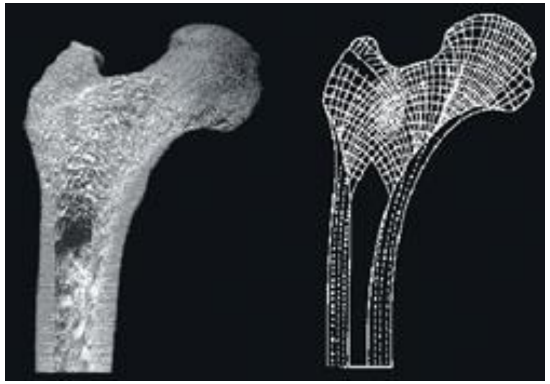
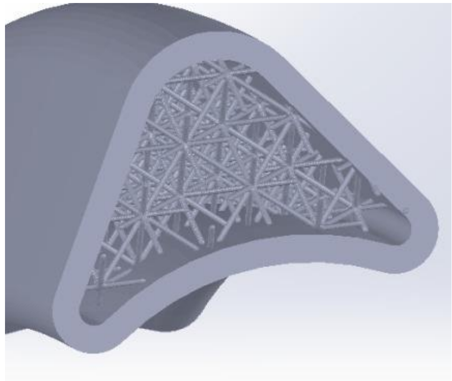
Biomimicry – Design like mother nature
Certain analogies

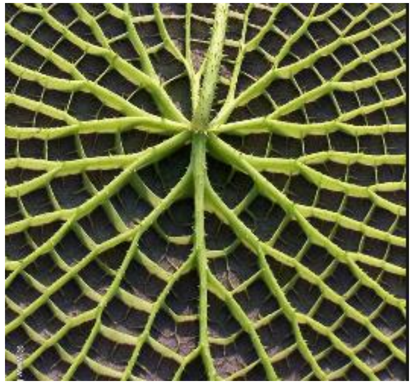

Honeycombs [10]

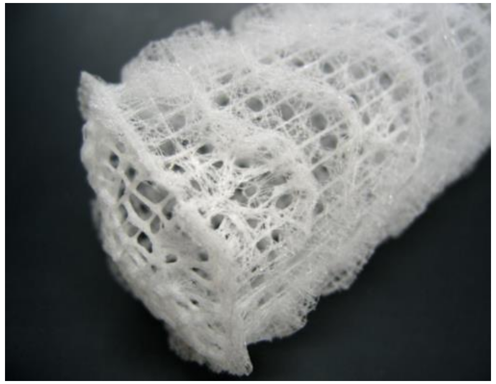

Stalks [11]

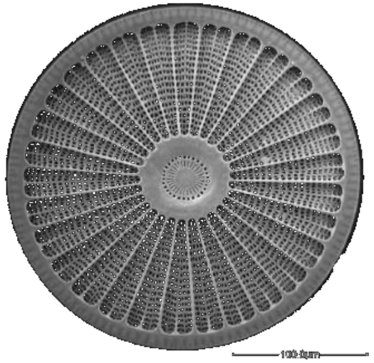

Juncus [12]


Bone [13]


Toucan beak [14]

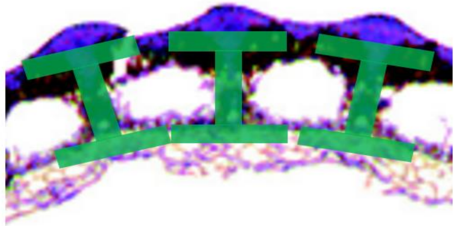

Giant water lilly [15]


Glass sponge [16]

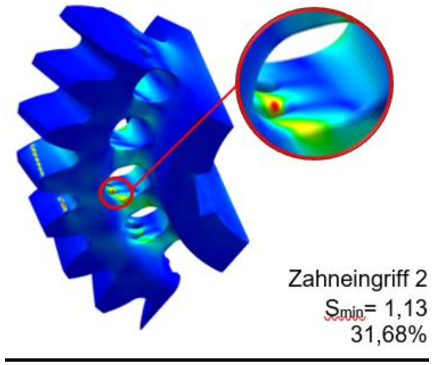

Diatom algae [11]

Abstraction and use for a technical part
Rough horsetail (stalks)

Analogy Rough horsetail

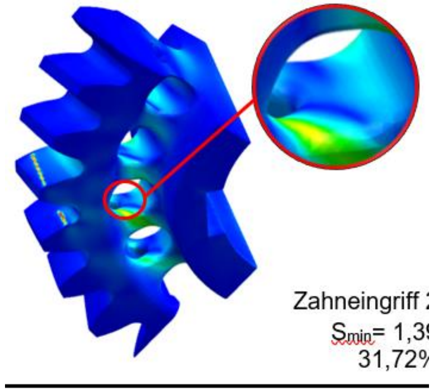


Optimization



Safety factor = 1,13

Mass improvement = 31,68 %



Safeay factor = 1,39

Mass improvement = 31,72 %

Abstraction and implementation

Quelle: VDI 6223

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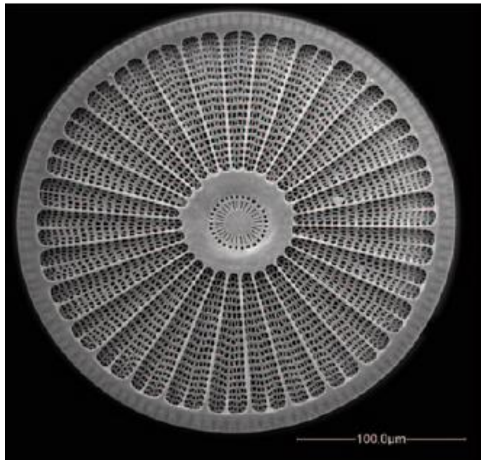
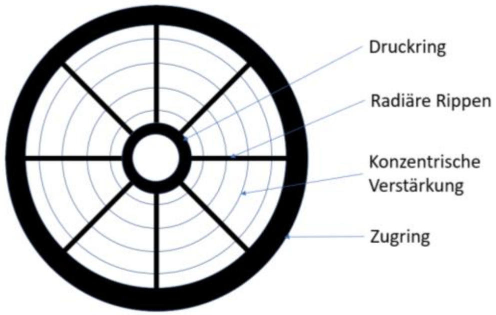
Abstraction and use for a technical part

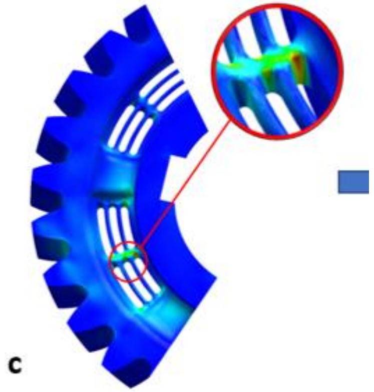
Diatom (algae)

Analogy Diatom (algae)



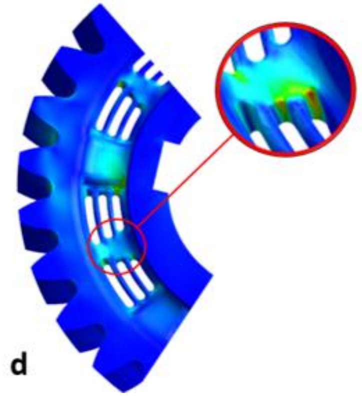


Optimization



Safety factor = 1,13

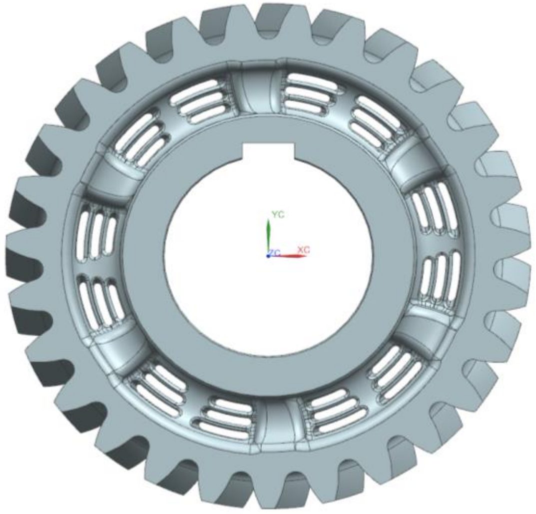
Mass improvement = 31,39 %



Safety factor = 1,20

Mass improvement = 31,41 %

Abstraction and implementation



Quelle: VDI 6223

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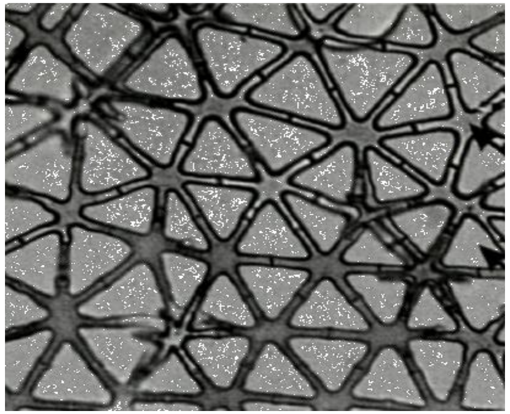
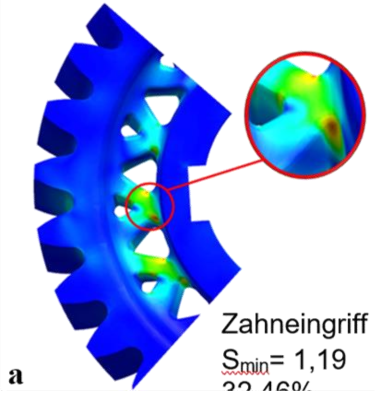
Abstraction and use for a technical part

Juncus

Analogy Juncus

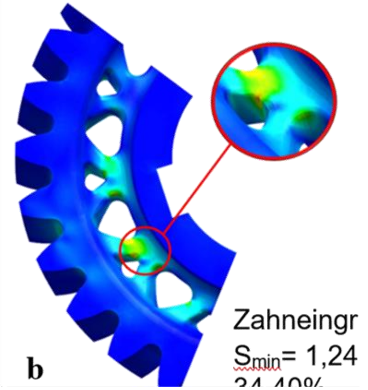


Optimization



Safety factor = 1,19

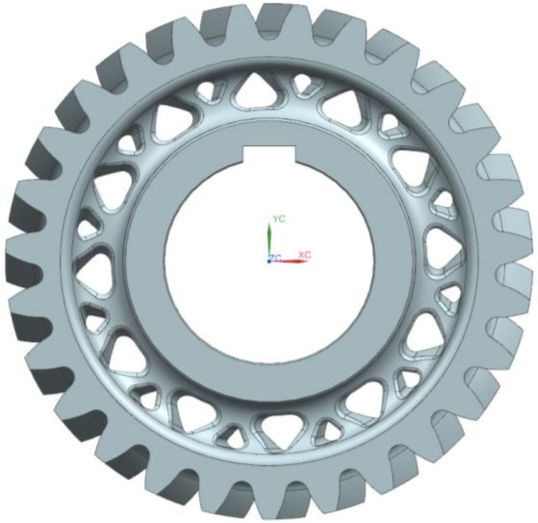
Mass improvement = 32,46 %



Safety factor = 1,24

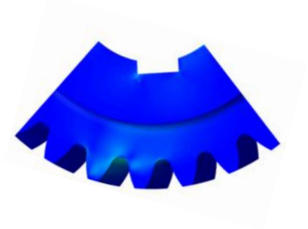
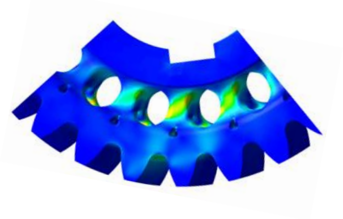
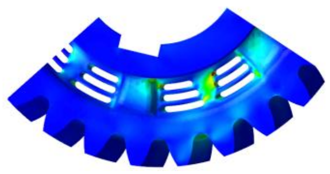
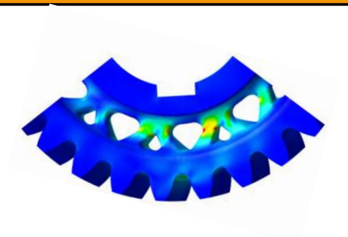
Mass improvement = 34,4 %

Abstraction and implementation



Quelle: VDI 6223

Comparison

	Starting point	Rough horsetail (stalks)	Diatom (algae)	Juncus
				
Mass in kg	0,9917	0,677	0,680	0,651
Mass improvement in %	-	31,72	31,41	34,40
Max. displacement in mm	0,0172	0,0440	0,0465	0,0636
Safety factor	6,95	1,36	1,20	1,24

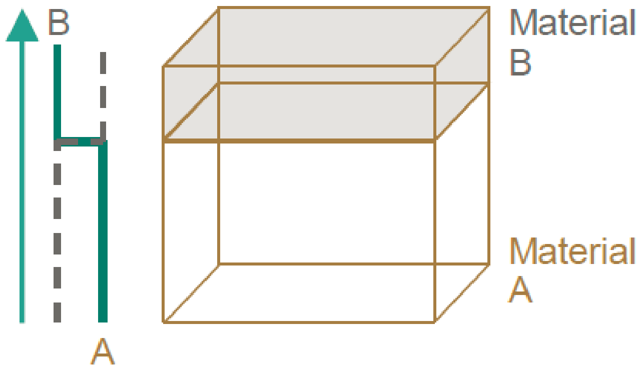
→ Nature supplies many relevant optimization examples which can be applied to technical problems

Multi-material Additive Manufacturing

Next step in Design Freedom

2-D-Multi-material

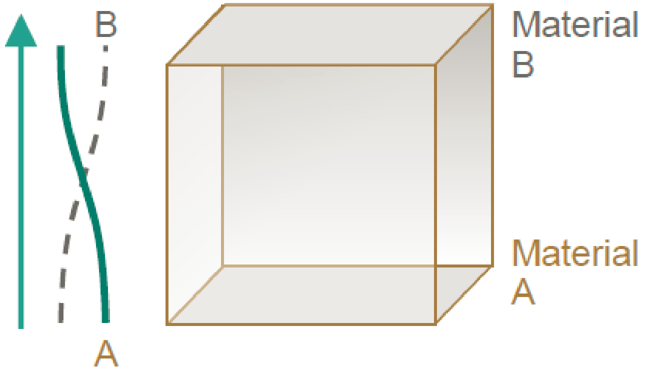
1 Discrete material transition



Industrially available

Graded Material Transitions

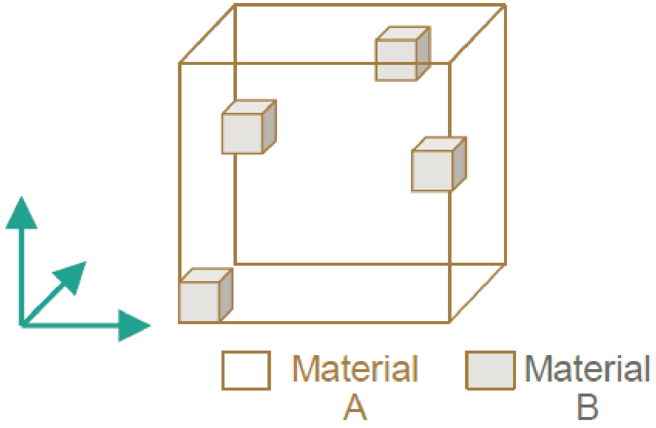
2 Continuous material transition



Ongoing research

3-D-Multi-material

3 Multi-material application



Ongoing research

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3-D-Multi-material Additive Manufacturing allows to combine materials with different properties

Material	Property
Ti6Al4V	Biocompatibility Corrosion resistance Specific strength
CuCr1Zr	Thermal conductivity Electrical conductivity Ductility
AlSi10Mg	**Specific strength** **Electrical conductivity**
Ta	Osseo-integration Biocompatibility
1.2709	Strength Hardness
…	…

Copper infiltrated parts for electrical motors

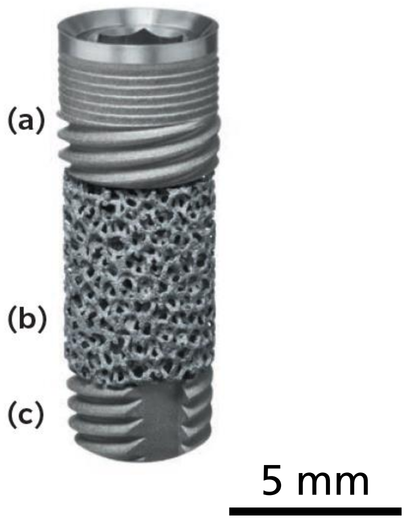
Property	Material
Biocompatibility Corrosion resistance Specific strength	Ti6Al4V
Thermal conductivity **Electrical conductivity** Ductility	**CuCr1Zr**
Specific strength Electrical conductivity	AlSi10Mg
Osseo-integration Biocompatibility	Ta
Strength Hardness	1.2709
…	…

Bildquelle: favi.com

3-D-Multi-material Additive Manufacturing allows to combine materials with different properties

Material	Property
Ti6Al4V	**Biocompatibility** Corrosion resistance **Specific strength**
CuCr1Zr	Thermal conductivity Electrical conductivity Ductility
AlSi10Mg	Specific strength Electrical conductivity
Ta	Osseo-integration Biocompatibility
1.2709	Strength Hardness
…	…

Dental implant made from Titanium (a, c) and Tantalum (b)



Property	Material
Biocompatibility Corrosion resistance Specific strength	Ti6Al4V
Thermal conductivity Electrical conductivity Ductility	CuCr1Zr
Specific strength Electrical conductivity	AlSi10Mg
Osseo-integration **Biocompatibility**	**Ta**
Strength Hardness	1.2709
…	…

Bildquelle: Zimmer Biomet

Fraunhofer IGCV

3-D-Multi-material Additive Manufacturing allows to combine materials with different properties

Material	Property
Ti6Al4V	Biocompatibility Corrosion resistance Specific strength
CuCr1Zr	**Thermal conductivity** Electrical conductivity Ductility
AlSi10Mg	Specific strength Electrical conductivity
Ta	Osseo-integration Biocompatibility
1.2709	Strength Hardness
…	…

Part of a die casting tool

Property	Material
Biocompatibility Corrosion resistance Specific strength	Ti6Al4V
Thermal conductivity Electrical conductivity Ductility	CuCr1Zr
Specific strength Electrical conductivity	AlSi10Mg
Osseo-integration Biocompatibility	Ta
Strength **Hardness**	**1.2709**
…	…

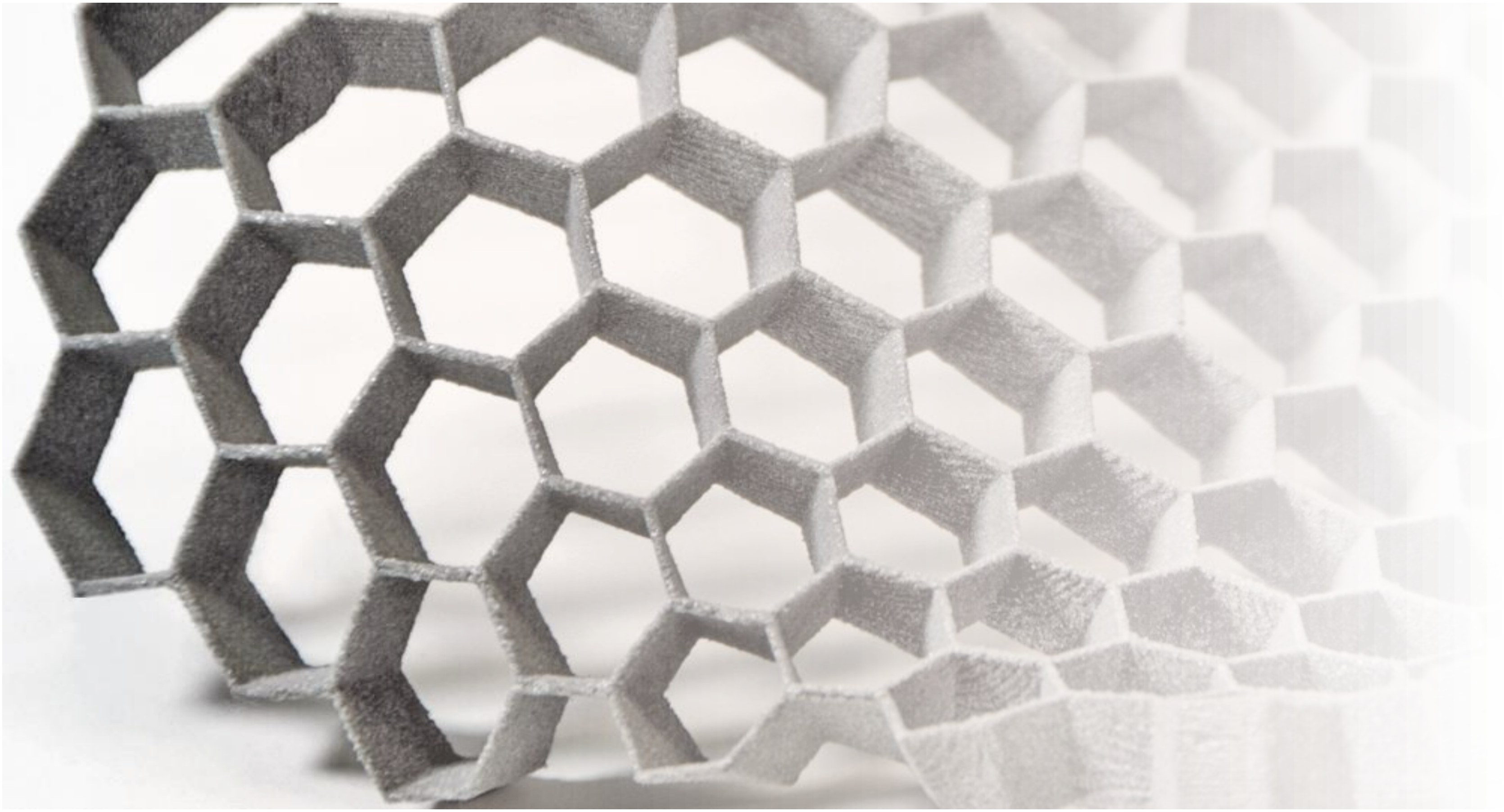
Bildquelle: Fraunhofer IGCV

Fraunhofer IGCV

3-D-Multi-Material example

→ Multi-Material Additive Manufacturing increases the need for 3D thinking on a new level
→ Implementation of 3D Thinking in companies will become even more demanding

Thank you very much!
Questions or remarks?



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www.amlab.de

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