KREISLAUFFÄHIGER FAHRRADRAHMEN HERGESTELLT IM SPRITZGUSS

DI Dr. Umut Çakmak

JOHANNES KEPLER UNIVERSITY LINZ

Institute of Polymer Product Engineering

31.03.2021, Teams Meeting

MOTIVATION

KIDZBIKE
REVOLUTION

First injection molded bicycle frame (1980s)

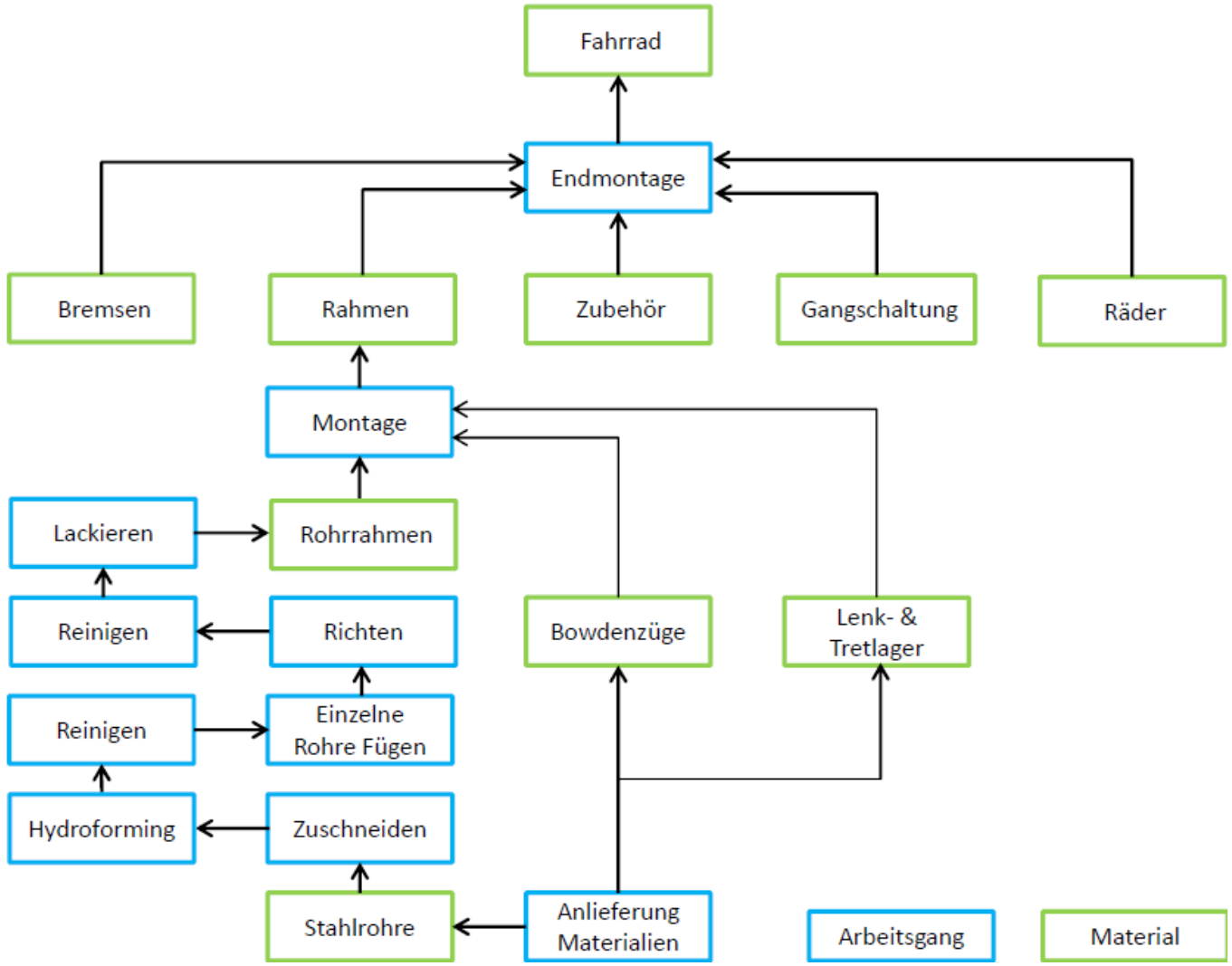
JKU iPPE PLASTIC Innovation

MOTIVATION

NUVELOS
engineered by
REHAU
NUVELOS
SCHWALBE G-ONE

THE RV01 E-BIKE
no carbon.
no aluminium.
only advanced composites.
go green.
STAJ

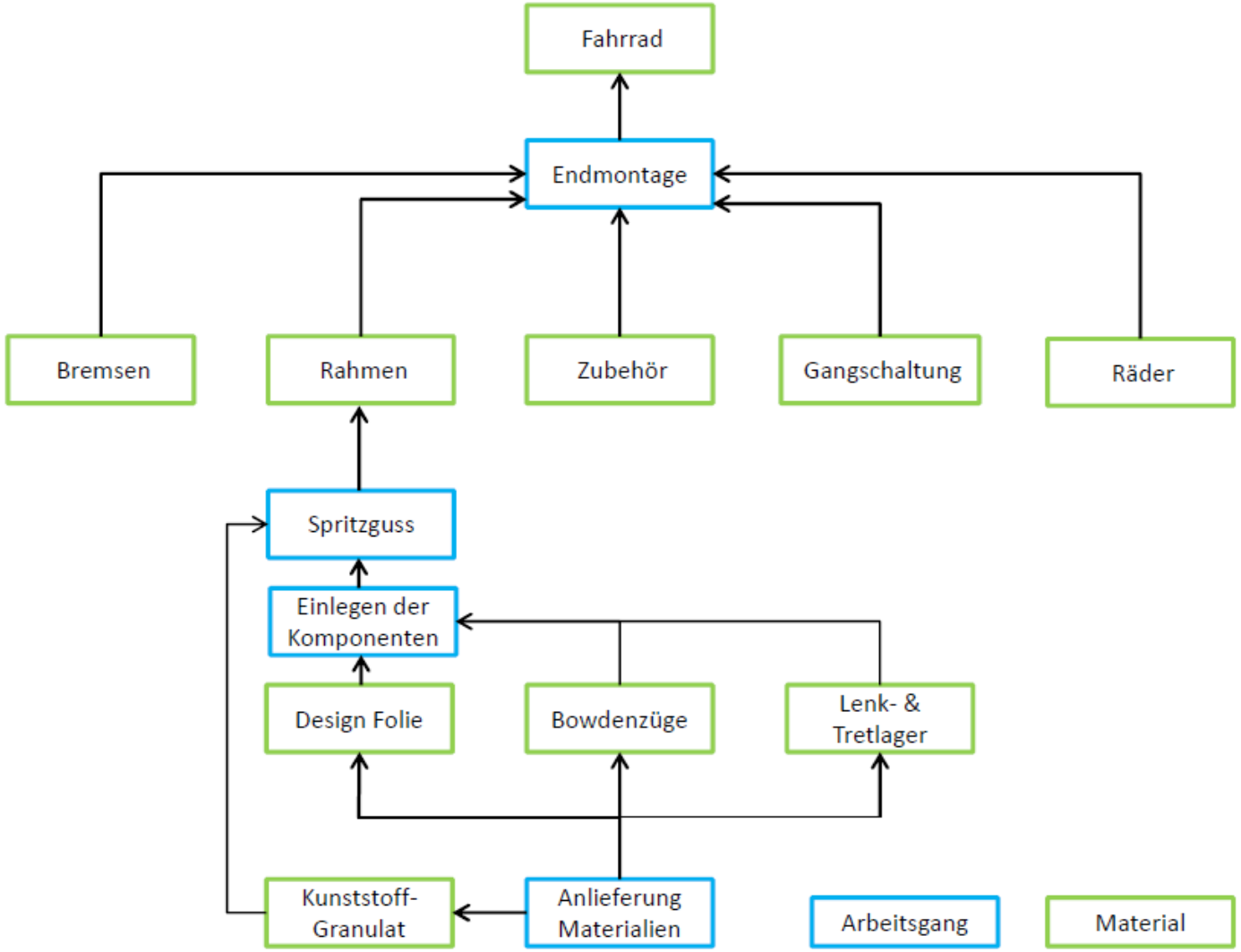
MANUFACTURING PROCESS OLD



current manufacturing process

- alloy frame has highest market share (complex production of the raw material)
- time and labour consuming to manufacture alloy or steel frames
  - hydroforming
  - welding
  - painting
- production in „low-wage countries“
- long lead time

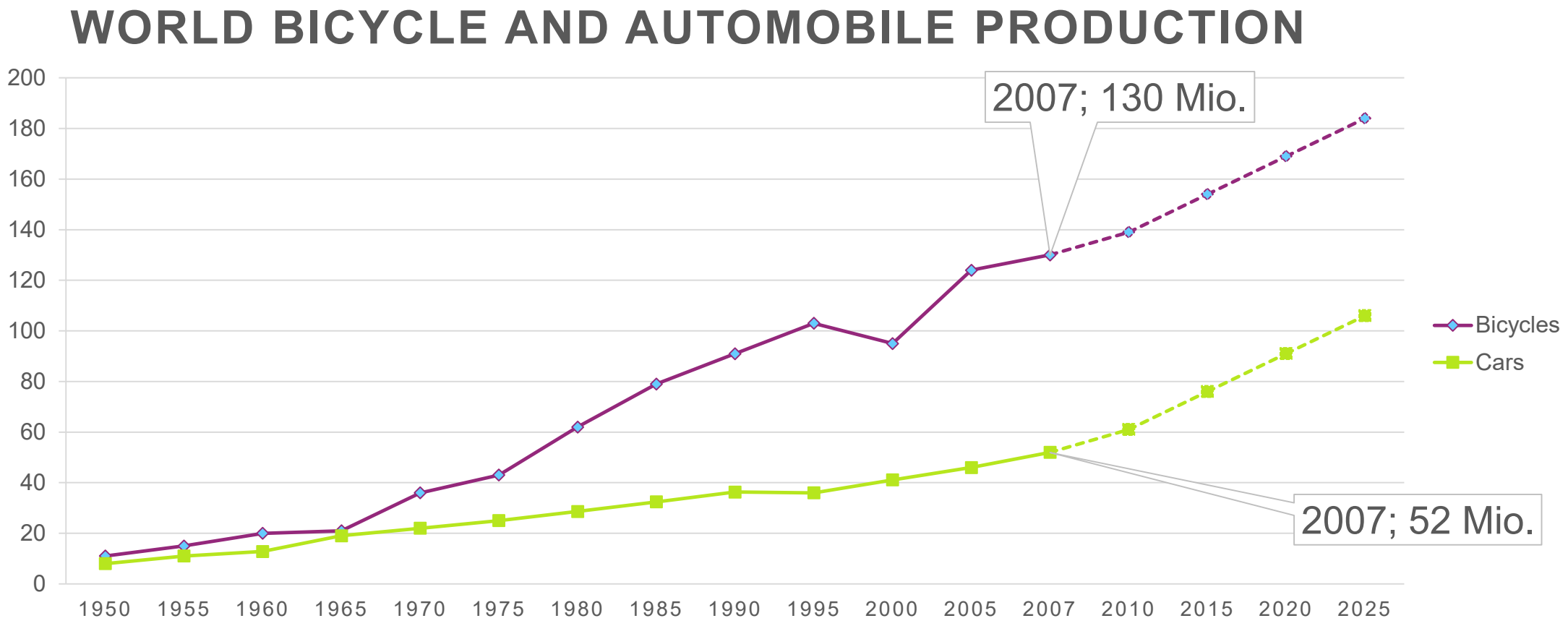
MANUFACTORING PROCESS NEW



manufacturing with injection moulding

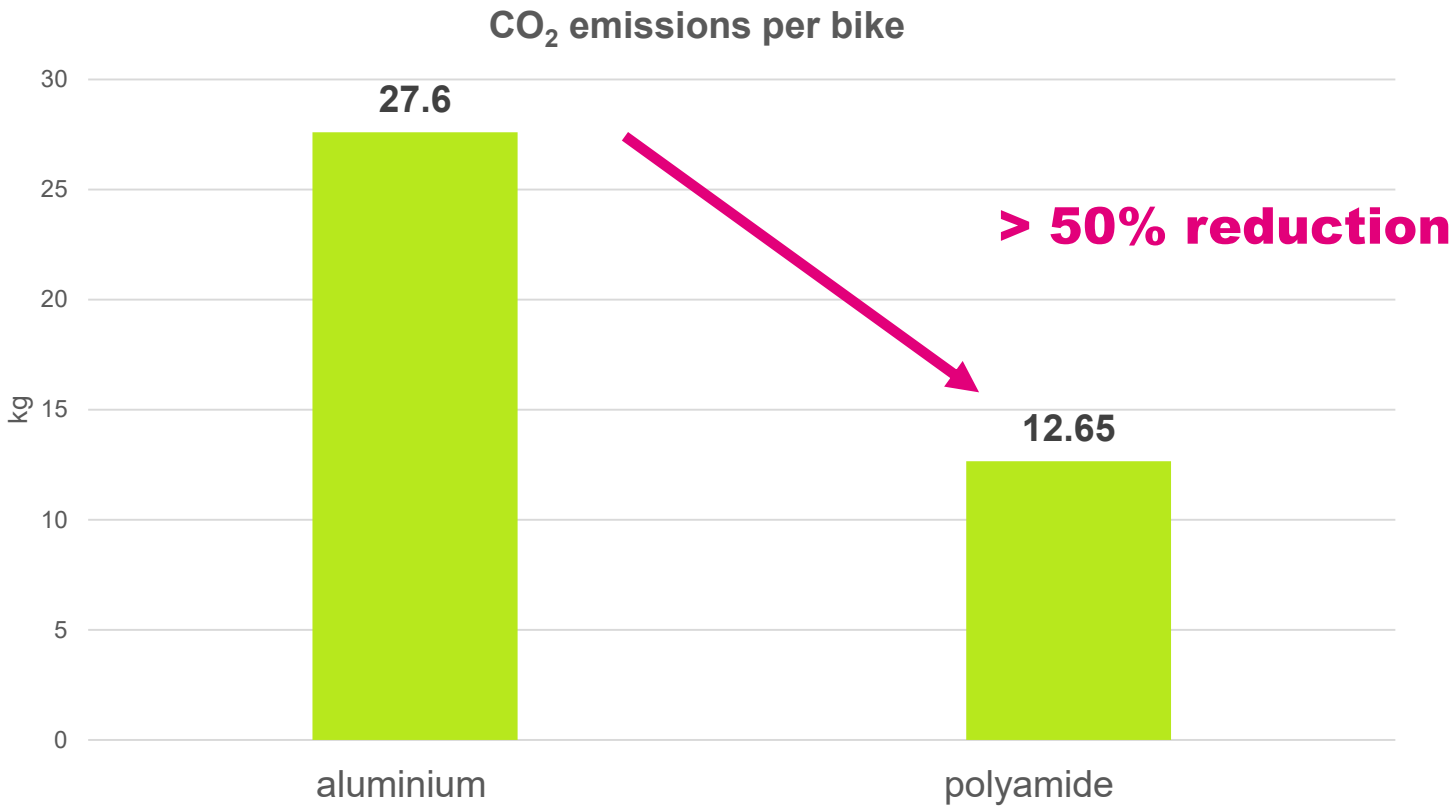
- fully automated production
- Know-how and production in Europe (in the countries of sales)
- shorter lead times (production on demand)
- better product life cycle (closed-loop recycling), less CO_2 emissions

MARKET



© Worldwatch Institute

CO_2 EMISSIONS



frame material	mass frame	density	CO_2 emission factor	CO_2 emissions per bicycle frame
aluminium	2,3 kg	2,70 g/cm³	12,0 kg/kg	**27,60 kg**
polyamide	2,3 kg	1,35 g/cm³	5,5 kg/kg	**12,65 kg**

SUSTAINABILITY

.....if the world would produce yearly 130 Mio bicycles in injection molding.....

CO_2 reduction = more than 200.000 tons / year

is equivalent to:

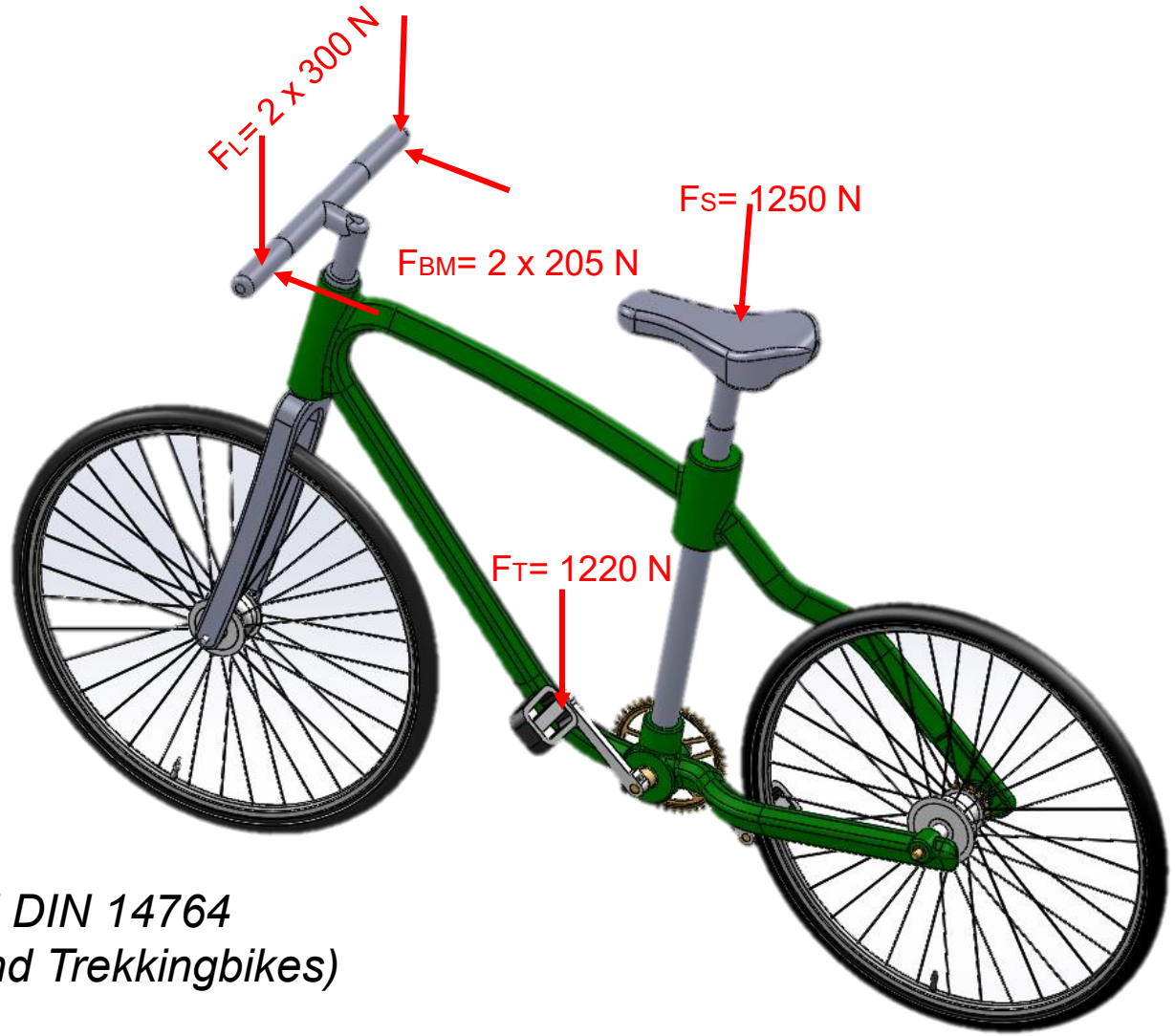
CO_2 emissions of 700 000 cars per year

and

182 000 tons of plastic waste would be transformed into bicycles

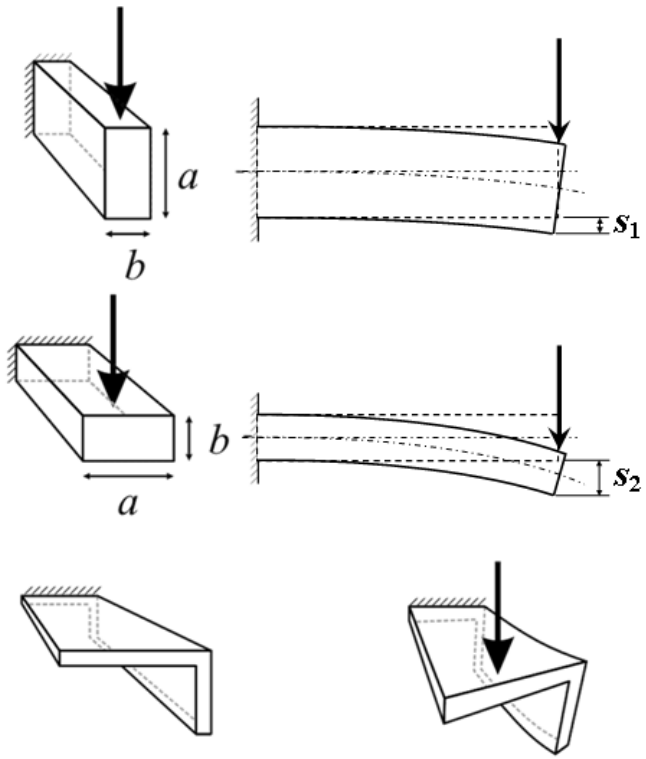
(equals 2,9% of total plastic waste of Germany 2017)

MECHANICS



Acc. EN DIN 14764
(City- and Trekkingbikes)

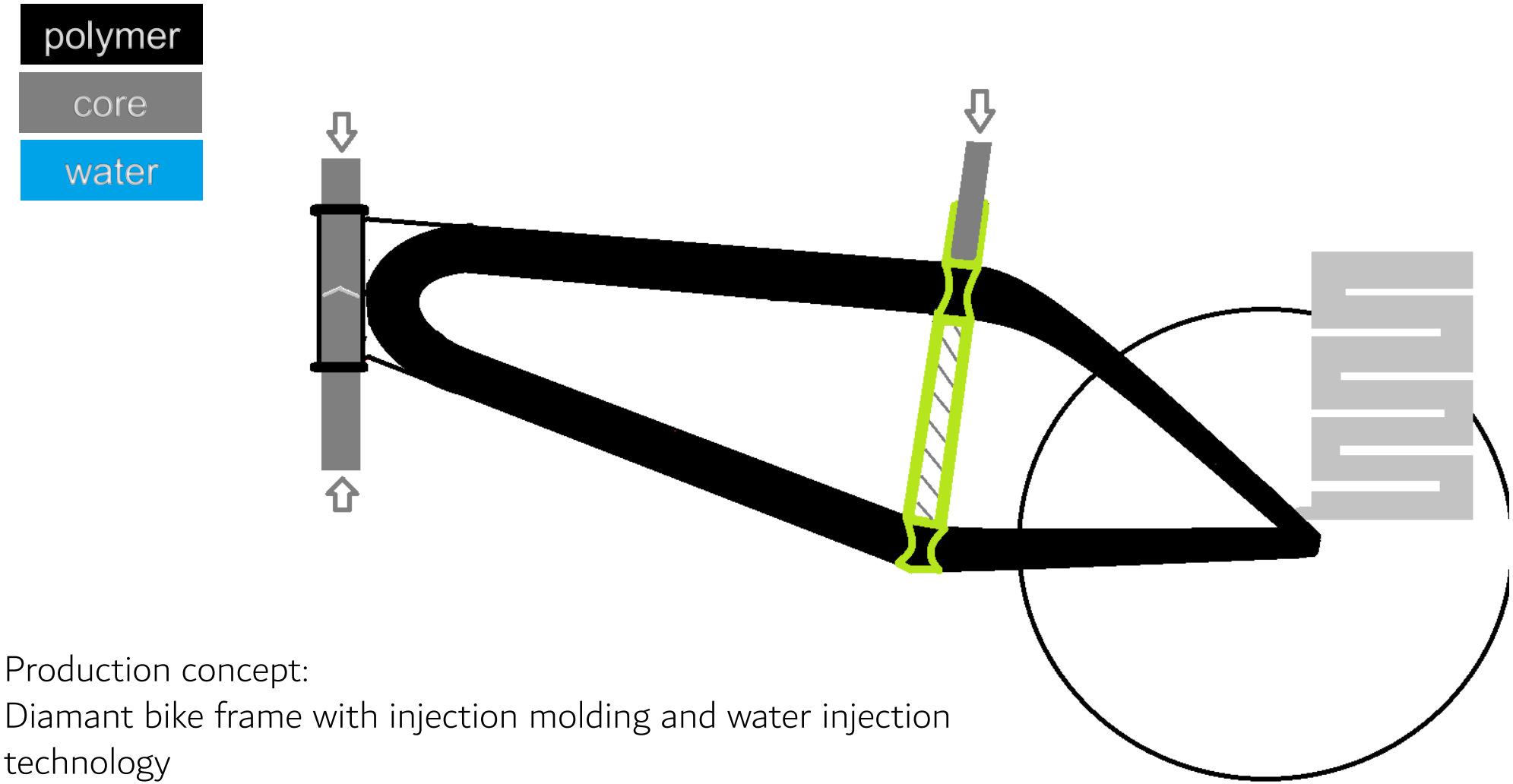
Ribbed design



< bending stiffness

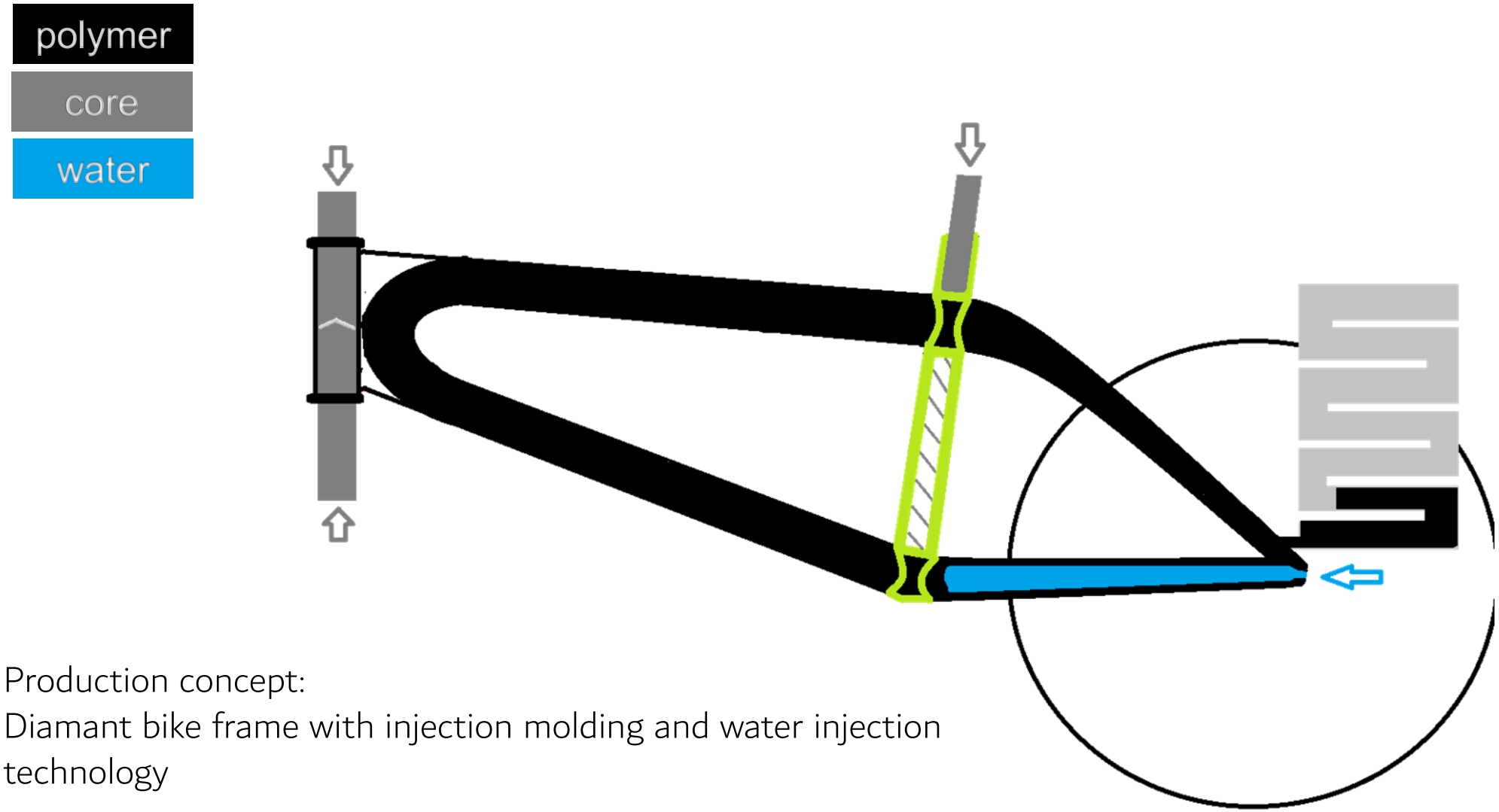
< torsional stiffness

CONCEPT FOR PRODUCTION



Production concept:
Diamant bike frame with injection molding and water injection technology

CONCEPT FOR PRODUCTION



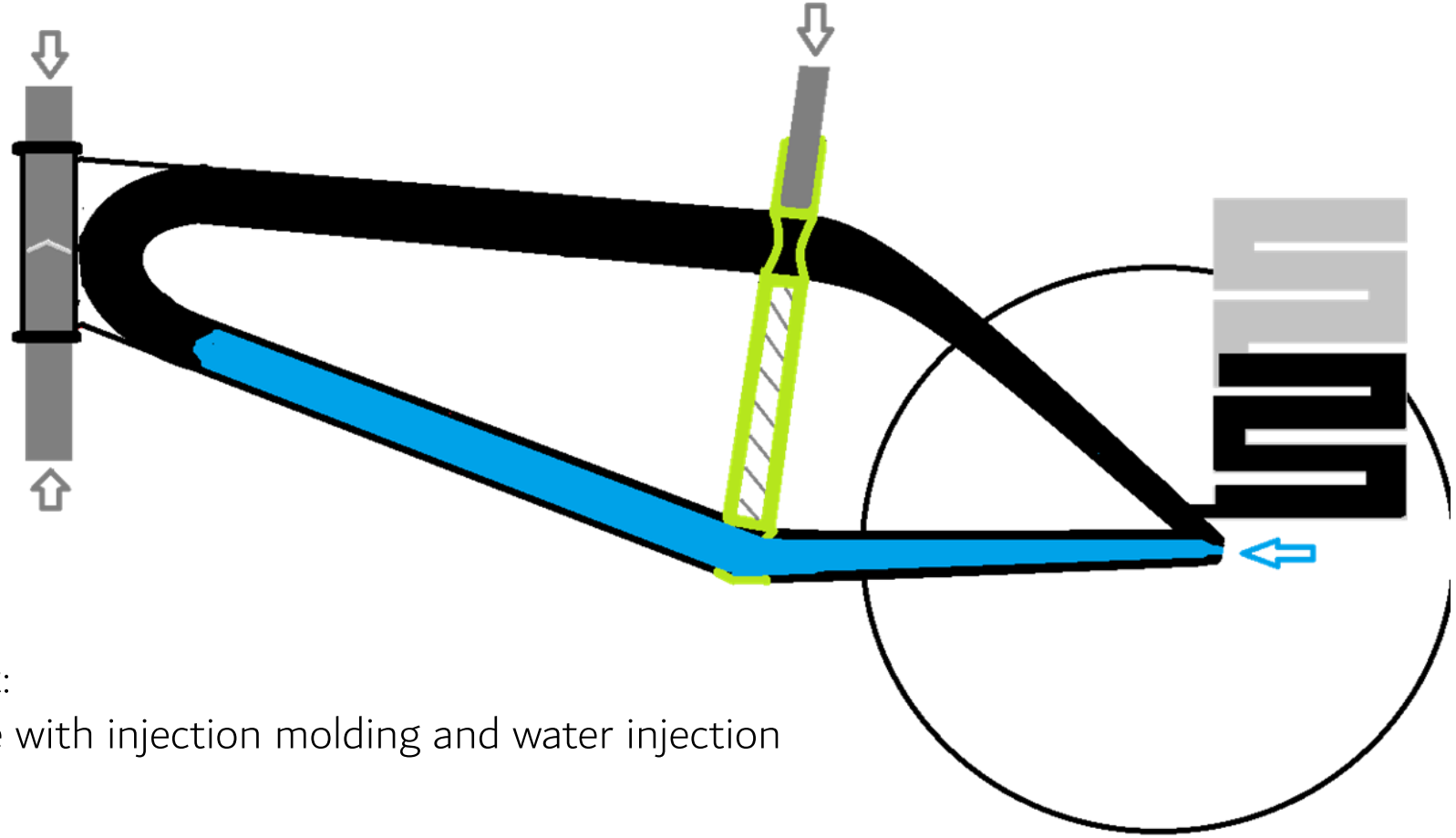
Production concept:
Diamant bike frame with injection molding and water injection technology

CONCEPT FOR PRODUCTION

polymer

core

water



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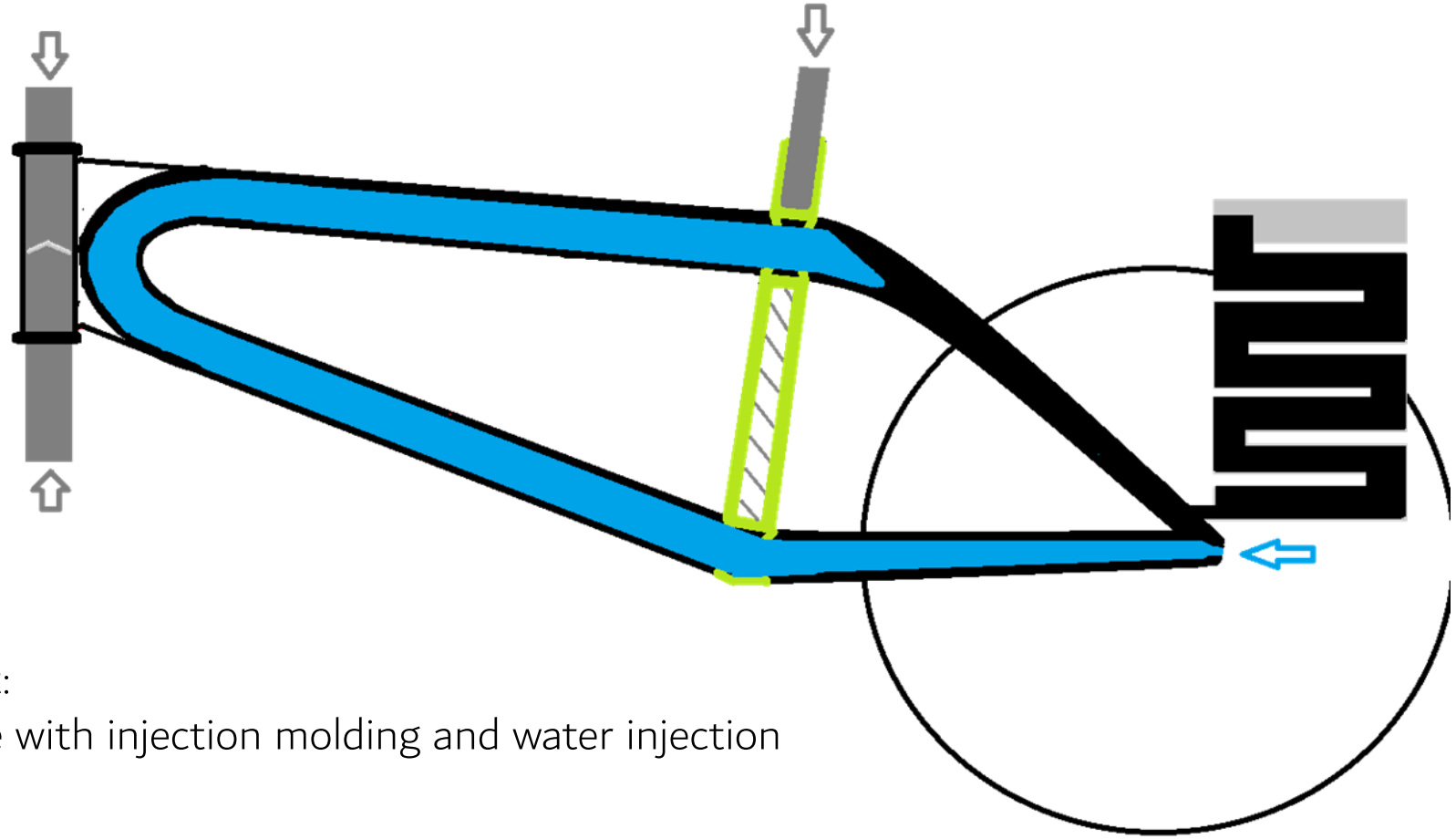

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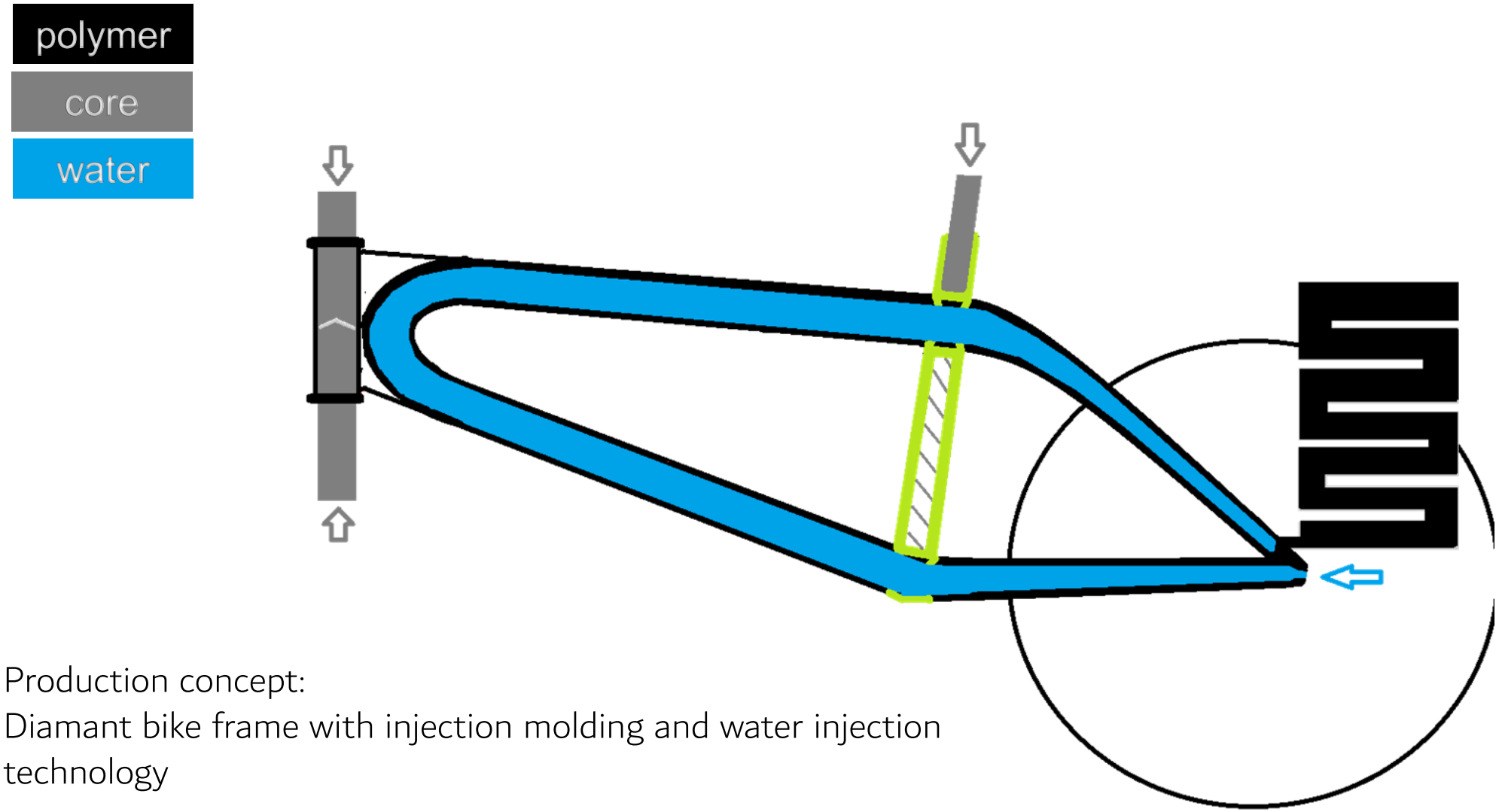

Production concept:
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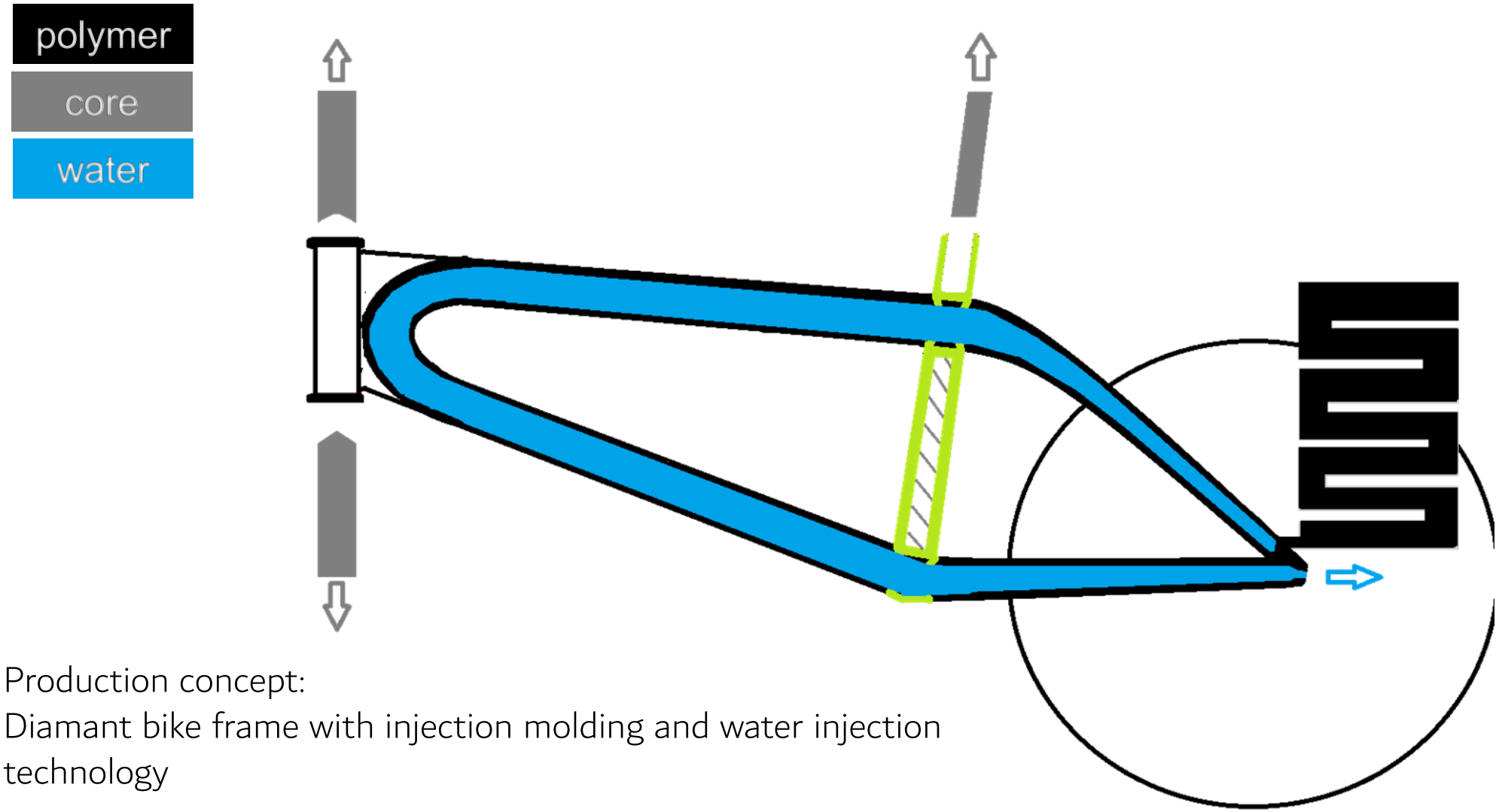
CONCEPT FOR PRODUCTION

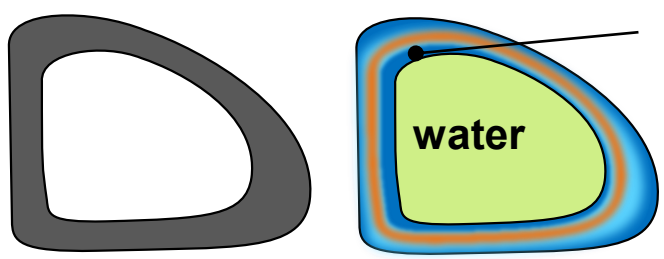


Production concept:
Diamant bike frame with injection molding and water injection technology

WATER ASSISTED- VS. GAS ASSISTED IM

water

- thinner wall thickness
- more constant wall thickness
- smoother surfaces (gas diffuses into the polymer melt)

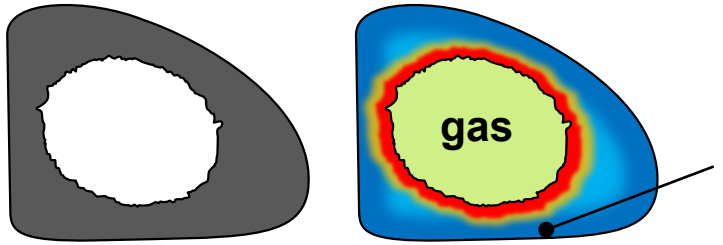


additional cooling from inside out

thinner remaining wall thickness

gas

- Nitrogren is easier to handle
- without residuals in the component
- easier tool



only cooling from the tool

thicker remaining wall thickness

comparison water- und gasmelt [by co. ENGEL, co. PME]

FUNCTION INTEGRATION

first concept bike 2018

video: https://youtu.be/1ug0P9gPHAc

Proof of Concept

first bike in series production 2020

first bike in series production 2020

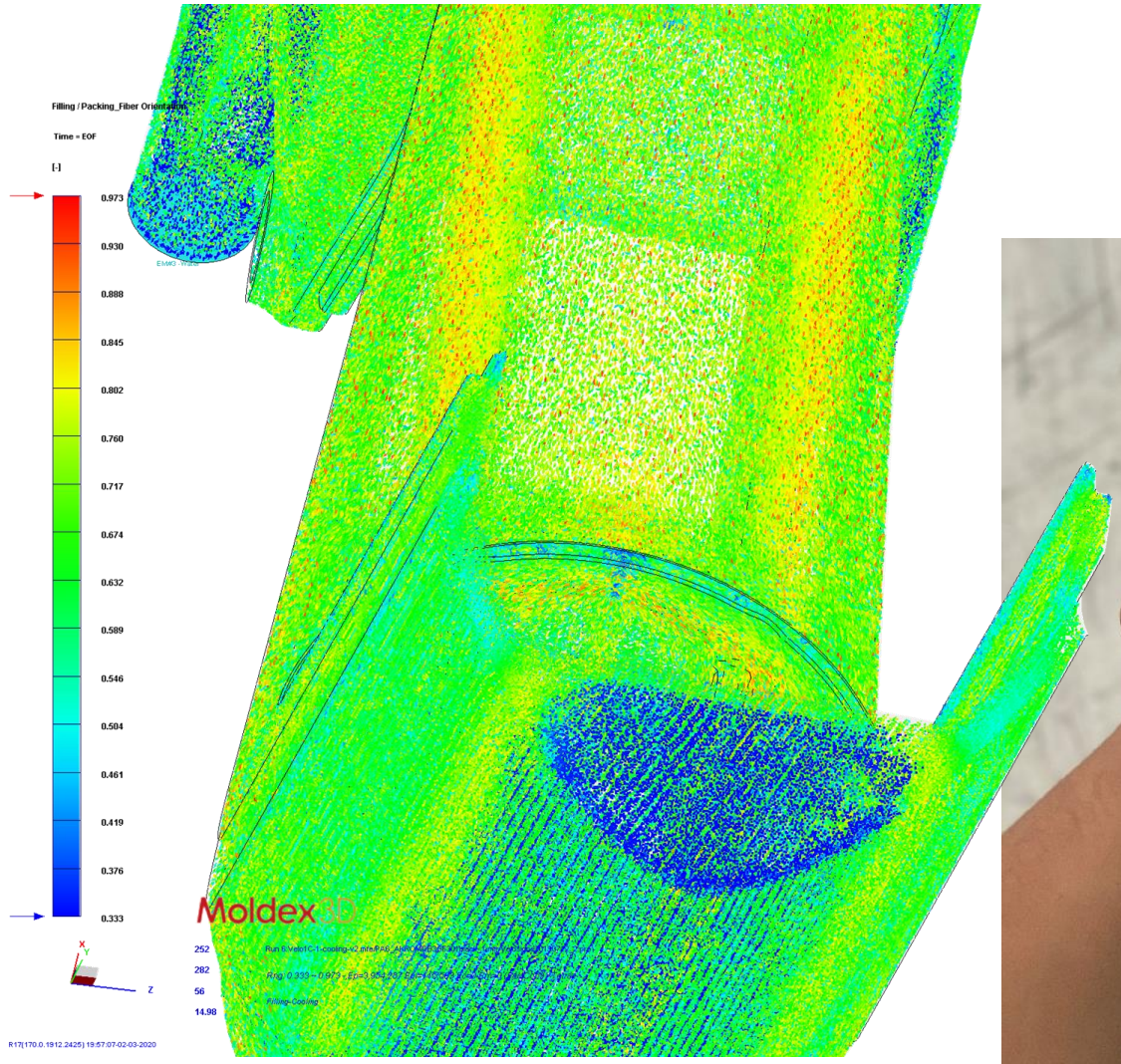
FRAME DESIGN

coleo design

JKU iPPE PLASTIC Innovation

Injection Molding Simulation & Production

Filling simulation: Water injection

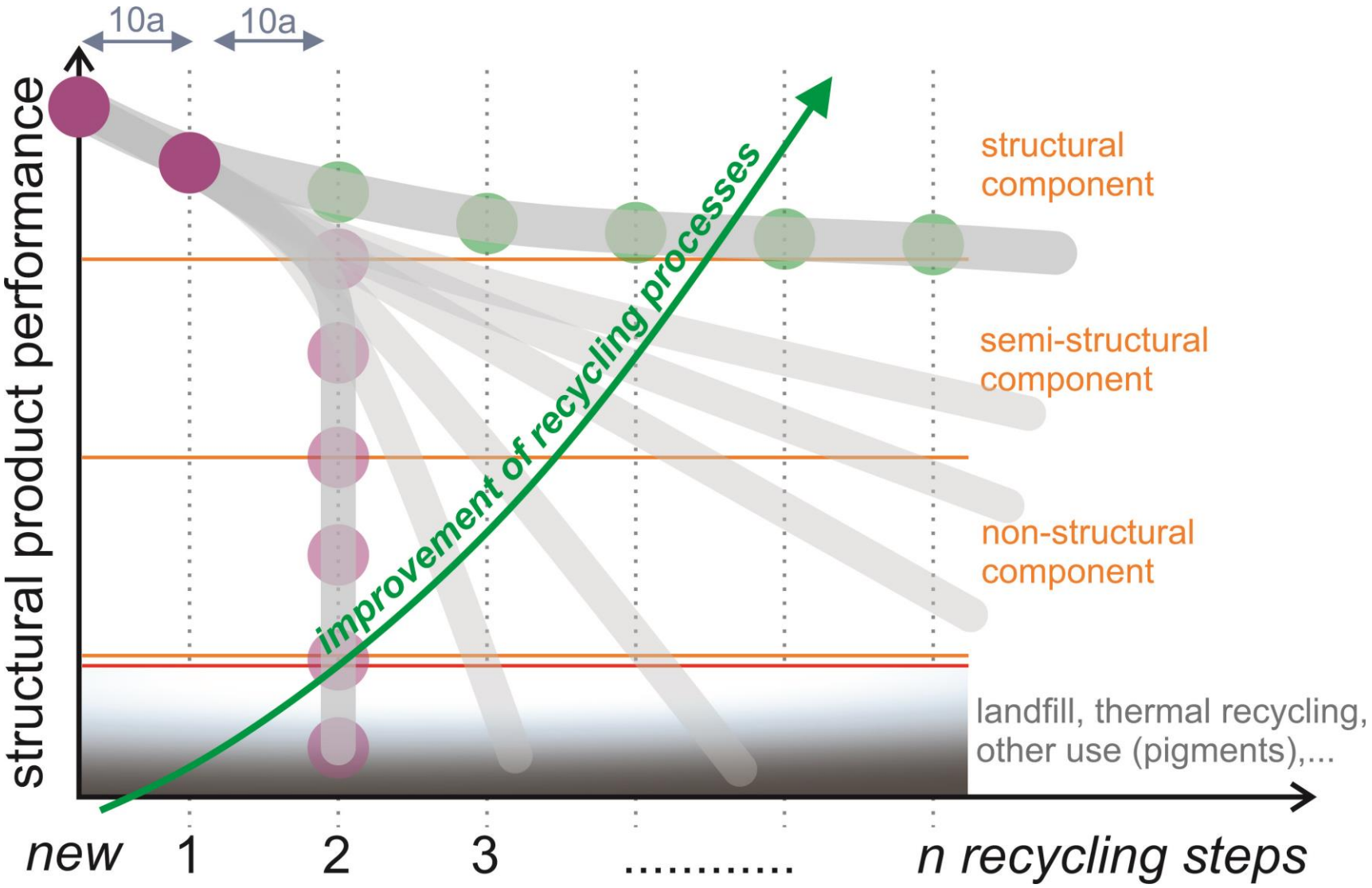


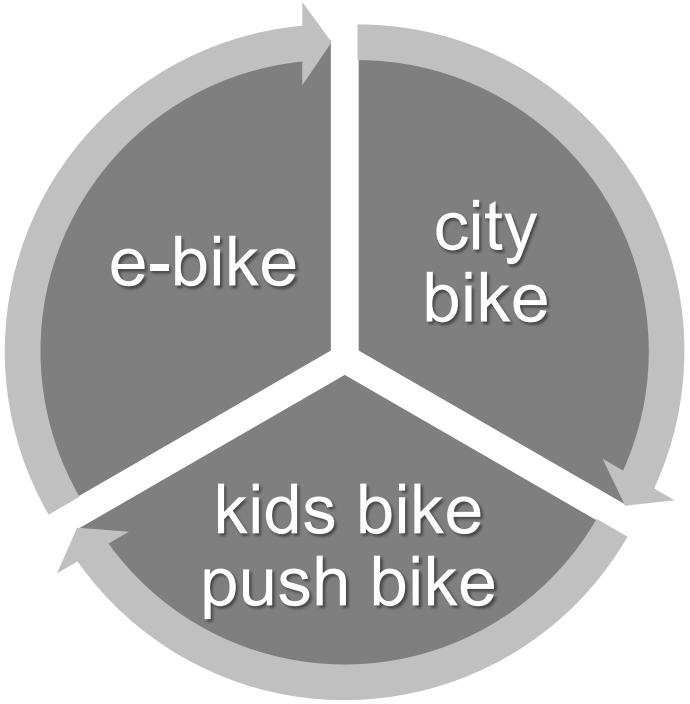
- 1/3 random orientation in the core of the thick-wall sections
- after water injection → remaining sections highly oriented >0.7

EPAL

ENGEL

MULTIPLE PRODUCT LIFE CYCLES





Structural Analyses

Digimat-MF
-lag vs Digimat MF

VELOSIONE

Contact

VELOSIONE

TEICH
WERK

Summary

- proof of concept successfully completed
- WAIM enables design freedom and high degree of production automation
- short cycle times (additional cooling as well as packing from the injected water)
- sustainable value chain
- fully recyclable material

GERMAN INNO VATION AWARD '19 GOLD

category: „transportation“

GERMAN INNO VATION AWARD '19 WINNER

category:
„design thinking“

Edison 2017

Greenstart 2017

HIGH
PERFORMANCE
ECOLOGICAL
INJECTION-MOLDED
COMPOSITE
BIKE FRAMES

GAMECHANGING

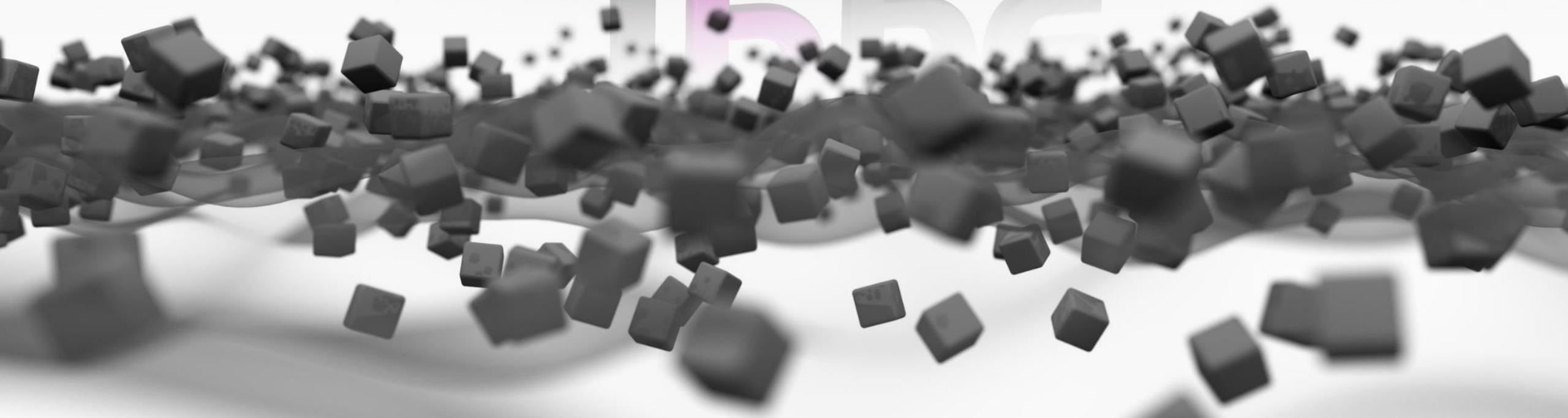
... developed in Austria

„There is a way to do it better, find it“

JOHANNES KEPLER
UNIVERSITÄT LINZ

iPPE

Institute of
Polymer
Product Engineering

Umut Çakmak

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