Additive Manufacturing in the Automobile of the Future: Evolutionary and Revolutionary Innovation Paths

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Engineering Services and turn key projects of EDAG and FFT

PRODUCT DEVELOPMENT

- Design concepts
- Vehicle development
- Function development
- Vehicle validation
- Electrics / electronics



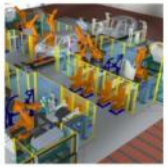


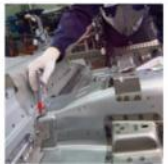
- Project management
- Quality and documentation management
- IT services
- Process consulting (FEYNSINN – die wissensWerker)

PRODUCTION SOLUTIONS

- Control engineering and automation technology
- Production engineering
- Production process planning
- Factory and logistics planning
- Tooling and vehicle body systems





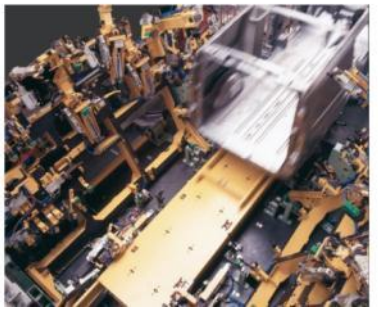


PLANT REALISATION

FFT

Turnkey systems, body in white and assembly

System technologies and products



Agenda

1 **Lightweight Design 1.0: Definition**
Trends in vehicle development

2 **Lightweight Design 2.0: Current solutions and concepts**
Cost efficient lightweight design versus hybride lightweight design

3 **Opportunities through additive manufacturing**
Method, growth potential, benefits

4 **Visionary concepts and approaches with additive manufacturing**
EDAG Genesis & Light Cocoon, Concept examples

5 **Summary**
Industry 4.0, cooperation models and success factors

Energy-efficient lightweight design: or shall we obtain a little bit more driving dynamics?

EDAG Engineering GmbH

CO_2 Targets = Risk -> Cost increase

Lightweight design = Chance -> Benefit

EDAG Competence Centre “Lightweight design”: May can be welding/joining the essential manufacturing process?

Feasibility study for carbonfibre sandwich composite
with prospects for larger quantities (2012)

- 40%

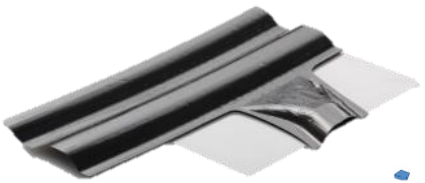
GOLD AWARD 2013

BiW knots in thin-walled steel castings (2011)

- 30%

Direct lay up of thermoplastic tapes for load-optimised structures (2013)

- 70 %



Additive Manufacturing of ultra light multifunctional components (2014)

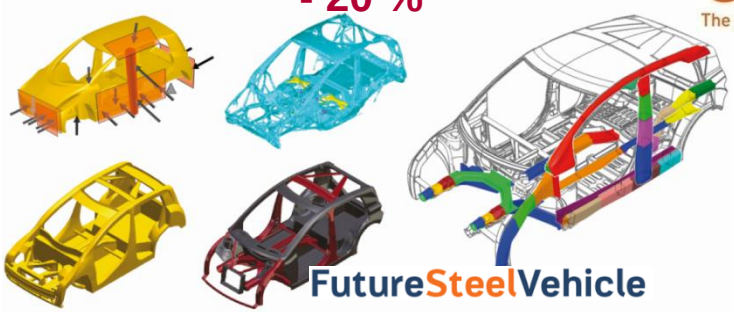
- 50%

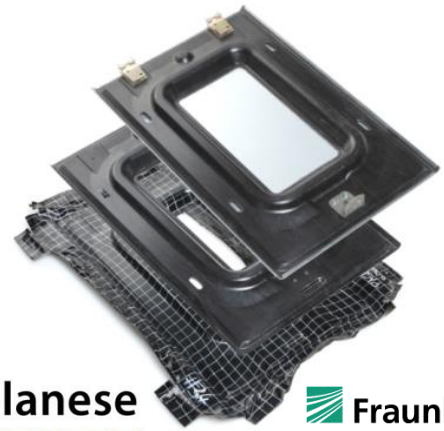
Production of body parts from Mg sheets: Tooling, forming, joining (2013)

- 30 bis -40 %

FutureSteelVehicle (2011)

- 20 %



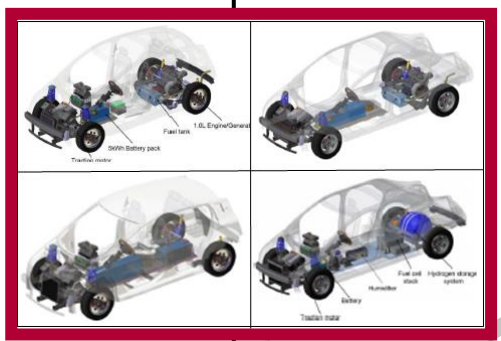


Thermoplastic tape laying: structural component, reinforcement inlay (2013)

- 20 %

Alternative drivetrains increase the number of derivatives and vehicle types: Are „load categories“ an essential future benefit for the carmakers?

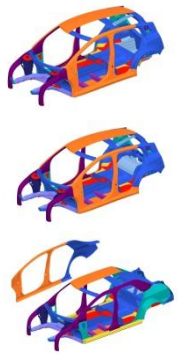
Alternative drive systems also generate new types of vehicles (f.e. BMW i3, Renault Twizzy)



the 60s	the 70s	the 80s	the 90s	the 2000s	the 2010s
					Sharing vers.
					SUV-Conv.
					Mini
				SUV-Coupé	SUV-Coupé
				SW-Coupé	SW-Coupé
			Pickup	Pickup	Pickup
			Off-Road	Off-Road	Off-Road
			SUV	SUV	SUV
			Roadster	Roadster	Roadster
		MPV	MPV	MPV	MPV
		Convertible	Convertible	Convertible	Convertible
	Hatchback	Hatchback	Hatchback	Hatchback	Hatchback
	Station wagon	Station wagon	Station wagon	Station wagon	Station wagon
	Compact car	Compact car	Compact car	Compact car	Compact car
Spider	Coupé	Coupé	Coupé	Coupé	Coupé
Sports car	Sports car	Sports car	Sports car	Sports car	Sports car
Sedan	Sedan	Sedan	Sedan	Sedan	Sedan

100 %

Various variants with alternative drive trains



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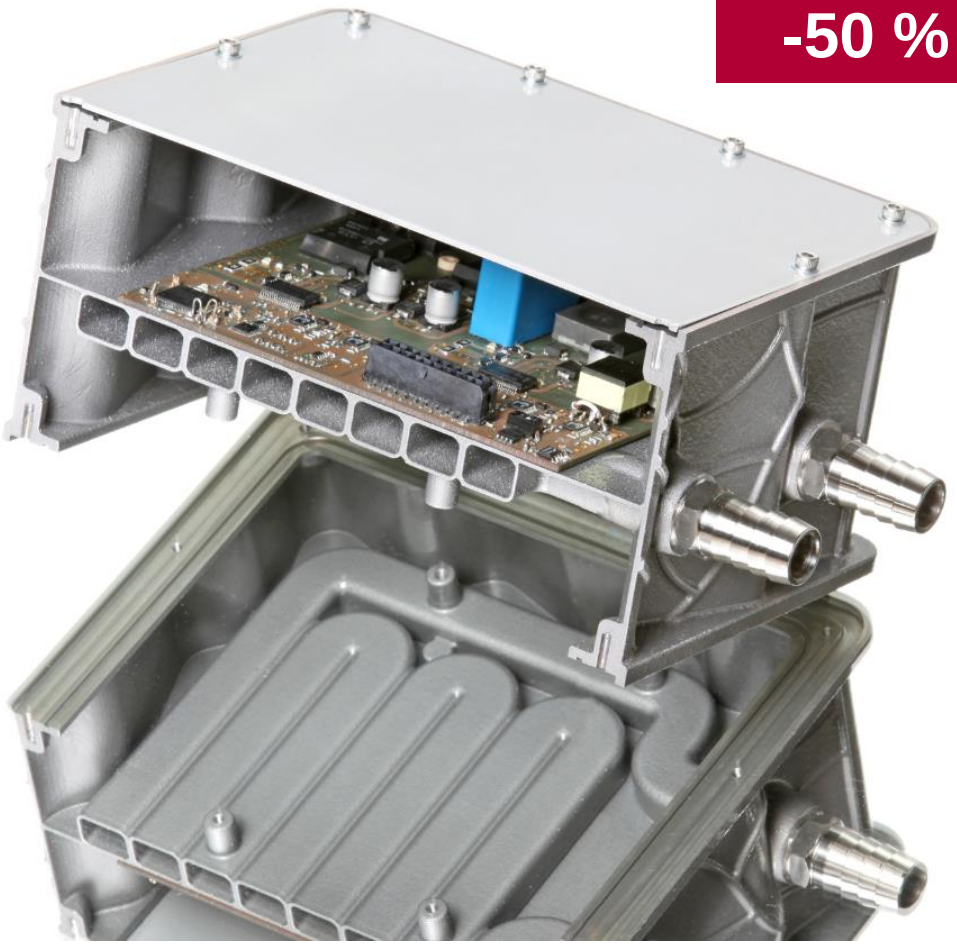
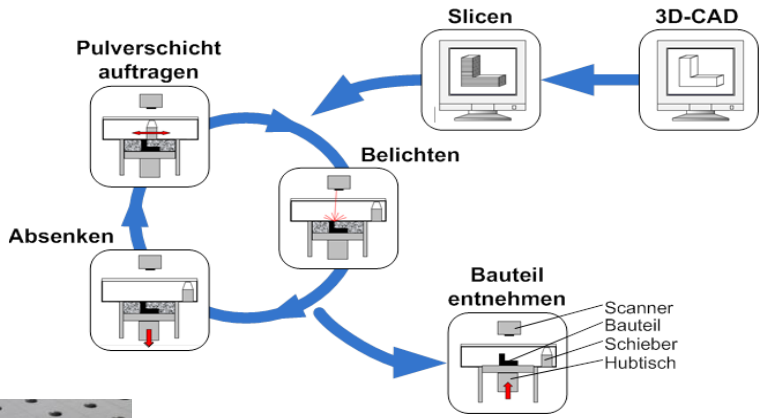
Additive Manufacturing versus Rapid Prototyping?

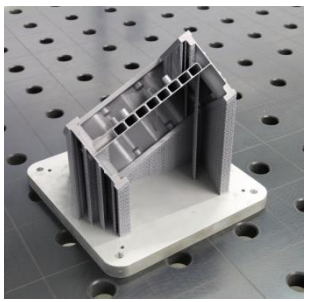
Additive manufacturing of ultralight, multifunctional components using the example of power electronics (2013)

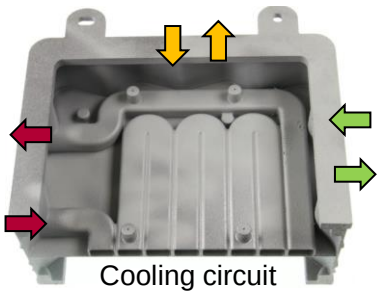
-50 %



Weight reduction potential	↗
Functional integration	↗
Cost impact	→
Sustainability & resource efficiency	↗





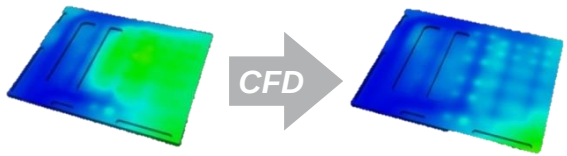

Cooling circuit

- Tool-less production of complex metal structures with unachieved freedom of design and maximum weight reduction potential for small series.
- Production directly from the data set.

In co-operation with:

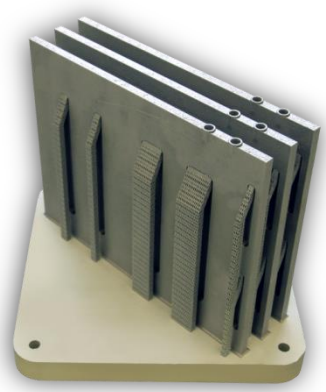
Power electronics housing with additive manufactured cooling structure

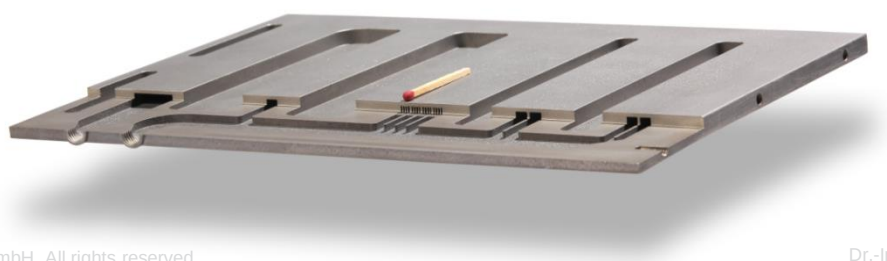
- combination of conventional manufacturing and additive manufacturing
- high efficient cooling of the power electronics through CFD optimized aluminium coldplate
  - manufactured applying the selective laser melting (SLM)
  - no thermal “hot spots” of the electronics, improved lifetime



  - hermetical sealed cooling circuit
  - low weight, minimal space
- minimum tool investments, economical manufacturing for low and medium volume series (50 – 25.000 pc./a)
- weight reduction of 50 % vs. aluminium cast housing

Weight reduction potential	↗
Functional integration	↗
Cost impact	→
Sustainability & resource efficiency	↗



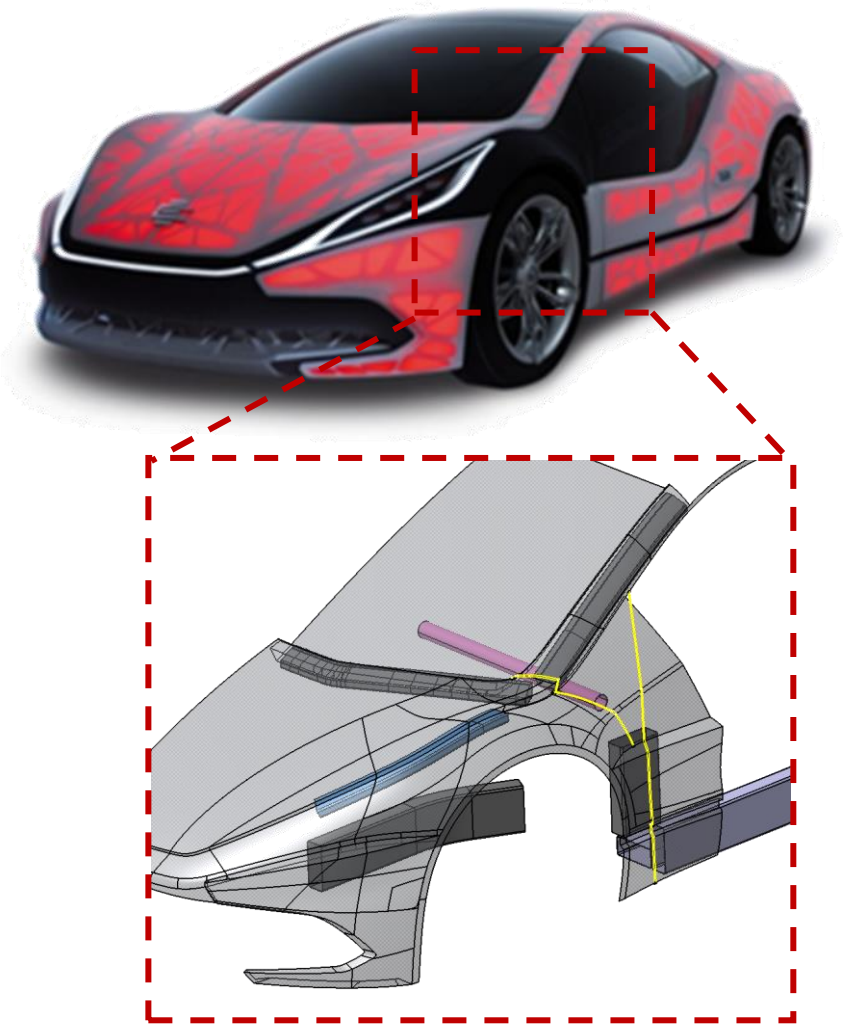


EDAG Light Cocoon, 2015

Ultimate lightweight design inspired by the natural. *Bionic design.*

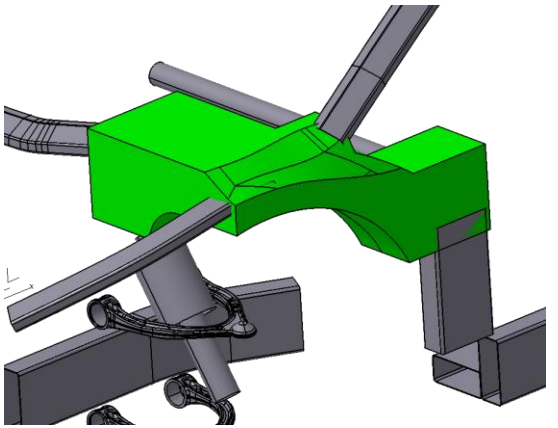
- ***Additive Manufacturing***
- ***Sustainability***
- ***Lighting Technology***

Package basing on EDAG „Light Cocoon“

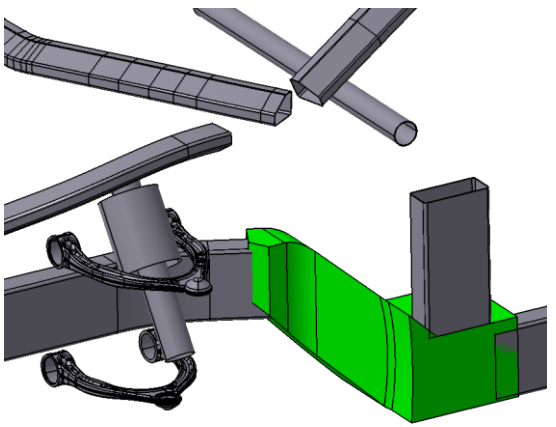


A-Pillar Section

Optimization space: upper knot



Optimization space: lower knot

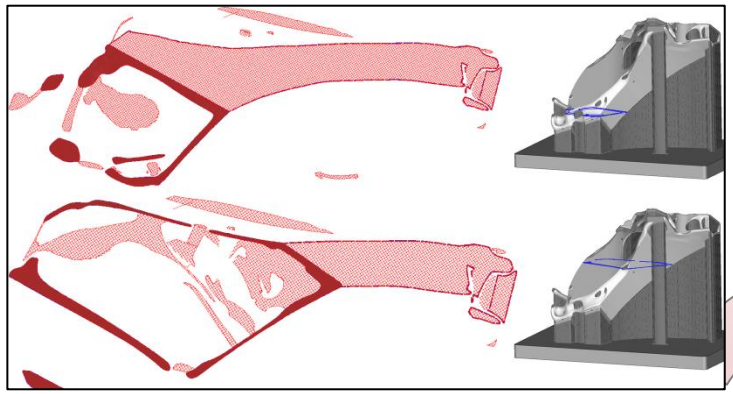


Maximum design space for additive manufacturing:
630x400x500mm^3 *(Source: Concept Laser)*

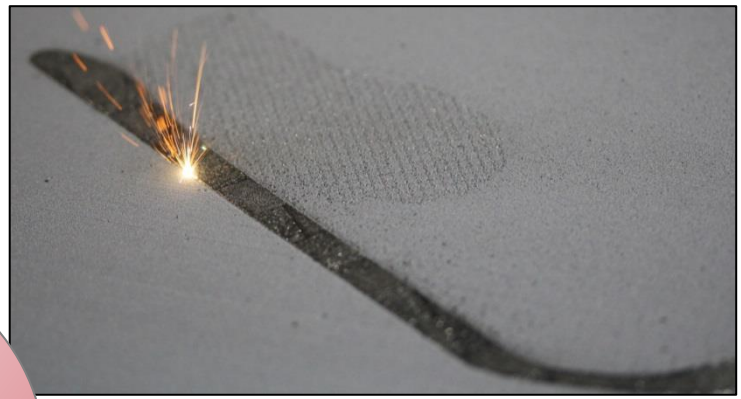
Definition of design space for knot optimization according to additive manufacturing requirements.

Additive Manufacturing of structural knots

[1] Data Preparation



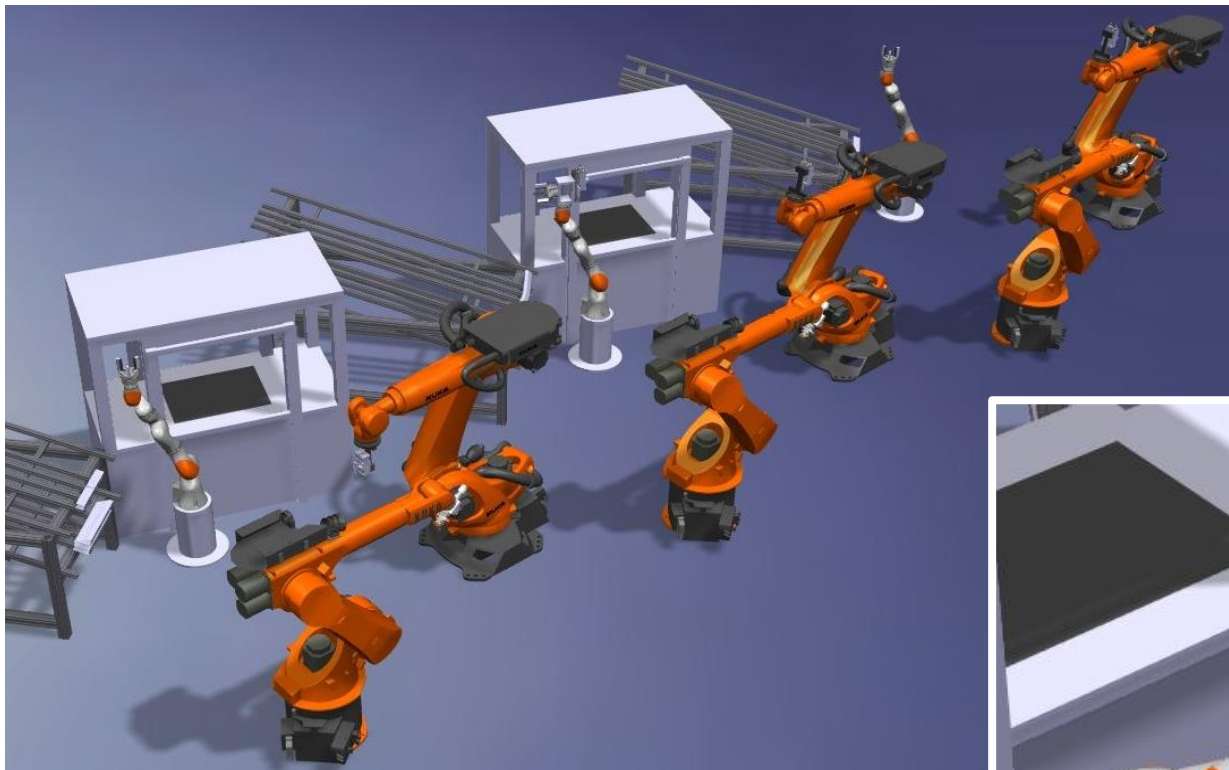
[2] LaserCUSING Process



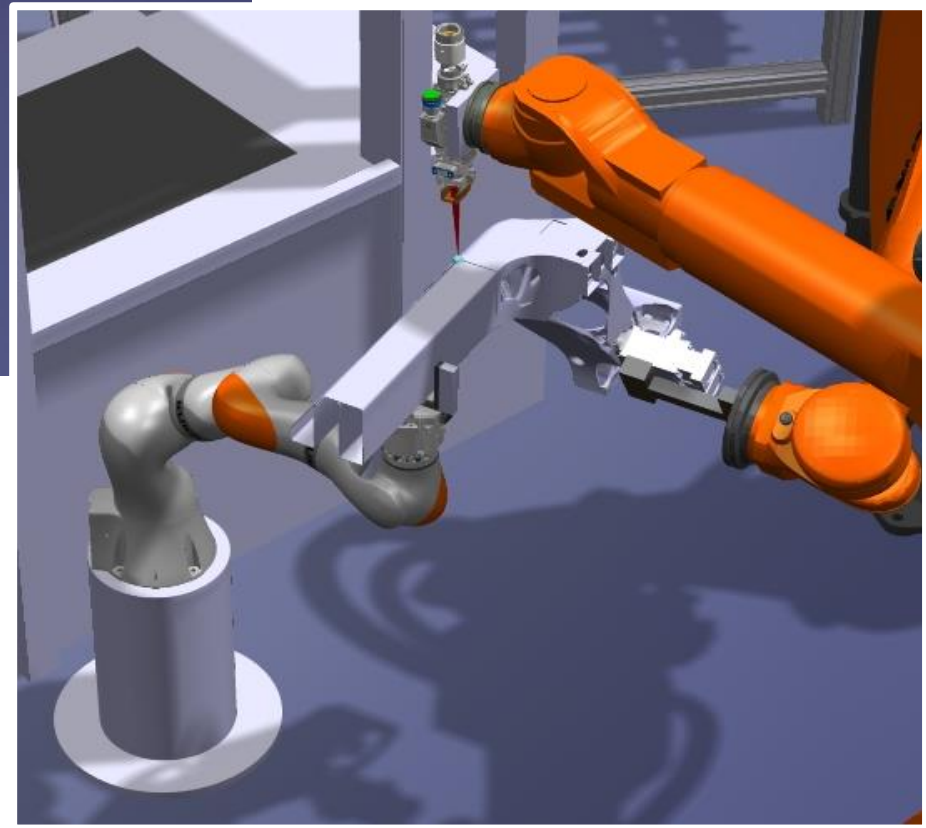
[3] Removal of powder, building platform and support

[4] Finish

Virtual Production Concept (EDAG Production Solutions)

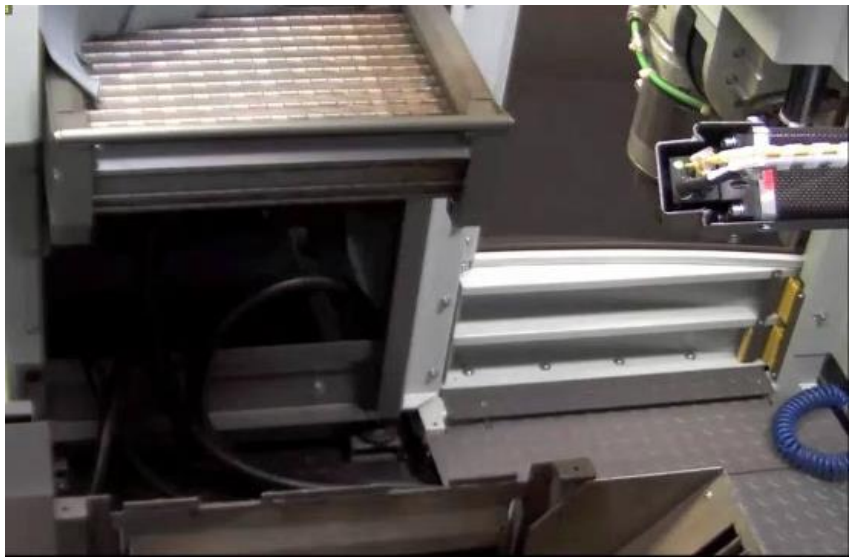


- **collaborating robots**
- **jigless manufacturing**
- **only two standardised grippers**



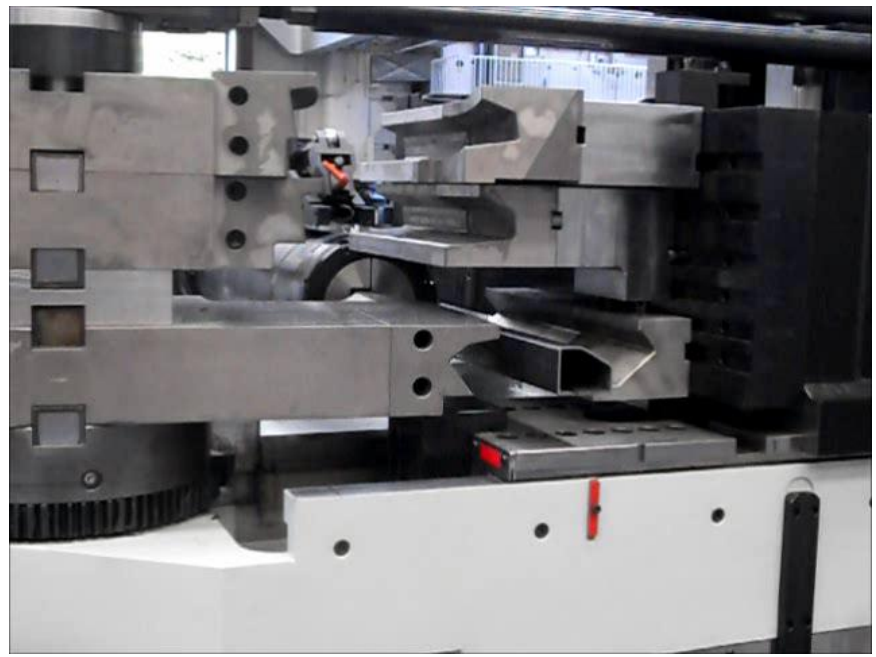
- **horizontally networked QM**
- **simplified logistics concept**
- **Scalability** of production layout
- **space optimised layout**

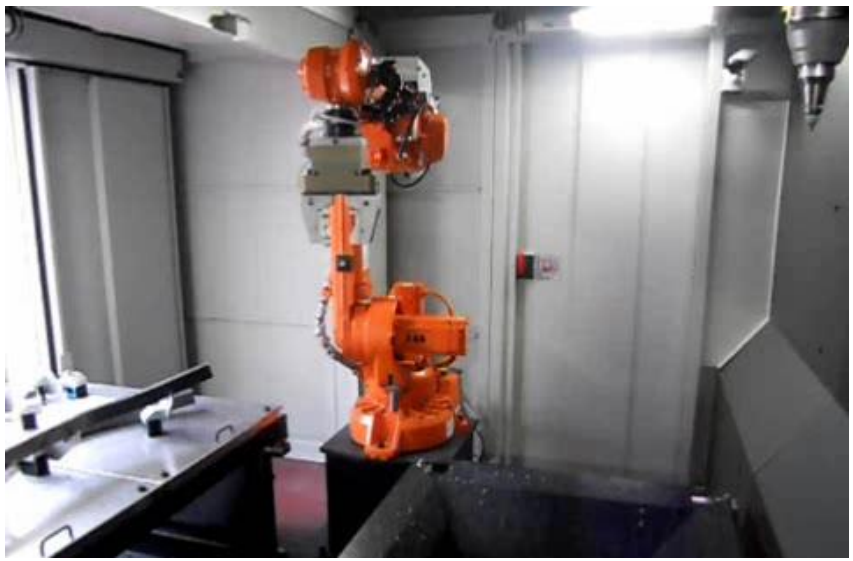
Cutting and Bending of Profiles



2D Laser Cutting

3D Bending

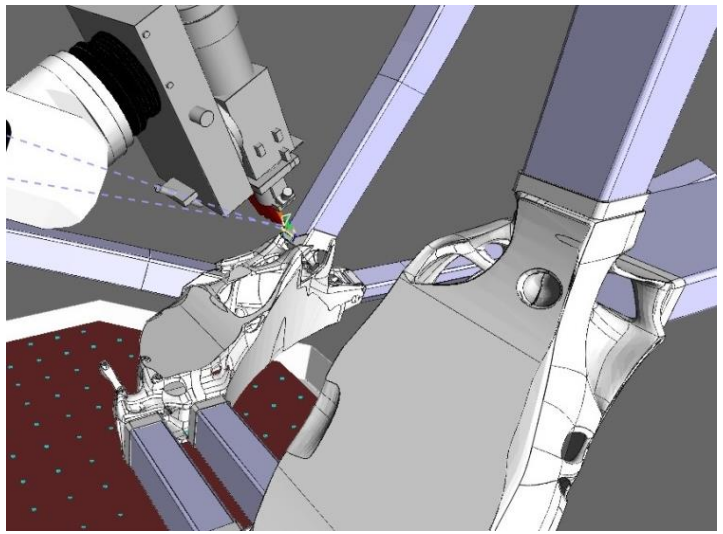




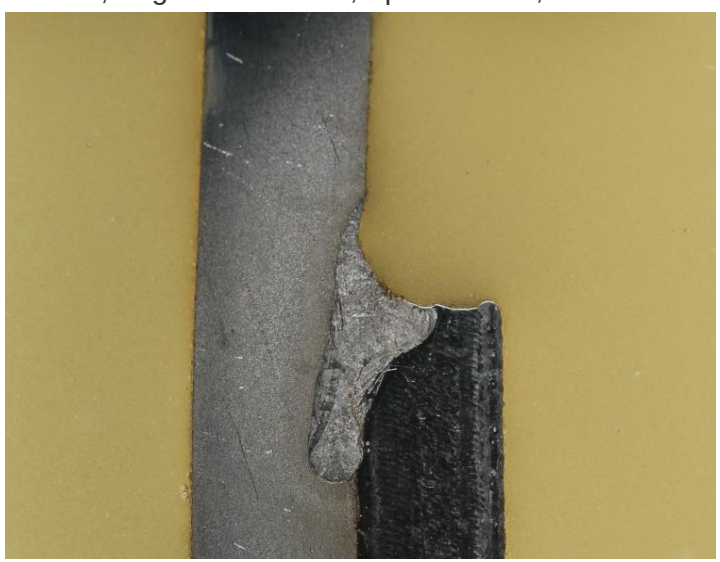
3D Cutting

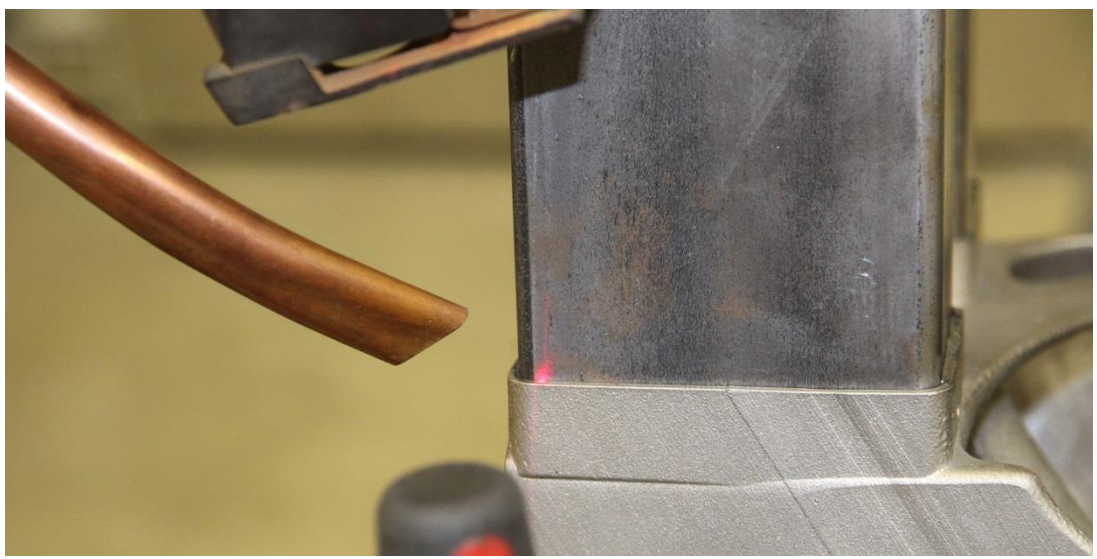
Preparation for welding

- Offline programming
- Development of stable Process
- Interface design suitable for laser welding
- Reduction of clamping devices



Parameters: Laser power 3000 W, Feed: 2 m/min; Angle - lateral 18°, Spot size ~ 0,8 mm





Bionic optimised vehicle lightweight structure in flexible production

Weight reduction potential	↗
Functional integration	↗
Cost impact	→
Sustainability & resource efficiency	↗

- **„Next-Gen“ Spaceframe“**
  combination of additive manufactured knots and intelligent bended and cutted profiles
  - BIONIC and LIGHTWEIGHT DESIGN
- **„On Demand“** Production
  Flexible, **tool and fixture less processes** targeting high efficiency
  - INDUSTRY 4.0
- **Load category concept**
  integration of different powertrain concepts and energy storage systems
  - complex and VARIANT intensive Products ON DEMAND

in cooperation with:

CONCEPTLASER

BLM GROUP

LZN LASER ZENTRUM NORD

Personalized headlights with individualized daytime running lights for small series by additive manufacturing (GenLight)

- Individualized daytime lights and personalization „EDAG”
- Optical and thermal design
- Intelligent lightweight bionic
- Heatsink in combination with external cooling air flow in tool-less production of smaller series
- Additive Manufacturing:
  - Fuse Deposion Modeling (FDM)
  - Stereolithographie (SLA)
  - Selective Laser Sintering (SLS)
  - Selective Laser Melting (SLM)
  - Multi-Jet Modeling (MJM)

Weight reduction potential	↗
Functional integration	↗
Cost impact	→
Sustainability & resource efficiency	↗