Advanced technologies of forming

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Fraunhofer Institute for Machine Tools and Forming Technology

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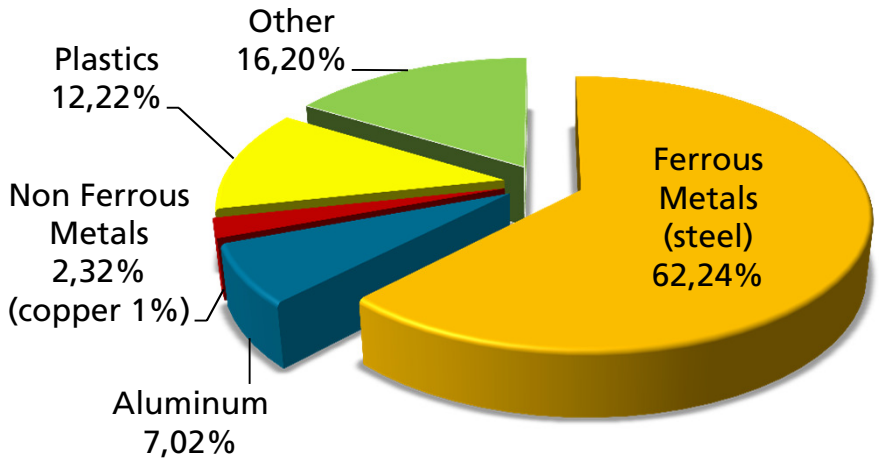
Automotive Related Materials

2012 world wide production – automotive main materials

1 548 Mio. t	**steel**
48 Mio. t	**aluminium**
16 Mio. t	**copper**
288 Mio. t	**plastic***

*** at about 4 119 Mio t mineral oil production → less than 7 %**

Average passenger car construction material mix



2012 share of passenger cars production: 63,1 Mio.

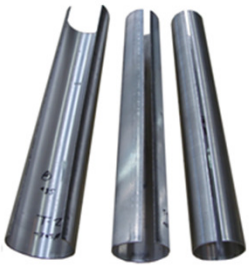
How to reduce CO_2 emmisions of car production ?

Lightweight Materials

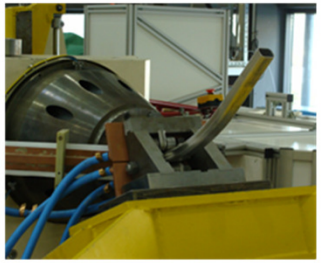
Development of the process chain by magnesium door

car body shell

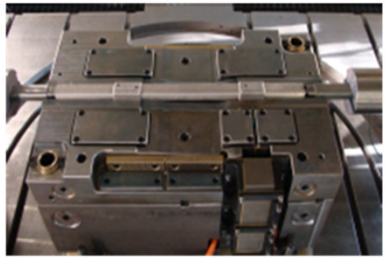
roll bending



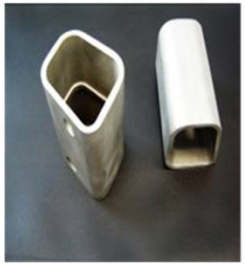
tube bending



hydroforming

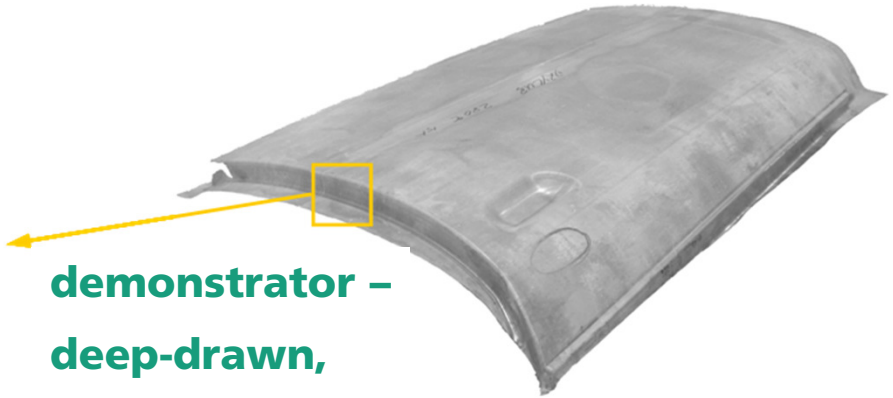


extrusion



tool components for inner door part

joining



demonstrator – deep-drawn, laser-welded car body shell

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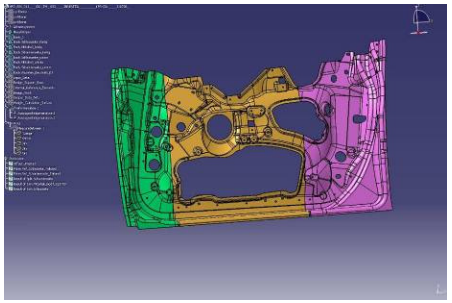
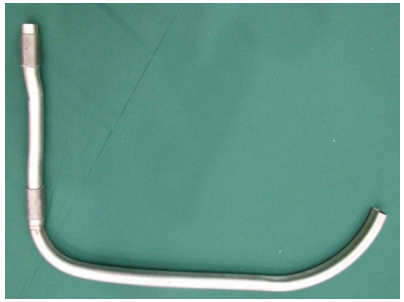
The use of magnesium for car body parts

The inside component of a passenger car door

Inner door made of a magnesium wrought alloy



jointed frame made of a magnesium wrought alloy



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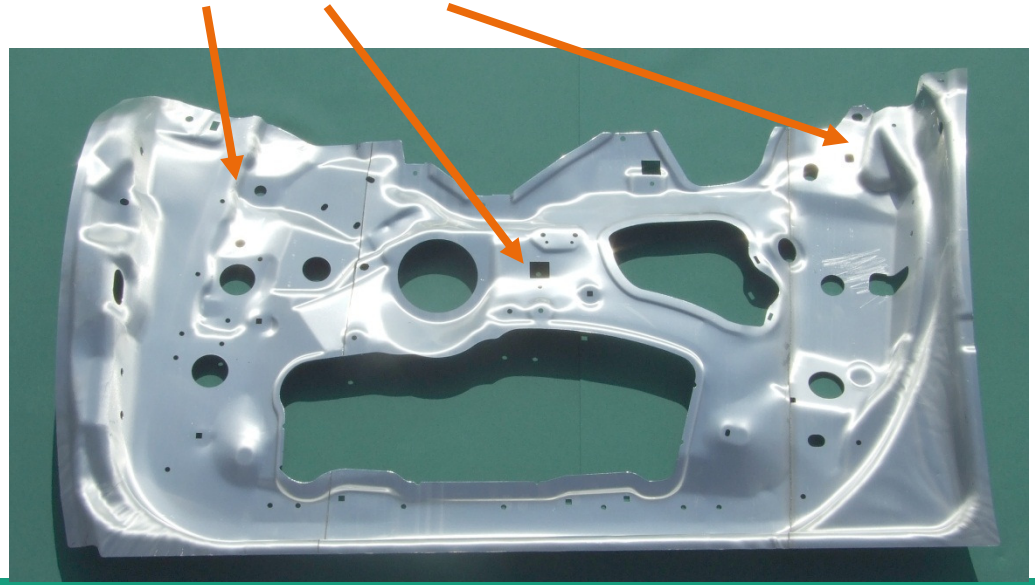
The use of magnesium for car body parts

Realization of a magnesium inner car door

- Use of tailored blanks
- Material: AZ 31
- Die temperature: 280 °C
- Lubrication: PTFE foil (Teflon®)
- Sheet thickness s_0 = 2.0 – 1.2 – 2.0 mm



application of tailored blanks

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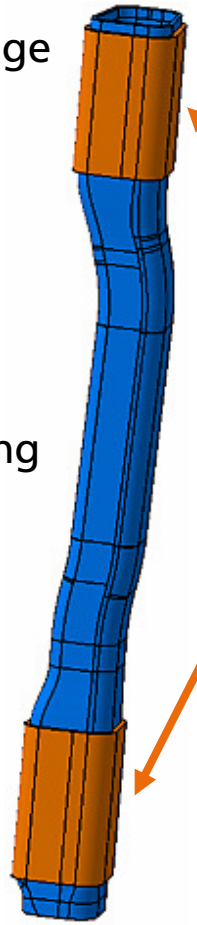
The use of magnesium for car body parts

Realization of a magnesium supporting frame

Upper cage



Lower cage

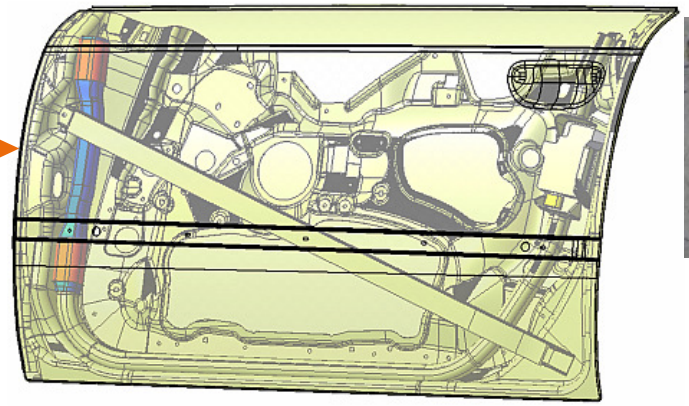
Frame

- Bending
- Hydroforming
- Joining

- Semi-finished product
- Material: AZ61 A
- extruded rectangular profil
  (40 mm x 30 mm; 2,5 mm thick)

Hinge reinforcements

- Magnesium extrusion parts
- Joined during hydroforming process



Complete door

(Pressure = 35 MPa)

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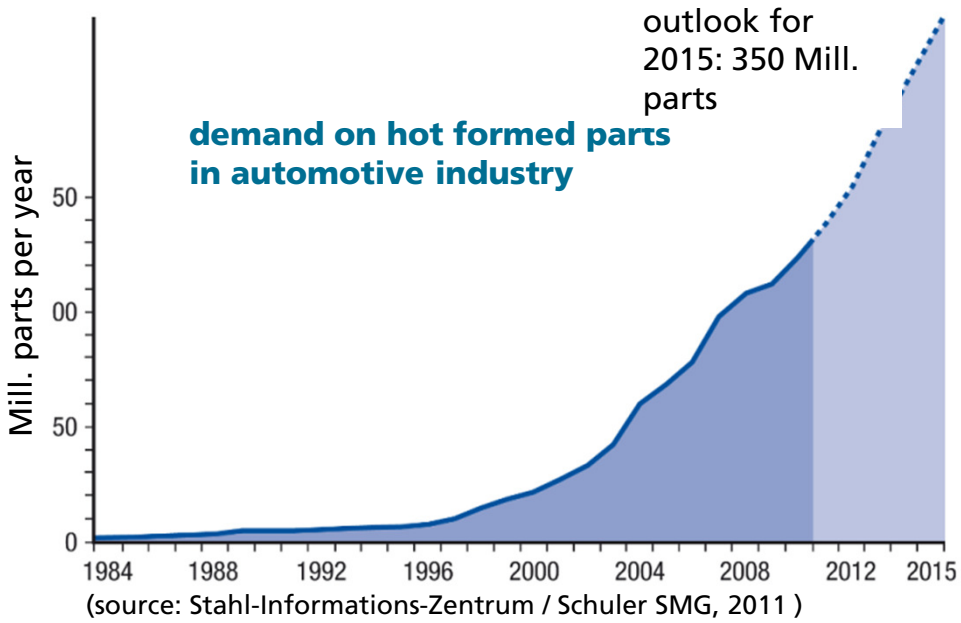
High Performance Metals

Press hardening – steel as a material for light weight design



(source: Stahl-Informations-Zentrum / Schuler SMG, 2011)

- high material and energy efficiency over the life cycle
- small ecological footprint (emission of greenhouse gases)

additional costs to safe **1 kg** weight in automotive industry

steel: **2 €** | alu: **11 €** | CFK: **50 €**

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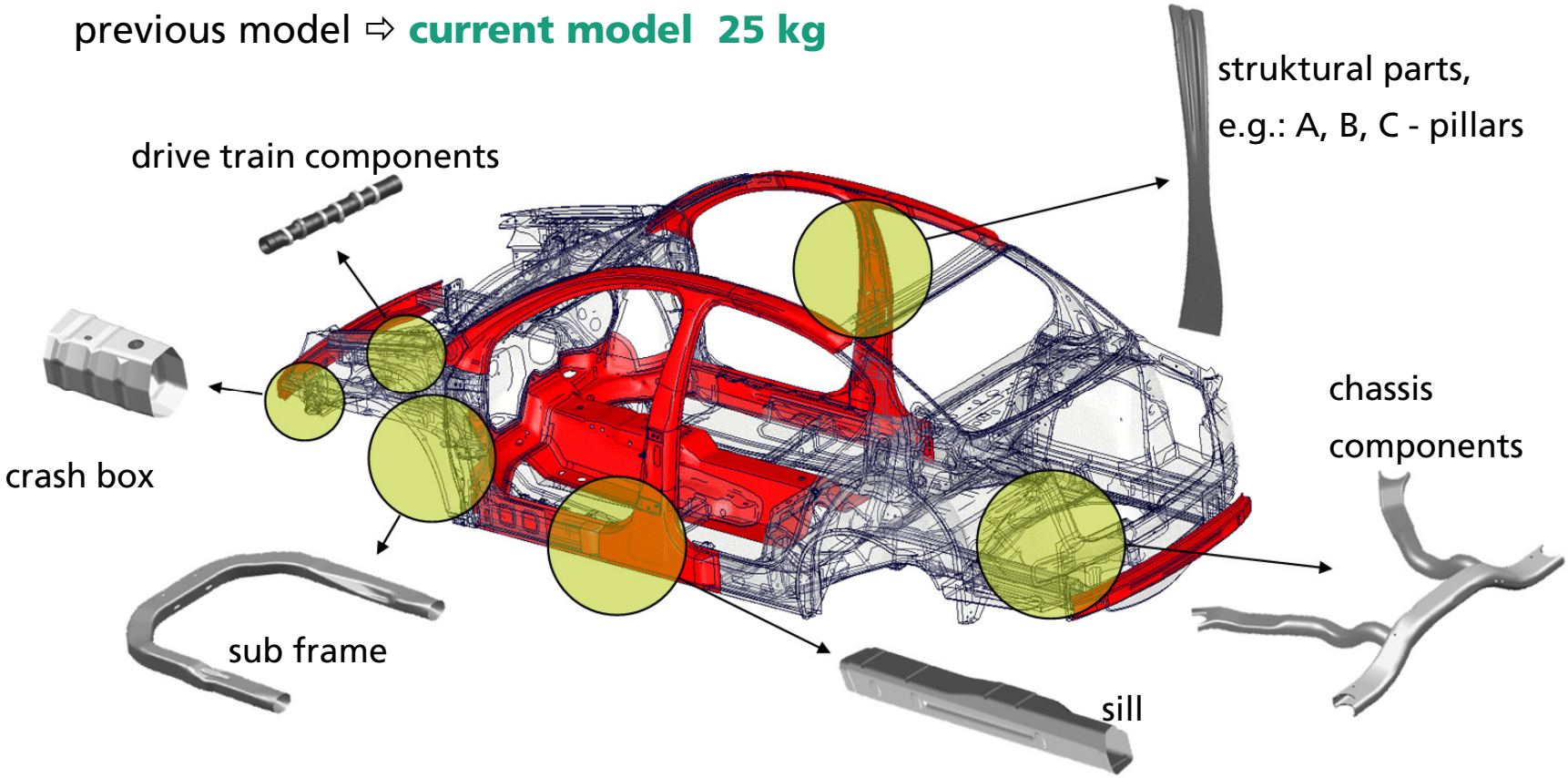
Leight weight structure

Typical applications for hot stamped parts

weight savings VW Passat (based on form hardening of sheets)

previous model ⇨ **current model 25 kg**



Potential applications for tube press hardened parts (20 ...30 kg)

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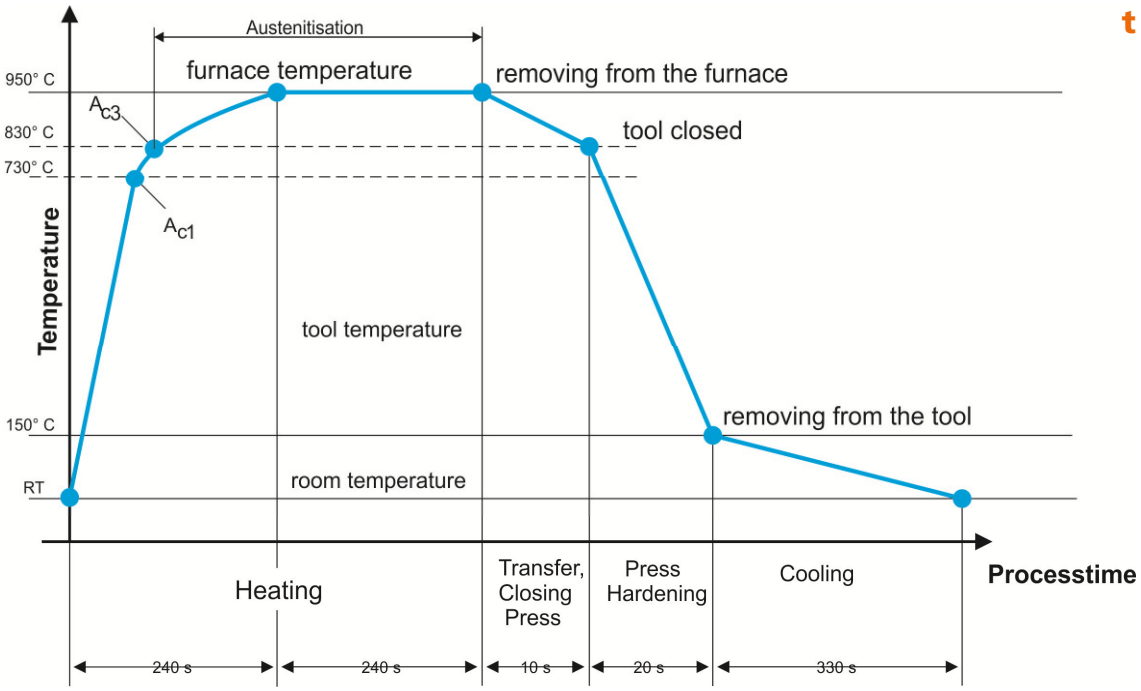
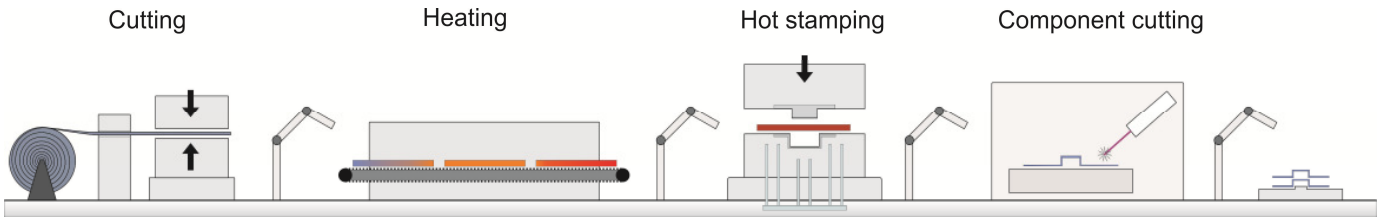
Tube Press Hardening Sequence



T ≈ 950 °C
t = 60 - 300 s

T ≈ 800 – 850 °C

T ≈ 120 °C



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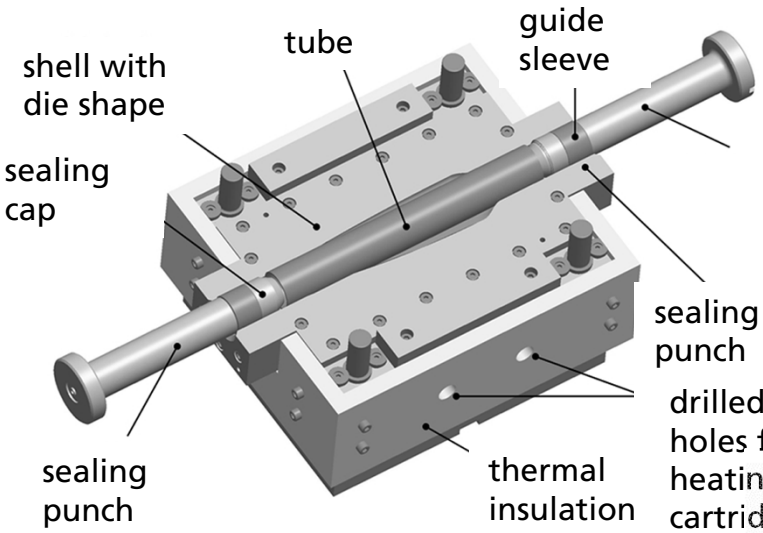
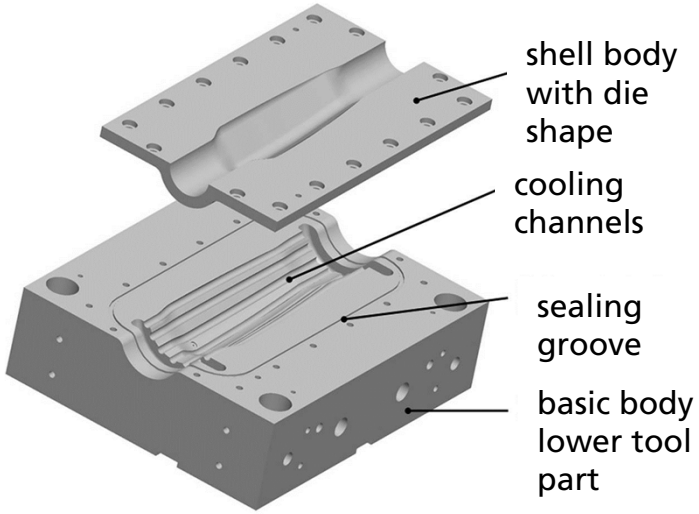
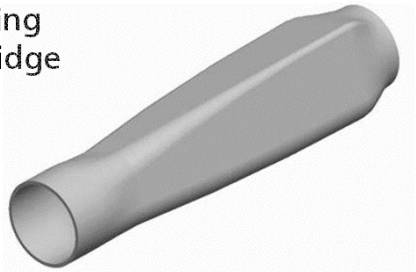
Tool and process design

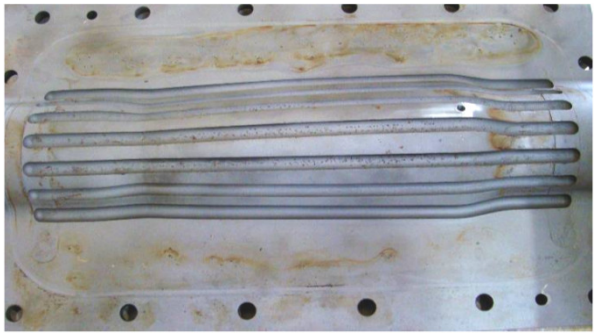




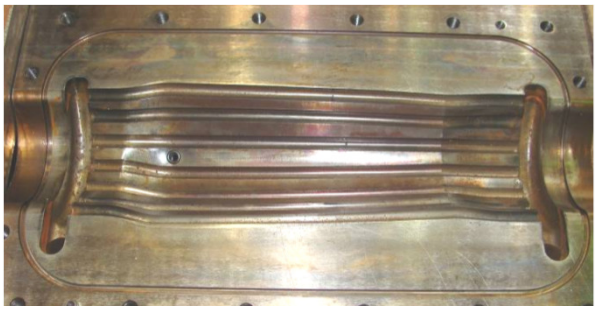


demonstrator geometry

shell with die shape (front side)



shell with die shape (backside)



basic body with cooling channels

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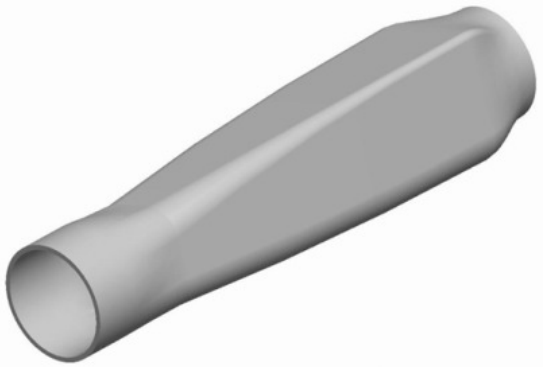
Efficient Production Technology

Materials and part geometries:

- 22MnB5
- 34MnB5
- LH 800®
- MW 1000L
- 42SiCr



„Demonstrator I“, MW 1000L

ø45 x 1,35 / 2,05 mm

R_m = 1600 ... 1400 MPa

„Demonstrator I“, 42SiCr

ø45 x 2,5 / 4 mm

R_m = 2000 MPa

„Crashbox“, 22MnB5

ø70 x 2 mm, 400 mm lang

R_m = 1400 ... 1600 MPa

„Demonstrator II“, LH 800®

ø58,5 x 1,35 / 2,05 mm

R_m = 1250 ... 1400 MPa

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Lightweight design – closed profiles

Testing Conditions

→ external induction heating preform part up to 1100 °C

→ forming media Nitrogen

→ forming pressure 700 bar

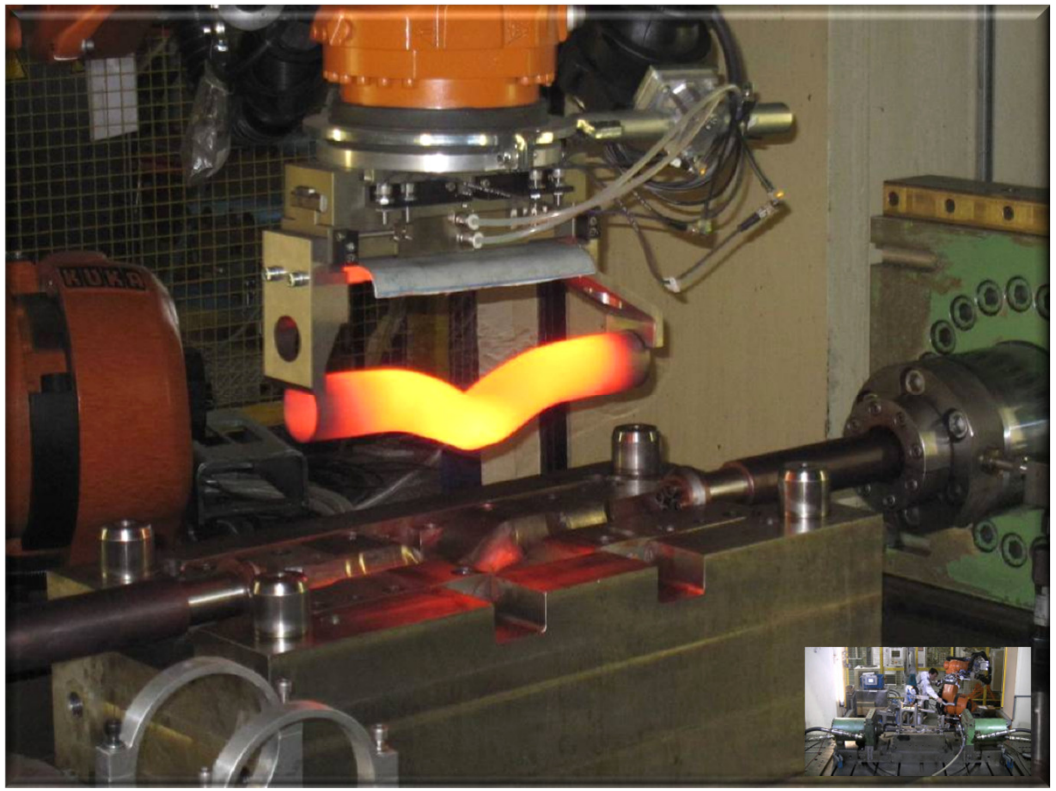
→ cycle time: 99 s

- heating 53 s
- handling inductor 10 s
- handling robot 6 s
- press time 30 s

(open to open)

all time steps

without optimization,
shorter cycle time (~30 sec)
with optimized devices and
plant components realistic



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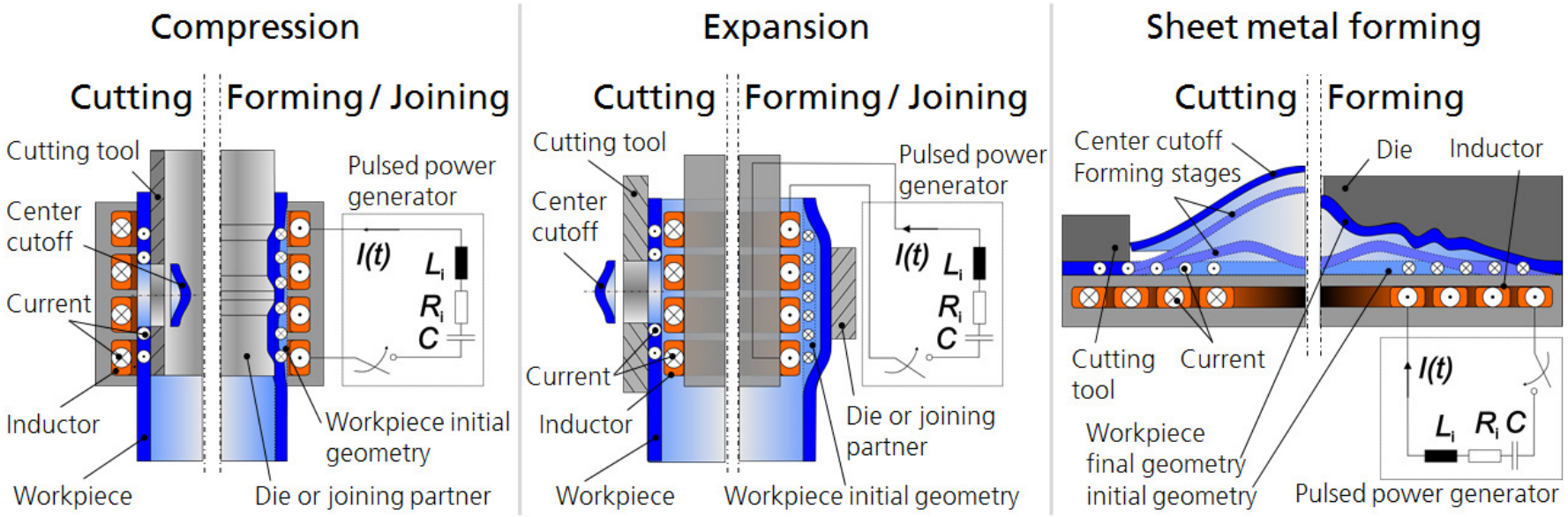
Efficient Production Technology

Electromagnetic forming

Process principle

- pulsed magnetic fields initiate repulsive Lorentz forces between inductor and electrically conductive work pieces
- compression / expansion of tubes and hollow profiles as well as forming on flat or preformed sheet metal materials is possible within microseconds

Technology variants



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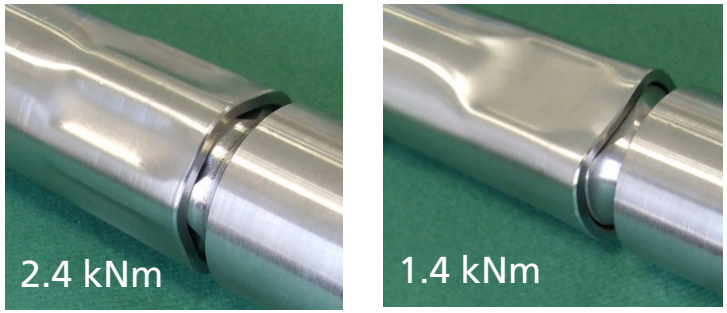
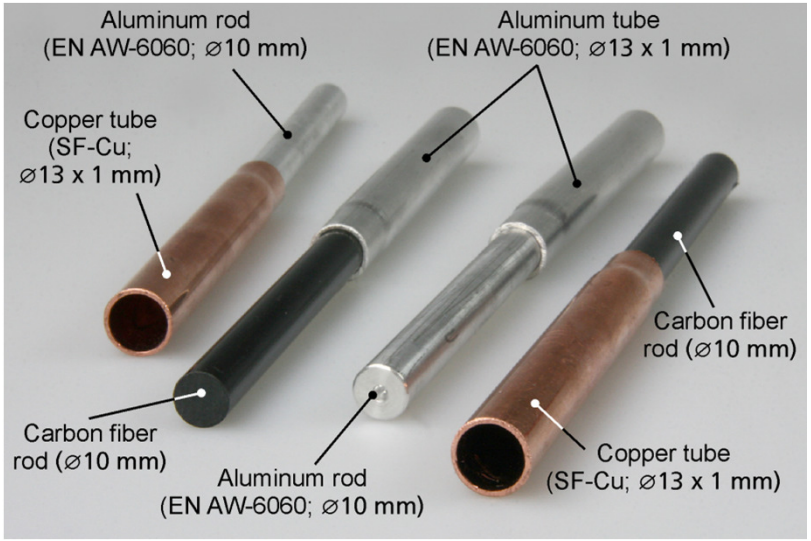
Efficient Production Technology

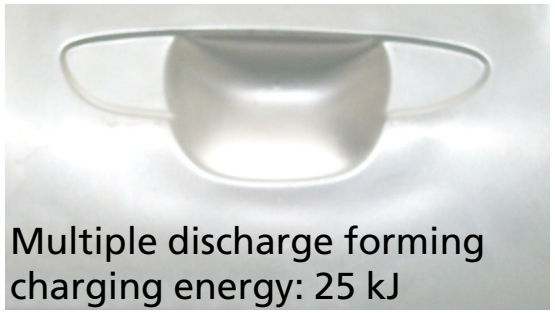
Electromagnetic forming

Joining metal and nonmetal





Sheet metal forming



cutting

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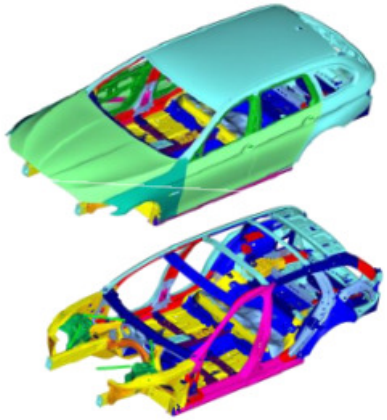
Material and Construction Trends in Car Production

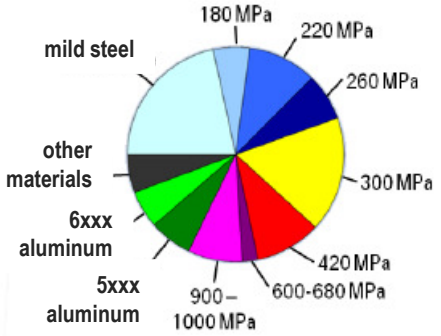
Die less HSIC piercing of tubes

source: BMW, Wikipedia

conventional concepts – shell design

high strength steel, aluminum





new concepts – Live Drive concept

carbon fiber reinforced plastic, aluminum

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