

Circular Economy Production using high strength Aluminium Alloys for Applications in Mobility

Introduction

About HoDforming GmbH...



HoDforming offers unique and very cost efficient **HOT-Die forming** technologies for **all Aluminium Alloys**

Small production volumes as well as **mass production**

The aim is to **provide the Manufacturers** with future oriented **Extreme Lightweighting Technologies**

Industry can use **the HOT-Die forming** technologies for **manufacturing**

Why is extreme Lightweighting a major enabler for circular Economy in Mobility?

Extreme Lightweight Constructions
using **high-strength Aluminium** offer
a Reduction of CO₂ Emissions as
well as a **Reduction of needed**
prime/scrap Materials

To realize **Extreme Lightweight
Constructions** for circular economy
in Mobility **new production
Technologies** are needed

**Requirements for Extreme
Lightweighting
using existing mass Production
Equipment/Lines**

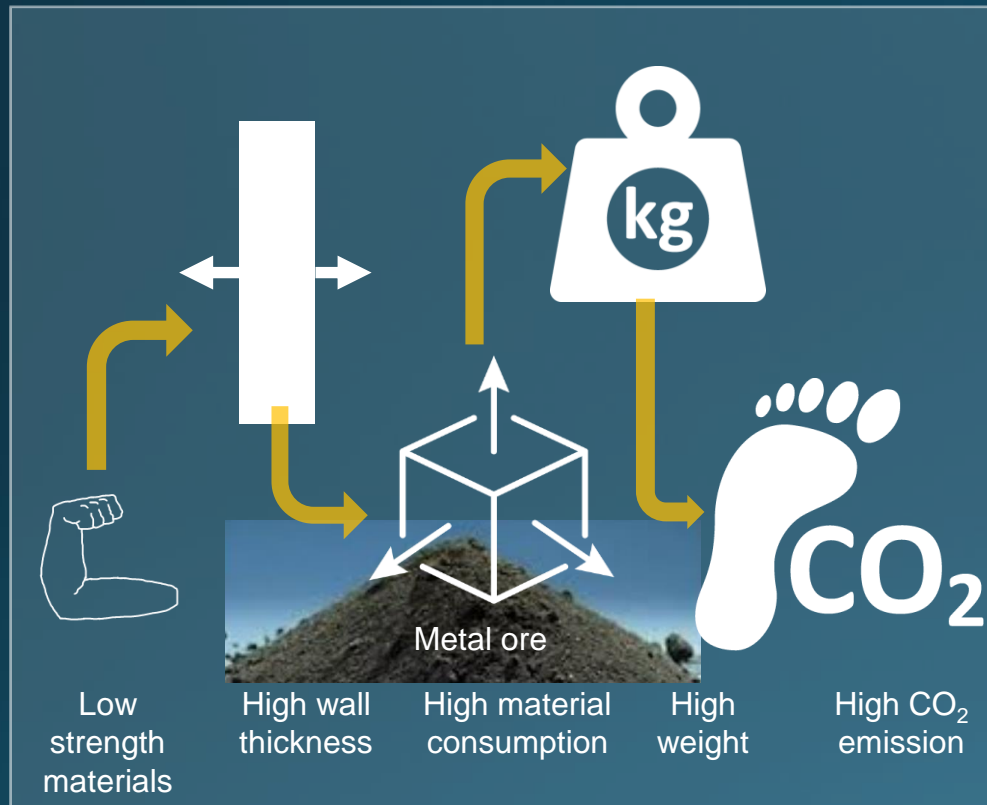
Requirements for Extreme Lightweighting...



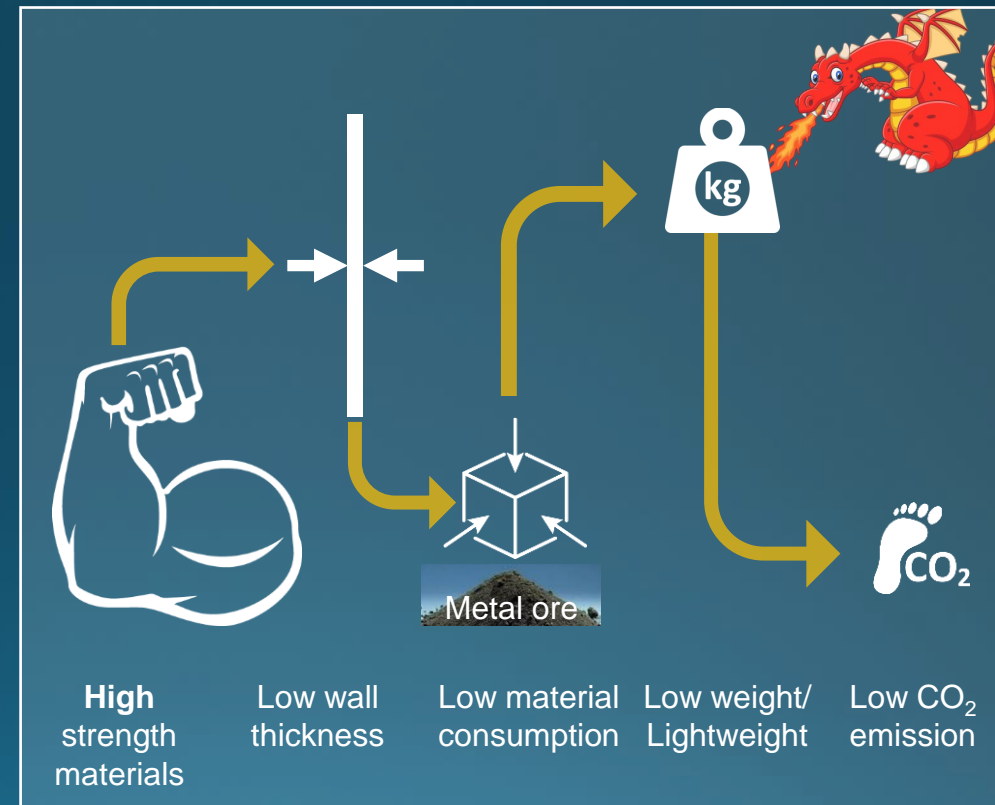
1) Apply high & highest $R_{p0,2}$ Alloys

Apply high & highest $R_{p0,2}$ Alloys

Today

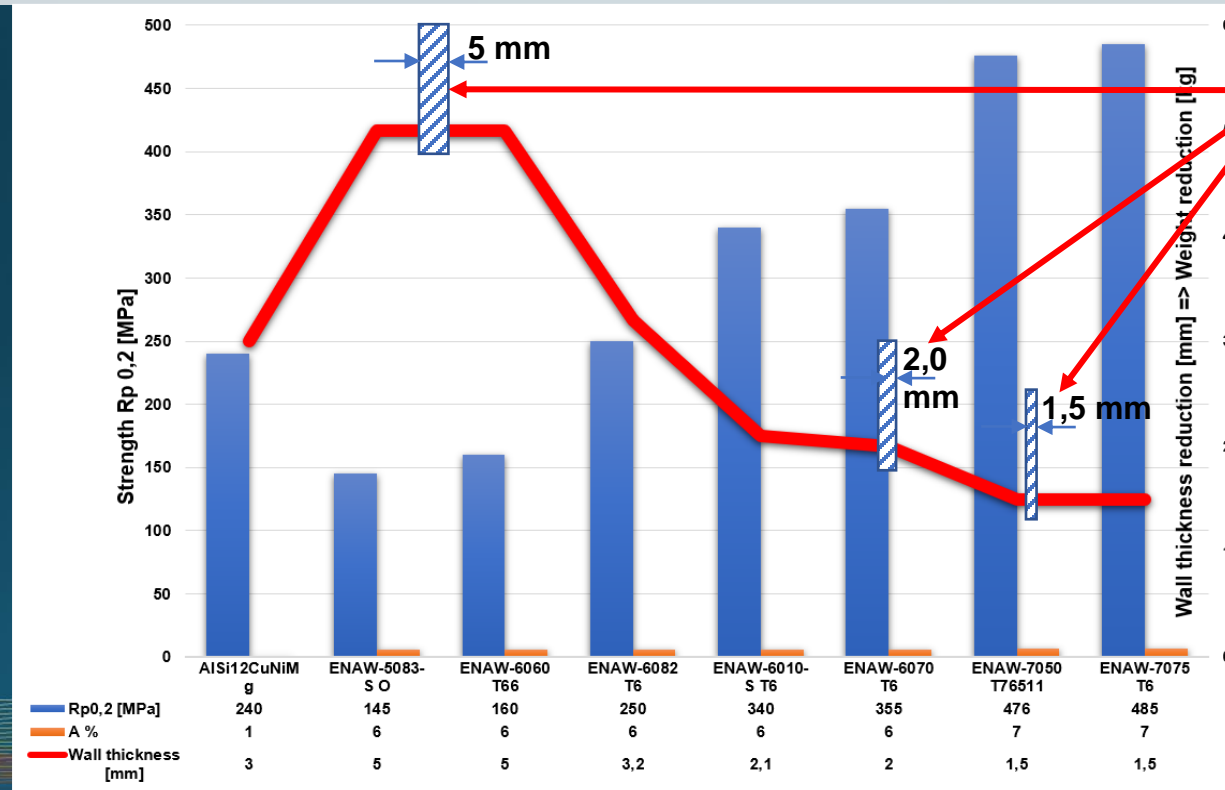


Future Standard!



Apply high & highest $R_{p0,2}$ Alloy

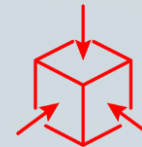
The Solutions for extreme Lightweighting is based on High Strength Aluminium Alloys



For equal Load

Apply high & highest $R_{p0,2}$ Alloy

Standard Alloys versus High Strength **Aluminium** Alloys



CastingAlSi12 → 6070* = -32%

5083 → 6070* = -59%

6060 → 6070* = -55%

5083 → 7075 = -70%

*Stable to corrosion

Requirements for Extreme Lightweighting...



1) Apply high & highest $R_{p0,2}$ Alloy

2) Replacement of several Members by high-strength aluminium

Replacement of several Members by high-strength aluminium

Additional way for Extreme Lightweighting is the replacement of Steel Members by High-Strength Aluminium



Requirements for Extreme Lightweighting...

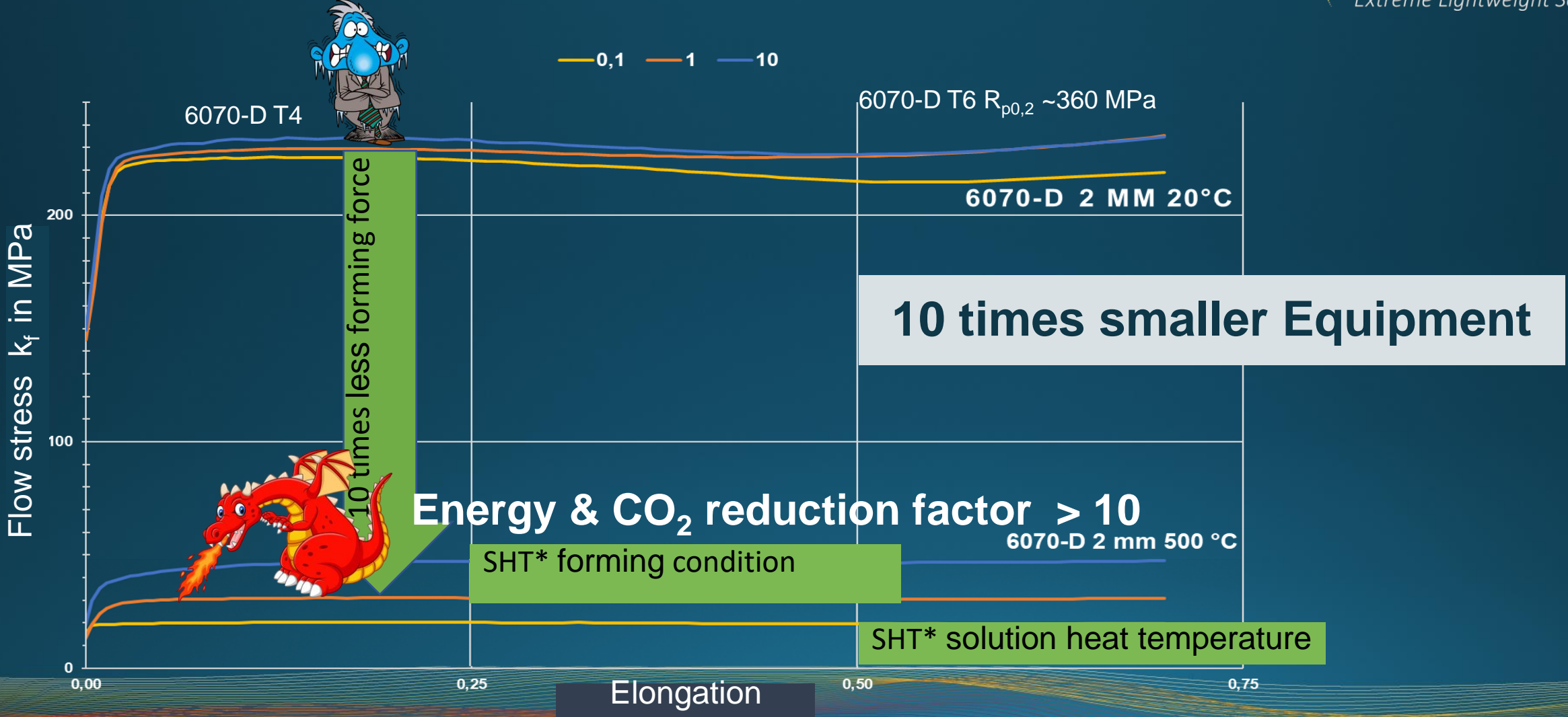


1) Apply high & highest $R_{p0,2}$ Alloy

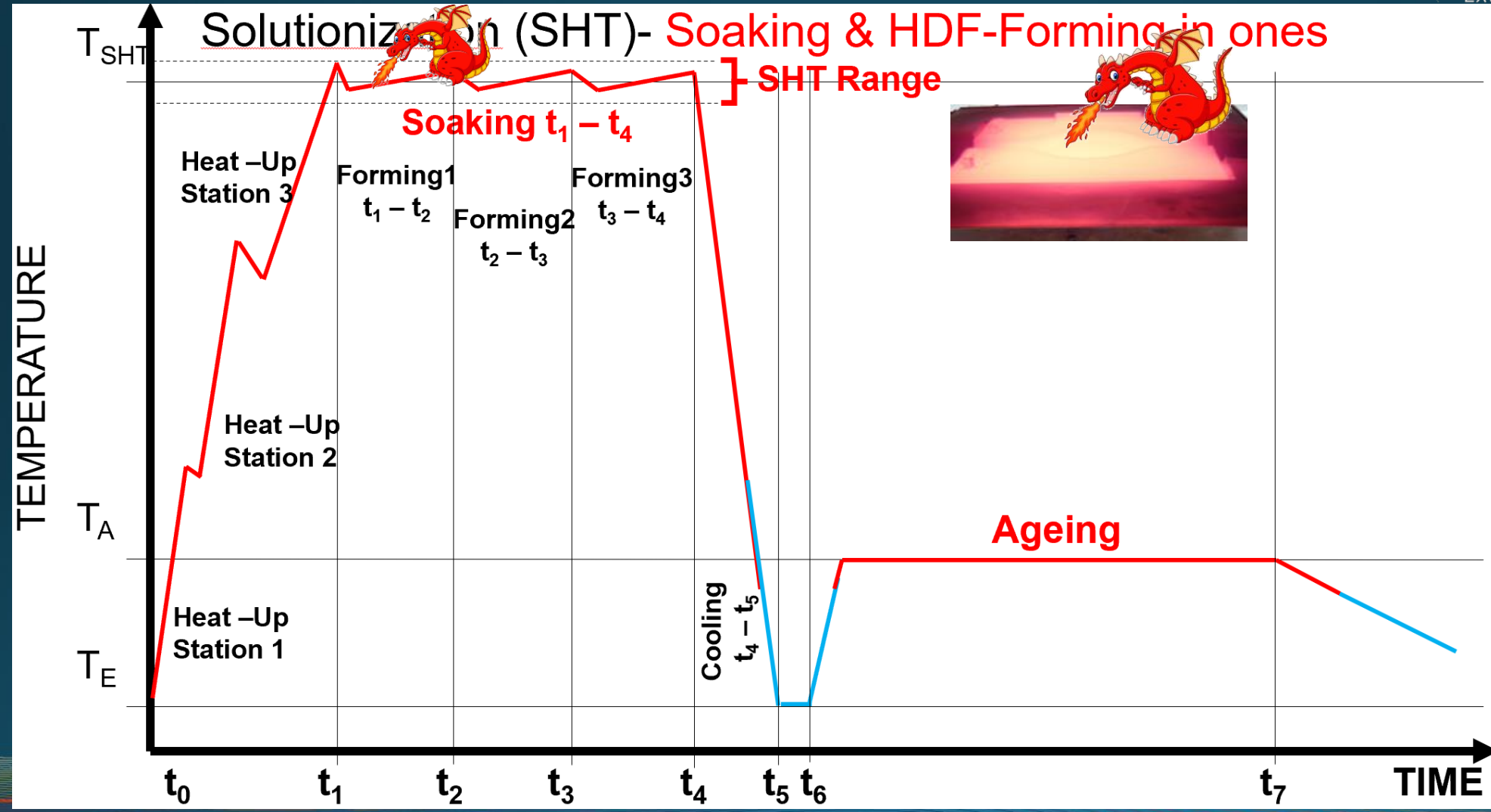
2) Replacement of several Members by high-strength aluminium

3) Forming at SHT Temperature in several hot Dies

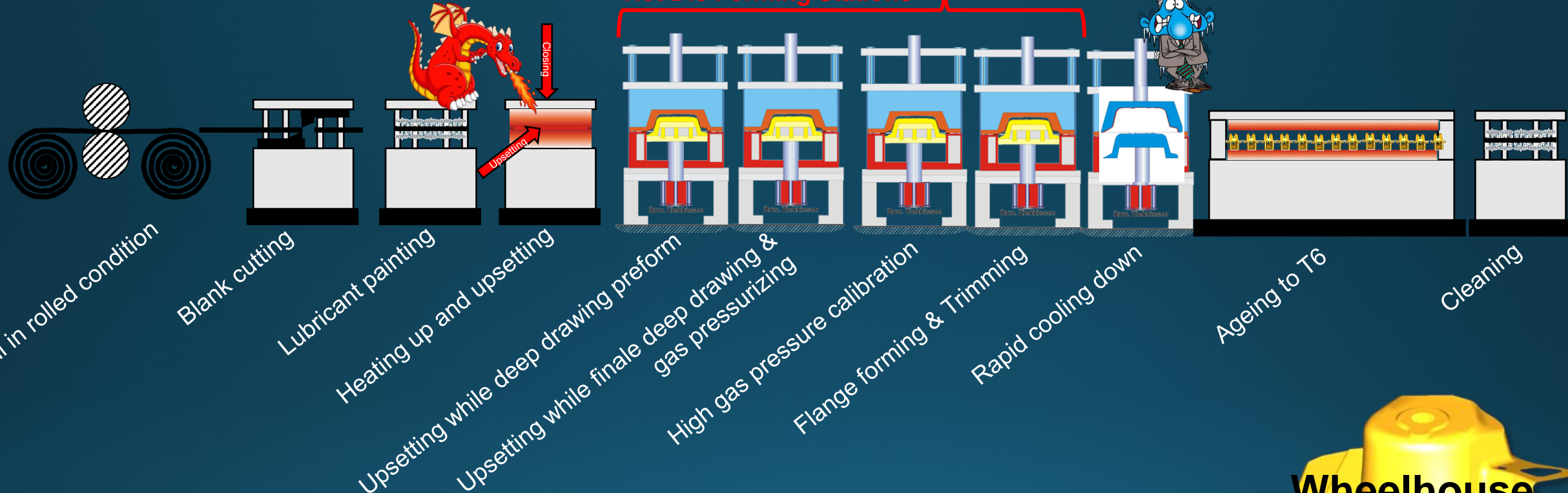
Forming at SHT Temperature in several hot Dies



Forming at SHT Temperature in several hot Dies



Forming at SHT Temperature in several hot Dies



Cycle Time 5 - 8 Seconds

**Tailored product-wall-thickness produced in SITU
COST EFFICIENT**



Requirements for Extreme Lightweighting...



1) Apply high & highest $R_{p0,2}$ Alloy

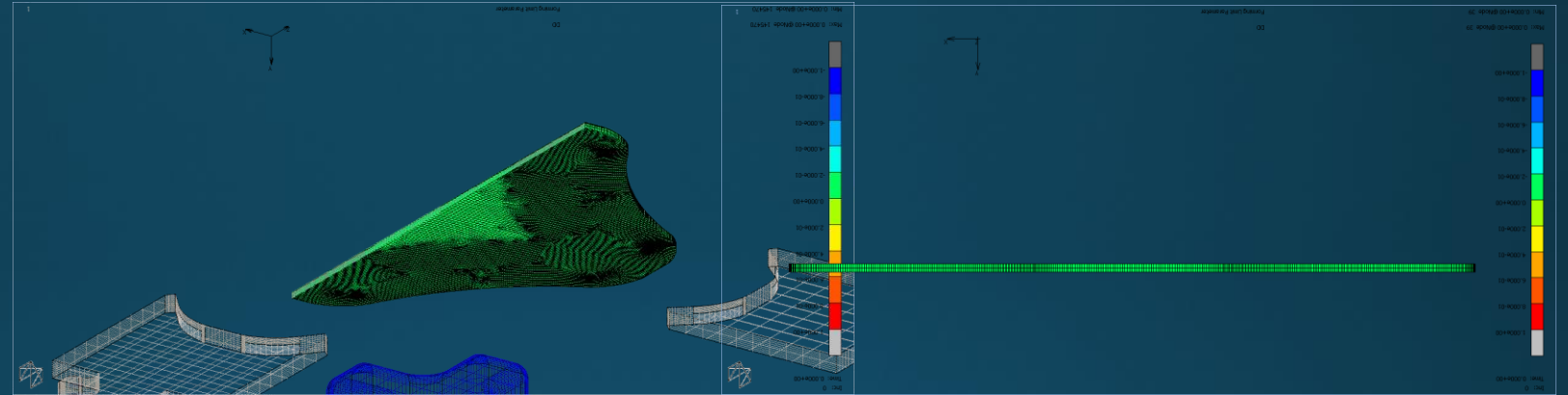
2) Replacement of several Members by high-strength Aluminium

3) Forming at SHT Temperature in several hot Dies

4) Tailored Blanking in situ => Members of equal stress
and not equal wall thickness

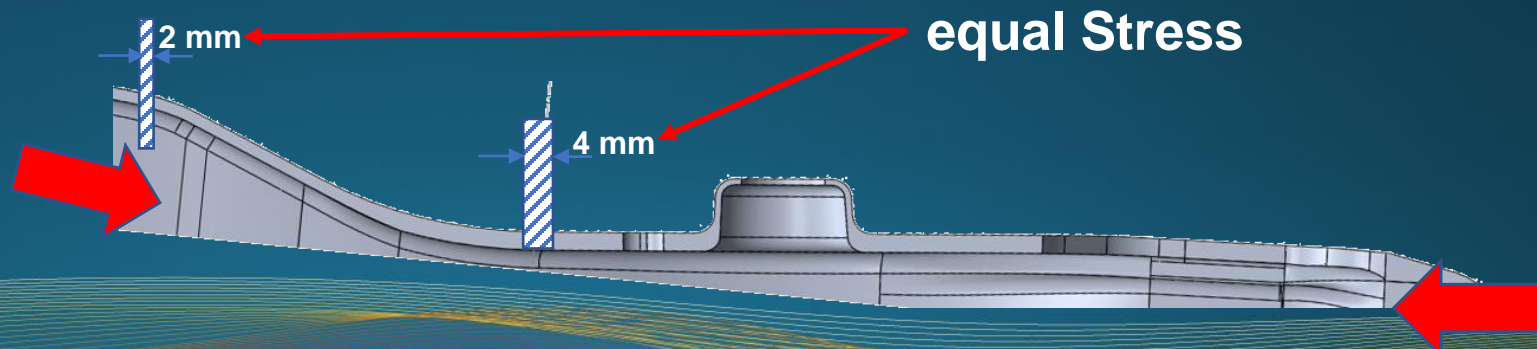
Tailored Blanking in situ => Members of equal stress and not equal wall thickness

Sheet based multi step forming



Tube based multi step forming

- optimized extruded cross walls
- different wall thickness while longitudinal pressings



Basics to overcome today's Hurdles forming high strength Alu-Alloys

The best forming Condition for Alloys with limited Elongation

e.g. Chocolate is just right for forming at 36-39°C (Temperature Sweet Spot).
It does not break or melt, it transforms into new shapes.

Temperature: 0 °C



Sweet Spot
Optimal "forming"
temperature,
depending on recipe



The best forming Condition for Alloys with limited Elongation

Each metal has it's own specific ideal temperature "sweet spot" for forming!

This "sweet spot" defines the ideal condition for energy, CO₂ and materials efficiency!

Aluminium Alloys

Temperature: 0 °C



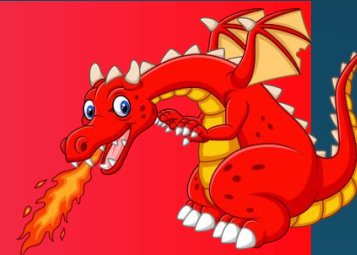
Spring back
Less formability
Higher CO₂
Higher investment

480 °C 550 °C



Material structure will be damaged

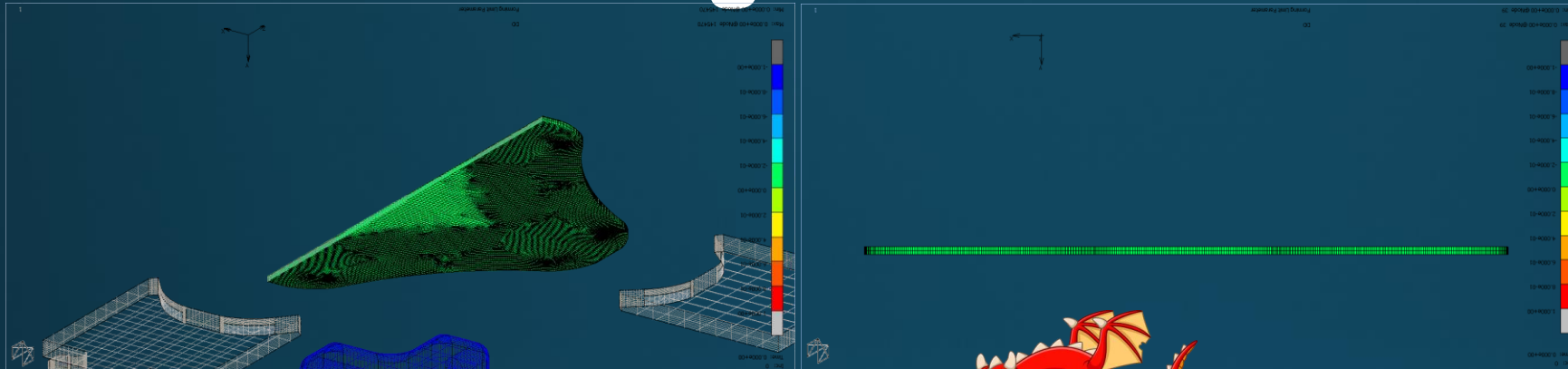
~ 660 °C



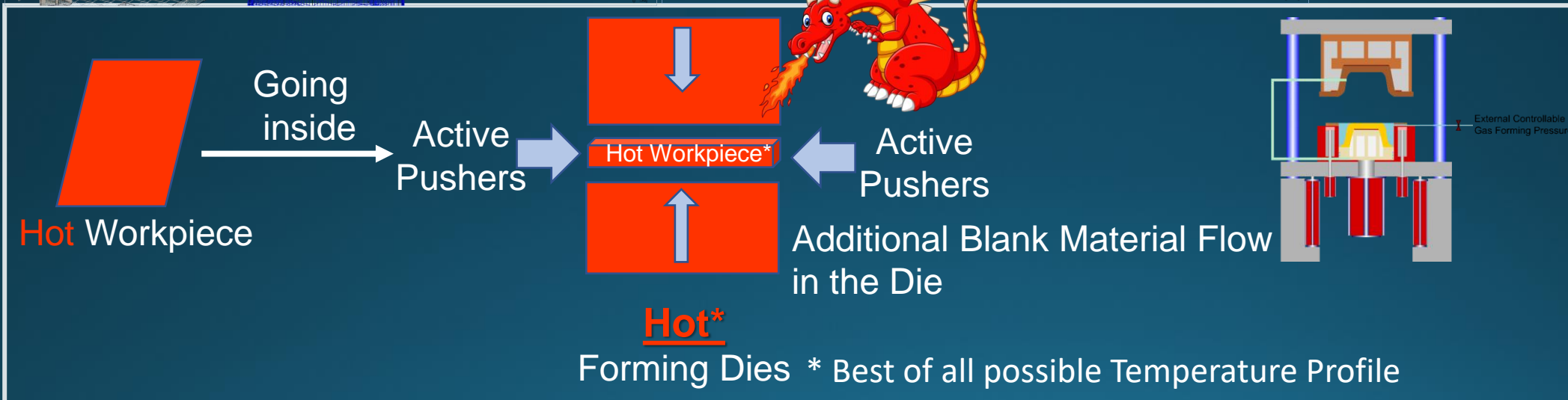
Sweet Spot
optimal forming
temperature within the
solution annealing range
(depending on alloy)

Lowest possible forming force = energy = CO₂

Best forming Conditions for Alloys with limited Elongation forever



Gas Forming
or
Deep Drawing
or
Combination
of Both

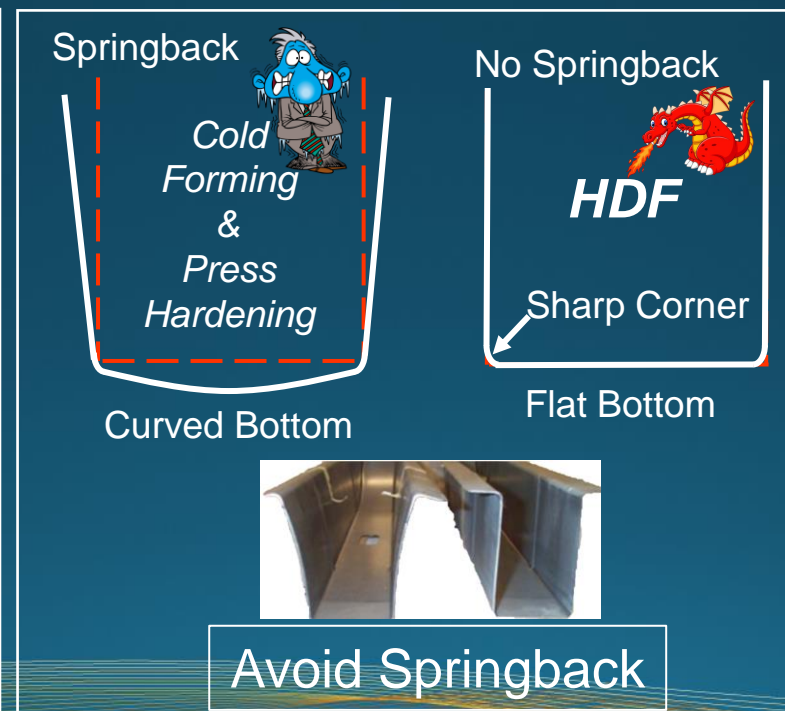
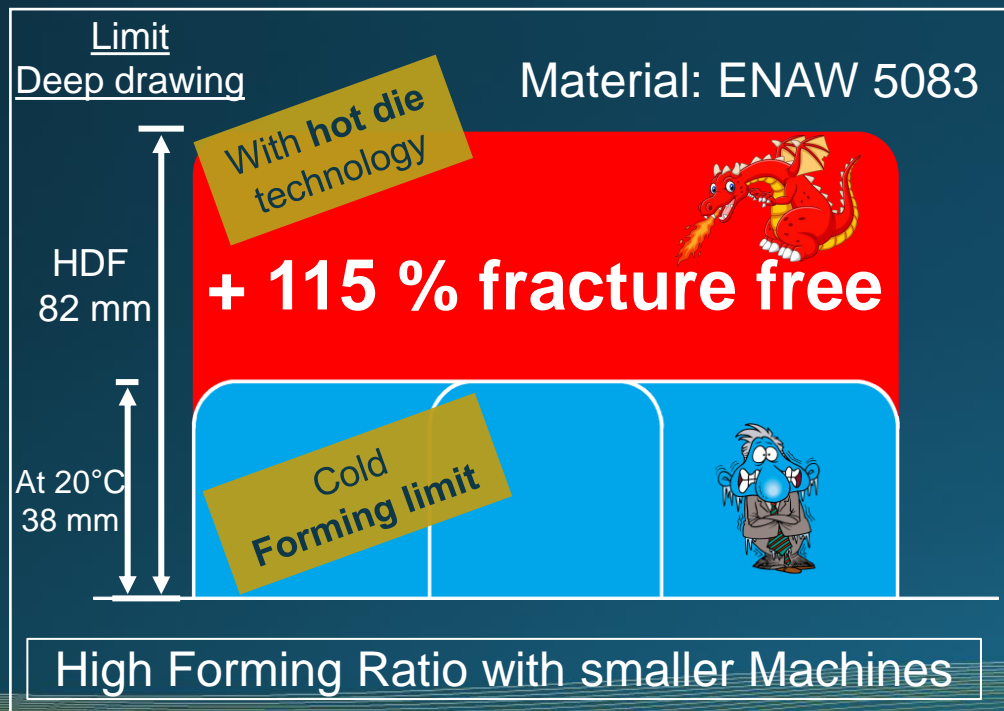


Applicable for both Sheets as well as Tubes

Stable Process - High Forming Ratio or needed Accuracy

Warm die forming overcomes today's forming hurdles for all metal alloys* that do not achieve high forming ratio or needed accuracy in cold or warm conditions

*e.g. EN AW 7075, which offers less than 10 % of tensile elongation in T4 condition



Energy Comparison for **warm die forming** versus **cold die forming**



warm-blank and warm die

cold-blank and cold die

T-condition

all conditions

T-4 condition = annealing is required

Blank elongation

all elongations

for higher forming ratio further annealing is required

Forming energy

10 times lower vs cold

significant hydraulic energy is needed

Effect of high strength

up to 50% less material

need up to 50 % more prime/scrap material

Manufacturing scrap

tailored blanking in situ

limited wall thickness distribution

Energy at all

0,37 kWh/kg

0,52 kWh/kg

Summary

Reduction
of vehicle
components weight
by up to 50%

Increasing
production process
efficiency by
up to 30%

Reduction
of materials
demand
up to 70 %

extreme, cost- and CO₂-efficient construction in mass

Only achievable by the Usage of High-Strength and
Ultra High-Strength Materials



Massive Reduction of CO₂ Emissions

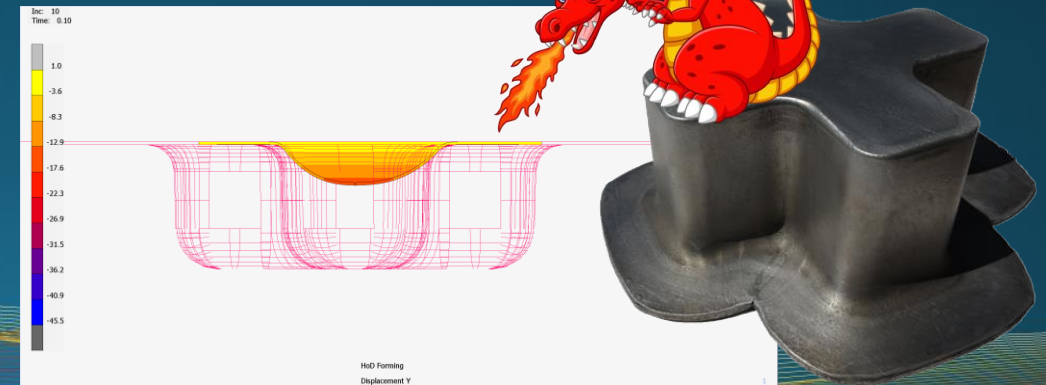
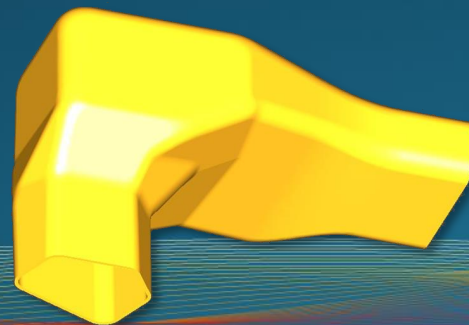
Warm Forming and the future main R&D Targets



- **Improve the Corrosion Condition for the 7xxx Alloys**
- **Improve the time for Post Ageing Condition (Time to achieve T6 Condition)**
- **Improve the Condition for Avoiding Grain Growth without Forming Stress**
- **Develop High Strength Alloys for Economic Extrusion Condition (350 MPa)**

Warm Die Forming and the Future

- The warm forming technology is already developed known as Hot Die Forming (HDF)
- HDF is suitable for small as well as high volume production sheets & tubes
- It is not any more the question if HDF will be applied in the mobile industry as a standard, it is only the question when.



Thank You for Your Attention

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