MetalForming LIVE

JULY 2022

How Newer Materials

[Advanced Steels, Aluminum Grades etc.]

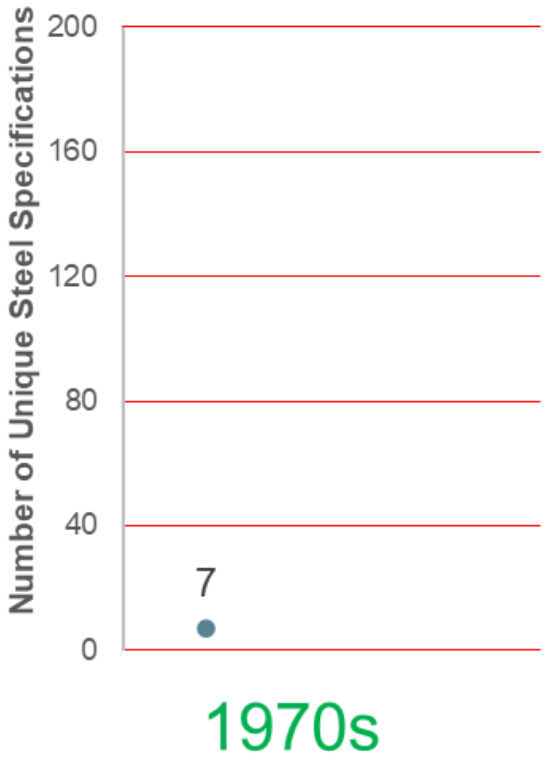
Impact Metal Formers

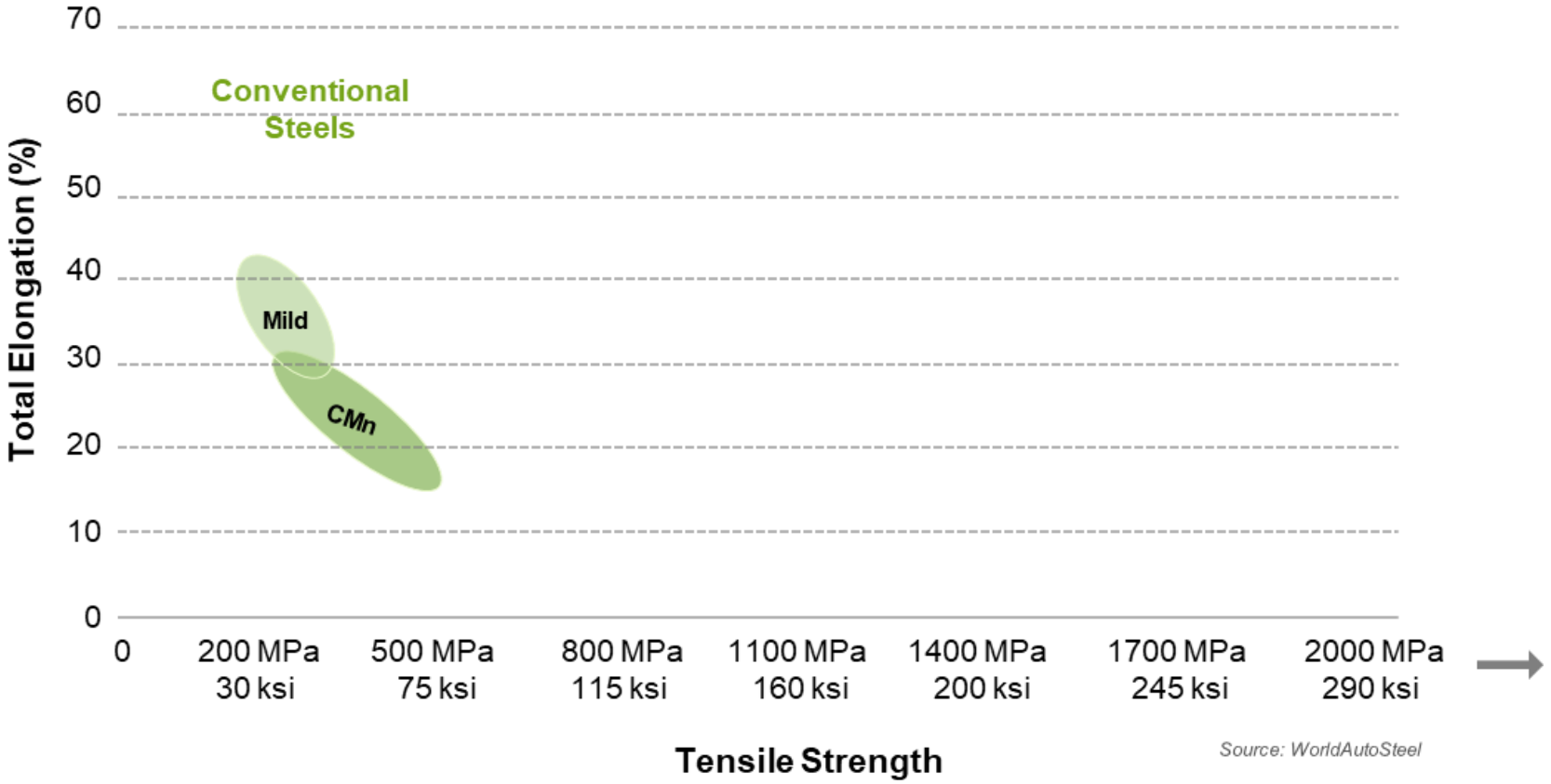
Daniel J. Schaeffler, Ph.D.

President, Engineering Quality Solutions, Inc., www.EQSgroup.com

ds@EQSgroup.com +1(248) 667-8335

Metal Grade Innovation by Decade





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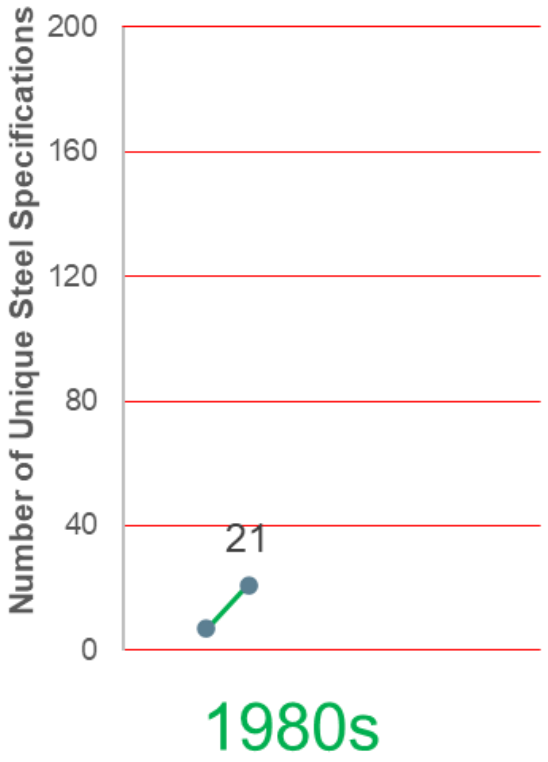

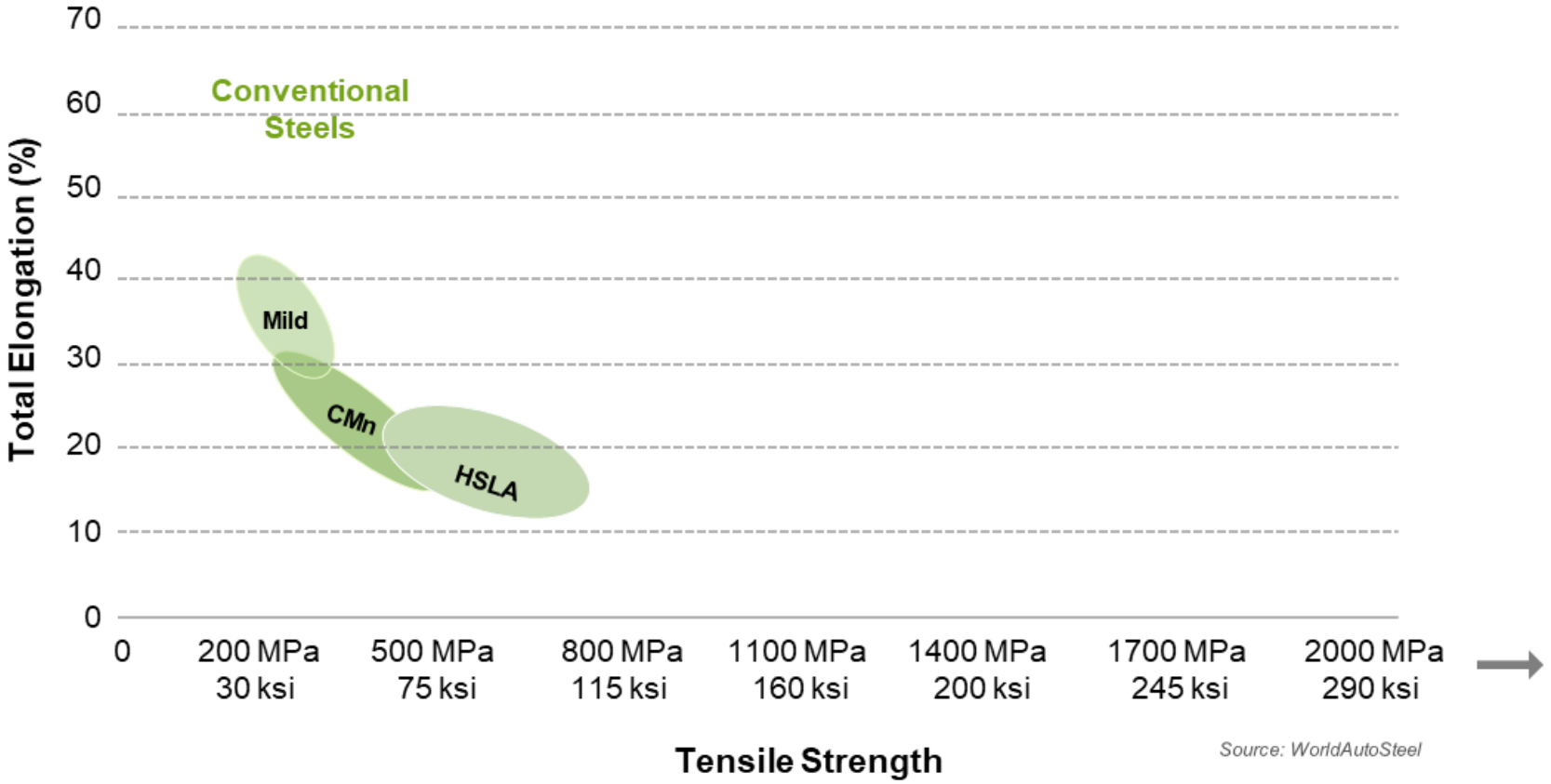

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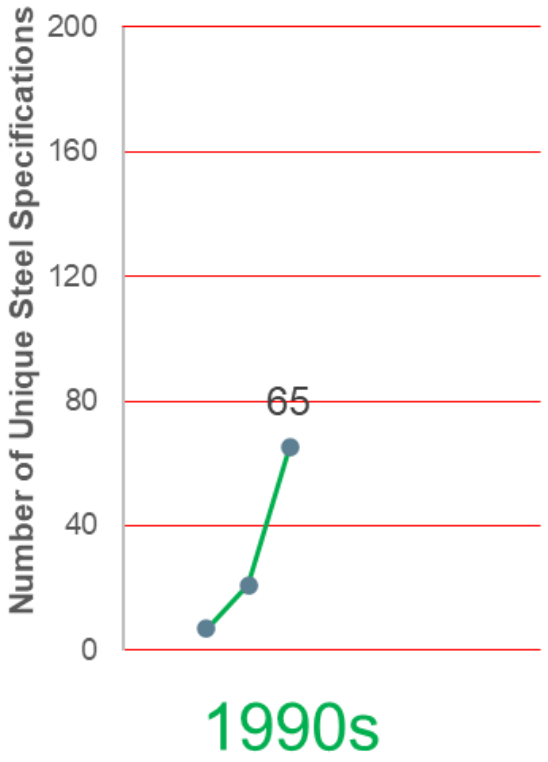

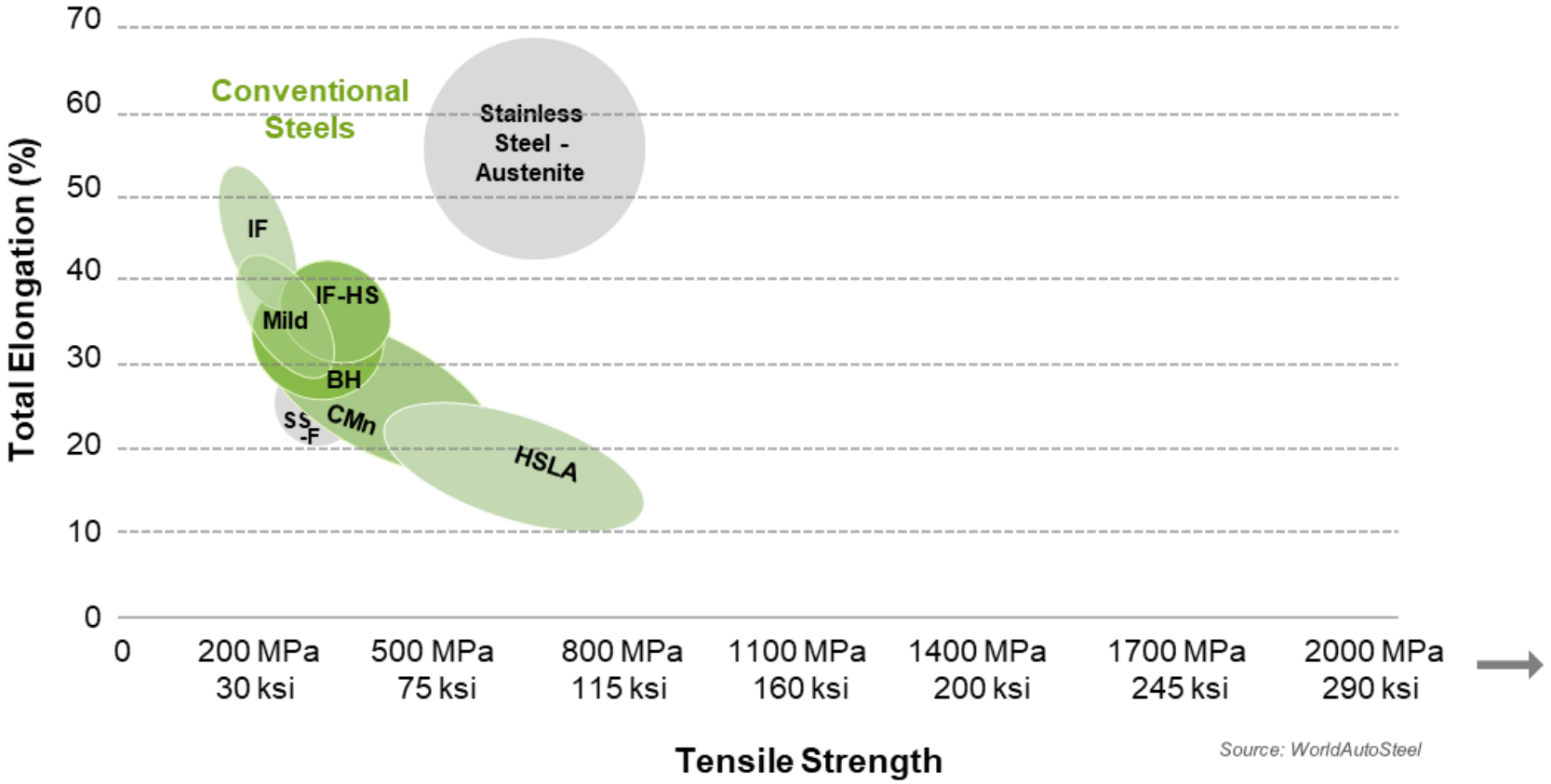

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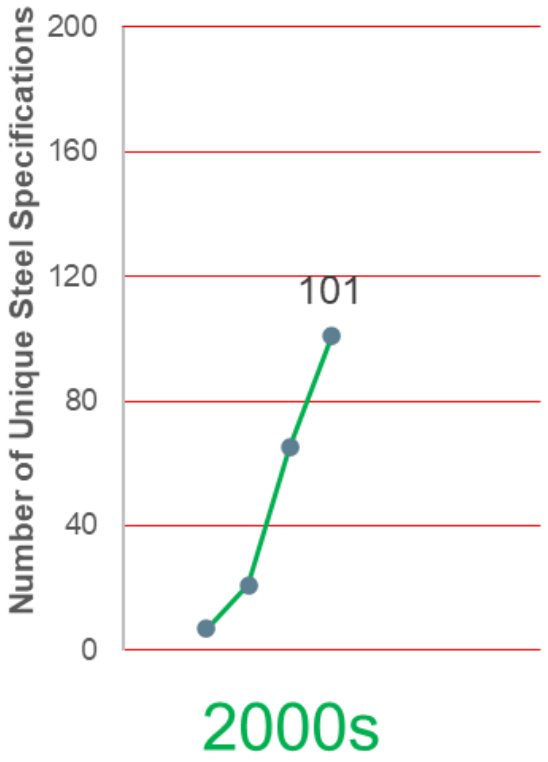

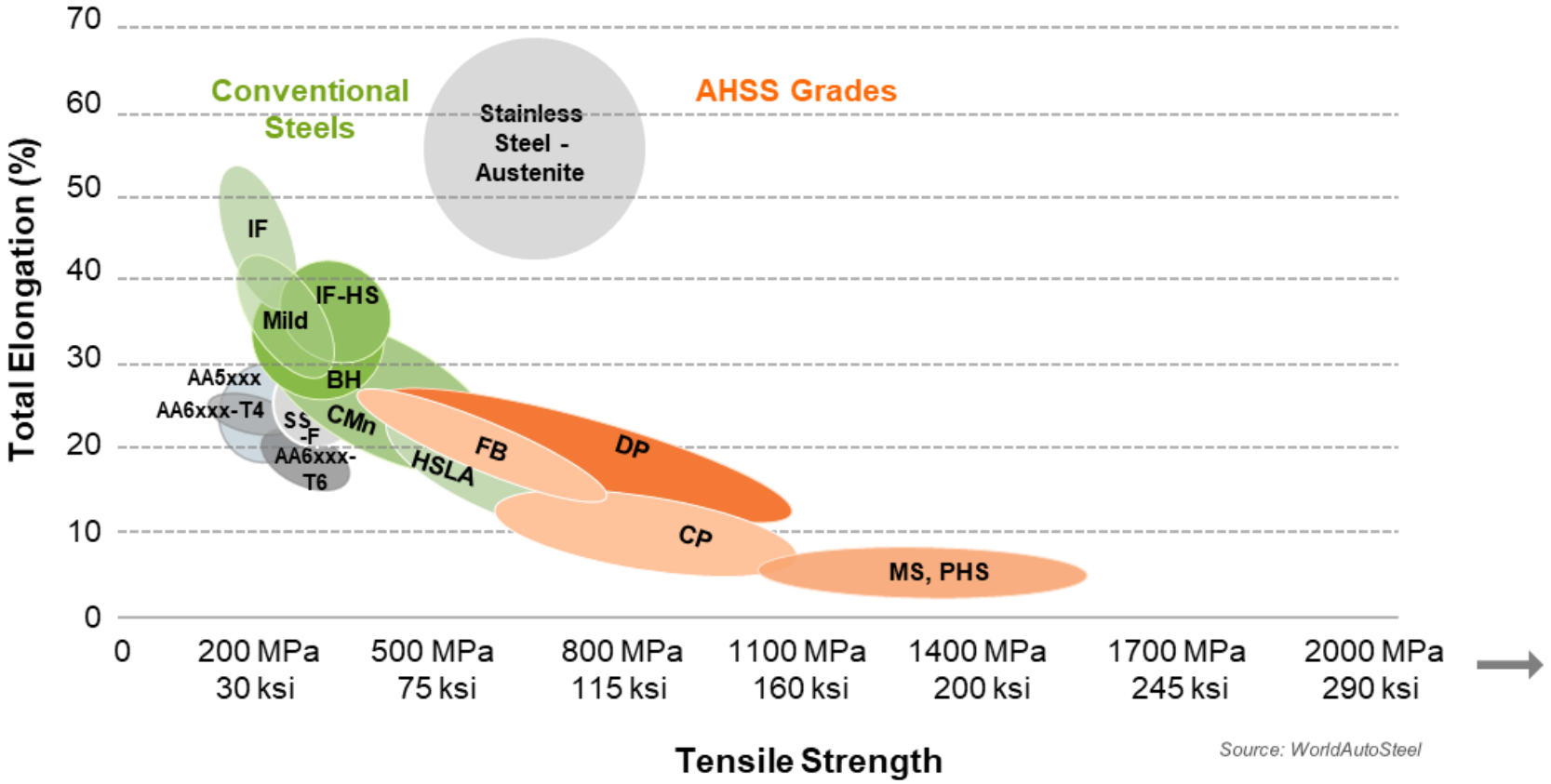

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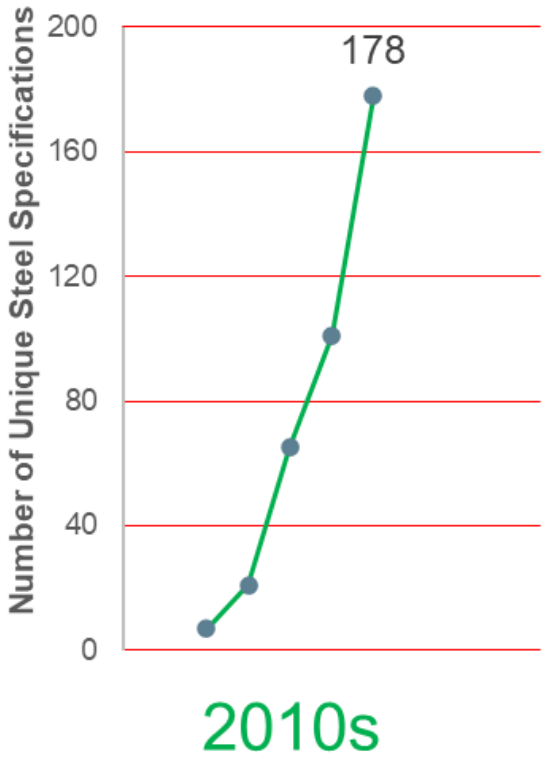

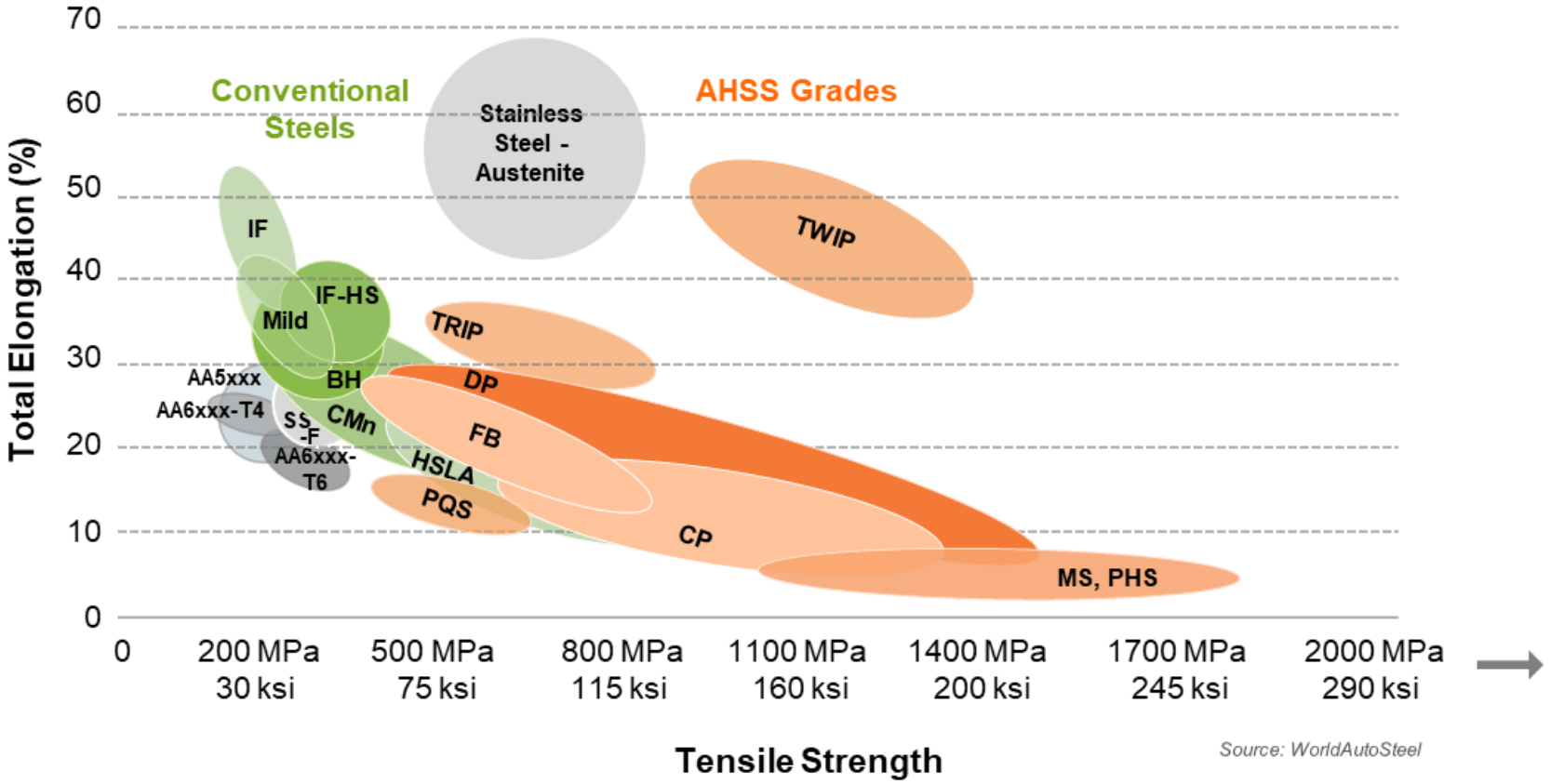

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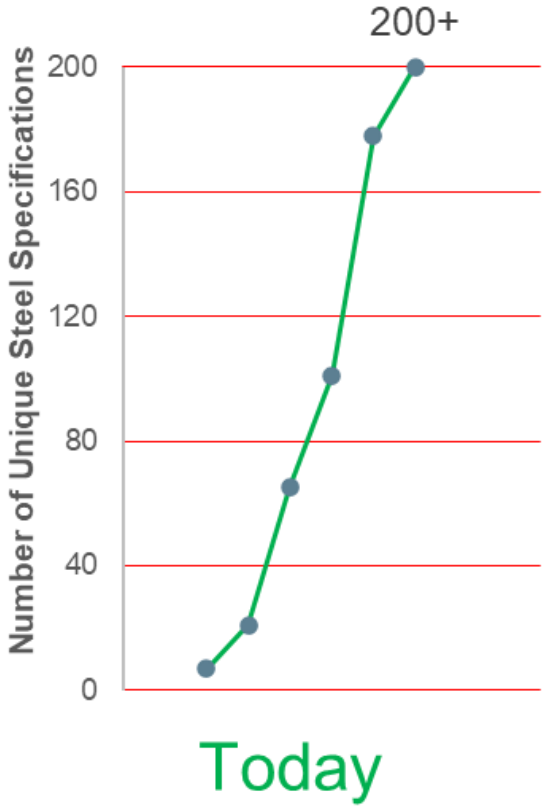
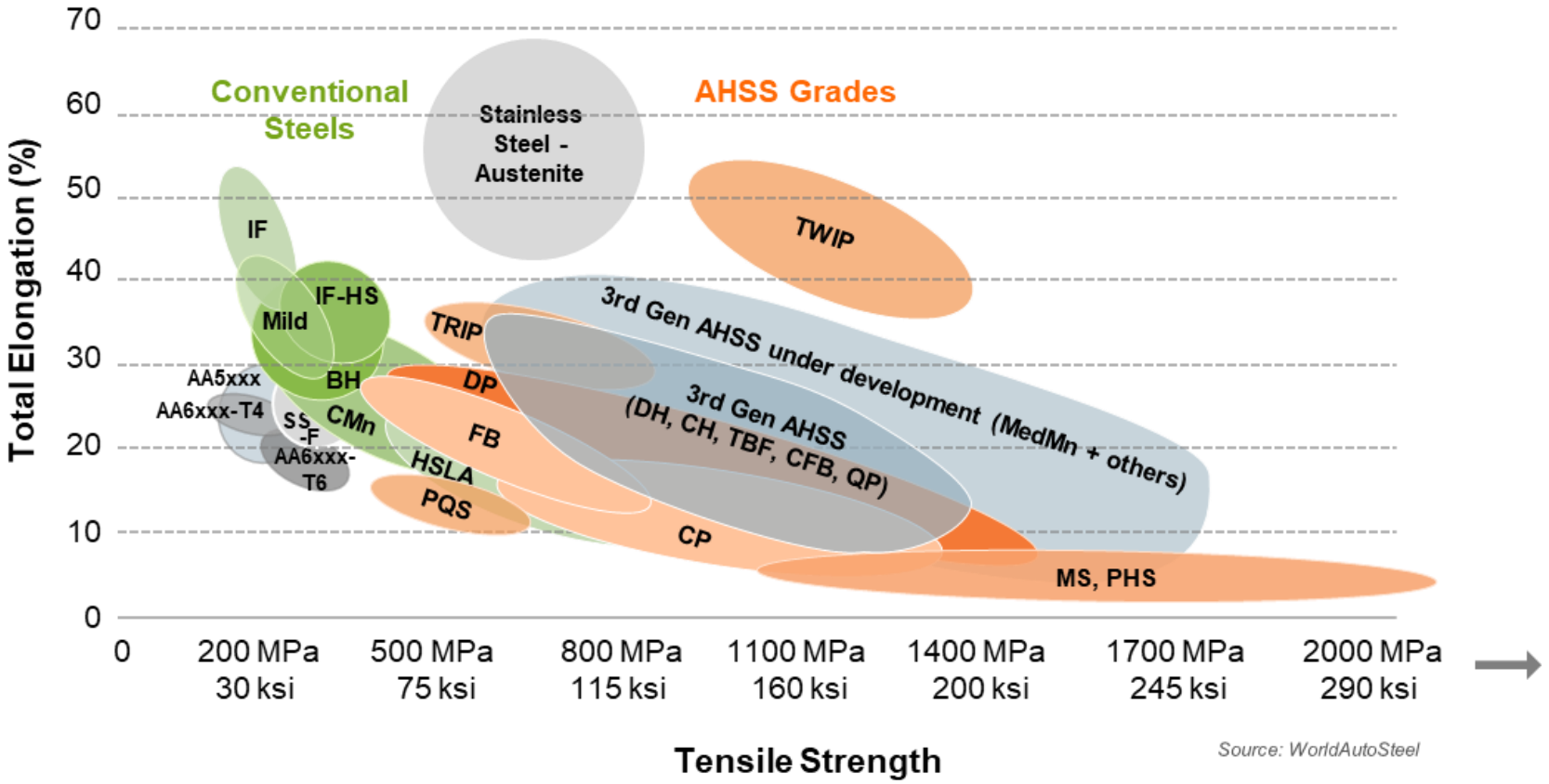
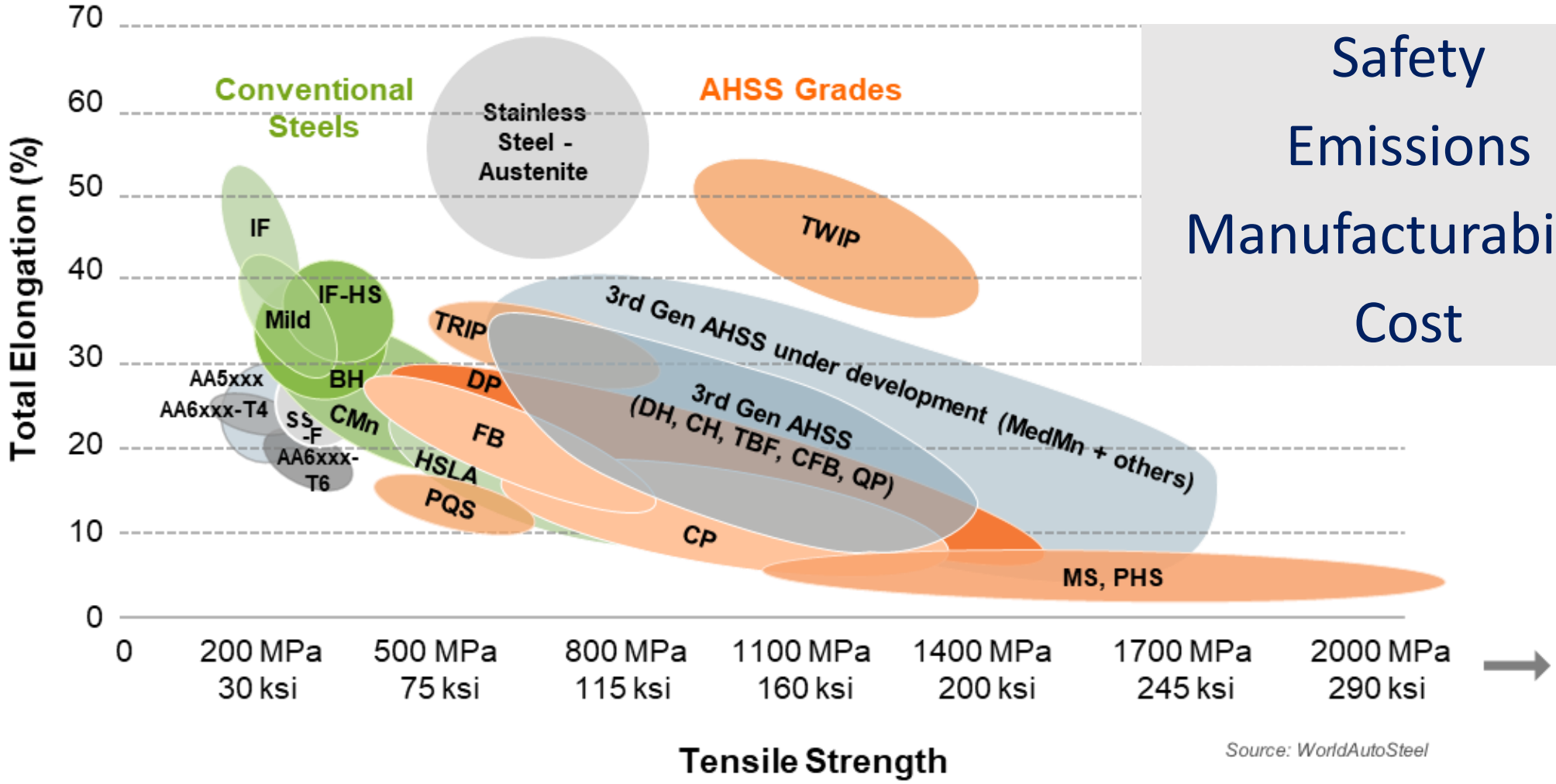




Spectrum of Grades with Different Properties



Safety

Emissions

Manufacturability

Cost

Mild Steel → HSLA → Advanced High-Strength Steel

Low carbon and conventional high-strength steels

- Globally available using similar Chemistry/Processing “recipe”
- Ferrite (and pearlite)

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Advanced high-strength steels

- No longer commodity! Chosen chemistry and mill processing parameters are a function of available mill equipment
- Ferrite, Martensite, Bainite, Retained Austenite

Dual Phase and TRIP Steels

Dual Phase

- Ferrite (soft) + Martensite (hard)
- Ductile (formable) and strong

Transformation Induced Plasticity (TRIP)

- Ferrite + Martensite + Bainite + Austenite
- Even more ductile and strong

Elongation and n-value: Metal certs and sim input

B-pillar reinforcement
CR590Y980T-DP-GI
https://automotive.arcelormittal.com/products/flat/first_gen_AHSS/DP

Complex Phase

Ferrite + Martensite + Bainite + Austenite

- Precipitation Strengthened Ferrite (like HSLA)

Smaller difference in hardness

- Much better bendability and edge expandability

Not captured on metal certs; Not captured on most sims

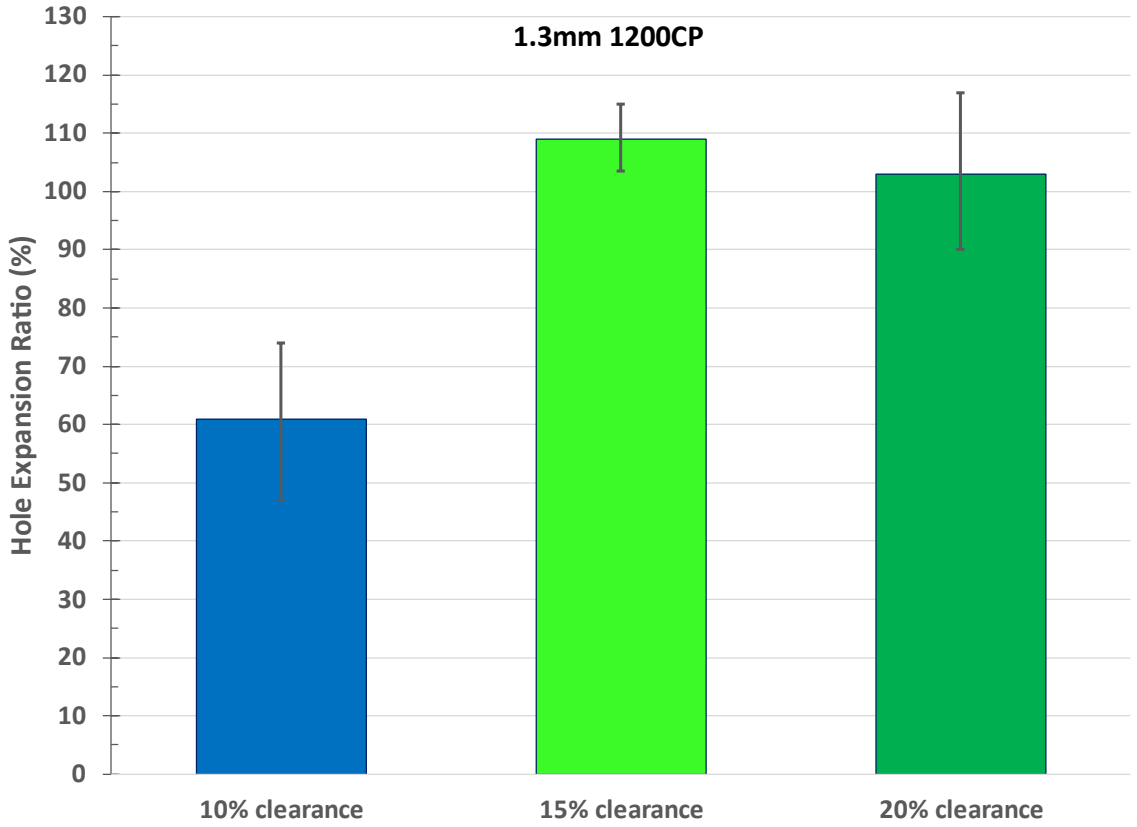
Seat flange: 1.5 mm CR360Y590T-CP

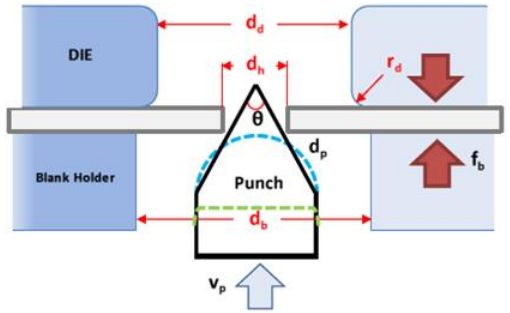
automotive.arcelormittal.com/products/flat/first_gen_AHSS/CP

Toyota Yaris Front Lower Control Arm: HR780Y980T-CP

ssab.com/en/brands-and-products/docol/automotive-steel-resources/automotive-insights/gestamp-and-ssab-collaborate

10% Cutting Clearance? Not Always The Best





v_p=punch velocity
f_b=blankholder force
θ=punch angle (conical)
d_d=diameter of the die
d_b=diameter of blankholder
r_d=die radius
d_h=diameter of pierced hole in the blank
d_p=punch diameter (hemispherical)

Hole Expansion Ratio, HER (λ)

$$= \frac{D_f - D_0}{D_0} \times 100$$

K. Unruh and M. Heuse, "New challenges on materials evaluation for advanced high-strength steels in automotive seat structures", Steels in Cars and Trucks Conference, June 2017 Amsterdam, Netherlands

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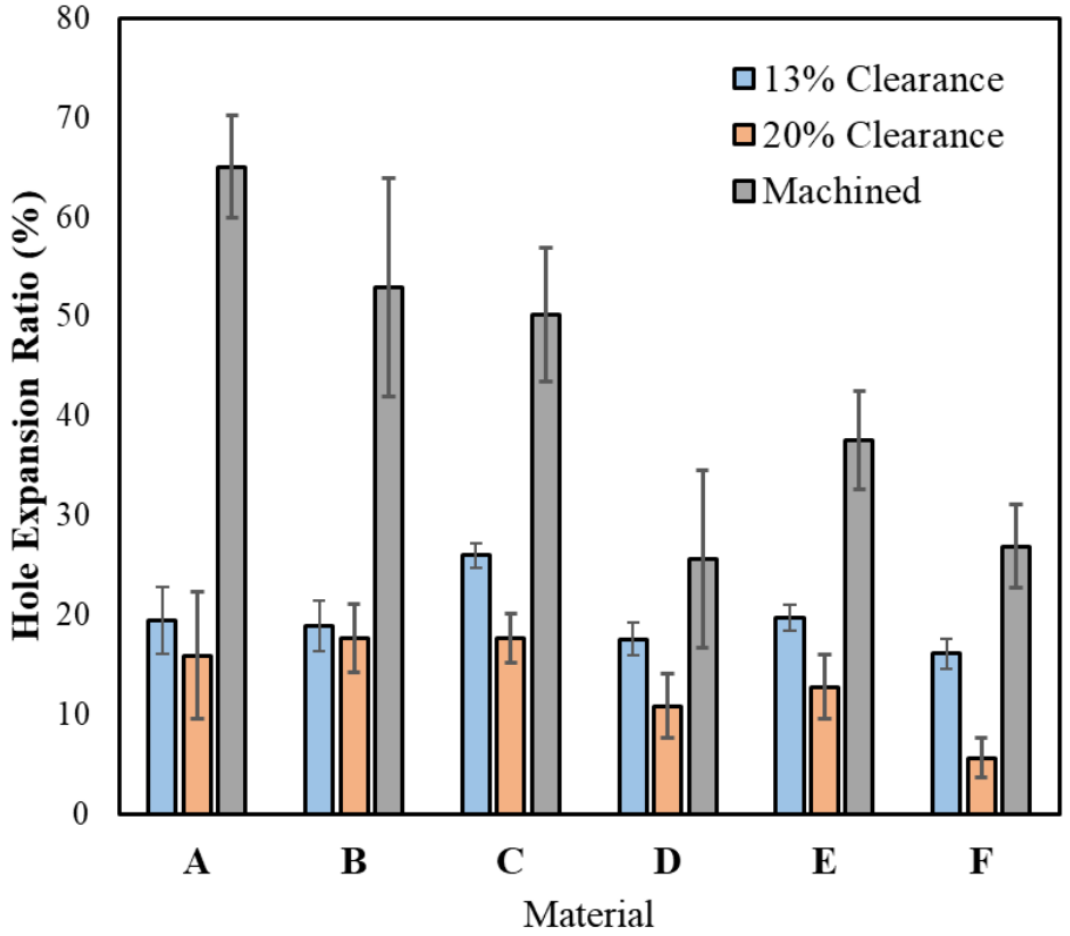

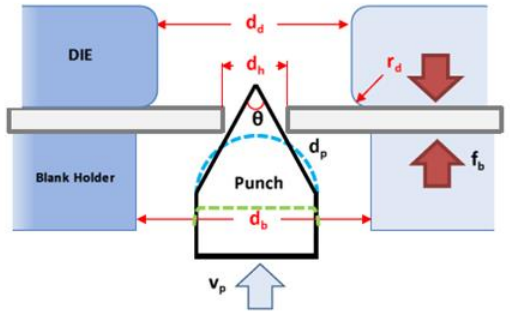

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H. Kim, J. Gu, M. Enloe, and J. P Singh, "A New Testing Method For Evaluating Edge Cracking Of AHSS", Presented at 2021 Great Designs in Steel, Sponsored by American Iron and Steel Institute.

Usage Challenges with Advanced Steels

- Press Load AND Press Energy
- Press/Die Alignment – Off Center Loading
- Tool steels and tool coatings
- Lubricant strategy
- Heat

Aluminum Alloys

5XXX (Aluminum-Magnesium)

- Age softening

6XXX (Aluminum-Magnesium-Silicon)

- Age hardening

7XXX (Aluminum-Zinc)

- Formable with heat

Be sure to segregate scrap

When is Aluminum not Aluminum?

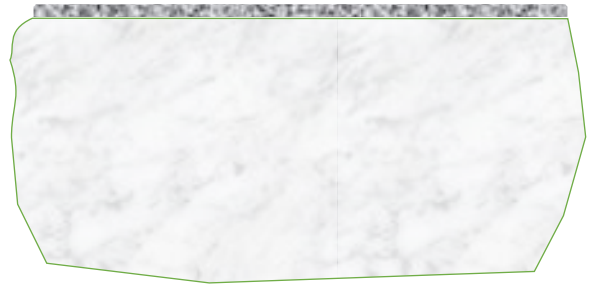
Hints:

- It’s one of the things that makes aluminum difficult to weld
- It’s one of the things that makes aluminum not rust
- It’s one of the things that makes aluminum gum up tooling

Aluminum Surface is Not Aluminum

Al_2O_3 (aluminum oxide) surface layer

- Thickness ≈ 4 nm
  = 0.004 µm = 0.000004 mm
  = 4 millionths of a millimeter = < 0.0000002 inch



Aluminum melts at ≈ 660 °C ≈ 1200 °F

Aluminum oxide melts closer to 2000 °C … ≈ 3600 °F

[… Steel melts at ≈ 1370 °C (≈ 2500 °F)]

Many Options Within Each Alloy Family

Novelis

- Advanz™ 6CM S118
- Advanz™ 6CM s300
- Advanz™ 6HS s600
- Advanz™ 6HS s615
- Advanz™ 6HS s650
- Advanz™ 6HS e600
- Advanz™ 6HF e200
- Advanz™ 6HF s200
- Advanz™ 6F e170

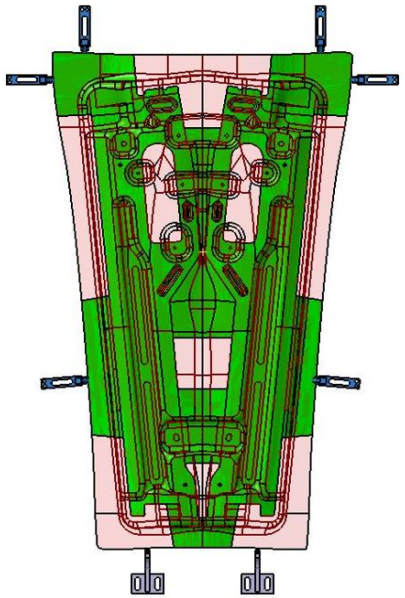
Constellium

- 6016X
- 6016 DRX
- Surfalex® HF
- Surfalex® HS
- Formalex® REMOTE
- Strongalex®
- Securalex® (HS/UHS/P6)
- HSA6™
- HCA6™

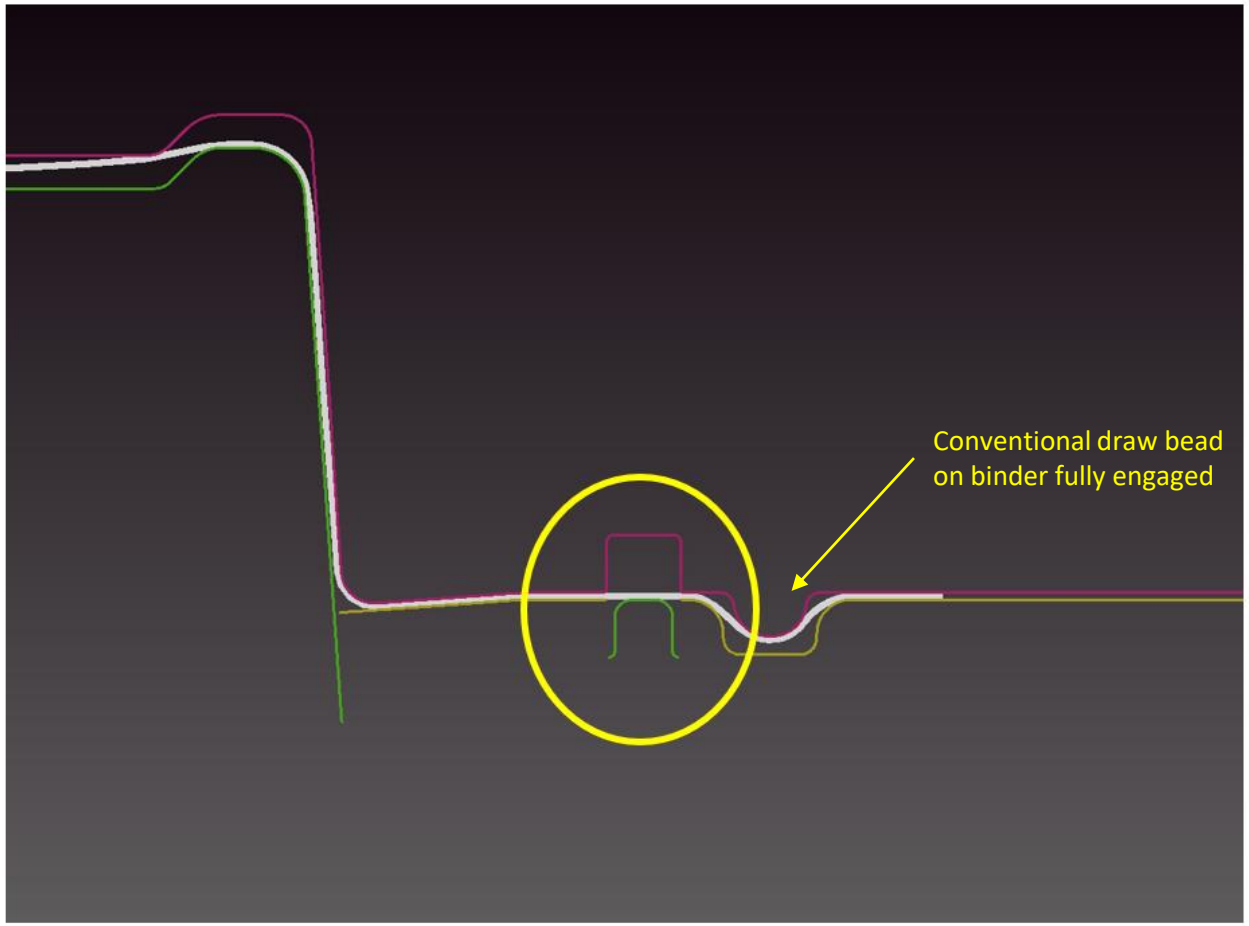
Process/Design elements:

- Balance operation to aid in offsetting thrust conditions – trimming/flanging (A)
- Employ higher-strength casting/bar-stock materials (Caldie)
- Consider high-strength material applications as high-volume tools (casting materials/thickness, double wear plates, back-up for trim/flange operations)
- Insert draw dies for maintenance/wear
- Implement stake beads to aid in reducing curl/springback

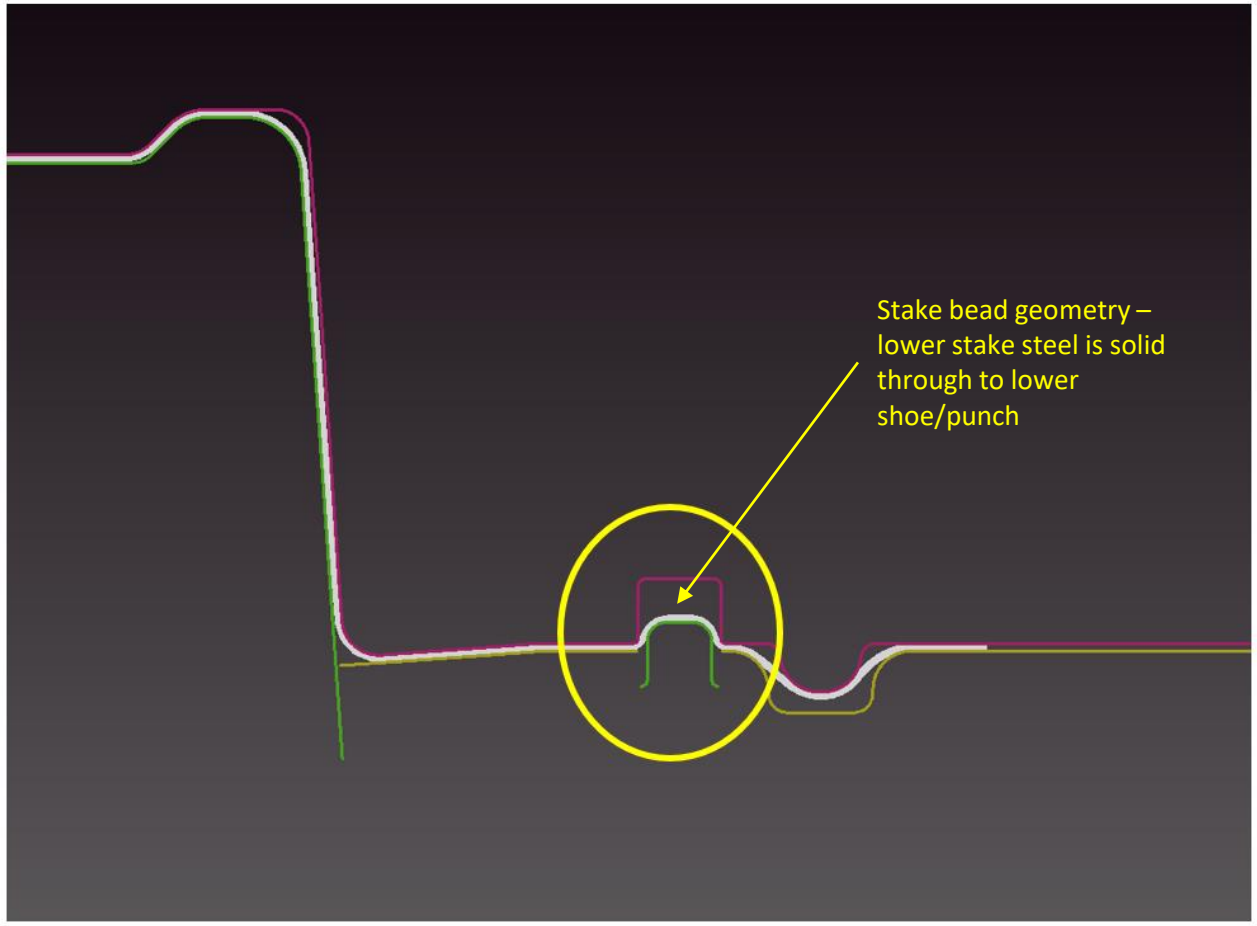
A



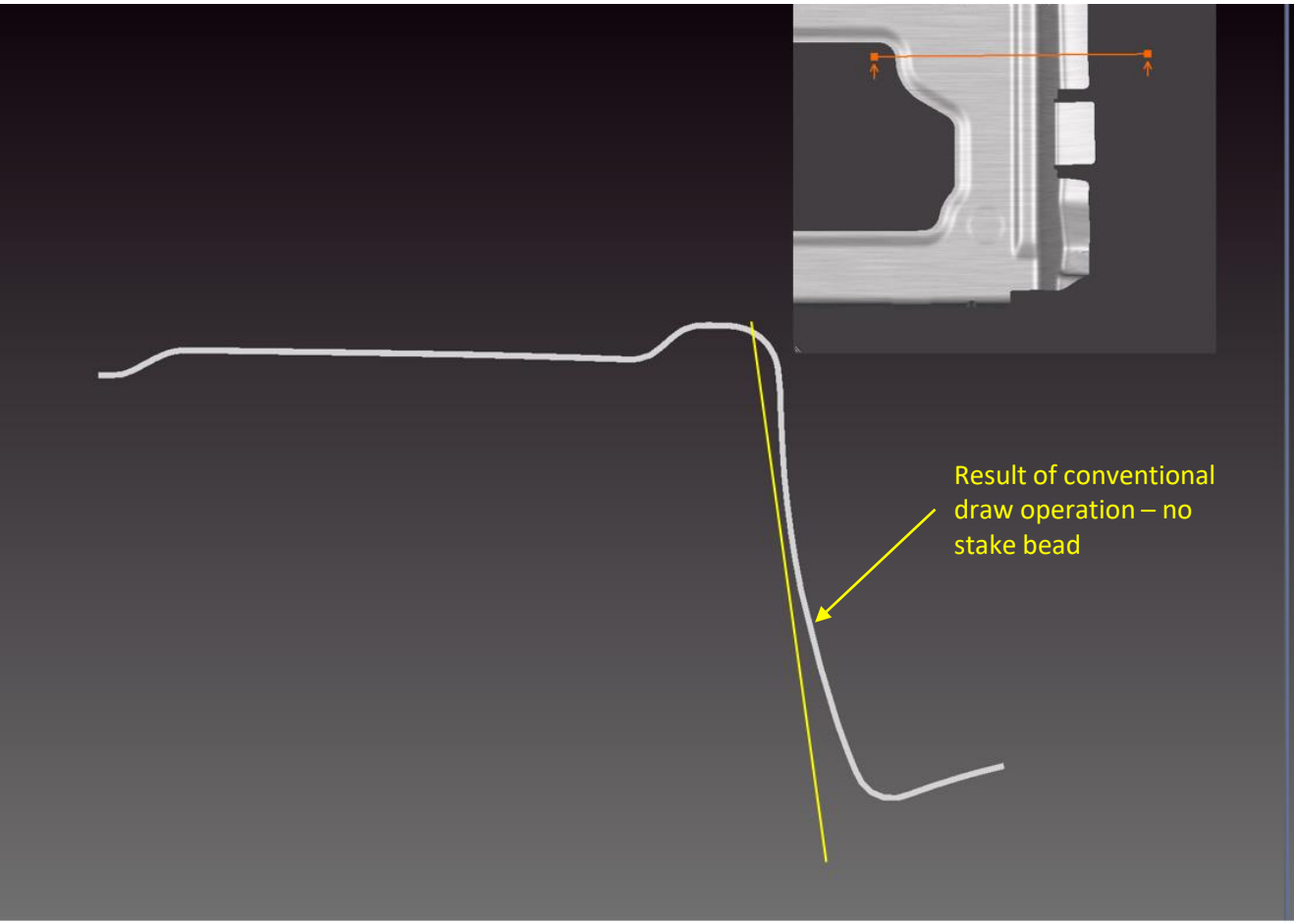
Introduction of stake bead in draw operation in order to minimize sidewall curl.



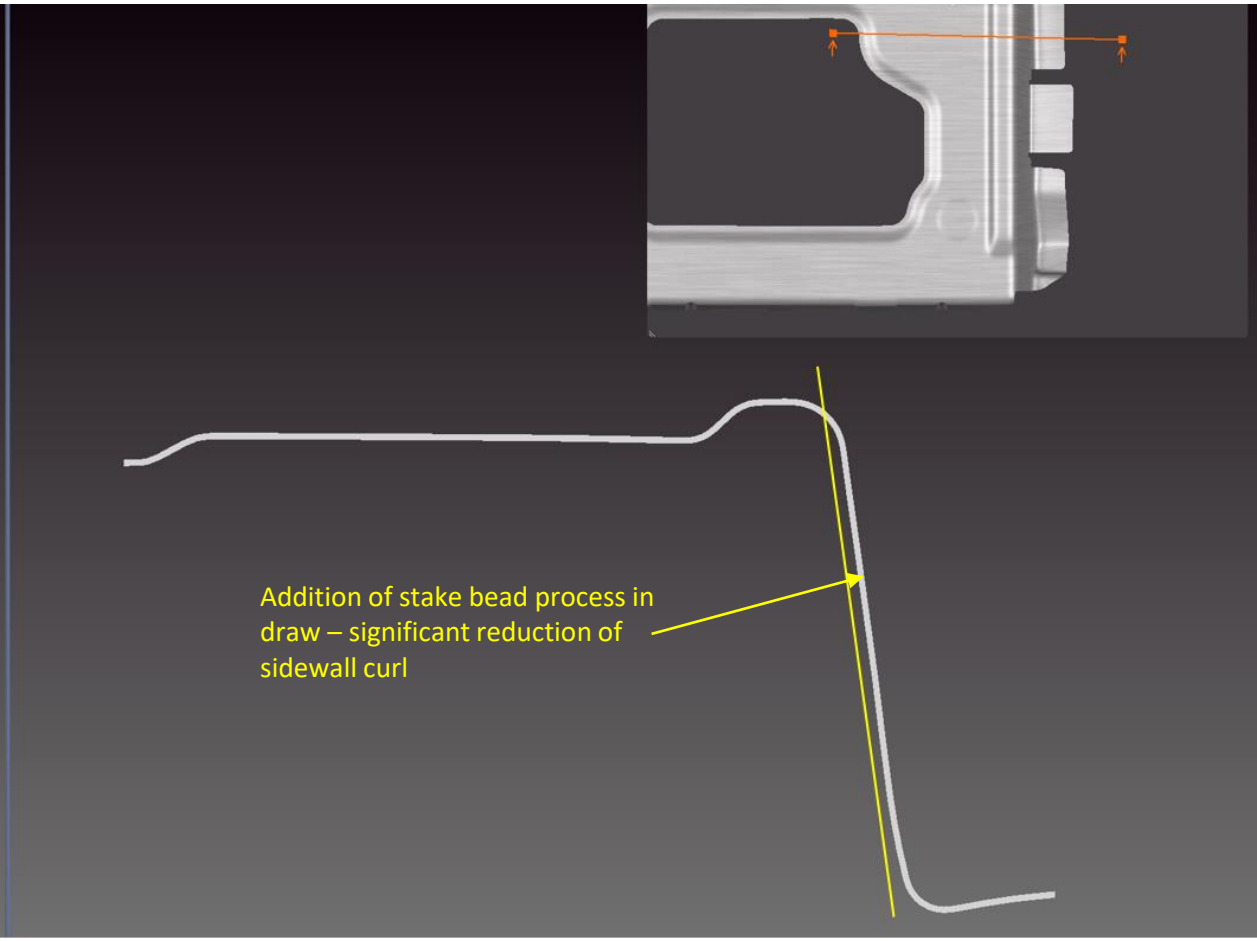
Conventional stretch draw 5mm off bottom – stake bead at first contact.



Draw closed, stake bead entered 5mm.



Final springback analysis – conventional draw bead only



Final springback analysis – introduction of stake bead in draw operation.

And now…

Our Roundtable