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Global Market and Technology Trends in Sheet Galvanizing – 2016 Update

International Galvanizing Conference
New Delhi, India
October 20-21, 2016

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Outline

- **Global Regions & Market Sectors**
- Key Market & Regulatory Drivers
- Process Technology Trends
- Product Technology Trends
- A Look into the Future

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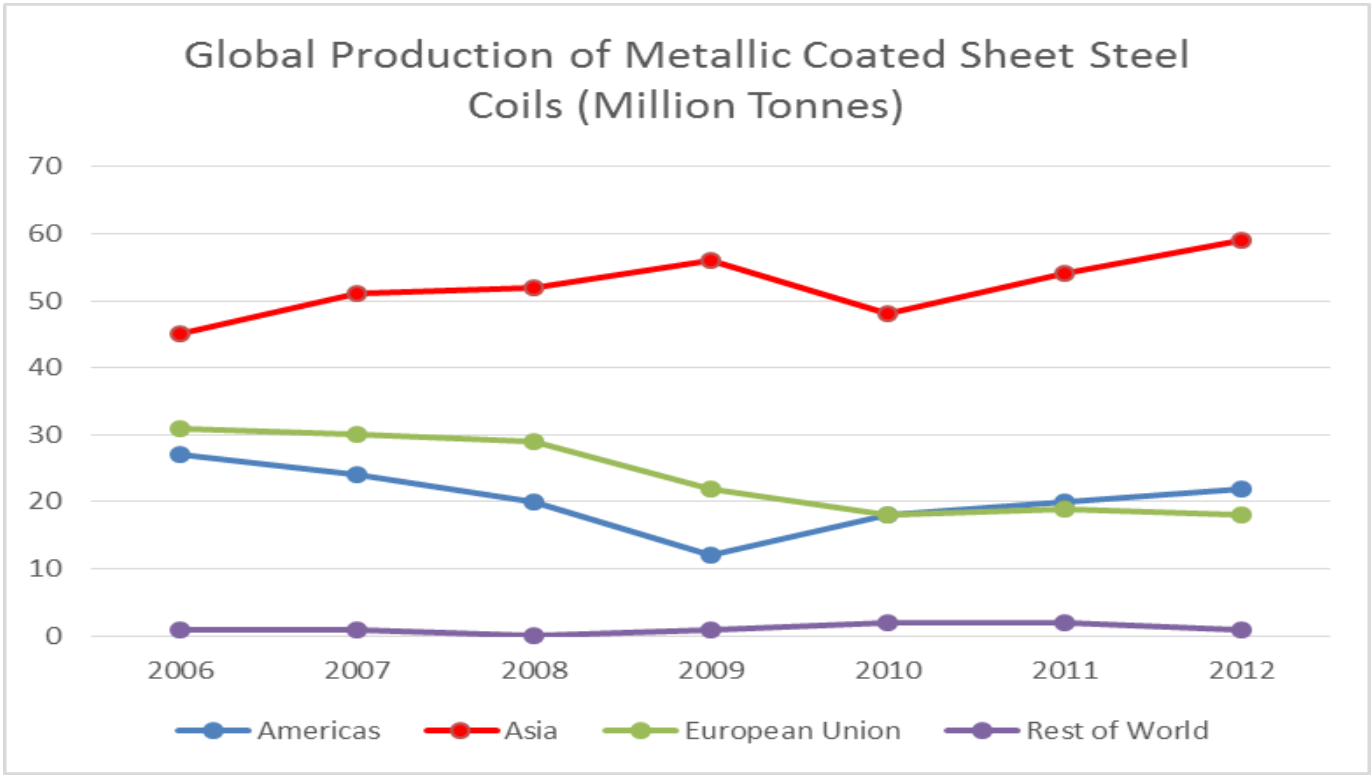
Global Production of Coated Steel



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Distribution by End Use
(Metallic Coated Sheet)

- **Asia**

  China - Auto 15%; Construction 37%; Appliance 20%

  Japan - Auto 55%; Construction 16%; Appliance 4%

  India - Auto 9%; Construction 26%; Appliance 9%

- **Americas**

  Auto 26%; Construction 40%; Appliance 4%

- **Europe (EU 28)**

  Auto 44%; Construction 24%; Tubes 18%;
  Appliance 6%

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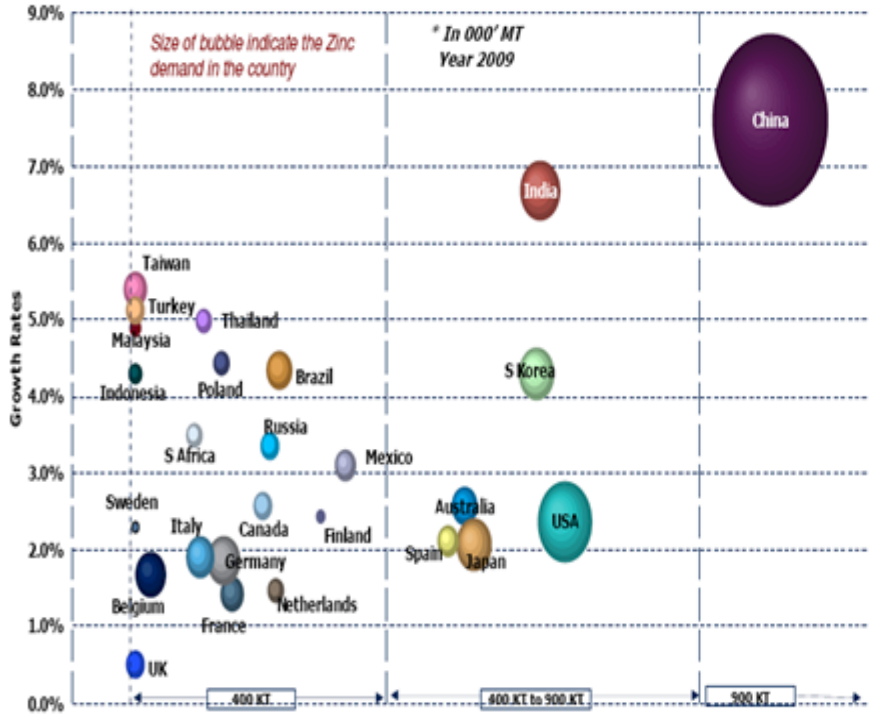
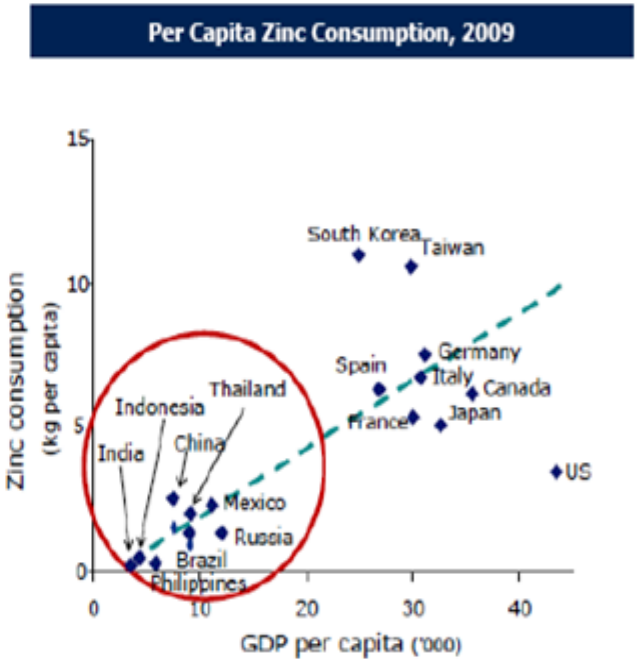
Indian Zinc Market





Source: Hindustan Zinc Limited

India: High Growth, High Demand Market, but the Lowest Zinc Consumption Per Capita

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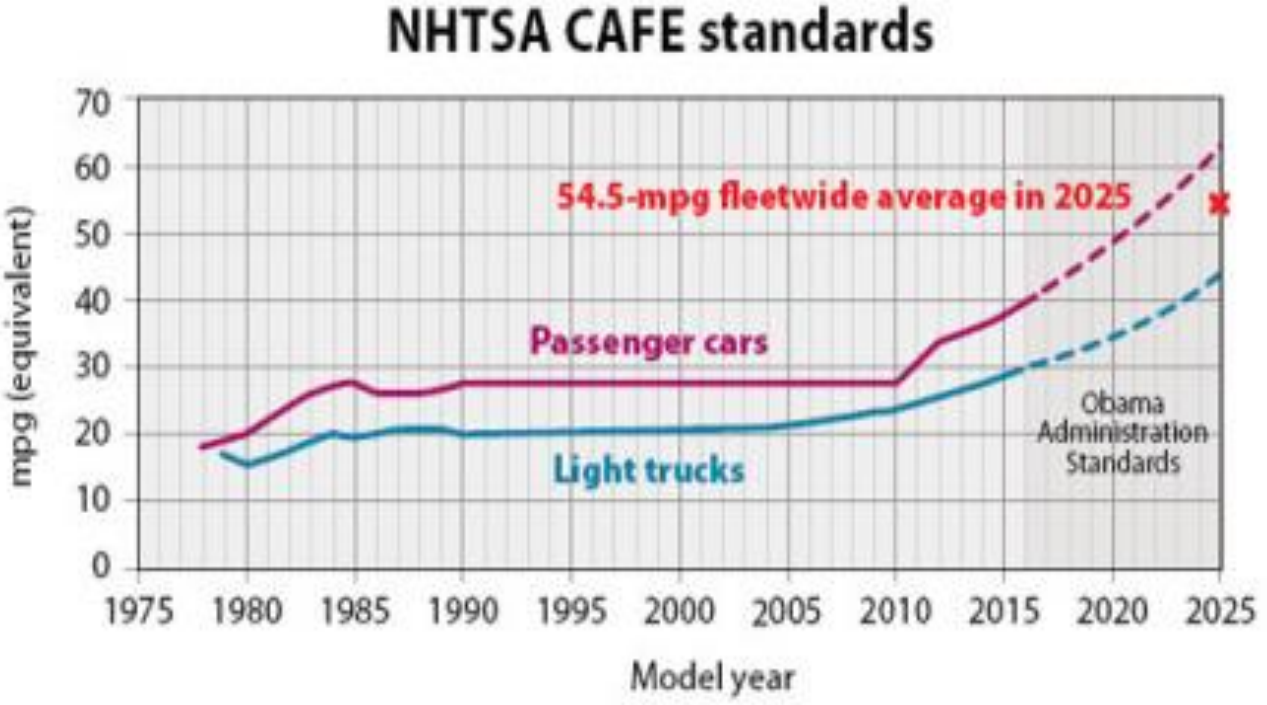
Major Drivers for NA Automotive Materials development: Fuel Ecomony & Safety standards



Also, increasing safety standards

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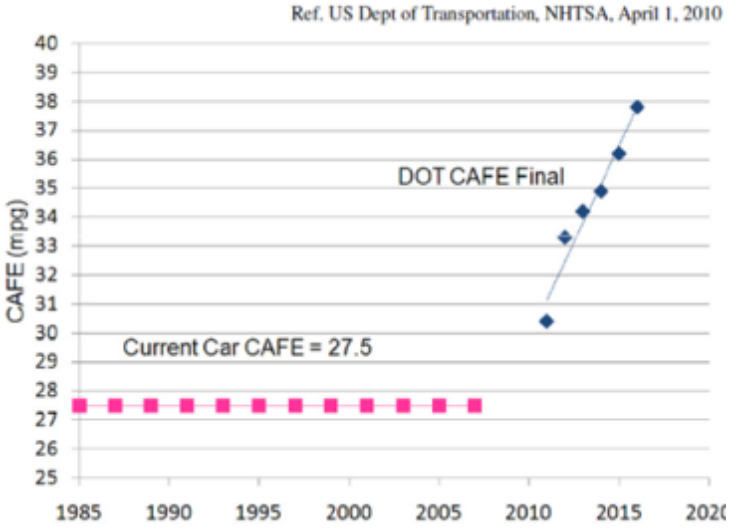
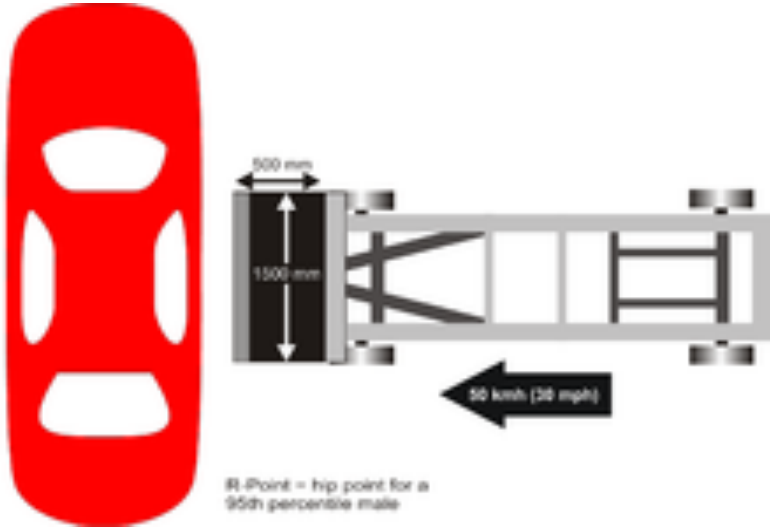
EU Constraints in vehicle design

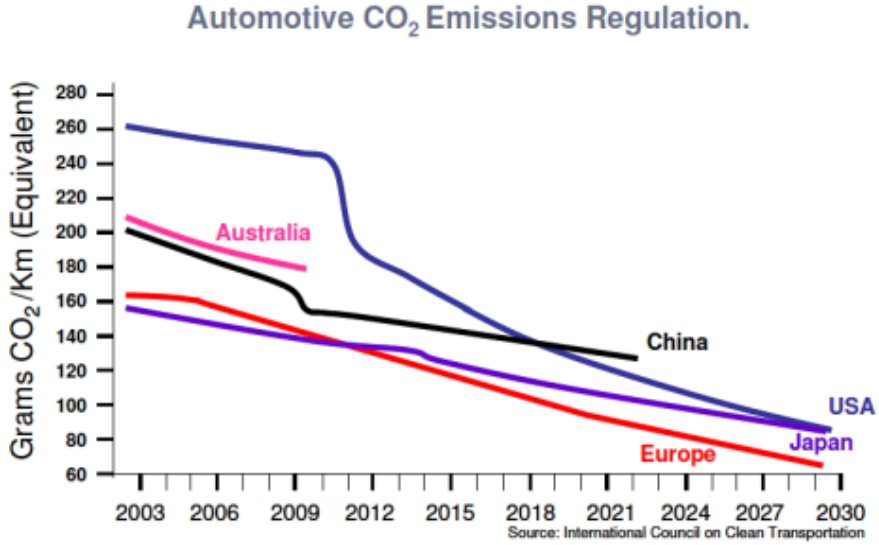
Fuel Economy Regulations





Safety: ie Euro NCAP side impact

Emissions Regulations



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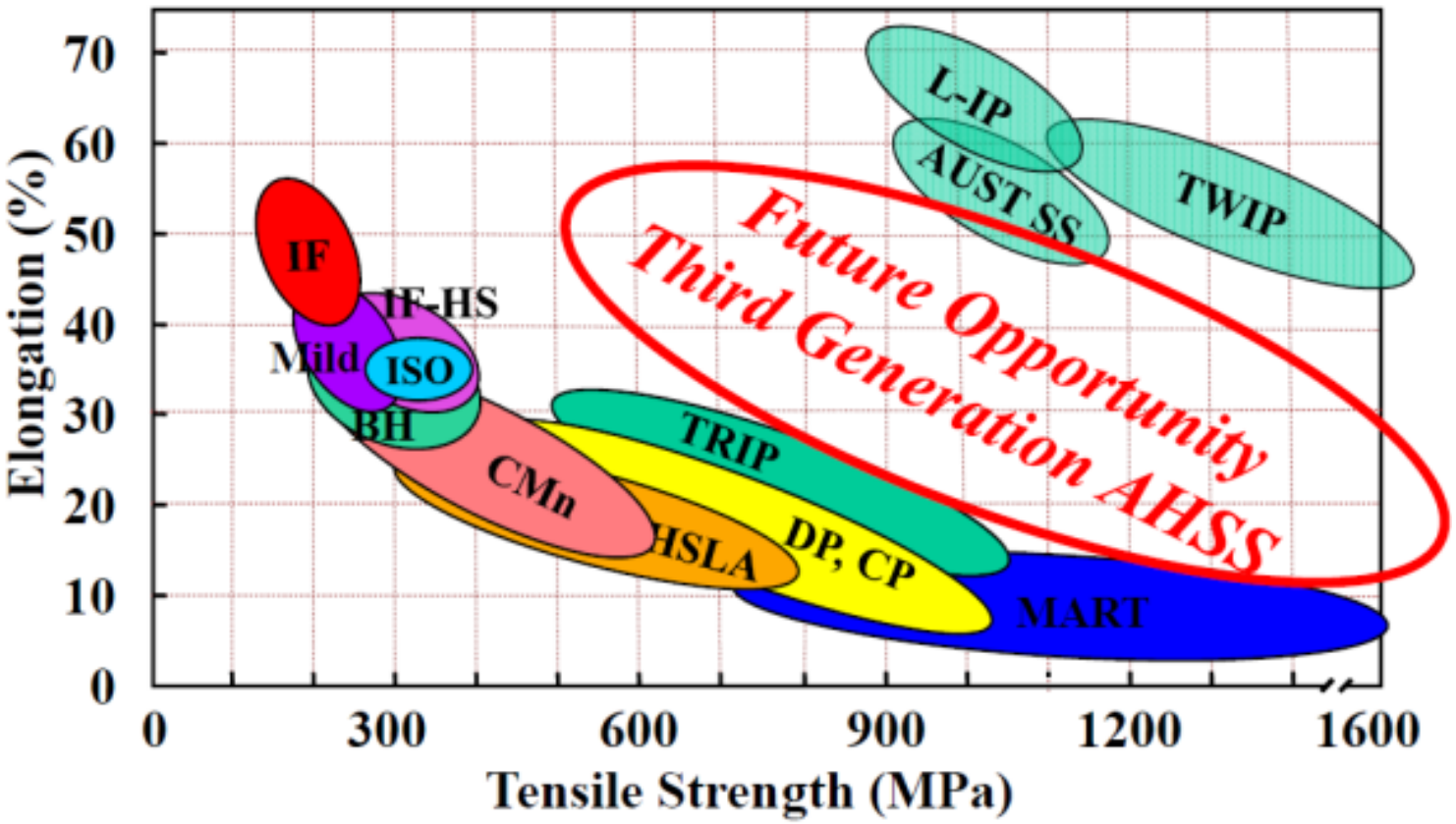
Grades of Automotive Steels



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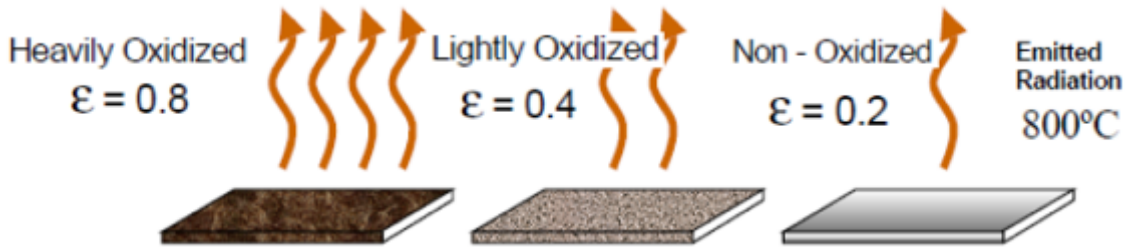
CGL Control Improvements

- *Environmental Efficiency … less heat and electrical power needs & lower wastes*
- *Multi-wavelength spot pyrometers, much less sensitive to steel surface emissivity*
- *Improvement of snout control especially for AHSS*
- *Control and management of Zn wettability by optimizing steel composition and surface treatment in the Furnace*
- *Use of electromagnetic strip stabilizing systems positioned just above the coating knives: to reduce overcoating; improve GA alloy uniformity; wipe thinner coatings, such as 35 to 40 g/m² per side, or can run at higher line speeds.*



Schulz et al

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The risks …

- *High Technology and Class 1 products require good auxiliary Process & Design*
  - *Quality of Utilities (Water, gas, H2, N2…)*
  - *Cooling of electrics*
  - *Calibration procedures of instrumentation*
  - *Maintenance procedures at required frequency*
  - *Quality of spare parts*
  - *Customer-Galvanizer-Equipment supplier relationship*
- *Too many products and wide mix product range reduce line flexibility and productivity*
  - *Multi coating lines*
  - *Number of annealing cycles*
  - *Number of steel surface roughness types*
  - *Range of thickness and width*

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And more risks …

- *Higher Level of Automation has higher risks*
  - *Results are highly sensitive to sensor quality & reliability*
  - *Detection of malfunctions is always difficult*
- *More models and complex line requires highly qualified personnel*
  - *For repair & improvement*
  - *For detection of malfunctions and origin of failure*

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Substrates

- ***CS – low carbon steel***
- ***FS – low carbon steel***
- ***SS – carbon steel***
- ***DDS – extra or ultra low carbon steel***
- ***EDDS – ultra low carbon stabilized steel***
- ***HSLAS – micro-alloyed low carbon steel***
- ***AHSS – advanced high strength steels***

AHSS Chemistries

Table I *Overview of the Alloy Basis, the Applied Hardening Mechanism and the Resulting Steel Grades*

Steel Grade	Alloy Basis	Hardening Mechanism	Main Alloying Addition
Microalloyed grades	LC	precipitation, grain refinement, solid solution	Ti, Nb and/or V, Mn
Rephosphorized LC grades	LC	solid solution, grain refinement	P, Mn, Si
HS IF grades	IF (Ti, Nb or Ti + Nb)	solid solution, grain refinement, precipitation	P, Mn, Si, B
BH grades (LC)	LC	solid solution, grain refinement	P, Mn, Si
BH grades (ULC)	ULC (Ti, Nb, V)	solid solution, grain refinement	P, Mn
DP/MP grades	LC	transformation	C, Mn, Cr, Mo
TRIP grades	LC	transformation	C, Mn, Si, Al, P

- ***For both DP and TRIP***
  - ***C level of 0.1 to 0.4%, but as low a possible for good weldability***
  - ***Mn level of 1.0 - 2.5%***
  - ***Cr & Mo up to 1.2% (together)***
  - ***Si level of 1.0 - 2.5%, and/or Al level of 1.0 - 2.5%***
  - ***Often micro-alloyed with Nb, V, or Ti for grain refining and precipitation hardening***

AHSS Mechanical Properties

Steel Grade	YS (MPa)	UTS (MPa)	Tot. EL (%)
HSLA 350/450	350	450	23-27
DP 300/500	300	500	30-34
DP 350/600	350	600	24-30
TRIP 450/800	450	800	26-32
DP 500/800	500	800	14-20
CP 700/800	700	800	10-15
DP 700/1000	700	1000	12-17
MS 1250/1520	1250	1520	4-6

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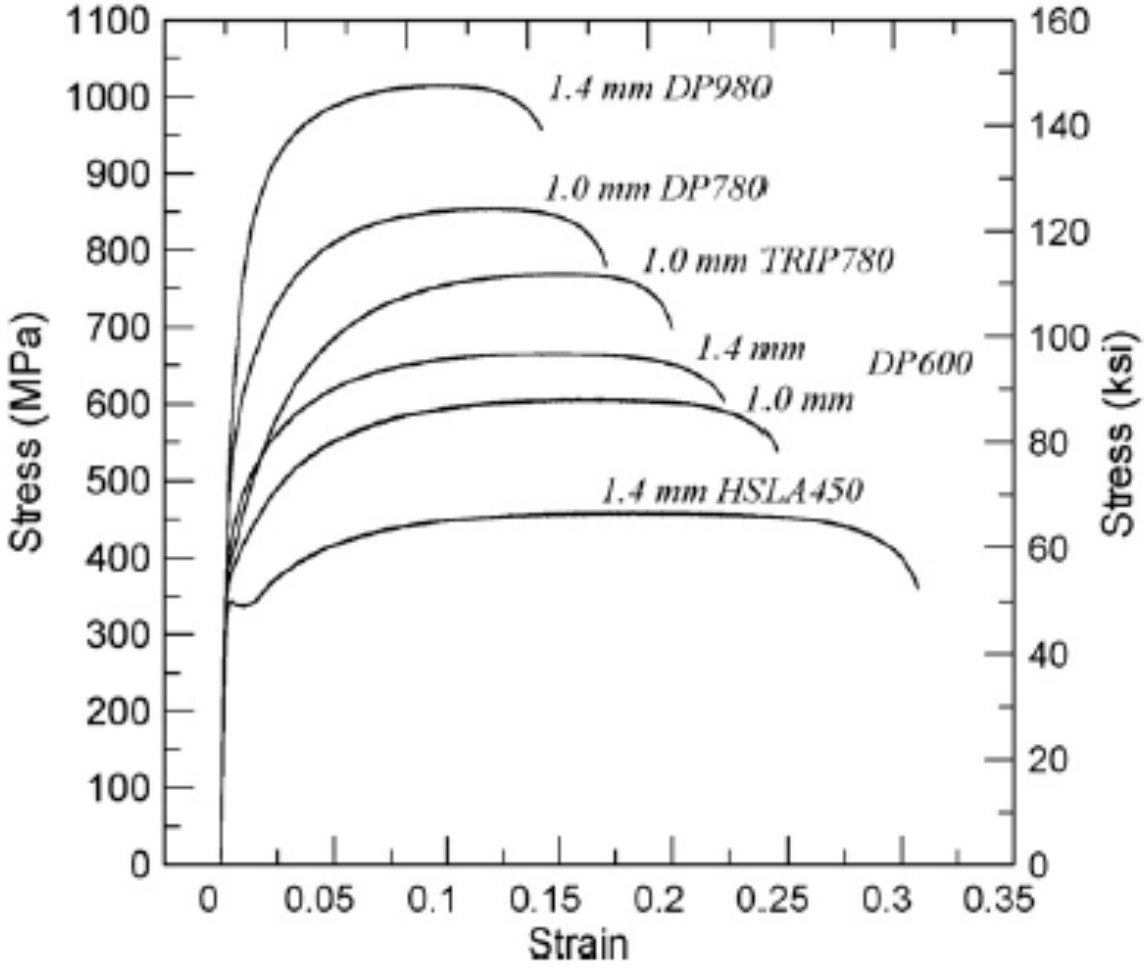
Tensile Properties of Automotive Sheet Steels

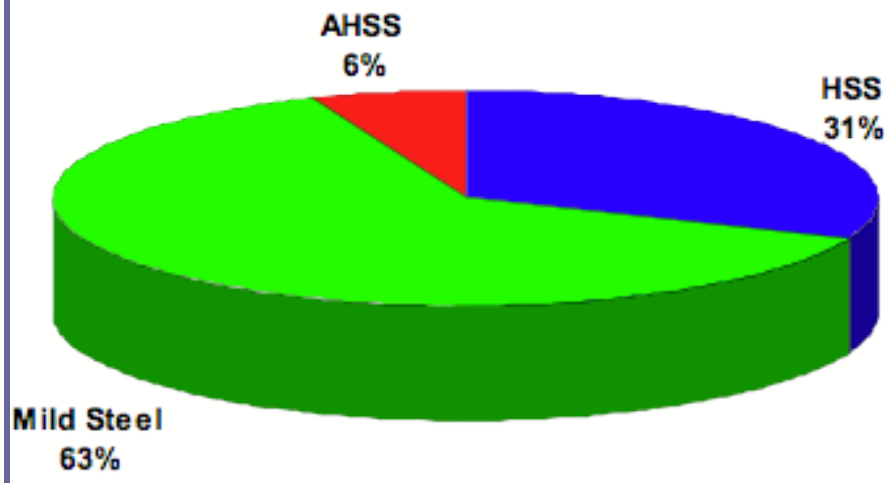


A.W. Hudgins et al. / Journal of Materials Processing Technology 210 (2010) 741–750

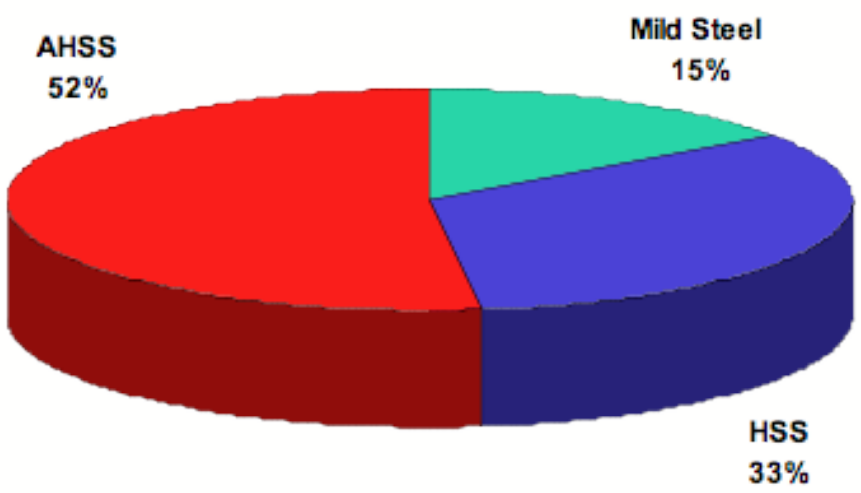
HSS/AHSS Automotive Application Trends

Projected Growth ***(ASTI estimate)***

2006 – Automotive steel Breakdown



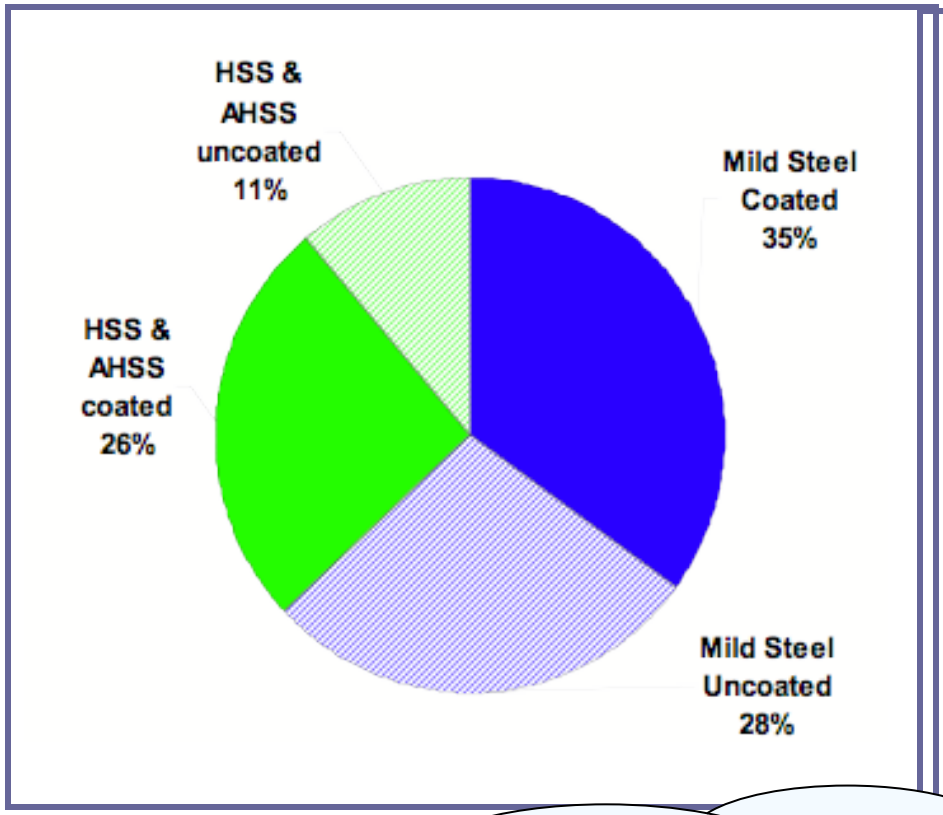
2016 – Automotive steel Breakdown



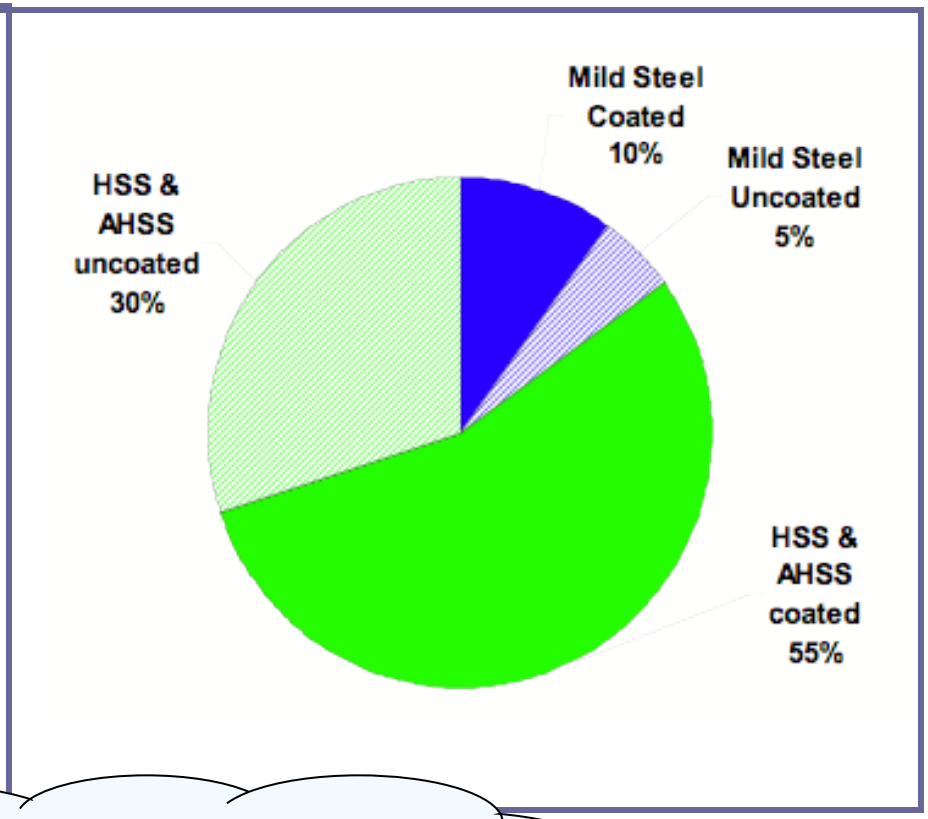
HSS/AHSS Automotive Application Trends

Breakdown by coated versus uncoated

2006



2016



Most of coated HSS/AHSS will be made on CGL

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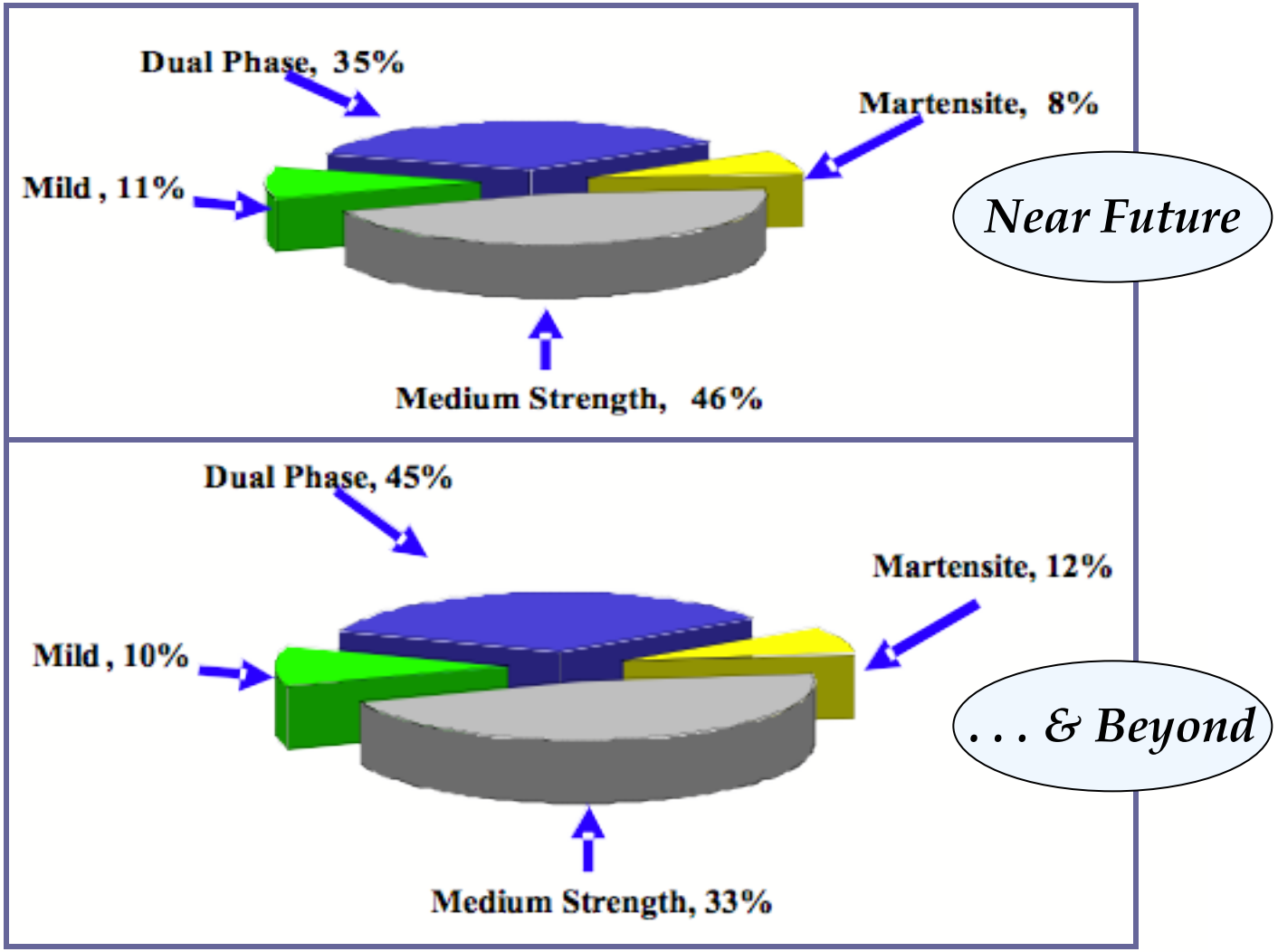
HSS/AHSS Automotive Application Trends

General Motors



[Source: Curt Horvath — GM — GDIS 2004]

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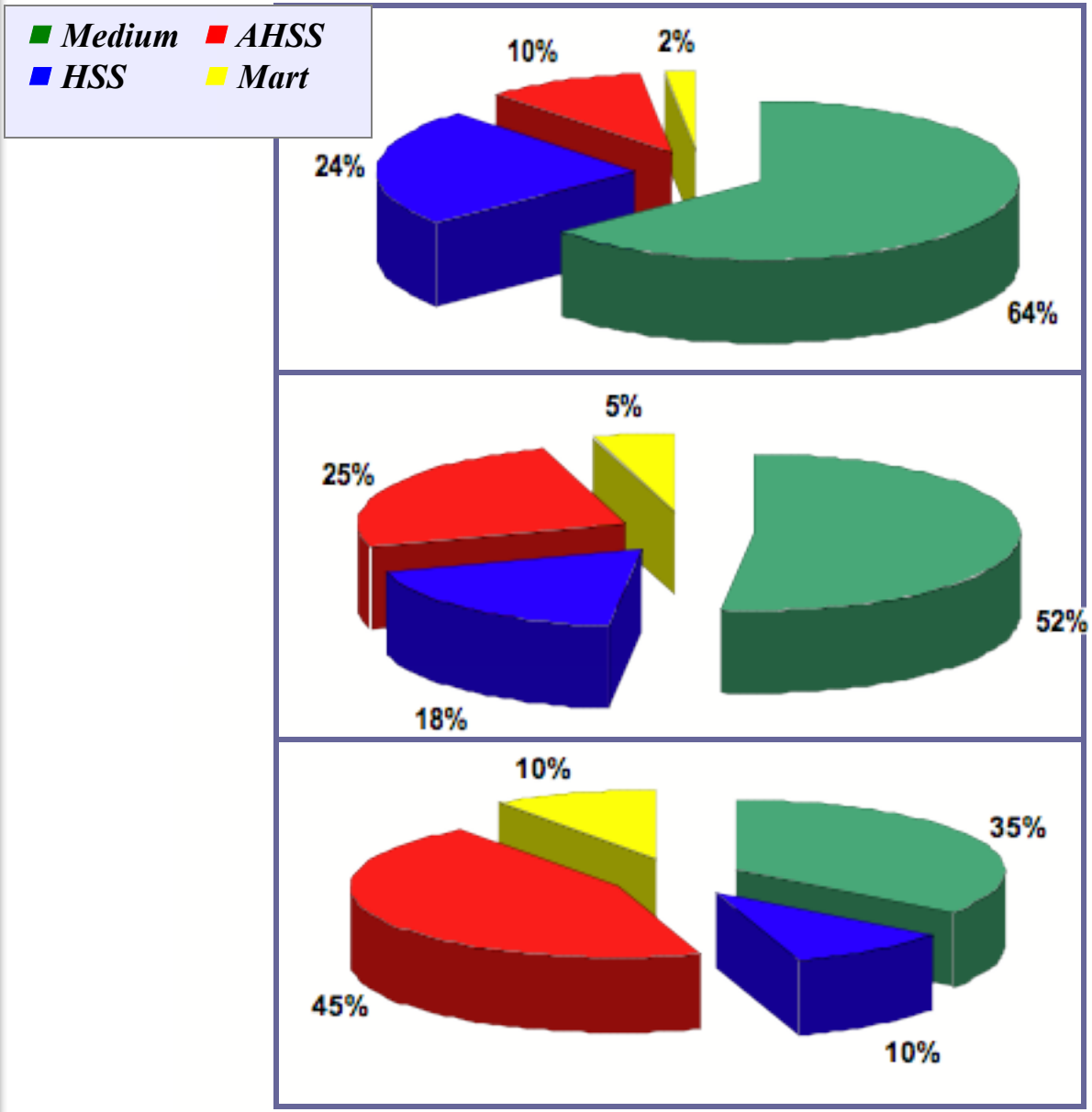
HSS/AHSS Automotive Application Trends



DaimlerChrysler

2005

2010

2015

[Source: J.P. Singh — DCX — GDIS 2005]

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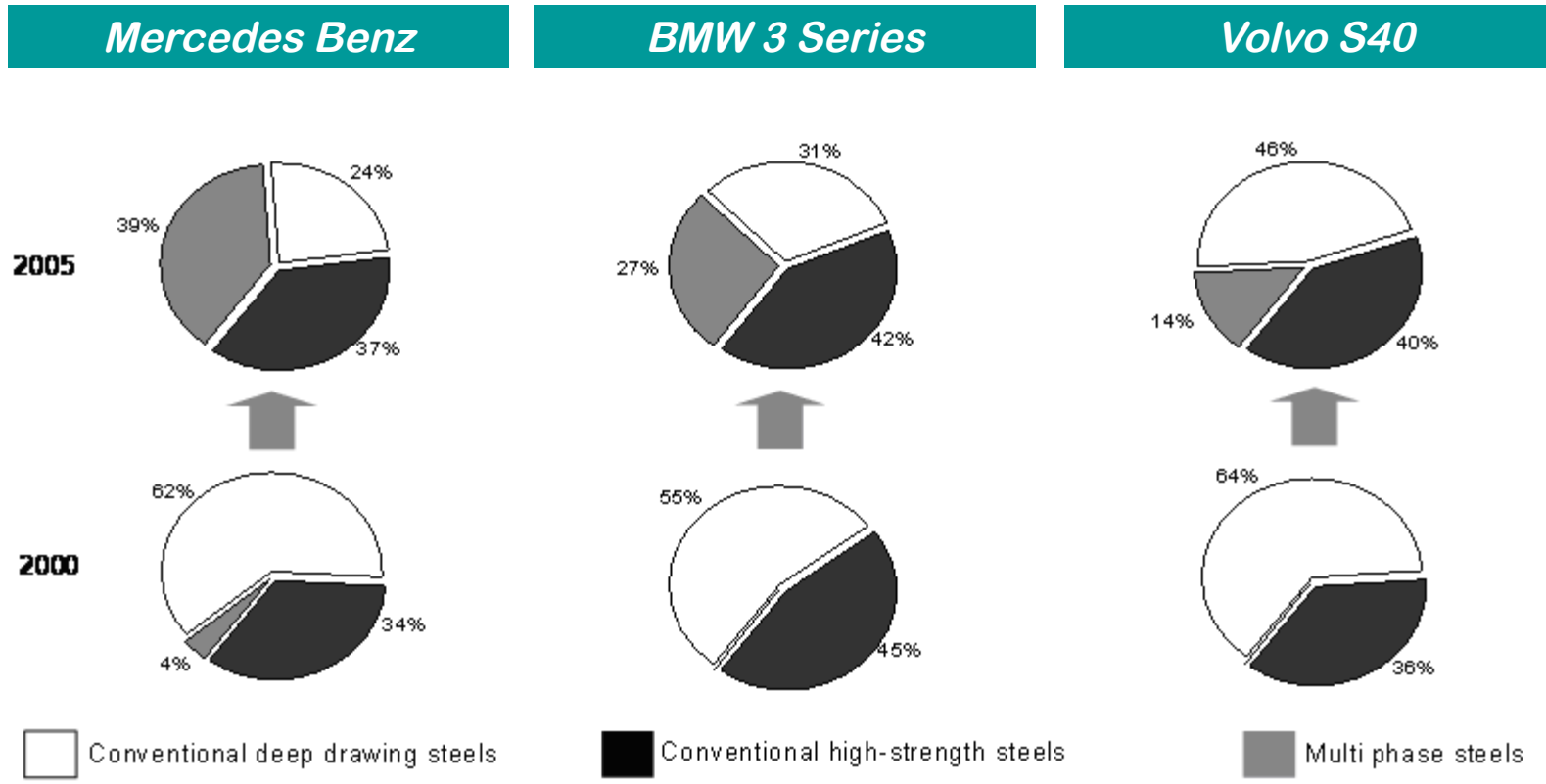
HSS/AHSS Automotive Application Trends

European Auto Makers



Source: Stahl Zentrum Germany

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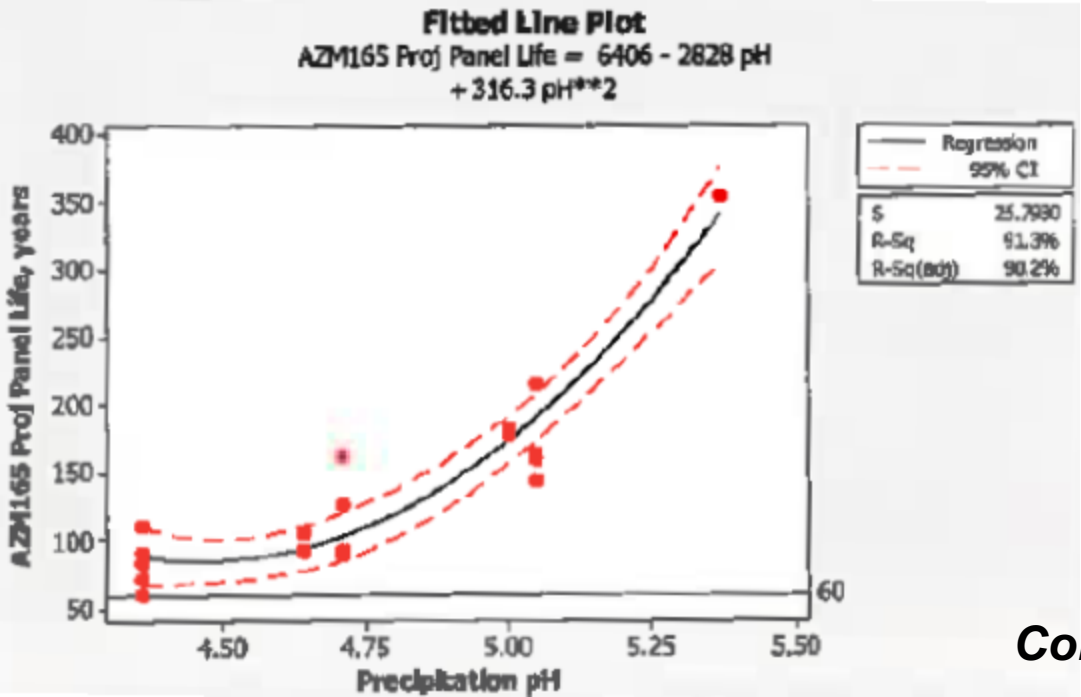
Zn-55AL and Zn-5Al Developments

- *20-35 year inspections for unpainted Zn-55Al roofs in 4 USA climates project 60+ year lives*
- *Zn-55Al now used to retrofit membrane roofs after 15 years give 30 years more life at half the cost of a new roof*
- *New Zn-5Al supply available*



Coil World Jan/Feb 2013

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Post Treatment Developments

- *Anti-Fingerprint polymer-based treatments widely available in North America*
  - *May include lubricity additives*
  - *ROHS compliance*

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In Conclusion ...

- ***Sheet Galvanizing will continue to grow strongly in all global regions***
- ***Regulatory drivers around fuel economy, emissions, and safety will not diminish but will expand to all global regions***
- ***Compared to HSS, AHSS grades use higher amounts of alloys such as Mn, Si, Mo, and C - many of which have a higher affinity for O than Fe - and cause processing, surface quality and zinc adherence issues***
- ***HDG has improved significantly during the last 20 years in process and technology, new developments will be slower***
- ***Considerable research is underway that focuses on modified CGL furnace conditions from those used for low carbon and HSLA steels in order to make AHSS***

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Acknowlegments

- *Steel.org*
- *Eurofer.org*
- *Q.F. Zhang et al (China)*
- *A. Yoshie (Japan)*
- *Frank Goodwin (NA)*
- *Michel Dubois (Europe)*

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Thank You

Namasté

2015 Aluminum Ford F-150

- Third Generation Steel Galvanizability Approach Developed
- Internal/External Oxidation Thresholds Established for Dual Phase Grades
- Dross-Minimizing Bath Control Techniques Defined
- ZnAlMg Bath Analysis Techniques
- Hydrogen Effects on AHSS Determined
- Promising new ZnAlMg-X coatings defined
- Effects of Zn, ZnFe coatings on Tailor Welded Blanks

Automotive Steel Markets in China and India

If Western intensities of use (22kg Zn/MT of steel):

- China: 28% of global manufacturing by 2019, 25% CAGR, 350,000 MT Zn annually in next 5 years
- India: 7% of global manufacturing but 25% CAGR, no Zn used today, 150,000 MT annually in next 5 years