WorldAutoSteel

FutureSteelVehicle

Reinventing Automotive Steel

California ARB Lightweighting Workshop – May 18, 2010

Jody Shaw - U. S. Steel

WorldAutoSteel

automotive group of the worldsteel

Ansteel	Hyundai-Steel	Sumitomo
ArcelorMittal	Kobe	ThyssenKrupp
Baosteel	Nippon Steel	USIMINAS
China Steel	NUCOR	U. S. Steel
Corus-Tata	POSCO	voestalpine
JFE	Severstal	

AISI Steel Market Development Institute

Automotive Applications Council

AK Steel

ArcelorMittal Dofasco

ArcelorMittal USA

Nucor Corporation

Severstal North America

United States Steel Corporation

Partner Funding
$6, 627,000
68%

Today's Presentation

- Past steel projects and impact on vehicle structures
- Future Steel Vehicle
  - The new drivers of materials selection
  - New capability of steel.
  - Objectives
  - Performance criteria
  - Design methodology
  - Preliminary results

Steel Industry Investment in Automotive Lightweighting

ULSAB
UltraLight Steel Auto Body

ULSAC
UltraLight Steel
Auto Closures

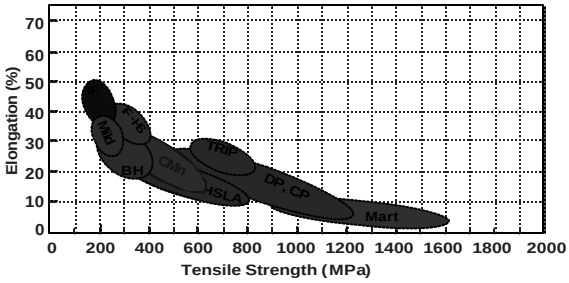
ULSAS
UltraLight
Steel
Auto
Suspensions

More than
$60 Million

ULSAB - AVC
Advanced Vehicle
Concepts

Steel Industry Investment in Automotive Lightweighting

Automotive Steel Grades



Steel Industry Investment in Automotive Lightweighting

22% to 32% Weight Reduction

Lightweight Closures
- 22% Mass reduction
- At no additional cost

Lightweight Rear Chassis
- 24% Mass reduction
- At no additional cost

Lightweight Front End Structures
- 32% mass reduction
- At no additional cost

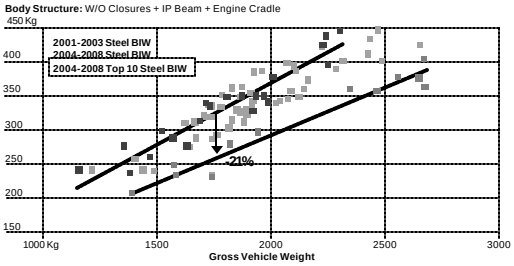
Future Generation Passenger Compartment
-30% mass reduction
- Improved crash performance
- At no additional cost

Light Weight Control Arm
- Same mass as aluminum baseline
- At 66% of the cost

Source: Auto/Steel Partnership

Impact of AHSS Solutions

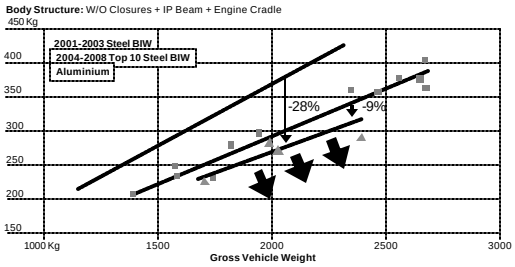
Body Structure Weight vs. Gross Vehicle Weight



(a2mac1 database 2001-2008 production vehicles)

Impact of AHSS Solutions

Body Structure Weight vs. Gross Vehicle Weight



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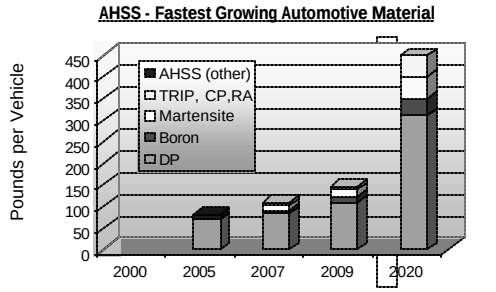
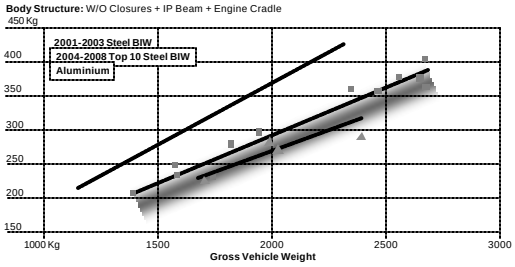
Impact of AHSS Solutions



Source: *Ducker Worldwide*

Impact of AHSS Solutions

Body Structure Weight vs. Gross Vehicle Weight



(a2mac1 database 2001-2008 production vehicles)

Steel Industry Investment in Automotive Lightweighting

FutureSteelVehicle

ULSAB
UltraLight Steel Auto Body

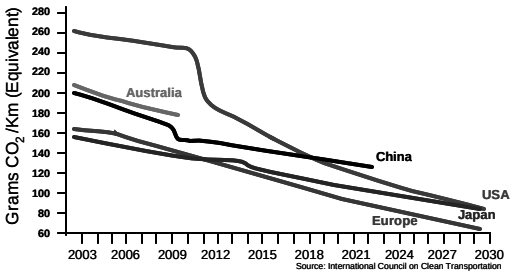
ULSAC
UltraLight Steel
Auto Closures

ULSAS
UltraLight
Steel
Auto
Suspensions

ULSAB - AVC
Advanced Vehicle
Concepts

Why Future Steel Vehicle? – The New Drivers

Automotive CO_2 Emissions Regulation.



Why Future Steel Vehicle? – The New Drivers

Early Introductions of Dedicated Platform Advanced Powertrain Vehicles

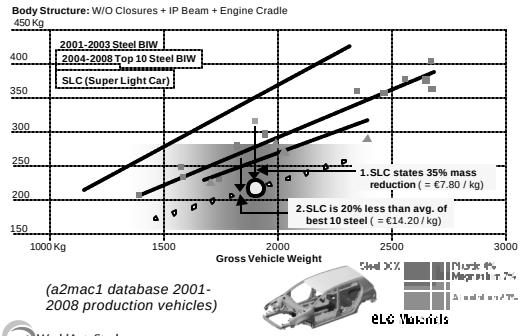
Honda Clarity FCX

Mercedes E cell Plus

Mercedes F cell

Why Future Steel Vehicle? – The New Drivers

Body Structure Weight vs. Gross Vehicle Weight



(a2mac1 database 2001-2008 production vehicles)

Why Future Steel Vehicle? – The New Drivers

Future Steel vehicle will address:

- Future emissions regulations
- Advanced powertrains vehicles
- Competitive material solutions

for 2015 to 2020

What is New in Steel?

FSV's Steel Portfolio

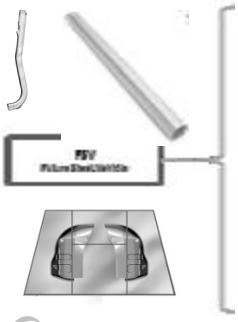
Mild 140/270	DP 350/600	TRIP 600/980
BH 210/340	TRIP 350/600	TWIP 500/980
BH 260/370	SF 570/640	DP 700/1000
BH 280/400	HSLA 550/650	CP 800/1000
IF 260/410	TRIP 400/700	MS 950/1200
IF 300/420	SF 600/780	CP 1000/1200
DP300/500	CP 500/800	DP 1150/1270
FB 330/450	DP 500/800	MS 1150/1400
HSLA 350/450	TRIP 450/800	CP 1050/1470
HSLA 420/500	CP 600/900	HF 1050/1500
FB 450/600	CP 750/900	MS 1250/1500
HSLA 490/600		

Expanded range of steel grades

denotes steel included in ULSAB -AVC
denotes steel grades added for FSV

What is New in Steel?

FSV's Manufacturing Options

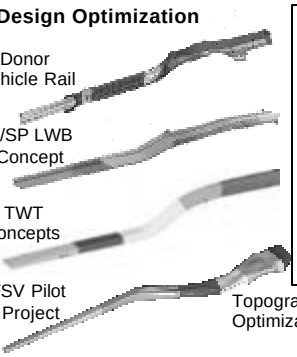


- Conventional Stamping
- Laser Welded Blank
- Tailor Rolled Blank
- High Frequency Induction Welded Hydroformed Tubes
- Laser Welded Hydroformed Tubes
- Tailor Rolled Hydroformed Tubes
- Hot Stamping (Direct & In-Direct)
- Laser Welded Blank Quench Steel
- Tailor rolled Blank Quench Steel
- Roll Forming
- Laser Welded Coil roll Formed
- Tailor rolled Blank Roll Formed
- Roll Form with Quench
- Multi Walled Hydroformed Tubes
- Multi Walled Tubes
- Laser Welded Finalized Tubes
- Laser Welded Tube Profiled Sections

What's New in Design?

Design Optimization

FSV Pilot Program
Donor Vehicle



Mass Reduction
22.4%
32%
45%

What is New in Steel?

Lightweighting technologies

- Expanded materials portfolio
- Expanded manufacturing technology portfolio.
- Aggressive design optimization technologies

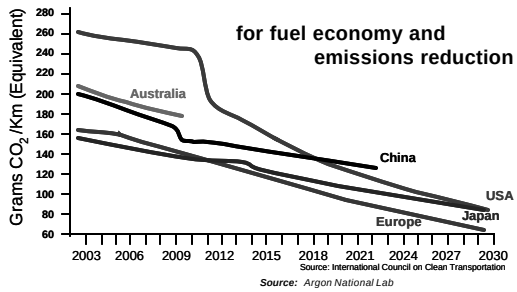
Future Steel Vehicle Performance Criteria

Manufacturing Cost

$

Future Steel Vehicle Performance Criteria

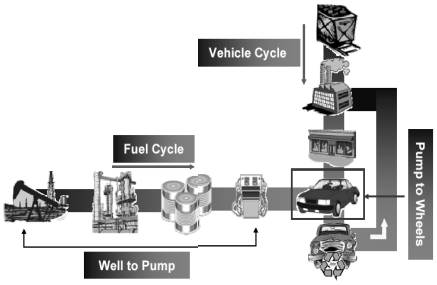
Mass Reduction



Source: *Argon National Lab*

Future Steel Vehicle Performance Criteria

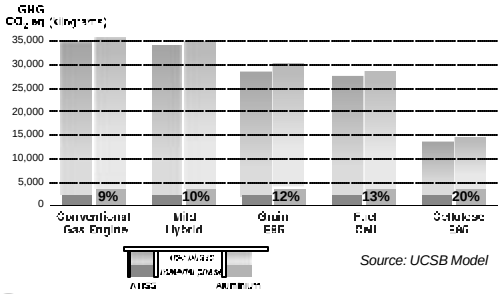
Vehicle Carbon Footprint



Source: *Argonne National Lab*

Future Steel Vehicle Performance Criteria

Effect of powertrain and fuel efficiency improvements



Source: UCSB Model

Future Steel Vehicle Performance Criteria

Design Performance Criteria

- Manufacturing cost
- Mass reduction
- Vehicle's carbon foot print

What is Future Steel Vehicle?

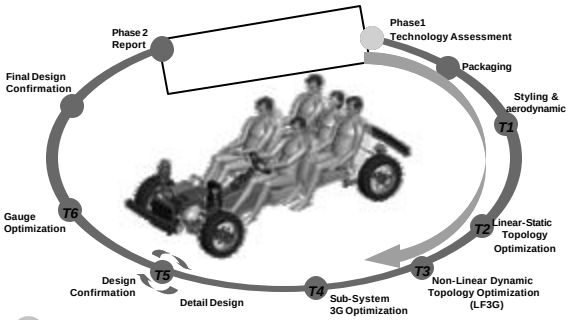
Vehicle Size & Powertrain Configurations

FSV 1 4-door hatchback 3700 mm	PHEV20 Electric Range: 32km Total: 500km Max Speed: 150km/h 0-100 km/h 11-13 s	BEV Total Range: 250km Max Speed: 150km/h 0-100 km/h 11-13 s
FSV 2 4-door sedan 4350 mm	PHEV40 Electric Range: 64km Total: 500km Max Speed: 161km/h 0-100 km/h 10-12 s	FCEV Total Range: 500km Max Speed: 161km/h 0-100 km/h 10-12 s

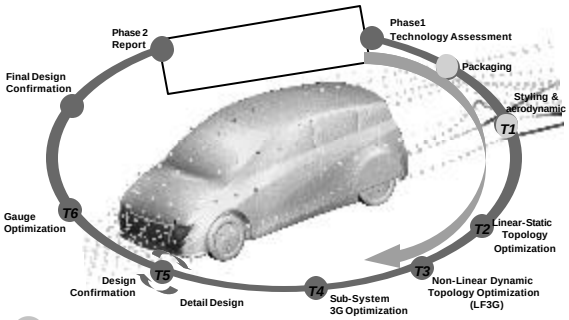
Range based on UDDS cycle

- **Common front end**
- **Common front wheel drive traction motor**

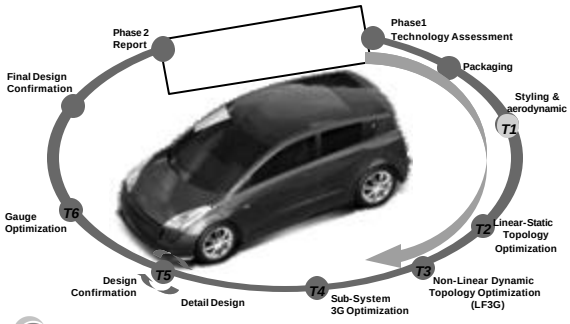
Future Steel Vehicle –Design Methodology



Future Steel Vehicle –Design Methodology



Future Steel Vehicle – Design Methodology



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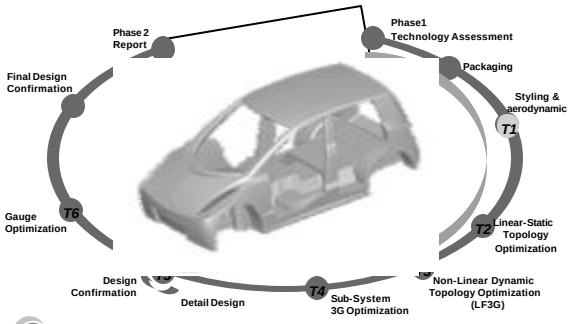
Future Steel Vehicle – Design Methodology



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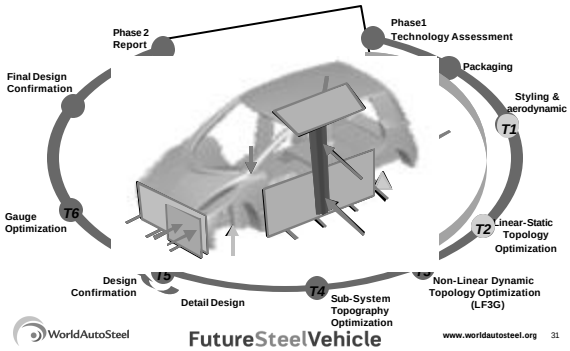
Future Steel Vehicle – Design Methodology



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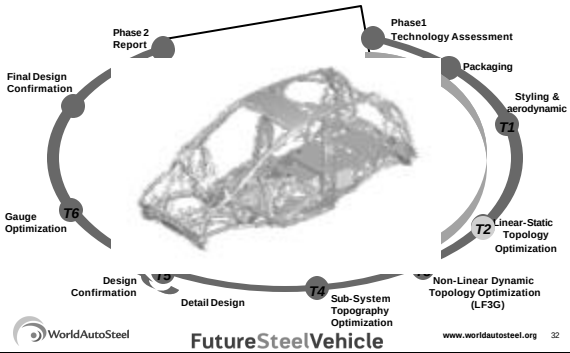
Future Steel Vehicle – Design Methodology



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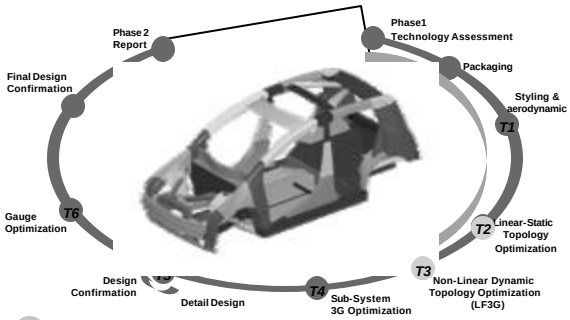
Future Steel Vehicle – Design Methodology



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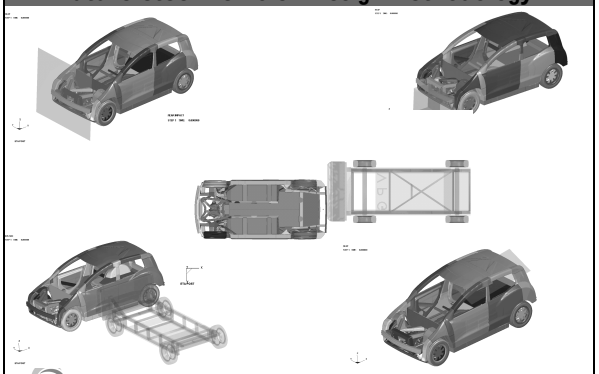
Future Steel Vehicle – Design Methodology



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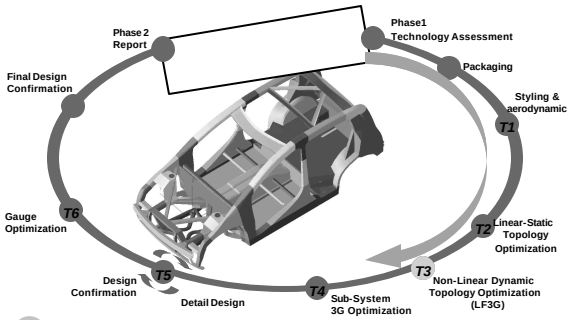
Future Steel Vehicle – Design Methodology



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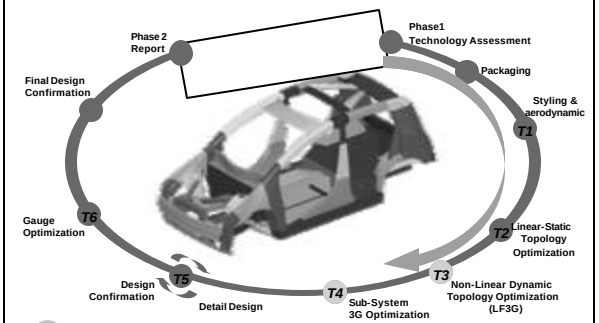
Future Steel Vehicle – Design Methodology



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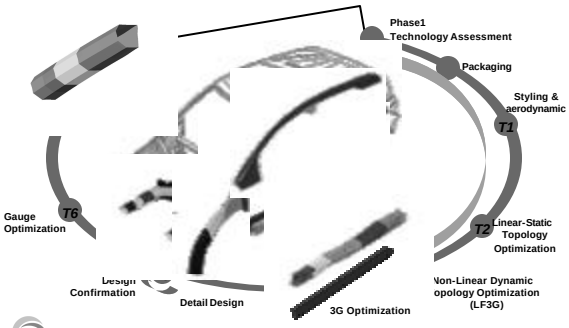
Future Steel Vehicle – Design Methodology

Detailed Steel Alternative Solutions for Critical Load Paths



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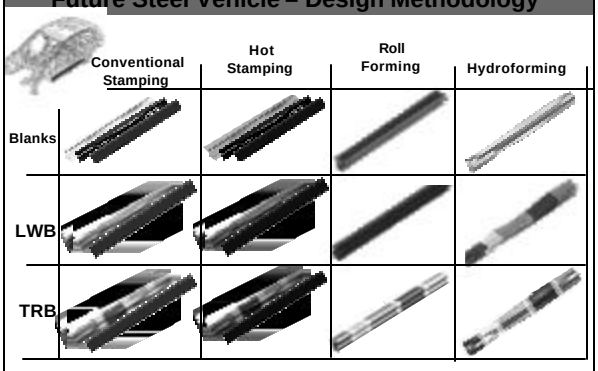
Future Steel Vehicle – Design Methodology



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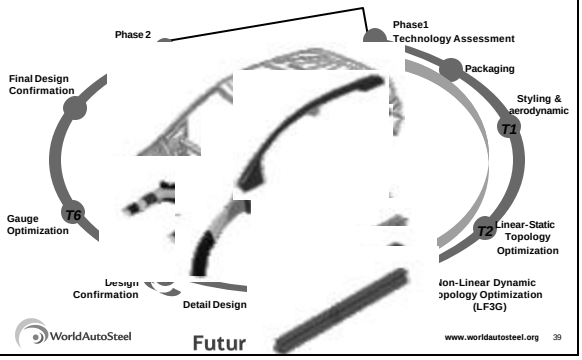
Future Steel Vehicle – Design Methodology

Detailed Steel Alternative Solutions for Critical Load Paths



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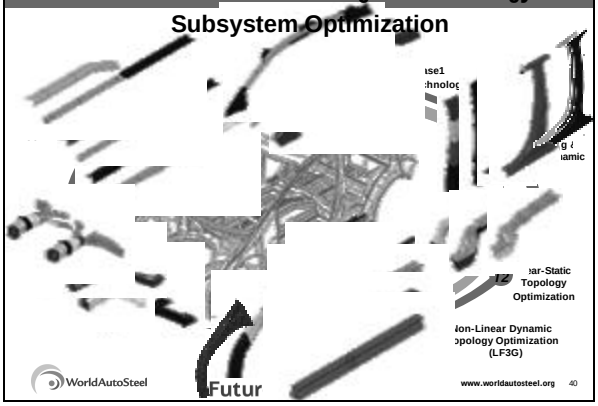
Future Steel Vehicle –Design Methodology

Subsystem Optimization



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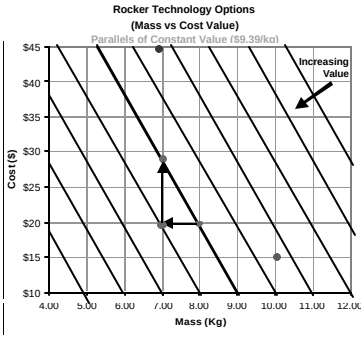
FSV – Rocker Cost, Mass & LCA $CO_{2\,eq}$ Assessment

Subsystem Optimization - Rocker

G hnology essment	HF3G Manufacturing Interpretation		High Volume Manufacturing Feasibility	Sub-System Mass (kg)	Manufacturing Cost ($)	LCA CO2 Savings (kg)
aseline	B ST	Stamping	Conservative	10.26	19.99	0
Stamping Solution (HEEDS Mass)	ST	Stamping	Conservative	10.95	21.33	53
	ST TRB	Stamping TRB	Mid-Term	10.52	24.18	16
	ST LWB	Stamping LWB	Conservative	10.47	27.86	30
	HST	Hot Stamp	Conservative	9.80	24.98	-37
	HST TRB	Hot Stamp TRB	Mid-Term	9.66	27.68	-47
	HST LWB	Hot Stamp LWB	Mid-Term	9.66	31.60	-37
Roll Form (HEEDS Mass)	RF	Roll Form	Conservative	7.98	14.18	-183
	RF TRB	Roll Form TR Coil	Aggressive	7.95	16.47	-189
	RF TWC	Roll Form TW Coil	Conservative	8.07	15.66	-177
Hydroform (HEEDS Mass)	HF	HydroForm	Conservative	7.05	22.80	-248
	HF LWT	Hydroform LWT	Mid-Term	6.96	27.89	-245
	HF MWT	Hydroform MWT	Aggressive	6.96	23.91	-255
Aluminum	AL	Extrusion	Mid-Term	7.53	39.70	-204

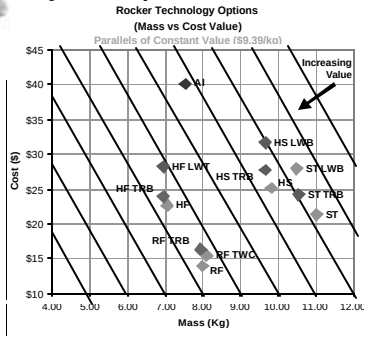
FSV – Mass Paradigm Shift

Subsystem Optimization - Rocker

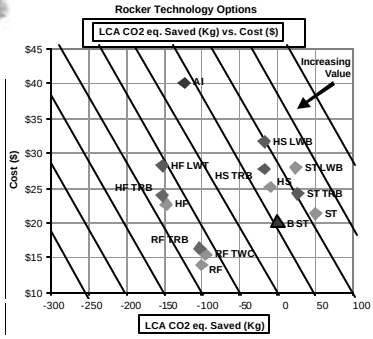


FSV – Rocker Cost & Mass Assessment

Subsystem Optimization - Rocker

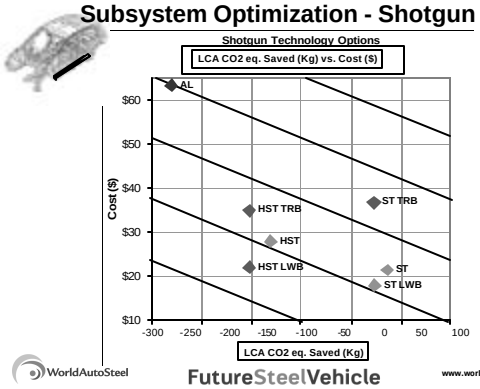


FSV – Rocker Cost & LCA $CO_{2\,eq}$ Assessment



FSV – Shotgun , Cost & LCA $CO_{2\ eq}$ Assessment

Subsystem Optimization - Shotgun



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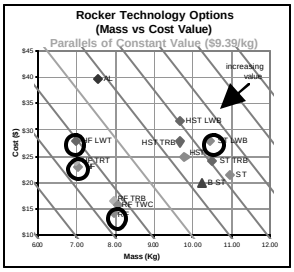
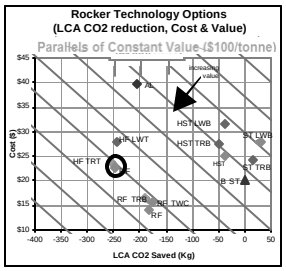
FSV – Rocker, Cost, Mass & LCA CO_{2e} Assessment





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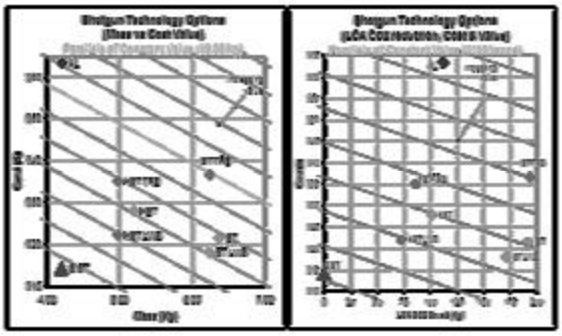
FSV – Shotgun, Mass & LCA CO_{2e} Assessment



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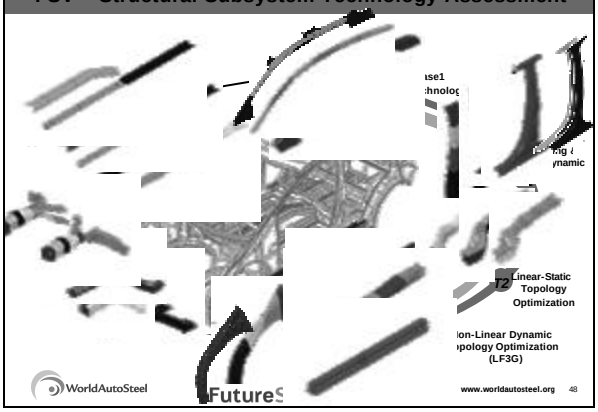
FSV – Structural Subsystem Technology Assessment



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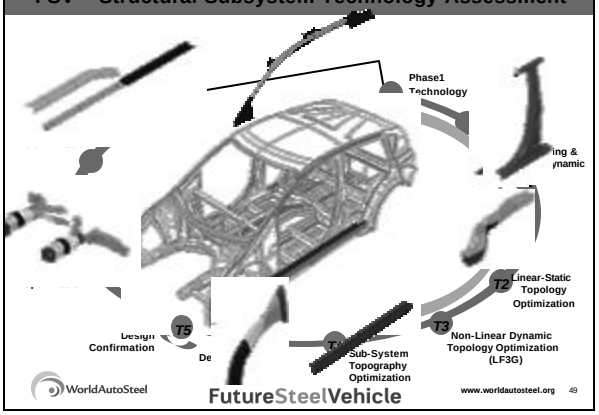
FSV – Structural Subsystem Technology Assessment



Thank you for your attention

Strong, Safe, Sustainable