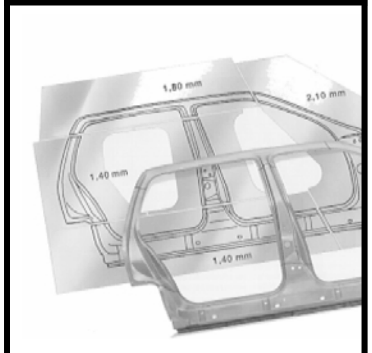
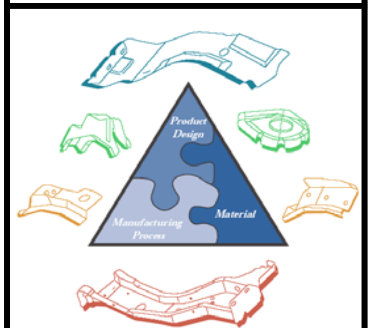




Auto/Steel Partnership:

Hydroforming Materials and Lubricant
Lightweight Rear Chassis Structures
Future Generation Passenger Compartment

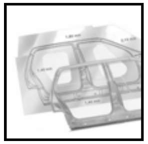
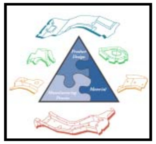
Dr. Roger A. Heimbuch
Auto/Steel Partnership

Project ID: lm_27_heimbuch

Auto/Steel Partnership

www.a-sp.org

Hydroform Materials and Lubricants


OVERVIEW

Timeline

- Start – 10/2001
- End – 09/2009
- 95% Complete

Budget

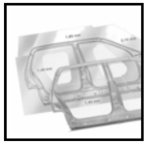
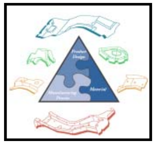
- Total Project Funding
  - DOE - $941K
  - Cost Share - $728K
- Funding for FY08
  - DOE - $31K
- Funding for FY09
  - DOE - $0K

Barriers

- Fabrication of AHSS tubes
- CAE Tools
- Material properties
- Process knowledge

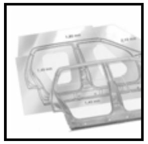
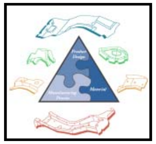
Partners

- CANMET
- University of Waterloo
- IRDI
- Schuler Inc
- Soudronic


PROJECT GOALS

- Explore design, manufacturing and material implications/limitations of tubular hydroforming using Advanced High-Strength Steel (AHSS).
- Develop in-depth understanding of critical issues pertaining to fabrication of tubes from AHSS.
- Improve advanced CAE tools to streamline hydroforming process design.
- Facilitate the adoption of cutting-edge hydroforming applications in vehicle structures.

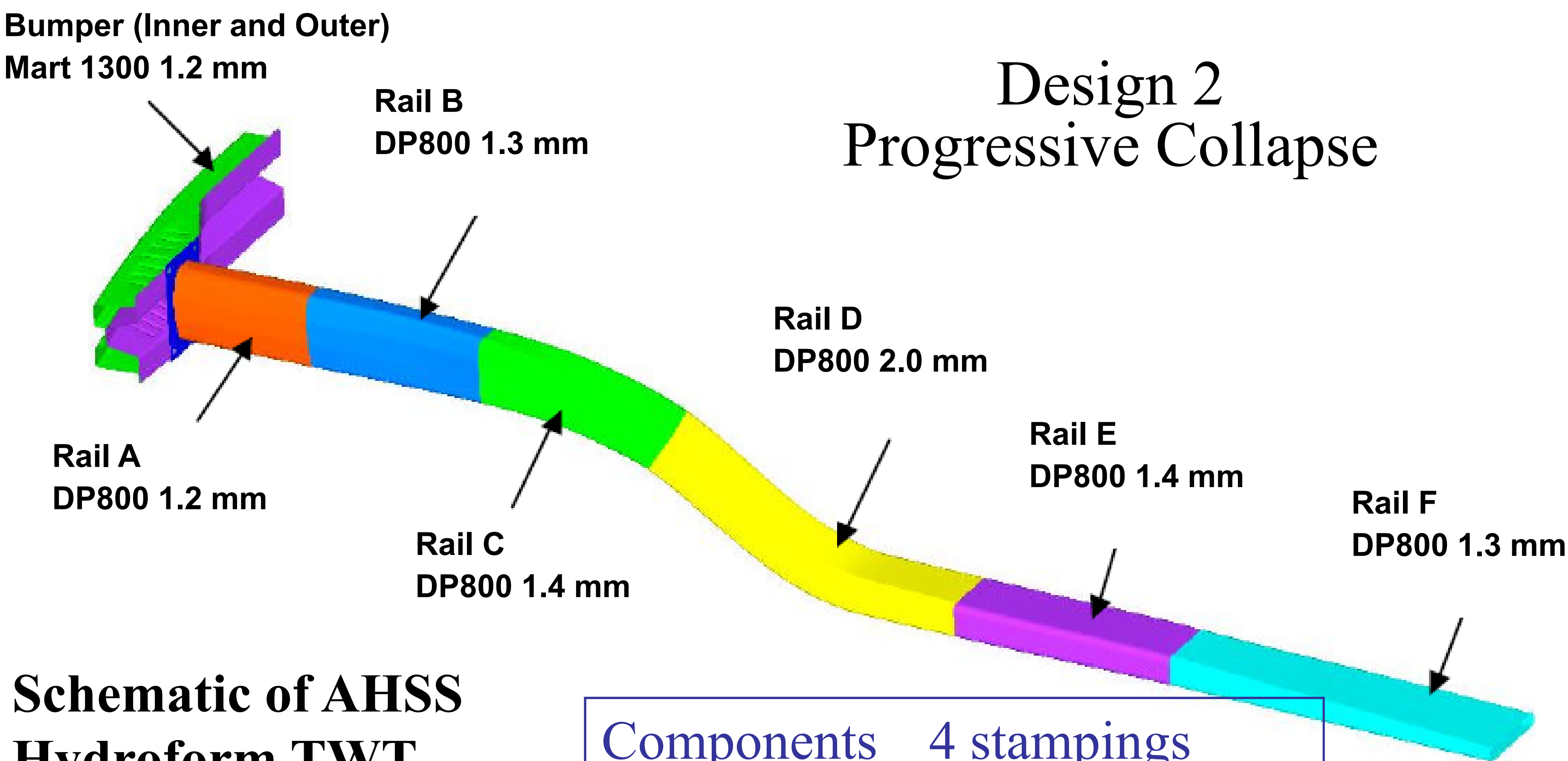





PROJECT APPROACH

- Investigate fabrication of DP and TRIP Steel Tube on an ERW and Laser Production Lines
  - ERW work nearly complete
  - Laser contract canceled-lack of funding

- Fabricate AHSS Hydroform TWT Lightweight Front Rails

Design 2
Progressive Collapse



Schematic of AHSS Hydroform TWT Lightweight Front Rail

Components	4 stampings
Steel Grade	DP780
Mass	28.8 kg
Mass Savings	26.5%

PROJECT RESULTS

AHSS Hydroform TWT lightweight front rail
Initial unsuccessful rotary draw tube bending attempts at Erin Industries.

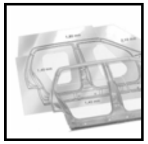
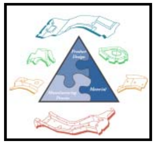
AHSS hydroform TWT lightweight front rail
Bent tube preform at Erin Industries.

PROJECT RESULTS

AHSS hydroform TWT lightweight front rail dies at Schuler Hydroform.

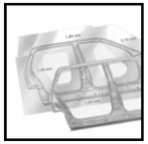
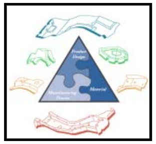
PROJECT RESULTS

AHSS hydroform TWT lightweight front rail
Tube collapse during hydroforming at Schuler Hydroform.

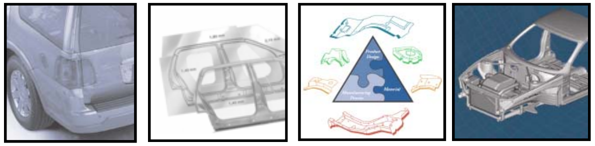

TECHNOLOGY TRANSFER

- "Influence of Bending Parameters on the Hydroforming of IF and DP600 Tubes with Welded Ends Caps."
  - Tech transfer CD.
- "Investigation of Fabricating Dual Phase and TRIP Steel Tube from an ERW Production Line."
  - Tech transfer CD.
- "Comparing Laser Welded DP and TRIP Steels with ERW Tubes of Same Materials."
  - Tech transfer CD.
- "Fabricate AHSS Hydroform TWT Lightweight Front Rail."
  - Tech transfer CD and road show with hardware display to be prepared.
- Great Designs in Steel 2009.
- 2009 SAE World Congress technical paper and presentation.
  - Draft manuscript submitted.


Summary

- Improved understanding of failure criteria for hydroforming.
- Improved understanding of test and evaluation methods for tubes.
- Improved understanding of effect of tribological and bending effects in hydroforming.
- Improved understanding of tube seam welding of AHSS tubes.
- Improved understanding of issues involved in fabicating and hydroforming AHSS TWT tubes.

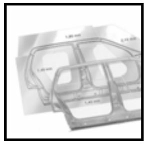
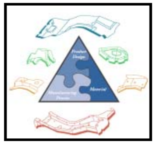


Lightweight Rear Chassis Structures

This presentation does not contain any proprietary, confidential, or otherwise restricted information

PROJECT GOALS

- Develop mass efficient solutions for passenger car chassis structures using AHSS.
- Demonstrate successful use of AHSS in chassis structures.
- Address corrosion issues associated with reduced thickness AHSS.
- Reduce chassis mass by at least 25 percent with no more than a 9 percent cost premium.
- Technology transfer of project results.


PROJECT TIMELINE

Phase I – Material Substitution:

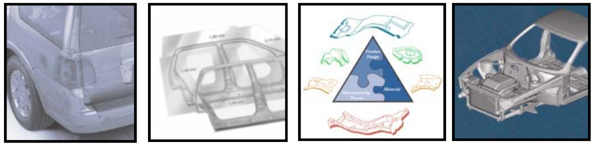
- Design — Completed
- Prototype Build — Completed
- Performance Testing — Completed
- Gap Analysis — Completion: June 2008
- Final Report — Completion: June 2008

Phase II – Clean Sheet Re-Design:

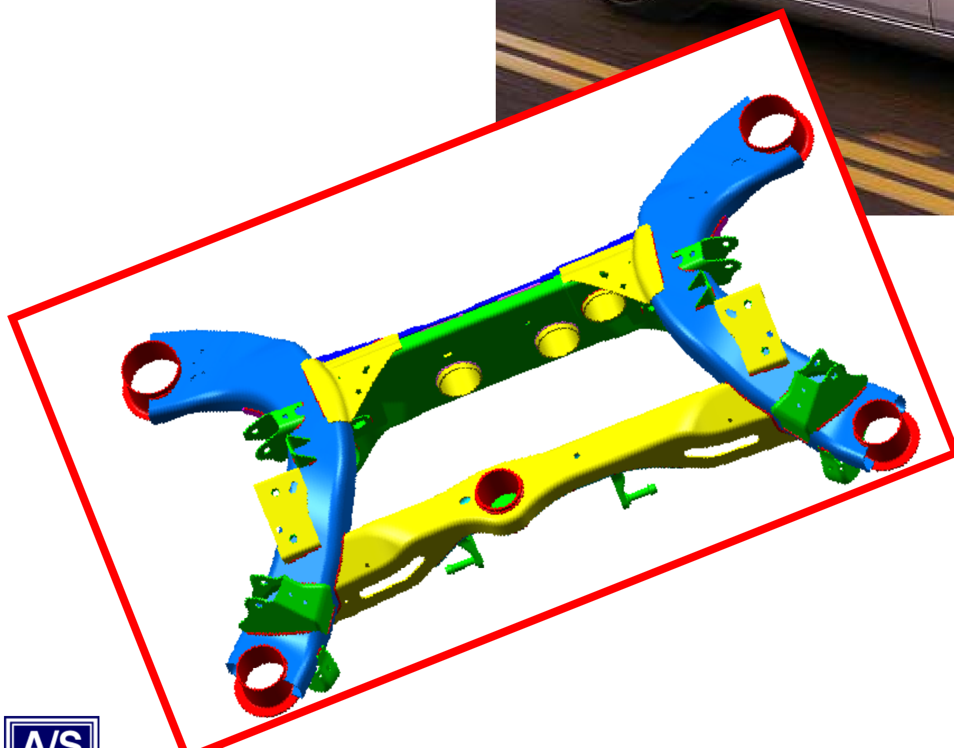
- Design — Completed
- Virtual Testing — Completed
- Final Report — Completion: June 2008

Phase III – Technology Transfer — June – Sept. 2009

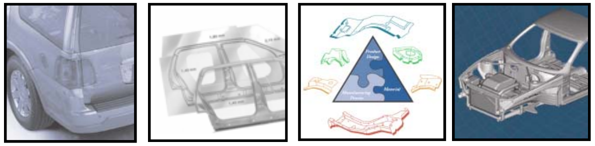
- Road Shows
- Technical Presentations



PROJECT APPROACH

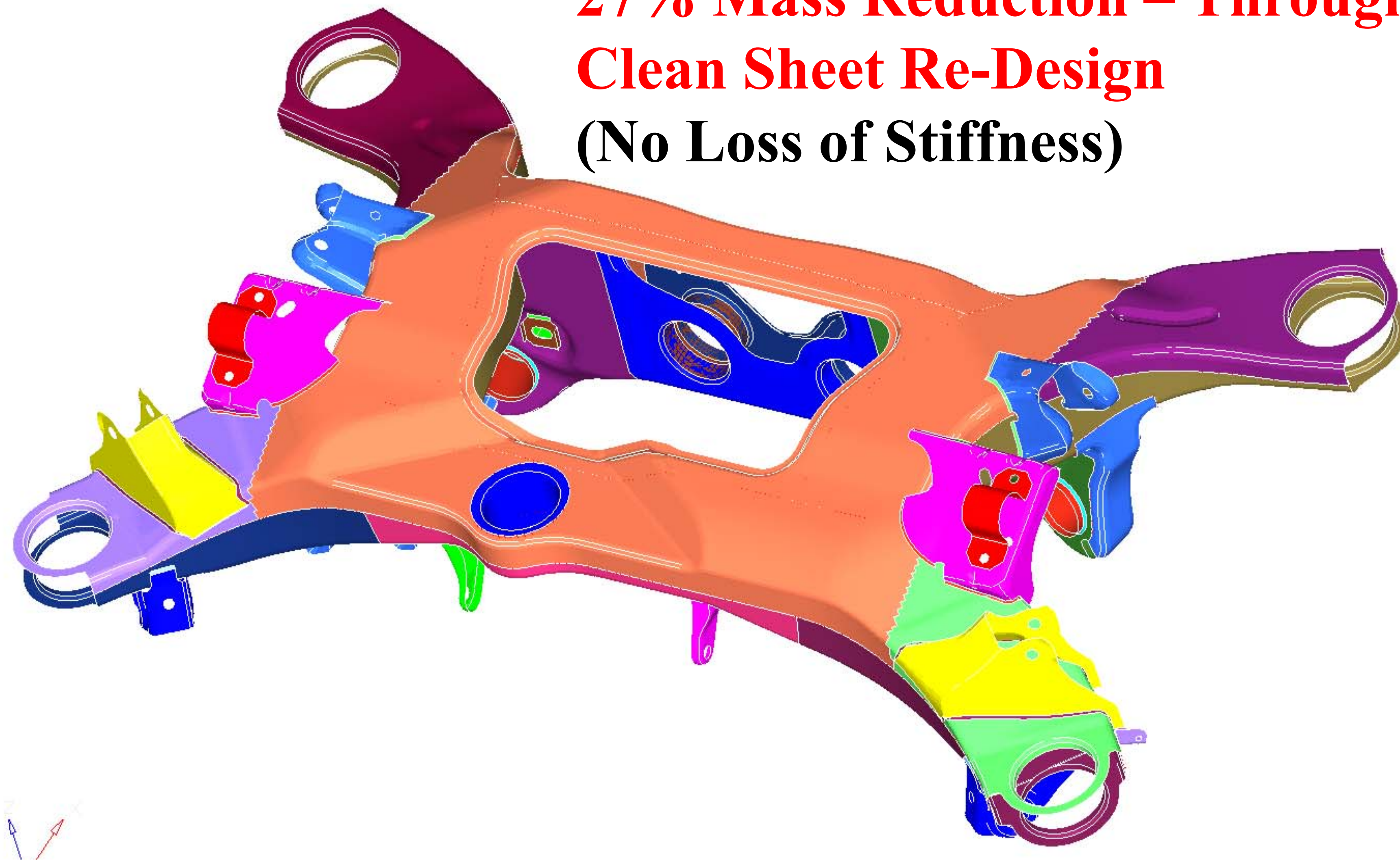


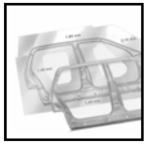
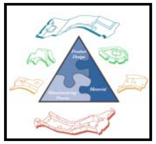
- Chrysler LX
- Rear Chassis Structure



27% Mass Reduction – Through Clean Sheet Re-Design

(No Loss of Stiffness)



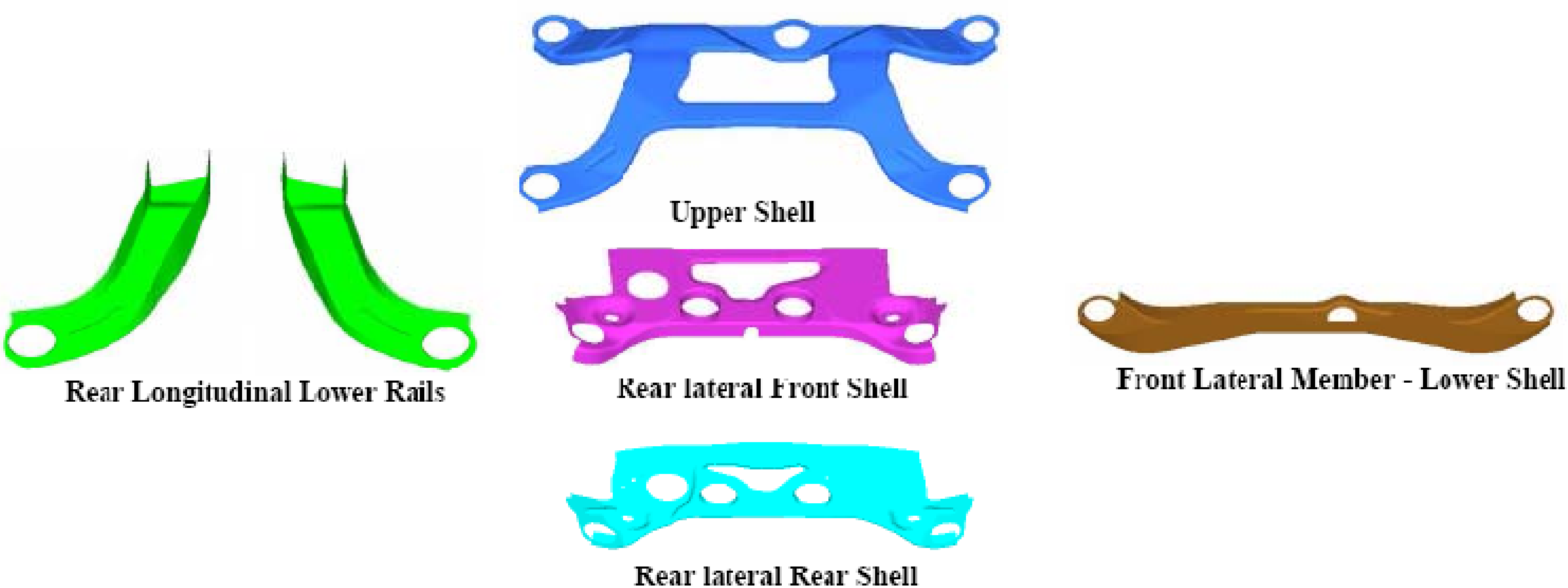

PROJECT RESULTS - Phase II

Lightweighting features:

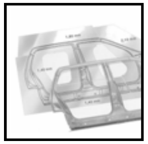
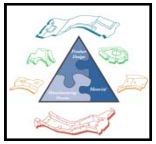
- Advanced High-Strength Steel
- Laser Welded Blanks
- New Architecture
- Extensive optimization and redesign

PROJECT RESULTS - Phase II

- **Baseline steel grades ranged from: 240 – 345 MPa.**
- **New grades for Phase II are DP590, DP780, TRIP 780.**

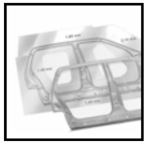
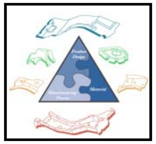


- Through virtual testing, determined that the durability of the Final Design is as good as or better than the baseline.
- Completed corrosion testing.

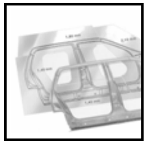
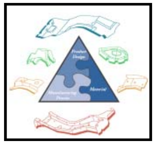

NEXT STEPS

- Analyze corrosion test results.
- Prepare Phase I Final Report.
- Complete cost analysis for Phase II Final Design.
- Prepare Phase II Final Report.
- Transfer technology.



TECHNOLOGY TRANSFER

- Final Reports for Phases I and II will be posted in the public domain on www.a-sp.org.
- Five technology transfer road shows will be given to Chrysler, Ford, General Motors and Tier 1 chassis structure suppliers.
- Technical presentations will be given at GDIS 2009.


Future Generation Passenger Compartment

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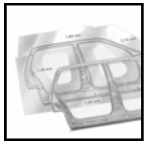
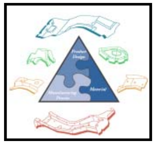




OVERVIEW

Timeline

- Start – 06/2006
- End – 06/2009
- 90% Complete

Budget

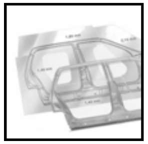
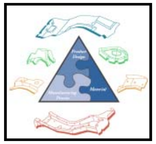
- Total Project Funding
  - DOE - $1,366K
  - Cost Share - $697K
- Funding for FY08
  - DOE - $910K
- Funding for FY09
  - DOE - $47K

Barriers

- Mass efficient design solutions

Partners

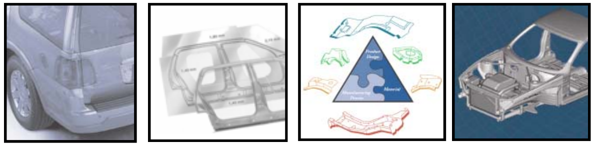
- ETA
- EDAG
- Caminoe
- University of Michigan
- Altair



PROJECT GOALS

- Develop mass efficient design solutions and AHSS applications for the passenger compartment which enable energy savings via mass reduction of 20 to 25 percent and cost parity relative to current architecture/material applications while meeting the increased crash performance requirements of FMVSS and IIHS.

- Focus on side impact and roof strength requirements, but do not exclude front and rear impact load cases, global stiffness and durability performance.



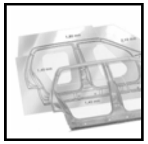
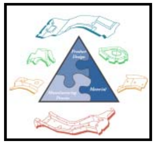
PROJECT GOALS

- Perform study on a four-door, five-passenger, Body Frame Integral sedan, based on rear drive donor vehicle (i.e., the reference Multi-Material Vehicle).

- Apply Phase 1 Concept Development to Phase 2 Validation on the donated vehicle to study applicability to a current production design.

- ~~Build validation properties and subject them to crash testing and correlate with model predictions~~. Build cancelled due to cost and timing constraints

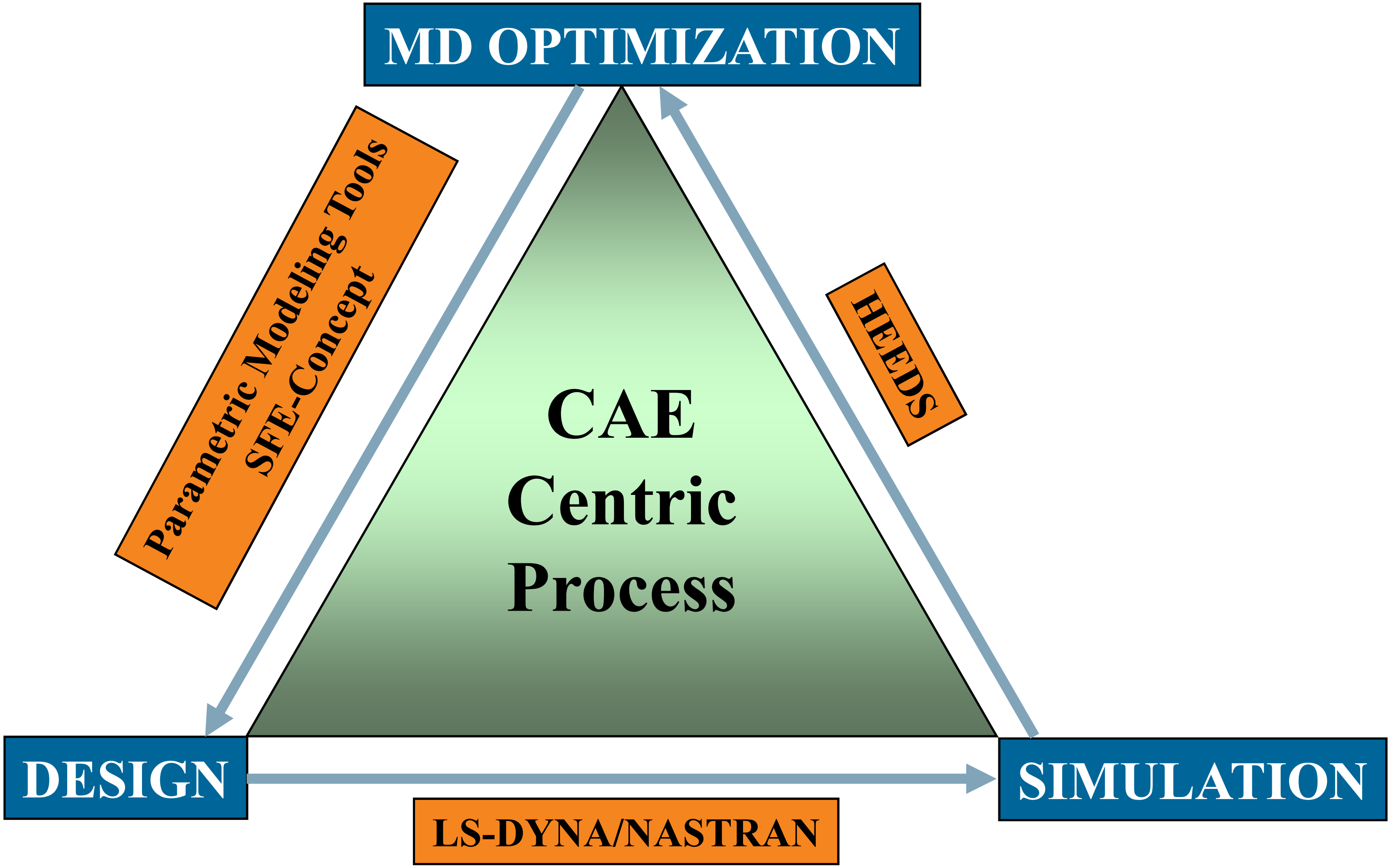
- Perform cost evaluation.

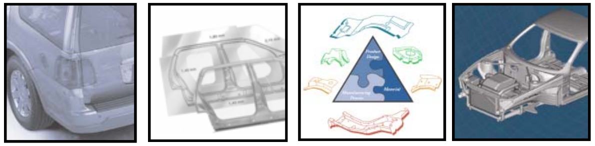





PROJECT TIMELINE

Deliverables	Timing
• Confirmation and Target Setting – Complete	04/07
• Design Optimization & Confirmation – Complete	12/07
• Parts Consolidation – Complete	03/08
• New Concept Design – Complete	04/08
• Design Confirmation & Improvement – Complete	06/08
• 2nd Optimization – Complete	08/08
• Final Design Modification – Complete	08/08
• Final Design Confirmation – Complete	10/08
• Sensitivity Analysis	12/08
• Final Report	02/09

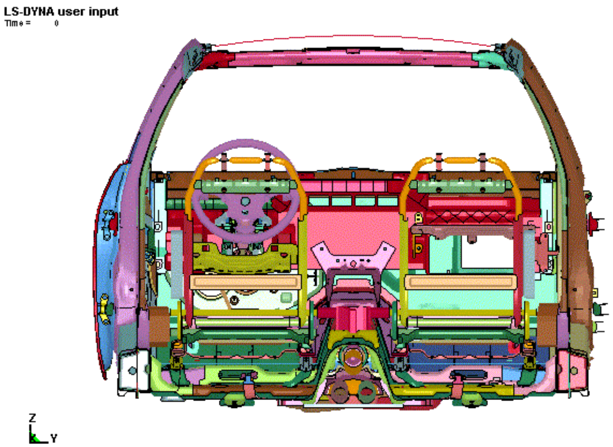
CAE CENTRIC PRODUCT DEVELOPMENT



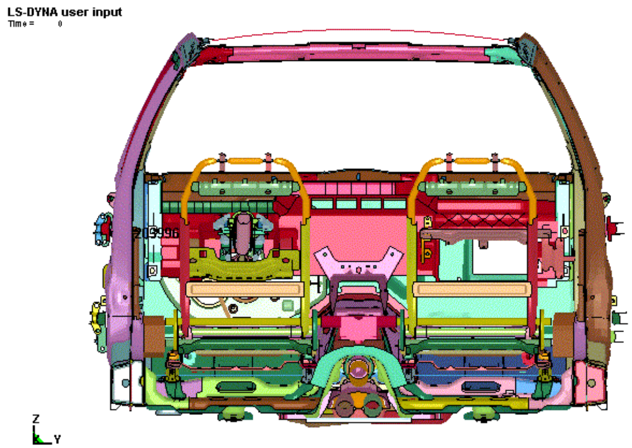


PROJECT RESULTS

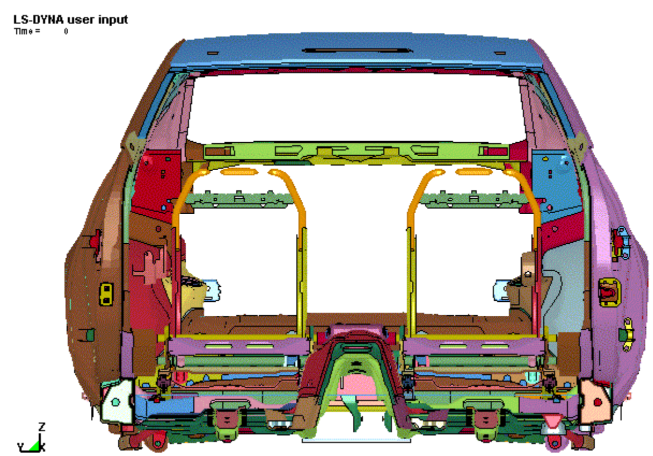
POLE IMPACT



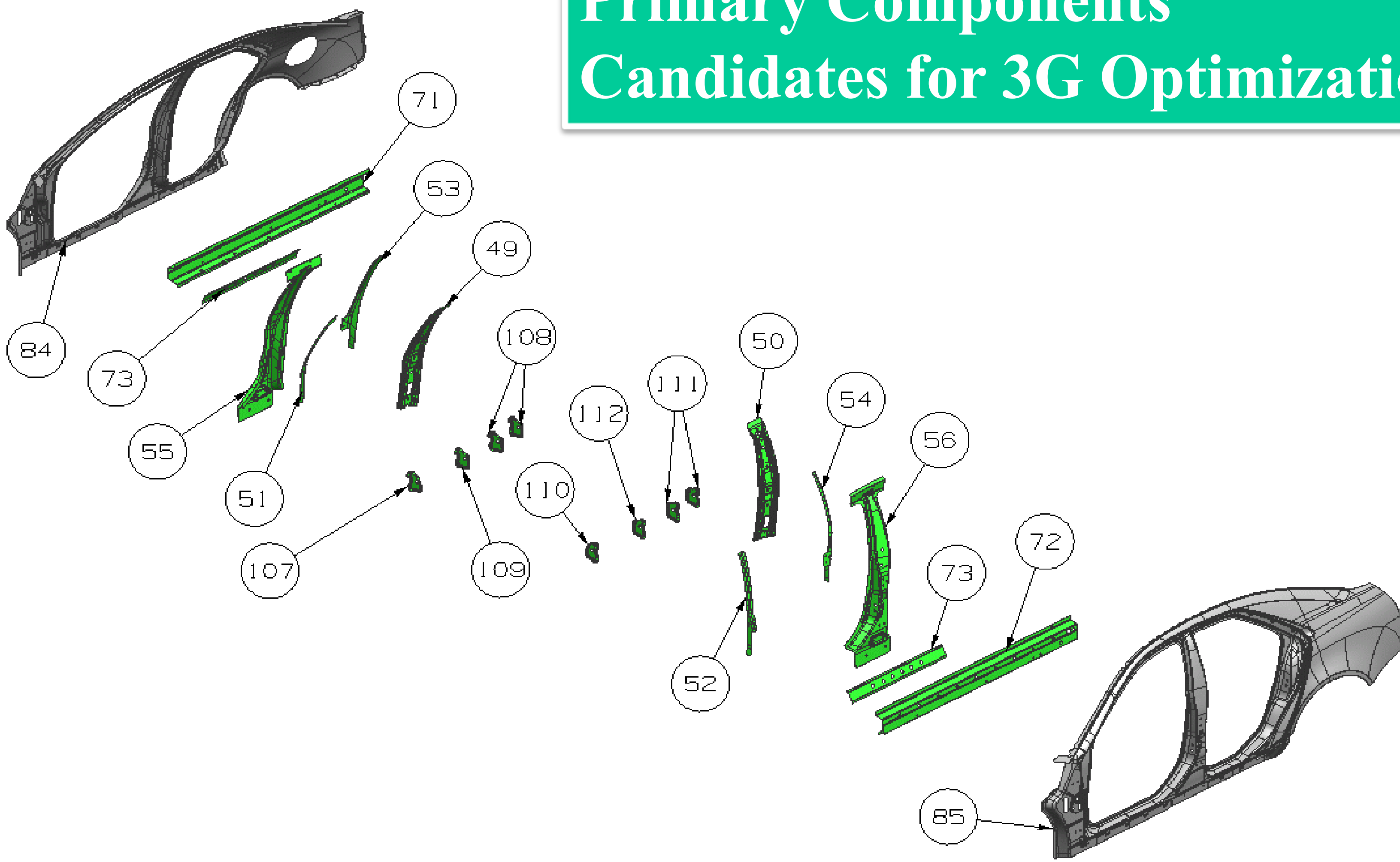
SIDE IMPACT

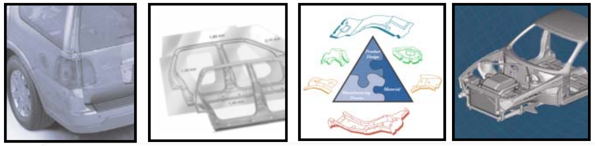


ROOF CRUSH

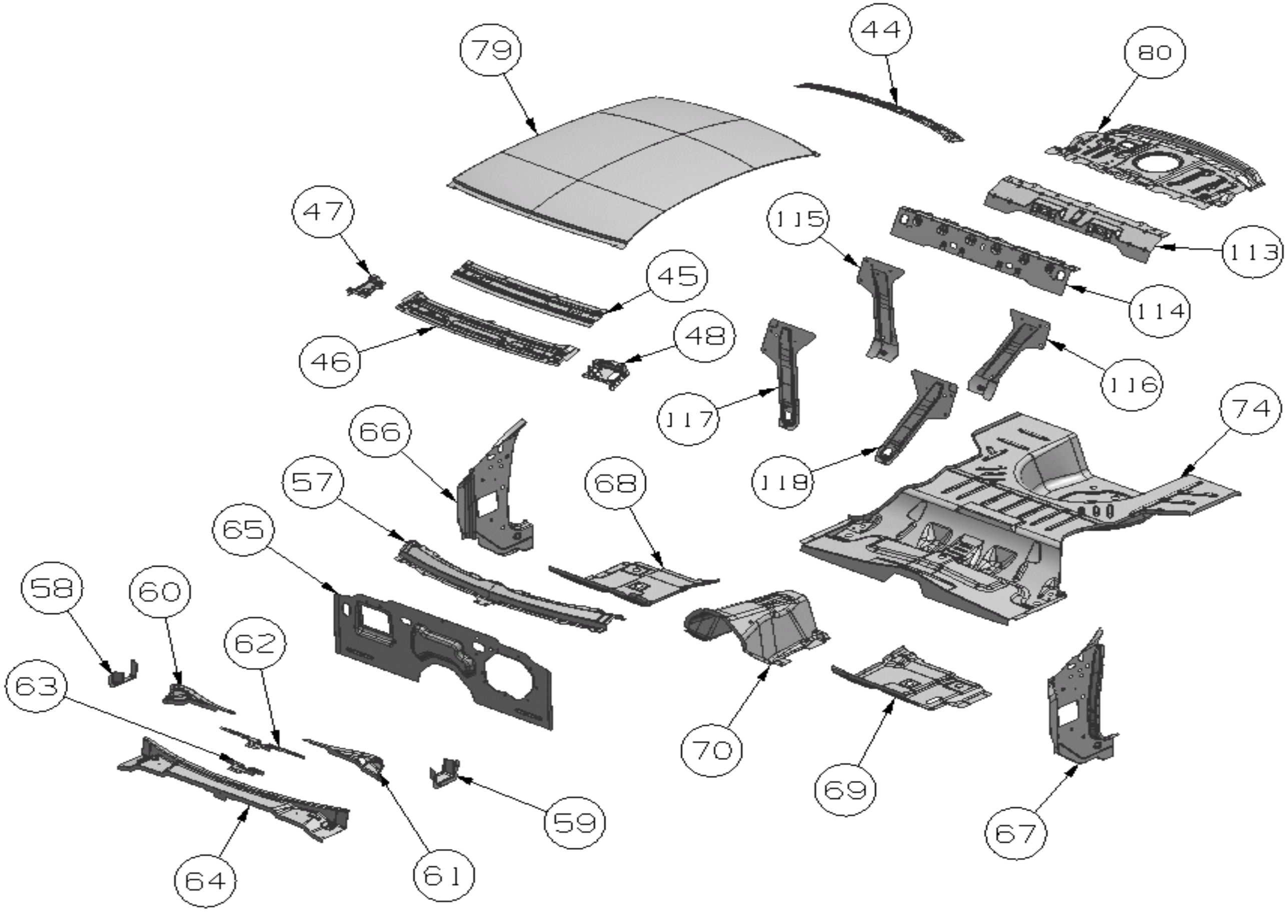


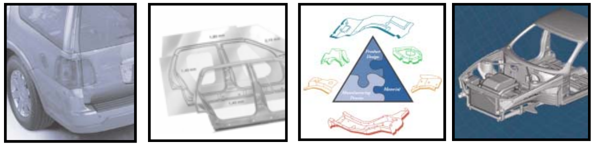
Primary Components Candidates for 3G Optimization





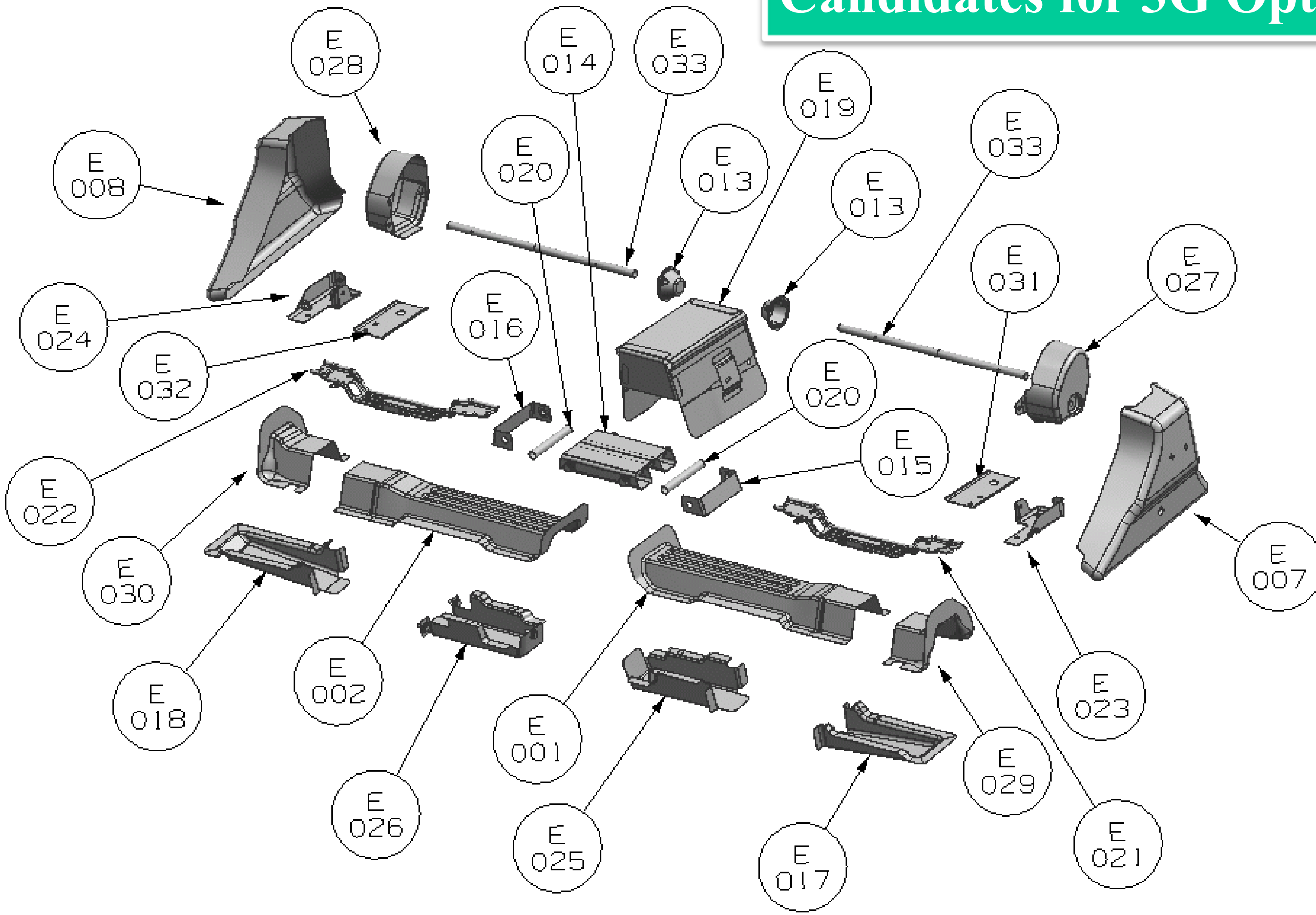
Secondary Components
Candidates for Grade & Gauge Optimization

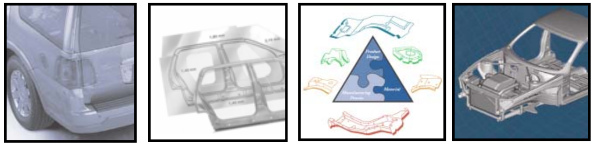




PROJECT RESULTS

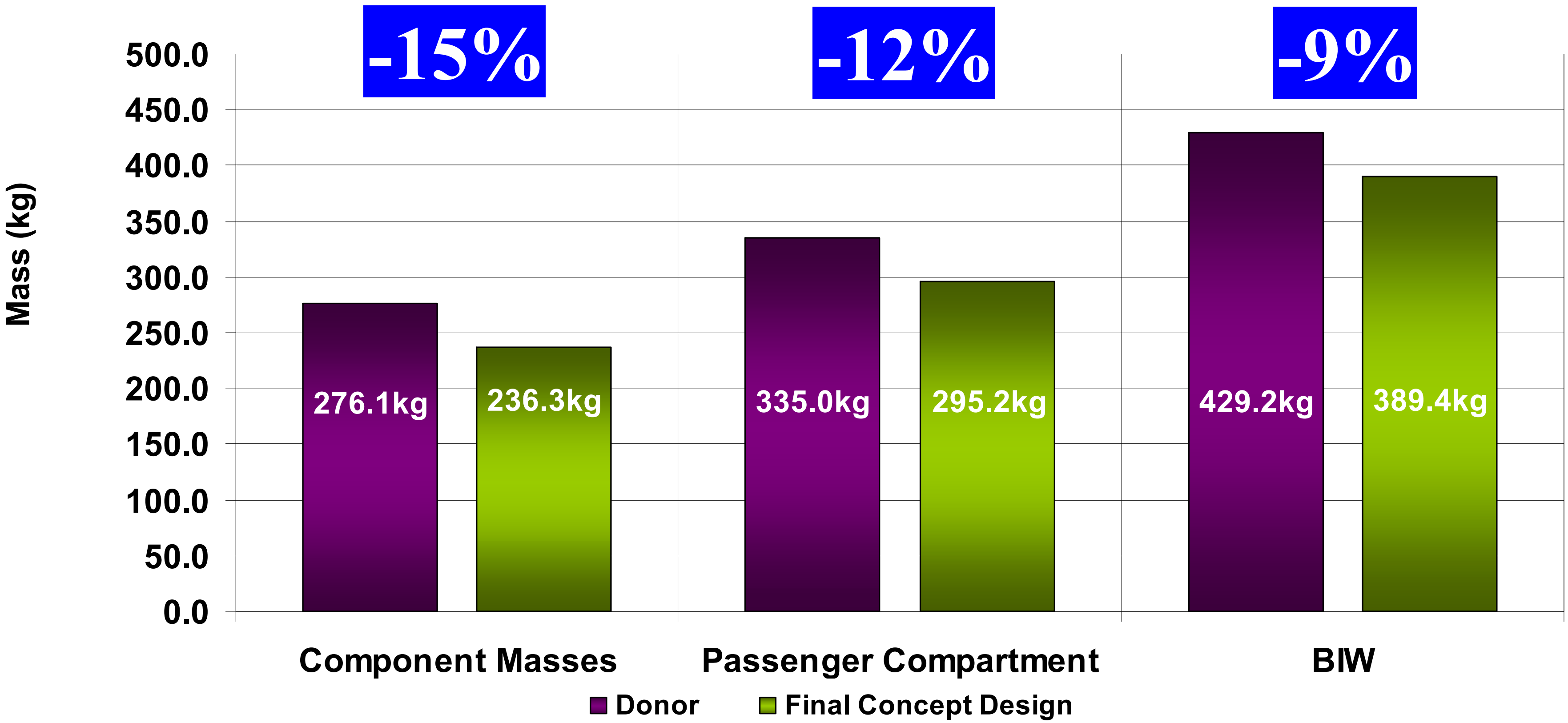
New Components
Candidates for 3G Optimization

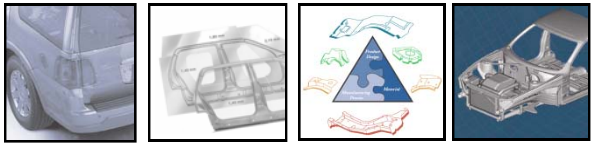




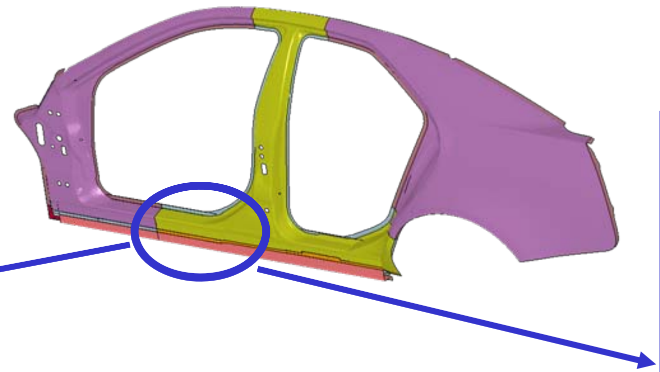
FINAL CONCEPT DESIGN RESULTS

(Mass reduction with doors -39.8kg)

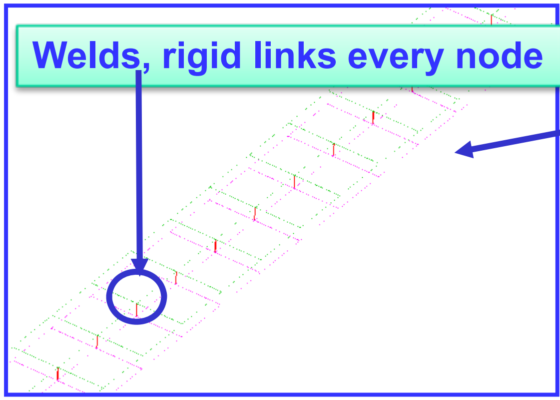




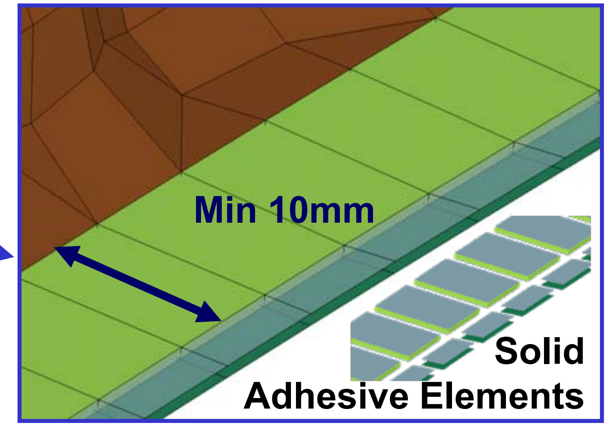
FGPC – MODIFIED BASELINE WITH CONTINUOUS JOINING OPTIONS:



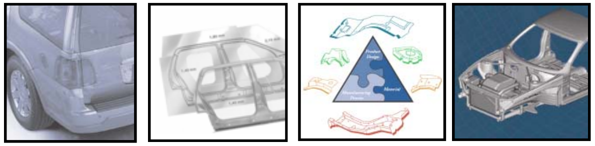
Laser welding



Weld Bonding

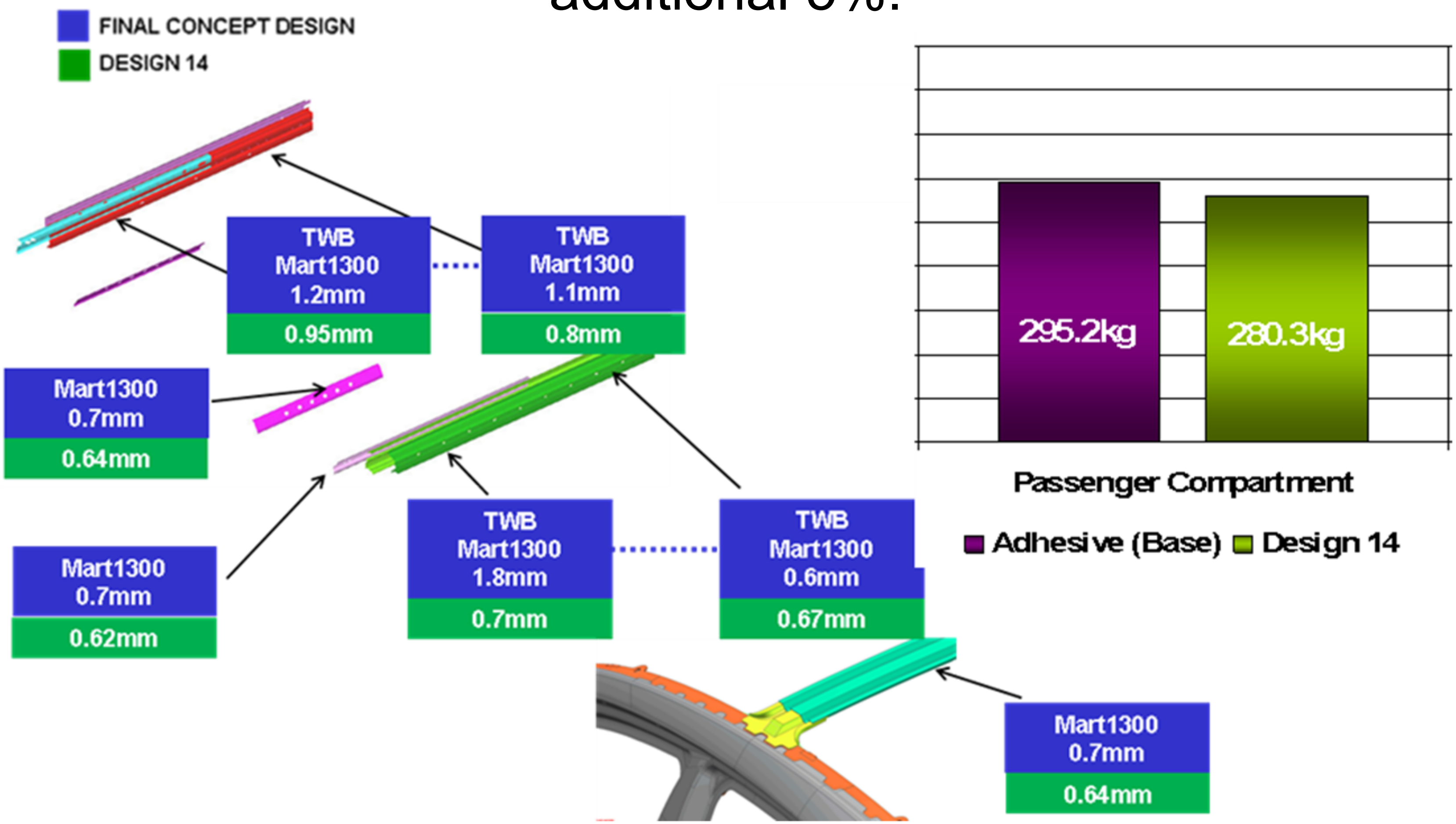


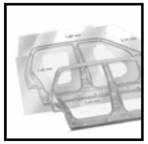
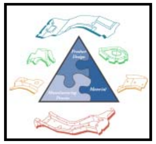
	PERFORMANCE IMPROVEMENT	
	SPOT-WELD➔LASER	SPOT-WELD➔ADHESIVE
IIHS Side Impact	2%	16%
IIHS Front Impact ODB	16% to 44%	22% to 60%
Roof Crush	15%	25%
Bending	13%	19%
Torsion	14%	15%



RE-OPTIMIZATED GAGE TO BASELINE PERFORMACE FOR WELD BONDING

FGPC results 15% mass reduction. Continuous joining results in additional 5%.

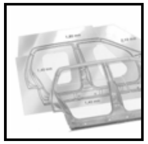
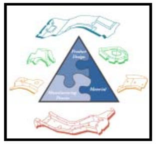



NEXT STEPS

- This project will be completed in Q2 FY2009

- Further work to be completed includes:
  - Fatigue sensitivity study
  - Cost modeling
  - Final Report
  - Technology transfer


LIGHTWEIGHTING SUMMARY

- Mass reduction projects
  - Achieved 10 to 30% mass reduction
  - Used optimization techniques
  - Applied AHSS steels
- Roof strength project
  - Achieved 63% higher load carrying capacity
  - Minimal mass increase
  - Used optimization techniques
  - Applied AHSS steels with plastic inserts
- Further mass reduction can be achieved by applying mass compounding estimates to drive initial design criteria.