Automotive Composites Consortium

Focal Project 4 (ACC 007)

Structural Automotive Components from Composite Materials

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General Motors

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Project ID: lm_08_kia

Overview

Timeline

- Start – October 2006
- Finish – December 2010
- 55% Complete

Budget

- Total Project Funding
  - DOE: $4,600k
  - Contractor: $720k
- Funding received FY07
  - $920k
- Funding received FY08
  - 943k
- Funding for FY09
  - $943

Barriers and Targets

- A 2 ½ minute cycle time (100k vpa, 2 shift operation)
- Methods of joining and assembly of the composite structure to the vehicle
- Processes for fabricating localized areas of oriented reinforcement within the time window

Partners

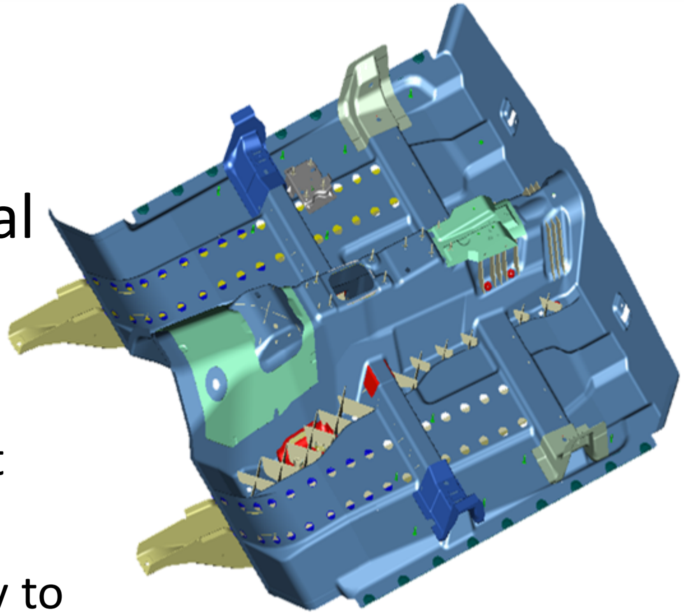
- Multimatic
  - Design and engineering
- U Mass Lowell
  - Fabric drape analysis

Objectives

- Design and fabricate structural automotive components with reduced mass and cost, and with equivalent or superior performance to existing components.

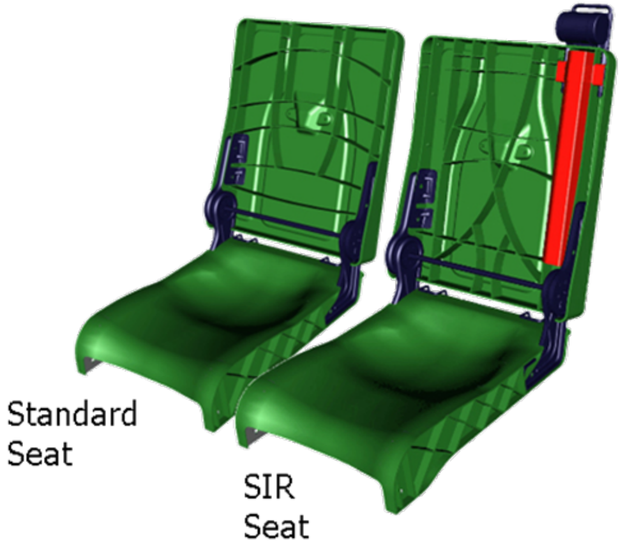
- Develop new composite materials and processes for the manufacture of these high volume components.

Approach



Design, analyze, fabricate and test a structural composite underbody, capable of carrying crash loads, focusing on:

- A 2 ½ minute cycle time (100k units per year, 2 shift operation)
- Methods of joining and assembly of the underbody to the vehicle
- Processes for fabricating oriented reinforcement within the time window



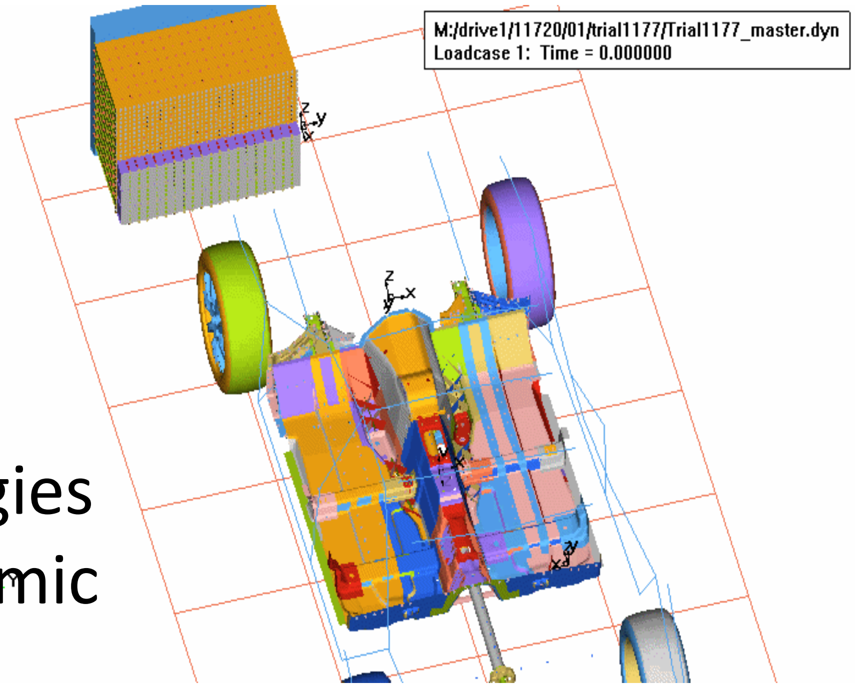
Design, analyze, fabricate and test a second row composite seat which will combine the functions of a seat and a load floor.

Milestones

- Structural Composite Underbody
  - *Phase 1:* The selection of a design concept and a material and process system, completed 4Q07.
  - *Phase 2*: Full design, 4Q09.
    - Underbody, suitable for full tooling.
    - Fabrication and assembly scenario.
  - *Phase 3:* fabrication and testing of the composite underbody, 4Q10.
- Composite Seat
  - *Phase 1:* Develop ribbed single surface design. Completed 1Q08.
  - *Phase 2:* Develop bonded two-piece design. 2Q09.

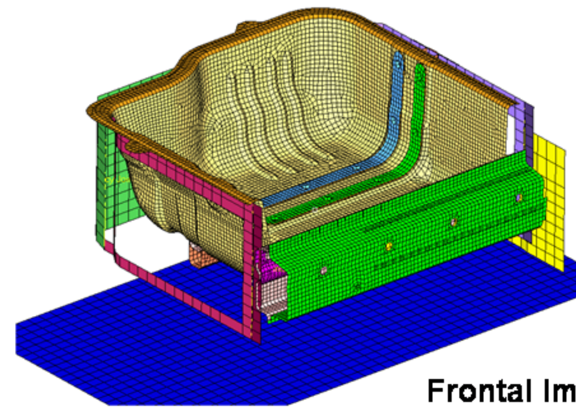
Technical Accomplishments
Structural Composite Underbody

- Selected glass fabric SMC with a high elongation core as material and process system
  - Glass fabric gives high strength needed for crash loads
  - High elongation core allows for structural connectivity post crash (more development needed for core)
  - Enables a 31% mass savings over optimized high strength steel
- Developed design methodologies for acceptable static and dynamic performance

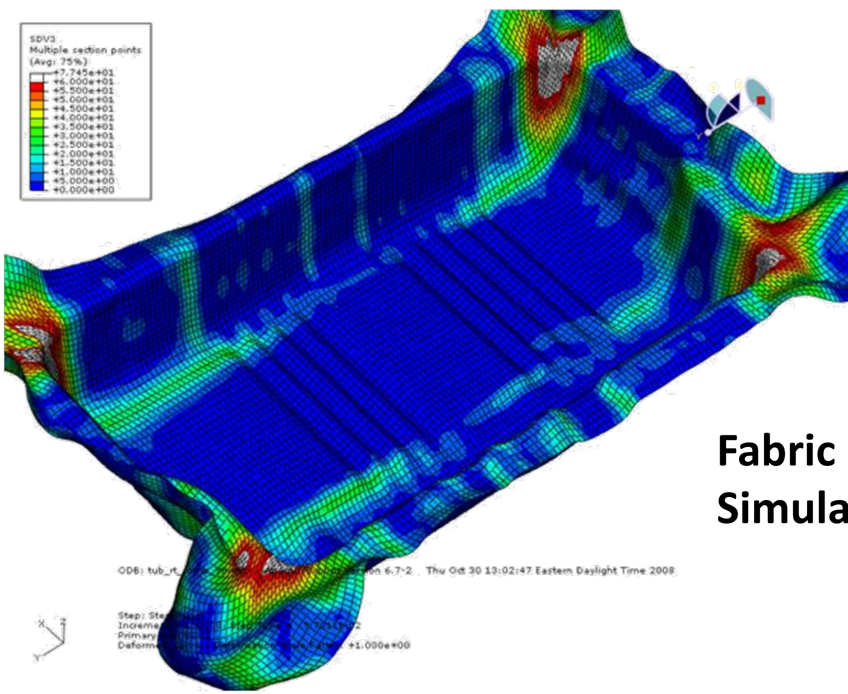


Technical Accomplishments
Structural Composite Underbody

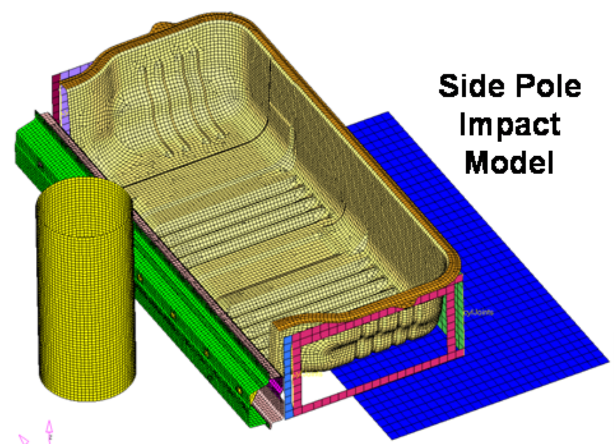
- Selected surrogate tool for initial processing, fabric drape, and correlation of analytical and experimental dynamic testing.



Frontal Impact Model



Fabric Drape Simulation

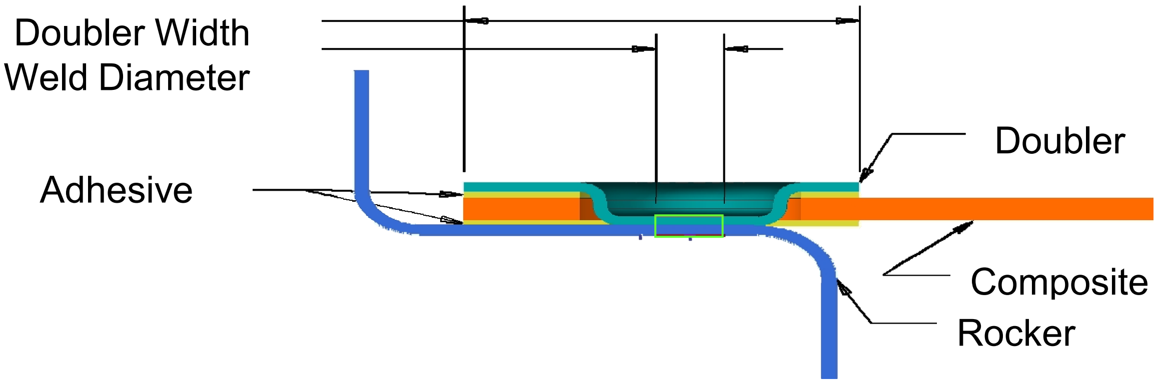


Side Pole Impact Model

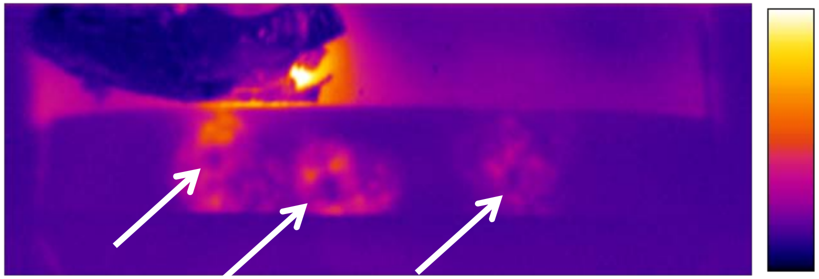
Design of dynamic tests

Technical Accomplishments
Structural Composite Underbody

- Initial testing of composite-to-steel weld bond joint, with steel double (Applied for US patent)



- Demonstrated vibro-thermography for NDE of damaged weld bonds.



Future Direction
Structural Composite Underbody

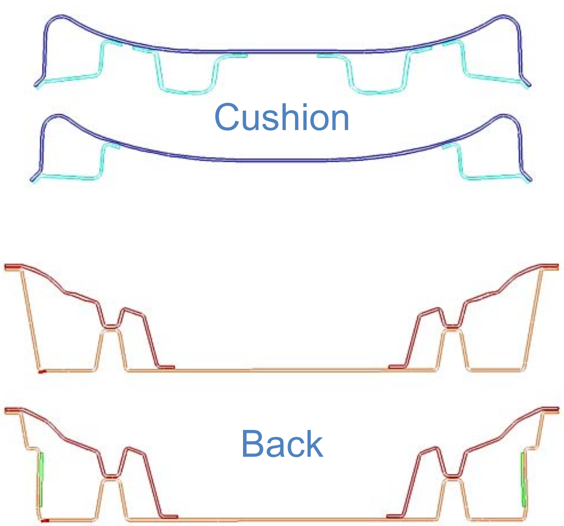
- Development of high elongation core material
- Fabrication of surrogate parts
  - 2 ½ minute cycle time
  - Drape analysis
  - Durability and high strain rate properties
- Weld bonded joint development
  - Processing
  - High strain rate properties
  - Durability
- Development of NDE techniques for durability validation
  - Target use by independent body shop
  - Low cost
  - Easy to use

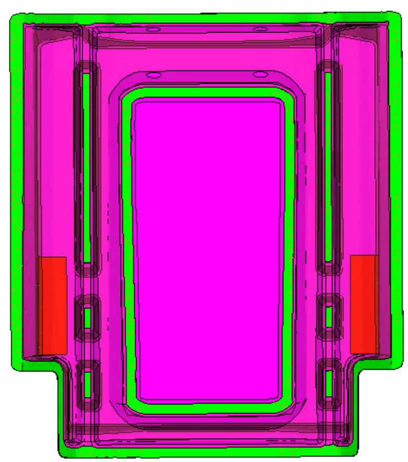
Summary
Structural Composite Underbody

- A structural composite underbody, capable of carrying crash loads, is being designed and fabricated
- A weld bonding method for joining the composite to a steel structure has been developed
- Fabric drape analysis is being used to guide processing and to fine tune the design
- Non-Destructive Evaluation methods for manufacturing quality and long-term inspection are being developed

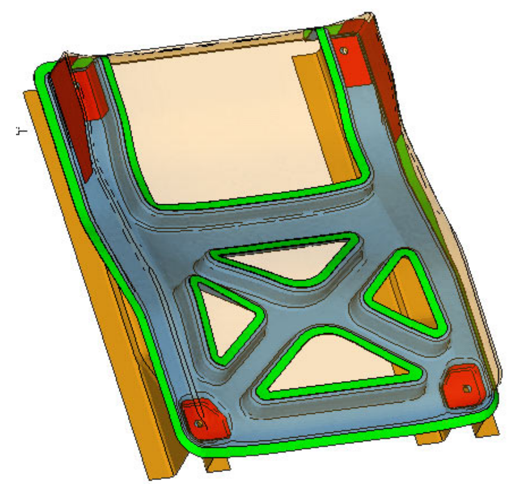
Technical Accomplishments
Composite Seat

- Inner and outer bonded shell designs allow much more geometric section modulus to be designed into the seat.
- Adhesive bonding of the inner and outer shell provides closed sections for managing loads.





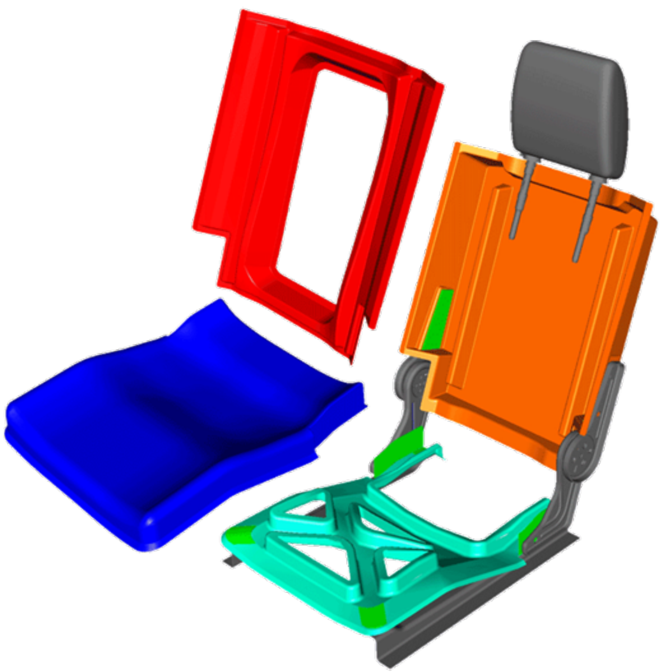
Back



Cushion

Technical Accomplishments
Composite Seat

- Cost modeling of initial design has been completed that shows:
  - Significant cost penalties for carbon based designs
  - Opportunity to get reasonable cost with glass based designs.



	Cushion	Back	
	Weight (kg)	Weight (kg)	Cost [1] ($)
ACC Carbon Design	2.70	2.92	$73.76
% of Steel Comparator	-30%	-18%	738%
ACC Re-Design Carbon	1.71	2.11	TBD
% of Steel Comparator	-56%	-41%	
ACC Re-Design Glass	TBD	TBD	TBD
% of Steel Comparator			
EPFL Carbon Design	na	1.50	$41.51
% of Steel Comparator		-58%	415%
EPFL Glass Design	na	2.42	$15.74
% of Steel Comparator		-32%	157%
Steel Comparator	3.88	3.56	$10.00

[1] at 260k upa

Future Direction
Composite Seat

- Optimize design of carbon-reinforced design
- Develop glass-reinforced composite design based on above design.
- Re-do cost modeling exercise to determine final cost of a composite seat structure.
- Determine appropriateness of tooling , building parts and testing them based on the results of the above steps.

Summary
Composite Seat

- Weight savings greater than 50% can be achieved with a carbon reinforced composite seat structure, *but at significant cost penalty*.
- A two-piece bonded design is being developed with glass-reinforcement to reduce the cost.