Polymer Composites Research in the ALM Materials Program

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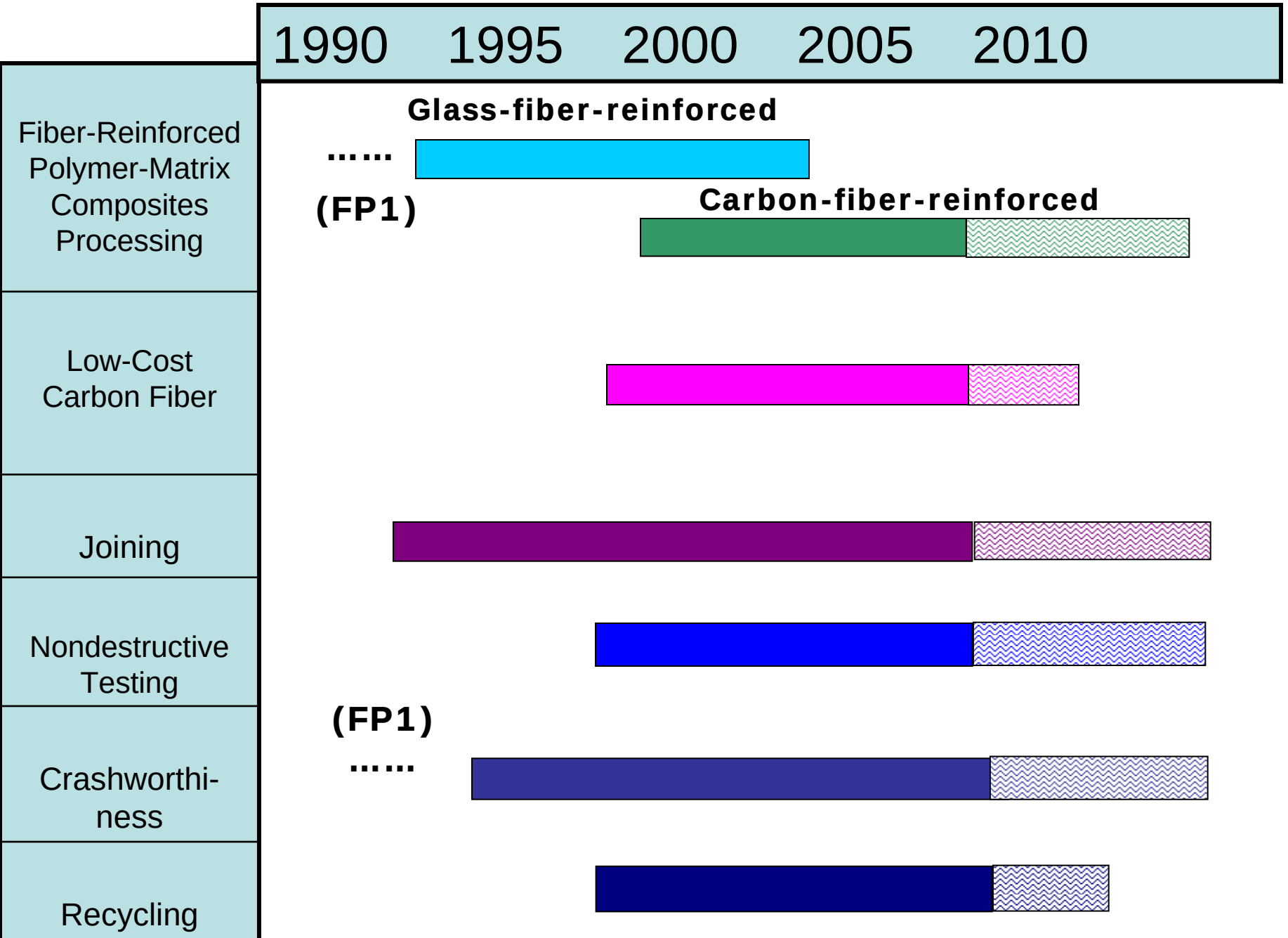
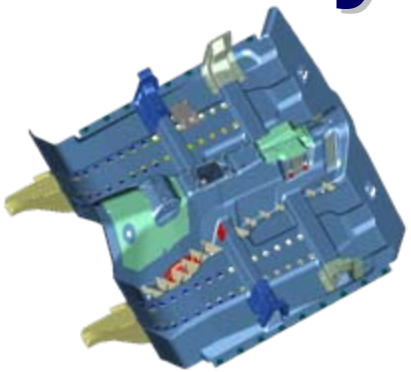
ALM Historical Timeline – Composites



ACC Key Deliverables

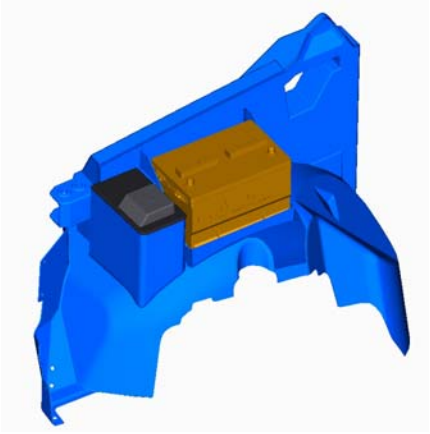


Composite Underbody

Low Cost Carbon Fiber

Carbon Fiber SMC Hood

2008 **2010** **2012** **2014**



Polymer Encapsulated Mega-Module

Composite Seat

EMWG Composite Front Structure

DOE/ALM COMPOSITE MATERIALS RESEARCH
Automotive Research Program Organization

FreedomCAR Materials

USCAR — Program Coordination — DOE/OFCVT

USAMP — Program Management — DOE/Materials

ACC AUTOMOTIVE COMPOSITES CONSORTIUM — Field Technical Management — ORNL

Materials | Energy Management | Processing | Joining

Manufacturability Demonstration Projects

Car Platforms | Automotive Suppliers

COMPOSITE MATERIALS RESEARCH
What Was Done --- Glass Fiber Composites

FreedomCAR Materials

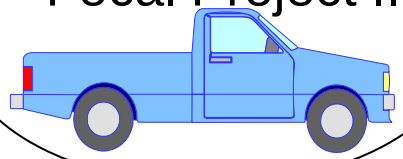
Processing

P4 Preforming
Slurry Modeling
Slurry Processing

Materials

Durability
Deformation & Degradation
Materials Screening

Focal Project II



Energy Management

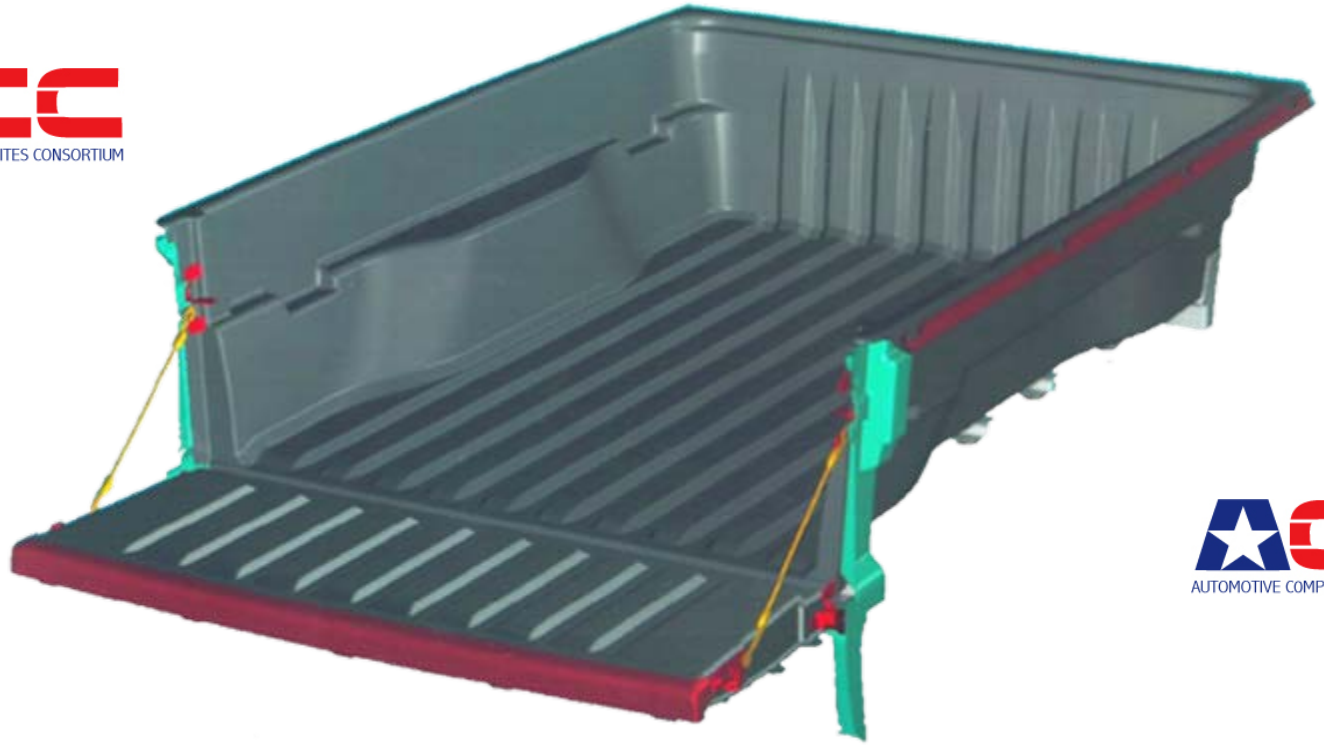
SCAAP
NHTSA Modeling
Energy Management

Joining

Adhesive Bonding
Adhesive Modeling
NDT Rapid Testing
NDT Laser Shearography
Test Method Analysis

FreedomCar and Beyond Goals

Automotive Composites Consortium



Focal Project 2: Composite Pickup Truck Box

COMPOSITE MATERIALS RESEARCH

What we were Doing --- Carbon Fiber Composites

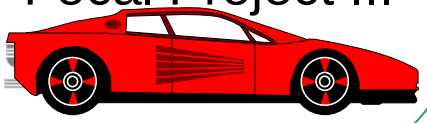
FreedomCAR Materials

Processing
- P4 Carbon Fiber
- High Vol Process of Composites **(4)**
- Next Generation P4
- Optimal CF for P4
- *Chassis Support Structures*
- *Chassis Structures*
- *Body and Door Structures*

Low Cost Carbon Fiber
- Lignin Based Precursors
- Microwave Processing
- Carbon Fiber Two Splitting
- Advanced *Oxidation*
- Advanced Stabilizaton
- LCCF Integration Line

Joining
- Advanced Joining
- Joint Energy Absorption
- NDE Techniques
- *Heavy Vehicle Joining*

Focal Project III



Materials
- CF Comp Durability
- Compressive Creep
- Materials Dev & Screening
- Recycling PMCs
- *CF SMC Structures*
- Development of CF SMC

Other
- Cost Modeling – Program
- Composites Conference

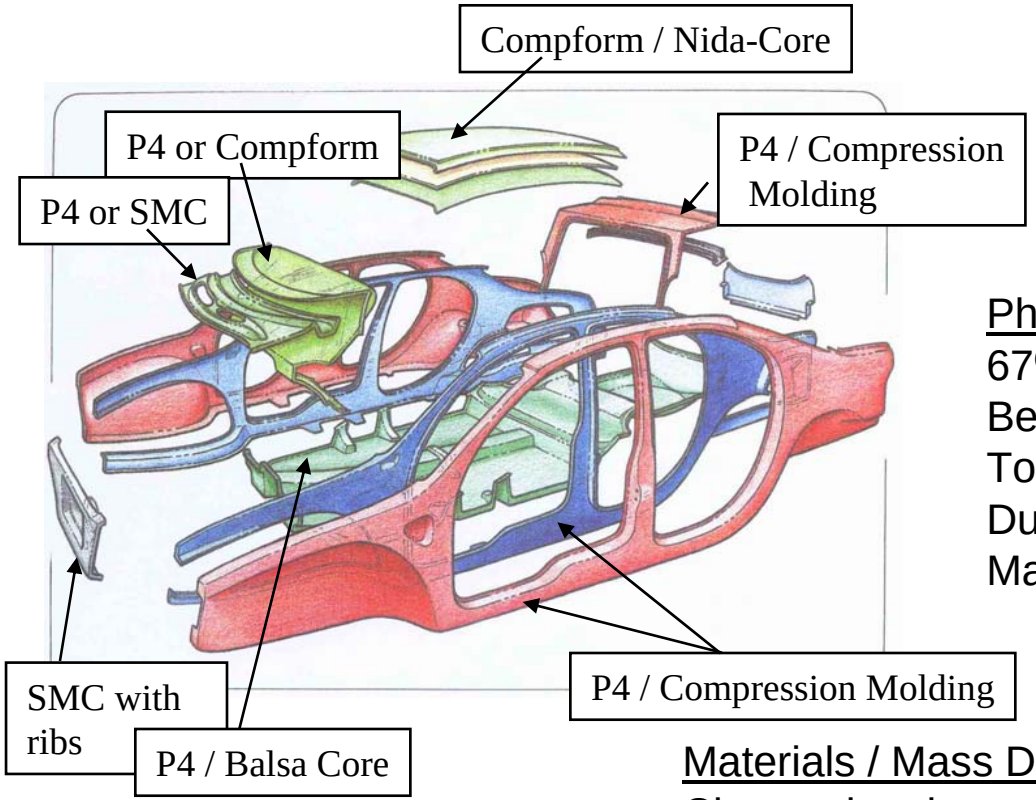
FreedomCar & 21Century Truck Goals

Energy Management
- Crash Adsorp of Bonded Structures
- Crash Energy Management **(7)**
- Testing Machine for Auto Crash
- Crash of Sandwich Structures

21st Century Truck
Automotive Lightweighting Materials

FreedomCAR Materials

Composite (Carbon) Intensive Body-In-White



Vehicle package
(based on DC JA)

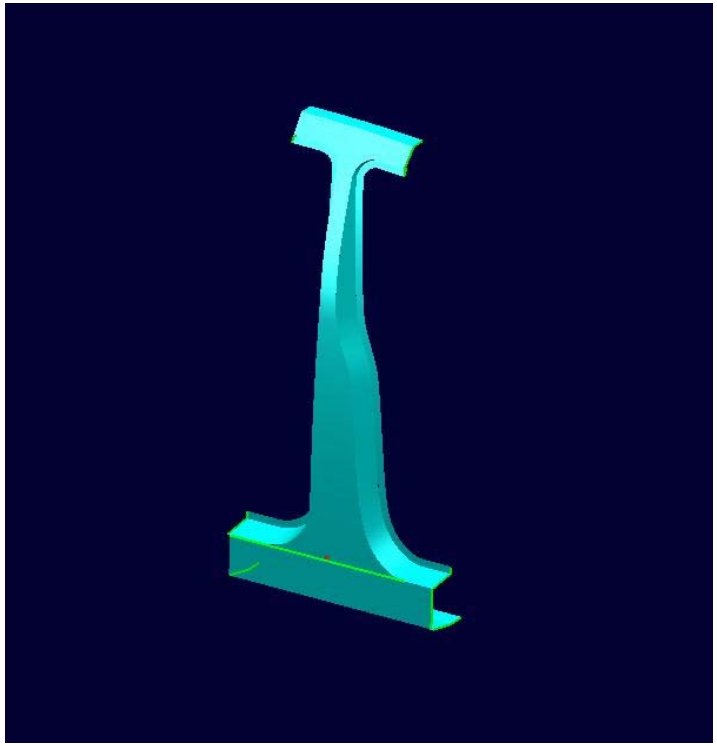
Phase 1 Results:
67% mass savings over baseline
Bending stiffness exceeded 20%
Torsional stiffness exceeded 140%
Durability and abuse load cases satisfied
Manufacturing strategy developed

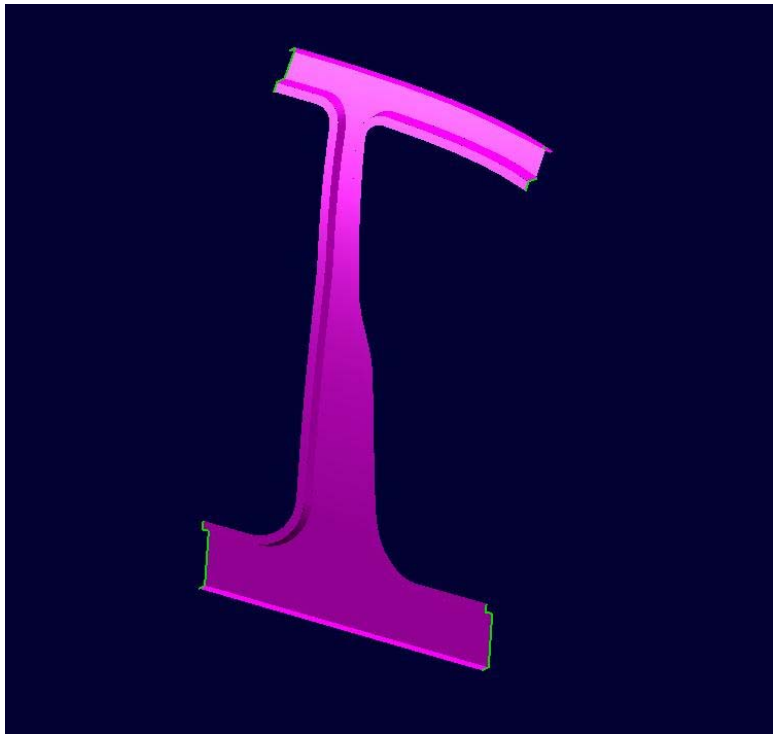
Materials / Mass Distribution:
Chopped carbon - 54.8 kg
Carbon fabric - 17.7 kg
Core - 3.2 kg
Adhesive - 1.6 kg
Inserts - 8.8 kg

High-Volume Molding of Composites

FreedomCAR Materials

Test Piece Design: Multi-Purpose B-Pillar Tool





COMPOSITE MATERIALS RESEARCH (2008)

What we are Doing --- Carbon Fiber Composites

FreedomCAR **Materials**

Processing
TPP4
✓ High Vol Process of Composites
(- CF SMC, Press, Inj Tools, etc)
✓ Next Generation P4
✓ P4 Preforming

✓ Previously Briefed
✓ Briefed Now
✓ Briefed Later

Low Cost Carbon Fiber
✓ Lignin Based Precursors
✓ Lignin Purification
✓ Advanced Oxidation
✓ Advanced Stabilizaton
✓ LCCF Integration Line
✓ FSD of Textile Precursors
Higher Performance Fibers

Materials
✓ Natural Fiber Composites
✓ Recycling PMCs
✓ Predictive Modeling of PMCs

Focal Projects IV
✓ - Underbody
- Comp Seat

Joining
Bond-line Read Through
Bonding of TP
Composite Underbody

Other
✓ Cost Modeling – Program
Focal Project 3

✓ **Energy Management**
Crash Adsorp of Bonded Structures
Crash Energy Management **(7)**
Testing Machine for Auto Crash

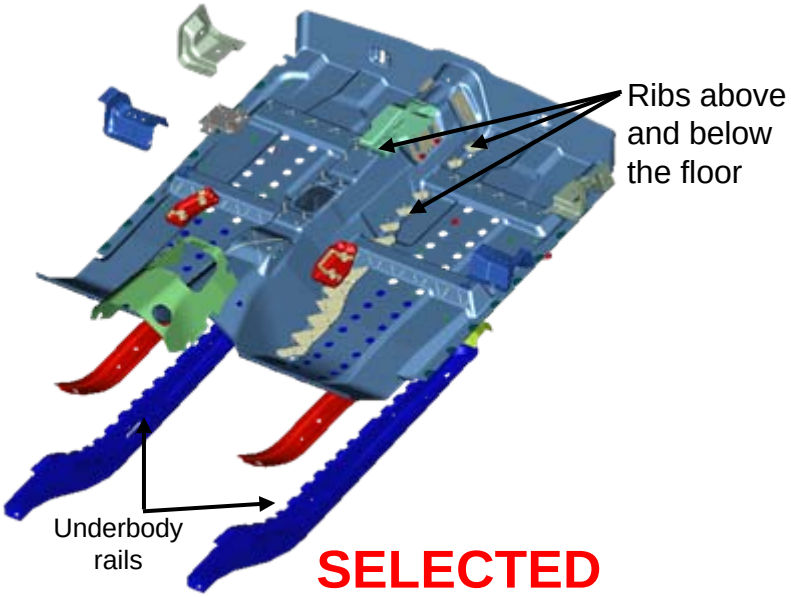
FreedomCar &
21Century Truck
Goals

Coordinated with Hydrogen Program
Current

Focal Project 4 – Composite Underbody

FreedomCAR Materials

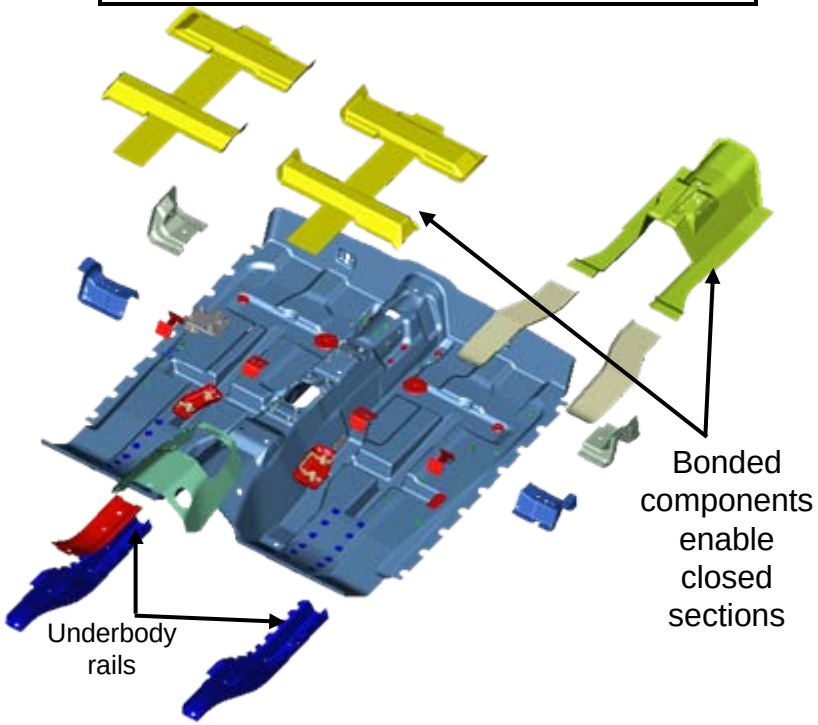
Ribbed Composite:
Components: ~55% reduction
Reinforcements: ~17% reduction



SELECTED

Ribbed Design Concept

Bonded Composite:
Components: ~41% reduction
Reinforcements: ~17% reduction



Bonded Design Concept

Focal Project 4 - Composite Seat

FreedomCAR Materials

- **Structures Level**
  - Back Frame and Cushion Frame only
  - Carry-over Headrest Design
  - Mechanisms and legs not included (except as related to attachments and joints)
  - Seat Integrated Restraint to be included.
- **Materials Level**
  - Thermoplastics and Thermosets included
  - Glass reinforcement with local carbon as required
  - Metal reinforcements included.

Courtesy of:

ACC
AUTOMOTIVE COMPOSITES CONSORTIUM

CARBON FIBER – Research Efforts

FreedomCAR Materials

Time	Agreement	Technical Presentation	Briefing	Presenter(s)	Funding ($)
Low-Cost Carbon Fiber					
10:20 – 12:00		Overview of Polymer Composites	A	David Warren	
	11131-11130 12559	Predictive Modeling of Polymer Composites	B	Mark Smith	1,203,000
	ACC 040	P4 Preform	C	Don Vesey	426,000
	9223	Development of Next Generation P4	D	Dave Warren	690,000
	ACC 007	Focal Project 4 – Floor Pan (Composite Underbody)	E	Don Vesey	644,000
	ACC 115	High-Volume Processing of Composites	E	Don Vesey	683,000
	16313	Natural Fiber Composite Retting, Preform Manufacturing and Molding	F	Mark Smith	400,000
	ACC 100	Crash Energy Management	G	Don Vesey	750,000

B Predictive Modeling of Polymer Composites
C P4 Preform
D Development of Next Generation P4
E Focal Project 4 – Floor Pan (Composite Underbody)
E High-Volume Processing of Composites
F Natural Fiber Composite Retting, Preform Manufacturing and Molding
G Crash Energy Management