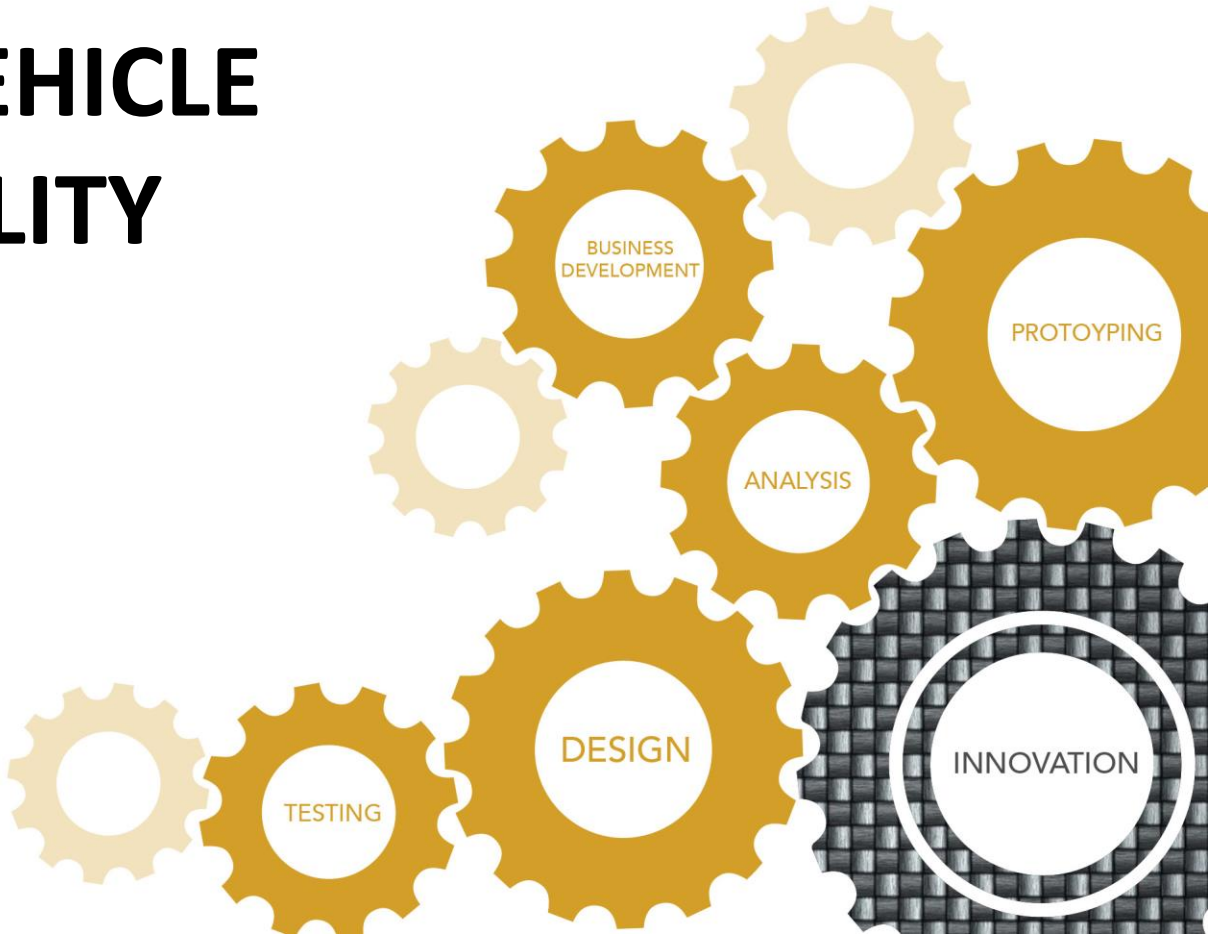
Composites Innovation Centre

ADOPTING COMPOSITE MATERIALS TO IMPROVE VEHICLE SUSTAINABILITY

Vehicle Technology
International Conference
Oct. 1, 2019



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Outline

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- CIC Introduction
- What are Composites?
- Why Composites?
- Composites in the Vehicle Industry
- Case Study – Heavy-Duty Truck Floor
- Case Study – Vehicle Tub
- Case Study – Automotive Interiors
- Case Study – Tractor Hood
- Conclusion

CIC Introduction

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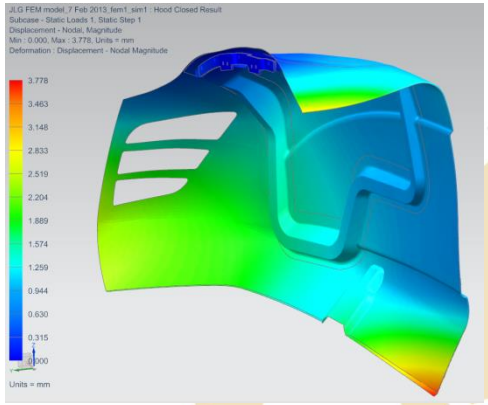
CIC supports the entire product development process through:

- Feasibility Assessments
- Design
- Analysis (FEA)
- Material & Process Development
- Testing
- Prototyping – Tooling & Products
- Engineering Support for Manufacturing



CIC Introduction

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We work with our clients to:

- Reduce product development time and cost
- Manage risk
- Increase product performance
- Develop products for new markets
- Enhance product value

What are Composites?

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Materials created by the combination of **two or more materials**, on a macroscopic scale, to form a **new material with enhanced properties** superior to those of the individual constituents alone

What are Composites?

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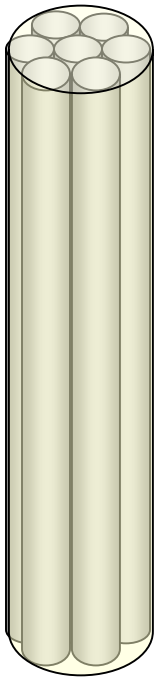
Fibres

Provide strength and stiffness

Examples:

Carbon fibre, fibreglass, kevlar (aramid fibres), natural fibres



Composite

Resin

Protects and transfers load between fibres

(Similar to a glue; it holds the composite together)

Examples:

Polyester, vinyl ester, epoxy, polyurethane

When you combine fibres with resin you create a composite

A composite combines two or more materials to make something that has better performance than the individual parts alone

Why Composites?

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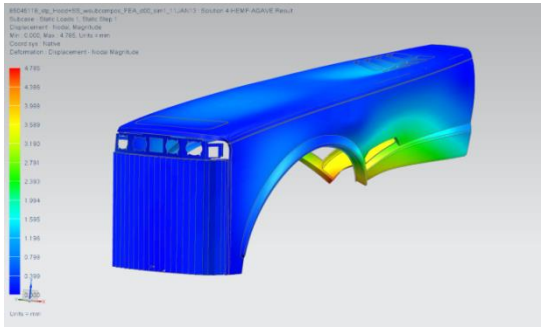
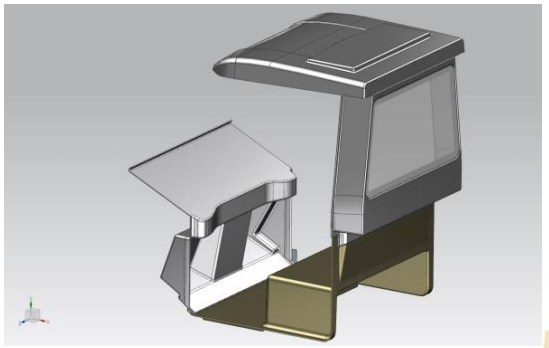
- Strong but lightweight components
- Allows complex shapes for design and manufacturing flexibility
- Parts consolidation
- Innovative / attractive designs
- Corrosion resistant
- Longer lifespan





Why Composites for Sustainability?

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- Various studies estimate that every 10 % reduction in vehicle weight results in 5 to 7% fuel savings
- Lighter vehicles allow for smaller engines without compromising performance
- Lighter vehicles helps to enable electric vehicle technologies
- Natural fibres come from a renewable resource and replace petroleum-based fibres

Composites in the Vehicle Industry

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Types of vehicles that use composite materials include:

- Buses
- Trains
- Heavy-duty trucks
- Agricultural equipment
- Recreational vehicles
- Cars

Composite components include:

- Exterior panels
- Floors
- Roofs
- Interior panels and headliners
- Vehicle tubs

Composites in the Vehicle Industry

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Common fibres include:

- Fibreglass
- Carbon fibre (typically for high-performance, low volume)
- Natural fibres

Common resins include:

- Thermosets including polyester and vinyl ester
- Thermoplastics including polyurethane and polypropylene

Common manufacturing processes include:

- Hand layup
- Infusion
- Pultrusion
- Compression moulding

Case Study – Heavy-Duty Truck Floor

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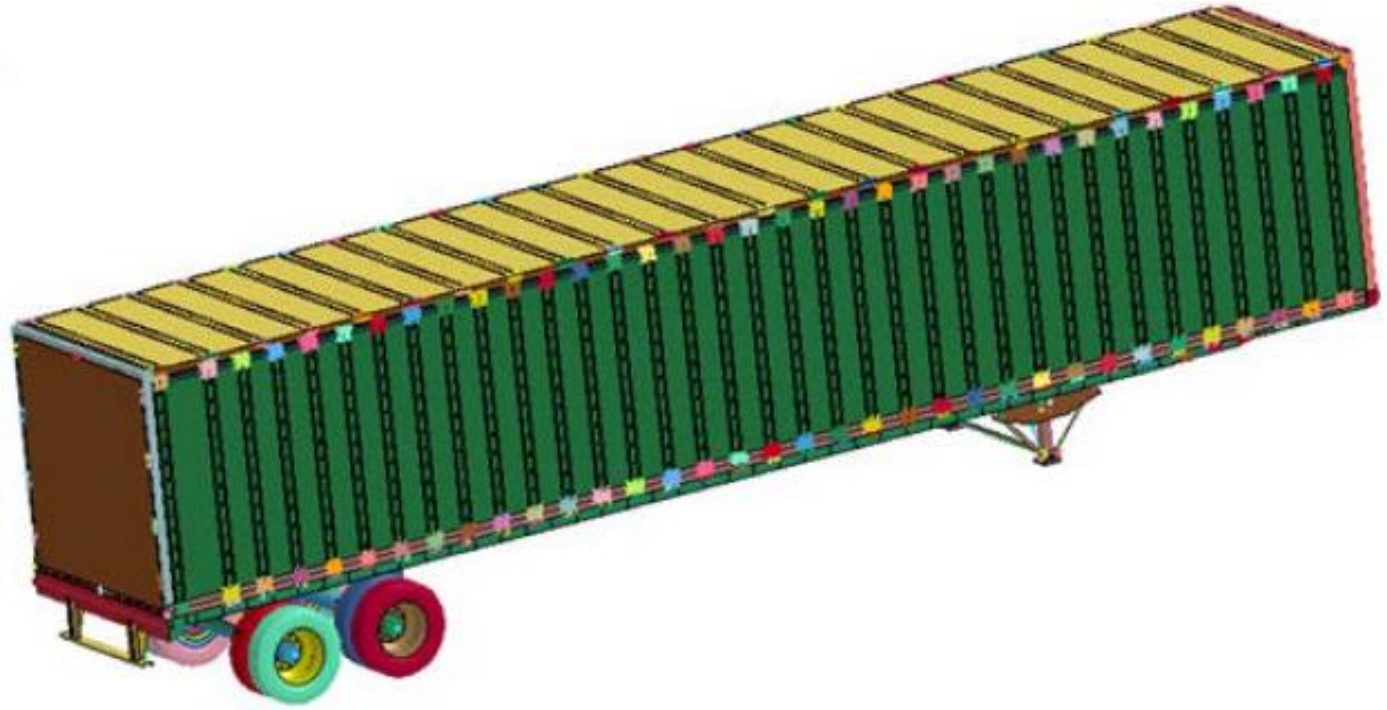
Dry freight van trailer

- 14.63 m (48 ft) long Great Dane P-Series haul trailer



Prucz, J. C., Shoukry, S. N., William, G. W. & Shoukry, M. S., 2013. *Lightweight composite materials for heavy duty vehicles.* [Online] Available at: https://www.osti.gov/scitech/

Case Study – Heavy-Duty Truck Floor

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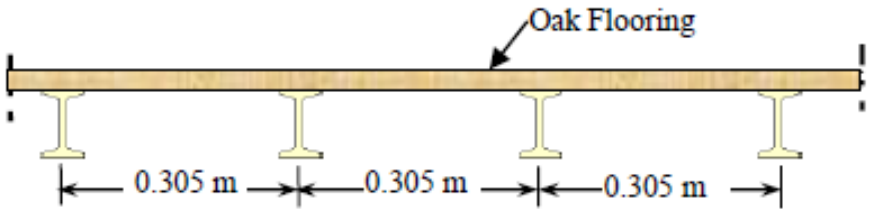
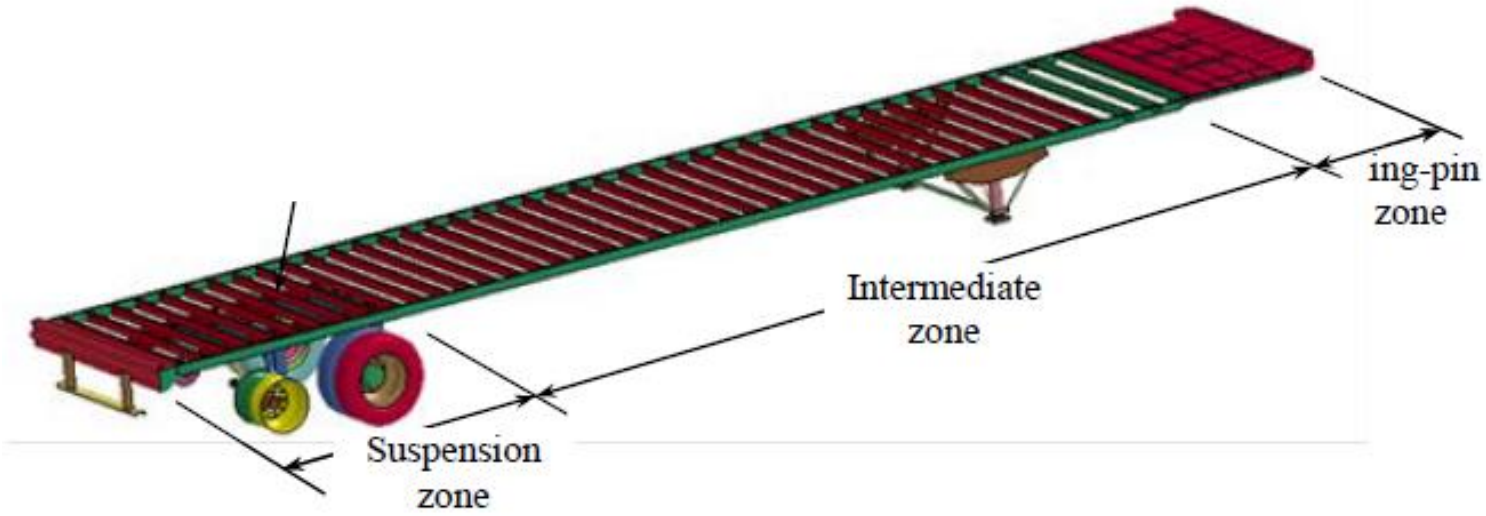
Original design

- 38mm thick hardwood
- Supported by steel I-beams





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Case Study – Heavy-Duty Truck Floor

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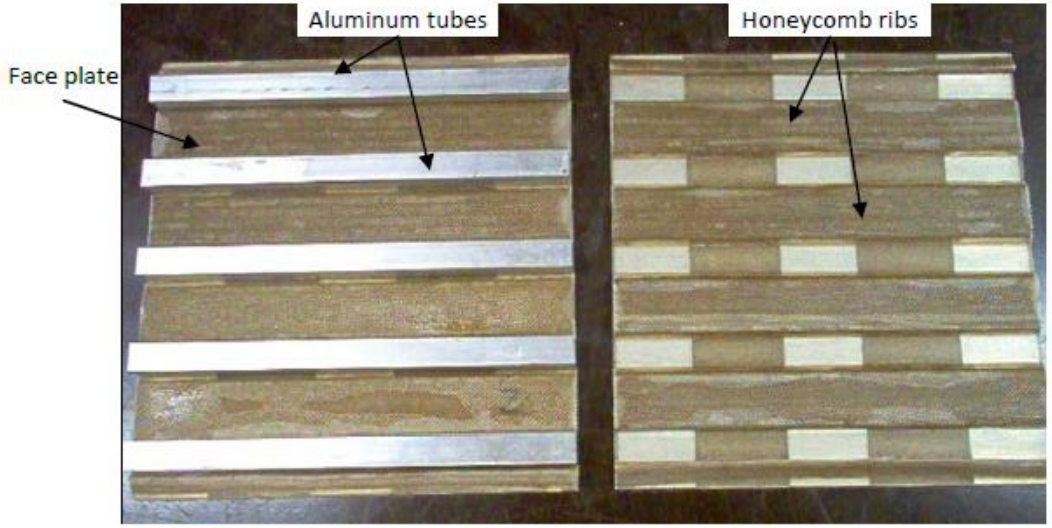
Proposed design

- Sandwich panel with composite face sheets (fibreglass or carbon fibre)
- Aluminum extrusions in the core (replace the steel I-beams)
- Paper honeycomb ribs included as filler between aluminum extrusions



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Case Study – Heavy-Duty Truck Floor

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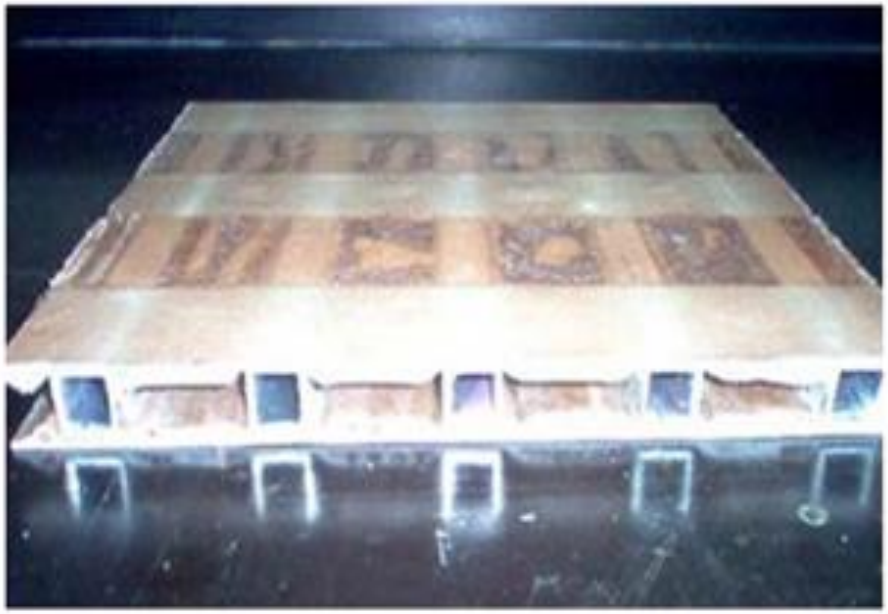
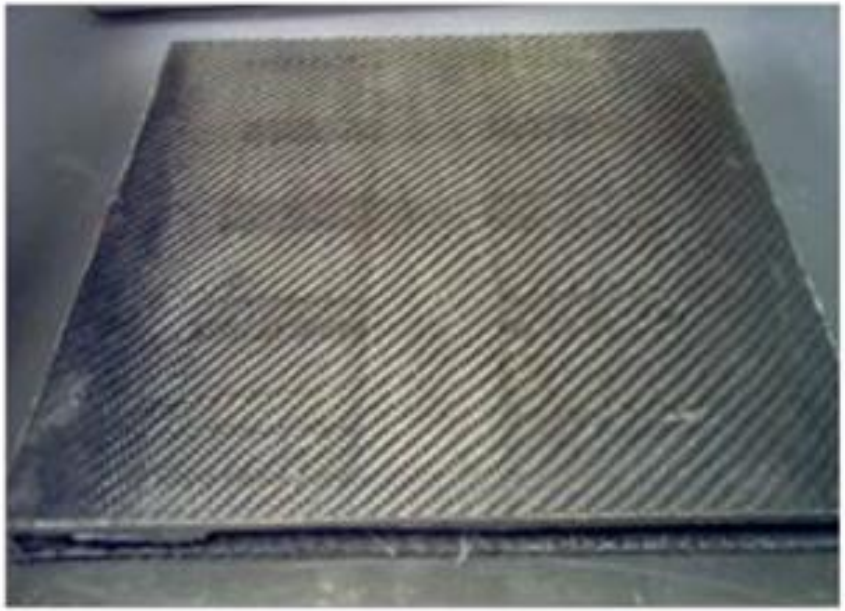
Proposed design



FIBERPLATE



CARBONPLATE

Prucz, J. C., Shoukry, S. N., William, G. W. & Shoukry, M. S., 2013. *Lightweight composite materials for heavy duty vehicles.* [Online] Available at: https://www.osti.gov/scitech/

Case Study – Heavy-Duty Truck Floor

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- Composite designs resulted in reducing the mass by more than 50%
- Cost of carbon design was 4.3 times greater than the original
- Cost of fibreglass design was comparable to the original
- Estimated fuel savings of approximately 7%

	Mass kg/m^2	Cost $\$/m^2$	Fuel Used to Transport One Ton of Cargo Over 1000 km (Liter/ton×1000 km)
Current Floor Design	76.23	126.4	20.053 (0%)
Carbonplate-4	34.18	550	18.584 (7.3%)
Fiberplate-4	35.2	120	18.617 (7.1%)

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Case Study – Vehicle Tub

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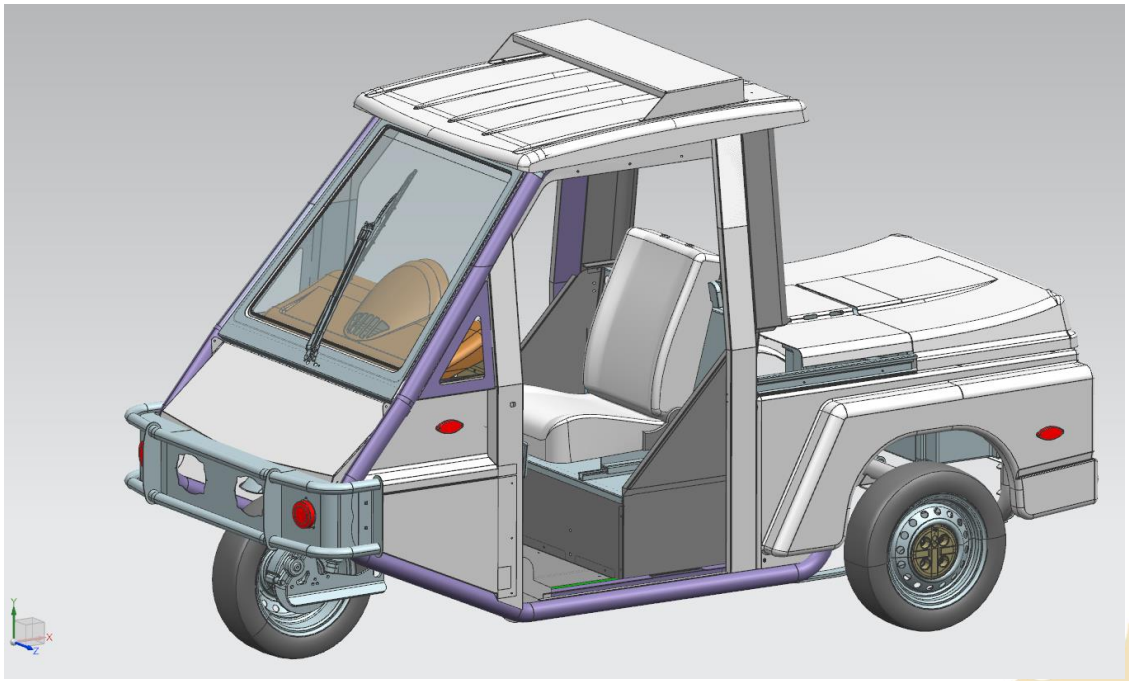
Westward GO-4 Vehicle

- Three wheel vehicle commonly used by parking patrols due to its maneuverability



Case Study – Vehicle Tub

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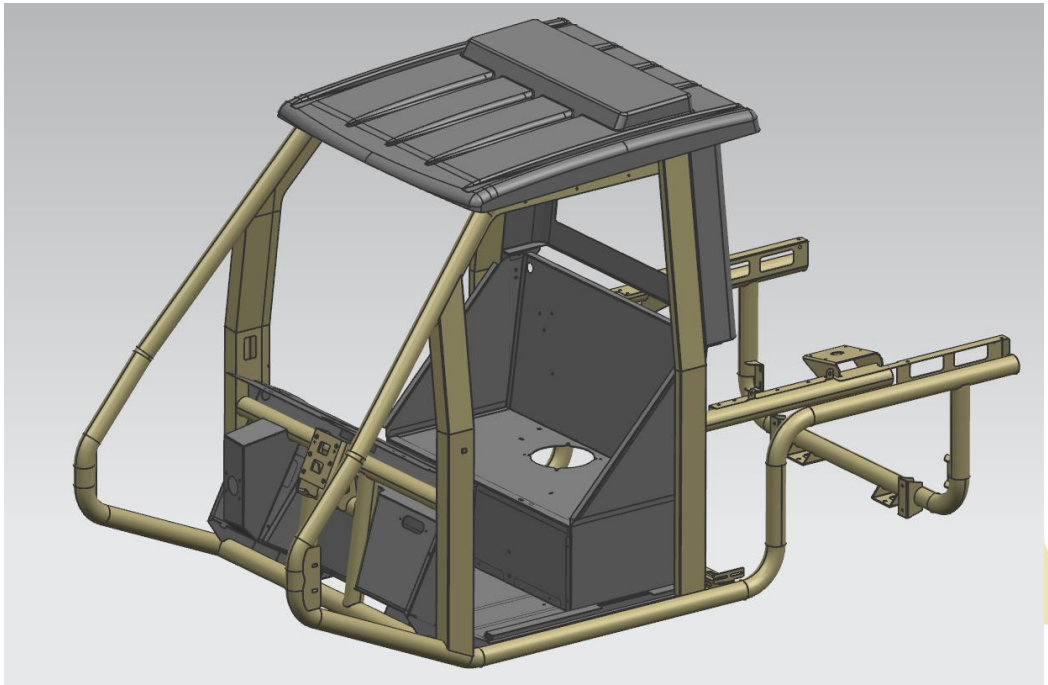
Original design

- Metallic tubular frame
- Sheet metal and plastic panels
- Welded structure



Case Study – Vehicle Tub

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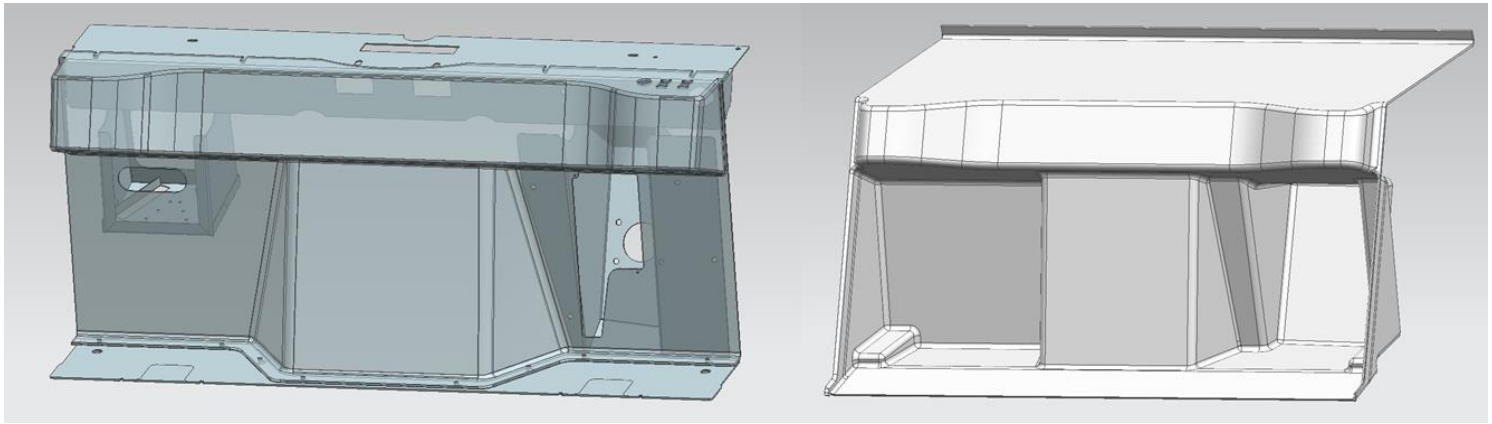
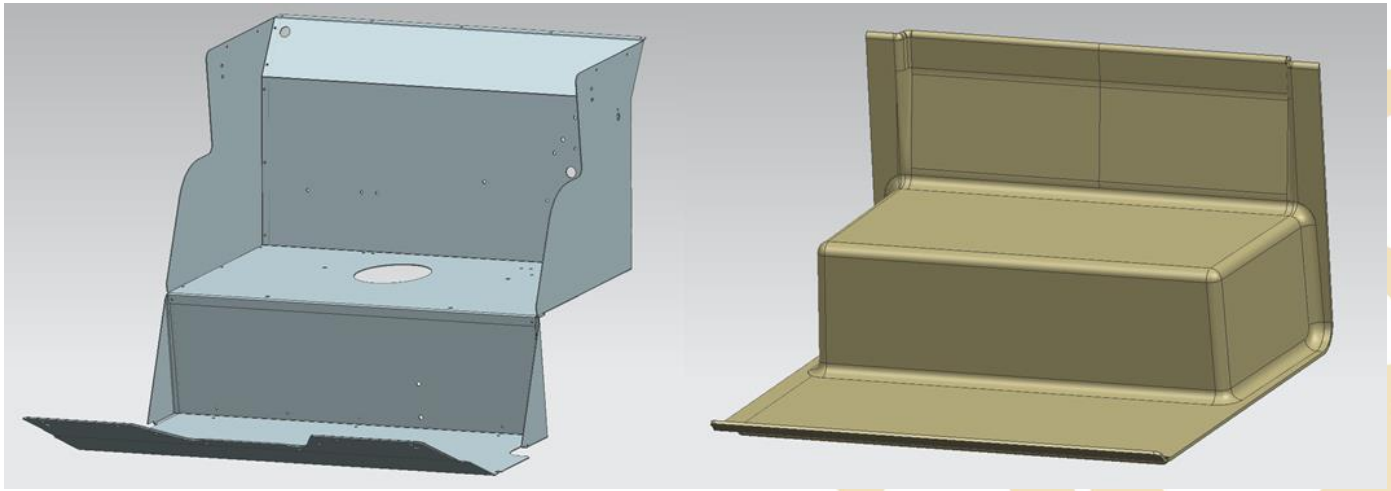
Proposed design

- Four composite components to make up the vehicle tub





Case Study – Vehicle Tub

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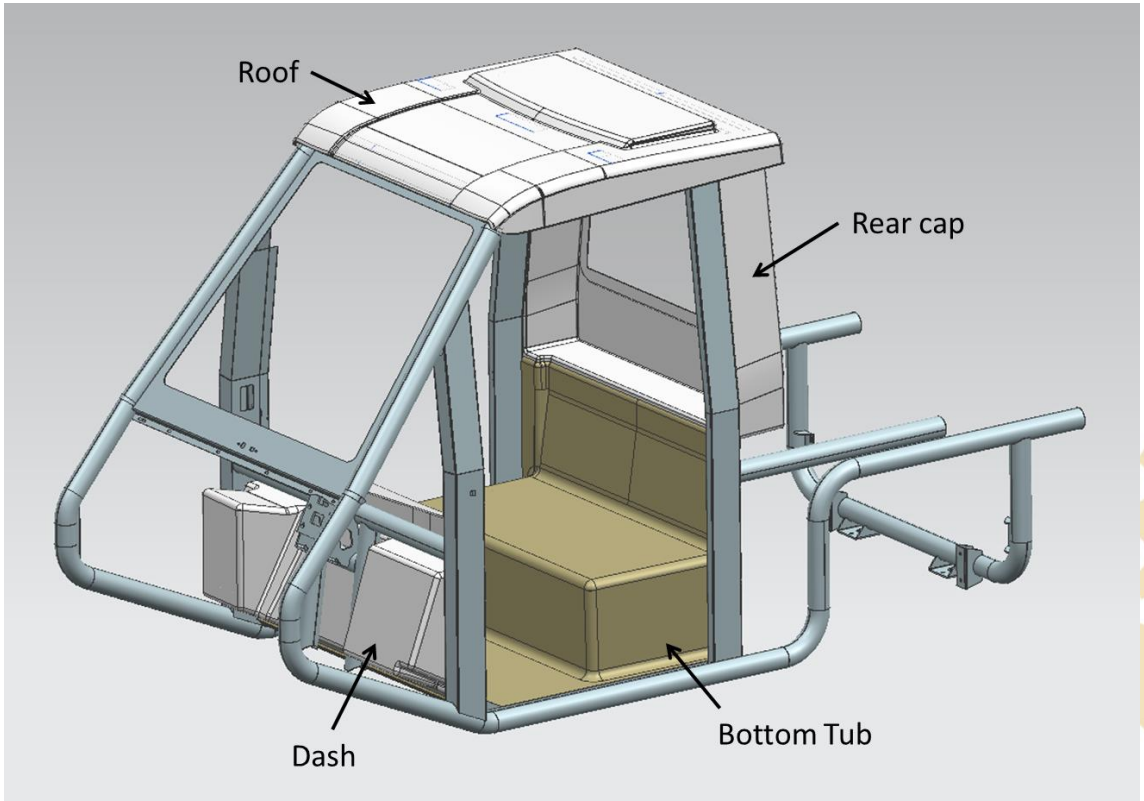
- Weight savings = 13%
- Beneficial when moving to an electric motor
- Additional benefit of reducing part count from 19 to 8



Case Study – Automotive Interiors

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- Canadian hemp and flax are primarily grown for their seeds
- Stalk is waste product
- Fibres can be used to replace fibreglass

Case Study – Automotive Interiors

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- Typically nonwovens although some wovens are used
- Interior components
  - Wheelhouse liners
  - Headliners
  - Door panels
  - Boot linings
  - Centre consoles
  - Acoustic panels
- Typical process is low pressure compression moulding

Case Study – Automotive Interiors

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Major automotive OEMs are adopting due to benefits including:

- Weight savings
- Recyclability
- Replaces petroleum-based fibres with a renewable resource

Case Study – Tractor Hood

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Buhler Industries Versatile tractor components

- Tractor hood, fan shroud, and fenders
- Original design combination of fibreglass mats
- Proposed design includes non-woven hemp and agave fibres

Case Study – Tractor Hood

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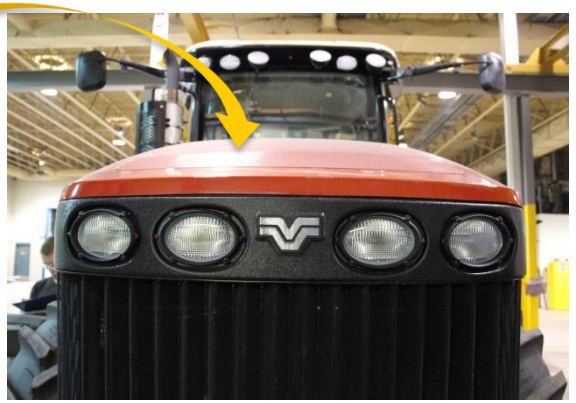
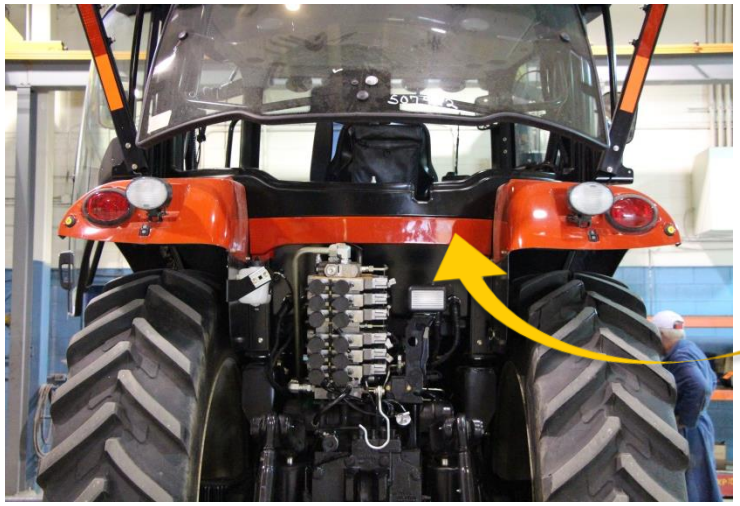
Hood

Side Shield





Rear and Crossover Fenders

Fan Shroud

BioFibre Tractor Components

Case Study – Tractor Hood

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Tractor Hood / Side Shield Assembly

Ply	Zone	Material	Thickness (mm)
1	Side Shields	EM0015 Glass CSM	0.38
2		Hemp-Agave Nonwoven Mat	2.00
3		Hemp-Agave Nonwoven Mat	2.00
4		EM0015 Glass CSM	0.38
		Total	4.76
1	A Side	EM0015 Glass CSM	0.38
2	Hood	CORECORK NL20	2.00
3		Hemp-Agave Nonwoven Mat	2.00
4		Hemp-Agave Nonwoven Mat	2.00
5	B side	EM0015 Glass CSM	0.38
		Total	6.76

Fan Shroud, Rear Fender and Cross-Over Fenders

Ply	Material	Thickness (mm)
1	EM0015 Glass CSM	0.38
2	Nonwoven Hemp-Agave	2.00
3	Nonwoven Hemp-Agave	2.00
4	EM0015 Glass CSM	0.38
	Total	4.76

Case Study – Tractor Hood

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Manufactured using RTM-Light process

- Tooling was developed to accommodate production of biofibre parts at Eastside Composites
- Nonwoven biofibre mat acted as infusion media for improved resin flow between the glass plies

Case Study – Tractor Hood

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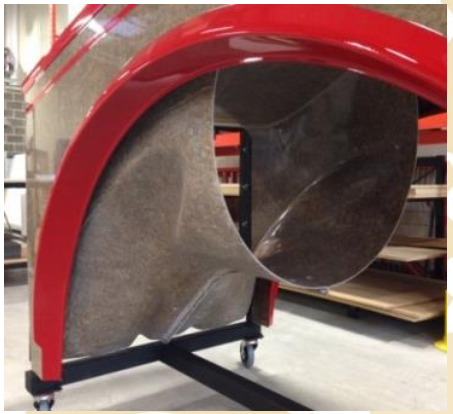
In-field Performance Testing

- Rigorous bump-track
- Used during harvest season in both hot (Arizona) and cold (Manitoba) climates
- Parts remained intact and performed well in both hot and cold temperatures, under vibration, and in humid and moist conditions.



Case Study – Tractor Hood

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Future Work

- Development of biofibre mat for improved processing
- Fibre resin interface characterization and optimization
- Environmental and long term durability assessment
- Bio-based resin for composite processing
  - Fibre preparation/sizing (coatings) for processing, bonding, fire retardancy, minimize moisture uptake
  - Mat architecture to meet mechanical and processing requirements and to compete with other fibreglass forms – stitchmats, fabrics and wovens

Conclusion

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- Composites usage in the vehicle industry continues to increase
- One of the drivers is the need to reduce vehicle weight due to more stringent fuel efficiency standards
- Natural fibres are an emerging material that shows promise for reducing the reliance on petroleum-based fibres

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Questions?

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