



# Co-operative Research Centre for Advanced Automotive Technology

Project C2-23

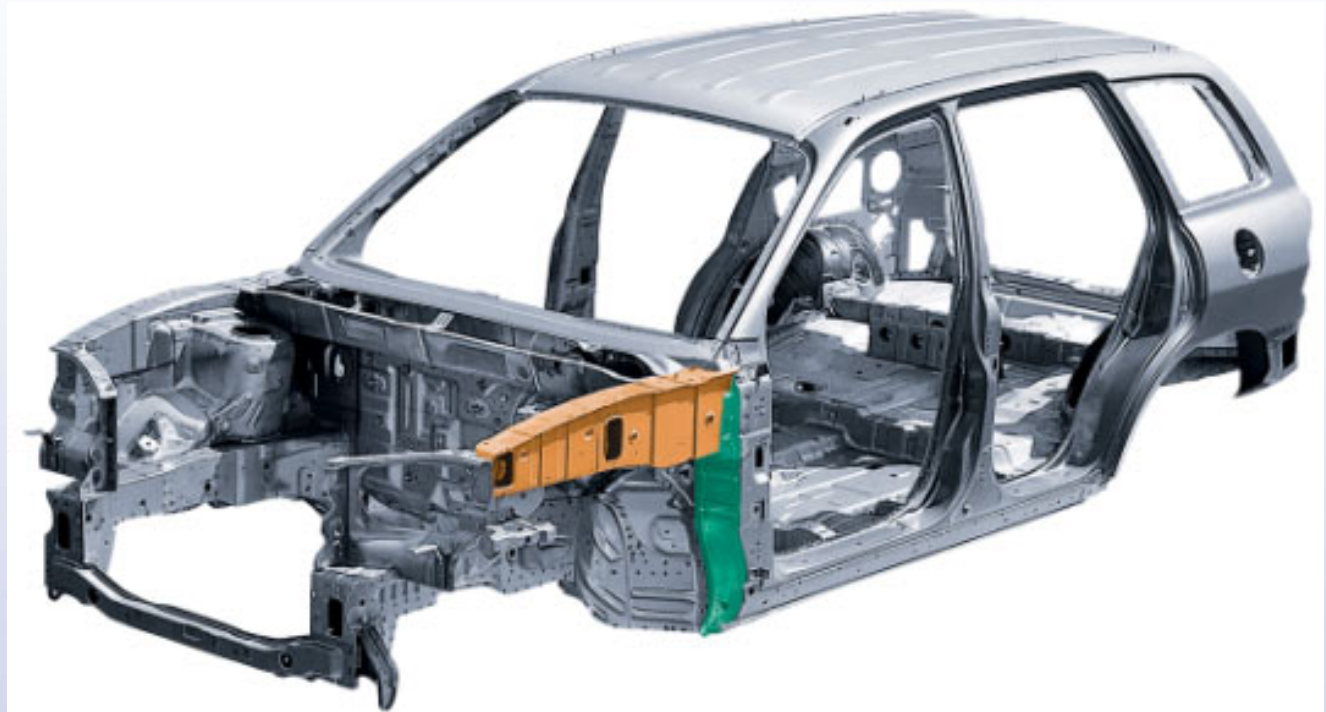
## Lightweight Modular Vehicle Platform Manufacturing and Assembly Constraints

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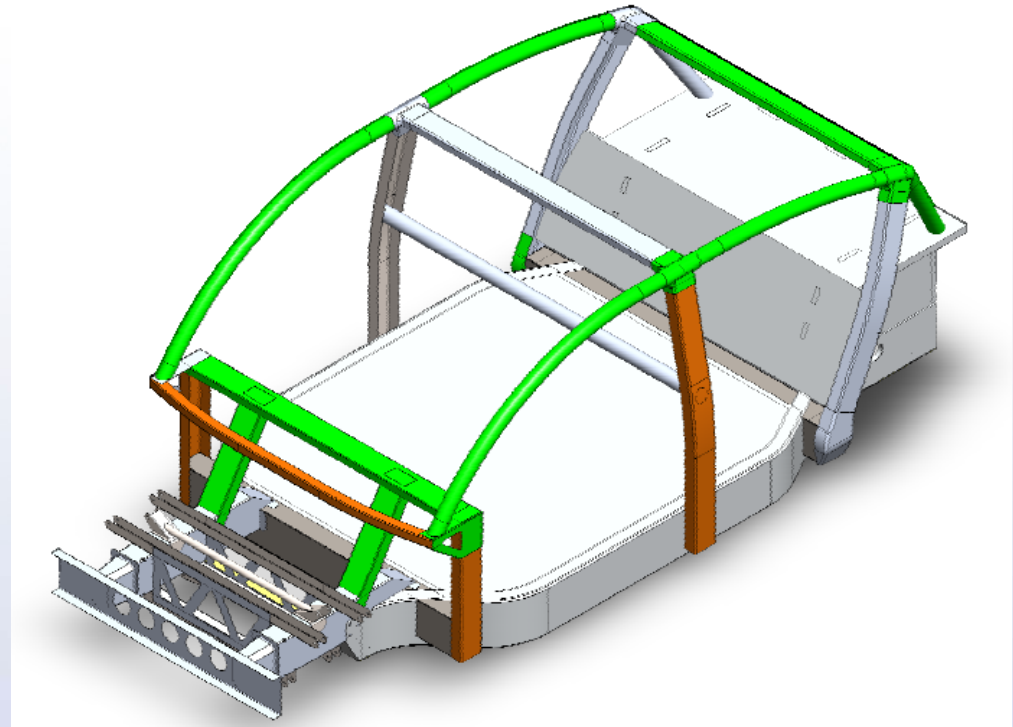
# Traditional Chassis Systems

- ◆ Unibody design
- ◆ Material is primarily steel
- ◆ Stamping
- ◆ Welding



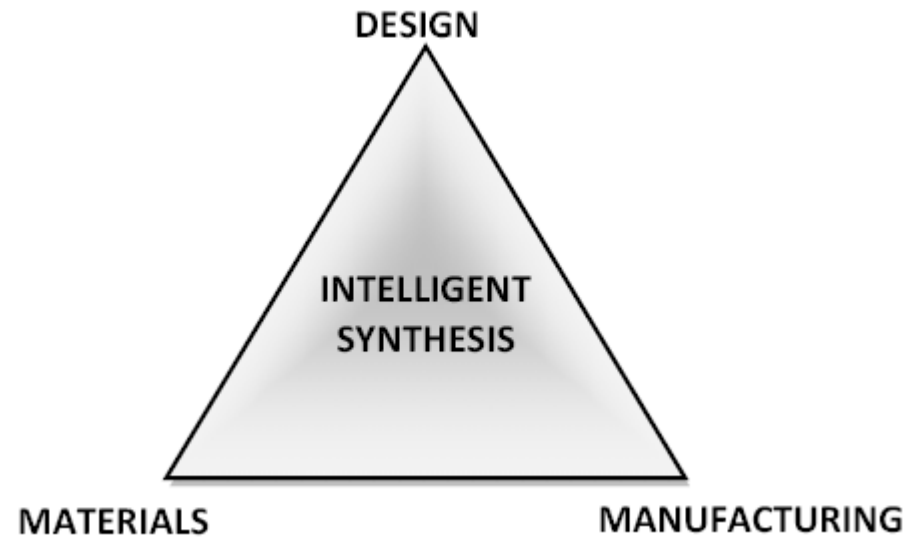
# Concept Design

- ◆ Space Frame based
- ◆ Materials include Aluminium, Steel, High Strength Steel, GFRP, PVC Foam
- ◆ Constructed from closed sections, open sections, tubular sections, sandwich panels, cast nodes



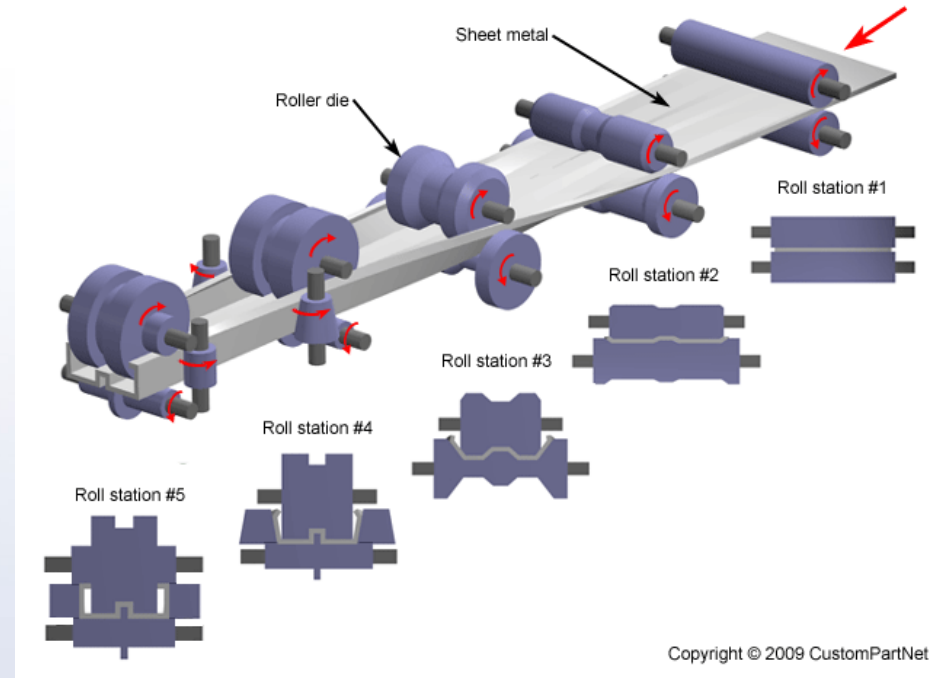
# Manufacturing Aims

- ◆ Cost Effective
- ◆ Allow for more expensive materials
- ◆ Simple
- ◆ Flexible Tooling
- ◆ Minimal Infrastructure
- ◆ Scalable Production Volumes



# Manufacturing Constraints

- ◆ Lightweight materials have different properties to traditional steel
- ◆ Can be more difficult to form
- ◆ More expensive
- ◆ Multiple materials are present in the body structure design
- ◆ Different processes for each material



# Assembly Constraints

- ◆ Joining dissimilar materials can be difficult
- ◆ Closed members are not easy to join
- ◆ Single sided joining is required
- ◆ Joining aluminium via liquid phase welding is difficult
- ◆ Disassembly considerations
- ◆ Adhesives require
  - ◆ Application
  - ◆ Thickness control
  - ◆ Flexible fixturing
  - ◆ Curing



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## Manufacturing



# Parts Manufacture

## ◆ Composite Panel

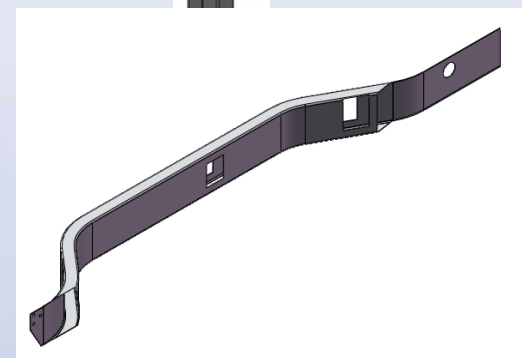
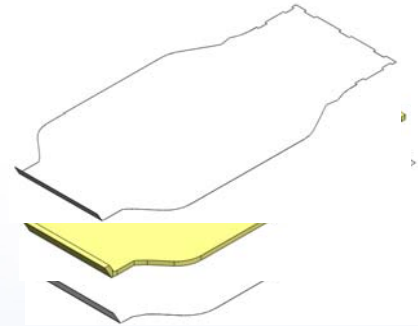
- ◆ Bonding occurs offsite
- ◆ Routing and Shaping

## ◆ Open Section Members

- ◆ Uncoiling and Straightening
- ◆ Laser Cut to correct width
- ◆ Roll Forming
- ◆ Stretch Bender

## ◆ Closed Section Members

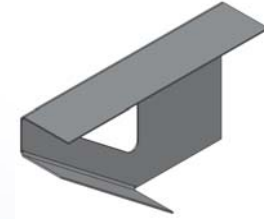
- ◆ Uncoiling and Straightening
- ◆ Laser Cut to correct width
- ◆ Roll Forming with Inline Laser Welding
- ◆ Trimming
- ◆ Stretch Bender



# Parts Manufacture (cont...)

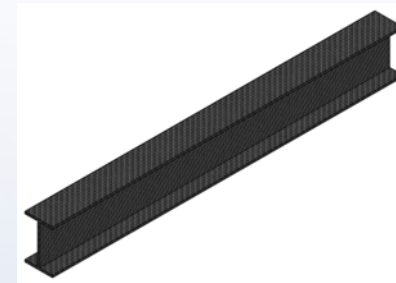
## ◆ Extruded Sections

- ◆ Provided in lengths
- ◆ Cut to length
- ◆ Stretch Bender



## ◆ GFRP I-Beams

- ◆ Laser Cutting

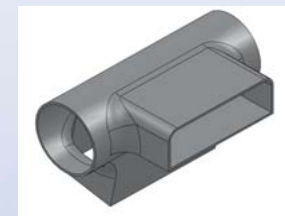
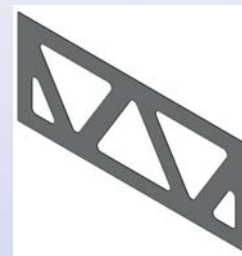


## ◆ Flat Panels

- ◆ Uncoiling and Straightening
- ◆ Laser Cutting

## ◆ Folded and Welded Parts

- ◆ Uncoiling and Straightening
- ◆ Laser Cut
- ◆ Folding/Bending Machine
- ◆ Welded



## ◆ Cast Parts

# Infrastructure

- ◆ The required infrastructure includes
  - ❖ Uncoiler and Straightener
  - ❖ CNC Laser Cutter
  - ❖ Roll Former
  - ❖ Roll Former with Inline Laser Welder
  - ❖ Stretch Bender
  - ❖ CNC Laser Router
  - ❖ Welder
  - ❖ Casting
- ◆ This equipment can be used on multiple components with minimal tooling changes
- ◆ The equipment can also accommodate the different vehicle variants with minimal tool changes

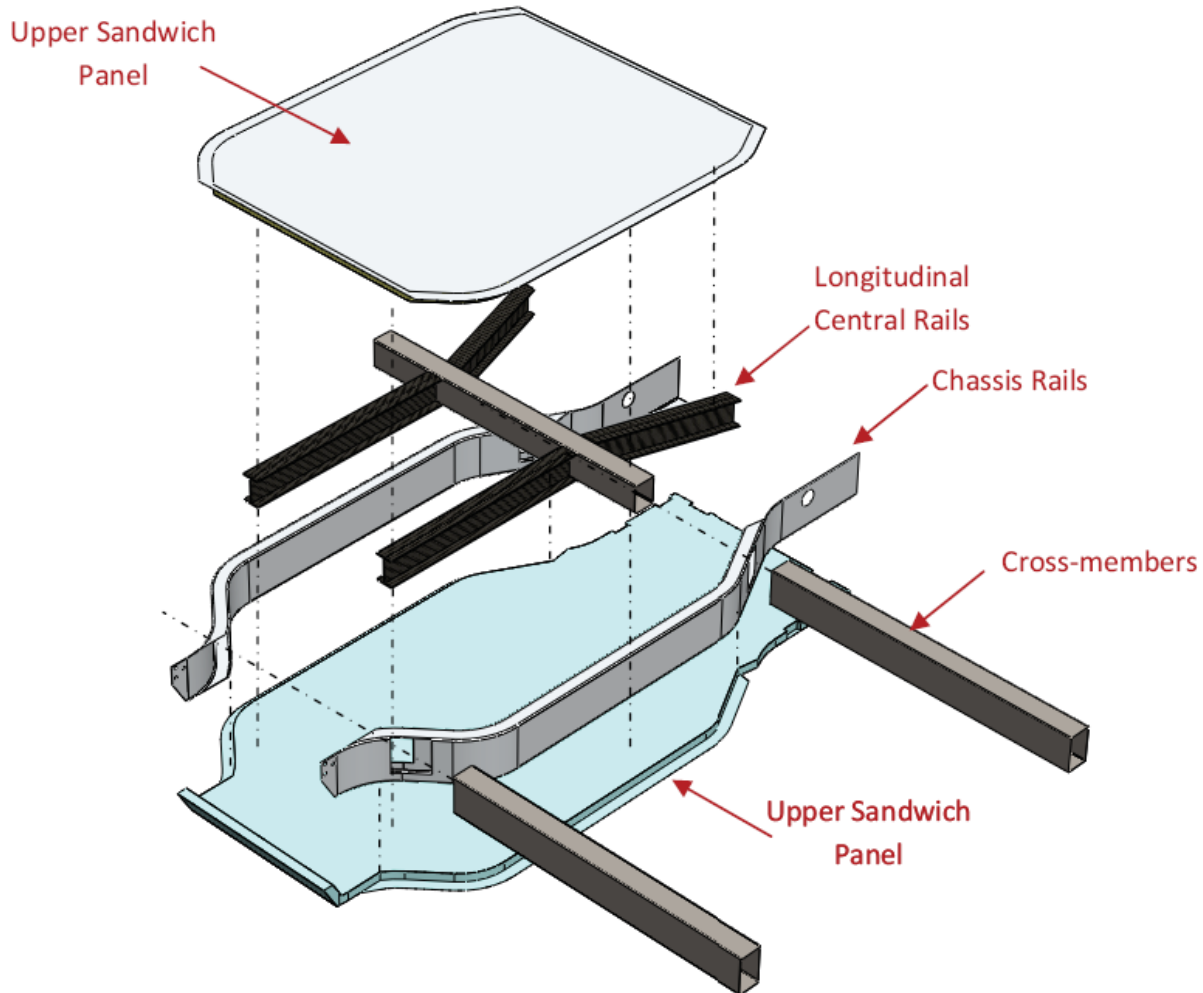


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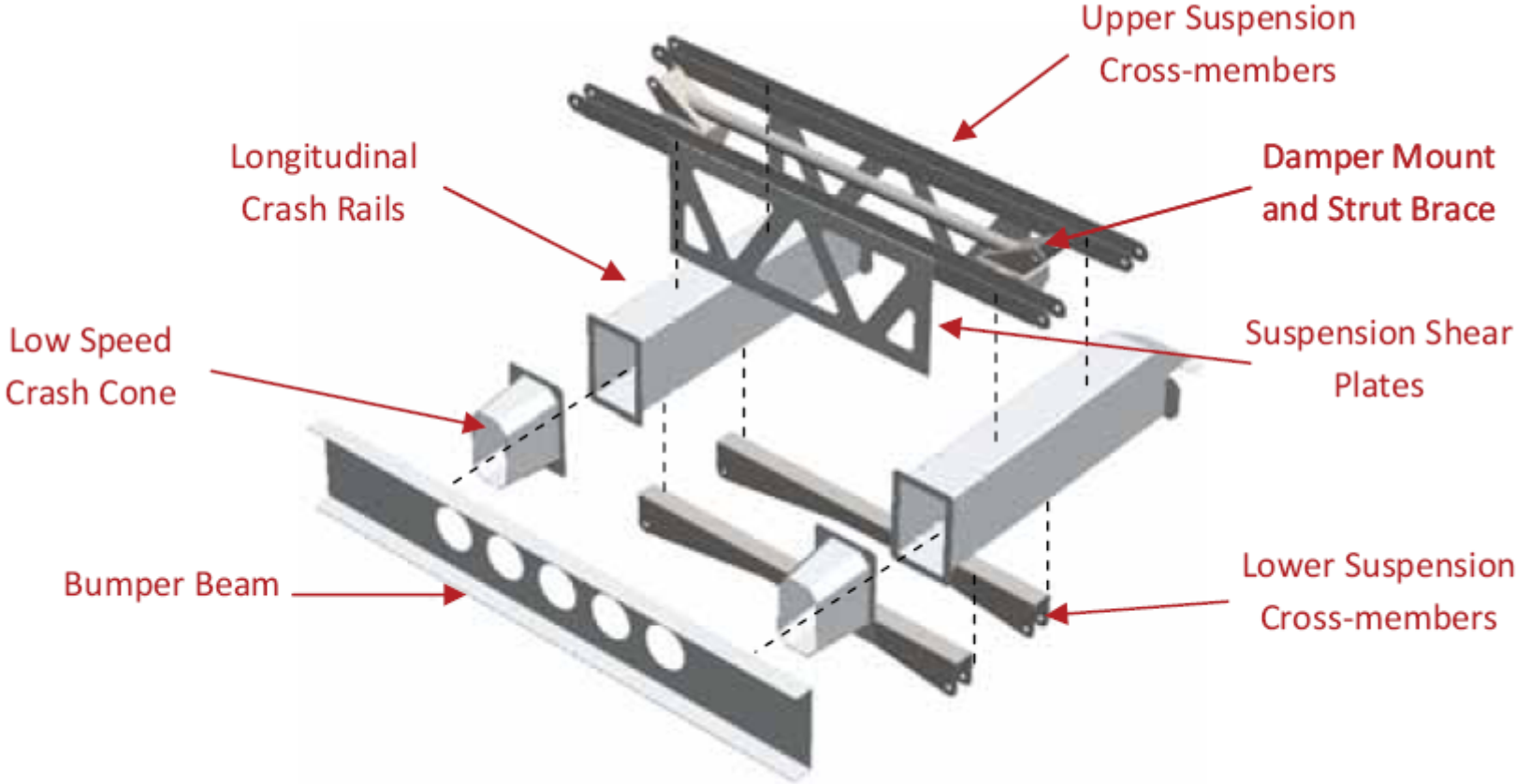
## Assembly



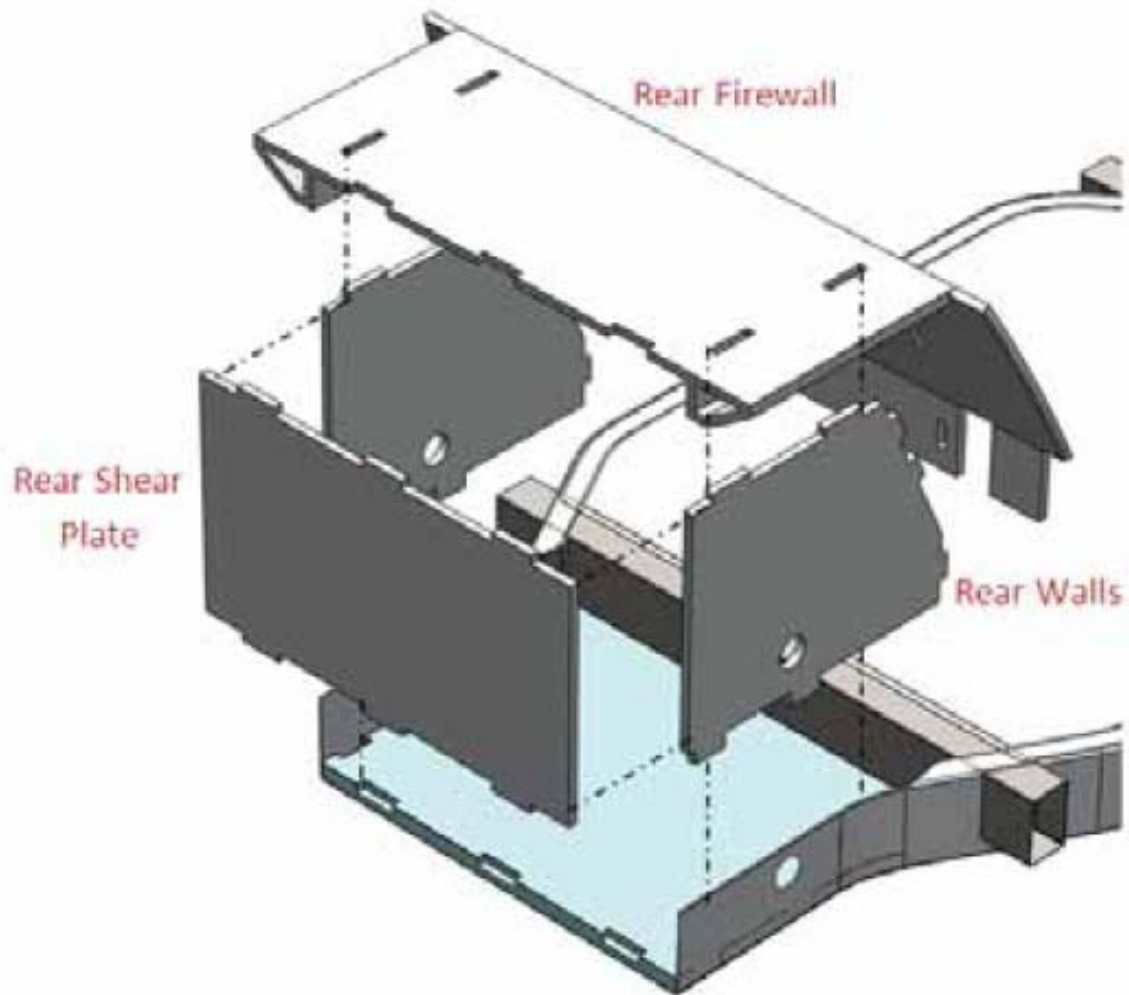
# Assembly - Deck Module



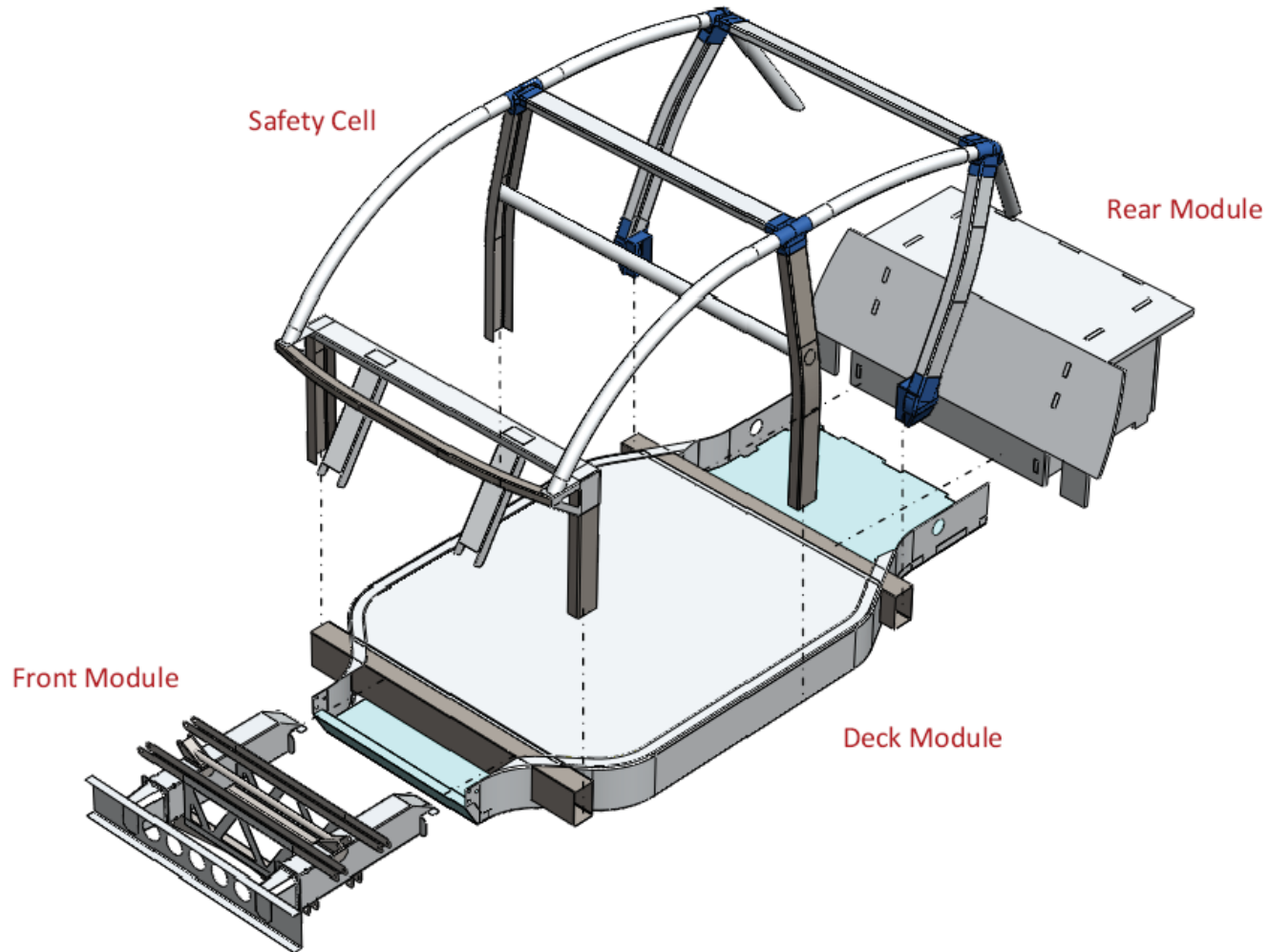
# Assembly - Front Module



# Assembly - Rear Module



# Assembly - Body Structure





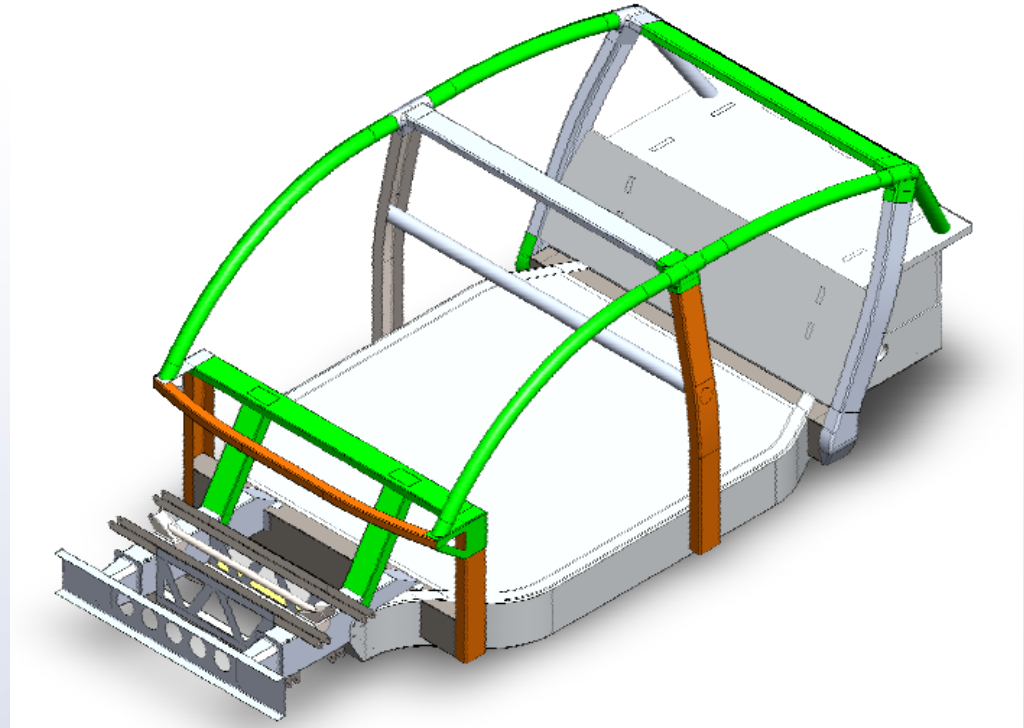
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Joining



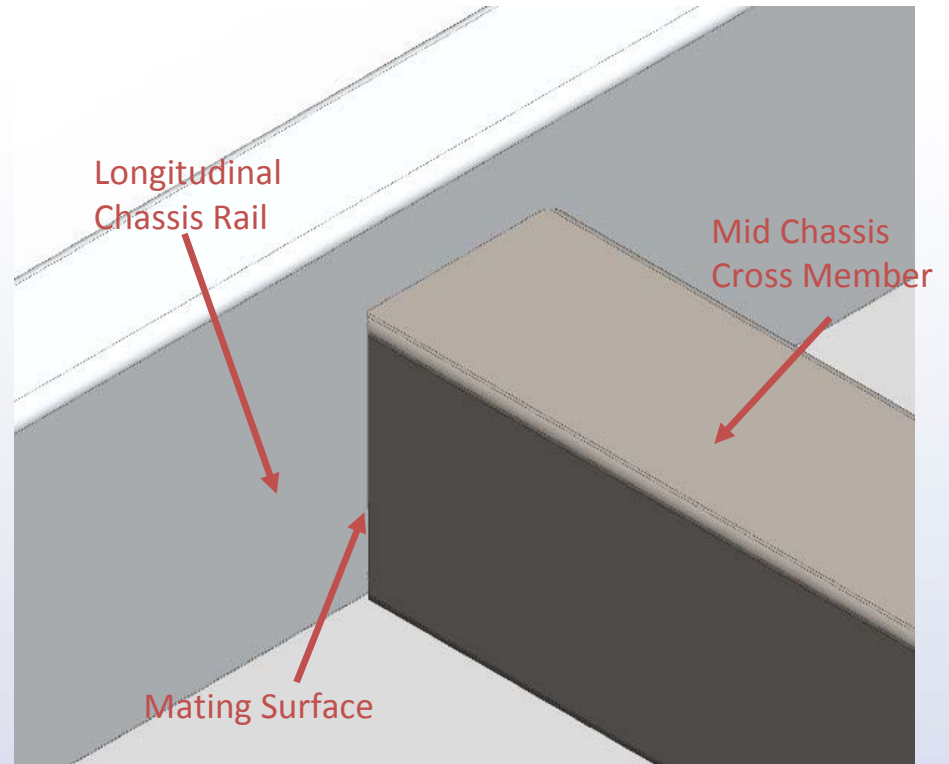
# Joining

- ◆ 68 parts in the body structure
- ◆ 134 separate joints
- ◆ Roughly 20 “types” of joints
  - ❖ Closed Section End to Closed Section
  - ❖ Closed Section to Sandwich Panel
  - ❖ End Sandwich Panel to Open/Flat Section



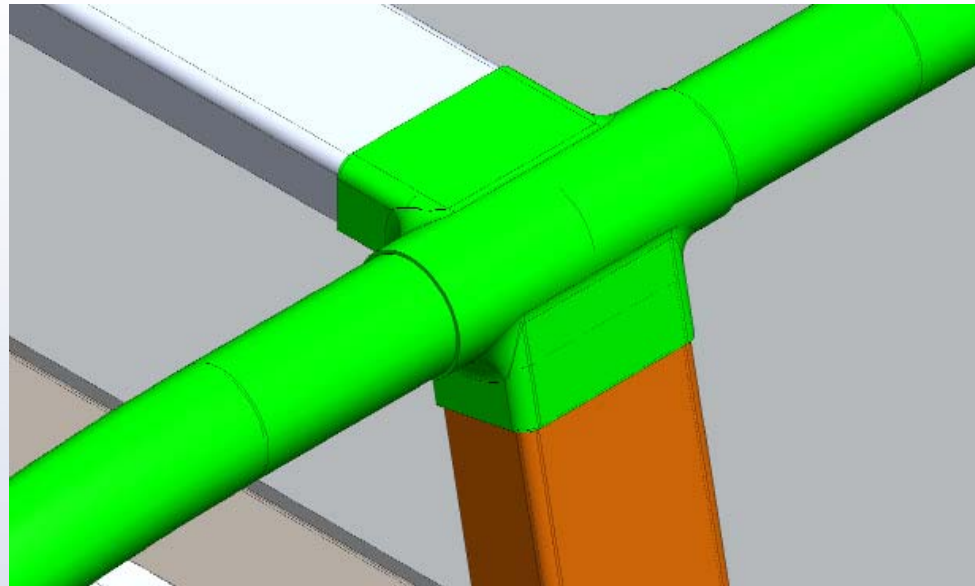
# Joining Challenges

- ◆ Dissimilar materials are involved in a joint
- ◆ Closed Sections
- ◆ Sandwich Panel
- ◆ Perpendicular joints of dissimilar materials



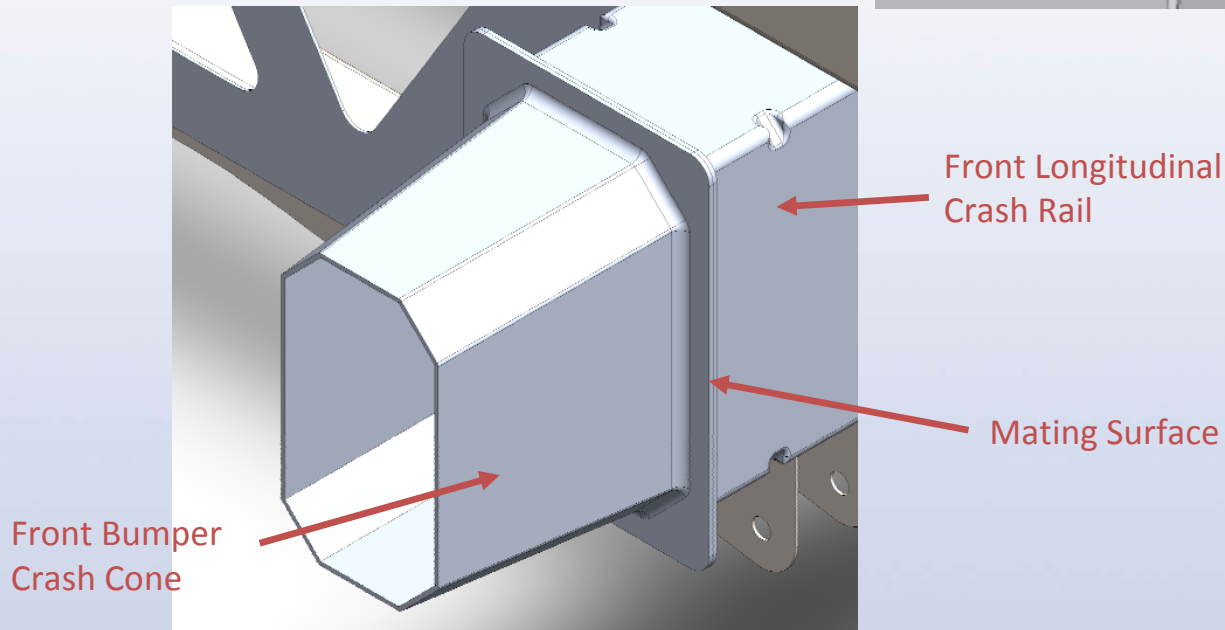
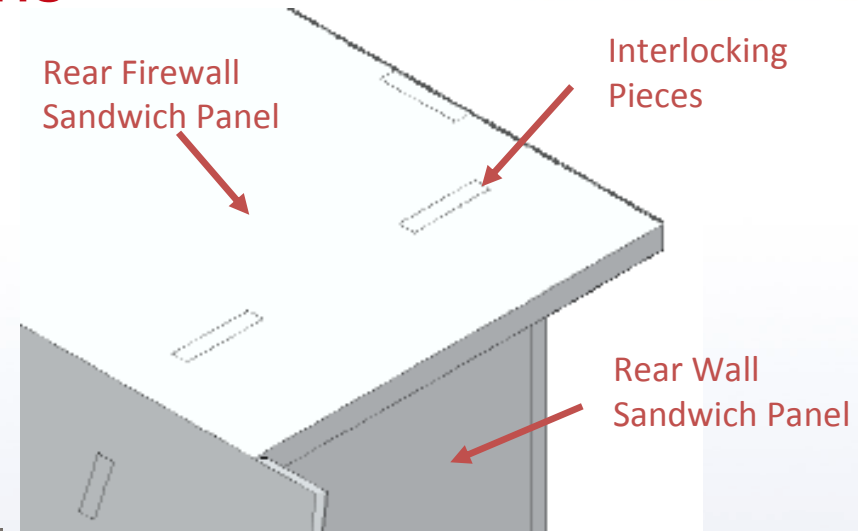
# Joining Example

- ◆ B-Pillar Upper Cast node
  - ◆ Cast node
    - ❖ Cast Aluminium
- ◆ B-Pillar
  - ❖ High Strength Steel
- ◆ B-Pillar Roof Cross Member
  - ❖ Roll Formed Aluminium Sheet
- ◆ A to B-Pillar Roof Rail
  - ❖ Aluminium Alloy Tube
- ◆ B to C-Pillar Roof Rail
  - ❖ Aluminium Alloy Tube
- ◆ Adhesives and Blind Rivet



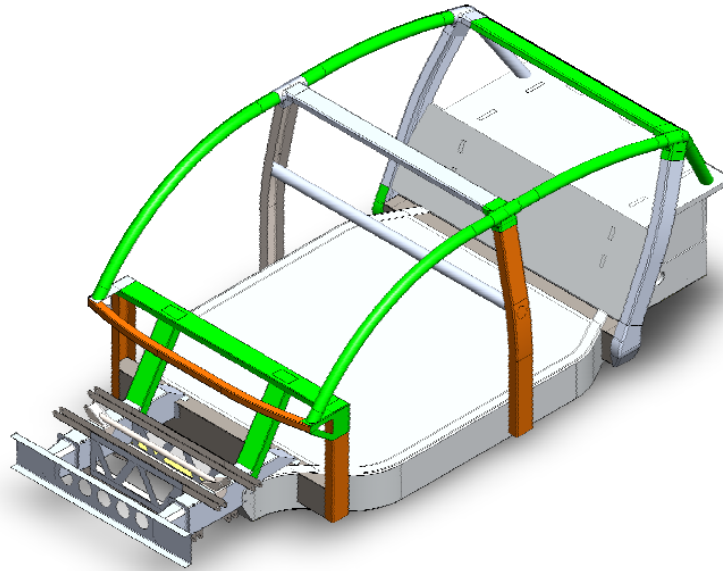
# Joining Solutions

- ◆ Simple Design
- ◆ Clever design of joints
- ◆ Adhesives
- ◆ Blind rivets



# Conclusion

- ❖ LMVP represents a challenging project in terms of manufacturing and assembly
  - ❖ Desirability for low cost manufacturing
  - ❖ Lightweight materials
  - ❖ Dissimilar materials
  - ❖ Composite structures
  - ❖ Single-sided joints
- ❖ Challenges can be met
  - ❖ Flexible manufacturing and infrastructure
  - ❖ Cleverly designed joints
  - ❖ Use of advanced joining methods



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