AutoCRC
Smarter Safer Cleaner

Low-Cost Composites for Light-Weight Automotive Vehicles

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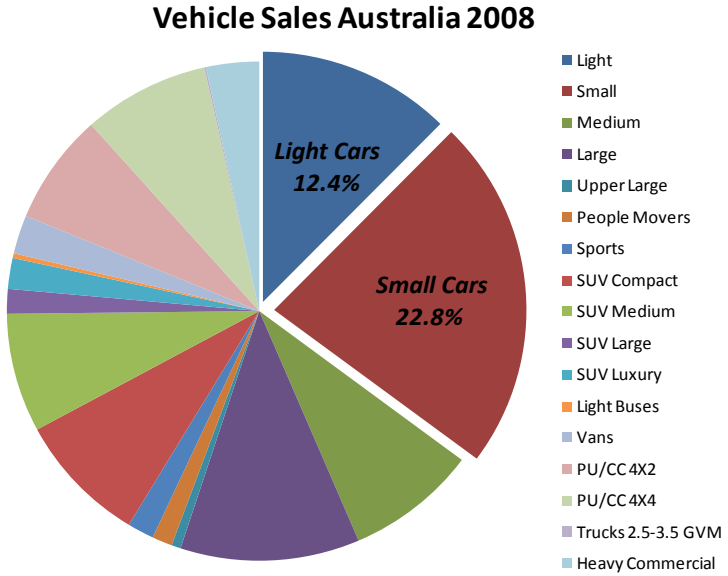
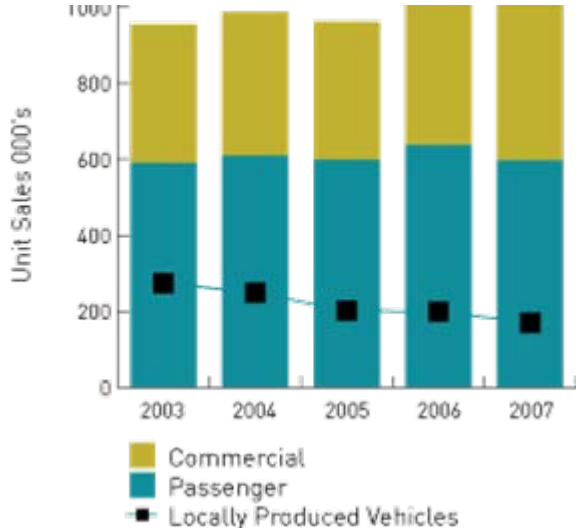
Light-weight Vehicle

- Increasing demand for smaller more environmentally friendly vehicles
- Australian automotive companies do not locally produce a vehicle to fit this emerging market
- One key technology: light-weight structures
- AutoCRC launched three projects
  - Light-weight vehicles
  - Electrical drive
  - Gaseous fuel





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Current Status of Automotive Composites

- Automotive composites starts from
  - 1945 Stout 46, Owens Corning work with William Stout

  the 1st automobile developed with a fibre glass composite body
- Composite leadership
  - Wide use in non-structural automotive parts
  - Current Immense interests from automakers on structural composites
  - Emerging fibre, resin, processing technologies
  - Progresses have been made
    - Application examples in structural component
      - Revolution concept car
      - Mazda MX0
      - ACC's structural composite underbody

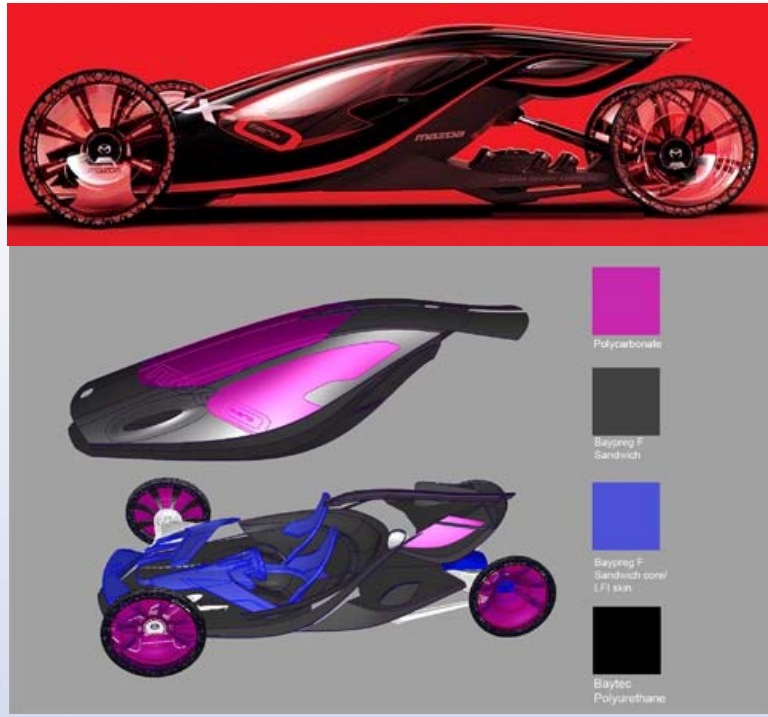
Recent Application Examples

- Hypercar-Revolution Concept Car
  - Carbon fibre composites for safety cell and energy absorbing members
  - Fuel cell vehicle
  - Focus on structural design and manufacturing methods to make advanced composites economical feasible
    - Part consolidation
      65% and 77% less major parts and total parts than a conventional stamped steel BIW

Revolution fuel cell vehicle

Recent Application Examples

- Mazda's MX0
  - Light weight glass fibre/polyurethane composite
  - Compression moulding
    - Mainly fibre reinforced sandwich panels
    - High performance elastomers for the wheels
    - Transparent polycarbonate to replace glass
  - Light but fast, minimum weight for superior cornering and acceleration



Material choice of Mazda's MX0

Recent Application Examples

- Automotive Composites Consortium Structural Composite Underbody
  - A joined program by GM, Ford, and Chrysler
  - To develop structural automotive components from composites
  - Composite underbody: compression moulding of SMC
    - Vinyl ester matrix + glass fabric reinforcement (with some chopped glass)

Paul Deslauriers (left) and Dr. Hannes Fuchs with the award winning composite underbody

Advantages of Automotive Composites

- Substantial weight reduction
- Less complex manufacturing process
- Reduced tooling cost
- Better damage resistance and corrosion resistance
- Better internal damping
- Improved design flexibility
- Can be cost-effective as well as aesthetic like steel

Light-Weight Technologies

1. New materials
2. Novel structural concepts
3. Low-cost processing technologies

1. New Materials

- Carbon fibre composites (continuous fibre)
  - light, strong, tough (crash protection), noise absorbing, durable.
  - Already used in racing and luxury cars
  - But very expensive and in short supply
- Alternatives for low-cost vehicles
  - Sheet moulding compound (SMC): chopped glass fiber in polyester matrix
  - Glass mat thermoplastic (GMT)
- Emerging technologies
  - HexMC (Hexcel): specific tensile modulus better than aluminium and 350% greater than SMC
    - Application to highly-loaded structures yet to be demonstrated, together with failure theory

SMC

Complex parts made using HexMC

1. New Materials

- Emerging technologies (continued)
  - Light-cured fibreglass (UV-cure)
    - Resin-infusion process can be developed
  - Continuous fibre-thermoplastic composites (wind blade manufacturer)
    - Co-mingled fibres for one-step closed mode production (Quadrant SymaLITE)
      - 20-50% higher mechanical properties

Australian Composites

Blade section made using commingled glass/PP fibers

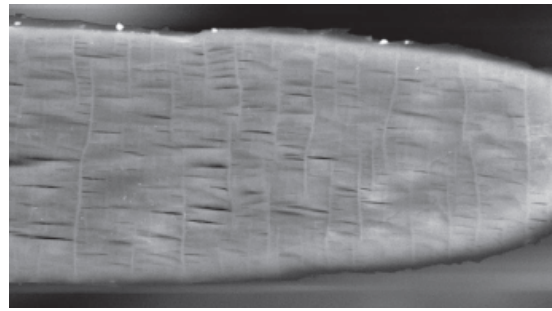
Source: Wind blade manufacturing, *Composites World 2008*

1. New Materials

- Gurit structural SPRINT
  - Moulding compound, resin film infusion
    - Glass fabric can have similar mechanical properties as long carbon fibre HexMC
    - Very low void content 0-0.5%
    - Highly drapable and conformable

Gurit structural SPRINT

- New light, tough and low cost reinforcement
  - Light weight and tough
  - Unique surface feature-superior grip, both in fabrics and composites
  - About 7-10%void volume, lightest high performance fibre



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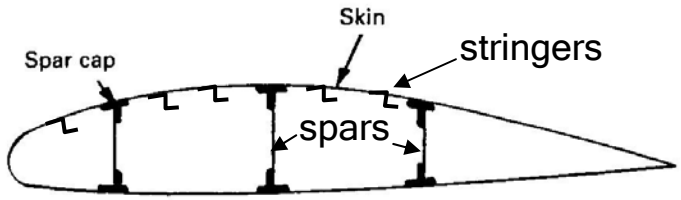
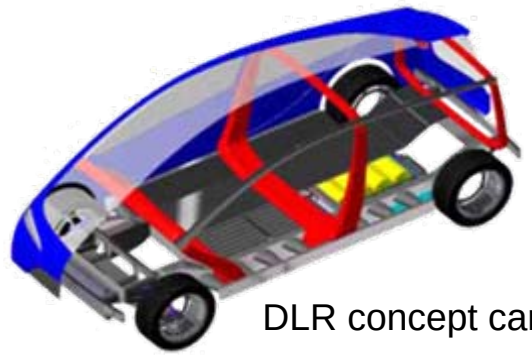
2. Novel Structural Concepts

- Aerospace technologies
  - Aerospace structures are highly optimised to reduce weight

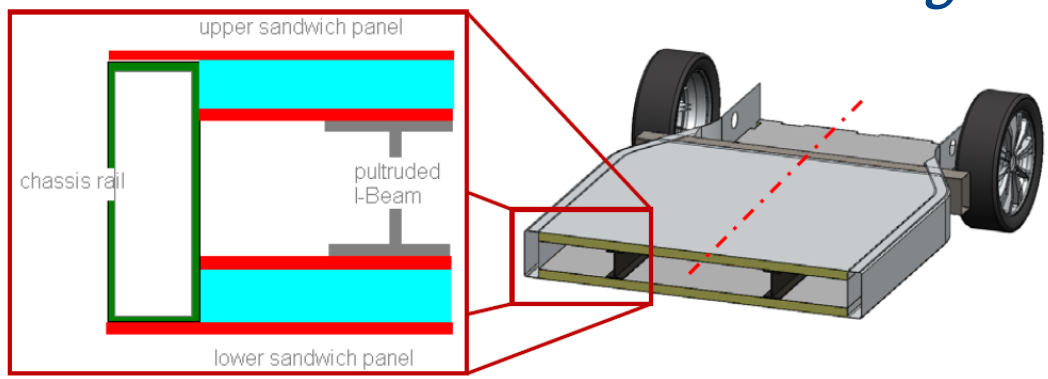


Cross-section of wing



DLR concept car

Can we adapt the fuselage structure for space-frame ?
Can we make deck module like an aircraft wing?

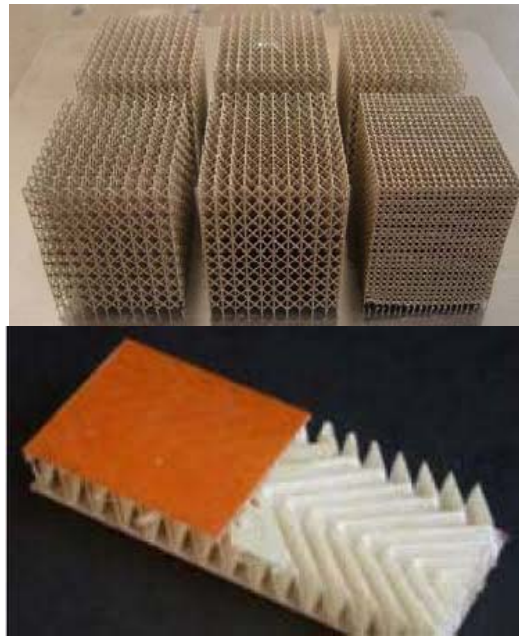


2. Novel Structural Concepts

- Glass/carbon fibre hybrid composite structure
  - Cost-effective pultrusion process
  - Hybrid composites were used when higher strength were desired

Hybrid composite cross section

- Cellular structures for improved impact
  - New sandwich material concept for aircraft primary structure
  - Low weight, low fabrication cost and enhanced impact resistance
  - Wide range of candidate materials and geometries considered



CELPACT novel sandwich core structures

3. Low-cost Processing Technologies

- RTM materials suitable for closed moulding
- Resin infusion process to reduce tooling costs (half mould)
  - Thermoplastics requires high temperature
- Pultrusion used for parts have constant cross-section profile
- Automation
  - Robotic
  - Textile technologies: weaving, braiding, knitting
- Newly designed process: hybrid materials
  - E-LFT process
    - Compression moulding
    - Long fibre thermoplastic+ unidirectional continuous fibre tapes

E-LFT process produced EF crossing

Summary

- Low-cost **high-strength** composites for load-bearing automotive structures remain a key challenge
- Promising research directions:
  - Novel structural concepts/designs, e.g. hybrid structures to selectively reinforce load-path
  - Long carbon fibre/epoxy composite (similar to HexMC) for complex-shaped components
  - Commingled continuous glass/PP composites