Use of Advanced Composites in the Cycling and Automotive Industries

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Outline

Cycling Industry

- *Commonly Used Processes*
- *Testing vs. Analysis*
- *Newer Technologies*

Automotive Industry

- *Low / Med Volume Processes*
- *High Volume Processes*
- *Future Potential*

Cycling Industry

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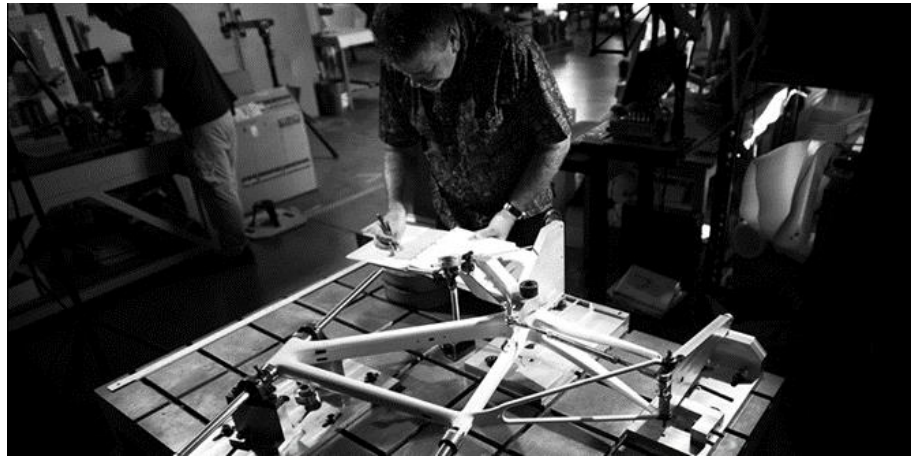
Commonly Used Processes

- Most bicycle parts are hollow tubular-style structures
- Primary manufacturing process – hand layup of prepreg materials
    - Most manufacturing in Asia due to labour costs
- Bladder molding used to make hollow structures
- Separate parts are bonded together to make the final product



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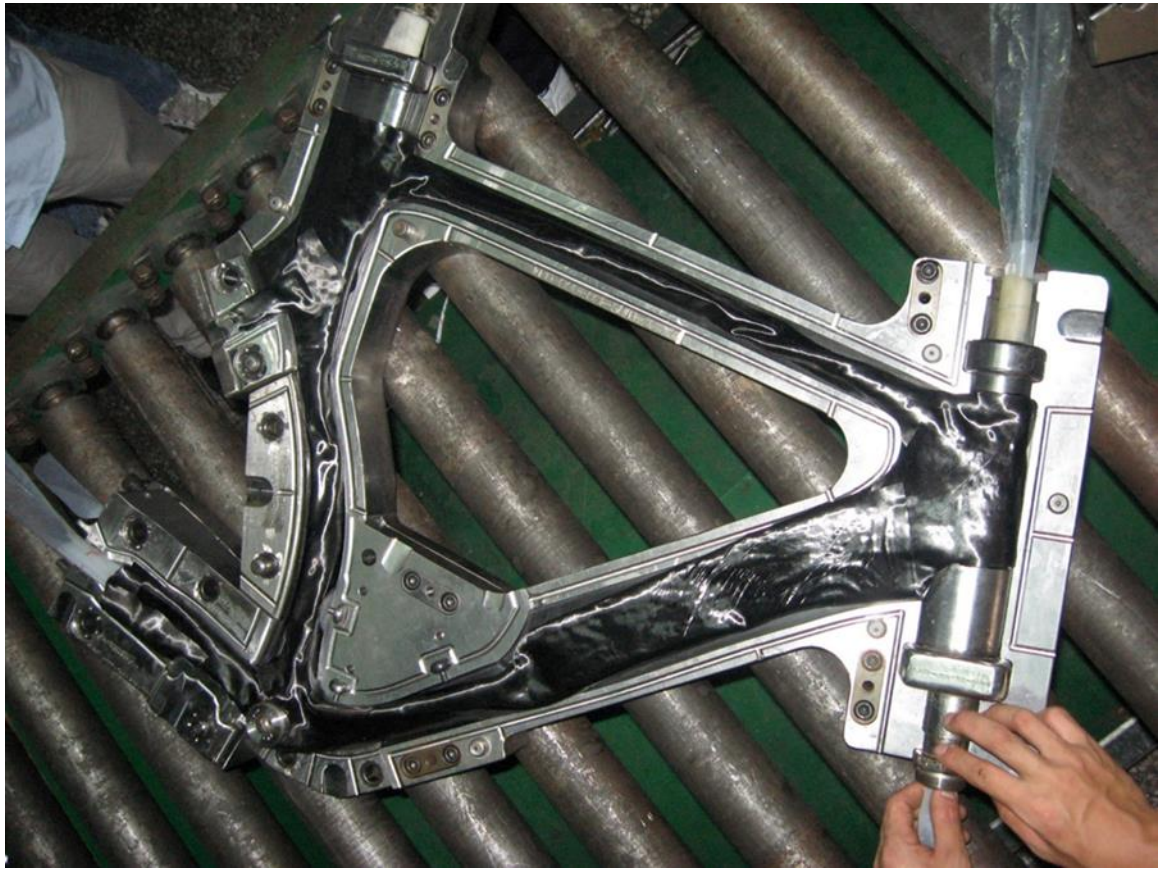
Bladder molding

- Basic (Original) style
  - Wooden mandrels and plastic bags
  - Cheap and easy, but leaves interior wrinkles, which can cause strength issues
- EPS Mandrel
  - Partially cured EPS foam core left in mold
  - Uses bags or latex dipped bladders for cleaner inside surface
- Key factor – compaction

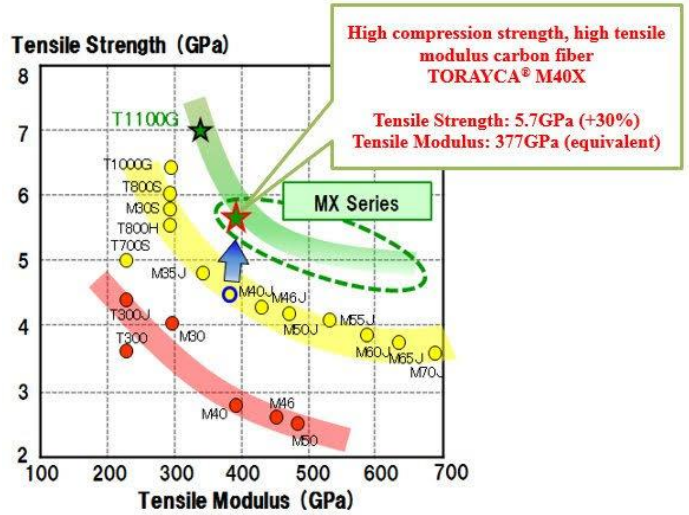


Layup

- Layup is still generally done by hand, especially on smaller parts, but can be automated or semi-automated
- Layup design is quite advanced, using non-symmetric and unbalanced often
- Very localized strength and stiffness reinforcement

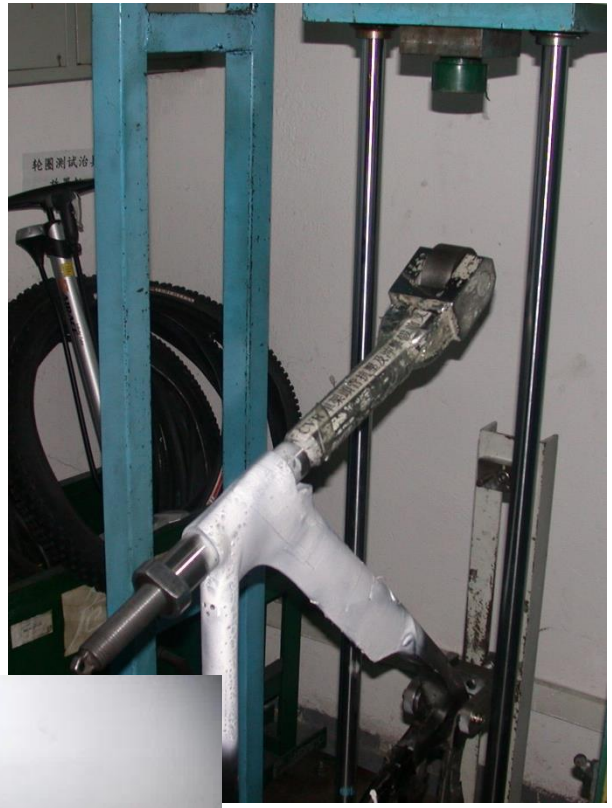
Materials

- Bulk is still lower cost carbon fibres (T300 etc)
- Starting to be more use of higher modulus in specific areas
- More incorporation of other fibres for specific properties
    - Glass, Innegra, Aramid, Boron
- Thin parts lead to much lower areal weights of material – down to 25 gsm, commonly < 100 gsm
- Often factories do their own pre-pregging for reduced cost. Solvent or hot melt based



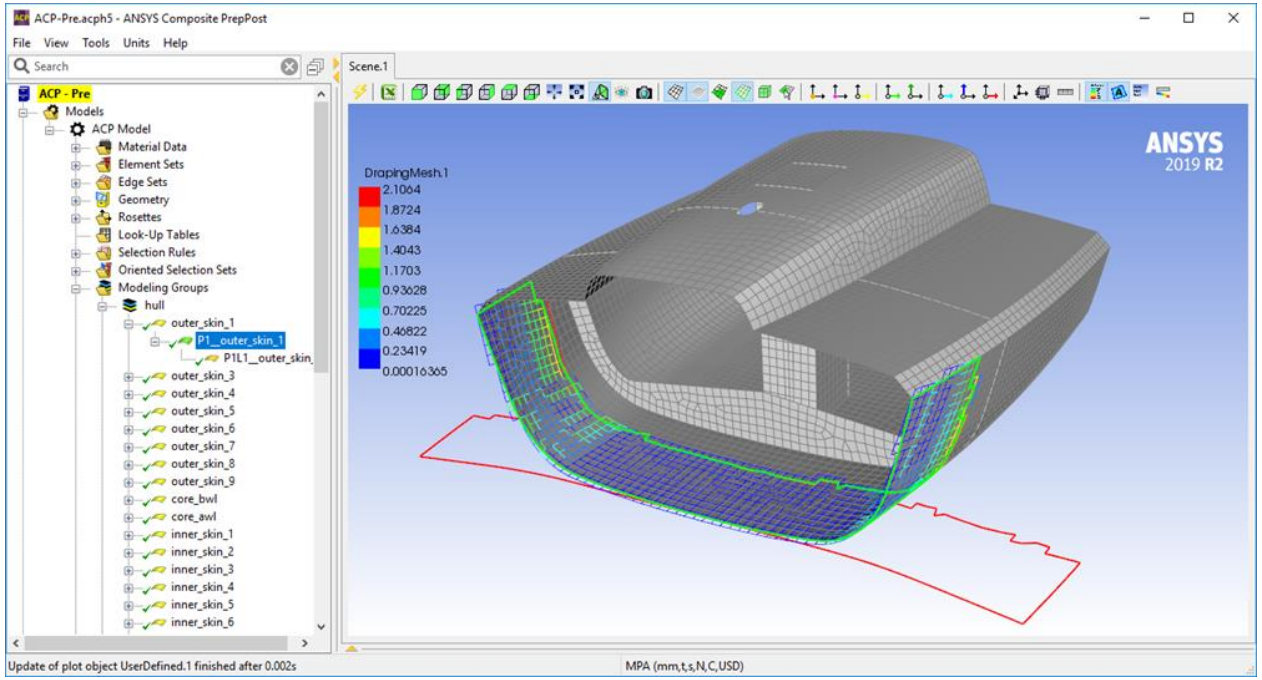
Testing vs. Analysis

- Majority of development done on a ‘make and break’ basis, supported by general calculations and knowledge
- Recently, many larger companies have moved to a much more analytical basis
- Pushing the performance envelope further and further requires more analysis



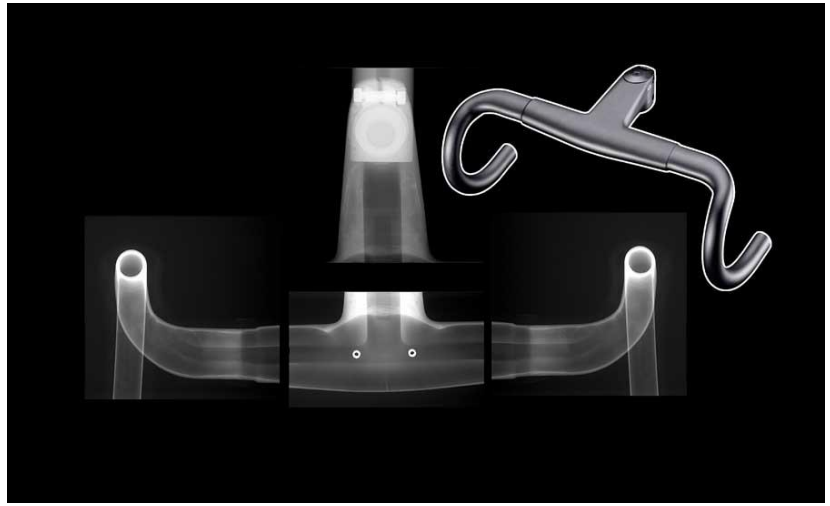
Testing vs. Analysis

- Composite analysis can be quite complex and expensive
- Highly specialized knowledge is required to properly analyze complicated designs
- Material properties understanding is key to this
- Pushing the performance envelope further and further requires more analysis



Newer Technologies

- X-Ray Testing in production for quality control
- Design for ductile failure using layup design and materials
- Resin Transfer molding (RTM)
- Robotic layup and Robotically assisted layup



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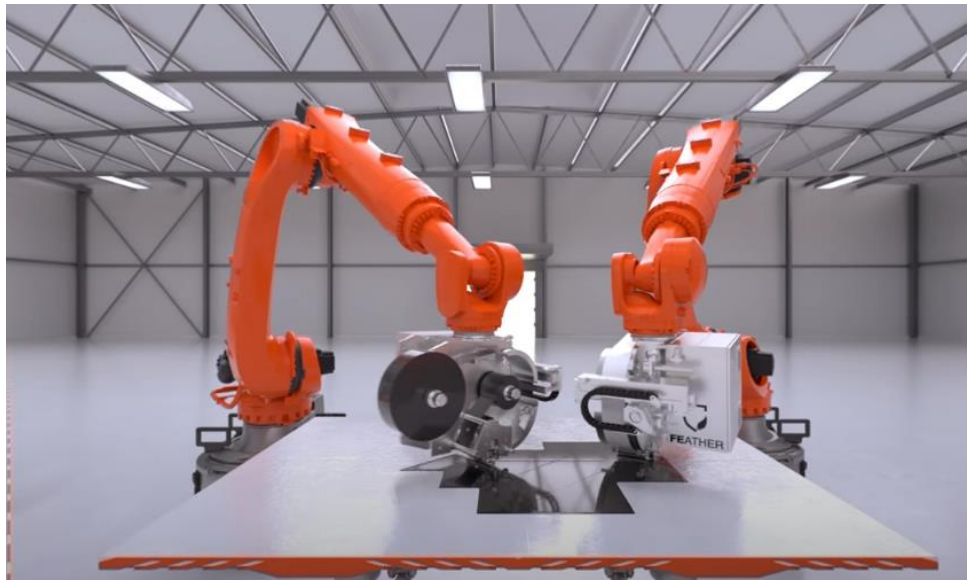

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Automotive Industry

Image © Lotus Cars

Low – Med Volume
Commonly Used Processes

- Most automotive parts are single sided, flat style structures
- Primary manufacturing process – hand layup of prepreg materials
- Autoclave molding commonly used at low volume, RTM at medium
- Parts are often made in a single piece in final form, but can be bolted or bonded to other structure

Image © Lotus Cars

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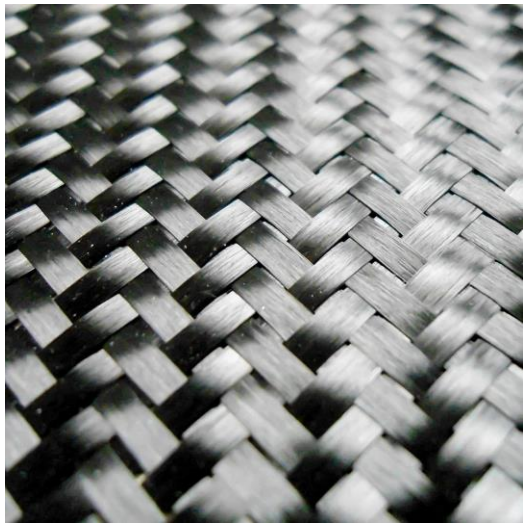
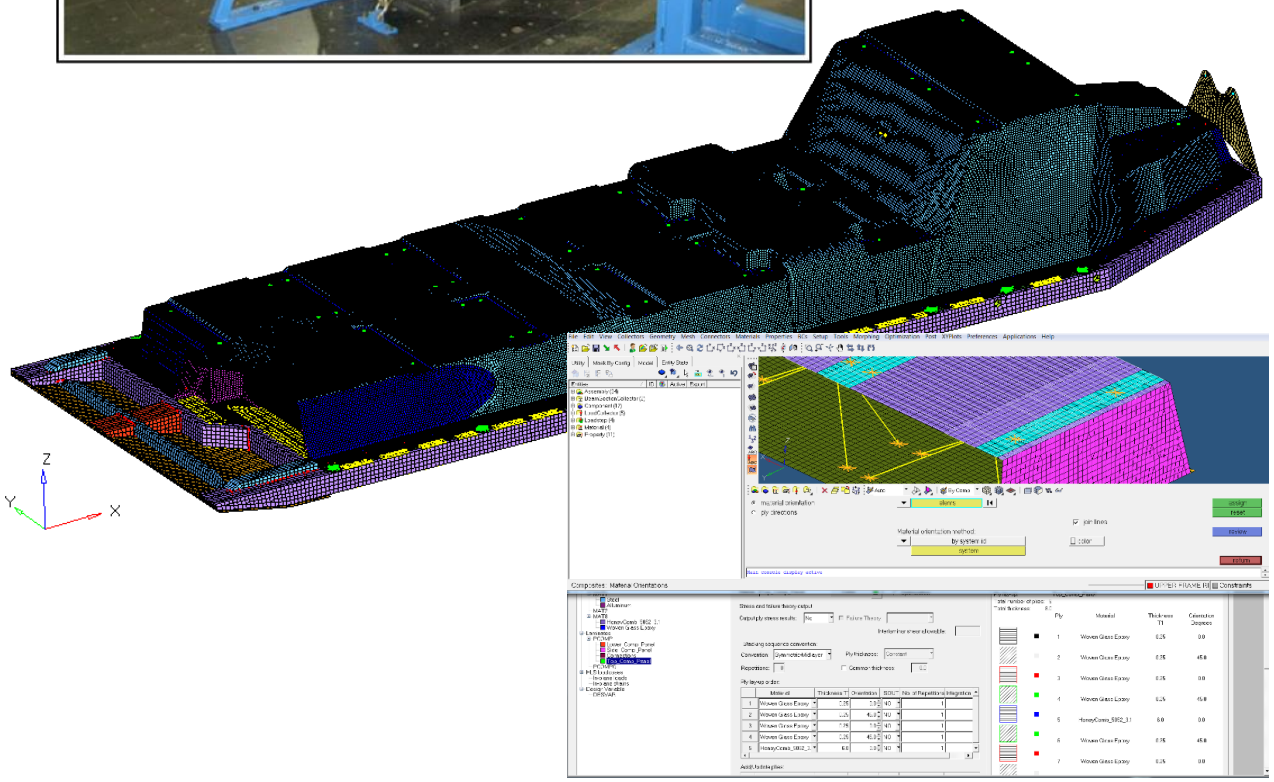
Design and Analysis

- 2 different design tracks
  - ‘Black aluminum’
    - Uses mostly just woven material, in quasi-isotropic layups
    - Design based on bulk material properties, from analysis or curves
    - Commonly uses only high strength woven carbon
  - Advanced unidirectional design
    - Taking full advantage of composite properties, with unidirectional fibers placed in key load directions
    - Can be developed by experience or trial and error, but often advanced non-linear FEA is used
    - Uses a full range of carbon and other fibers



Analysis

- Complex design and analysis to make maximum use of material properties and to take into consideration complex load cases, including life predictions
- Usually use large design and analysis teams running the latest complex FEA and modelling software
- Involves the full range of available reinforcing and matrix materials
- Design and development lead times can be years



High Volume Manufacturing

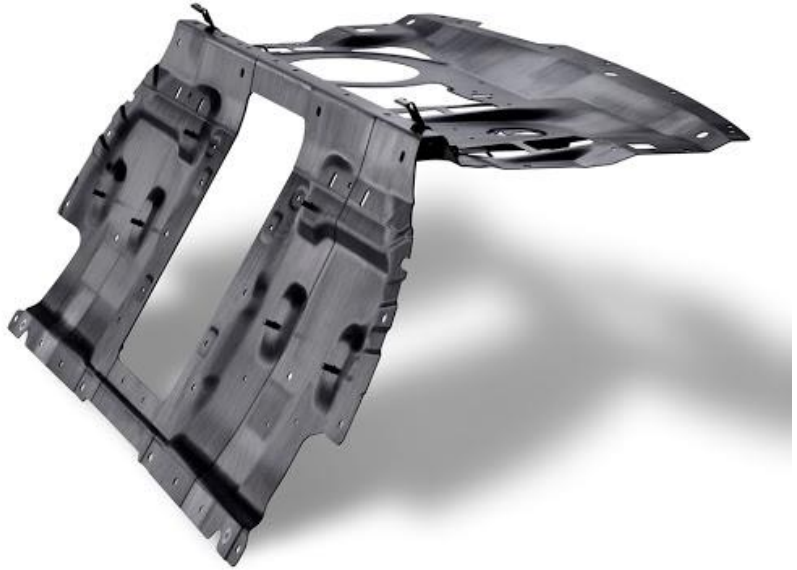
- Low cycle time is the key parameter
- Parts usually made using automated processes like AFP, ATL
- Mostly RTM for low cycle time, using fast cure epoxies
- Thermoplastic matrix materials also being used
- Compression molding used for thick parts

Image © Coriolis Composites

Image © Wards Auto

Future Areas

- Snap Cure Resins, Thermoplastic Materials
- More automated layup, automated joining
- Natural materials (Flax, Basalt fibers), recyclability
- Eliminating pre-preg materials (cost)



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