

Affordable Thermoplastic Matrix CFC / Metallic Framework Structures Manufacture

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Talk

- Background
- Aims
- Concepts

Steel Auto Body – Pressing and Welding

CFC Auto Body – Alfa 4C



Need an equivalently fast process for lightweight composites

Current CFRP Automotive Bodies

'Lightish' Panels now sorted for niche, medium and rate production

- BMW HP RTM
- Audi Gap RTM
- Dieffenbacher Wet Pressing
- Toho Tenax PvP
- Hexcel HexMc
- Hexcel, Cytec, Gurit Pressed prepreg



What about Frameworks?



McLaren MP412C - Aluminium



Audi R8 - Aluminium



Complex assembly and heavy



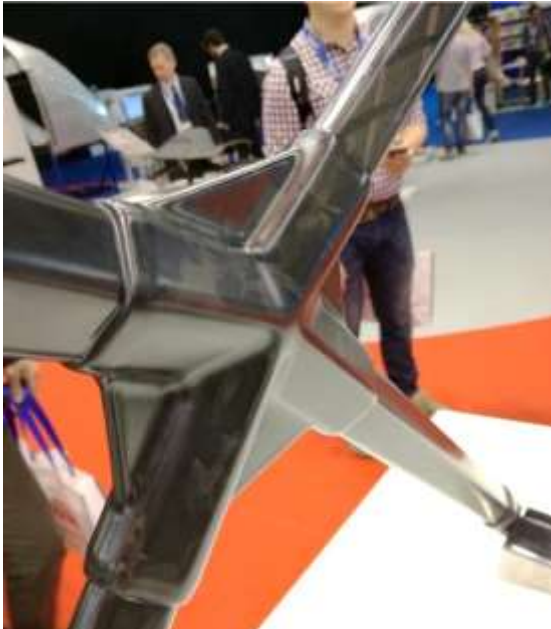
Porsche 918 - CFC



Very light weight – but extreme labour cost

CFC Frame beams/ struts are lightweight - Joints are tricky

Audi Concept - Strebencreuz



- – Fibre angle lay up precision is essential to provide
 - framework stiffness
 - strength
- Placing fibres to match loads is too slow and costly
- Flowing discontinuous fibres cannot provide this
- Metals provide isotropic stiffness and strength very cheaply
- **Need ...Right material – right place**

The Challenge

- **How to design and build CFC strut and metallic joint frameworks**

Aim

- Investigate the feasibility of manufacturing exceptionally lightweight framework structures appropriate for >5000 P.A. production using hybrid CFRP / Metals
- Identify and assess potential solutions for:
 - Weight
 - Manufacturing rate and automation potential
 - Cost

Conventional Joining Techniques

JOINING OPTIONS
for Composites

Mechanical Fasteners

Embedding

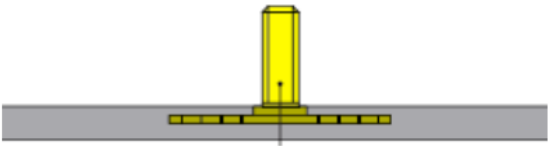
Adhesive bonding

Rivets

Screws

Bolts

Big head



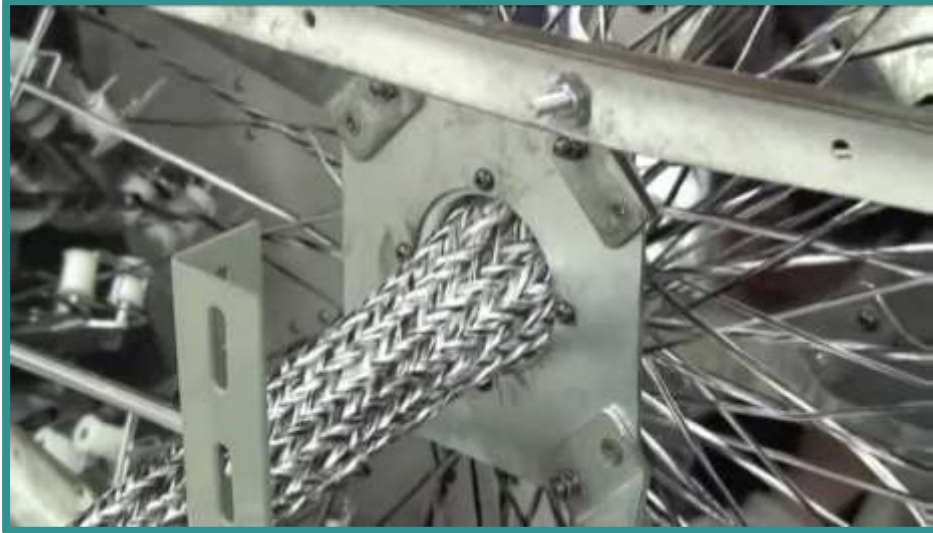
**All Slow and costly for thermoset CFRP
....but thermoplastics are different....**

Thermoplastic matrix composites?

Why we have been slow to use them for structural applications?

- The very stiff ones are processed annoyingly hot
 - Tool and process cost issue
- Bonding and bolting are worrying
 - Adhesion and creep -do you need to tighten bolts in service?
- Floppy when hot
 - Demoulding from an isothermal tool is tricky
 - Warm tool stamping means robots have to rush and surfaces aren't pretty
 - Latest automotive epoxies can cure in 60 seconds (3mm laminate)
- Crystallinity and shrinkage complications
 - Cooling rate needs to be considered
- **BUT –**
- They allow us to reshape parts post moulding
- This may revolutionise high rate manufacturing

Pull-braiding (Braiding + Pultrusion)



Braiding



Pultrusion

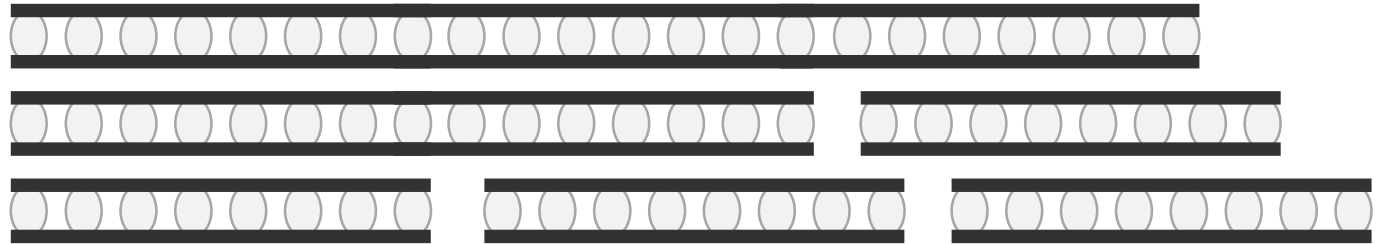
PROCESS ADVANTAGES

- Continuous lowest cost process
- Enables fibre angle tailoring providing very lightweight
- Curved profiles can be also obtained

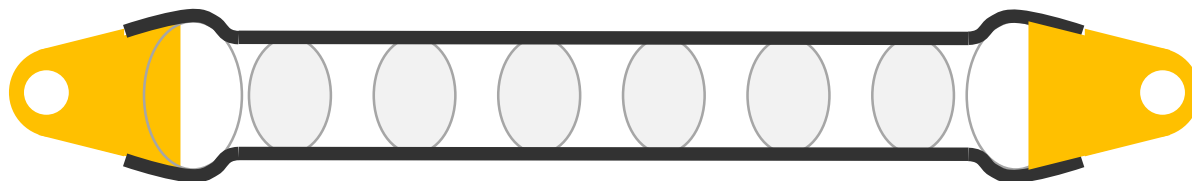
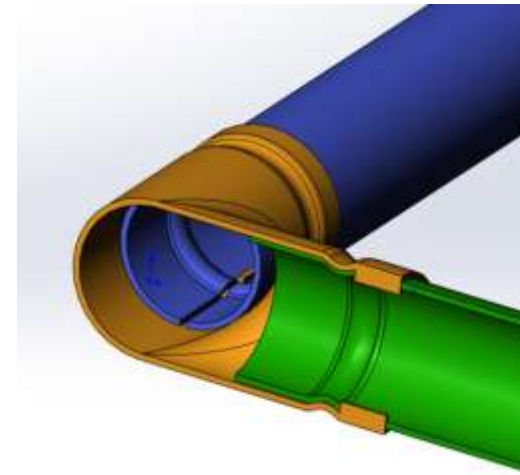
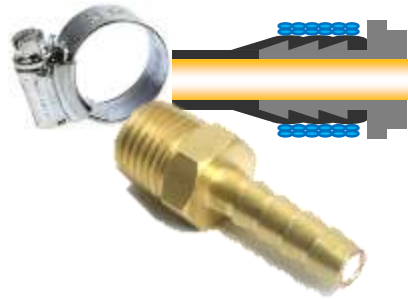


Framework Joining Concept A – Clinching

Fast, rapid section
manufacturing &
cutting to defined
lengths



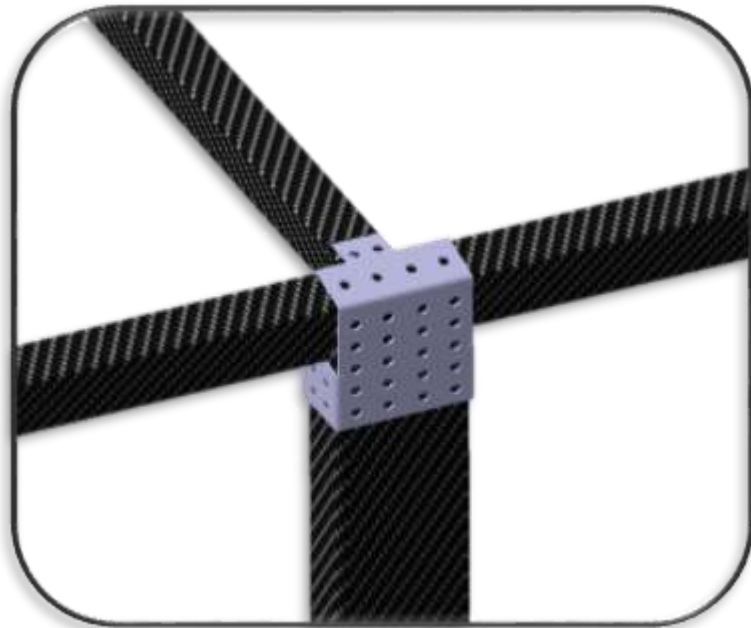
Fast, reliable end
fitting preparation



Concept B – Crimping

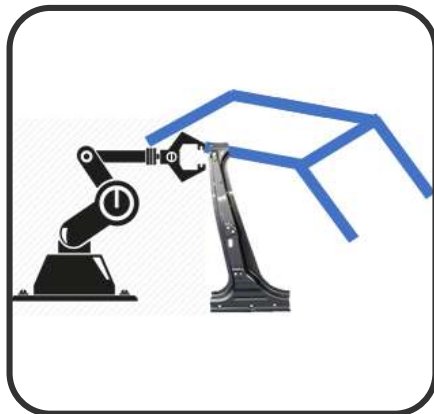


Concept C – Flow Drilled Joint (FDJ)

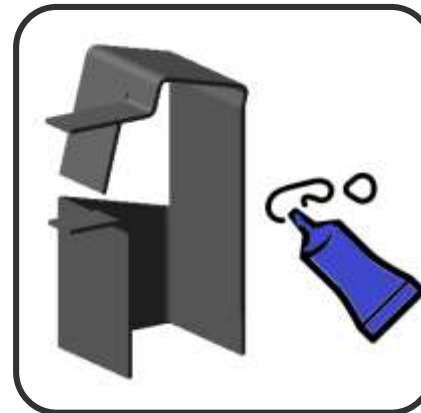


- **Metallic plates mechanically interlocked with CFRP sections by self piercing fasteners which locally melt the CFRTP**
- **A fast process**

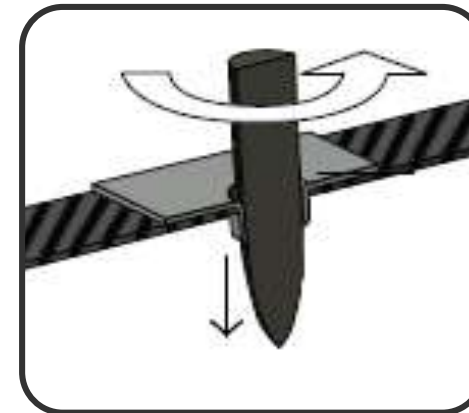
Place B pillar



Positioning



Joining



Concept D – Dimple Interlocking

**Heat press sheet metal onto CFRTTP
with weldable sheet**

- We look forward to showing you some exciting schemes to investigate in detail and scale up
 - August 2017
- **Current advisory partners:**
 - AMRC
 - Expert Automation
- **Future proposed additional partners:**
 - Automotive design and manufacture+?

The EPSRC Future Composites Manufacturing Hub