Prototype to Production
A Case Study for Niche Vehicle Development

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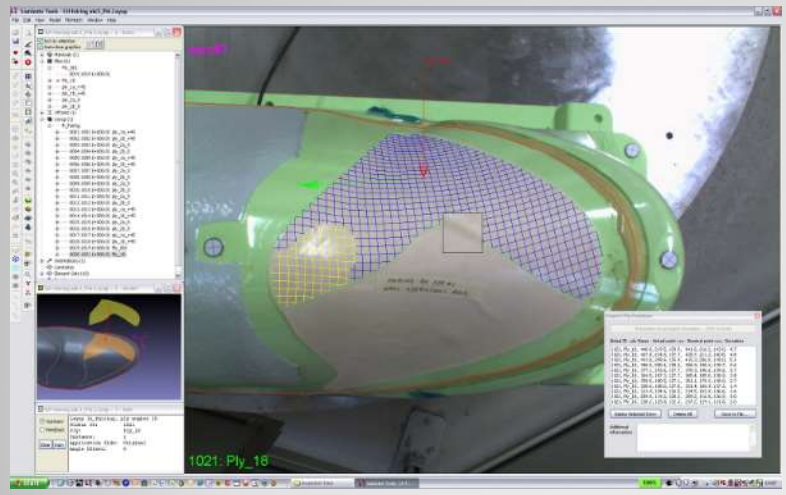
Engineering and Beyond Ltd

- Specialist in lightweight technologies including composite and 3D Printing applications
- Structural Engineering; Project Engineering and Management
- Multi-industry including automotive, motorsport, wind energy, marine and aerospace
- 15+ Years in the composites industry and a further 10+ years in high level motorsport and aerospace



PlyMatch (Anaglyph)

Aluminium Additive Manufacturing

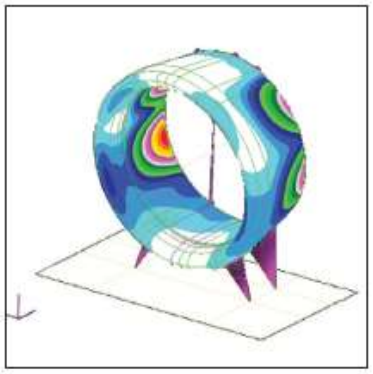
Engineering & Beyond

SYSTEMS AND ENGINEERING

Combining parts, manufacturing tools and engineered structures

Some previous example demonstrating:

- Technical, Engineering and Project Management
- Structural Engineering, Materials selection, Tooling, Prototyping, Processing, Systems and Component Manufacturing



FEA of duct in MSC Patran

Duct leading edge component sitting in assembly jig

Systems and Engineering

Programme Management of body-in-white composite panels

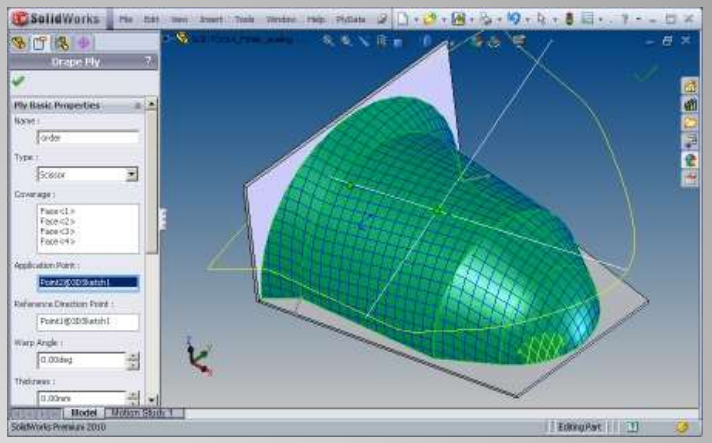
- From concept
- Through detail design
- To Production

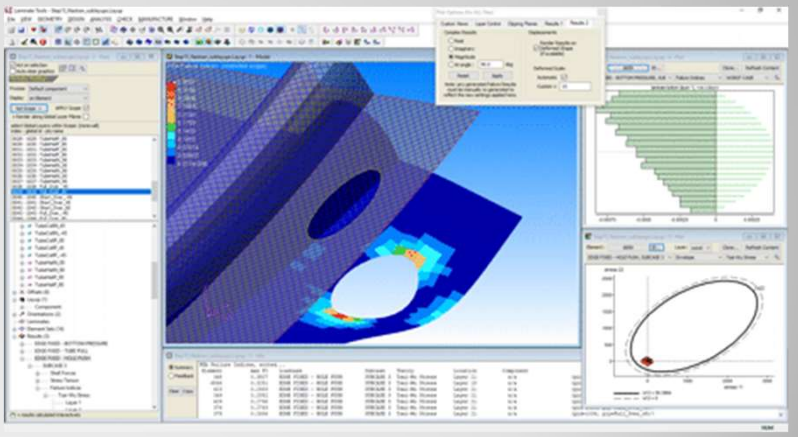
Typical Automotive Composite Panels

- Extensive composite processing and prototyping experience

- 3D modelling and Composite analysis experience/support
  - **Solidworks**
  - **Laminate Tools/LAP ***

Interfacing to
- *DS Abaqus*
- *MSC Patran/Laminate Modeler*
- *Altair Hypermesh, Optistruct/RADIOSS*
- *Femap*
- *Ansys*



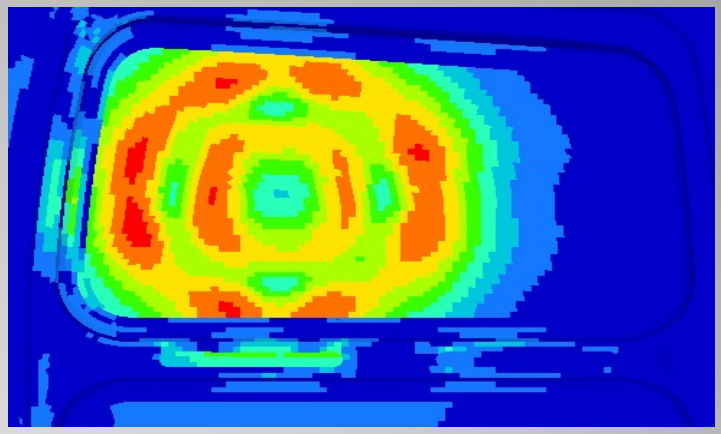


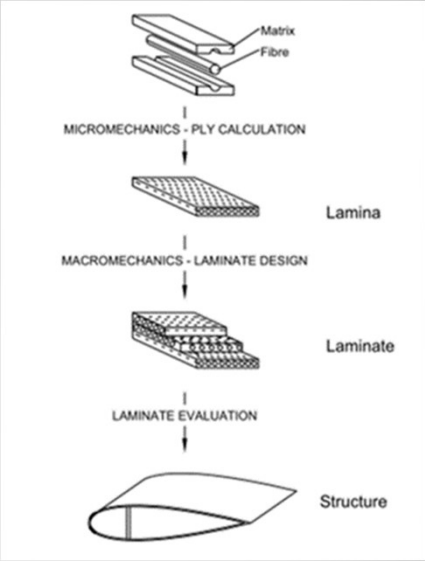
*Partnership with Anaglyph Ltd

Composites Engineering - Capabilities

Laminate Optimisation for Stiffness

- Selection of material weights, fabric and UD fibre orientation, core materials and overlaps.
- Optimise laminate thickness and backing structure for stiffness/weight, buckling resistance and customer perception
- Compare with known metal solutions
- Quantify effect of core thickness and fibre orientation





Composites Engineering

- Materials selection using LAP
- Comparisons of the variety of fabric/resin choices

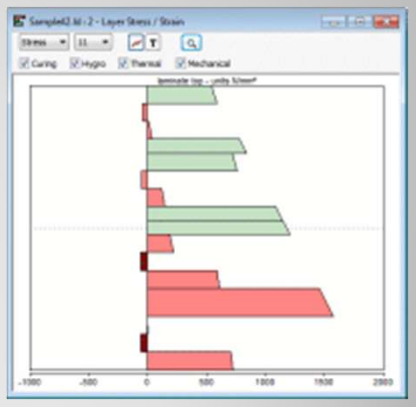
XC611 – 600 gsm stitched biax
Default material

E11	64210	α11	2.64
E22	64210	α22	2.64
G12	3800	β11	
ν12	0.037	β22	
resin E	3350	nominal Vf	0.52
resin ν	0.34	actual Vf	0.52
Ultimate Strength properties:	○ Stress ◉ Strain		
S11 T	609.995	U11 T	0.95
S11 C	513.68	U11 C	0.8
S22 T	609.995	U22 T	0.95
S22 C	513.68	U22 C	0.8
S12	67.64	U12	1.78
S13	67.6		
S23	67.6		
F12	auto		

XCHM304 – 300 gsm stitched biax
Alternative High Modulus material

E11	107657	α11	1.68
E22	107657	α22	1.68
G12	4310	β11	
ν12	0.02	β22	
resin E	3350	nominal Vf	0.56
resin ν	0.34	actual Vf	0.56
Ultimate Strength properties:	◉ Stress ○ Strain		
S11 T	796	U11 T	0.739385
S11 C	579	U11 C	0.537819
S22 T	796	U22 T	0.739385
S22 C	579	U22 C	0.537819
S12	77.58	U12	1.8
S13	64.7		
S23	64.7		
F12	auto		

Case #	Construction	Max Deformation (mm)
1	Default material (XC611)	1.067e-002
4	High modulus material	0.635e-002



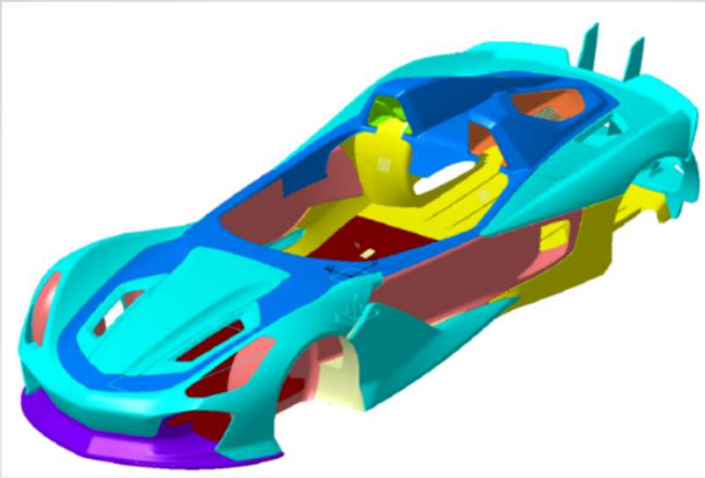
- The max deformation is reduced to 60% of default
- However price is >2x per metre square and twice the amount would be required for geometric requirements
- Hence this is not a viable solution for all the construction

Investigation into fibre modulus/cost effectiveness

The "Dubai Roadster"

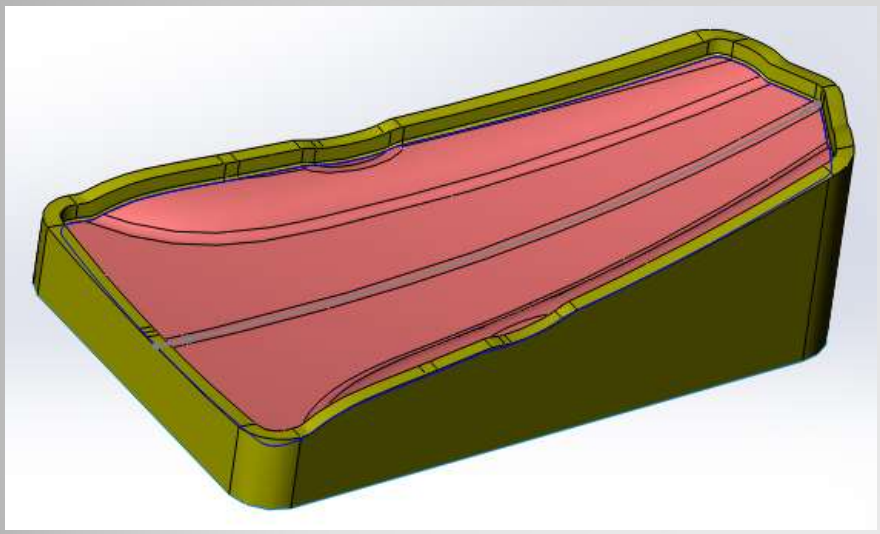
- Ambitious project initiated by two young Emiratis
- Limited budget and resources, to be built in Dubai so not a large supporting infrastructure
- Initial car built using some novel technologies but generally very traditional
  - Steel spaceframe
  - Glass fibre (CSM) panels

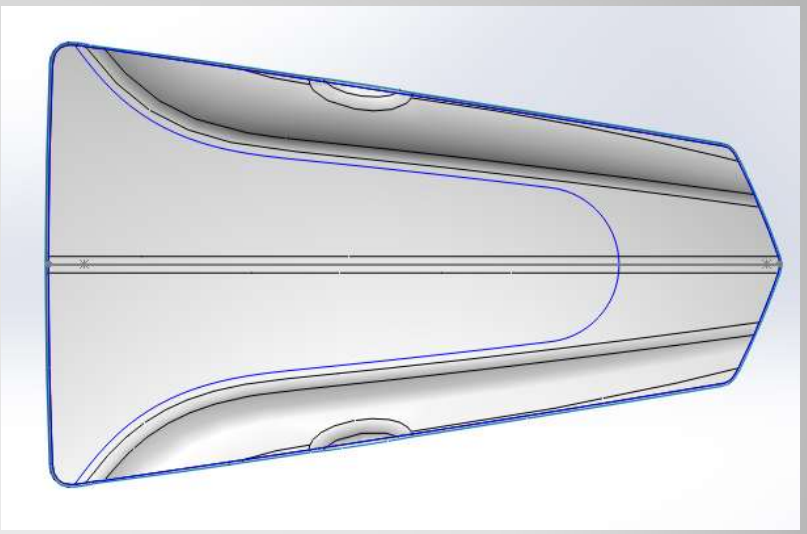
- Car was surfaced in traditional automotive software (Alias) by a designer working for GM
- Surface data imported to SolidWorks and panel splits defined and panels developed for tooling
- Tools created for bodywork and some made by Additive Manufacturing; others more traditional route
- Low temperature cured parts made directly in glass fibre



Prototype production

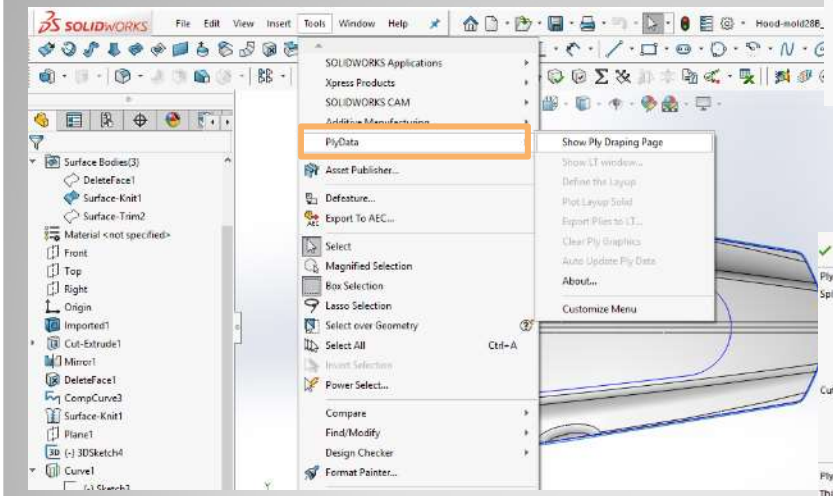
- Process unsuitable for multiple vehicles
- Requirement to have lighter panels from carbon fibre/epoxy to be investigated
- Development of plies from CAD using interface from SolidWorks to Laminate Tools
- Goal: Creation of ply book and ply shapes exported for cutting

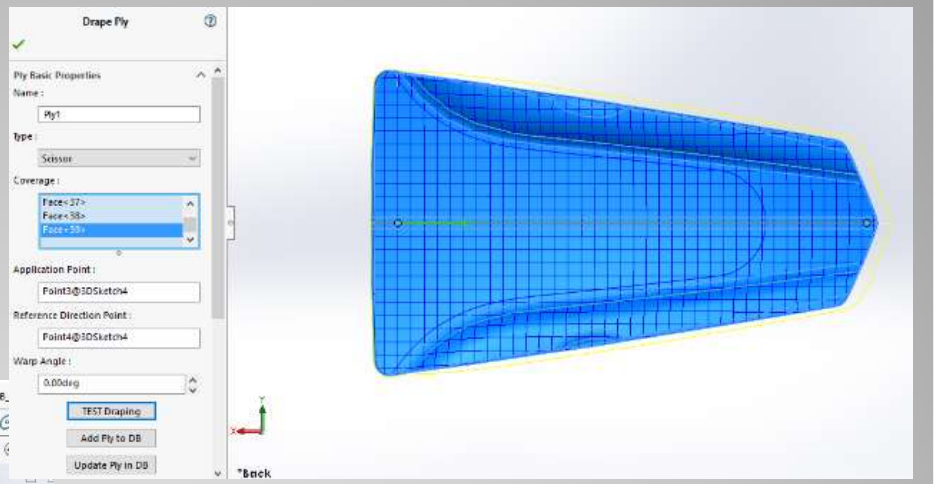


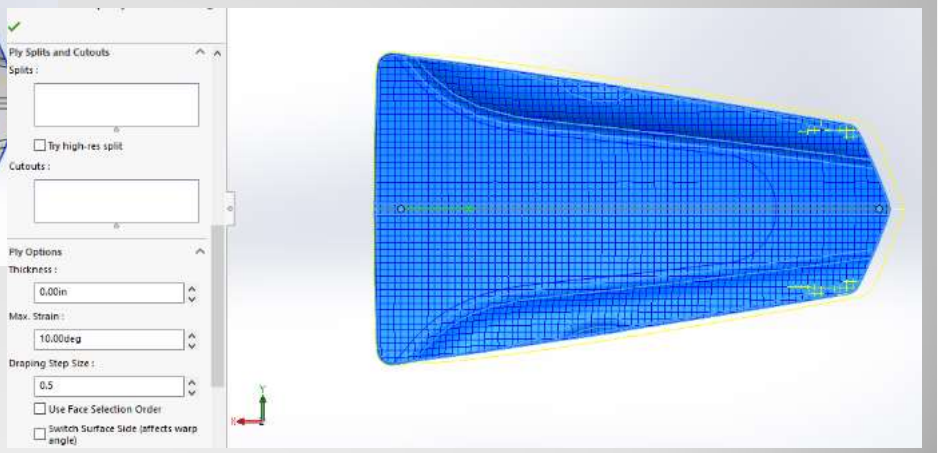


Design + development

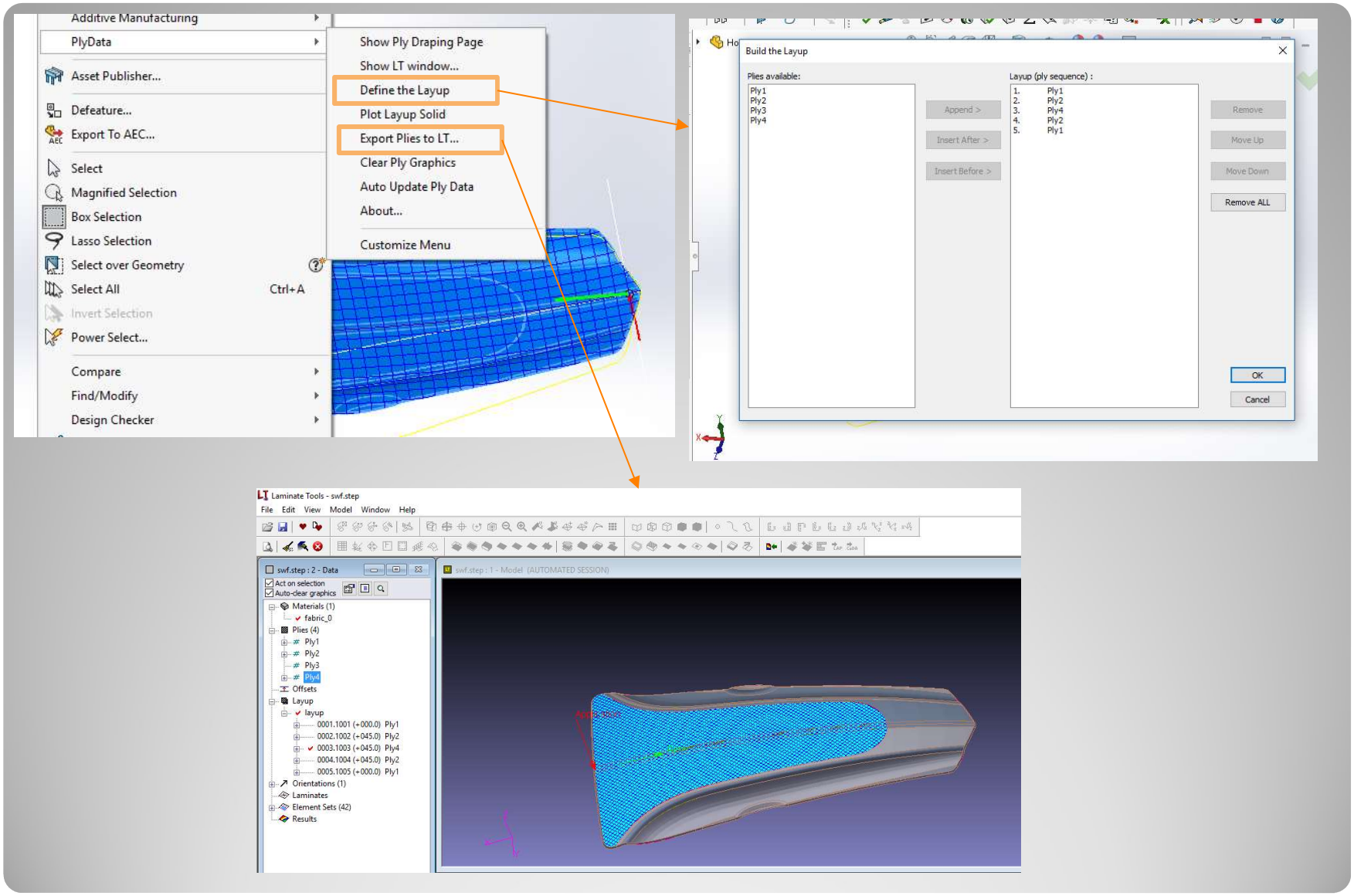
- Various laminates considered and investigated using LAP (Anaglyph)
- Plies shapes developed in SW and exported to LT for downstream actions





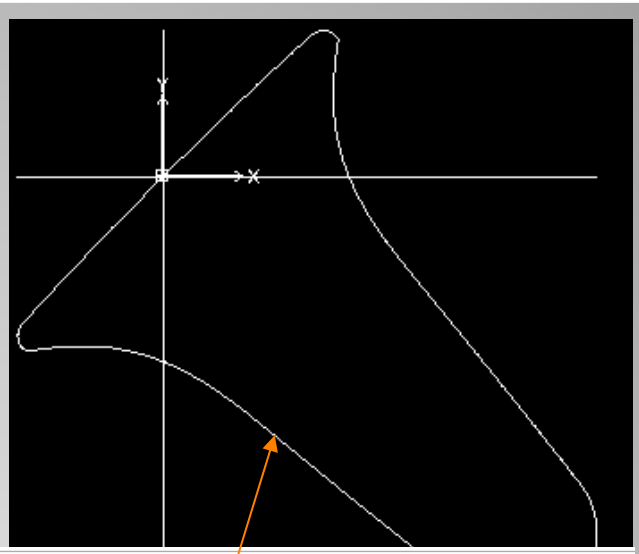


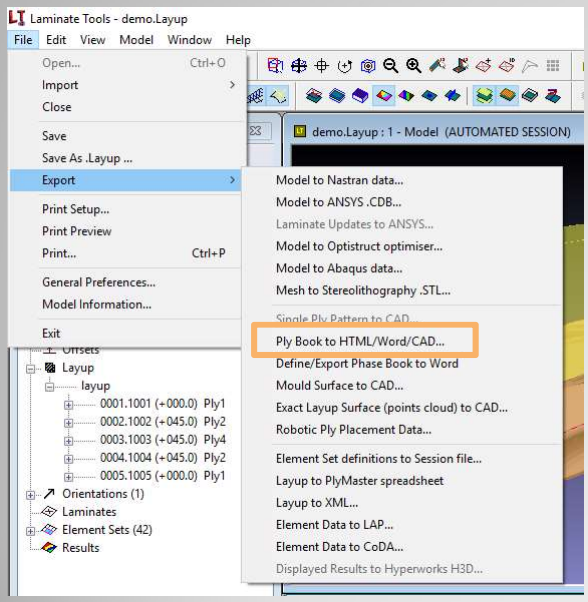
Design + development

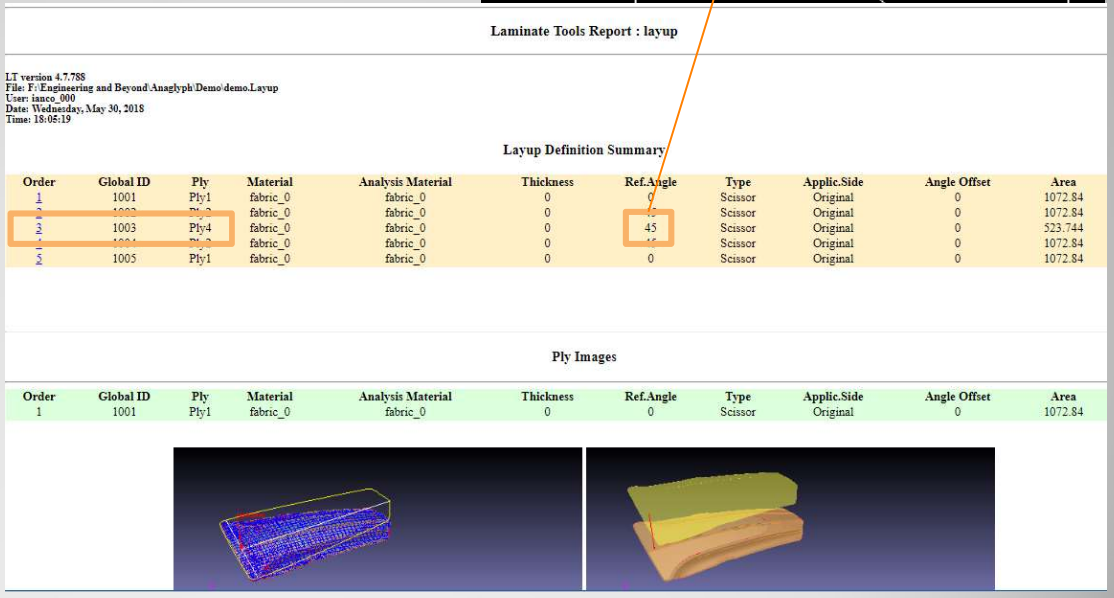


Laminate Tools Interfacing

- Ply books
- Flat patterns
- Export options
- No budget available for FEA at this stage so the original partners are looking at technical partners to develop the vehicle further.







Laminate Tools Report : layup

LT version 4.7.788
File: F:\Engineering and Beyond\Anaglyph\Demo\demo.Layup
User: ianco_000
Date: Wednesday, May 30, 2018
Time: 18:05:19

Layup Definition Summary

Order	Global ID	Ply	Material	Analysis Material	Thickness	Ref.Angle	Type	Applic.Side	Angle Offset	Area
1	1001	Ply1	fabric_0	fabric_0	0	0	Scissor	Original	0	1072.84
2	1002	Ply2	fabric_0	fabric_0	0	45	Scissor	Original	0	1072.84
3	1003	Ply4	fabric_0	fabric_0	0	45	Scissor	Original	0	523.744
4	1004	Ply2	fabric_0	fabric_0	0	45	Scissor	Original	0	1072.84
5	1005	Ply1	fabric_0	fabric_0	0	0	Scissor	Original	0	1072.84

Ply Images

Order	Global ID	Ply	Material	Analysis Material	Thickness	Ref.Angle	Type	Applic.Side	Angle Offset	Area
1	1001	Ply1	fabric_0	fabric_0	0	0	Scissor	Original	0	1072.84

Manufacture support

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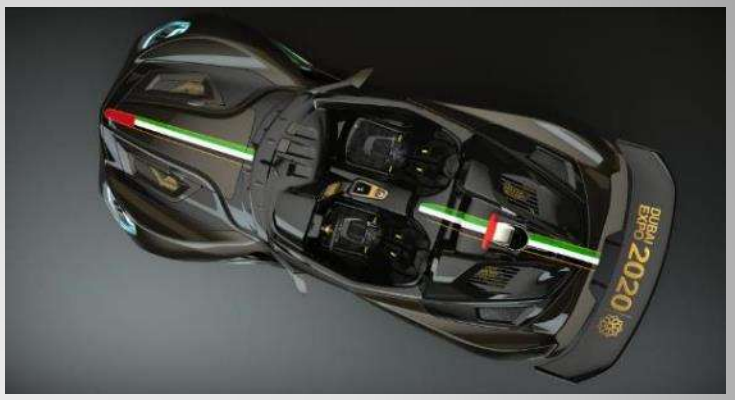

Thank you for your time!