Resin Infusion Best Practices

Advanced Composites Institute

*Home of the **Marvin B. Dow Stitched Composites Development Center***

Mississippi Advanced Composites Training Center

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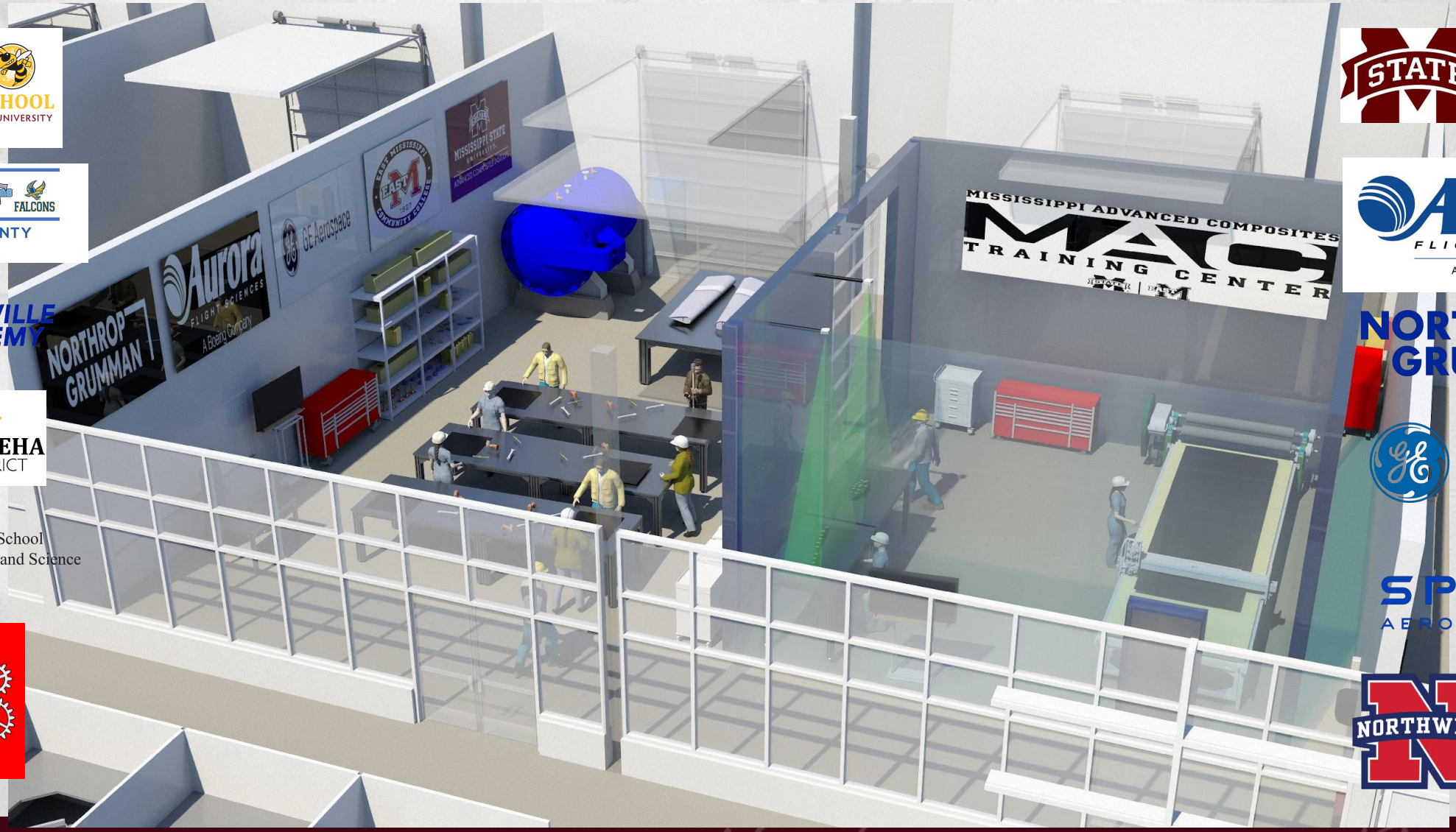
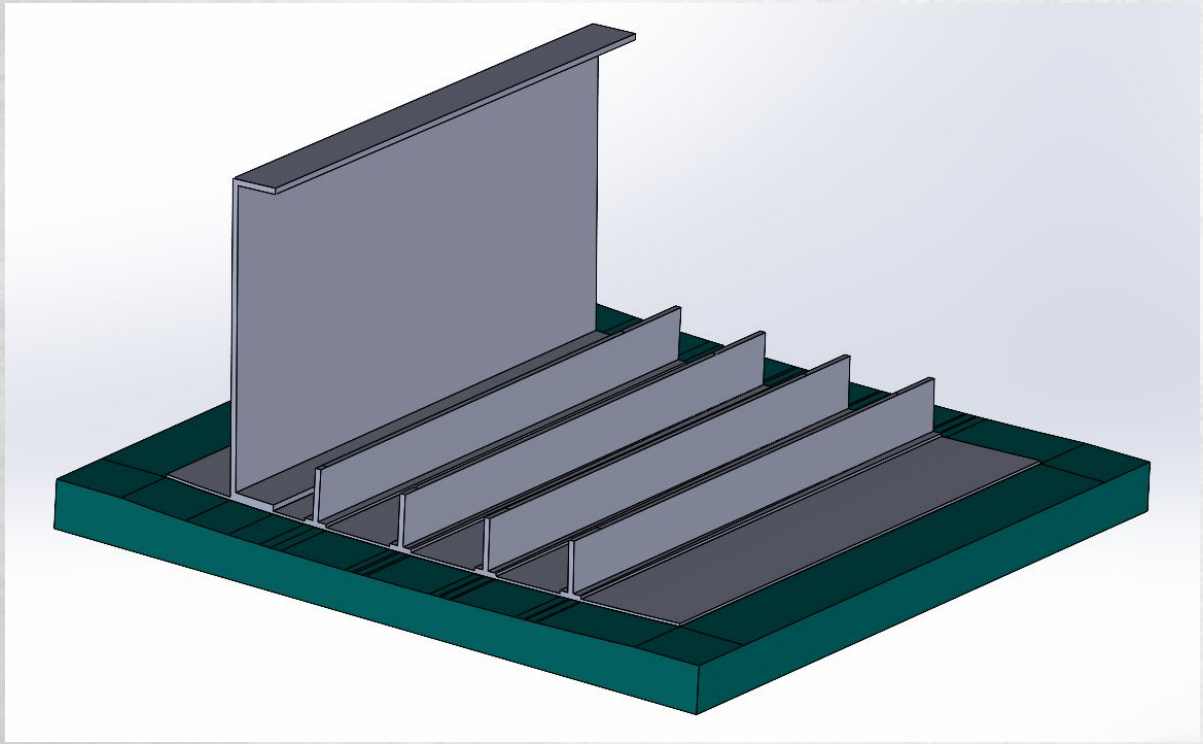
Mississippi Advanced Composites (MAC) Training Center

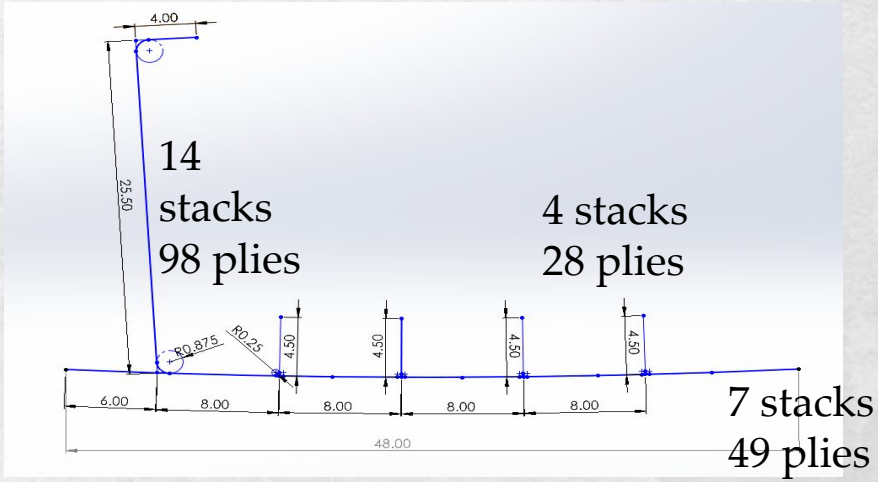


The Project that brought me here! 4’x4’ wing box

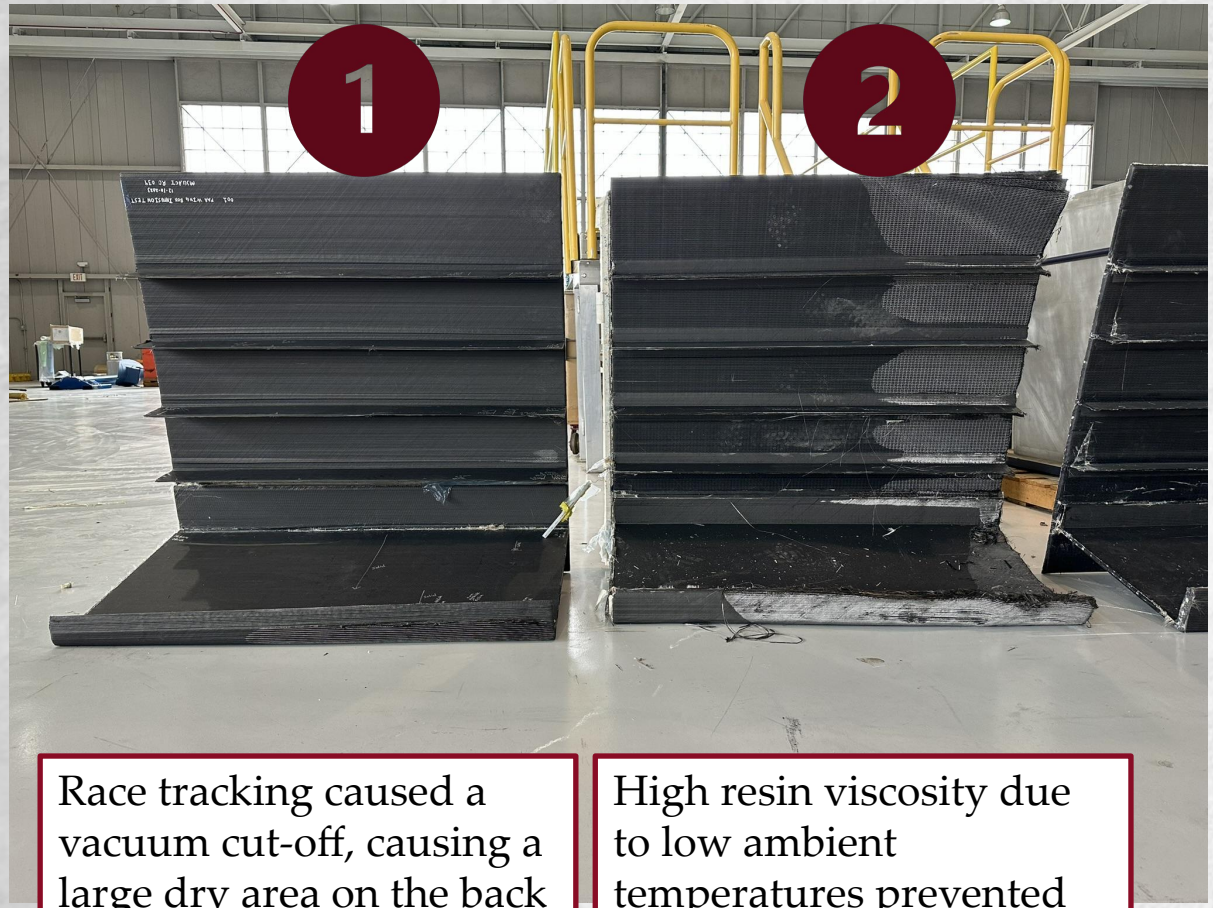
FAA - Technology Readiness for Un/Stitched Resin Infusion

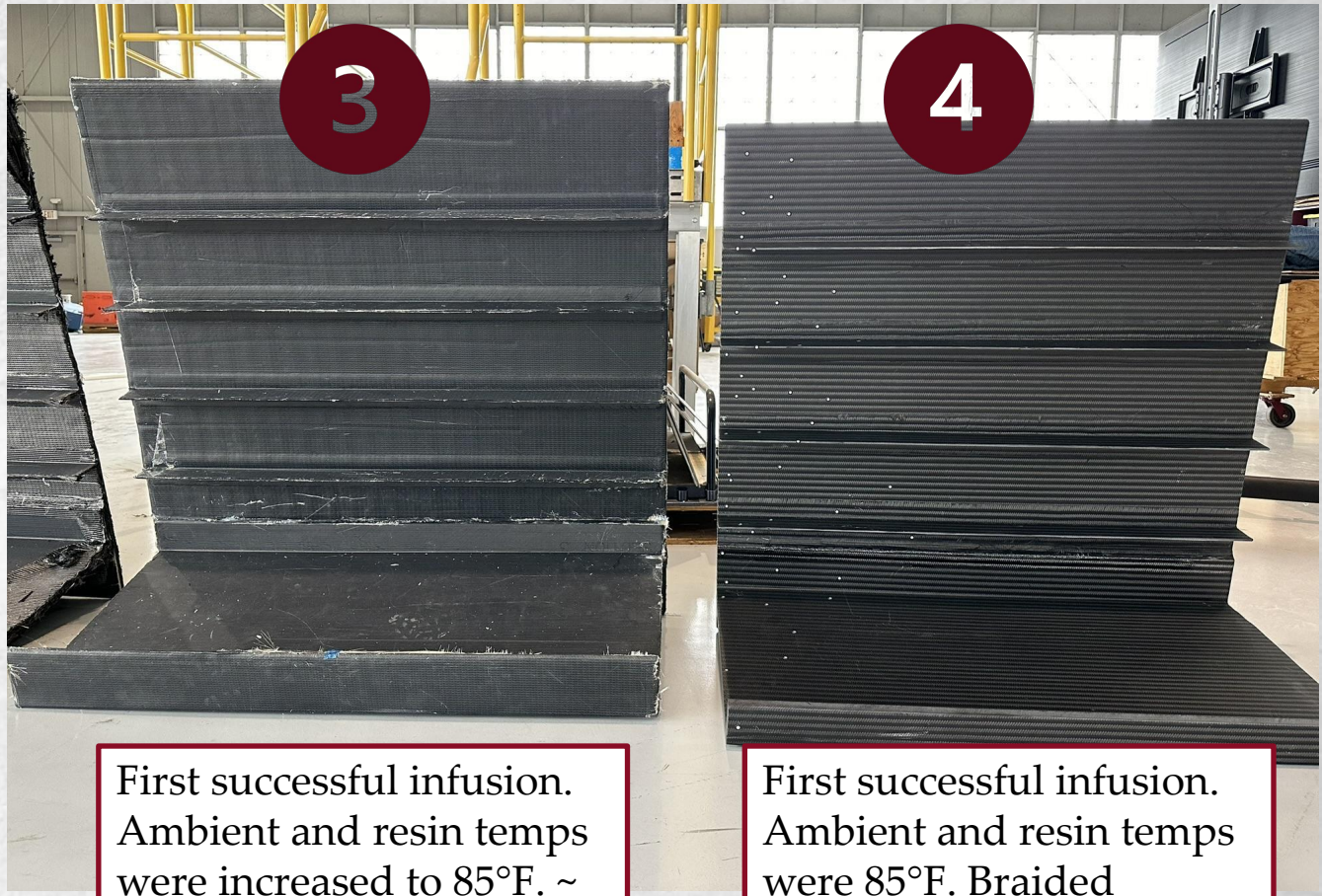


1	+45	153	1425
2	-45	153	
3	0	320	
4	90	173	
5	0	320	
6	-45	153	
7	+45	153	



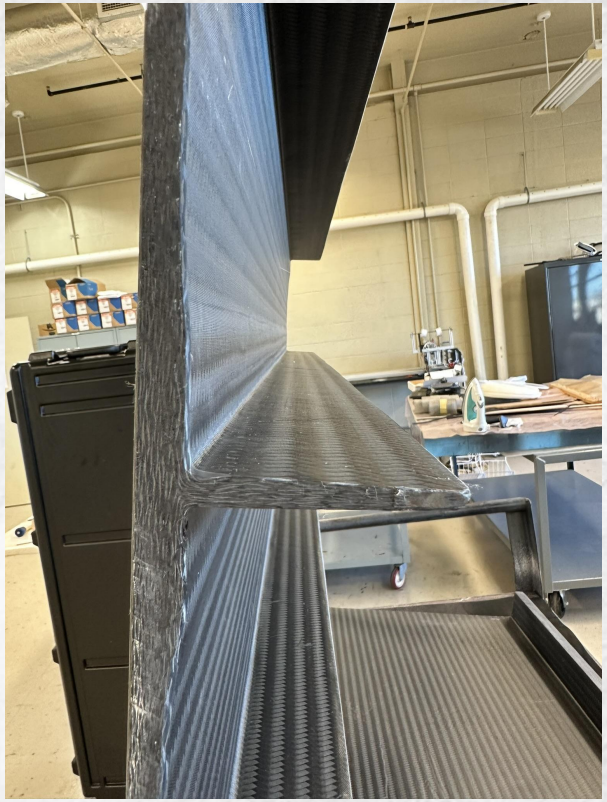
Wing Box Progression -- Manufacturing

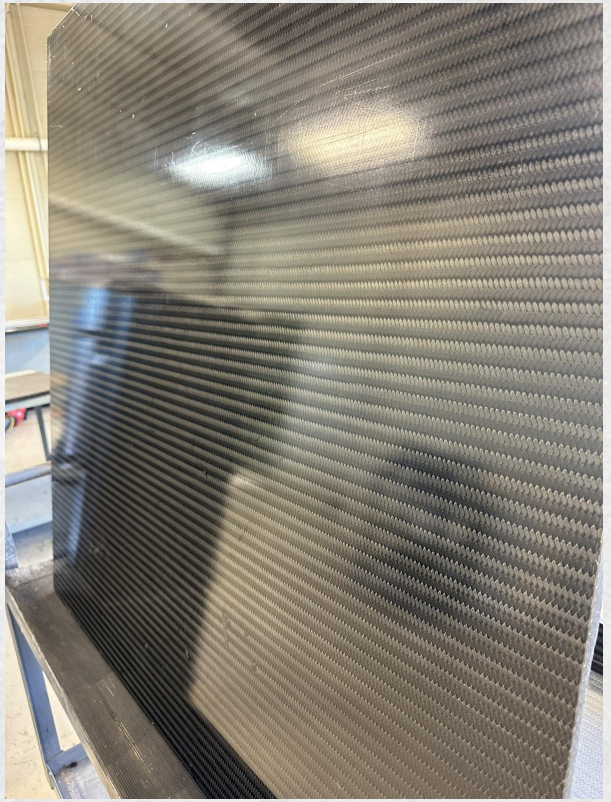


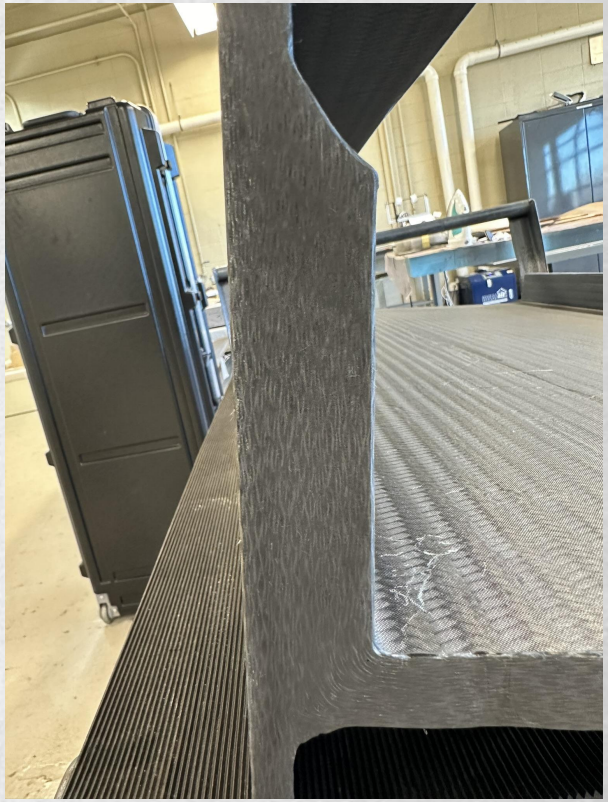


1	2	3	4
Race tracking caused a vacuum cut-off, causing a large dry area on the back of the spar.	High resin viscosity due to low ambient temperatures prevented fully wet out.	First successful infusion. Ambient and resin temps were increased to 85°F. ~ 50 min infusion time.	First successful infusion. Ambient and resin temps were 85°F. Braided material with binder.
Pressure pot/ Saertex NCF	Pressure pot/ Saertex NCF	Isojet/ Saertex NCF	Isojet/ Braided fiber

4’x4’ wing box – Images







Version 3

Version 4

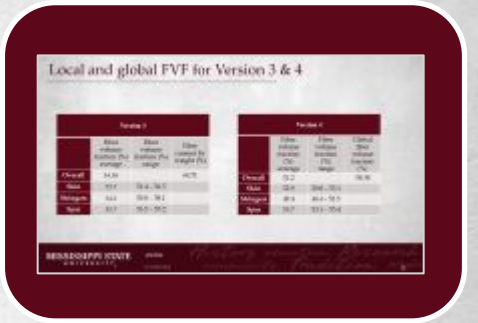
The top issues we experienced were …

Vacuum integrity is especially important for infusion.

The resin viscosity and flow plays a huge role in a successful infusion.

There is little difference between vacuum bagging for an infusion and for a prepreg.

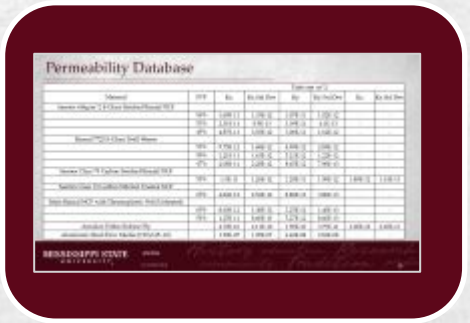
Dry fabric can be tricky to work with, mostly because it is slippery.



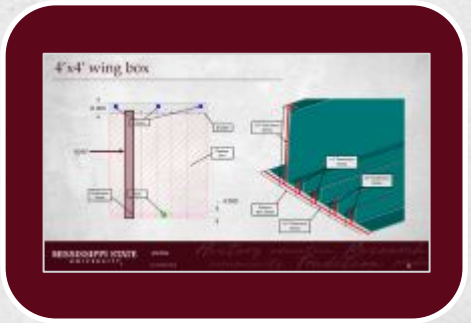
Global and local FVF are not always equal. Tooling plays a huge role in correct local FVF control.

A successful infusion with a specific material set does not all material sets will be successful.

Integration of the spar, stringers, and skin was easier than expected.



The simulation provided direction, but not quantitative information.

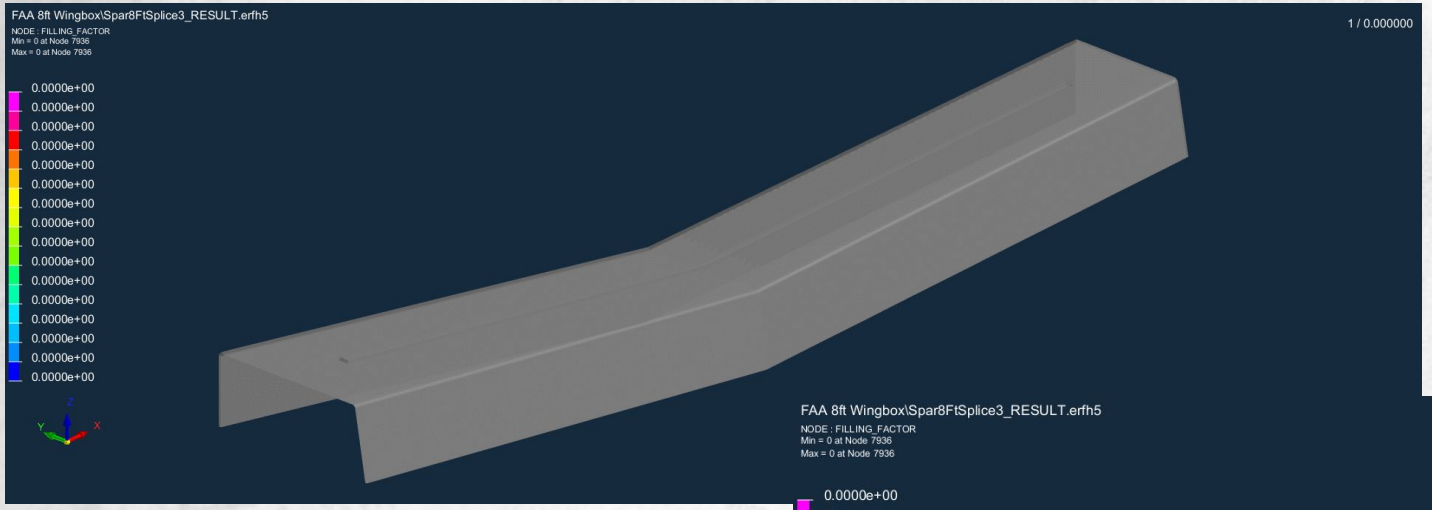


Resin reaching the vacuum outlet causes a vacuum loss, a killer for infusions.

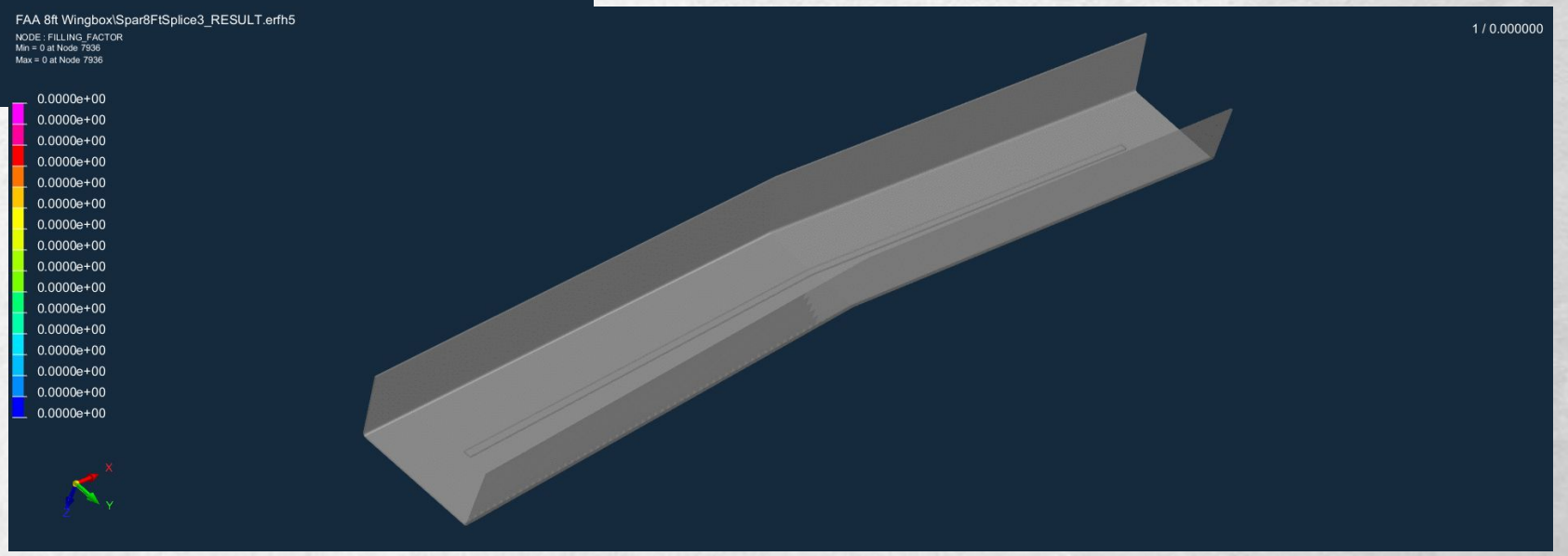
The pot life of the resin should not be a concern.

Questions?

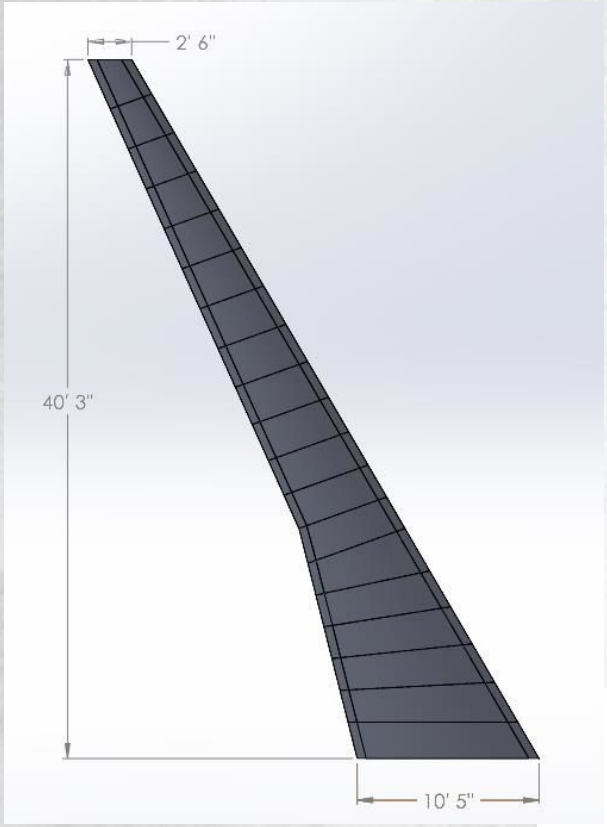
Next steps – 8′ kinked spar

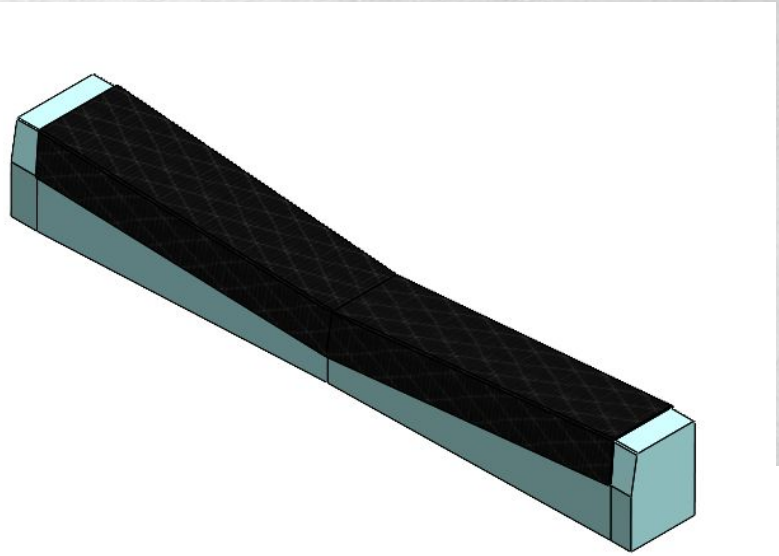


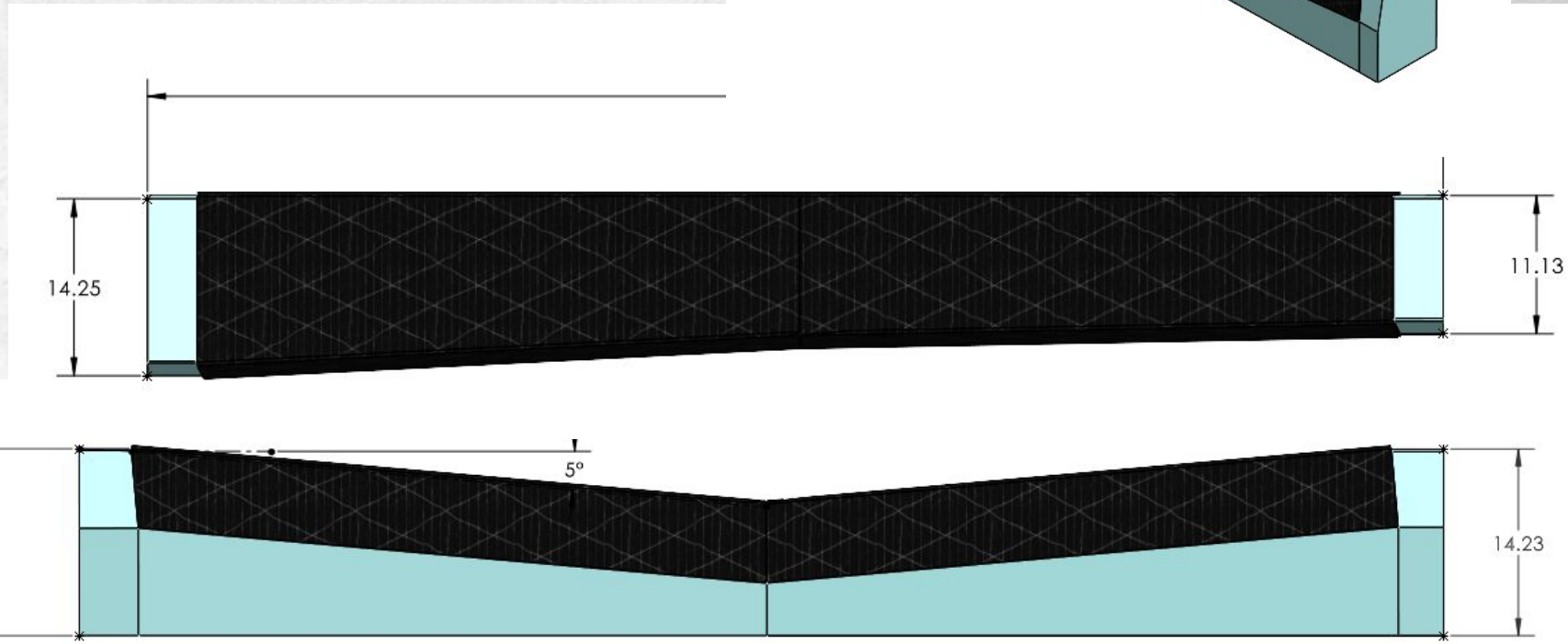
Focusing on 8′ kinked spar section



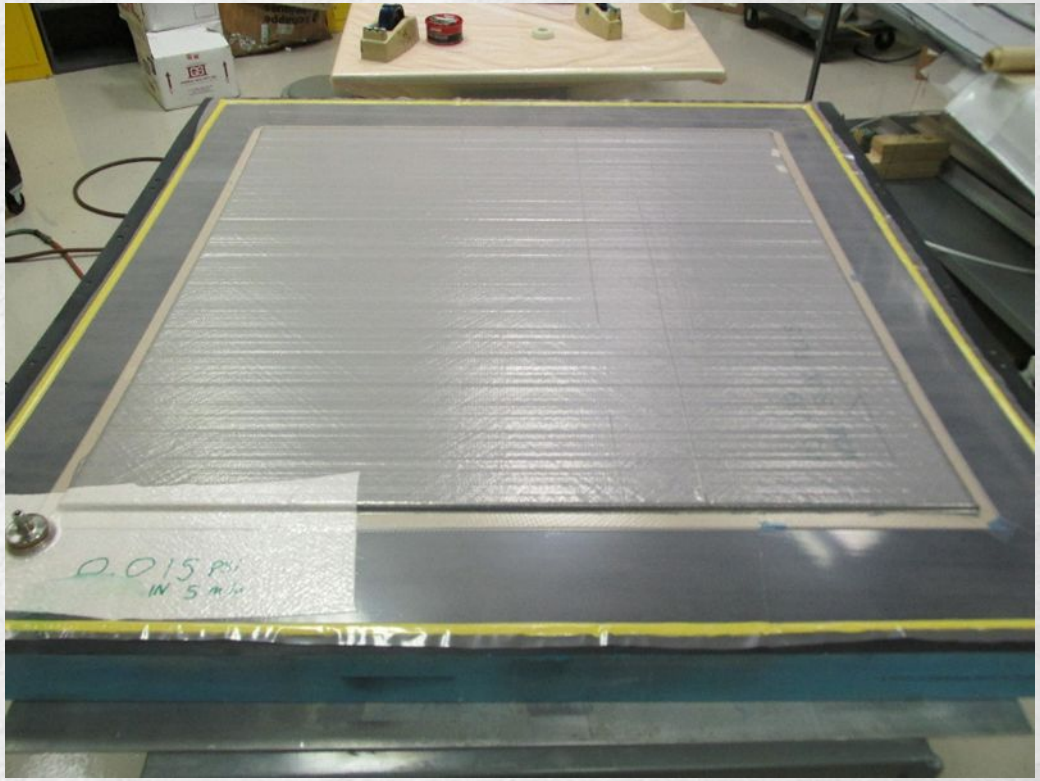
Next steps – 8′ kinked spar







We continually had leaks at the tooling board interfaces



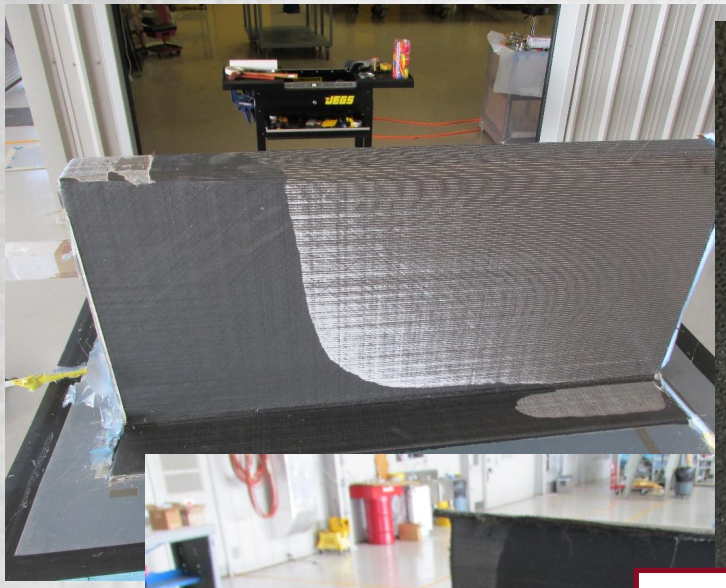
The leak down rate was 0.015 psi/5 min.

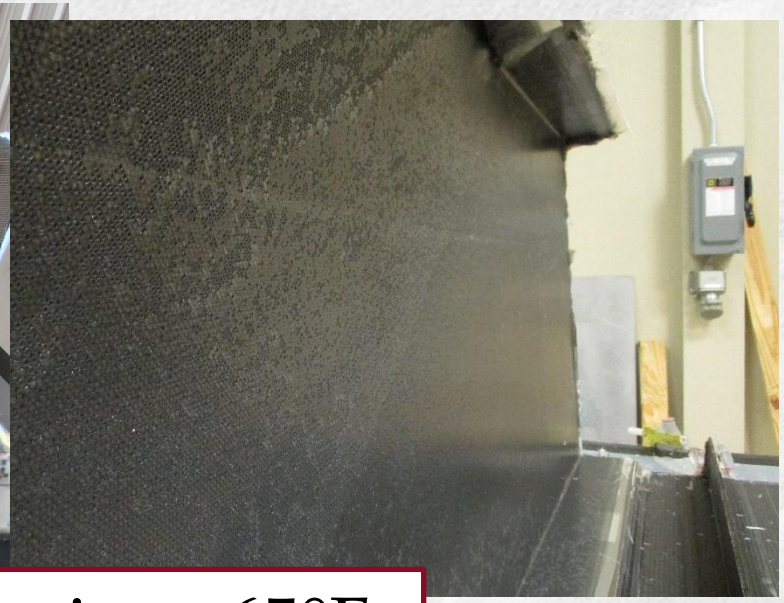
<u>Acceptable leak rate</u>

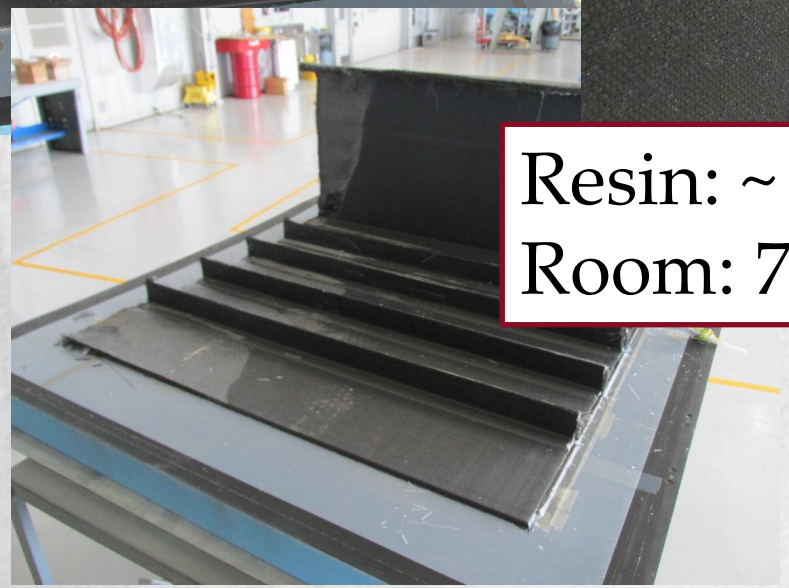
0.3 psi/5 min primary bag

0.00 psi/5 min secondary bag

Resin viscosity is crucial – V2 failed, V3 succeeded!





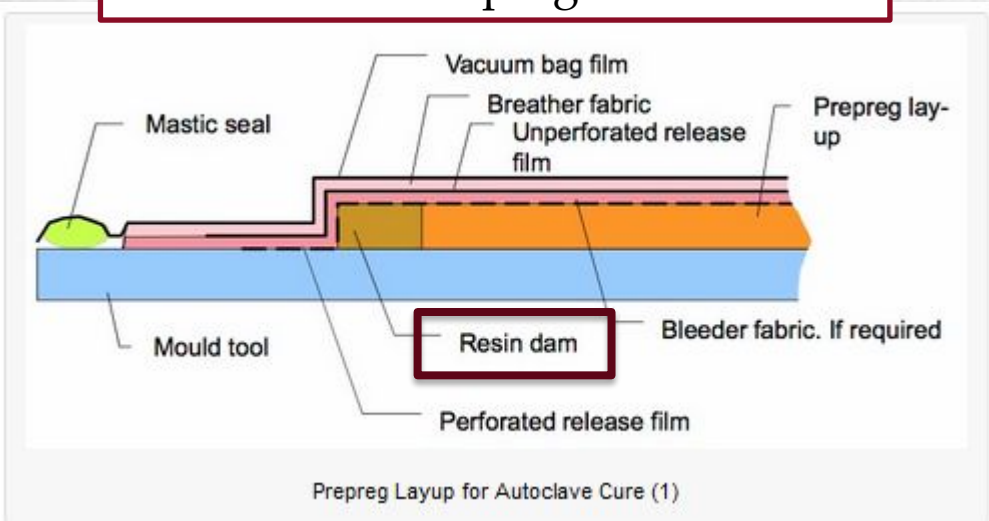


Resin: ~ 65°F
Room: 72°F

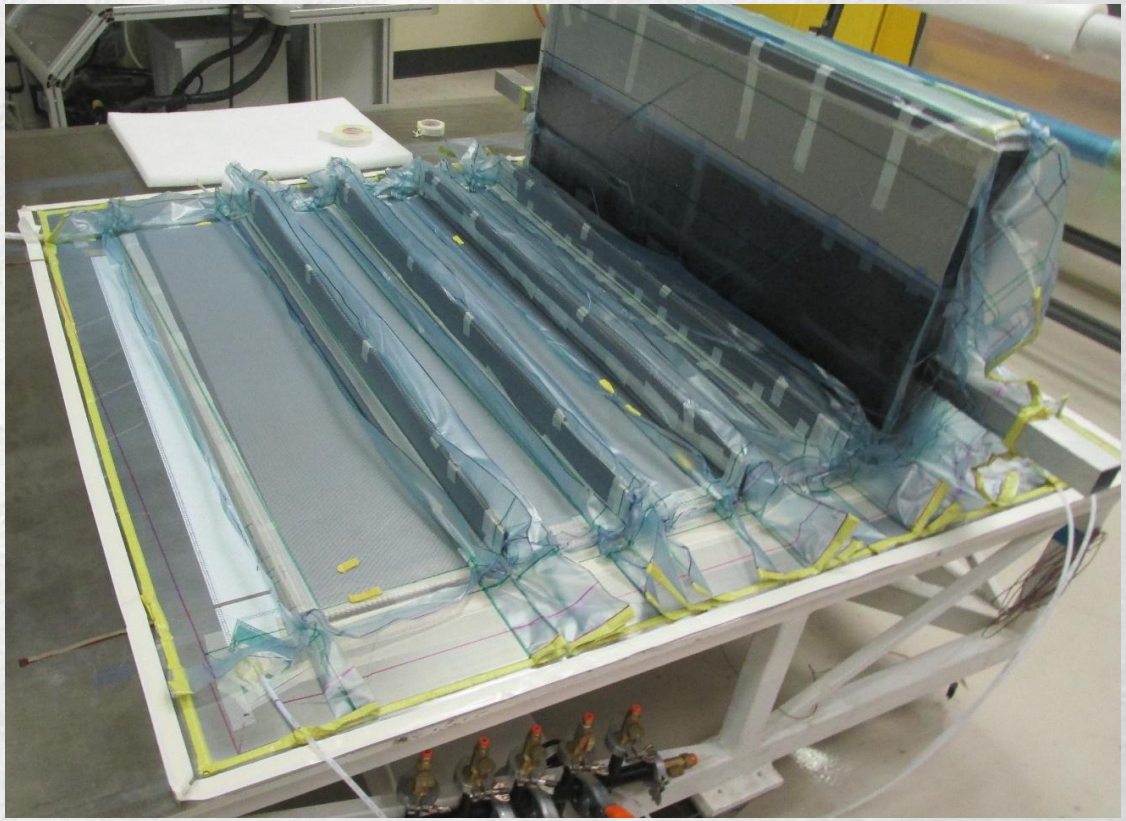
Resin: 90°F
Room: 85°F

The vacuum bagging skills easily transfer from prepreg to infusion.

Prepreg

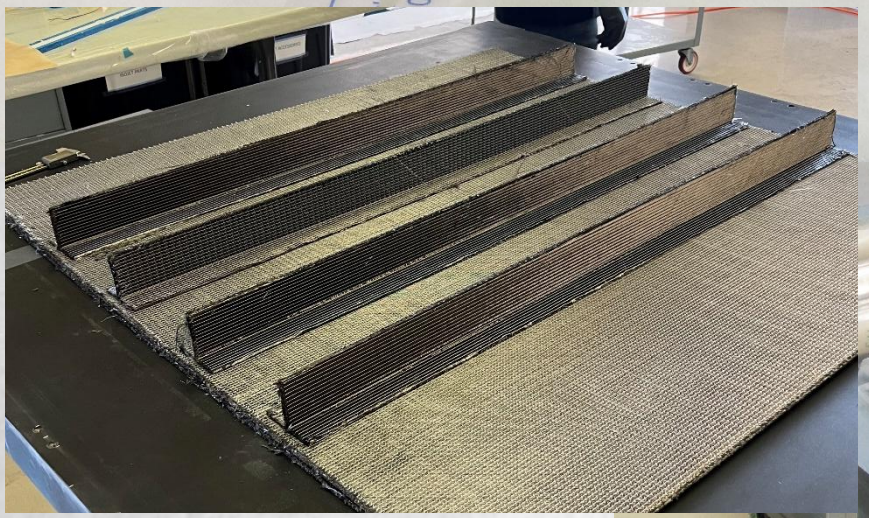


Prepreg Layup for Autoclave Cure (1)

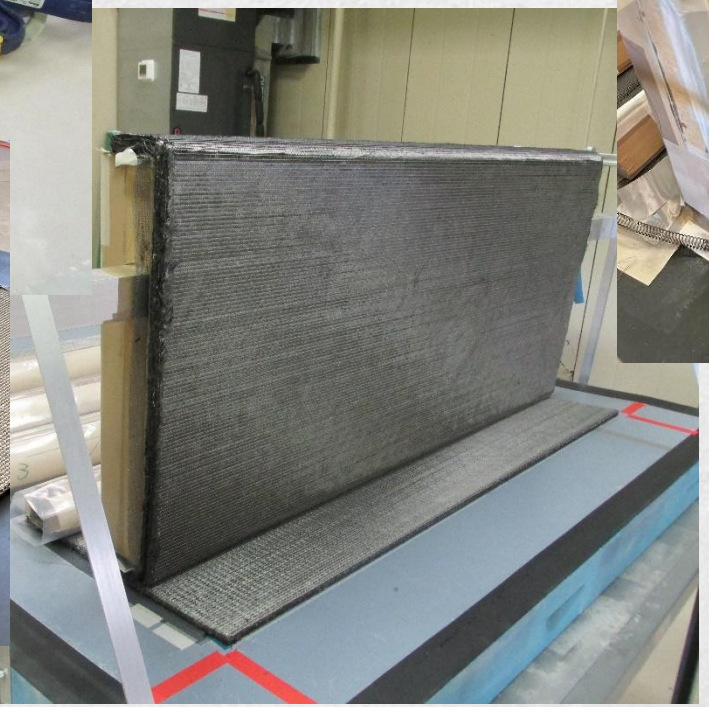


Primary and secondary bag

Dry fabric has zero tack.



Spray tack is your friend!



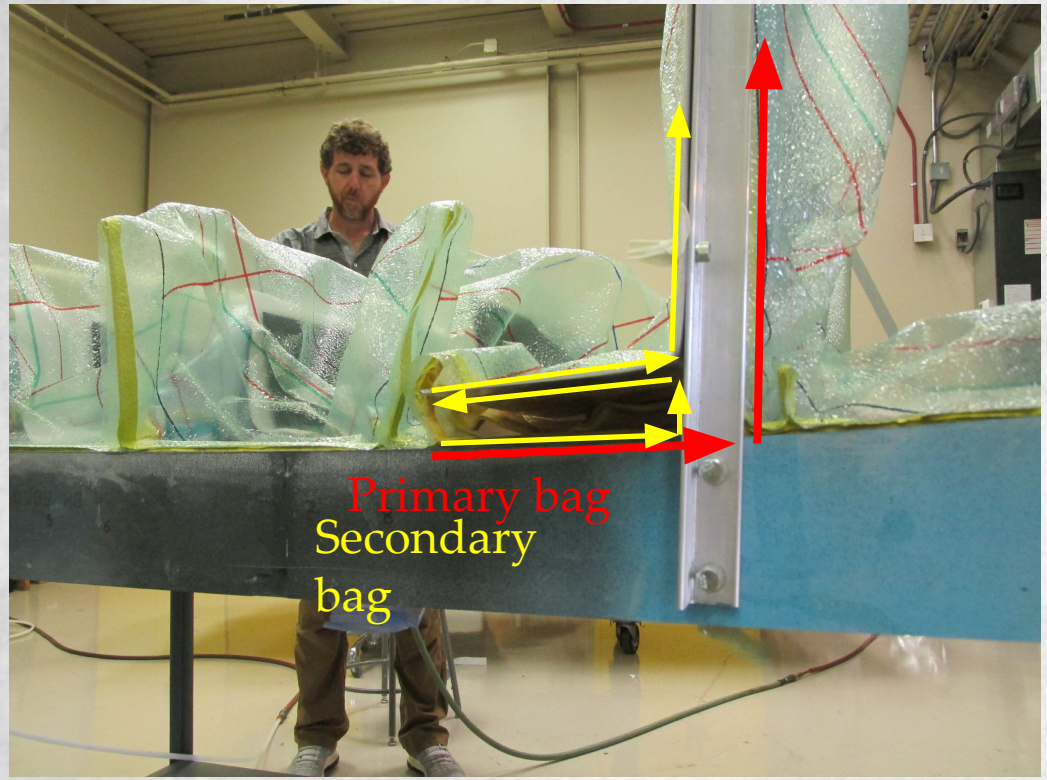
Novel fabrics have binder/veils.

Local and global FVF for Version 3 & 4

Version 3			
	Fiber volume fraction (%) average	Fiber volume fraction (%) range	Fiber content by weight (%)
Overall	54.56		64.51
Skin	53.7	51.4 – 56.5	
Stringers	54.2	50.8 – 58.1	
Spar	55.7	53.5 – 57.2	

Version 4			
	Fiber volume fraction (%) average	Fiber volume fraction (%) range	Global fiber volume fraction (%)
Overall	51.2		58.38
Skin	52.9	50.8 – 55.1	
Stringers	49.4	46.6 - 52.5	
Spar	53.7	53.1 – 55.4	

Lack of compaction

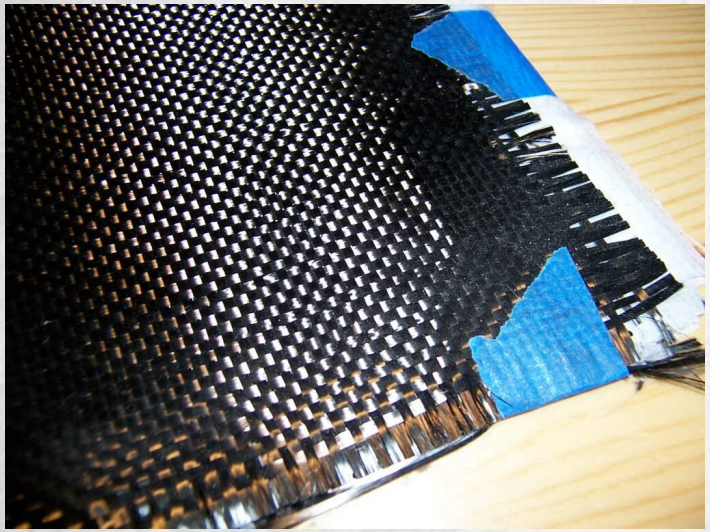


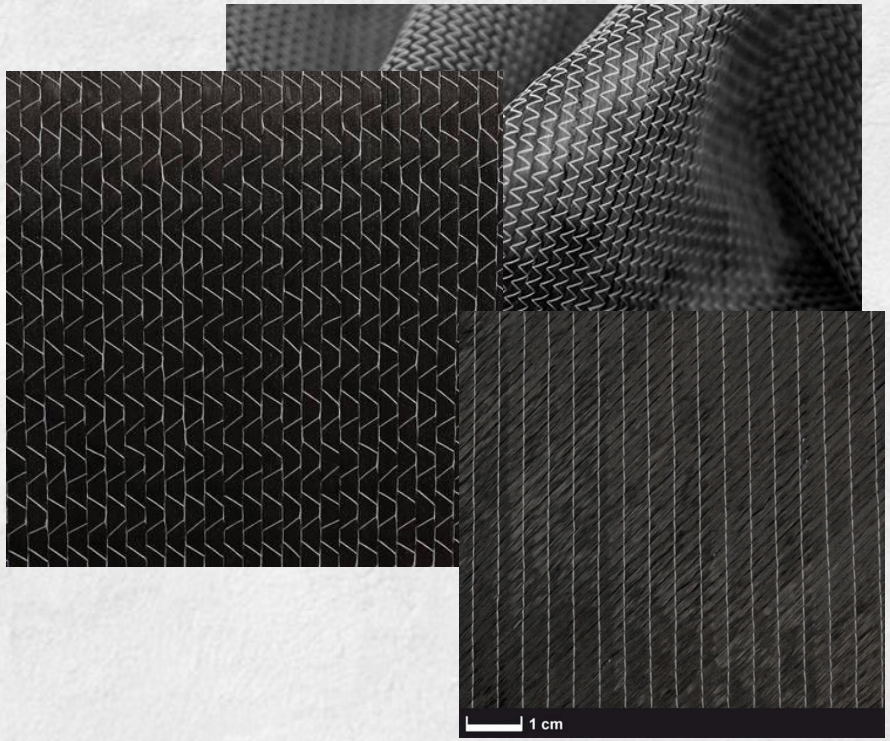
V1 -- We lacked compaction on the spar flange due to tooling on the outside of the primary bag.

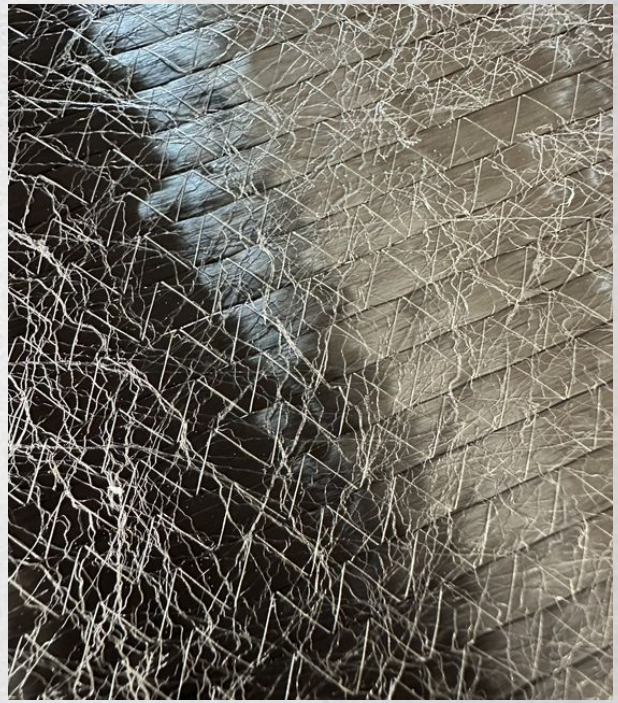
V3 – Improved tooling still caused local variations in FVF.

Materials may have different infusion performances.

Typical fabrics	Non-crimp fabrics	Veil/binder NCF



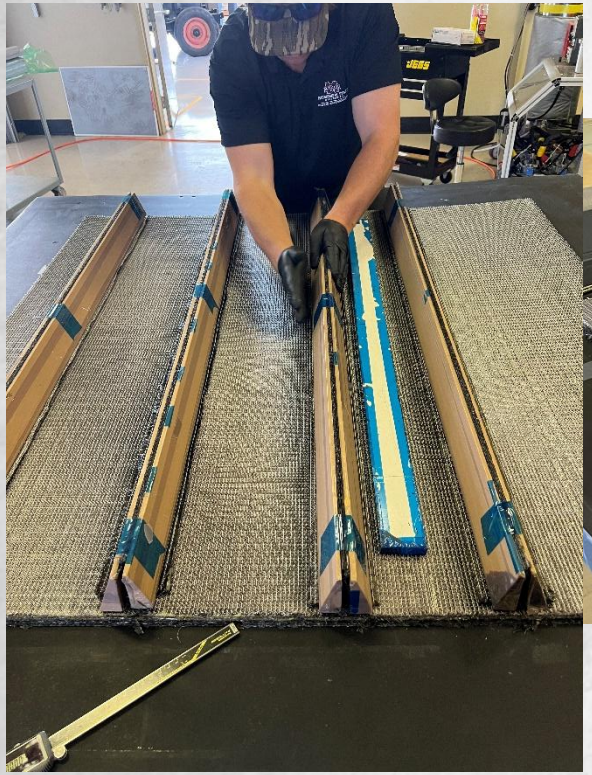


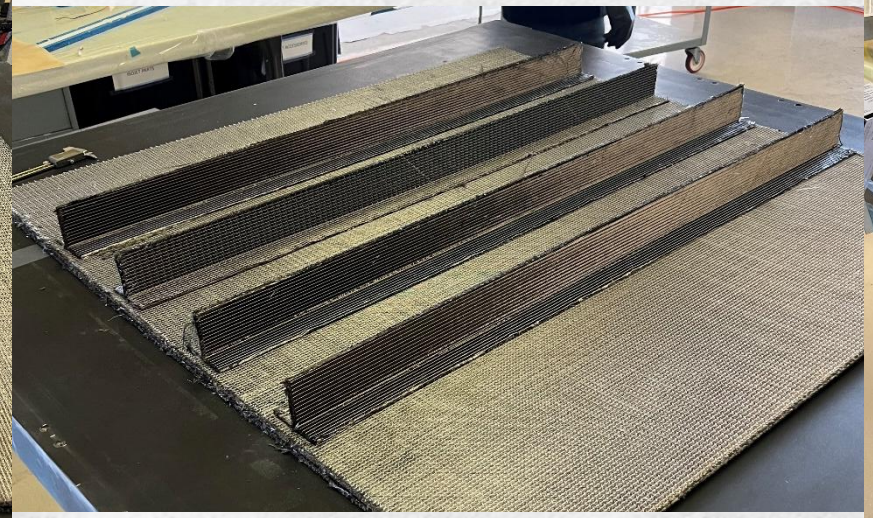


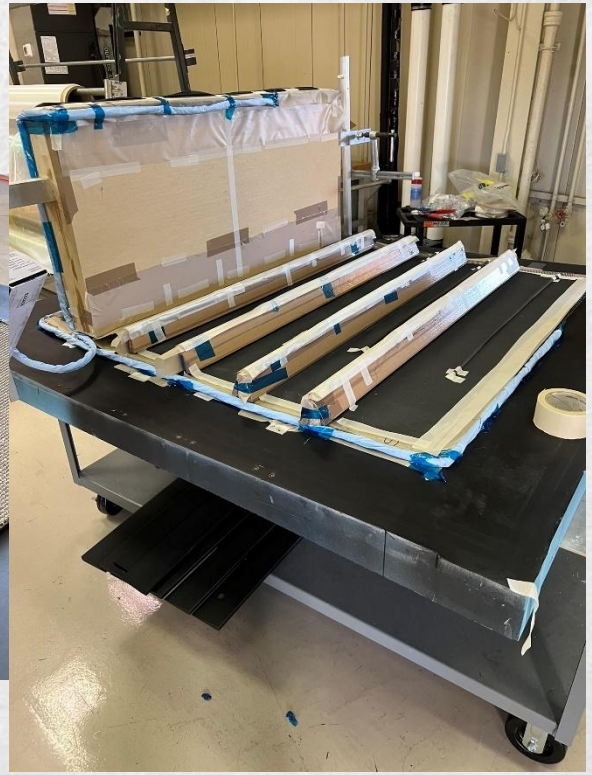
- Plain weave
- Twill weave
- 5-harness satin

https://www.cf-composites.toray/images/prod_woven_fabrics_other_02.jpg
https://ezentrum-res.cloudinary.com/image/upload/h_2000,c_scale/f_auto/q_auto/v1697624125/rg/gkq6f7ha60hd4sfggs9y.jpg
https://media.easycomposites.eu/products/large/CF-UD-300-125-300g-Unidirectional-Carbon-Fibre-(1250mm)-wide.jpg

Integrating the stringers, spar, and skin was easier than expected.



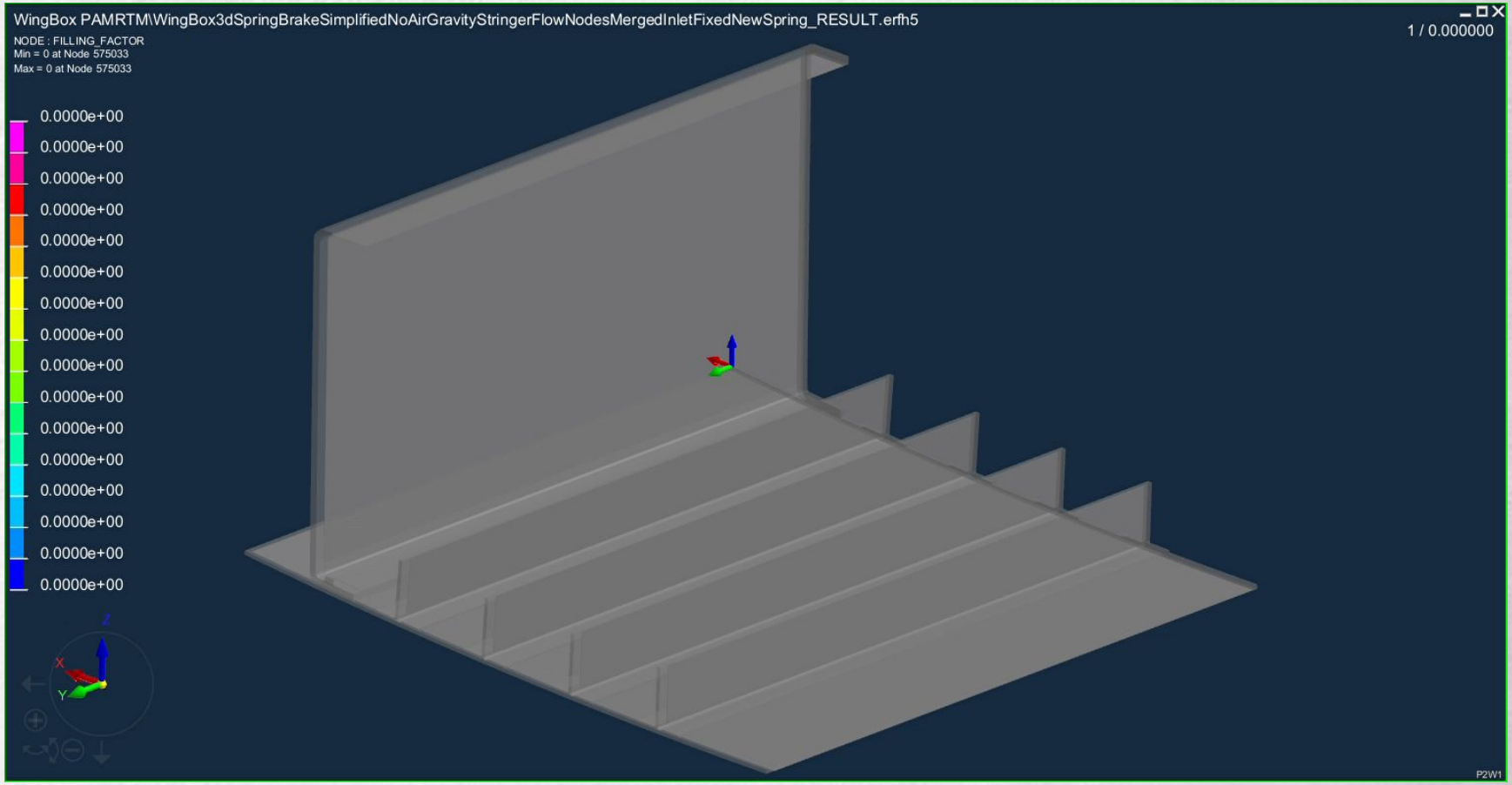




Resin distribution springs move resin around.

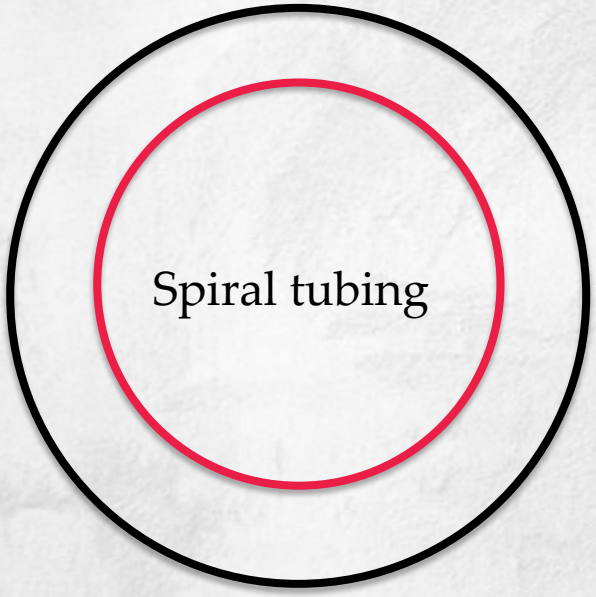
Simulation provided a good starting point

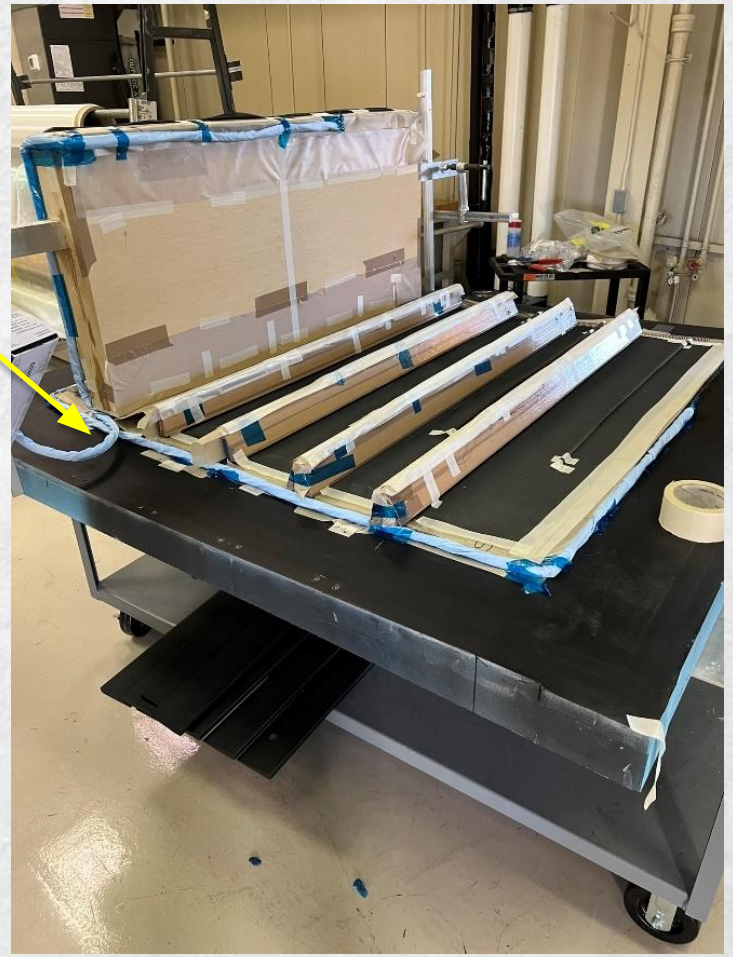
- Simulation of 4’x4’ wing box
  - 3D sim
  - Includes flow media
  - Using Hexcel 1078-1
  - Flow media on stringers



V3 & V4 did not have resin race tracking issues.

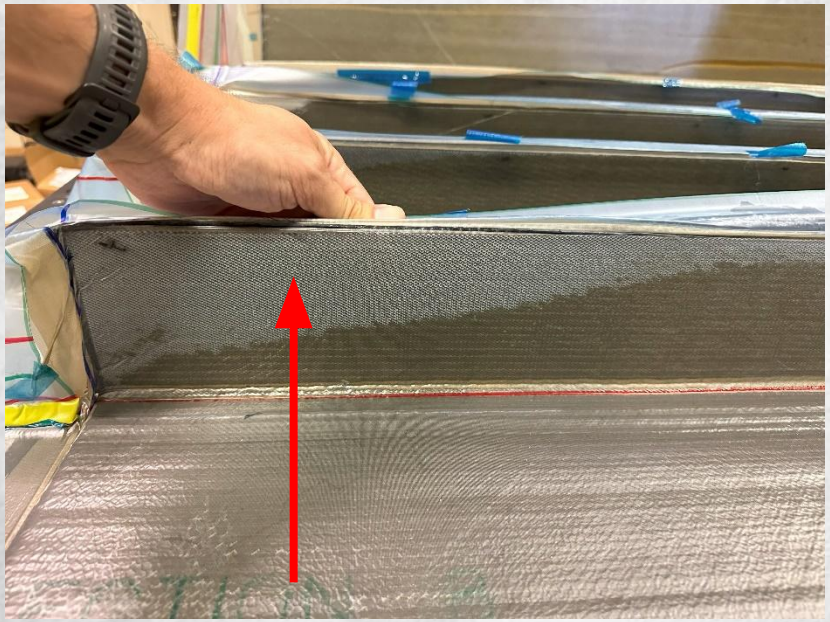
Airtech Dahlvac RC-1/2” vacuum line



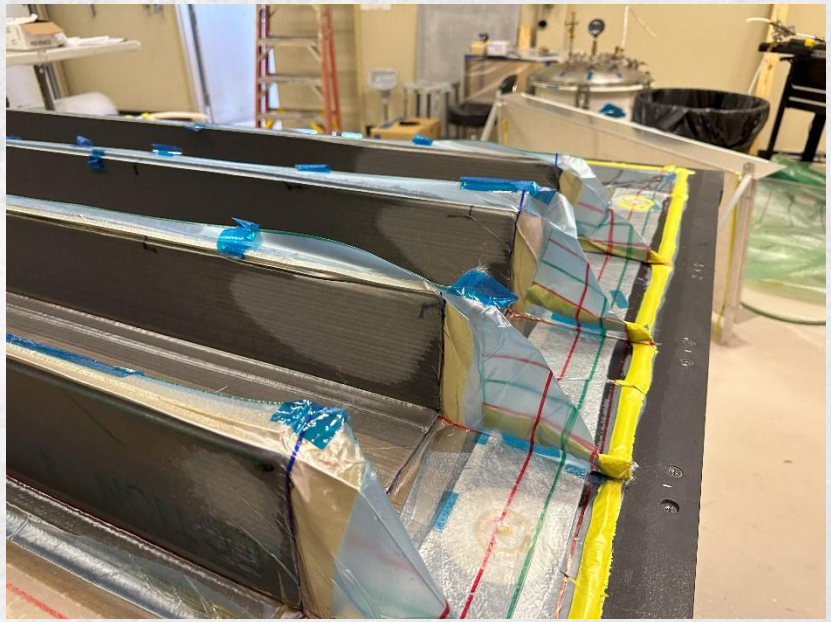


4’x4’ wing box -- Infusion Version 1

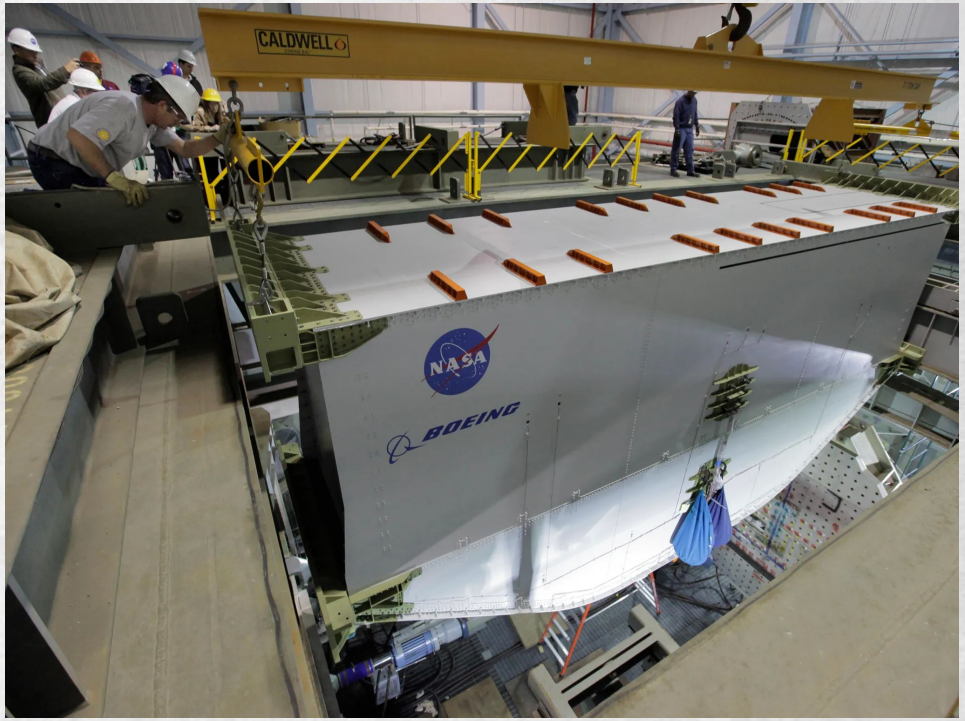
We expect a vacuum leak caused dry flow media.



Unusual to have dry flow media.



30′ part infused within 1 hour!



Pot life is > 2 h for contemporary aerospace resins.