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Engineering Portfolio

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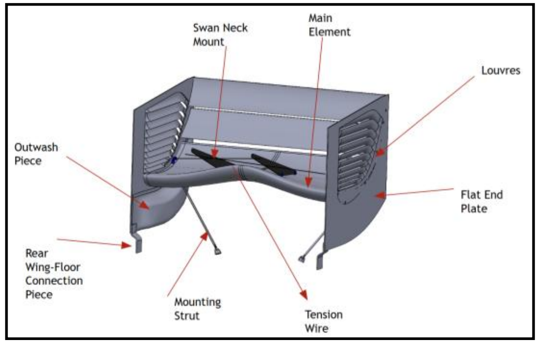
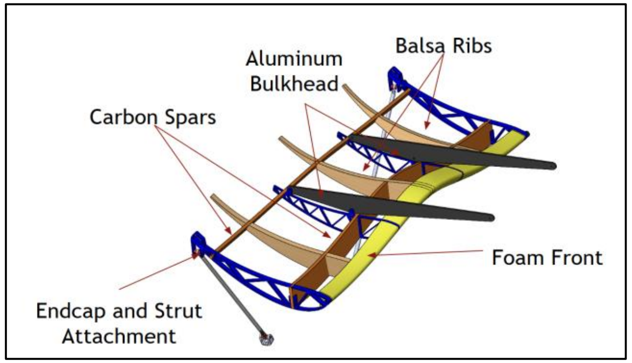
Wisconsin Racing FSAE:
Rear Wing Structure Design

(Fall 2025 - Present)

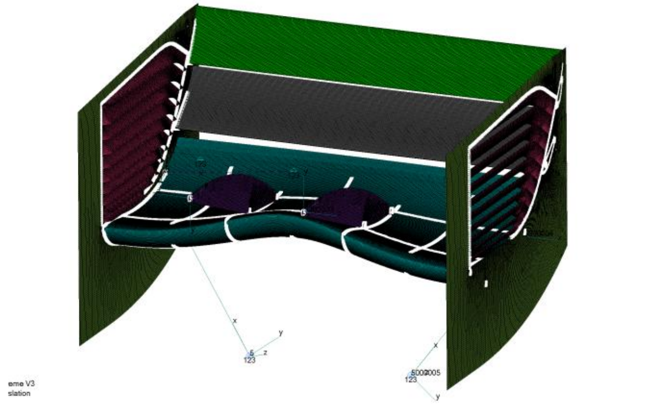


Overall design of the Rear Wing



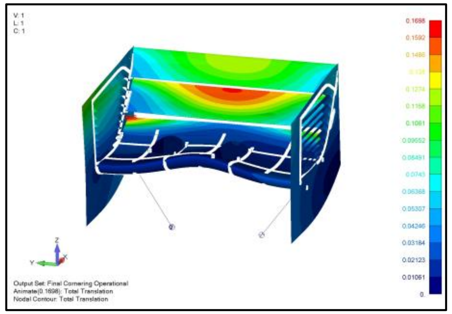
Torsion box internal structure design in **SolidWorks**

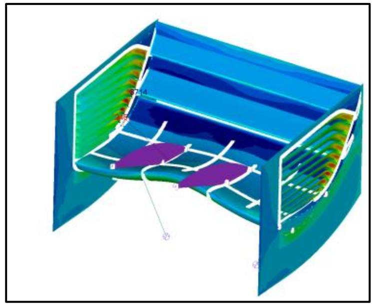
- Designed the rear wing mounting architecture to create an efficient load path: struts at aerodynamics center of pressure reacting downforce, swannecks supports transferring drag loads from mainplane to roll hoop and lateral tension wires constraining side loads and alignment
- Engineered the mainplane internal structure using the torsion box concept to minimize deflection under aerodynamic loads and maintain structural integrity under peak load cases while optimizing mass
- Built a full system finite element model in **Siemens Femap** with **NASTRAN** solver
  - Mapped rear wing pressure distributions from **StarCCM+** CFD simulation onto FEMAP
  - Evaluated composite failure using the Tsai-Wu criterion (failure index 0-1) and assessed metal mounting ribs using von mises yield to compute margins of failure
- Ran parametric deflection studies using **Excel** and the FEM model across the mainplane, secondary elements, and endplates, sweeping ply count and core thickness to meet stiffness targets with minimum mass

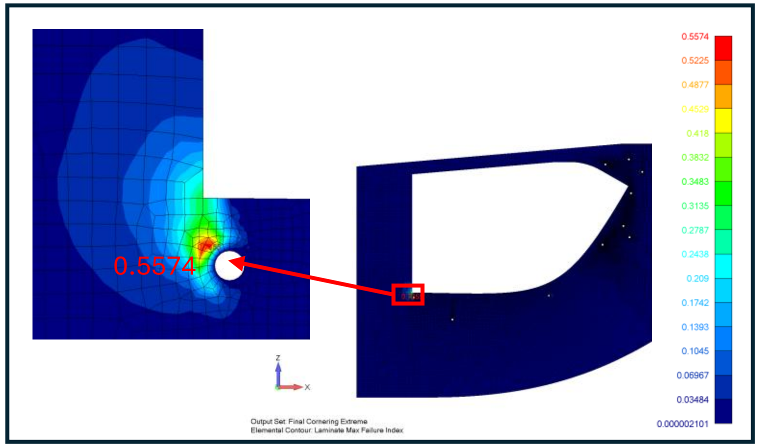


- Pinned constraints for swanneck, tension wire, and strut connection
- Adhesive bonds modeled using RBE2 rigid elements
- Strut and tension wires modeled as CBEAM
- Plate meshed carbon fiber composite with PCOMP laminate card
- Mesh Size:
  - Composite Components - 0.1
  - Aluminum Components - 0.02
- Bolted joints modeled using CBUSH element at faying surface and rigid elements to threaded surface

System FEM set-up


Max Deflection under cornering


Pressure Mapping to FEM

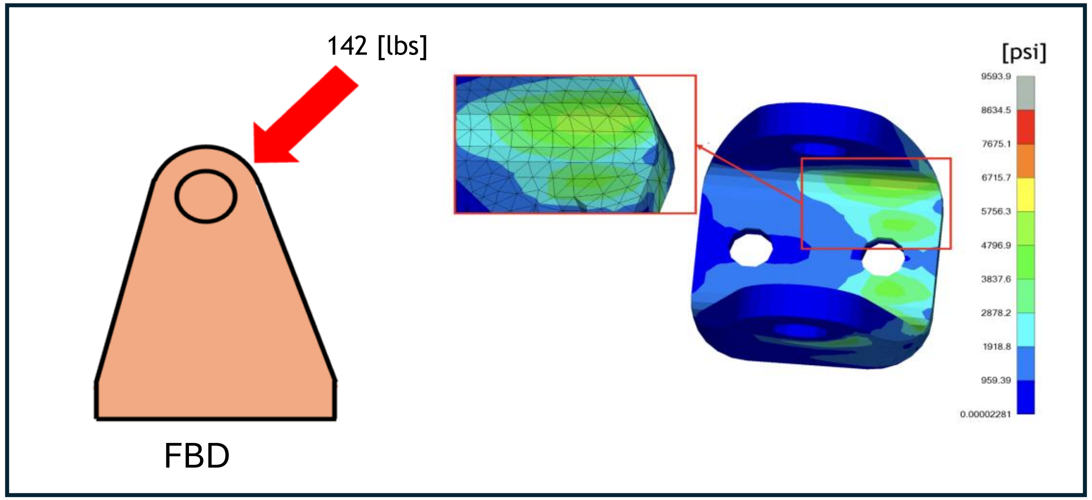


Endplate failure analysis using Tsai-Wu Failure Index

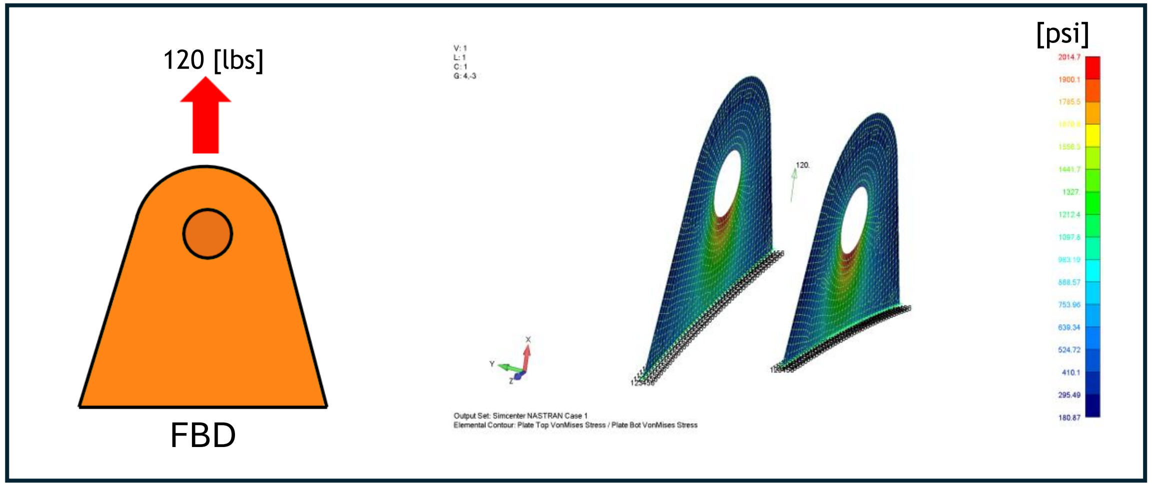
Wisconsin Racing FSAE:

Other structural analysis

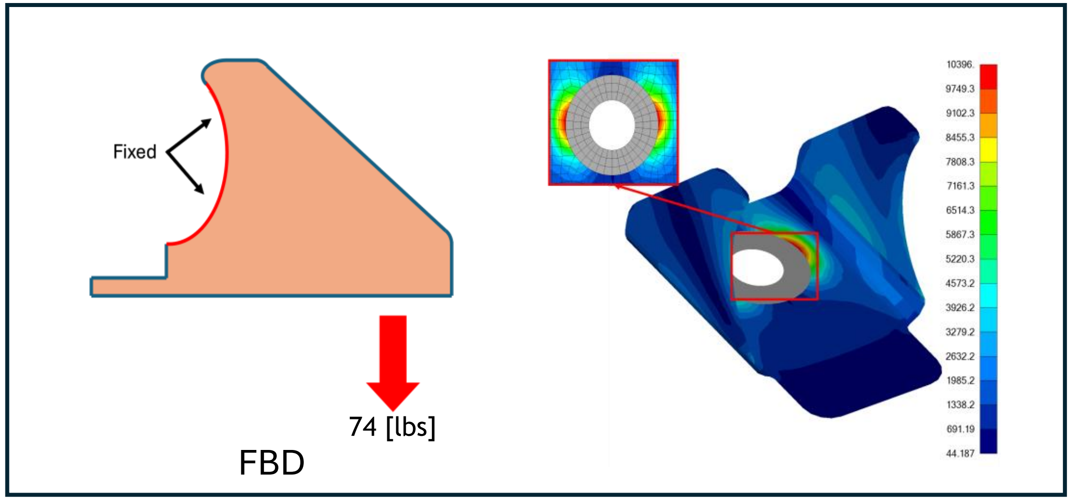
(Fall 2025 - Present)



Monocoque Strut clevis Analysis



Roll hoop Swanneck tab analysis



Roll hoop tension wire tab analysis

			FEM Output	Allowables	Safety Factors		Margins
Loadcase	Part Desc.	Material	σ_{VM} [psi]	F_{TY} [psi]	FF [-]	FS_Y [-]	MS_Y
Straightline Extreme	Strut Clevis	7075-T6	9593.9	68000	1	1.25	4.67027
Cornering Extreme	Tension Wire Tab	AISI 4130 Steel	10396	66717.36	1	1.25	4.13408
Straightline Extreme	Swan Neck Tab	AISI 4130 Steel	2014.7	66717.36	1	1.25	25.4922
					Min Margins		4.13408

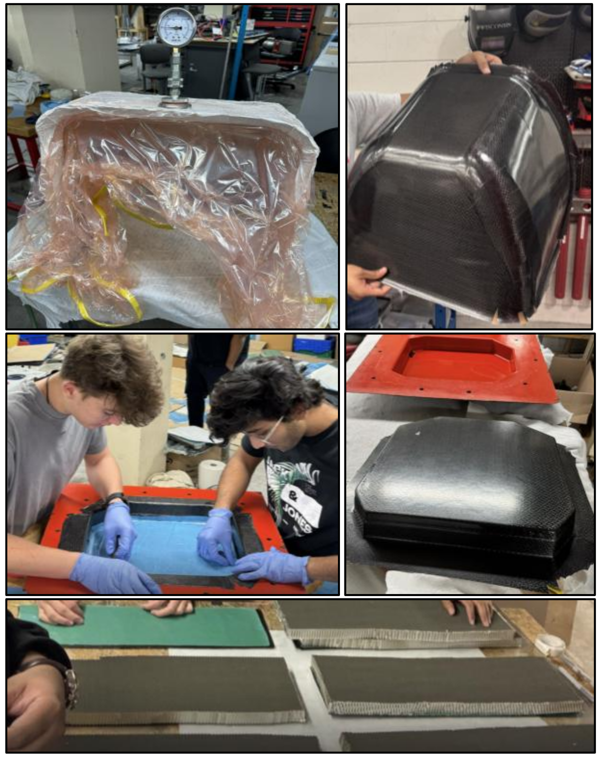
Presented margins for all the shown analysis

Wisconsin Racing FSAE:

Composite Manufacturing

(Fall 2024 – present)

- Designed and fabricated molds for RTM composite components, generated CAM in **Autodesk Fusion** and routed polyurethane/epoxy tooling boards on a 3-axis CNC
- Postprocessed the molds by applying vinyl ester coating, sanding and polishing to attain surface finish suitable for composite layups
- Utilized an additive manufacturing process for prepreg tooling using PC-ABS, including split-tool design for build volume constraints
    - Introduced a novel method of hot air filament welding to fuse the different parts together aligned by dowel pins.
- Produced aerodynamic and bodywork parts using RTM infusion and prepreg manufacturing processes
- Built prepreg laminate 3-point bend and impact structure test samples for mechanical validation of chassis structures

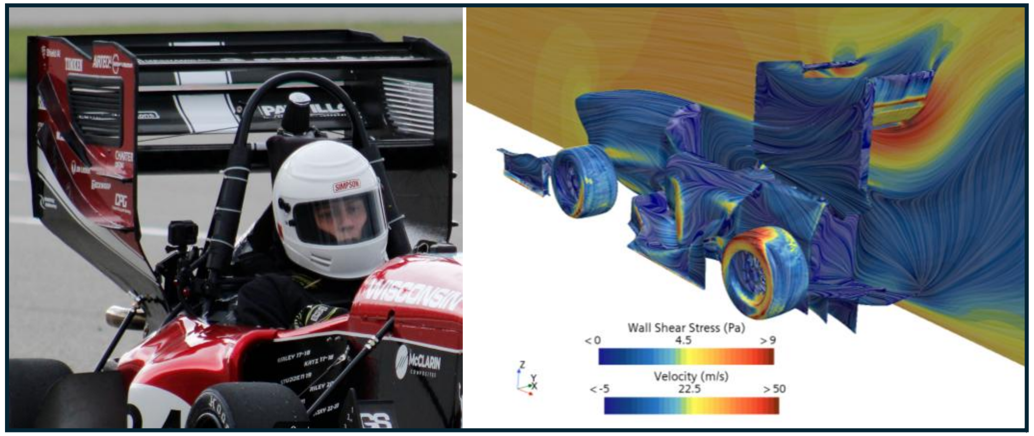

CFRP Prepreg Manufacturing


CFRP manufacturing through RTM infusion


Mold Manufacturing for composite parts

Wisconsin Racing FSAE:

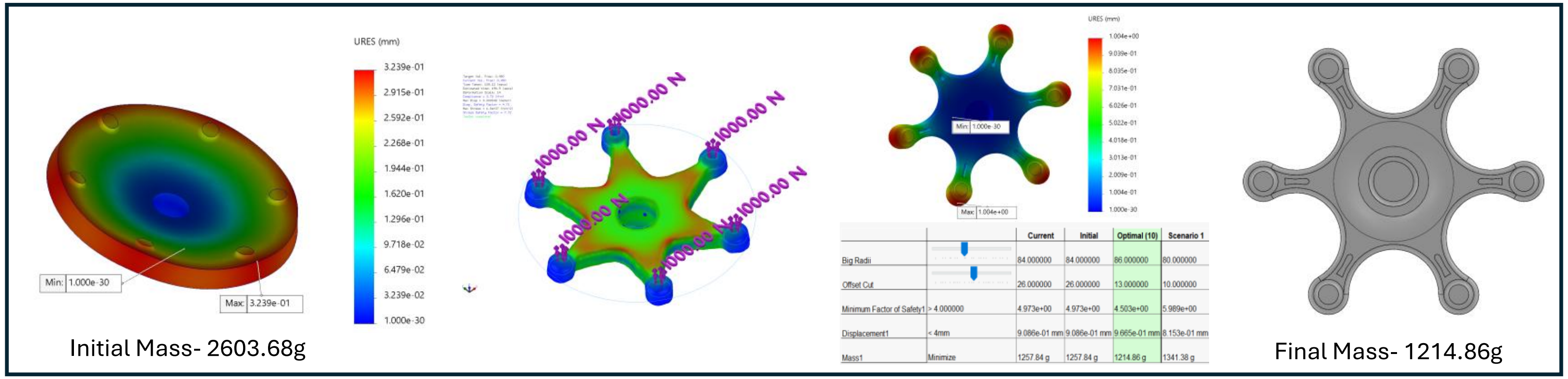
Other Analysis & Testing



Rear Wing Elements Redesign for 225 IC Car in **StarCCM+**


Machined Front Wing Mounts


Aerodynamic wind tunnel testing



		Current	Initial	Optimal (10)	Scenario 1
Big Radii		84.000000	84.000000	86.000000	80.000000
Offset Cut		26.000000	26.000000	13.000000	10.000000
Minimum Factor of Safety1	> 4.000000	4.973e+00	4.973e+00	4.503e+00	5.989e+00
Displacement1	< 4mm	9.086e-01 mm	9.086e-01 mm	9.665e-01 mm	8.153e-01 mm
Mass1	Minimize	1257.84 g	1257.84 g	1214.86 g	1341.38 g

Initial Mass- 2603.68g

Final Mass- 1214.86g

Topology optimization for drone base using **SolidWorks** topology and design studies


3 element cascade stall characteristic testing