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Background

- Stroke patients can suffer from spasticity due to brain damage and develop issues with movement, mobility, and general positioning of their foot and ankle
- Custom ankle foot orthoses (AFO) are manufactured using uni-directional carbon fiber/epoxy prepreg for optimal strength to weight ratio, and are designed to have a low profile to maximize comfort during use

Problem

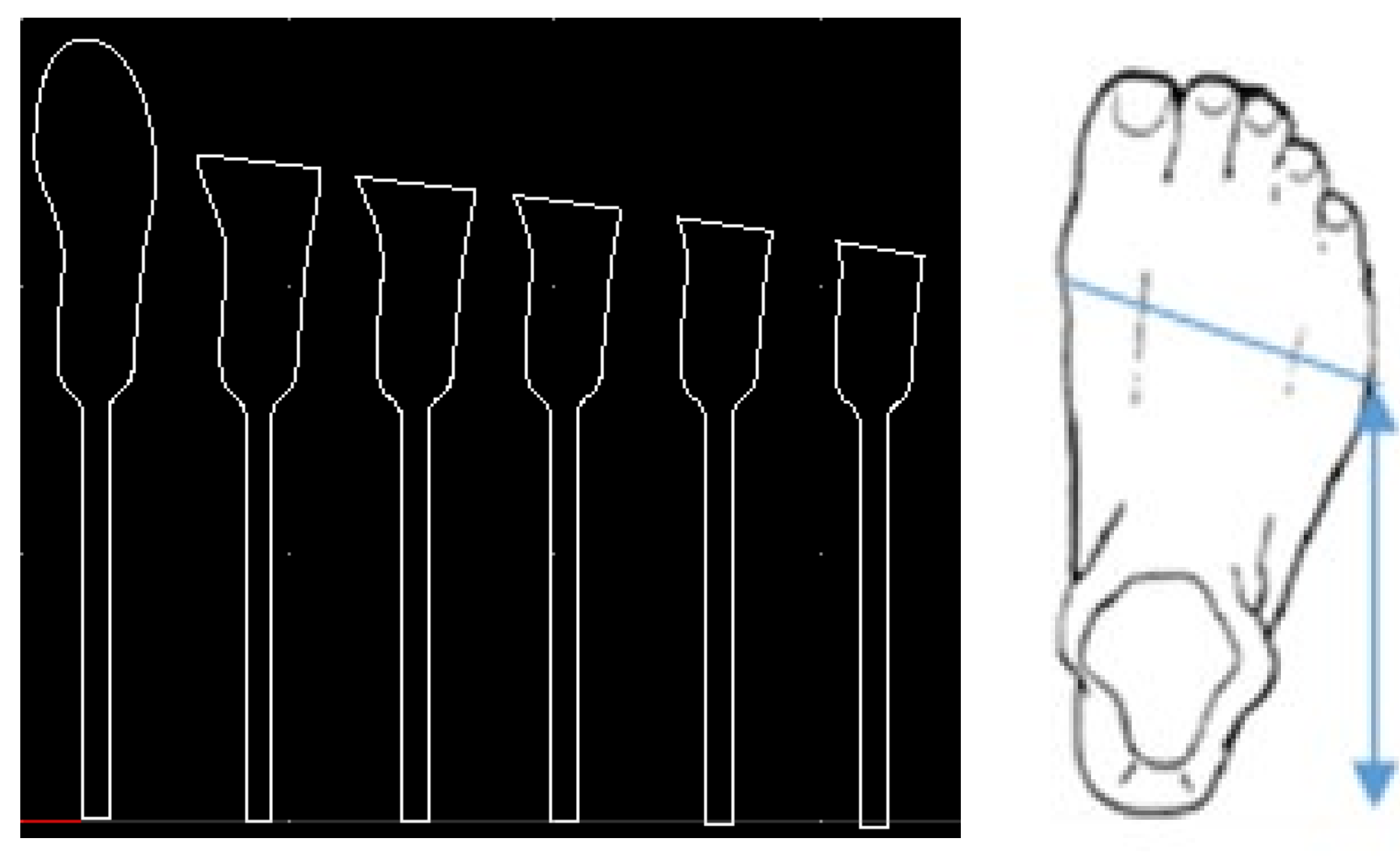
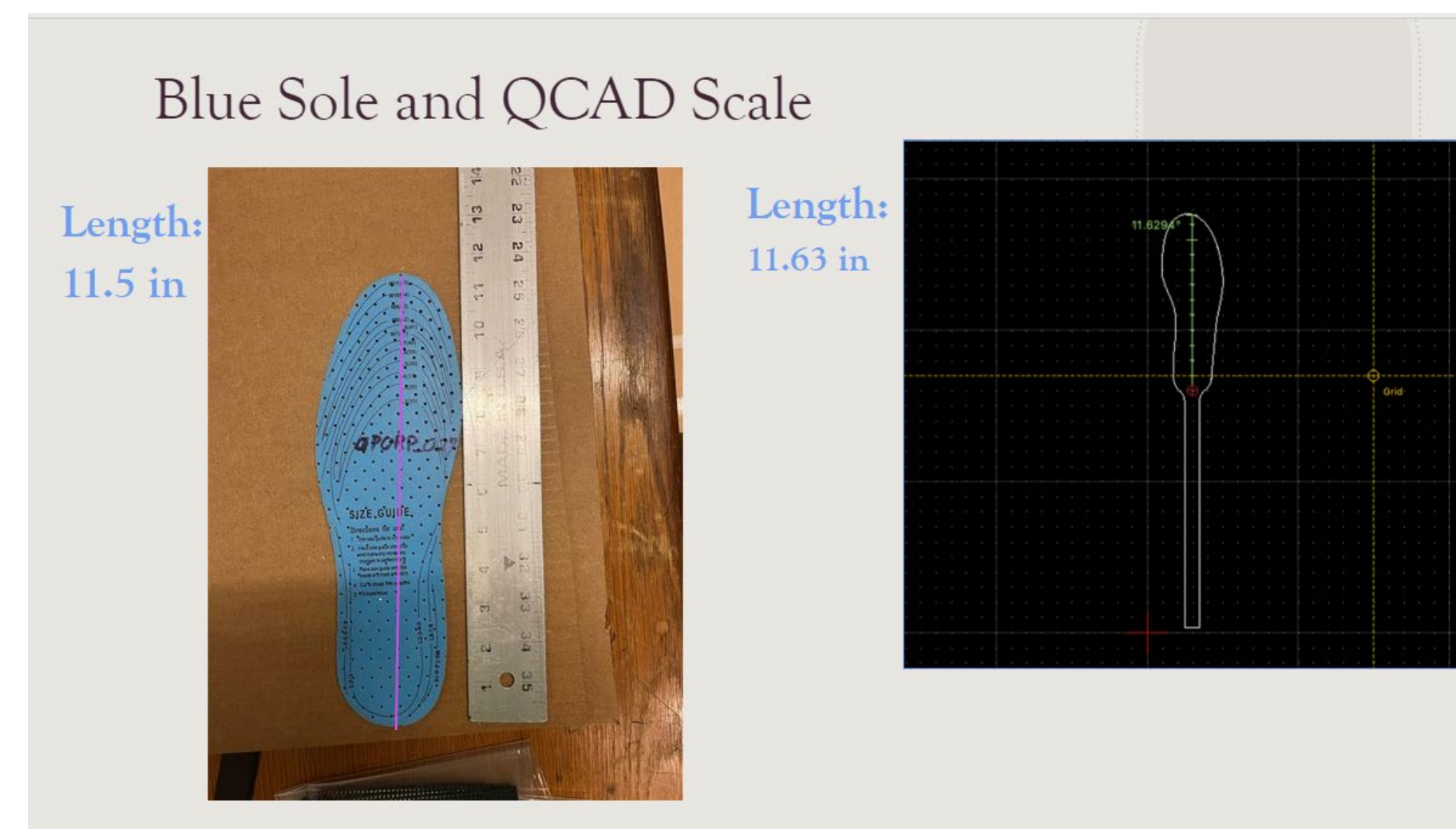
- Post stroke patients often lack stability and require assistance to walk due to muscular impairments caused by the stroke. This general lack of stability can lead to issues like pain, trouble walking and general risk of injury due to a fall

Approach

- Manufacture AFO with custom layers of prepreg carbon fiber according to patient foot dimensions
- Use computer aided design to design and optimize ply pattern for manufacturing

Ply Design and Manufacturing

- Ply design is chosen based on the geometry requirements in the datasheet
- Ply sizing is done according to the geometric requirements based on the patient's data sheet using QCAD to generate appropriate DXF's
- Number of plies and ply drops are determined based on stiffness requirement for the AFO
- Plies are nested and cut out using the Carlson Ply Cutter



Footplate/Strut Lay Up

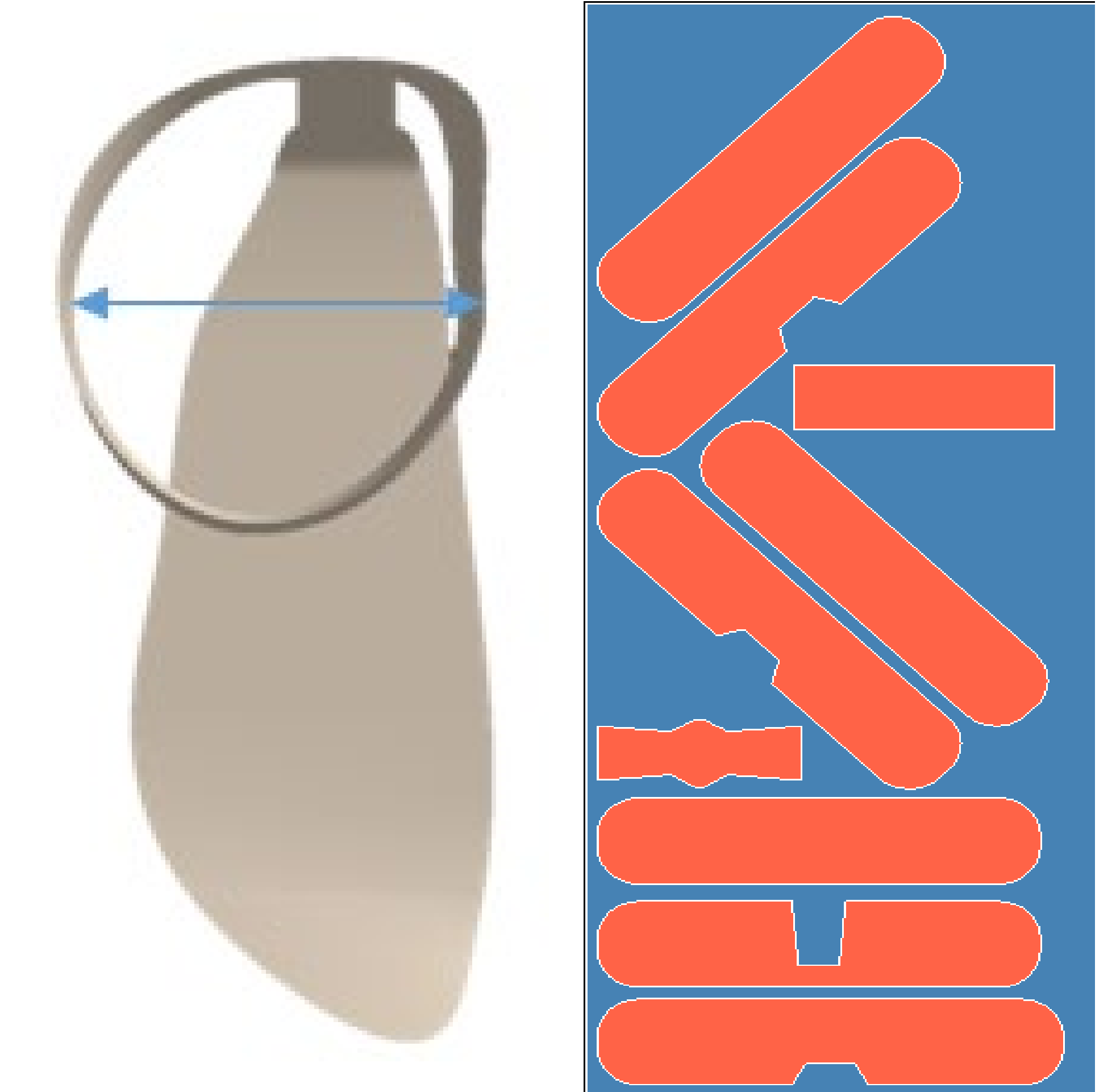
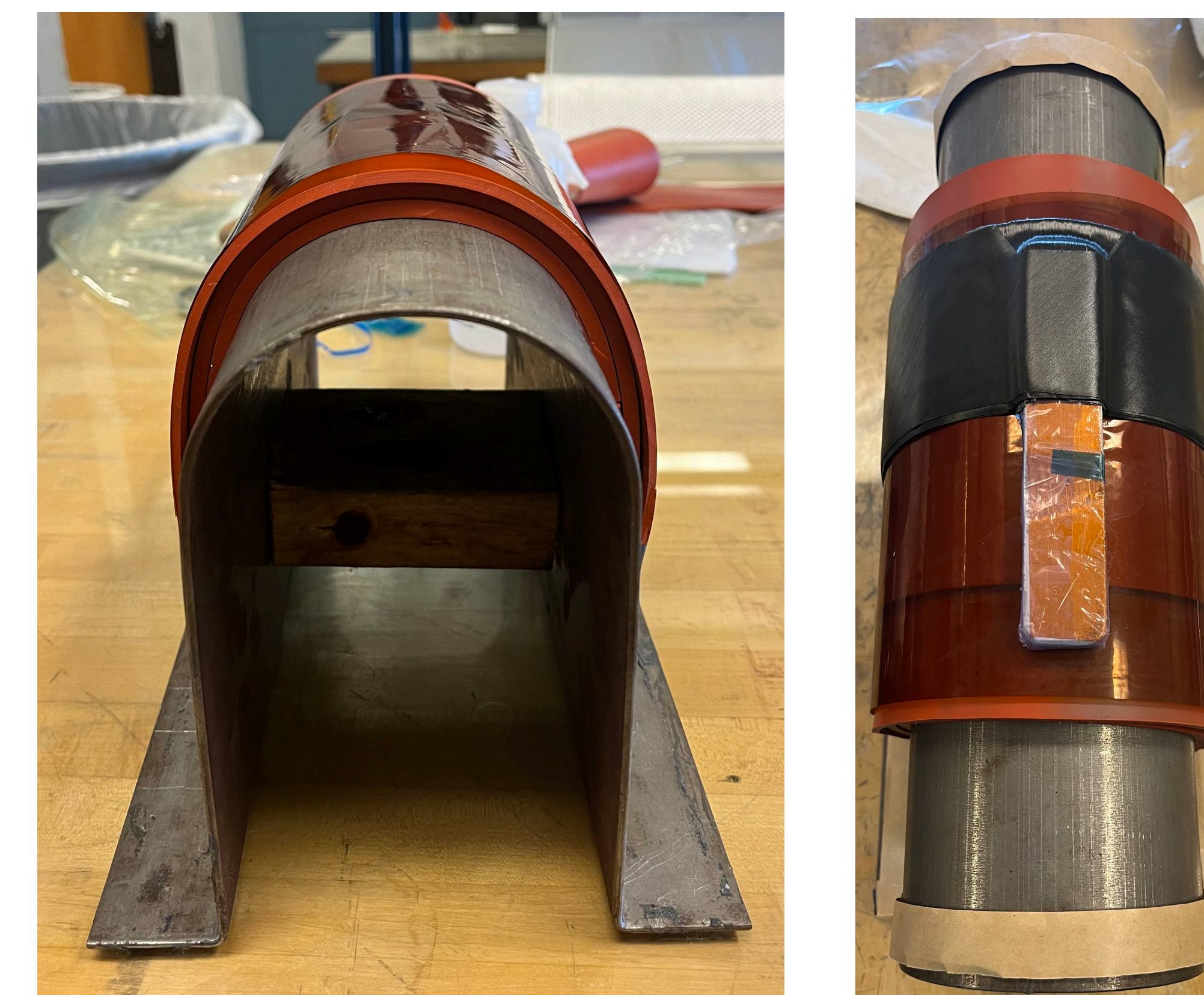
- A series of successive ply drops are used in the foot plate region to provide a comfortable fit and feel
- Debulking steps are used during the layup to ensure good compaction/nesting of the plies
- The layup is oven cured, under vacuum pressure with a dwell time of 1.5 hours at 250 F with 45 minute ramps



AFO 26 Ply Lay Up Order							
#	layer	#	layer	#	layer	#	
1	-45	11	M2	21	M3	31	M4
2	45	12	M2	22	M3	32	M5
3	M1	13	M2	23	M3	33	M5
4	M1	14	M2	24	M3	34	M5
5	M1	15	M2	25	M4	35	M5
6	M1	16	M2	26	M4	36	M5
7	M1	17	M3	27	M4	37	M5
8	M1	18	M3	28	M4	38	-45
9	M1	19	M3	29	M4	39	+45
10	m2	20	0	30	m4		

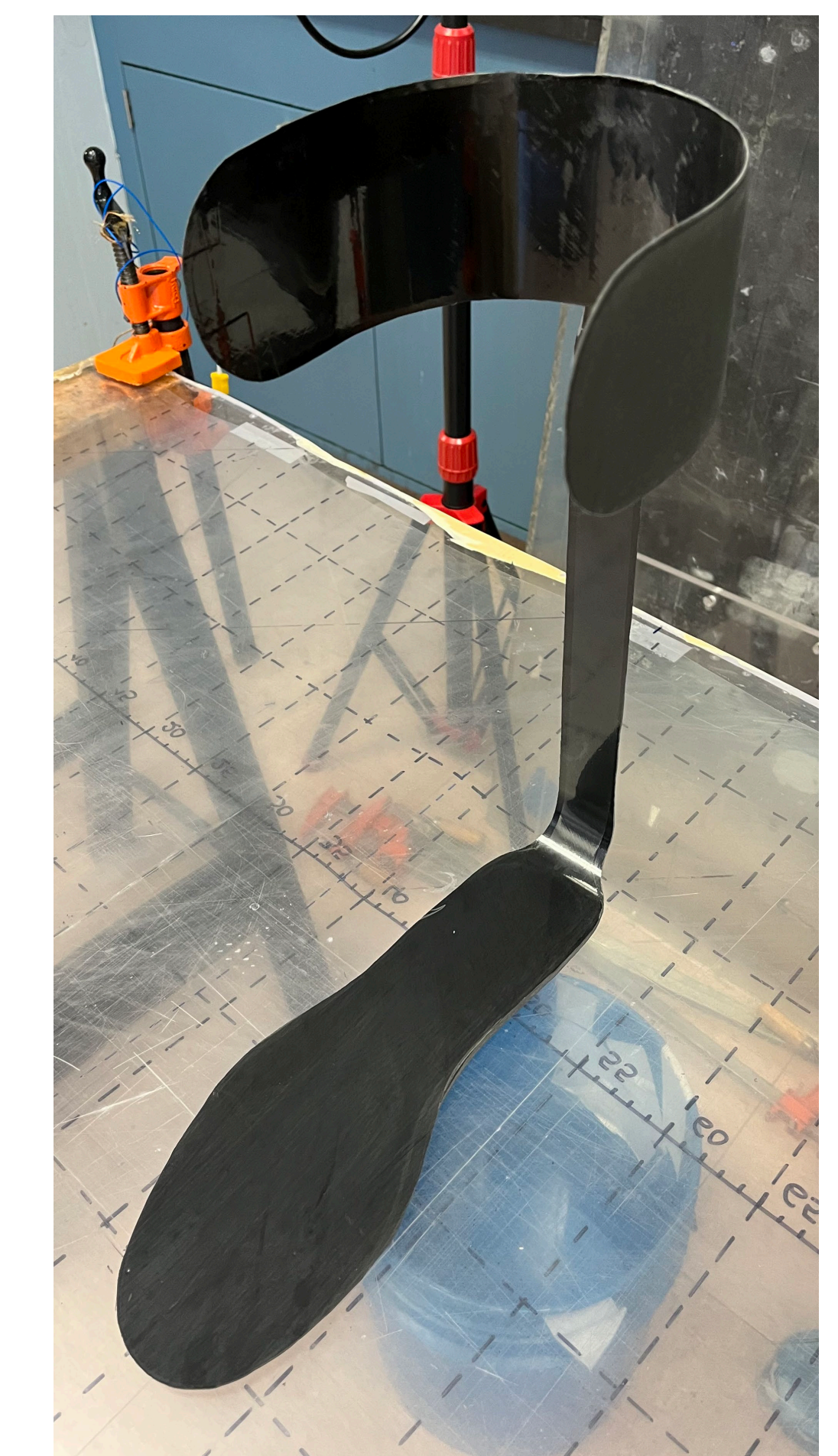
Cuff Design and Layup

- Similar to the foot plies, QCAD was used to design each cuff ply and measurements were made according to the patient's data sheet
- Cuff plies were nested and cut using the Carlson Ply cutter
- The cuff mold width is adjusted accordingly to the cuff width requirement for the respective AFO
- A metal insert is used to create a pocket for the strut attachment in a secondary step
- Cuff plies are cured in the oven under vacuum



Final Product

- Cured footplate/strut, and cuff are trimmed using power tools to meet the dimensions of the patient's foot
- Strut is fit into the cuff and delivered for patient fitting



Acknowledgements

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