An Insight Into My Thesis

Manufacturing and Design Process of Composite Airfoil

As part of my research at Purdue University, I have been involved in designing, manufacturing, and testing of composite materials in hopes of advancing the scope of Structural Health Monitoring (SHM) to real-life applications. SHM is the continuous evaluation of structural components to detect internal defects in materials usually not visible using the naked eye. For this purpose, non-planar CFRP (carbon fibre reinforced polymers) were manufactured to be tested. Below is a brief description of the design and manufacturing process I built and followed in order to further my experimentation.

Design the Aluminum Mold

The mold was designed based on

- Constraints set on the dimensions of the required airfoil, based on the test rig in which the airfoil shall be placed to be impacted in later stage of the experiment
- Curing oven size into which the mold shall be placed for manufacturing
- Availability of exact aluminum block sizes

Based on the above constraints, a block of 6x6x1.5 inches in size was chosen. **SolidWorks** was then used to design the female mold in the shape of NACA 4424 as shown in Figure 1.

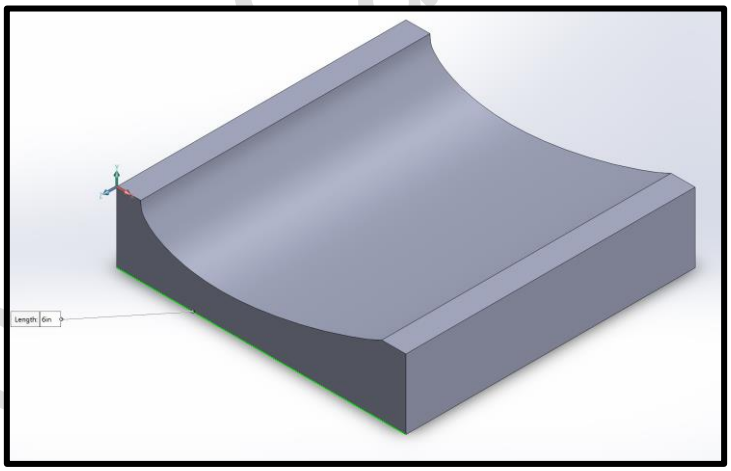

Figure 1 Design of the female aluminum mold

Manufacturing the mold

Once the design was confirmed, **Fusion360** was used to simulate the **CAM** process involving probing/facing/milling/finishing process of the mold to be fabricated as shown in Figure 2.

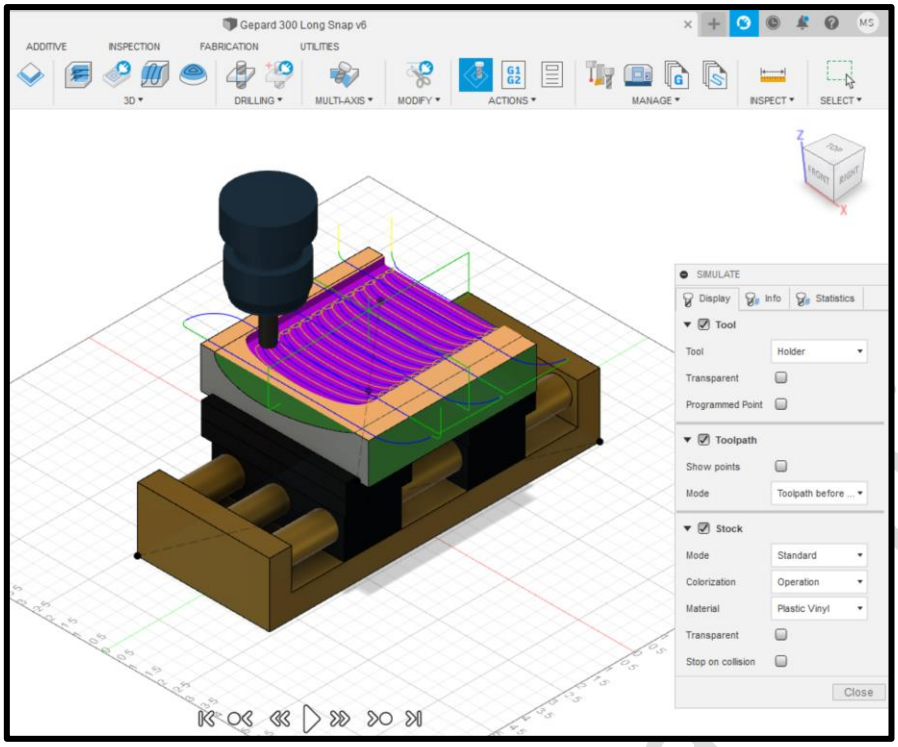

Figure 2 Simulation of CAM process using Fusion360

The CNC code was then generated to be fed into the 3-axis VF2 milling machine. The mold was then personally milled (with expert assistance for safety) at the university machine shop as shown in Figure 3.

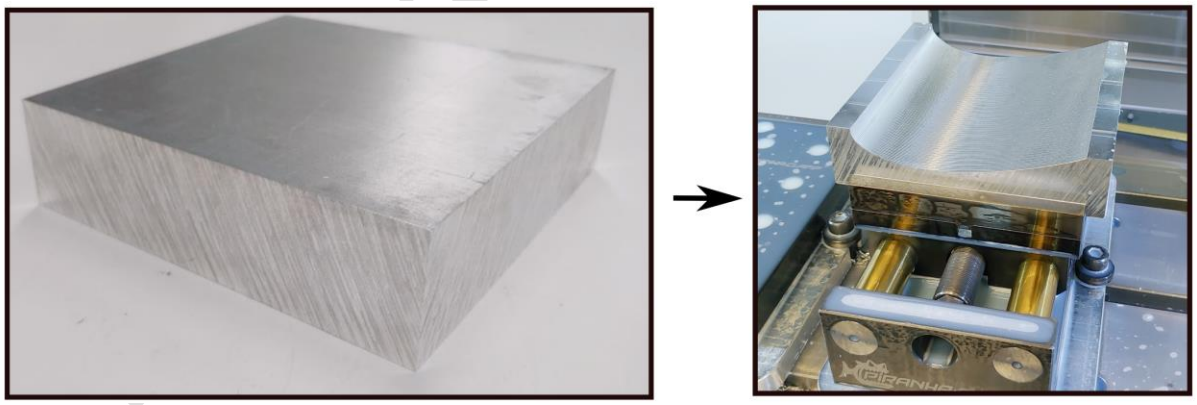

Figure 3 Stock to final milled product

Manufacturing carbon fiber airfoils

The milled mold was then used in the wet-layup technique to make a carbon fibre/epoxy laminate as shown in Figure 4. The laminate was cured in an oven under vacuum. This same procedure was used to make multiple airfoils of 5 inches in chord length and 4 inches in width. A representative example is depicted in Figure 5.

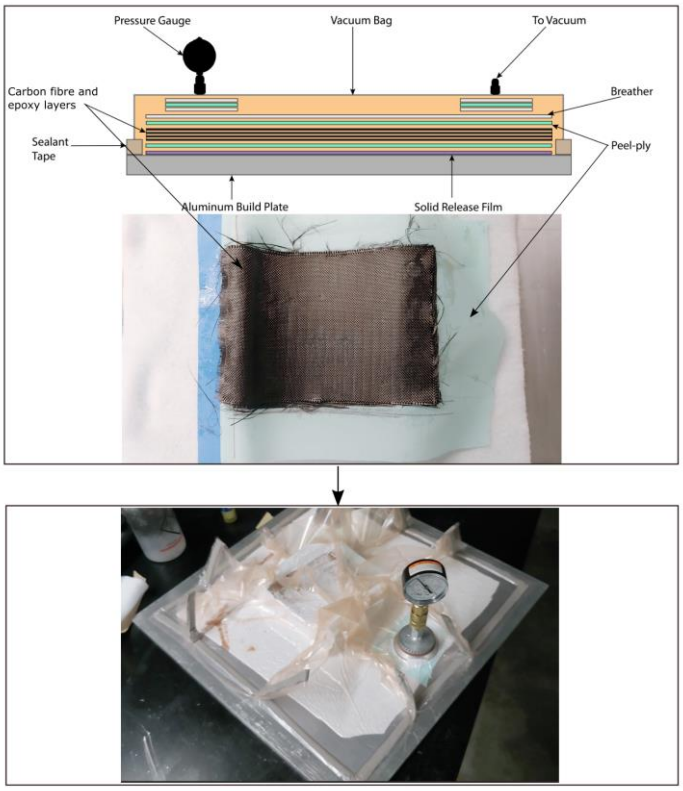

Figure 4 Wet layup of laminate to be vacuum bagged and cured in an oven

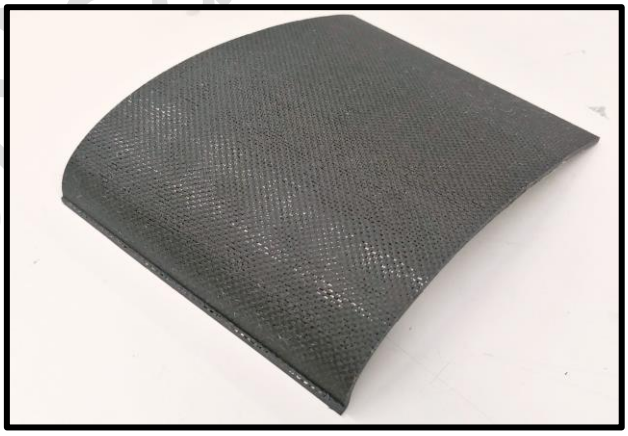

Figure 5 Final airfoil shaped composite laminate

These manufactured laminates undergo through-hole and impact tests to localize the caused damages using Electrical Impedance Tomography (EIT).

We have one accepted conference proceeding – ASME Smart Materials, Adaptive Structures, and Intelligent Systems (SMASIS) 2021 Conference.