Strength and Weight Optimization of Foam-Core-Free Composite Airfoil for Unmanned Aerial Systems

Master's Thesis Defense in Mechanical Engineering

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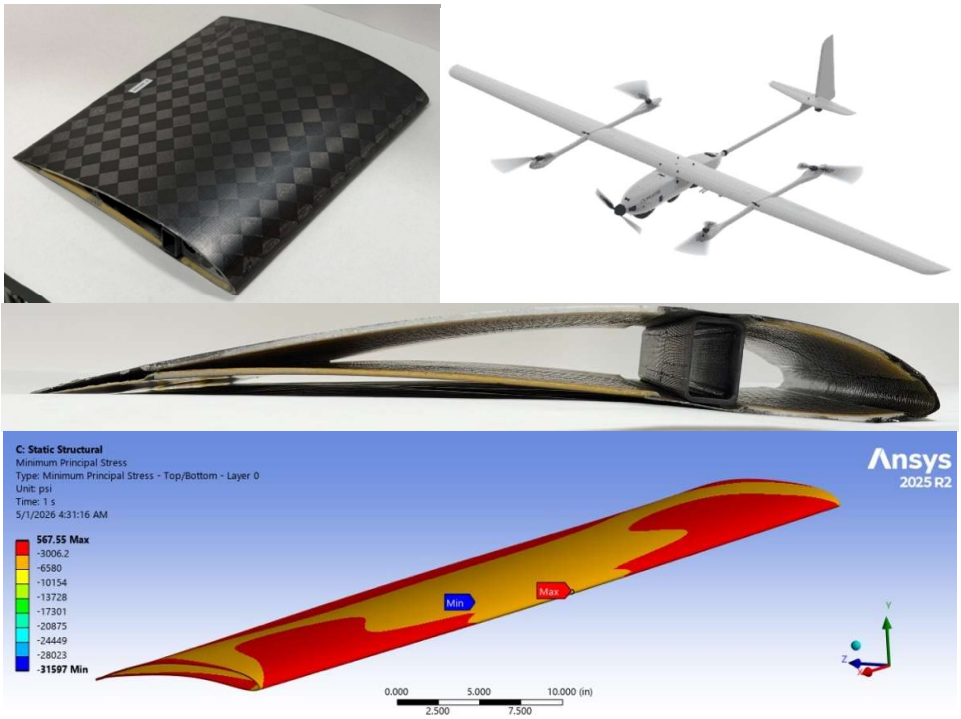

Composite airfoil structures are widely used in lightweight unmanned aerial systems (UAS) because of their high strength-to-weight ratio, but current foam-core wing designs can add unnecessary mass, introduce surface defects, and have a complex manufacturing process. This thesis investigates a redesigned composite wing section for the Edge Autonomy Stalker UAS by removing the solid extruded polystyrene foam core while maintaining the wings strength with carbon fiber, Kevlar, Divinycell foam, and adhesive-bonds. The proposed design is manufactured in an open configuration using an aluminum mold and silicone plug for laminate compaction, then bonded closed with a spar to form the final airfoil geometry. Physical prototypes, finite element analysis, weight measurements, and surface-accuracy scans are used to evaluate whether the redesigned wing can reduce weight while maintaining structural performance and improving manufacturability. Early prototype iterations showed improved surface finish, reduced weight, accurate shape, and improved compaction throughout. This work supports the development of lighter, more manufacturable composite UAS wing structures.