2016

Remote Control Aircraft

Thomas Gutema
Virginia Commonwealth University

Catherine Jones
Virginia Commonwealth University

Judy Liang
Virginia Commonwealth University

Kendall Moore
Virginia Commonwealth University

Team Members: Thomas Gutema, Catherine Jones, Judy Liang, Kendall Moore

Faculty Adviser: Dr. Atulasimha

MECHANICAL AND NUCLEAR

Remote Control Aircraft

Team: JTG Engineering

CAPSTONE DESIGN EXPO 2016

Theory

Problem Statement

Develop a remote controlled aircraft to take off, fly, and land in a controlled and repeatable manner.

Calculations

Design:

Airfoil - The Eppler 423 was an ideal choice for an airfoil due to its low drag coefficient and high lift coefficient.

Wing Design - Moderately tapered, top-mounted wings were chosen to maximize lift without losing stability during flight.

Fuselage - The diameter was minimized to 6 inches from the initial calculations of 12 inches, to reduce the overall weight of the plane.

Tail - Tail parameters were calculated using proportions from the wings and considering an estimated weight of the plane. From these estimations and relationships, the exact sizes of both the vertical and horizontal tails and their control surfaces could be determined.

Lift-Off:

Lift - Lift of an airplane is mostly driven by the weight of the plane and its drag.

Take off Velocity - The value used in the calculations was assumed to be around 15 m/s after research found typical lift-off velocity to be 12-17 m/s for RC aircrafts.

Power Required - The required power the engine would need to achieve lift off, determined to be 430W, is dependent on the coefficients of lift and drag, take-off velocity, and the assumed weight of the aircraft.

Torque Required - The required torque the motor would need to achieve take-off, determined to be 4.6 J/rad, is dependent on angular velocity of the propeller and the required power for lift off.

Structural Calculated Values	
Wing Span	6.6 ft
Wing MAC	13.6 in
Wing Surface Area	7.17 ft^2
Fuselage Length	5.5 ft
Fuselage Diameter	6 in
Horizontal Tail Span	2.09 ft
Horizontal Tail Area	1.09 ft^2
Horizontal Tail MAC	1.04 ft
Vertical Tail Span	12.03 in
Vertical Tail Area	0.67 ft^2
Vertical Tail MAC	8.02 in
Coefficient of Lift	2.357
Coefficient of Drag	0.5113

Lift :

$$L = \frac{1}{2} C_L \rho V^2 A$$

Power Required:

$$P_{req.} = V\left(\frac{W}{C_L/C_D}\right)$$

Torque Required:

$$T_{req.} = \frac{P_{req.}}{\omega_{req.}}$$

Design

Objective

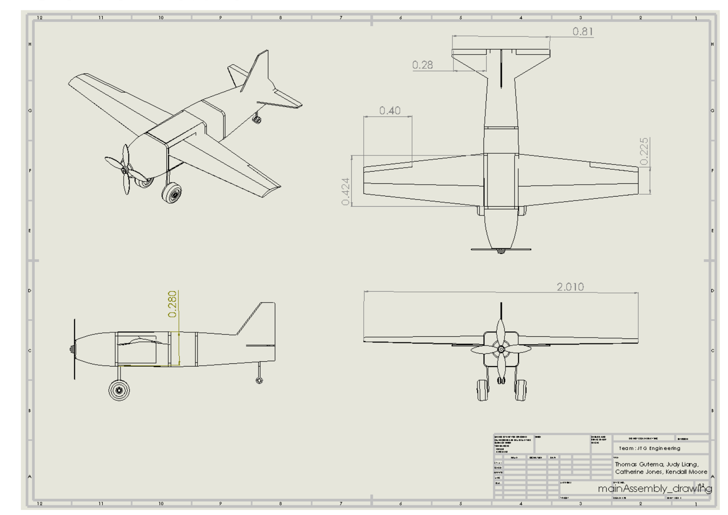
To design and fabricate an R/C aircraft that adheres to design considerations and can successfully fly and land with remote control operation.

Solid Modeling

SolidWorks : The aircraft was modeled using the Solidworks software package. Using the data from our calculations, we created a 3D design .

3D Model :

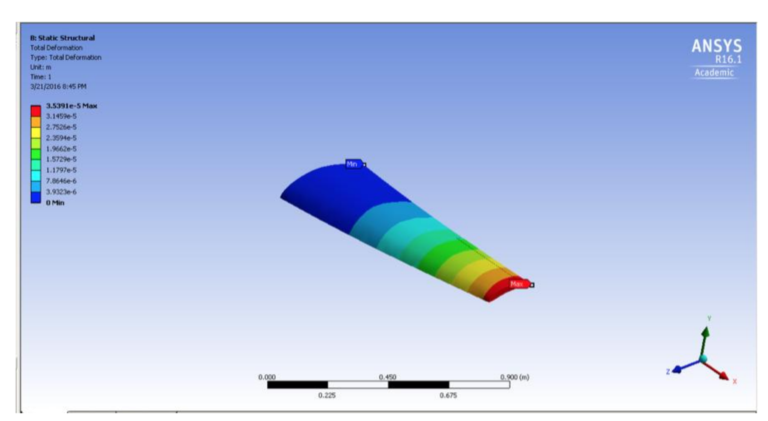
Schematic :

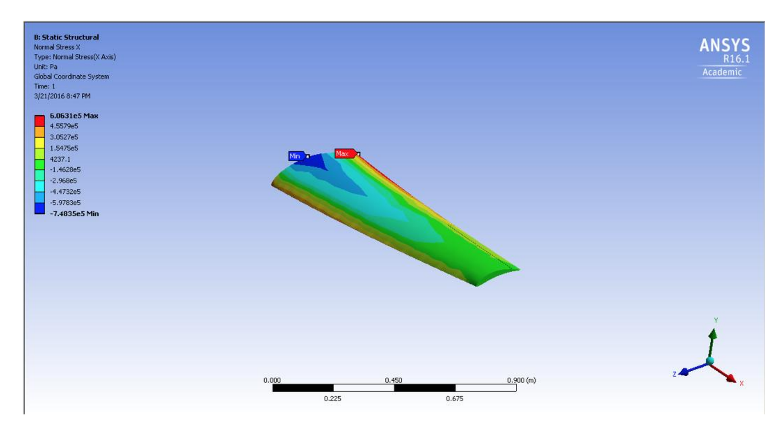


ANSYS : Using ANSYS Workbench, structural analysis was performed to find the deformation and normal stress on the structural components of the aircraft.

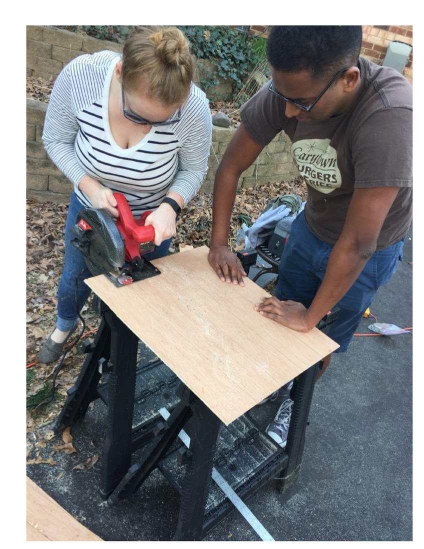
Total Wing Deformation due to lift

Max Deformation = 3.53E-5 m





Fabrication : Most of the fabrication was done by hand using power and hand tools. The structure of the aircraft was built using foam, balsa, and plywood; then covered with a plastic finish. The fuselage contains the main motor, the servo motors, and wires connecting to the control surfaces.



Engineering Process

Design Considerations

Safety

Due to toxic chemicals and adhesions, it is advised to wear safety equipment such as goggles, masks, gloves. Before operating power tools, steel toed shoes, hard hat, and safety goggles should be worn.

Manufacturing

The materials to be used will be balsa wood, plywood, and foam. Balsa wood was chosen for its light weight, with toughness properties increasing with sheet size. The fuselage and tail would be made of plywood and balsa wood, surrounded by foam. The wings would be also made with foam. The aircraft is assembled by hand.

Design Limitations

Limitations encountered are obtaining supplies on time, finding a location for fabrication, assembly repairs due to fractures from cutting, budget of $500, and testing old parts.

Regulations

The Federal Aviation Administration (FAA) says that small Unmanned Aircraft Systems (UAS):

- Must be flown during the day in the operator's visual line-of-sight
- Weigh under 55 lb,
- Have a maximum speed of 100 mph,
- Have a maximum altitude of 400 ft above ground
- Yield to other aircrafts,
- Must not be carelessly operated

Working Cost Analysis–

Item	Units	Cost Per Unit	Total Cost
Balsa Sheet (1/32 x 4 x 36 in)	5	$2.49	$12.45
Balsa Sheet (3/32 x 3 x 36 in)	10	$5.41	$54.10
Balsa Sheet (1/2 x 3 x 36 n)	5	$6.25	$31.25
X-acto FIle Set (Item 790-73610)	1	$16.65	$16.65
X-acto Razor Saw (52T / 5 - 1/2")	1	$4.09	$4.09
Sand Paper (220 grit)	2	$7.63	$15.26
Sand Paper (150 grit)	2	$7.63	$15.26
	Total	$50.15	$149.06