SAE Aero Micro: Final project Proposal

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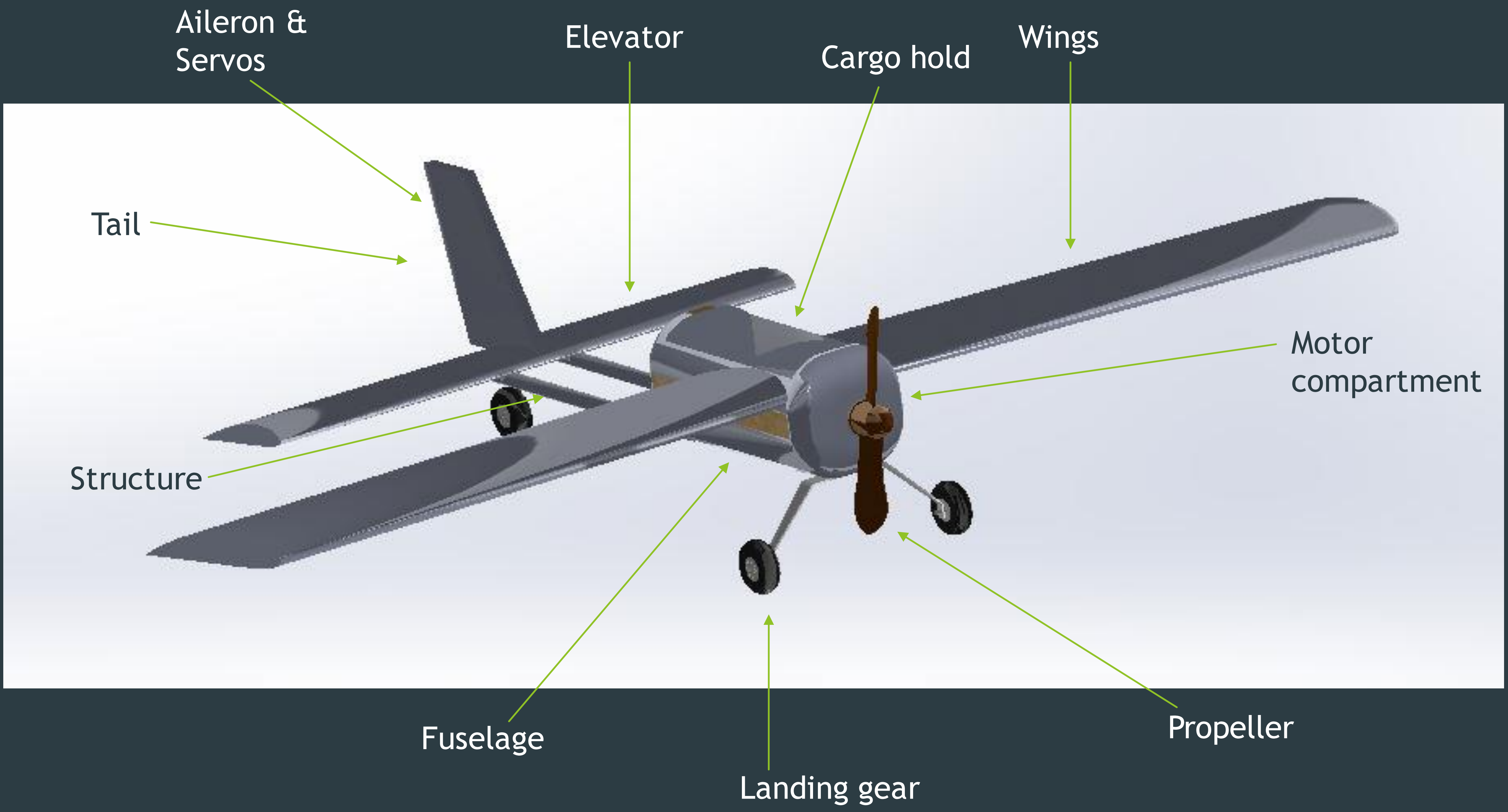
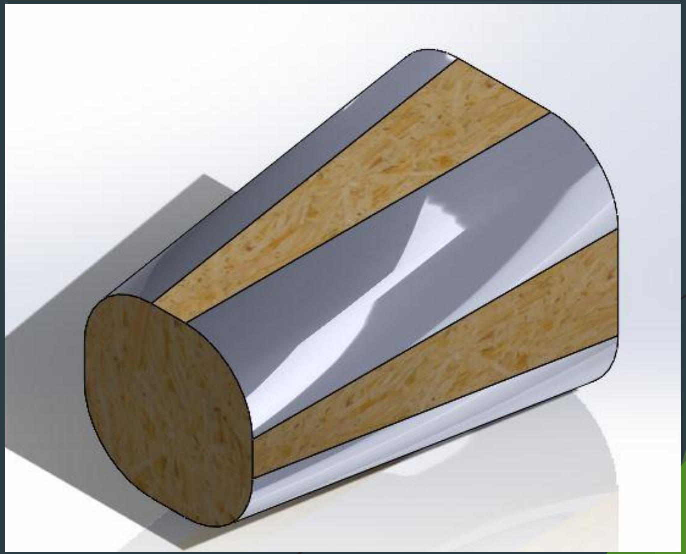
Project Description

- SAE Aero Micro Class
  - Design aircraft that can take off and land
  - Meet all SAE Aero requirements
- Sponsors
  - NAU Department of Mechanical Engineering
  - W.L. Gore


Aileron &
Servos
Elevator
Cargo hold
Wings
Tail
Motor
compartment
Structure
Fuselage
Landing gear
Propeller

Design Description

- Design functions
  - Structure
    - Balsa wood, Reinforced ribs in every structure
    - Foam, tape
    - Hollow connection rods
    - Solid Landing gear
  - Cargo hold
    - Fuselage, max volume
    - Landing gear and extension connection points
    - Non-retracting landing gear
  - Tail
    - Rudder controller
  - Elevator
    - Aileron
    - Reinforced connection points
  - Motor
    - Brushless, electric motor
  - Servos
    - Micro, metal gear, high torque
    - Controls the Ailerons
  - Propeller
    - Brushless, electric motor, thrust



Design Requirements

- Technical Requirements:
  - **Meet SAE rules and regulations**
  - **Adequate servo sizing for aerodynamic forces**
  - Thrust
  - Optimize safety factor
  - Drag forces
  - Lift forces
  - Increase impact tolerance
  - Lightweight

Jared

Design Requirements

- Customer Requirements:
  - **Meets requirements of rules**
  - **Able to take off and land**
  - Static load capability
  - Safe design
  - Manufacturable
  - Low Cost
  - Must have one cargo bay
  - Appropriate center of gravity

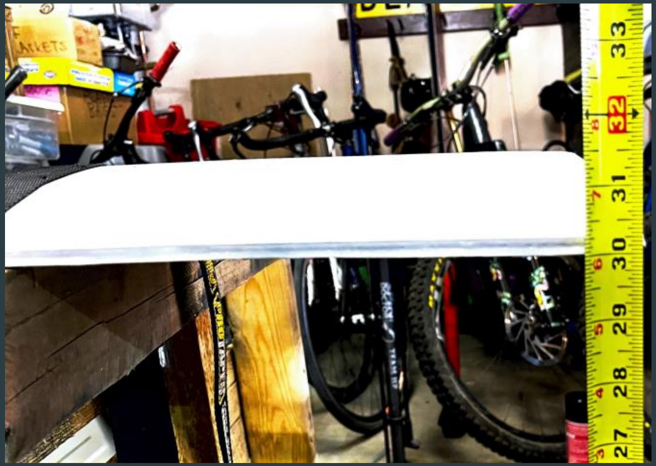
Jared

Design Validation

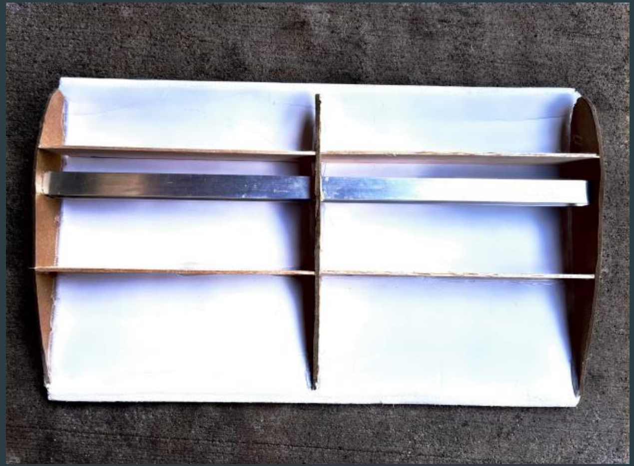
- Test the validity of the wing design
  - Three unique designs
  - Balsa wood, hot glue, foam, tape
  - Three tests to show final design choice
  - Two weighted tests, one torque test

- Design 1: Melissa
  - A frame design
  - Middle weight: 27 lbs, .1 in of deflection, broken outer wrap
  - Torque: 4 lb/ft, two broken small inner beams, broken mount
  - One end weight: 6 lbs, 3.5 in of deflection, one broken rib, broke mount again
  - Max deflection: .2 inches
  - Final comments: 1 broken outer wrap, 3 broken small inner beams, broke the connecting mount. Physically could not break it.

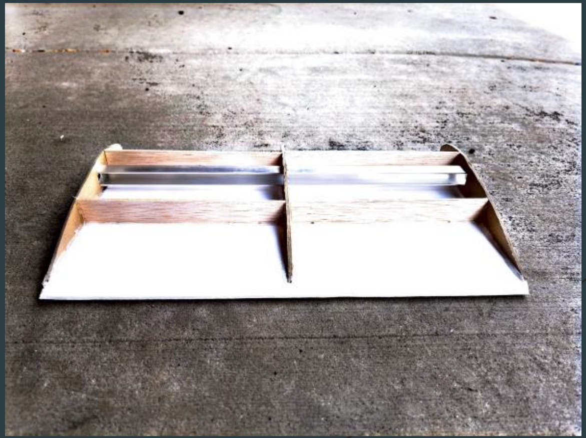
Design Validation



- Materials:
  - Balsa wood, chipboard, hot glue, foam board, packing tape, aluminum



- Design 2: Jared
  - Middle weight: 10lbs, 1/8 in. Deflection
  - Torque: 4 ft/lb, 1/8 in. Deflection
  - One end weight: 5 lbs, 1in Deflection
  - Final comments: Wing did not break, stress caused resulted some deflection as well as bending due to mounting surface slop.



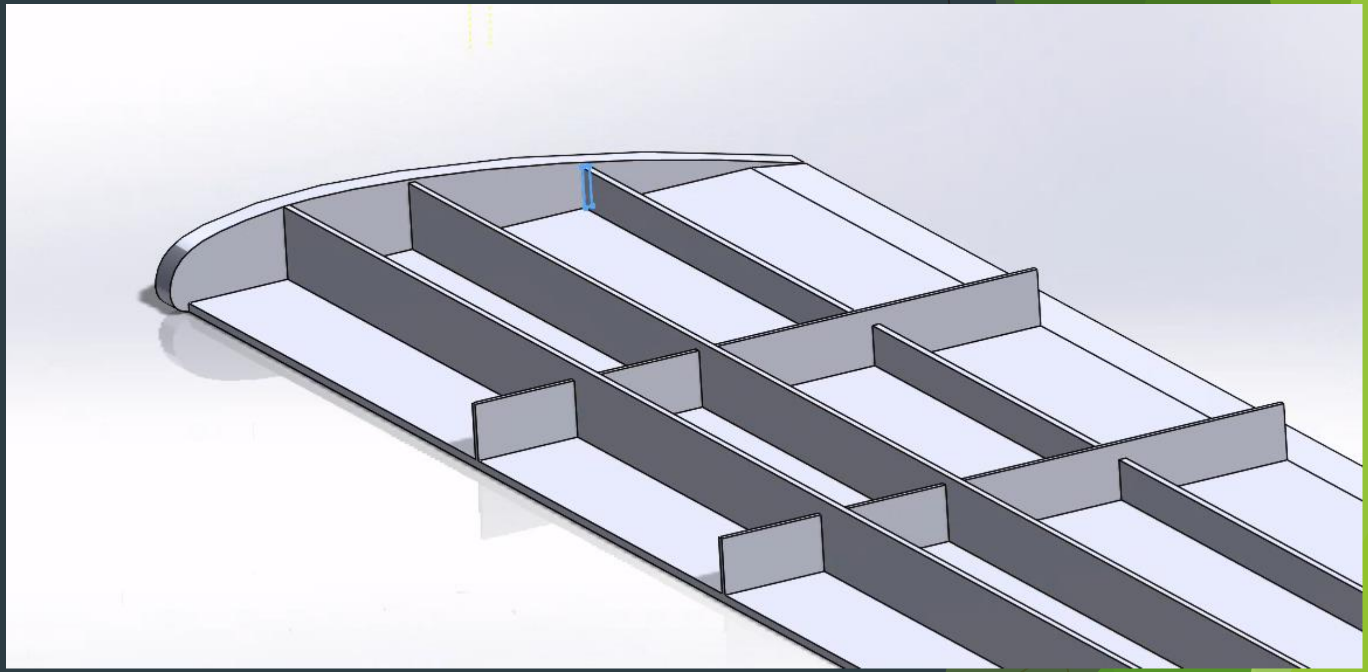
Design Validation

Design3: Junjie
Materials:light wood, glass glue, iron nail, aluminum alloy support

The test is still being planned. According to the plan, the test will test the bearing capacity, torque, lift and weight of the wing to determine whether the wing can meet the design requirements.

The instruments required for the test including: force measuring device, torque measuring device (if any), electronic scale, ruler.

Site requirements: indoor space that can provide safety assurance.



Junjie Shi

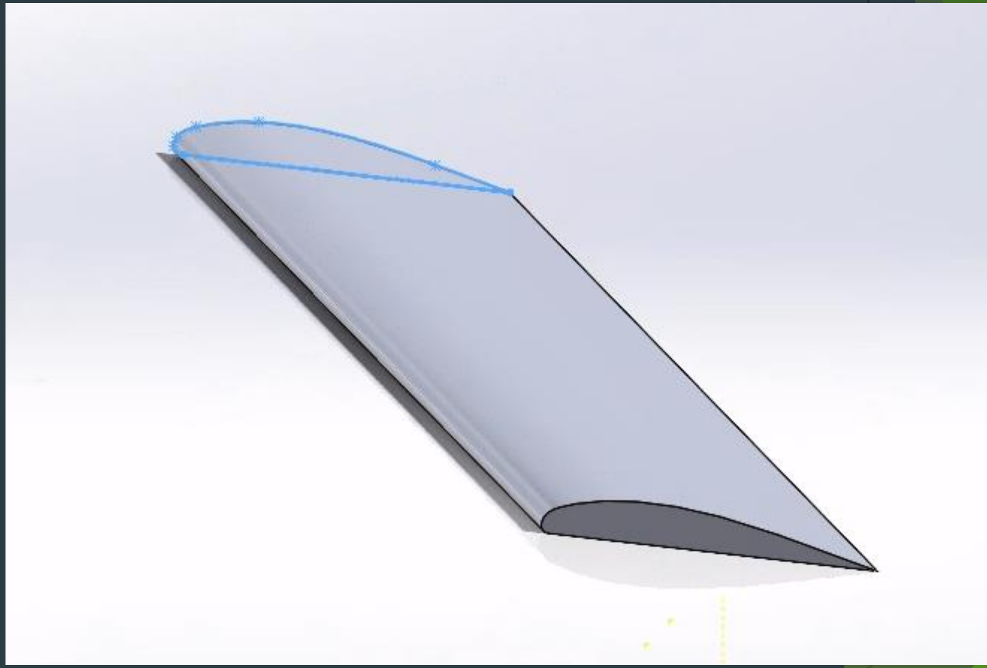
Wings

- Lift coefficient needed

  Cy=2Y/(ρV^2S)=

  2*55lbf/(1.225kg/m^3)(20m/s)^2(100in^2)

  =15.478



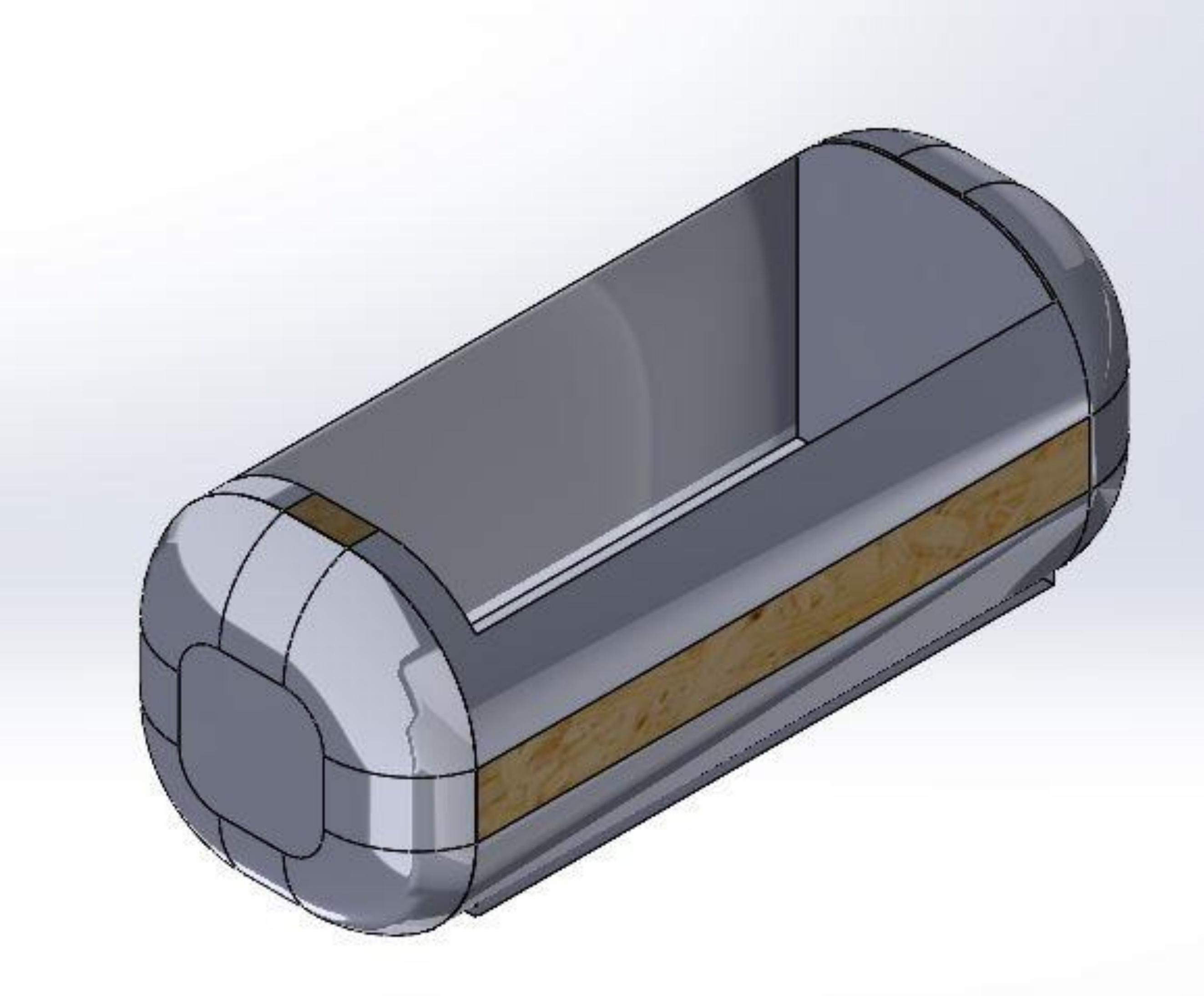
- Maximum Shear Stress
- τ=F/A=55lbf/2.19in^2=

  244.651 N/1.413*10^-3 m^2

  =173.155 KPa

Fuselage

- Cargo Bay Volume
  - L x W x H = V
    - $9\ in * 4\ in * 3.82\ in = 137.52\ in^3$
- Impact Tolerance
  - Impact Force
    - $F = \frac{m*g*h}{d} = \frac{3.27\ lb*384\ \frac{in}{s}*5\ in}{.1\ in}$ = 62,784 lb in/s



Electronics

- Thrust
  - Thrust = weight * thrust/weight ratio
  - Thrust = 1800g * 0.7 = 1260g
  - Power = thrust * power/thrust ratio
  - Power = 1260 g * 0.226 W/g = 284.76 W
  - Current motor: 600W max
- Servo torque
  - Servo torque: 91 oz-in @ 7.4V
  - Micro servo (lightweight)
  - Metal gears

Landing Gear

- Maximum force:

$$F = m * a = 3.9N$$

- Maximum deflection:

$$\Delta_{max} = \frac{F L^3}{48EI} = 0.0096m = 0.96cm$$

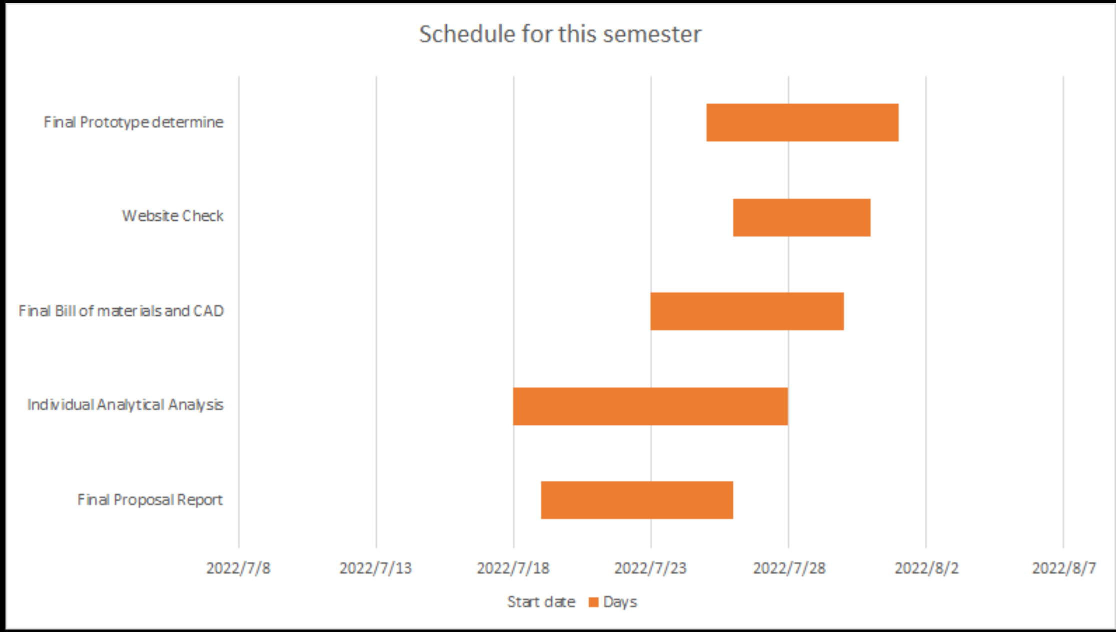
- Material Selection: Aluminum
- Material width: 5mm

Design Validation

Subsystem	Potential Failure	Mitigation	Trade off
Aileron	Surface Fatigue	Layering of materials	Added weight
	Low-cycle Fatigue	Layering of materials, easy to replace	Added weight, higher cost of replacement parts
	Abrasive wear	Layering of materials, proper lubrication	Added weight
Elevator	Abrasive wear	Layering of materials, proper lubrication	Added weight
	Impact Deformation	Layering of materials, internal structural supports	Added weight, more materials needed for internal supports, higher cost, higher manufacturing time
Motor	High-cycle Fatigue	Proper lubrication, proper connection points	Higher cost for a better motor
	Impact Fatigue	Contained connection lines	Larger fuselage, more loss of connection points
Servos	High-cycle Fatigue	Proper lubrication, proper connection points	Higher cost for a better servo
	Impact Fatigue	Contained connection lines	Larger fuselage, more loss of connection points
Landing gear	Impact Fatigue	Longer body, stronger connection points and supports	More materials, added weight

Schedule

Schedule for this semester



- Currently on schedule
- Now working on Analytical Analysis
- Specific tasks are assigned every meeting
- Few dates subject to change.

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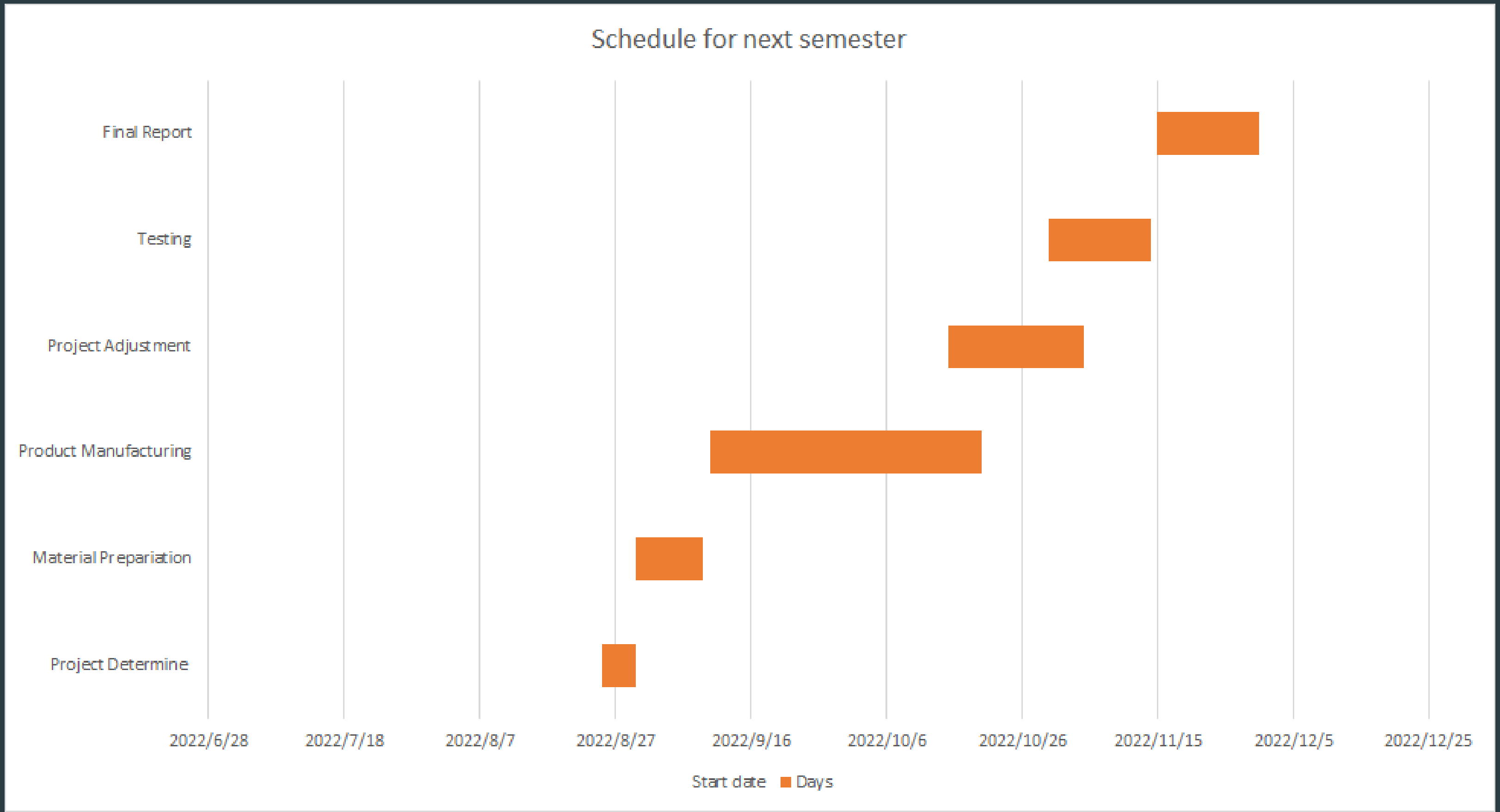
Schedule

- Schedule for next semester



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Budget

- **Current budget**

  Total budget: 1500 USD

- Current expenses

  Motor: $ 89.99

  Servos: $ 54.99 * 4

  ESC: $ 69.99

  Battery and charger: $ 49.99

  Transmitter and receiver: $ 279.99

Purchasing List		
Name	Number	price
Motor	1	89.99
Servos	4	54.99*4
ECS	1	69.99
Battery and charger	1	49.99
Transmitter and receiver	1	279.99
	Total	709.92

Total: 709.92 USD

Resulting Balance: 790.08 USD

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Future work

- Website Check
- Final Proposal Report
- Individual Analytical Analysis
- Next Semester
  - Meet as a team to build
  - Build main structure first, adding on subsystems later
  - Main focus being manufacturing process
  - Team will use Engineering Building as a meeting and testing location
  - Use of the Maker Lab, Internet Café, Machine Shop and Library to complete tasks and manufacturing

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References

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