# 2019 NAU SAE Micro Aero Final Presentation Flapjacks Team #329

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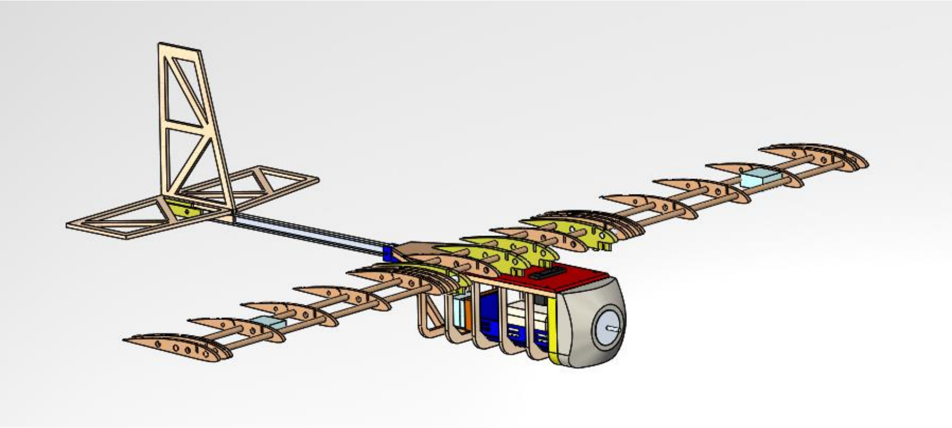

# Project Description

The goal of this project was to create a micro aircraft capable of completing competition requirements in one academic year and compete in Van Nuys, California on April 5th at the SAE Aero Design West Competition [1].

The team's goal was to place in the top 50th percentile at competition and complete multiple test flights.

# Competition Requirement

1. Must fit within box dimensions: 12.125” long X 13.875” wide  X 3.625” tall
2. Must be electrically powered
3. Must be assembled within 3 minutes
4. Must be radio controlled
5. Payload is 2” PVC standard wall pipe

5  Carry a high payload-to-weight fraction

# Anatomy of an Aircraft

- Aileron
  - Controls rolling
- Rudder
  - Controls yawing or side-to-side motion
- Elevator
  - Controls pitching or up and down motion
- Fuselage
  - Main body

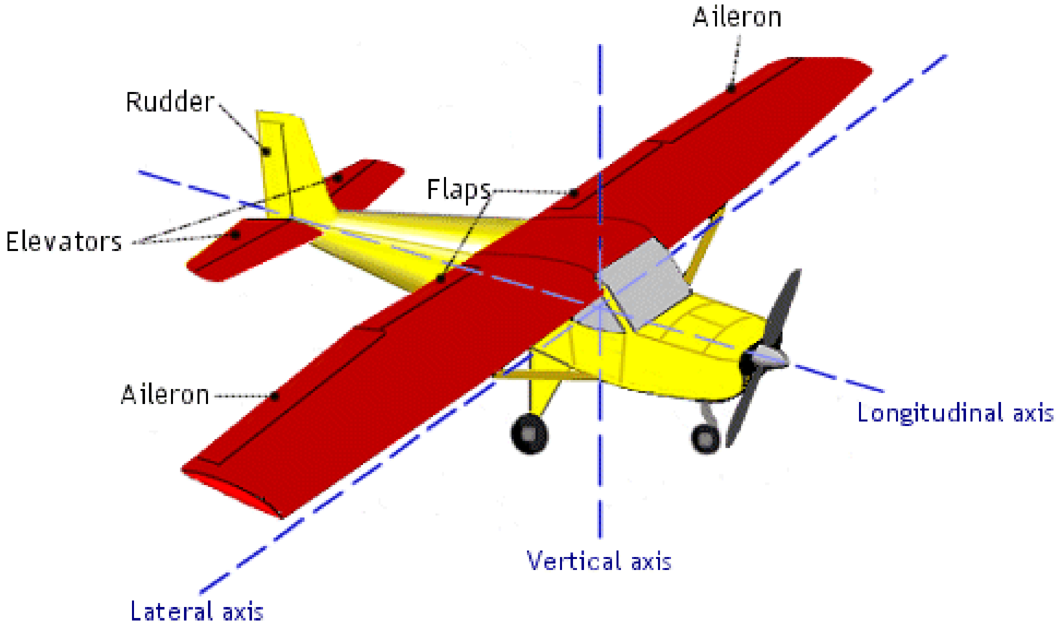


Figure 1: Aircraft control surfaces [2]

# Initial Design

- Modular interlocking fuselage
- Tail mounting bracketry
- Wing dowel inserts
- Payload carrying wing rib

# Fuselage and Tail Bracket

- Holds position of tail shaft in x, y, and z direction
- Holes for quick installation of tail shaft and hardware
- 3D printed PLA material

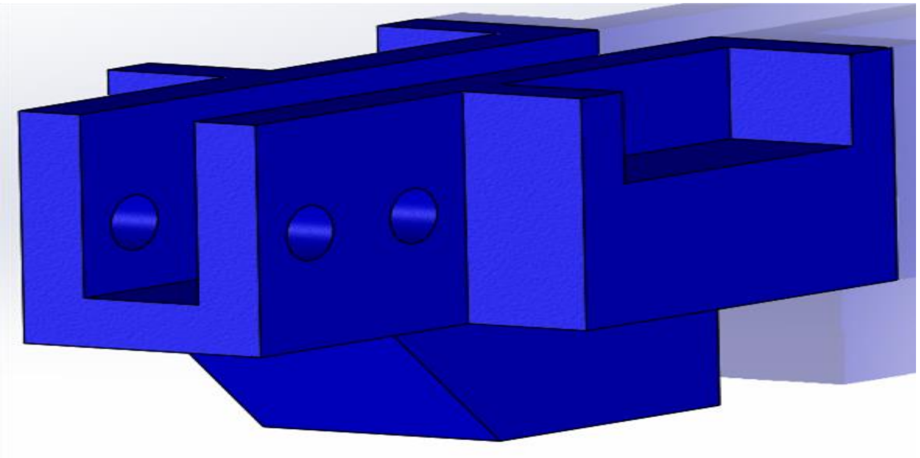

Figure 1: Fuselage mounting bracket

# Wing Dowels and Payload Rib

- Combination of two pieces solves 2 problems
  - Holds wings in place
  - Mounts payload
- Payload spacer material is ABS
- Wing dowel is machined 6061 aluminum

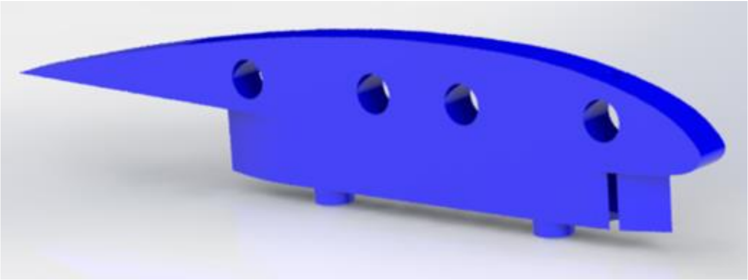

Figure 2: Wing and payload attachment rib

Figure 3: Wing dowel attachment

# Payload and Wing to Fuselage Attachments

- Size and weight
- Compact and quick assembly
- Safety

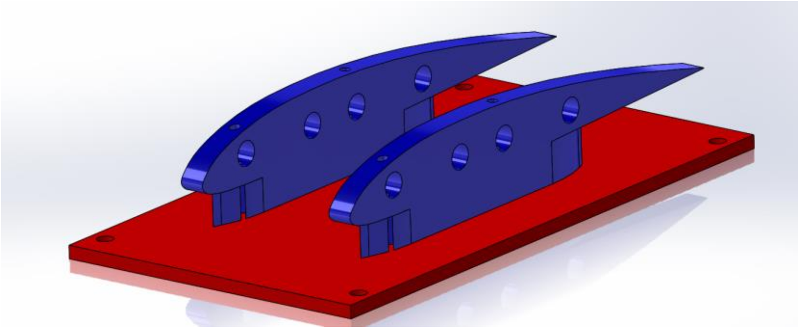

Figure 4: Wing to fuselage attachment

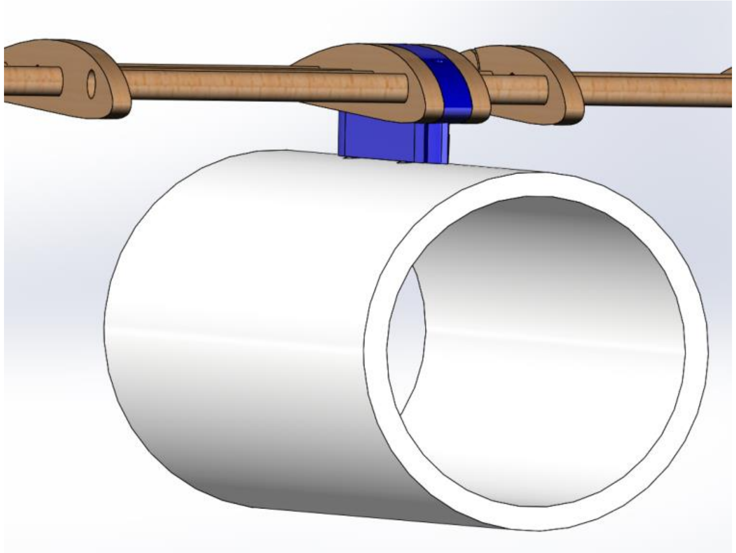

Figure 5: Payload attachment

# Simulation Video

# Manufacturing (Initial Design)

- Laser cutting for tail, wings, and fuselage
- Modular design for ease of replacement

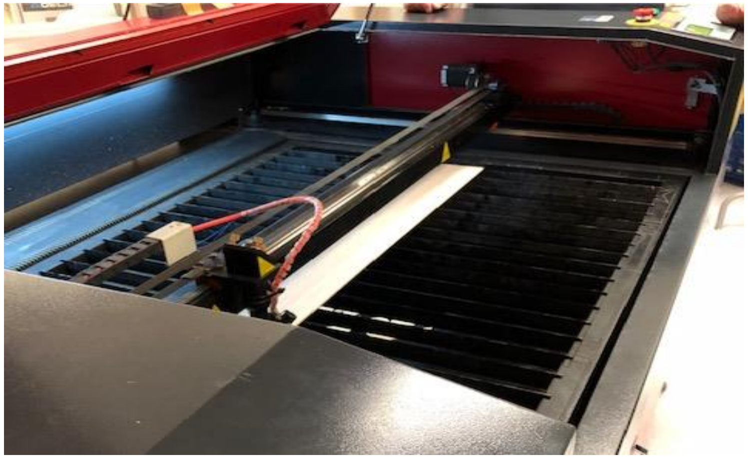

Figure 6: Laser cutter

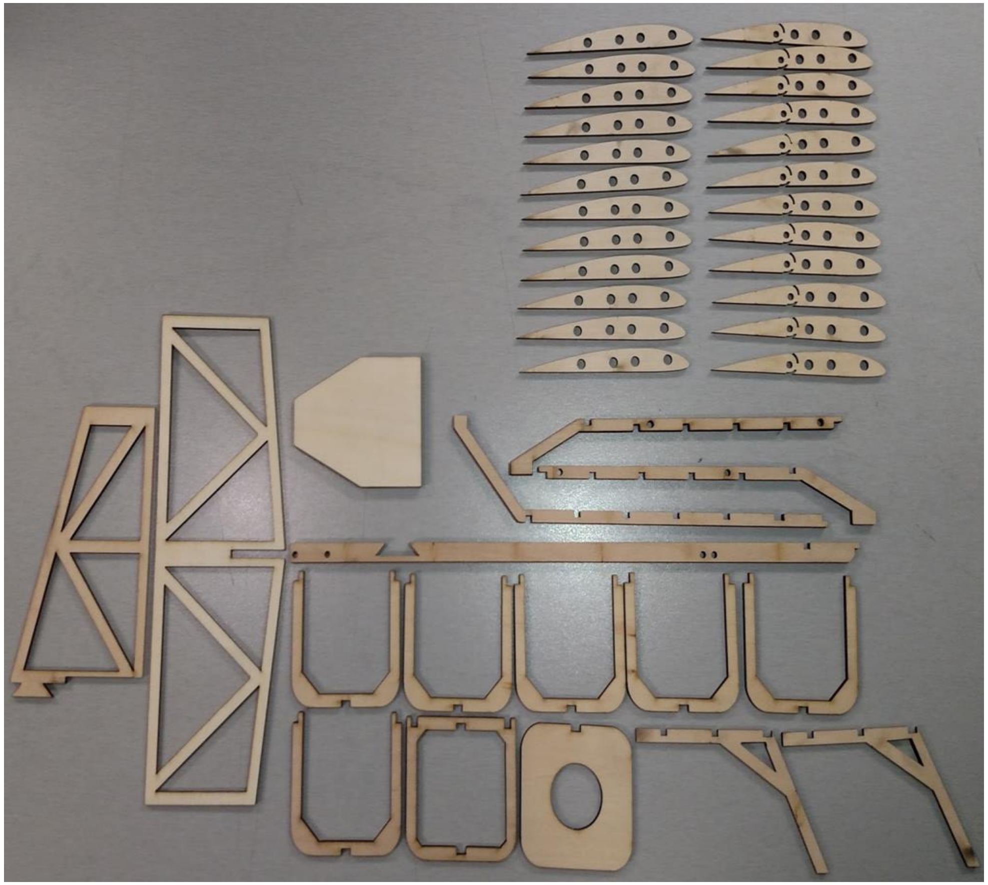

Figure 7: Laser cut parts

# Manufacturing (Initial Design) Cont.

- **Aluminum Inserts**
  - Wing Stiffness
  - Self-Centering

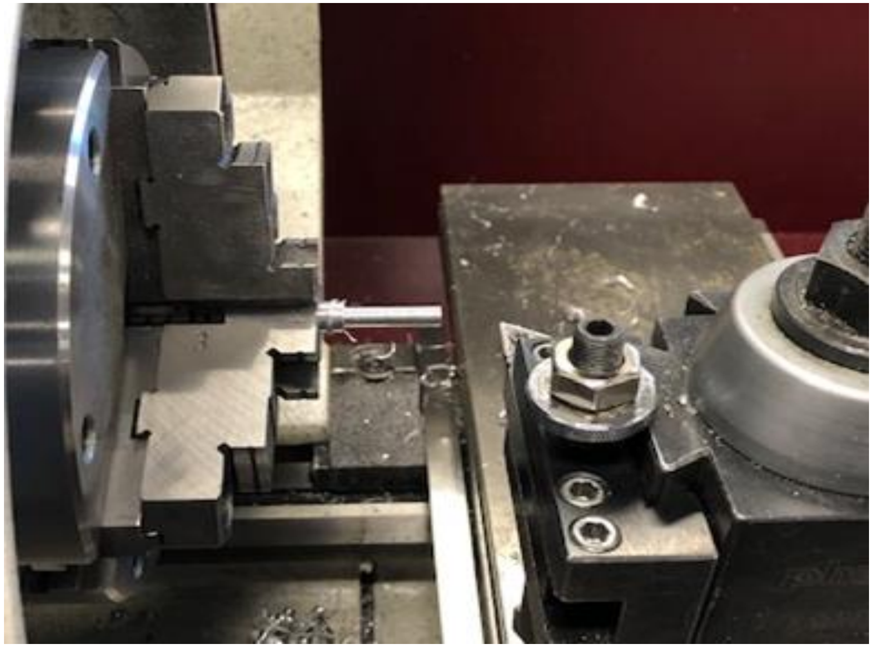

Figure 8: Turning on the lathe

Figure 9: Comparison to a pen

# Picture Proof



# Meeting the requirements

| Requirement | Design |
|---|---|
| 1. Must fit within specific box dimensions | ✓ |
| 2. Must be electrically powered | ✓ |
| 3. Must be assembled within 3 minutes | X |
| 4. Must be radio controlled | ✓ |
| 5. Payload is 2” PVC standard wall pipe | ✓ |
| 6. Carry a high payload-to-weight fraction | ✓ |

# Issues with Initial Design

- The initial design was taken to competition
  - Unsuccessful flight in 4 flight attempts
  - Main issue was airspeed needed
    - 1.4 pounds of lift at cruise speed (20 mph)
- New design was developed
  - Wing length increased to 42 inches from 30 inches
  - Chord length increased to 7 inches from 4 inches

# Final Design Airfoil Change

- A new airfoil was selected to generate greater lift at lower speeds.
  - Selig S1223 airfoil that is used for high lift at low speeds.

Figure 10: Clark Y 11.4% Airfoil

Figure 11: Selig S1223 Airfoil

# Final Design Lift Calculations

- **Initial calculation**
  - Difference was minimal
- **Re-calculation**
  - 1.6 lbs for Clark Y
  - 3.4 lbs for Selig
  - **2x the lift at same speeds**

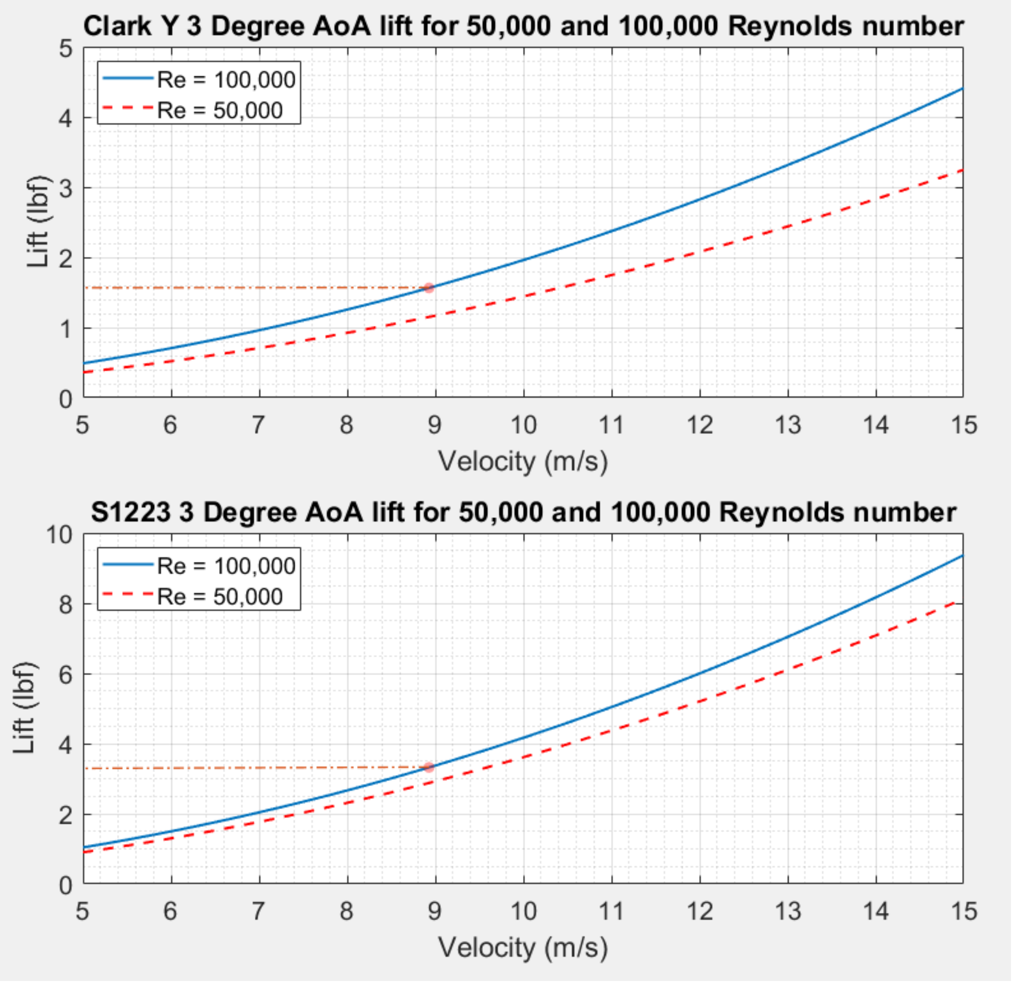


Figure 12: Lift comparison

# Final Design Wing Change

- 15° dihedral was added to the aircraft
  - Increases aircraft stability by allowing the aircraft to roll back towards the center during turns

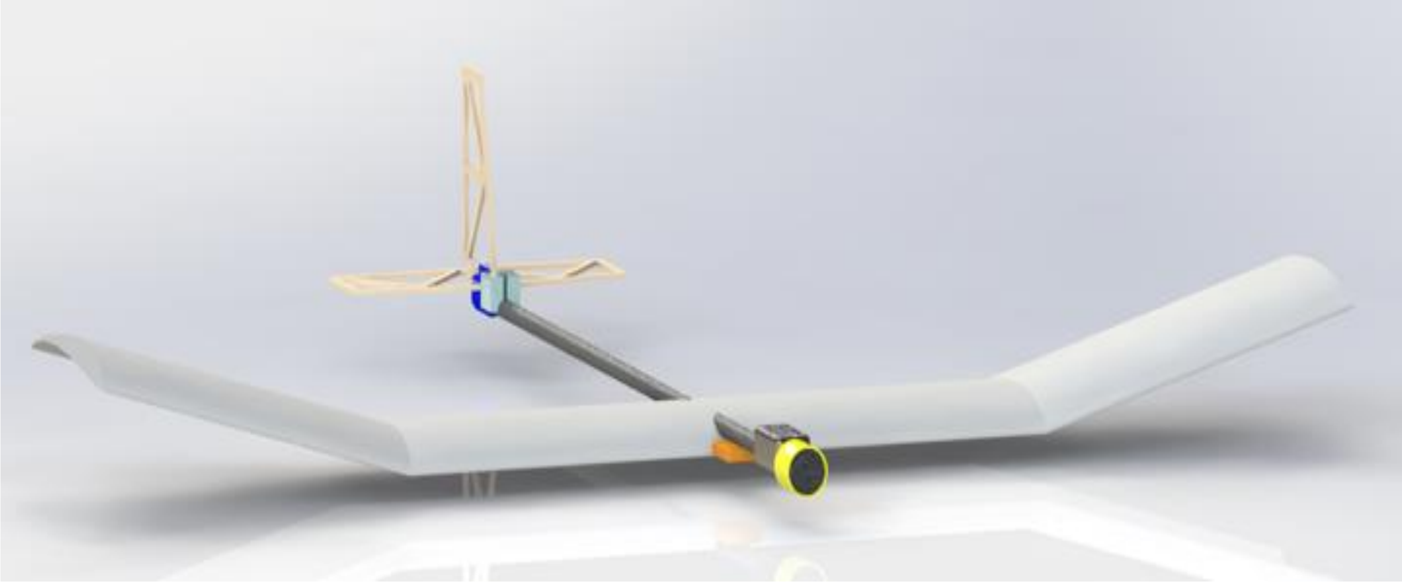

Figure 13: Final CAD design with dihedral

# Manufacturing (Final Design)

- **New Parts needed:**
  - A boom (fishing rod)
  - Mounts (3D printed)
  - A wing

- **Manufacturing of the wing**
  - Foam cut sections
    - Saw
    - Fiberglass mesh to increase wing strength

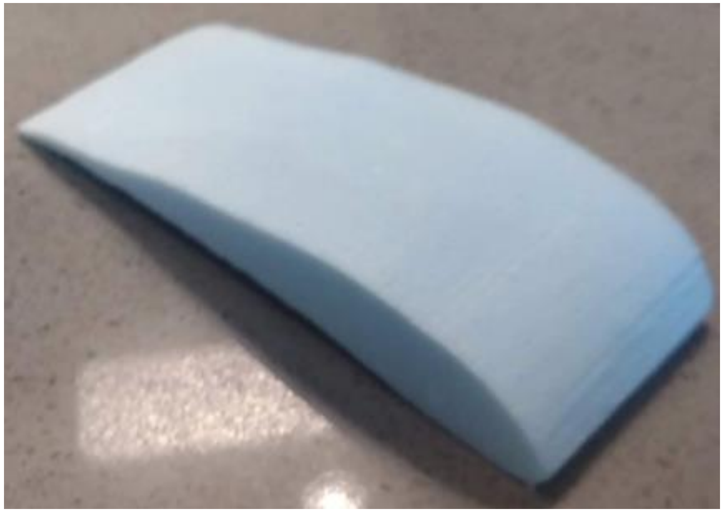

Figure 14: A 3” foam cut section of the S1223 airfoil

# Testing

- **On March 18th, 2019**
    - Successful test flight in Flagstaff, AZ (7,000 feet)
- **On April 6th, 2019 (competition)**
    - Resulted in crashes at hand launch in Van Nuys, CA (sea level)
- **Once returned from competition (in Flagstaff):**
    - Once completion of final design, a flight test will be performed

# Conclusion

- **The initial design crashed 4 times at competition:**
  - This resulted in competition being a learning experience on how to construct a new micro aircraft.
- **From the learnings**:
  - A new airfoil was selected
  - A dihedral was implemented
  - A new center boom was inserted
- **The final design will be tested in Flagstaff with and without payload**
  - Provides a base model for the next micro team

# Acknowledgements

*We would like to specially thank*

- **Northern Arizona University**
  - Funding project and making this project possible
- **David Trevas**
  - Senior design mentor
- **John Tester**
  - Being our client and providing necessary knowledge
- **Craig Howdeshell (CHS Engineering Group)**
  - Use of the laser cutter at CHS
- **Quality Vans and Specialty Vehicles**
  - Providing travel funds

# Work Cited

[1] *2019 Collegiate Design Series SAE Aero Design Rules.* SAE Aero Design. 2019. [E-Book] Available: http://www.saeaerodesign.com/cdsweb/gen/DocumentResources.aspx

[2] A. Iftikhar. *Computer based movement of flight control surfaces.* Blogspot. 2012. [online] Available: http://anasiftikhar.blogspot.com/2012/10/computer-based-movement-of-flight.html

# Questions?