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**Relevant Projects:**

- ◇ Aero 2020 Advanced Class Plane and Autonomous Gliders
- ◇ Aero 2019 and 2018 micro planes
- ◇ Heat Transfer Project
- ◇ Fluids Project
- ◇ Doms Project
- ◇ Dops Labs
- ◇ Personal RC planes
- ◇ Quadcopter

## SAE Aero International Design Competition Projects:

**Senior Project- Advanced Class, 2019-2020**

Senior year myself and a team of 4 others designed and constructed a plane with a 10.3 ft wingspan and 9ft length, with maximum weight 25 lbs. The 10 lb payload comprises dropped howler footballs and water bottles to be dropped on a target from above 100 ft, and two autonomous gliders to be released 100 ft laterally from the target. The scoring equation factored in static payload, howlers, water bottles, and table tennis balls that were stored in gliders. The optimal configuration of the non-convex scoring equation comprised no static payload, and a high amount of pimp pong balls. Dropped values were summed over all rounds, and other scoring categories were technical design report and oral presentation, graded by SkunkWorks engineers.

Figure 1: 2020 plane first flight, not the final plane and only including one glider. At competition, there would be two gliders and a slightly resized and more streamline fuselage.

Because of the CORVID-19 epidemic, competition was canceled and we did not score. However, the plane was successfully flown and all other scoring categories were completed, but not scored. The construction of the above craft was completed by the team with carbon fiber layups, laser and water cutting CNC, and hot wire cut foam. We designed and dimensioned the plane, calculated static and dynamic stability, fabricated the plane, and successfully flew the plane with zero crashes. I also created a numerical takeoff accurately predicting takeoff behavior of the plane, plotted below.

Our team fund-raised money for both the underclassman Aero Micro team and the Advanced class, the total yearly budget for construction, competition registration and travel to and from Texas for competition being $ 30,000.

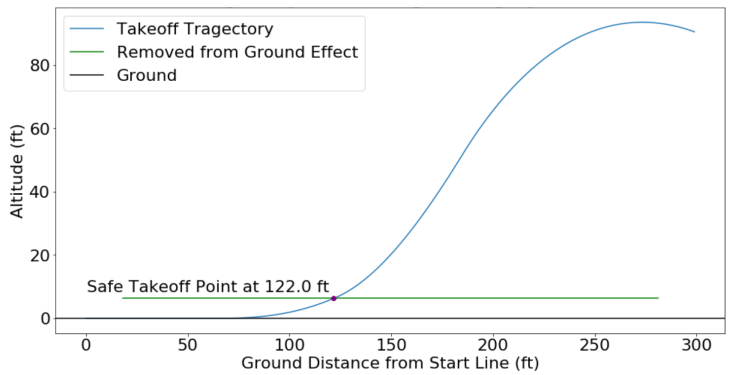



Figure 2: Numerical model integrated using the Runge-Kutta (4) technique, including lift, drag, gravity, and thrust components in vertical and horizontal axiis. The model incorporates ground effect and slight adjustments to high lift devices effectively changing the angle of attack during takeoff.

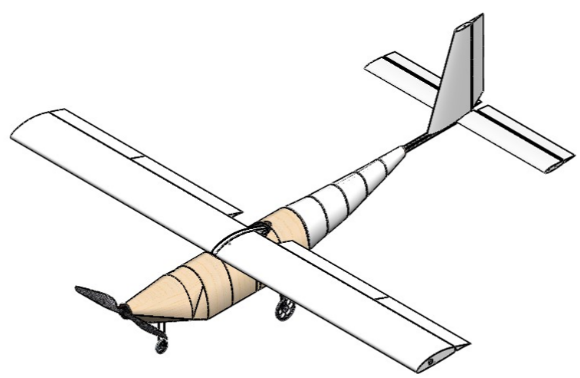


Figure 3: 2020 plane SolidWorks model.

**Micro Class, 2018-2019**

Junior year we scored first in flight amongst American teams by producing a craft for the Micro class with a 3 ft wingspan, able to disassemble and fit with its payload within a postage bot $3.5 \times 12.785 \times 11.5$ $in^3$. The payload is purposefully a very non-dense material, PVC pipe, of which the plane can fit  tubes, summing  lbs. The score was based around successful flights carrying payload and timed assembly demonstration, applicable to small crafts sending humanitarian aid. Additional scoring categories were oral presentation and technical design report, graded by SkunkWorks engineers.

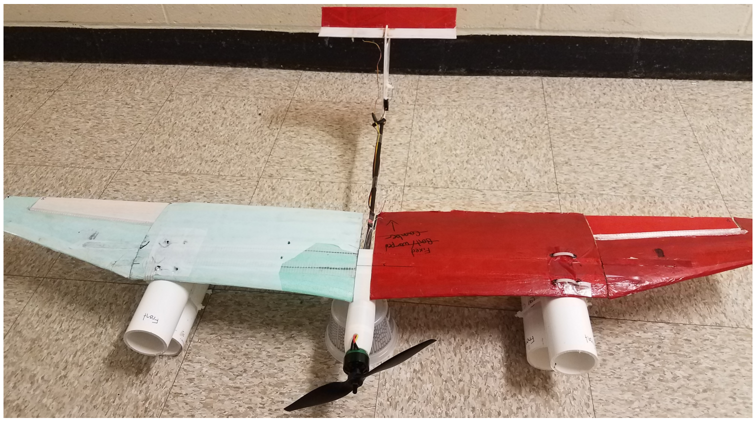


Figure 4: Micro class 2019 plane, approximating an elliptically tapered planform, this plane used a very thin Eppeler airfoil and could be assembled in 2 minutes.

**Micro Class, 2017-2018**

This year I was the president of the Union College Aero Team, we scored first out of the American teams and third overall in competition, amongst international aeronautic academies from India, Poland, China, Egypt, America, and more. The score was based around successful flights carrying payload and timed assembly demonstration, applicable to small crafts sending humanitarian aid. Additional scoring categories were oral presentation and technical design report, graded by SkunkWorks engineers.

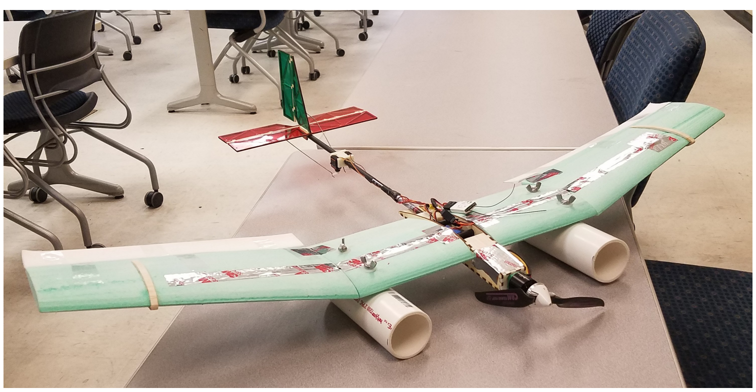


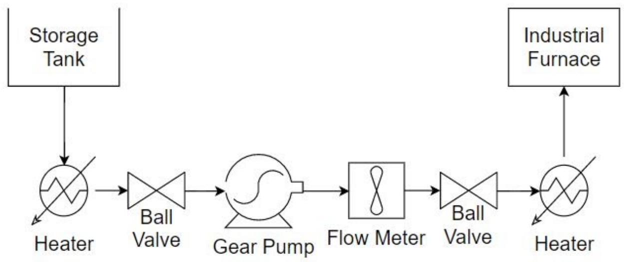
Figure 5: Micro class 2018 plane. This wing planform Incorporated some dihedral, washout, and taper, and the whole plane could be assembled in 1 minute 45 seconds.

## Academic Projects:

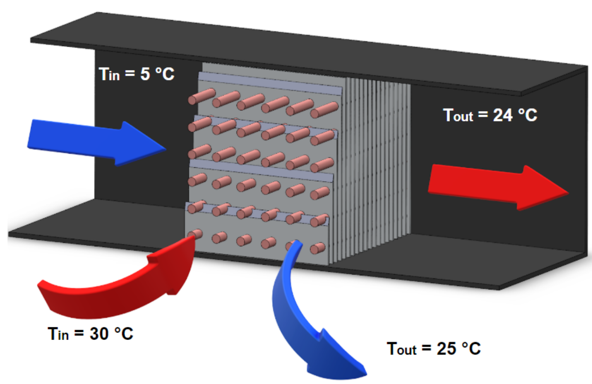
**Design of Thermofluid Systems Projects**

Each of these was treated as a contract a company could bid on, depending on quality and price.

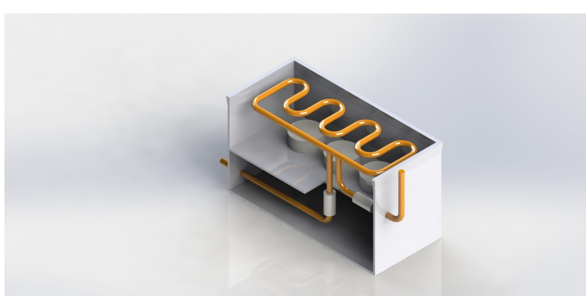
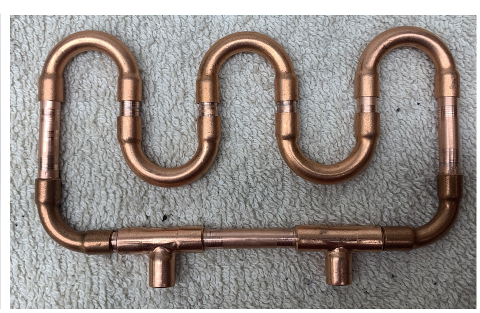
1. Cycle Design for House Conditioning Heat Pump
2. Fluid Heating and Transport Optimization




3. Crossflow Heat Exchange Recovery Unit Dimensional Optimization




4. Steam Cycle Water Pump Design and Construction

#### CPU Cooling Heat Transfer Project

Given an aluminum block analogy of a CPU, we designed, modeled, and simulated a fan powered cooling unit to reduce the temperature of the heated aluminum block as much as possible.

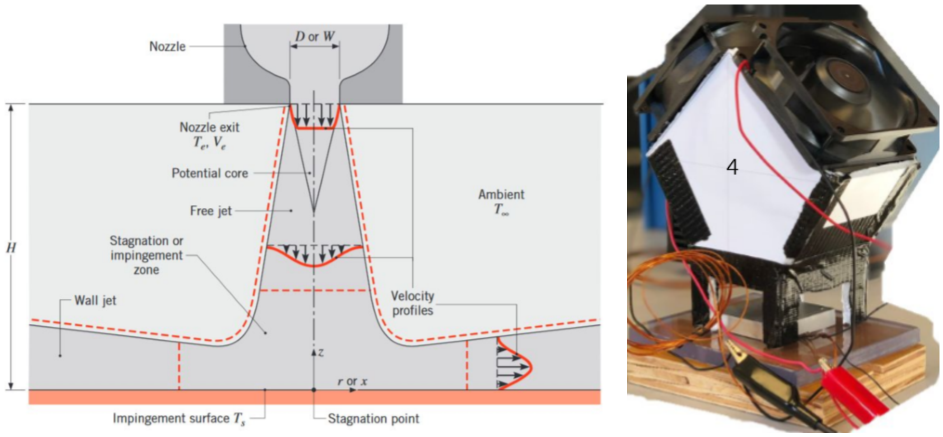



Figure 6: Caption

#### Dynamic Fluid Analysis on Mercedes CX

Using data from PIV analysis, pressure and force sensor readings from a frequency-driven open return wind tunnel, and StarCCM+ CFD software, we produced pressure, lift, and drag coefficient curves for a 1:20 scale Mercedes CLK model after calibrating the wind tunnel.

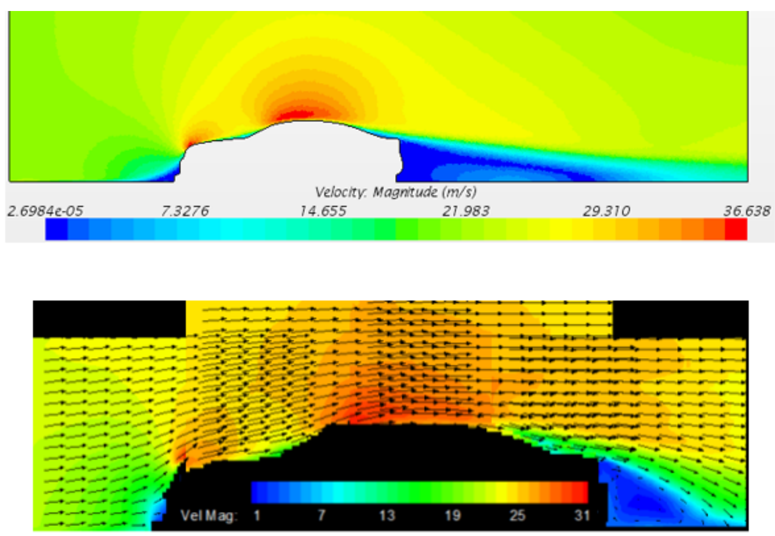



Figure 7: Caption

#### Design of Mechanical Systems Paper Extruder

The ASME yearly competition this year was a machine that extrudes paper, fed in one unaltered sheet at a time, to construct the highest possible vertical paper tower. Over 10 weeks, my team of eight people designed a prototype in class and assembled it from scratch. It had succeeded individually in rolling the paper, fastening it, and lifting it, but could not stack the paper. A success in that only 10 weeks and a $300 budget went into its construction, this was a great lesson in design restrictions pertaining to budget and time. This link outlines the competition, if it's still available.

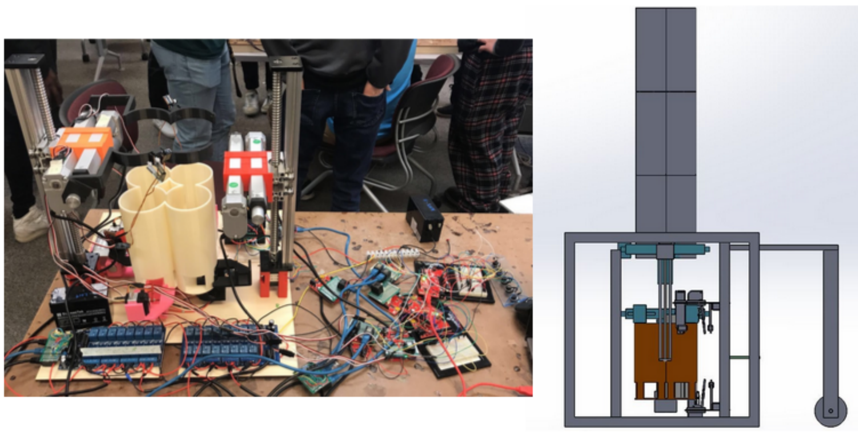


Figure 8: The final construction compared to the functional model. Much of it was left undone, but whereas actual competition teams had a year to design and construct it, we had 10 weeks.

#### Dynamics of Physical Systems projects

This class had several similar labs, but a great example of modeling the dynamics of a system and showing comparatively the desired, modeled, and actual output. This class analytically modeled the responses of physical systems, electrical systems, and feedback systems using transfer functions and integrator algorithms. These were done with self written programs in Python and Matlab, and in Simulink.

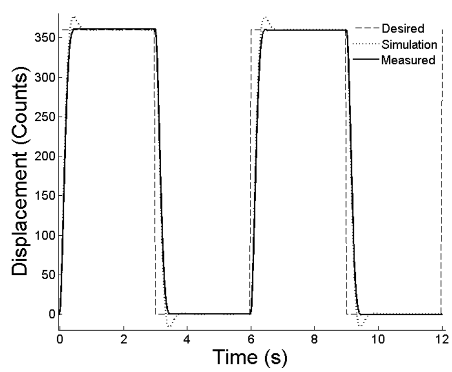



Figure 9: Physical response of a lego motor given a voltage input. This was modeled in Simulink, and plotted in Matlab.

## In-Depth Personal Projects:

**RC Planes, Carbon Fiber Layup**

Carbon Fiber layups over wire-cut insulation foam formed the wings of this particular craft, dimensioning and wiring before flying. A washout is Incorporated into the foam before the carbon fiber layup to create the wings. The body is a self-created design made with foam board,

Other planes made from foam board and wired up are combinations my personal designs and designs from FlightTest.

Figure 10: A picture of some self built flying RC aircrafts.

**Quadcopter**

I put together this combination of parts for a 180mm wheelbase quadcopter, with carbon fiber frame and self-chosen electronics stack components.

### Woodworking/epoxy/metal projects

**Eagle Scout Project: Self Designed 15 ft Bridge**

In high school in attaining my Eagle Scout badge, I lead, organized, supervised, and trained 5 to 10 people at a time through cutting 500 feet of new hiking trail, cleaning a quarter mile of old trail, and designed/built a 15-foot bridge to go over a brook connecting this territory to the trail system nearby. I alco coordinated with town council for permissions and grants to construct on public land, and had to make sure my bridge was up to several building regulations specific to conservation land and state parks.

Figure 11: Construction of the bridge

#### Axe/Hammer Restoration

Restored a vintage axe, making a new handle and properly setting the head.

#### Go-Board

Cut, laser etched, sanded and coated a Go board from pine. The play pieces were created using latex moulds filled with epoxy, and colored with coffee grounds.

#### Found-Parts Knife

This knife was created with scrap material, shaped by hand, uniquely designed, and heat treated with a manufactured forge.

#### Epoxy Mouldings

This sums up work making and using ComposiMold and latex molds to form epoxy into espresso glasses, Go board play pieces, chess pieces, spinning tops, dice, and composite materials. Carbon fiber or fiber glast layups are entirely about almost fully setting the minimum amount of epoxy in a set shape. Figures 1 and 10 show some molds made using a large vacuum-bagging method. Updates to come including additional pictures for the above.