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Relevant and Personal (Completed) Projects:

◇ Recent Work-Related Product Design and Modeling

◇ Recent Personal Projects

- Printed Plane Modeling
- Iris Mechanism, Rough Gyroscope and Misc

◇ Pandemic Modeling and Printing Projects

◇ Aero 2020 Advanced Class Plane and Autonomous Gliders

◇ Aero 2019 and 2018 micro planes

◇ Course Projects

- Heat Transfer Project
- Fluids Project
- Design of Mechanical Systems Project
- Design of Physical Systems Labs

Recent Work Related Product Design and Modeling

5G Networking Enclosure

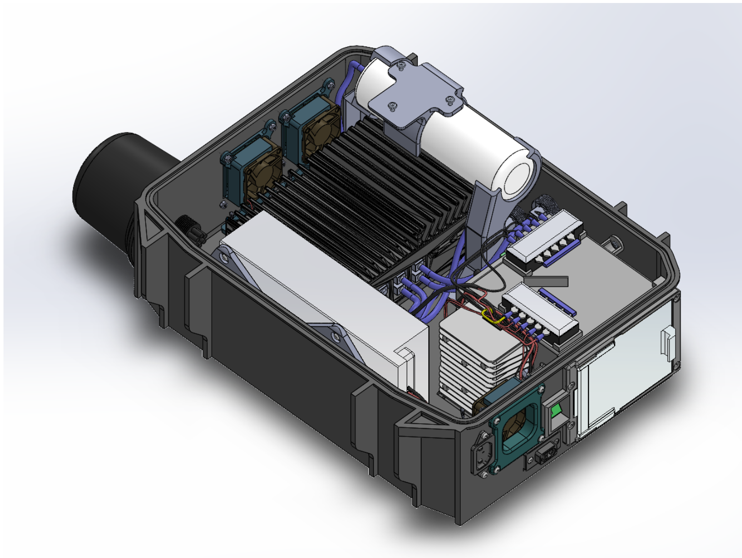


Figure 1: A ruggedized, force-cooled networking enclosure with desire to use static or carried, on shore power, vehicle power, or batteries.

Although I cannot share project details, this enclosure was a unique challenge because I received a list of specific equipment needed in an enclosure and was unable to physically interact with the components. Modeling and layup was done based of spec sheets and drawings, and only one component had an available to-spec model existing. After designing the physical and electrical layup included in the 300 part assembly, I was also not the one assembling the parts. I had to make step by step documentation considering what machinery was available and communicating with the team for more information. The resulting prototype was fully functional, though there will be improvements on the design for ease of assembly and replacing some existing components to further reduce weight.

Enclosure Considerations:

- 3 power modes will be used, Batteries, AC shore power and DC 24V input.
- Power sources need to be switchable during active operation without interfering.
- Each component needs to fit and several need to be cooled in operation.
- A removable base plate is desired that contains most of the mounted hardware.
- This has the option to be carried, so it must fit within these dimensions and be light as possible.
- Materials should not block RF propagation, besides some scattering that the required hardware will inherently produce.
- Specified 6 desired internal components and 8 desired external ports.

Radio Operational Deployment Box

Figure 2: Radio Operations Deployment enclosure seen in-field and in model.

This enclosure was simple, but required 20 to be fabricated for use in tropical rain forest conditions. Before this development, tactical radios were previously being put out individually in precarious locations early in the morning and taken in after many had run out of batteries in the evening. This took an exceedingly large amount of man power and time. These enclosures can be put out once, last up to 80+ hours before they need to be tampered with, and have protected expensive equipment from falls of 15-20 feet. Additionally they protect equipment from the very high temperatures and UV exposure, and has forced convection cooling to prevent overheating. Planned updates will extend battery life further, up to doubling it.

Recent Personal Projects

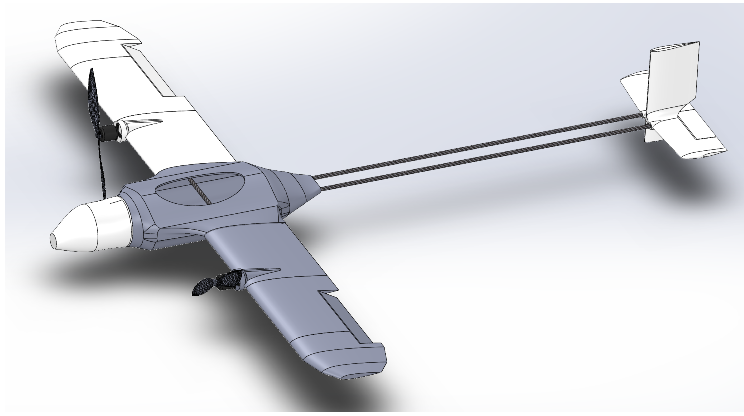


Figure 3: Model for a snap-together plane primarily 3D printed, 1.5m wingspan with carrying capacity of 1.5kg.

This is an RC plane I've wanted to make for a while, and is still being iterated on. I've designed and flown several RC planes, but this is an attempt to make a modular and variable plane from primarily 3D printed parts, except for electronics and a few structural spars. I made a python script to calculate the full dimensions of a plane, given some common assumptions based on viable stability requirements. It then calculated static stability and can alter dimensions slightly to improve, though the goal is to eventually have some dynamic stability approximation too. The goal is to output the required variables in the format of SolidWorks assembly variables, immediately update modeled dimensions, and have the ability to create viable planes with varying dimensions, carrying capacities, takeoff velocities, and maneuverability with the change of a few settings. So far the program has been tested on foamboard RC planes and against existing small and large scale planes with a reasonable success rate, though both the program and models are currently in iteration.

Iris Mechanism, Rough Gyroscope, and Misc

These projects were mainly because I saw some interesting mechanisms and knew I could replicate them. Also, each has one or two difficulties that I wanted to work through- mainly, friction and tolerances. Printing with tolerances is usually easy and includes very large tolerances for material

Figure 4: Design for 3D printed iris mechanism with geared actuation.

shrinkage, but having thin panels that requires loose sliding like the iris mechanism takes some testing [Figure 4]. Also, maximizing the rotational inertia of the gyroscope is essential, and ultimately required a smaller center bearing and a redesign of the flywheel to move the mass away from the central axis. Finding bearings with low enough friction to spin on a 3D printed snap-together structure was difficult, and as of now it can only stand for a few seconds [Figure 5]. Actively improving tolerances, and I have now replaced the gearing on the iris with proper Involute gears that I've modeled.

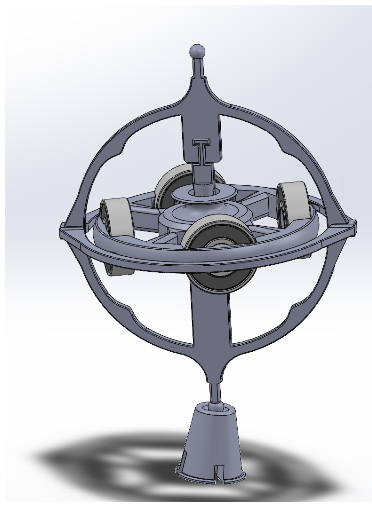


Figure 5: Gyroscope assembly, components 3D printed flat form PETG and snap-fit to assemble.

Assembling Chess Board

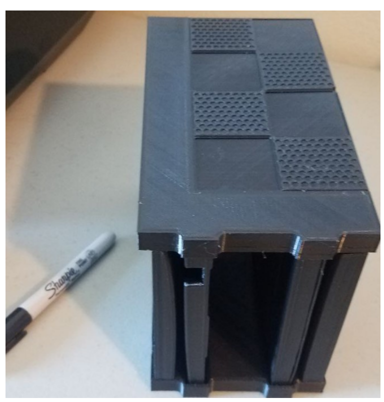


Figure 6: Chess board snapped together and stored in a (not-quite) cube. Realistically a rectangular prism, but still much easier to store and carry.

This was a successful attempt to print a chess board that can form into a cube holding its pieces inside, mainly for storage and portability. Future designs I want to include are a mechanical switch for signaling end of turn, and a microcontroller chess timer that fits into the middle section.

Figure 7: Chess board assembled for play and disassembled into parts.

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 aimed at 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 ping pong balls. Dropped score values are summed over all rounds, and other major scoring categories included the technical design report and oral presentation, graded by SkunkWorks engineers.

Figure 8: 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 pandemic, competition was canceled and no one could compete. 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 approximation that accurately predicted 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 acquired budget for construction, competition registration and travel to and from Texas for competition was \$ 30,000.

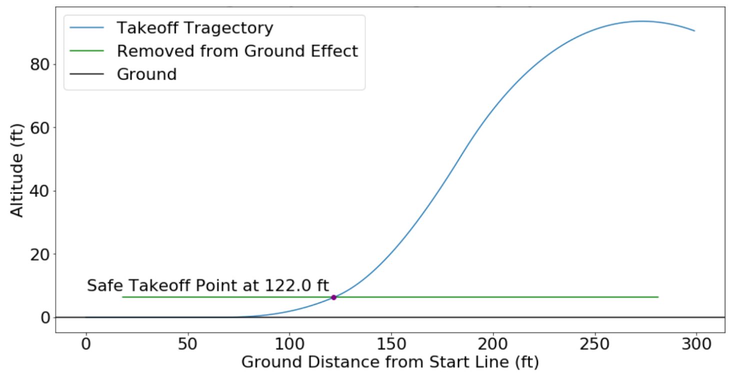


Figure 9: Numerical model integrated using the Runge-Kutta (4) technique, including lift, drag, gravity, and thrust components in vertical and horizontal axiis. The model incorporates ground effect and slight adjustments to high lift devices effectively changing the angle of attack during takeoff.

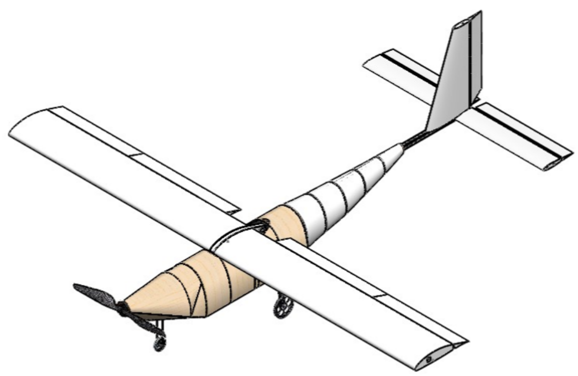


Figure 10: 2020 plane SolidWorks model.

Micro Class, 2017-2019

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 2 tubes, summing 2.4 lbs.

Sophomore year I was the president of the Union College Aero Team, and 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.

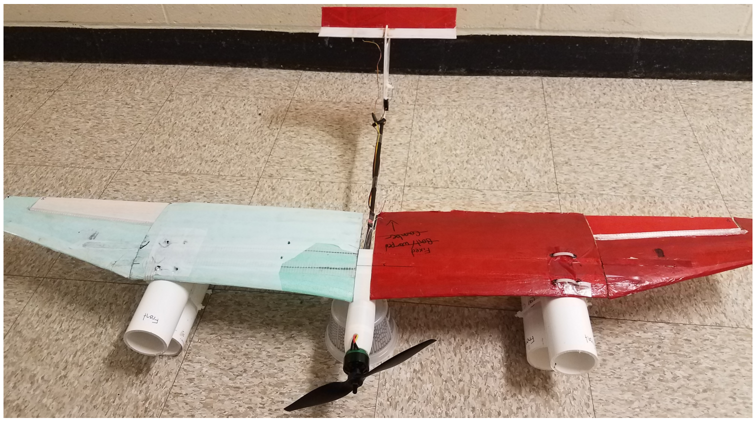


Figure 11: Micro class 2019 plane, approximating an elliptically tapered planform, this plane used a very thin Eppeler airfoil and could be assembled in 2 minutes.

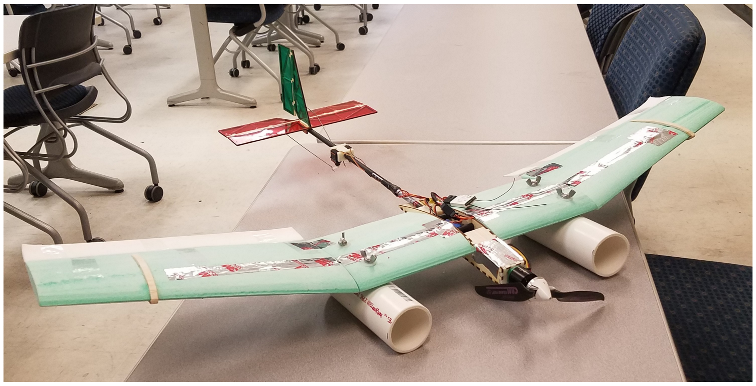


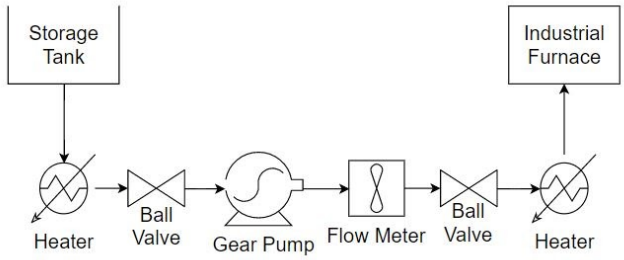
Figure 12: Micro class 2018 plane. This wing planform Incorporated some dihedral, washout, and taper, and the whole plane could be assembled in 1 minute 45 seconds.

Academic Projects:

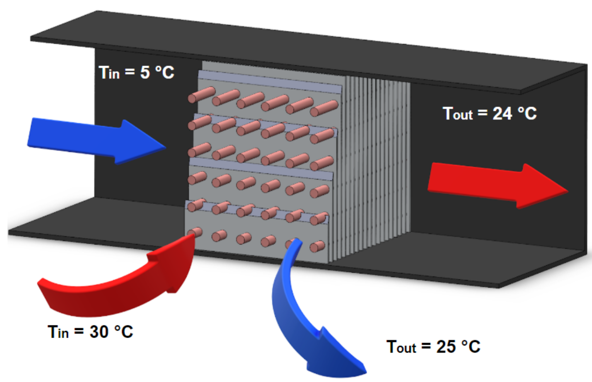
Design of Thermofluid Systems Projects

Each of these was treated as a contract a company could bid on, depending on quality and price. Teams of 4 split the project into economic, environmental, and system components to create and present for critique, with full report aimed at selling this design to a hypothetical company for use.

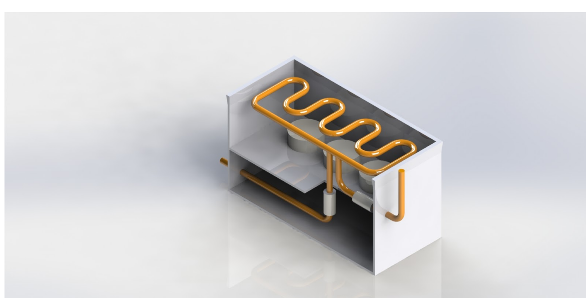
1. Cycle Design for House Conditioning Heat Pump
2. Fluid Heating and Transport Optimization

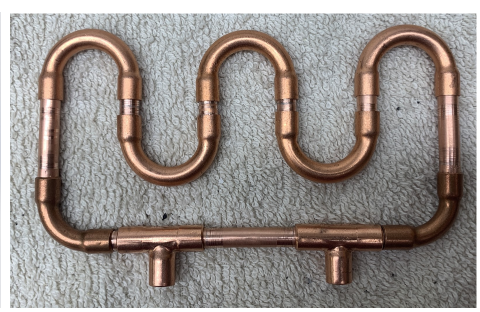


3. Crossflow Heat Exchange Recovery Unit Dimensional Optimization



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.

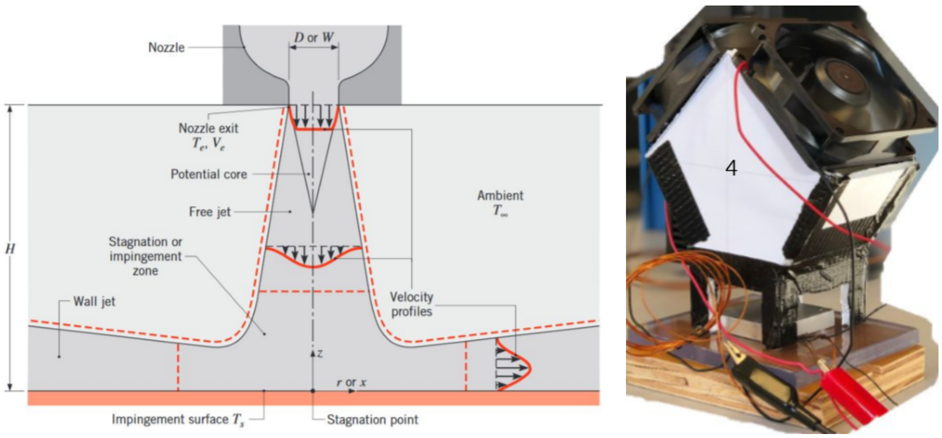


Figure 13: Caption

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.

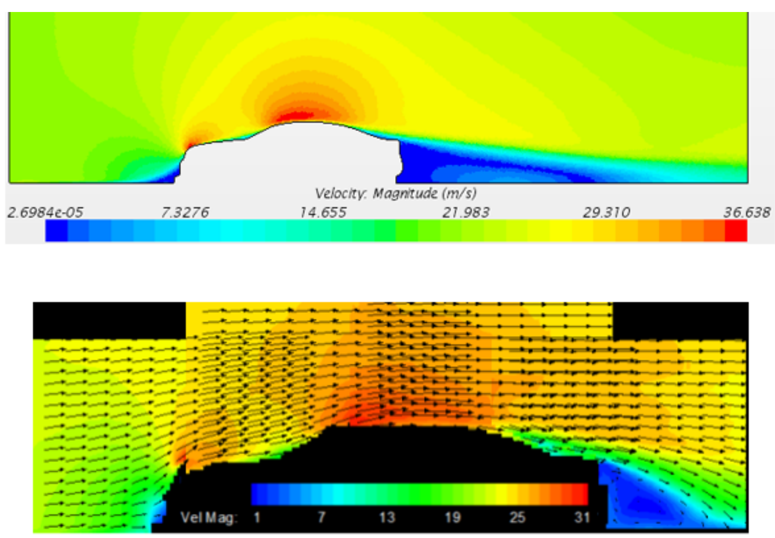


Figure 14: Caption

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 and assembled it from scratch. It had succeeded individually in rolling the paper, fastening it, and lifting it, but ultimately within our time limit 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, time and man power. This link outlines the competition, if it's still available.

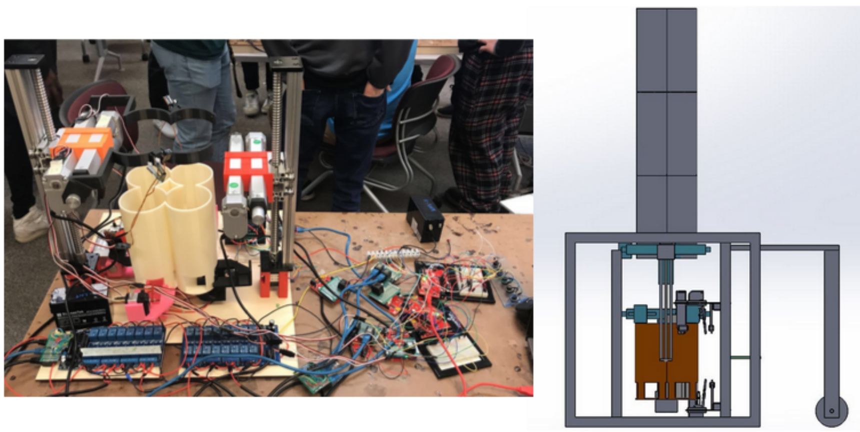


Figure 15: The final construction compared to the functional model. Much of it was left undone, but whereas actual competition teams had a year to design and construct it, we had 10 weeks.

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.

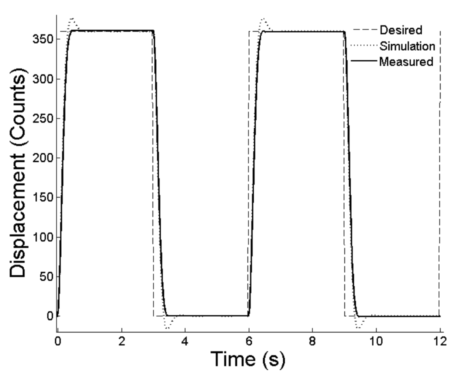


Figure 16: Physical response of a Lego motor given a voltage input. This was modeled in Simulink, and plotted in Matlab.