Mechanical Engineering Design Portfolio

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Competitions

Engineering Projects

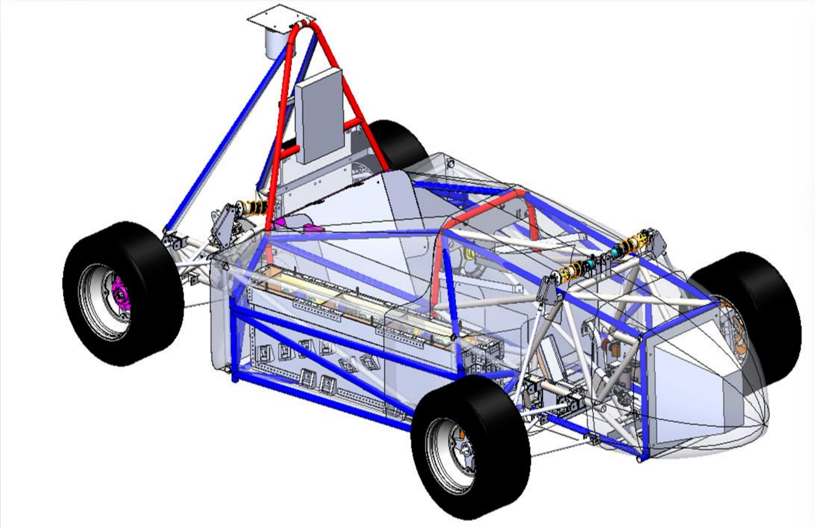
FSAE Electric Racecar – AR10 “Electra” *Fall 2015-Spring 2016*

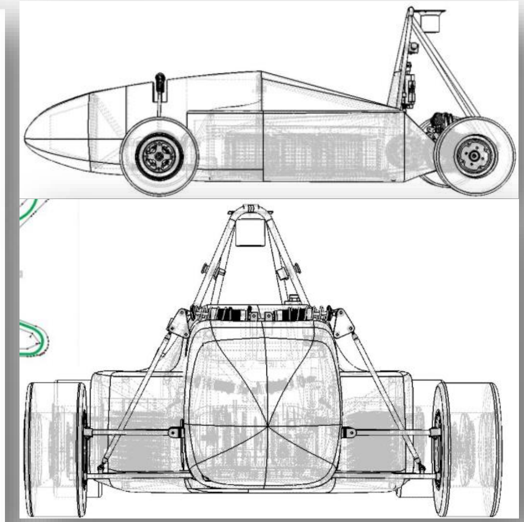
Project Description:

UC Irvine’s entry into the FSAE Racecar competition. This open-wheeled racecar features a Lithium Iron Phosphate battery pack with a 7.68 kWh capacity and a max discharge rate of 1000 Amps.

Role on Project:

My role on the project was as a “shadow to the team lead”. Because this was my first engineering project, I only designed small components for the car in Solidworks. More importantly, I gained hands on experience in electromechanical systems and was able to learn about relevant engineering principles from experienced upperclassmen.





Engineering Projects

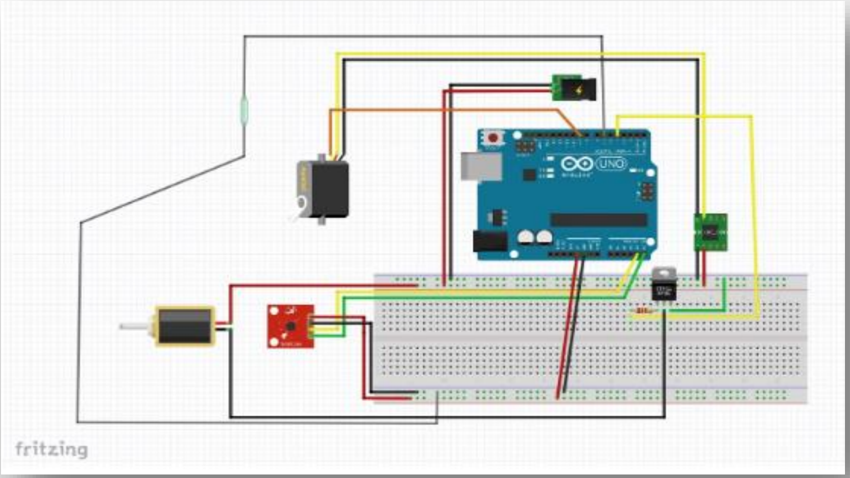
Pneumatic Robot *Spring 2017*

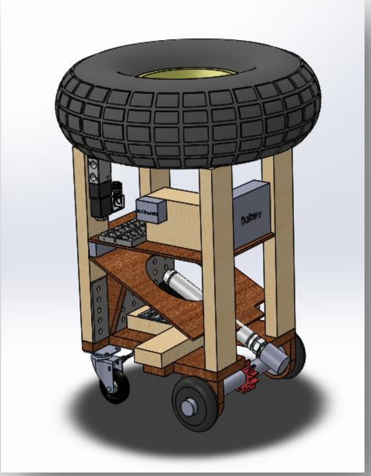
Project Description:

Part of UCI's Mechanical Systems Lab, the pneumatic robot is a required class for all undergraduate mechanical and aerospace engineering students. The pneumatic robot is required to use several key components, including a 30-40 PSI tire, a pneumatic piston, a 5v solenoid valve, and a 3000 mAh 12V battery. With these components, students must power the pneumatic piston using the tire pressure and navigate the entire system through an obstacle course. The initial design of our robot featured two one-way bearings to convert linear to rotational energy.

Role on Project:

The pneumatic robot team consisted of three responsibilities: mechanical and fabrication, electronics and testing, and controls. My responsibility on the project was designing the circuit and testing the control system. The electronic subsystem contained a servo motor, solenoid valve, battery, Arduino Uno, magnetometer, reed switch, and 12V to 6V step.





Engineering Projects

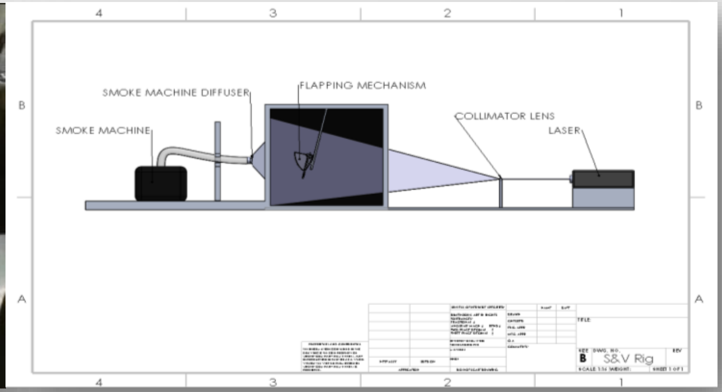
Flapping Wing Micro Air Vehicle – Project Manager *Spring 2018- Spring 2019*

Project Description:

The Flapping Wing Micro Air Vehicle Project (FWMAV) is a senior design project working out of UCI's ADCL (Aeronautics, Dynamics, and Control Laboratory). Through detailed observation and study of insect flight dynamics, the FWMAV team aims to apply the flight dynamics and control strategies observed in nature to unmanned aerial vehicles. The most successful aircraft to come from this project is referred to as the Quadflapper; this UAV takes the control strategy of a modern quadcopter and replaces the propeller blades with ornithopters.

Role on Project:

During Spring 2018, my role on the project was as a design engineer on the Quadflapper team. During this quarter, we were able to significantly improve the stability, agility, and maneuverability characteristics of the UAV. From summer 2018 to spring 2019, I served as the team lead/project manager for the 20+ students on the team. During this time, I managed technical documentation, competitions, research papers, and quarterly goals. In addition, I presented on behalf of the project for quarterly progress reviews and design reviews.



FWMAV in the News

2018 Beall Student Design Competition

Beall Student Design Competition

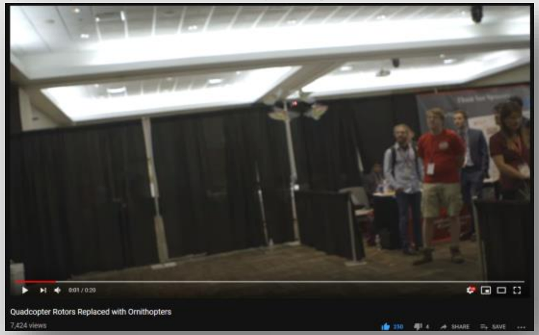
Engineering Dean Gregory Washington announced the winners of the Beall Student Design Competition, starting with third-place winner Mechanodontics, which was developed by Zahra Mardy, Mahdi Abbaspour, James Wratten and Mehdi Roein-Peikar. The proposed customized braces aim to reduce treatment time, pain and number of visits to the clinician while also increasing oral hygiene.

Second place went to HUMBLE Technologies team members Bien Gutierrez, Wendy Nguyen, Jonathan Enriquez, Xiantong Yang, Chad Bishop and Krissa Tassin for their HUMBLE syringe, which removes the need for old syringe priming methods. The new syringe reduces medical errors by cutting the amount of misdosage cases.

Coming in first place was Patrick Zhu, Nathan Cabezut and Bao Pham for their Flapping Wing Manned Aerial Vehicle. The FWMAV is a non-invasive drone that replaces each of the four traditional propellers of a quadcopter with a pair of mechanical wings. Using the phenomenon of vibrational stability that occurs in birds and other flying winged organisms to self-stabilize without heavily relying on feedback loops, the FWMAV has a significant maneuverability advantage over traditional quadcopter drones.

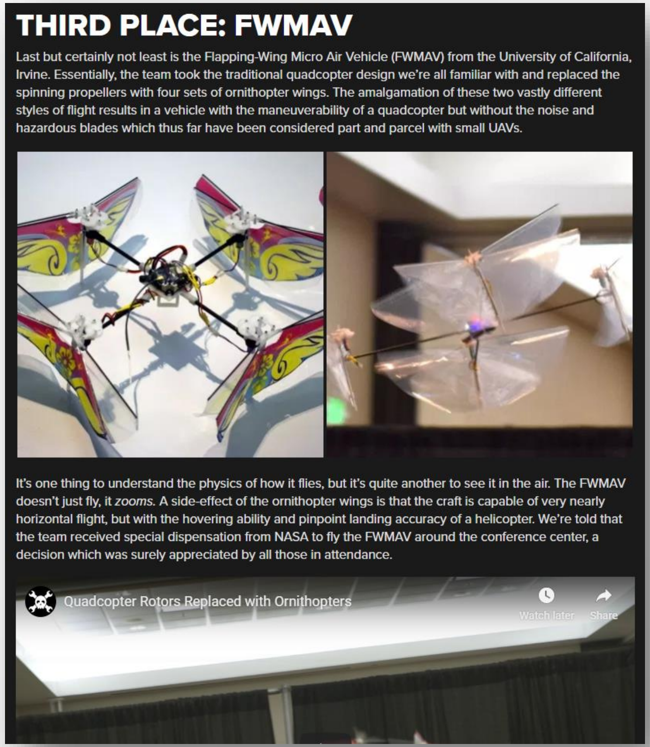
http://tech.uci.edu/competitions/past-2018.php

Flying at Kennedy Space Center



https://www.youtube.com/watch?v=kocnm8xpoJc&feature=youtu.be

2019 Cornell Cup Systems Engineering Competition



THIRD PLACE: FWMAV

Last but certainly not least is the Flapping-Wing Micro Air Vehicle (FWMAV) from the University of California, Irvine. Essentially, the team took the traditional quadcopter design we're all familiar with and replaced the spinning propellers with four sets of ornithopter wings. The amalgamation of these two vastly different styles of flight results in a vehicle with the maneuverability of a quadcopter but without the noise and hazardous blades which thus far have been considered part and parcel with small UAVs.

It's one thing to understand the physics of how it flies, but it's quite another to see it in the air. The FWMAV doesn't just fly, it *zooms*. A side-effect of the ornithopter wings is that the craft is capable of very nearly horizontal flight, but with the hovering ability and pinpoint landing accuracy of a helicopter. We're told that the team received special dispensation from NASA to fly the FWMAV around the conference center, a decision which was surely appreciated by all those in attendance.

https://hackaday.com/2019/05/15/2019-cornell-cup-winners-include-autonomous-boat-flapping-uav-and-leaping-rover/

UCI News

Quadflappers Take Third in Cornell Cup

June 5, 2019 - Samueli School engineering students who are building a **Flapping-Wing Micro Air Vehicle (FWMAV)** won third place and $5,000 in the Cornell Cup competition at the NASA Kennedy Space Center Visitor Center in Florida last month.

The FWMAV students, from left, Alejandro Aguilera, Branson Davis, Miguel Balta (adviser), Sam Hince, Fernando Pablo and Nathan Cabezut, proudly pose with their third place check in front of the space shuttle Atlantis at NASA Kennedy Space Center.

Eighty-one teams from the United States and Canada competed in the Cornell Cup, a national competition that tasks applicants with solving a real-world problem in a unique and interesting way. The competition provides engineering undergraduate students a chance to win up to $10,000 in prize money and highlight their ideas nationally.

Inspired by the agility, maneuverability and stability of insects, the FWMAV project is under the guidance of Haithem Taha, an assistant professor of mechanical and aerospace engineering. Taha's research involving rigorous mathematical modeling and analysis of insect flight dynamics revealed a hidden stabilization mechanism that insects unconsciously exploit during flight.

http://engineering.uci.edu/news/2019/6/quadflappers-take-third-cornell-cup

Engineering Projects

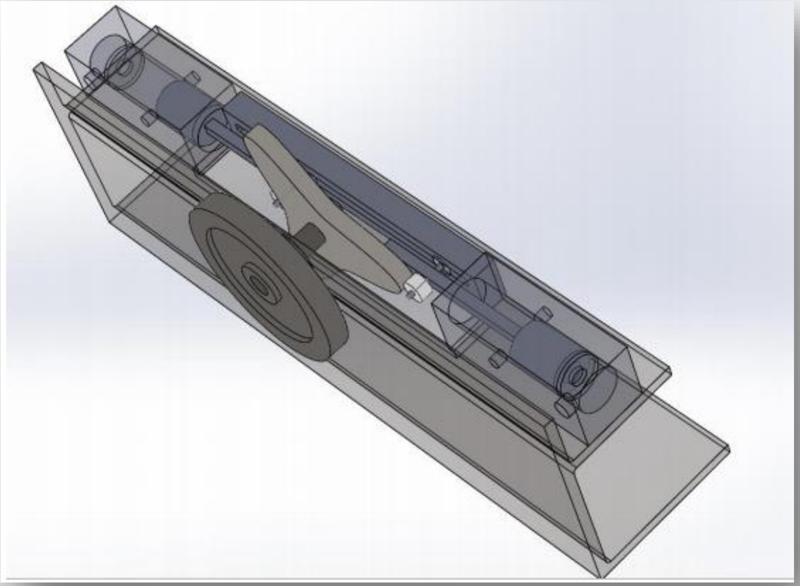
Greensteam *Fall 2018 - Winter 2019*

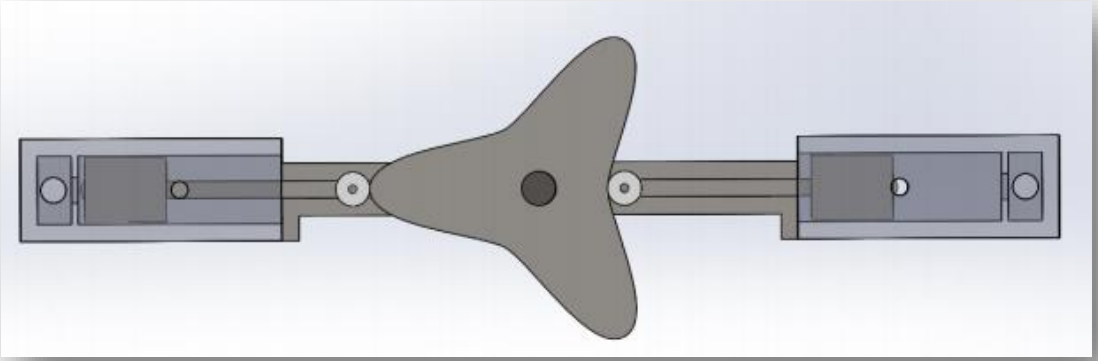
Project Description:

The Greensteam Project aims to combine modern advancements in metallurgy and manufacturing with the versatile platform of steam engines. The goal of this project was to design a small-scale uniflow steam engine power station to be used in remote areas.

Role on Project:

During the first quarter on this project, I researched the various types of mechanisms to convert the energy from high pressure steam into mechanical work. For design requirements, our goal for the final output was around 5kW of power, enough energy to run a small camp or station. My role on the project was deriving the geometry of the central trilobe cam and deciding the dimensions of the prototype engine.





Engineering Projects

Musical Stack Modular Robot

Spring 2019

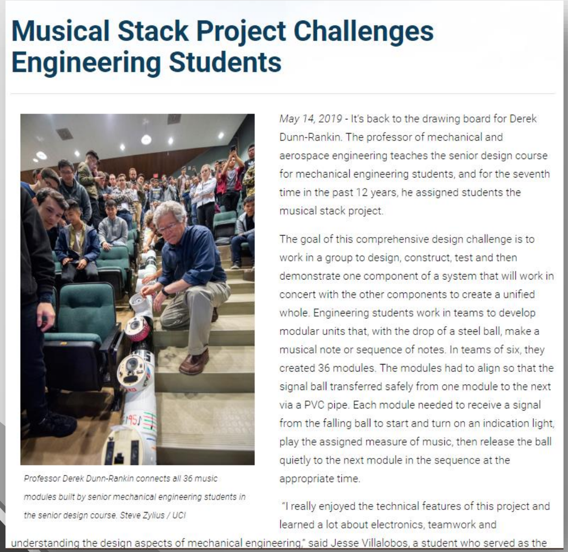
Project Description:

The musical stack robot was the main project in the “design of mechanical systems” course at UC Irvine. In this course, students were given a set of specific requirements determined by the professor (acting as a customer). With these requirements came various design options, specifications, prototyping, testing, and iterations. At the end of the course, these student projects would be arranged into musical stacks, each stack representing a different instrument. The robot was required to sense the ball, catch the ball, play a measure of a song, then release the ball through the conduit.

Role on Project:

During the mechanical systems course, my responsibility was creating multiple design options (seen below), and programming the microcontroller to sense, actuate, and synthesize an instrumental piece.

http://engineering.uci.edu/news/2019/5/musical-stack-project-challenges-engineering-students



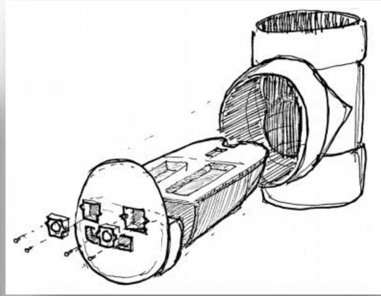
Musical Stack Project Challenges Engineering Students

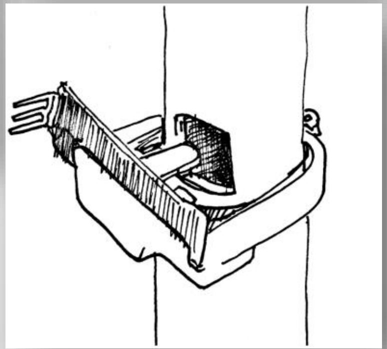
May 14, 2019 - It's back to the drawing board for Derek Dunn-Rankin. The professor of mechanical and aerospace engineering teaches the senior design course for mechanical engineering students, and for the seventh time in the past 12 years, he assigned students the musical stack project.

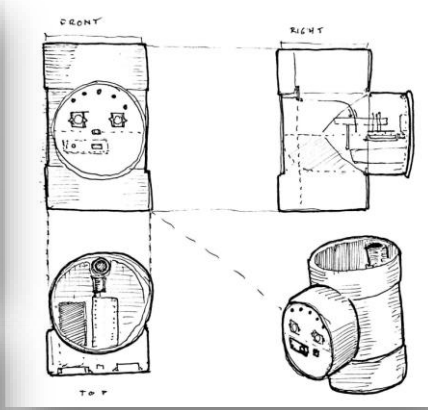
The goal of this comprehensive design challenge is to work in a group to design, construct, test and then demonstrate one component of a system that will work in concert with the other components to create a unified whole. Engineering students work in teams to develop modular units that, with the drop of a steel ball, make a musical note or sequence of notes. In teams of six, they created 36 modules. The modules had to align so that the signal ball transferred safely from one module to the next via a PVC pipe. Each module needed to receive a signal from the falling ball to start and turn on an indication light, play the assigned measure of music, then release the ball quietly to the next module in the sequence at the appropriate time.

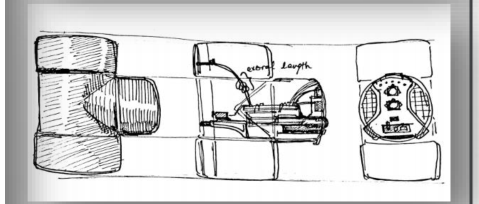
Professor Derek Dunn-Rankin connects all 36 music modules built by senior mechanical engineering students in the senior design course. Steve Zylius / UCI

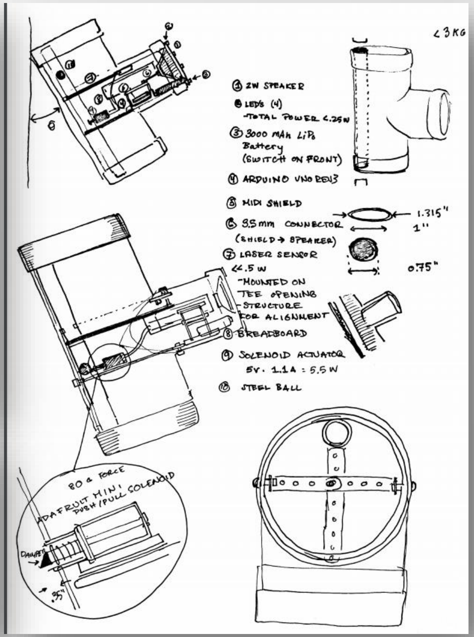
"I really enjoyed the technical features of this project and learned a lot about electronics, teamwork and understanding the design aspects of mechanical engineering," said Jesse Villalobos, a student who served as the











Engineering Projects

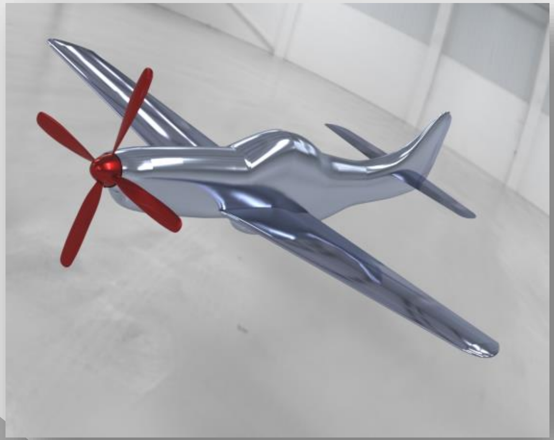
P-51 Mustang Wing & Landing Gear Finite Element Analysis *Winter 2019*

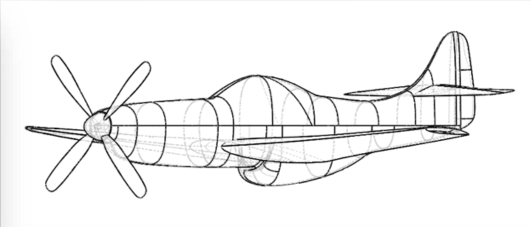
Project Description:

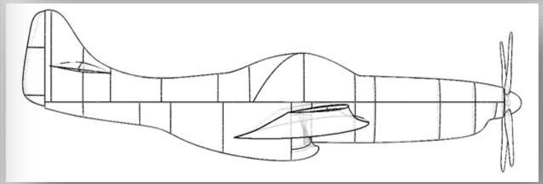
As part of the final project for UCI’s finite element analysis elective course, students were required to perform a series of simulations on one of their designs. For our project, we chose to analyze structural component and approximate some flight dynamics of the historic P-51 mustang airplane. The group consisted of five members, two of which modeled the airplane, while the remaining three documented and performed various tests on the model.

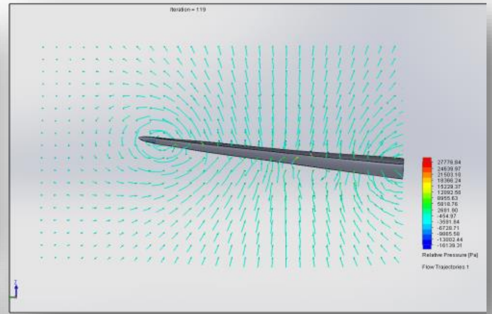
Role on Project:

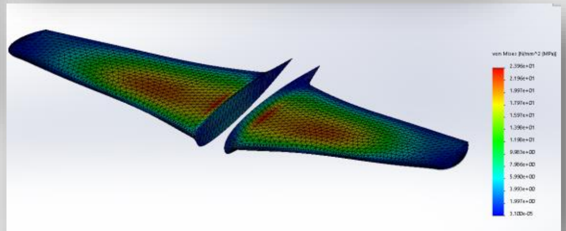
My primary responsibilities included modeling the wings and ensuring the all components in the assembly meshed properly. To start, I performed a simple Solidworks flow simulation to approximate the lift on one of the wings, given a cruising speed, air density, and Reynolds number. After estimating the load under nominal conditions, I conducted a von Mises test top identify regions of maximum stress. Additionally, I performed a modal analysis to determine if resonance would occur, as well as a displacement test to identify any excessive wing deflection.











https://www.youtube.com/watch?v=8L8CdjG9nIs&feature=youtu.be

Engineering Projects

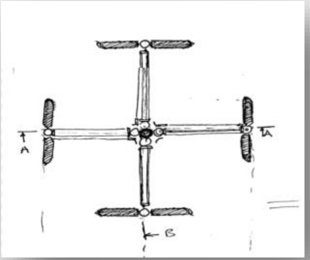
Variable Pitch Quadcopter *Spring 2019*

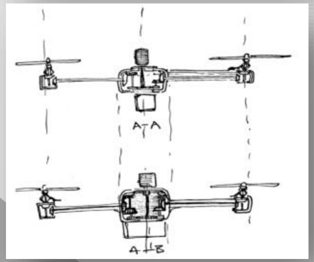
Project Description:

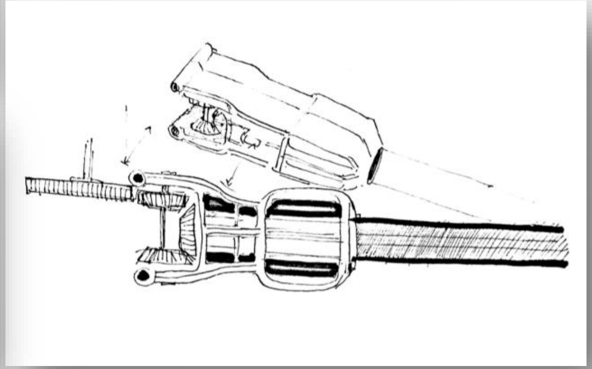
Recent downscaling of computing hardware has allowed for a surge in popularity of unmanned aerial vehicles. In this project, we wanted to apply high-speed processors to a quadcopter configuration. Rather than controlling the roll, pitch and yaw of the drone through changing the speed of the motors, we would use the tail booms of RC helicopters and control the pitch of the propeller blades using servos. Additionally, rather than four motors driving the blade, we would use a single motor powering all four propeller blades. The advantages of controlling the pitch of the blades instead of the motor speed include inverted flight and improved maneuverability.

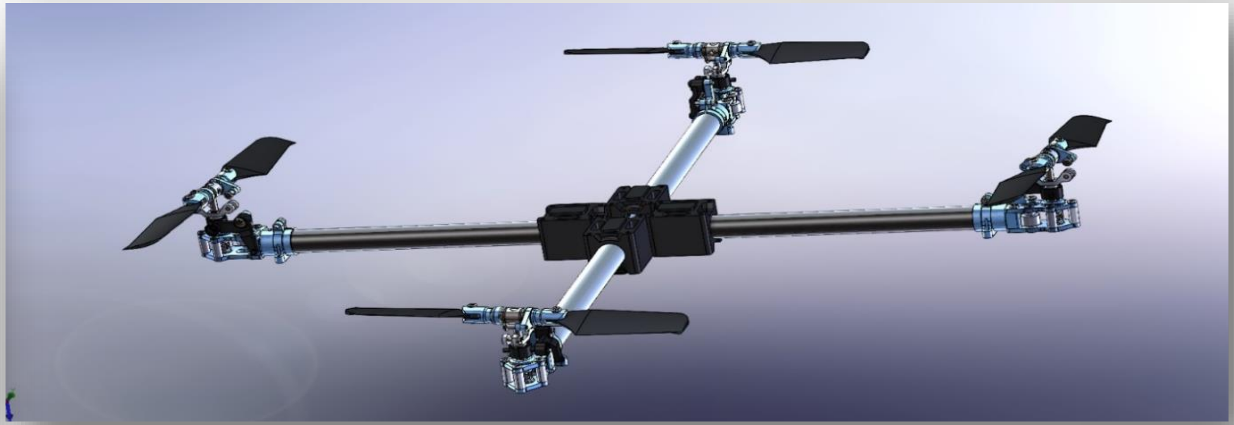
Role on Project:

My role on this project was sizing the main brushless motor based using dimensions from an RC helicopter tail boom. For our design, we chose the tail boom of a TREX-450 RC helicopter. Using blade element theory to calculate the lift under maximum designed loads for the tail boom, we found the power required to overcome the torque due to drag was around 300 watts. Due to shipping time constraints, we were only able to construct a dual-copter test rig by the end of the course. Additional responsibilities included









Engineering Projects

Bio-Inspired Flapping Engine with Thrust Control *Spring 2019*

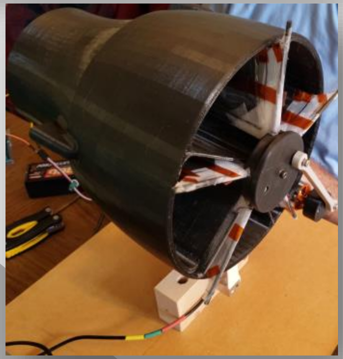
Project Description:

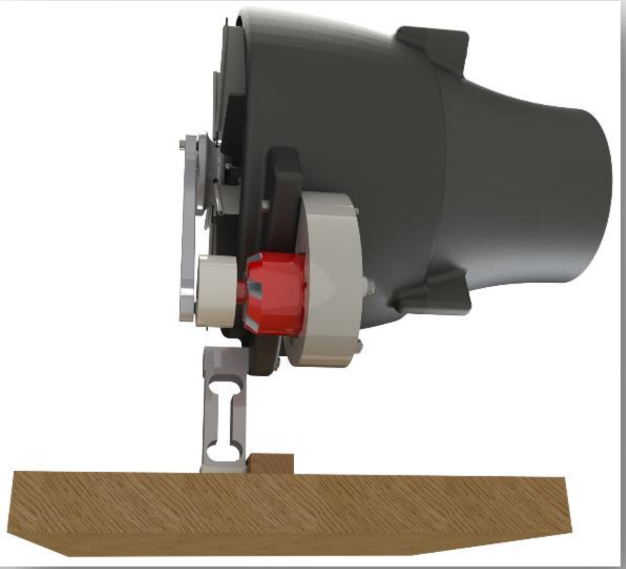
Using what I learned during my year on the Flapping Wing Micro Air Vehicle Research project, I chose to apply some of the fundamental concepts of flapping wings to a new type of engine format. The most effective fluid mechanism utilized by natural flyers and swimmers is the reverse von karman street. Another mechanism used by natural flyers and swimmers is clapping; by clapping two surfaces together, the animal creates a high pressure and resulting jet out the back.

Role on Project:

In this project, with the help of a PhD advisor, I designed an oscillatory engine that would be capable of producing this reverse von Karman street at extremely high frequencies. My responsibility on this project included designing the engine, modeling the parts in Solidworks, and printing the components. The final engine test bench was able to read the thrust output of the engine and use feedback to limit the acceleration of the motor. This project was awarded a $1,000 Micro Grant from UC Irvine for future research.

https://youtu.be/E_h8udSu_RI





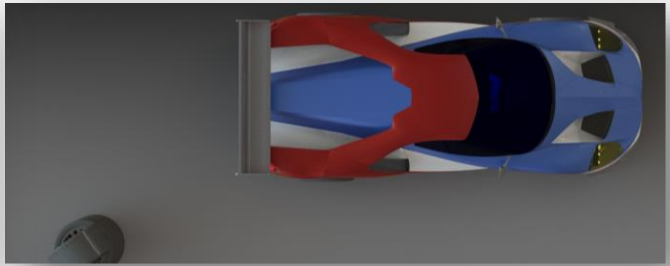
Solidworks Projects

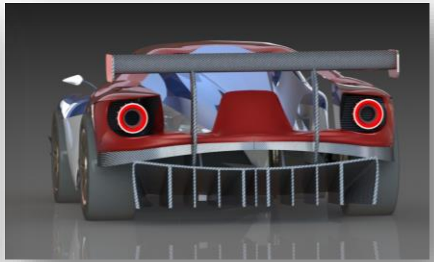
Ford GT Race Car

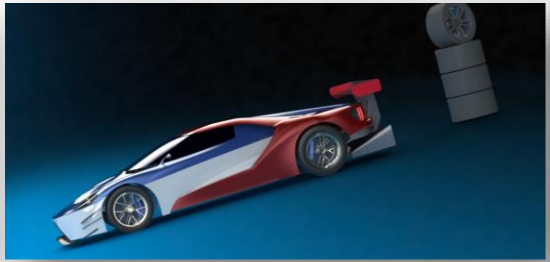
Spring 2016

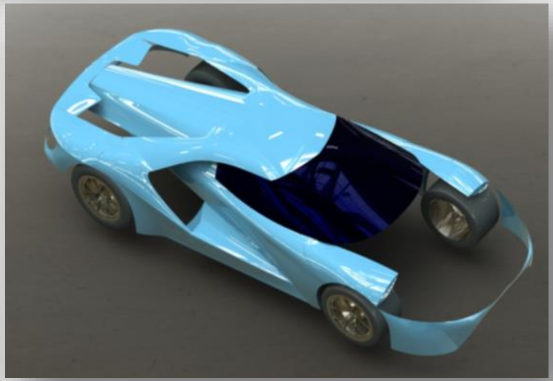
Project Description:

This Solidworks project was my final project submission in Introduction to Computer Aided Design. I chose the Ford GT LM racecar because the buttresses connecting the roof to the rear quarter panel presented a significant challenge. The final assembly contained 17 unique parts, including two different sets of wheels. For my first large Solidworks project, the main body had many complicated surfaces that were difficult to get right. The total project took around 60 hours, however if I were to do this again it would take significantly less time.







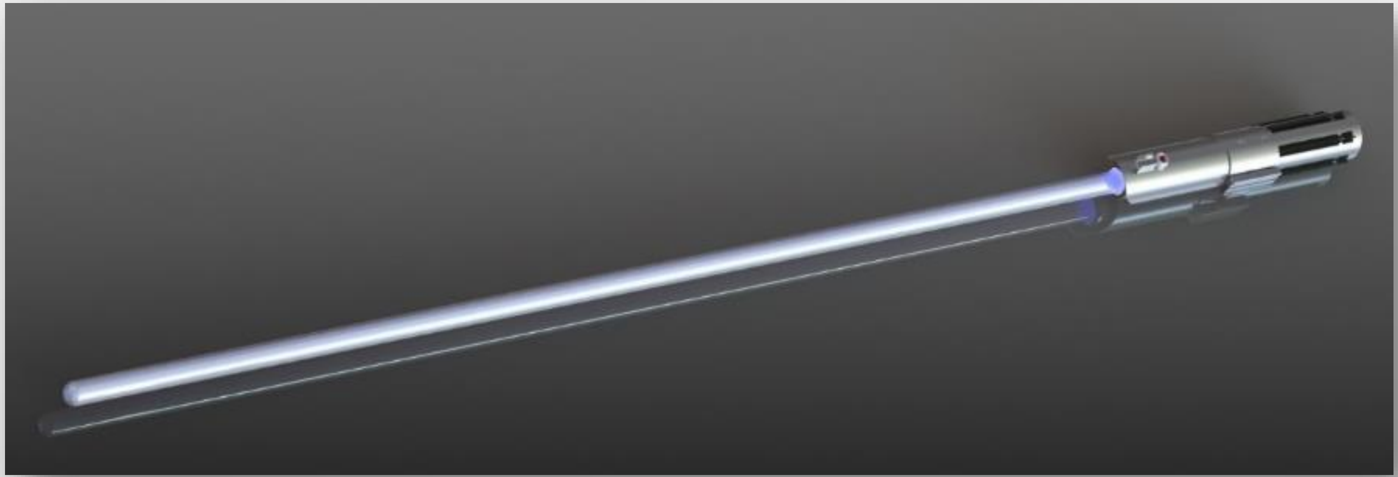


Solidworks Projects

Star Wars Lightsaber *Spring 2016*

Project Description:

This Solidworks project involved recreating Luke Skywalker's lightsaber from Star Wars: A New Hope. After completing the Ford GT LM car, I wanted to gain more experience in Solidworks while using some creativity. As a result, I spent several hours designing an accurate replica for the lightsaber shown in the movie. To recreate small details, I used reference images from the movie.

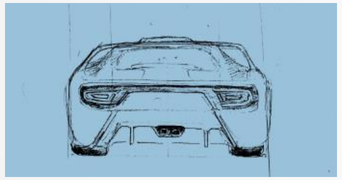


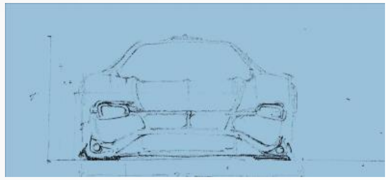
Solidworks Projects

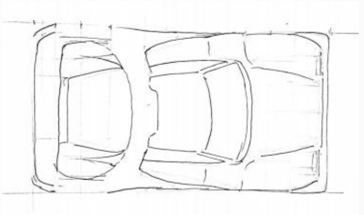
Lancia 037 Concept *Fall 2016*

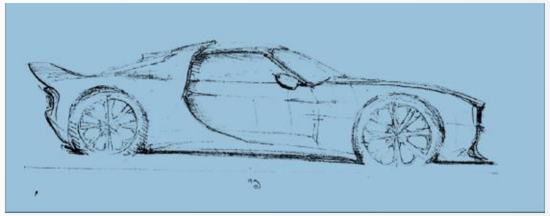
Project Description:

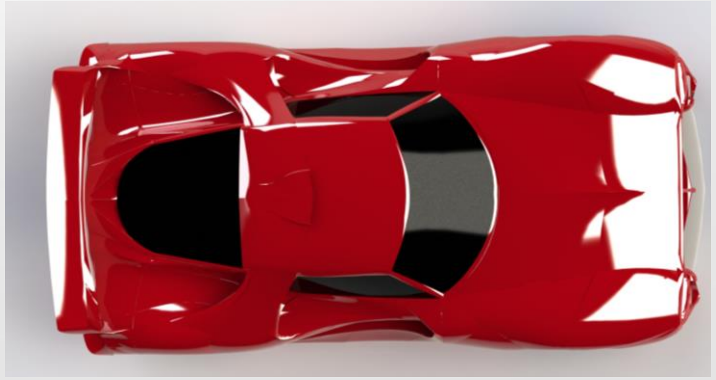
This Solidworks project was an exercise in bringing an original design to life. In this project I wanted to reimagine the Lancia 037 homologation car (seen below) as a modern supercar. Taking what I learned from the surfacing of the Ford GT racecar, I created an original Solidworks model based off some design sketches. Overall, I was pleased with the outcome of the car and learned more about surfacing in the process.









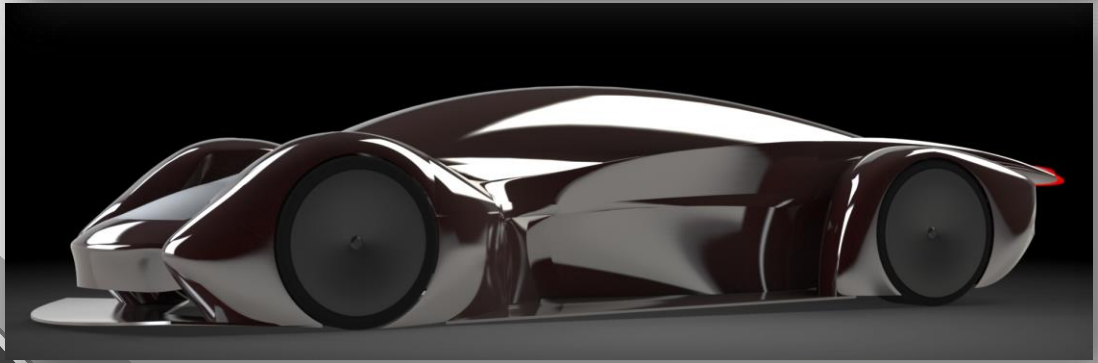


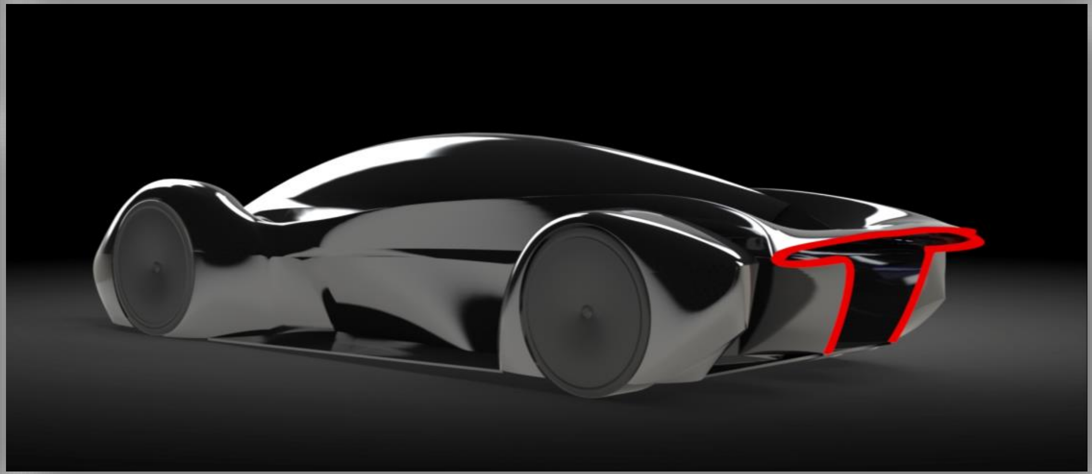
Solidworks Projects

Ford GT Race Car *Fall 2018*

Project Description:

For my next large Solidworks Project, I wanted to design a high-speed concept car with unique styling cues. One of such cues was the long airfoil shape of the main body, tapering off into a narrow region towards the end of the car; by having vertical tails towards the end of the car, it would have weathercock stability. In addition, the long airfoil shape of the body would reduce drag at high speeds. While downforce is important for maintaining a negative pitching moment and keeping the tires on the road, too much downforce creates excessive friction and drag at high speeds. This car would ideally feature active aero and floor fans to keep the tires on the ground.



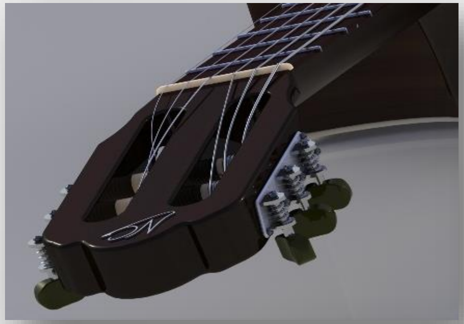


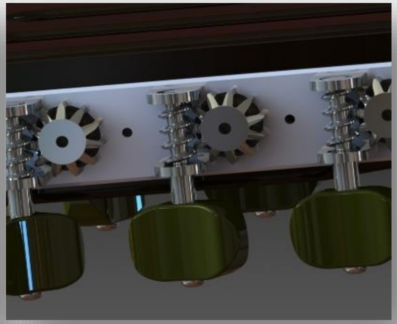
Solidworks Projects

Custom Classical Guitar *Summer 2019*

Project Description:

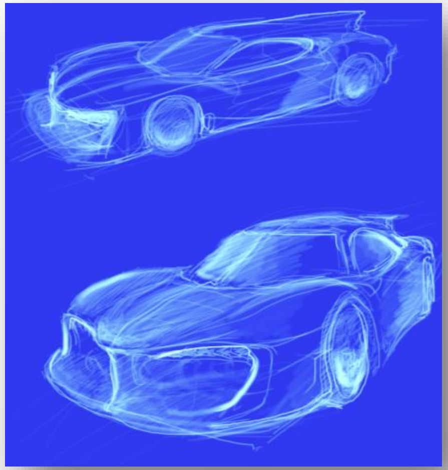
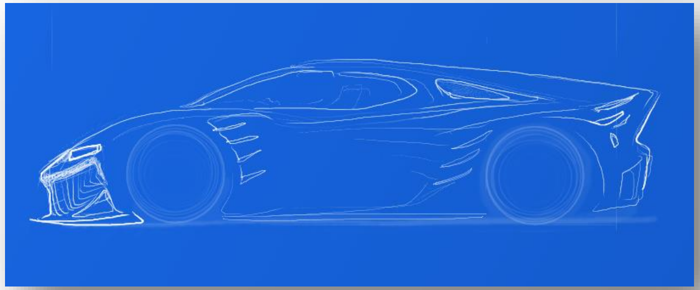
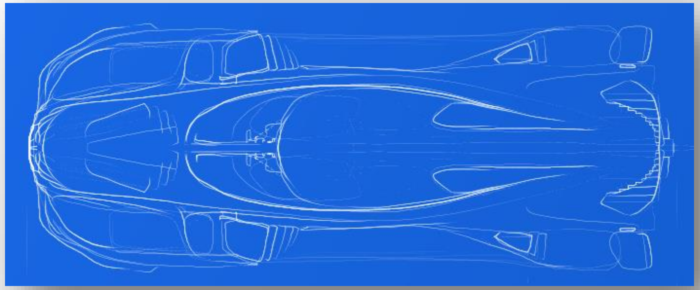
Without the resources to order a custom classical guitar, which can cost in excess of $10,000, I chose to do the next best thing and design my own guitar. After playing guitar for 10 years and playing classical guitar for 6 years, I have created a list of features that would have appeared on my dream guitar: Rosewood head, neck, neck joint, bridge, sides and back. Mahogany sound board with cutaway. Forest green tuning keys and sound hole decorations. Silver-plated tuning pegs and tuning peg mounts, and silver-plated brand logo. I was very pleased with the final guitar and plan on making many more designs in the future.

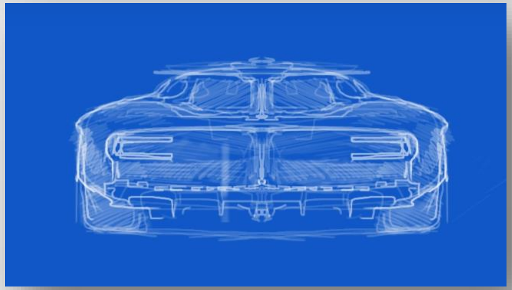


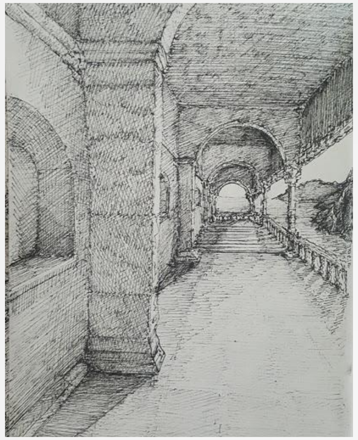


Drawings

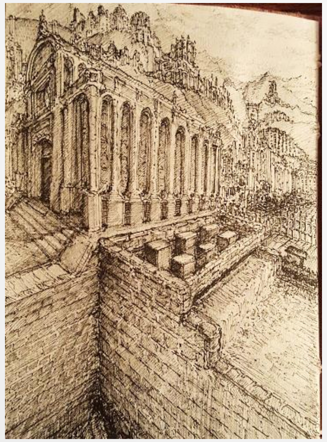
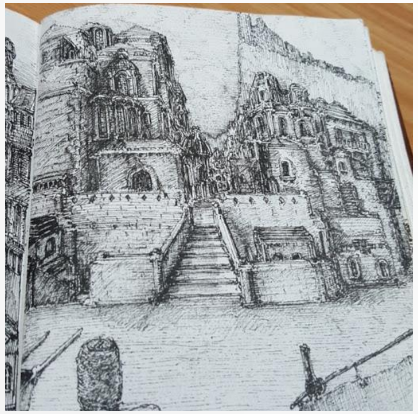
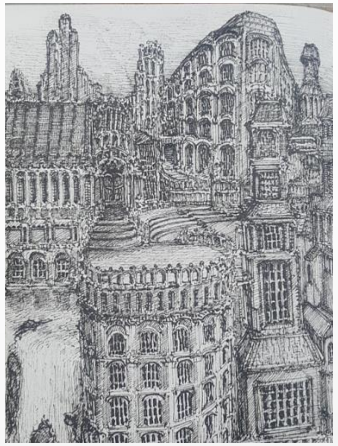
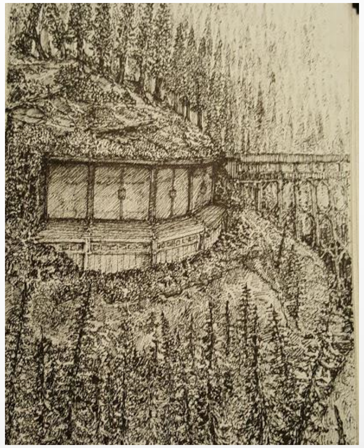
An integral part of the design process is considering various design options and thinking through possible ideas. One skill I have found particularly useful in designing and communicating ideas quickly is drawing. The following slides contain a small collection of my drawings.

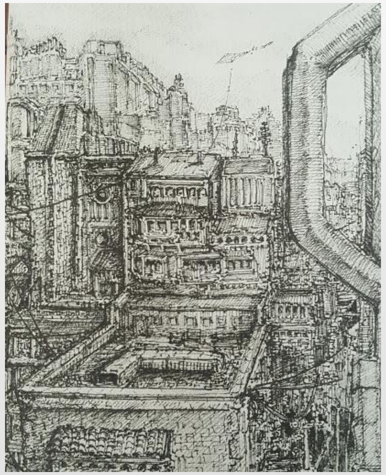









Competitions

3^{rd} Place 2019 Cornell Systems Engineering Competition

- International competition hosted by Cornell University
- 83 University Teams
- All systems must utilize of ARM Processors
- $5,000 prize
- Finals held May 2^{nd}-5^{th} at NASA Kennedy Space Center
- Submitted the Flapping Wing Micro Air Vehicle Project

1^{st} Place 2018 Beall Student Design Competition

- Hosted by University of California, Irvine
- 15 Finalists
- $10,000 prize
- Finals held June 2018
- Submitted Flapping Wing Micro Air Vehicle Project

1^{st} Place Design of Computer Controlled Robotics Class

- Graduate and Undergraduate class at UC Irvine
- 17 Group Projects
- Bio-Inspired Flapping Engine with Thrust Control

Honors and Awards

UCI Dean's Honor List: Fall 2016, Spring 2018, Fall 2018, Winter 2019, Spring 2019

AIAA Member

UC Irvine 2018 Ingenuity Technology Showcase:

- One of six teams chosen to present their projects to distinguished alumni and faculty

AIAA Sci Tech Conference Paper:

- https://doi.org/10.2514/6.2019-1048

UC Irvine 2019 Ingenuity Technology Showcase:

- One of six teams chosen to present their projects to distinguished alumni and faculty
- Project speaker (over 200 attending)

UC Irvine Applied Innovation Microgrant Awardee:

- Awarded $1,000 to continue research on Bio-Inspired Flapping Engines

References

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