A collection of projects completed for academic purposes, student organizations, and personal enjoyment.
PAN FLUTE

★ CURRENT PROJECT

Introduction
This project was an effort to come to terms with a sudden, unmerited (perhaps teenage-like) desire to learn how to play the pan flute. Hoping to find a more pleasant sounding, portable instrument to bring camping in the backcountry, I spent hours searching for the “right” pan flute on Amazon. Options seemed endless, so I gave up and decided to make one instead.

Process
- Calculate lengths based on harmonics
- Cut bamboo to length
- Sand everything smooth (esp. inside)
- Seal porous bamboo with paraffin wax
- Tune using paraffin wax
- Assemble in compact configuration

Project Details
Since I’m a geeky engineer, I used Excel to calculate the lengths of the 13 pan flute tubes corresponding to the octave C4-C5 using equations from physics:

\[ L = \frac{v}{4f} \]

where \( f = 440 \times 2^{(n/12)} \). Lengths ended up varying between 6.4-12.8 inches.

Each tube was cut so one end was closed by the naturally occurring knots in the bamboo. I’ve sanded all the tubes smooth, but because this is a work in progress, I will eventually need to seal/waterproof them with paraffin wax and assemble. One cool trick I learned was that the tubes can be tuned, not by cutting down the open end, but by pouring wax into the bottom of the tube, thereby shortening its length.

In case you love math:
- \( L = \frac{v}{4f} \)
- \( f = 440 \times 2^{(n/12)} \)
- \( v = \) speed of sound (340.29 m/s)
- \( n = \) # of notes away from A4 (A4 has \( f = 440 \) Hz)
Introduction
As a freshman at BU, the first club I ever joined was Unmanned Aerial Vehicles (UAV) Club. In a team of three and one mentor, we designed and built a quadcopter using materials we cut and 3D printed ourselves. This experience was influential in my decision to pursue engineering and has cultivated a creative and hands-on mentality with which to approach and solve problems.

Process
- Sketch overall design
- Model parts with SolidWorks
- Make parts with GibbsCAM and 3D printer
- Program Arduino microcontroller
- Assemble body and connect Arduino, brushless motors, propellers, and electronic speed controls (ESCs)
- Configure MultiWii flight controller to quadcopter

Project Details
The quadcopter body consisted of four steel rods arranged in an X, the inner ends sandwiched between two 4" x 4" Plexiglas sheets. I used SolidWorks to model the body and arms, and my teammates designed and 3D printed landing gear. The brushless motors were mounted on the rod ends and the Arduino microcontroller fit nicely inside the Plexiglas casing. Though wiring was complicated, our student mentor ensured our rotors were turning in the correct directions.

Our quadcopter turned out to be very stable, and we were able to fly and hover easily. The great thing about Fly Day was not just flying awesome drones with awesome people, but rather realizing that we actually built this thing, and it freakin' works!

PROJECT FACT
Because rotation of the motors cause the quadcopter to yaw in the opposite direction, the motors could not all spin in the same direction. They had to be programmed to turn in opposite directions so the spin of two motors would counteract the spin of the other two.
TRUSS PROJECT

MECHANICS CLASS, EK301

Introduction

The EK301 truss project enabled me to apply equilibrium equations to the design and construction of a truss out of straws. In a team of three, we tested straw strength vs length, wrote a computational analysis program in MATLAB, and optimized the truss design for strength. The project gave me an opportunity to use my newfound MATLAB skills from the previous semester to efficiently compute data and see the handmade structure collapse in the way the program had predicted.

Process

- Straw testing
- Write MATLAB program
- Optimize truss design using MATLAB results
- Build and test truss

Project Details

The truss project began with straw testing which determined the relationship between straw length and maximum load. Using this data, we designed a preliminary truss and wrote a MATLAB program that computed the member loads, theoretical maximum truss load, and first member to fail. By shortening the first member to fail and adjusting the lengths of the other members, we optimized the design such that the first member to fail was at the shortest allowed length of 10 cm, thus giving it the maximum strength.

Assembly of the truss took more time than expected because the straws at each gusset plate joint had to converge to one point to prevent rotation and decreased strength. The truss eventually held 1300 g which was within 10 g of our prediction (1337 g).