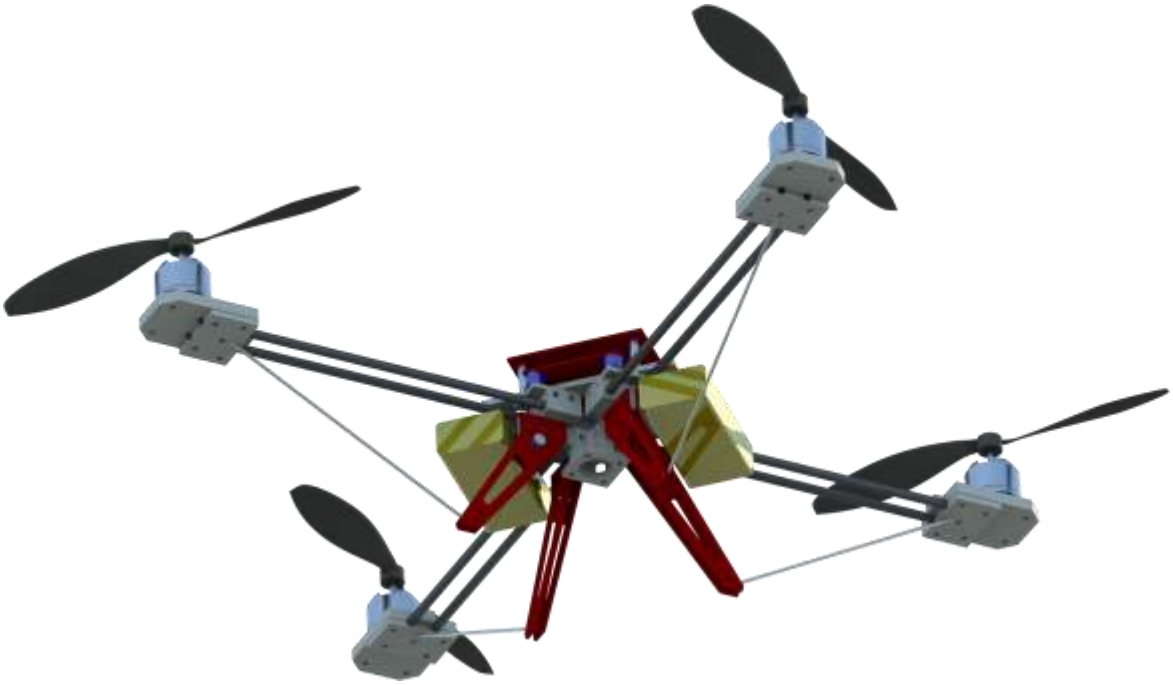
Engineering Project Portfolio - Maximilian Kapczynski

Quadcopter Project

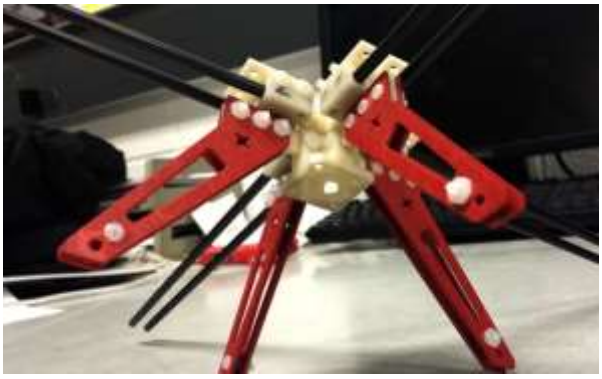
April 2014 - Present

I have designed a custom remote control aircraft for aerial photography. I set an ambitious goal: The aircraft must lift its own weight in payload, and have an endurance of 15 minutes. This necessitated a lightweight, strong airframe, which I have also fabricated myself.

- Uses a novel truss structure that greatly reduces weight, up to 50% over comparable airframes, without compromising structural stiffness.
- Diverse materials selection, including various polymers, carbon fiber, and fiberglass.
- The sensitive camera and instruments have been isolated from harmful vibrations.
- Batteries are mounted low and motors high, in order to provide a very stable filming platform.



A SolidWorks render showing the carbon fiber arms and tensile truss structure.



Photos of the prototype under construction.

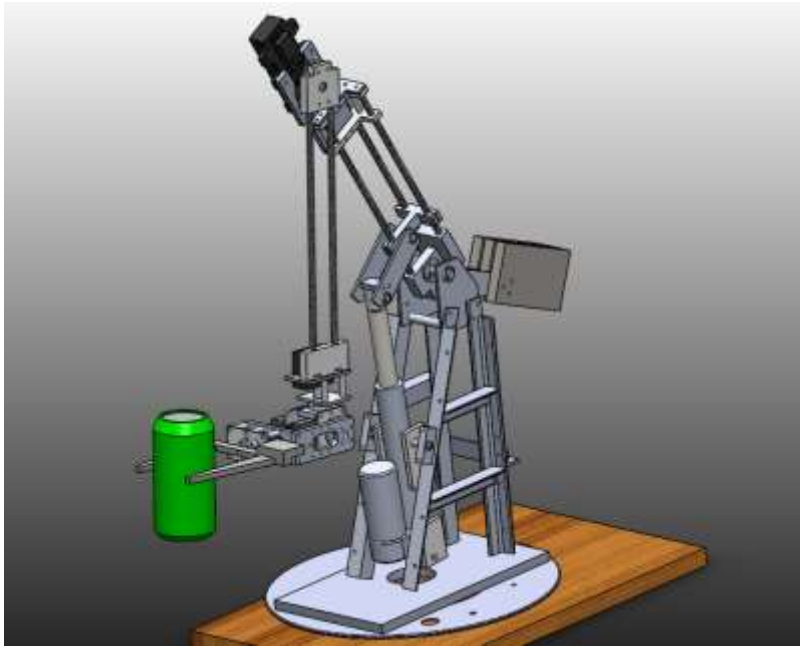
Robot Arm

January 2015 - Present

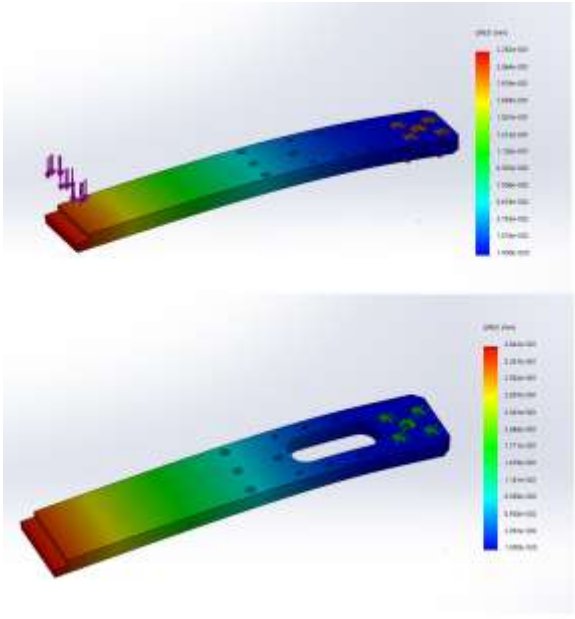
Working with a colleague, Ethan Glassman, we have designed a 6-degree of freedom robotic arm and are working to manufacture it.

- Designed for a payload of 1lb. and a reach of 2ft.
- We specified the actuators by weighing price, power, ease of interface, and factor of safety.
- Full closed-loop control in each joint ensures reliable positioning.
- This project was funded in part by a grant from our student chapter of ASME. We hope to build this project as a software experimentation platform for future engineering students.

A render of the robot arm assembly during the design process



The robot has gone through many major design revisions, continuously incorporating new improvements.



We compared several different design features using SolidWorks FEA.

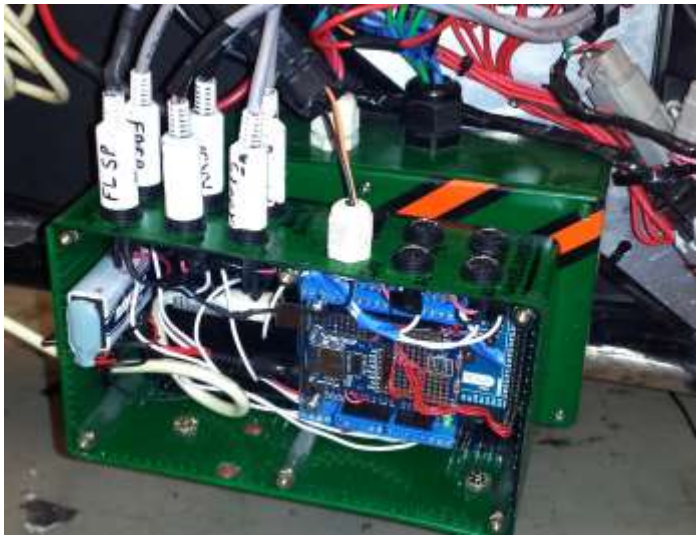
Formula SAE - Electrical and Electronics Team Leader

September 2014 – May 2015

Working on this year's race car, I had many responsibilities in my position as electrical designer. I fell into this position almost by accident, but I managed to set and reach many ambitious design goals. As a mechanical engineer, integrating these different systems has been a challenge, but has expanded my horizons and taught me a great deal about design and prototyping.

- Implemented a completely new sensor package to gather information on suspension and handling.
- With the help of our manufacturing partners, we used waterjet cutting and rapid prototyping to create sensor housings and other hardware.
- Designed an embedded Arduino-based data logging system that gathers information from ten sensors and writes the data to an SD card for capacious storage and easy processing.
- Using MATLAB, I wrote several scripts to process the data files and gain knowledge of the car's handling characteristics.
- Created and installed 12V car wiring harness and power distribution system.
- Trained junior team members to fill my role in future years, and to improve upon my designs.

Power distribution box showing relays and fuses.


The custom Arduino data logging system.


Front wheel hub with wheel speed sensor assembly attached.


Front suspension and suspension travel potentiometers.

Mechanical Engineering Capstone Project

September – December 2014

My team and I worked to construct a two-axis motorized solar panel capable of tracking a light source throughout the day.

- Aimed to gather sunlight with better than 90% efficiency compared to a fixed panel.
- Processed information from five photodiodes and reliably positioned itself towards light, even in low light conditions or from odd angles.
- We used an Arduino microcontroller to process the photosensor data and direct the motors.
- Operated off of an internal battery, and produced enough power to run the microcontroller and the motors while storing a surplus.
- Design went through several rounds of comprehensive changes in order to meet our specifications.

A photo of the finished solar tracker.

Photos of several stages in the design.

Music Visualizer Project (Songwave)

January 2014 – Present

Music is a big part of my life, and I have always been fascinated by visualization software and light shows at concerts. But I had never seen one that merged the visuals and audio perfectly. Inspired by this thought, I have spent the last eighteen months teaching myself many electronics principles, in order to build this perfect music light show system that I have been imagining for so long.

- Two channels and three colors, corresponding to amplitude and pitch of the music being played.
- Quick and crisp response to audio input, even to soft or rapid notes.
- No pre-programming required, output is based only on musical input and hardware signal processing.
- Desktop-sized and wall-mounted versions, with adjustable pitch sensitivity and output brightness.
- Attractive product packaging and display, with great potential for more changes.

This is the third prototype of the visualizer. The processing electronics are housed in the enclosure on the right, and light strips are visible behind the diffuser plate on the left.

The LED lights produce a wide range of colors. Bass frequencies trigger red hues, mids produce green, and treble blue.