Engineering Systems in High Altitude Ballooning

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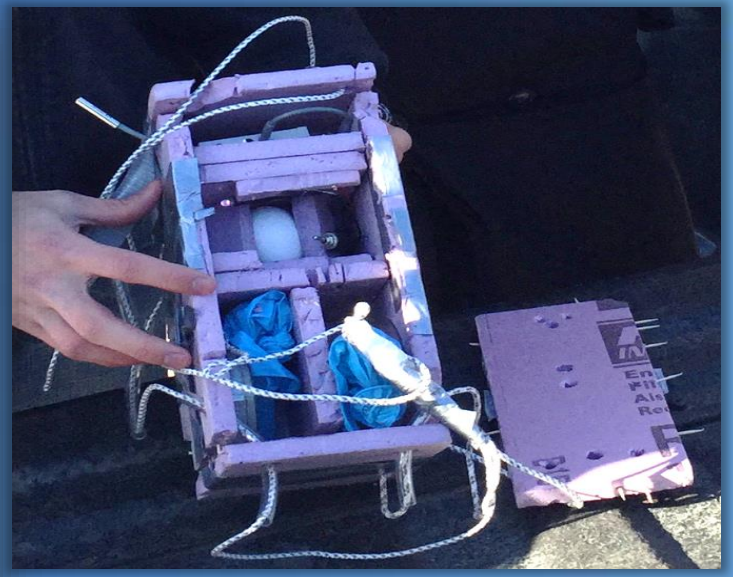
Near-Space Ballooning Competition (NSBC)

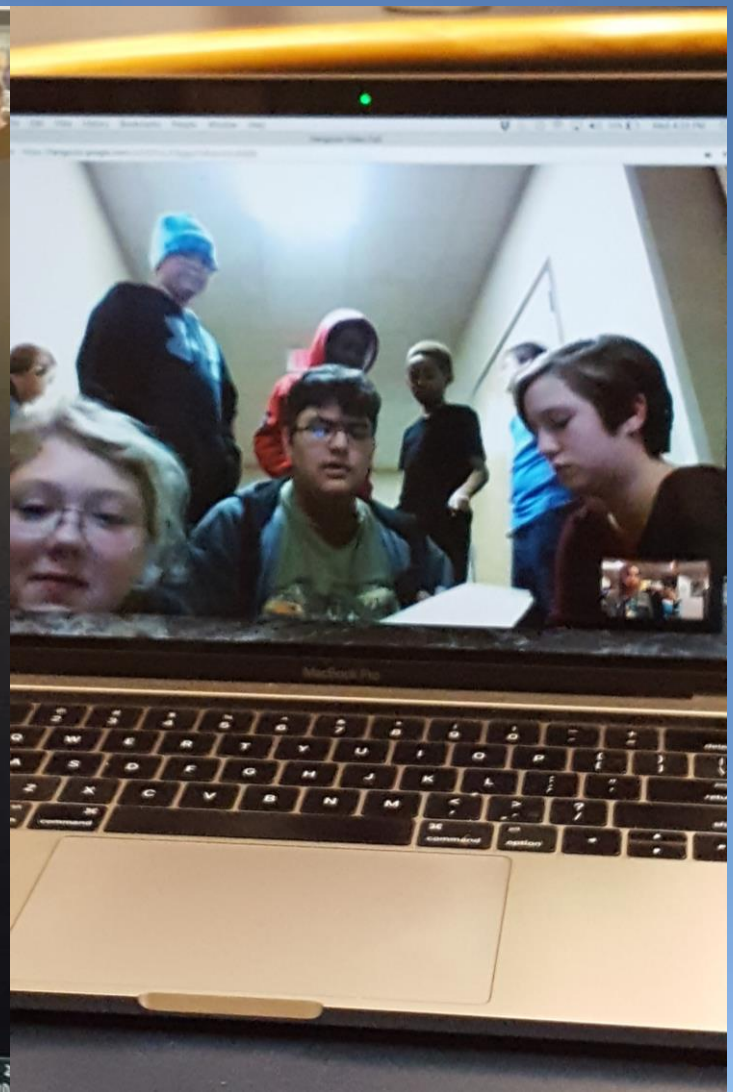
- Payload design competition
- All students from grades 6-12 in North Dakota!!
- Funded by the North Dakota Space Grant Consortium
- Student-led, semester-long project

Construction

- Students build the payload, or the container, for the experiment
- Commonly used materials: Styrofoam, zip ties, hot glue, strapping tape, duct tape, Velcro, and vinyl tubing



Digital Conference Calls with Teams



Visit Teams

2017 Total Solar Eclipse Payload

2017 Lunar Martian Habitat Balloon EVA Payload

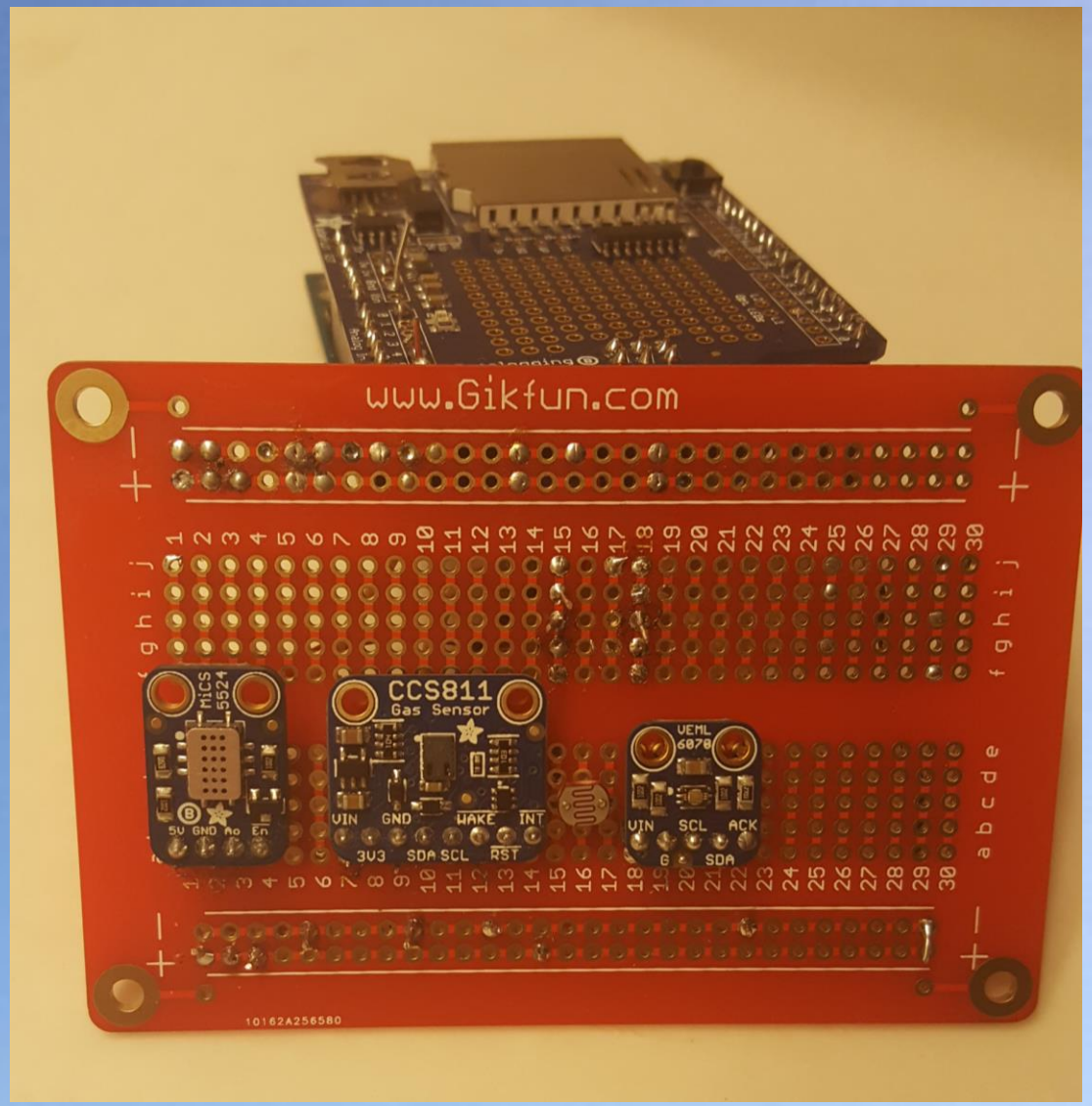
Chase Team Tracking

- HAM Radio
- Iridium Satellite Modem
- SPOT Tracker

Sensor Package #1

<u>Air Quality Monitoring</u>

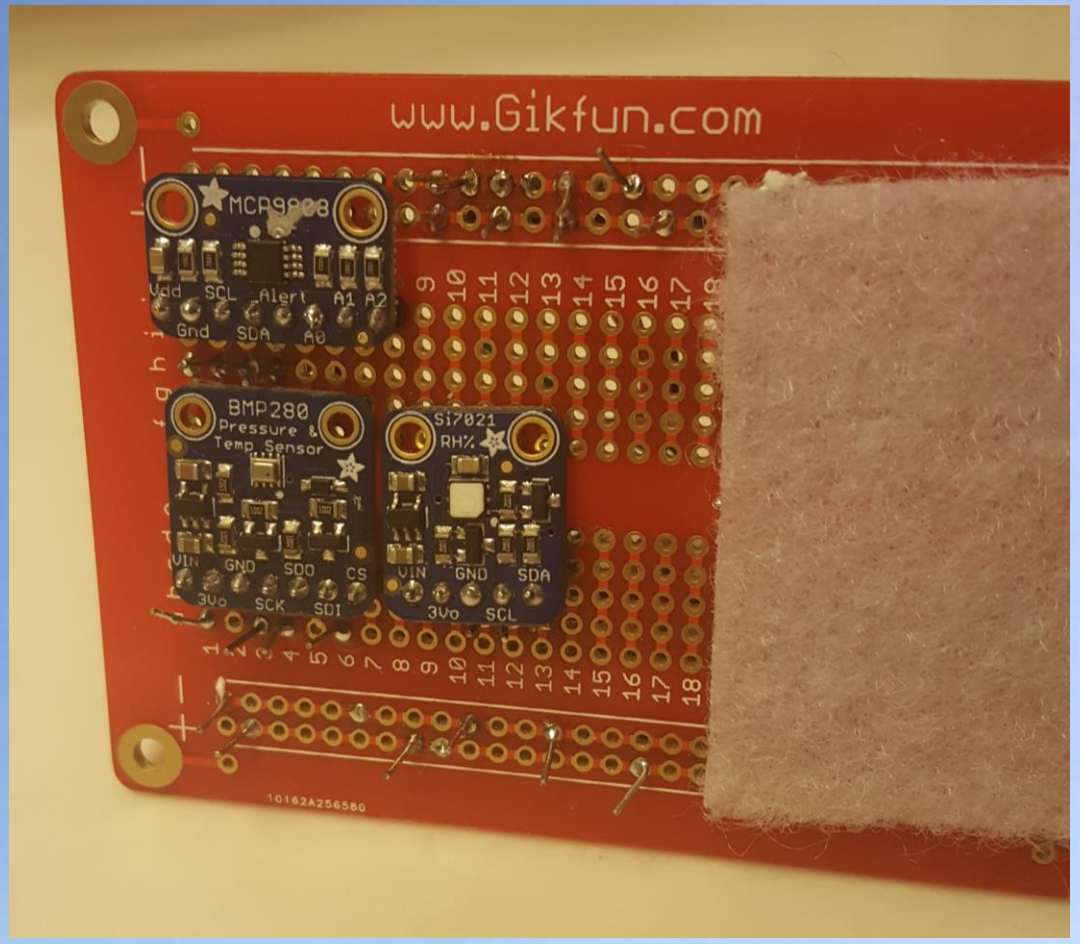
- Arduino microcontroller
- MiCS Alcohol Sensor
- CCS811 Gas Sensor
- VEML6070 UV Light Sensor
- Photocell
- Datalogging Shield



Sensor Package #2

Environmental Monitoring

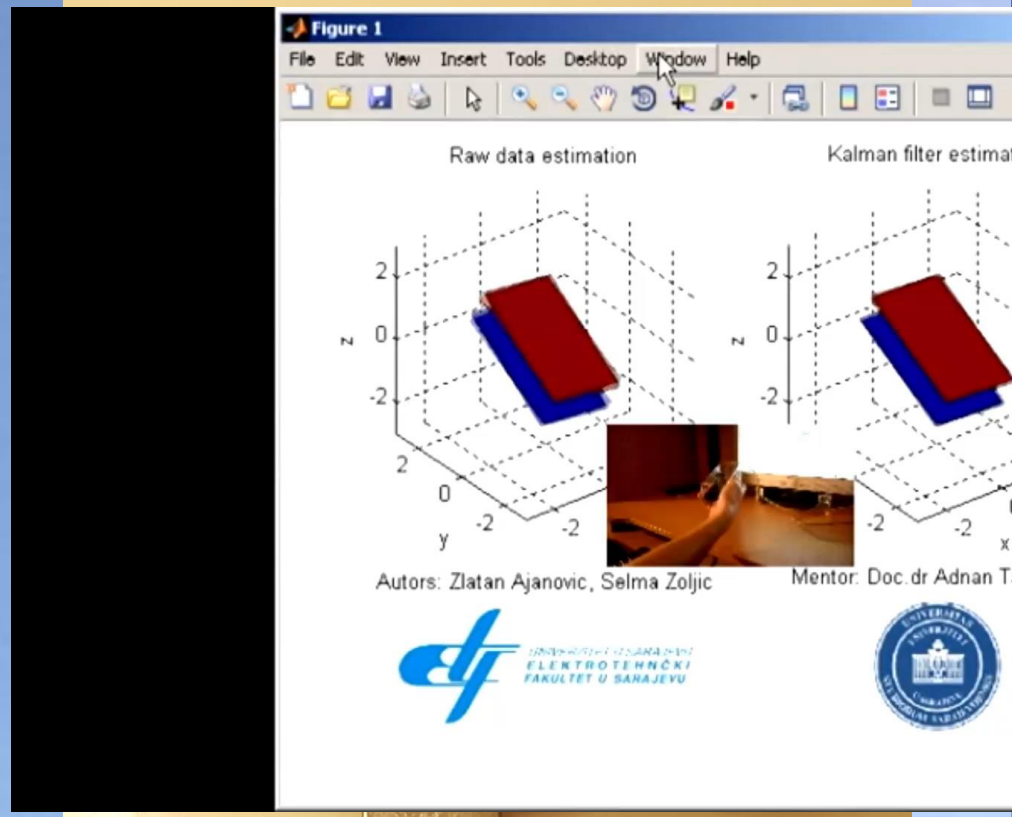
- MCP9808 Temperature
- BMP280 Pressure
- Si7021 RH%



Accelerometer/Gyrometer/Magnetometer Compass System

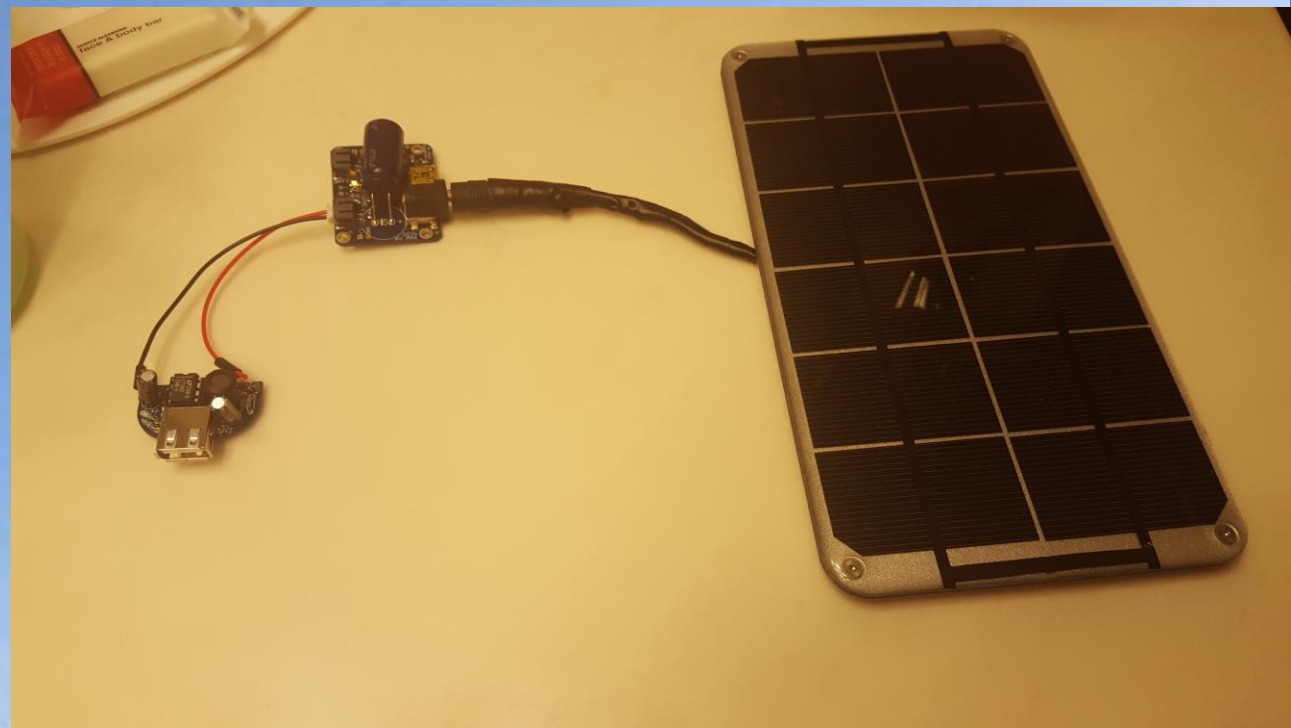
Ranges:

- ±2/±4/±6/±8/±16 *g*
- ±245/±500/±2000 dps
- ±2/±4/±8/±12 gauss



Solar Power Circuit

- 6V Solar Panel
- Lithium Polymer/Ion Batter
- Voltage Proportional Charge Controller
- 4700 micro Farad capacitor
- DC/DC boost converter chip



B alloon
L ine
A utonomous
I nstrument, [Using]
N ichrome [Wire and]
E lectricity

Nichrome Wire Cutdown System

- Uses 80% Nickel 20% Chromium Wire
- Same wire used in electric radiating heaters such as toaster ovens
- High melting point

Specifications

Composition: 80% Ni, 20% Cr

Specific Resistance:
650 Ω per circular mil-foot at 20°C (68°F). See table below for multiplication factors to obtain resistance at other temperatures.

Specific Gravity: 8.41

Density: 0.304 lb/in³

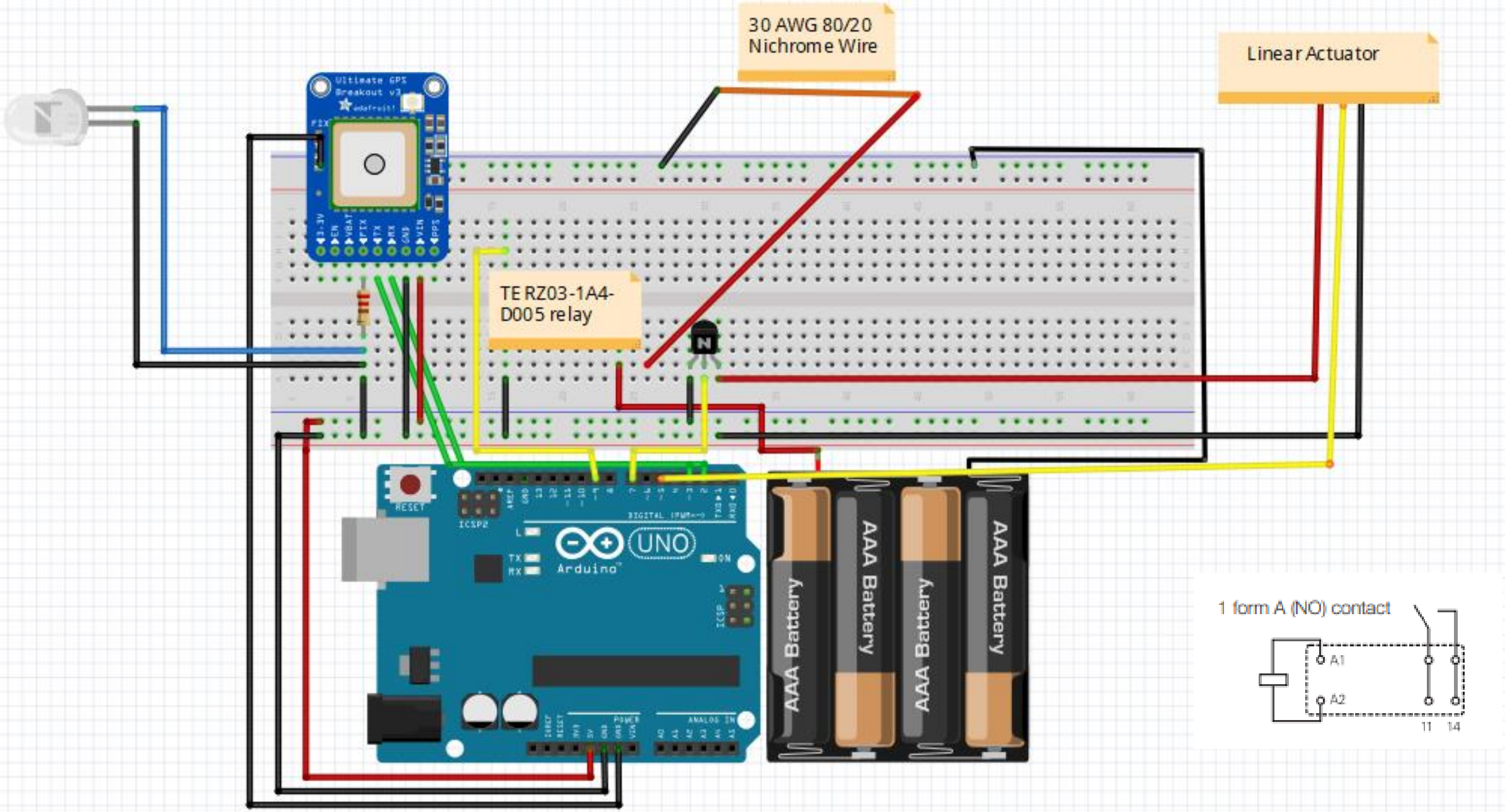
Melting Point: Approx 1400°C (2550°F)

Nominal Coefficient of Linear Expansion: 0.000017 (10 to 1000°C)

Tensile Strength (lb/in²) at 20°C (68°F):
Soft Annealed: 100,000

Nominal Temperature Coefficient of Resistance:
0.00011 Ω/Ω/°C (20 to 500°C)

Ref: Nichrome Wire specifications from datasheet https://www.omega.com/temperature/pdf/NI80.pdf


30 AWG 80/20
Nichrome Wire
Linear Actuator
TE RZ03-1A4-
D005 relay
Ultimate GPS
Breakout v3
adafruit
FIX
3-3V
EN
VBAT
PPS
RESET
ICSP2
UNO
Arduino
TX
RX
ON
ICSP
POWER
ANALOG IN
AAA Battery
AAA Battery
AAA Battery
AAA Battery
1 form A (NO) contact
A1
A2
11
14

How hot do we need the wire?

- 6.50 Ω/ft
- Need ~1400°F

  to cut the nylon rope
- 2.53 amps will do

  the trick

AWG	Dia. mm (1")	Ω per ft @ 20°C (68°F)	Current Temperature Characteristics* °C (°F)						Model No.
			425 (800)	550 (1000)	650 (1200)	750 (1400)	875 (1600)	1100 (2000)	
18	1.0 (0.040)	0.4062	8.32	10.17	12.48	15.11	18.06	24.03	NI80-040-(t)
20	0.81 (0.032)	0.6348	6.17	7.56	9.24	11.13	13.23	17.57	NI80-032-(t)
22	0.64 (0.0253)	1.015	4.62	5.62	6.85	8.20	9.69	12.85	NI80-025-(t)
24	0.51 (0.0201)	1.609	3.46	4.18	5.06	6.04	7.10	9.40	NI80-020-(t)
26	0.40 (0.0159)	2.571	2.62	3.12	3.76	4.49	5.27	6.90	NI80-015-(t)
28	0.32 (0.0126)	4.094	1.98	2.38	2.84	3.37	3.93	5.09	NI80-012-(t)
30	0.25 (0.010)	6.50	1.50	1.81	2.14	2.53	2.93	3.75	NI80-010-(t)

Ref: Nichrome Wire specifications from datasheet
https://www.omega.com/temperature/pdf/NI80.pdf

How long should our Nichrome Wire be?

Ohm's Law

$$R = \frac{V}{I}$$

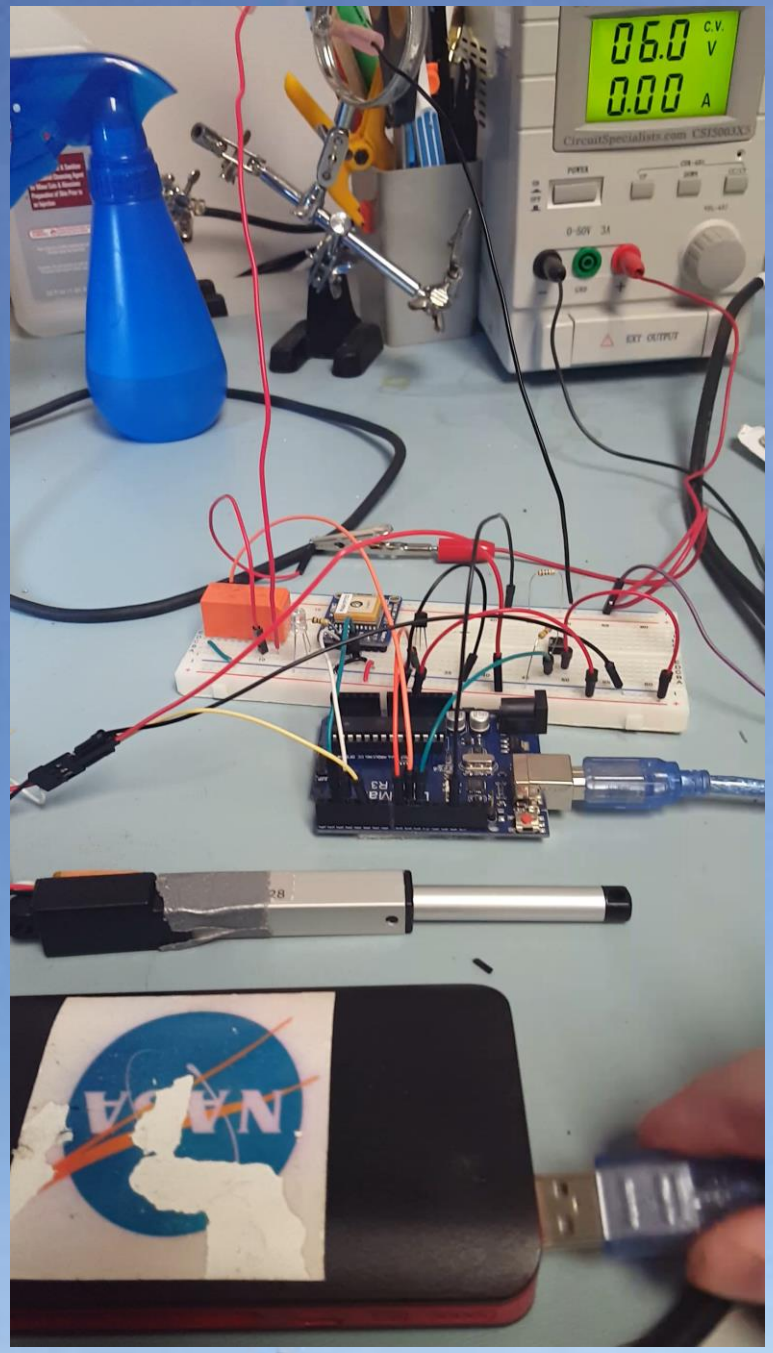
$$resistance\ (\Omega/\text{ft}) \times \text{length (ft)} = \frac{voltage\ (V)}{current\ (A)}$$

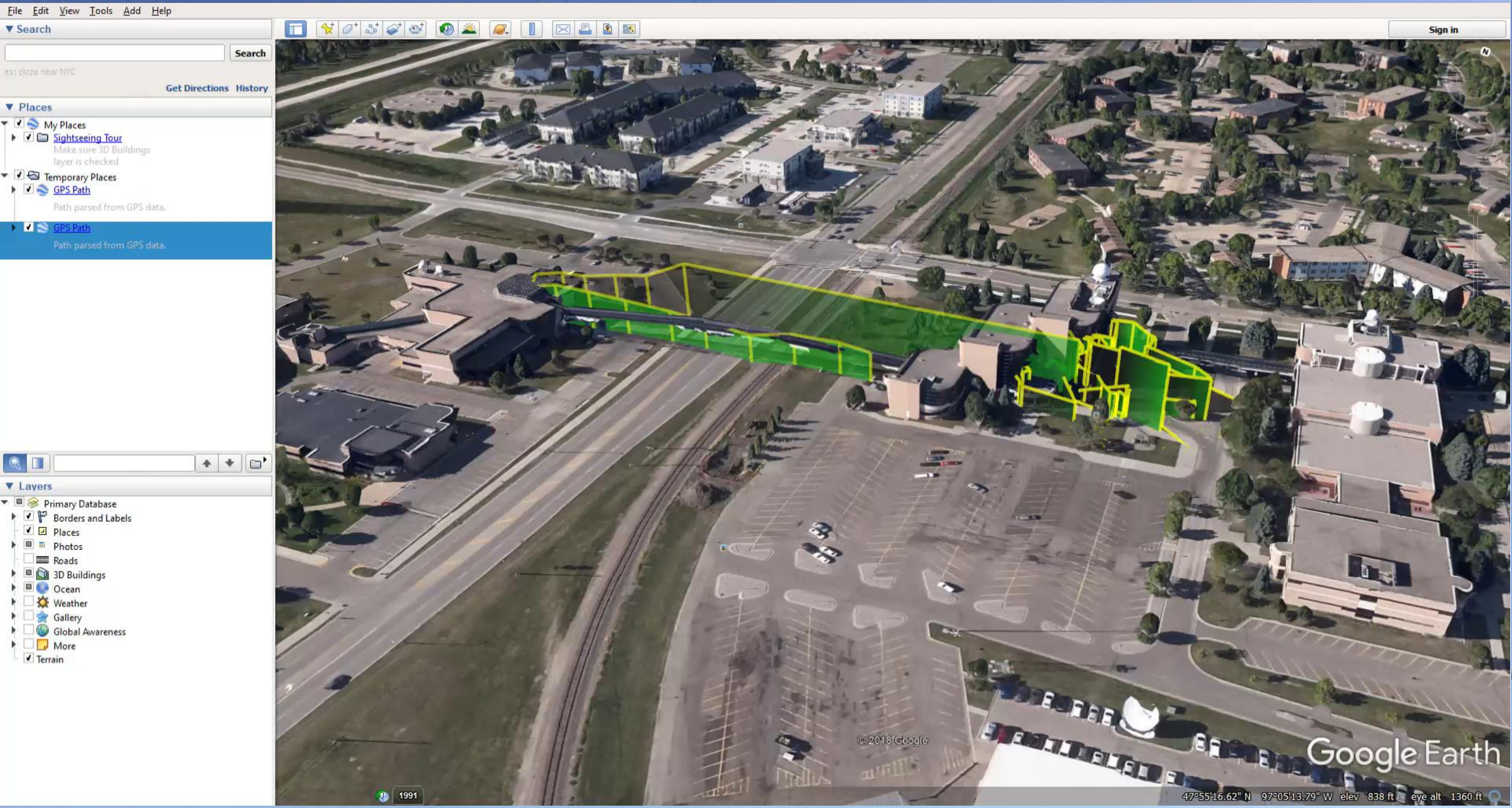
$$\text{Length (ft)} = \frac{voltage\ (V)}{resistance\ (\Omega/\text{ft}) \times current\ (A)}$$

$$Length = \frac{6\ V}{(6.5\ \Omega/\text{ft}) \times (2.53\ A)} = 0.36\ ft \approx \boxed{4\frac{3}{8}\ inches}$$

Demo #1

Demo #2




File Edit View Tools Add Help
Search
Search
ex: pizza near NYC
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Places
My Places
Sightseeing Tour
Make sure 3D Buildings layer is checked
Temporary Places
GPS Path
Path parsed from GPS data.
GPS Path
Path parsed from GPS data.
Layers
Primary Database
Borders and Labels
Places
Photos
Roads
3D Buildings
Ocean
Weather
Gallery
Global Awareness
More
Terrain
Sign in
© 2018 Google
Google Earth
1991
47°55'16.62" N 97°05'13.79" W elev 838 ft eye alt 1360 ft

Future Work for BLAINE

- Redesign using newly found voltage/current levels
- Test GPS data acquisition, determine when to use the Nichrome blade

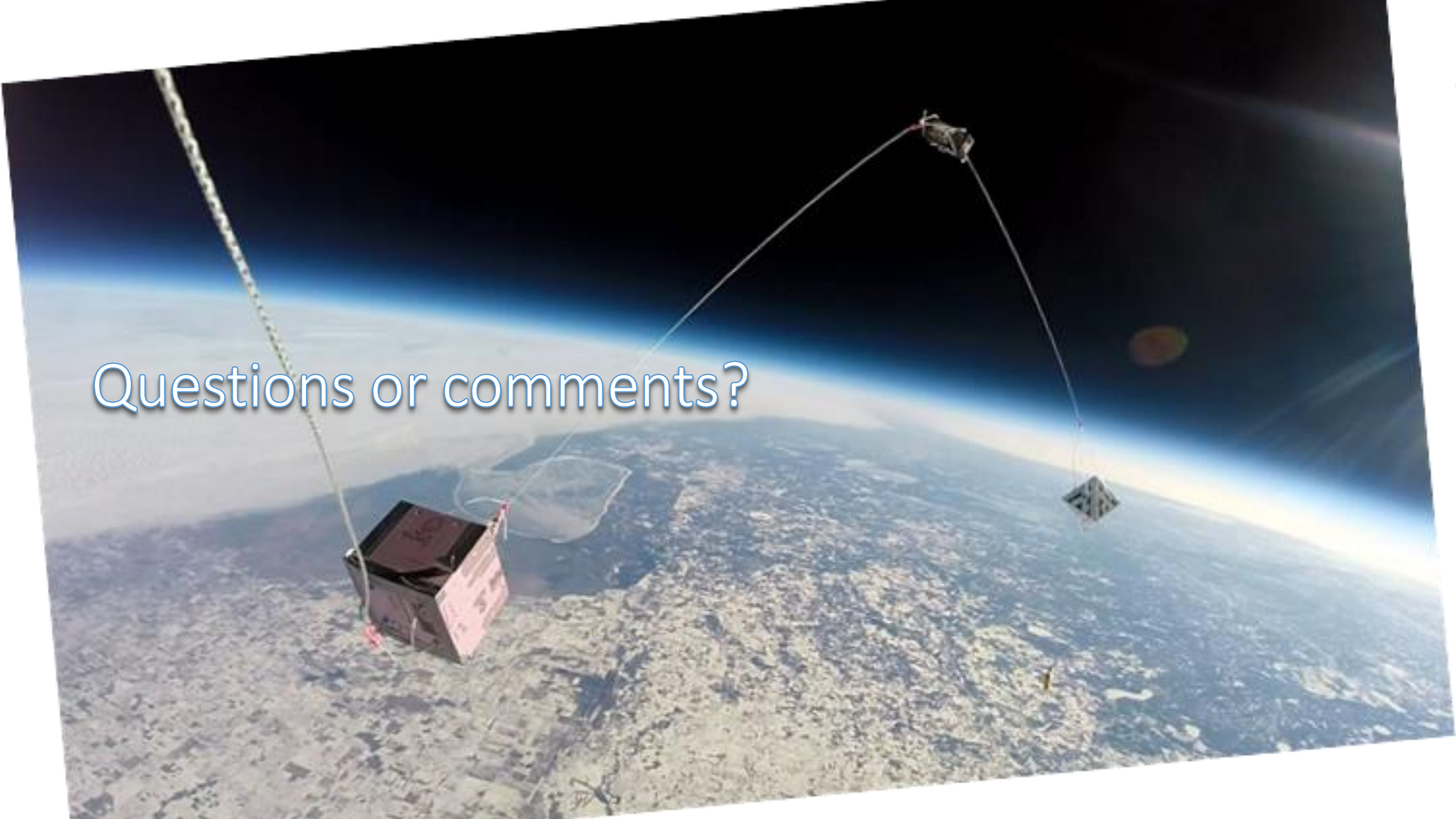
  (multiple ground tests, tethered balloon tests, full-flight test)
- Solder permanent connections
- Design case for system and 3D print (in Autodesk Fusion 360)
- Design/manufacture custom circuit board (in Eagle PCB software)

Thank you


NORTH DAKOTA
SPACE GRANT CONSORTIUM


Digi-Key
ELECTRONICS


adafruit


Questions or comments?