Instrumented Baseball

David Adams | Mathew Brown | Riley Ferrer | Yanni Giannareas | Charles Whitaker

TEAM 516

Meet Team 516

David Adams

Design Engineer

Mathew Brown

Mechatronics Engineer

Riley Ferrer

Manufacturing Engineer

Yanni Giannareas

Systems Engineer

Charles Whitaker

Test Engineer

Charles Whitaker

Sponsor and Advisor

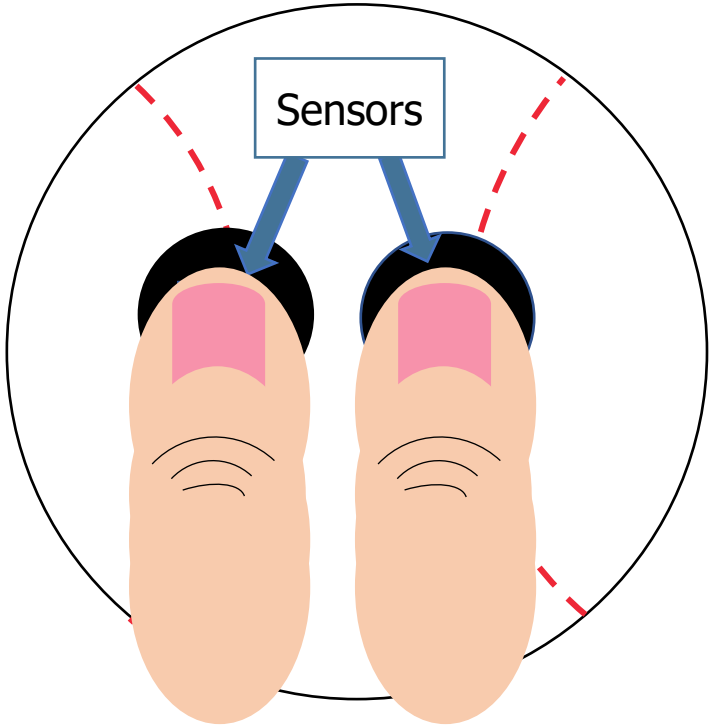
Dr. William Oates, P.E.

FAMU-FSU
College of Engineering

Charles Whitaker

Project Objective

Develop technology to monitor dynamic fingertip forces on a baseball



Develop accurate method of measurement

Maintain the original characteristics of a ball

Facilitate access to the gathered data

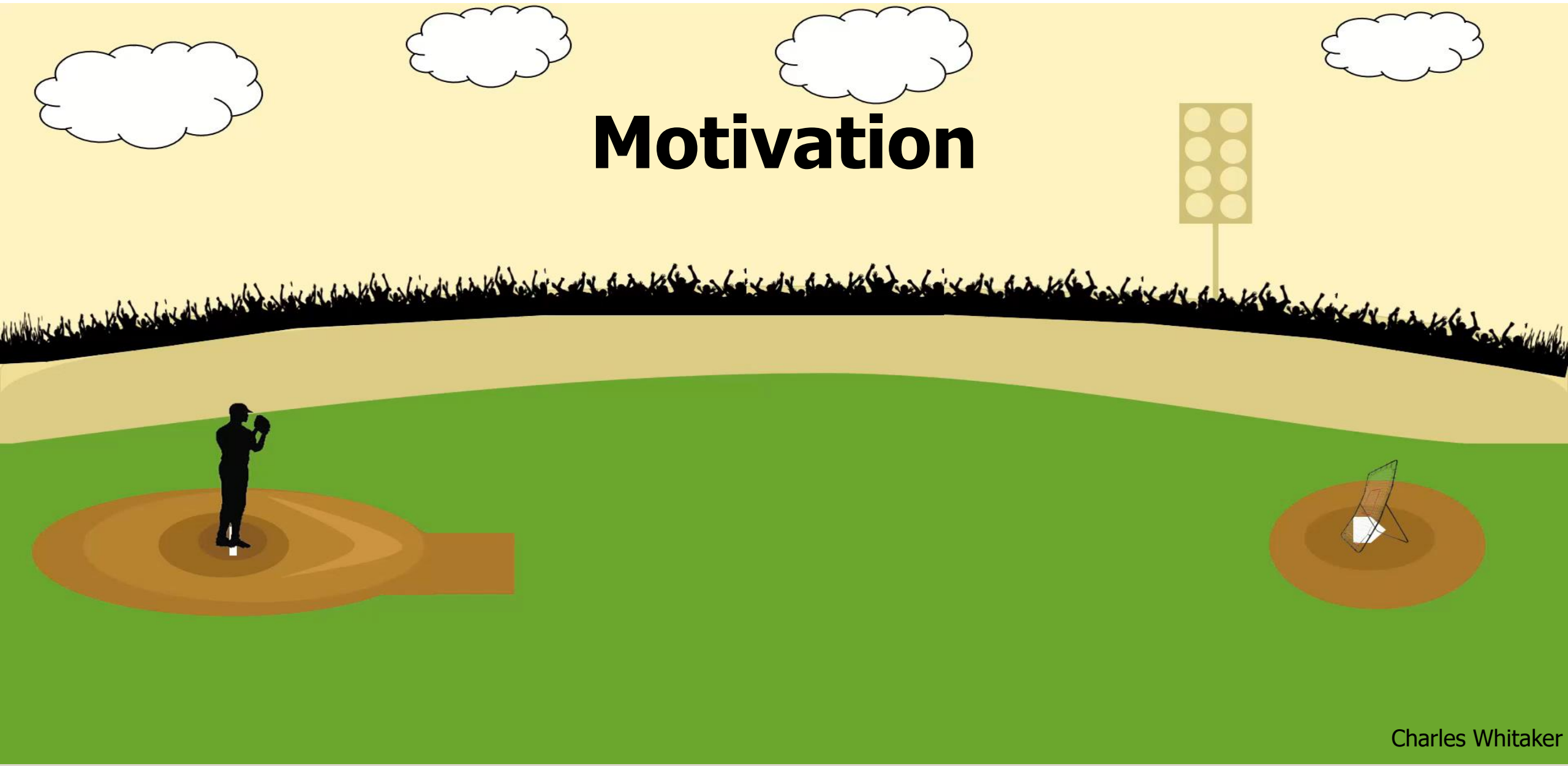
Charles Whitaker

Background

Your goal shouldn't be to buy players. Your goal should be to buy wins. In order to buy wins, you need to buy runs.
- *Michael Lewis, Moneyball*

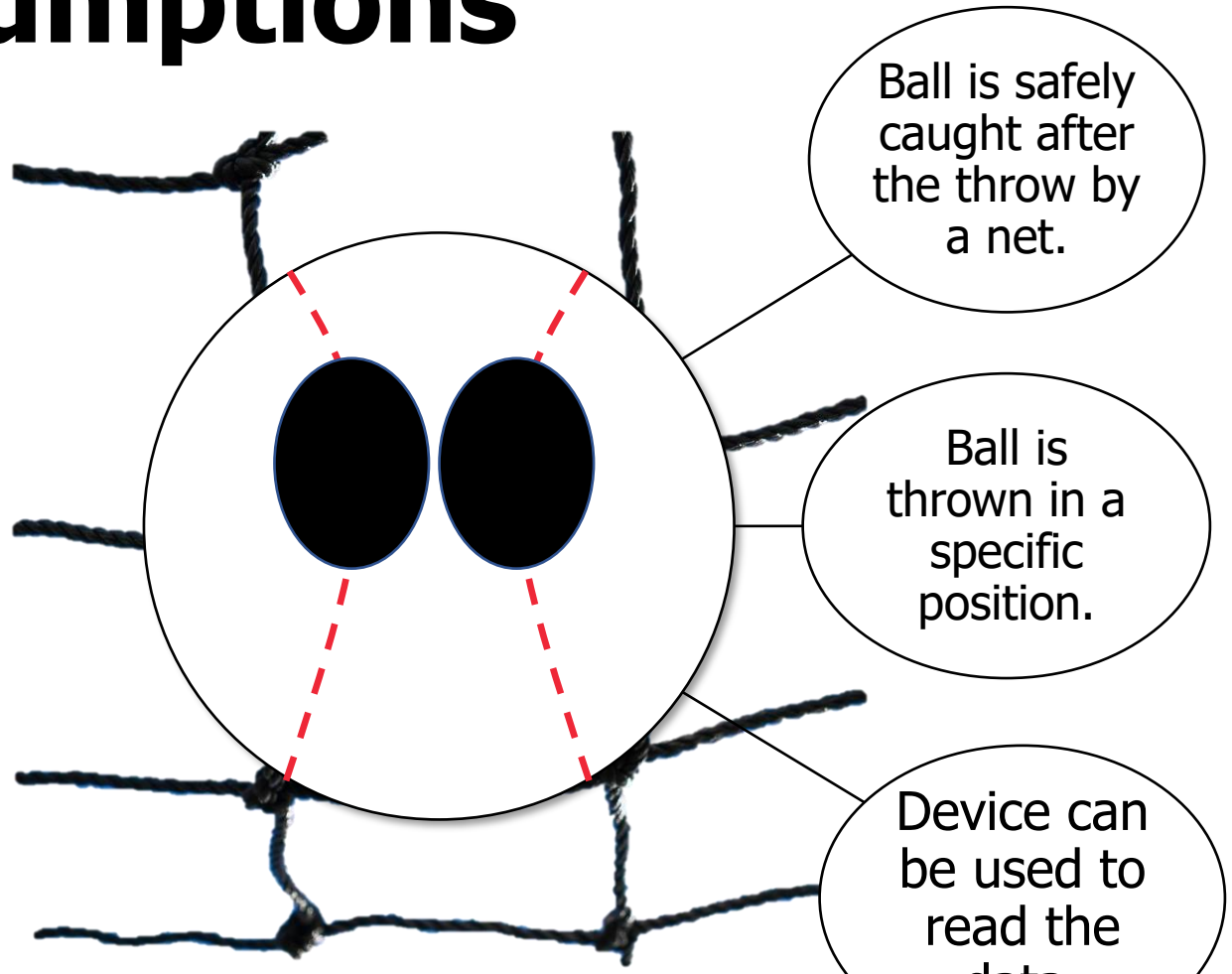
Charles Whitaker

Motivation



Charles Whitaker

Assumptions



Charles Whitaker

Customer Needs

The device can be charged repeatedly.

The device doesn't interfere with the pitcher.

Device is tailored to detect forces on the index and middle fingers.

The device captures pressure and shear forces.

Device is tailored to a 4-seam style.

Charles Whitaker

Functional Decomposition

Contains supplied voltage

Transforms signals from analog to digital

Plot time-dependent data

Senses applied load

Isolates region for fingertip application

Match moment of inertia close to standard

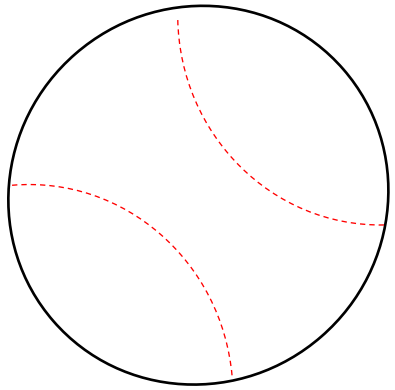
Lock components in place

Supports weight of components

Riley Ferrer

Targets And Metrics

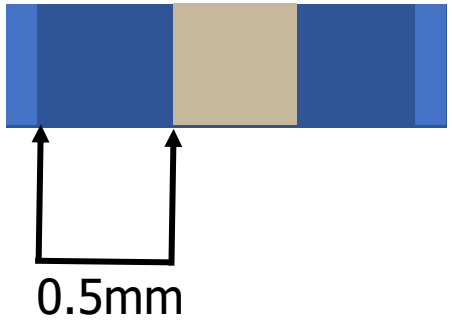
Standard Moment of Inertia



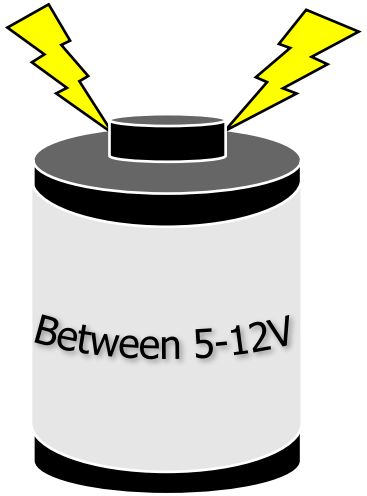
81.56 ± 5% kg•mm^2

Component Movement

Click to add text



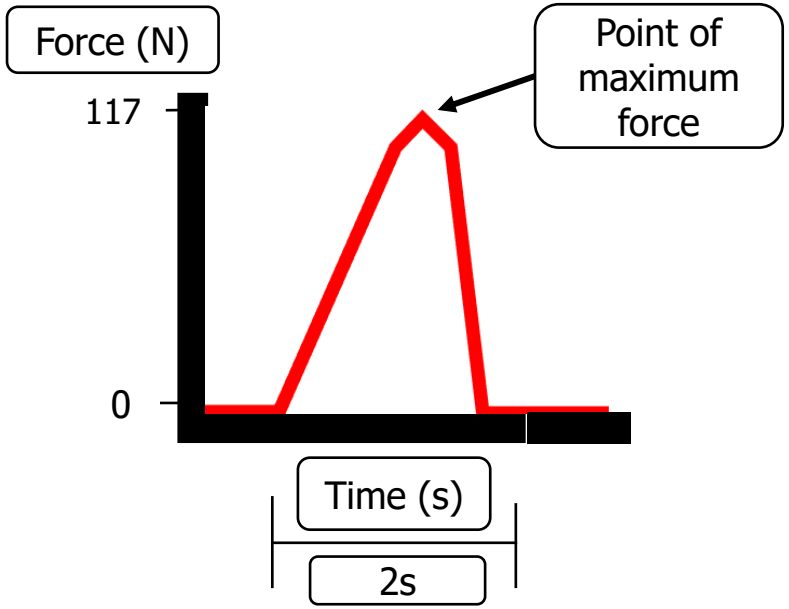
Supplied Voltage



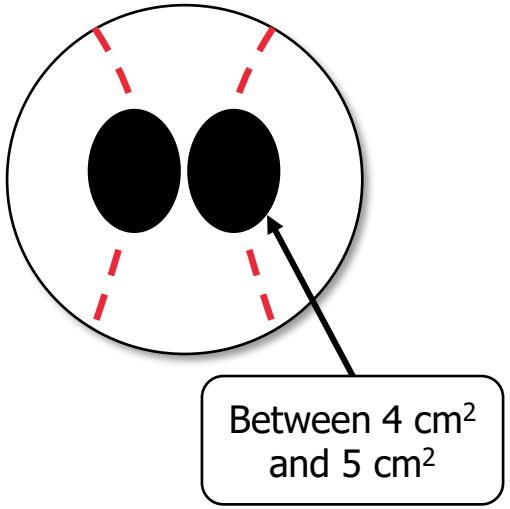
Riley Ferrer

Targets And Metrics

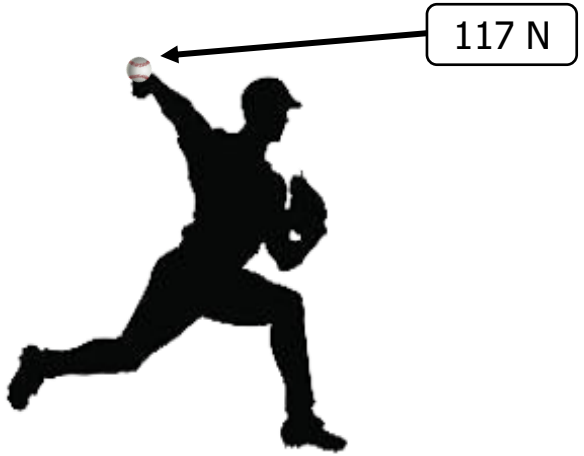
Plot time-dependent Data



Region for index and middle finger application



Senses applied load



Riley Ferrer

Concept Design

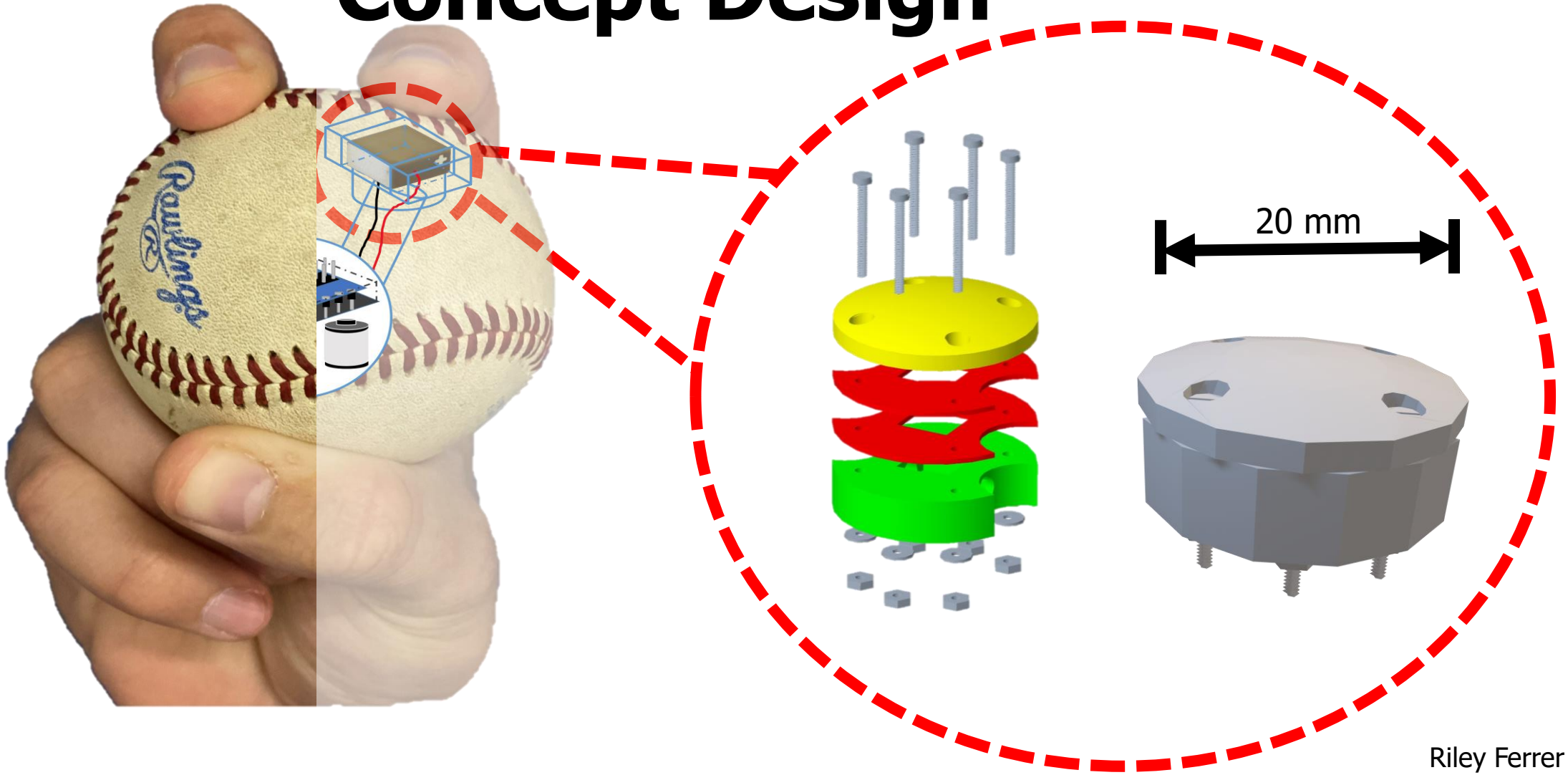
Piezo Sensors

3D Printed Housing

Arduino Blue Nano

Lithium-ion Battery

Indications



Riley Ferrer

Concept Design

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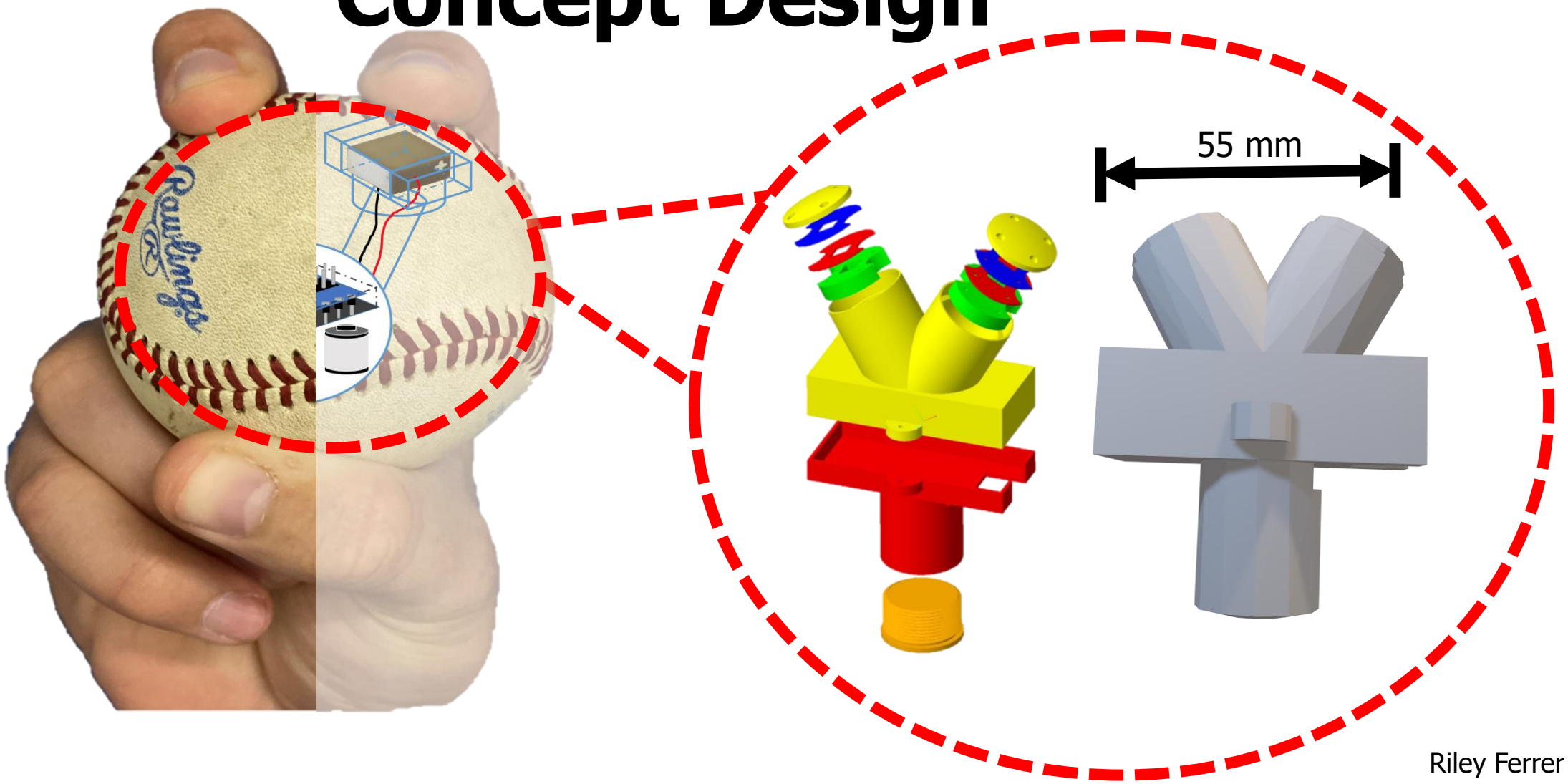
- 3D Printed Housing
- Arduino Blue Nano
- Lithium-ion Battery
- Indications



Riley Ferrer

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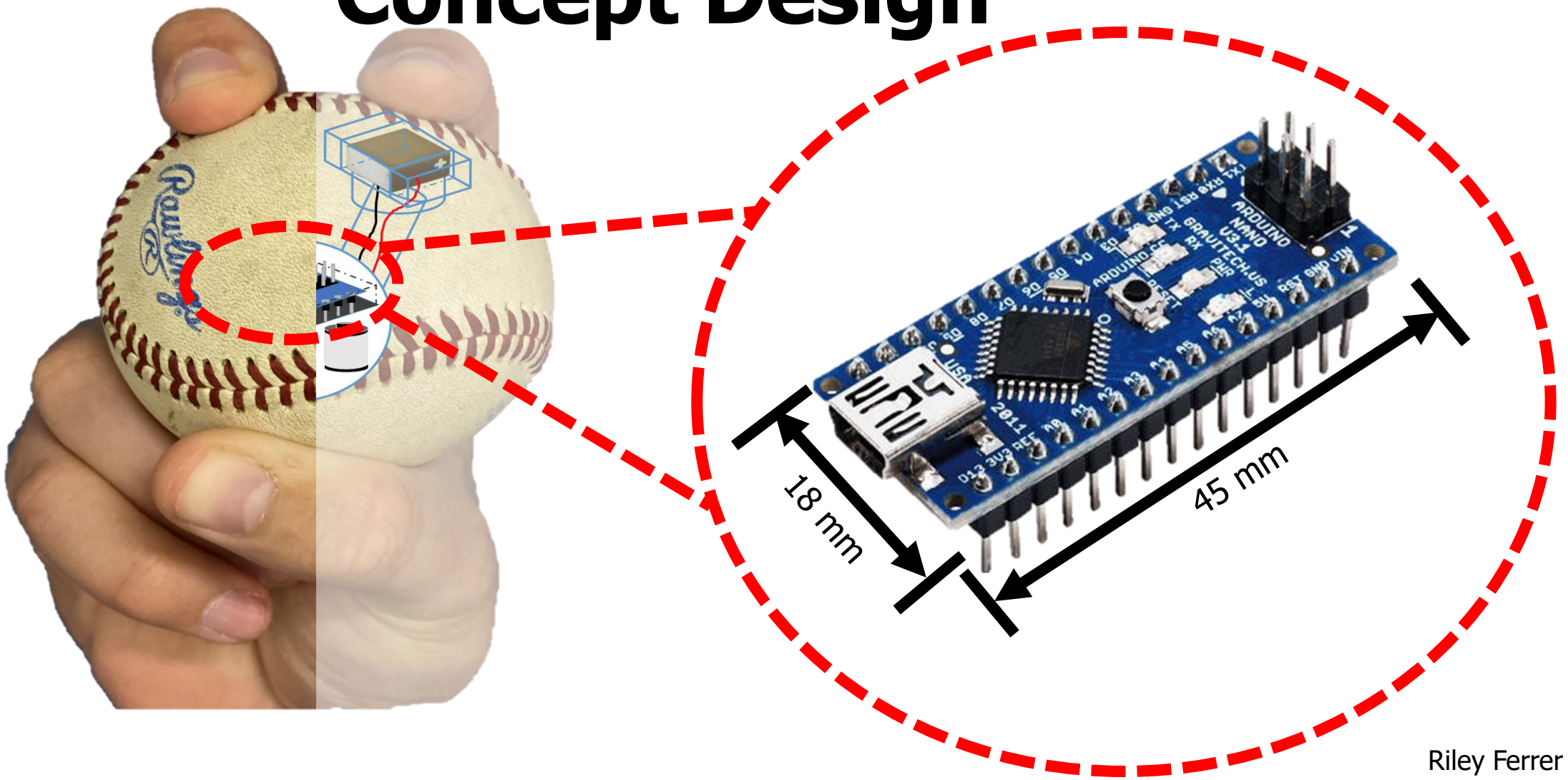

Riley Ferrer

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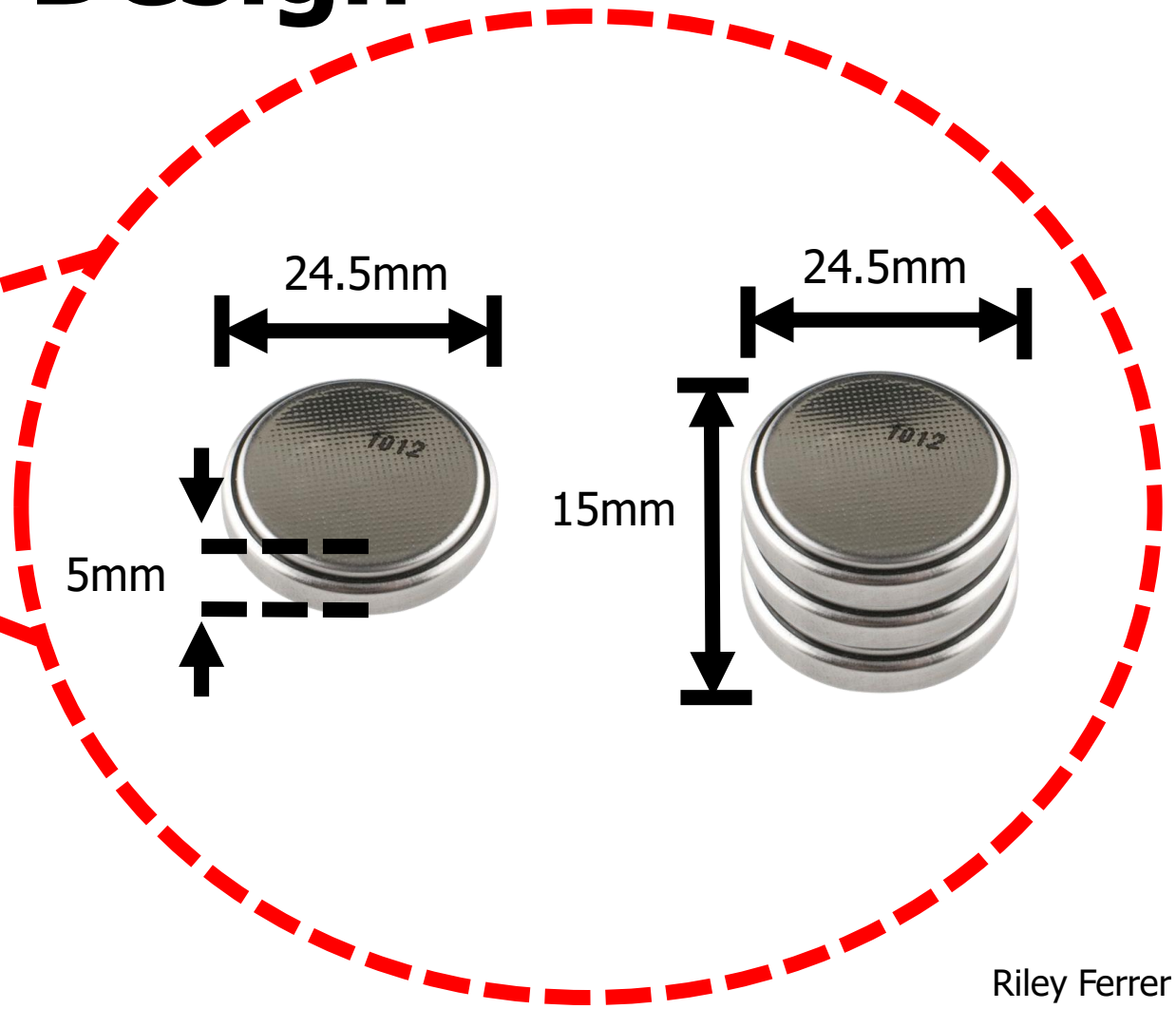


Riley Ferrer

Concept Design

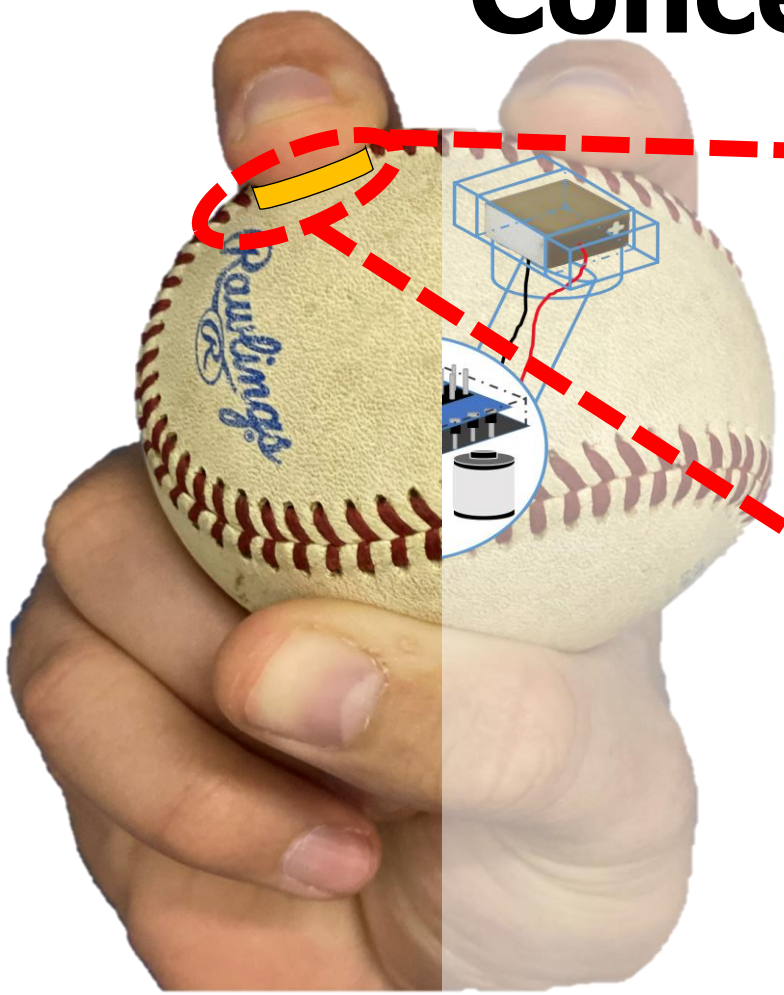
Piezo Sensors

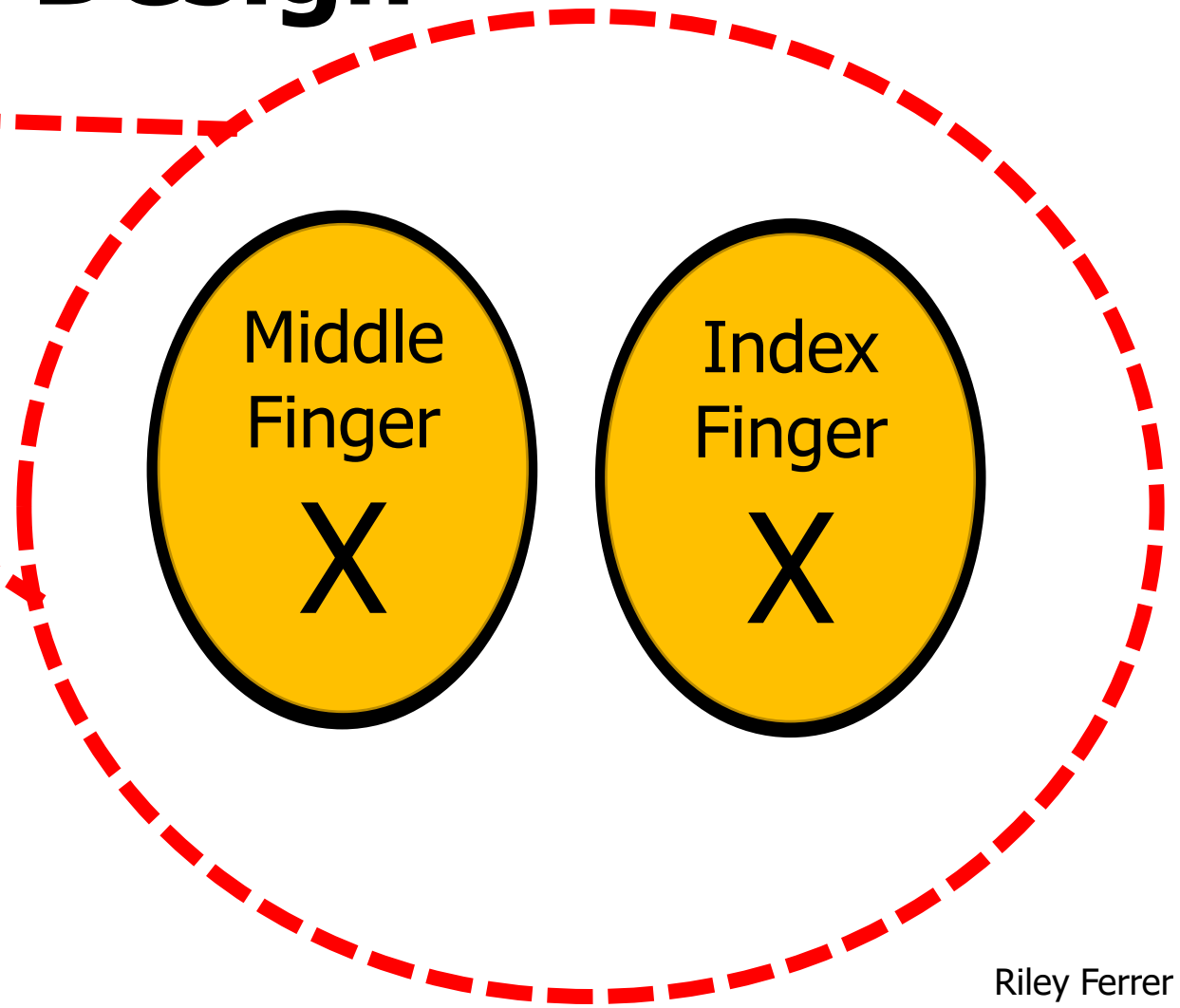
3D Printed Housing

Arduino Blue Nano

Lithium-ion Battery

Indications

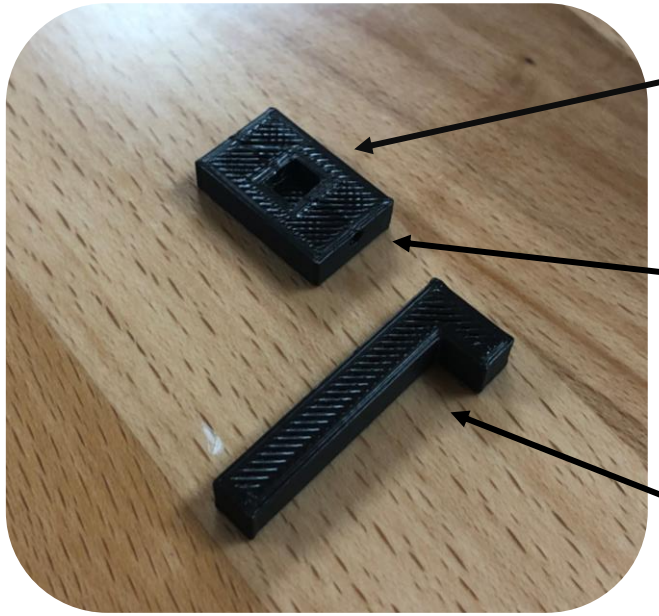




Riley Ferrer

Initial Prototyping

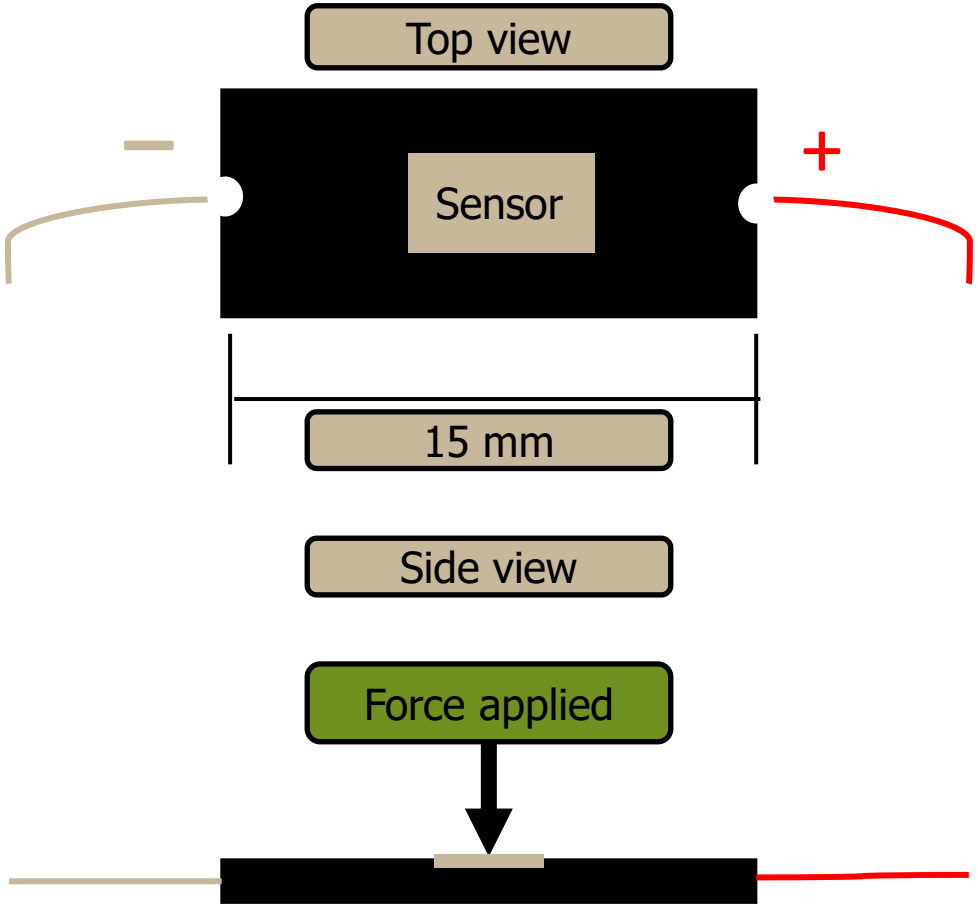
3D-Printed Housing



Gap for sensor

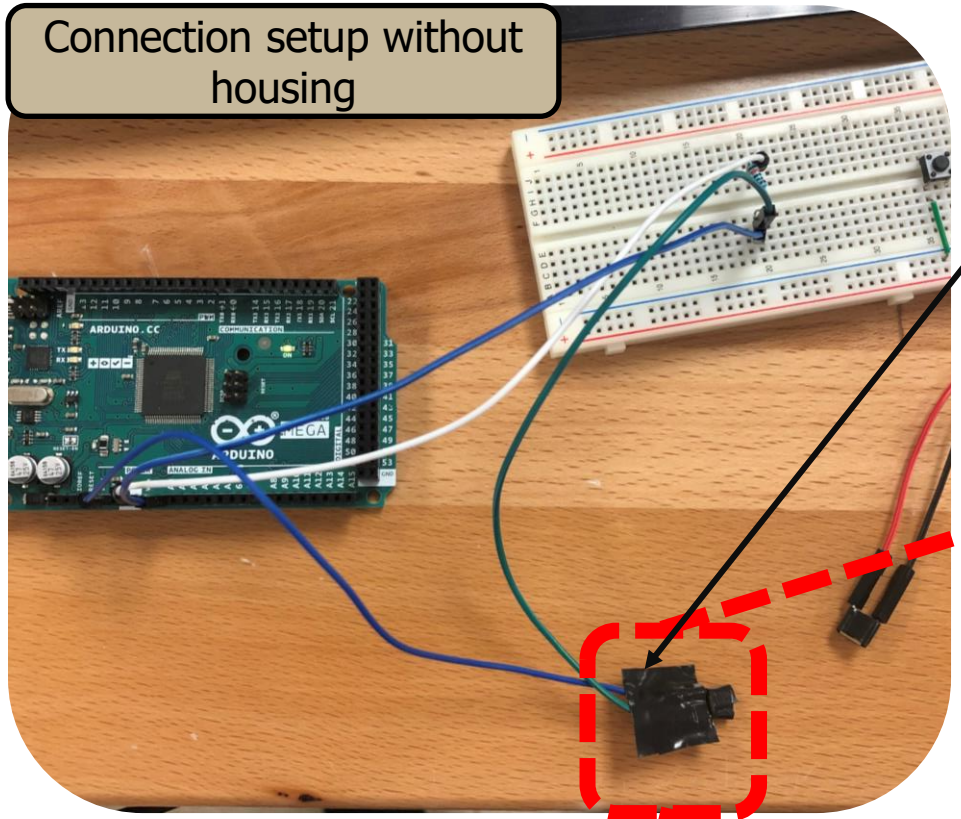
Opening for cable connection

Bracket for force application



Yanni Giannareas

Sensor Testing



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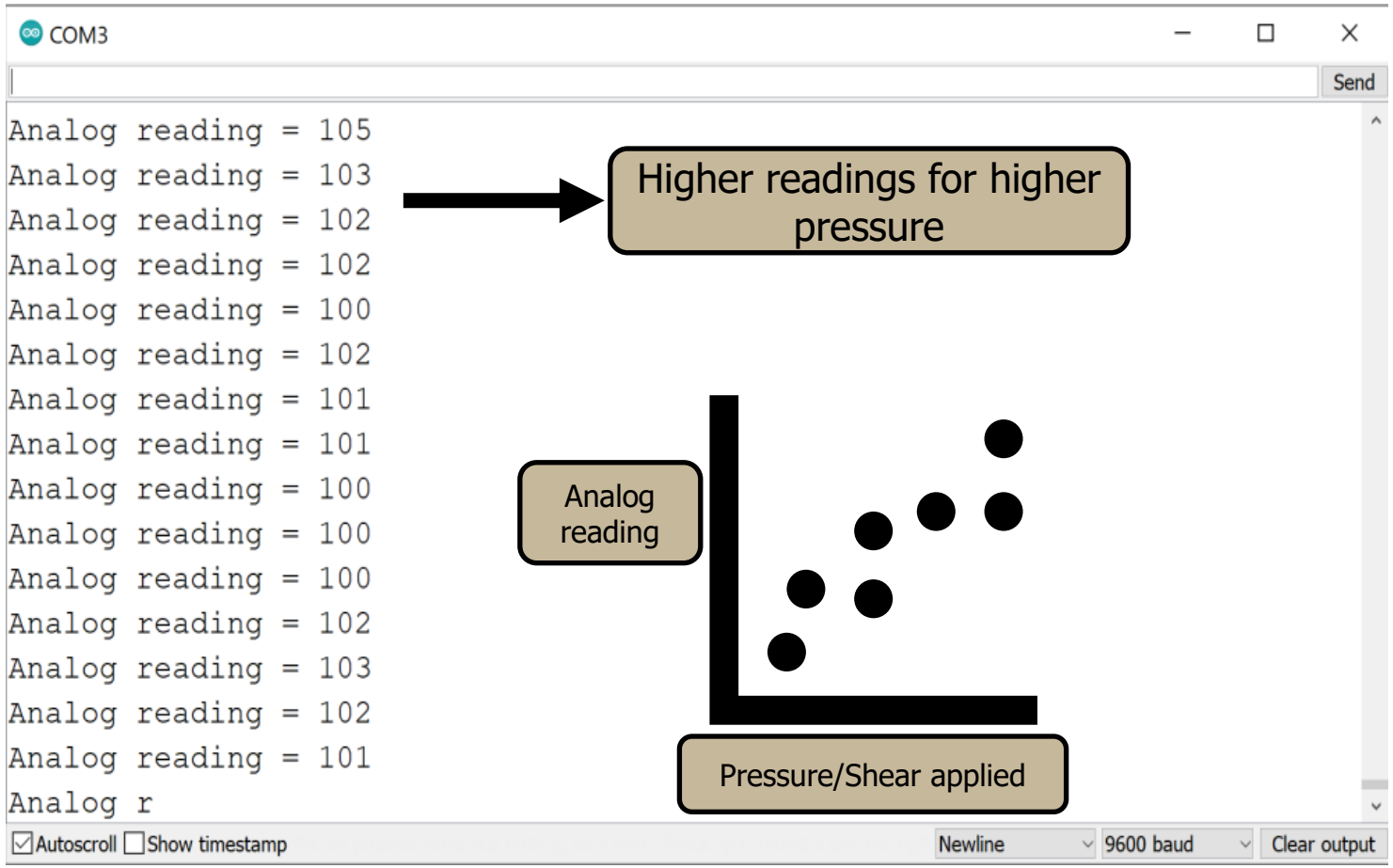
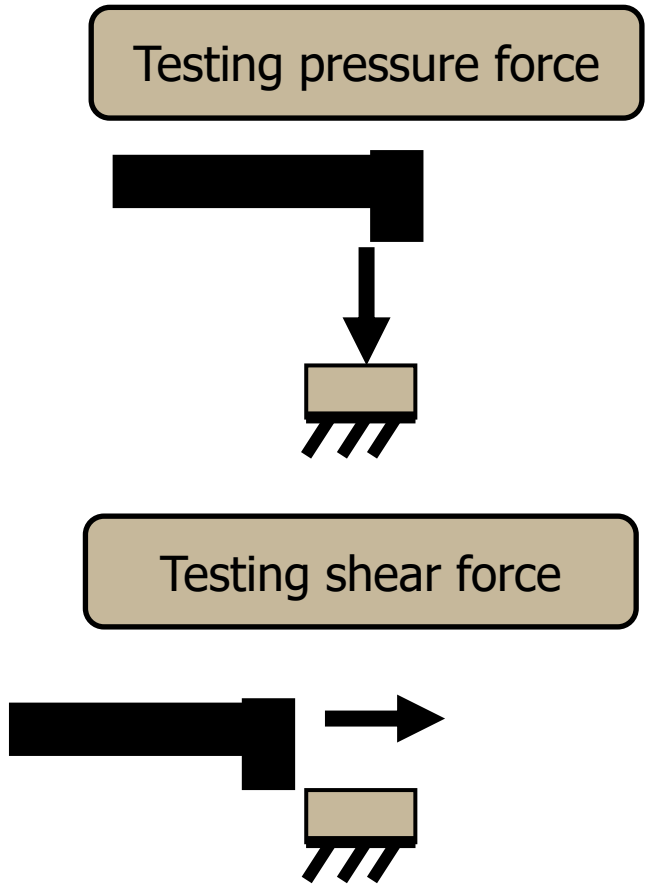
Sensor Testing

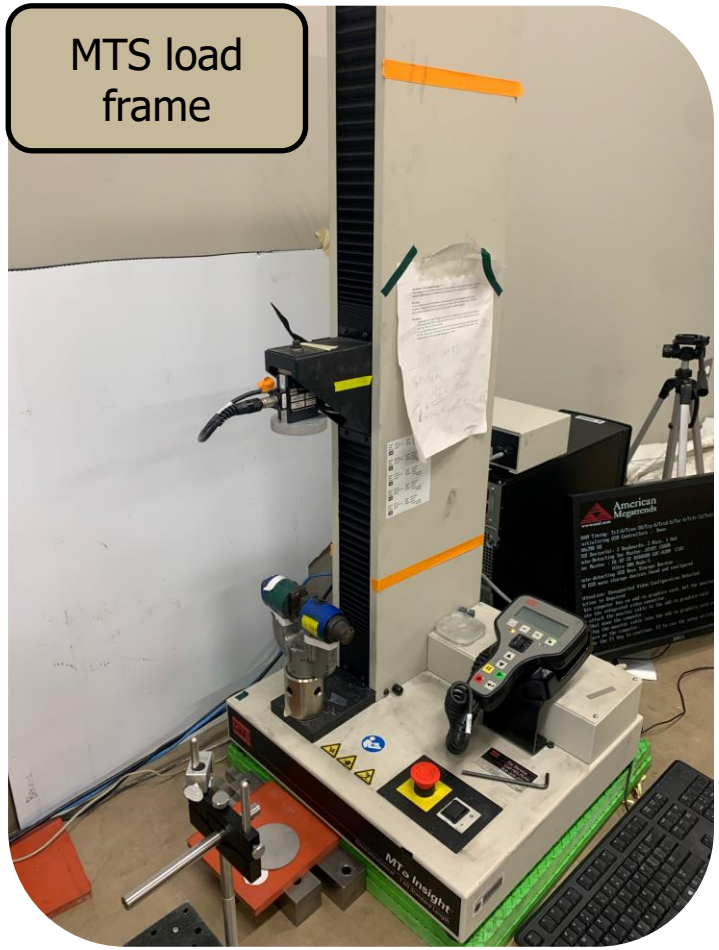




Yanni Giannareas

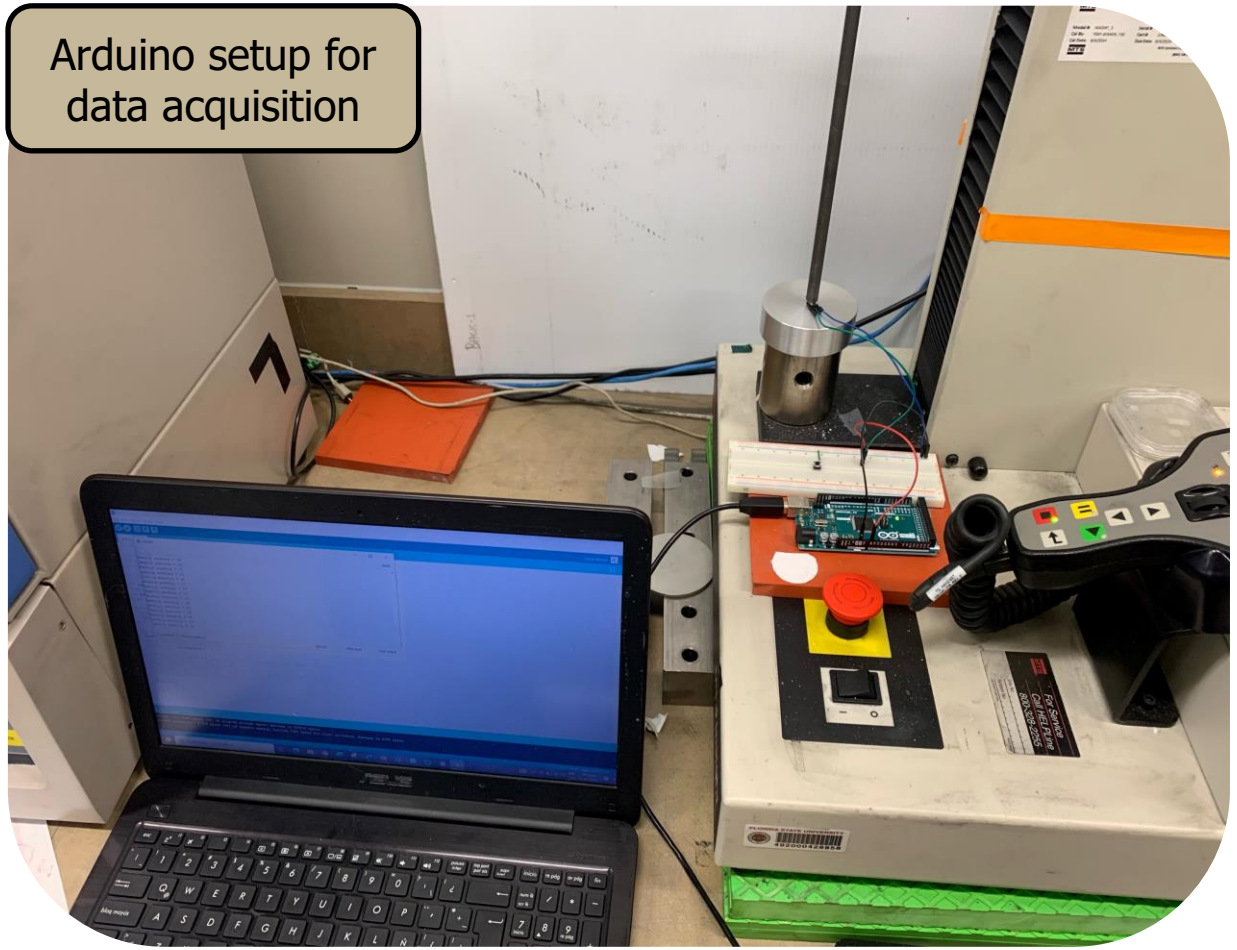
Sensor Testing

MTS load frame



Digital force gauge

Arduino setup for data acquisition



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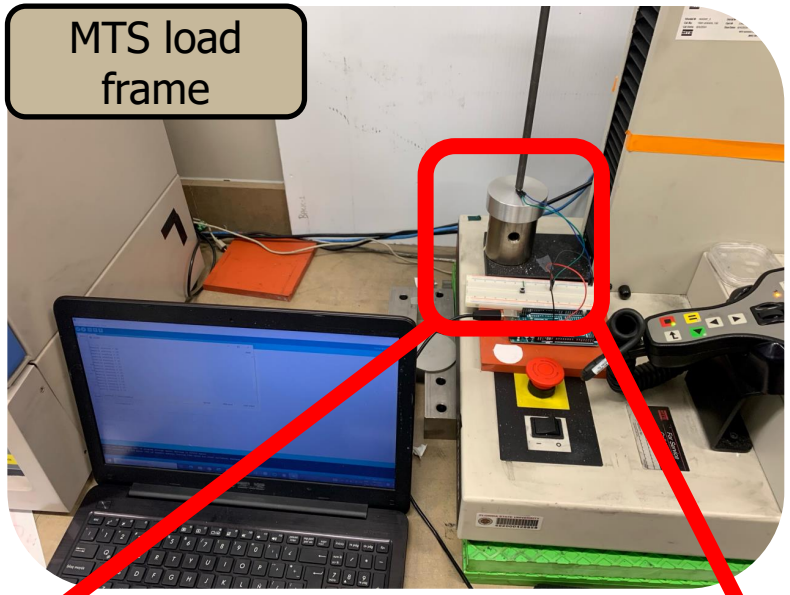
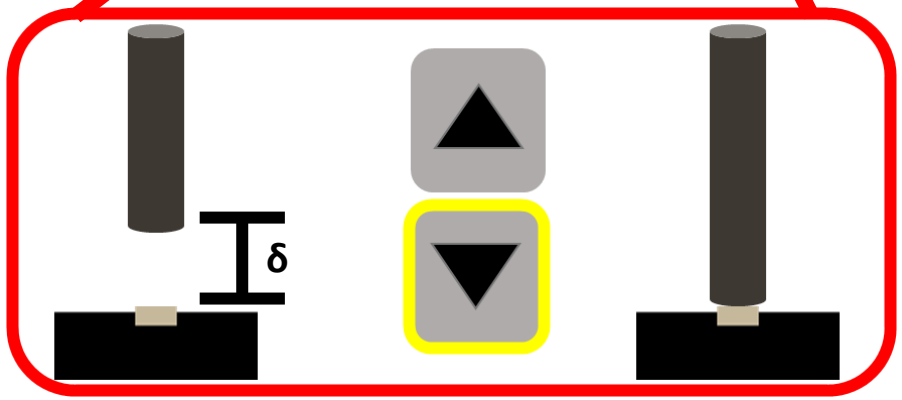
Sensor Testing

MTS load frame



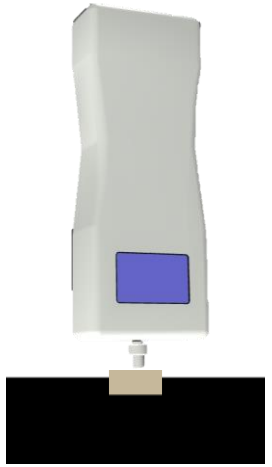


Minimum δ of **5 mm**

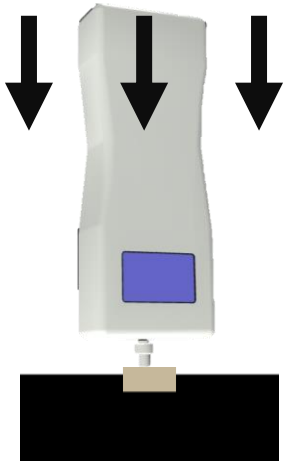
Sensor thickness is **2.4 mm**

Digital force gauge

Idle



Manual pressure applied



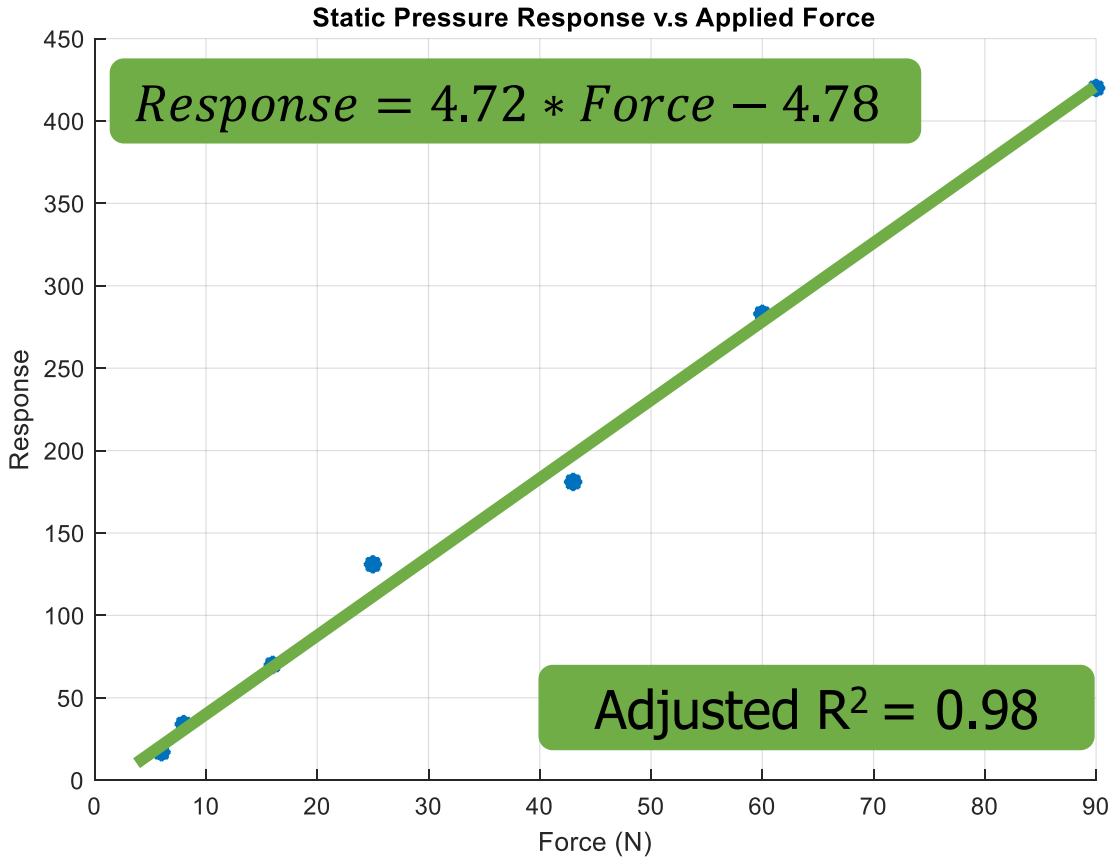
Easier to control applied pressure

Real-time pressure values available

Yanni Giannareas

Sensor Testing

Force (N)	Response
6	17
8	34
16	70
25	131
43	181
60	283
90	420



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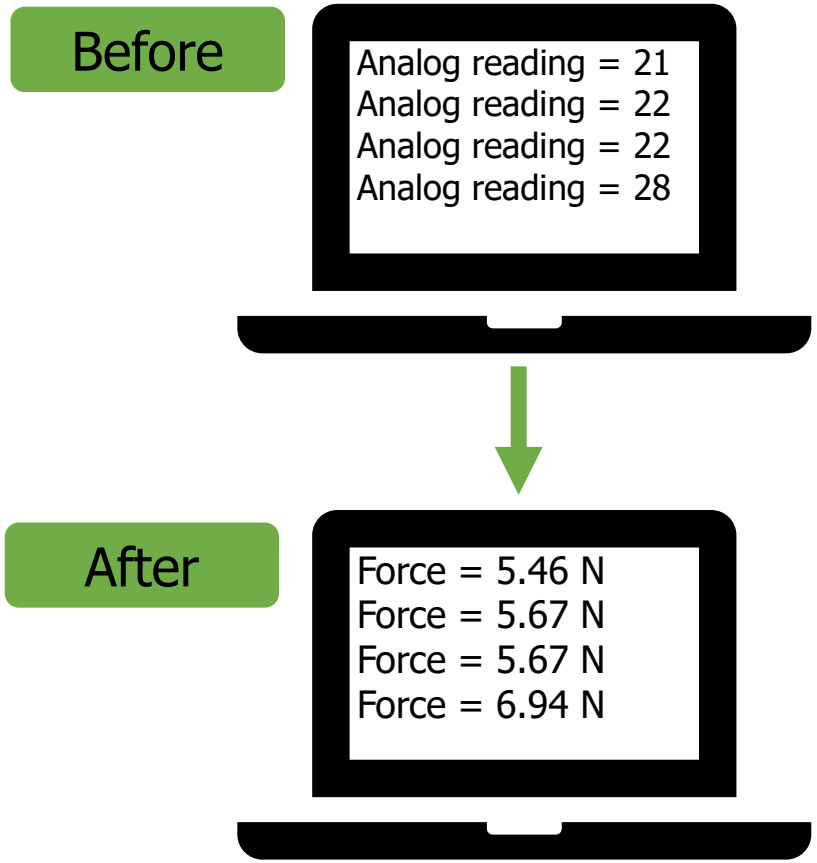
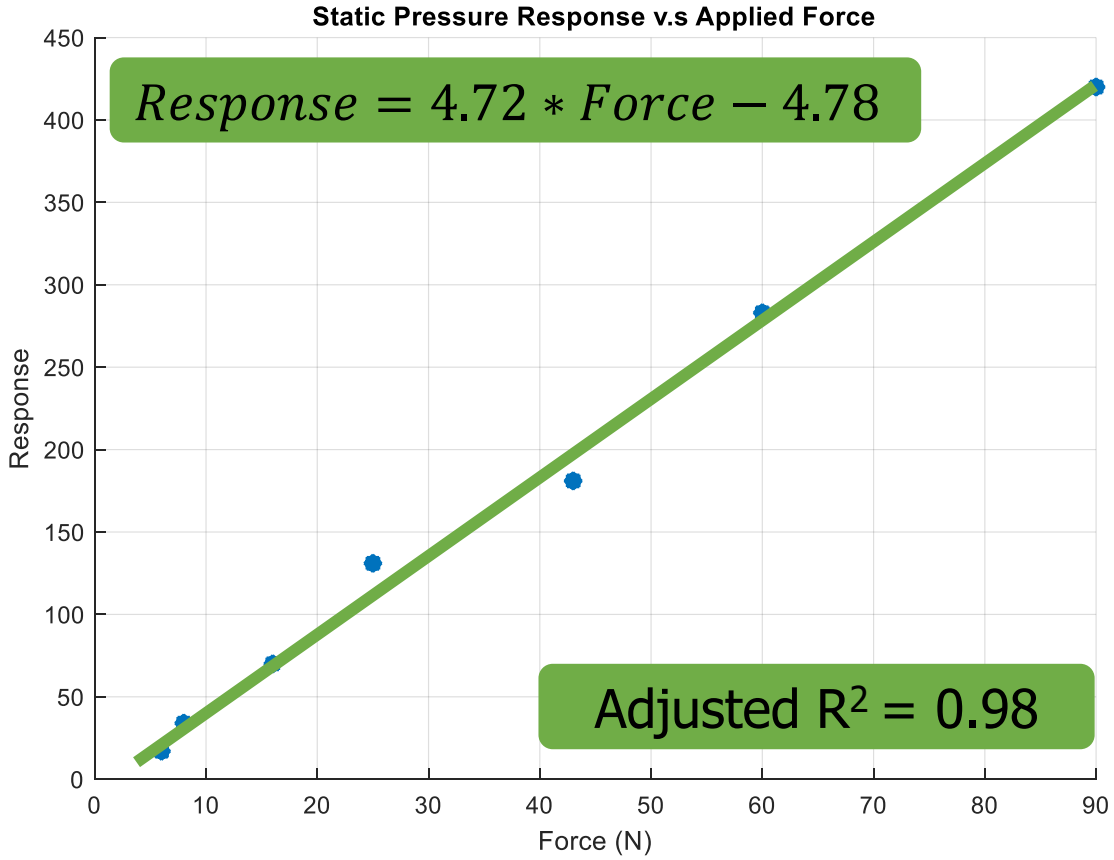
Sensor Testing





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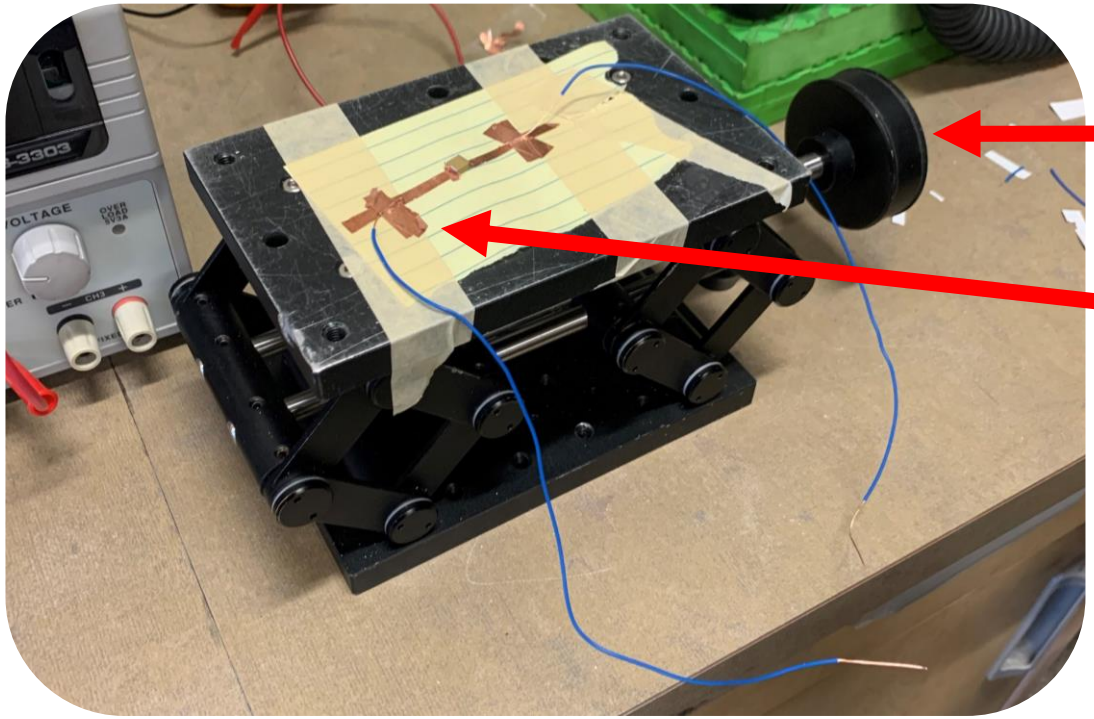
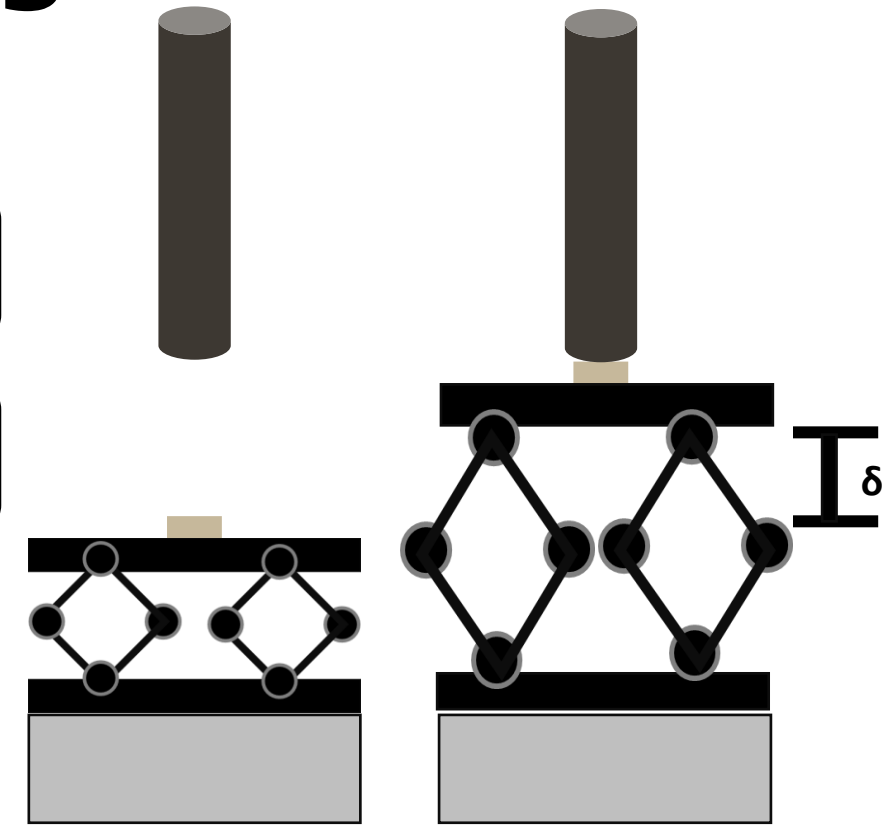
Sensor Testing



Micrometer stage

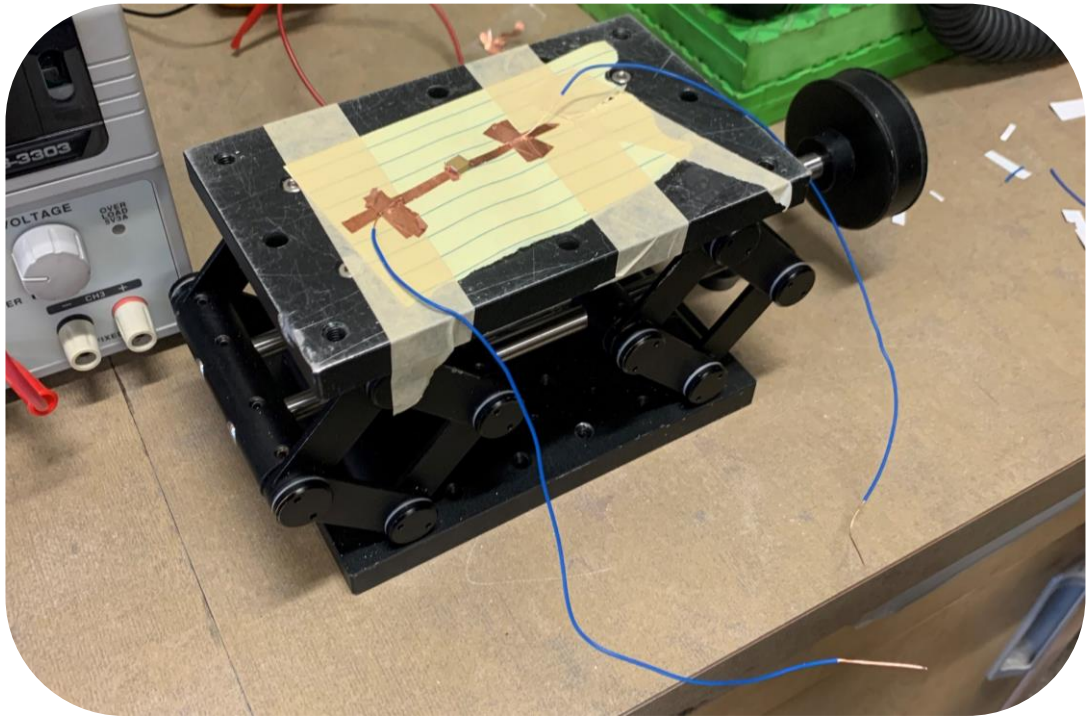
Copper foil

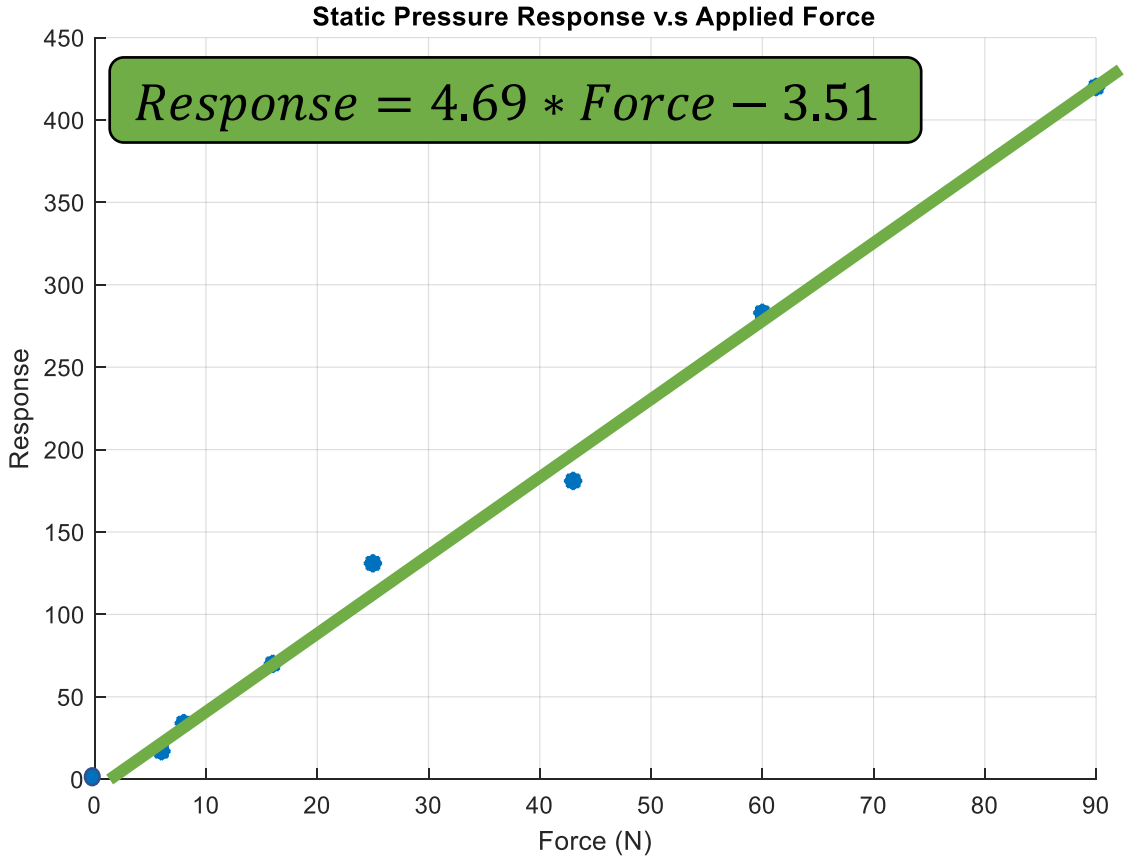


Minimum δ is 100 μm per one turn

Yanni Giannareas

Sensor Testing

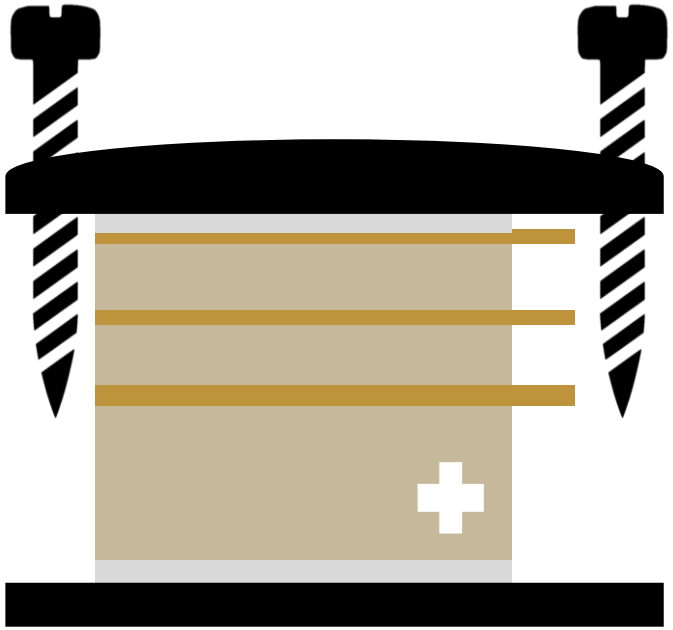




Yanni Giannareas

Sensor Preloading

Piezoelectric stack (before preload)



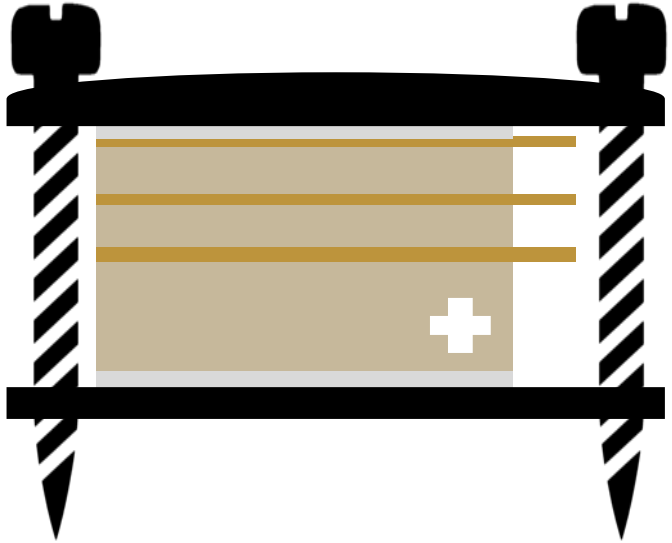
Preload specs

F.O.S = 2.5

F_{load} = -180 N

$\sigma_{load} = -7.2$ MPa

Piezoelectric stack (Under preload)

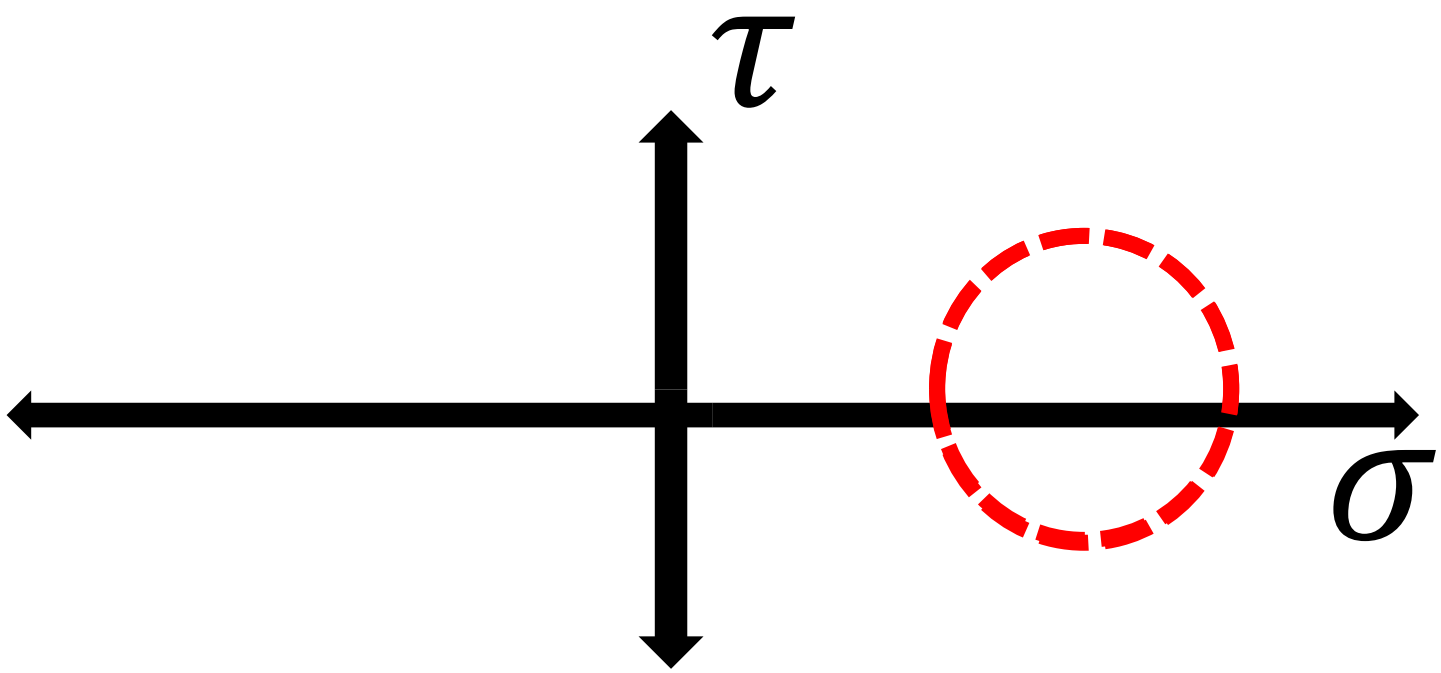


Mathew Brown

Sensor Preloading

Force (N)	120 N Normal Load Values			
-120	30	45	60	DEG
Sigma_x	4.743	-4.084	1.463	MPa
Tau_xy	-1.234	-4.203	7.619	MPa
Sigma_avg	2.371	-2.042	0.732	MPa
R - Radius	2.673	4.672	7.654	MPa
Sigma_1	5.044	2.630	8.386	MPa
Sigma_2	-0.302	-6.715	-6.923	MPa

Force (N)	300 N - Preload Values			
-300	30	45	60	DEG
Sigma_x	11.856	-10.211	3.658	MPa
Tau_xy	-3.085	-10.506	19.048	MPa
Sigma_avg	5.928	-5.105	1.829	MPa
R - Radius	6.683	11.681	19.136	MPa
Sigma_1	12.611	6.576	20.965	MPa
Sigma_2	-0.755	-16.787	-17.307	MPa



Mathew Brown

Sensor Preloading

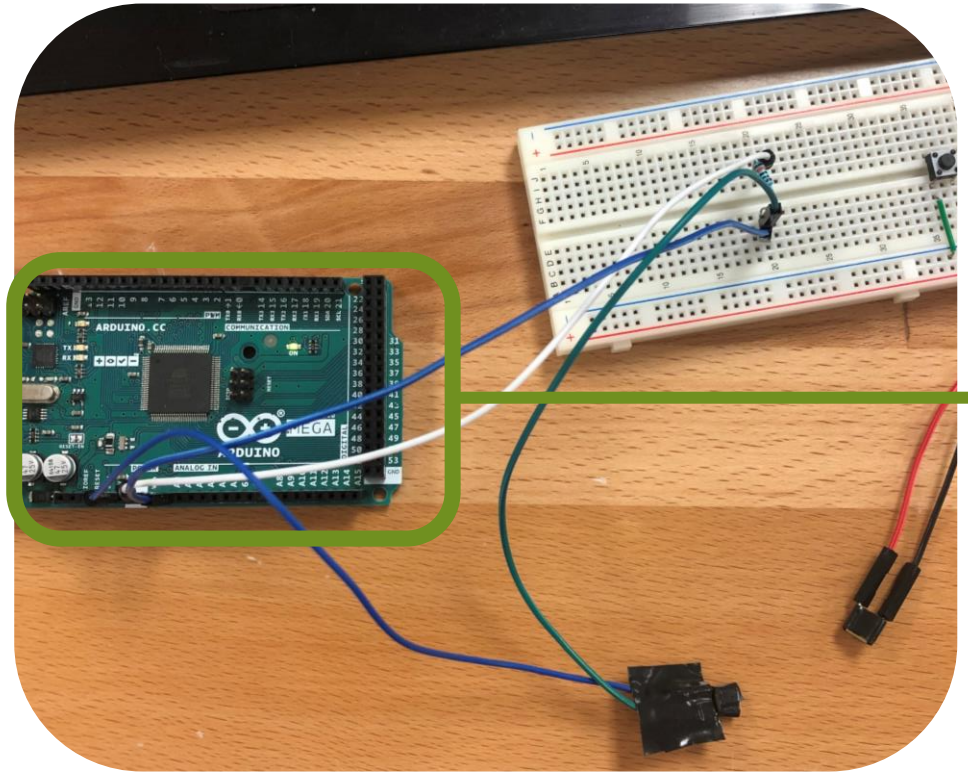
Initial stack prototype

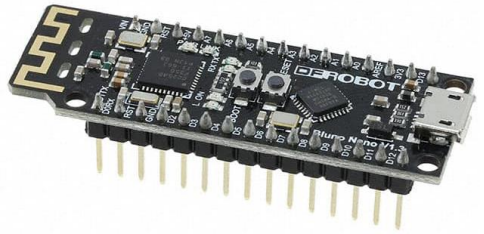
Subjected to compression

Smaller preload stack

Mathew Brown

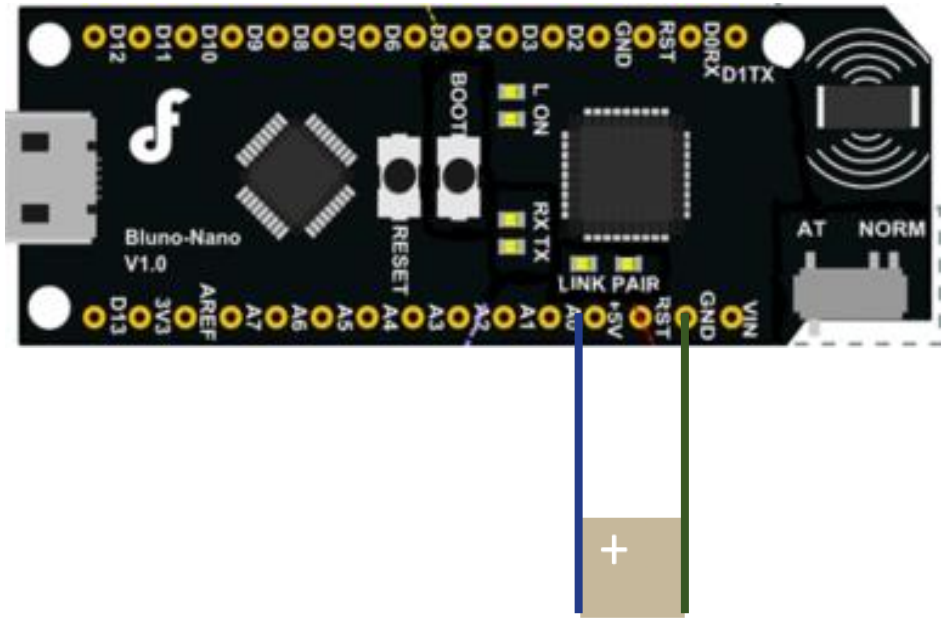
Bluetooth Incorporation





Bluetooth module incorporated

Sufficient pins for our purpose



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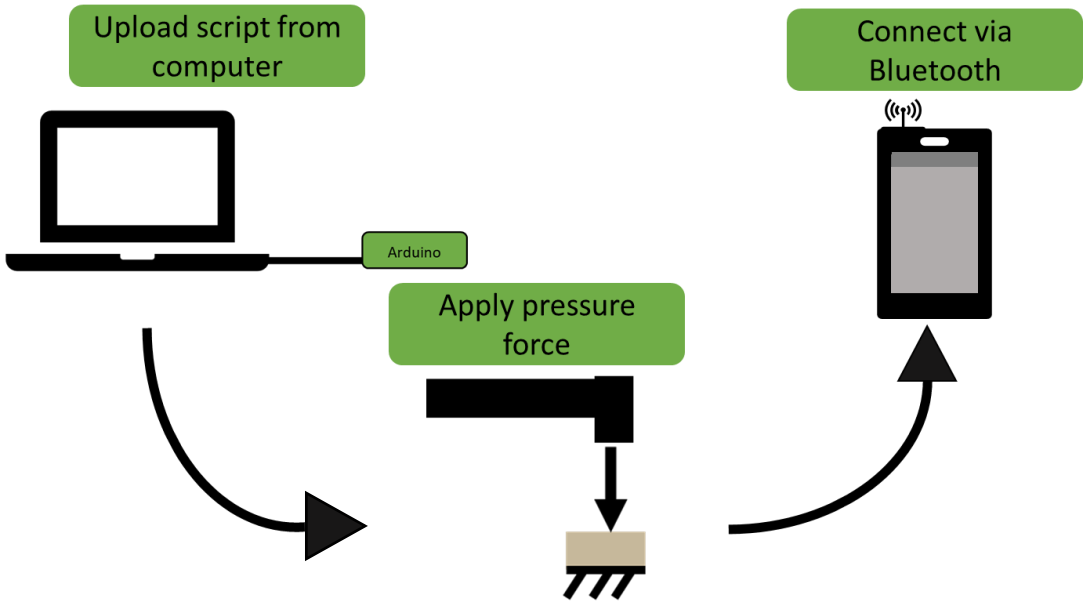
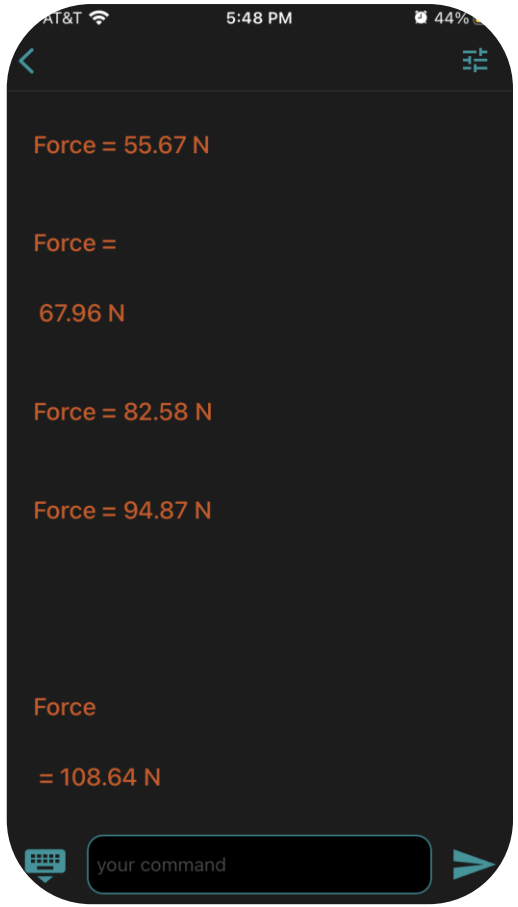
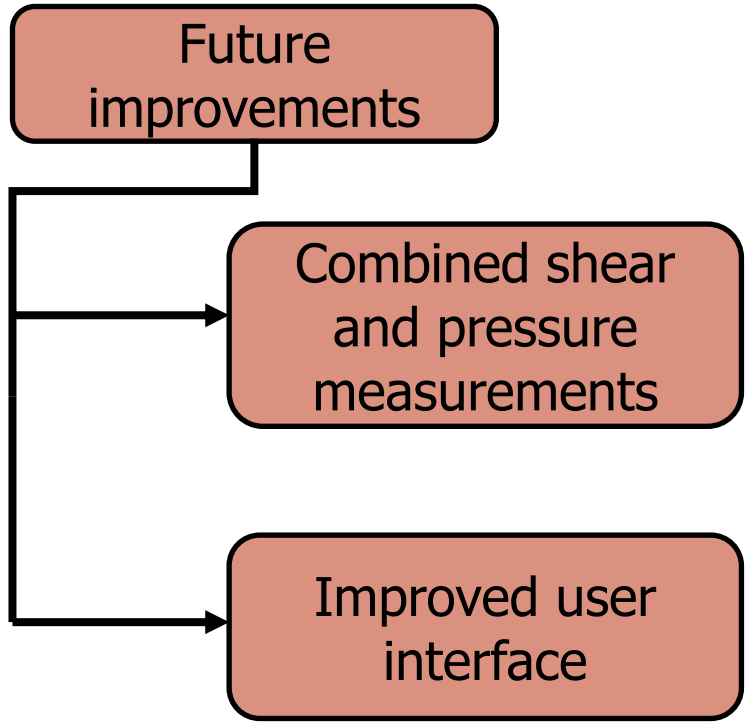
Bluetooth Incorporation

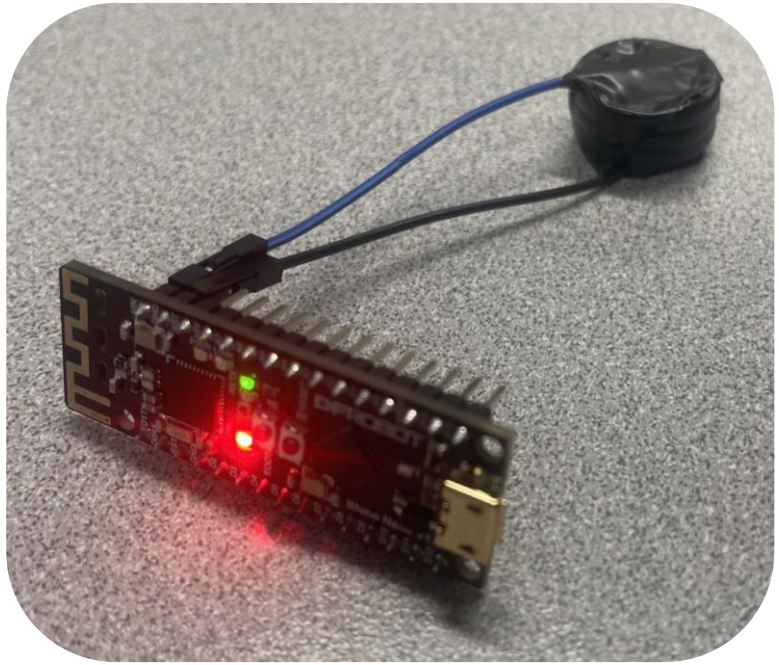






Mathew Brown

Battery Incorporation



Batteries connected in series to create necessary voltage to power Arduino

Semi-limited to power output

Incorporating spring in housing to secure battery connection

Mathew Brown

Manufacturing

DAP Ultra Clear Silicon Sealant

Properties

- Waterproof
- Crackproof
- Minimal flexibility
- Curable within 24 hours

Density

DAP: $0.89\ \frac{g}{cm^3}$

Baseball: $0.7 - 0.8\ \frac{g}{cm^3}$

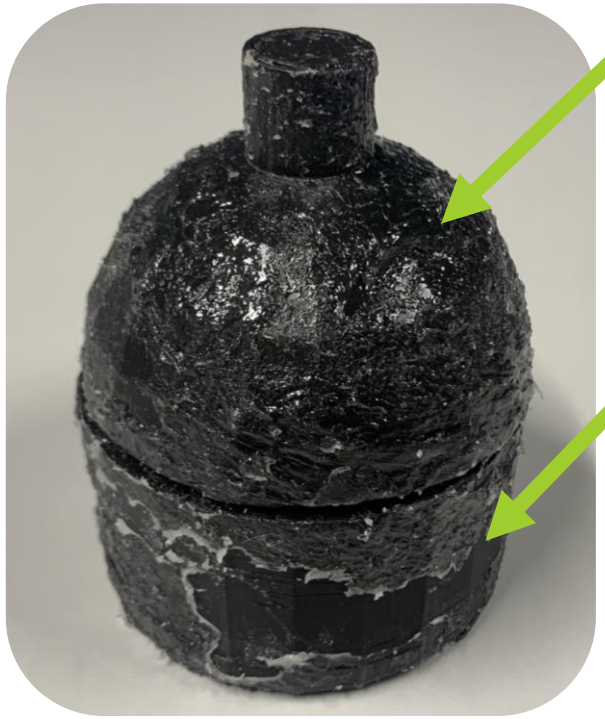
Texture

Cured material has similar texture to a rubber cage ball

David Adams

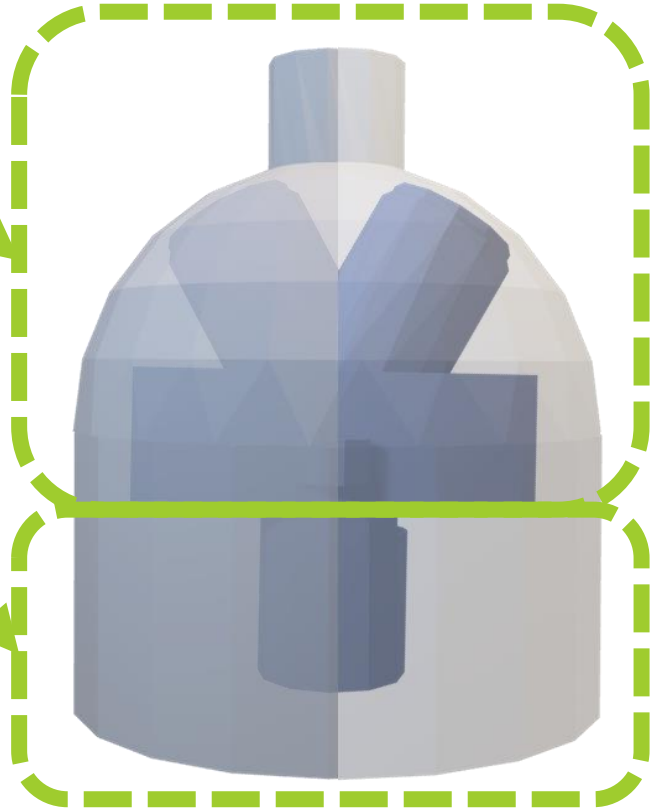
Manufacturing

Complete Shell of Ball



Top Shell

Bottom Shell

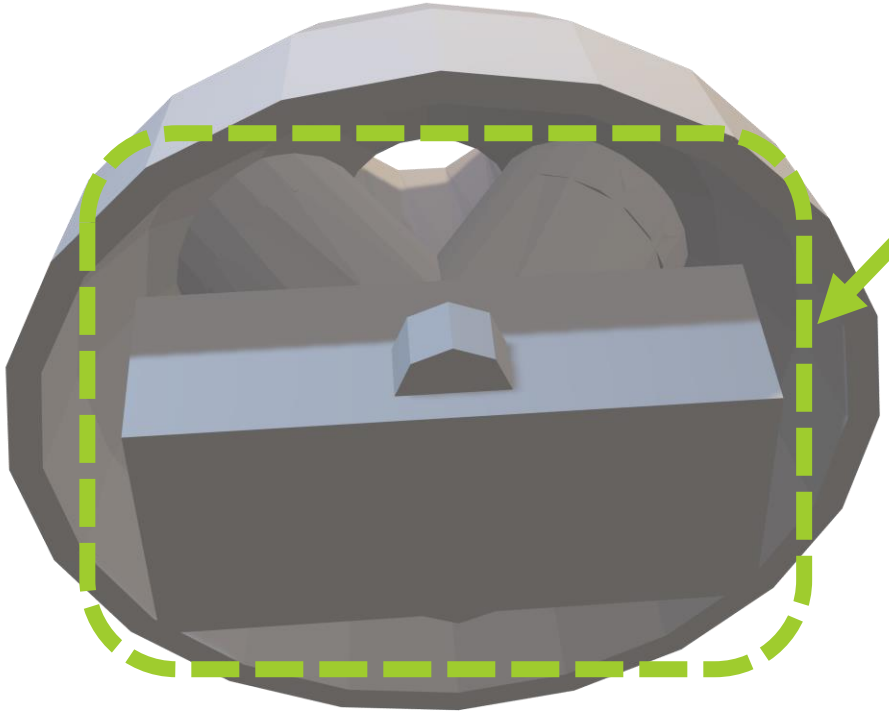


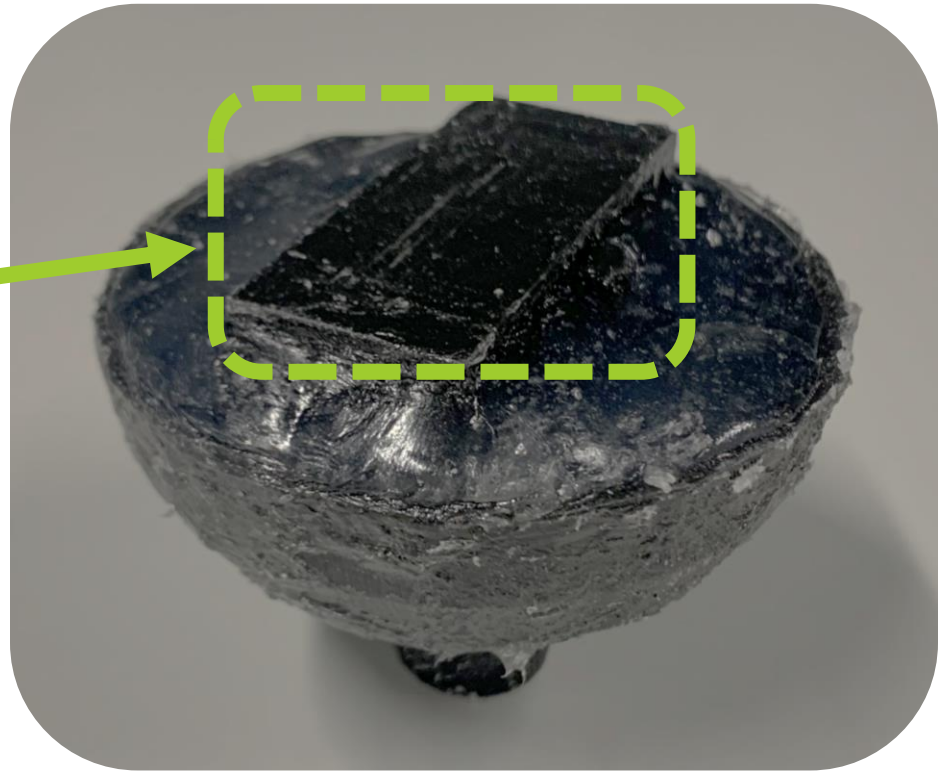
David Adams

Manufacturing

Top Shell of Ball

Sensor &
Arduino Housing

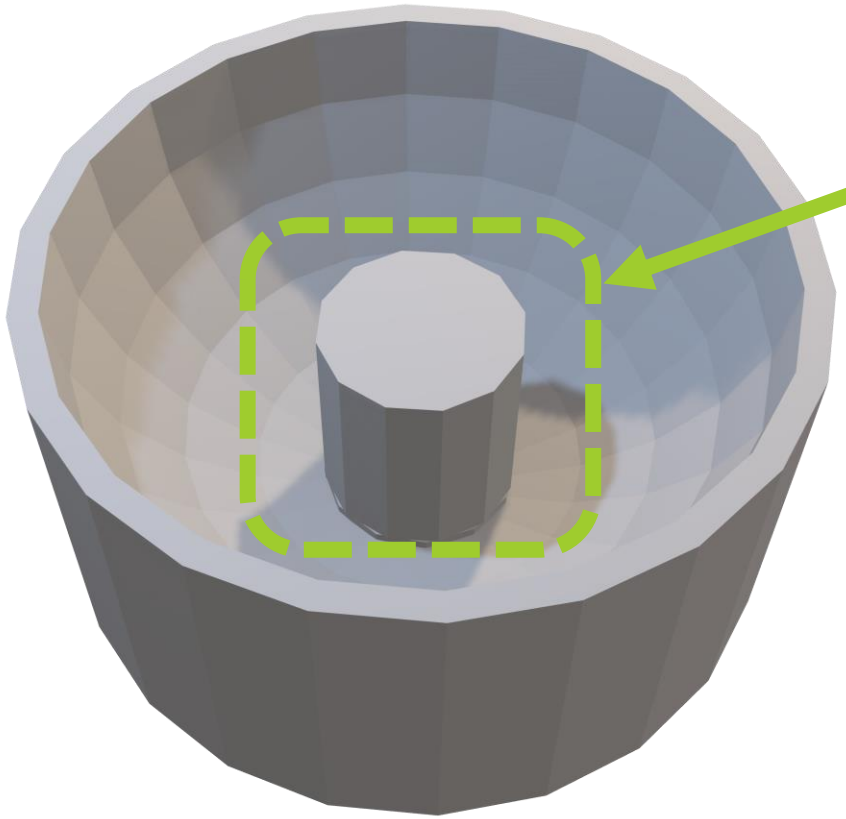




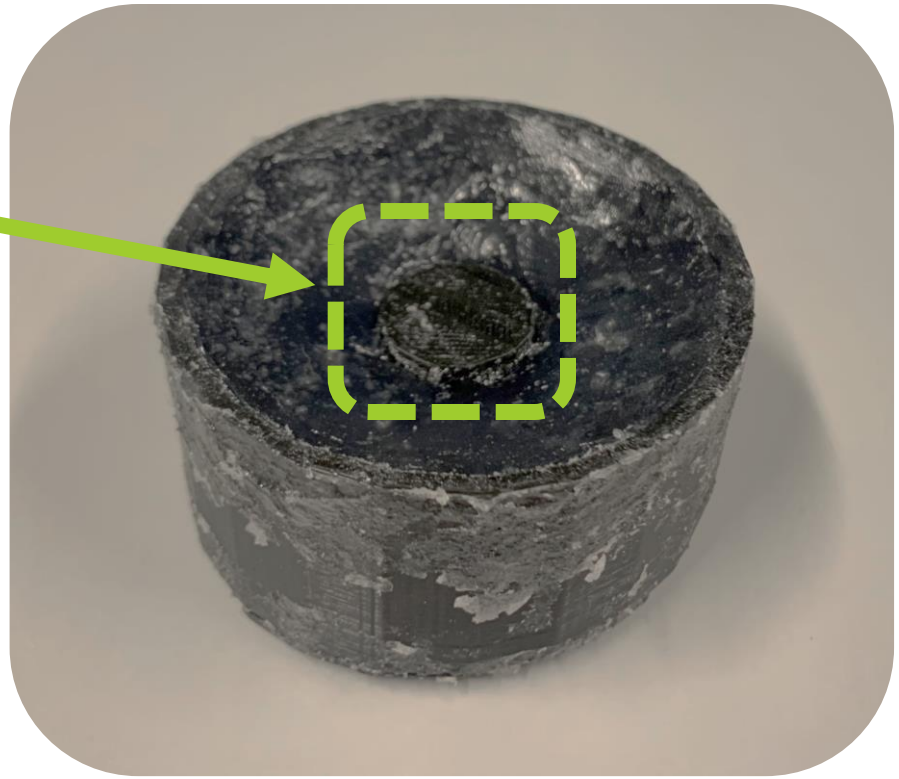
David Adams

Manufacturing

Bottom Shell of Ball

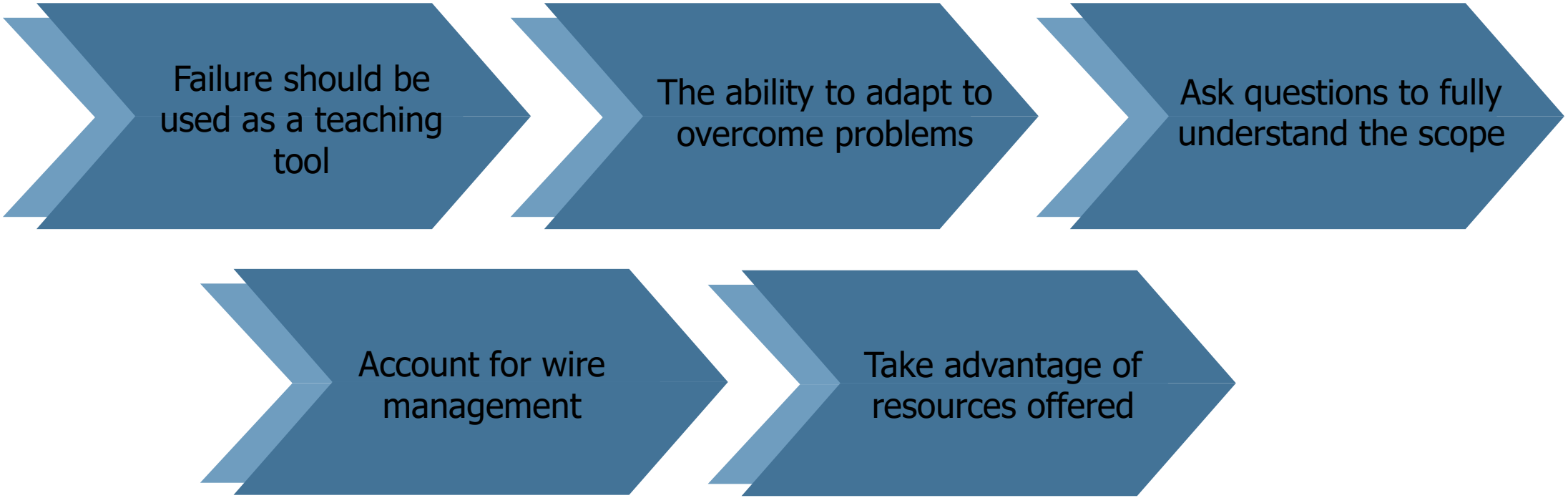


Battery Compartment



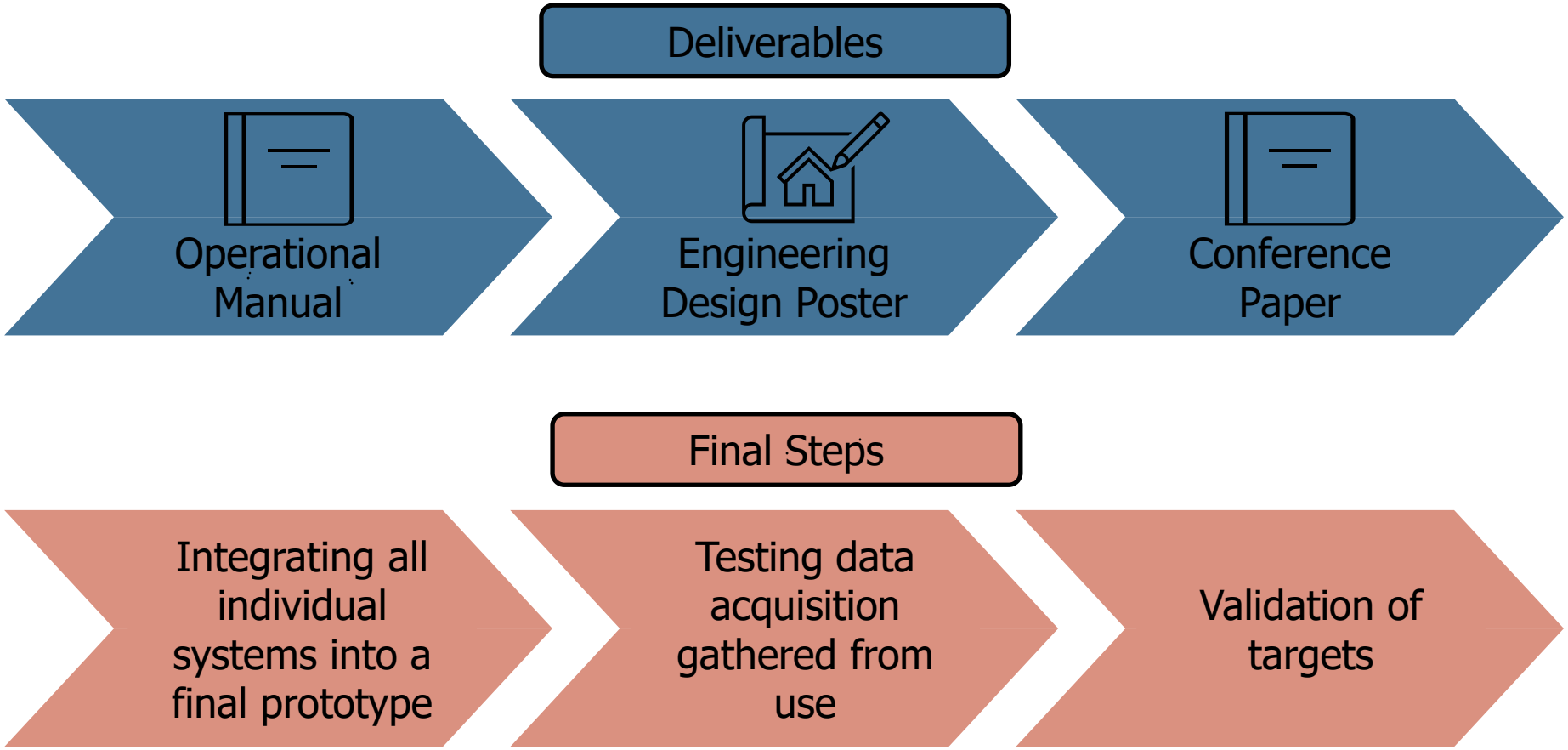
David Adams

Project Takeaways



David Adams

Future Work



David Adams

Instrumented Baseball

David Adams | Mathew Brown | Riley Ferrer | Yanni Giannareas | Charles Whitaker

TEAM 516