Lockheed Martin Low-Cost F-35 Simulator

Senior Design Team 514

Will Rickles

Meet the Team

Jonah Gibbons
Electrical & Manufacturing Engineer

Laiken Kinsey
Test Engineer & Project Manager

Francisco Lopez
Mechanical & Product Design Engineer

Branden Pacer
Mechanical Engineer & Gimbal Design

Will Rickles
Mechatronics Engineer

Emelia Rodriguez
Purchasing & Research Engineer

Will Rickles

Sponsor and Advisor

LOCKHEED MARTIN

Andrew Filiault

Mechanical Engineer, B.S.

JSF F-35 Pilot Training and Training Infrastructure Systems

FAMU-FSU College of Engineering

Brandon Krick

Mechanical Engineer, Ph.D.

Associate Professor

Will Rickles

Project Objective

The objective of this project is to create F-35 flight controls that integrate with Lockheed Martin's simulator software to be used in the pilot training program.

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3D Printed Cockpit and Desktop Simulator

- Pilots train in simulators to develop muscle memory and learn the unique operating procedures of the aircraft

Full Scale Simulator

3D Printed Cockpit

Desktop Simulator

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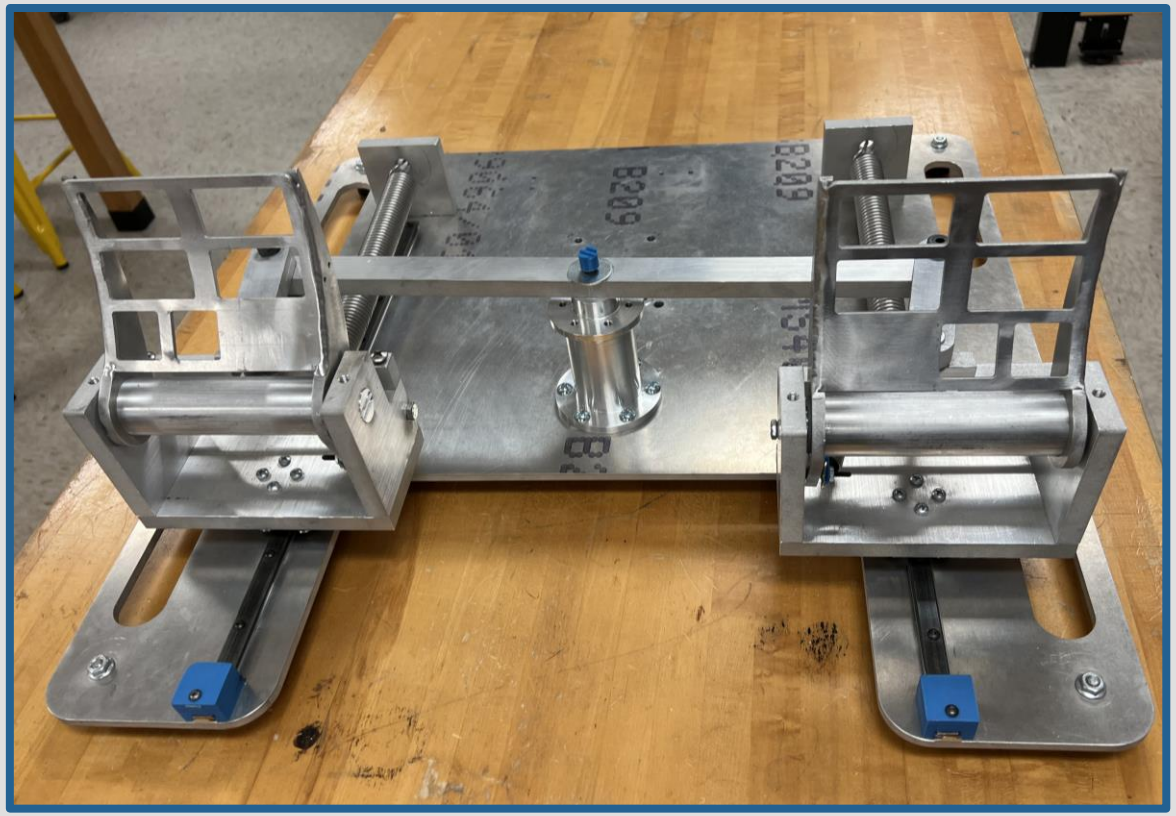
Rudder Pedal System



- Rudder Pedal System (RPS): Controls the jet rudders, nose wheel steering and rear wheel brakes
- Initially developed by a previous senior design team, we will integrate this RPS with minor modification

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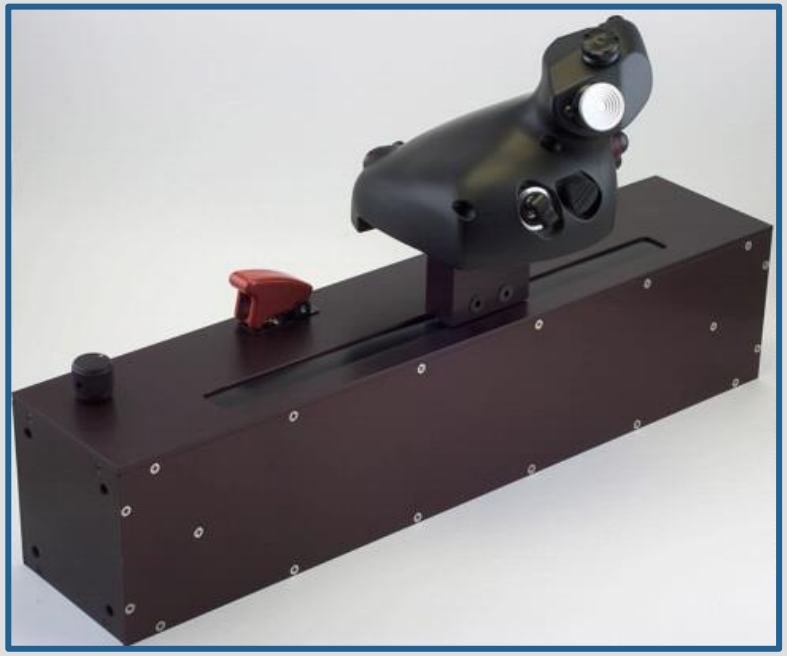
HOTAS System

- HOTAS: Hands on Throttle and Stick
- Throttle: Controls the thrust from the jet engine
- Stick: Controls the pitch and roll axes of the aircraft
- Aspects of the HOTAS from previous senior design team will be incorporated in our version



Throttle

Stick

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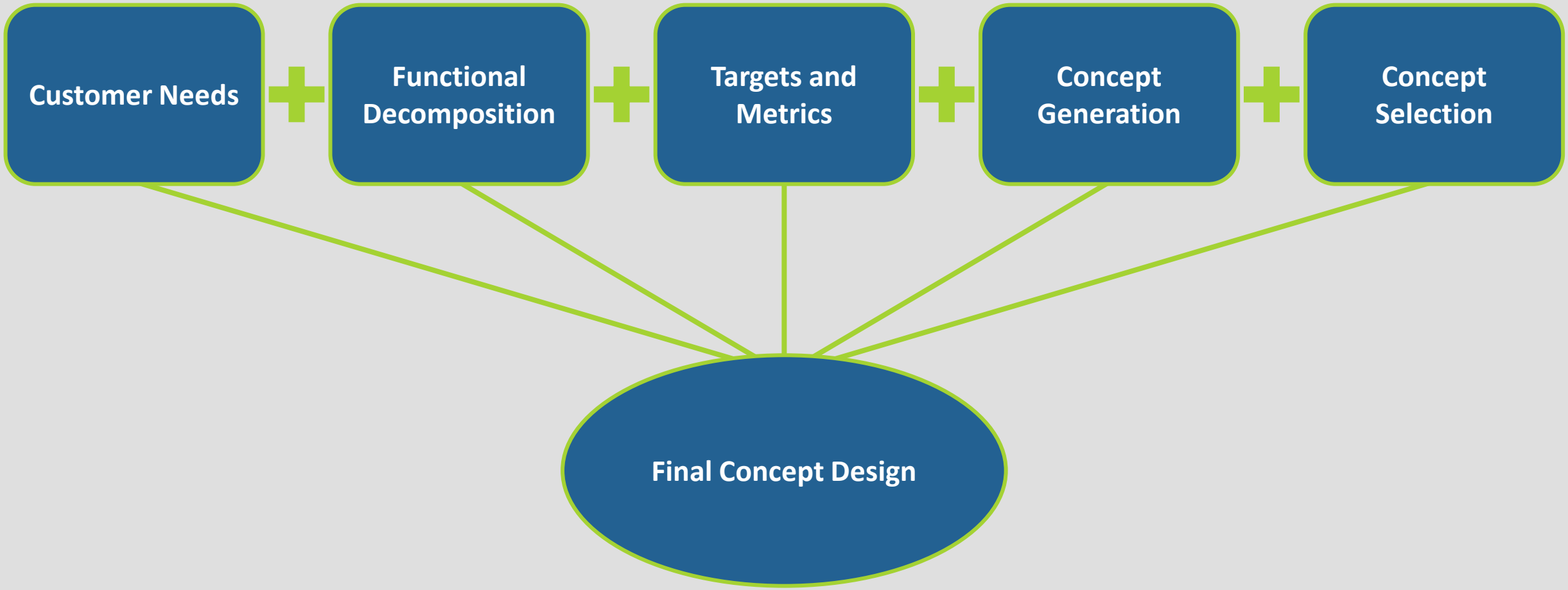
Last Semester



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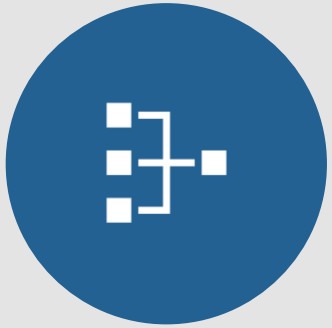
Key Goals

Create finished, working prototype



Integrate physical sub-systems into the simulation software

Keep manufacturing costs low

Design for use in desktop or cockpit training models

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Flight Control Functions

Pilot Interface

- Controls closely mimic F-35 look and feel
- Mechanic parts will withstand repeated use

Communicate to Software

- Controller position awareness
- Negligible input delay
- Inputs accurately affect simulated jet

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Critical Targets

Cost

- Each new sub-system less than $1000

Latency

- No more than 20ms delay from input

Compatibility

- 3D printed cockpit and standard desk

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Additional Targets

Individual Component < 35 pounds	Joystick deflection 13 degrees in all directions	Throttle travel 6 inches
Operates 1 hour without defect	No more than 15 lbf required to move RPS	HOTAS withstands applied 7.5 lbf

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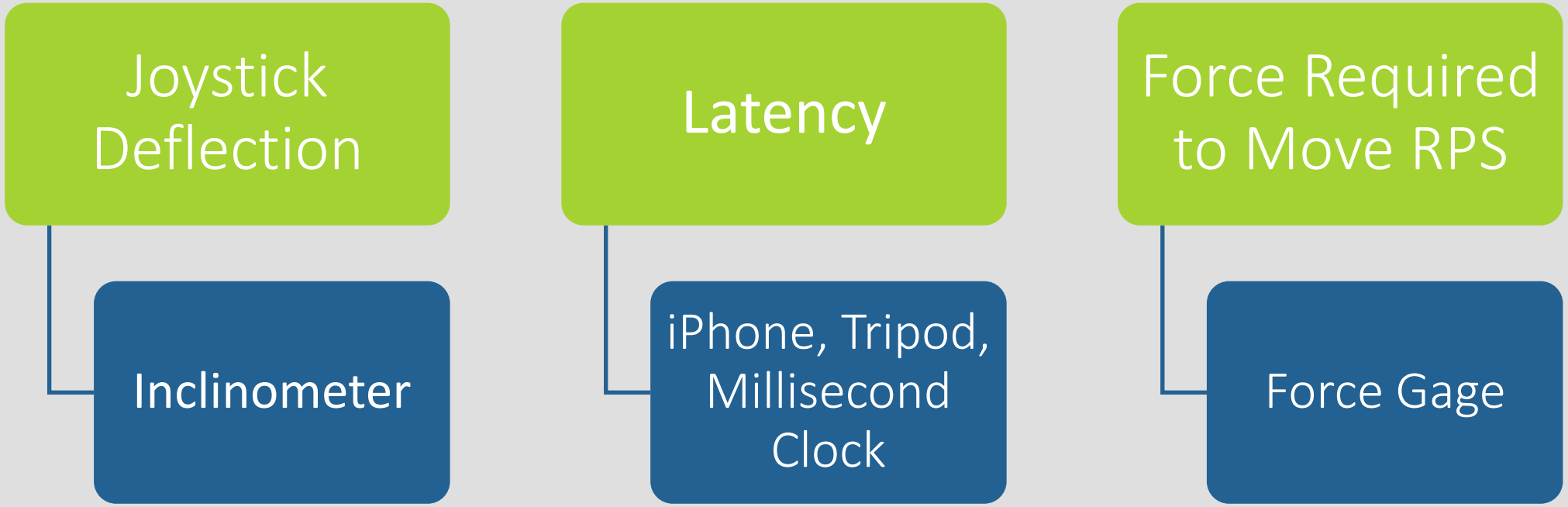
Testing and Validation Plans



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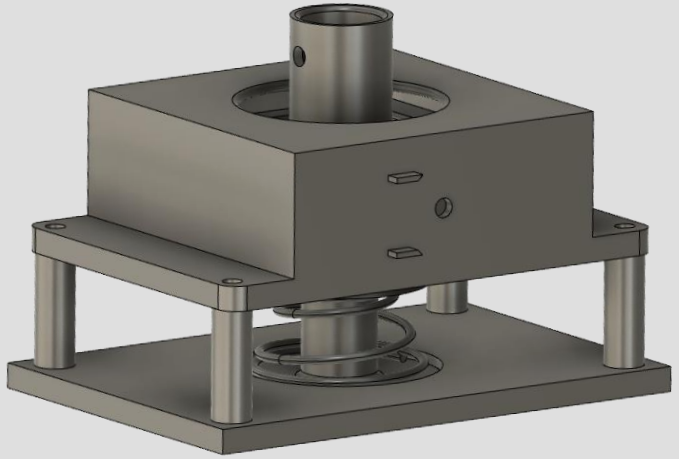
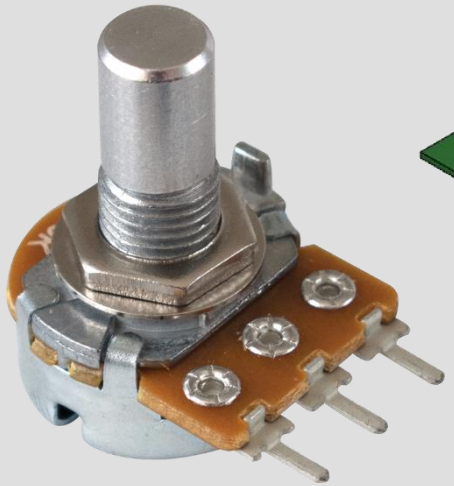
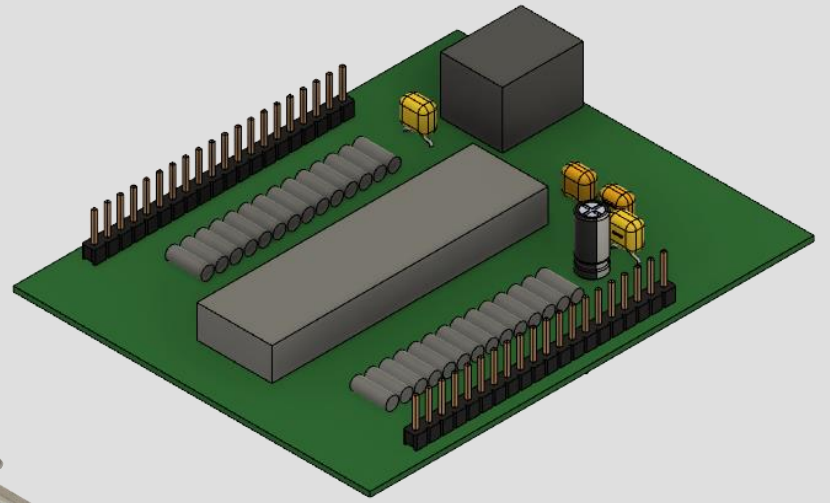
Final Design Selection

- Stick: 2-axis gimbal, rotary sensors, custom USB microcontroller
- Throttle: linear square rail, rack and pinion with rotary sensor, custom USB microcontroller
- Rudder Pedal System: updated rotary sensors, custom USB microcontroller







Branden Pacer

Final Design Selection

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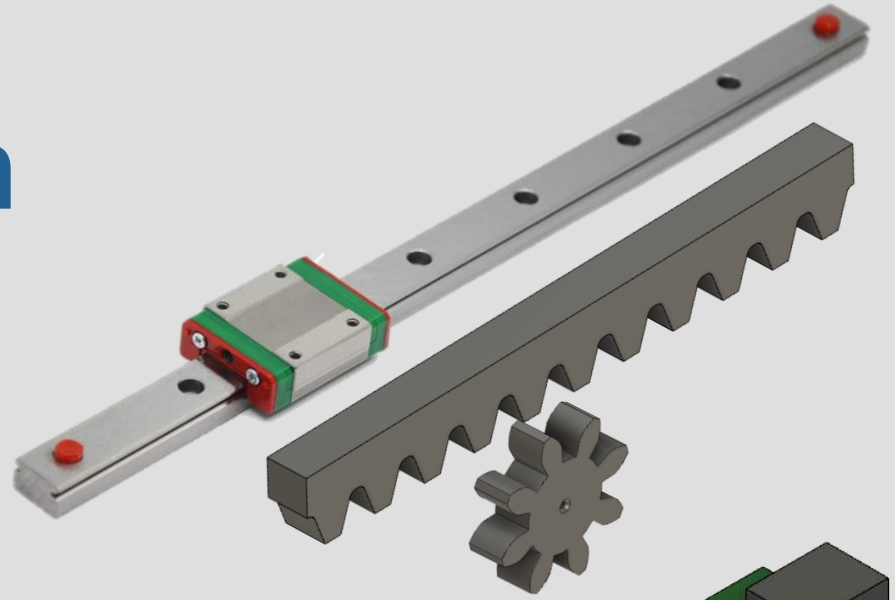

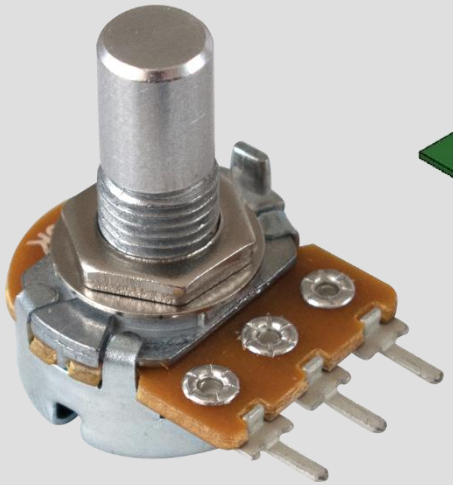

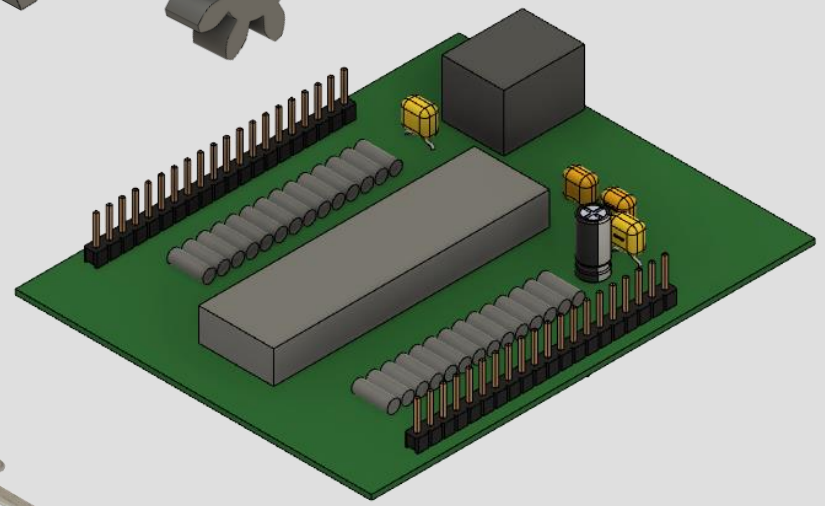

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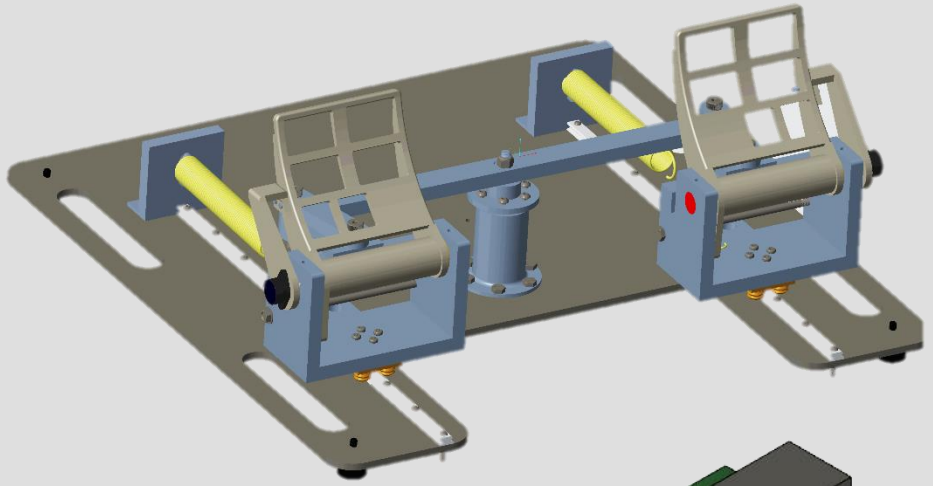

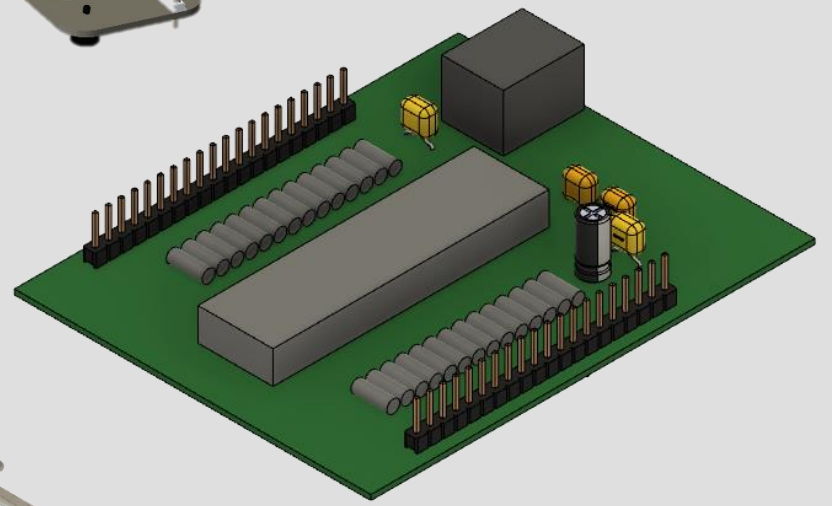

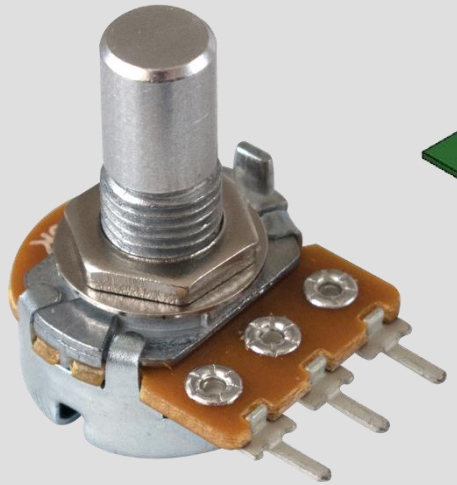

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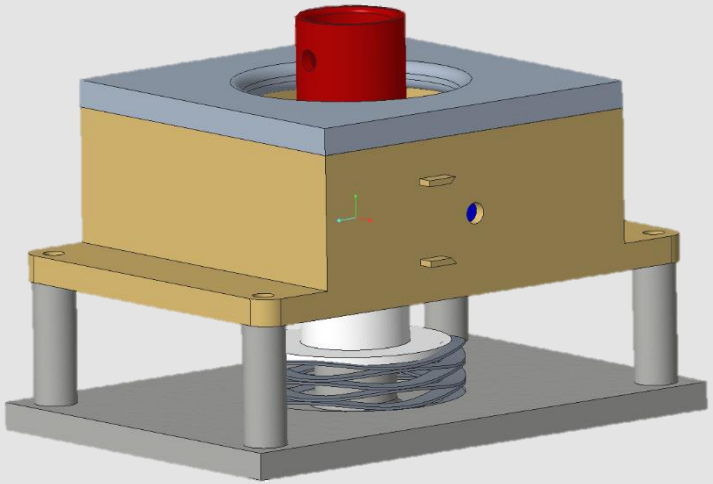
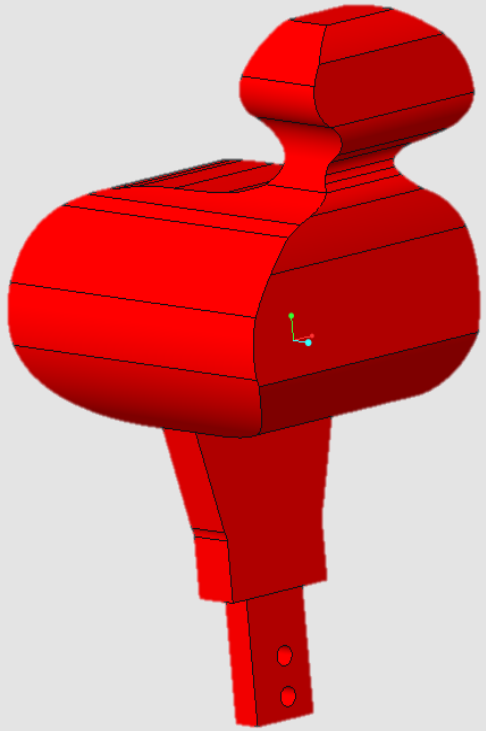
Current CAD Designs

Stick



Joystick Gimbal



Throttle

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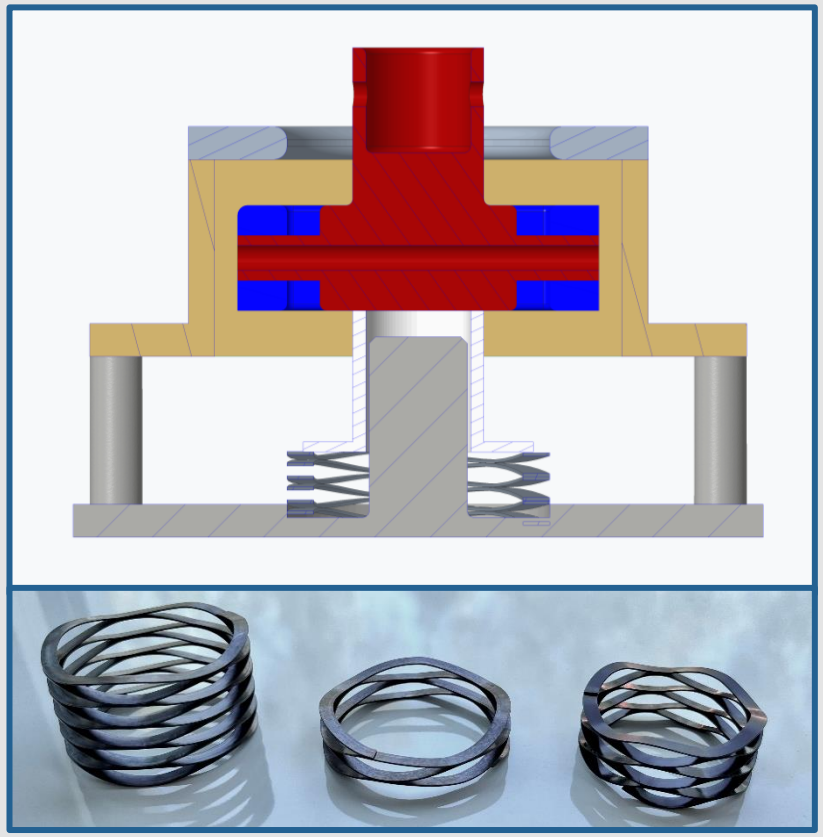
Update to Joystick Mechanism



- Adjustable tension configuration considered.
- Wave spring now implemented.
- Gimbal geometry modified for potentiometers selected.

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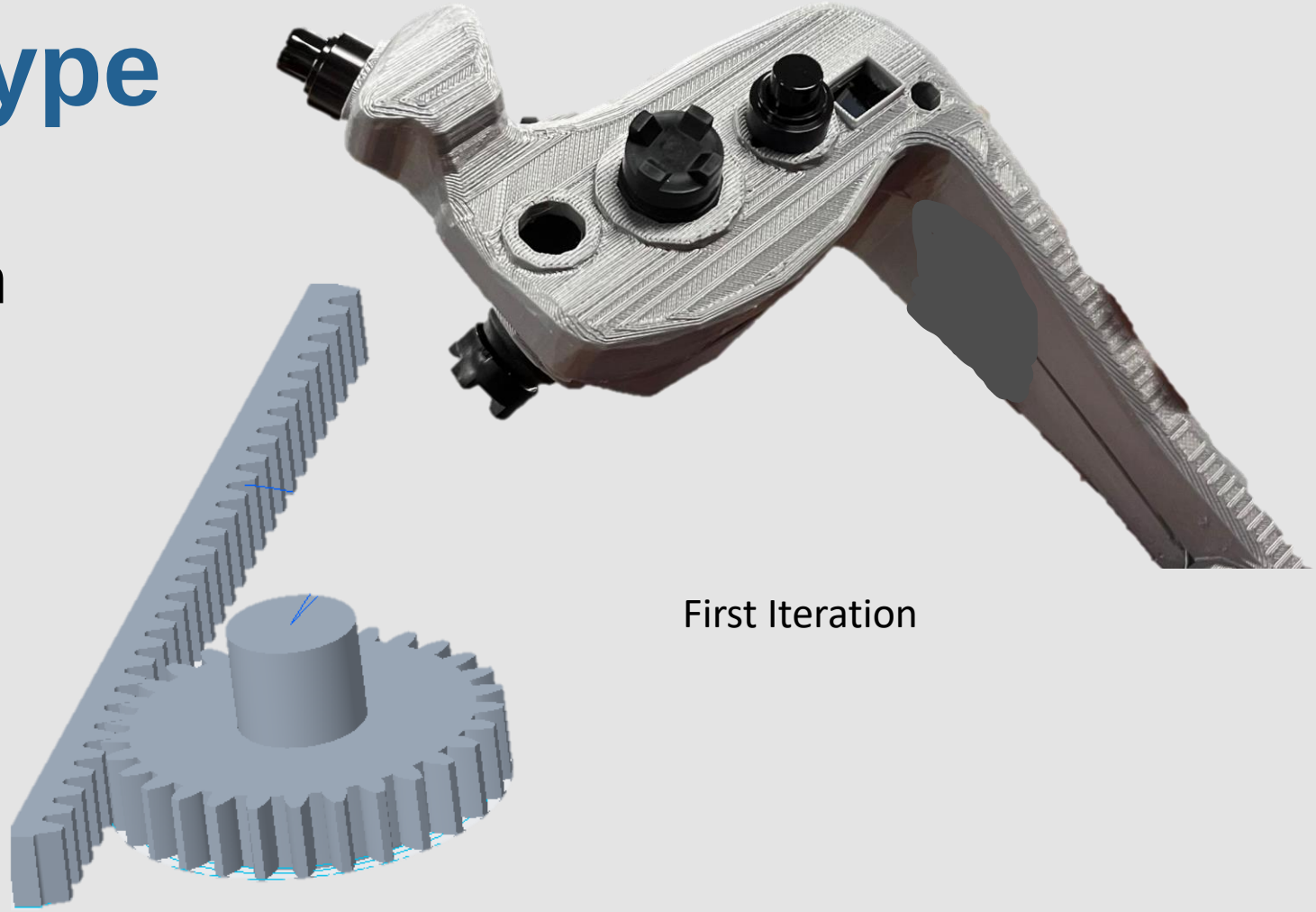
Throttle Prototype

- Utilized Rack and Pinion to sense displacement
- Redesigned handle to conform to Naval Air Systems Command (NAVAIR) button mapping



First Iteration

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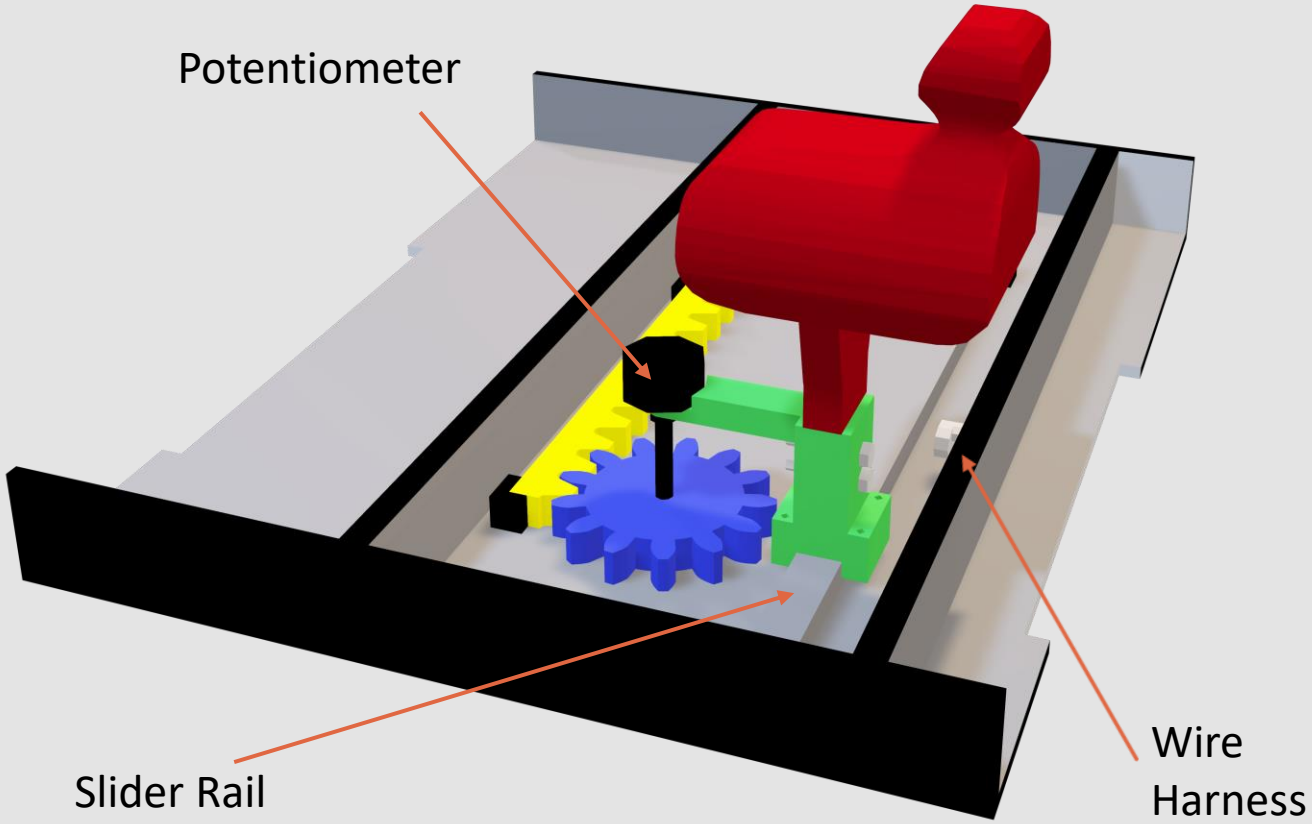
Throttle Prototype

- First complete prototype has been drafted
- Kept rotary potentiometer due to budget
- Inner parts are being printed; outer shell is being revised



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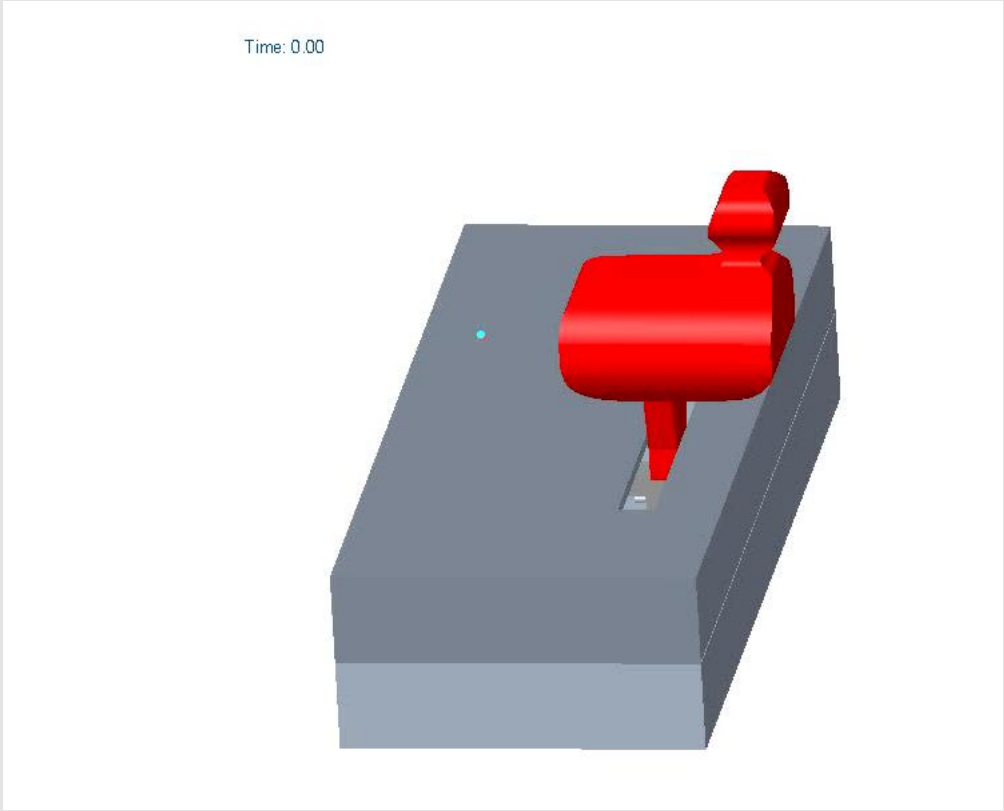
Throttle Prototype

- Handle needs to be hollowed out and extruded for button placement
- Handle needs an updated design for negating misalignment errors under load



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Software Update

Integration

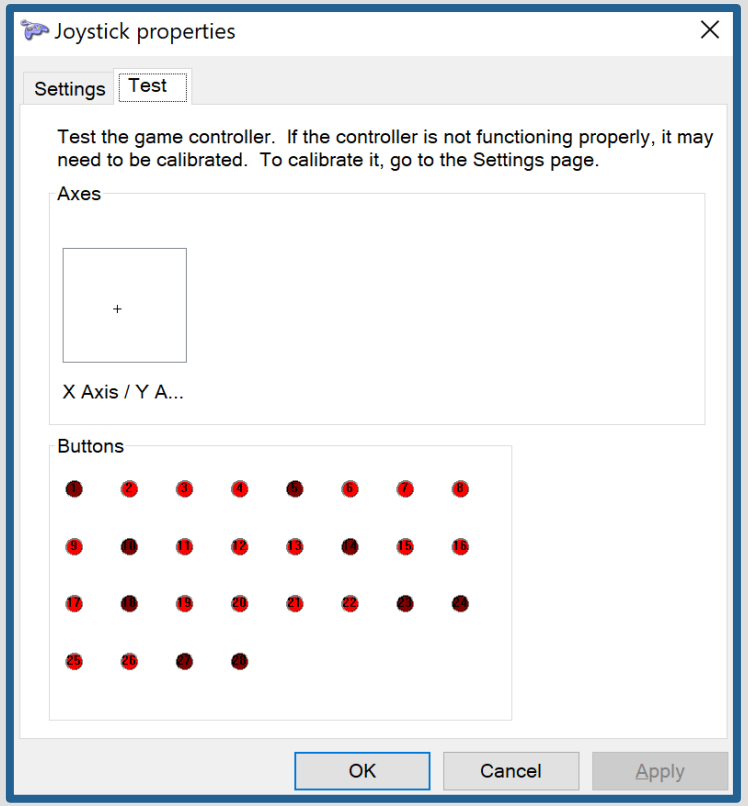
- Buttons are recognized by software
- Next function mapping

Latency

- Exceeds expectations
- Recognizes buttons immediately

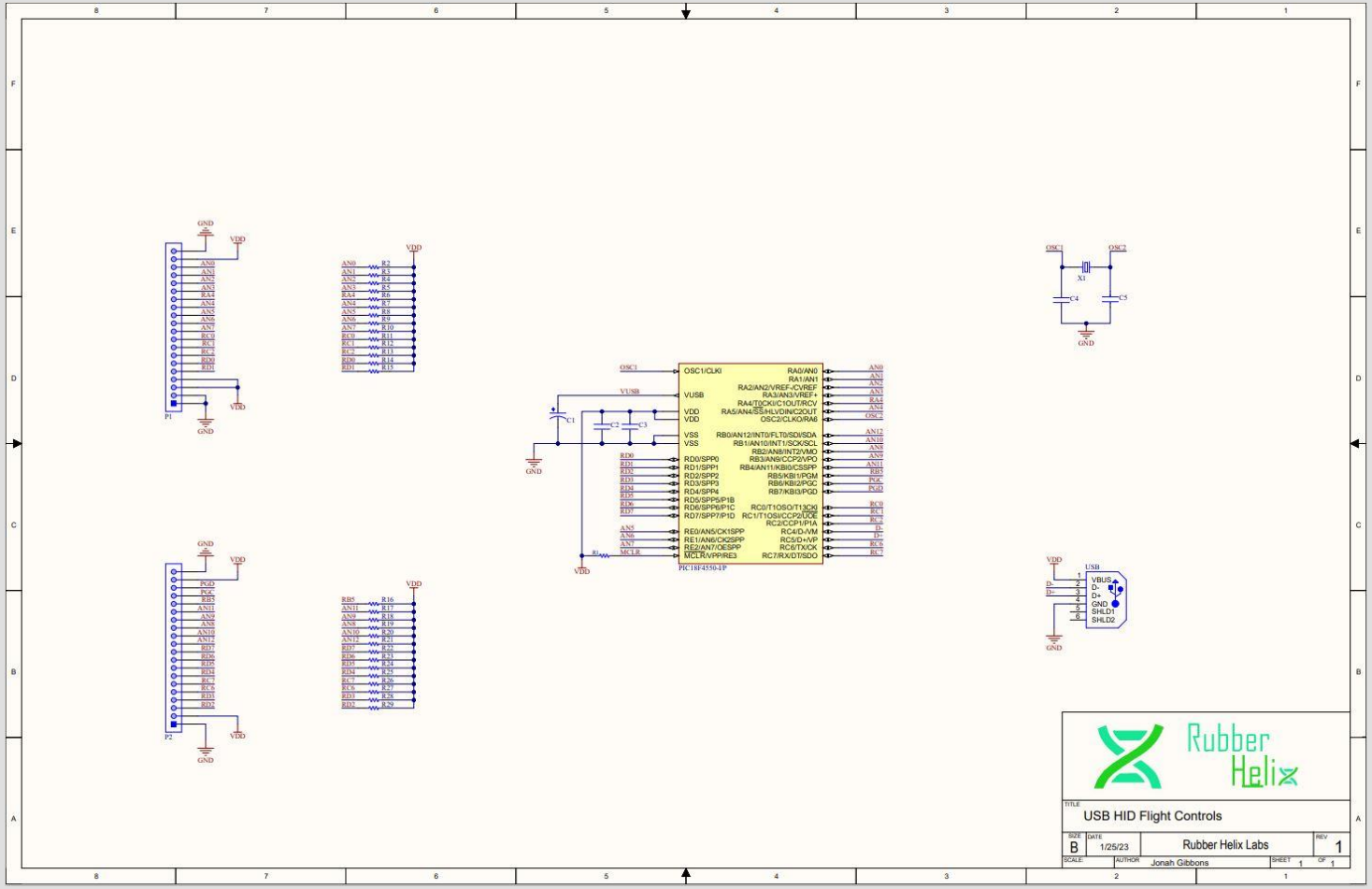
Firmware

- Over 90% complete



Laiken Kinsey

Printed Circuit Board Schematic



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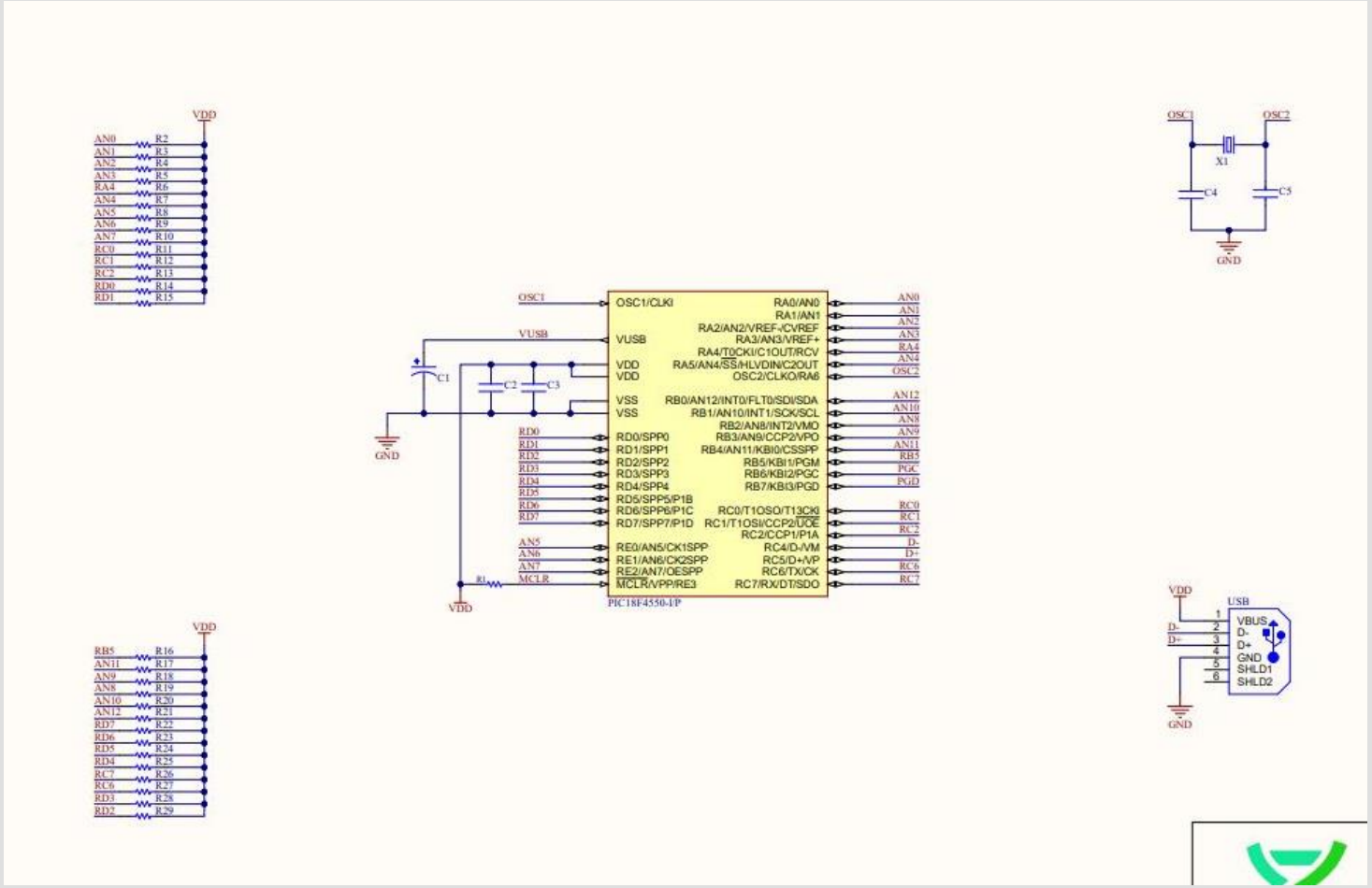

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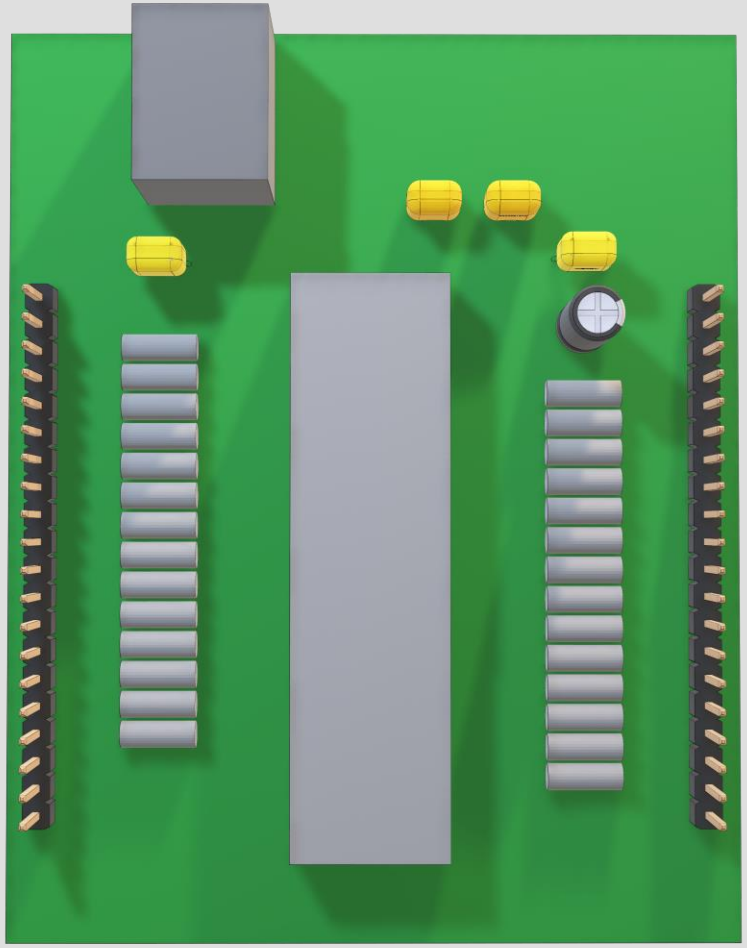
Printed Circuit Board Model



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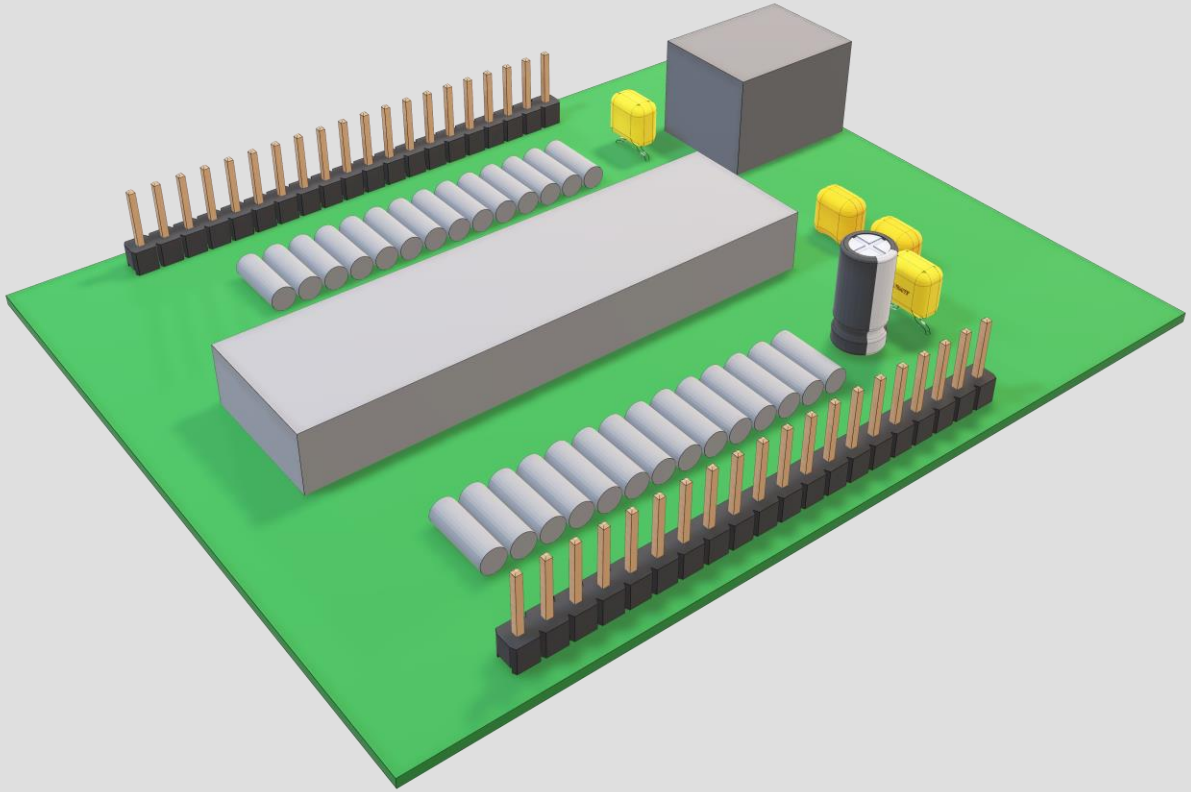

Laiken Kinsey

Materials Update

- Almost all parts have arrived.
  - The parts that have yet to come in are not crucial to assembly.
- We have used 62% of the budget on the first order and 28% on the second order.
- Currently, we are using parts already available to use for simple and non-specific applications.

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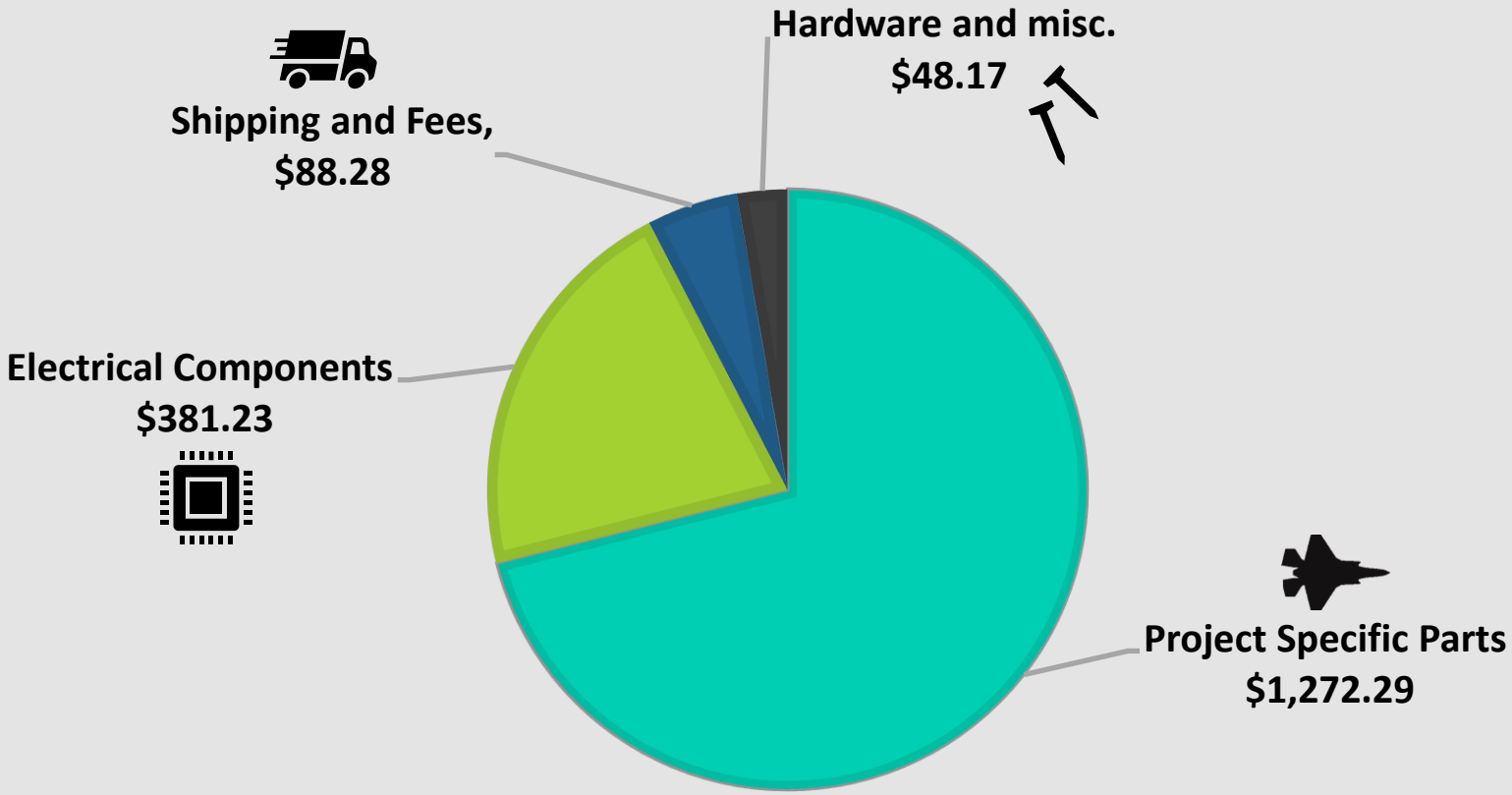
Budget Update



TOTAL COST TO DATE:
$1789.97
89.5% OF OVERALL BUDGET

- Project Specific Parts : 71.1%
- Electrical Components : 21.3%
- Shipping and Fees : 4.9%
- Hardware and misc. : 2.7%

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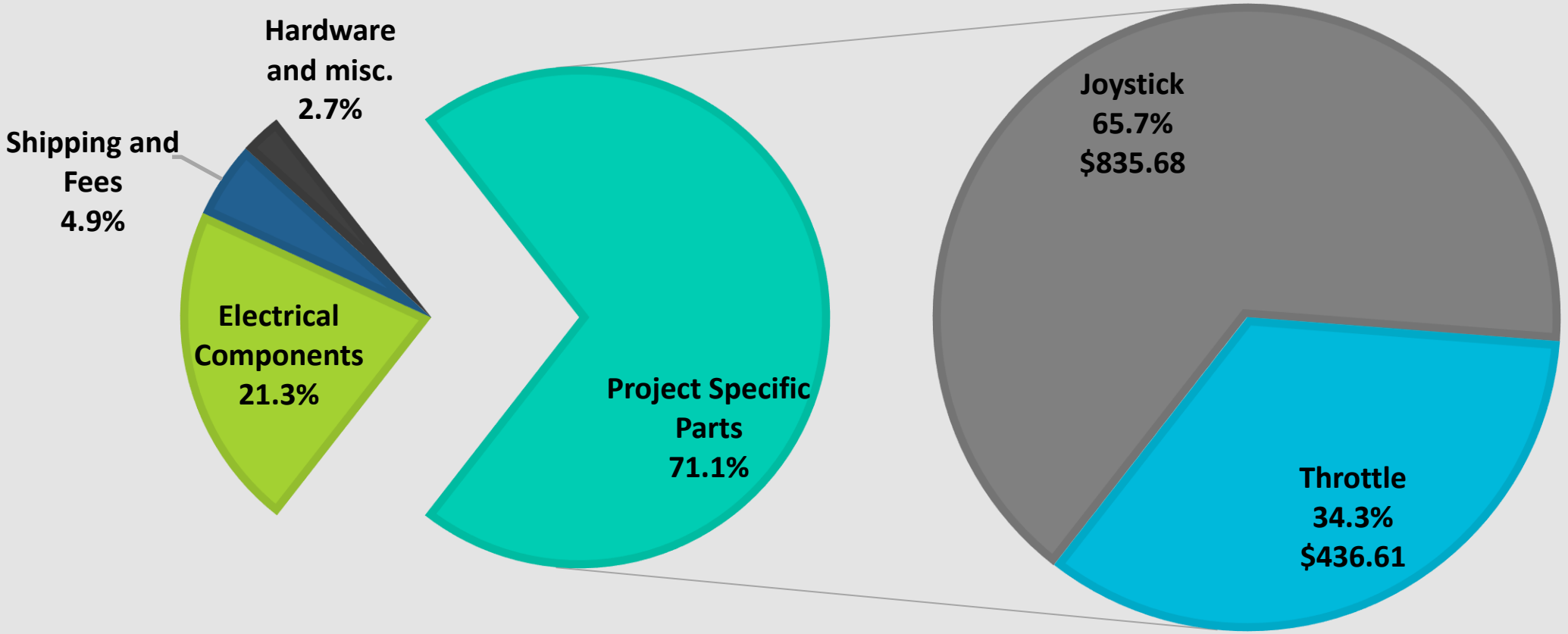
Budget Update



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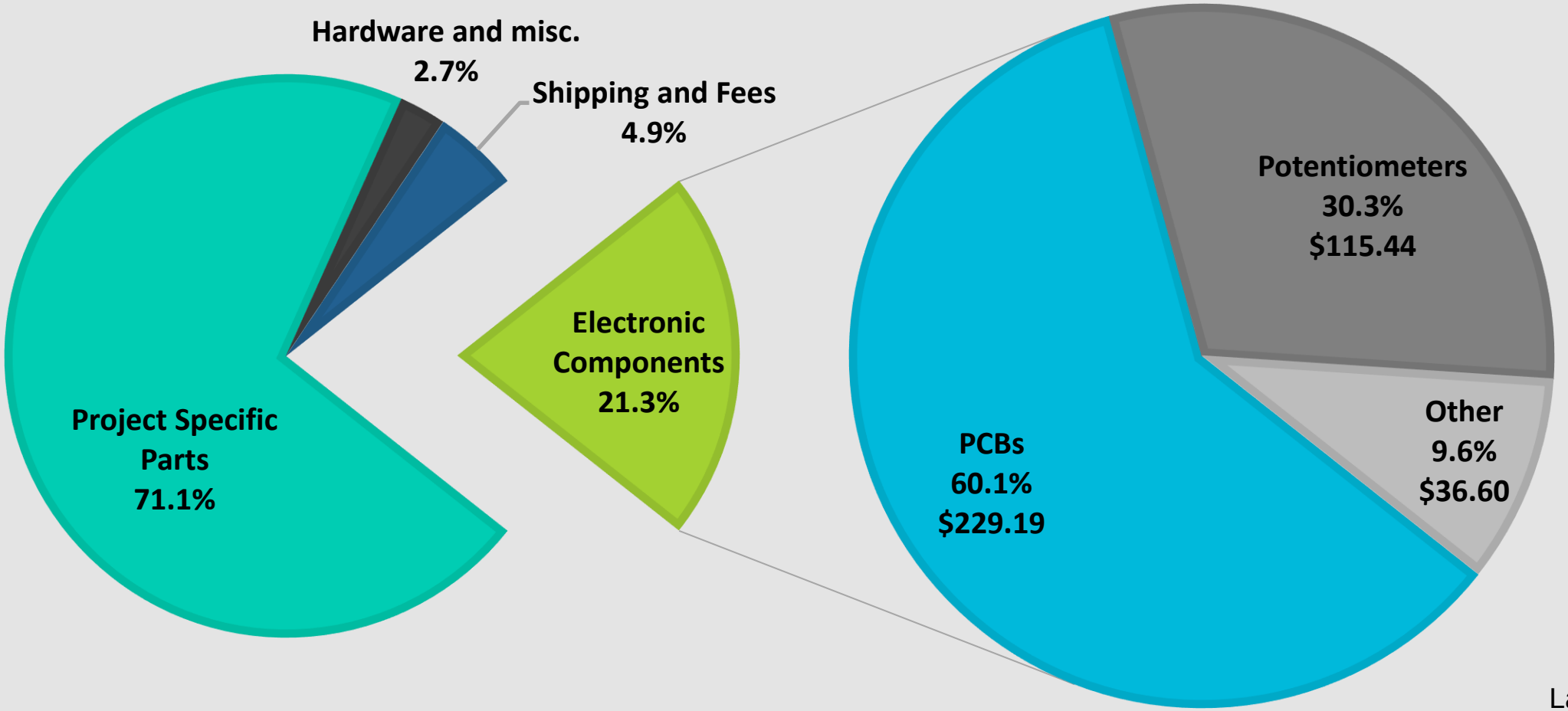
Budget Update



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Current Priorities

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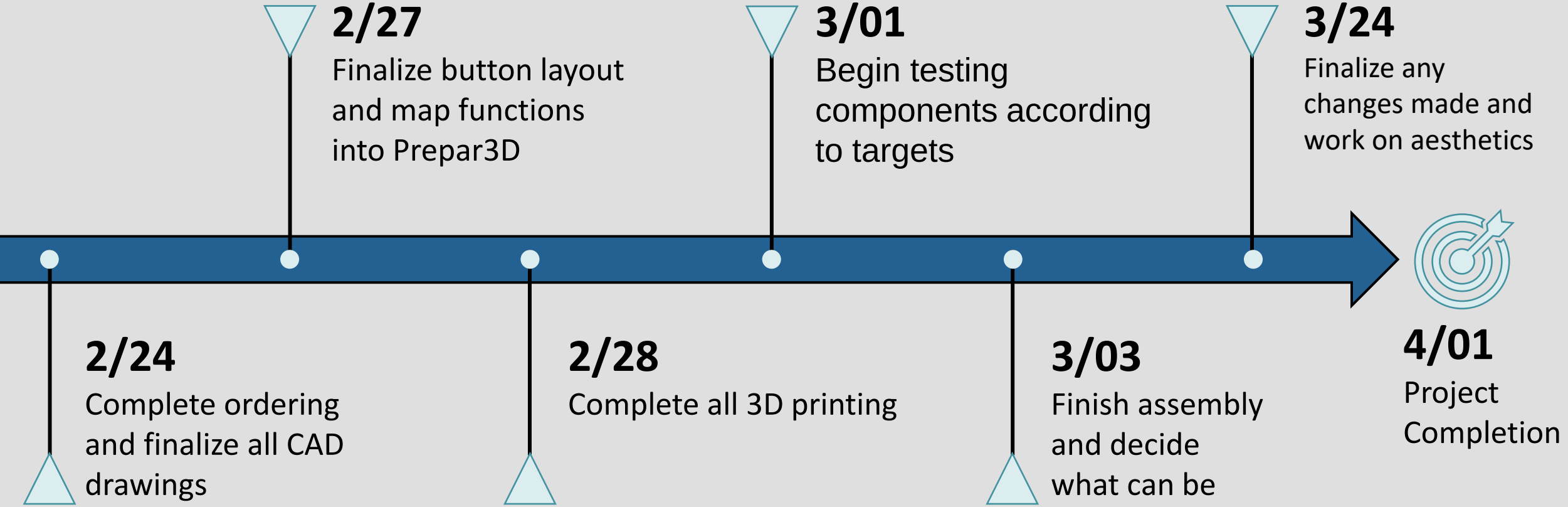
Project Timeline



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Questions?

- Design Team
- Sponsor
- Objective
- Background
- Functions
- Targets
- Current CAD
- Concept Selection
- Project Timeline

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