Lockheed Martin Low-Cost F-35 Simulator

Senior Design Team 514

Francisco Lopez

Meet the Team

Jonah Gibbons
Manufacturing & Electrical Engineer

Laiken Kinsey
Project Manager

Francisco Lopez
Control Systems Engineer

Branden Pacer
Mechanical Engineer & Web Design

Will Rickles
Mechatronics Engineer

Emelia Rodriguez
Purchasing and Research Engineer

Francisco Lopez

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

Francisco Lopez

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

Prepar3D with 3D Printed Cockpit

3D Printed Cockpit

Desktop Simulator

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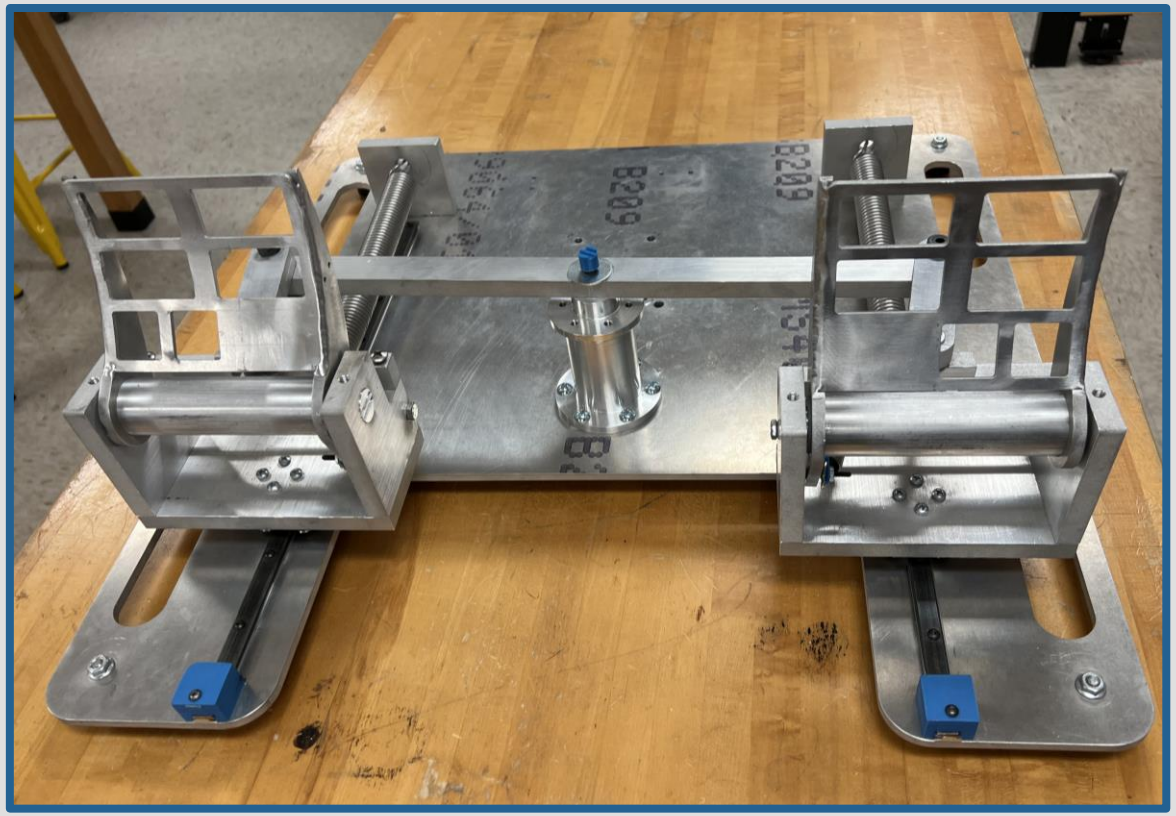
Rudder Pedal System



- Rudder Pedal System (RPS): Controls the rudders which change the yaw axis of the aircraft and also the wheel brakes
- Initially developed by a previous senior design team, we will incorporate this Rudder Pedal System with minor modification

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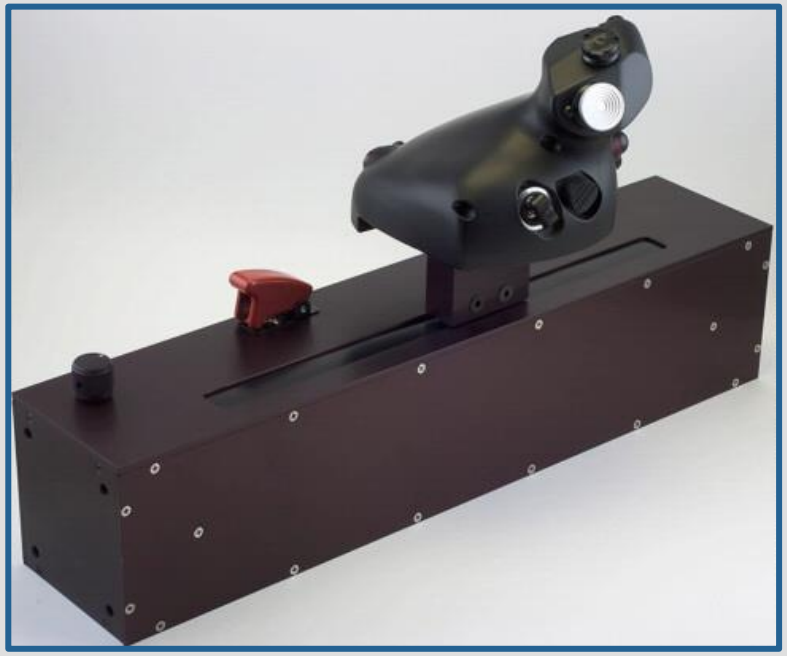
HOTAS System

- HOTAS: Hands on Throttle and Stick
- Throttle: Controls the thrust from the jet engine
- Stick: Controls the pitch and roll axes of the aircraft
- Initially developed by a previous senior design team, we will modify to fit the needs of this project



Throttle

Stick

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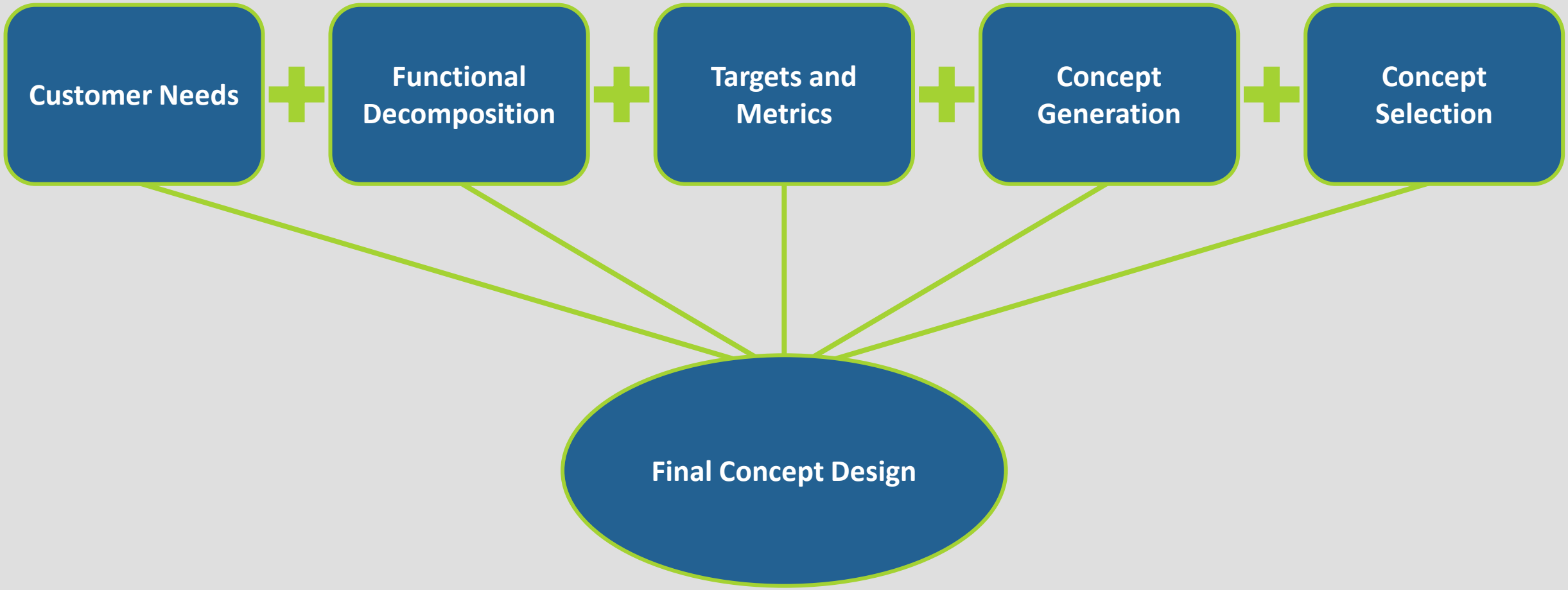
Last Semester



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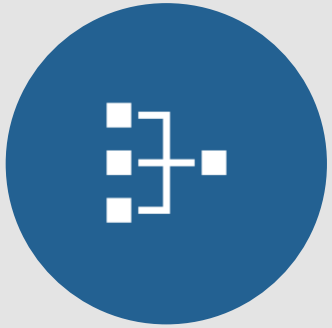
Key Goals

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

Jonah Gibbons

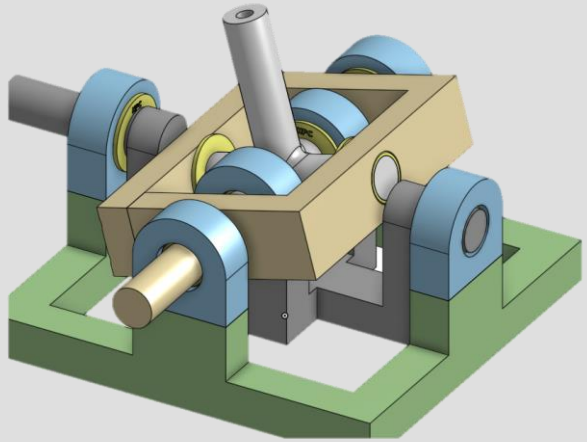
Additional Targets

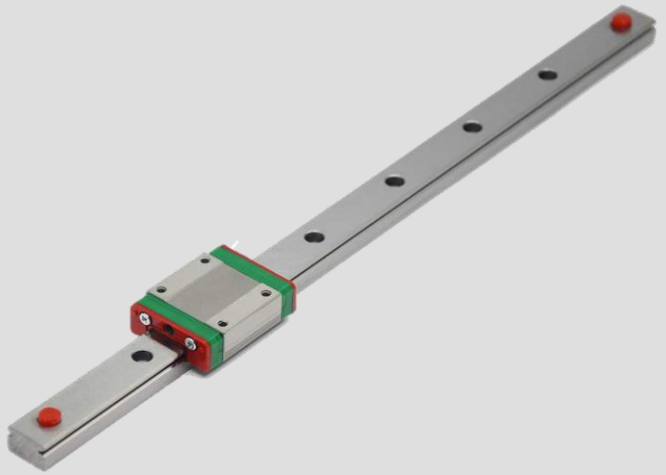
Individual Component < 35 pounds	Joystick deflection 13 degrees in all directions	Throttle travel 6 inches
Operates 1 hour without defect	No more than 15 lbf required to move RPS	HOTAS withstands applied 7.5 lbf

Jonah Gibbons

Final Design Selection

The design will feature potentiometer to sense position, individual microcontrollers for the RPS, throttle, and joystick, the throttle slides on a single rectangular rail, and the joystick is on a multiplane gimbal joint





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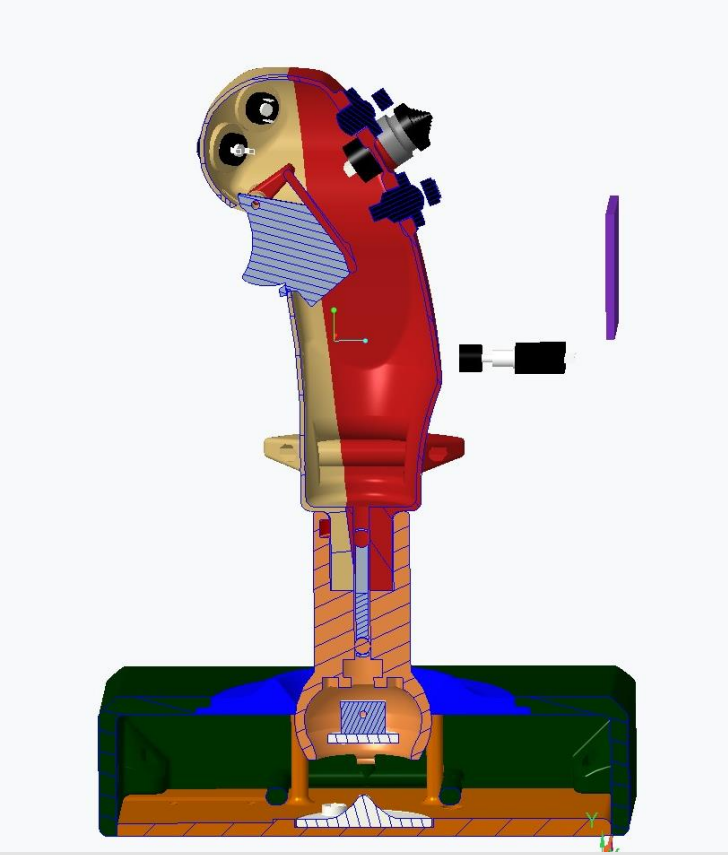
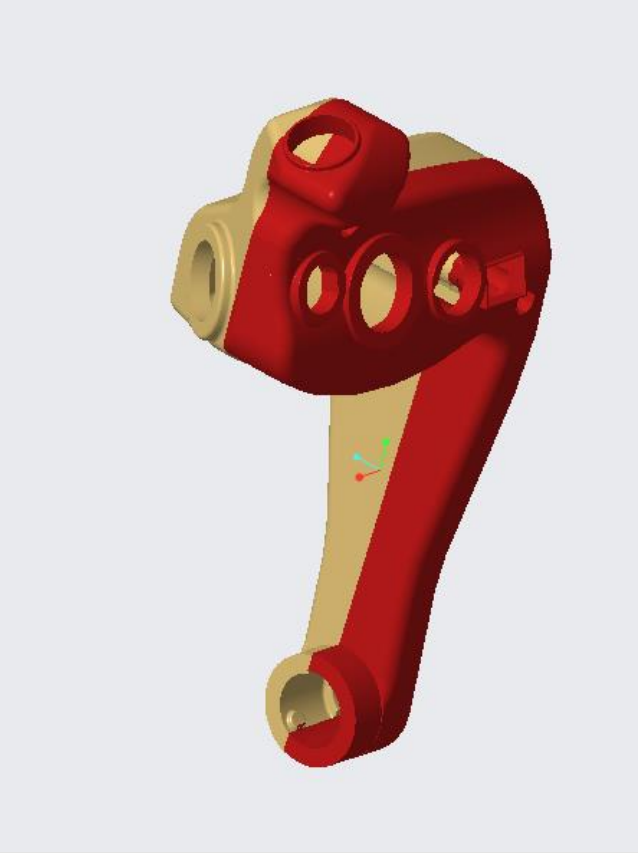
Current CAD Designs

Stick



Stick



Throttle

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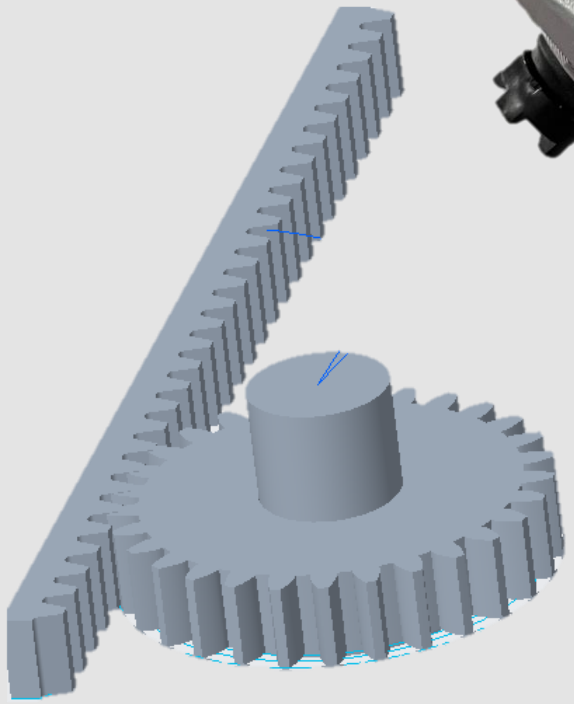
Throttle Prototype

- Need to adjust width and shape to be able to fit all required buttons
- The arm of the throttle needs to be moved to the center
- Figure out which printer will produce higher quality parts
- Size down the rack and pinion



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Software Update

Integration

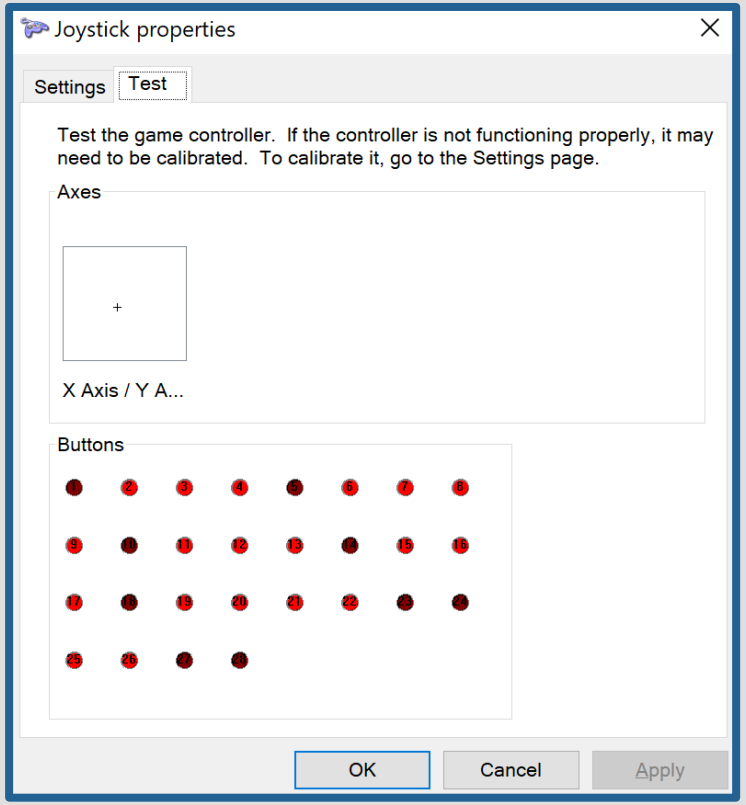
- Buttons are recognized by software
- Next function mapping

Latency

- Exceeds expectations
- Recognizes buttons immediately

Firmware

- Over 90% complete



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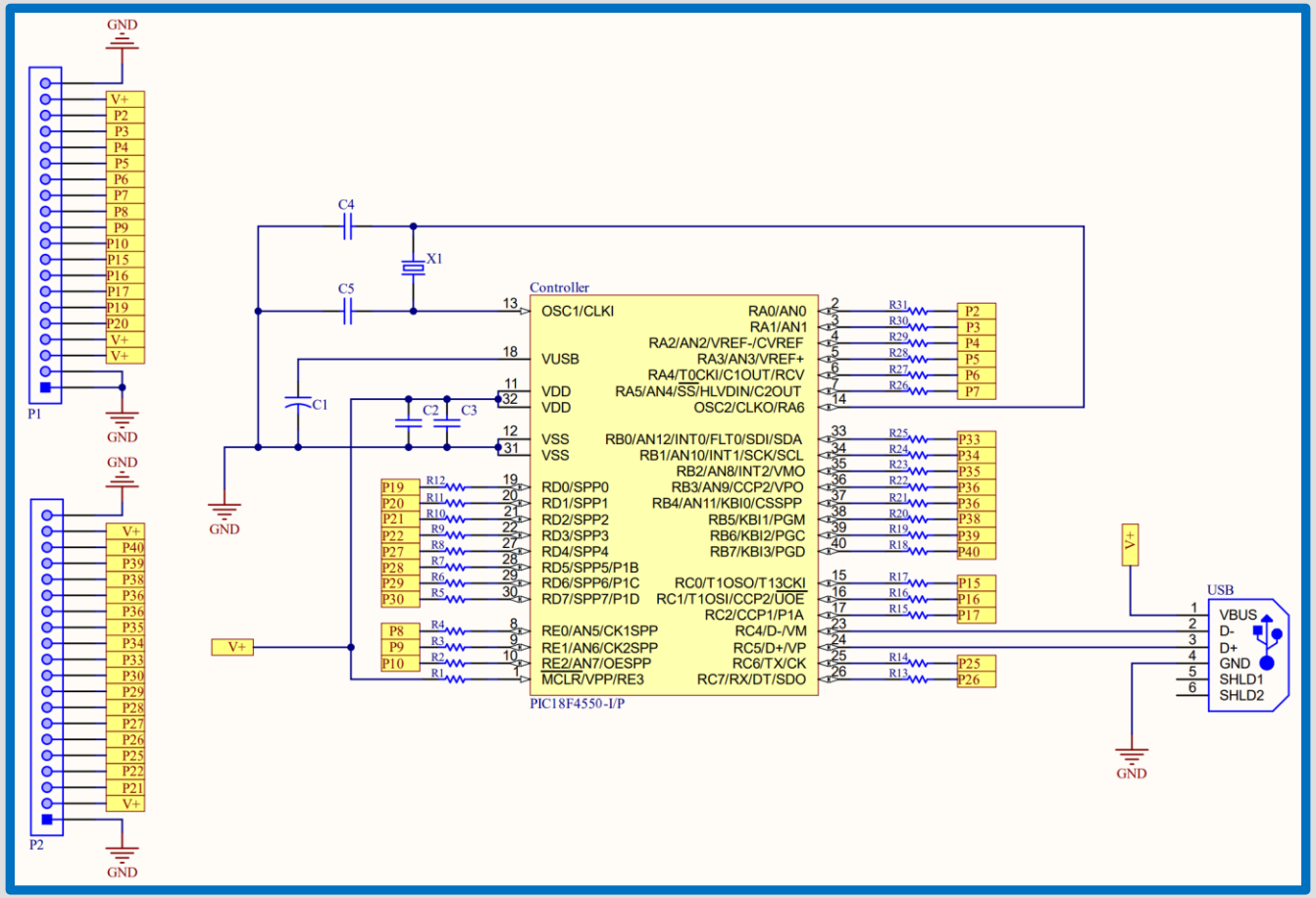
Printed Circuit Board Schematic



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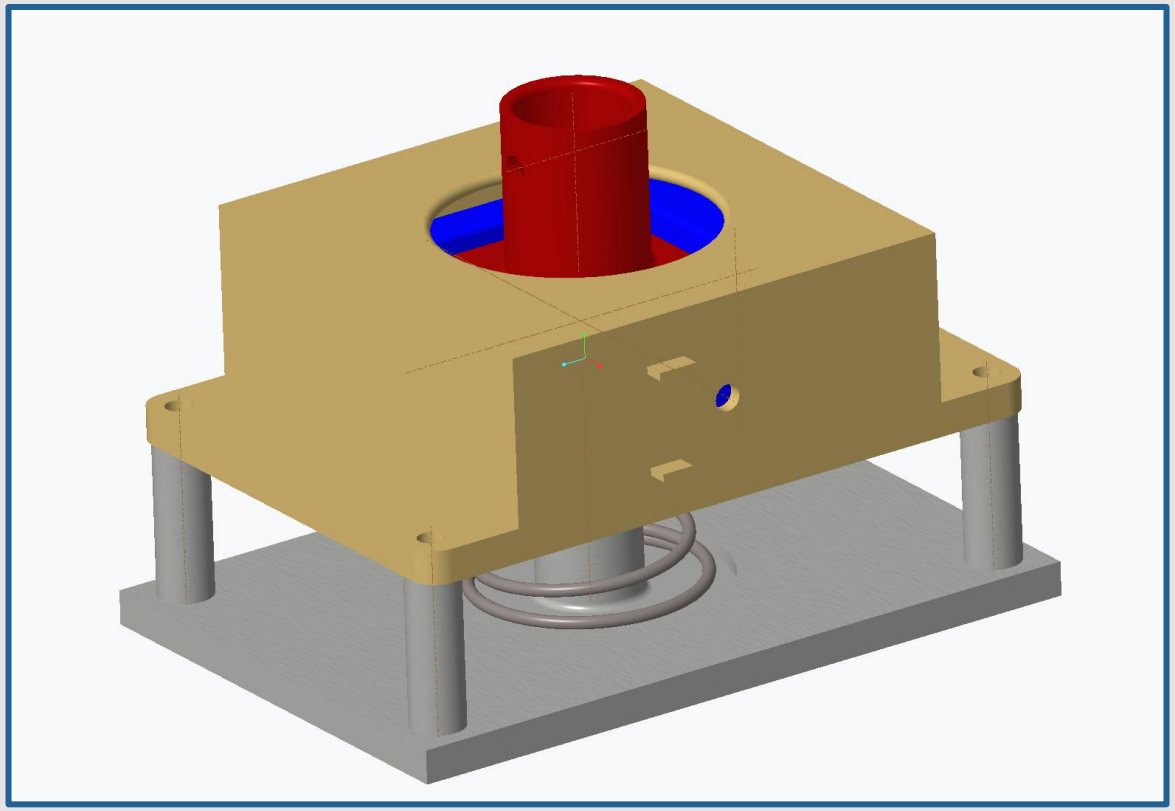
Update to Joystick Mechanism

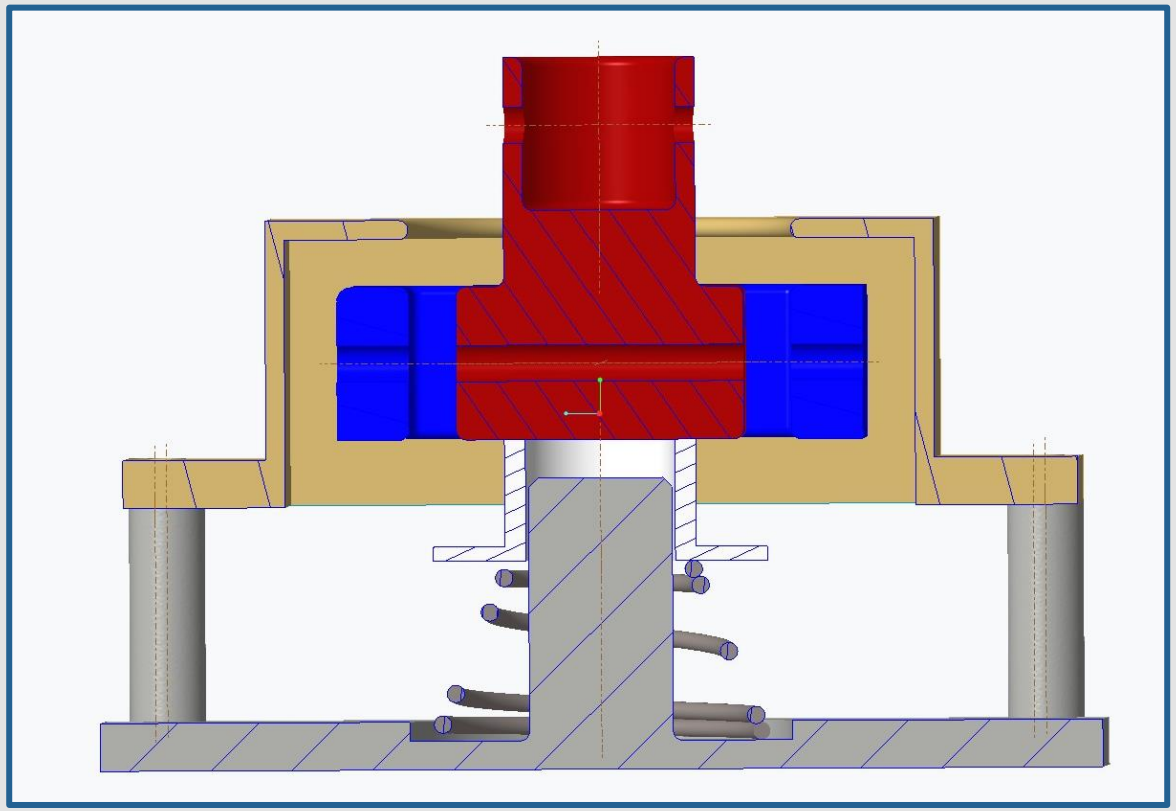


- The joystick mechanism has been changed.
- Retaining multiplane gimbal.
- Replacing linkages with multiple linear springs to “push plate” and single conical spring.

Emelia Rodriguez

Update to Joystick Mechanism

- Adjustment needed in geometry to meet targets.
- Next revision should include adjustable spring force.
- Conical and linear springs considerations:
  - Buckling behavior
  - Linearity of force per deflection (rate of a spring)



Emelia Rodriguez

Bill of Materials and Purchasing

- Several iterations of the bill of materials have been made since November
  - Since the original draft, a few parts have gone out of stock
- We have used about 45% of the budget on the first order
- Some items have already been purchased in order to get started on design and assembly.

Emelia Rodriguez

Current Priorities

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Project Timeline

2/03
Fill out all order forms and finalize CAD drawings

2/10
Have model to begin interfacing with Prepar3D and tweak existing code

2/17
Finalize button layout and map functions into Prepar3D

2/24
Begin to test components according to targets

3/03
Finish assembly and decide what can be improved

3/24
Finalize any changes made and work on aesthetics

4/01
Project Completion

Emelia Rodriguez

Questions?

- Design Team
- Sponsor
- Objective
- Background
- Functions
- Targets
- Current Work
- Concept Selection
- Future Work

Emelia Rodriguez