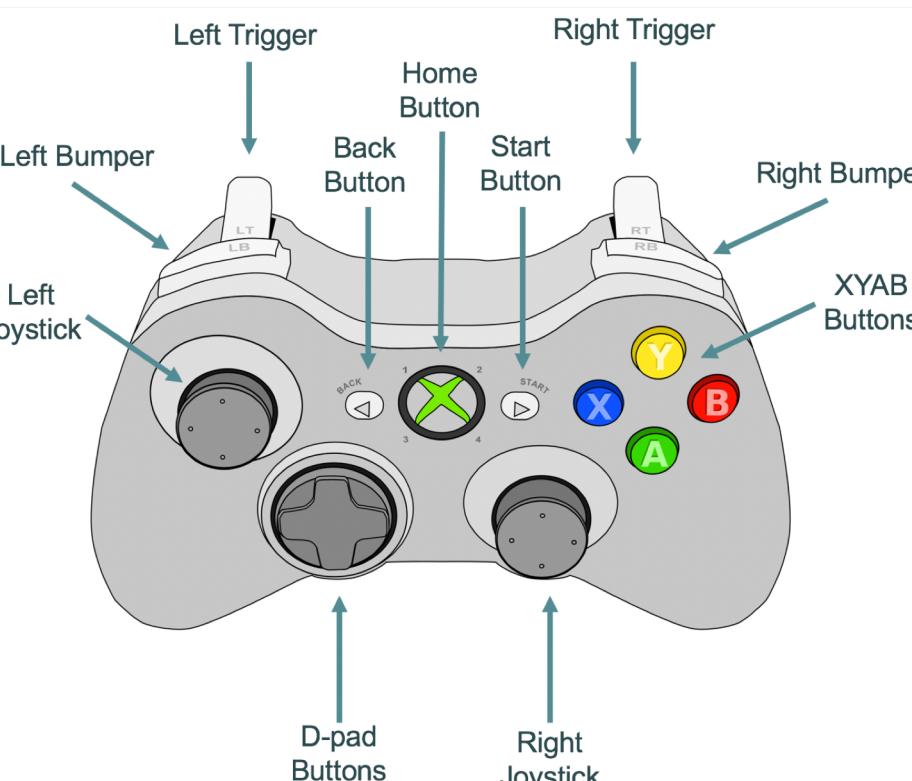




NUB-TROLLER:

VIDEO GAME CONTROLLER FOR DOUBLE ARM AMPUTEE

CONTROLLER 101



ABXY: Used for special moves, attacks, jump
D-pad: Used to move player, misc.
Joysticks: Used for moving and panning
Triggers: Used for attacks, aiming and combo moves
Bumpers: Used for combo moves, misc.

"The controller is one of the most essential products in the video game industry as it acts as the primary input device for a variety of gaming consoles."^{*}

PROBLEM STATEMENT

Design a comfortable foot-operated video game controller for double arm amputee, Mary "WonderNubs" Dague, that is functionally analogous to a hand-held controller.

OUR CLIENT: MARY DAGUE

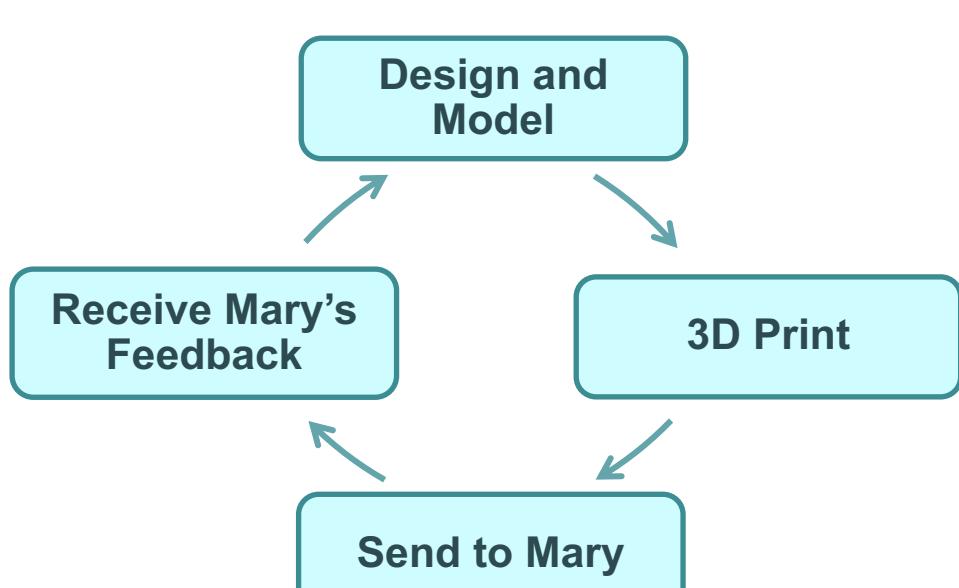


Mary Dague is a double-arm amputee war veteran. She was an explosive ordnance disposal technician and now works to raise awareness on the military suicide epidemic and helps people work through rough situations. She is also an avid video gamer, playing with her feet for 8-12 hours at a time on a handheld Xbox360 controller.

**Mary's Current Set-up:**

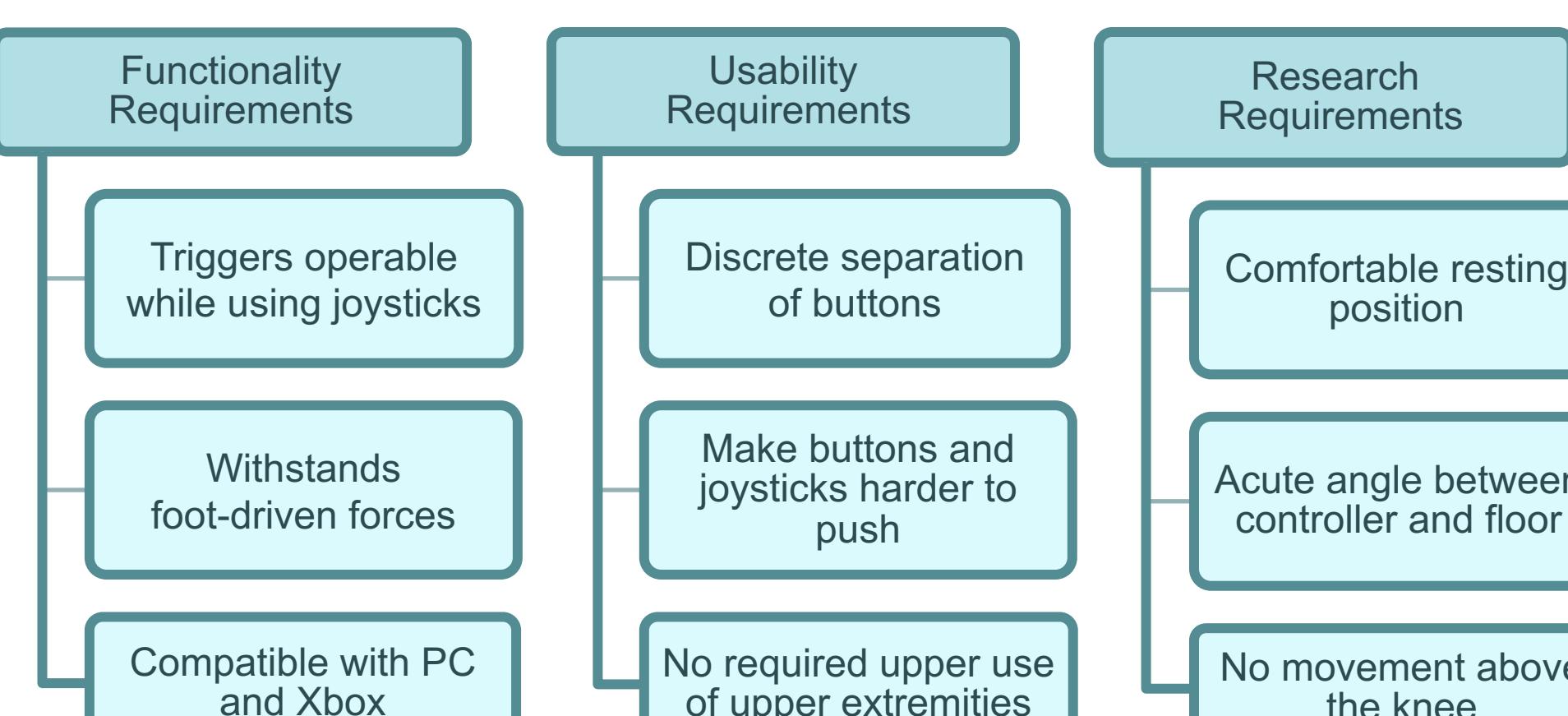
Mary currently uses a handheld Xbox 360 controller on top of a Lovesac cushion. She is unable to press the triggers without lifting her foot off all other buttons.

USER-BASED DESIGN



The user-based design process consisted of working through Mary's requirements, designing, and then receiving feedback from Mary on each stage of our process.

DESIGN REQUIREMENTS

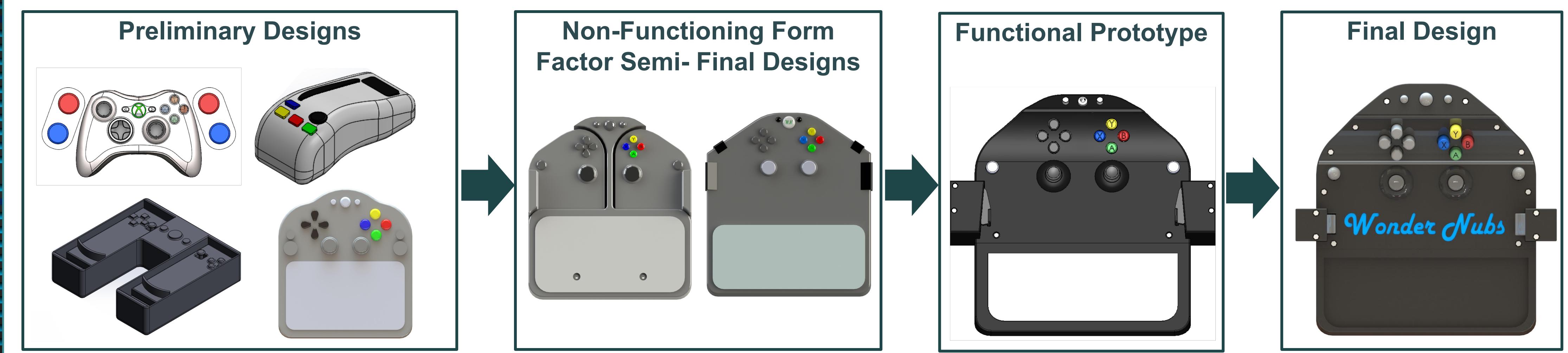


ACKNOWLEDGEMENTS

The group would like to recognize war veteran Mary Dague, Northeastern University's Prof. Jack Dennerlein, and our advisor Prof. Andrew Gouldstone for their contributions to this Capstone project.

*Bhardwaj, R. (2016). *The Ergonomic Development of Video Game Controllers*.

ITERATIVE PROCESS

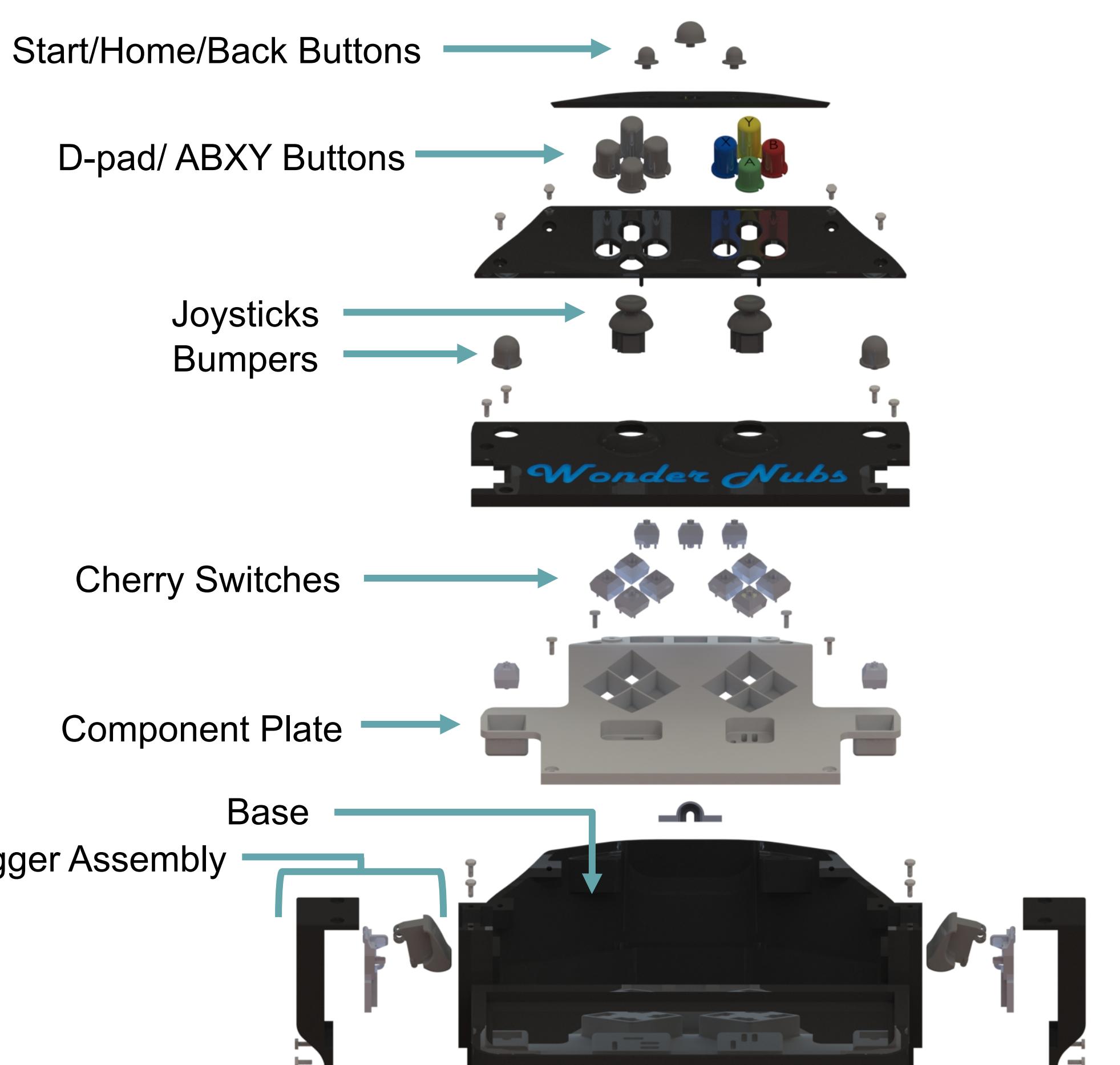


FINAL DESIGN

ISOMETRIC VIEW:



EXPLODED VIEW:



JOYSTICK MODIFICATION

Purpose:

Decrease joystick sensitivity for foot movement.

How it Works:

- Reuses 2 rotational potentiometers to register 2 degrees of motion and preserve analog output.
- Increases joystick stiffness by stacking 2 resistive springs.



BUTTON CAP DESIGN

Purpose:

To create a secure way to actuate the button that would feel comfortable and familiar.

How it Works:

- Ensures security by adding keys and skirt.
- Reduces accidental button pressed by variable button height.



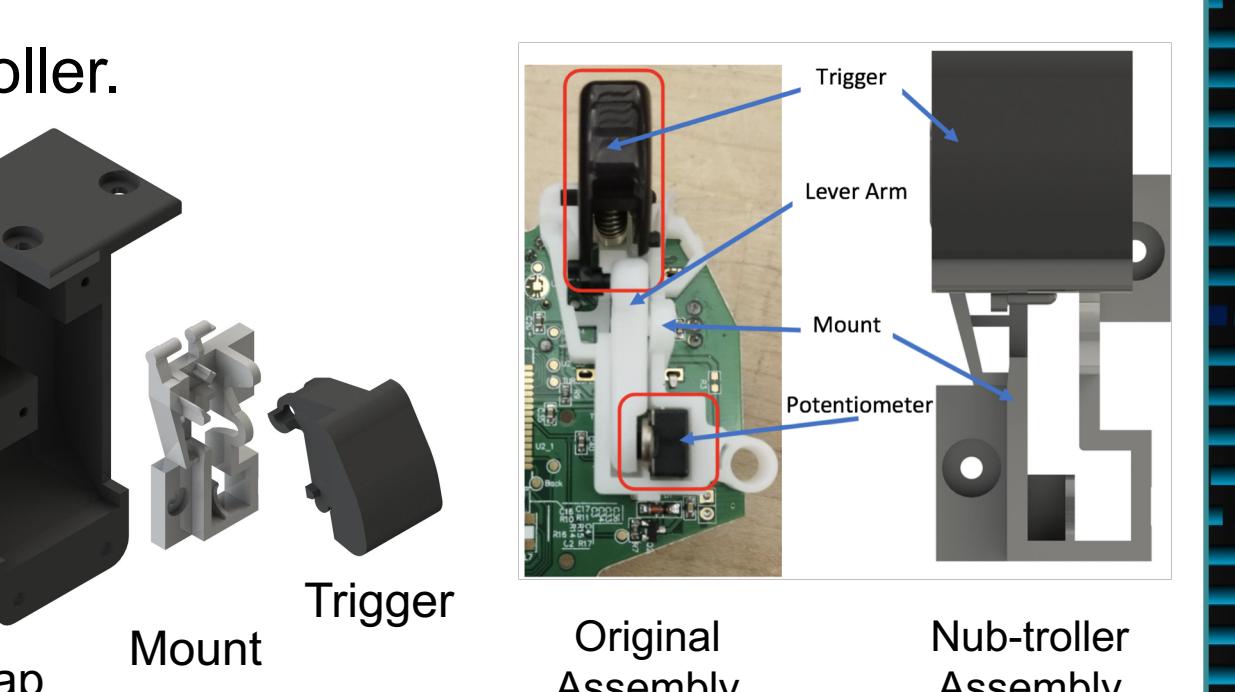
TRIGGER ASSEMBLY RE-DESIGN

Purpose:

Relocate triggers to side of controller.

How it Works:

- Incorporates original lever arm/potentiometer.
- Improves trigger form and mounting method for exterior mounting.



CHERRY SWITCHES

Purpose:

Allow surface mounted button connections to be made off-board.

How it Works:

- Keyboard switches are designed for high cycle use.
- Provides desired tactile "click" from mechanical switch.
- Increases stiffness by incorporating customizable springs.



TESTING AND ANALYSIS

LAG TESTING:

Purpose:

To test if there was any added lag to the altered PCB

Procedure:

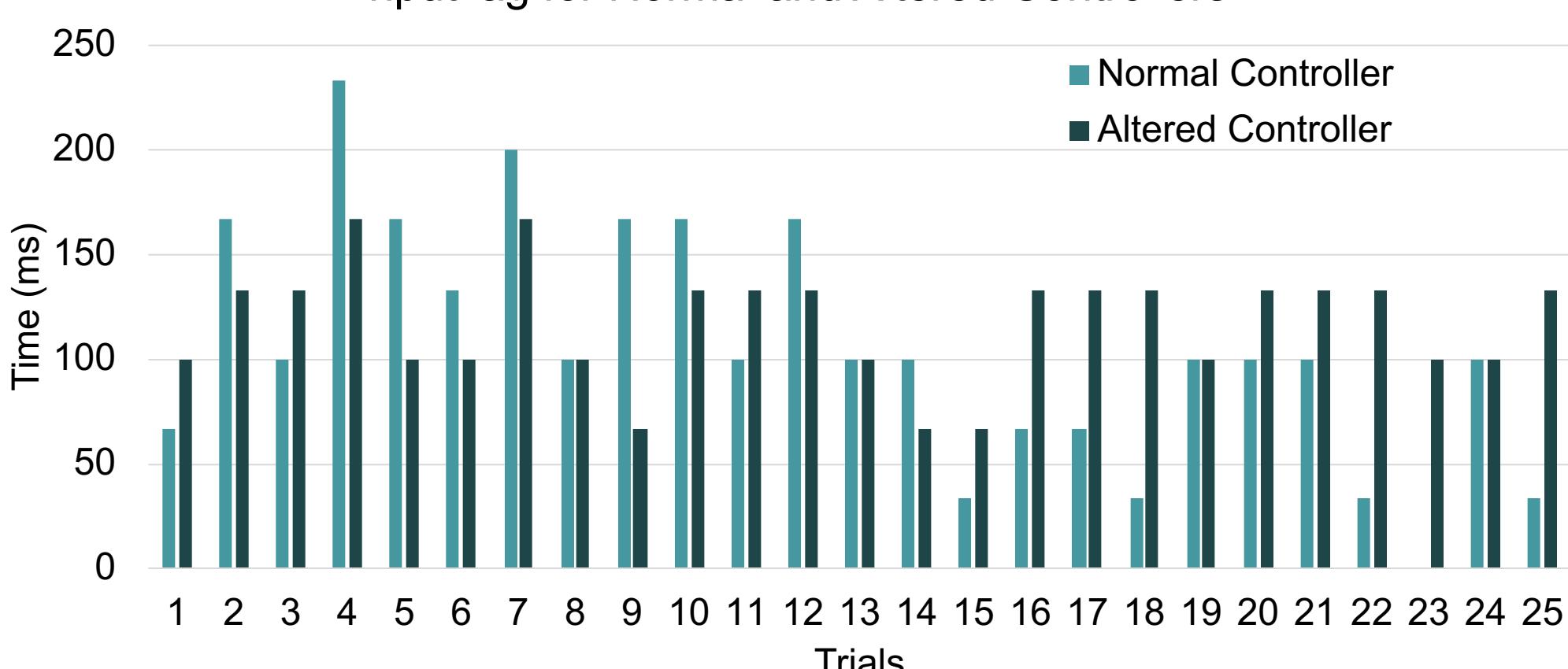
Recorded video of a button actuated and a video game character jumping at 240fps and measured time between button press and player jump

Result:

No noticeable lag.

Average Control Lag	Average Modified Lag	Lag Added by Modification
105.33 ms	117.33 ms	12 ms

INPUT LAG FOR NORMAL AND ALTERED CONTROLLERS



WORK ANALYSIS:

Purpose:

To confirm buttons are "harder" to push

Procedure:

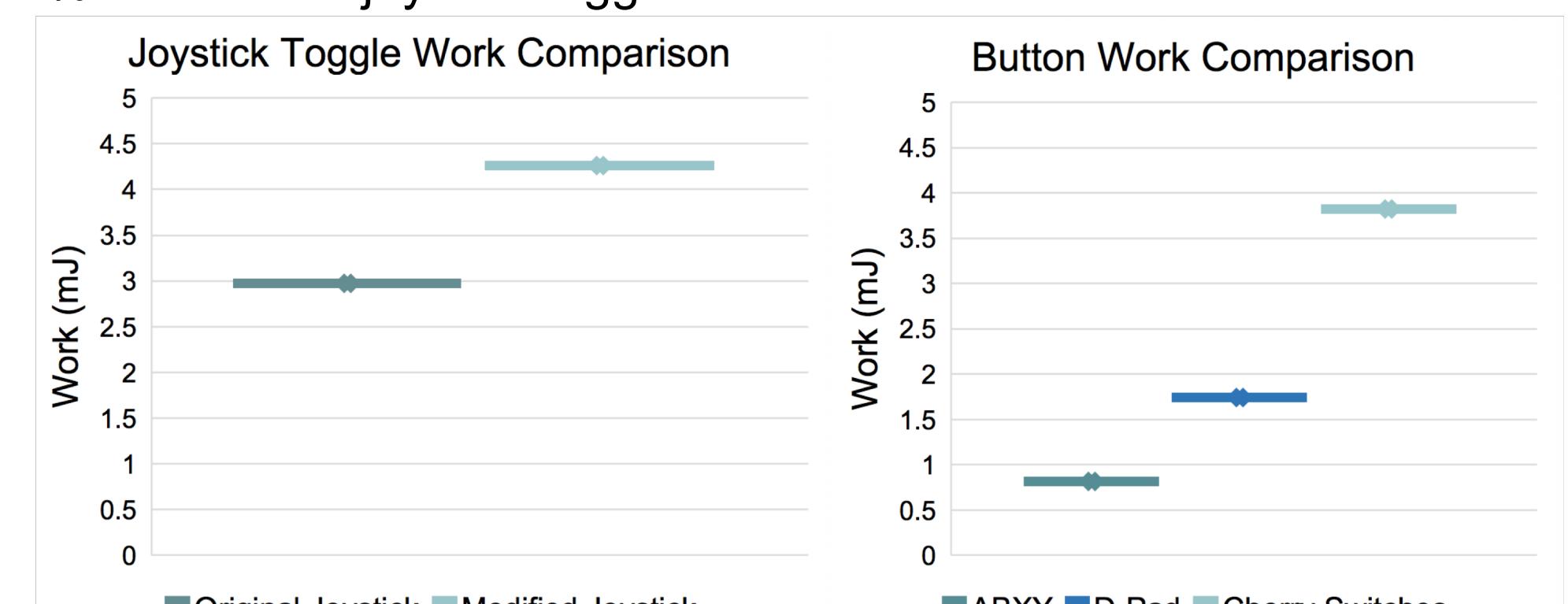
- Force transducer mounted to a linear actuator records force data 10 times for each button
- Results used to find spring constant for work analysis ($W = \frac{1}{2}KX^2$)

Result:

374% increase in ABXY work

77% increase in D-pad work

39% increase in joystick toggle work



FORCE AND FATIGUE ANALYSIS:

Purpose:

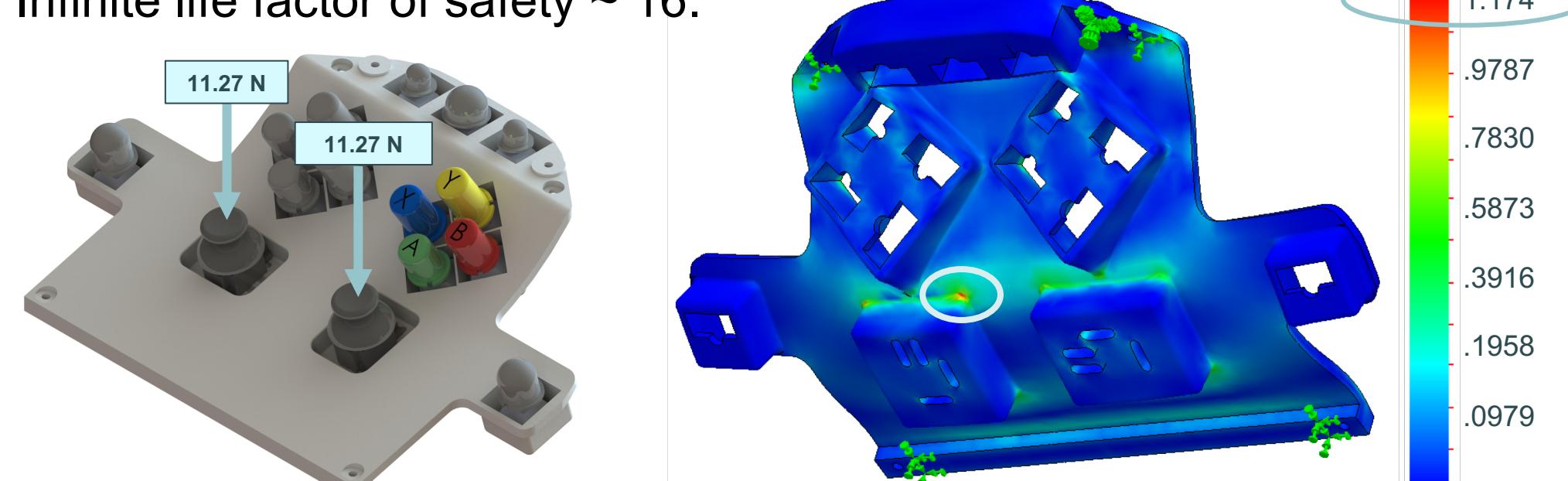
To ensure the component plate could endure foot-driven forces for near-infinite life.

Procedure:

- Determined max. stress due to joystick toggle force through FEA.
- Determined safety factor based off PA11 Nylon material.

Result:

Infinite life factor of safety ~ 16.



CONCLUSION

Throughout the project, Mary provided us with feedback that helped us finalize our design. Mary has streamed herself using the functioning prototype on her Twitch channel and is now looking forward to receiving the final controller. She will receive two copies of the finished design, providing a back up in case of failure. A bill of materials and assembly instruction will be left with the Northeastern Mechanical Engineering Department to facilitate replacement or continuation of this project.