



# Physical Function Testing Apparatus for Monkeys



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## Abstract

Rhesus monkeys have long been used in research as a model for humans due to their similar anatomy. It has been proven that caloric restriction without malnutrition can delay sarcopenia and its accompanying health problems. Current methods for testing the threshold for muscle loss do not provide quantitative data on physical function; however, a device to measure the maximum strength of the monkeys will offer more versatile records for Dr. Colman's research on aging. A prototype that has the capability of testing the maximum strength of the subject's entire lower body has been fabricated, but improvements are necessary before the device can be used on any animal participants.

## Background

- Humans and monkeys share similar anatomical structures, which makes rhesus monkeys good candidates for comparing human and non-human primate health [1]
- Rhesus macaques are quadrupedal with opposable toes, which allows for an increased range of motion and strength [1]
- To obtain muscle mass data, biopsies are taken from the quadriceps but quantitative muscle strength data is required to show the decay over time of physical function with limited caloric diets
- Sarcopenia: the natural loss of muscle tissue with aging [2]

## Motivation

There is currently no product on the market that accurately tests muscular function and strength in rhesus monkeys.

## Product Design Specifications

- Measures the entire force range generated by the monkeys
- Safe for use with the monkeys and easily sanitized
- Durable enough to withstand long term stresses
- Able to be set up, then function without human assistance
- Isolates leg strength as much as possible

## Preliminary Design

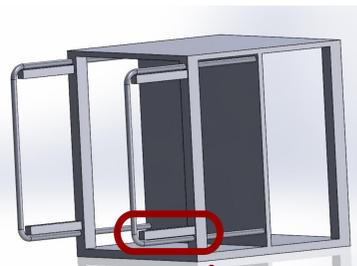


Figure 1: SolidWorks design of a cage. Included is a squeeze plate with bars that extend out front. Highlighted is the device which is around the extended bar of the squeeze plate.



Figure 2: The device attached to one of the bottom bars of the cage

## Final Design

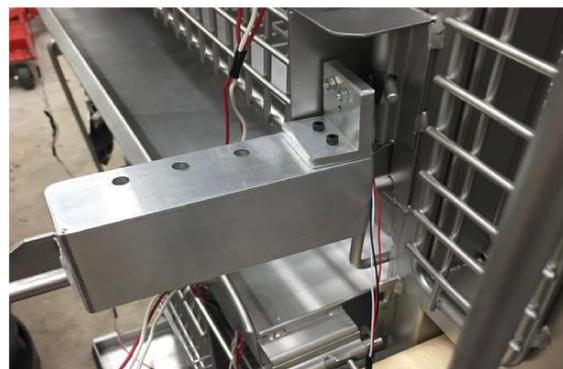


Figure 3: The Final Design of the aluminum device. The back side of the device is open.

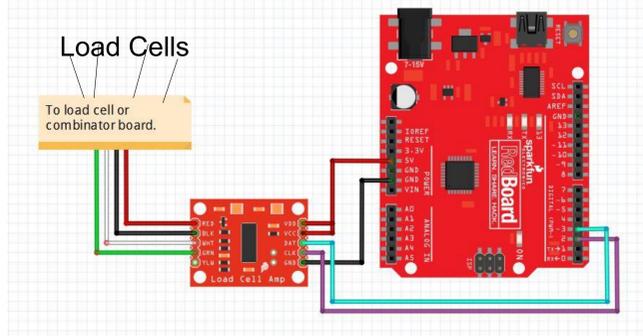


Figure 4: The figure above shows the arduino, amplifier, and combinator setup. The four load cells are connected to the combinator.

## Testing

- Device was calibrated with a series of series of weights
- Devices were pinned on all four corners
- Device tested over a series of weights



Figure 5: This image shows the setup of testing. Only one load cell was used on the top left corner.

## Results

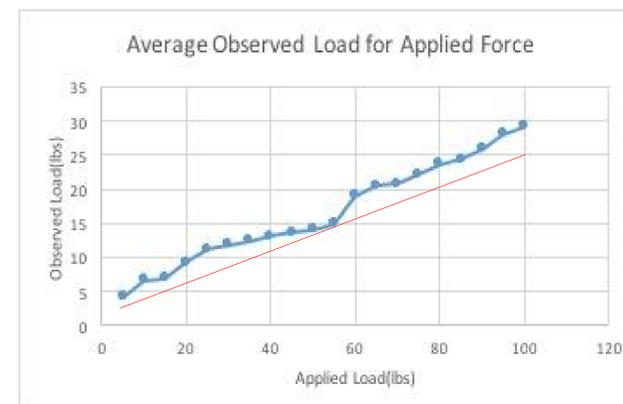


Figure 7: Measured load from single load cell, with all four corners pinned. The red line represents expected results.

Failure Points as Detected by Load Cell (lbs)	Failure Point as Detected by Scale (lbs)	Place of Failure
38.4	138.5	Both left clamps
40.7	142.3	Both left clamps
40.1	142.8	Bottom left clamp

Figure 8: Clamps commonly failed on the left side, but a large force was required to induce a slip.

## Discussion

- The devices were easily attached to the cage
- The load combinator was broken, therefore only one load cell could be used
- Newly aquired load combinator allows all four load cells to work
- The load cell generally measured above the anticipated value of one fourth of total force
- While pinned on all four corners, force distributed is not always even
- Code for threshold was not implemented

## Future Work

- Integrate automatic food reward system
- Implement a Bluetooth system so the device can connect to the computer wirelessly
- Design a container than protects the circuit from the rhesus monkeys

## Acknowledgements

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- Dr. Beth Meyerand, Advisor
- Scott Baum, Research Assistant
- Wisconsin National Primate Research Center

## References

[1] K. C. Lang. "Primate Factsheets: Rhesus macaque (*Macaca mulatta*) Taxonomy, Morphology, & Ecology". National Primate Research Center Library, 2005. [Online] [Accessed: 16 Oct. 2016].  
 [2] R. J. Colman et al., "Muscle mass loss in Rhesus monkeys: Age of onset," *Exp. Gerontol.*, vol. 40, no. 7, pp. 573-581, 2005.  
 [3] Bennett, Allyson J. "Wisconsin National Primate Research Center." *Speaking of Research*. Word Press, 31 Mar. 2016. Web. 05 Dec. 2016.  
 [4] Al-Mutlaq, Sarah. "Load Cell - 200kg, Disc (TAS606)." *Learn at SparkFun Electronics*. N.p., n.d. Web. 07 Dec. 2016.