Physical Function Testing Device for Monkeys

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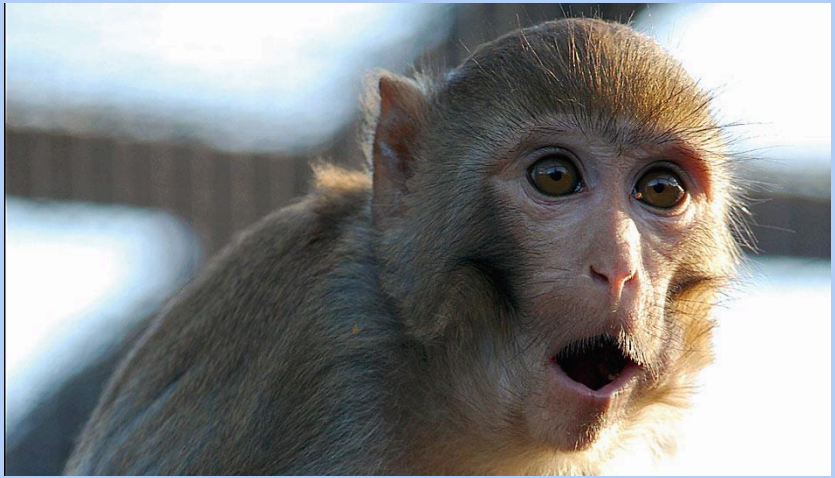

http://www.monkeyhaven.org/wp-content/uploads/2015/11/rhesus-macaques-960x540.jpg

Outline

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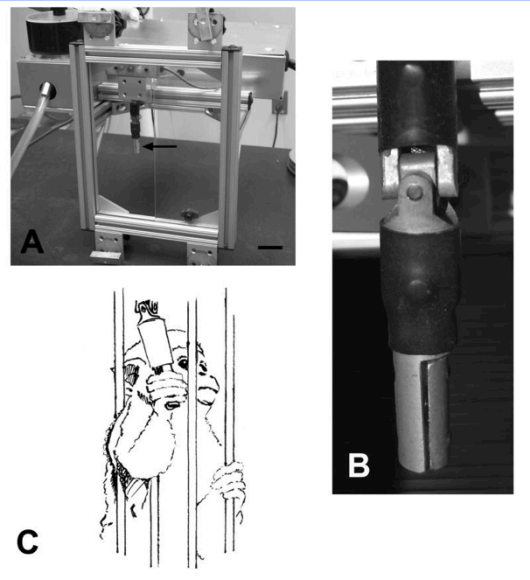
Problem Statement

In studying the muscular effects of calorie-restricting diets and their impact on aging, Rhesus monkeys must be assessed for muscle strength. Current methods simply accurately measure muscle mass, which only loosely correlates with muscular function. The Wisconsin National Primate Research Center (WNPRC) requires an apparatus that intuitively allows moneys to complete a range of motion under resistance and delivers quantitative feedback on the animal's strength. The goal of this project is to develop a safe, durable, and easily sanitizable device that meets this goal.

Competing Designs

Grip Strength Device

- Measured grip force of squirrel monkeys through a small force transducer embedded in a bisected aluminum cylinder
- Reward was provided per grip



Pulling Strength Device

- Measures pulling strength using a force gauge attached to a handle on one end and a sled with adjustable weight on the other
- Monkey pulls the handle with arms and legs, reeling in the weighted sled to obtain an attached reward
- With each successive pull, weight is increased on the shelf

Background Research - Monkey Physiology

- Hands and feet designed for grasping
- Similar to people in musculoskeletal anatomy and movements
- Biopsy site – located on quadriceps (largest and most easily measured muscle group)

Previous Work

Initial prototype created and tested

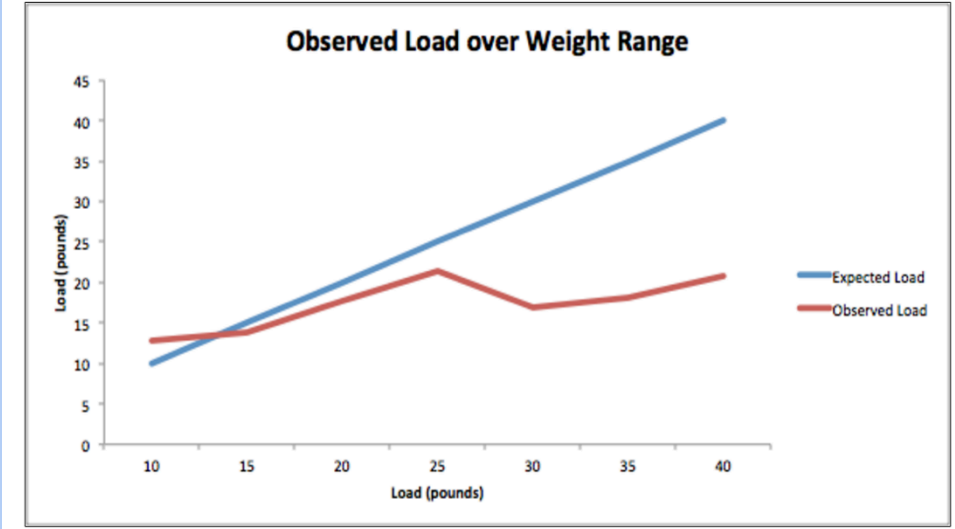
Problems with first prototype:

- Clamping method is difficult and inefficient

- Device is not accurate above loads of 20 pounds

- Need to make four of the device

- Circuit should implement Bluetooth connection



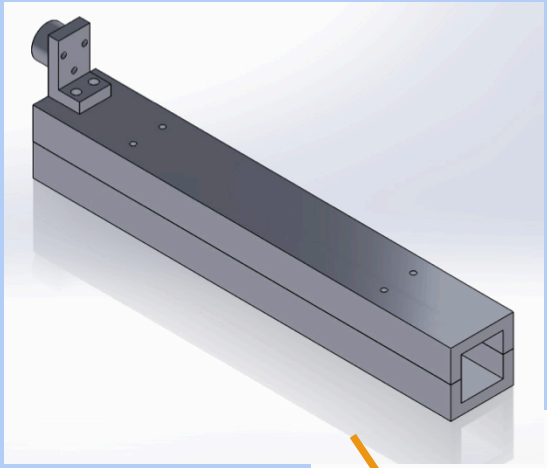
Product Design Specifications

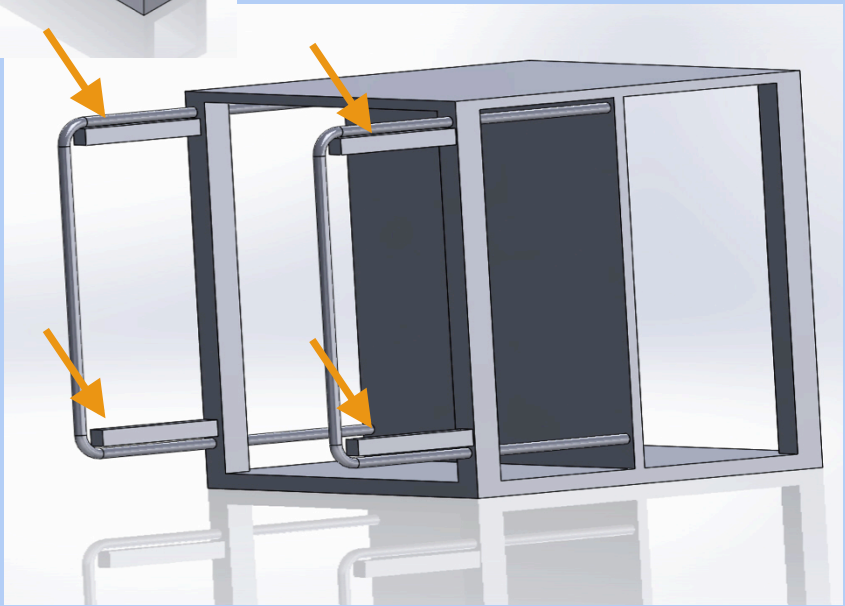
- Device must be safe, durable, and rust resistant
- Device must be easy to set up and compatible with multiple cages
- Monkey should be able to operate the device after training
- Device must accurately measure the load the monkey places on the cage
- Device must be connected externally to the cage

Original Clamp Design

Pros:
- Simple Design
- Isolates force onto load cell
- Tested and accurate up to 20lbs

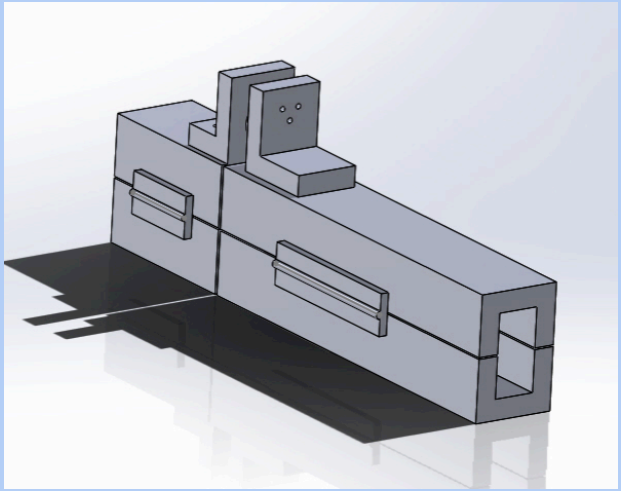
Cons:
- Difficult to attach to cage
- Had only two sides in contact with bar
- Difficult to find solid contact point for load cell on cage





Considered Designs

Hinged Clamp



Pros:

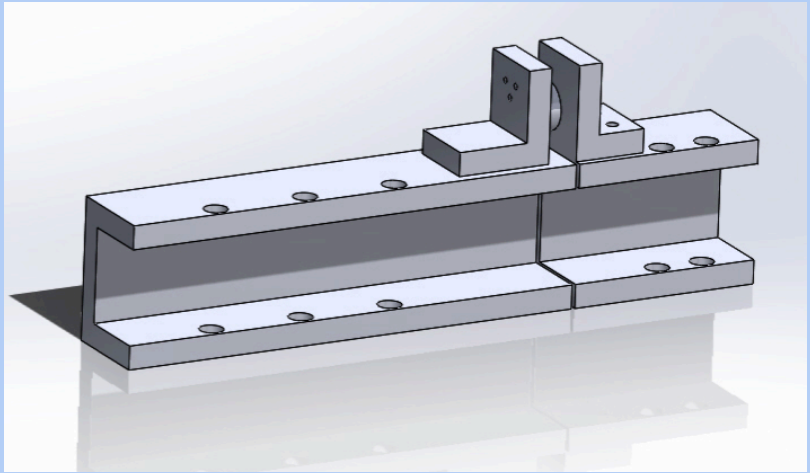
- Easy to attach
- Guarantees flat solid contact point for load cell.
- Friction and contact on all four sides
- Shortened lighter design

Cons:

- Very difficult to fabricate
- Must buy additional materials for hinge and locking mechanism
- Must fabricate materials to new dimensions

Considered Designs

One Piece Screwed Clamp



Pros:

- Easier to fabricate (only have to mill one piece off)
- Still gives three sides of friction
- Shortens device and provides flat solid point of contact for the load cell

Cons:

- Has an open side and open screws that the monkeys could potentially reach
- Is a slightly more difficult attachment method

Clamp Design Matrix

	Original Clamp		Hinged Clamp		One Piece Screwed Clamp	
Safety (25)	4	20	3	15	4	20
Durability (20)	5	20	3	12	4	16
Ease of Fabrication (20)	4	16	3	12	4	16
Ease of Use (Researcher) (20)	2	10	5	20	4	16
Measurement Accuracy (10)	5	10	5	10	5	10
Cost (5)	5	5	4	4	5	5
Total (100)		**81**		**73**		**83**

Other Design Matrices

Materials Matrix

	Stainless Steel 304		Aluminum 2024	
Strength (25)	5	25	4	20
Ease of Fabrication (25)	2	10	4	20
Weight (20)	2	8	4	16
Cost (15)	4	12	5	15
Durability/ Corrosion Resistance (15)	5	15	4	12
Total (100)		**72**		**83**

Circuit Matrix

	Original Circuit		Quadruple Circuit		Combined Circuit	
Cost (30)	5	30	2	12	4	24
Accuracy (30)	1	6	5	30	5	30
Ease of Fabrication (20)	4	16	3	12	5	20
Safety (10)	1	2	5	10	4	8
Ease of Use (Researcher) (10)	1	2	5	10	5	10
Total (100)		56		74		92

Future Work

1. Place material order for circuitry and material
2. Begin process to gain access to monkey subjects
3. Fabricate four devices and test attachment and dimensions on physical cages
4. Set up and attach all circuitry
5. Test circuitry on empty cages with human forces (multiple trials)
6. Run statistical analysis on test results
7. Test devices on monkey subjects with assistance of researchers
8. Run statistical analysis on results
9. Re-evaluate design decisions

Acknowledgements

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Wisconsin National Primate Research Center

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