

Physical Testing Apparatus for Monkeys

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Problem Statement:

In studying the effects of diet on the macaque monkey, muscle function and strength give important data to the aging of the test subjects. Currently, only muscle mass can be measured; however, information on the animal's' muscle strength lacks. An apparatus to motivate the monkeys to test their strength, exercise their upper and lower body, and give feedback, isn't available in the primate center on the UW campus. The goal of this project is to develop a method for testing the physical function of the hind and forelimbs of a macaque monkey that will be durable, able to be sanitized, and safe for the animals.

Client Requirements:

1. The device must be able to measure the strength of a rhesus monkey.
2. The device must be sanitizable.
3. The device must not be harmful to the monkey.
4. The device must be durable enough to withstand long-term abuse from a monkey.
5. The device must be resistant to rust.
6. The device must be able to be operated by a monkey after training.
7. The device must be able to give feedback to the client in real time.
8. The device must be able to measure the strength of the monkey's arms and legs separately.
9. The device must be able to be moved by a single person.
10. The device must have a way to reward the monkey with food.

Preliminary Product Design Specifications

Physical and Operational Characteristics:

a. Performance Requirements:

The physical testing apparatus for rhesus monkeys should be wear-and-tear resistant with long term durability. The apparatus must be able to test rhesus monkey upper body and lower body strength separately, while providing feedback to the user. The rhesus monkeys are very strong, so the device must be able to withstand large forces from the monkeys.

b. Safety:

The device should meet all of the regulations for animal testing established by the Institutional Animal Care and Use Committee (IACUC). The device cannot harm the animals in any way, and we must be careful to design a

device that is still safe even if used incorrectly. The device also must be made using a metal that cannot rust, likely stainless steel.

c. Accuracy and Reliability:

The device must be able to accurately and reliably relay data to the client on the strength of the animals. Ideally, the device returns leg strength and arm strength as two separate sets of data.

d. Life in Service:

The client did not give any specific description into life in service; however, the device will be used several times a day and should be able to last at least a year. The device will be under constant stress while in use, so it must be able to withstand high forces from the animals.

e. Shelf Life:

The device should be able to maintain the wear and tear damage while in use with the monkeys. The client stressed the strength of the monkeys and their ability to break devices easily.

f. Operating Environment:

The device will primarily be used in the cages that the rhesus monkeys are currently kept in. As a result, the biggest factor of the operating factor are the monkeys themselves. The device also must remain rust free over time.

g. Ergonomics:

The testing apparatus must be able to withstand the full strength of the monkeys. It must be easy to use for the monkeys and motivate them to use their full strength.

h. Size:

The product should be able to work on different sized cages. It must be detachable so that it can be fully sterilized. It should be portable enough to move from one cage to another. It should have a maximum weight of 40lbs.

i. Power Source:

The product can be outlet or battery powered.

j. Weight:

The strength testing device should not exceed 40lbs.

k. Materials:

All parts that are open to the monkeys should be made from metal or plexiglass so the monkeys can not destroy the equipment or hurt themselves with parts. The apparatus must be rust resistant too.

l. Aesthetics, Appearance, and Finish:

This product should have no sharp corners or edges that the monkeys could injure themselves on. It should be smooth enough that the monkeys cannot grab and destroy it. It must be rust resistant.

Production Characteristics:

a. Quantity:

The product may be produced on a larger scale, but a working prototype must be created first.

b. Target Product Cost:

The current product cost is \$500.

Miscellaneous:

a. Standard and Specification:

The strength testing apparatus must be able to gauge force produced by macaque monkeys during specific forelimb and hindlimb movements and export readings to a data collection interface. It must be attached to and functioned within monkey cages, easily detached and transported, resistant to animal-abuse, dishwasher-safe, and operated without mechanical, electrical, chemical, or biological hazards to the animals. Properties and usage of the device must fall under AWA (Animal Welfare Act) regulations.

b. Patient-Related Concerns:

Our client's most significant concern is the safety of the device, as aforementioned. In their perspective, our greatest challenge will be creating an apparatus that the monkeys will use properly and consistently. Preferences include minimal requirement of animal and human training to use, reinforcing monkey compliance with an automated reward system, not using physical restraints, and using washable, corrosion and oxidation-resistant materials (such as plexiglass and stainless steel). Our client is in favor of operating the device in environments familiar to the monkeys, such as individual cages, to maximize the subjects' comfortability.

c. Competition:

Several monkey-strength testing devices built for individual studies exist. Each mechanism is used with increasing resistance over trial number, and supplies a reward after each successful trial as positive reinforcement. For example, a device utilized by Katarzyna Bozek et al. consists of a sliding shelf attached to a handle on one side, and suspended adjustable weights on the other. Sufficient displacement of the shelf brings food within the subject's reach. Another example is a device utilized by Bury SD et al. that measures grip strength through the squeezing of two halves of an aluminum cylinder against an internal force transducer. If sufficient force is provided, food is dispensed as a reward.

d. Customer:

Our client is Dr. Ricki Colman, PhD, an expert on primate aging, caloric restriction, and primate models as well as an associate scientist at the Wisconsin National Primate Research Center.