

Lion Stalking Device

Group 22

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Outline

- Need, Scope, and Requirements
- Specifics Details of Analysis
- Specific Details of Chosen Design (top)
- Parts, Materials, Manufacturing (top)
- Specific Details of Chosen Design (bottom)
- Parts, Materials, Manufacturing (bottom)
- Manufacturing/ How to make
- Safety
- Prices/Lead Times
- Conclusions



<http://lindenlink.com/wp-content/uploads/2013/07/zoo.jpg>

Need, Scope, and Requirements

- Stalking behavior is difficult to encourage in captivity
- Contributes to health problems
- **St. Louis Zoo wants to keep its lions healthy**



<http://www.mathewssafaris.com/gallery/msLionStalking.jpg>

Need, Scope, and Requirements

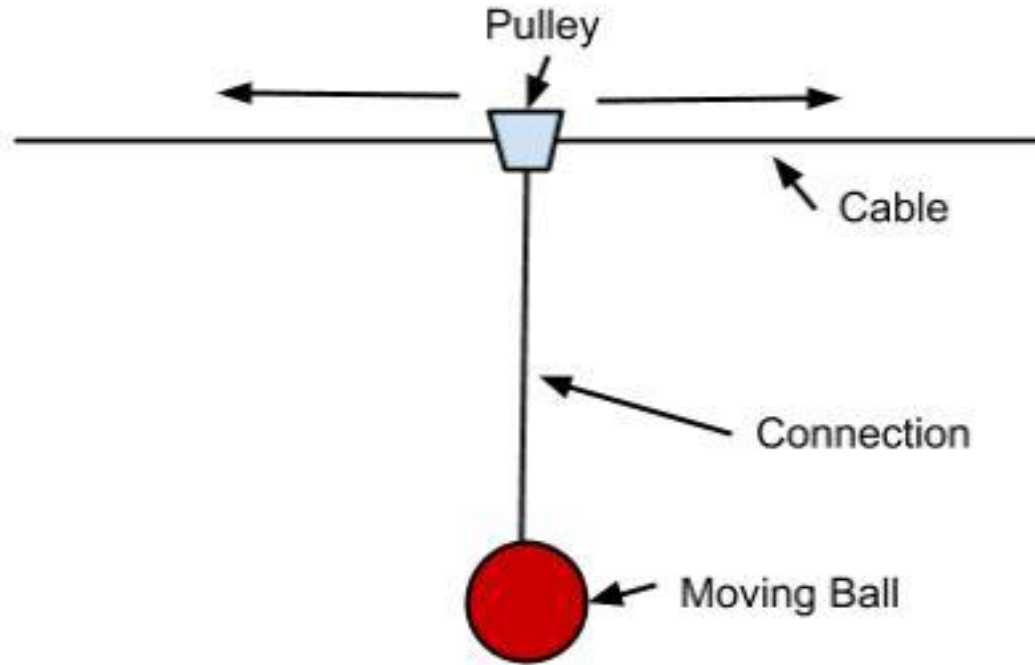


- Design a device to elicit stalking behavior
- Minimize direct human interaction
- **Do not hurt the lions**

Need, Scope, and Requirements

- Size
 - Must be smaller than 4ft x 2ft x 2ft (1.22m x .61m x .61m)
 - Must be larger than 4in x 4in x 4in (.10m x .10m x .10m)
- Cost
 - Must cost less than \$400.00
- Durable
- Safe

Specific Details of Analysis



Features:

- Locomotion
- User-controlled
- Ball connected by reversible process

Specific Details of Analysis

Specific Calculations:

- Friction of pulley on wire
- Gear Ratio between motor and pulley
- Magnetic force attaching ball and wire
- Stall torque of ball motor
- Tensile requirements of wire

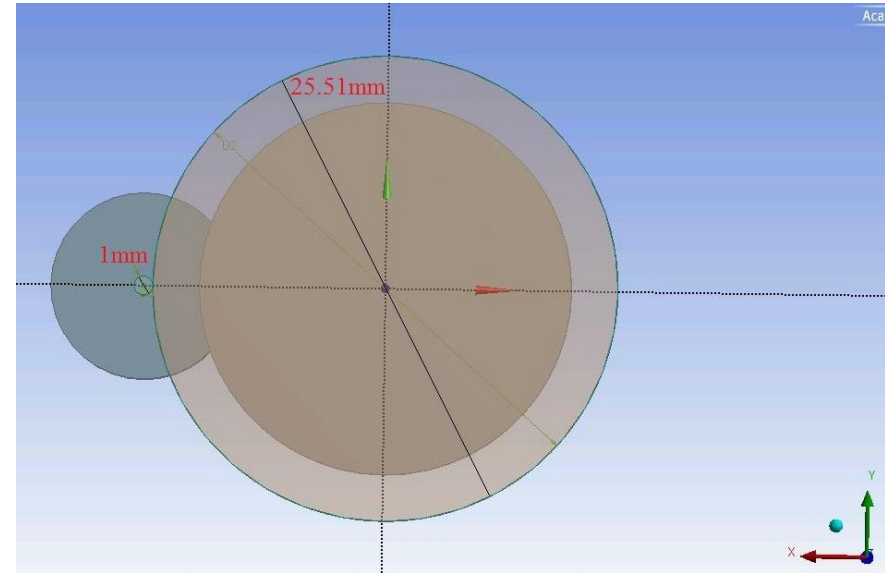
Specific Details of Analysis

Gear ratio: $(8.4V)(5800rpm/V) = 48,720rpm$
 $\frac{(4m/s)}{.02^2\pi} = 31.83rps = 1909.86rpm$

$$(2\pi)(gear_{pulley})(rpm_{pulley}) = (2\pi)(gear_{motor})(rpm_{motor})$$

$$(gear_{pulley})(rpm_{pulley}) = (gear_{motor})(rpm_{motor})$$

$$\frac{rpm_{motor}}{rpm_{pulley}} = \frac{gear_{pulley}}{gear_{motor}} = 25.51$$



Specific Details of Analysis

Maximum Rotational Acceleration:

$$I\alpha = Fl$$

$$\alpha = \frac{Fl}{I}$$

$$I = \frac{1}{12}\pi\rho h(3(r_{out}^4 - r_{in}^4) + h^2(r_{out}^2 - r_{in}^2))$$

$$F = \mu mg$$

$$\alpha = 4.93 * 10^9 \frac{rad}{s^2}$$



Specific Details of Chosen Design

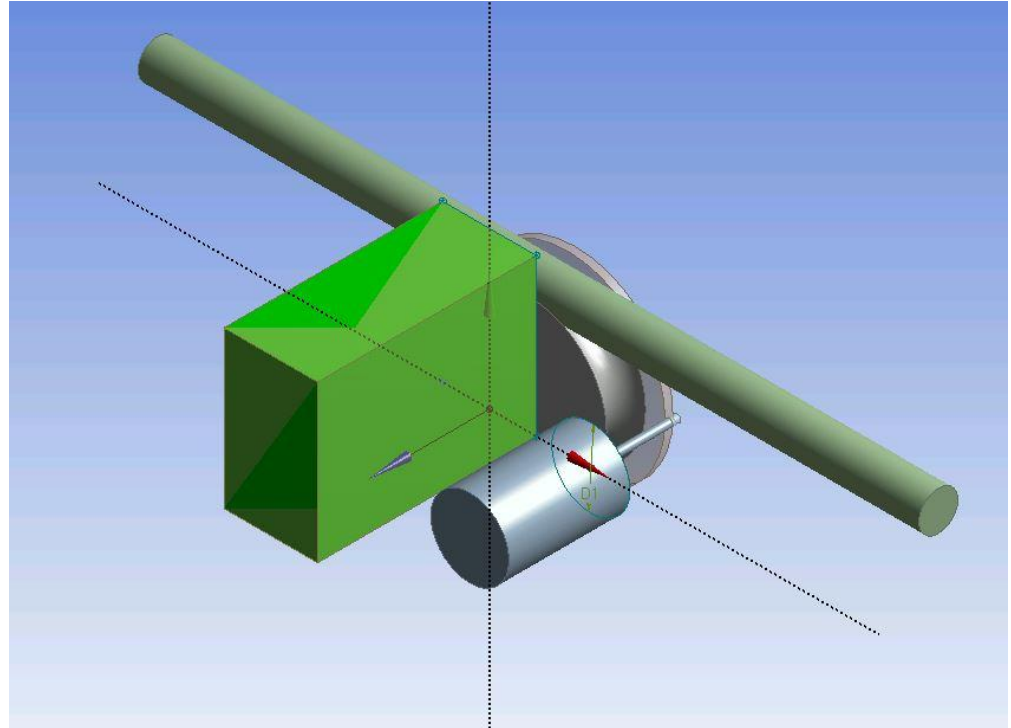
Key features:

- Moving parts is novel in this field
 - Due to durability
- Keeper interaction

Specific Details of Chosen Design

Top

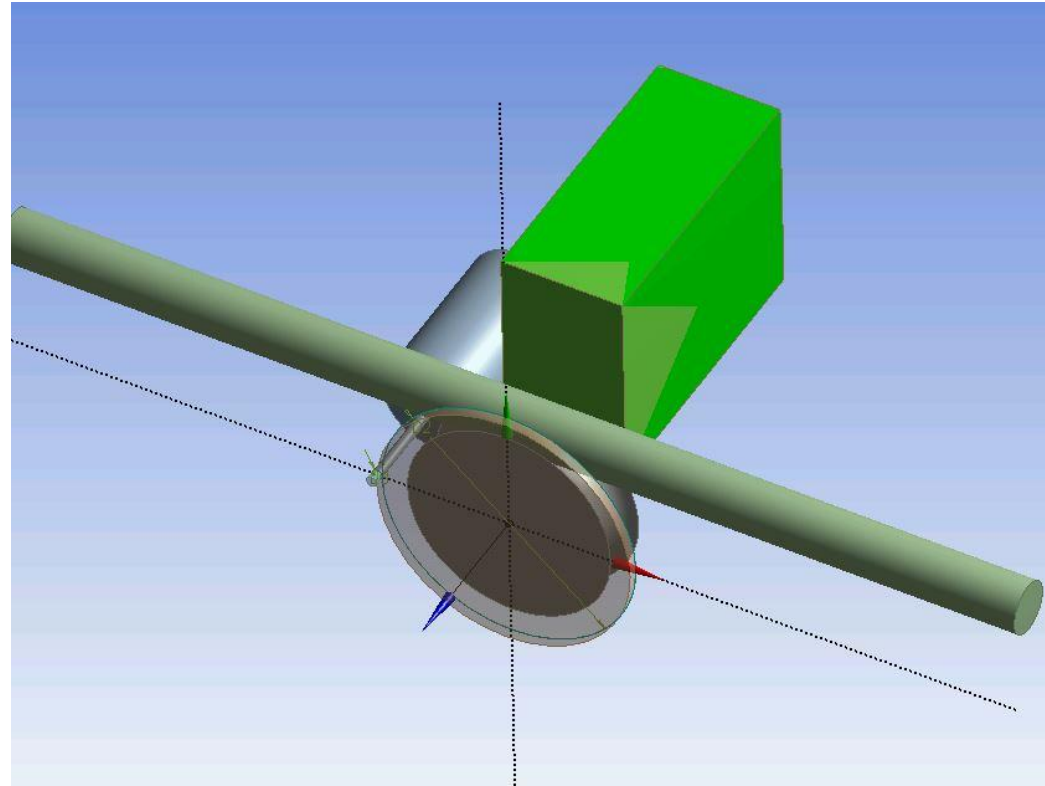
- Motor
- Pulley
- Radiofrequency Receiver
- Power Source



Specific Details of Chosen Design

Top (cont.)

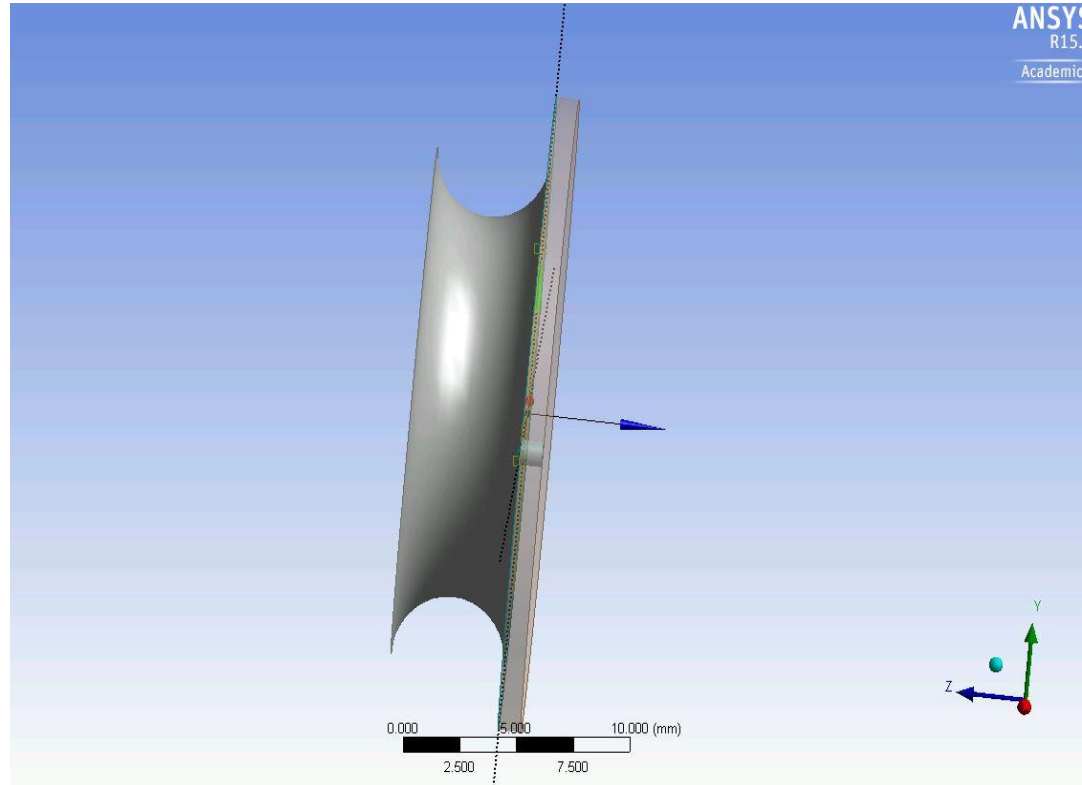
- Gears
- Wire Rope



Specific Details of Chosen Design

Top (cont.)

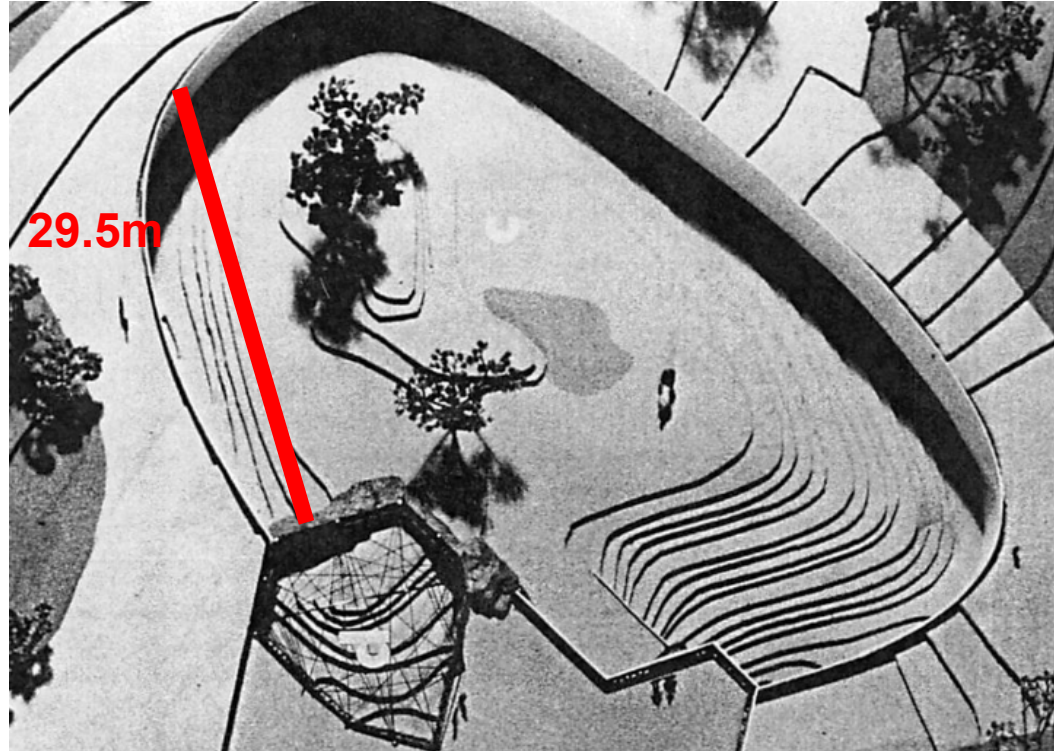
- Gears will be attached directly to the pulley wheel and the motor shaft



Specific Details of Chosen Design

Top (cont.)

- Location of wire



Specific Parts and Materials

1/4" Heavy-Duty Pulley



1/4" Vinyl-Coated Wire

130ft



<http://www.homedepot.com/p/Everbilt-1-4-in-x-200-ft-Galvanized-Vinyl-Coated-Wire-Rope-806410/203958877>

Specific Parts and Materials

2.4 GHz Ground Receiver ^[1]



109W Electric Motor ^[2]



Specific Parts and Materials

Gears

-1mm

-25.51mm

Custom-made from *rushgears.com*

9 Volt Battery



Specific Part and Materials

Padeye

(for construction)

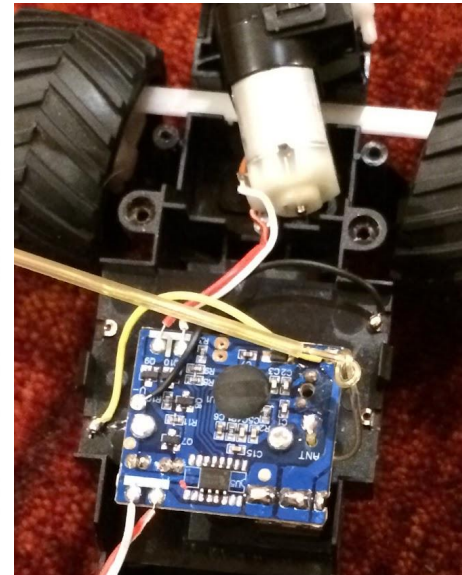


http://www.berkeleypoint.com/products/hardware/parts/hd_square_pad_eye_h.jpg

Circuit Board



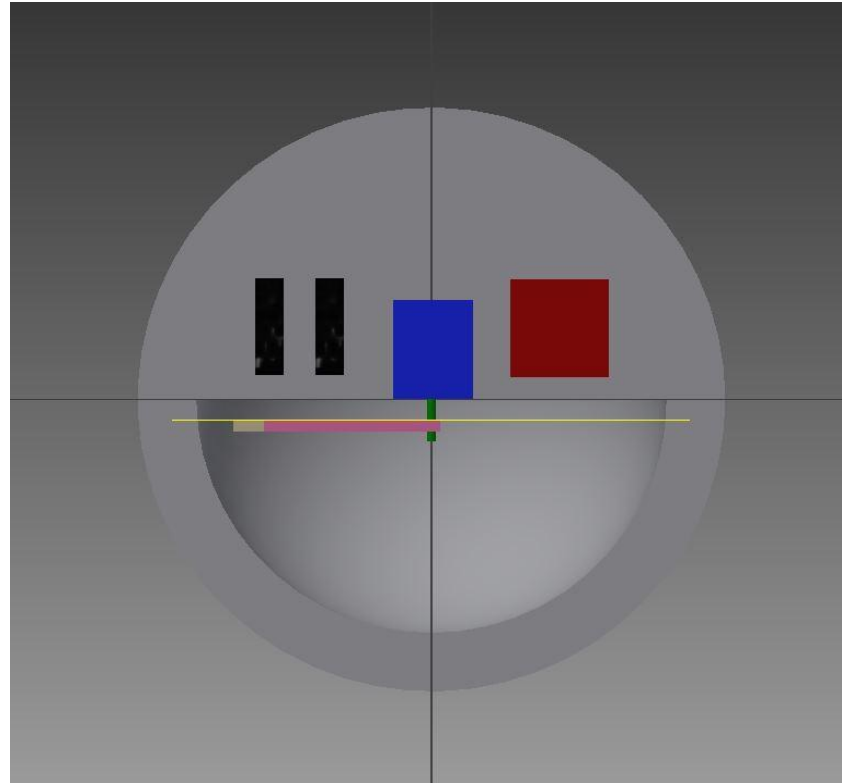
[3]



Specific Details of Chosen Design

Bottom

- Motor
- Ball (two halves)
- Power Source
- Weight
- Radiofrequency Receiver



Specific Parts and Materials

Ball

10" dia., hollow

Manufacturing Note: EcoBond adhesive vs. manufactured whole



Motor, Controller, and Receiver

Cost-effective to use the same as previously mentioned



Specific Parts and Materials

Weight

50g ideal, many options for best movement.



http://ecx.images-amazon.com/images/I/51AlgFTqVeL._SY355_.jpg

Power Source

Less power needed, so cheaper option is AA batteries



Manufacturing/ How to make

Top

- Pulley manufacturing process to include gear
- Print circuit

Bottom

- Ball manufacturing to include inner machinery
- Print circuit

Safety

- Most issues are with lion interaction
- Reduce likelihood of risk by informing handlers of potential risks
- Reduce severity of risk with new design concepts

User / Task	Hazard / Failure Mode	Initial Assessment		Risk Reduction Methods /Control System
		Severity Probability	Risk Level	
Lion Bite	electrical / electronic : energized equipment / live parts Live magnets present where the lions can reach them	Minor Very Likely	Medium	None /Written warning
Lion Bite	slips / trips / falls : falling material / object Moving object may hit lions	Minor Likely	Low	Ensure lions are not in the way when operating. /Written warning
Lion Bite	chemical : reaction to / with irritant chemicals Lions may ingest trace levels of chemicals	Moderate Unlikely	Low	Ensure the lions are not consuming large sections of the setup. /Written warning
Lion Push/Pull	mechanical : drawing-in / trapping / entanglement Risk of becoming entangled with the wire	Serious Unlikely	Medium	Ensure that the wires are properly secured, and do not coil on the ground (are the appropriate lengths) /Written warning
Lion Push/Pull	material handling : excessive weight If the lion bites the device and pulls on it, it will lead to breaking of the wire and destruction of the setup	Catastrophic Likely	High	Ensure that the magnetic attraction is sufficiently weak to allow release of the ball under stress. Use a wire that is difficult to bite and hold. Another method for consideration is an additional failsafe at the top of the vertical wire. /Written warning

Price/Lead time Summary

PRICE SUMMARY

Wire Rope, 130ft.....(24hrs).....	\$80.39
Heavy-duty ¼" Pulley.....(24hrs).....	\$5.00
Two Pad Eyes.....(24hrs).....	\$52.00
Neodymium Magnets (x2).....(1-2 weeks).....	\$6.00
Electric Motor (for top portion).....(3-6 weeks).....	\$15.00
Radiofrequency receiver (x2).....(3-6 weeks).....	\$20.00
Radiofrequency Transmitter (x2).....(3-6 weeks).....	\$33.78
Controller Board (x2).....(2 weeks).....	\$65.98
Boomer Ball(3-6 weeks).....	\$48.00
Gears (1mm & 25.51mm).....(1 week).....	\$20.00
Electric Motor (for ball)(3-6 weeks).....	\$35.00

Total.....\$381.15

Conclusions

- Did you solve the problem?
 - Original problem is nebulous
 - Under budget
 - Accomplishes subtasks
- Future Direction
 - Test with live animals
 - Refine mechanisms
 - Incorporate other senses
- What we learned
 - Pragmatism vs idealism
 - Problem breakdown from complex to manageable

Physical Prototype

DEMO

Sources

1. http://www.hobbyking.com/hobbyking/store/_23784_OrangeRx_GR300_DSM2_compatible_3Ch_2_4Ghz_Ground_Receiver.html
2. http://www.hobbyking.com/hobbyking/store/_22299_XK2030_5800KV_Brushless_Inrunner.html
3. https://www.bananarobotics.com/shop/Pololu-Simple-Motor-Controller-18v7?gclid=Cj0KEQiAwPCjBRDZp9LWno3p7rEBEiQAGj3KJokROs2YL4kOpzBdLXFJSNrK_qmPipFt59E-dSVUawaAh6S8P8HAQ
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8. "Friction and Coefficients of Friction." *Friction and Coefficients of Friction*. Engineering Toolbox, n.d. Web. 28 Nov. 2014. <http://www.engineeringtoolbox.com/friction-coefficients-d_778.html>.
9. "Gorilla 7/8 Fl. Oz. General Purpose Epoxy-42001 at The Home Depot." *The Home Depot*. N.p., n.d. Web. 01 Dec. 2014.
10. "Gorilla Epoxy." *Gorilla Glue*. Gorilla Glue, Inc., n.d. Web. 1 Dec. 2014