

Retractable Pool Cover

Project Proposal

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Overview

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Introduction

- Our client, Brian Herzog, is a resident of Flagstaff, AZ and the retired CEO of Frontline Energy Services
- Mr. Herzog would like to bring an affordable and retractable pool cover to the market
- Currently, there is not a product that is affordable and comparable in the market

Problem Definition

“There is not an affordable and automated retractable pool cover on the market that can withstand the weight of multiple people.”

Project Goal

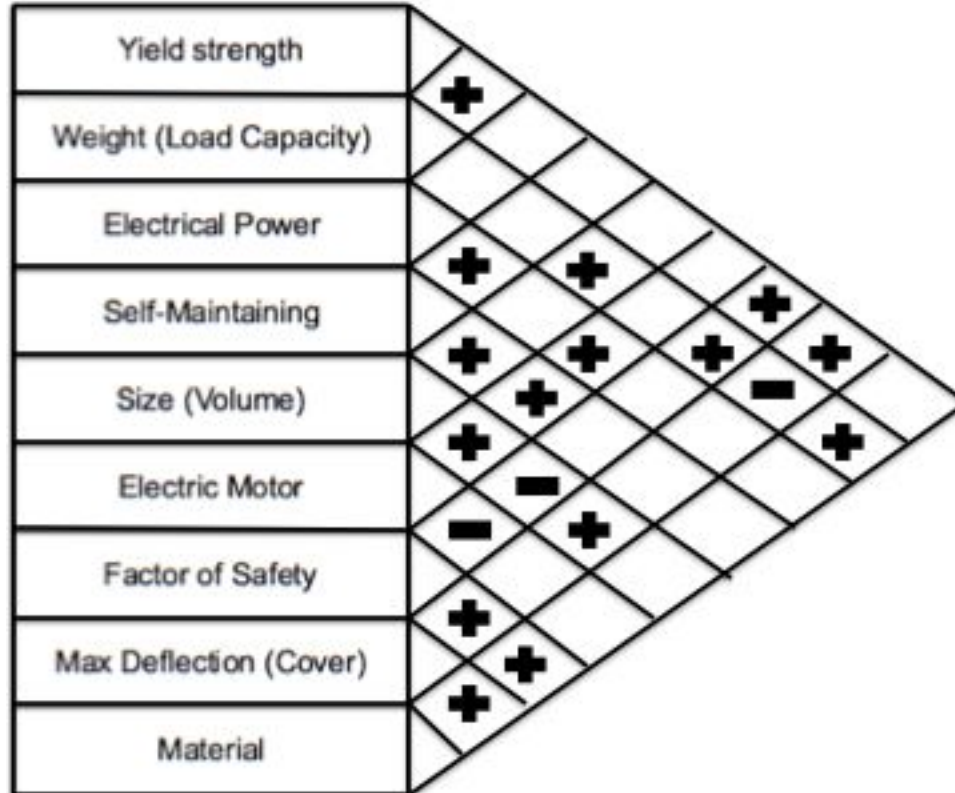
Design and manufacture a retractable pool cover that is:

- Automated
- Easily Maintainable
- Rigid
- Aesthetically Pleasing
- Lightweight

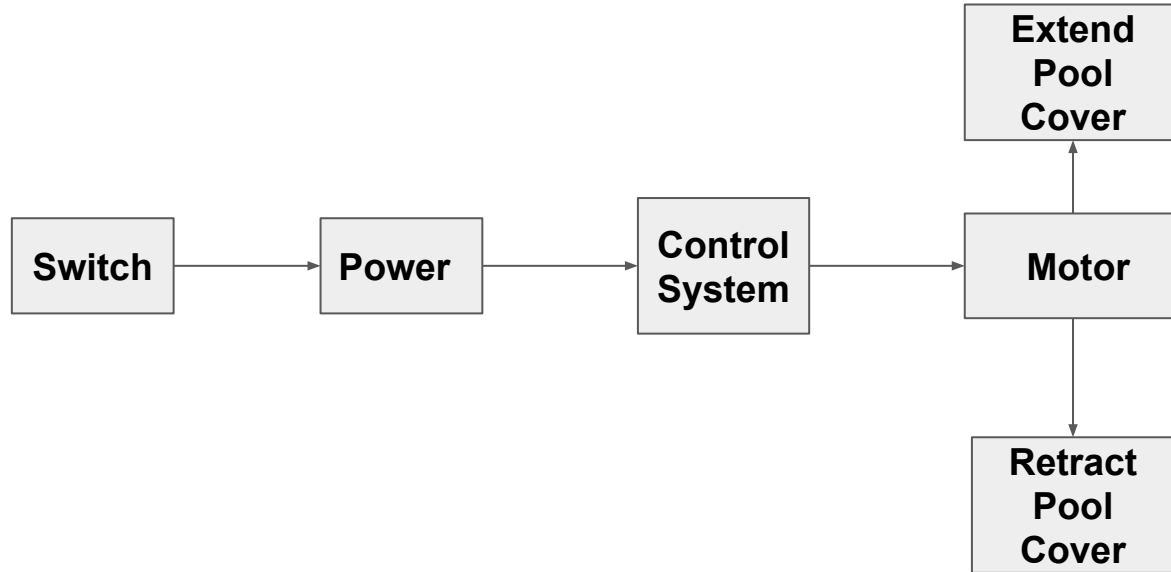
Quality Function Deployment

<div style="text-align: center;">Engineering Specs</div> <div style="text-align: center;">Customer Requirements</div>	Yield strength	Weight (Load Capacity)	Electrical Power	Self-Maintaining	Size (Volume)	Electric Motor	Factor of Safety	Max Deflection (Cover)	Material
Easy to Maintain				●					
Easy Installation and Removal	●		○	●	○	●			
Automated Retraction			●	●		●			○
Able to Sustain Weight	●	●			○		●	●	●
Fit Within Alloted Space					●	●			○
Aesthetically Pleasing		●			●		●		●
Non-Corrosive			●			●	●		●

House of Quality



Functional Diagram



Criteria

Motor	Design	Control System	Materials
<ul style="list-style-type: none">● Power output● Safety● Price● Lifespan● Manufacturability	<ul style="list-style-type: none">● Volume● Ease of retraction● Maintainability● Manufacturability	<ul style="list-style-type: none">● Response time● Ease of use	<ul style="list-style-type: none">● Price● Water resistance● Yield strength

Decision Matrix: Motor

		Electric		Hydraulic	
Criteria	Weight	Scale	Weighted Scale	Scale	Weighted Scale
Power output	0.245	10	2.45	10	2.45
Safety	0.4118	4	1.647	8	1.647
Price	0.1015	7	0.711	6	0.609
Lifespan	0.1128	7	0.79	7	0.79
Manufacturability	0.1289	8	1.031	8	1.031
Sum	1.0	36	6.629	39	8.174

Decision Matrix: Design

		Stacking		Rolling		Garage Door		Meet in Middle	
Criteria	Weight	Scale	Weighted Scale	Scale	Weighted Scale	Scale	Weighted Scale	Scale	Weighted Scale
Volume	0.3662	7	2.563	7	2.563	9	3.296	4	1.465
Ease of retraction	0.2783	7	1.948	7	1.948	5	1.392	8	2.226
Maintainability	0.2056	9	1.85	8	1.645	7	1.439	6	1.234
Manufacturability	0.1499	9	1.349	7	1.049	6	0.899	4	0.6
Sum	1.0	32	7.71	29	7.205	27	7.026	22	5.525

Decision Matrix: Control System

		Key Start		Remote Start		Button/Switch		Lever Start	
Criteria	Weight	Scale	Weighted Scale	Scale	Weighted Scale	Scale	Weighted Scale	Scale	Weighted Scale
Response time	0.5915	10	5.915	9	5.234	9	5.234	9	5.234
Ease of use	0.4085	9	3.677	10	4.085	10	4.085	8	3.268
Sum	1.0	19	9.592	19	9.319	19	9.319	17	8.502

Decision Matrix: Materials

		Aluminum		Stainless Steel	
Criteria	Weight	Scale	Weighted Scale	Scale	Weighted Scale
Price	0.217	8	1.732	4	0.866
Water Resistance	0.246	8	1.969	9	2.215
Yield Strength	0.537	9	4.837	9	4.837
Sum	1.0	25	8.538	22	7.918

Decision Matrix: Materials

		Brass		Polymer		Fiberglass	
Criteria	Weight	Scale	Weighted Scale	Scale	Weighted Scale	Scale	Weighted Scale
Price	0.2165	6	1.299	4	0.866	5	1.083
Water Resistance	0.2461	7	1.723	9	2.215	10	2.461
Yield Strength	0.5374	8	4.299	6	3.224	10	5.374
Sum	1.0	21	7.321	19	6.305	25	8.918

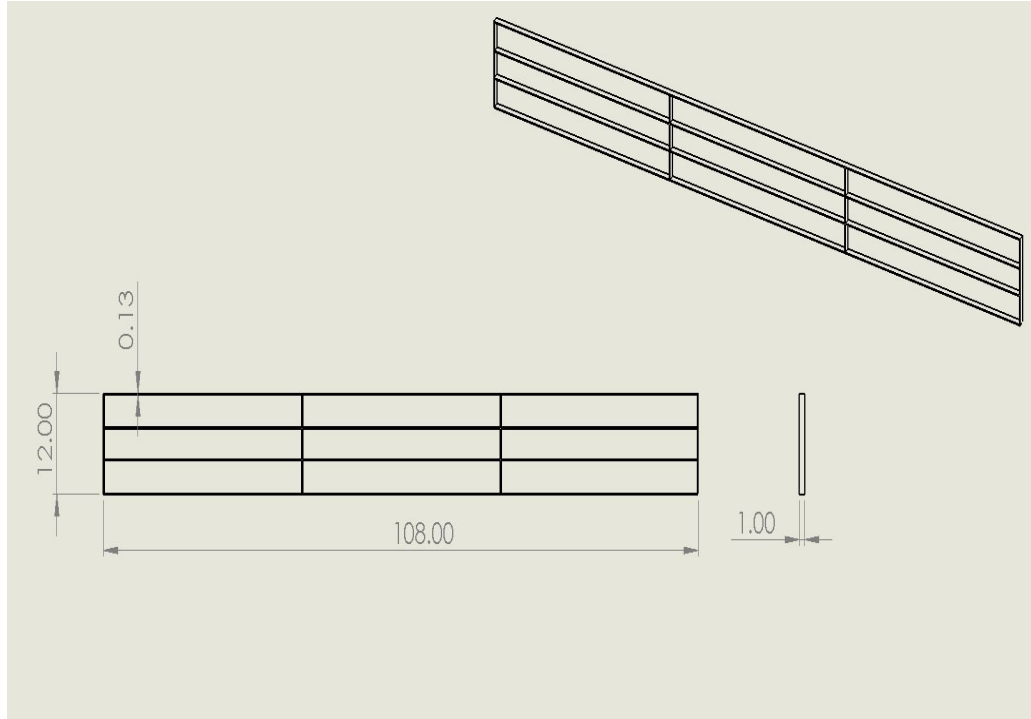
Prototype



Prototype



Plate Design



Average weight of a person = 250 lb

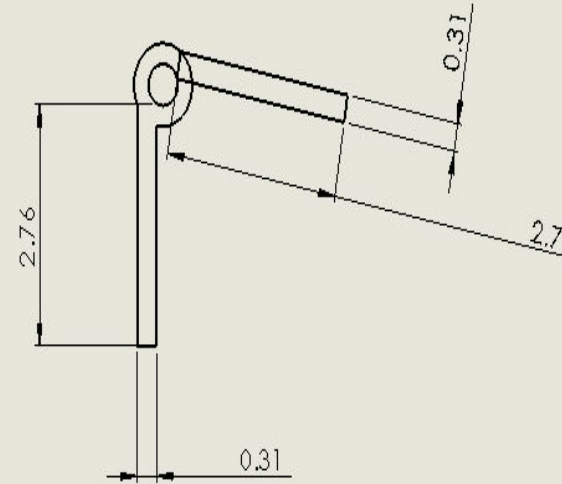
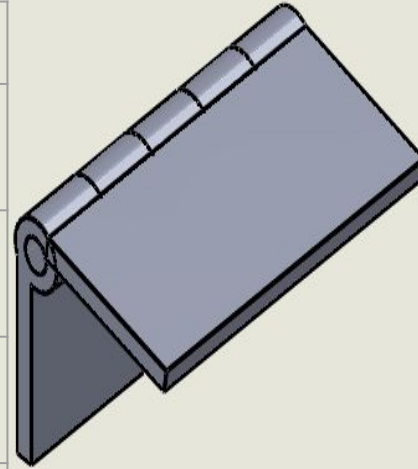
$$\sigma = \frac{MC}{I} = \frac{\left(\frac{35.92}{2}\right)\left(\frac{250}{2}\right)(0.5)}{\frac{1}{96}} = 10.8 \text{ ksi}$$

$\sigma_y = 35 \text{ ksi} \rightarrow \text{Aluminum}$

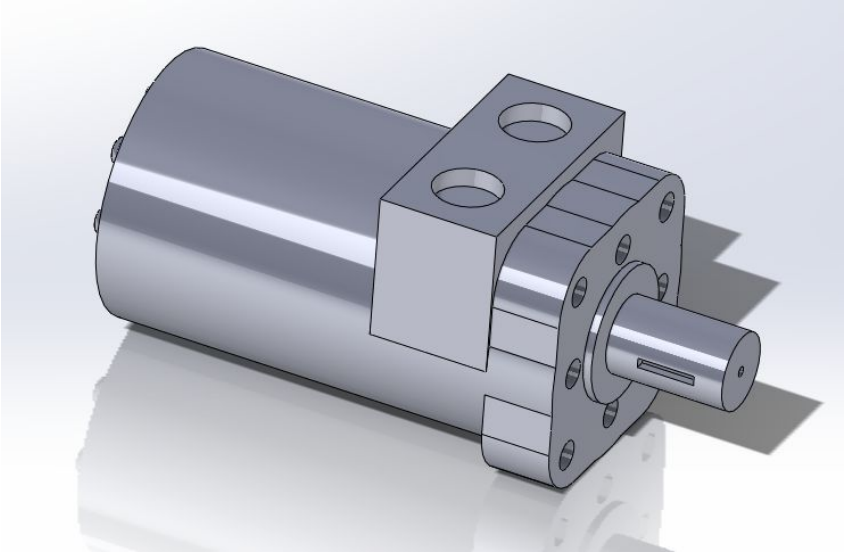
$$n = \frac{\sigma_y}{\sigma} = \frac{35 \text{ ksi}}{10.8 \text{ ksi}} = 3.2 \rightarrow \text{Factor of Safety}$$

Plate Design

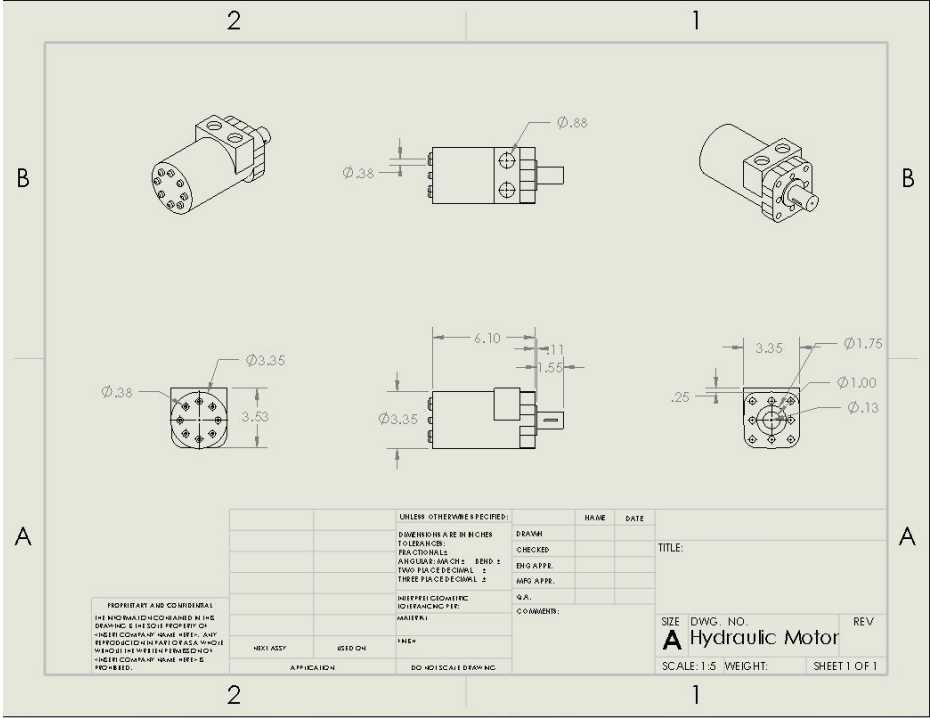
Material	Quantity/Dim.	Price
Aluminum Frame	64 long beams (9' X 0.125" X 1")	\$252.80
Aluminum Frame	64 short beams (1' X 0.125" X 1")	\$45.44
Aluminum Sheet	16 (1' X 9' X 0.125")	\$1530.72
Hinges	30	\$102
Total Price	-	\$1828.96



Motor



Extreme Hydraulics IHI-BMPH-160-H4-K-S



Motor

What's left:

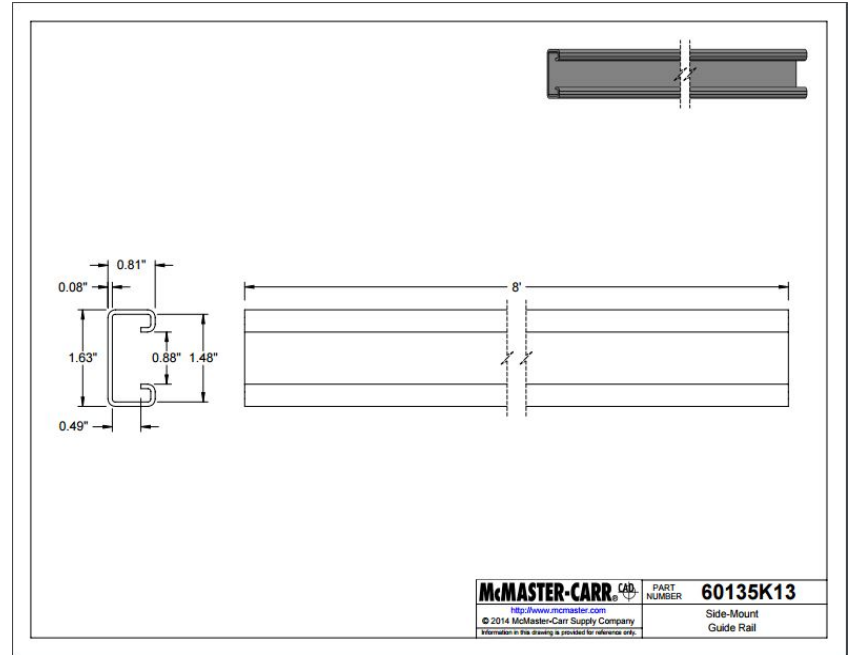
- Design hydraulic system
- Provide power to motor



<http://www.coverpools.com/customize-your-cover/motors-and-mechanisms/hydraulic-motor>

Railing System

	Steel	Stainless Steel
Length Needed (ft)	32	32
Price per Foot (\$/ft)	\$9.86	\$34.16
Total Price	\$315.52	\$1093.12

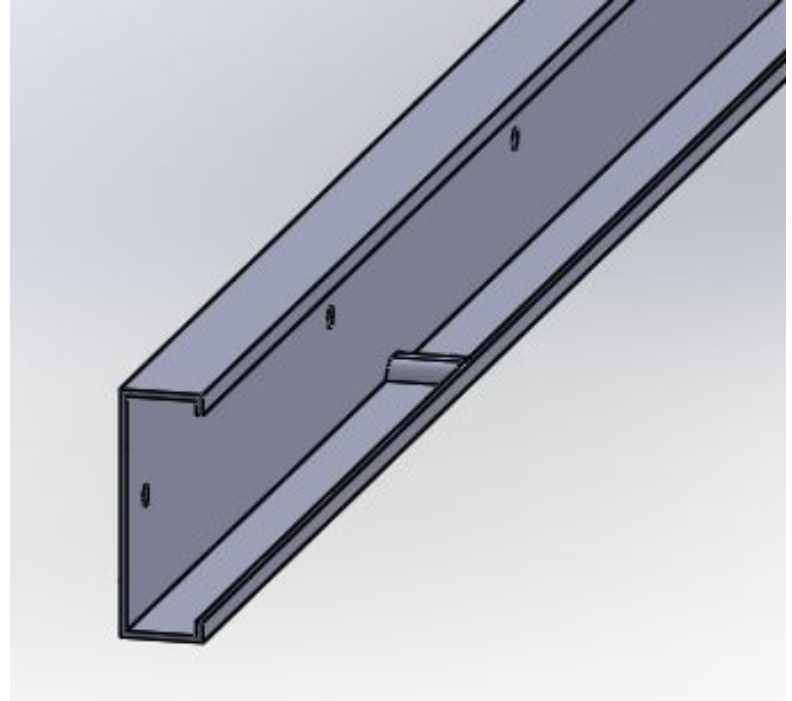


<http://www.mcmaster.com/#60135k13/=105nbf0>

Railing System

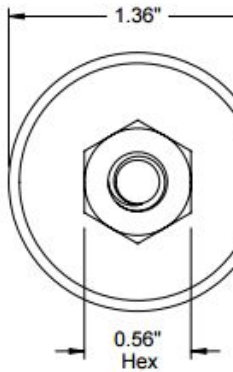
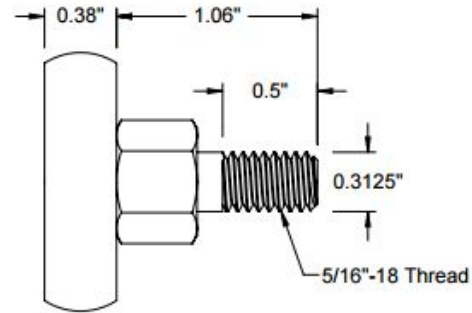
What's left:

- The bump theory
- Installation
- Applying anti-corrosive paint or spray



Wheels

	Steel Roller	Stainless Steel Roller
Price per unit (\$/unit)	\$20.04	\$36.65
Total Units Needed	16	16
Total Price	\$320.64	\$586.40



<http://www.mcmaster.com/#60135k71/=105n8ra>

Wheels

What's left:

- Mounting system
- Anti-corrosive
- Alternative material



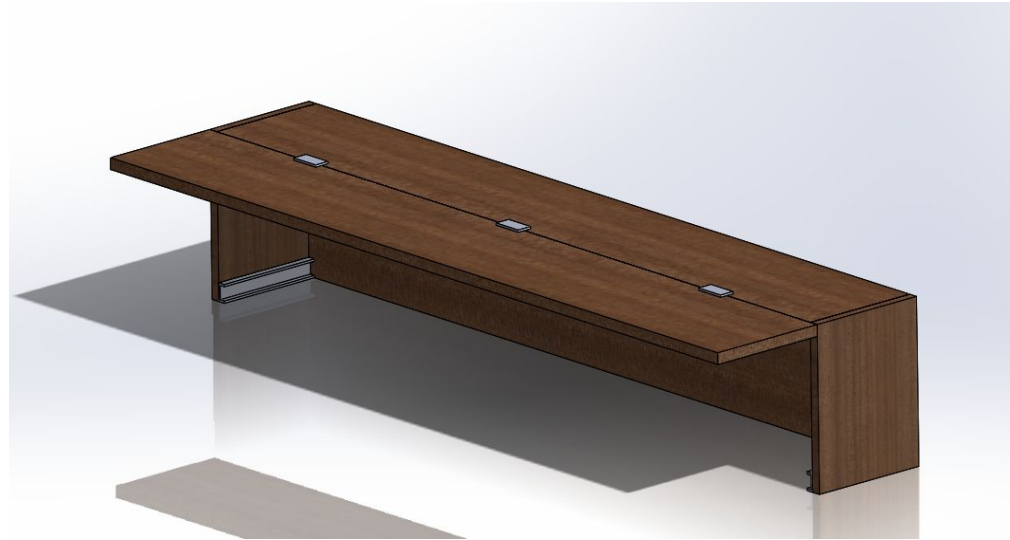
<http://www.revvocaster.com/index.php/product-line/caster-wheels>



<http://www.mcmaster.com/#60135k71/=105n8ra>

Housing

Material	Quantity	Price
Red Oak Plywood (4' x9')	4	\$159.80
Wood Finish (1 quart)	3	\$23.31
Hinges	3	\$22.98
Stepper Motor	1	\$35.50
Total Price	-	\$241.59



Housing

What's left:

- Design electrical system for stepper motor
- Install railing system
- Obtain exact pool measurements for housing size
- Assemble housing

Bill of Materials

Materials	Quantity/Dimension	Price
Motor	2	\$309.94
Rails	2	\$1093.12
Wheels	16	\$586.40
Aluminum Frame	64 long beams (9' X 0.125" X 1")	\$252.80
Aluminum Frame	64 short beams (1' X 0.125" X 1")	\$45.44
Aluminum Sheet	16 (1' X 9' X 0.125")	\$1530.72
Hinges	30	\$102
Housing Materials	-	\$241.59
Total Price	-	\$4138.70

Conclusions

- A system utilizing vertically stacking plates and hydraulic motors has been designed
- A prototype of the system has been built and tested
- Empirical load testing was done to find factor of safety
- Tasks have been outlined for the future
- Current estimated price is \$4138.70

References

- https://www.metalsdepot.com/catalog_cart_view.php
- <http://www.mcmaster.com/#60135k13/=105nbf0>
- <http://www.mcmaster.com/#60135k71/=105nnxo>
- [http://www.onlinemetals.com/merchant.cfm?
pid=18075&step=4&showunits=inches&id=1279&top_cat=60](http://www.onlinemetals.com/merchant.cfm?pid=18075&step=4&showunits=inches&id=1279&top_cat=60)
- <http://www.homedepot.com/b/Lumber-Composites/N-5yc1vZbqpg>
- [http://internationalhydraulicsus.com/hydraulic-motors-gerotor-bmph-160-h4-s-
p-711.html](http://internationalhydraulicsus.com/hydraulic-motors-gerotor-bmph-160-h4-s-p-711.html)