PROJECT 2: WHEELS ON ANYTHING

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Abstract

Through our group brainstorming, design research, and our own experiences, our group found that the best method of doing this is to create a dolly that has an expandable base. This method will not only be the cheapest method, it will be the easiest for us to build, and the easiest for our customers to use. Our group found this idea to be the best idea through researching other dolly models, surveying potential future customers, experimentation, and our own experiences. The design of the dolly was hard to come up with, but we followed what our customers wanted, and what we thought would be most essential parts of the dolly (i.e. strength, durability, price, etc…). We found that our customers want the dolly to be portable, strong, collapsible/expandable, and durable.

1.0 Introduction

The entire body text of the report should be Times New Roman, 10, and justified. Major headings should be numbered consecutively, 1.0, 2.0, 3.0, etc., typed in bold face with a font size of 16. Sub-headings should be numbered consecutively, 1.1, 1.2 … etc., typed in bold face with a font size of 14. Finally, sub-sub-headings should also be numbered consecutively, 1.1.1, 1.1.2,... etc., typed in bold face with a size 12 font face. It is not recommended to go beyond three levels of headings.

Throughout the report all information that you did not generate should be referenced. For your reports, please use the *parenthetical references: author-date system* (Ogot and Kremer, 2004, pg.71).

A sample reference list addressing each of the five main types of information sources is given at the end. These include: websites (Swanson, 1999), journals (Muriru and Daewoo, 2002), books (Zacharia and Daudi, 2001), conference proceedings (Peters et al., 2001) and patents (Wen-Cheng, 1994). Please refer to pages 71-73 of text for different ways to include the reference within the text using this system. The reference list should be the last section of your report.

1.1 Initial Problem Statement (Times New Roman, 14, left)

The problem that we were issued was to put wheels on anything. The challenge in this is to build a dolly type figure that can hold heavy objects, but still be portable enough to transport the object where it needs to go. To do this we will revise current dolly designs.

2.0 Customer Needs Assessment

Our survey was created based on the questions that we had to possible future customers. We surveyed and collected date from 10 different people. This was the survey that we gave them:

1. How often do you move heavier objects that require assistance to move?
2. How big of an object would you want to move?
3. Where do/would you store your dolly?
4. How much would you be willing to pay for a dolly?
5. Would you want the dolly to be able to collapse to make it easier to store?
6. Would you be willing to pay more for a dolly that can change size to better support the object you're moving, can hold heavier and bigger objects, or collapses for easier storage?
7. What surface would you be using the dolly on (flat, inclined, up or down stairs)?
8. Do you consider yourself strong enough to be able to move a somewhat heavy object without help?

2.1 Weighting of Customer Needs

The needs list (Table 1) was formed by the results of the surveys and individual interviews. From the needs list we found the hierarchal customer needs list (Table 2) and used this list to calculate the weights of each subject we put the needs into an AHP pairwise comparison chart (Figure 1 and 2). The weights are important because it tells our group what we need to focus on when designing our project.

Table 1. Initial Customer Needs List Obtained from Team Focus Group and Individual Interviews/Surveys

Cost
Retail Cost
Accessories Included
Design Features
Durability
Strength
Appearance
Size
Collapsible/Expandable
Use
Ease of Assemble
Ease of Use
Weight it Can Hold
Portability

Above is a list of what our group found our customers wanted based on the surveys that they filled out.

Table 2. Hierarchal Customer Needs List Obtained from Focus Group and Individual Interviews

1. Cost
    a. Retail Cost
    b. Accessories included
2. Design Features
    a. Durability
    b. Strength
    c. Appearance
    d. Size
    e. Collapsible/Expandable
3. Use
    a. Ease of assemble
    b. Ease of use
    c. Weight it can hold
    d. Portability

Above is the categorized list of what the customers said they needed through the surveys.

	Retail Cost	Accessories	Durability	Strength	Appearance	Collapsable/ Expandable	Ease of Assemble	Ease of Use	Portability	Total	Weighted
Retail Cost	1	1/4	1/5	1/4	4	1/4	2	2	1/6	10.12	0.0724
Accessories	4	1	1/2	1/8	2	1/4	1/5	1/5	1/6	8.44	0.0604
Durability	5	2	1	1	3	1/5	3	3	1/2	18.70	0.1339
Strength	4	8	1	1	7	1/2	3	3	2	29.50	0.2112
Appearance	1/4	1/2	1/3	1/7	1	1/2	1/5	1/5	1/4	3.38	0.0242
Collapsible/Expandable	4	4	5	2	2	1	1	1	3	23.00	0.1647
Ease of Assemble	1/2	5	1/3	1/3	5	1	1	1/3	1/3	13.83	0.0991
Ease of Use	1/2	5	1/3	1/3	5	1	3	1	1/3	16.50	0.1182
Portability	6	6	2	1/2	4	1/3	3	3	1	24.83	0.1778

Figure 1. AHP Pairwise Comparison Chart to Determine Weighting for Main Objective Categories

Above is our pairwise comparison chart that determined what we thought was the most important objective to keep in mind while designing the dolly.

	Retail Cost	Accessories	Durability	Strength	Appearance	Collapsable/ Expandable	Ease of Assemble	Ease of Use	Portability	Total	Weighted
Retail Cost	1	1/4	1/5	1/4	4	1/4	2	2	1/6	10.12	0.0724
Accessories	4	1	1/2	1/8	2	1/4	1/5	1/5	1/6	8.44	0.0604
Durability	5	2	1	1	3	1/5	3	3	1/2	18.70	0.1339
Strength	4	8	1	1	7	1/2	3	3	2	29.50	0.2112
Appearance	1/4	1/2	1/3	1/7	1	1/2	1/5	1/5	1/4	3.38	0.0242
Collapsible/Expandable	4	4	5	2	2	1	1	1	3	23.00	0.1647
Ease of Assemble	1/2	5	1/3	1/3	5	1	1	1/3	1/3	13.83	0.0991
Ease of Use	1/2	5	1/3	1/3	5	1	3	1	1/3	16.50	0.1182
Portability	6	6	2	1/2	4	1/3	3	3	1	24.83	0.1778

Figure 2. AHP Pairwise Comparison Chart to Determine Weighting of User Friendly Sub-Objectives

Above is our pairwise comparison chart that determined what we thought was the most important objective to keep in mind while designing the dolly.

Table 3. Weighted Hierarchal Customer Needs List Obtained from Focus Group and Individual Interviews

1. Cost (0.1328,0.1328)
    a. Retail Cost (0.0724,0.5452)
    b. Accessories included (0.0604,0.4548)
2. Design Features (0.5340,0.5340)
    a. Durability (0.1339,0.2507)
    b. Strength (0.2112,0.3955)
    c. Appearance (0.0242,0.0453)
    d. Collapsible/Expandable (0.1647,0.3084)
3. Use (0.3945,0.3945)
    a. Ease of assemble (0.0991,0.2512)
    b. Ease of use (0.1182,0.2996)
    c. Portability (0.1772,0.4492)

Above is the weighted values plugged into our hierarchal customer needs list. The values in this list are found in the pugh chart. The first number in the parenthesis describes the total that category is worth overall, and the second number in the parenthesis for the sub-categories the percentage that that value is worth of the major categories, and the second number in the parenthesis of the main categories is just the percentage that that category takes up out of 100%.

3.0 Revised Problem Statement

The initial problem that we were presented with was to be able to put wheels on anything. Based on what our customers want we need to make this dolly portable, easy to use, collapsible so it can store nicely, and strong so it can lift heavy objects. Our possible future customers are focused more on the strength, portability, the collapsibility/expandability, and the durability. After researching different patents and doing some experimentation, our group believes that the dolly will cost somewhere between $50-$75 with everything included.

4.0 External Search

Our team worked hard on researching this project, and used a lot of methods in doing so. We created a survey to ask questions to possible future customers, and searched online for patents on current dollies that we plan to revise.

4.1 Patent Search

Table 4. Function Matrix for Dolly

Patent Search			
	Frame	Base	Attachment
Collaspable	8,061,722		
Mobile	D655,881		
Pivoting Wheels		8,061,952	
Automated Assembly			8,162,302
Telescoping	D661,859		
Combined		8,256,778	

4.2 Product Archaeology

In previous dolly models, users had to deal with certain limitations in regards to each type of dolly. The Rock N' Roller was a great option in terms of giving the consumer different options and moving different objects with ease, but it was also considered to be a bit pricy for most of the customers. The DIY dolly is great to use when moving heavy objects, but users are limited in terms of the things that the dolly is able to move. Similar to the DIY dolly, the Loading dolly was great for moving tall and slim objects, but also had the problem of only being able to move a limited number of things. It is important to note however, that this dolly was the first that is made to be easily assembled. Finally, the extended hand dolly had many different options in terms of the things that it can move, but it was also considered pricy by consumers.

The dolly we are going to design will work like most dollies, but it will be able to expand to be longer and wider. The typical dolly would allow the operator to move a limited range of objects. Our dolly however could carry heavier objects, such as refrigerators. We are trying our best to maximize the efficiency of our dolly by designing certain things that fit our customers' wants and needs. For instance, a wheel that can turn 360 degrees in the back. We decided to take the best functioning features in each machine and combining them in our dolly, while adding in a few ideas of our own.

4.3 Benchmarking

Table 5. Benchmarking of other Dolly models

	Rock N´Roller	DIY Dolly	Loading Dolly	Extended-Handle Dolly
Objective Value	It gives the user options. 5	It allows the user to move a limited range of things. 2	It allows the user to move a limited range of things. 2	It keeps things in cart and moves a variety of things. 4
Function Value	It can move anything with ease. 5	It can move heavy objects with ease. 3	It moves tall and slim objects with ease. 3	It can move larger items. 4
Constraint	It will probably be	As it was hand-	It is very basic and	It may be slightly

Value	pricy; also it can´t move smaller objects. 1	built, it was cheaper than in stores. 4	easy to assemble. 5	pricy, but also it can´t carry small or medium objects. 2
Total	11	9	10	10

4.4 Design Target

Our team learned that some of our ideas won't work. However we learned that one of our ideas can work and is preferred by a lot of customers. We are going to create a dolly that has an expandable/collapsible base and that can hold big/small objects as well as heavy/light objects.

5.0 Concept Generation

Below is the concept generation for the wheel placement and the grip on the handlebar.

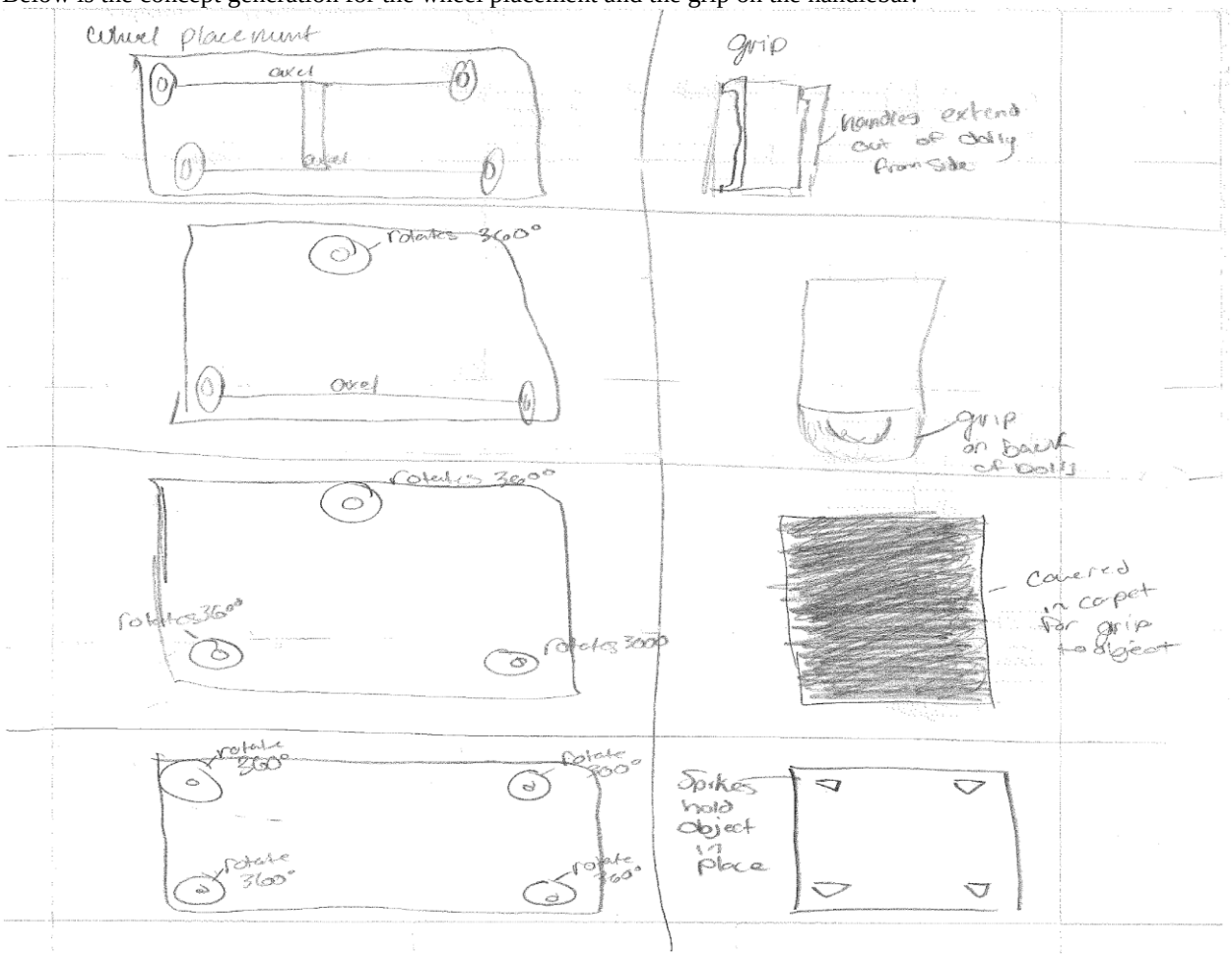

Figure 3. Concept Generation for wheel placement and grip

Below is a concept generation of the shape of the dolly and how our group was going to make the dolly expandable.

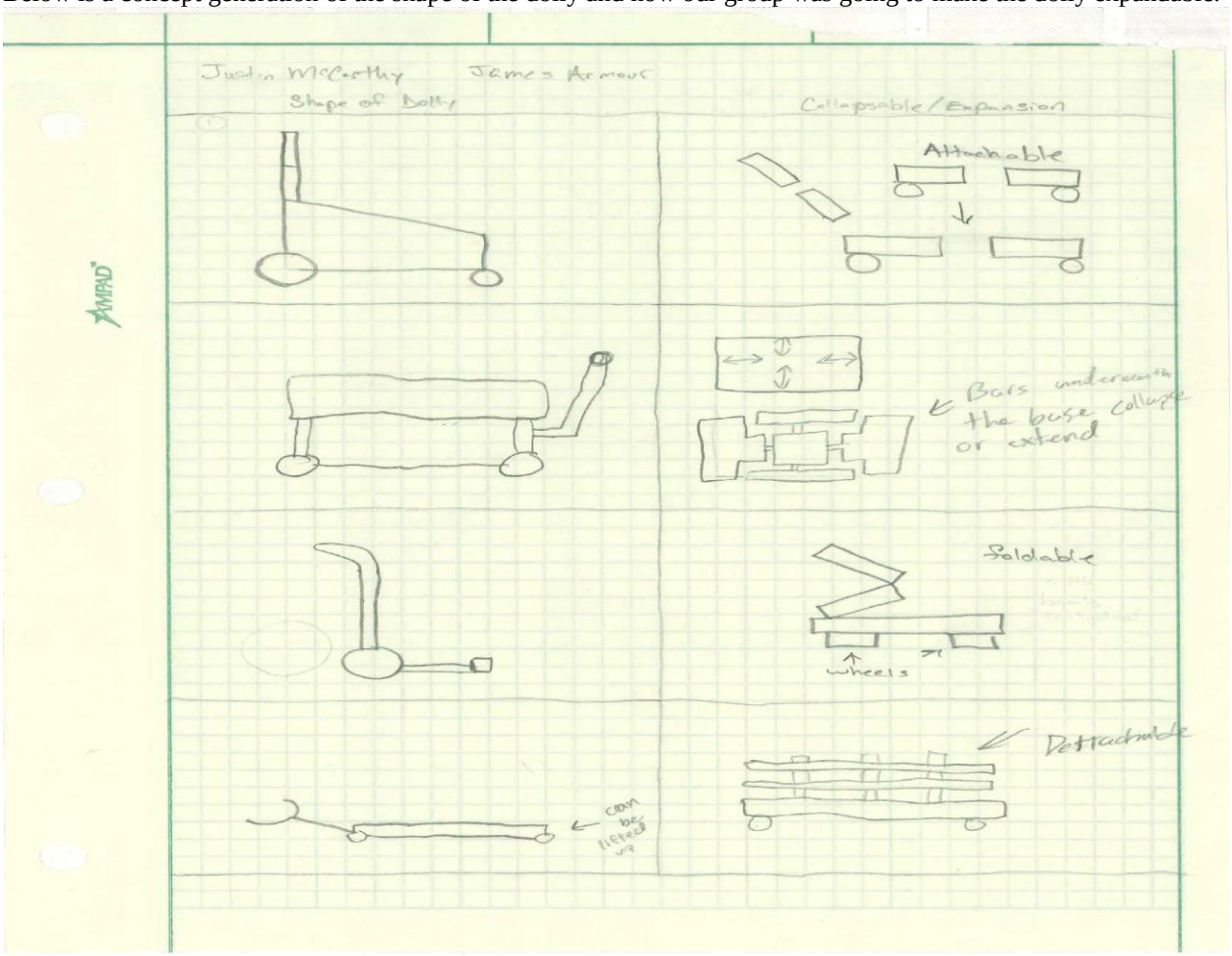

Figure 4. Concept Generation of the shape of the dolly and how it was to be expanded

6. Concept Selection

Below is a pugh chart that our team made that lays out which of the four categories we think is more important in a dolly. Strength is the most important because you need to be able to hold what you are looking to hold.

Table 6. Pugh Chart for Dolly

	Portable	Collapsibility	Strength	Durability	Total	Weighting
Portable	1	2	0.33	3	6.33	0.31
collapsibility	0.5	1	0.5	3	5	0.24
Strength	3	2	1	2	7	0.34
Durability	0.33	0.33	0.5	1	2.16	0.11

7. Concept Improvement through Creativity Methods

Below is the TRIZ chart that our team came up with to better our dolly. We found that the stability, the wheels on non-flat surfaces, and the wheels turning needed to be improved.

Table 7. TRIZ Chart for Dolly

Feature to Improve	Contradiction	Principles	Design Solutions
Stability	Force	1. Needs to withstand 2. Handle makes inefficient 3. Needs to not collapse	1. Add stabilizers 2. Slightly angle the handle 3. Add a tightening switch
Wheels	Non-flat Surfaces	1. Needs to get up steps 2. Can't get wobbly after a bump 3. Can't tip over	1. Add a ramp extension 2. Make wheels larger 3. Add wheels to the sides
Wheels	Turning	1. Make tight turns 2. Withstand a 360® turn-around	1. Make front wheel(s) swivel 2. Make back two wheels stationary

8.0 Final Design

Below is the final design of our dolly on a drawing sheet. This drawing sheet was made in Solidworks.

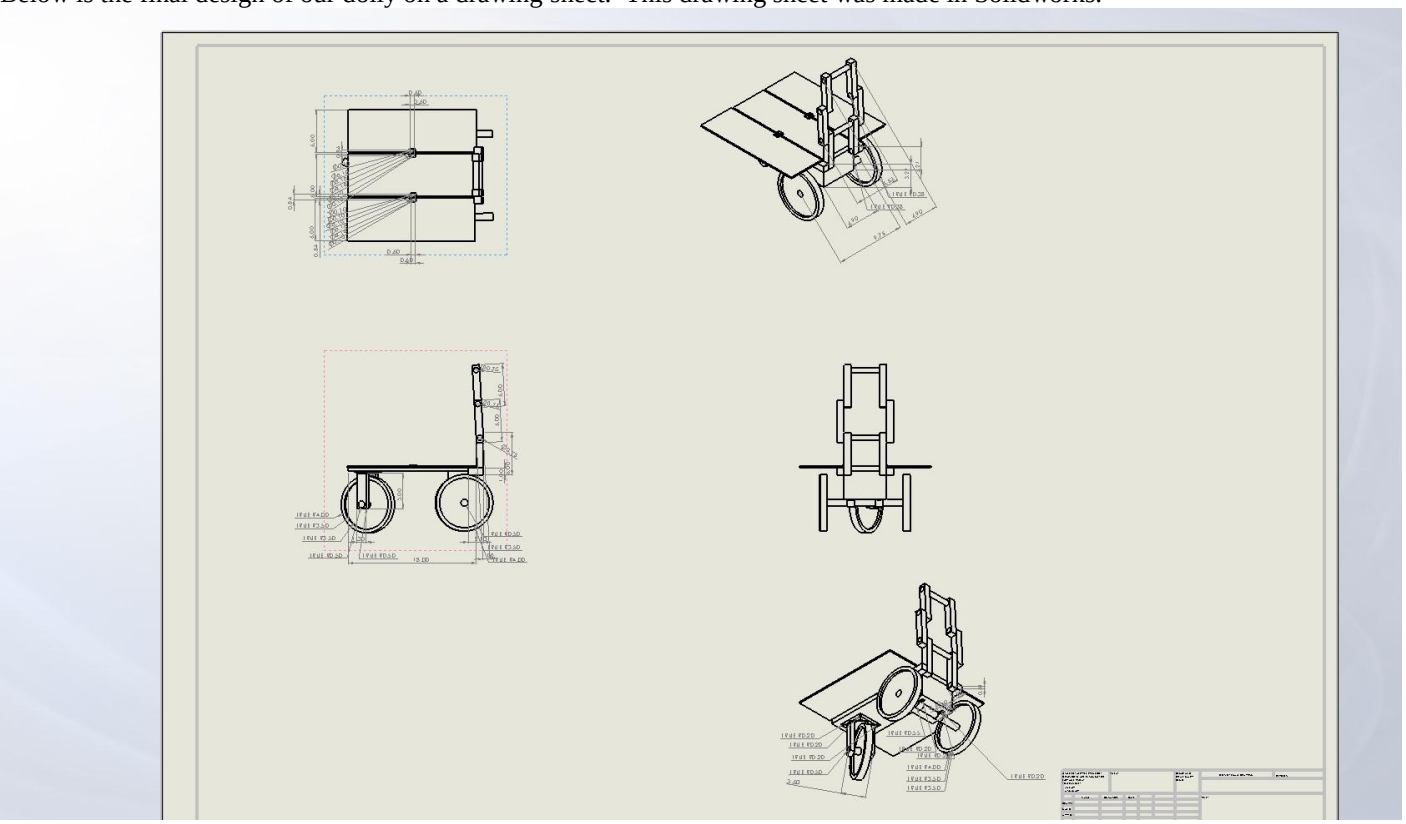

Figure 5. Drawing sheet of final design of our dolly

8.1 Materials and material selection

Our team decided to use Aluminum 6061 for the metal in our dolly. We chose this metal because it is dense enough to withstand the forces that it needs to, but yet it is lighter and less expensive than the other metals shown below. Aluminum 6061 is weather resistant and it is resistant to "dings" in the metal which will keep the original form of the dolly. We will also be using abs plastic and this is because it too is cheap, light, and will resist dings and the weather.

	Decision	Matrix	For	Material	Selection		
Criteria	Ey (psi) 10^3	Norm.	E(psi) 10^3	Norm.	d(lb/in^3)	Norm.	Total
Weights	0.5	0.5	0.2	0.2	0.3	0.3	
Steel 1010	44.2	1	29000	1	0.28	0.15	0.75
Aluminum 6061	8	0.18	10000	0.34	0.1	0.43	0.29
Lexan 9334	9	0.2	330	0.01	0.043	1	0.42

Figure 6. Decision Matrix of the metal we used

8.2 List of Materials

Table 8. List of required materials and components

Qty	Description	Catalog Number	Vendor	Total Cost
52	3/4 in. screws	SPM5986087601	Sears	33.28
1	6 foot pole	202054825	Home Depot	88.96
4	8 inch diameter wheels	202038826	Home Depot	51.88
4	Hinges	202634940	Home Depot	19.96
1	Bag of 7" Aluminum rods	865982	Home Depot	7.8
2	Rotating Wheel	9194	Amazon	11
2	Metal Bar to hold wheels together	61r1.75	Speedy Metals	24.6
1	Bag of 6 wingnuts	202704511	Home Depot	1.18
2	Handlebar	61r1.75	Speedy Metals	9.84
4	1 foot by 2 foot aluminum sheet metal	202091748	Home Depot	39.52
			Total:	288.02
	Makes 2 carts		Price per cart:	144.01

Table 9. Contact information for suppliers of required Materials

Home Depot	Speedy Metals
homedepot.com	speedymetals.com
2615 Greentech Drive State College, PA 16803	(866)-938-6061
(814) 238-1524	.

Amazon.com 800-220-4242	Sears 183 Shiloh Road State College, PA 16801 (814)-231-5682

8.3 Cost & Life Cycle Cost

Our dolly is made out of aluminium and abs plastic because they are both weather resistant and ding resistant which keeps the dolly in its original condition longer. Assuming our dolly is used a good amount (twice a month) around the house carrying refrigerators and washers, and the dolly is kept in good condition (it is clean, kept in a dry environment, and there isn't constant pressure on the wheels) the dolly will last around 3 years.

9.0 How Does It Work & Conclusions

Our dolly was a major success. We made it to fit our customers' needs by making the dolly expandable so that it can fit a washer or refrigerator on it while still being able to collapse down to fit into a closet. We also stayed within our budget and kept it affordable so that customers actually buy the dolly. The design can be easily followed by companies so that the dolly can be manufactured quickly and easily for maximum profit.

References

amazon.com
homedepot.com
sears.com
speedymetals.com
wikipedia.org