Needs Assessment Report

Team No. 20

Levitating Hoverboard

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ABSTRACT

In the following report, Group 20 has formulated a needs assessment of the Levitating Hoverboard project in order to create a basis for the subsequent steps of the design process. This was done through research of the hoverboard market and the science governing hoverboard function, which draws a clearer picture of the viability of the project. Additionally, a small portion of the potential customer base was surveyed about traits of the product that they found most important. Combining the research, survey data and engineering intuition, a House Of Quality (HOQ) was developed. The HOQ maps out the top three important qualities: performance, durability, and ease of use; which will be focused upon as the initial conceptual design phase continues.

ACKNOWLEDGMENTS

We would like to acknowledge the FSU/FAMU College of Engineering, Mechanical Engineering Department, as well as the Industrial Engineering Department for providing resources and allowing us to progress through our senior design project. In particular, we would like to say thank you to Dr. Shih (our advisor), Dr. Devine (our sponsor), and also Dr. Gupta (our senior design instructor). Throughout these next 2 semesters, we will utilize their help and resources in order to complete our senior design project, scheduled to be completed in May of 2017.

1. Introduction

The idea of some kind of levitation hover board was unheard of until the movie: Back To The Future was filmed in the 1980's. Throughout the series, Marty McFly traveled around town on his hover board, which looked very similar to a skate board, but with no wheels. Since then, scientists, engineers, handymen, and others have attempted to create an actual performing model, but few have truly succeeded. In recent news, Lexus successfully created a hover board made from super cooled magnets and liquid nitrogen. Though, the track they tested their prototype on had magnets underneath the surface to help oppose the force, hence the levitation. Another company that created a successful levitation hover board is Hendo Hover. Both seem to be lacking a steering mechanism though so direction is still of importance.

It is a slow transformation, but futuristic looking devices are starting to emerge when it comes to transportation. Nearby locations that do not necessarily require vehicles have allowed people to use bicycles, skate boards, roller blades, and much more. Bicycles have evolved over the years with gear mechanisms and aerodynamics. Skate boards were created as a different means to get around quicker than walking as well, utilizing the board and trucks for steering. Afterwards, scooters emerged, changing the toy industry due to an easier turning mechanism (handle bars). From scooters, Segway created personal transportation mechanisms used anywhere from security to personal use. The latest, possibly the most "futuristic looking" mechanism that has been designed is the hover board, created by HX, though it does not levitate. This design incorporates self-balance to determine speed and direction. One thing is still missing though, the levitation aspect.

It is believed that a design that can include the true levitation affect can greatly alter the transportation industry. This mechanism will include a rechargeable feature in an easy and convenient portability setup. A design has already been constructed, but this will be a base model for further implementation. Studies of aerodynamics can enhance the travel distance; materials will determine costs but conditions must be met whether environmental or any other surrounding conditions so the lifetime of the levitating hover board will last. Many components will be analyzed before the actual design process and manufacturing actually begins.

2. Project Definition

The ideology of the project is to build an air powered device that can function not only as a recreational device, but also as short-range transportation. The principal that will make this idea possible relies on an upward force that pushes against gravitational force and makes the device float. Air, applied with different pressure ranges, is the prime component that creates the upward force. The air supply can be sourced from several optimum options of machines. When the air is propelled, a downward thrust is created; the capability of this force will determine how much levitation is obtained.

The levitation not only depends on the force, but also on different factors such as weight, balance, and loads. There are other physics principles that can be used to crate "levitation", such as magnetism and chemical reactions. These principles are not going to be taken into consideration due to the fact that they aren't cost effective, which is one of the goals.

The concept of the levitating hoverboard comes from the original model of the larger existing hovercrafts. A hovercraft is a medium of mobility that is sustained on a pad of air that is provided by a powered fan, which is placed on the craft. Hovercrafts were originally designed to travel over water surfaces by floating on a coat of air, which reduces friction between the device and surface. The project's design will follow a different scope from hovercrafts by being smaller, portable, easier to use, and able to go on land [1].

2.1 Need Statement

There are only two prototypes of commercial floating hoverboards, the *Hendo Hoverboard* and the *Lexus Hoverboard*. Both models budget starts around $10,000 and are not available for purchases yet nor targeted for people who are not trained for its use. The physics principles behind these mentioned prototypes are what make it so expensive and only directed to professionals. For this reason a simpler and inexpensive approach can be used to create an innovative product for a vast market [2].

Furthermore, several homemade hoverboards attempts aren't too practical. The simpler models with low-cost applications of physics principles don't possess steering control systems and need

to be plugged into the wall, which restricts mobility. Because of this, a better prototype can be created in order to resolve these constraints.

2.2 Background Research

People are always looking for the most innovative gears out there in the market. The success of technologic gadgets/toys around young generations seems to keep growing. The idea of a floating hoverboard can overcome the current success of "wheel" hoverboards. By the end of 2015, 40,000 wheel hoverboards were coming into the U.S. each day. While nobody tracks total sales, manufacturers have shipped more than $2 billion worth of hoverboards over the past year and a half, by Fortune's estimates. According to statiscticbrain.com the average retail sale price of a "wheel hoverboard" is $386.

Since the main competitor is the wheel hoverboard, the project's design will be entering an existing market and attempt to dominate it with its innovation. Therefore, the same market can be accounted for the floating hoverboard. The targets of this recreational and practical idea are people from the ages of five years old and up. With a realistic scope of people over 70 years old not being able to use it because of physical limitations, the project's age range can be based for research purposes [3].

According to the US Census, as for 2010 the population number of people of ages from 5 to 69 years old was 260,711,455; this would be absolute market size of the project. As for an exact market size, a more extent research has to be done to know what number of this population quantity wouldn't be taken into consideration. Different social classes, special needs people, handicaps, and many other factors might reduce this number [4].

2.3 Goal Statement and Objectives

The objective of the project is to create an air powered hoverboard that can be used for recreation or short-range transportation. For this, modification of the simpler/homemade prototypes and incorporation of innovative ideas are going to be used so that the design can be safe, enjoyable, and functional. The engineering characteristics that will estipulate the design of the prototype

will be influenced by the customer's voice. In order to achieve the mentioned assessments, surveys and analysis of data would need to be performed.

The overall engineering design will consist mainly in a wireless blower, as well as an efficient rechargeable battery or something similar that can power it. An operating system that replicates these components in a more efficient way can be built. The team will conduct tests and trials to decide which alternative is better to achieve the operating system objective. Additionally, a steering system needs to be generated, tested, and applied. The whole design will to be aesthetically appearing and follow an ergonomic design.

2.4 Constraints

One of the most considerable constraints is the balance of the entire prototype. Previous attempts were successful on stability because the board itself was round and only had the load of one person on the middle. By adding components such as a steering wheel and an operating system, which encompasses a battery and a blower, an uneven load across the board could be created. These are conceptions that need to be taken into consideration and worked through testing of designs and calculations.

Another significant constriction is sound. Some blowers and fans can be very loud when they are on use. Also, the airflow created from the blower creates a cushion of air below the board itself and if it comes into heavy contact with solid surfaces, it can create a loud sound. For this reason, the different types of terrains become a problem as well. It is desired that the prototype can be able to ride over various types of land without any interference and/or excessive noise production.

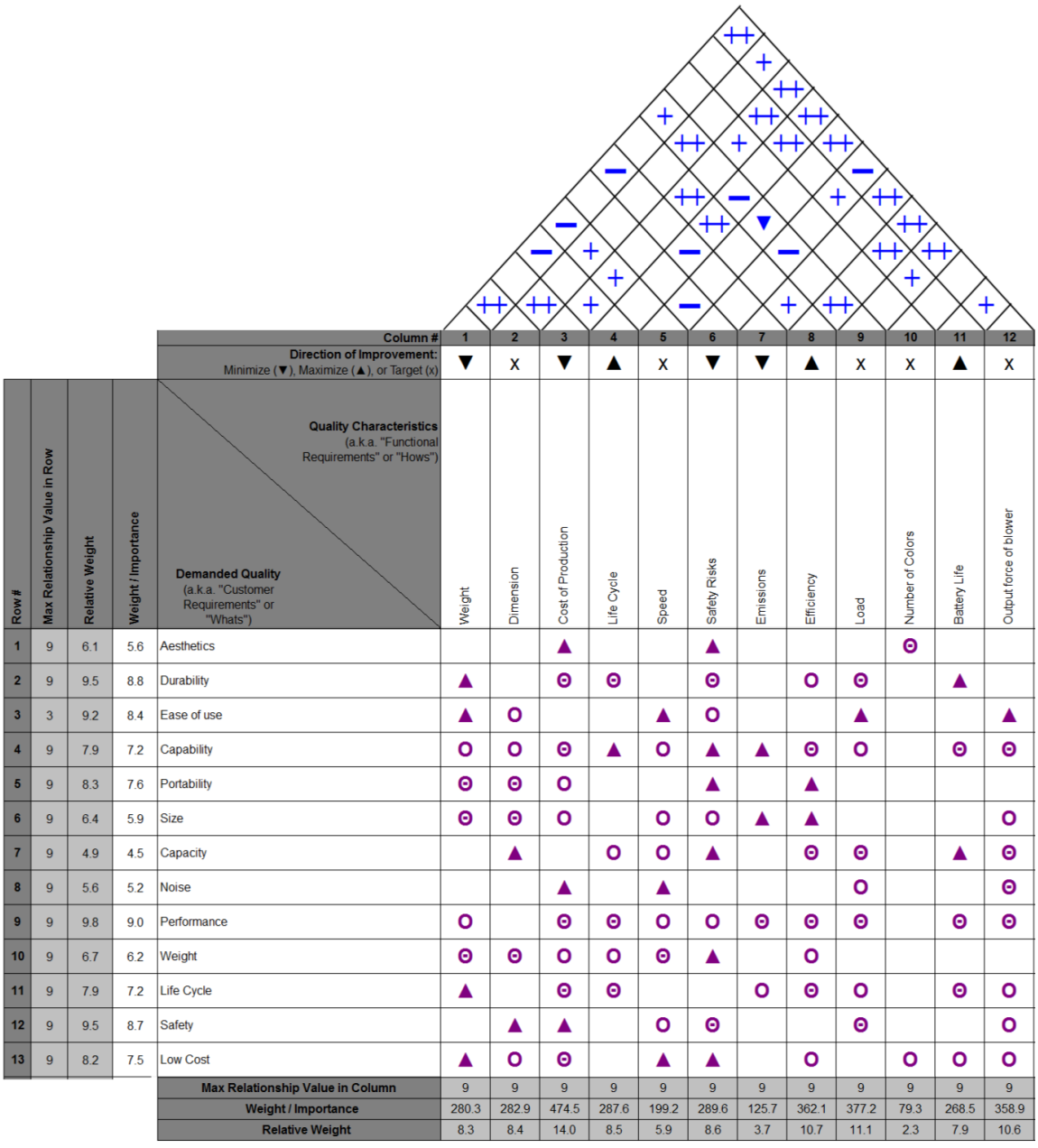
3. Methodology

A House Of Quality was created as part of the Quality Function Deployment (Figure 2). The proposed customer requirements (CR) are listed on the left, while the engineering characteristics (EC) occupy the top row. The numbers obtained for the CR were obtained from a survey done by the group members to 100 people between the ages of 12 and 50; the scores of this survey are further explained in the results. Group 20 went through and decided upon correlations among the EC's ranging from strongly negative to strongly positive. Afterwards, Group 20 went through the body of the HOQ and used critical thinking to decide upon relationship strengths between the CR's and EC's by using strong (9), moderate (3), and weak (1) relationship values. There were other criteria represented in different symbols and colors used to analyze the roof of the HOQ and the quality characteristics (Figure 1).

The template for the HOQ was sourced from QFD Online [# reference]. Using an established template with mathematic functions for the desired calculations included allowed the team to obtain more accurate results. The template automatically calculated the relative weight on the bottom of the HOQ when it examined the team's analysis results for the body of the structure. The relative weight obtained gives a number to each quality characteristic. The characteristics with the higher values represent the features that need to be taken as a priority for the design of the prototype of the project. These chosen characteristics are meant to satisfy both customer and engineering's independent priorities of design at the same time.

Legend		
⊙	Strong Relationship	9
O	Moderate Relationship	3
▲	Weak Relationship	1
++	Strong Positive Correlation	
+	Positive Correlation	
−	Negative Correlation	
▼	Strong Negative Correlation	
▼	Objective Is To Minimize	
▲	Objective Is To Maximize	
X	Objective Is To Hit Target	

Figure 1: Legend corresponding to the House of Quality [5].



Row #	Max Relationship Value in Row	Relative Weight	Weight / Importance	Demanded Quality (a.k.a. "Customer Requirements" or "Whats") \ Quality Characteristics (a.k.a. "Functional Requirements" or "Hows")	Weight	Dimension	Cost of Production	Life Cycle	Speed	Safety Risks	Emissions	Efficiency	Load	Number of Colors	Battery Life	Output force of blower
				Column #	1	2	3	4	5	6	7	8	9	10	11	12
				Direction of Improvement: Minimize (▼), Maximize (▲), or Target (x)	▼	x	▼	▲	x	▼	▼	▲	x	x	▲	x
1	9	6.1	5.6	Aesthetics			▲			▲				⊙		
2	9	9.5	8.8	Durability	▲		⊙	⊙		⊙		O	⊙		▲	
3	3	9.2	8.4	Ease of use	▲	O			▲	O			▲			▲
4	9	7.9	7.2	Capability	O	O	⊙	▲	O	▲	▲	⊙	O		⊙	⊙
5	9	8.3	7.6	Portability	⊙	⊙	O			▲		▲				
6	9	6.4	5.9	Size	⊙	⊙	O		O	O	▲	▲				O
7	9	4.9	4.5	Capacity		▲		O	O	▲		⊙	⊙		▲	⊙
8	9	5.6	5.2	Noise			▲		▲				O			⊙
9	9	9.8	9.0	Performance	O		⊙	⊙	O	O	⊙	⊙	⊙		⊙	⊙
10	9	6.7	6.2	Weight	⊙	⊙	O	O	⊙	▲		O				
11	9	7.9	7.2	Life Cycle	▲		⊙	⊙			O	⊙	O		⊙	O
12	9	9.5	8.7	Safety		▲	▲		O	⊙			⊙			O
13	9	8.2	7.5	Low Cost	▲	O	⊙		▲	▲		O		O	O	O
				Max Relationship Value in Column	9	9	9	9	9	9	9	9	9	9	9	9
				Weight / Importance	280.3	282.9	474.5	287.6	199.2	289.6	125.7	362.1	377.2	79.3	268.5	358.9
				Relative Weight	8.3	8.4	14.0	8.5	5.9	8.6	3.7	10.7	11.1	2.3	7.9	10.6

Figure 2: House of Quality [5].

4. Results

Understanding the potential audience for the product increases chances for a successful outcome. Finding an audience that has an interest and those that understand its need was a priority. The engineering criteria's that was formed was based on public feedback through a survey that was created. The results from the survey were analyzed, and it was noticed that performance, durability, and ease of use was the top 3 criteria our audience chose. The result from the survey is ranked with respect to importance, which is shown below in Table 1. The same results are shown in Figure 3 but in a bar chart that helps visualize the importance of each criterion [6].

As for the results of the house of quality, the outcomes are going to help in the design process of the project. According to relative weight results it can be seen that the cost of production is the most important thing to focus on; it got the highest percentage out of all, a 14%. Following the highest score is efficiency with a 10.7% and the output force of the blower is very close with just a 10.6%. Subsequently is the consideration safety risk with an 8.6% along with lifecycle with an 8.5%. The rest of the results can be directly seen from Table 2 [5].

Table 1: Results from survey [6].

	Ranking													Total	Score
	1	2	3	4	5	6	7	8	9	10	11	12	13		
Aesthetics	2	4	4	7	2	6	9	10	4	7	15	12	8	90	5.58
Durability	11	8	21	8	7	10	3	5	4	5	4	3	3	92	8.75
Easy to Use	8	14	9	12	7	12	5	4	7	6	5	4	1	94	8.43
Capability	6	14	9	12	7	12	5	4	7	6	5	4	1	91	7.21
Portability	3	5	4	10	15	9	13	10	8	6	4	2	1	90	7.58
Size	3	6	3	5	6	3	6	10	15	16	11	10	3	97	5.87
Capacity	8	2	3	1	5	5	6	1	8	4	7	16	32	98	4.54
Noise	2	4	4	3	5	7	6	6	9	5	12	14	14	91	5.16
Performance	16	21	4	14	5	1	8	3	1	4	2	4	8	91	8.95
Weight	0	3	7	5	10	12	7	12	7	8	13	6	6	96	6.19
Life Cycle	4	5	9	10	12	8	8	7	9	15	5	2	4	98	7.23
Safety	24	9	6	12	6	8	7	2	3	2	7	7	4	97	8.73
Low Cost	8	6	13	2	11	11	8	9	7	7	4	6	5	97	7.51

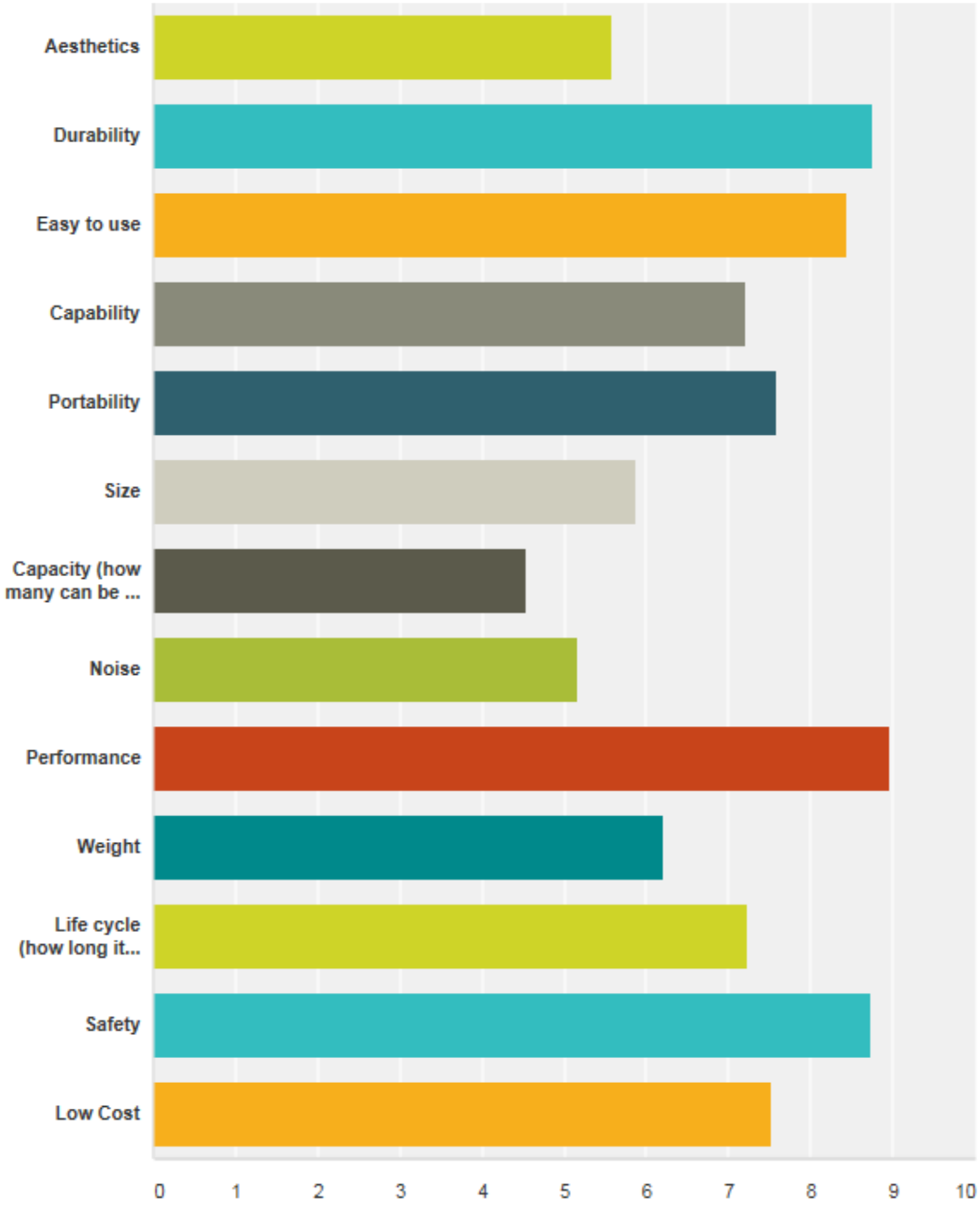


Figure 3: Bar charts of survey results [6].

Table 2: Relative Weight Results from HOQ [5].

Relative Weight Results			
Engineering Characteristic	Result (%)	Engineering Characteristic	Result (%)
Weight	8.3	Emissions	3.7
Dimension	8.4	Efficiency	10.7
Cost of Production	14.0	Load	11.1
Life Cycle	8.5	Number of Colors	2.3
Speed	5.9	Battery Life	7.9
Safety Risks	8.6	Output force of the blower	10.6

5. Conclusion

The basic idea behind the levitating hover-board is to have a wireless blower that will be used to generate the lift needed to support the user's weight. The output force of the blower will equal the user weight to maintain a certain height, and be more mobile for a finite amount of time. The overall design will include a rechargeable battery, so it can be a convenience for the targeted audience.

Gathering information from a survey, it was noticed that performance and durability was both criteria of high demand. With the expressed needs for this project, the HOQ diagram was developed. The engineering criteria for the hover board design were evaluated against what the customers wanted, which mapped out important qualities that will be in the concept of the design. Many innovative ideas will be used to design a levitating hoverboard, which meets the requirements acquired from our intended customers.

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