Electric Longboard and Ripstik

Senior Design Report submitted to the
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by

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Table of Contents

Problem Statement

Electric longboards paved the way for a new wave of transportation that has swept the world. Many products have been enhanced by implementing battery powered motors that allow for ease of use and great transportation potential. I myself heavily relied on an electric longboard to traverse my college campus for four years. Having used the product for that long, I experienced first-hand the benefits and drawbacks of the product.

The problem being address is the mobility of the electric longboard. In order to keep the board stable at high speeds, the trucks must be tight, and this drastically decreases it's turning capabilities. My goal for the project will be to maximize the mobility of a product similar to an electric longboard with aspects of other state of the art technology, such as a ripstik. Combining the speed and stability aspects of the electric longboard with the precision movements that can be achieved with a ripstik could potentially create the most effective motorized transportation technology of this type.

Background

When you think of inner-city travel, what comes to mind for the most ideal form of transportation? Some would argue that the subway system offers the most effective transportation for a moderate cost. The subway is fast, but it does not totally eliminate the need to walk to your destination. Something more personalized that could be taken with you all the time could totally eliminate walking. This brings up the argument that a one-time purchase of a bike would fulfill all of your long-distance mobility needs. Although, a bike needs to be locked up at a bike rack because it is not small enough to be taken with you. So, A problem that needs to be addressed is a reliable form of personal transportation that can be carried around on your person, what product could fulfill that role?

Over the past decade, we have seen a flood of electric motorized transportation products fill the sidewalks and streets. (1)Especially in areas like cities and campuses, these products offer an individual a fast mode of travel that can easily be picked up and stored in small spaces. As with any new product, there will be many variations made that all try to be the best option out there.

Currently, the most popular option for electric motorized personal transport is the electric longboard. (2) The problem that is being addressed about the electric longboard is its maneuverability. The high speeds that are attainable with this product is great for a quick thrill but when it is being considered for a real mode of transportation, it has some serious drawbacks;

- Sharp turns are almost unattainable when riding these boards which doesn't make them a great option to traverse through high traffic areas with many obstacles.

- The safety of yourself and the people around you is at risk if you cannot confidently maneuver with the board.

It will be my goal for my senior design project to combine the best aspects of different state of the art technology and merge them with the electric longboard to make the most dependable, maneuverable, and safe mode of personal transportation.

State of the Art

Electric longboard (2)

Pros:

- Large battery capacity that grants longer usage time and more travel distance. Average range is around 30-35 miles.
- The boards can have 2wd or 4wd which can achieve high speeds up to 45mph, average speed is around 25-30mph.
- The large size of the wheels combined with the longer length of the boards provide a smooth and stable ride the feel comfortable and fun.
- Even though this product is meant to be used on the sidewalk/street, it has the potential to be used off of the road in grass/dirt.

Cons:

- The large size of the board, battery, and wheels combined make this product very heavy ranging from 30-50lbs
- The length of the board and the required tightness of the trucks to achieve a stable ride and avoid speed wobbles hinders this products ability to make sharp turns.
- Because of the long range, and high speeds that this product offers, the price tag to obtain one of these is very high, ranging from $500-$3000.
- They can be difficult to maintain and any major damage done to the electrical part of the board will most likely deem it unusable and require a costly repair.
- The only way to operate the board is through a handheld remote control that also needs to be charged.

One Wheel (3)

Pros:

- This product is operated without the use of a remote control, it is operated entirely by your bodies movements while you stand on the platforms.
- Because the product only has one wheel, it has its own self stabilization system to help you balance and give you a safe feeling while riding.
- The need for only one wheel, one motor, and two platforms to stand on makes the product much lighter compared to the other state of the art technology, ranging from 15-25lbs.

- The overall riding feel of the one wheel is superior to other products because of its much larger, rubber wheels. There is little to no vibrations that you feel in your feet and up your legs that you would get with the smaller wheels that are made from urethane or pneumatic

Cons:

- Although this product is lighter, the bulky wheel can be inconvenient to carry around.
- The onewheel's battery is much smaller than other products and only provides a 10-20-mile range.
- Because the there is only one motor on the product to drive the wheel, and the large size of the wheel, the top speed of the onewheel is much lower compared to other similar products, averaging from 16-19mph.
- The turning abilities of the one wheel can be difficult to master because you have to maintain your balance while shifting your weight enough to make the board turn. It can make tight turns and carve well but the speeds of these actions are much slower compared to other products.

Electric Ripstik (4)

Pros:

- The two wheeled board combined with its twisting platforms allow for the sharpest turns capable of an electric board and the most maneuverability around people and obstacles.
- The base traits of the ripstik still provide the ability to move around seamlessly without the use of the motor, so even when the battery is dead, this product can still get you to where you need to go.
- This board is extremely easy to carry because its weight is only around 12-15lbs and has a handle like feature in between the two platforms of the board.

Cons:

- This board offers the slowest speeds, ranging from only 10-13mph because of the small, singular wheel that drives the board.
- The board has the shortage usage time/range, only allowing the user for around 40 minutes of motor use before recharging is needed.
- Because there are only two wheels and no auto stabilization feature, this product can be extremely difficult to learn how to ride and takes much time to master.
- There is no adaptive breaking feature on this board that recharges the battery while going downhill.

Applicable Standards

The standard weight that a longboard should be able to hold is 200 lbs, I will incorporate this into my design and try to ensure a factor of safety of 3.

End User

The specific end user of my product will be for people who want a product that can double as a means of transportation that can be carried on their person that is also something that can be used in their leisure time for personal enjoyment. The best application of the product will be in cities/suburbs by teenage to middle aged people. Teenagers can use the product to travel to school, parks, friend's houses, etc. College students can use the product to traverse their campus quickly. People aged 25 and up can potentially use the product to go to and from work while avoiding inner city traffic. All of the users will be able to rely on the product and enjoy it whether it is charged or not.

Summary of Research

The initial question that was brough up in the background of this project was, what is a reliable form of personal transportation that can be carried around on your person? By now you might have a good idea of what type of product would suit this dilemma. The electric longboard and state of the art technology like it have widely been used to meet this specific need. Now the question is, how can we improve upon the products and bridge the gap between speed, range, and maneuverability. By combining the large battery and 2wd system from the electric longboard, lightweight design of the onewheel, and the maneuverability of the electric ripstik, I believe I can make the most reliable, safe, and entertaining electric motorized personal transportation product on the market. The product will meet common standards of the state-of-the-art technology to provide a similar experience and be competitive in the market. The standards would include a max speed above 15mph, minimum range of 15 miles, and to be usable when the battery is dead with leg movement (like that can be achieved on a ripstik) without needing to push off of the ground. This product would largely benefit teenagers, college students, and inner-city people by providing all of them a mode of transportation that can easily be carried and stored.

Quality Function Deployment

The survey below was posted to a reddit forum dedicated to the discussion of motorized longboarding/skateboarding on September 15th, 2022. The purpose of this survey was to get feedback from individuals who use similar products to the one I am focusing my capstone project on and to develop key product objectives from the results.

Sample Survey

Electric Longboard and Ripstik Crossover

Hello, my name is Blake Oprea, I am currently pursuing a degree in mechanical engineering technologies. In order to graduate I must complete a senior design project which I have chosen to design a crossover between an electric longboard and a ripstik for. Please answer the questions below to help me narrow down my focuses for the project.

Answer 1 to 5 in order of importance; 1 being the least important and 5 being the most

How important are these features for an electric board to you?

Top Speed (5)
Range (5)
Stability (3)
Maneuverability (4)
Weight (2)
Cost (3)
Ease of use (1)

How satisfied are you with current electric longboards?

Top Speed (5)
Range (4)
Stability (3)
Maneuverability (3)
Weight (3)
Cost (2)
Ease of use (4)

How much would you be willing to pay for an electric longboard featuring castor wheels?

$200, $400, $600, $800, $1000

Customer Features

Top Speed

Range

Stability

Maneuverability

Weight

Cost

Ease of use

Engineering Characteristics

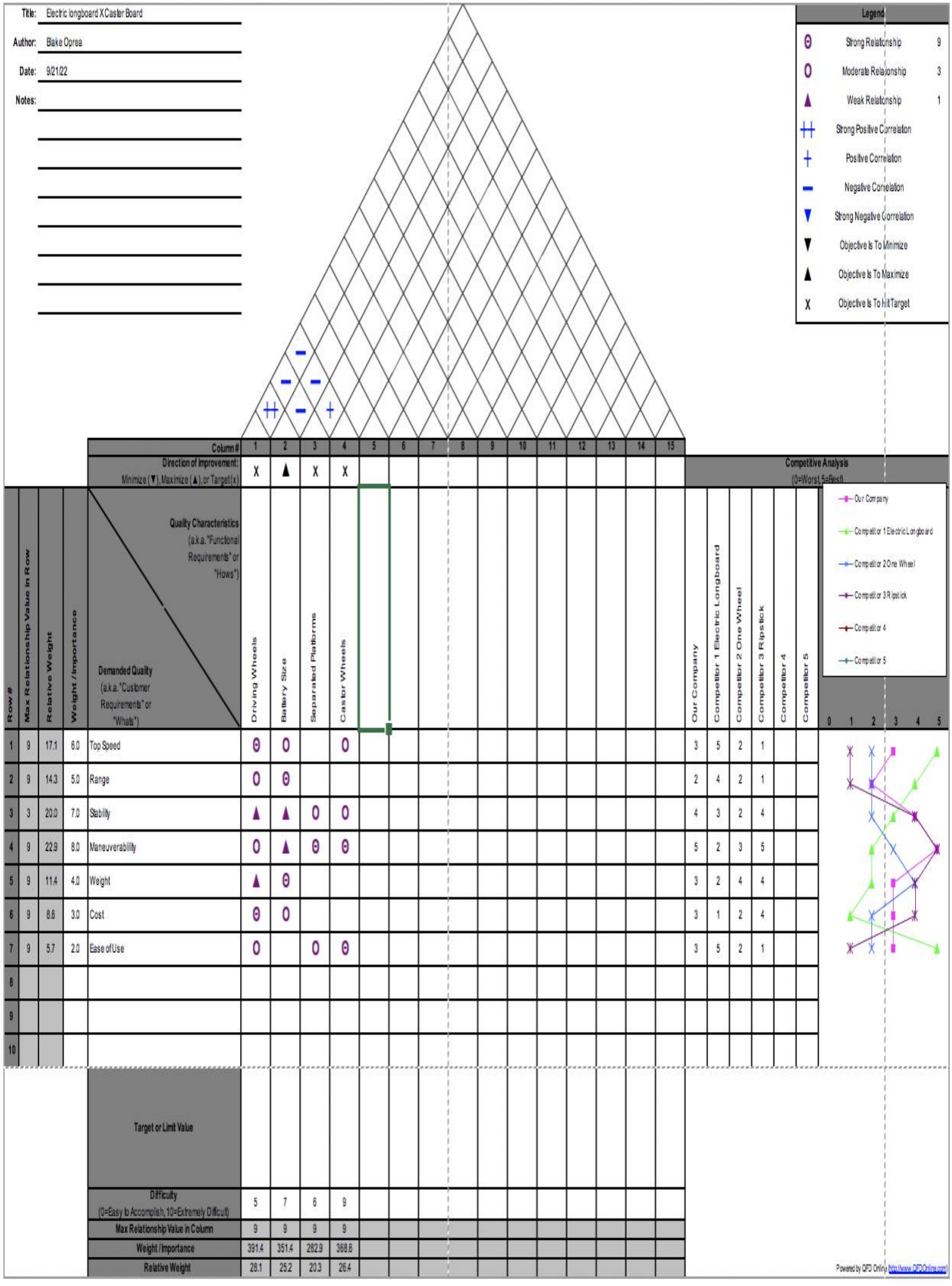
Driving Wheels

Battery size

Separated Platforms

Castor Wheels

House of Quality



Product Objectives

Can achieve a 90 degree turn or better (30%)

Top Speed of at least 15mph (15%)

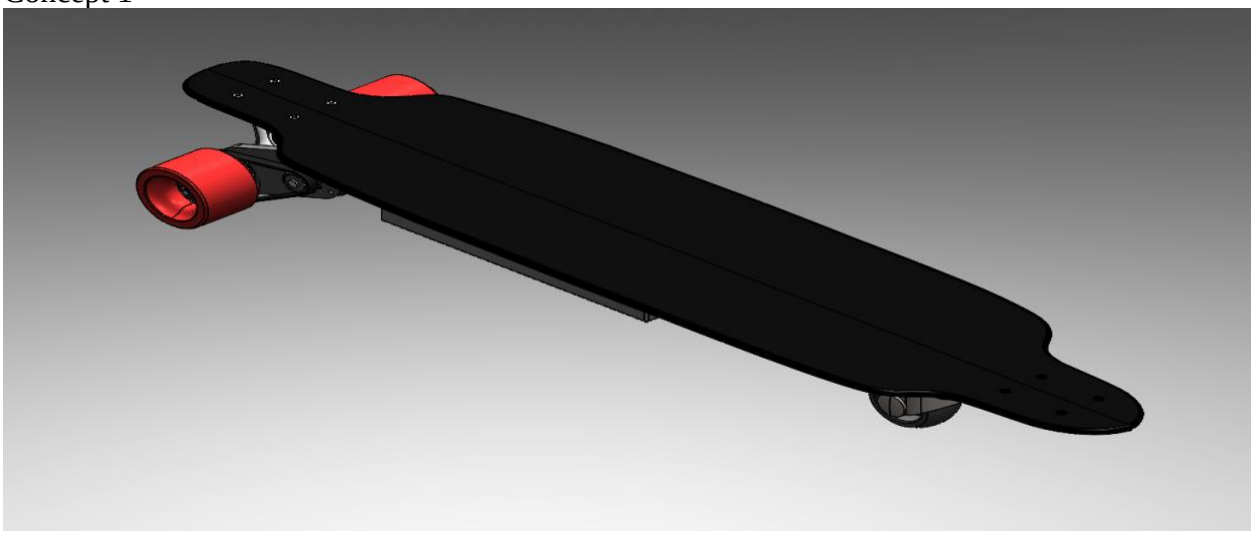
Range of at least 10 miles (10%)

At least two motorized wheels on back platform (20%)

One castor wheel attached to front platform (25%)

Concept Drawings

Concept 1



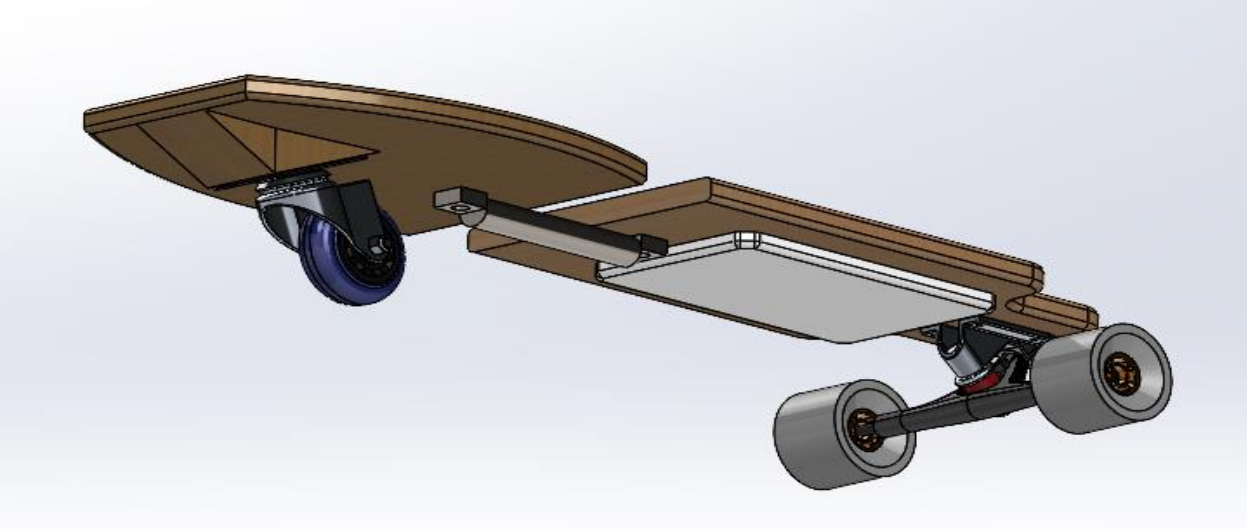
This concept keeps almost all aspects of the current longboard with the only change being the single castor wheel on the front of the board. The two back wheels are motorized by a large battery underneath the board.

This concept will provide a slight improvement to maneuverability but not much. Its main drawback is that it will not be able to perform the carving motions that can be achieved with two separated platforms.

Concept 2
This concept will feature two separated platforms connected similarly to how the ripstik's boards are connected. The two motorized wheels and battery will be on the back platform. The front platform will have a single castor.

Having the motorized wheels in the back will provide for more traction because while riding a board your weight is shifted on your back foot. It will also provide a sharper turning radius due to the flexibility of the front platform combined with the castor wheel. Propelling yourself forward by utilizing the front part of the board as a traditional ripstik is also an option but is difficult to accomplish.

Concept 3



This concept will feature two separated platforms connected similarly to how the ripstik's boards are connected. The two motorized wheels and battery will be on the front platform. The back platform will have a single castor.

Having the motorized wheels in the front will cause a more difficult riding experience because you will have less traction and less turning capabilities. The main draw of this design is its ability to propel yourself forward by utilizing the back part of the board as a traditional ripstik.

Design Process

Week One

Accomplishments:

1.) Selection of longboard conversion kit
   - Selected the Teamgee electric longboard DIY Kit H3. The product features a range of 9 miles, a top speed of 16 mph, and a max load of 220 lbs. The wheels are 90mm and are made out of polyurethane. There are 4 different speed and break modes that the board can be switched between for a variety of riding experiences.

2.) Selection of component material for the wooden platforms, mounting plates, and fasteners.
   - Platforms will be made out of maple wood because they are the highest strength wood and most longboards are made of the same material.

- Mounting plates will be made out of 316 ss because the section of the board that is mounted to the torsion bar needed something to reinforce the connection to ensure the platforms could withhold the needed weight.
- The bolts/nuts will be made out of 316 ss to be consistent with the mounting plates and to ensure the connections wont fail under load.

Week Two

Accomplishments:

1.) Reverse engineering the connecting rod for the joining of the two sections of the board
   - The two boards are connected with a spring-loaded rotating bar. Each part of the board can rotate independently, and this gives the ripstik the unique s curve movement that allows for propulsion with just the twisting of your hips. I plan on implementing this design into the front part of my board to achieve the same independent movement capabilities of the ripstik. This way, my board will be able to achieve a tighter turning radius compared to other longboards and still be able to be propelled without having to push off the ground. Due to the complexity of this part, I may have to compromise and simply attach the product to my board instead of making one myself.

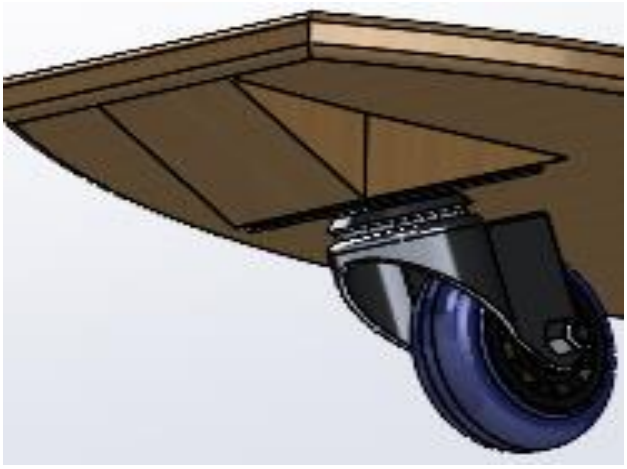
2.) Selected a torsion bar to be used in the assembly. The torsion bar that I have selected is from the Razor company, made of 316 SS, costs $60, and is rated to hold 660 lbs.

Week Three

Accomplishments:

1.) Design considerations of the caster for the front of the board
   - The caster will be mounted onto the bottom of the front platform with four screws. The front platform will have an angles section of wood on it for the caster to be mounted on. This will mimic the design of the ripstik and allow for the forward propulsion that is attainable by performing s curve movements on the board.

2.) Selection of the wheel for the front caster
   - The wheel for the caster will be made out of the same polyurethane as the back wheels to keep consistency. The wheel will be much thinner than the back wheels but much longer as well. This will provide the same ability for the board to achieve an s curve movement as the ripstik but will sacrifice speed and stability.



Week Four

Accomplishments:

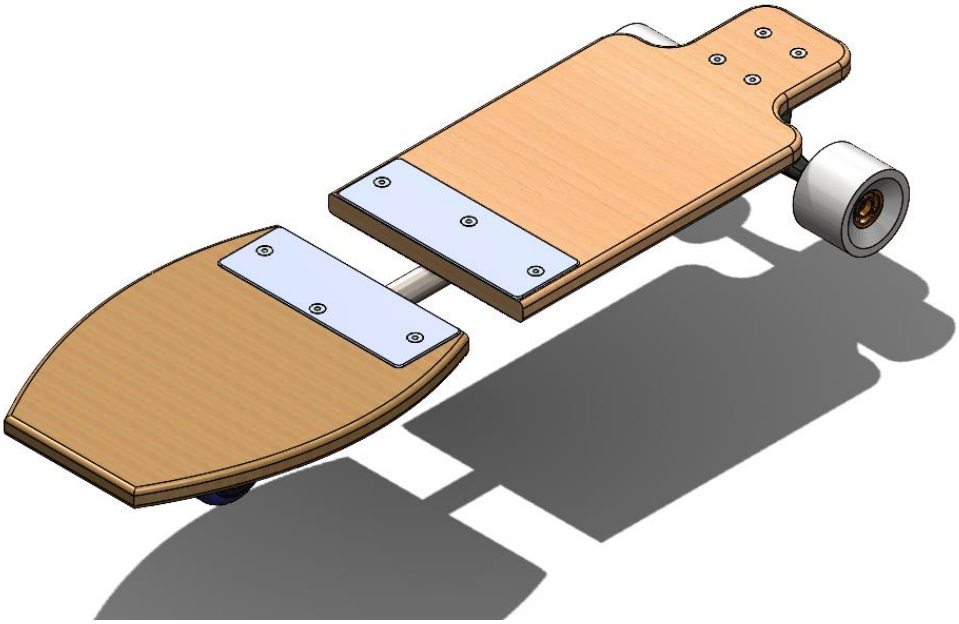
1.) Researched types of trucks to be used on the rear end of the board.
   - Selected reverse kingpin longboard trucks. These are the most popular trucks that are used on longboards for a good reason. They provide a stable ride as do most trucks available but the main draw to these particular trucks is the reversed direction. The front of the trucks point outward towards the ends of the board and the wheels are pointed inward. This allows for a more efficient use of weight shifting for the rider and provides a tighter turning radius.

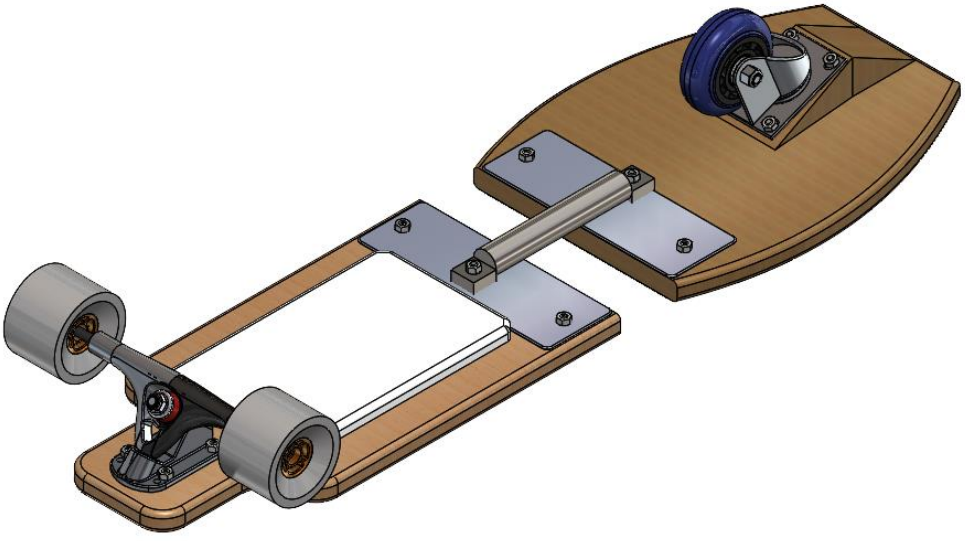
2.) Researched types of wheels to be used on the rear end of the board
   - Selected 80a, 90mm, polyurethane wheels. I selected a larger size for the back wheels to accommodate the front part of the board being on a caster. The caster and wheel combination that I have in mind are much larger than typical caster wheels and because of this, the front end of the board is expected to have a large height. In order to keep the board level, the back wheels need to be large enough to keep the back section of the board parallel with the front. 80a grade wheels are much softer and slower compared to 90a wheels but they can handle a much rougher terrain. The board is most likely going to be used on sidewalks and streets at high speeds, this required a softer wheel. Polyurethane wheels are common among longboard wheels because they provide more traction over rough terrain without compromising speed.

Week Five

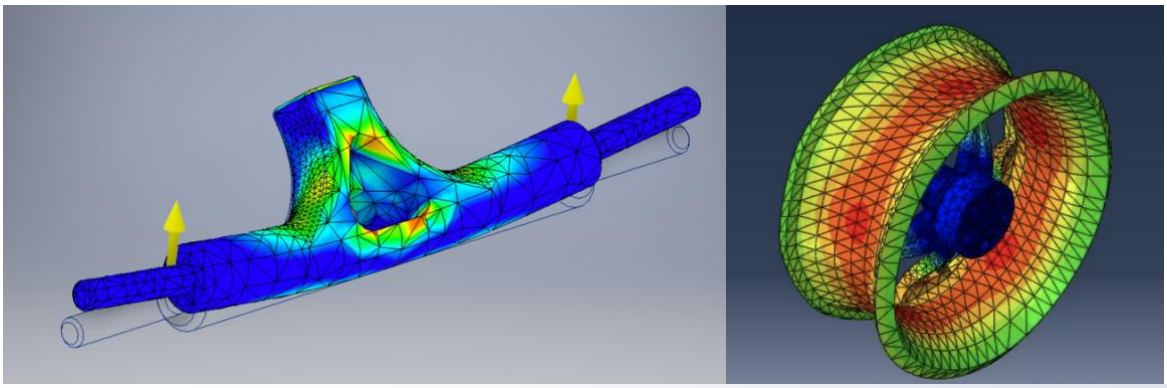
Accomplishments:

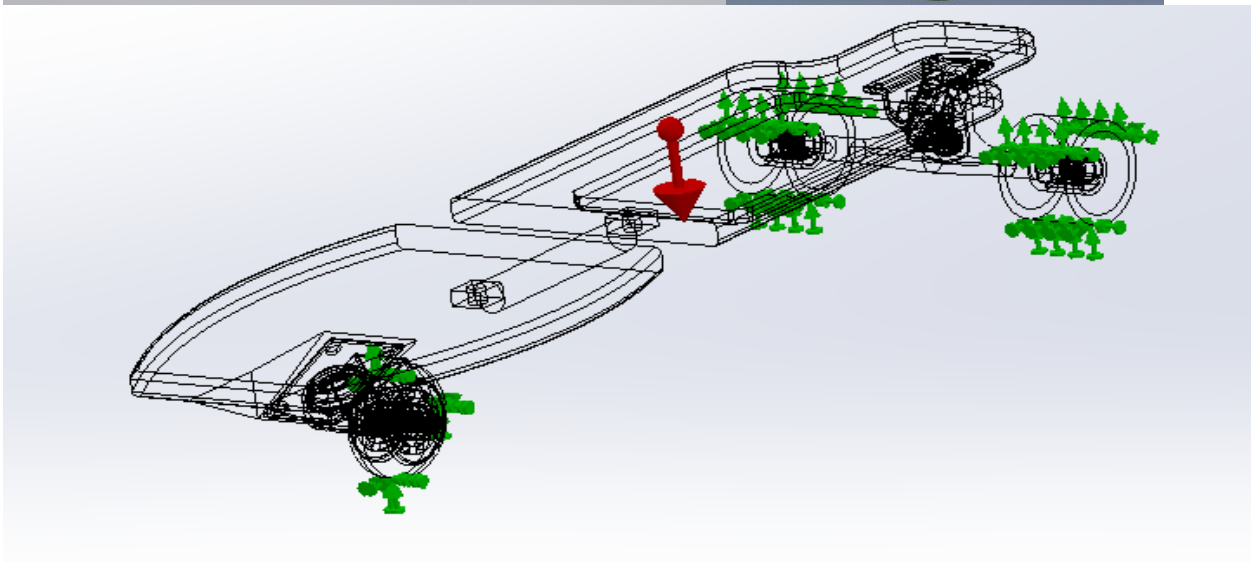
1.) Put together final model and applied a FEA to determine if the current design could uphold a factor of safety of three.





To ensure a factor of safety of three, the trucks and caster were put under a load of 600 lbs.





Calculations:

Maximum strength – 2688 N (600 lbs)

Designed load – 899 N (200 lbs)

Factor of safety – 2668/889 = 3

Project Management

Project Budget

The budget for this project is estimated to be $800 after factoring in all of the parts that will need to be bought. A standard electric longboard kit is $500, the board itself will range from $80-150, and the torsion bar will be $60.

Actual Budget

Battery and motor	$250
Trucks	$70
Castor	$22
Wood	$250
Torsion bar	$60
Bolts/fasteners	$50
Grip tape	$30
Total	$732

Landmark Goal Dates

Dates	Goal
10/25/2022	Design back platform with battery and two motorized wheels
11/23/2022	Design front platform and select appropriate castor
12/20/2022	Design connecting piece for two platforms
1/20/2023	Begin assembly of product
2/22/2023	Finish/test product and record finding
3/25/2023	Make and implement any necessary adjustment
4/6/2023	Ensure total preparation for Tech Expo Day

Fabrication and Assembly

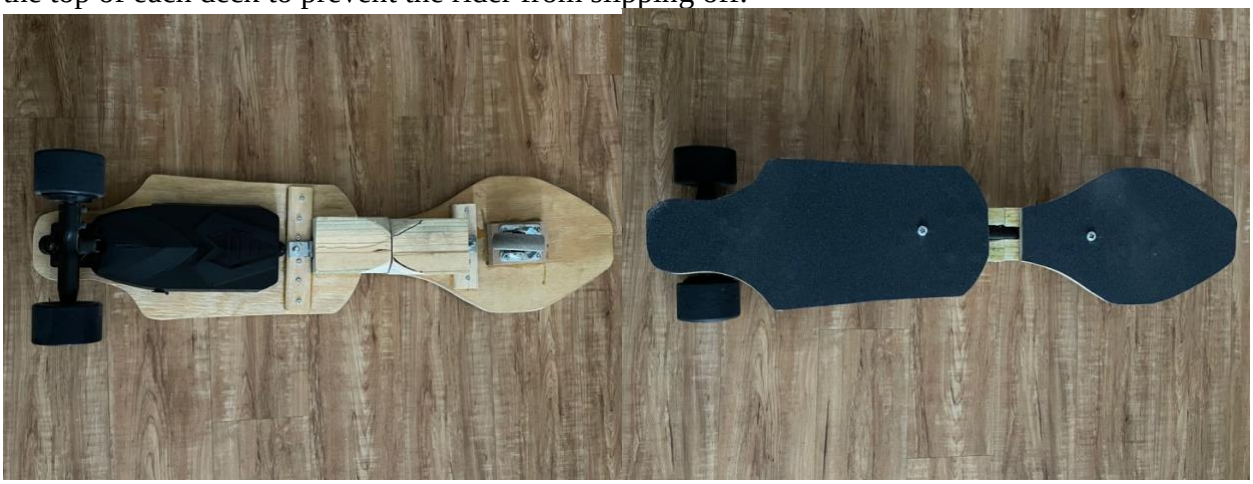
The assembly process was started by tracing and cutting large sheets of wood into the desired dimensions of the board pieces. Then, holes were drilled into the separate decks where the wheels would be mounted and where the decks would be attached to each other.

For the next step in the assembly process, the back trucks, wheels, and battery were attached to the rear deck of the board. Then, the mounting piece, torsion bar, and supporting metal rod was attached to the rear deck of the board. The mounting piece was attached to the board with screws and wood glue.

For the next step in the assembly process, the mounting piece was secured to the front deck with wood glue and screws. Then the torsion bar and support rod were attached to the front deck of the board.

For the next step in the assembly process, the castor was mounted onto the front deck of the board with a wooden block to ensure that the wheel to board height stayed consistent from both ends of the board. The castor and block were secured to the board with wood glue and bolts.

For the final step in the assembly process, I added support blocks around the supporting rod that connect to each deck to improve the stability of the board. Also, grip tape was added to the top of each deck to prevent the rider from slipping off.



Testing

After the final assembly process was completed, it was time to find out if the board functioned as desired. In order to determine if the board met the objectives of the project, it was subjected to three main tests. A normal stress test, a battery life test, and a maneuverability test.

In the stress test, the board was operated with a total of 250lbs of weight on top of it. This weight was selected because it is on the higher end of typical weight of eligible users who would ride the board. I observed slower speeds and more difficulty in turning the board than at a lower weight but the board did not crack or break.

In the battery life test, the board was used after a full charge in an environment of a college student until the battery was completely dead. The board managed to survive for 2 hours before the battery life expired. The battery life is dependent on how much weight is on top of the board along with the incline/decline of the surface that is being traversed (will not always be consistent).

The maneuverability test was conducted by using obstacles for the board to carve in and out of and compared to the maneuverability of a common longboard. In this test, the project board outperformed the longboard easily, being able to weave in and out of obstacles at a quicker rate and without the need to step off/reset the board. The project board was able to achieve a turning radius of 6ft compared to the longboard which has a much higher turning radius of 10-12ft. Another area where the project board outperformed the longboard was its ability to make a 90 degree turn. The longboard has difficulty making these types of turns due to its reliance on two sets of trucks to support the 4 wheels. All turning for the longboard is based off how tight the trucks are and how much you can comfortably distribute your weight while riding the board. The project board simply relies on the front castor for direction and is easily manipulated by the front foot of the rider.

Conclusion

Based on how the finished product performed compared to the current state of the art technology, I can confidently say that the objectives for this project have been met. The most important aspect of the project was to provide an electric board that could achieve a tighter turning radius than that of a current electric longboard. This was achieved by utilizing aspects of current state of the art technology and implementing them into my design. The use of the torsion bar between the separated decks of the board, based on the ripstik, allowed for maximum maneuverability. The electric motor driven wheel, based on the electric longboard, provided the desired speed and range for the board. In testing, the board easily provided the rider with the capability of making a 90 degree turn as well as being able to completely turn around without removing a foot from the board/falling off. The battery lasted for a solid 2 hours and the motor achieved a top speed of 12 mph. With the exception of the 15mph objective, every other objective of the project was met. In conclusion, the project was successful in delivering a product that met the desired objectives

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