NORTHERN ARIZONA UNIVERSITY

GoBabyGo-D

GoBabyGo

Preliminary Report

Hussen Alajmy

Saleh Almasari

Shahah Eshkanani

Yousef Alenezi

Yousef Alraqem

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Project Sponsor: Dr. Sarah Oman

Faculty Advisor: Dr. Sarah Oman

Sponsor Mentor: Dr. Sarah Oman

Instructor: Dr. Sarah Oman

DISCLAIMER

EXECUTIVE SUMMARY

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1 BACKGROUND

1.1 Introduction

Go Baby Go is a project that aims at helping children that are disabled and cannot move like normal children. GBG will help by making them toy cars that they can ride on by themselves without the assistance of any person. This is not a commercial exploit and the cars that are made through this program are given out to needy children. Our team is just one of the many teams across the world that is doing this kind of work.

We intend to make a unique design of a baby toy car. The team will come up with its own prototype, find the funds that are to be used to make the design and then go ahead and do the work. We hope that after the completion of the project, we have helped one more baby to be able to ride on itself. This project is also a chance for us to give back to the society what it truly deserves and by giving them an avenue to give through this project.

This project began with research on the development of young children and how it affects their lives in the future. This was done by the pioneer of the project named Professor Cole Galloway from Delaware University. According to him, if a child has a vibrant childhood, they tend to have a more normal adulthood. He said that children ought to play and have all the fun in the world and even if they are disabled and if they do, they will be no different from any other children when they grow up.

Some of the benefits that the child will get is having a better intellectual capacity. When children are playing and moving about and discovering things, it builds their intellectual capabilities. The second benefit is that it leads them to being able to relate well with other people. When children are playing, they are able to make friends something that they will be able to do in the future if they are able to have fun with the cars in their young age. Finally, it will be a form of rehabilitation to the child. It will help to strengthen their weak bones and even perhaps it may allow them to walk again. One of the main goals is to make them feel that they are able to achieve what any ordinary child could, as well as equipping them with the ability to interact with other kids.

This project is an engineering challenge that we are taking upon ourselves. It happens to be a good challenge in that it will not only build our engineering brainstorming skills, but it will be a useful contribution to society.

1.2 Project Description

Children with limited mobility often do not receive the much needed exposure to socialization to appropriately cognitively develop. Existing research shows that equipping young children with self-control of their own environment can have meaningful impacts on the long term outcomes given such impairments as cerebral palsy or muscular dystrophy. The Go Baby Go (GBG) project that started at the University of Delaware has developed a set of DIY cars for families with children with mobility restrictions. These cars have been designed on commercially available ride on toy car platforms (like Power Wheels) and have been deployed worldwide by the GBG team. These cars have shown to be a cost-effective means of enabling young children to move and interact with their peers.

The goal of this project will be to design and build a new version of the GBG retrofits – specifically to design a universal control for children with extremely limited mobility of their arms and/or legs.

1.3 Original System

This project involved the design of a completely new <Pressure Pad Go Baby GO>. The project involves a lot of new designs that the team has accomplished in order to build a new highly developed go baby go car**.**

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1.3.1 Original System Structure

The original system is something unique that is something completely different from all ideas designed for GBG. It’s going to be a toy car with a lot of modifications. The GBG team would like to establish a toy ride that satisfies the needs of the disabled child with the newest technologies such as a hand pressure system that makes the child wander around by themselves without the help of a parent and a new technology that would use renewable energy sources as a part of the car to make it environmentally friendly. This is just one of the modifications that the team will develop throughout the project. The objective of this project is to build a cheap-cost car with the latest technologies to help serve the child better.

2 REQUIREMENTS

The GBG team met with the client Dr. Oman to get briefed on the current customer requirements based on the project description that was provided to the team. These customer requirements must be met by the final product.

2.1 Customer Requirements (CRs)

The GBG team has five main customer requirements (CR) which will be weighted using a scale of 1 to 5 (5 = top), depending on the importance of each CR.

In the table provided below (Table 1), there is a list of customer requirements – each requirement has a brief description to clarify customer requirements clearly.

Table 1 Customer Requirements

Customer requirements	**Description**
Power system	**The system should include an acceleration controller, cruise controller, and safety breaks**
Physical	**The system should have comfortable seats, trunk mobility, and legs supporting**
Operating system	**The system must be easy to operate, so the child can use it easily**
Financial	**The system must be low cost that not exceed $ 400**
Safety	**The system should ensure the safety of the child, by having seatbelt harness and bars.**

2.2 Engineering Requirements

The following Engineering requirements were created by GBG team to achieve and ensure the whole five main customer requirements.

In the table provided below (Table 2), there is a list of Engineering requirements, each requirement has a brief description to clarify engineering requirements clearly.

Table 2 Engineering Requirements

Engineering requirements	Description
weight (lb.)	The final solution should not exceed 60 lb. as a total wait, so it can be easy to move or carry
Price/cost ($)	The final solution should be less than $400 as a maximum cost for the device
Smooth sides (rad)	The system should have smooth angles to ensure safety from sharp edges
Suspension (lbf/in^2)	The system should have springs to ensure there is no jerking motion while using the system in curved roads
Store energy (w)	The system should generate and store electrical energy
OSHA Standards	The system should meet OSHA's standards to ensure the safety of the child
Multiple speeds	The system should have at least 3 different speeds (low, medium, high)
Steering options	The system should have new idea of steering options instead of the regular steering wheels

2.2 House of Quality (HOQ)

The current house of quality is a diagram which helps in determining how the customer needs are being valued and weighted with regards to the product.

Table 3 HOQ

Customer Requirement	**Weight**	**Engineering Requirement**	Weight <<	Price/cost <<	smooth sides >>	suspension >>	Store energy >>	Multiple speeds >>	steering options >>	OSHA Standards >>
1. Power system										
a. Control acceleration	5		9	5	0	0	9	9	9	9
b. Cruise controller	3		9	5	0	0	9	5	5	9
c. brakes	5		5	0	5	5	5	9	5	9
2. Physical										
a.Comfortable seats	5		1	5	9	5	0	0	0	9
b. trunk mobility	4		9	0	0	0	0	0	0	0
c. legs support	3		0	9	9	0	0	0	5	9
3. Operating system										
a. easy to operate	5		0	0	5	1	0	9	9	9
4. Financial	5		0	9	0	0	9	0	0	0
5. Safety										
a. Seatbelt harness	5		0	0	0	0	0	0	0	9
b. bars	3		9	5	9	0	0	0	0	9
Units			lb	$	rad	lbf/in^2	W	m/s	N/A	N/A

3 EXISTING DESIGNS

There are many existing designs for GBG created out of similar ideas of a wheel chair, toys and mobility games. Three different ideas caught the group's attention: the scoot, the current GBG retrofit (electric car) and the scooter. These products have some disadvantages that need to be fixed or improved. The team will start to think briefly in order to create a new idea for mobility that could meet the clients need. The existing design element of this project is important for the team and will be helpful for the future of this project.

3.1 Design Research

On November 2015 Go Baby Go organization was created. This organization is taking care of children with special needs to make them feel like normal children by building mobility to let them play [6]. Kids with special needs are part of the community so Go Baby Go program will get them achieve their dream and play as and have fun. The organization facing some difficulties on designing Go Baby Go Devise because every single child has a particular need. Also, the group facing that challenges too. While research most of the Ideas are similar to each other and most of them are expensive. The group has a limited budget to make a new design with all specialty that required from the client so in this research missed all too expensive idea of GBG. Most of the research was from online websites and most of the team members got a lot of Ideas since they learned ME286 class at the Northern Arizona University. There are other universities have GBG program, it seems that all schools were beating each other to create a new design that can be useful for kids. Almost all university do not have a unique design for GBG just a toy car that have new modified Idea.

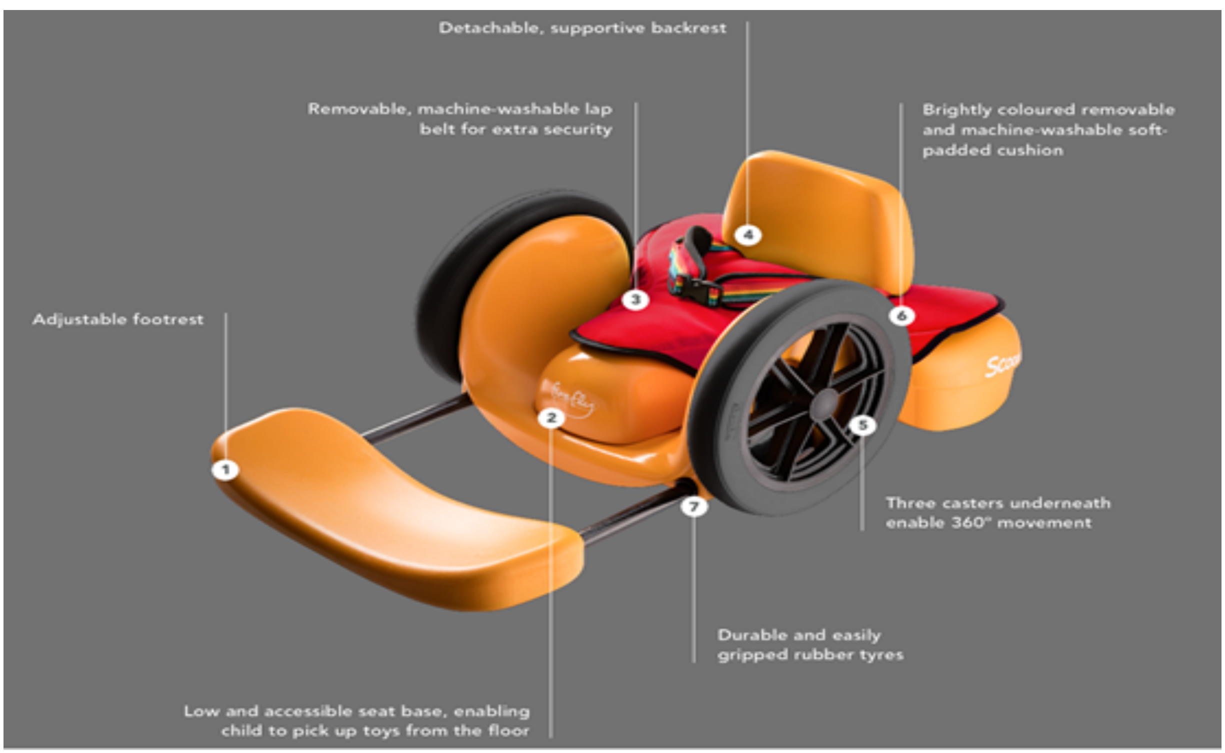
3.2 System Level

The GBG project requires a main system of mobility to transport a child from point A to point B. The current systems mainly depend on using a retrofit with tires to transport the child. The main system level will be dependent on the customer requirements and on how it relates to the requirements. Accordingly, there are many different systems that were used for each retrofit. For example, wheelchairs rely on human energy in order to move a patient from point A to point B. The 3 main system designs which will be discussed in the subsequent pages are the following:

1) Scoot
2) Current Go Baby Go retrofit (electric Car)
3) Scooter

3.2.1 Existing Design #1: Scoot

The scoot is a current main system that is used for both normal and disabled children to transport them from a point to another. This system could be used in three different ways – the first method is that it can be used by crawling. Crawling will help the child in exploring and strengthening the upper body muscles such as the abdominal area [2]. The second way to use this system is by scooting. Scooting allows the child to move while sitting up straight and using their legs. This will help the child move more freely to explore outer surroundings. The final way to use this device is by riding it. The device allows the parent to add a tire on each side which will make the device act like a wheelchair. This system will depend completely on human energy since there are no electrical components involved and the child will have to move physically by himself or



herself to maneuver it.

Figure 1 Scoot

3.2.2 Existing Design #2: Current Go Baby Go Retrofit (Electric Car)

The current design for the GBG project is a great system for use by disabled children to socialize and transport themselves freely and independently. Current Go Baby Go retrofits are based on electric toy cars that are modified based on each requirement [1]. The cars are cost-effective and do not cost much compared to medical solutions that cost much more than the GBG retrofits. This current system relies on electrical power that is controlled by the child in order to accelerate and decelerate. The present solution mostly does not control acceleration – it is only adjusted to one speed. Each retrofit is designed differently depending on the disability of the child.

Figure 2 Current GoBabyGo

3.2.3 Existing Design #3: Scooter

The final existing system that is used is the toy scooter. The chosen system is a three-wheeler retrofit that depends on human energy in order to move [3]. This device is mainly used to transport the child from one point to another using the three wheels attached. Additionally, there is a stick which allows the parent to control the movement of the child with regards to the direction of the scooter. This will give the parents more control over the child in terms of their movement and will therefore not be able to meet the requirements for most disabled children.

Figure 3 Scooter

3.3 Subsystem Level

Any machine or mechanical design must contain a support system for main system mobility – for example, controlling parts and energies. For this GBG project the team will follow the sponsor's requirement with regards to the design in order to help normal and disabled children. During the research stage, there were three main categories of subsystems that the team explored: human power, electrical power and main control system.

3.3.1 Subsystem #1: Human Power

Human power represents energy that is transferred from the human body to power a machine into operating. This may involve using one's arms and legs [4].

3.3.1.1 Existing Design #1: Arms

As shown below in Figure 4, arms are the source of human power of the scoot's main subsystem. It works when a disabled child pushes and rolls the scoot's wheels in order to move from one place to another.

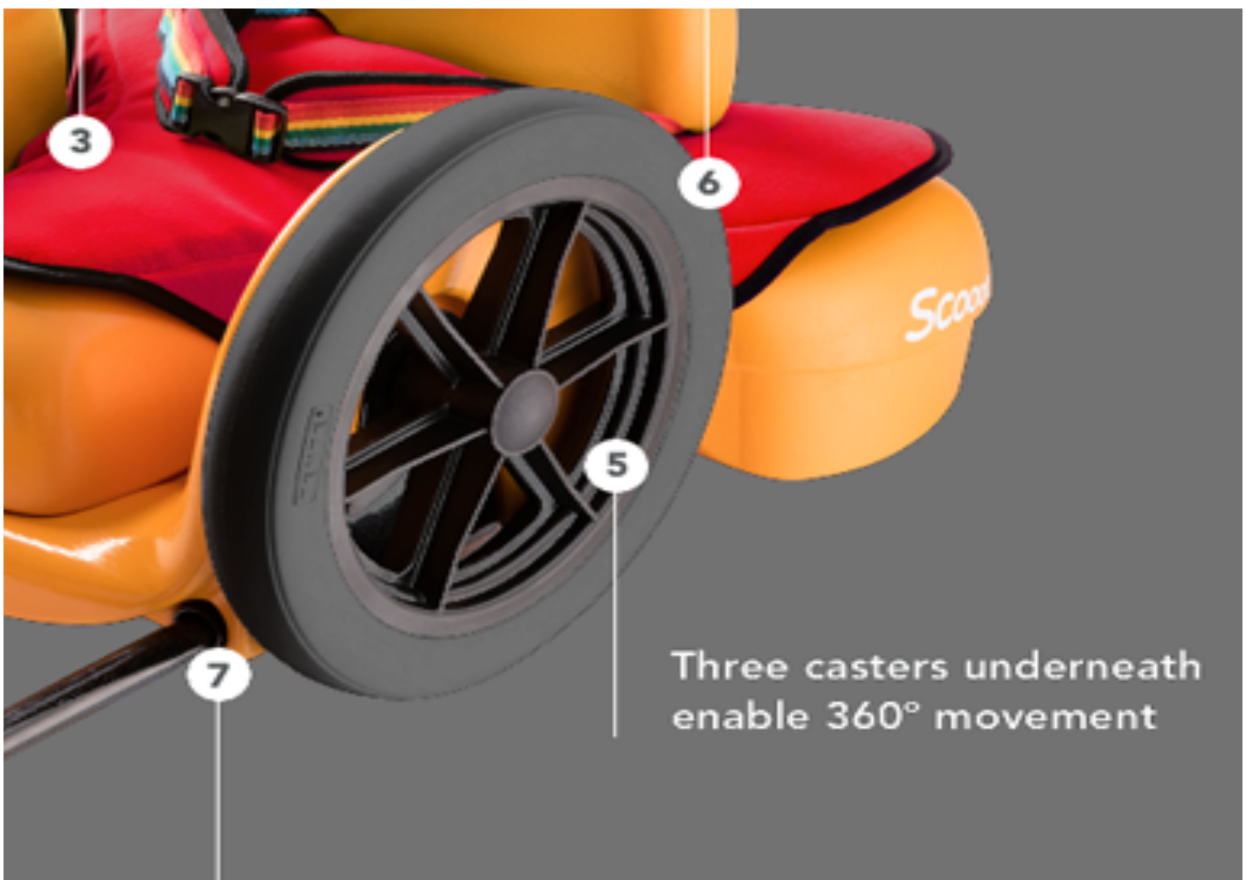


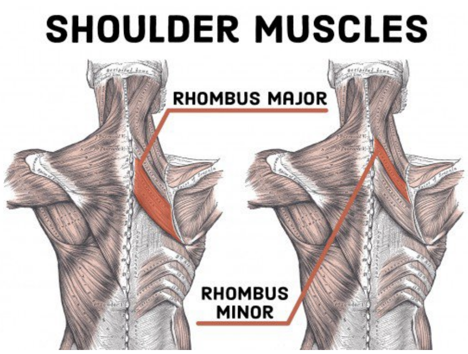
Figure 4 Scoot Wheels

3.3.1.2 Existing Design #2: Legs

Legs are the most efficient power source for many transport machines, such as a scooter. In the scooter's existing design, we can see that children have the ability to move the scooter by pushing the pedals.

Figure 5 Scooter Pedals

3.3.1.3 Existing Design #3: Human muscles



Human muscles is another source of human power. For example, children's that do not have arms and legs they can use the shoulder muscles as a human power body part. Moving the muscles sideways and the design will move is one of the human body powers.

Figure 6 Shoulder Muscles

3.3.2 Subsystem #2: Electrical Power

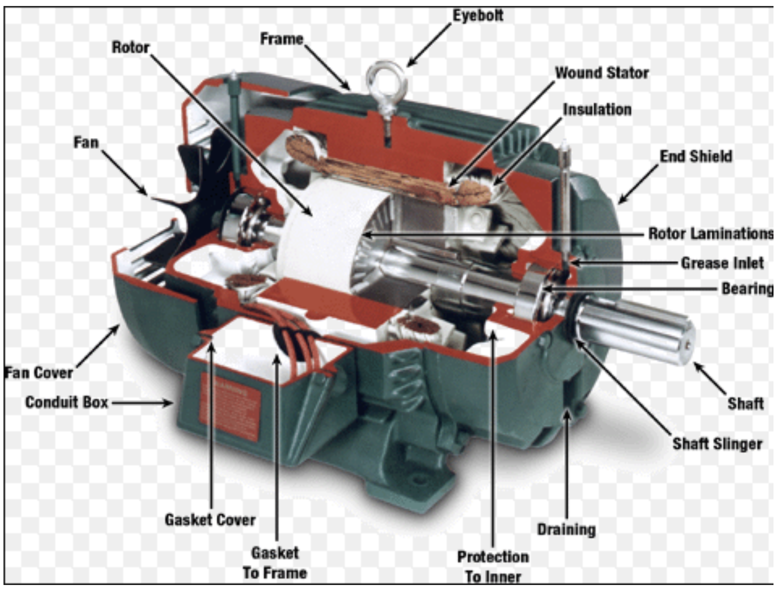
Electricity has been used in everyday human life consistently because it is a strong source for machines. There are two existing designs which showcase the usages of electrical power – this report will now outline two of those: batteries and electric motors.

3.3.2.1 Existing Design #1: Battery

Batteries are good sources of energy. They have chemical energy contained within the case which can be converted to electrical energy. Some batteries can be recharged as well.

Figure 7 Batteries

3.3.2.2 Existing Design #2: Electric Motor



Using an electric motor as a subsystem converts electricity to mechanical energy. Therefore, this piece of machinery will help with the GBG future design.

Figure 8 Electric Motor

3.3.2.3 Existing Design #3: Solar Panel System

Solar panel system works by collecting photons from the sun, then release electrons from the solar panel to the wires or any electrical device to run the machine.

Figure 9 Solar Panel System

3.3.3 Subsystem #3: Main Control System

Every device should have a spatial control system – in cars, this allows the rider to control the vehicle and display its duration. For this subsystem, a steering wheel and pressure pads have been deemed to be the most effective for the purposes of the GBG project.

3.3.3.1 Existing Design #1: Steering Wheel

Most vehicles have steering wheel to control it, and the team might use this control system for the car.

Figure 10 Steering Wheel

3.3.3.2 Existing Design #2: Pressure Pads

Self-balancing scooters have become very popular today. They operate according to a clever idea – the pressure pads are fixed around the scooter. They work by having many small systems implemented under the pads, so that human balance and nerves from the body control how the scooter operates – to move, stop, steer and rotate [5]. The team is interested in using this notion by designing a hand pressure pad instead of self-balancing pressure pads which require the use of the legs. These hand pads will help children who suffer from disabilities involving their legs so that they can control the car by using their hands instead.

Figure 11 Pressure Pads

3.3.3.3 Existing Design #3: Joystick

Joystick control system have been used for video games, but in our case using a joystick as a control system for the car designs. By select any button on he joystick the car will start work and by moving it the car will move for the directions the person choose.

Figure 12 Joystick

4 DESIGNS CONSIDERED

The hypothesized functional model is an important aspect of this report because it is what challenges you to know and understand the way your project works and functions. As for the material, energy, and signals used in the device you created. It tells you clearly what is inside your project, how it works, and what comes out of it. Creating the functional model has given our team the ability to understand how to work the device and how it will operate without the use of some sources of the device. Engineers are supposed to know how to reverse engineer their projects, with the black box and hypothesized functional model you are certainly able to achieve the qualified standards for any device. The models clearly give you true understandings in determining the inputs, outputs, and the sub functions of the project its self.

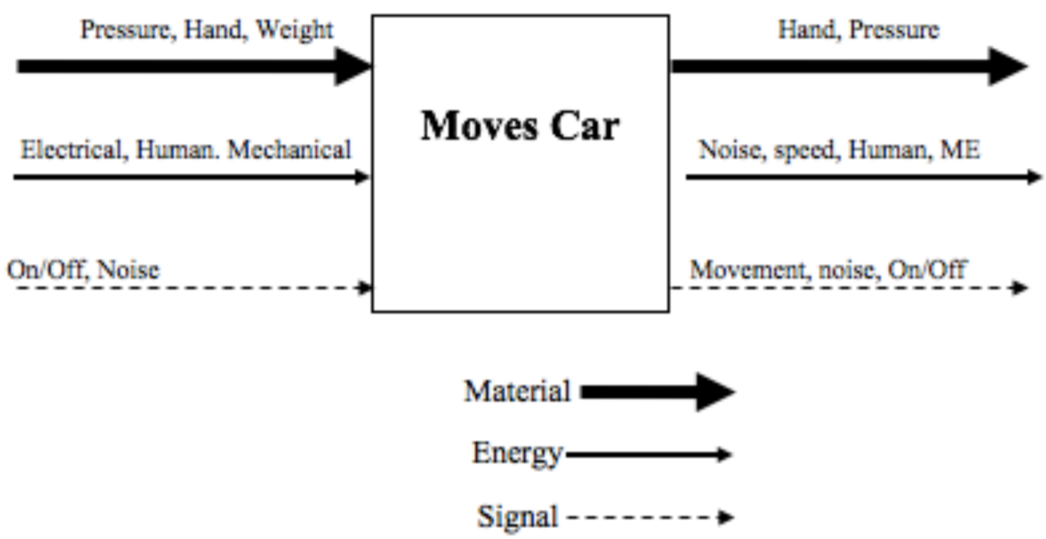


Figure 13 Black Box Model

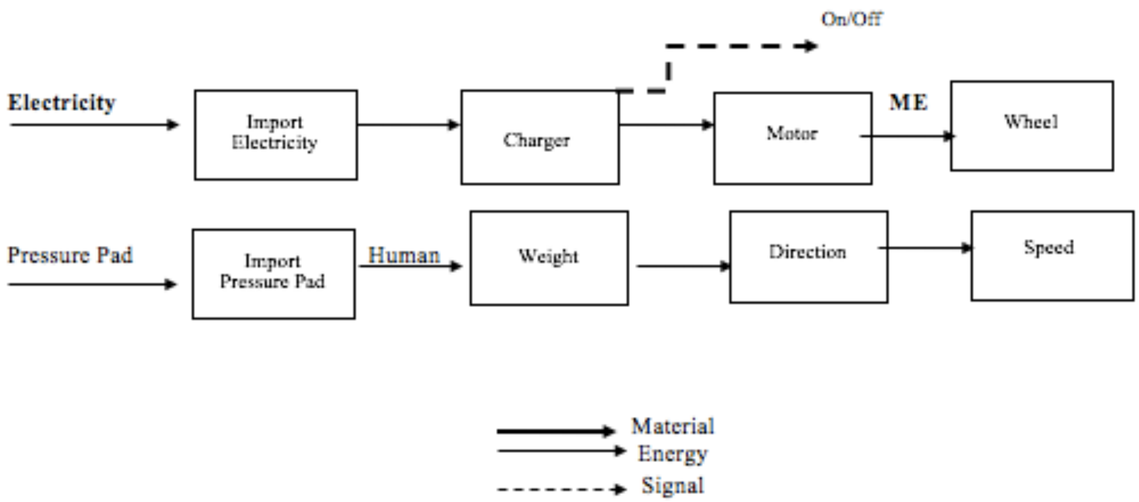
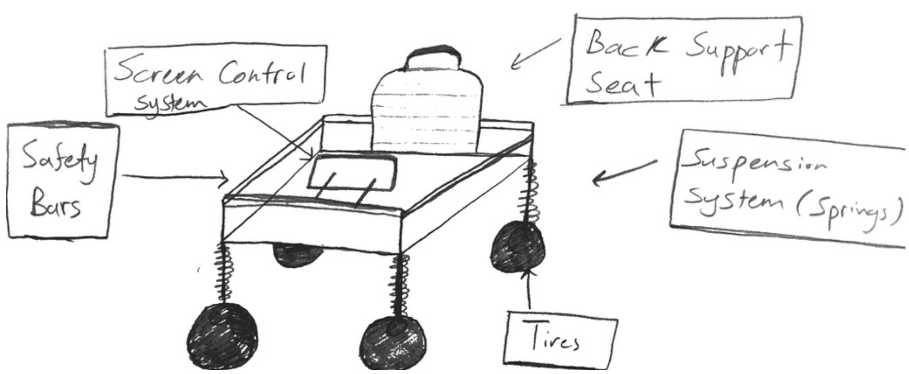


Figure 14 Functional Model

4.1 Design #1: Suspension Seat

In this design there is a screen control system, back support seat attach to the seat with safety bars, and between the seat and the tires they are attached to a suspension system.



Advantages: 1. No jerking motion due to suspension system.

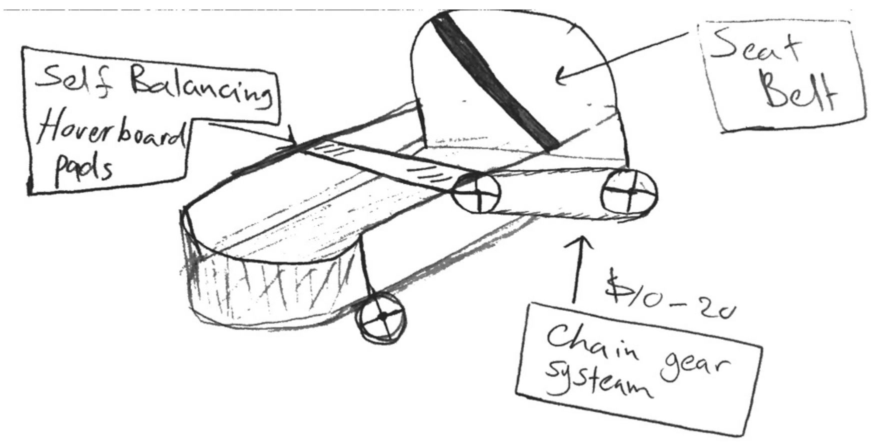
2. Safety Bars.

Disadvantages: 1. The height of the seat might not be pleased to the children due to not touching the ground.

Figure 15 Suspension Seat

4.2 Design #2: Hover board Bed

This basic design is all about self balancing hover board pads system, so its tires attached to chain gear system with the actual tires therefore, when the tiers on the self balancing hover board pads tiers rotate the actual tiers rotate also.



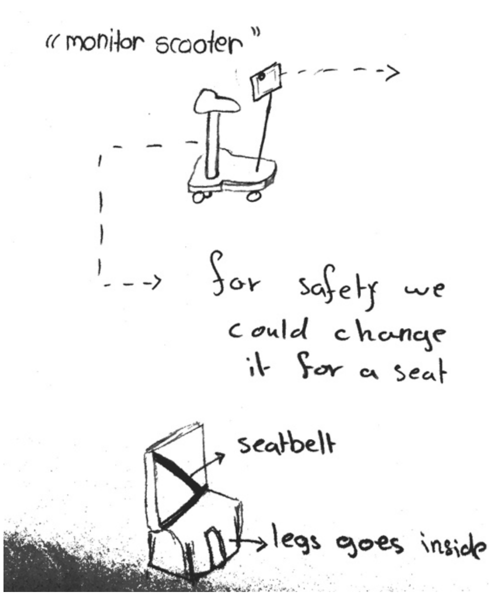
Advantages: 1. Due to seat belt it will add more safety for children's.

2. The child will ride the seat easily because the car has low height.

Disadvantages: 1. The chain gear might fail.

Figure 16 Hover board Bed

4.3 Design #3: Monitor scooter



The design has a normal scooter design but there are some changes to it. Instead of scooter steering wheel the team decided to have a monitor touch screen system. Another change is having a comfortable seat with seatbelt harness.

Advantages: 1. By having the touch screen so it is easy to control.

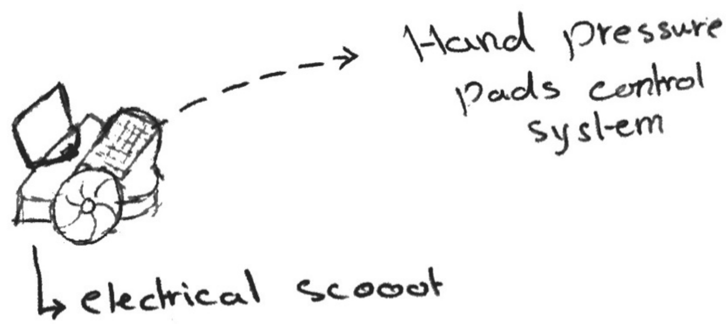
2. Extend the safety by having a seatbelt.

Disadvantages: 1. The weight of the user might affect the balance of the chair.

Figure 17 Monitor scooter

4.4 Design #4: Electric Scoot

This a scoot design that from the benchmarking but instead of physical use, the team added a hand pressure pads control system to make electric scoot.



Advantages: 1. Comfortable seat.

2. The child can feel the ground.

Disadvantages: 1. It is too low device have to elevated a bit.

Figure 18 Electric Scoot

4.5 Design #5: Hydraulic Baby Walker

This CV has a hydraulic system so the child has the choice to move freely and the baby walker also has control panel system.

Advantages: 1. With the hydraulic system the child going to feel freely.

Disadvantages: 1. There is not enough safety features therefore, the guardians need to watch out of them.

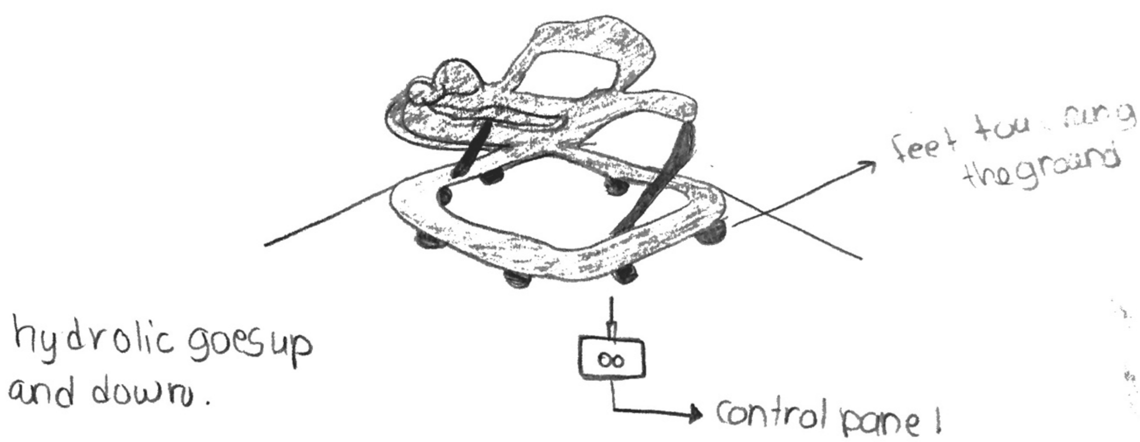


Figure 19 Hydraulic Baby Walker

4.6 Design #6: Baby Walker

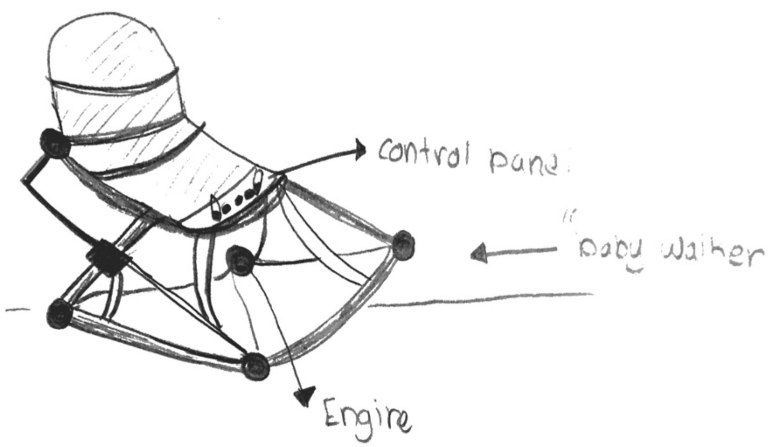


Figure 20 Baby Walker

This design is a normal baby walker but the team want to add an engine and can be controlled by control panel.

Advantages: 1. The child has the ability to control the baby walker.

Disadvantages: 1. The engine is underneath the child without a safety box.

4.7 Design #7: Speed and direction Controller

This design has a speed and direction controller system by using the feet therefore, the steering wheel is fake. Also the design has a both auto and remote control brakes.

Advantages: 1. Comfortable seat.

2. Remote control brakes for guardians.

Disadvantages: 1. Due to the car move using feet, it is distracting to have a feet brake too.

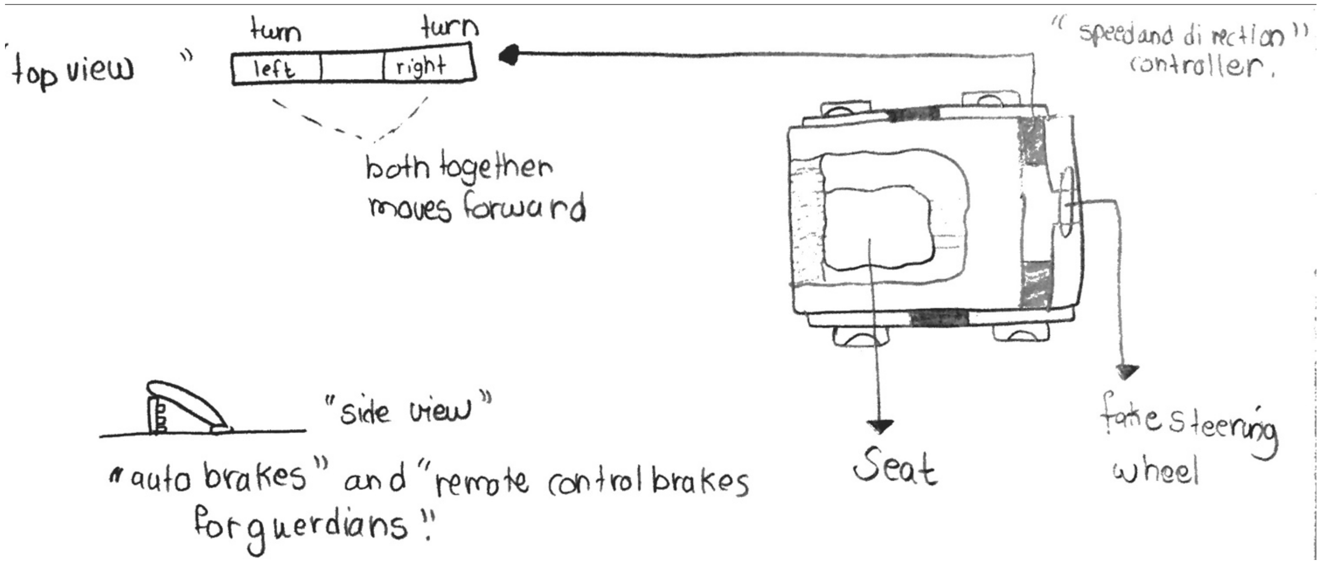


Figure 21 Speed and direction Controller

4.8 Design #8: Superman Bed

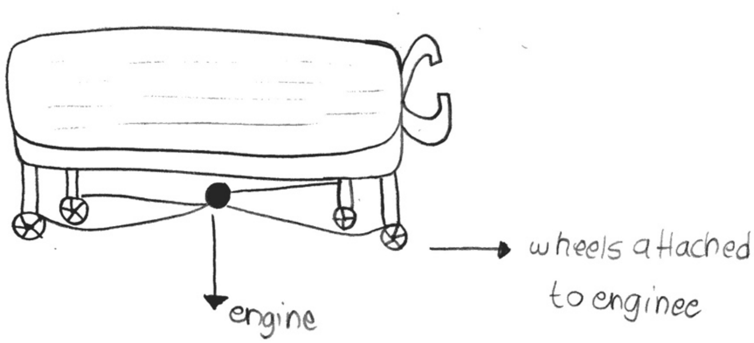


Figure 22 Superman Bed

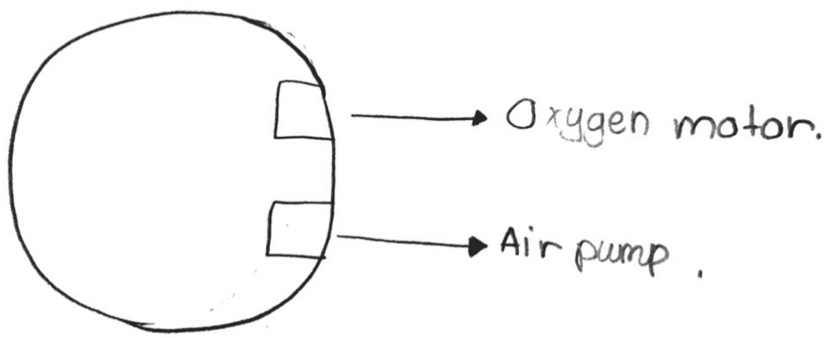
The idea of this design is came from a hospital bed. So the child can lay down on their belly and use the control steering wheel, that attached to the engine too.

Advantages: 1. Comfortable use by lying down.

Disadvantages: 1. The bed is too big to control.

4.9 Design #9: Pumping Ball

This ball design is can be used over water and grass. There is an oxygen motor for the user to breath and air pump for the ball.



Advantages: 1. It gives a change for the child to use their physical body.

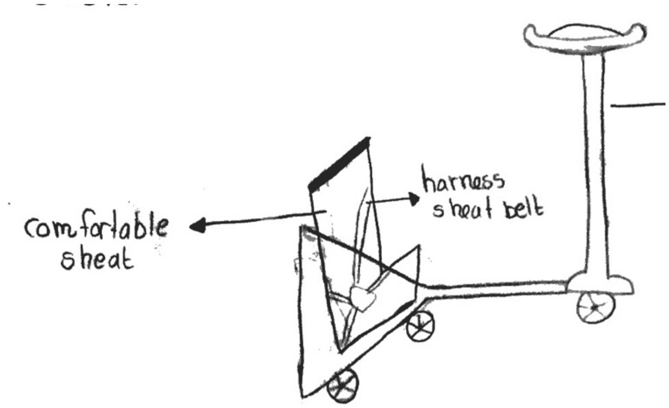
2. Easy to use in the pool.

Disadvantages: 1. The ball can break easily.

Figure 23 Pumping Ball

4.10 Design #10: Scooter

On this scooter design it has a comfortable seat with harness seat belt and a scooter steering wheel. Also this design has a three wheels for stability.



Advantages: 1. Comfortable seat.

2. Not dangerous to use.

Disadvantages: 1. The steering wheel is too high to reach.

Figure 24 Scooter

5 DESIGN SELECTED

5.1 Rationale for Design Selection

5.1.1 Pugh Chart

The team has created a total of 20 concepts in order to finalize the design of the project. The concepts were created based on different customers such as normal children and children with disabilities. The team then chose the top 10 design in order to compare them using the Pugh chart below. The Pugh chart comparison was depending on the criteria below where all designs were compared to CV9 design. CV9 was chosen since the design was an out of the box design and the lowest in meeting the Pugh chart criteria. The chart below will display the most creative designs in order of having most positive signs. The winning designs in the Pugh chart were CV's 2; 4; 5. The winning designs later moved to be compared in the decision matrix in order to choose the final design.

Criteria

a. All materials and construction cost must be under $1500
b. Development risk (will it work? What are the chances it won't?)
c. Technical difficulty (Does the team have the skills/resources to create the CV?)
d. Schedule risk (will the team be able to finish the device by the due date?)
e. Does it meet the customer requirements?
f. Does it have jerking motion?
g. Is it accurate?
h. Is it made of standard components?

Table 4 Pugh Chart

Concepts	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
a	+	+	+	+	+	+	-	+		+
b	-	S	-	-	+	-	-	-	**D**	-
c	-	+	-	-	+	+	-	+		+
d	S	S	S	S	S	S	S	S	**A**	S
e	+	+	+	+	+	+	S	-		S
f	+	+	-	+	S	S	+	S	**T**	+

g	+	+	+	+	+	-	+	-		-
h	-	+	+	+	+	+	+	+	**U**	-
Σ +	4	6	4	5	6	4	3	3		3
Σ-	3	0	3	2	0	2	3	3	**M**	3
ΣS	1	2	1	1	2	2	2	2		2

5.1.2 Decision Matrix

After considering the three designs from the Pugh chart CV 2; 4; 5. The team used decision matrix (table 5) with the same criteria that has been used in the Pugh chart. The criteria weight has to be sum of 1 therefore, the team weighted the most importance to less importance for each criterion. After weighting the criteria, the team considered a raw weight out of 100 for each CV with each criterion. Then the teams used the weight criteria and multiplied it with the raw weight to get the final weight of each CV. Finally, by sum up the final weight the team gets the total weight for each CV, and ranked each CV from the highest total weight. The final design that the team will design is CV4 the electrical scoot.

Table 5 Decision Matrix

Designs		**CV 2**		**CV 4**		**CV 5**	
Criteria Weight		**Raw**	**Weight**	**Raw**	**Weight**	**Raw**	**Weight**
All cost must be under $1500	0.1	80	8	85	8.5	40	4
Development risk	0.2	80	16	90	18	40	8
Technical difficulty	0.25	80	20	80	20	60	15
Schedule risk	0.15	90	13.5	100	15	75	11.25
Does it meet the customer requirements?	0.1	85	8.5	85	8.5	70	7
Does it have jerking motion?	0.05	100	5	100	5	80	4
Is it accurate?	0.1	70	7	75	7.5	30	3
Is it made of standard components?	0.05	85	4.25	85	4.25	100	5

Total weight	1		82.25		86.75		57.25
Relative Rank			2		1		3

6 REFERENCES

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