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Project Title

Solar Powered Ergonomic Beach Wheel Chair: Mobility For Physically Challenged

Team (9) Members

Student Name	Student ID
Abdulaziz Albasri	**201201101**
Abdullah Alqhtani	**201102937**
Bejad Alsubei	**201201864**
Hatim Alsahfy	**201200067**

Advisor Name: DR. NADER SAWALHI

Co-Advisor Name: DR. FARAMARZ DJAVANROODI

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Solar Powered Ergonomic Beach Wheel Chair: Mobility For Physically Challenged

Abstract

This project is a modification and phase 2 of an existing previous project (Electric Beach wheelchair) done by PMU students. The objective of this project is to modify the Electric Beach wheelchair to run on solar energy and add a rotational functionality to the seat, to make it more versatile for a handicap rider. At this phase, our main focus has been on the source energy (Solar), for which solar panels where, utilized and improved batteries life. Moreover, efficiency will be improved and reserves storage unit might be added as extra precautions.

On the journey to mobility and freedom, motorized scooters and wheelchairs are the tools to finish that journey. The addition of some devices enables persons with physical disabilities a comfortable travel beyond their own homes. In the past, many people disliked the idea of a mobility scooter because of low-life of the battery. People started to purchase a mobility scooter in order to lead a more comfortable and independent existence. Considering a primary method to get around, they are perfect for people with limited or no body mobility. Electric powered wheelchair is essentially powered by electric motors located at the rear of the wheelchair.

Acknowledgement

We are thankful to the Mechanical Engineering Department because of whom; we have gained knowledge and professional skills that were applied in throughout this project. We are also grateful to Prince Muhammad University as a whole which provided us a platform where we can learn and apply our understanding in order to make real world projects.

We are grateful to our project advisor, Dr. Nader Sawalhi and our Co-Advisor Dr. Faramarz Djavanroodi for providing us assistance and guidance where ever we needed it, without them this project would have been very difficult for us to finish in time. Last but not the least; we will like to thank our families for their endless support. Also we will like to thank all our friends and everyone who became a part of this project in any possible way.

CHAPTER 1

Introduction

1.1 Project Definition

Design of a solar powered electric beach wheelchair. The solar energy would be harvested through a solar panel, and this process is controlled by an electric controller to channel the energy to the battery then shut the flow off once battery is full. This clean energy is abundant and reliable. Also, the seat on the wheel chair is capable of rotating 90^0 to the right and left, using a DC motor and a gearbox channeling the rotary power to the seat.

1.2 Project Objectives

- Utilization of clean energy source reduces pollution and save energy wasted.
- Offer reliable and abundant energy source to charge the wheelchair almost anywhere exposed to sunlight.
- Ease access to the seat with the rotation function.
- Wheelchair should meets the user’s needs and environmental conditions;
- Provides proper fit and postural support. (ergonomic design and functionality)
- Be safe to use, versatile, and durable.
- Should support an average full size adult.
- Reduce the weight of the chair and improve the maneuverability (Have a reasonable turning radius).
- Improve the energy reserve capacity.

1.3 Project Specifications

Metrics features:

- ❖ Maximum speed of 4.6 km/h.
- ❖ Distance Range: 20 km’s
- ❖ Battery Range: < 5 hours
- ❖ Charging Time: around 8.5 hours
- ❖ Seat rotational range: 90^{o} to each side.

Marketing features:

- ❖ The chair is very sturdy and rigid.
- ❖ The system utilizes clean energy.
- ❖ Easy to move.
- ❖ The whole system is portable.
- ❖ Easy access to the seat with rotational function.
- ❖ Upgradable batteries if needed.

1.4 Applications

- ❖ Can be used in remote locations with no electric plug source.
- ❖ Transport patients from remote inaccessible areas, which can be further upgraded with remote controls.
- ❖ Can be used by elderly or handicapped individuals in urban areas on asphalt.

CHAPTER 2

Literature Review

2.1 Project Background

Wheelchairs have existed since late 1700 are helping the people with disabilities to move around. Today, a variety of wheelchairs are available in market and serve different purposes, ranging from ordinary manual or electric wheelchairs to sports wheelchairs to beach wheelchairs. The purpose of this project is to design an electric beach wheelchair, providing the disable person easy access to the beach with complete independence.

This project will serve as Senior Design Project for students of Mechanical Engineering department at Prince Mohammad University.

The need for this project arises from lack of beaches which are wheelchair accessible in the Eastern Province, Saudi Arabia. Although physically fit individuals can freely enjoy their time on beaches, the disabled ones can only rely on travelling on cars up to certain limits and lack independence. Beach wheelchair would enable them to go places which they could have only wished before and at the same time they would have complete independence as the wheelchair will be electrically powered and would not require any assistance. Also, the project will be first of its kind in the kingdom as there are no beach wheelchairs manufactured or available in the market currently. Therefore, a group of senior students at PMU decided to take the initiative and design such wheelchair.

Sun is a huge source of energy which has recently been tapped into. It gives huge resources which can generate clean and non-polluting electricity. Solar energy is a truly renewable energy source. It can be harnessed in all areas of the world and is available every day. Moreover, solar energy will be accessible as long as we have the sun, therefore sunlight will be available to us for at least 5 billion years, when according to scientists the sun is going to die. One of the challenges that people with limited range of mobility regularly face is the difficulty of getting on and off the chair, due to the obstructions created by the design of the wheelchair. The obtrusion of the front tires obstructs the ease of accessibility to the seat on the chair. Additionally, the energy that supply and run the chair is limited by battery capacity and shortage of electrical sources. Modifying the chair to rotate 90 degrees would allow the user to access the chair more easily. With regards to the energy supply, utilization of detachable solar panels would allow the chair to tap into a high abundant source of energy.

2.2 Previous Work

In the beginning the team will study the existing outdoor wheelchairs to analyze the designs and understanding their functionality. This will help in development of our design and overall project.

Although it was decided in the initial stages of the project that our wheelchair will be electrically powered, in this section we will be analyzing both electric and manual outdoor wheelchairs in order to acquire a much extensive understanding.

As mentioned earlier, no beach wheelchairs exist in the market in Saudi Arabia therefore, most of our research will be based on the internet as we will look at their specification sheets, brochures and read reviews about them.

In the beginning we started looking at the following types of wheelchairs:

1. Outdoor wheelchair
2. All Terrain wheelchair
3. Manual/Push beach wheelchair
4. Electric beach wheelchair
5. Design and development of solar power-assisted manual/electric wheelchair
6. Wheelchairs Run on Sunshine: KYOCERA Solar Modules Generate Energy to Charge Electric Wheelchairs

By looking at all these different types of wheelchairs, we got different ideas and understanding of the designs. One of each types designs will be discussed in the report, the remaining will be added in the appendix as they were used as reference.

1. Outdoor Wheelchair

As shown in figure 2.1 the first wheelchair we reviewed was P4 country wheelchair by 4Power4. It is designed to work mostly outdoors on surfaces such as: Gravel, Grass, Pebbles and Cobblestones. The specifications of the wheelchair are provided by the manufacturer. The maximum speed for this wheelchair is 10km/h and the range is 30 km. Maximum upward and downward till is 30% and the maximum sideways tilt (pathways) is 20%. All four wheels are powered and thus it used 4 batteries each rated at 250 Watts, 24 Volts. The batteries used were maintenance free (gel batteries) and the total weight capacity is 120 kg and the total empty weight (without the user) is 249 kg.

Fig 2.1: P4 Country Outdoor

From this design, we realized that the power required to run the wheelchair on these surfaces is a lot as the total power for this wheelchair is:

4x250 = 1000 W.

Also the tires used in this wheelchair initially seemed to be able to work on sand, but as sand was not mentioned in the surfaces that the wheelchair will work on in the specification sheet, we highly doubted that these wheels will work on sand with this power as the wheelchair by itself was quite heavy weighing at 249 kg without the user.

After reviewing this wheelchair thoroughly, we come to a conclusion that the wheelchair had enough power to work on hard surfaces but when it comes to sand, as the surface is soft and the wheelchair is quite heavy and the contact area of the tires with the surface is not a lot, we understood that this will not work on sand.

2. All-terrain wheelchair

Majority of the all-terrain wheelchairs used tank tracks. As shown in figure 2.2 the chair we reviewed is known as Tank-chair. It uses 12-inches rubber tracks capable of working on snow, sand, gravel and mud. The drive terrain consists of 2 batteries, rated at 2hp each and the RPM is 2700. The frame is constructed from aluminum and weighs 550 lb. or 250 kg. The staring price of this wheelchair is $18,000. The majority of the cost is due to the huge tank tracks.

The positive feature of this wheelchair comes from its name, Tank-chair which gives it the capability of maneuvering easily on almost any surface.

Fig 2.2: All-terrain wheelchair

3. Manual / Push Beach Wheelchair

In figure 2.3 the beach access wheelchair by 1800Wheelchair is a simple wheelchair constructed by durable non-corrosive PVC pipes. The rear and front shafts were made of steel. As this is a manual wheelchair, the construction was very easy and simple.

The structure was very light weight (70 kg) and it used balloon tires. The total weight capacity is 115kg. Most of the reviews stated that pushing the wheelchair was relatively easy and did not require a lot of effort to move.

Some negative reviews stated that the turning was a very difficult task as you literally had to lift a little and guide the wheelchair towards left or right.

Fig 2.3: Beach Access Chair

4. Electric Beach Wheelchair

The Beach Cruiser by Beach Powered Mobility shown in figure 2.4, is powered by two dc motors rated at 760W each. The batteries used are rated 12 V and provide 55Ah. This wheelchair also uses the balloon tires and has a range of 16 km and a maximum speed of 10km/h. The structure is very light and the total weight capacity is 110 kg. But the majority of weight is added by the batteries and the motors.

The biggest advantage of this wheelchair when compared to manual beach wheelchair is that it requires no assistance and is surprisingly fast in sand.

- 49cm Polyurethane balloon wheels (rear)
- 30cm Polyurethane balloon wheels (front)
- Emergency motor disengage levers
- Standalone 3 stage battery charger

Fig 2.4: Beach Cruise

5. Design and development of solar power-assisted manual/electric wheelchair

As shown in figure 2.5 wheelchairs need aid a fundamental assistive gadget for a significant number people for harm or inability. Manual wheelchairs furnish a moderately minimal effort answer for those versatility necessities of such people. Furthermore, they provide a viable method for enhancing those user's cardiopulmonary capacity and upper-limb muscle quality.

However, manual wheelchairs have a terrible reduction from claiming mechanical efficiency; furthermore consequently those dangers about client weariness and upper-limb damage will be expanded.

Electric-powered wheelchairs diminish the danger of damage what's more give An more advantageous method for transportation. However, they bring an extensive physical extent Also would moderately exorbitant.

Accordingly, the available consider uses a nature capacity organization technique with create An wheelchair with An user-selectable manual/electric propulsion mode Also a assistant sun powered force supply framework. Those assistant sun based force supply expanded the venture out range of the wheelchair Eventually Tom's perusing pretty nearly 26% compared with that of a wheelchair powered Toward battery alone. Moreover, those wheelchairs need a secluded plan What's more might be disassembled and collapsed to straightforwardness for transportation or capacity. Overall, the exhibit outcomes recommend that those suggested wheelchair gives a powerful also advantageous method for meeting those portability needs about people for versatility challenges.

Fig 2.5: Solar Power-assisted Manual/Electric Wheelchair

7. Wheelchairs Run on Sunshine: KYOCERA Solar Modules Generate Energy to Charge Electric Wheelchairs

Electric wheelchairs normally might make powered by those primary utility grids what are more generally obliging two 12 volt rechargeable batteries.

Those clues behind the Quimby Huus sun based venture might have been with inferring this energy actually starting with renewable vitality. In place on figure it out this idea, a sun based force generating framework necessary will be introduced on the top to nothing tenants from reliance on the primary grid and secure an environmentally-friendly type of vitality. Those pioneers of the project, Sandro Buff, rapidly picked up the help of the Quimby Huus director.

2.3 Comparative Study

There are many projects that have been made similar to our project. Our project (Beach Wheelchair) is designed to be able to be driven on road and off road. And a hydraulic is going to be used in order to raise the seat above in certain number of inches and rotates 90 degrees to the left. In addition, a solar panel will be used to be the source of charging the battery. Also, a safety system organizer is going to be installed with the battery to the wheelchair.

Moreover, the seat will be replaced with another one. The reason of changing the seat is to have a seat that is attached to the new parts that we are going to install.

There was a project from University of Virginia's School of Engineering and Applied Science which has been made by its students. Their wheelchair design won first place in the World Cerebral Palsy "Change My World in One Minute" competition. The solar panels serve two purposes. Not only do they allow the wheelchair to charge even on cloudy days, but they also provide shade on sunny days. Everything on this wheelchair can be controlled with a joystick.

Anyone who has enough mobility to move a joystick can control the chair with ease. The wheelchair also has several USB power outlets so the user can charge a Smartphone, tablet or any other mobile device using solar power.

Another similar project was made in. Dr. Azad is a member of the Institute of Electronics and Electrical Engineers (IEEE) Special Interest Group in Humanitarian Technology (SIGHT) in Bangladesh, called the CARG SIGHT. He and his team delivered their prototype to the Centre for the Rehabilitation of the Paralyzed, where researchers will continue to improve the design. This project is almost similar to our project. The only deference was the seat shape.

CHAPTER 3

System Design

3.1 Design Requirements, Constraints and Specifications

3.1.1 Engineering Standards

Engineering standards are documents that specify characteristics and technical details that must be met by the products, systems and processes that the standards cover. The purpose of developing and adhering to standards is to ensure minimum performance, meet safety requirements, make sure that our project is consistent and repeatable, and provide for interfacing with other standard-compliant equipment. Speaking of our project from engineering standards perspective, it must meet safety, environmental and health responsibility.

3.1.2 Sustainability

Solar is originally developed for energy requirement for orbiting earth satellite have expanded in recent years for our domestic and industrial needs. So we are trying to combine these solar panels to a wheelchair to make solar energy is the only source. Solar power is produced by collecting sunlight and converting it into electricity.

As we know that solar energy is most often used in remote locations, although it is becoming more popular in urban areas as well. After the battery of the wheelchair is charged, the wheelchair will be able to move remotely (controls attached to the chair) for few hours.

3.1.3 Environmental

The project we are working on depends on solar energy, which is safe and an environment friendly. Unlike other sources of energy, using solar energy does not affect the environment. The design of our project is made to keep the one who uses it and people around safe from injuries. The seat will be well designed and for the passenger to avoid any pain in the passenger's back while using the wheelchair for a long time. Also, the speed of the wheelchair is not high so it will never cause any injuries if accidently hit someone.

3.1.4 Social

The solar powered wheelchair will help handicap people to be able to move from place to another without asking for help. So, people who can't walk or have difficulties to move around easily, now they can do it in a very easy and comfortable way. This project will make it possible for handicap people to let them depend on their self and be a valuable part of the society that still can produce and give regardless of their body disability.

3.1.5 Economic

Components which are driving the development of the worldwide electric wheelchair market are developing overall elderly population, need of robotized wheelchair for impaired individuals from developed nations, such as UK, France, Germany, US, Canada and Japan. Moreover expanding the interest or demand of advanced wheelchairs from the gaming industries like sports is also impacting the development of electric wheelchair market, the same number of sport events are sorted out for handicapped people.

3.1.6 Manufacturability

Design for manufacturability will allow some potential issues to be addressed and fixed in the design stage and will address the least costly way to apply this fix. Other factors that affect the manufacturability are the type of raw material to use on the adjustments of the wheelchair, the form in which these raw materials are added on the wheelchair, the dimensional tolerances of the hydraulic system, the rotational angle of the gear in which the wheelchair will rotate in.

3.1.7 Safety

Accident and injuries for people with special needs are consistently in a high rate especially injuries that occur in the mobility phase, which means accidents in the transport stage from one point to another. Other major safety issues are in the stopping phase, which is controlled by the breaks on the wheelchair.

In the research and background part of this project it has been researched that these safety issues are the most common ones:

- Wheelchair or scooter user gets hurt when in a new operating environment
- Wheelchair or scooter user is hurt, trapped and alone, and cannot call for help.
- Safe Equipment Storage and Battery Charging Practices.
- Periodic equipment examination, cleaning, tune-up and repair maintenance.

3.2 Design Methodology and Considerations

3.2.1 Rotational Function

The proposed rotational ability for the seat was to mainly allow for easier seating, since previously the design of the chair posed as a constraint due to the far protrusion of the big front wheels, plus the fixed far positioned hand rest which wasn't practical. While designing the rotational function, the protrusion of the big front wheels posed an obstruction impeding the footrest from rotating along with the seat, plus more space was needed to house the DC motor and gear housing below the seat, thus the side supports had to be removed and replaced with four vertical supports to offer more vertical and horizontal space.

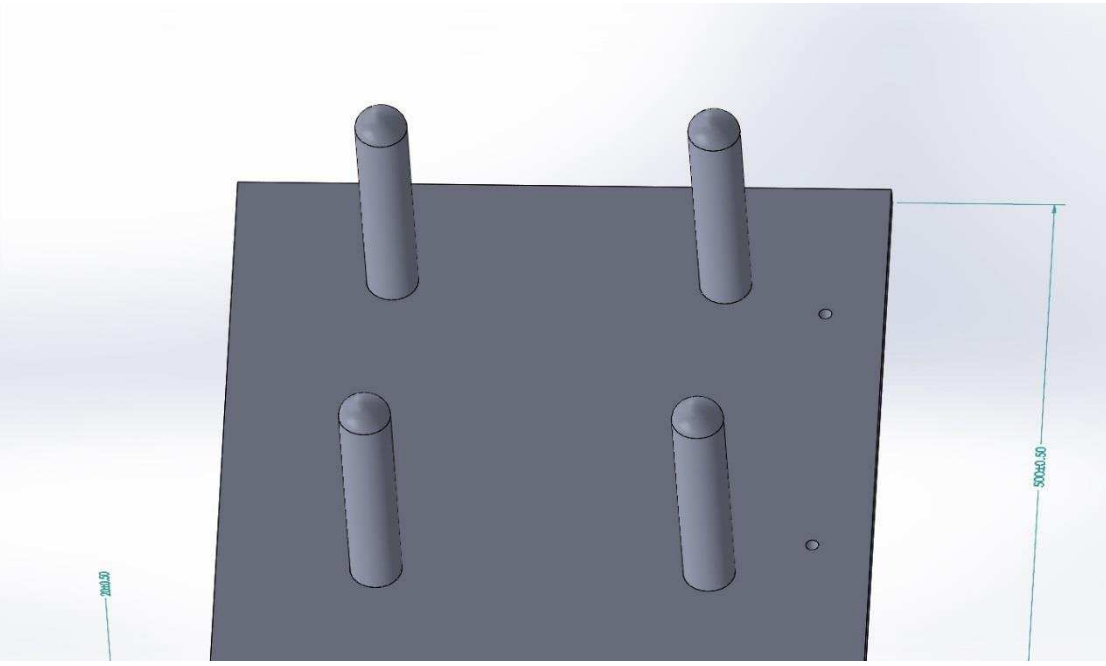

Figure 3.1: Base Plate (housing the motor and gearbox)

While designing the supports, the main goal was to support the weight of the passenger without impeding the rotational ability, thus the support bars were designed housing free spinning ball at the top to allow the seat to slide on them.

A shaft is connected to the seat and connected to the gear housing that is operated by a DC motor, which was the most effective and economical solution since the compacted hydraulic pumps and AC motors were expensive.

To find the torque needed to rotate the seat through the shaft equation 3.1 is used:

$$T=\mu*m*g*R \quad \text{......... Equation 3.1}$$

Where:

T : the required torque

μ : the friction coefficient

m : the weight

g : earth gravity

R: radius

Our acceptable/desired RPM agreed upon by our team-members is 2 RPM, as in equation 3.2.

$$\text{Power} = \text{Torque} \times \text{RPM} \quad \text{......... Equation 3.2}$$

3.2.2 Solar Energy

The idea in this phase is to charge the battery using solar energy while the seat is idle. While designing the seat two ideas were proposed; one of which is installing the solar panels on the seat, or building a portable solar charging station.

After much considerations and discussions, the group was advised by the co-advisor to install an attached solar panels on the seat, and use them to charge the battery only while the seat is idle. While keeping in mind, the board has to have enough charging speed that pretty much surpasses home electrical sockets charging speed.

The average solar panels found in the local market are around 100watt in output and 1000mm x 750mm in size, such size constraint would prevent us from utilizing more than one panel on the chair. Therefore, the design of the system will consist of the previous battery, controller and this mentioned above solar panel.

Considering that the charging time is vital in this study, the below equation is used to measure the time needed for full charge:

The battery capacity 70 A X 12 V = 840 watt

The solar panel 100 watt

Estimated charging time = 840 / 100 = 8.4 hours

3.3 Product Subsystems and Components

The chair will be rotating to one side by 90 degree. The parts used for this function are gears. We were going to use a hydraulic function, but we asked for advice about this issue and gears function was the most appropriate and convenient more than hydraulic function.

The only source for the beach wheelchair is solar energy. We looked carefully for a high quality solar panel to install it. There are many solar panels available in the market with different qualities and sizes, but we still looking for the best solar panel for the wheelchair.

The previous seat that was installed in the previous project was not ergonomically, thus it will be upgraded with a more suitable and ergonomically seat.

According to many researches the best seat that can provide comfort for the passenger is an ergonomic medical seat, which can be provided in many models and sizes.

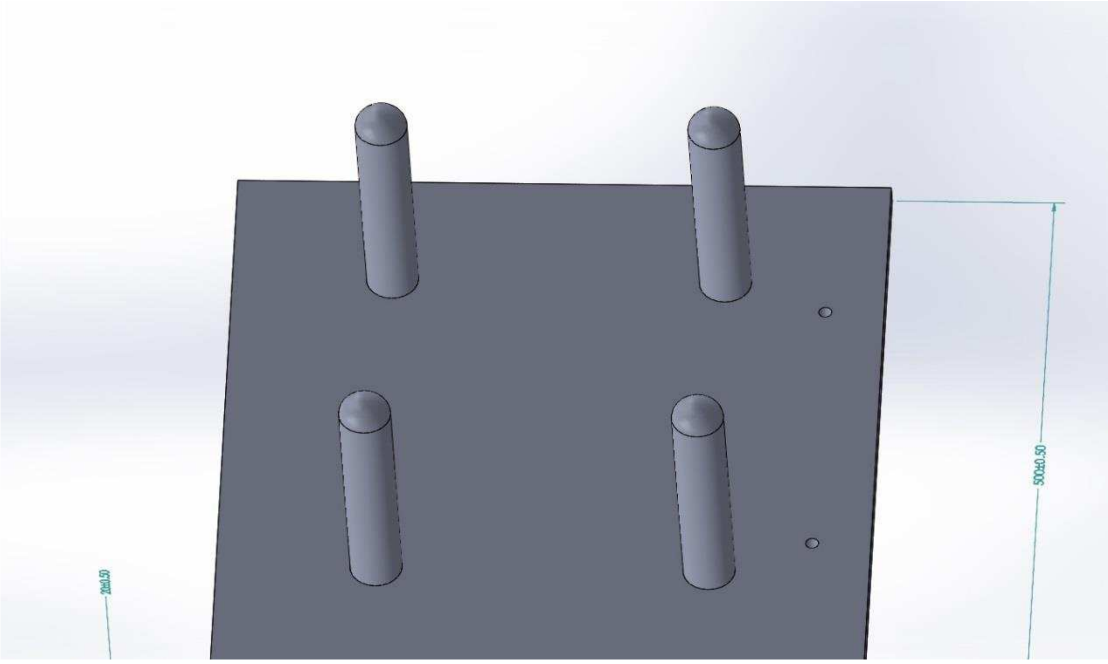

Figure 3.2: Base Plate

This base plate sits on top of the batteries and the chair motor, as its main purpose to house the rotation mechanism (gearbox and DC motor)

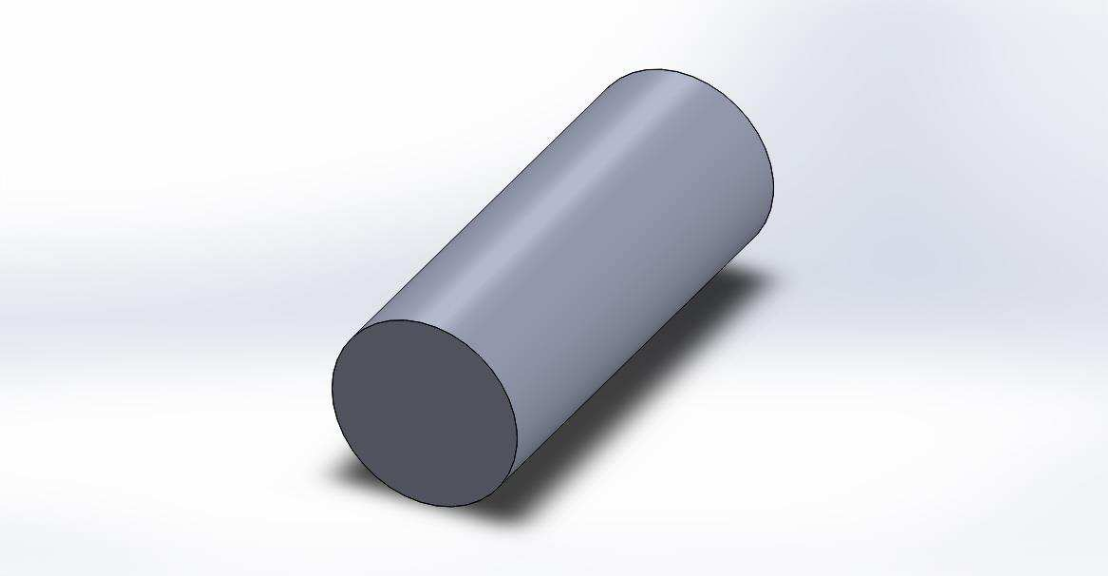

Figure 3.3: Rotating Shaft

The rotating shaft transfers the torque of the motor to the gearbox, as another one welded to the seat transfers the torque from the gearbox.

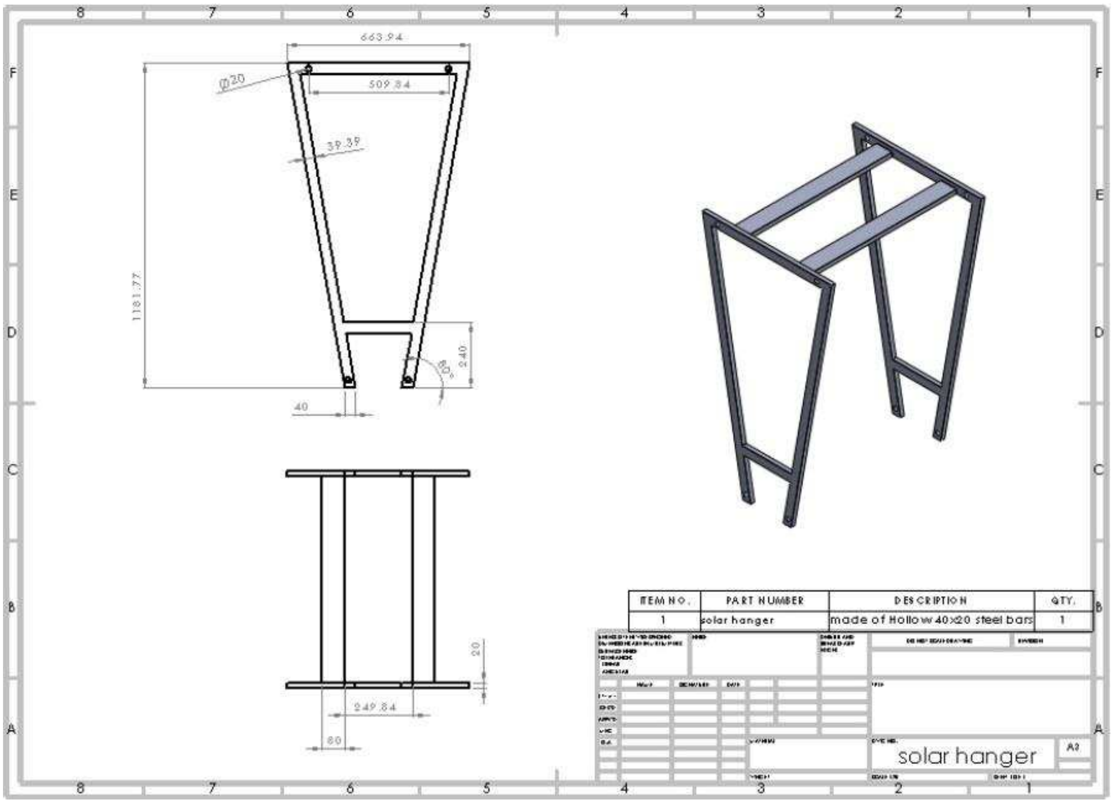

Figure 3.4: Solar Hanger

The solar hanger attaches to the seat on the chair and mainly supports the weight of the solar panel.

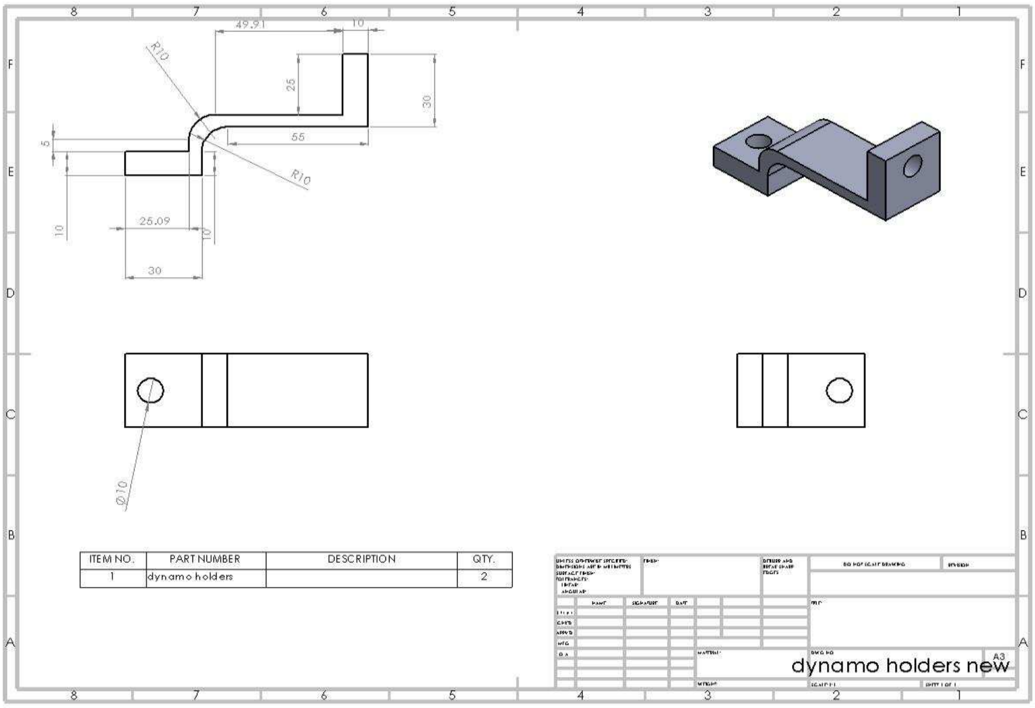

Figure 3.5: Dynamo Holders

The dynamo holder attaches to the dynamo and holds it down in place to help transfer the torque to the gear box effectively.

3.4 Implementation

In the figure 3.6 the implementation phase of each part is shown, and how each component is connected together to form the rotating mechanism designed to assist the user of the wheelchair.

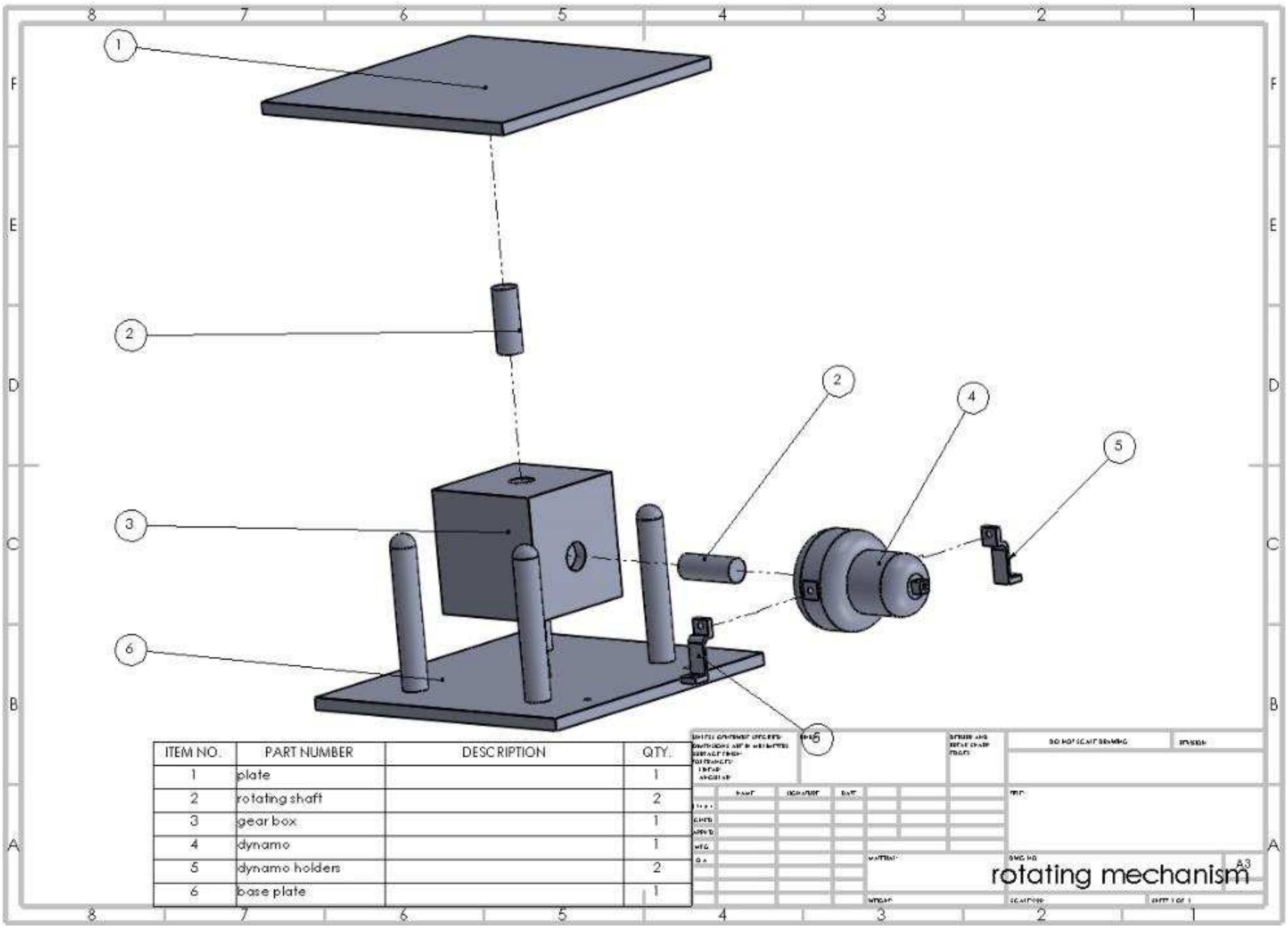

Figure 3.6: Rotating Mechanism

CHAPTER 4

System Testing and Analysis

4.1 Subsystem 1 (Seat Rotation)

4.1.1 Objective:

The rotational functionality has to be fully operational whether under stress (the user's weight) or free of stress (idol), while maintaining reasonable steady rotational speed and achieving 90^{o} degrees turn on either side.

2.1.2 Setup:

In the shop, we've used a non-contact tachometer (CDT-2000HD) as shown in figre 4.1. We used it in order to measure the rpm of the shaft attached to the seat, and long sand bags weighing 40 kg each to simulate the distribution of the human's body weight on the seat. We've conducted this testing for several scenarios (without weight, 40kg, 80kg, 120kg, and 160kg on the seat).

Figure 4.1: Non-contact Tachometer (CDT-2000HD)

4.1.3 Results:

To measure this we have taken the RPM randomly during full 180^{o} rotation from right to left 3 times and calculated the average RPM for all the weights using CDT-2000HD. The results are shown in table 4.1.

Table 4.1: Turning Speed

Weight	RPM
0 kg	1.765
40 kg	1.744
80 kg	1.705
120 kg	1.676
160 kg	1.630

Figure 4.1 shows the graph plot from the result we got from table 4.1. The conclusion was the more weight you increase the lower the revolution per minute.

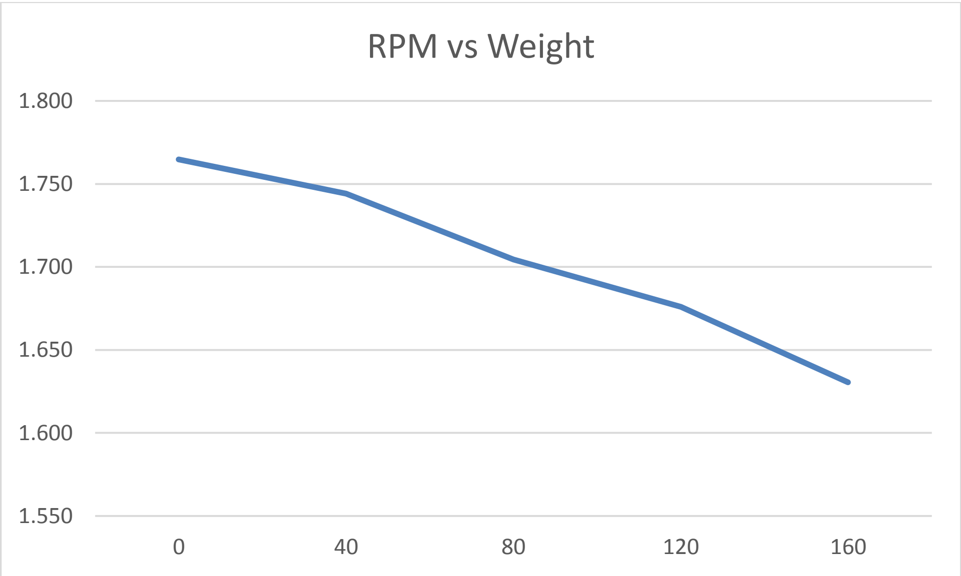

Fig 4.1: Rev per min as weight increases

4.2 Subsystem 2 (Solar System)

4.2.1 Objective:

The Solar panels has to charge the batteries in a reasonable time, taking into consideration the suggested charging power given by the manufacturer. Moreover, the controller has to cut the power when the batteries are fully charged.

4.2.2 Setup:

In the shop, we've used a Multimeter (Fluke 117) which is shown in figure 4.2 below. We used it to measure the batteries, and also to check if the controller is cutting off the power when the battery is fully charged.

Fig 4.2: Multi-meter (Fluke 117)

4.2.3 Results:

To measure this we've only started timing when the battery is fully dead and made sure the multimeter gave us a reading of 0. Then at around 8:30 a.m. we started the system and the timer, and kept taking down readings every hour and kept a close eye on the multimeter when reached over 800 watt, then when reached 840 watt the time was taken and the process stopped, as shown in table 4.2

Table 4.2: Charging Cycle During The Day

Times	Watts
8:30 AM	0
9:30 AM	80
10:30 AM	170
11:30 AM	263
12:30 PM	358
1:30 PM	453
2:30 PM	548
3:30 PM	643
4:30 PM	736
5:30 PM	821
5:56 PM	840

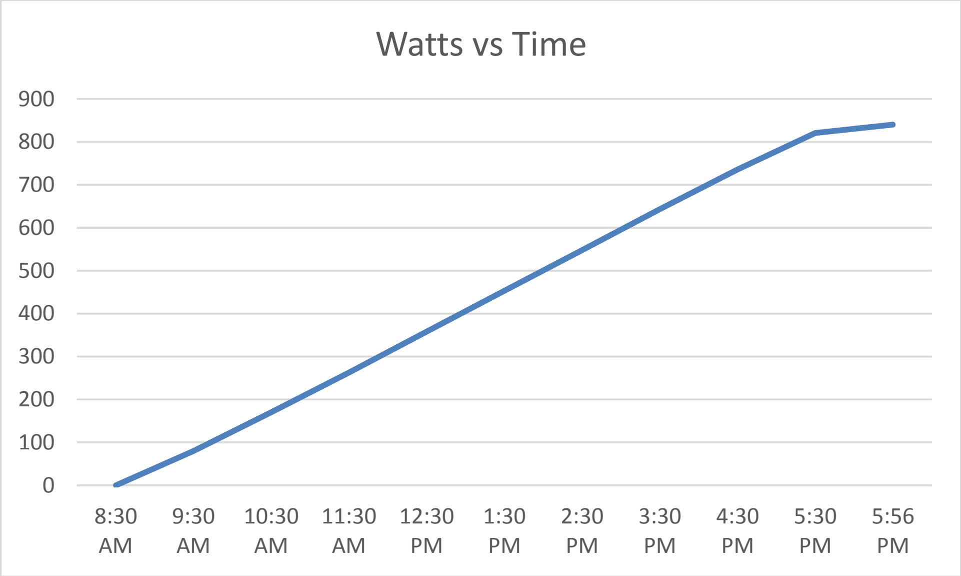

Fig 4.2: Watts vs Time

The graph shows the results we received from table 4.2, as shown in the graph by 5:30 PM the power will be 800 watts.

4.3 Overall Results, Analysis and Discussion

The RPM data obtained from the rotational system table (4.1) had to be translated into turning time using the following equation:

60 / (RPM x 2) = Time for a 180^{o} turn .... Equation 4.1

Therefore, the table below is developed.

Table 4.3: Average Turning Time

Weight	Ave. Turning Time
0 kg	17 sec
40 kg	17.2 sec
80 kg	17.6 sec
120 kg	17.9 sec
160 kg	18.4 sec

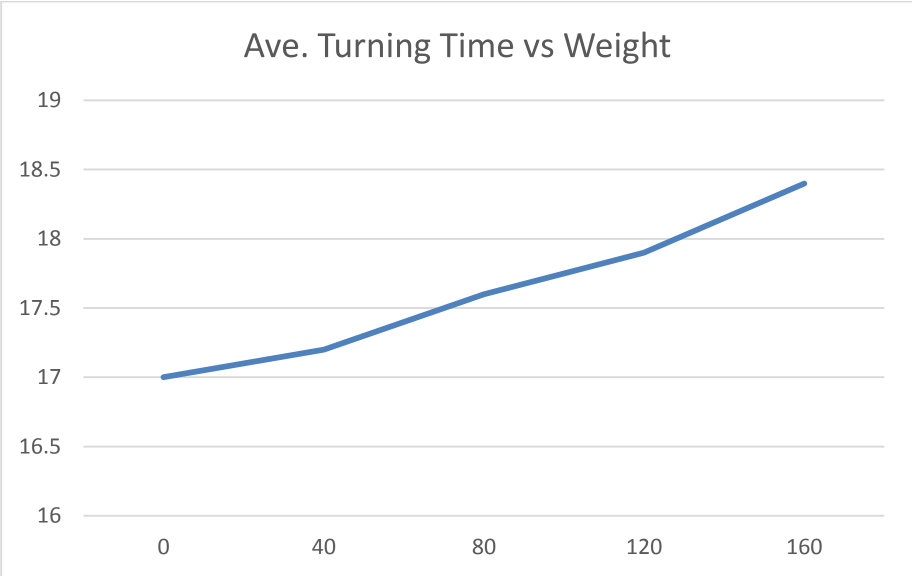

Fig 4.3: Average Turning Time

With each increase in weight the average turning time doesn't follow closely with constant fixed increase, which most likely due to the data gathering accuracy or the changes in distributions of the weights on the seat. Although there are some variations in the times obtained from different weights, those variations are still acceptable, and are considered to be negligible.

From the solar system charging test results in table 4.2, a new graph was interpolated to further investigate the fluctuations in the charging potential throughout the charging interval.

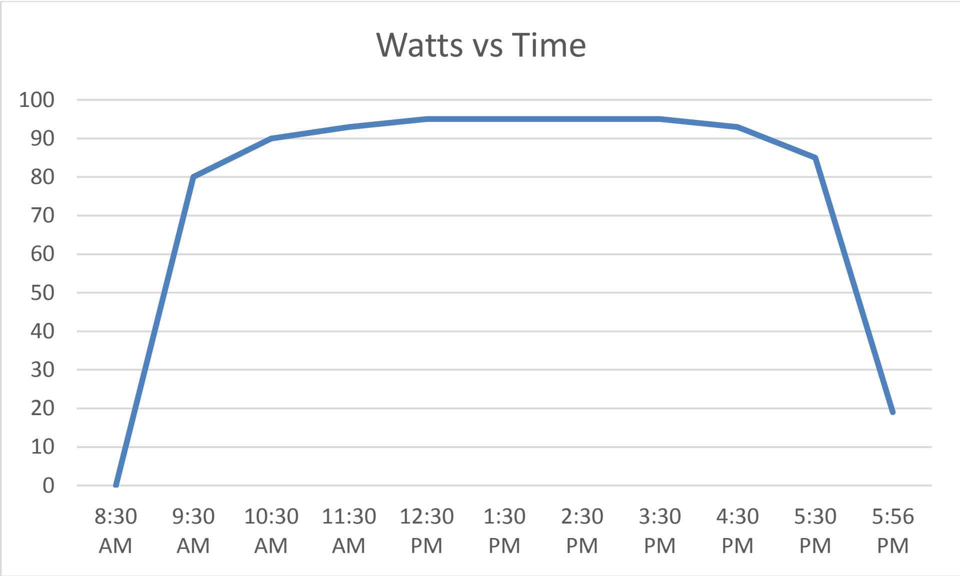

Fig 4.4: Charging Potential Thru Out The Day

The graph indicates that the highest charging potential of 95 watts happens between 12:30 pm and 3:30 pm, which is normal considering the position and exposure of the sun. However, the Actual charging time is 9 hours and 26 minutes, while the charging time estimated using the information given by the manufacturer of the panels and batteries:

The battery capacity 70 A X 12 V = <u>840 watt</u>

The solar panel <u>100 watt</u>

Estimated charging time = 840 / 100 = <u>8.4 hours</u>

It is clear that there is 1.43 hour increase in time between the actual and estimated by the numbers given by the manufacturer, which can be attributed to many factors such as the panel's, inverter, and batteries efficiency and sun exposure and position as well. The charging capability for each hour varies during different hours of the day from early morning versus an hour in mid-day when the sun exposure and heat is much better. As for the controller itself, it proved to be working by shutting down electric current when the batteries reached 840 watt.

CHAPTER 5

Project Management

5.1 Project Plan

Table 5.1: Project Plan and Tasks

Task Name	Start Date	End Date	Duration	Assigned To
Brainstorming	09/25/16	09/29/16	5d	Team
Advisor First Meeting	09/28/16	09/28/16	1d	Team
Identify Project Mechanism	10/02/16	10/06/16	5d	Team
First sketch	10/09/16	10/12/16	4d	Team
Literature Review	10/09/16	10/12/16	4d	Team
Advisor Second Meeting	10/13/16	10/13/16	1d	Team
Rotating Chair Mechanism	10/16/16	10/20/16	5d	Abdulaziz & Bjad
Solar panel study and connections	10/16/16	10/20/16	5d	Abdullah & Hatim
Calculations	10/16/16	10/20/16	5d	Team
First Progress Report	10/27/16	10/27/16	1d	Team
Finalize Design Sketch & Electrical Components	10/20/16	10/27/16	6d	Team
Purchase Parts	10/30/16	11/27/16	21d	Team
Assembly	10/30/16	11/29/16	23d	Team
Second Progress Report	12/01/16	12/01/16	1d	Team
Submit Final Report	12/25/16	12/25/16	1d	Team
Presentation Day & Submission Of Videos Brochures & Posters	12/29/16	12/29/16	1d	Team
Final bound Thesis (Leather Bound)	01/05/17	01/05/17	1d	Team

Table 5.1 shows the entire project plan of the course from the starting date till the end date, each tasks duration and to whom this task was assigned to. This is important in order to manage the project timeline and keep up with our due dates when submitting the work.

5.2 Contribution of Team Members

Table 5.2: Contribution of Team Members

#	Task	Team Member Assigned	Progress 0%-100%	Duration
1	**Project Background**	**Abdulaziz Albasri**	**98%**	**1 Week**
2	**Previous Work**	**Abdullah Alqhtani**	**97%**	**1 Week**
3	**Comparative Study**	**Hatem Alsahefy**	**95%**	**2 - 3 Weeks**
4	**Researching Parts**	**Bejad Alsubaie**	**90%**	**3 Weeks**
5	**Solar Panel Research**	**Abdulaziz Albasri**	**98%**	**2 Weeks**
6	**Research For DC Dynamo**	**Abdullah Alqhtani**	**97%**	**4 Weeks**
7	**Ergonomic Seat Purchase**	**Hatem Alsahefy**	**95%**	**1 Week**

8	Researching a Suitable Battery	Bejad Alsubaie	90%	1 Week
9	Design Requirements, Constraints and Specifications	Abdulaziz Albasri	98%	3 Weeks
10	Design Methodology and considerations	Abdullah Alqhtani	97%	2 Weeks
11	Product Subsystems and Components	Hatem	95%	3 Weeks
12	Implementation	Bejad Alsubaie	90%	2 Weeks
13	System Testing and Analysis	Abdulaziz Albasri	98%	1 Week
14	Subsystem 1	Abdullah Alqhtani	97%	1 Week
15	Subsystem 2	Hatem Alsahefy	95%	1 Week
16	Overall Results, Analysis and Discussion	Bejad Alsubaie	90%	1 - 2 Days

Table 5.2 consists of the contribution of each task member on a specific task, the table includes the team member assigned to the task, the progress percentages from 0% to 100% and the duration of each task. This is important for the success of the project because it show how the team divided the tasks equally and shares all the responsibilities and work.

5.3 Project Execution Monitoring

- Meeting with advisors. (DR. NADER SAWALHI & DR. FARAMARZ DJAVANROODI)
- Team meeting every week.
- Research.
- Testing shaft.
- Testing solar panels.
- Testing wheelchair speed.
- Testing rotation of wheelchair.
- Testing efficiency.

5.4 Challenges and Decision Making

Many challenges where face trough out this project, some of the major issues was requiring some of the parts needed to complete the rotation part of the project. These parts included the DC Dynamo and the gear box for the shaft. The barriers faced in this project definitely effected the schedule that was set in the beginning.

Problems with the equipment was an issue as well, for example the old batteries that were inserted in the first phase of the project malfunctioned in the middle of the testing process, this issue impacted both the schedule and the budget given that new batteries had to be purchased.

As for issues within the team members, in the first two weeks the team face a couple of disagreements as for the location of our meeting or the timings but in the end these problems where faced and solved for the benefit of the project and the greater good.

5.5 Project Bill of Materials and Budget

5.5.1 Bill Of Material

Material	Quantity
Solar panel	1
12-24 V Reciver	1
Fabricated DC Dynamo	1
12 V Battery	2
Gearbox	1

Table 5.3: Bill of Materials

5.5.2 Budget

Item	Price (SR)
Solar panel	400
12-24 V Reciver	200
Fabricated DC Dynamo	300
12 V Battery	540
Gearbox	600
Fabrication	1500
Total	3540

Table 5.4: Budget Table

CHAPTER 6

Project Analysis

6.1 Life Long Learning

During making our senior project we've learnt many things through out the stages and obstacles we've been through. Besides getting help from our advisors, we communicated with many people that have experience in mechanical engineering to get advices and have ideas about our project. Also, we've searched through the Internet about previous projects to get a general view before we start our senior project. In addition, we acquired many skills in Solidworks because we designed our project with the correct dimensions using Solidworks. While installing the control bottom, we've learnt about the basic circuit idea in controlling the seat to rotate it in both sides. And there was new information when we installed the solar energy panels like how much time it takes to fully charge the batteries.

There were too many struggles that we faced during building our senior project, but we effectively handled it and went through it with no delay. For sure there was one or two hard issues that needed to be solved in time or our work will not be submitted on time, but we managed to handle them before it is too late. The time was really a big struggle because we faced troubles to find some parts for our project, but fortunately we could manage that and controlled the situations. There was one particular part that was really difficult to find and we were worried that we wont make it on time. That part was the 'dynamo', we finally found it and we made it before the time runs out. Those situations made us learn how to manage the time effectively and make our job professionally without worrying about the deadlines. Also, we learnt how to handle the tasks that we need to finish without any issues. Making the project helped us be professionals in doing and task or making any project. Also, we acquired few skills in communication, time management and project management.

However, the obstacles we've been through taught us so many skills to be better in the work site. And not only obstacles, communicating and asking for expert people helped us be familiar with how teamwork in the work site is going to be.

Building on our previous knowledge of using Solidworks, we will be better in the worksite when we apply all the skills we gained. During making our project, we have learned to make some of our project parts using Solidworks. We now understand and appreciate the number of individual parts that can go into a design. Also, we created simulations that test how well our improvements on the chair will be. By testing our work through solidworks simulation, we saved time and money so we did not waste any materiel that could fail when subjected to the required load.

Engineering design process is the most important technique that we have learned during making the senior project. We have figured many ways to solve certain problem, and found the best ways to build up our projects' ideas. We have looked for high quility products but cheap that are available and can be reached in the markets. by doing this, we reduced the time and cost for making the project without any obsticles

6.2 Impact Of Engineering Solutions

Power wheelchair in general cost huge amount of money. Building a solar beach wheelchair or any kind of powere wheelchair from the scratch can be more expensive than purchasing one from a manufacturare. Since the self-made chair has almost exactly the same functuality as the commercial ones, it is a viable economic option. The self-mmade wheelchair may not be as the quilty of the commercial wheelchairs, but it will surely work like one nevertheless.

Solar energy wheelchairs are also called as power chairs or electric power wheelchairs. They do not require any human assistance for mobility as they are powered by battery. Most obvious advantage of electric wheelchair is that they are user friendly and convenient. These electric wheelchairs are useful for those unable to use manual wheelchair or who may want to use wheelchair for travelling longer distance and in such case using manual wheelchair is very difficult. Apart from people with traditional mobility disability, they may also be used by people with cardiovascular diseases or who met with any accidental conditions.

Wheelchairs have existed since late 1700's helping the people with disabilities to move around. Today, a variety of wheelchairs are available in market and serve different purposes, ranging from ordinary manual or electric wheelchairs to sports wheelchairs to beach wheelchairs. The purpose of these projects is to design a proper electric beach wheelchair, providing the disable person easy access to the beach with complete independence.

Factors which are driving the growth of global electric wheelchair market are growing worldwide elderly population, necessity of automated wheelchair for disabled people and high disposable income of people from developed countries such as UK, France, Germany, US, Canada and Japan. Furthermore increasing demand of advanced wheelchairs from sport industry is also influencing the growth of electric wheelchair market, as many sport events are organized specially for disabled persons. Apart from several advantages, global electric wheelchair market is also facing some challenges such as high cost of electric wheelchair and lack of awareness and infrastructure. However these issues are expected to reduce during forecast period.

The solar energy wheelchair is an effective project and has a huge impact on the economy and the society and has a lot of advantages. The solar energy wheelchair can be used on road – off road and has strong wheels that are flexible, but hard when it is driven in small sharp objects.

In addition it has a fare long time duration (8 hours) and charging using the solar energy. In addition, the seat of the solar energy wheelchair can be rotate 180 degrees in the right and left sides which make it too easy for handicapped people to set down or stand up without having any difficulties. Also, the seat is comfortable and convenient for the back of the passenger. The project can also effectively help the people in going different places easily and conveniently.

6.3 Contemporary Issues Addressed

The solar energy wheelchair has a huge effect in the society, economically and environmentally. Several organizations exist that help to give and receive wheelchair equipment. Organizations that accept wheelchair equipment donations typically attempt to identify recipients and match them with the donated equipment they have received. Organizations that accept donations in the form of money for wheelchairs typically have the wheelchairs manufactured and distributed in large numbers, often in developing countries. Organizations focusing on wheelchairs include direct relief, the free wheelchair mission, Hope Haven, Personal Energy Transportation, the Wheelchair Foundation and WheelPower.

Wheelchair users are frequently frustrated by the general public's poor understanding of etiquette towards wheelchair users. In general, a wheelchair should be treated as an extension of a user's body. It should not be touched or leaned on without permission. In particular, no one should attempt to push or lift a wheelchair without permission. Wheelchair parts are easily damaged and very costly, while power chairs weigh much more than expected. If you think a wheelchair user would appreciate help, ask politely and do not be angered if the answer is that they do not. When dealing with a wheelchair user, address them directly, not the person with them. No matter how severely disabled a wheelchair user is, assume they are as intelligent as you are, if not more so.

CHAPTER 7

Conclusions and Future Recommendations

7.1 Conclusions

The project we have done is the Senior Design Project and one of the requirements of Mechanical Engineering degree at Prince Muhammad University. We have successfully made a phase 2 of a previous senior project (Beach Wheelchair) and we have done some advanced adjustments to the chair and made it more comfortable, able to charge by solar energy and much easier to sit on the chair's seat.

Before we actually start working on our project, we have discussed and planned with our course advisers Dr. Nader Sawalhi and Faramarz Djavanroodi. Our advisers approved our project after having many ideas about how to improve and upgrade the previous project.

The main focus in this project is the execution of phase 2 without deviating from the previous requirements of the main project, which are:

- Wheelchair should easily work on sand.
- Wheelchair should be stable.
- Have a reasonable speed. (5-6 km/h)
- Should support an average full size adult.
- Easy to turn and maneuver in sand (Have a reasonable turning radius).
- Have a strong and rigid structure.

Those requirements are kept in mind while discussing the vision of phase 2 with our advisor and co-advisor, Dr. Nader Sawalhi and Dr. Faramarz Djavanroodi, after several meetings we have agreed on certain requirements, which are:

- Charging the chair using solar energy.
- Adding rotational function to ease accessibility to the seat.
- Fabricating or adding ergonomic seat.

Thus far, all the previous requirements are kept on this project, and all the requirements for phase 2 are achieved. The solar panels are fully functional and are charging the batteries as required, and these requirements might need additional work or simply more expenses to make it more efficient than the previous work. The rotational function is working without a problem, and it is fully capable of supporting the weight suggested for an adult flawlessly. As for the seat ergonomics, the seat has added cushions for extra comfort and additional back support, as it also helps in absorbing shocks during the ride, which makes the ride more enjoyable and comfier.

7.2 Future Recommendations

This project (Solar Energy Wheelchair) is a recent invention that was developed in few countries. We did few adjustments that upgraded using the chair in a more advanced way. It’s obvious that our project is not 100% completed and other techniques can be done to make the project even better. Many accessories and parts can be added to make the project more advanced and this is what we are going to discuss in this part of the report.

One of our recommendations is to have a comfortable and flexible moving table to the user to make it easy for him/her to use their laptop or eat without having any problem. The table can be removable so when the user does not need to use it, they can attach it on any side of the chair or store it somewhere till they need it.

We thought about this idea but we did not have time for making it. Another recommendation is to have sort of entertainment functions. For example having a USB and microphone outputs. Also, few electric plugs to make the user be able to charge any device they want like portable gaming devices.

In addition, a small bag can be installed in any side of the chair along with a cup holder in case the user needs to put their stuff. If the user is student or working in place that requires holding notebooks, this bag will make it much easier for them to carry books and notebooks anywhere they want. Also the chair can be waterproof. The chair is designed for using it at the street or beach and these places for sure will have water around. So, users might get into some water by mistake. To avoid any corruptions in the chair, it's recommended to seal the batteries and wires below so the chair will be able to be used through water without any problems.

The ride is functional and serves its purpose, but more functions are not as necessary as much as making this wheelchair more efficient and more reliable.

The future recommendations from our experience are more toward the efficiency aspect, as we think that next phase should focus on:

- Frame weight reduction.
- Increasing existing functions efficiency such as the solar system.
- Working on the seat accessibility as it is a bit elevated now.

As for the floating feature chased in the previous report, we are highly against it and don't suggest it as it is too early to be considered. If our project (the beach wheel chair) has all the recommendations above, it will meet the standards of making a wheelchair that is ready to be used by handicapped users. And the chair will be advanced enough to have the satisfaction of anyone who will use it.

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Appendix A: Progress Reports

	SDP – WEEKLY MEETING REPORT 1
	Department of Mechanical Engineering **Prince Mohammad bin Fahd University**

SEMESTER: ACADEMIC YEAR:	**FALL 2016-2017**	**Date:**	**20th of October**
PROJECT TITLE	**Solar Powered Ergonomic Beach Wheel Chair**		
SUPERVISORS	**DR. NADER SAWALHI**		

Member Name	Present/Absent	Arriving on time
Abdulaziz Albasri	Present	
Abdullah Alqhtani	Present	
Hatem Alsahefy	Present	
Bejad Alsbaie	Present	

Task progress report for the last week effort:

#	Task description	Team member assigned	Progress 0%-100%	Delivery proof
1	Project Background	Abdulaziz Albasri	98%	
2	Previous Work	Abdullah Alqhtani	97%	
3	Comparative Study	Hatem Alsahefy	95%	
4	Researching Parts	Bejad Alsubaie	90%	

Task allocation for the next week:

#	Task description	Team member assigned
1	Solar Panel Research	Abdulaziz Albasri
2	Research For DC Dynamo	Abdullah Alqhtani
3	Ergonomic Seat Purchase	Hatem Alsahefy
4	Researching a suitable Battery	Bejad Alsubaie

	SDP – WEEKLY MEETING REPORT 2
PMU	Department of Mechanical Engineering Prince Mohammad bin Fahd University

SEMESTER: ACADEMIC YEAR:	FALL 2016-2017	Date:	3rd of November
PROJECT TITLE	Solar Powered Ergonomic Beach Wheel Chair		
SUPERVISORS	DR. NADER SAWALHI		

Member Name	Present/Absent	Arriving on time
Abdulaziz Albasri	Present	
Abdullah Alqhtani	Present	
Hatem Alsahefy	Present	
Bejad Alsbaie	Present	

Task progress report for the last week effort:

#	Task description	Team member assigned	Progress 0%-100%	Delivery proof
1	Solar Panel Research	Abdulaziz Albasri	97%	
2	Research For DC Dynamo	Abdullah Alqhtani	98%	
3	Ergonomic Seat Purchase	Hatem Alsahefy	99%	
4	Researching a suitable Battery	Bejad Alsubaie	96%	

Task allocation for the next week:

#	Task description	Team member assigned
1	Design Requirements, Constraints and Specifications	Abdulaziz Albasri
2	Design Methodology and considerations	Abdullah Alqhtani
3	Product Subsystems and Components	Hatem Alsahefy
4	Implementation	Bejad Alsubaie

	SDP – WEEKLY MEETING REPORT 3
	Department of Mechanical Engineering **Prince Mohammad bin Fahd University**

SEMESTER: ACADEMIC YEAR:	FALL 2016-2017	Date:	17th of November
PROJECT TITLE	Solar Powered Ergonomic Beach Wheel Chair		
SUPERVISORS	DR. NADER SAWALHI		

Member Name	Present/Absent	Arriving on time
Abdulaziz Albasri	Present	
Abdullah Alqhtani	Present	
Hatem Alsahefy	Present	
Bejad Alsbaie	Present	

Task progress report for the last week effort:

#	Task description	Team member assigned	Progress 0%-100%	Delivery proof
1	Design Requirements, Constraints and Specifications	Abdulaziz Albasri	97%	
2	Design Methodology and considerations	Abdullah Alqhtani	98%	
3	Product Subsystems and Components	Hatem Alsahefy	99%	
4	Implementation	Bejad Alsubaie	96%	

Task allocation for the next week:

#	Task description	Team member assigned
1	System Testing and Analysis	Abdulaziz Albasri
2	Subsystem 1	Abdullah Alqhtani
3	Subsystem 2	Hatem Alsahefy
4	Overall Results, Analysis and Discussion	Bejad Alsubaie

Appendix B: Bill of Materials

Bill Of Material

Material	Quantity
Solar panel	1
12-24 V Reciver	1
Fabricated DC Dynamo	1
12 V Battery	2
Gearbox	1

Budget Table

Item	Price (SR)
Solar panel	400
12-24 V Reciver	200
Fabricated DC Dynamo	300
12 V Battery	540
Gearbox	600
Fabrication	1500
Total	3540

Appendix C: Solid Works

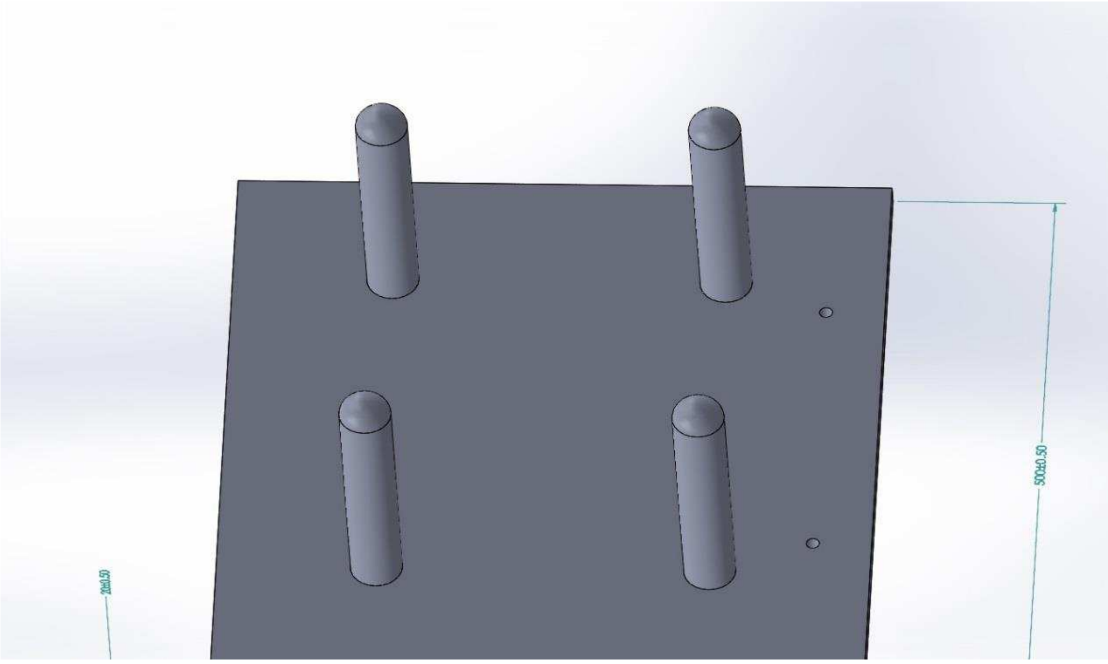


Figure 3.2.1 A: Base Plate (housing the motor and gearbox)

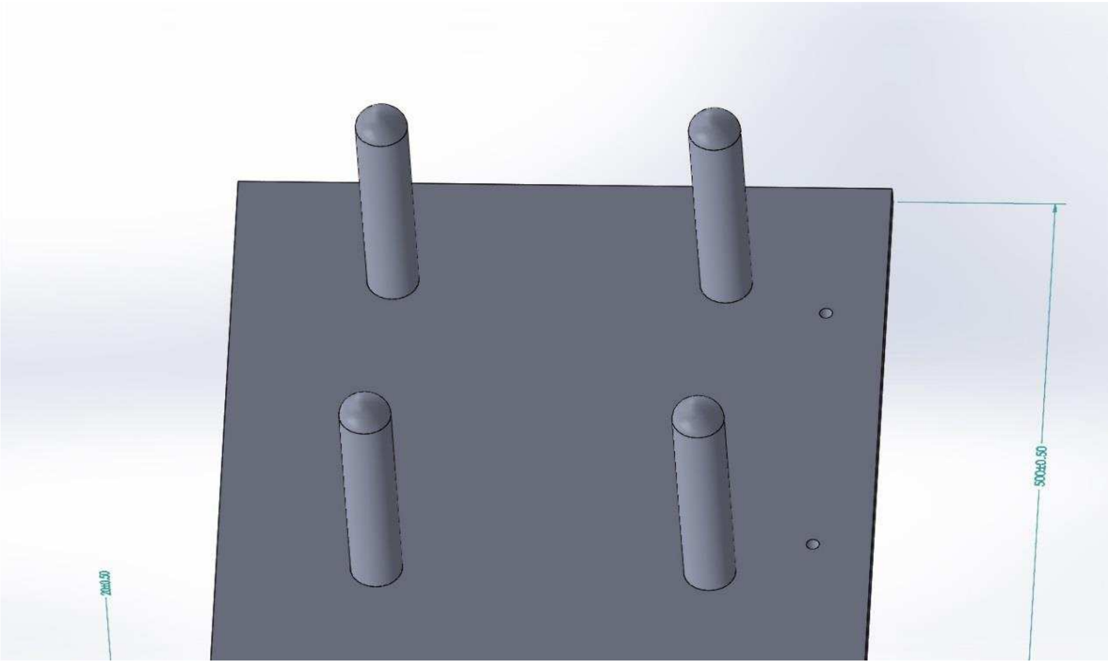


Figure 3.2.2 B: Base Plate

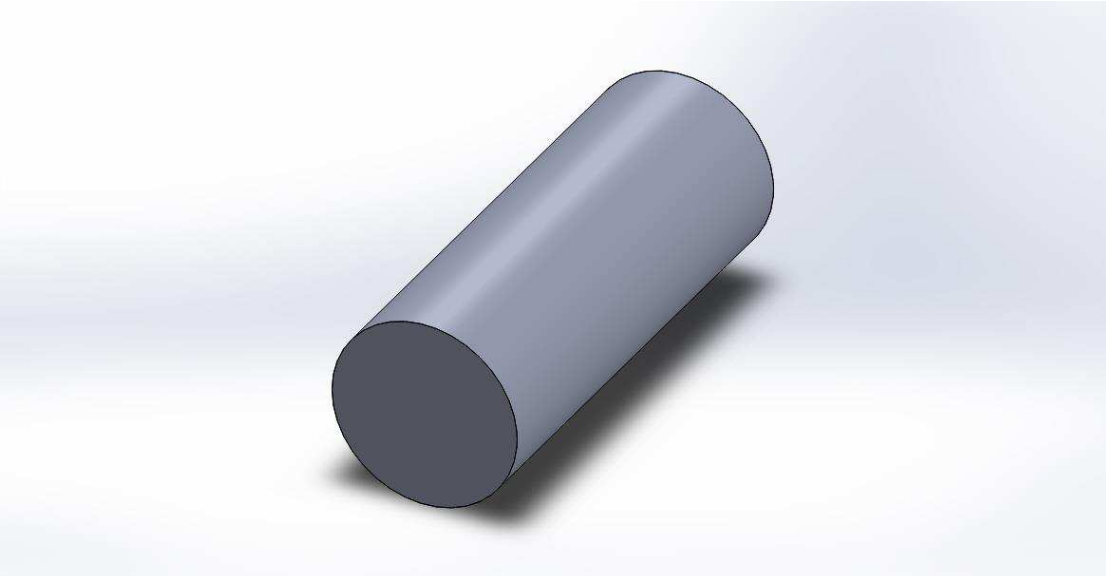


Figure 3.3A: Rotating Shaft

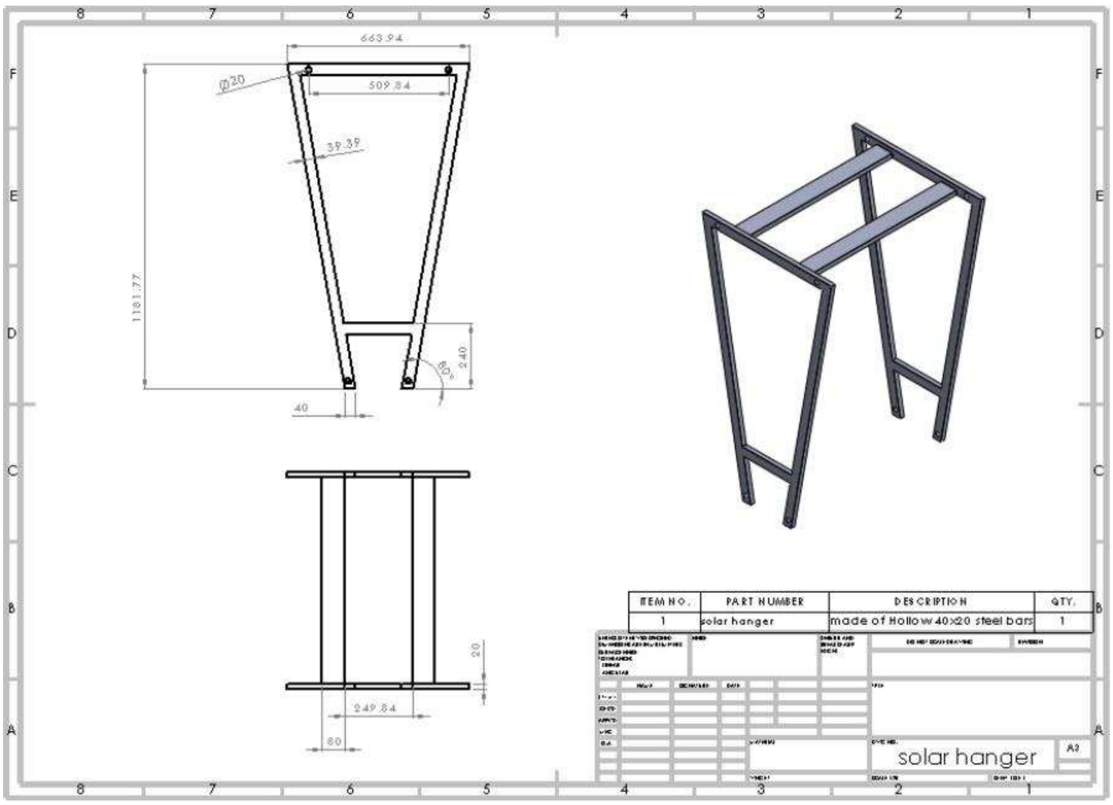


Figure 3.3 B: Solar Hanger

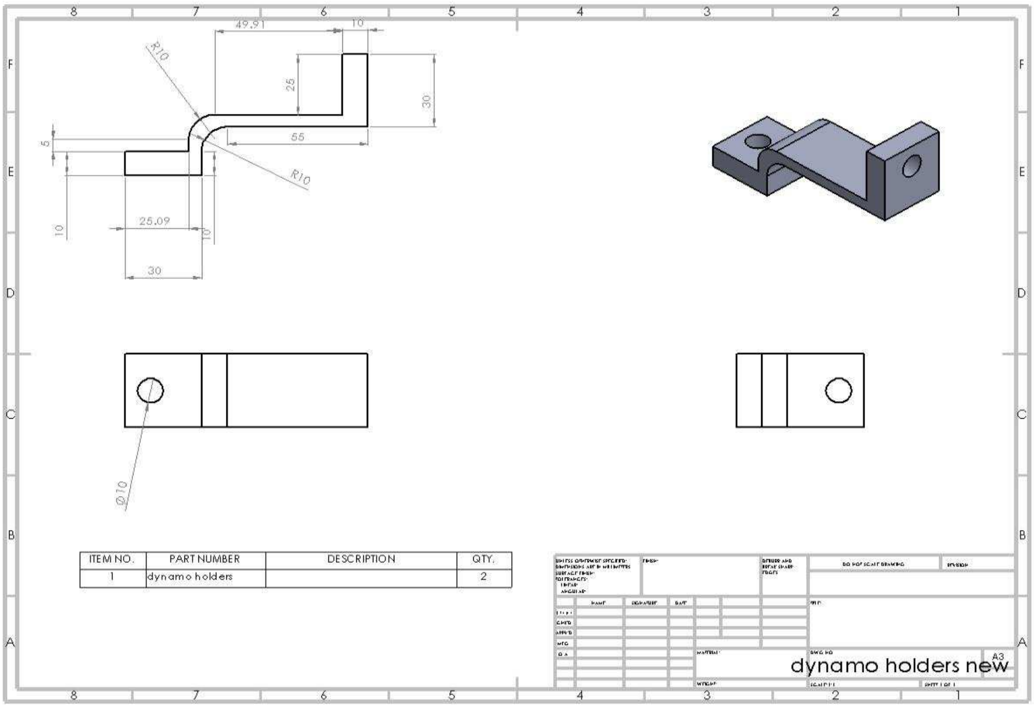


Figure 3.3C: Dynamo Holders

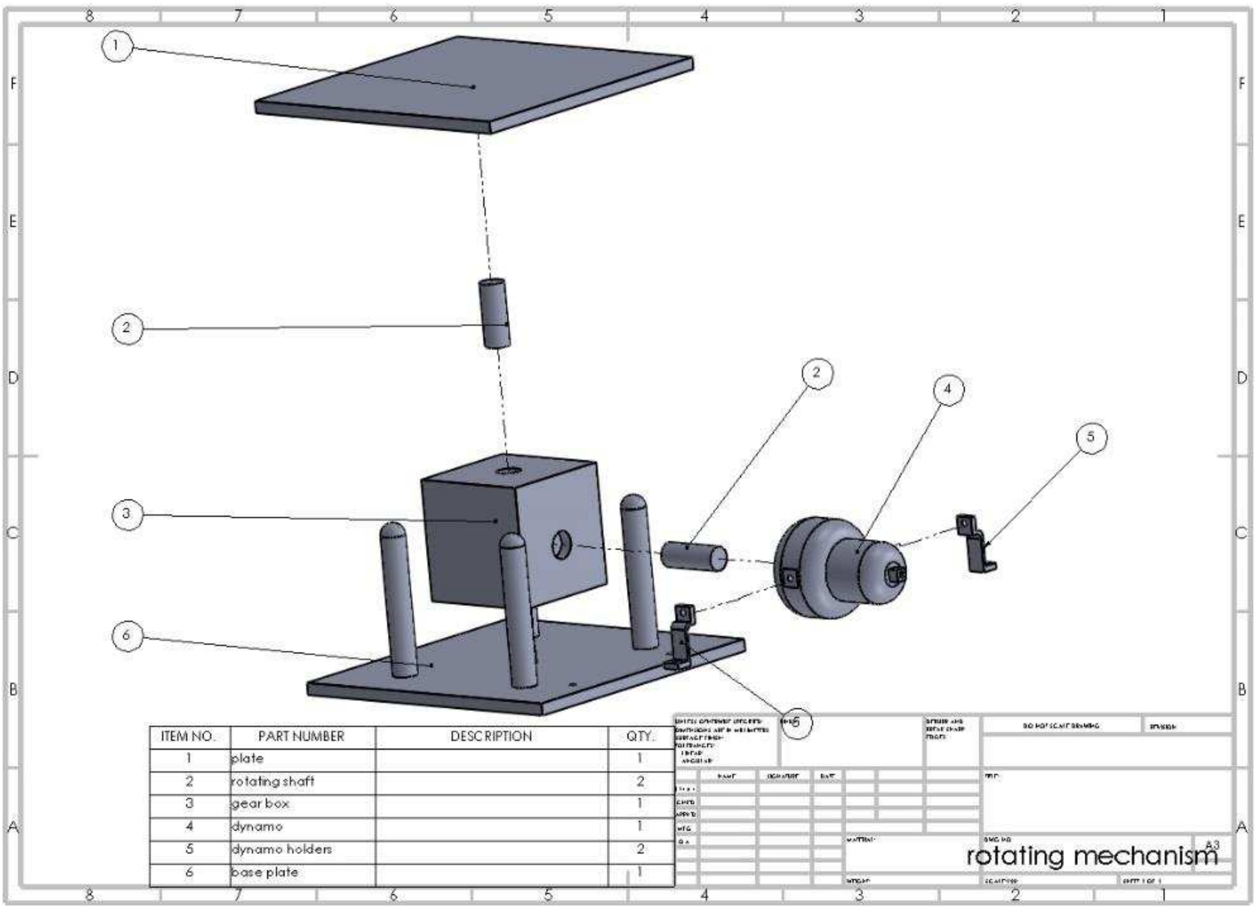


Figure 3.4: Rotating Mechanism

Appendix D: Catalogues

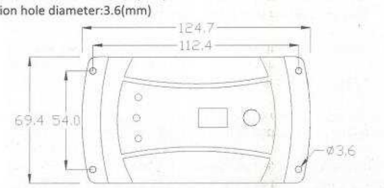
LM10A-U series solar power intelligent PV controller
Instruction book

Ⅰ.Main features

1. Automatic identification of 12V/24V system voltage.
2. LED digital display and single key operations which makes operate simply and conveniently.
3. Adopting ternary form charging algorithm, charge the storage battery in equalizing charge mode once a week .It can prevent battery from imbalance and vulcanization effectively, also battery service life will be extended.
4. Four working modes which made it convenient to use in all kinds of street lamps and monitoring devices.
5. Designed in industrial-scale which can suitable use for harsh environments.
6. Has the electricity protection data function .Parameter can be stored when the power system failure. No need to setting again. It is very simple and convenient to use.
7. Various status indications.
8. Over charging protection, over discharging protection, over load, short circuit protection, reverse polarity protection
9. TVS lightning protection.

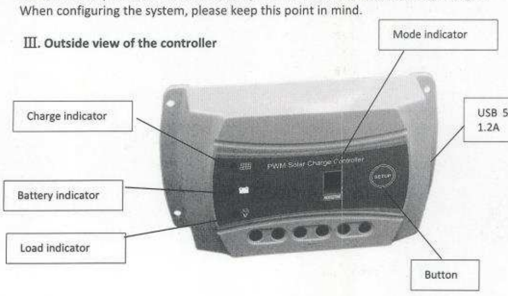
Ⅱ.Installation and wiring

1. Installation of controller should be stable and dimensions are as follows:
   Overall dimension:124.7×69.4×34.0(mm)
   Installation dimension:112.4×54(mm)
   Installation hole diameter:3.6(mm)



2. SR-LM series controller can work under 12V or 24V voltage. Please connect the storage battery at first, controller will work after recognize the battery volt automatically. If 12 V, the digital tube will shows "0.".If 24V, the digital tube will shows "1.".
3. First, connected to the storage battery: Pay attention to the "+" and "–", in case of reverse connection. If connected well, the indicator light will be on. Otherwise, please check the connection.
4. Second, connected to the solar panel: Pay attention to the "+" and "–" ,in case of reverse connection. If connected well and have sunshine, the indicator light will be on. Otherwise, please check the connection.
5. Third, connected to the load: connect the load lead with the load output end of controller, be care that the current must be less than the current rating of the solar controller.
6. Controller can identify voltage of storage battery the circuit is powered on. Please connect storage battery at first and ensure the installation is reliable.
7. Controller will become hot during running. Therefore, it is suggested to install it in a ventilated environment.
8. Controller will test the ambient temperature and then charge the storage battery. Therefore, please place the storage battery and the controller in the same environment.
9. Choose the cable with enough capacities for connection to avoid excessive consumption on circuit which may result in wrong judgment of controller.
10. Controller is designed with share positive poles. If grounding needs to be connected, please use the positive pole.
11. It is important to completely charge the storage battery, at least once a month. Otherwise, battery will suffer from permanent damage. Only when power that enters into the battery is more than that used by the load can the battery be fully charged. When configuring the system, please keep this point in mind.

Ⅲ. Outside view of the controller



Ⅳ. Status indications

LED lamp	Indications	Status	Functions
	Charging indication	Long-term On	There is voltage on battery panel
		Long-term Off	No voltage on battery panel
		Slow twinkling	Be on charged
		Fast twinkling	Over voltage of system
	Storage Battery	Long-term On	Storage battery works normally
		Long-term Off	Storage battery is not connected
		Slow twinkling	Storage battery is under voltage
		Fast twinkling	Storage battery is excessively discharged
	Load	Long-term On	Load is open
		Long-term Off	Load is close
		Fast twinkling	Overload protection or Short circuit protection or system voltage unusual.

Ⅴ. Introduction of modes and table of settings

LM10A-U series controller has four working modes. Table of settings is as below:
1. Purely light-operated (0): When there is no sunlight, the light intensity will fall to the starting point. The controller will affirm the starting signal after a delay of 10 minutes. Load will be opened as per set parameters to start working. When there is sunlight, the light intensity will rise up to the starting point. The controller will close output after confirming closing signal in a delay of 10 minutes and the load will stop working.
2. Light-operated + time-controlled (1~4.): Starting process is same to that of pure light control. The load will automatically close when it works to the preset time. Set time will be 1 to 14 hours. At the same time can setting the lighting time in the morning, this function just can use under the Light-operated and time-controlled mode.
3. Manual mode (5.): Under this mode, users can control the load-on and load-off by key-press no matter day or night. This mode is suitable to occasions in need of specia loads or for debugging.
4. Long-term On mode (6.): If being powered on, the load will be under the output status all the time. This mode is suitable for loads in need of 24-hour power supply.

LED Display	LED1 mode	LED Display	LED1 mode
0	Purely light-operated	9	Light-operated + time-controllec for 9hours
1	Light-operated + time-controlled for 1 hour	0 . (0 point)	Light-operated + time-controllec for 10hours
2	Light-operated + time-controlled for 2 hours	1 . (1 point)	Light-operated + time-controllec for 11hours
3	Light-operated + time-controlled for 3 hours	2 . (2 point)	Light-operated + time-controllec for 12hours
4	Light-operated + time-controlled for 4hours	3 . (3 point)	Light-operated + time-controllec for 13hours
5	Light-operated + time-controlled for 5 hours	4 . (4 point)	Light-operated + time-controllec for 14hours
6	Light-operated + time-controlled for 6 hours	5 . (5 point)	Manual mode
7	Light-operated + time-controlled for 7hours	6 . (6 point)	Long-term On mode
8	Light-operated + time-controlled for 8hours		

Ⅵ. Methods for setting

Setting mode: Press a key for more than 3s, the nixie tube will start to twinkle and tł system will enter into debug mode. Release the key and then press the key agai figures of nixie tube will change one digit each time until digits shown on the nixie tuk match the digits corresponding to the mode the user' request. Wait until the nixie tuk stop twinkling or press the key again for more than 3s to finish the setting process.

Ⅶ. Safety suggestions

1. When connecting 24V system, terminal voltage of battery panel may surpass th

human body safety voltage. If operations are needed, insulating tools should be used and hands must be dry.

2. If storage battery is connected in reverse, the controller would not be damaged. However, there may be output of negative voltage at the load end which may damage your load equipment. Pay attention to avoid such things.
3. In 24V system, if one end of storage battery or solar battery panel is connected in reverse, controller may very likely be damaged.
4. There is a great deal of power stored in the storage battery. Therefore, short circuit of storage battery must not happen in any case. We suggest tandem connection of fuses on storage battery.
5. Storage battery may generate combustible gas and therefore should be far away from sparks.
6. Please make sure that children are far away from the storage battery and the controller.
7. Please follow the safety suggestions given by the battery manufacturer.

Ⅷ. Instructions for parameters

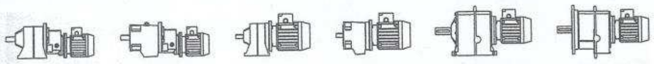
System voltage	12V/24V Auto
System current	10A
No-load loss	< 10mA/12V;10mA/24V
Solar energy input voltage	< 55V
Over voltage protection	17.0V; ×2/24V
Equal charging voltage	14.6V; ×2/24V(25℃), duration:1h
Ascending charging voltage	14.4V; ×2/24V(25℃), duration:2h
Float charging voltage	13.8V; ×2/24V (25℃)
Return voltage during charging	13.2V; ×2/24V (25℃)
Return voltage for over-discharging	12.6V; ×2/24V
Under voltage	12.0V; ×2/24V
Over-discharging voltage	11.1V; ×2/24V
Temperature compensation	-4.0mv/℃/2V;
Light-control voltage	Light-control open 5V; light-control close 6V
Light-control judgment time	10min
USB Output	5V/1.2A
Circuit protection	Over-charge, over-discharge, short circuit and over-load protection
	Anti- connection-reverse protection for solar battery and storage battery.
Working temperature	-35℃ to +65℃;
Protection level	IP30
Weight	106g
Dimensions	124.7×69.4×34.0(mm)(L×W×H)

Notice1: If reverse connection of the storage battery, the controller would not be damage, but there is the negative voltage output from the load will lead to the load damage.

Notice2: Time delay function when overload, the protection time is related to the ambient temperature. When overload, the overload protection will running auto.

Ⅸ. Problems and solutions

Phenomena	Problems and solutions
There is sunlight but indicator lamp of solar panel is not on.	Please check the wiring of solar panel and ensure the connection is correct.
Indicator lamp for charging of solar panel twinkles fast	Over voltage of the system; please check if the storage battery voltage is too high.
Indicator lamp of solar panel is off; voltage of battery is normal and there is no output	Wait for 10 minutes and the load will open automatically.
Indicator lamp of battery is not on	Power supply to storage battery fails. Please check the connection of storage battery.
Indicator lamp of storage battery twinkles fast and without output	Storage battery is over discharged. When full charge the battery will recover.
Indicator lamp of load twinkles fast and without output	Power of load exceeds rated power or short circuit. Press the key one time for a long time or wait until the next day will recover.
Indicator of load is on permanently and without output	Please check connections of electric equipment are correct and reliable.
Other phenomena	Check the reliability of wiring and the automatic identification of 12V/24V system.



IPRCM IPRCMF | IBRCM IBRCMF | IPCM IPCMF | IBCM IBCMF | SPCM SPCMF | SBCM SBCMF

PREMIUM INTELLI POWER

RATINGS & SELECTION

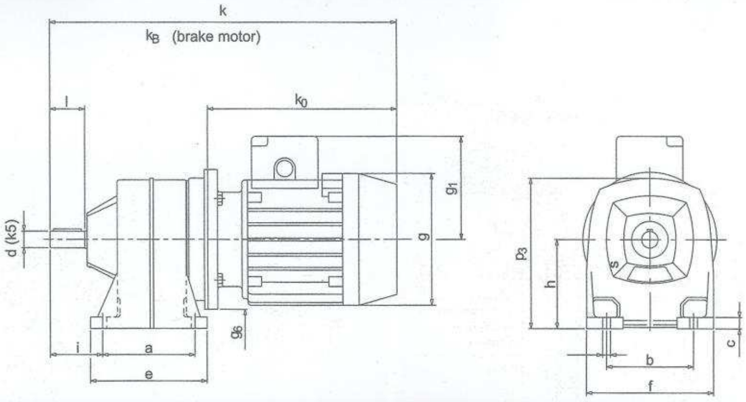
P [kW]	n2 [1/min]	M2 [Nm]	iR	FRa [N]	fb	Type
			Double stage			
0.18						
	14	117	47.6	6240	1.7	IPCM 128/80K-8/14 IBCM 128/80K-8/14
	14	121	100.1	6320	1.4	IPCM 128/63G6-4/14 IBCM 128/63G6-4/14
	19	86	71.4	5870	2.2	IPCM 128/63G6-4/19 IBCM 128/63G6-4/19
	26	62	51.6	5450	3.3	IPCM 128/63G6-4/26 IBCM 128/63G6-4/26
	33	50	41.5	5190	3.3	IPCM 128/63G6-4/33 IBCM 128/63G6-4/33
	66	25	20.7	4370	3.3	IPCM 128/63G6-4/66 IBCM 128/63G6-4/66
	83	20	16.5	4150	3.3	IPCM 128/63G6-4/83 IBCM 128/63G6-4/83
	14	116	47	3100	1	IPCM 102/80K-8/14 IBCM 102/80K-8/14
	19	88	47	4000	1.4	IPCM 102/71F5-6/19 IBCM 102/71F5-6/19
	25	66	35.2	3790	1.6	IPCM 102/71F5-6/25 IBCM 102/71F5-6/25
	29	57	47	3730	1.8	IPCM 102/63G6-4/29 IBCM 102/63G6-4/29
	39	43	35.2	3500	2.3	IPCM 102/63G6-4/39 IBCM 102/63G6-4/39
	47	35	29.1	3360	2.7	IPCM 102/63G6-4/47 IBCM 102/63G6-4/47
	55	30	24.6	3220	3.1	IPCM 102/63G6-4/55 IBCM 102/63G6-4/55
	69	24	19.9	3060	3.2	IPCM 102/63G6-4/69 IBCM 102/63G6-4/69
	92	18	14.8	2860	3.2	IPCM 102/63G6-4/92 IBCM 102/63G6-4/92
	115	14	11.9	2740	3.2	IPCM 102/63G6-4/115 IBCM 102/63G6-4/115
	30	56	45.9	1730	0.72	IPCM 84/63G6-4/30 IBCM 84/63G6-4/30
	38	43	35.7	1730	1	IPCM 84/63G6-4/38 IBCM 84/63G6-4/38
	48	35	28.7	1670	1.1	IPCM 84/63G6-4/48 IBCM 84/63G6-4/48
	58	29	23.6	1610	1.3	IPCM 84/63G6-4/58 IBCM 84/63G6-4/58
	73	23	18.7	1540	1.6	IPCM 84/63G6-4/73 IBCM 84/63G6-4/73
	95	17	14.3	1460	1.8	IPCM 84/63G6-4/95 IBCM 84/63G6-4/95

All geared motors can be supplied with brake motor (MF).
The indicated codes are for the geared motor without brake.

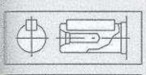
17 rpm

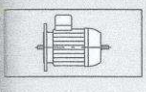
PREMIUM INTELLI POWER

"IPCM - IPCMF"
DIMENSIONS (mm)



Type	Weight [Kg]	g	g_1	g_6	k (1)	k_B (1)	k_0 (1)	a	b	c	e	f	h	i	p_3	s	d	l
84/56	7	109	95	120	321	-	172											
84/63	8	123	100	140	347	379	190	88	78	11	108	120	84	48	143	10	16	34
84/71	11	138	109	160	404	453	214											
102/63	11	123	100	140	371	403	190											
102/71	14	138	109	160	395	444	214											
102/80	18	156	124	200	461	517	236	106	100	13	134	150	102	60	176	9	19	40
102/90S	23	176	129	200	479	536	254											
102/90L	25	176	129	200	504	561	279											
128/63	15.5	123	100	140	396	428	190											
128/71	18	138	109	160	421	470	214											
128/80	24	156	124	200	461	517	236											
128/90S	29	176	129	200	496	553	254	126	118	16	160	178	128	74	215	11	24	50
128/90L	31	176	129	200	521	578	279											
128/100	38	194	138	250	575	645	309											
128/112	46	218	152	250	594	668	328											
142/80	29	156	124	200	489	545	236											
142/90S	34	176	129	200	524	581	254											
142/90L	36	176	129	200	549	606	279	145	130	18	179	196	142	95	237	11	28	60
142/100	44	194	138	250	621	691	309											
142/112	52	218	152	250	640	714	328											
162/80	42	156	124	200	574	630	236											
162/90S	46	176	129	200	592	649	254											
162/90L	48	176	129	200	617	674	279											
162/100	55	194	138	250	650	720	309	205	160	21	245	226	162	120	269	14	38	80
162/112	63	218	152	250	669	743	328											
162/132S	82	258	178	300	782	865	371											
162/132M	95	258	178	300	820	903	409											





(1) These dimensions are indicatives, they are depending of motor manufacturers.
Bare shaft dimensions are on page 12
General motors dimensions page 8, 9 & 10

Unless specified differently by the customer, motor reducers supplied, use B-5 flange mounting motors and normal position terminal board box.

Approximate weights are shown in the tables.
We reserve the rights to modify any dimensions, without changing the Type number of reducers.
CD for CAD systems are also available, providing to scale, drawings of reducers and accessories.

Solar Powered Ergonomic Beach Wheel Chair

"Mobility For Physically Challenged"

Final Presentation

Team Members:

Abdulaziz Albasri	201201101
Abdullah Alqahtani	201102937
Hatim Alsahfy	201200067
Bjad Alsubai	201201864

Advisors:
Dr. Nader Sawalhi

Co-Advisor:
Dr. Faramarz Djavanroodi

Outline

- Objectives
- Background
- Work Tasks
- Major Constraints
- Conclusion & Recommendations

Objectives

- PHASE I:
  - Wheelchair Should Be Stable.
  - Have a Reasonable Speed. (5-6 km/h)
  - Should Support an Average Full Size Adult.
  - Easy to Turn and Maneuver in Sand (Have a reasonable turning radius).
  - Have a Strong and Rigid Structure.

Objectives

- Our PHASE II:
  - Solar Powered Wheelchair
  - 90^0 Degree (To Each Side) Rotational Feature
  - Ergonomically Comfortable Seats

Background

- World's First Solar Wheelchair
- Importance of The Project
- Solar Energy
- Similar Projects

Background

University of Virginia

BRAC University

Work Tasks

- Solar System (save environment)
  - Time to charge
  - Receiver process

Work Tasks

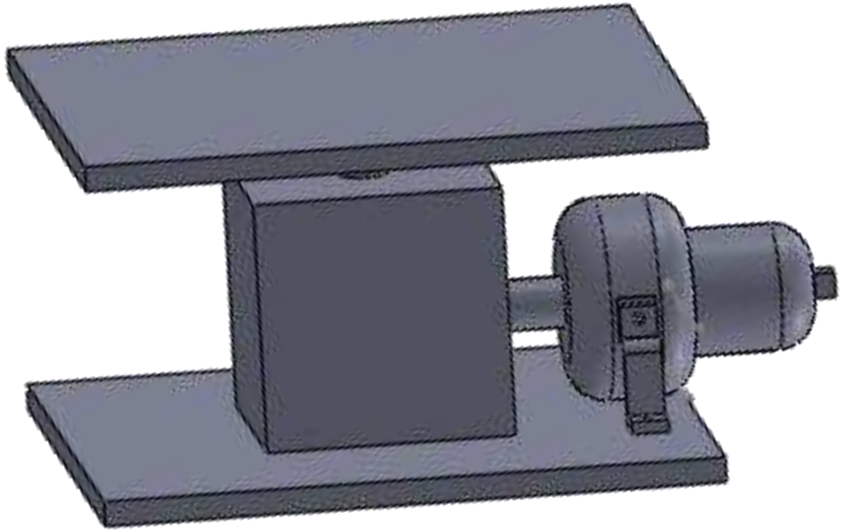
- Seat (beach wheelchair must be comfortable – users complain)

  - Ergonomic Design

  - Medical equipments supplier (wheelchair standard)

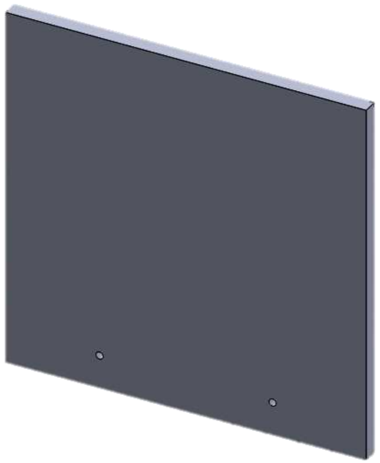
Work Tasks

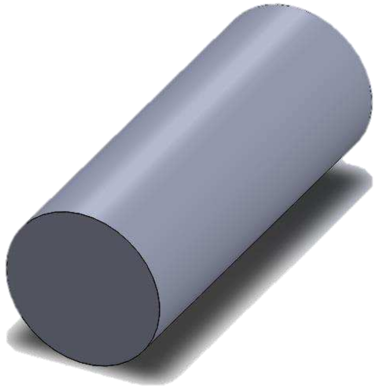
- Rotation
  - Rotation mechanism
  - Time of rotating
  - Switch sensors



Work Tasks

- Fabrications
  - Platform
  - Shaft
  - Shade (detachable structure)





Major Constraints

- DC Dynamo.
- Rotational Function (Mechanism) Room.
- Solar Panel’s Size.

Conclusion & Recommendations

- Solar System is functional.
- Rotational Function is implemented.
- Seat upgraded
- The charging time is around 9 hours.
- The speed is sacrificed by almost 17 %.

- Frame weight reduction.
- Increasing existing functions efficiency.
- Reducing the seat’s height.

Thank You For Listening

Questions ?