ES 101: Motorised Wheelchair Project Proposal

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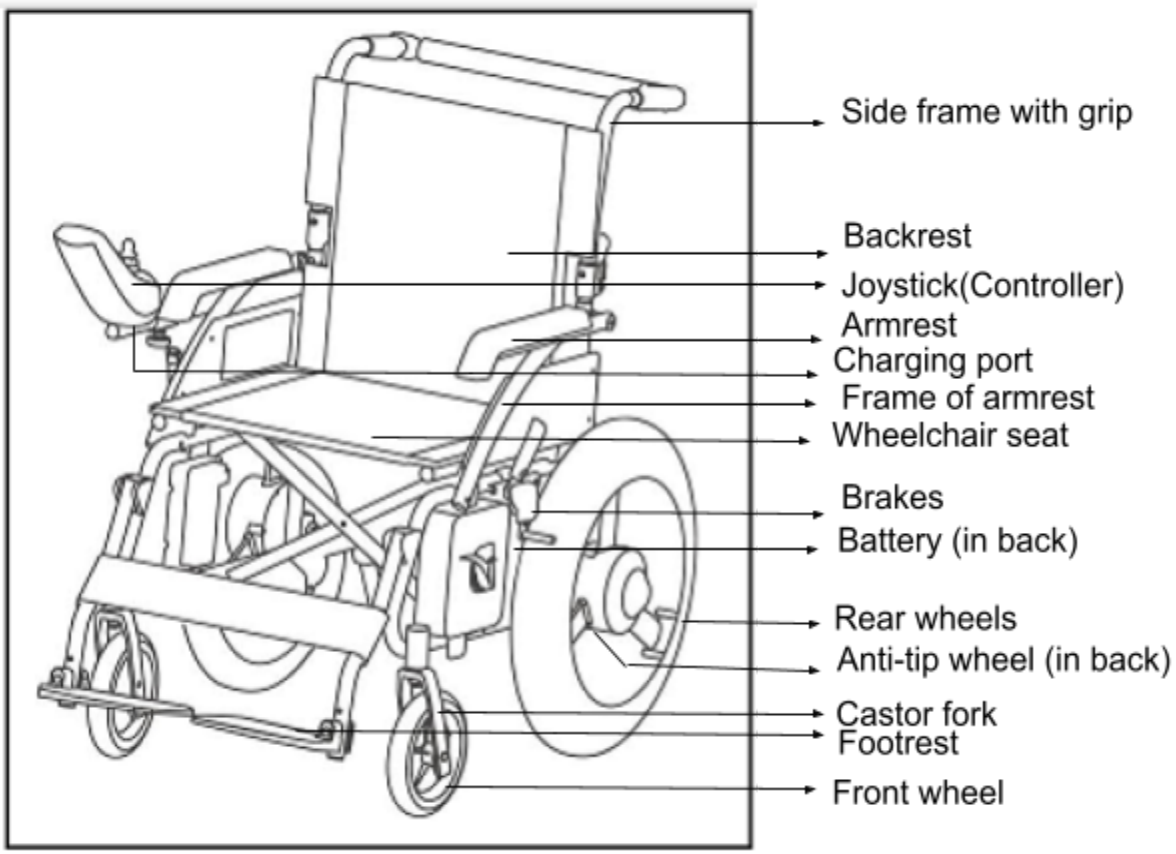
Side frame with grip
Backrest
Joystick(Controller)
Armrest
Charging port
Frame of armrest
Wheelchair seat
Brakes
Battery (in back)
Rear wheels
Anti-tip wheel (in back)
Castor fork
Footrest
Front wheel

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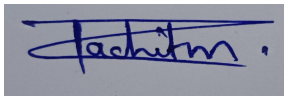
1)	Rachit Mehta (23110261)	
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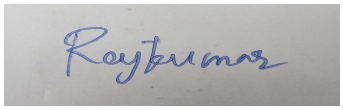
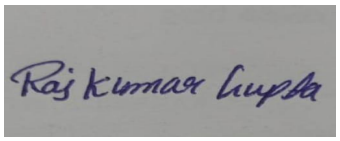
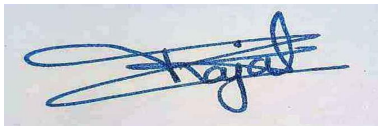
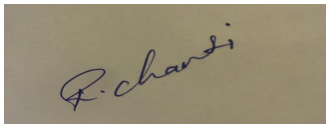
6)	Raj Kumar (23110266)	
7)	Raj Kumar Gupta (23110267)	
8)	Rajat Kabra (23110268)	
9)	Vivek Rajput (23110269)	
10)	Ramavath Chanti(23110270)	

Introduction

In engineering, engineers constantly strive to enhance the quality of life for people with mobility impairment—one such innovation has improved the lives of millions. Wheelchairs have served as a symbol of empowerment, enabling individuals with mobility challenges to live their lives smoothly and freely. However, when technology advances, we come across more features in wheelchairs. After introducing an electric motorised vehicle, this feature was also incorporated into the wheelchair, making it an electric wheelchair.

Everyone may be surprised that the electric wheelchair is not a recent technology, but the idea began developing in the 1930s. Engineers Harry Jennings and George Klein developed the electricity-run wheelchairs initially for military purposes. However, these models were heavier and mostly used lead-acid batteries for power. Later, the E&J company played a vital role in advancing this field. Though this is a brief history, it gave us another reason to take on this as our project.

After many engineering years, this imagination of someone to create an electric wheelchair came true, and nowadays, every person with mobility impairment can go anywhere without the help of any other person. With time, the cost of this electric wheelchair is also decreasing, and more features like accident sensing technology are needed. Calling technology and conversations with Google Assistant are also developing and coming to market with the evolution of artificial intelligence, self-driving technology, object monitoring systems, and alerting technologies with the help of wide-angle cameras.

Our project, "Design and Development of a 3D CAD Model for an Advanced Wheelchair," seeks to contribute to this ongoing evolution by creating art through Autodesk software. This project is motivated by deep commitments to enhance the lives of people with motor disabilities and recognise the immense potential of technological innovation.

Motivation:

1. **Empowering independence:** Mobility is a fundamental need, and those without any mobility challenges take the ability to move freely for granted. For individuals with disabilities, even moving from one place to another is a challenging task. By making a 3D CAD model of an electric wheelchair, we will ensure mobility with comfort.
2. **Advancement in technology:** The progress in material science, electronics, and mechanical engineering has paved a path to creating more technologically sophisticated wheelchairs catering to users' unique needs and preferences.

Our project draws inspiration from rapid development in the technology of wheelchairs. We recognise the potential for integrating cutting-edge technologies, such as advanced sensors, AI algorithms and lightweight materials. These innovations can make the wheelchair a refined, intelligent and adaptable device that can meet various needs.

- **Inclusivity and accessibility:** Wheelchairs should not be a barrier to the user and should not provide any limitation to the user. By developing a 3D CAD model of an advanced wheelchair, we aim to contribute to the creation of more inclusive and accessible spaces, both indoors and outdoors.

- **Educational and inspirational value:** Beyond the practical benefits of our wheelchair project, we also want to recognise its educational and inspirational potential. By making a 3D CAD model of a wheelchair, we will learn about the mechanical science of different components and parts of a wheelchair. We can also make innovative and imaginary components of wheelchairs by putting effort into our 3D CAD modelling techniques.

Why a wheelchair:

We chose a wheelchair not as a random project but for the improvement we can make in this area. Given the many wheelchair users, any slight improvement can benefit many. The progress can be anything from making the wheelchair more affordable to adding powerful motors with

complicated sensors to climb stairs and navigate automatically. We want to contribute towards this goal, however small that may be.

- **Multifaceted design challenges:** Designing a wheelchair is complex, as indicated by the project's multidisciplinary nature. Such a task requires material science, mechanical engineering, and electronics knowledge. Since every one of us has an area of interest in these fields, this project gives us an excellent opportunity to collaborate and work together.
- **Innovation potential:** Even though the first motorised wheelchair was invented in 1953, there is still ample room for innovation. By selecting a wheelchair as our project, we aim to develop and incorporate innovative features that strike our minds in the CAD model.

In conclusion, our goal to bring innovative design developments to motorised wheelchairs and make the user experience better drives our project to design and develop a 3D CAD model for a motorised wheelchair. We aim to narrow the gap between individuals who use wheelchairs and those who do not while fostering team collaboration skills throughout the journey.

Fig II, III Motorised wheelchair

Sources (Bibliography):

Creating a bibliography for a CAD project on a wheelchair design is an excellent way to provide proper attribution to your sources and show the depth of your research.

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Description and rough sketches of each part

I. Side frame with grip

Introduction:

The side frame of a wheelchair is a crucial component of a wheelchair. The side frame gives the wheelchair its shape and structure. The side frame is often overlooked as it has a straightforward and intuitive design, but the construction is such that the wheelchair's life is prolonged and involves physics concepts in design. Since the side frames make up most of the wheelchairs, users use them for aesthetic purposes, such as customising their wheelchairs with stickers, wraps, and colours, giving them a sense of ownership.

The side frame joined with other parts, makes the main frame, which houses all the pieces. A frame is the most elementary and crucial part of a model as it gives the entire model structure, support, and shape. The side frame of a wheelchair is typically shaped to incorporate the castor fork, footrest, armrest, push handle, seat, and backrest. The side frame must be rigid and be able to distribute the user's body weight without any deformation. A wheelchair is usually designed with two side frames equipped with a scissor mechanism to fold the wheelchair, reducing its storage size.

The frames of a wheelchair can be of many types, and it is selected depending on the user's need. This model has a non-rigid (folding) structure. These wheelchairs are lightweight and inexpensive. They are designed for users using this chair for their daily needs. Since this type of wheelchair can be folded, it can easily be stowed in small spaces according to the user's need. The side frame consists of the armrest padded with soft material to provide comfort for the user. The side frame has a circular cross-section.

Features:

1. **Support:** The side frame distributes the user's weight evenly, ensuring the wheelchair's stability and durability.
2. **Attachment point:** The side frame provides multiple points for the attachments of other parts, such as castor wheels, armrests, footrests, and wheels.
3. **Rigidity:** The side frame is rigid, hence preventing flexures of the entire wheelchair when the user makes turns or applies force on it.
4. **Accessibility:** The side frame is modelled, keeping in mind that it can provide easy access to the user by swing-away wheels.
5. **Push handle:** The side frame also encompasses the push handle so that the wheelchair user can be pushed/pulled by other users.

Materials:

We have a decent number of choices to choose from. Let's analyse each to find out the best material.

- **Wood:**

Historically, wood was used to make the frame of a wheelchair, but we moved away from that design because of durability issues. Timber exposure to water will permeate the wood's membranes, causing it to rot, soften and fall apart.

- **Plastics:**

Plastics like high-density Polyethylene (HDPE) can be used for paediatric or low-cost wheelchairs. Even though this is a lightweight material, it is not used as it is less durable than metals.

- **Carbon Fiber:**

Carbon Fiber is an advanced material with a high strength-to-weight ratio. It is the perfect material for the side frame of a wheelchair, if not for the cost of this material, as this is very costly.

- **Titanium:**

Titanium is a cheaper alternative to carbon fibre. Titanium can be used in this case as it is highly corrosion-resistant.

- **Steel:**

Steel is known for its durability and strength. It is generally used in heavy-duty wheelchairs where light weight is unnecessary.

- **Aluminium:**

Aluminium offers an excellent strength-to-weight ratio and resistance against corrosion. Since these are also light, this is the most popular choice for wheelchairs. Also, aluminium is infinitely recyclable, making it environmentally friendly.

Since we expect the frame to be rigid, light, and corrosion-resistant, Aluminium is the best material tailored to these needs.

Possible challenges:

- We are to get the dimensions right such that it integrates with the parts made by my team members.
- Not missing out on changes, if any, to the design.
- Make sure the design has the correct slots for joining other parts.

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2. https://en.wikipedia.org/wiki/Wheelchair
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4. https://terpconnect.umd.edu/~zhang/414_98/team/team7/oldframe.gif

Sketches and Images:

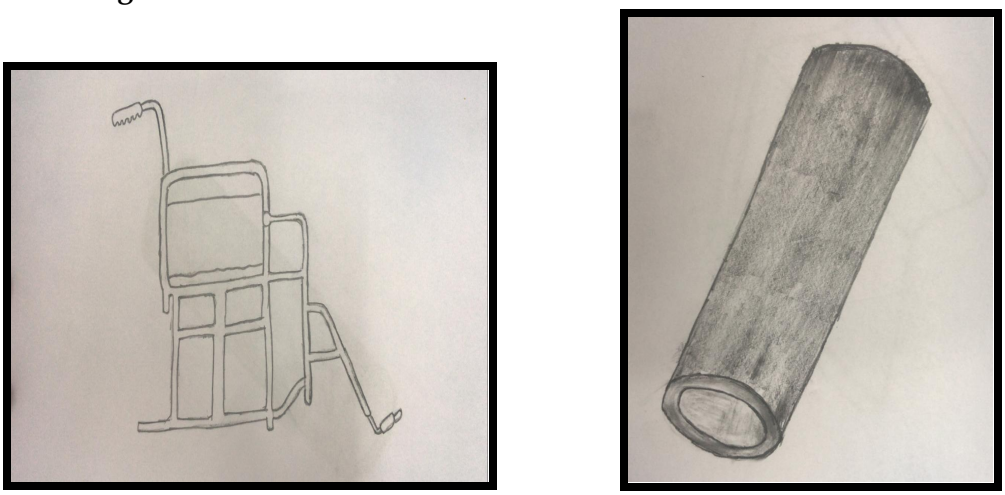

Fig: 2. A) The Side Frame and the grip

II. Backrest

Introduction:

The curved back is an essential component of a wheelchair, built for users who require perfect back support. It also provides headrest, lateral support, shoulder support and comfort zone. The backrest frame is made of lightweight material like steel or aluminium. It serves as the structural support.

Here is padding, which provides comfort to users. It is usually made from various materials, including foam, gel or air-filled cushions, to distribute pressure equally and reduce the danger of bedsores.

Parts of the backrest:

Wheelchair backrests are integral to the whole wheelchair body. It serves multiple essential functions. Some of the functions are the following.

1. The main frame of the backrest is designed with solid metals like steel, iron or aluminium. It is built by welding metal rods.

2. Upholstery: the outer part of the Wheelchair is usually made from easily cleanable and breathable material like nylon vinyl or PVC. It helps to protect the padding of the backrest. It also provides an easy way to wash and clean. It gives the user a smooth and very comfortable surface for his/her back.

3. Adjustability**:** In this wheelchair, the backrest is most adjustable and provides every adjustment like height adjustment, angle adjustment, width adjustment and the ability to recline at various positions as preferred by the user needs.

5. Lateral supports**:** Backrests have lateral(side) supports to provide proper posture and prevent sideways leaning.

6. Removability**:** Sometimes, we may also need to remove the backrest from the chair. We can easily remove it at that time for transferring or cleaning purposes.

7. Height**:** Generally, the height of the backrest depends on the model of the wheelchair, with some extending that provide head comfort to tall users.

8. Materials**:** Backrests of wheelchairs are typically designed with a variety of materials. Each of them has its advantages and disadvantages. The most common materials used to construct backrests include:

a) Steel**:** Steel is a durable material often used to design the backrest frame. It provides excellent structural support to the backrest. It adds some weight to the wheelchair.

b) Aluminum**:** It is a lighter alternative to steel. Primarily, it is used in lightweight wheelchairs. It is a most useful material to reduce the weight of a wheelchair.

c) Plastic**:** Plastic is a lightweight material. It is easily cleanable and can be moulded in various shapes to accommodate the user's preference.

d) Foam**:** Many materials are used to make the foam. But now most of the things are as follows:

Polymers (a primary component of foam that provide the main structure of foam) like polyurethane, PVC, dacron, etc.

Gases: many gas bubbles are trapped within the structure of polymers. This makes the bobble form soft so that the user can be comfortable. This gas can be normal air or any specific gas like nitrogen and carbon dioxide that was defended on the type of foam.

e) Leather**:** Leather is used chiefly in making seat covers. Comfortable, long-lasting and soft leather is used as seat covers. Nowadays, synthetic leather is more popular. It offers a similar look to the original leather but is more affordable. It is also cheaper than genuine leather.

Conclusion:

The backrest is an essential thing for the wheelchair. If it is not in a wheelchair, then the wheelchair will be more of a dilemma than convenience.

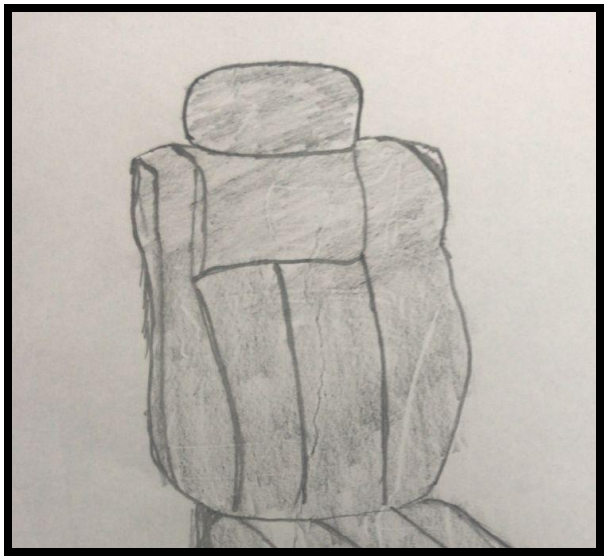

Fig: 4. B) The Backrest

III. Joystick (Controller)

Introduction
Our team is working on modelling a motorised wheelchair. Our model has 16 essential parts, of which I am interested in working on 2 parts: the Joystick and the Footrest.

- The Joystick is crucial, making a motorised wheelchair more special. If we want to convert a hand-run wheelchair to a motorised wheelchair, the Joystick is an integral part.
- It is a controller which helps in a full 360-degree rotation and even controls the wheelchair's speed. There are three basic power wheelchair controls: 1) Proportional Control, 2) Digital (Non-proportional control), the one that was present in Sir Stephen Hawking's wheelchair, and 3) Attendant Control.
- Proportional control is the most popular one for the daily witnessed power wheelchairs; our team has mentioned it for this project.
- Adding a joystick to the wheelchair is an excellent comfort to the user, as it shifts from rotating the wheels entirely with muscular efforts to just turning the Joystick's tip to navigate.

Location:
It is placed on one of the wheelchair's armrests, depending on the user's requirement.

Design
Its base is a rotatable stick which moves like we have the radiocarpal (wrist) joint in humans. Its structure is like that of the gear handle we have in cars, but the function is different. The Joystick's height and girth are decided for obvious reasons, considering the user can comfortably use it. Considering the average human palm length, 3.7 inches ≈ 9.4 cm and palm width 3.3 inches ≈ 8.38 cm, the Joystick is designed accordingly.
The Joystick is not an individual part but counted as one of the controller parts, which may also include a small display that displays speed and some extra buttons for additional features that vary from company to company. But Joystick remains the part to be included irrespective of the designer of the wheelchair.

Selection of Materia*l*
The Joystick is made of [ABS] material, waterproof rubber with a long service life.

Challenges we may face while modelling the project
As we imagine the structure of such a Joystick, we wonder how any engineer would have given such a design to an object. The significant complexity comes at the part while designing its base with a spring-like wavy structure. Drawing a 2-D diagram of such a thing becomes a challenge for some. So, why will not making a 3-D model of such an object be a challenge? Other than that, giving the buttons a natural look can be challenging.

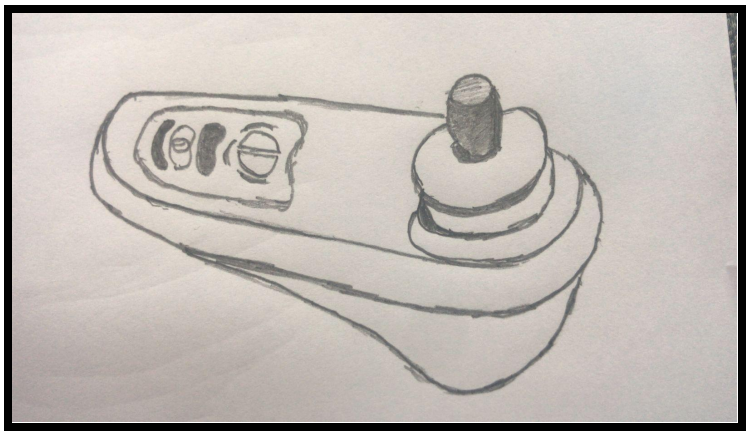

Fig: 5. A) The Joystick (or controller)

IV. Armrest

Introduction:

In the continued designing and crafting of an electric motorised wheelchair, our attention now turns towards the armrest component. The armrest is vital in ensuring user comfort, stability, and accessibility. A side frame supports it. It helps the lower part of the arm and the palm. The armrest serves as the connection between the user and the wheelchair. Design Parameters: As with the seat, the armrest's design is crucial. It must be adjusted to the natural posture of the user's arms and provide adequate support. The design includes armrest height, width, contour, and the choice of cushioning materials. These factors collectively contribute to user comfort, reducing strain during prolonged use.

Materials selection:

The choice of materials for the armrest concerns its functionality and durability. We will use lightweight but robust materials, such as aluminium or composite materials, to ensure structural integrity without adding excessive weight to the wheelchair. The used materials should be selected for both comfort and ease of cleaning. Just like the seat, the armrest should be adjustable to satisfy varying user needs as the wheelchair is used by a specially-abled person whose body structure and alignment differ from an average person. The armrest height and

angle are crucial to accommodate different users' arm lengths and preferred arm positions. Our design will incorporate adjustment mechanisms. The armrest design will ensure that it enhances the stability of the wheelchair. The locking mechanism of the wheelchair will resist unintended movement or folding of the armrest during use. The armrest must fit tightly on the wheelchair frame to maintain structural integrity. The armrest design should include pressure-relieving features to prevent discomfort and pressure sores. These elements distribute pressure evenly on the user's arms. The armrest should be designed with ease of entry and exit in mind. Removability or flip-up features can facilitate these transitions. Armrest can have arrangements to access, manage or replace the battery, power systems, and control units.

Functions:

Armrest provides relief and comfort. It gives a facility to reduce fatigue. It redistributes pressure in the overall arm of the user. Armrests provide leverage and support for users when transferring in and out of the wheelchair, fostering greater independence. Armrests contribute to the user's stability while navigating uneven terrain, ensuring a secure grip. It is used to access different features of the wheelchair.

Location:

It is located on the armrest frame. It is situated under your hand. It can be of any colour or beautiful pattern. It can be of different shapes based on the person to whom the wheelchair will cater.

Conclusion:

In this exploration of the wheelchair armrest, we have made the same standards of design and user-centred that characterised our seat. Ergonomics and materials selection, adjustability and safety have been the essential principles in our approach. The armrest is integral to the electric motorised wheelchair, contributing to the overall user experience.

As we develop our 3D CAD model, we remain addressing the challenges posed by the armrest's complex geometry and interface integration. We aim to create an electric wheelchair that enhances mobility and prioritises user comfort, accessibility, and safety. In the remaining

sections of our project, we will continue to explore and refine each component of the wheelchair, ensuring a comprehensive and exemplary design.

V. Charging port

Introduction:

It is the primary source through which the whole wheelchair work. It is usually used to connect a battery to a power source to recharge the battery. We can call it a connector that can charge an electric vehicle, regardless of plug type or standard.

Connector:

It is the physical interface between the battery and the power source of electricity which delivers the energy. It is an insertion port, which is also a power supply and power port. Provided in the electric wheelchair to where The power connector is inserted to supply the power to run the electric wheelchair by the user, and to insert the charge connector supplies electricity in the battery connection structure of the electric wheelchair provided with the battery having the charging port. Our electric wheelchair is characterised by the charging connector being partially covered with a shielding portion integrated with the power connector in the state where the power connector is inserted into the power connector. battery connection structure.

Design and Location:

Charging ports are usually made for user convenience and safety. It is usually located at an easily accessible position on the wheelchair, such as near the armrest, beside the joystick controller, or on the backside of the seat. The charging port may or may not be a female receptacle. Still, usually, it is a female receptacle having a specific connector design to match the male plug in the charger. Usually, the connector type has a three-pin XLR connector and two-pin DIN connectors. These connectors are made in such a way that ensures compatibility with vivid chargers.

Functionality:

The charging port's functionality seemed straightforward but not easy. It is crucial when anyone plugs the charger into the charging port. Charger connected to electricity. When power is turned on, electricity goes through the charger and into the wheelchair's battery via the charging port. The charging process of an electric wheelchair's battery involves a built-in charging controller, which observes and controls the flow of electricity to confirm that the battery is charged safely and efficiently. It prevents overcharging (which can damage the battery); this also provides a screen, known as a charging status indicator, informing the user when the battery is ultimately charged.

MAINTENANCE AND CARE: when we use something, then it becomes necessary to care about the proper maintenance. Charging ports are essential parts of wheelchairs, so we must care for them properly to ensure reliability and safety. Here are some essential maintenance tips:

1. **KEEP IT CLEAN:** Regularly check the charging port for dirt, debris, or corrosion. Use a soft and dry cloth to prevent the charging port from corrosion during cleaning. Avoid using the material that can damage the connectors.

2. **CHECK THE CONNECTOR:** check the female and male connectors for damage. If there is any problem (which can be corroded pins or bends) with the charging port, have them made correct or repaired or replaced promptly.

3. **SECURE CONNECTIONS:** Always confirm a secure connection when you use it for charging the battery. An improper connection can become a reason for incomplete charging or even destroy the charging port or charge.

4. **STORE THE CHARGER PROPERLY:** Store the charger in a dry and cool place when the charging port is not in use. Avoid from extreme temperature or also moisture.

5. **BATTERY STRENGTH:** Check daily the battery health, as the good-health battery will charge easily through the charging port.

DIFFICULTIES FACED:

The structure of the charging port is quite simple, so I do not think I would face any problems while making it. Assembling all the parts might be a bit difficult.

SOURCES:

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- **https://www.youtube.com/watch?app=desktop&v=sqtl-X0ZjBs**

VI. The frame of the armrest

Introduction:
In this world, all people are not the same; some have disabilities.So, for them, wheelchairs are used, but they need people to help themselves.But if they have electric wheelchairs, then they may be independent almost.
Electric wheelchair has many parts, one of them is the armrest frame. The frame of the armrest in an electric wheelchair plays an important role in the comfort of a person who needs the wheelchair. It is an essential component in the wheelchair. It is positioned at some height above the wheels or lower part of the electric wheelchair. The functionality of the wheelchair and the comfortability of the person. This component is designed with precision and durability.The frame provides crucial support for the armrest so that the users may feel comfortable and rest their arms when driving their electric wheelchairs.The frame of the armrest makes users feel comfortable and reduces the pressure they may face without any frame of the armrest.

Explanation:
In an electric wheelchair, the frame of the armrest, positioned at some height above the lower part of the wheelchair, is an important part of it because it makes the user feel comfortable and plays a crucial role in functioning.This frame generally contains various key elements.
The first is armrest pads, protected surfaces attached to the frame.When the user drives the wheelchair for a long time and his hands need to rest, these armrest pads help him feel comfortable.
The second one, the armrest frame, generally points up the height and width adjustability. These doings allow the users to use the wheelchair to their unique needs, ensuring that the armrests are at the most appropriate and comfortable position.
Moreover, some electric wheelchairs have a removable armrest that makes the person more comfortable.He can remove them inside or outside the room or anywhere.This feature enhances the user's accessibility and decreases the dependency on others.
Last, the armrest frame in some electric wheelchairs may have trays, cup holders, etc. This again increases the user's comfort because he can fulfil his basic requirements.
In summary, the frame of the armrest of an electric wheelchair has multiple facilities. it increases the user's experience.

Challenges Faced During Designing Frame of Armrest:
The Frame of the armrest in an electric wheelchair is a multifaceted component that provides comfortability, ensures adjustability and helps in the functioning of the chair. So it is not so easy to design it. Some of the key challenges faced during its development –
**Comfort and Appropriate : It must be designed so the user can use the chair without discomfort and may do all his daily tasks.
**Durability and Weight: The materials used to form armrest frames are durable, yet we have to make them lightweight.

**Safety and Accessibility:It is necessary to ensure that the armrest frame doesn't cause any safety hazards and is easily usable for users with limited mobility.
**Cost Effectiveness:Since, armrest frame making materials are costly, we have to think that the users can easily afford the cost; it is an ongoing challenge.

Materials Used:
The frame of the armrest must be made up of such a material that it has very little possible weight because if the frame of the armrest has a high weight, then the overall weight of the wheelchair will increase. It will not be comfortable for the user.So it is essential to have lightweight for the whole wheelchair.There are some materials which are used in making the armrest of the wheelchair, such as steel, aluminium, and titanium.
Steel: since we have to make the wheelchair lightweight, direct use of steel is not profitable.So, high-strength alloy steel is used for the formation of the frame of the armrest.High-strength alloy steel has high strength and light weight that is favourable for the wheelchair.
Aluminium: Engineers use 6000 series to 7000 series aluminum for the same purpose mentioned above. this type of aluminium has high strength and is lightweight, favourable for lightweight electric wheelchairs.This type of aluminium is resistant to corrosion .T6 aircraft-grade aluminium is also used for the formation of chairs.Generally this type of aluminum is used for bicycles but to make the wheel chair lightweight engineers use this also.
Titanium:Titanium is also the material that is used to make the frame of armrest of electric wheelchair not only the armrest frame but in other parts also it is used ,because it also has high strength and light weight.

Conclusion:
The frame of the electric wheelchair that enhances the comfortability of the user.It provides comfort and stability for the user whenever he use it.Because the user is not the same person, thet can be different persons so the wheelchair and its frame of armrest is made to meet the needs of every person like howmuch wide and all those ..In summary, the frame of the armrest is an essential component . .If frame of armrest is not attached in wheelchair, then user may face a lot of problems; he can not rest his hands, so he may feel distressed.He may feel like God has done this with him. He always feels very low and think that he cannot do anything because he is not like other people with no physical disability.

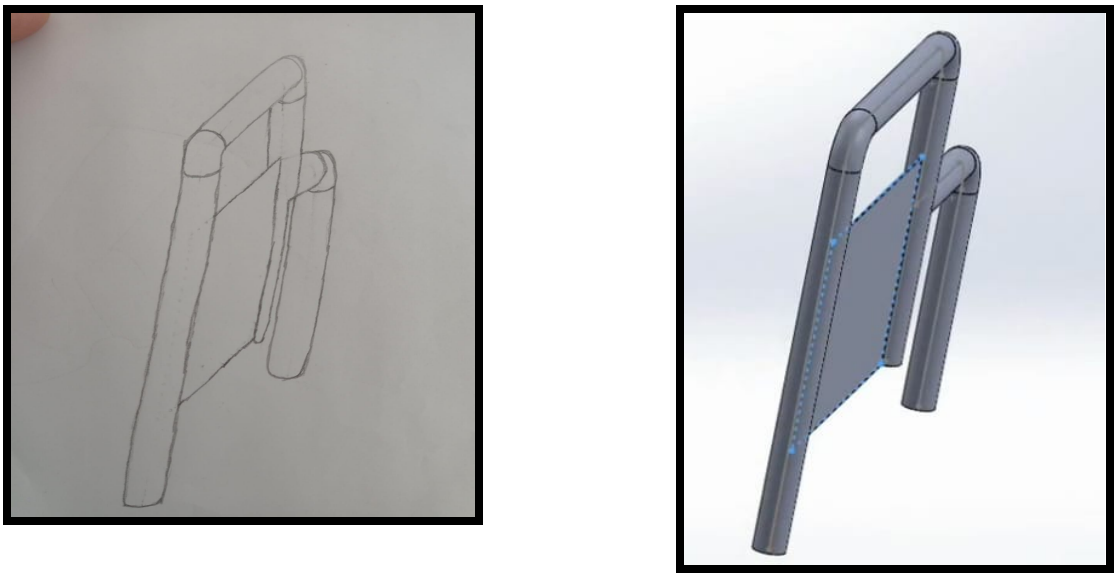

Fig: 6. A) The Frame of the Armrest

VII. Wheelchair seat

Introduction:

Wheelchair has a part which provides comfort and stability to user. It provides safety for individuals with mobility impairments. It ensures that the person using it is comfortable and does not slip. It gives support to the hips and provides the base to support the whole upper body. In this segment of our engineering graphics project, we will meticulously examine the design considerations, ergonomics, and materials selection for the wheelchair seat. Our aim is to create a 3D model that not only serves its primary purpose but also takes into account the comfort and well-being of its users. As people with special needs use the electric wheelchair, the material used for this part should be particular and comfortable.

Location:

This part is placed above the motors, battery, and wheels(both rear and front). This part is strongly connected to all the other parts. This part has no electric connections, but it has mechanical connections. It can be fixed and adjusted according to the user's needs.

Design:

It is designed with keeping in mind the comfort of the person in use. It has a curved shape structure, as shown in the above rough sketch. It has a minimum required thickness to provide durability. We will ensure that the seat incorporates safety features such as secure locking mechanisms to prevent accidental tipping and reliable restraint systems. In our 3D model, the seat is designed to ensure easy entry and exit for the user. We have designed it so that the armrest can be taken out or removed for comfort and to wash and clean the wheelchair.

Selection of material:

The choice of materials for the seat plays a vital role in durability, weight and comfort. We will explore materials like lightweight but robust aluminium frames and cushioning materials that provide both support and comfort. The cushioning materials must be chosen with hygiene and ease of cleaning in mind.

Challenges we will probably face to make this part

Creating a 3D CAD model of a wheelchair seat presents several challenges that demand careful consideration. The first challenge we will probably face is to balance the part and make it in proper symmetry. The seat must be designed for the user while accommodating a wide range of body types. Precision is vital to ensure that the dimensions, contours, and support mechanisms align with the unique needs of individuals with mobility impairments. Another challenge is material selection. The choice of materials impacts the seat's durability and weight. Creating an

Autodesk part will require great proficiency in the software. We will be required to spend more and more time with the software.

Conclusion:

We will have to try and repeat to make the final part. Designing mechanisms for seat height, tilt, and reclining must be precise to cater to varying user preferences. Additionally, ensuring the seat complies with safety standards, including crash-testing requirements, is crucial.

SOURCES

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2. Wheelchair - Wikipedia
3. Wheelchair Parts and Wheelchair Accessories - Wheelchair Parts
4. Wheelchair Spare Parts: Buy Genuine Replacement Spare Parts Online Low Price (wheelchairindia.com)

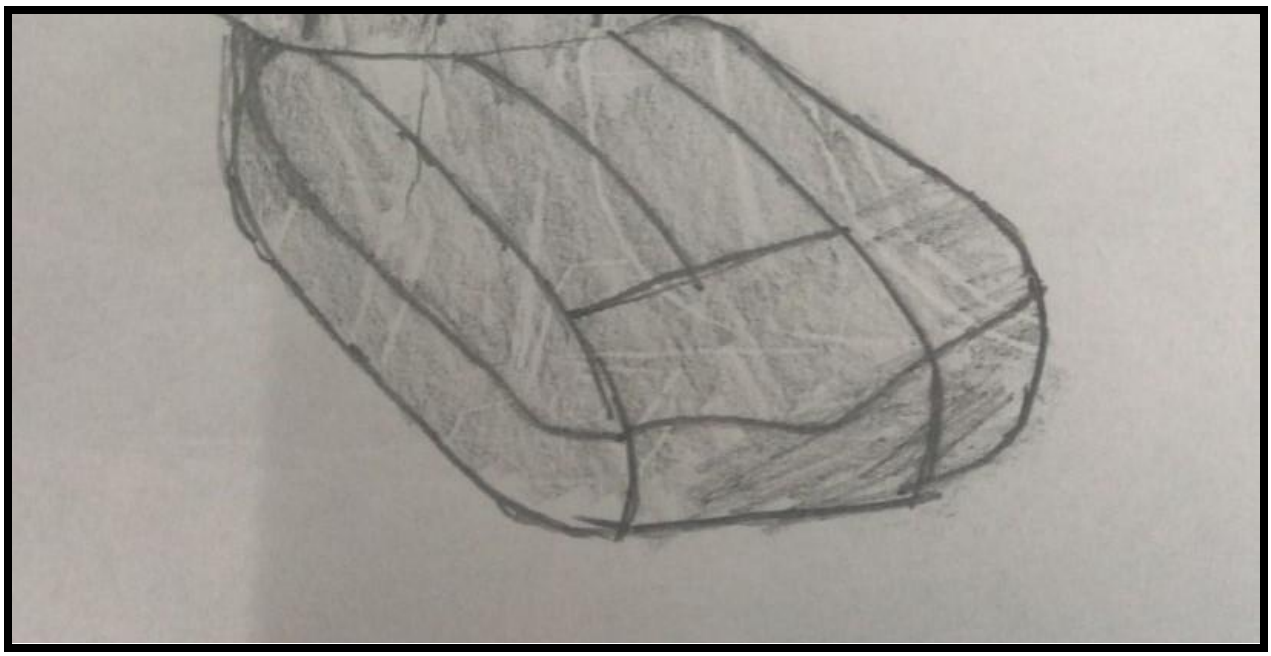


Fig: 1. A) The Wheelchair seat

VIII. Brakes

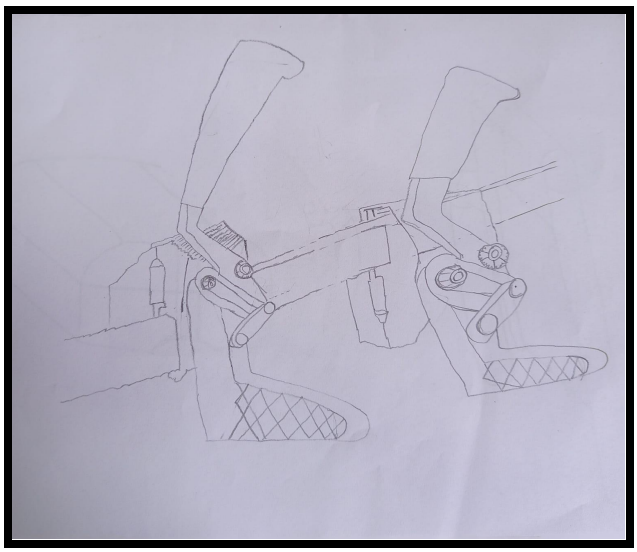
While a propelling system is an essential and critical component of an electric wheelchair, a braking system is equally important. Brakes play an essential role in ensuring the safety of the user. Electric wheelchairs usually have two braking systems: Electromagnetic brakes and Dynamic brakes. Both types of brakes have their own merits and demerits.

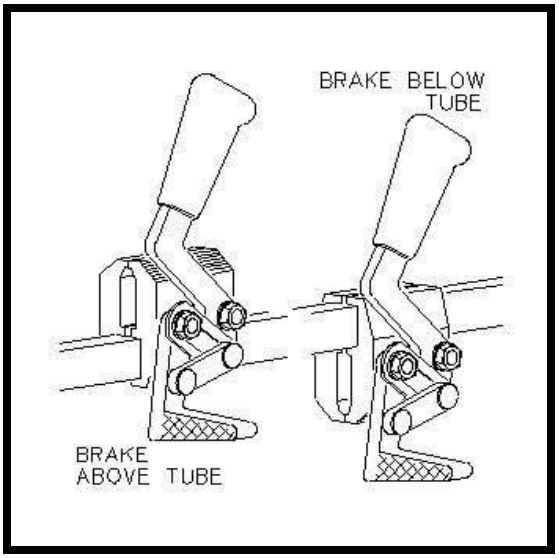
Electromagnetic brakes operate on the principle of electromagnetic force. When the user applies brakes, an electric current is generated, passing through a coil. Because of this, a magnetic field is generated, which attracts a metal disc. This disc is attached to the wheels of the wheelchair. When the magnetic field attracts the disc, frictional force is created on the wheels, and the wheelchair can be slowed down to a stop. Electromagnetic brakes are known for their precise control and effortless, smooth stops.

These features make electromagnetic brakes ideal for operating in crowded areas and tight spaces. Dynamic brakes work differently than electromagnetic brakes. Unlike electromagnetic Brakes, dynamic brakes use the wheelchair's motor to slow down the wheels. The user must release the joystick or control panel to apply brakes, and the motor switches from propulsion to reverse mode. This mode reversal generates resistance in the motor, which effectively helps slow down the wheelchair. Dynamic brakes are usually used as a backup braking system. These are most useful when the wheelchair is running on slopes. These brakes prevent the wheelchair from rolling backward on slopes. The brakes must be quickly and smoothly applicable in an unavoidable emergency. This quick response can help avoid injuries to the user. Electric wheelchairs are designed in such a way that they can be used on uneven terrain, indoor spaces, etc. So, brakes enable users to make precise adjustments according to their environment, such as to stop or slow down whenever necessary.

When the user of a wheelchair needs to be transferred from chair to bed, the chair needs to be steady enough for this challenging task. Brakes help in stabilizing the chair during these transitions. This eventually reduces the risk of falling and helps in avoiding injuries. Brakes in electric wheelchairs also affect the efficiency of the battery. Electromagnetic brakes are primarily known for their energy-saving qualities. When the brakes are used, they convert the chair's kinetic energy to electrical energy, which gets stored in the battery and can be used to supply power to other functions. This is known as regenerative braking. This system involved in

braking also increases the chair's battery life and reduces overall energy consumption. To conclude all the above, in the world of electric wheelchairs, brakes are far more than a safety feature. In fact, they can even be considered the backbone or linchpin of wheelchairs that ensure the user can interact with their environment quickly and move anywhere with confidence, control and peace of mind. Also, proper brake maintenance is a compulsory practice that the user should adopt. Regular inspections and adjustments according to the user's needs by a qualified technician are a must.





Problems faced while making brakes in a wheelchair may include their proper alignment on the handles and their smooth and curvy shapes. We will also face challenges in finding the dimensions and specifications of the brake component. We will require experience and expert knowledge about Autodesk inventor software to make our model efficient.

SOURCES:

1. wheelchair - Recent models | 3D CAD Model Collection | GrabCAD Community Library

2.» Wheelchair Brakes: Maintenance and Adjustments (invacare.eu.com)

3. (579) Wheelchair Maintenance - Adjusting Brakes - YouTube

IX. Battery

Introduction: A battery is an electrochemical device used to store electrical energy in chemical form. Battery can convert the chemical energy into electrical energy as per our requirement. Batteries play a very important role in our daily lives. It provides electrical energy to electrical devices like TV, smart phones, bulb, etc.

It consists of one or more electrochemical cells. Each cell of the battery contains an anode, a cathode and an electrolyte material that is the major part to store electrical energy. When we connect the battery to a circuit, it provides its energy in the form of electricity to the electrical appliance.

Components of Battery

1. Cathode: The cathode is the electrode in the battery where reduction (loss of electrons) takes place during the process of discharge. Manganese dioxide, compounds of nickel and cadmium, are used in the cathode.

2. Anode: Anode is another electrode in a battery where oxidation (addition of electron) takes place during the process of discharge. The most common materials used for anode include zinc, lithium and graphite. But all these materials depend on battery chemistry.

3. Electrolyte: It is the medium of conduction that allow the electrons (ions) to move between anode and cathode. It can be a liquid or can be a solid, depending on the type of battery.

4. Separator: The separator is a membrane that is situated between the cathode and the anode. This allows the flow of ions and prevents short circuits. Separator can be made from a variety of chemical materials like nylon, polyester, and cardboard. The separator does not chemically react with any component of the battery; Cathode, Anode and Electrolyte are not affected by the separator.

5. Housing or Casing: It is an outside structure of the battery. In other words, a battery requires a way to contain its components, and this way is housing. The casing of battery is mostly made of steel, soft polymer, plastic and bakelite.

Types of batteries: On the basis of chemistry, characteristics and applications, there are many types of batteries that can be used in a wheelchair.

1. Lead-acid batteries: It is a rechargeable battery. Its anode is made of sponge lead, and its cathode is also made of lead dioxide. Sulfuric acid is used as an electrolyte.

2. Nickel-cadmium batteries: It is a rechargeable battery. Its cathode is made by nickel oxide and hydroxide, and its anode is also made by cadmium. Potassium hydroxide is used as an electrolyte.

3. Lithium ion batteries: It is also rechargeable. Its cathode is made of lithium cobalt oxide or lithium iron phosphate. Its anode is of graphite.

Key Features of Wheelchairs Batteries:

1. Longevity: Longevity is more significant for those who are completely dependent on a wheelchair. Good quality batteries have a long life.

2. Energy density: Lithium-ion batteries have higher energy density so these types of batteries can store comparatively more quantity of energy in a smaller and lighter package.

3. Safety: In this wheelchair, the battery is designed in a safe way from overheating, overcharging and short circuits.

4. Charging efficiency: In this wheelchair, the battery is efficient in accepting charge to make sure that it is ready for use.

Conclusion:

In conclusion, we can say that batteries are an essential part of electronic wheelchairs, which provide mobility, freedom and a better way of living to people with slow mobility. These devices have been carefully designed to meet the specific requirement of the user.

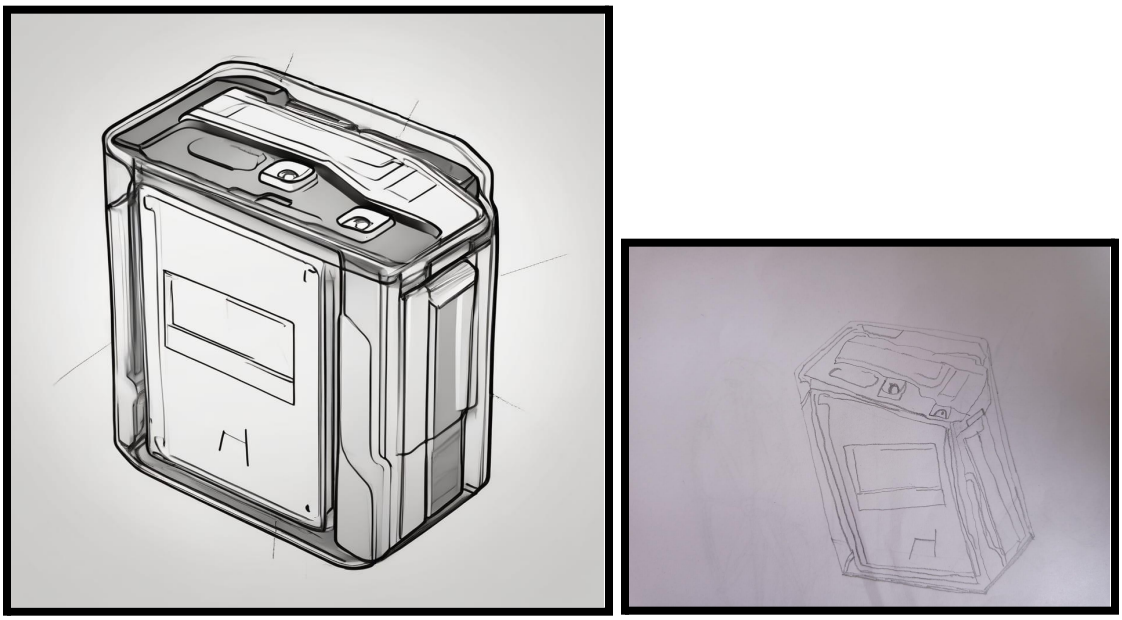


Fig: 4. A) The Battery

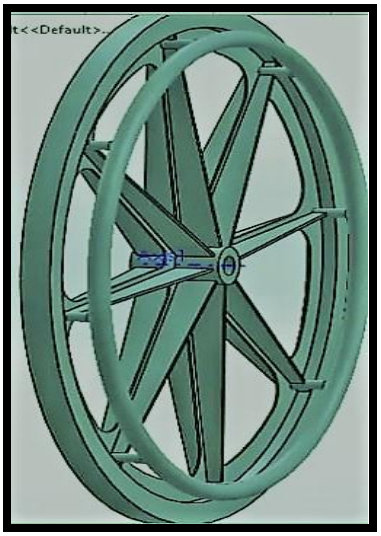
X. Rear wheels

Wheels are the ones responsible for moving the wheelchair ahead, backward, and side methods. The rear wheels are placed at the back of the wheelchair. They play a critical role in providing mobility to the consumer. Unlike guide wheelchairs in which the consumer propels themselves or wants any other person to facilitate them in moving, electric wheelchairs powered by electric motors are very accessible. They need not rely on others to assist them and are also self-dependent.

The rear wheels in an electric-powered wheelchair provide the primary propelling pressure to transport the chair. Electric automobiles located near these rear wheels generate the vital strength required for the movement of the chair. A rechargeable battery in the wheelchair

powers these automobiles. The person can manage the motion of the wheels using a joystick or a management panel. In electric-powered wheelchairs, the rear wheels offer more balance and higher coping with uneven terrain. Some models have large rear wheels and better suspension systems so that the consumer will have better out-of-door enjoyment.

Electric wheelchairs additionally include safety functions associated with rear wheels. The rear wheels should have proper grip to make inevitable friction between the floor and the wheelchair. The rear wheels must also encompass anti-tip mechanisms to save the chair from toppling even on incline terrain. Control interfaces include a joystick at the wheelchair whilst operated via the user, ship indicators to the automobiles inside the rear wheels, and the chair moves for that reason within the given direction and with appropriate speed.



XI. Anti-tip wheels

Introduction:

Wheelchair anti-tip wheels or anti-tippers are wheels attached to the frame of the wheelchair, either at the back or at the front. These small and strategically placed wheels often unnoticed play a crucial role in keeping the wheelchair stable. Their primary purpose is to prevent the wheelchair from toppling when climbing ramps or when the user tries to exit the wheelchair. In

many regions, it is mandatory for wheelchairs to have anti-tip wheels in their design. These wheels avoid injury to the user. Even though anti-tip wheels are available in many shapes and sizes, they all serve the same function. Anti-tip wheels give the user a sense of safety and allow them to maneuver around with confidence.

Need for Anti-tip wheels:

Based on the driven wheels of the wheelchair, most motorized wheelchairs can be broadly classified into Front-wheel drive (FWD), Mid-wheel drive (MWD), and Rear-wheel drive (RWD). Front-wheel drive has the front wheels as the driven wheels and the rear wheels as castor wheels. Mid-wheel drive has three pairs of wheels; the middle wheels are driven wheels, and the other two are castor wheels. Since the user directly sits on top of the central wheel in MWD, the risk of toppling is not pronounced; FWD may topple if the user tries to stand, and RWD always tends to level. Hence, anti-tip wheels are fitted onto the frames of FWD and RWD wheelchairs.

Possible challenges:

- Make sure that the wheels are of the right dimension.
- Adding details to the wheels.

Sources:

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- https://www.wheelchairparts.com/store/pc/Wheelchair-Anti-Tippers-c114.htm

XII. Castor Fork

Introduction

A fundamental component in the working of a motor wheelchair, it provides the required strength to hold the weight of a body and provides strength and stability to the wheelchair. Being one of the most pivotal parts of the movement mechanism, it can rotate 360 degrees to

give a complete roundabout. It is placed at the front of the chair and holds the castor wheels, which are accountable for steering and stability. They provide the necessary support and stability for smooth rolling.

The castor fork, being an integral part, works as the lifeline for the one sitting on it. Its failure can stop all the movements altogether. That's why castor forks should be made so they can also work correctly and hold the wheels in their place.

Function of Castor Fork

The working of the Castor fork is given below:

1. *Fork Structure*: Fork-shaped two arms structure, made of durable plastic or metal, extends downward and outward. Mounting is also known as socket. The primary function is to hold the wheel and adjust it as per movement.
2. *Socket*: The Socket is a small part present at the bottom of the equipment. Connected with a castor fork, its function is to provide further stability to make movement smooth.
3. *Swivel Function*: The swivel function is also the rotatory function. This type of function of the castor fork helps to allow the caster wheel to swivel freely in three sixty degrees that are in all directions. The mechanism is possible by joining the revolution to the swivel function within the fork. The swivel mechanism consists of a ball-bearing or a ball race. This allows the wheel to rotate smoothly and pivot in any direction.
4. *Steering and Mobility*: With the help of a castor fork present, working as the baseline for all the other components to make movement as smooth as possible. The use of the swivel mechanism allows the wheel 360-degree rotation, precise steering, and improved mobility, making it simple to move objects in any direction with minimum effort.

When the user uses it by pushing the joystick forward and backward, the caster wheels turn in the direction the one wants and provide steering control and driving force. The caster forks are

designed so that they allow even tight turns. Its design makes the user comfortable going through the crowded spaces.

Challenges faced during making on Autodesk

When designing the castor fork of an electric wheelchair using Autodesk or CAD (Computer Aided Design) software, we faced a complex shape, ensuring that it fit together precisely are:-

- Designing the fork while keeping the dimensions matching with others might be difficult.
- Assembly of all the Parts of the castor fork might be complex, and we have to do an assembly with other group members, so we need to keep that in mind while doing so.

Material Requirement

The caster fork, one of the most essential parts for movement support, must be in good shape but with the help of all body weight. It might wear down eventually, leading to rough movements. So we need high-strength materials for its continuous and proper functioning. Made up of steel and aluminum, which have high strength, castor forks provide strength and stability to the movement of wheelchairs. Being a crucial part, it must provide power not to let any harm be done to the wheels. While working on it, I learned that castor forks are laminated to increase their hardness.

Thus, one might need to look up materials with high tensile strength and high-pressure resistance that can provide smooth working to wheelchairs.

Conclusion

Caster forks are the essential parts of the electric wheelchair. They play a vital role in an electric wheelchair. Along with providing strength and support, the castor fork's primary function is to assign the wheel's movement while going in any direction. If it were not for casting a fork, the movement of a wheelchair would be different and much harder to do.

Source:

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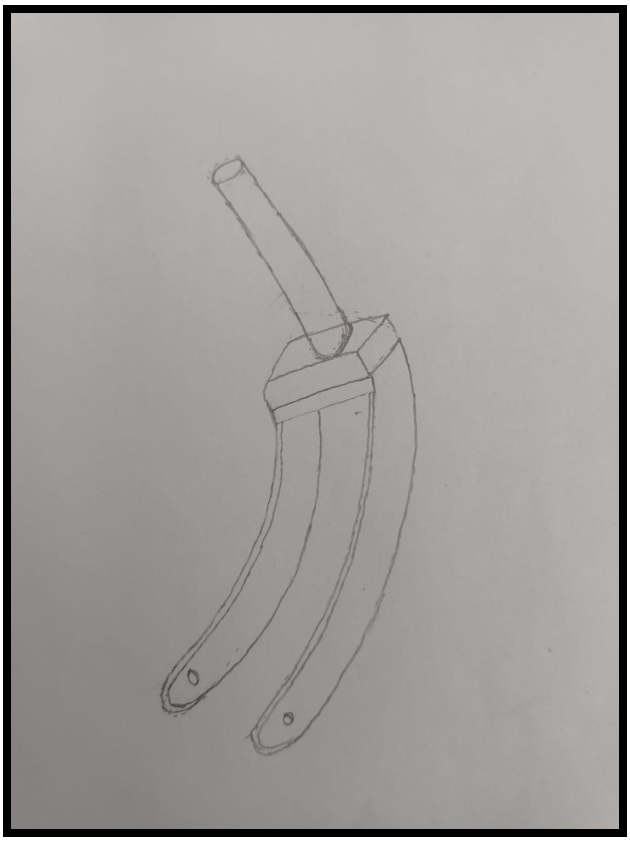
2. https://www.iqsdirectory.com/casters/



XIII. Footrest

Location:
It is located between the front wheels and at a height where the user may rest their leg.

Design:
It is a pair of two small rectangular platforms instead of a single extended platform. It is optimum thin to have that rigidity, so it does not fold just by the weight of the leg of the user. Considering human comfort and the average foot size, the length of each footrest is 400 – 900 mm.

Selection of Material:
The footrest is primarily made of plastic, with some companies offering a rubber layer over it. The plastic is made of excellent material that gives high strength, faces no deformation, and is durable, stable, wear-resistant, and impact-resistant.

Challenges we may face while modeling the project:

Someone may encounter the following challenges–

- Showing the footrest as a foldable part can be challenging.
- Modeling it while clearly showing its junction with the hinge and not as a separate part can be challenging.

***Citation*:**

Only the facts and figures have been picked from the following-

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2) OpenAI. (2023). *ChatGPT* (August 3 Version) [Large language model]. https://chat.openai.com
3) https://choosehandsafety.org/s.
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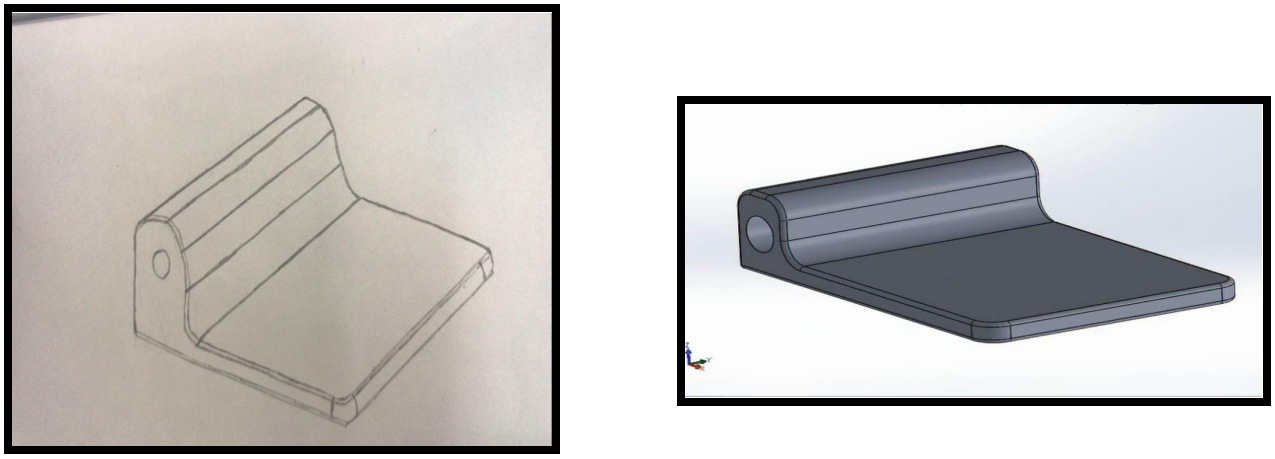

Fig: 5. B) The Footrest

XIV. Front-wheel

Front wheels in a wheel chair also serve a typical role in ensuring stability, maneuverability and control for the user.

These wheels are usually smaller in size as compared to the rear wheels. Front wheels are positioned at the front end of the chair and mounted on the side frame.

The main purpose of front wheels is to aid the user in steering and navigating through the environment. By turning the front wheels in different directions, the corse or the path of wheel chair could be changed.

The front wheels are equally important as the rear wheels are. They act as a pivotal point about which the wheel chair can rotate. This feature enables the chair to take turns in tight spaces and crowded areas where a broader turning radius could pose challenges.

Front wheels also help to prevent tip overs by distributing the weight of the chair and user equally. Due to front wheels, the wheel chair becomes steady and the avoids tilting of the chair. These features are especially useful on inclines and uneven terrain.

Besides these features that the front wheels add to the wheel chair, they also contribute to the overall aesthetics and design of the chair. They are designed in such a way that the wheel chair look gleamy and elegant. This really enhances the chair's appearance.

Problems that we might face while designing the front wheels are managing the proper dimensions of the wheel, distance from the rear wheel and proper thickness and that the wheels must be free to rotate in place.

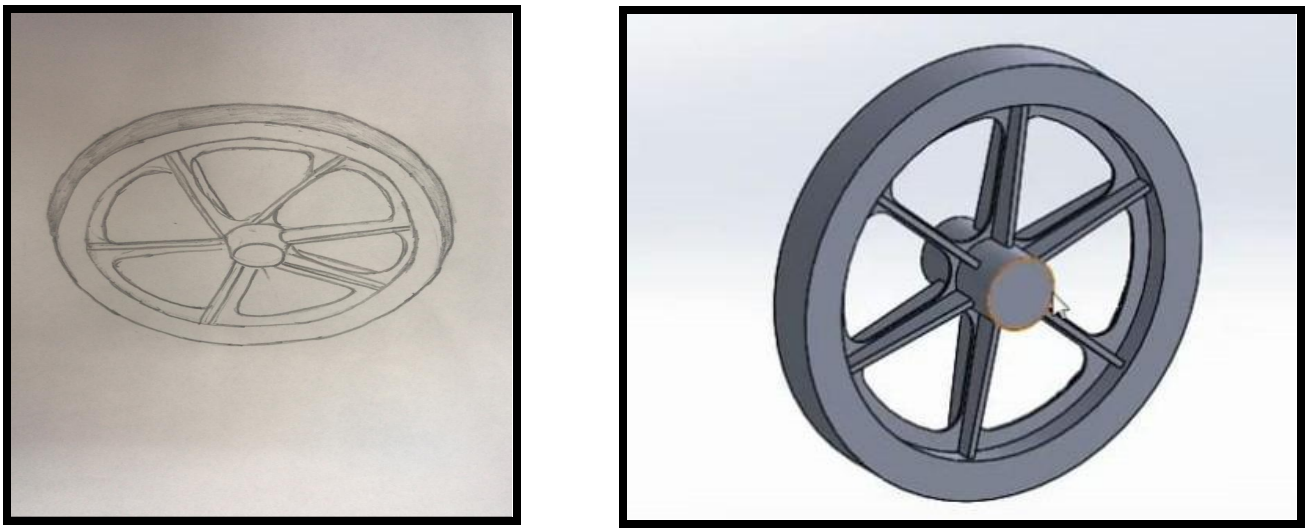

Fig: 8. A) The front wheels

XV. Electric motor

A) <u>ELECTRIC MOTOR</u>:

Introduction:

Electric motors are devices that convert electric energy to mechanical energy. Most electric motors operate through the interaction between the electric current in the windings and the motor's magnetic field to generate current. An electric generator fundamentally works in the opposite manner of an electric motor. Hence, electric motors in EVs are also used for regenerative braking.

William Sturgeon first invented a commutator DC motor capable of turning machinery. Over several decades, numerous design and development efforts were undertaken, yielding a series of inefficient designs. It wasn't until a pivotal realization emerged that the crucial factor lay in the air gap between the rotor and stator. It became evident that this gap needed to be minimised for an efficient design.

Preliminary model:

A preliminary model can be made by passing an axle through a bar magnet and setting a stationary bar magnet beside this axle such that the bar magnet is along the diameter of the axle. The inner bar magnet always tries to rotate such that the unlike poles of both magnets are closest to each other.

Components:

- **Armature:**

This is made of coils of wire, the rotating part of the motor. Armature can be considered the inner bar magnet in the Preliminary model. The armature is usually made up of multiple T-shaped laminated sheets made of iron stacked together. The Armature is never manufactured from a single iron block or any other magnetic material, as the eddy current produced is much more than the stacked design.

- **Stator:**

This is the stationary part of the motor that surrounds the armature and generally contains permanent magnets.

- **Commutator:**

This is a ring with breaks in the middle to reverse the current direction in the armature coil as it rotates. Without a commutator, the armature reaches a stable equilibrium point and stops the motor's continuous motion.

- **Brushes:**

These are composed of conductive materials like carbon and are in contact with the commutators. When working, the brushes constantly rub against the commutators. Hence, it is necessary for the brushes not to wear down or add friction to the commutator. Brushes are spring-loaded to ensure that they maintain contact with the commutator.

- **Bearings:**

These support and ensure the smooth rotation of the armature shaft or the rotor in a motor. Generally, ball bearings or sleeve bearings are used.

Working:

· Initially, current passes through the armature and due to strong magnets, the armature experiences Lorentz force and starts to rotate.

· The commutator rotates along with the armature coil, and due to the commutator's half-ring design, the current's direction is reversed every time it completes a half-turn. This ensures that the armature keeps on rotating in the same direction.

Uses:

- **General uses:**

DC motors have various applications ranging from simple toys to Electric vehicles. Some notable examples are

1. **Electric vehicles:**

   DC motors are used in forklifts, golf carts, and older inventions. The current EV market uses brushless DC motors as they are more efficient.

2. **3-D Printers:**

   3-D printers use three DC motors to precisely adjust the extruder's position in the 3-coordinate plane.

3. **Automobiles:**

   DC motors are generally used in automobiles for wipers and power windows.

DC motors have a lot more applications besides this.

- **In a wheelchair:**

  In a motorized wheelchair, the purpose of the DC motor is to propel the wheelchair forward through either a pair of wheels or multiple pairs of wheels. In this project, the motor drives the rear wheels.

Possible challenges:

- Make sure the dimensions are correct and all the shapes are correctly modelled.
- Ensure proper alignment of slots for bolting this motor during the assembly stage.