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Senior Design Project Report

Design and Manufacturing of an improved Car Wiper Mechanism

In partial fulfillment of the requirements for the Degree of Bachelor of Science in Mechanical Engineering
Team 5

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Abstract

Mary Anderson patented her invention of the mechanical windshield wiper in 1905, and it became standard equipment by 1913. Most transportation vehicles did not have wipers. The history of the windshield wiper began with the invention of the automobile. The project goal is to modify the existing design of Car Wiper mechanisms. The main objective is to design and manufacture a new mechanism to cover the complete area of the wind screen. Different types of mechanisms like Cam-Follower, Slider-Crank, Rack-Pinion, etc. or a combination of these mechanisms will be explored used to achieve the goal of this project. At the beginning, the project needs to achieve the design and some analysis of wiper mechanism. Manufacturing of the improved wiper will be carried out.

Acknowledgments

In performing our senior project, we had to take the help and guideline of some respected persons, who deserve our greatest gratitude. The completion of this project gives us much Pleasure. We would like to show our gratitude to our advisor Dr.Mohammad Asad and co-advisor Dr.Nader Sawalhi , for giving us a good guideline for project throughout numerous consultations. We would also like to expand our deepest gratitude to all those who have directly and indirectly guided us in writing this report. Many people, especially our classmates and team members itself, have made valuable comment suggestions on this project which gave us an inspiration to improve our assignment. We thank all the people for their help directly and indirectly to complete our project.

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Chapter 1: Introduction

In engineering sector, new ideas about machines come up each and every day. The ideas fall in either of the two categories:

- Innovative ideas
- Inventive ideas

In innovative ideas, engineers brought out those ideas that are meant to improve the performing of the machines. These ideas enhance the effective functioning of the machines whereby they either replace the current procedure of performing of a machine or add an extra design for the better performing of a mechanism. Here, the engineers do not have to come up with a totally different design for the betterment of a machine.

In inventive ideas, engineers brainstorm those ideas that are meant to improve the current performing of machines. These ideas, unlike the innovative ideas, are those that are came up with so that to came up with a totally different mechanism from the previous one but performing the same function but in a different and advanced way. The current design is absolutely new in terms of appearance and operation although it is intended to accomplish the same function.

Therefore, engineers are making steps daily to make sure that machines in the locomotive industry are operating in the right manner and in the latest advanced technology with maximum impetus given towards the safety and comfort of a person while driving a locomotive. A large number of avoidable accidents happen every day due to minute issues related to equipment and their related designs calibrated inside a locomotive like car, bus etc. Such issues relate to braking system, seat belt, windshield wiper mechanism etc. Thus, in the project to be defined here it is about to improve the previous mechanism of the windshield wiper to a new and more effective one which can perform better than the previous one.

1.1 Project Definition

This project is intended towards revolutionizing the automotive industry by designing a new and improved car wiper mechanism that can deal with visibility issues during events of rain. The conventional wiper mechanisms installed in cars are able to partially clear the windshield due to which water dripping problems are inevitable. This car windshield wiper mechanism can clean the whole windshield of the car. As a result, it will be beneficial in the sense that it will improve visibility of the driver up to a satisfactory distance and thus avoid unprovoked and unintentional collisions on roads.

1.2 Project Objectives

When designing a product, it is good to set up some aims and objectives which will be guiding you and they will give you an overview of what you are about to do. These aims and objectives are later analyzed after the finalizing of the work to see whether they were met.

These aims and objectives are:

- Develop a windshield wiper mechanism which is more effective in terms of power input and size it occupies.
- Invent an improved windshield wiper mechanism which is new in the market and presentable to the consumers.
- Come up with a mechanism of a windshield wiper which is friendly to the environment and actually provide safety to the operators.
- Bring out a wiper mechanism which is simple and cheap to manufacture and fabricate.

- Develop a windshield wiper mechanism which is durable in that it can be able to serve for a long time without breakdown.
- Study and analyze the implications of working of the wiper mechanism through computer based simulation.
- Compare working of the new wiper mechanism with the conventionally used mechanism and note the changes obtained related to the new design.
- Develop a prototype to obtain real time data and feedback from a human resource through experimenting in a secure environment.

1.3 Project Specifications

The project is divided into various subsystems which ensure synergy to produce effectiveness of the windshield wiper mechanism. The subsystems include but not limited to:

Mechanisms section- this is composed of the crank rocker mechanism to obtain the 160° arc and the crank slider to obtain the translatory motion for optimization of the area to be wiped.

Actuation- the actuation of the whole mechanism is achieved by an electric DC motor of 12V which makes whole 360° rotations to produce both the rotary and translatory motion of the windshield mechanism.

Electronic control system- this section is made of sensors, wiring system, power system and driver controls. The vehicle electronic control module (ECM) is the on-board computer that controls all automated systems by receiving signals and giving appropriate response- it ensures the coordination of the windshield wiper mechanisms.

1.4 Applications

When coming up with a design, it is obvious that it is intended to be used in a certain manner in a certain place. Therefore, it is good to understand the applications of a certain mechanisms which can also help you during the designing and fabrication processes. A mechanism can handle one function or multiple of functions. In this case, our project is about windshield wiper mechanism which is intended to wipe a maximum area of a windshield.

Some applications are as follows:

- I improved visibility of car windshield during rain.
- This mechanism can be applied to heavy automation like buses, trucks etc. with little modification.

Chapter 2: Literature Review

This chapter deals with the literature study to design and analysis the car wiper mechanism. It includes background, the investigation of what others have done in this area and comparative study of the previous work. This study included the areas of electric and electronic as a guide to design the circuit for the car wiper mechanism.

2.1 Project background

In the present scenario of scientific advancement, infrastructure building or other social and technical developments, transport plays a vital role. Whether it be the case of transport of goods and materials from one place to other or humans travelling from place to place for office work, leisure activities or exploring new opportunities, transport facilities play a significant role. Automations like buses, cars, two wheelers, etc. are examples of modes of transport utilized for day to day commutation by the masses. Out of the available transport facilities, cars are the most frequently used and preferred especially in big cities and metropolis. However, while transport is concerned, automobile industries pay great attention to a passenger's safety because although commutation facility eases the life of people but it also proves out to be fatal in some cases. There are an increasing number of road accident cases worldwide especially during rainy season because a driver has to confront visibility issues during rain. The modern day cars use wiper mechanism to wipe rain water from the windshield of a car however; this mechanism has its own constraints. Wiper is an important element in a vehicle that functions to wipe rain drop and dirt from windscreen. Wipers are also used in other vehicles, such as buses, trams, locomotives, aircraft and ships.

The design of wiper blades is very important in car wiper mechanism but it is not given much attention not only now days, but also during the first introduction of the blades. The result is many blades which are cracked split, torn, brittle, worn

or otherwise need of replacement. Some blades condition is good but in fact does not perform a good quality wiping when put to test.

We know that ninety percent of all driving decisions are based on a clear unobstructed view of the road, which means good visibility is very important, especially during wet weather and dusty environment. Vision may be obscured by water, road splash, dust, sleet or snow on the windscreen but good visibility requires wipers that can wipe away the dust. If the wipers chatter, streak or fail to wipe cleanly and consistently, new blades should be replaced with the old ones. According to the experts, wiper blades should be replaced every six to twelve months for optimum performance and good driving visibility. The reason is because wiper blades do not last forever due to natural rubber deteriorates over time. Dewulf, W.1999 found Halogen-hardened rubber as well as synthetic rubber provides longer life to wiper. But environmental factors i.e. exposure to sunlight and ozone causes the rubber to fall even if the wipers are not used much.

Blades cannot perform wiping task cleanly if it has lost its flip over flexibility. Development of a permanent set called "parked rubber" or curvature prevents full contact with the windscreen. This tends to be more of a problem on vehicles that is parked outside in the hot sun all day. The sun bakes and hardens the rubber. Then when the wipers are needed, they streak and chatter because they have taken a set and would not follow the curvature of the windshield. It can be annoying and dangerous.

Cold weather can also affect blade life. Freezing temperature makes rubber hard and brittle, which increases its tendency to crack and split. The wiper arm can be clogged with ice and snow, which prevents the holder from distributing spring tension evenly over the blade. The blade "freezes up" and leaves streaks as it skips across the glass.

Heavy use of wiper can be hard on blades of wiper because dust, abrasives, road grime and even bug juice wear away the edge that the blades need to wipe cleanly. Water gets under the blade and remains on the glass as the blade loses its edge which results in reduced visibility and poor wiping action. Blades which are chattering, streaking and not performing well should be replaced. Blade that is cracked, torn, nicked or damaged should be replaced as well.

This is because firstly, the design of the contemporary wiper system is such that it wipes a small area of the windshield thus rectifying a part of the whole problem. Secondly, the wiper mechanism is less efficient when it comes to operation because due to wiping a small area of the windshield, water from other area enters into the driver's field of view thus persisting the visibility problem. Therefore, for better safety of the passengers during travel, there is a need to modify the existing windshield wiper mechanism in a car. The current project report intends to develop a modified wiper system to improve a driver's comfort and safety during commutation.

In the interest of our project, the mechanisms section will be discussed. Most applications in the modern engineering world require a machine with a reciprocating, linear sliding motion of its main components. For crank slider its stroke is the most desired parameter since it establishes how far the slider can get off the crank. The maximum stroke is desired at any one time- since this is the most optimum quality so desired of any design of windshield mechanism. Taking the illustration below from Myszka, David H; Machines and Mechanisms: Applied kinematic analysis —4th Edition 2012 (Page 114)

$$L_2 = \frac{|\Delta R_4|_{max}}{2} \qquad \text{(Equation 2.1)}$$

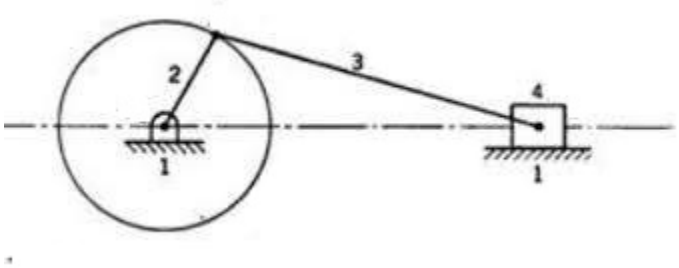

Figure 2.1 (crank slider mechanism)

R4 represents the range of distance of the stroke from the maximum stroke to the minimum stroke obtainable by the slider. The slider and the crank share a common axis as illustrated above and so they achieve a balanced and synchronous motion as long as the crank moves at a constant velocity obtained by an actuator such as an electric motor with a specified rpm. From analysis the desired stroke is given by twice the length of the crank by the equation below.

From the equation above it is noted that the length of connecting arm L_3 does really matter but if it's shorter, the mechanism will accelerate faster.

For a crank rocker system now, it's mostly appropriate where repeated oscillations are required such as those made by the windshield mechanism. From the illustration below, excerpted from

Myszka, David H; Machines and Mechanisms: Applied kinematic analysis —4th Edition/2012 (page 116):

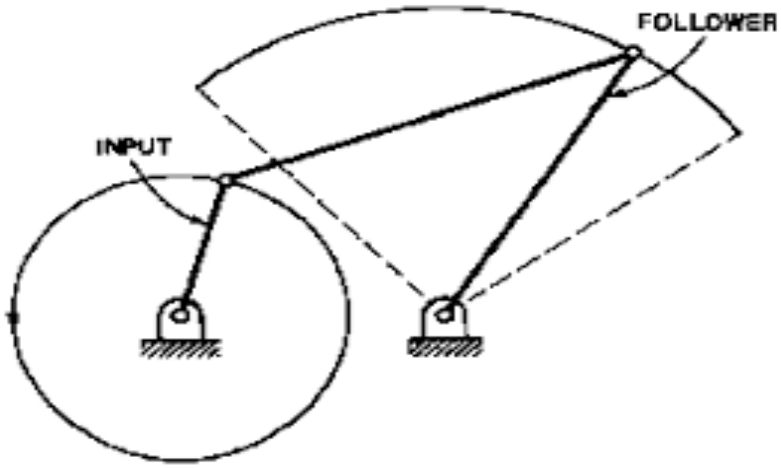

Figure 2.2 (crank rocker mechanism)

The analysis to determine the appropriate length of links is established by the following equations:

$$L_2 = {}^{1}/_{2}\,(AC_1 - AC_2) \qquad \text{(Equation 2.2)}$$

$$L_3 = AC_1 + L_2 \qquad \text{(Equation 2.3)}$$

NB: With Grashof's criterion and the analysis equations above, the two may be used to design a variety of lengths for windshield mechanisms.

The photos from CAD model are shown below:

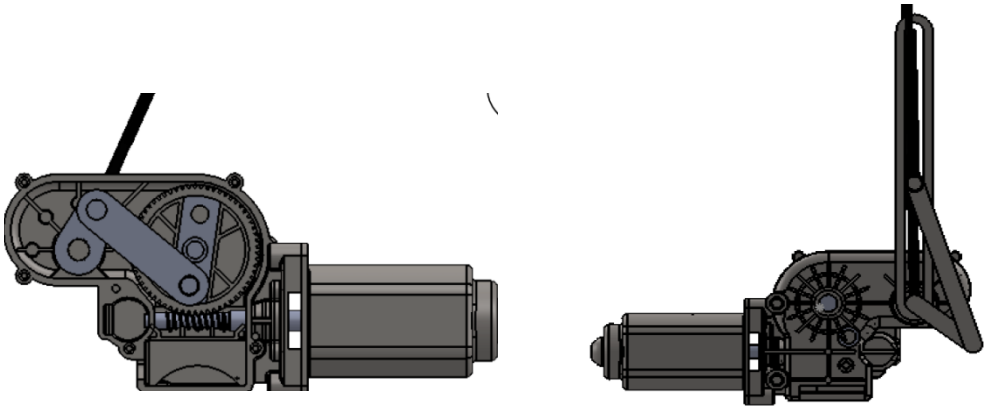

Figure 2.3 (car wiper mechanism model)

In regard to project metrics; it is going to be mainly focused on the mechanisms, actuator and electronic control system. The automobile's battery is the main source of power to any vehicle electrical and electronic systems and either a 12/24 V battery is sufficient for this purpose to drive the actuator which is a medium sized DC motor of the range 6-12V and all other on-board components that control the mechanisms and actuators. The development of sensors and accurate control features such as the electronic control module (ECM) saves on space by minimizing the connections of wires that are replaced by sensors.

On marketing features the project is economical, automated, environmental-friendly, safe and reliable. By integrating it with the recent electronic control module (ECM) and sensors it's cheaper by saving on cabling the whole automobile and on-time real assessment of vehicle system and subsequently sending appropriate response minimizing human monitoring. Sensors are able to detect dust and rain water on windshield and thereafter a signal is sent by the ECM to wipe the windshield. The use of electric power ensures the whole system is environmental friendly. The hollow Steel and Aluminum tubes and rubber on the mechanism makes the whole system to be of light and portable.

For the sake of engineering standards that ensure universality and interchangeability of products some charts and appendices obtained from Engineering handbooks are listed below:

Appendix C-23 *Materials for Machine Components*

Component or Tool	Candidate Materials
Balls	440 stainless steel
Bare plates	ASTM Class 25 gray cast iron, 1020
Bearing parts	440 stainless steel
Bearings	Acetal, Fluoroplastics, Nylon, UHMW Polyethylene, Polyimide, Polyurethane
Bolts	Acetal, 303, 410, 414, and 431 stainless steels, 1020, 1040, 4140, 4340
Brackets	6061 T6 aluminum, Class M3210 annealed malleable cast iron
Brake drums	ASTM Class 30 and 35 gray cast iron
Bushings	Acetal, Fluoroplastics (PTFE), Nylon, UHMW Polyethylene, Polyimide, Polyurethane, PTFE filled Nylon, Cloth—reinforced phenolic, P/M bronze
Cams	Acetal, Nylon, Phenolic
Camshafts	ASTM Class 40 gray cast iron
Chutes	PVC, 304 stainless steel, 1020
Chute liners	Acetal, Fluoroplastics, Nylon, UHMW Polyethylene, Polyimide, Polyurethane
Clutch plates	ASTM Class 30 and 35 gray cast iron
Connecting rods	Class M7002 heat treated malleable cast iron, 1030, 1040
Crane hooks	1030, 1040
Crankshafts	Class M4504 heat treated malleable cast iron, Grade 80-55-06 ductile (nodular) iron
Cylinder blocks	ASTM Class 25 gray cast iron
Cylinder heads	ASTM Class 25 gray cast iron
Cylinder liners	ASTM Class 40 gray cast iron
Dies	A2, D2, M2, SI, S7 tool steels
Drills	1090, 10100, 10120; M2 tool steel
Fan blades	Acetal, Nylon, Phenolic
Fasteners	384, 416 stainless steels
Files	10120, 10130
Fittings	Grade 60-40-18 ductile (nodular) iron
Flanges	6061 aluminum
Flywheels	ASTM Class 30 gray cast iron
Forgings	1040, 1050
Gears	Acetal, Nylon, Phenolic, Fluoroplastics, Polyethylene, Polyimide, Polyurethane, MoS_2 filled Nylon, Class M5003 and M8501 heat treated malleable cast irons, 1020, 1030, 1040, 1050, 4340, carbonized 4615 steel, Grade 80-55-06 ductile (nodular) iron, Grade 120-90-02 ductile (nodular) iron
Guards	Acrylic, Polycarbonate, 1020, expanded metal
Hammers	1080, S7 tool steel
Hand tools	1070, 1080, 1090
Housings	ASTM Class 25 gray cast iron
Hubs	Class M4504 heat treated malleable cast iron
Knives	1090, 10100, 10120, 10130; A2, D2, M2, S1, S7 tool steels
Leaf springs	1070, 1080, 1090
Levers	1020, 1030
Lock washers	1060, 1070
Milling cutters	1090, 10100, 10120
Nozzles	440 stainless steel
Nuts	303 stainless steel
Pipe	6061 and 6030 aluminum
Pump impellers	Acetal, Nylon, Phenolic
Pumps	ABS, Polycarbonate, Polyethylene, Phenolic
Razors	10120, 10130
Rivets	303 stainless steel, 1005, 1010
Rollers	Acetal, Nylon, Phenolic, Grade 80-55-06 ductile (nodular) iron, Grade 120-90-02 ductile (nodular) iron
Rolls	6061 T6 aluminum, 1020, 4340, D2 tool steel
Saws	10120,10130

Appendix C-23 *(continued)*

Component or Tool	Candidate Materials
Screws	1040, 1050,
Shafts	410 stainless steel, 1020, 1030, 1040, 1050, 4140, 4340
Shovels	1070, 1080, 1090
Slides	Grade 120-90-02 ductile (nodular) iron
Small housings	ABS, Polycarbonate, Polyethylene, Phenolic
Spring wire	1060, 1070
Springs	302, 414 stainless steels, 1080, 1090, 6150, 10100, 10120
Stampings	1005, 1010
Steering gear housing	Class M3210 annealed malleable cast iron
Tanks	1100 aluminum
Taps	1090,10100,10120
Tools	416 stainless steel, 1050; S1, S7 tool steels
Truck frames	2014 aluminum
Truck wheels	2024 aluminum
Universal joint yokes	Class M7002 heat treated malleable cast iron
Valves	Grade 60-40-18 ductile (nodular) iron
Wear strips	Acetal, Fluoroplastics, Nylon, UHMW Polyethylene, Polyimide, Polyurethane
Welded tubing	1020, 1030
Windshields	Polycarbonate
Wire	1005, 1010
Wire-drawing dies	10120, 10130
Worm gears	Aluminum bronze, Phosphor bronze

2.2 Previous Work

Windshield wiper mechanism in a car is a very important field of research in the modern times. Due to its relation with passenger's safety as well as reputation of an automobile company that manufactures the respective car, this is not the first project in this field. Several researches have already taken place in this discipline and some are still under process. Studying some of the related previous work will provide us with more insights into the dimensions of a car wiper mechanism.

In February 2014, Dr. Frederic Bernardin, Dr. Ronald Bremond and others published a research paper in "Accident Analysis and its Prevention" journal in which they proposed a methodology to assess the visual performance of a car windshield through rain. They recorded data from 40 observers under a controlled environment and identified the key issues related to effects of rainfall on the car windshield in terms of visibility. [1]

In the same year, Dr. Gabor Bodai and Dr. Tibor J. Goda published a research on another very important area of concern in the same discipline i.e. sliding friction of a wiper blade on a car windshield. The research was published in Tribology International on February 2014. In this research, they executed a combined numerical and experimental investigation on wiper blade and windshield glass contact. They used a commercial wiper to study the effects of friction between windshield and wiper and relevant issues related to it. [2]

In April 2015, Lubina Alazzawi and Avik Chakravarty published a research paper related to windshield wiper mechanism in the international journal of engineering and technology. They attempted to develop an automated, reconfigurable rain sensitive windshield wiper by combining the conventional windshield wiper with Arduino technology. [3]

The above discussed researches are just few of the works done in the field of wiper mechanism of a car windshield. This topic carries a great weightage and burden on the automobile companies of today's world such that day to day developments are going on in this field.

SELVERAJ A/L SUBRAMANIAM developed the new wiper retractor system which reduces the weariness of the rubber of the wiper which cleans the windscreen from moist and dirt. With the new system design, as the driver brings the car to a stop and turns off the ignition switch, the wiper retractor will be triggered to extend and move the wiper blade away from the windscreen. The retractor action is reversed when the ignition key is turned on. Almost all car wipers are retracted manually by hand and it is very troublesome at times.

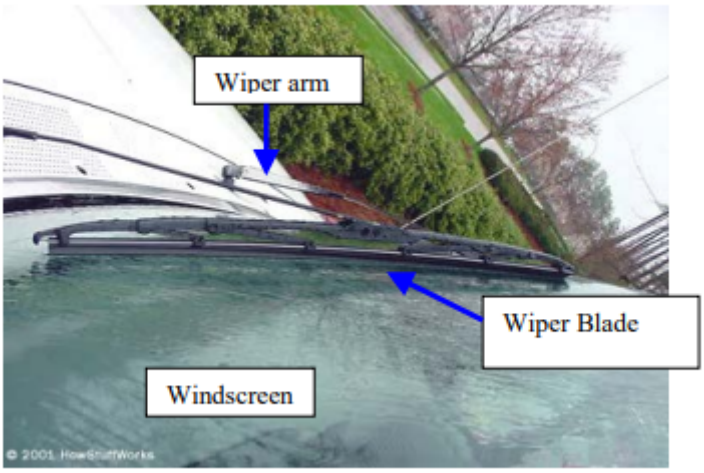

Figure 2.4 (wiper blade)

Fazle Elahi developed a complete windshield controlling system to increase human comfort and flexibility. The wiper has been controlled by a water level sensor which regulate the wiper motor through sensing the level of water or rain. A dust sensors has been integrated to spill some water in the windscreen and then wipe it. It senses when a certain level of dust get accumulated in the screen. He focuses on improving human comfort in the existing system so that the driver can pay full attention in driving at all weather even in dusty, rainy or summer.

Lubna AlaZZawi developed a cost effective and high performance automatic windshield wiper system using an Arduino Uno microcontroller and a rain intensity detection sensor. The system was programmed to use fuzzy logic to manipulate the analog data collected from the sensor, and the microcontroller controlled the wiper motor using pulse width modulation (PWM. The use of fuzzy logic allows the system to be easily reconfigurable. It was successfully connected to a commercial vehicle (Mazda Protégé) and tested for different rain conditions. The sensor data was collected using artificial rain conditions to mimic real world raining conditions and the resultant windshield wiper movement strongly resembled manual control of the wipers.

2.3 Comparative Study

The objective of this project is to design and analysis new automotive wiper retractor system, which can increase the life safe of the blade from excessive exposure to heat and moist. This project on windshield wiper mechanism development and modification is one of its kind in the university because no previous work has been ever done or traced by any undergraduate in this field. However, undergraduate students from other universities have done related projects under windshield wiper mechanism. Our work can be compared with their work and studied to test the uniqueness of this project.

Mohammad Fotouhi, Ali Eydgahi, Tom Malaby of University of Maryland had worked on design of a rain-based speed controller for automobile windshield wiper motor. Under this design project, the students attempted to develop a windshield wiper mechanism that can automatically adjust its frequency of operation based on the amount of rainfall. This was done to increase the efficiency of windshield wiper system of a car and respective safety related issues during rainfall. [4]

Obadah Abdulrazeq, Chris Ramprashad and others from Rutgers University, New Jersey worked on vehicle electronics automation in which they attempted to develop a mechanism that can control head lights and windshield wipers of a car with respect to amount of environmental light present and precipitation respectively. They tried to automate the basic systems of a car to provide a comfortable drive to the passenger. [5]

Allen Ayollo and Tony Barron of university of New Haven have done an undergraduate project on car maintenance where they studied different mechanism equipped in a car including windshield wiper mechanism. They

studied about the types of car maintenance and how different mechanisms such as windshield wiper, head lights, alarm system etc. work in a car. [6]

Different types of projects studied in this section target different areas of aspect and concern in the windshield wiper mechanism of a car. However, as we can see, none of the aforementioned projects discuss about developing a new system from the existing basic car wiper mechanism system for better efficiency at the ground level. Other projects discuss about automating the system or modifying the existing system but developing a new and better wiper mechanism is a different challenge in itself. Thus, this shows the uniqueness of this project.

Chapter 3: System Design

3.1 Constraints and methodology

3.1.1 Geometrical Constraints

Once the design is agreed upon, the next step that follows is to get down to drawing the design manually which is then transferred to a drawing software say Computer-Aided Design, solid works or inventor software and finally printed. This enables the manufacturer to be able to process the product because the dimensions of the parts are clearly stated. In dimensions' consideration, a designer has to take those dimensions that can fit the place where the final product will be installed. Also the dimensions of the wiper frames should be taken into consideration with the size of the windshield that it is intended to wipe. Also the limits and tolerances should be included in the dimensions of the parts so that to avoid misalignment of the parts during assembly.

3.1.2 Sustainability

As a criterion of an appropriate and efficient design, sustainability is at the heart of every designer. This criterion ensures the product design is long-lasting and effective to carry out its intended purpose efficiently taking into consideration attrition, reusability and adaptability of the whole product design, its subsystem and components. Looking into our design it's made up of various elements such as metal links, actuator, rubber and gear. The metal links made of Stainless steel are known to be durable and serve their purpose with less wear in the event of changing conditions such as impact, fatigue, dynamic loading and varying environmental conditions. The actuator which itself is a motor has been selected after careful consideration of adequate torque, controllability, ability to vary speed and reliability. The rubber pad used to wipe the windscreen is considered due to its long-lastingness to withstand changing environmental conditions such as extreme cold or heat and toughness to resist wear as continuous rubbing on the

windshield glass occurs. The gear parameters and geometry are carefully considered to ensure accurate positioning of the crank to produce desired rocking motion to wipe the windshield glass.

3.1.3 Environmental

Regarding the environmental aspect as a design constraint, material selection is important to ensure universality of the product design to be used in as many places with different environmental conditions as possible. In wet and cold climatic regions, there is much rain and the product design and its components are able to resist effects of water, low temperatures and snow on the windshield glass. In addition, hot and dry climatic conditions can be withstood by the product design, its subsystems and components to resist extreme heat that downgrades rubber and wiping dust particles from the windshield glass. Also the product design and its components selected are either recyclable or biodegradable to reduce environmental pollution. Since metal is recyclable and rubber can be remelted; the product design components have thus no adverse effects to the environment as long they are properly disposed. The product design and the mechanisms that make it up should have free movement between the interlocking joints to reduce noise and lubricated regularly with recommended lubricant to ensure efficient performance, reduced wear and noise. In regards to the maintenance, appropriate rust-preventive measures should be used since the product is to be used across different places with automobiles; painting, galvanization and sacrificial protection are versatile methods suitable in every geographical region world-wide.

3.1.4 Social

The social aspect of product design aims to bridge the gap between the users and the design itself in terms of aesthetics, ease of use and general safety. Aesthetics as the general appearance is mainly concerned as the visual appeal the product design will have to its consumers who are the automobile manufacturers and the

end user. The appearance of an object is that feature that people notice at first-sight, however, in some way the appearance may range from a very personal view to a generalized view of the finish applied to the surface. On people still, it's important to consider the anthropometrics of the design- to determine how the product design is suited to the users and the vehicle itself such as the field of vision the wiper can allow and the ease of fitting the design on an automobile. The uniqueness of the whole product design and its operation may be of varied taste and preference to the end users and automobile manufacturers; the uniqueness may also communicate innovativeness and ingenuity of the designer.

3.1.5 Economic

When selecting a design for a product it is always important to consider the cost that you are going to incur. A good design should not be too expensive. It should be economical. The costs of the components that are corporated in a design contributes to the cost of the design. It is wise to consider the cost of the members of the machine. It is advisable to use the correct part at its respective place to minimize the costs. For example, in a crank rocker mechanism of a wiper, one may decide to use couplers, cranks, rocker made of steel materials whereby iron materials would have been used instead and this makes the cost high since the steel materials are costly compared to the iron materials. Also a simple design should be preferred rather than a complex one so that to reduce the number of the members of the design hence minimizing the cost. The design should also be made to occupy the smallest space possible which will lead to production of small parts which will have less cost. Also the source of power used to run the machine is looked into, here in this design, the main source of power to run the machine is an electric motor.

3.1.6 Manufacturability

When going about selection of a design of a product, it is vital to consider the easiness of manufacturing of its parts. The easiness of manufacturing of the parts enhances fast production of the parts with high precision of dimensions. Also when it comes to repairing a broken part, it is easier to amend a part of a simple design rather than a complex one. When selecting parts, it is also advisable to consider those parts that can be manufactured easily without deformation or breakage. During manufacturing, the various parts should be selected considering the places to be fitted and the way they can be able to withstand different stresses and torques. In this design, manufacturability is considered since the wiper windshield mechanism consists a crank rocker mechanism as the main mechanism driven by the electric motor whereby the wiper filaments are connected to the rocker part which follows it motion. The external part consists of two wipers frames where the primary frame is directly connected to the rocker motion then the secondary one arises from the primary one and comprises of a crank slider mechanism which enhances its extension so that it can aid in coverage of the maximum area during wiping of the windshield.

3.1.7 Safety

This is one of the most important parameters to look into when designing a product to be manufactured. Safety comprises the pre-seen accidents and injuries that may occur to the operators of a machine. These accidents and injuries should be predicted and dealt with during the processing of the product. The nomenclature of the design should provide super safety to the operators in that it is not covering a large amount of space since it is a rotating machine and can cause injuries at any time. The design should also be friendly to humans' health in that it is not producing harmful elements to human beings. In this design, the safety is considered since the windshield wiper mechanism is installed inside the bonnet of the vehicle thus the most rotating parts are not exposed, only the wipers

filaments are exposed in the windshield hence reducing the occurrence of the accidents and injuries.

3.1.8 Ethical

During selection of a design to work on, it is good to consider the acceptability of the design to the people who are going to use it and also the people who will be around it. Most probably what will be focused under this subtopic is how the design might affect the customs of certain communities. The proposed design should not affect a community of people negatively rather positively. It is therefore important to do some research on how people reacts to various designs so that one can be able to know the criteria to follow on coming up with a design that will suit the people who will be operating it by asking questions about different designs and the way they would like it to be. In this design, the ethical principles have been considered since the mechanism is made to improve effectiveness in the locomotive industry and it caters for human safety.

3.2 Mechanisms Implementation.

3.2.1 Crank Rocker Mechanism

The main mechanism in this design is the four-bar mechanism which receives the power from the electric motor and transmits it to the outside parts.

A four bar mechanism consists of 4 rigid links connected end to end creating a closed loop. Further, one of the links, called the ground link, is in a fixed stationary position. When the input link rotates the output link may for example swing back and forth. Note that the fourth link is the frame of the machine and it is rigid and unable to move. Four bar mechanisms can produce a variety path of depending on the lengths and orientation of its links. It is for this reason that four bar mechanisms are used for a large number of applications, particularly in manufacturing. You may remember from MEEN 3391 (Mechanical Engineering Design l) that the type of motion produced from a 4 bar mechanism is determined by the Grashof conditions. Grashof conditions will determine the type of motion

based on the position and length of links in the mechanism. Determining the Grashof condition begins with the calculation of link lengths:

$$S + L \leq P + Q \qquad \text{(Equation 3.1)}$$

Where:

S = length of shortest link

L = length of longest link

P = length of one remaining link

Q = length of other remaining link

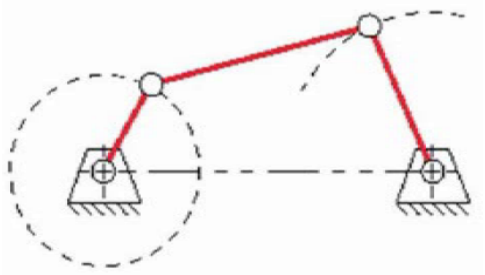

Figure 3.1(4 bar link mechanism)

For a crank-rocker mechanism, equation (3.1) can be simplified to:

$$S + L < P + Q \qquad \text{(Equation 3.2)}$$

Further, the final constraint to be met is that the shortest link MUST be adjacent to the ground link.

3.2.2 Crank Slider Mechanism

The outer section of the wiper mechanism has two wiper frames, the primary frame and the secondary frame. The secondary section consists of a crank slider mechanism which enhances it to extend beyond the limited area as it moves from one side to the other thus covering the maximum area possible.

This is the mechanism found in engines, pumps, wipers and in many other machines.

If the crank is turned, angular motion is converted into linear motion of the slider and input torque is transformed into force on the slider. If the slider is forced to move, the linear motion is converted into rotary motion and the force into torque. If the crank rotates at constant speed ω rad/s the motion of the slider is not perfectly harmonic.

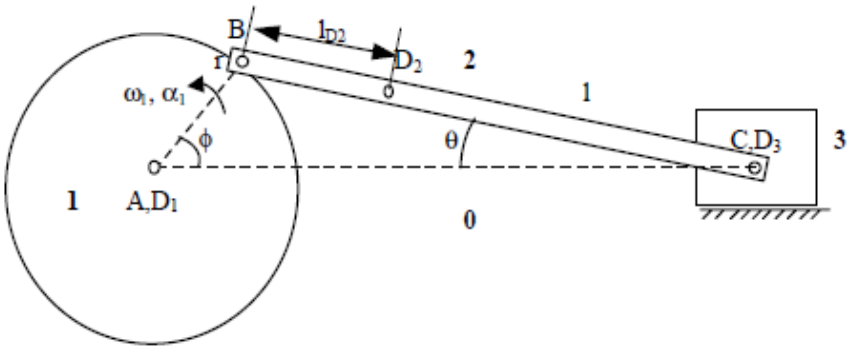

Figure 3.2(crank slider mechanism schematic)

3.3 Theory and theoretical calculations

An important feature in the analysis of mechanism is the number of degree of freedom of the linkage. The degree of freedom can be defined as the number of actuators needed to operate the mechanism. Any actuator of the mechanism could be manually moving one link to another position or connecting the motor to the shaft of one link. Mobility is the number of degrees of freedom of a mechanism and given the symbol M. Grumbler's equation is used to calculate the degrees of freedom for planar linkages joined with common joints and is given by:

$$M = 3(n-1) - 2j_p - j_h \qquad \text{(Equation 3.3)}$$

Where:

M = degrees of freedom

n = total number of links in the mechanism

j_p = total number of primary joints (pins or sliding joints)

j_h = total of higher-order joints (cam or gear joints)

A crank-rocker has the shortest link of the four-bar mechanism configured adjacent to the frame. If this shortest link is continuously rotated, the output link

will oscillate between the limits. Thus the shortest link is called the crank which has the actuator fixed on it and the output link is called the rocker. A wiper system mechanism is designed to be a crank-rocker. As the motor continuously rotates the input link, the output link oscillates or "rocks". The wiper arm and blade are firmly attached to the output link, oscillating the wiper across a windshield.

According to Grashof's criterion the following nomenclature is used to describe the length of the four links:

$$S + L < P + Q \qquad \text{(Equation 3.4)}$$

where;
s = length of the shortest link
l = length of the longest link
p = length of one of the intermediate length links
q = length of the other intermediate length links

Now the mobility of a four-bar mechanism consists of the following:

n = 4, j_p = 4 pins and j_h = 0

and therefore

$$M = 3(n-1) - 2j_p - j_h = 3(4-1) - 2(4) - 0 = 1$$

And since the four-bar mechanism has one degree of freedom, it is fully operated with one driver. In our wiper mechanism system, it is activated by a single DC electric motor. Typically, the pivoted link that is connected to the power source is called the input link whereas the other pivoted link attached to the frame (the link that is unable to move) is designated the output link or the 'follower'. And

finally the 'coupler' or connecting arm "couples" the motion of the input link to the output link. {David H. Myszka- Machines and Mechanisms; pages 19&20}.

Given the parameters of the crank, one may be able to compute the length of the rocker required to be used in the wiper mechanism and the length of the coupler to connect the crank and the rocker.

Four-bar crank rocker mechanism showing the path made by the input link ‘crank’ and the output link ‘rocker’ where links 1,2,3 are the crank, follower and rocker respectively.

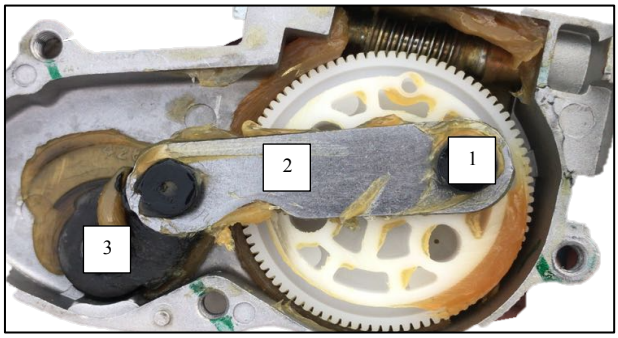

Figure 3.3 (links of crank rocker mechanism)

In comparison with the Grashof's criterion, where l, s, p, q, are the lengths of the longest and other respectively links and s is the length of the shortest link or the 'crank’. Then if from our design the length of input link ‘crank’ is given as 14.50 mm. the length of the 'rocker' will be given by q and that is 17.75 mm. the length of the 'follower' will be given by p and that is 48.30 mm. Finally the length of the longest link will be given as l and that is 50.65 mm. so when we apply the Grashof’s the result will be as below:

$$S + L \leq P + Q \qquad \text{(Equation 3.5)}$$

$$50.65 + 14.50 \leq 48.30 + 17.75$$

$$65.15 \leq 66.05$$

And the six columns give the appropriate comparison to ensure full mobility/degree of freedom of any pair of link lengths selected for the construction of the wiper mechanism. The highlighted row shows our selected parameters for the length of links: input link(s), coupler(l) and output link(q).

3.4 Product subsystems and selection of components.

When an appropriate design is selected, it determines the number of subsystems that are to be involved in the design and especially the specific selection of components that make the whole design. The components to be selected majorly depends on the function that a particular design is intended to perform. Also other parameters like shear stresses and strains, bending moments, compression forces, tensile forces and different failure modes (tensile failure, shear failure and crushing failure) that the members of mechanisms can handle especially in places where there is joints and connections because those are the areas where the various failure modes are likely to occur. Therefore, they are calculated and analyzed so that to prevent future breakdown of the machine and most importantly to increase the smooth running of the mechanisms.

In this design, the selection of components is keenly observed. Firstly, in terms of driving system, a DC electric motor is used to provide power to the crank rotating wheel which is connected to the motor by use of gear mechanisms in that the rotating wheel has gear teeth which engages with the teeth in the rotating shaft of the DC electric motor. Secondly, a four-bar mechanism is preferred to be the main mechanism which its motion of the rocker system making an arc is directly transferred to the two outside wiper frames. The crank wheel is preferably made up of steel material to withstand the motor forces, the connecting links are also made of up of steel to enhance hardness so that to withstand the forces provided by the crank wheel avoiding breakage and deformations. The casing of the four bar mechanism is made up of iron since it does not need to be so hard like steel because it only houses the components thus experiences little forces. The wiper

frames are also preferred to be made up of steel material so that it can move back and forth on the windshield without experiencing any deformation or breakage. The rubbing surface of the wipers is fit with rubbers so that it can efficiently wipe the windshield because rubbers are good surface wipers. The most outside wiper frame is fitted with a crank slider mechanism in which its moving members are made up of steel material so that it can also be able to able to withstand the forces transmitted to it as it moves up and down to cover the maximum area during wiping. Its wiping surface is also fitted with a rubber material.

It can be clearly observed that the design is made up three subsystems:

- Power system

Figure 3.4 (input power system)

As shown in figure 3.4 this is the 12-V DC electric motor that provides the power to the whole system.

- Crank rocker mechanism

Figure 3.5(crank rocker mechanism)

- Slotted slider crank mechanism

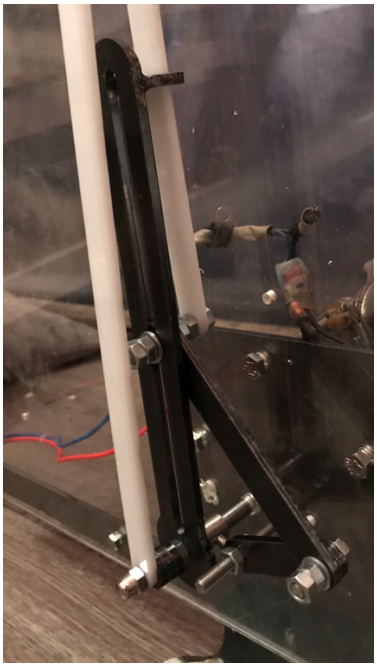

Figure 3.6 (crank slider mechanism)

The selection of the components is properly done since each and every component is performing its work properly.

3.5 Manufacturing and assembly.

Basically, the project design started from the scratch where a desirable design was to be selected based on various factors depending on its use and satisfying the aims and objectives that were set to provide a wiper which is new in the market and can be able to cover the maximum area possible of the windshield when wiping compared to the other design manufactured earlier. With a number of considerations and calculations in the manufacturing process, a desired product is processed. The assembly process involves fitting together the individual parts starting with the motor fixed to the four-bar mechanism and finally connected the outside wiper components. Since the individual components were accurately designed it was easy to fix them together to bring out the intended product. as you can see in the figures below this is our design in CAD.

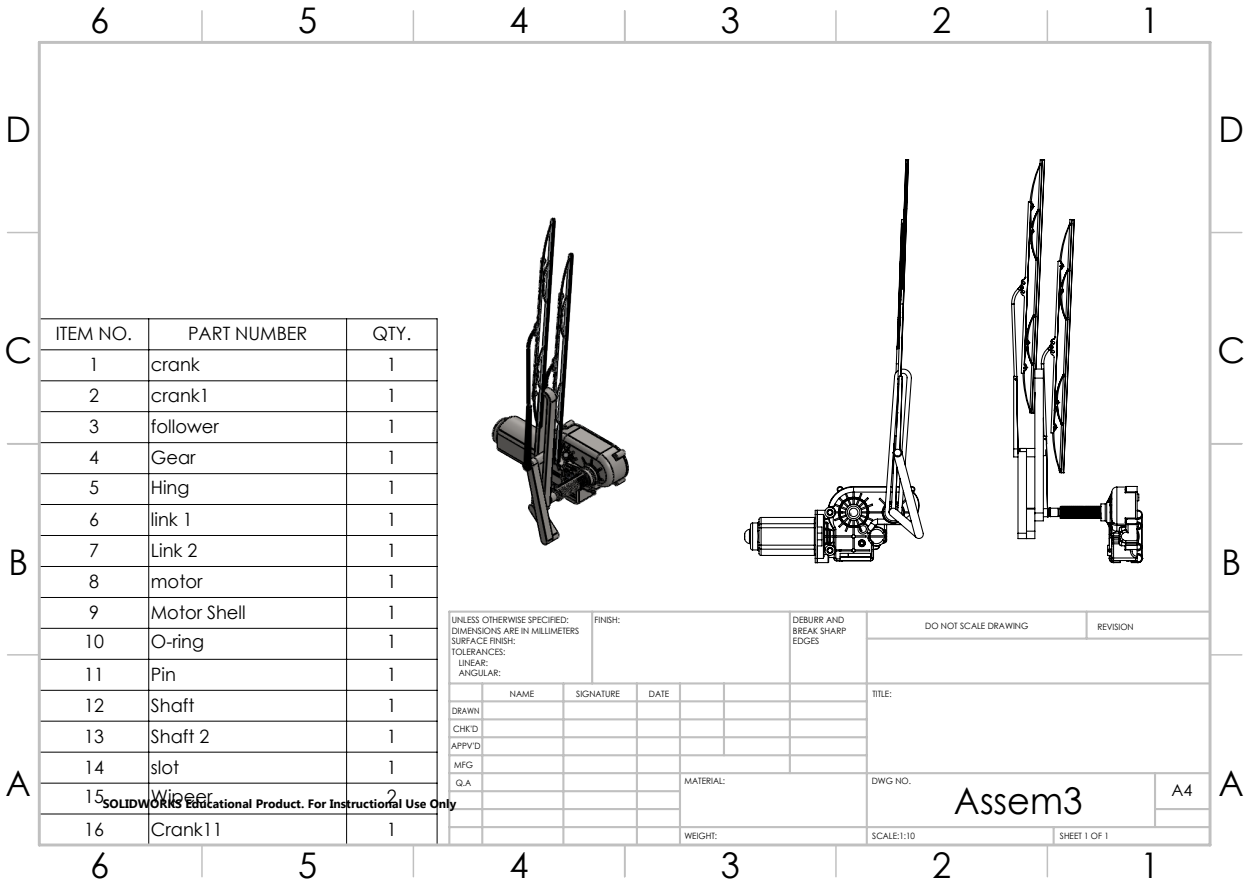

Figure 3.7 (Assembled view of CAD model)

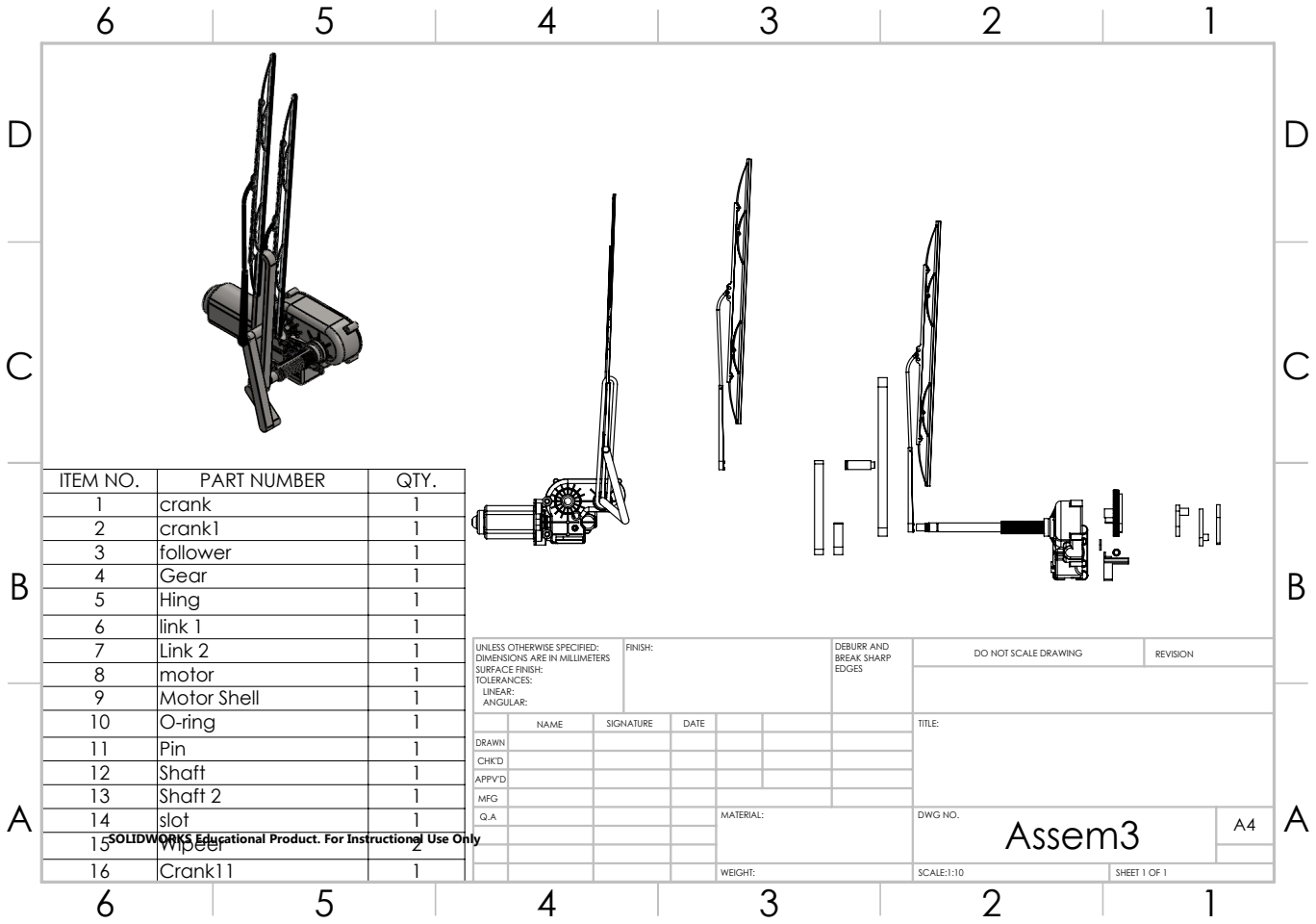

Figure 3.8 (exploded view of CAD model)

Chapter 4: System Testing and Analysis

4.1 Experimental Setup, Sensors and data acquisition system

Figure 4.1 (12v DC motor)

In our project, the input power is from DC motor. The motor will be behind the mechanism and it will be covered for aesthetic purpose. The motor will give the power to the mechanism to make it work and start cleaning the windshield. In addition, we will use the regular motor which is 12V because this amount of power is enough to make the wiper works. The specification of this motor is as follow:

- Power: 45 W
- Voltage: DC 12 V
- Working Life: 300,000 Hours
- Fitting Position: Front

4.2 Results, Analysis and Discussion

First of all before we start to test our new mechanism, it's clear from (Figure 4.2) below that the region cleaned by the wiper is limited. And using our new mechanism we can reach to the area which is inside the red box as shown in the figure.

Figure 4.2 (rear window cleaning zone)

We start the assembly process and we test the mechanism after we complete the assembly. We found that the mechanism is working perfectly for the rear window wiper.

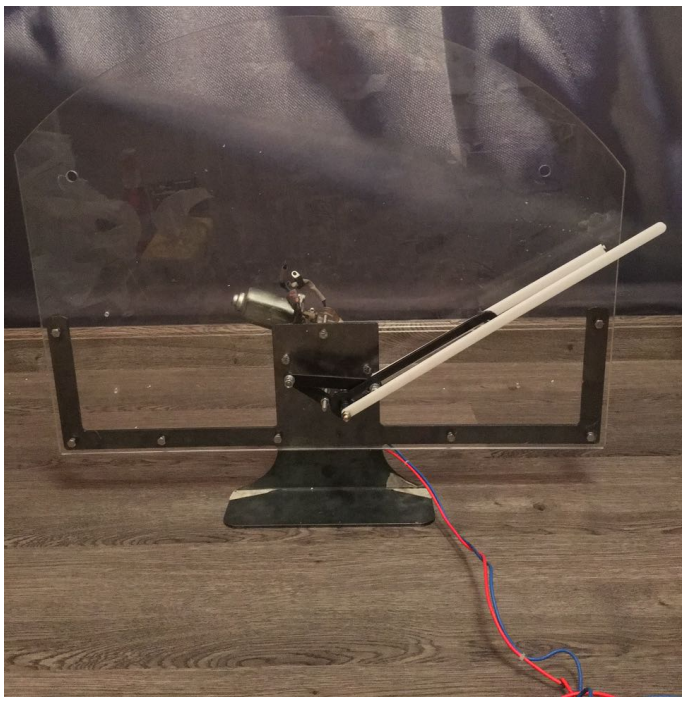

Figure 4.3 (the position two wipers at rest)

At the first process of this mechanism. We can see form this figure 4.3 that there are two wiper, one of them is the original wiper and the other one is the extension wiper which will extend to clean the whole area of the windshield. At the rest, the two wipers are at zero degree.

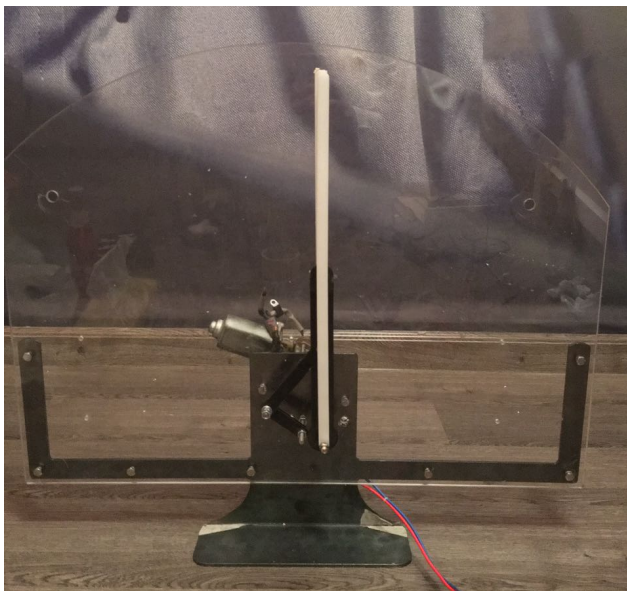

Figure 4.4 (position of two wipers at 45 degree)

As we can see in figure 4.4, the two wipers started moving to clean the windshield and we can see the extra wiper started increasing but not reaches the maximum extension yet.

Figure 4.5 (position of two wipers at 90 degree)

As we can see here in figure 4.5. We can see that two wipers reach the final point. We can see that the extension wiper extends at the maximum travel and clean the uncover area. While the original wiper remains the same form the first point to the end point.

Chapter 5: Project Management

5.1 Project Plan

In this project we worked as a group and we were in a role with time because there was a very limited time to finish the project. So we designed each task with a limited time period. Table 5.1 shows detailed task summary.

Table 0.1 Period of the tasks

No.	Tasks		Start Date	Finish Date	Duration
1	Introduction		February 23, 18	February 26, 18	4 Days
2	Literature Review	History of Wiper Mechanism	February 26, 18	March 1, 18	7 Days
		Review basic design definitions			
		Looking for a mechanism			
		Comparative study			
		Research about previous work			
3	Calculations	Measuring maximum uncover area	March 15, 18	March 29, 18	15 Days
		Motor velocity			
		Consider mass of the mechanism parts			
		Size of the windshield and the wiper			
		Gear Revolution per minute			
		Required power input			
4	Preliminary tests	Find more practical mechanism	March 1, 18	March 8, 18	9 Days

		Conclude the model in Solidworks			
5	Manufacturing	Solidworks model	March 29, 18	April 10, 18	13 Days
		Gear			
		Slotted slider crank mechanism			
		Motor selection			
		Wiper selection			
6	Testing of system	Test the new mechanism with the original mechanism	April 10, 18	April 25, 19	16 Days
		Testing the design model			
		Measuring the maximum distance of the wiper			
7	Writing, corrections and prepare for final presentation		April 20, 18	May 3, 18	15 Days

5.2 Contribution of Team Members

Each group must have a leader to arrange tasks and works. The group leader is responsible to assign task to the group members. All of these tasks in this project assigned to one member and some of these tasks assigned to more than one member. As shown in the Table 5.2 below, it is provide who assigned to each task and what is contribution for the each member.

Table 0.2 Tasks distribution

No.	Tasks		Assigned	Contribution
1	Introduction		Abdulaziz	30%
			Faleh	20%
			Abdullah	30%
			Abdulhadi	20%
2	Literature Review	History of Wiper Mechanism	All	20% each member
		Review basic design definitions		
		Looking for a mechanism		
		Comparative study		
		Research about previous work		
3	Calculations	Measuring maximum uncover area	Abdulaziz	100%
		Motor velocity		
		Consider mass of the mechanism parts		
		Size of the windshield and the wiper		
		Gear Revolution per minute		
		Required power input		
4	Preliminary tests	Find more practical mechanism	Abdulmohsen	50%
			Abdullah	50%
		Conclude the model in Solidworks	Abdulhadi	100%
5	Manufacturing	Solidworks model	Abdulmohsen	100%
		Gear	Faleh & Abdullah	50% each member
		Slotted slider crank mechanism		
		Motor selection		
		Wiper selection		
6	Test the system	Test the new mechanism with the original mechanism	All	20% each member
		Testing the design model		
		Measuring the maximum distance of the wiper		
7	Writing, corrections and prepare for final presentation		All	20% each member

5.3 Project Execution Monitoring

Throughout our project period we had many activities. Some of these were continuous and some of them were one time. As shown in the Table 5.3 below, it shows the time for these activities.

Table 0.3 Table of activities

Time	Activities
Two times a week	Assessment class
Weekly meeting	With group members
Biweekly meeting	With advisors
April 4	Midterm presentation
March 8	Preliminary test
April 10	Test the system
May 3	Final presentation

5.4 Challenges and Decision Making

We faced many challenges and difficulties throughout our project duration such as:

1. Time limitation
2. Report writing and documentation
3. Design problems

5.4.1 Time limitation

One of the big challenges we faced while working in our project is the time. Our group members had many concerns and questions about when we should start and finish for each tasks. We solved this problem by using some methods such as:

1- Distribute each tasks for one member or more.

2- Weekly meeting with group members.

3- Built a Gantt Chart to manage our time and avoid delayed completion of tasks.

5.4.2 Report writing & documentation

Report writing and documentation were one of the challenges we faced during our senior project. Report writing took a long time. The mistakes will bring a negative effect for us. It will minimize the value of the report. So, we did work hard to fix and decrease these mistakes. Moreover, we did some methods to minimize these mistakes such as taking a feedback from the advisor for the first draft, taking a feedback from assessment's instructor for the second draft, and letting another member of the group for each part to read it and correct it.

5.5 Project Bill of Materials and Budget

As shown in the Table 5.4 below, it provides all costs of the materials that we purchased and manufactured costs.

Table 0.4 List of material and their cost

Materials	Cost (SR)
Electric DC Motor	350 SR
Remanufacture the shaft	200 SR
Manufacture the slotted	200 SR
Manufacture the small link	150 SR
Manufacture the larger link	150 SR
Workshop manufacturing	700 SR
Manufacturing a windshield	350 SR
2 wipers	60 SR
The base of the design (holder)	100 SR
Total	2260 SR

Chapter 6: Project Analysis

6.1 Life-long Learning

Throughout our project's life we got the opportunity to learn and develop our knowledge, experiences and skills. Especially, from working in a group we acquired a lot of experiences. This had enhanced our understanding, provide us with better chance and developed our quality of social life. Each of these important things that we acquired during our project's life will be separated into two parts with their understanding.

6.1.1 Time and Project Management Skills

The most significant skills that we learned while working in our project was time and project management skills. It was like a challenge to us because we faced many tasks and the time was a very limited to finish it. So, we decided to distribute each tasks for each member of the group to manage our time and do it at a specific time. Moreover, we used a tool called Gantt Chart. Gantt Chart was a useful tool that help us to know when we start and when we finish to each tasks. We built our Gantt Chart to manage our time and avoid delayed completion of tasks.

6.1.2 Software Tools

While working in our project we used some software such as Microsoft Word and Solidworks. These tools weren't a new to us, however we had improved our skills into these tools and used them in professional way. Whilst, we needed more explanation of questions, our advisors were a great source of information especially in Solidworks software. We improved our knowledge and skills into these software from many website such as YouTube.

6.2 Impact of Engineering solution

6.2.1 Society

Our project is the design and improve of a car wiper to clean the whole area of the windshield can related to society part in very important way . our project can help the society in different way. For example. In cases of raining which consider as a dangerous situation, the driver in the street cannot see clearly the whole windshield which cause a dangerous situation to drive,

so by making the car wiper able to clean the whole area of the windshield, it can increase the safety of the car which can help the diver to drive safely because the whole area is cleaned.

6.2.2 Economy

When we look at the regular mechanism and bases of the car wiper , we can see that the car has two wiper, each wiper has a separate bases. On the other hand, when we look at our project which involve only one original wiper and one extra wiper attached to the original one with the same base instead of two original wiper with two bases such as in most of cars. By this small change in the number of original wipers ,we can see that our project will cost less amount of money than regular car wiper, because our project involves only one original wiper with one base not two original wipers with two bases.

6.2.3 Environment

Our project does not cause bad impact on the environment. Looking at extension car wiper which is our project, it is a part of the car which does not affect the environment in bad way like other parts of the car, such as, exhaust pipe that make smoke and cause pollution. Our project is very safe with the environment.

6.3 Contemporary Issues Addressed

One of the baggiest issues that face Saudi Arabia and GCC countries is the high number of accidents and deaths. Saudi Arabia and GGC countries have one of the highest number of deaths because of accidents .Nowadays, this problem consider as a big problem because many people die due to accidents . Our project which is improve the car wiper to clean the whole windshield can help a drive to see the street clearly when he drives and avoid accidents, most important in raining days. In addition, by using our project, the number of accidents will decrease which will help to decrease number of deaths because of accidents.

Chapter 7: Conclusions and Future Recommendations

7.1 Conclusion

Concluding the discussions it could be believed that this task is expected towards reforming the car business by outlining an as good as ever auto wiper component that can manage perceivability issues amid occasions of rain. The traditional wiper instruments introduced in autos can halfway clear the windshield because of which water dribbling issues are inescapable. This auto windshield wiper instrument can clean the entire windshield of the auto. Subsequently, it will be helpful as in it will enhance perceivability of the driver up to a palatable separation and in this way dodge unmerited and accidental impacts on streets.
Talking about the objectives, it could be said that when outlining an item, it regards set up a few points and goals which will direct you and they will give you a diagram of what you are going to do. These points and destinations are later investigated after the settling of the work to see whether they were met.
These points and targets are:

• Develop a windshield wiper system which is more successful as far as power information and size it possesses.

• Invent an enhanced windshield wiper instrument which is new in the market and satisfactory to the customers.

• Come up with an instrument of a windshield wiper which is neighborly to the earth and really give security to the administrators.

• Bring out a wiper component which is basic and modest to make and manufacture.

• Develop a windshield wiper component which is solid in that it can have the capacity to serve for quite a while without breakdown.

• Study and break down the ramifications of working of the wiper system through PC based recreation.

• Compare working of the new wiper component with the expectedly utilized system and note the progressions got identified with the new plan.

• Develop a model to acquire constant information and criticism from a human asset through testing in a safe domain.

Not only that but on this undertaking we filled in as a gathering and we were in a contention with time in light of the fact that there was an exceptionally restricted time to complete the venture. So we put to each assignment a restricted era. As appeared in the Table 5.1 beneath,

it is a give an introduction in detail of the time of the undertakings for the duration of the life of the task.

Each gathering must have a pioneer to organize errands and works. The gathering pioneer is mindful to suitable each errand to the gathering individuals. These undertakings in this venture appropriated to one part and some of these assignments appropriated to in excess of one part.

7.2 Future recommendations

We have many things and recommendations to improve our project and to make it better. One of these recommendations is to install another input source which will make the small link rotates 360 degree which is attached to the slotted to have a relative velocity with the slotted. We suggest installing a servo motor at the shaft. Another recommendation is to install another motor which has more power to make wipers reach the uncovered area to time in one trip.

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Appendix A: Progress Reports

SDP – Monthly MEETING REPORT

Department of Mechanical Engineering
Prince Mohammad bin Fahd University

SEMESTER:	Spring	**ACADEMIC YEAR:**	2017/2018
PROJECT TITLE	Design and Manufacturing of an improved Car Wiper Mechanism		
SUPERVISORS	Dr. Muhammad Asad		

Month: February

ID Number	Member Name
201201996	*Abdulaziz Alshehri
201202444	Faleh Aldossary
201200454	Abdulmohsen Alkhaldi
201202417	Abdullah Alshammari
201300520	Abdulhadi Abdullah

List the tasks conducted this month and the team member assigned to conduct these tasks

#	Task description	Team member assigned	Progress 0%-100%	Delivery proof
1	Form the Gantt Chart	Abdulaziz	100%	
2	Searching for a Typical Mechanism	Faleh	100%	
3	Taking Measurement	Abdulmohsen	100%	
4	Research for Similar Projects	Abdulhadi	100%	

List the tasks planned for the month of March and the team member/s assigned to conduct these tasks

#	Task description	Team member/s assigned
1	Start CAD drawings	Abdulmohsen
2	Introduction & Project Objectives	Faleh
3	Literature Review	Abdulaziz
4	Working Chapter 3: System Design and Chapter 4: System Testing and analysis	Abdullah & Abdulhadi
5	Prepare for Midterm Presentations	All members

- **To be Filled by Project Supervisor and team leader:**
- **Please have your supervisor fill according to the criteria shown below**

Outcome f:
An understanding of professional and ethical responsibility.

Criteria	None (1)	Low (2)	Moderate (3)	High (4)
f1. Demonstrate an understanding of engineering professional and ethical standards in dealing with public safety and interest	Fails to Demonstrate an understanding of engineering professional and ethical standards in dealing with public safety and interest	Shows limited and less than adequate understanding of engineering professional and ethical standards in dealing with public safety and interest	Demonstrates satisfactory an understanding of engineering professional and ethical standards in dealing with public safety and interest	Understands appropriately and accurately the engineering professional and ethical standards in dealing with public safety and interest

Outcome d:
An ability to function on multidisciplinary teams.

Criteria	None (1)	Low (2)	Moderate (3)	High (4)
d1. Ability to develop team work plans and allocate resources and tasks	Fails to develop team work plans and allocate resources and tasks	Shows limited and less than adequate ability to develop team work plans and allocate resources and tasks	Demonstrates satisfactory ability to develop team work plans and allocate resources and tasks	Understands and applies proper and accurate team work plans and allocate resources and tasks
d2. Ability to participate and function effectively in team work projects	Fails to participate and function effectively in team work projects	Shows limited and less than adequate ability to participate and function effectively in team work projects	Demonstrates satisfactory ability to participate and function effectively in team work projects	Understands and participates properly and function effectively in team work projects
d3. Ability to communicate effectively with team members	Fails to communicate effectively with team members	Shows limited and less than adequate ability to communicate effectively with team members	Demonstrates satisfactory ability to communicate effectively with team members	3. Understands and communicates properly and effectively with team members

Indicate the extent to which you agree with the above statement, using a scale of 1-4 (1=None; 2=Low; 3=Moderate; 4=High)

#	Name	Criteria (d1)	Criteria (d2)	Criteria (d3)	Criteria (f1)
1	Faleh Aldossary	3	4	3	2
2	Abdulmohsen	4	3	2	3
3	Abdulhadi	3	4	2	4
4	Abdullah	4	2	3	3

Comments on individual members

Name	Comments
	Signing Sheet after Presentation

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

SEMESTER:	**Spring**	**ACADEMIC YEAR:**	**2017/2018**
PROJECT TITLE	**Design and Manufacturing of an Improved Car Wiper Mechanism**		
SUPERVISORS	**Dr. Muhammad Asad**		

Month: March

ID Number	Member Name
201201996	*Abdulaziz Alshehri
201202444	Faleh Aldossary
201200454	Abdulmohsen Alkhaldi
201202417	Abdullah Alshammari
201300520	Abdulhadi Abdullah

List the tasks conducted this month and the team member assigned to conduct these tasks

#	Task description	Team member assigned	Progress 0%-100%	Delivery proof
1	Finalize CAD drawing	Abdulhadi	90%	
2	Introduction & Project Objectives (CH 1)	Faleh	100%	
3	Literature Review	Abdulaziz	95%	
4	Working Chapter 3: System Design and Chapter 4: System Testing and analysis	Abdulmohsen	65 %	

List the tasks planned for the month of April and the team member/s assigned to conduct these tasks

#	Task description	Team member/s assigned
1	Videotape and submit Midterm Presentation	All members
2	Start Manufacturing Process	Abdullah
3	Complete working on chapter 4	Faleh & Abdulaziz
4	Working on Chapter 5 & 6	Abdulmohsen & Abdulhadi
5	Prepare for Final Presentations	All members

- **To be Filled by Project Supervisor and team leader:**
- **Please have your supervisor fill according to the criteria shown below**

Outcome f:
An understanding of professional and ethical responsibility.

Criteria	None (1)	Low (2)	Moderate (3)	High (4)
f1. Demonstrate an understanding of engineering professional and ethical standards in dealing with public safety and interest	Fails to Demonstrate an understanding of engineering professional and ethical standards in dealing with public safety and interest	Shows limited and less than adequate understanding of engineering professional and ethical standards in dealing with public safety and interest	Demonstrates satisfactory an understanding of engineering professional and ethical standards in dealing with public safety and interest	Understands appropriately and accurately the engineering professional and ethical standards in dealing with public safety and interest

Outcome d:
An ability to function on multidisciplinary teams.

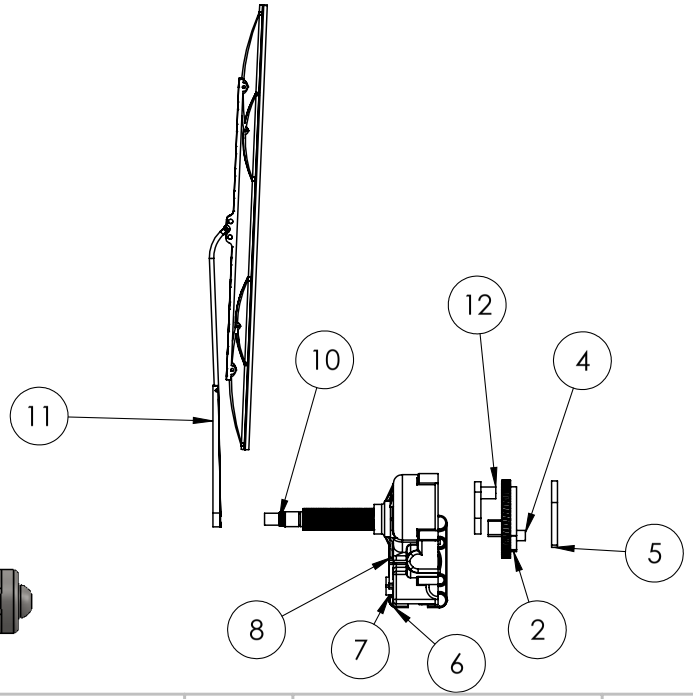
Criteria	None (1)	Low (2)	Moderate (3)	High (4)
d1. Ability to develop team work plans and allocate resources and tasks	Fails to develop team work plans and allocate resources and tasks	Shows limited and less than adequate ability to develop team work plans and allocate resources and tasks	Demonstrates satisfactory ability to develop team work plans and allocate resources and tasks	Understands and applies proper and accurate team work plans and allocate resources and tasks
d2. Ability to participate and function effectively in team work projects	Fails to participate and function effectively in team work projects	Shows limited and less than adequate ability to participate and function effectively in team work projects	Demonstrates satisfactory ability to participate and function effectively in team work projects	Understands and participates properly and function effectively in team work projects
d3. Ability to communicate effectively with team members	Fails to communicate effectively with team members	Shows limited and less than adequate ability to communicate effectively with team members	Demonstrates satisfactory ability to communicate effectively with team members	3. Understands and communicates properly and effectively with team members

Indicate the extent to which you agree with the above statement, using a scale of 1-4 (1=None; 2=Low; 3=Moderate; 4=High)

#	Name	Criteria (d1)	Criteria (d2)	Criteria (d3)	Criteria (f1)
1	Faleh Aldossary	4	3	2	3
2	Abdulmohsn	4	2	3	3
3	Abdulah	3	3	4	2
4	Abdulhadi	3	4	2	3

Comments on individual members

Name	Comments



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1	follower	1
2	Gear	1
3	Hing	1
4	link 1	1
5	Link 2	1
6	motor	1
7	Motor Shell	1
8	O-ring	1
9	Shaft	1
10	Shaft 2	1
11	Wipeer	1
12	Crank1	1

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: TOLERANCES: LINEAR: ANGULAR:		FINISH:		DEBURR AND BREAK SHARP EDGES		DO NOT SCALE DRAWING	REVISION
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CHK'D							
APPV'D							
MFG							
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ITEM NO.	PART NUMBER	QTY.
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6	link 1	1
7	Link 2	1
8	motor	1
9	Motor Shell	1
10	O-ring	1
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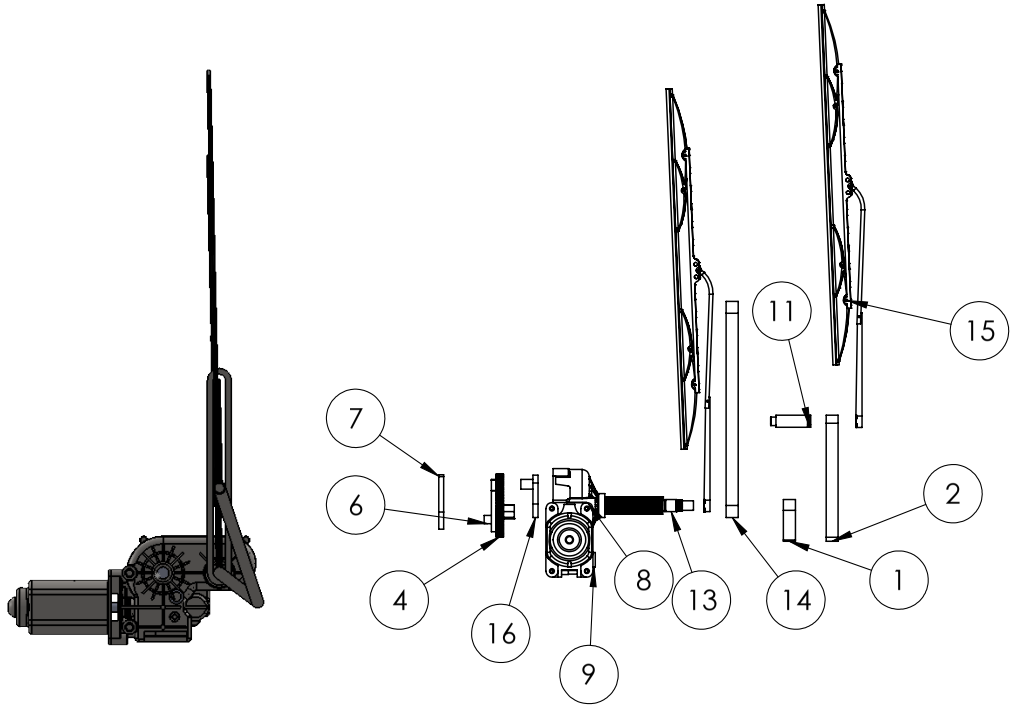
13	Shaft 2	1
14	slot	1
15	Wipeer	2
16	Crank11	1



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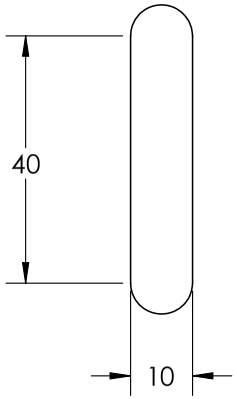

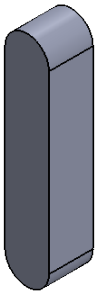

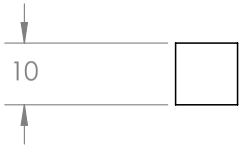

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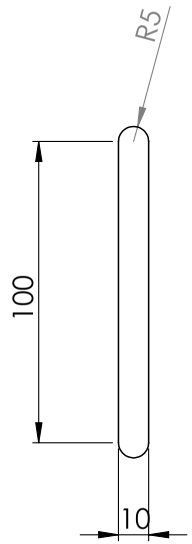

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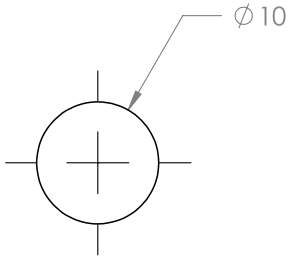

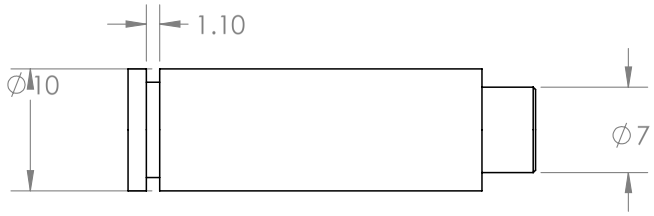

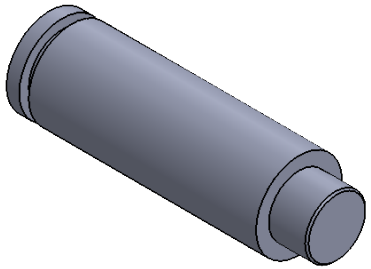

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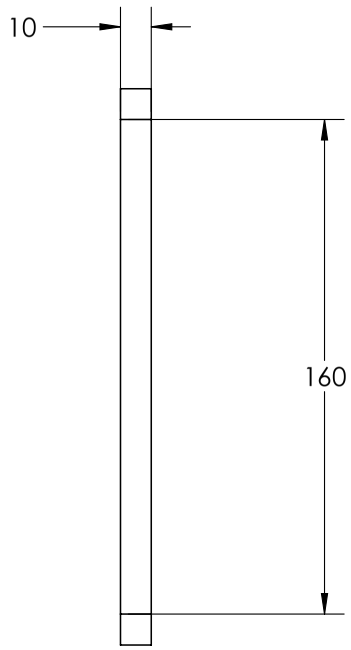

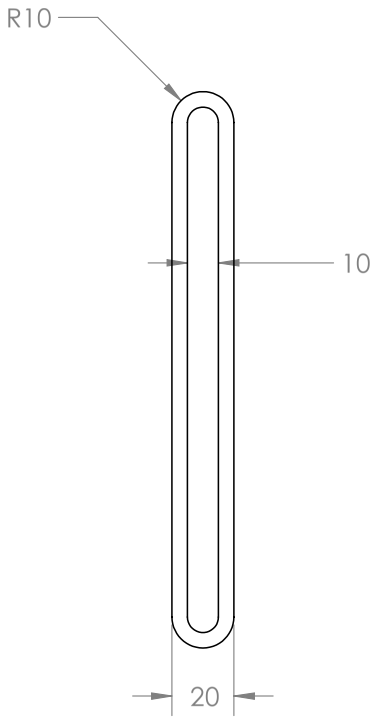

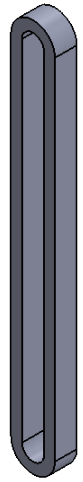

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