

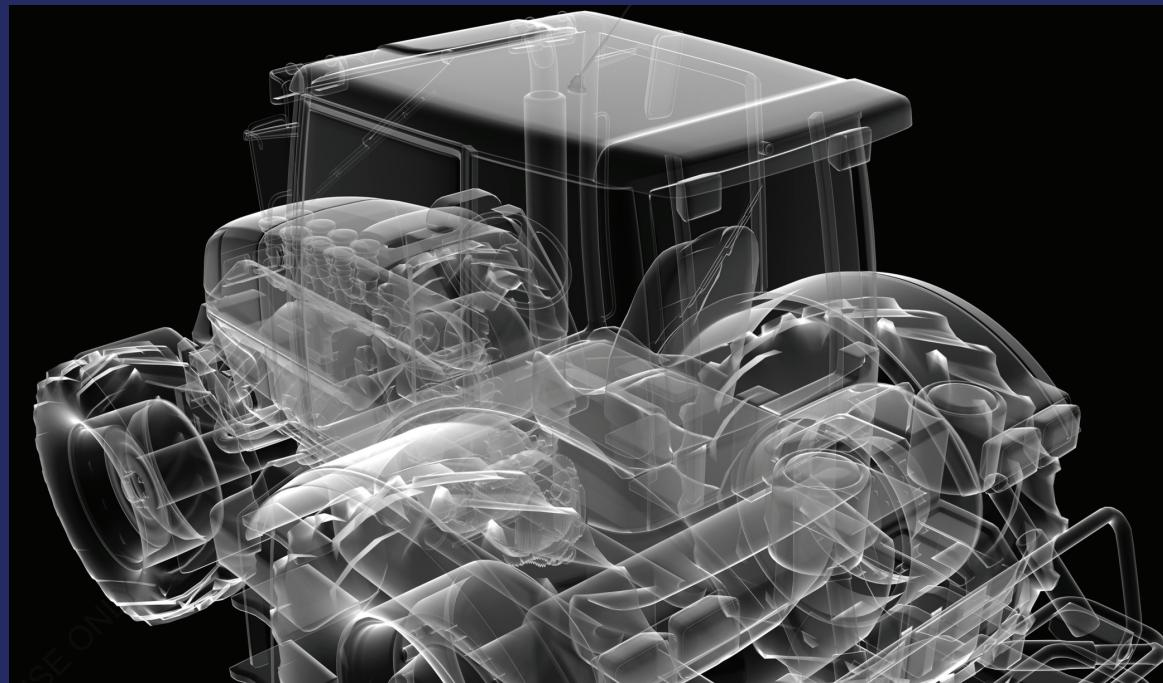
The objective of our Book was to design and fabricate a multipurpose agricultural vehicle in the most economical and efficient ways possible. It is aimed to simulate a real world engineering design project and their challenges. It involves the planning and manufacturing tasks found when introducing a new product to the consumer in industrial market. Our main aim is to design a vehicle capable of cutting grass in large lawns and to even out the surface of the lawn with the help of roller. It is also designed to carry light to medium loads. The vehicle is capable of performing various tasks related to the agricultural activities and therefore it was named "multipurpose agricultural vehicle (MAV)".



Sankalp Nagda is an enthusiast in the field of mechanical engineering. He is currently pursuing his bachelor's degree in Mechanical engineering from Rajasthan technical University, Kota. He lives in Udaipur, Rajasthan. He has been working on several projects and a few of the completed ones are the design of Lake monitoring system.



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Abhishek Sharma

## Design of Multipurpose Agricultural Vehicle

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# **Chapter 1**

## **Introduction**

Agricultural machinery are the mechanical arrangement used in cultivation, harvesting ,husbandry and other agricultural processes. These machines includes tractors , harvesters , grass cutters, planters sprayers etc.

Nowadays, there is great demand for machines capable of lawn trimming and surface flattening. A Lawn can be described as an area which is covered by soil land and planted with grasses and other small plants. These lawns are used for aesthetic and recreational purposes. Examples of such lawns and grass fields are lawns in villas, resorts cafeterias, cricket fields, football fields, etc. Maintaining the grass to optimum height can be a tedious task because it will require regular trimming and watering. Also, with regular use of these grass fields the surface or soil cover becomes uneven. This results in water stagnation, hard surface or humps in patches resulting inelegant fields.

The grass growth depends on the various factors such as the category or type of grass, weather/climate, water availability, sun exposure etc. In general the rate of grass growth is around 1.5 mm to 5 mm a day. So, for maintaining a certain or desired level of grass in a lawn their will be requirement of shortening or trimming of grass in every 3-4 days. Besides that weed or wild grass might also grow up in the fields.

For the purpose of trimming the grass lawn mowers are used. Lawn mowers are machines consisting of a single or a set of revolving blades to cut or trim a grass surface to an even or desired height. Lawn mowers are available as manually operated and automatically operated. Manually operated mowers will require human effort for revolving/rotating the blades whereas the automatic type have motors for rotating the blades and the operator is only required to walk behind the mower to guide and direct

it. For small lawn and grass fields these lawn mowers are fine but for larger grass fields of stadiums, resorts , gardens and fields of educational institutes etc., trimming of grass using these lawn mowers can be a tedious and time consuming task. Also, the waste of trimmed grass need to be swept away manually from the grass fields and again sweeping large grass fields will take hours. One problem which is encountered in grass fields used for sports is that the surface level should be consistent as uneven surface levels could result in uneven bounce of ball in case of football and cricket. This can also cause injury to the players. So for the purpose of maintaining the surface level in grass fields roller are used. Rollers also are of two types manually operated and vehicle operated (automatic). The automatic rollers are very expensive and on average costs around 2-2.5 lacs.

To address the above mentioned issues are team came up with a viable solution. The multipurpose agricultural vehicle (MAV). This is an Automobile which is capable of grass cutting/ trimming , surface levelling and small load (80-100kg) towing. The concept used in working of this vehicle is quite similar to that of an tractor. The grass cutter, levelling roller and trolley are all designed and fabricated with a provision that they can be detached and attached to the main vehicle assembly easily and according to the requirement of the user. The vehicle is a sturdy build and is aimed at only being used for grass cutting, surface levelling and light load towing and cannot be used for harvesting and cultivation. The use of this vehicle results in saving time and simplifies the above mentioned problems. The grass cutter of the vehicle has an bucket which collects the trimmed grass waste, so there is no need for sweeping the grass field after trimming. The MAV on average takes around 30 minutes to trim an area of 1000 square meters whereas normal lawn mower will take around an hour to hour and half for the same area plus it will require additional amount of time for sweeping the field. The reduction in time thus helps in making the overall operation economic. There are various machines available in the market ranging from 2 lacs to 4 lacs for the same operations performed by the MAV. The overall cost of MAV comes around to be 80,000 INR. Thus making it the most economical machine available in the segment.

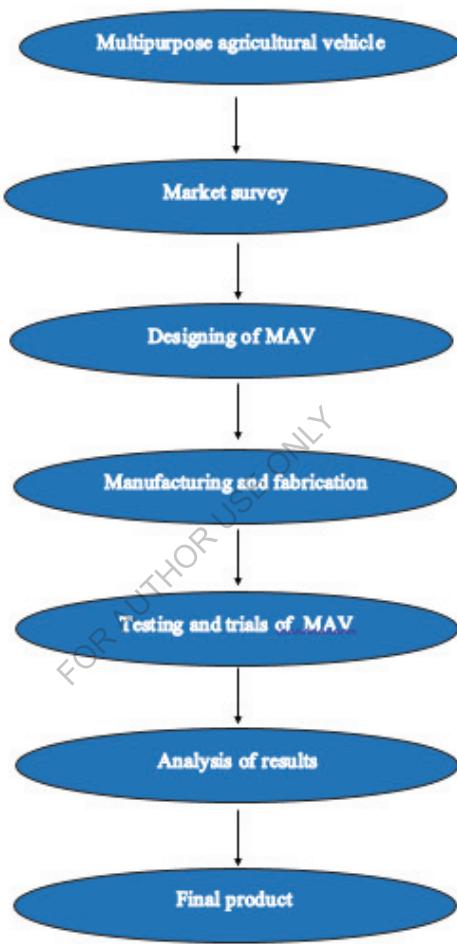


Figure 1.1: Planning and layout of MAV

# **Chapter 2**

## **Literature Review**

There have been many researcher who have been tried to applied technology for betterment of agriculture vehicle.

Dutta P.P et al [1] organized and cost-effective lawn mowers. Lawnmowers can be powered by solar energy, electricity, or an internal combustion engine. It has been noted that the literature on lawn mower design and development is similarly sparse.

Tanimola et al [2] To replace the usual gasoline-powered lawnmower, a solar-powered lawn mower has been designed. The machine has a field capacity of 1.11 hectares per hour and a 93 percent efficiency. At the 5

Sagar V. Palvei et at[7]: The solar-powered automatic lawn cutter machine is described in this project. The grass cutter machine may cut grass both manually and automatically. The system relies on a 12 volt battery to power both the vehicle moving motor and the lawn cutter motor. A solar panel is utilised to charge the battery, eliminating the requirement for external charging.

C Y N Norasma1 et al[13] The purpose of this article is to examine the use of unmanned aerial vehicles (UAVs) in agricultural applications. We discovered that UAVs can be used for a variety of agricultural purposes. Different sensors produce different analyses for agricultural applications, so the right sensor and UAV must be found.

Hui Liu et al[3] To implement the self-steering drive for a newly autonomous four-wheel independent-drive (4WID) agricultural electric vehicle, a model predictive control (MPC) strategy based on direct yaw moment control (DYC) was presented. If two rear electrical drive wheels could be commanded to follow the wheel tracks of two front wheels, it had a lot of potential for reducing wheel traffic damage to field crops.

The MPC controller was deemed a success since the trajectory error in the experiments was relatively low.

Stephen Daynes et al[4] The primary goals of aerodynamic design for road vehicles are to reduce drag and generate downforce. Morphing structures offer the ability to produce designs that are both simple to manufacture and light in weight. This article gives an overview of current advances in the field of morphing structures research.

Yimin ZHANG[5] : Dependability engineering can assist engineering design experts in establishing a reasonable production safety tolerance, governing the influence of stochastic characteristics, and optimising production for sufficient safety, reliability, and economic efficiency. This report summarises domestic research achievements in the field of car reliability-based design. The estimations include theories and methods, optimization, sensitivity, and robustness.

Priyanka Dubal et al[6] The adaptive front lighting system (AFS) aids in nighttime sight for the driver. During this time, 55 percent of all traffic accidents occur. The system uses a camera as an input sensor to alter the headlamp's horizontal rotation. When approaching a corner, it could avoid a "blind spot" generated by fixed lighting

Sang-Ha Kim et al[8] The reaction of the front bumper beam of cars subjected to an external impact load was investigated. An aluminium bumper with a polyurethane coating is subjected to an impact load, and a computer programme is designed to assess it. The investigation's main goal is to propose a method for designing the cross-sectional form of a car's front bumper beams in the most efficient way possible.

Changduk Kong [9] A natural flax fibre composite was used to create a structural design for an automotive hood. The flax/vinyl ester composite hood's results were compared to the metal hood structure's design outcomes. The hood construction was found to be adequate for structural safety and stability during the structural test. For the construction of an eco-friendly building, the mechanical properties of a flax-vinyl ester natural fibre composite are explored. A full-scale static structural test was conducted under simulated aerodynamic loads. The planned hood was found to have structural integrity based on the experimental results.

Shruti Ganesh Sarvankar et al[10] Additive manufacturing allows for the flexible creation of bespoke items with little cost and lead time effect. Every day, automotive firms manufacture new models and facelifts in response to new design trends and technology advancements. The automobile sector benefits from digitalization since

it allows them to transform ideas into successful vehicles faster and more efficiently. Some items made with AM technologies may have small "voids" or pores, which might reduce overall strength.

Harsimran Singh et al[11] SPC's strength rests in its capacity to investigate a process and its sources of variation with tools that prioritise empirical analysis above subjective judgements. The percentage rejection is lowered from 9.1 percent to 5

H. H. Kim et al[12] The Fabrication of Automobile Components A rheo-forming procedure for the creation of vehicle components such as knuckles is described. The process involves the use of rheology material and electromagnetic stirring (EMS) equipment. When exposed to the atmosphere, the molten aluminium alloy readily absorbs hydrogen gas during solidification. The EMS may be simply used during manufacturing in the rheo-forming process, and it is a highly effective way to boost the mechanical characteristics.

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# **Chapter 3**

## **Design of MAV**

Automotive designing- Automotive design can be defined as the procedure of developing the appearance and to some extent the ergonomics of motor vehicles - including automobiles, motorcycles, trucks, buses, coaches, and vans. The practical design and development of a motor vehicle is generally done by a large team from many different disciplines. Automotive design thus focuses on developing the visual aspects or aesthetics of vehicles. Automotive design is also involved in the creation of product concepts.

### **3.1 Design requirements**

The design constraints and criteria that we choose are as follows-

1. The vehicle will be powered by a 102cc Hero Honda Pleasure AUTOMATIC ENGINE.
2. The vehicle must not run at very high speeds and the maximum speed the vehicle can reach was kept less than 30km/h.
3. The vehicle will have hand lever operated front drum brake available in the steering / handle.
4. Appropriate frame was chosen for the vehicle in accordance with its load carrying capacity, failing under stress and rugged use.
5. The vehicle is so designed that its assembly and disassembly can be done easily with very few equipment requirements.
6. The power transmission system from the engine to rear wheels is so designed that it is cost effective and does not fail under various stresses and forces.

7. The vehicle is designed for rugged use.
  8. The vehicle is designed to have minimum turning radius and for that reason is made as a three wheeler.
  9. The vehicle is provided with a 5 litre fuel tank for working continuously for around 4 hours.
  10. A 12 volt and 4 ampere battery is used for the vehicle.
  11. To design a grass cutter attachment i.e., grass cutter, bucket and its connecting links.
- 

### **3.2 DESIGN PROCEDURE**

Design procedure includes various processes such as Product Planning, The Design Brief, Concept Generation, Theme Selection, 3D and Computer Model Generation, Design Evaluation, Styling Freeze, Prototype Development / Product Testing and Product Launch.

1. Product Planning – involves Brainstorming before any work begins i.e., market research needed for the requirement of product, available factory capacity, manufacturing processes, necessary equipment.
2. The Design Brief- involves Guidelines on the vehicle being designed i.e., identification for whom the vehicle is designed, what type of vehicle it should be, it's expected cost, etc.
3. Concept Generation – it means putting ideas on paper. Basic thumbnail sketches to start which is followed by more detailed drawings.
4. Theme Selection-Designer sketches are reviewed and a theme selection is made on which design best meets the matching design brief and more interesting look.
5. Design Evaluation -Total evaluation of the project design includes review of full size models and drawing, evaluation of appearance, ergonomics is evaluated, potential customer reactions and feedback
6. Styling Freeze - Specifications are finalized under this process. Finalization of body style and mechanical specifications, assessment of financial viability are categorized under this segment of design.
7. Prototype Development and Product Testing- in this process prototypes are made

and tested under normal and extreme driving conditions.

8. Product Launch -Formal introduction to the general public involves the unveiling of vehicle to general public.

### **3.3 Tools used for designing of MAV**

#### **3.3.1 Solidworks**

Solidworks is a solid modelling software that enables us to design objects in 3 dimensions. We create 2d profiles and then use features of solidworks such as extrude, swept, loft etc to create 3d models.

Solidworks gives a three-dimensional practical environment for these mechanical engineers to design cool stuff. Using three-dimensional CAD design software like Solidworks makes life simple for engineers because it saves time and money.

Solidworks is broadly used to create, plan, or perform any project in terms of infrastructure or construction. According to engineers, it is most functional for users as a part of their work. Because it only works on MS Windows. As it works only on MS Windows, it is comprehensive for users to install it on their computers. The engineers find it most functional to use Solidworks as part of their work.

Automotive design involves designing and planning a part of the automobile and planning or structuring any vehicle's design. Solidworks use is mostly performed in the automotive design and real estate industries. It takes input from users and examines it to produce any wanted output with the help of AI.

#### **3.3.2 Ansys**

Ansys is a designing and simulation software that is used for developing multiphysics engineering simulation software for product design, testing and operation and offers its products and services to customers worldwide. Most of the simulations of the vehicle were performed using the ansys software.

### 3.4 MAV design

The multipurpose agricultural vehicle is designed on the basis of the above mentioned requirements and design procedure. The various systems and components and their various design are further discussed in detail in the upcoming chapter.

#### 3.4.1 Design simulation results

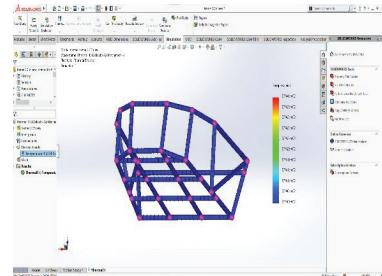


Figure 3.1: thermal analysis of frame

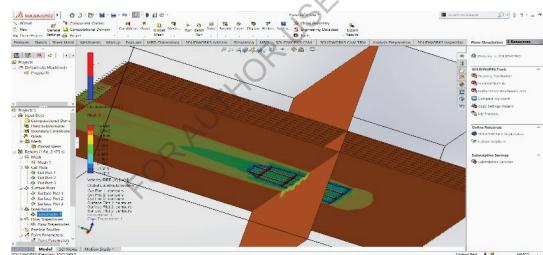


Figure 3.2: CFD analysis of Frame

#### 3.4.2 Mechanical Drawings of various components and systems

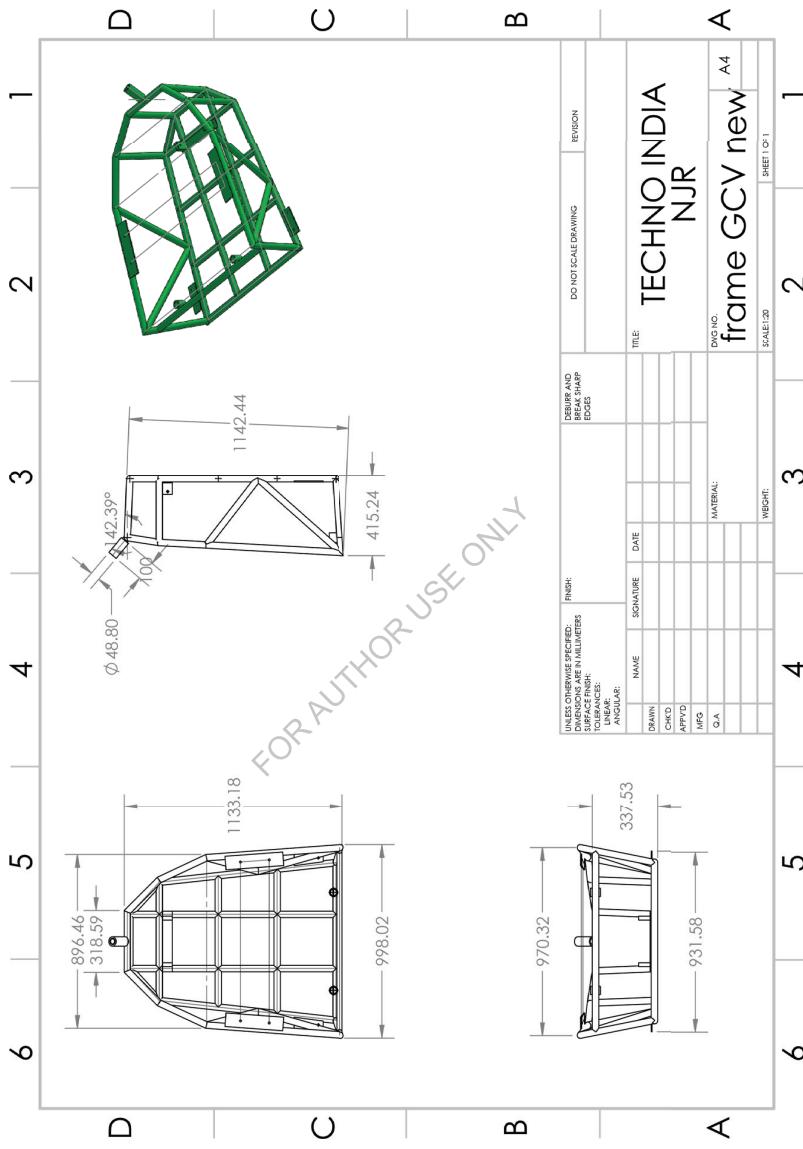
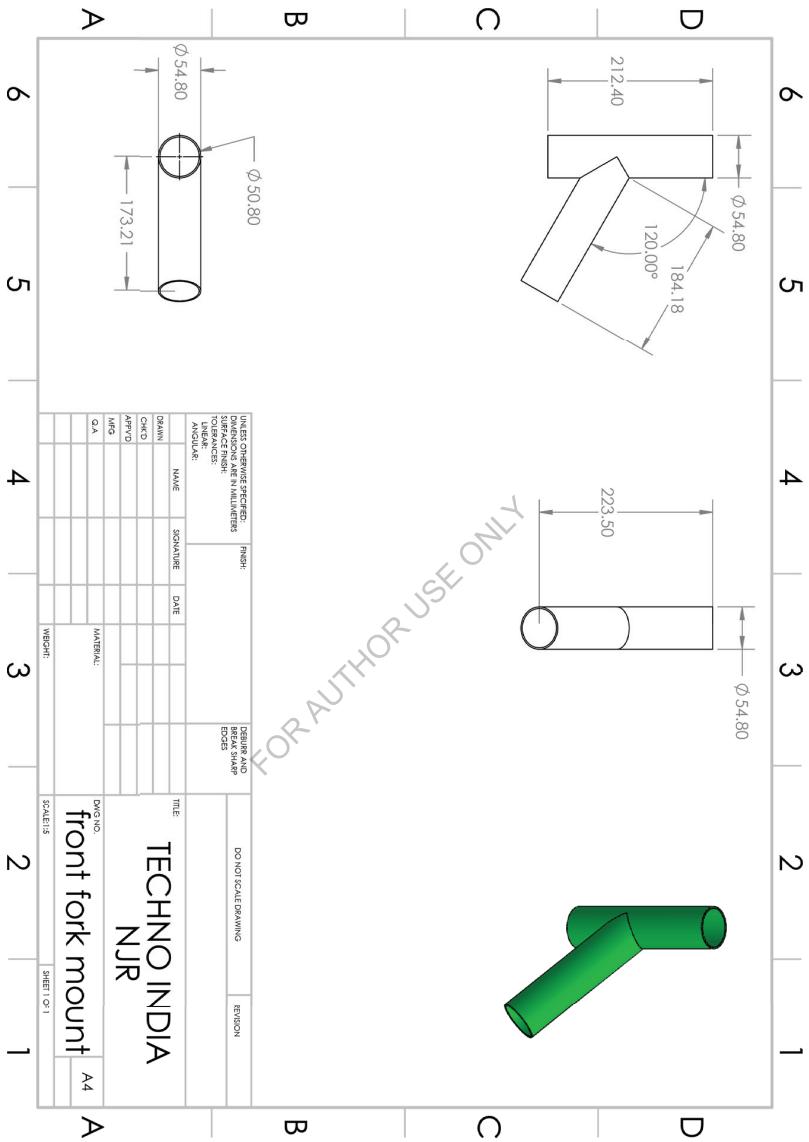


Figure 3.3: Frame



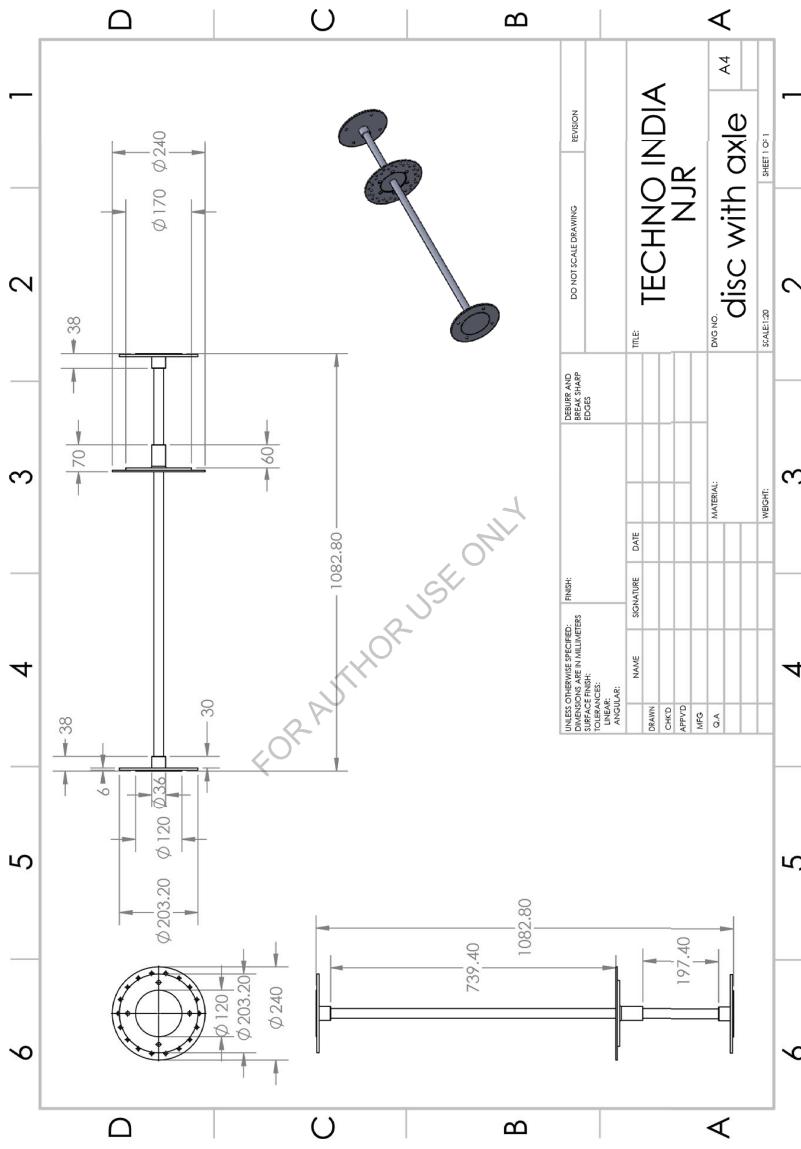


Figure 3.5: Shaft-rear axle

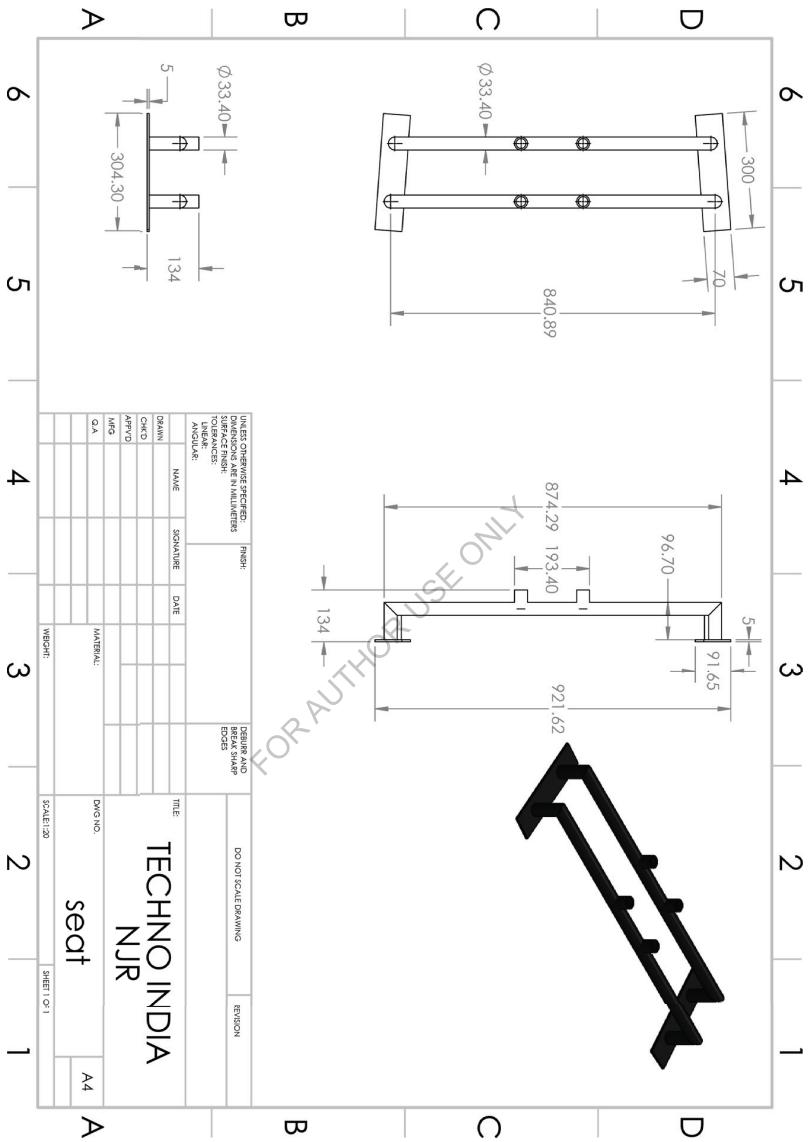


Figure 3.6: Seat mtg

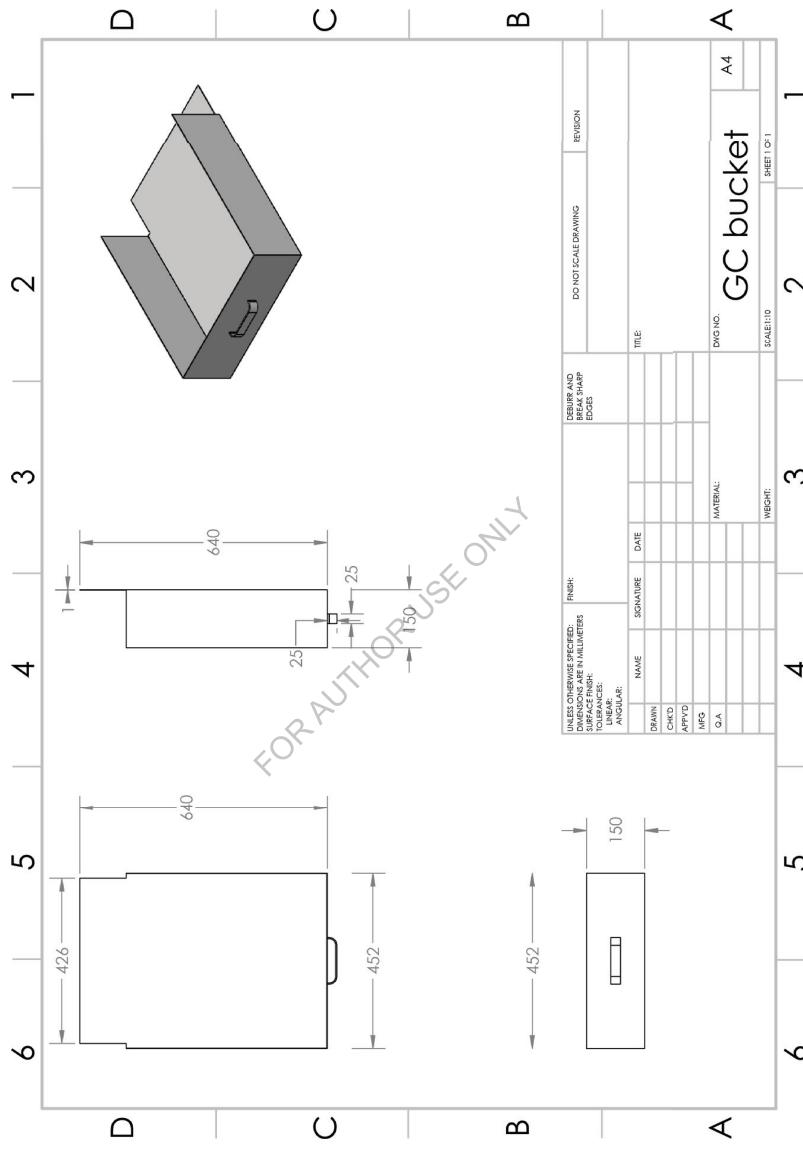


Figure 3.7: Grass cutter Bucket

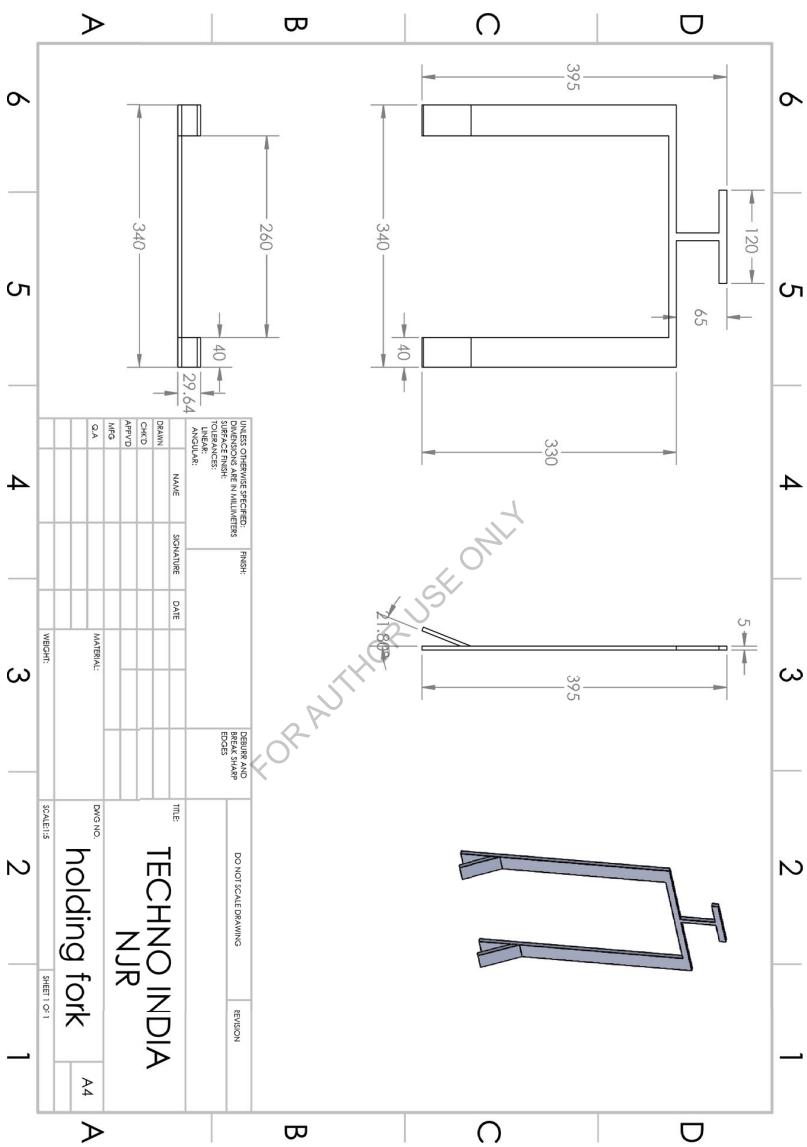


Figure 3.8: Bucket Mtg Fork

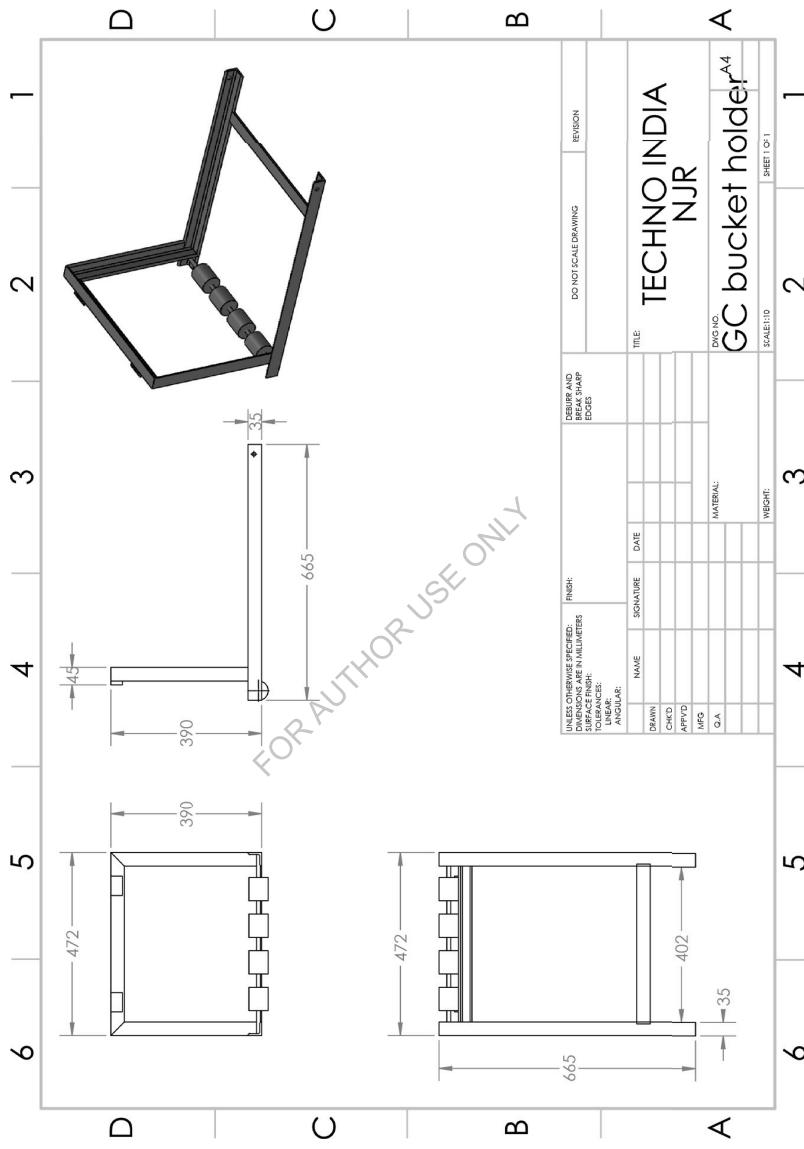


Figure 3.9: Grass cutter bucket holder

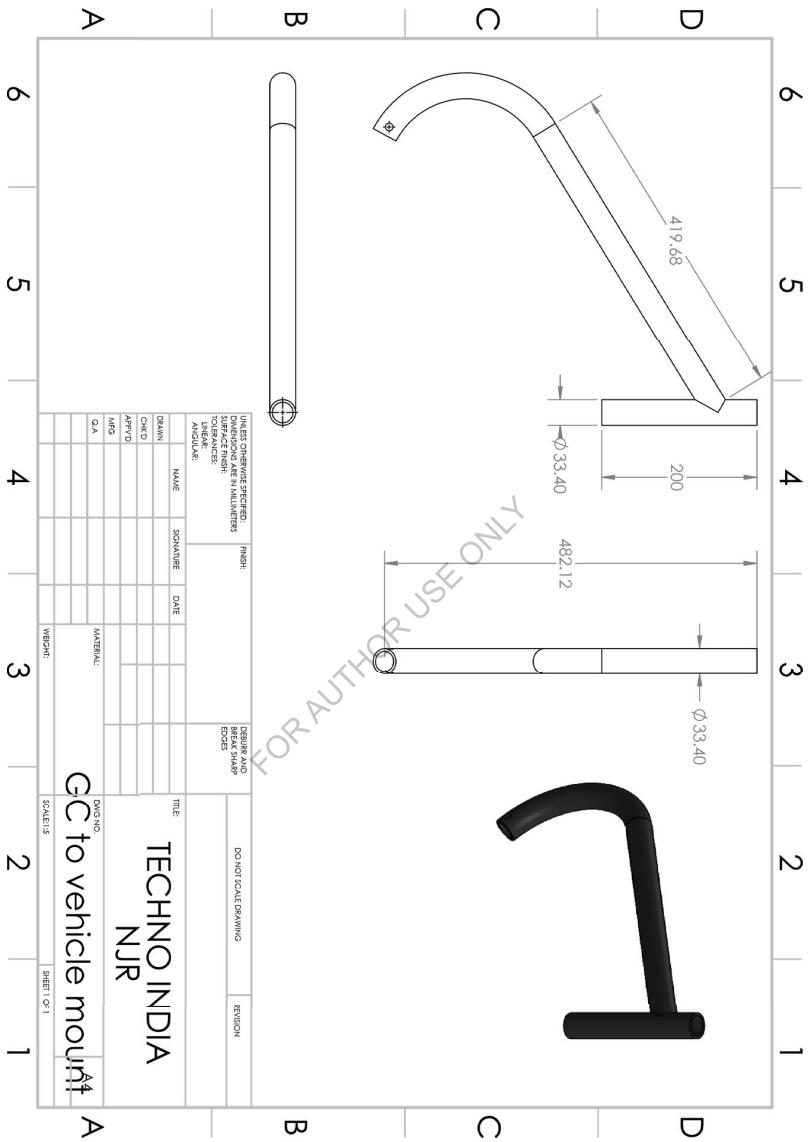


Figure 3.10: Grass cutter vehicle mtg

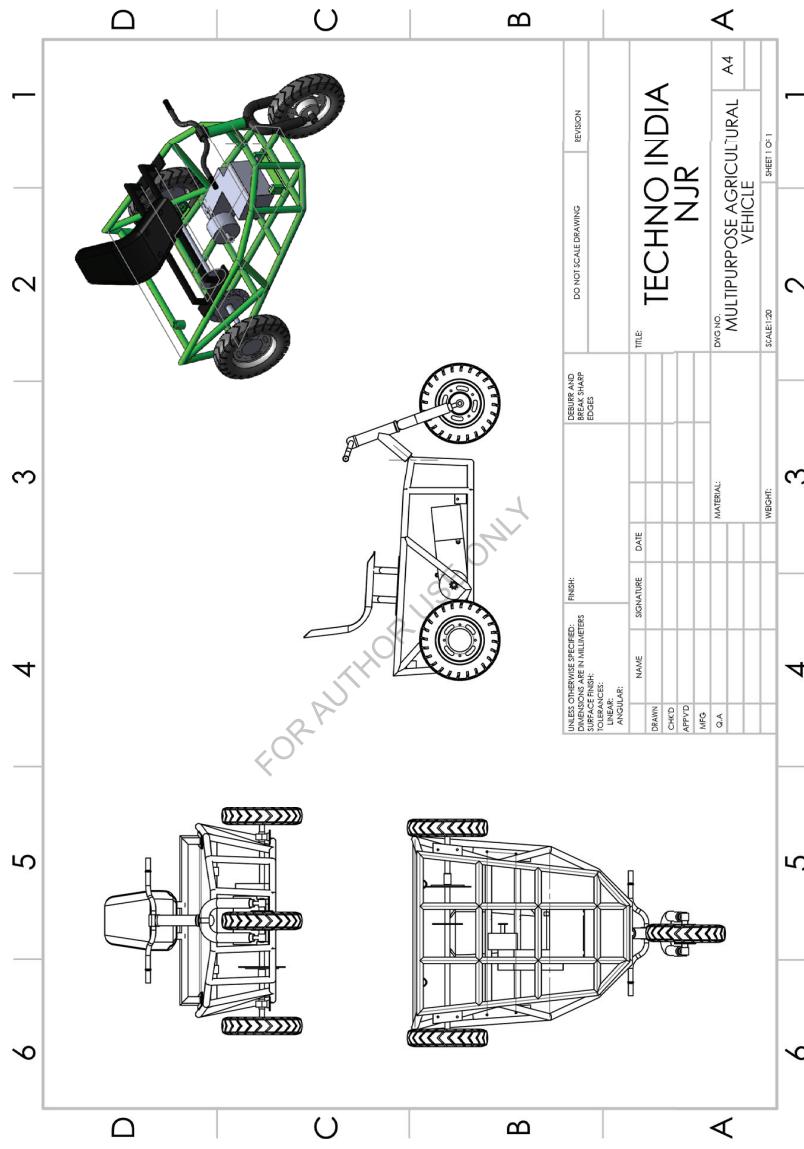


Figure 3.11: MAV

2

1

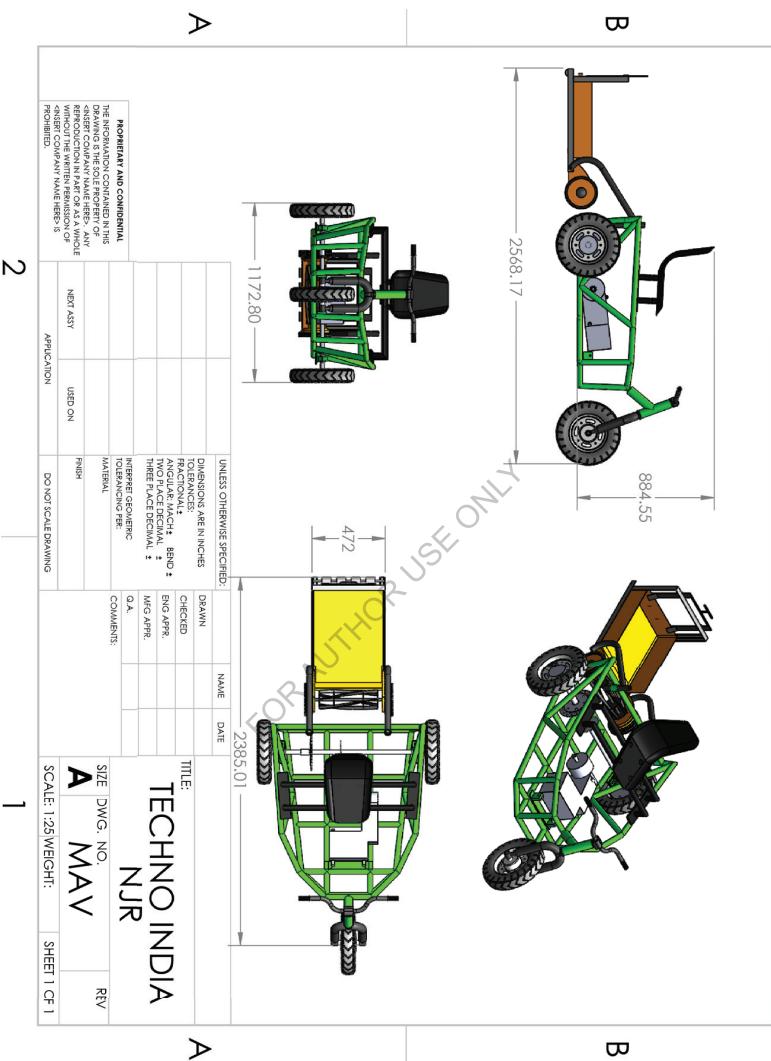


Figure 3.12: MAV with Grass cutter attachment



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ITEM NO.	PART NAME	QTY.
1	front fork	1
2	front axle pin	1
3	handle grip	2
4	rim	1
5	tyre	1
6	brake drum	1



Figure 3.13: Front axle and suspension

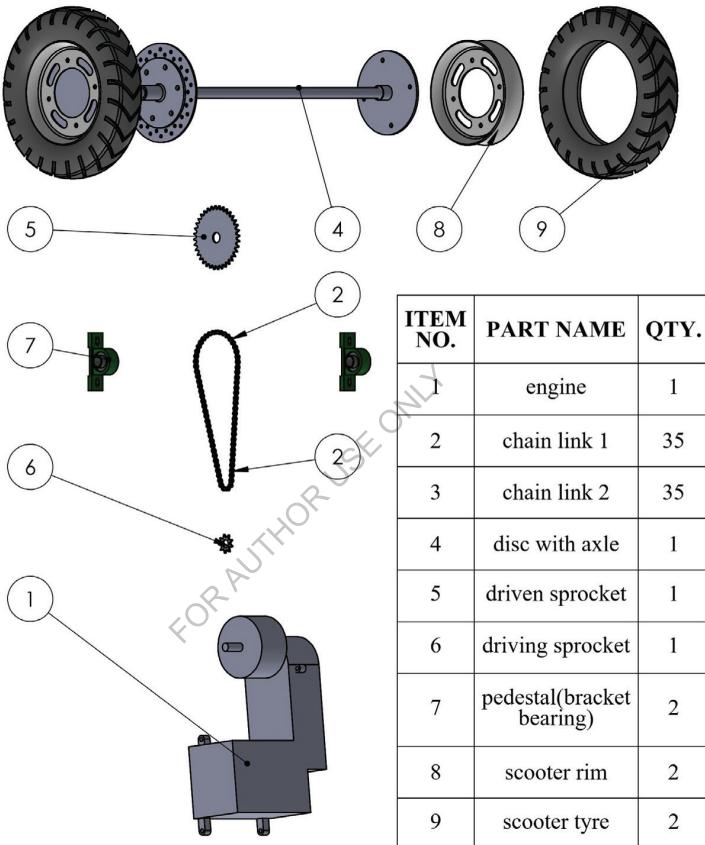


Figure 3.14: Transmission system

ITEM NO.	PART NAME	QTY.
1	GC main assembly	1
2	holding fork	1
3	GC bucket	1
4	GC blade	1

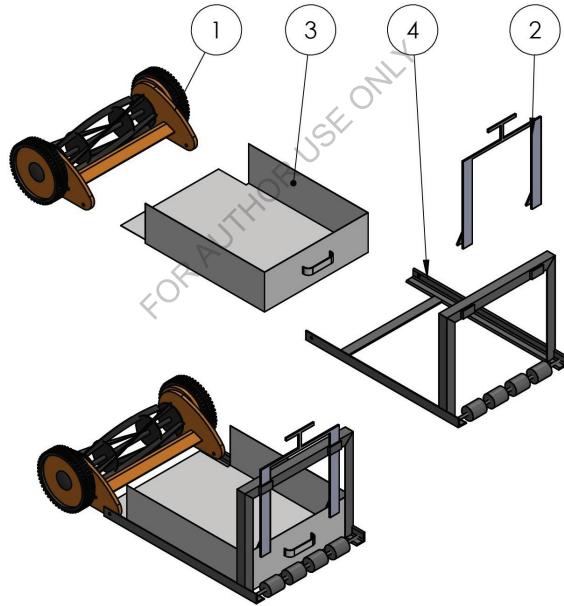


Figure 3.15: Assembly Grass cutter Attachment

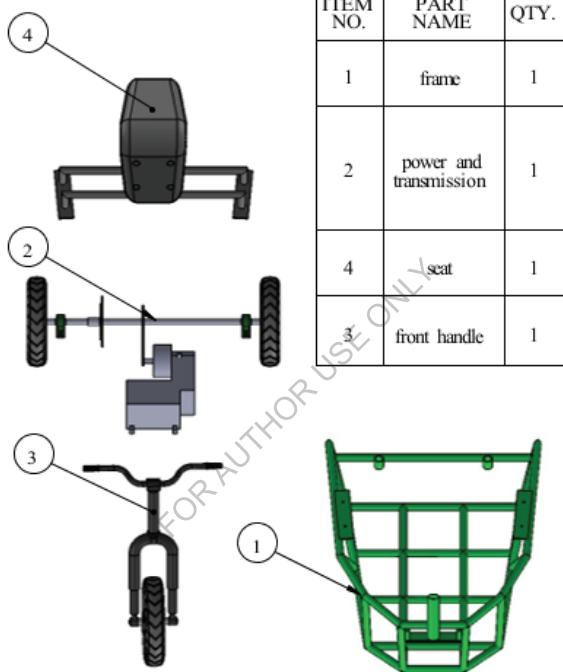


Figure 3.16: Vehicle Assembly

# Chapter 4

## Various components and parts of MAV

### 4.1 Frame

A vehicle frame, also historically known as its chassis, is the main supporting structure of a motor vehicle to which all other components are attached, comparable to the skeleton of an organism.

Frames can further be classified into

- Conventional frame
- Semi-integral frame
- Integral frame

Here, in our project we used tubular frame chassis it is a type of chassis that is similar to the body -on-frame design. Instead of a two-dimension ladder-type structure, it consists of a strong tubular backbone (usually rectangular in cross section) that connect the front and rear suspension attachment areas.

#### 4.1.1 Material comparison

Before starting the fabrication of chassis various materials were considered and a comparison was done to select the appropriate material for the chassis. The selection of material and dimensions of pipe used are based on the table depicted below. After a thorough and extensive research AISI 4130 pipes were selected.

Table 4.1: Comparisson of different materials

Property	1018 1" *0.65mm	1020 DOM 1" *0.65mm	4130 1" *0.65
Yield strength	365 MPa	539 MPa	670 MPa
Bending stress	2790 Nm <sup>2</sup>	3640 Nm <sup>2</sup>	3640 Nm <sup>2</sup>
Bending strength	391Nm	602Nm	747Nm
Weight	112 lbs	82 lbs	82 lbs

#### **4.1.2 AISI 4130 Chemical properties**

AISI-4130- Selected because it is suitable for ATV's, Referred in MAC and SAE BAJA. Tubes of 1" and 0.65mm thickness had been taken. Chemical composition of material is that it contains 0.3



Figure 4.1: AISI 4130 pipes

#### **4.1.3 Design and aggregate specification of chassis**

The chassis were designed in solidworks modelling software and the simulation and analysis of the chassis was performed in solidworks simulation software. The results obtained for the design of the chassis in the above software were above par then what was required for the same. The chassis are made from AISI-4130 pipes. The overall dimensions of Chassis are 3ft.\*4ft\*1ft. The design of chassis is based on tubular frame chassis.

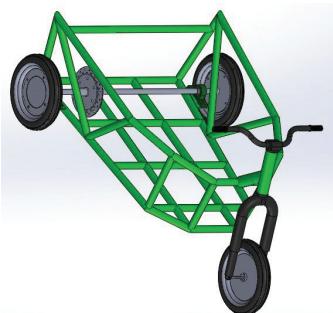


Figure 4.2: Frame Design in Solid-works

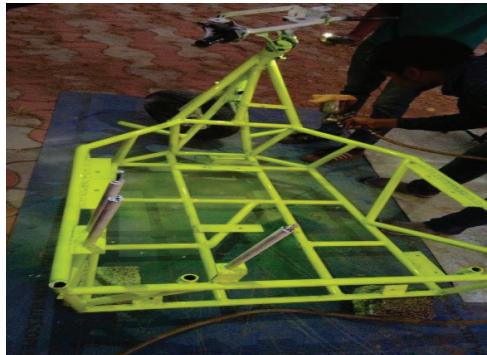


Figure 4.3: Fabricated Frame

## 4.2 Steering system

Steering is a system of components, linkages, etc. which allows any vehicle (car, motorcycle, bicycle) to follow the desired course. The primary purpose of the steering system is to allow the driver to guide the vehicle.

A steering system for a motorcycle includes a head pipe, a steering stem, a top bridge, a bottom bridge, a front fork, and a steering handlebar. The steering stem is supported by the head pipe. The top bridge has a center portion, a side portion extending from the center portion, and a holding portion provided at the side portion. The top bridge is supported by the steering stem at the center portion to steerable move around the head pipe. The bottom bridge is supported by the steering stem to steerable move around the head pipe. The front fork is held by the top bridge through the holding porting and is held by the bottom bridge. The top bridge has a protruding portion provided on an upper face of the top bridge and extending from the holding portion toward the center portion of the top bridge.

The handle bar is made of bended steel pipe with rubber grips at both the ends of the handle and it serves as the steering control for the vehicle. The hydraulic shock absorbers are used in the steering system so that it can react to imperfections in the road while isolating rest of the vehicle. The head tube is an tubular frame within which the steerer tube is mounted. The steerer tube is used to steer the fork which in turn steers the axle that has tyres mounted on it which results in steering of vehicle.



Figure 4.4: Steering side view



Figure 4.5: Steering top view



Figure 4.6: Steering during fabrication

### 4.3 Braking system

A drum brake is a brake that uses friction caused by a set of shoes or pads that press outward against a rotating cylinder-shaped part called a brake drum. The term drum brake usually means a brake in which shoes press on the inner surface of the drum. When shoes press on the outside of the drum, it is usually called a clasp brake. Where the drum is pinched between two shoes, similar to a conventional disc brake, it is sometimes called a pinch drum brake, though such brakes are relatively rare. Front drum brakes may be of either design in practice, but the twin leading design is more effective. This design uses two actuating cylinders arranged so that both shoes use the self-applying characteristic when the vehicle is moving forwards. The brake shoes pivot at opposite points to each other. This gives the maximum possible braking when moving forwards, but is not so effective when the vehicle is traveling in reverse. Drum brakes are easy on the pocket i.e., are low cost and maintenance cost is also low.



Figure 4.7: Drum brake



Figure 4.8: Various parts of drum brake

The vehicle uses an 110mm drum brake at the front wheel. The brake is operated with the help of a lever clamped at the handle bar. The drum brake is a brake that uses friction caused by a set of shoes or pads that press outward against a rotating cylinder-shaped part called a brake drum. The drum brake used in the vehicle consists of two brake shoes, shoe hold springs, friction lining, lever, drum casing, back plate and a brake wire. The figure below depicts more details about the drum brakes.



Figure 4.9: Drum Brakes used in vehicle

## 4.4 Engine and Transmission

An engine or motor is a machine designed to convert one form of energy into mechanical energy. Heat engines convert heat into work via various thermodynamic processes. The internal combustion engine is perhaps the most common example of a heat engine, in which heat from the combustion of a fuel causes rapid pressurisation of the gaseous combustion products in the combustion chamber, causing them to expand and drive a piston, which turns a crankshaft. Electric motors convert electrical energy into mechanical motion, pneumatic motors use compressed air, and clockwork motors in wind-up toys use elastic energy. In biological systems, molecular motors, like myosins in muscles, use chemical energy to create forces and ultimately motion.

The internal combustion engine is an engine in which the combustion of a fuel (generally, fossil fuel) occurs with an oxidizer (usually air) in a combustion chamber. In an internal combustion engine, the expansion of the high temperature and high pressure gases, which are produced by the combustion, directly applies force to

components of the engine, such as the pistons or turbine blades or a nozzle, and by moving it over a distance, generates mechanical work.

The vehicle is powered by an 102cc Hero-Honda automatic engine. It is an air cooled, 4-stroke single cylinder OHC engine. It produces a maximum power of 7PS @ 7000 rpm and a maximum torque of 8.1nm @ 5000 rpm. The fuel efficiency according to ARAI of this engine is 63 kmpl. This engine was selected keeping the availability of its parts and the requirements of the vehicle. The engine can be started both self -start and kick start. The self-start of the vehicle is powered by a 12volt 4 ampere battery.

Table 4.2: Engine Specifications

Displacement	102cc
Engine type	4 stroke single cylinder OHC
No. of cylinders	1
Maximum power	7PS @ 7000 rpm
Maximum torque	8.1 NM @ 5000 pm
Cooling system	Air cooled
Drive type	Hub motor
Starting	Kick and self start
Fuel supply	Carburettor
Clutch type	Dry,Auto-centrifugal
Ignition	CDI
Transmission	Automatic
Bore	50 mm
Stroke	52 mm
Compression ratio	9.9:1

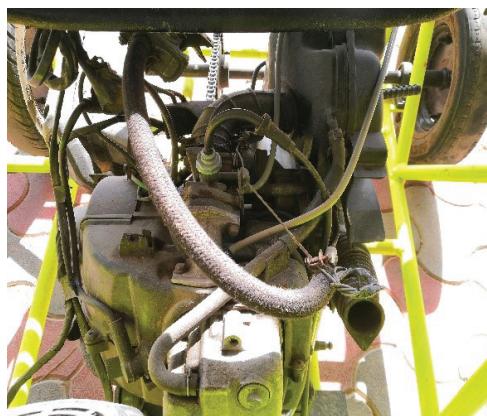


Figure 4.10: Engine Top View



Figure 4.11: Engine Side View

## 4.5 Wheel and tyre

A tyre is a ring-shaped component that surrounds a wheel's rim to transfer a vehicle's load from the axle through the wheel to the ground and to provide traction on the surface over which the wheel travels. Most tires, such as those for automobiles and bicycles, are pneumatically inflated structures, which also provide a flexible cushion that absorbs shock as the tire rolls over rough features on the surface. Tires provide a footprint, called a contact patch, that is designed to match the weight of the vehicle with the bearing strength of the surface that it rolls over by providing a bearing pressure that will not deform the surface excessively. The materials of modern pneumatic tires are synthetic rubber, natural rubber, fabric and wire, along with carbon black and other chemical compounds. They consist of a tread and a body. The tread provides traction while the body provides containment for a quantity of compressed air.

A wheel is a circular block of a hard and durable material at whose center has been bored a hole through which is placed an axle bearing about which the wheel rotates when torque is applied to the wheel about its axis.

The vehicle consists of three wheels one at the front and two at the rear. The wheels used are welded sheet metal wheels. These wheels used are manufactured by MRF (rear) and CEAT(front). Other specifications of the wheels are given below in table 3.

#### 4.5.1 Tyre size

1. Front - 90/100-10

2. Rear - 90/100-10

Table 4.3: Wheel/ tyre specifications

Rim diameter	10 inch
Rim width	3 inch
Tyre OD/ diameter	16 inch
Weight of tyre	21 lbs
Rear track width	3 feet 4 inch
Ground Clearance	160 mm
Wheel base	4 feet 2 inch
Tyre Pressure front	22 psi
Tyre Pressure rear	29 psi



Figure 4.12: Rim of Wheel



Figure 4.13: Tyre and wheel

## 4.6 Grass cutter

A grass cutter or grass trimmer or lawn mower is a mechanical device containing revolving blades used for the purpose of trimming grass and small weeds. Grass cutters are of two types namely, manually powered and automatic type. Manually powered type of grass cutter requires manual force by human or operator to operate them. Automatic type of grass cutter is powered by a motor or engine and the user is only required to direct the machine. The design of grass cutter depends upon the type of surface, field, type of grass and the area of action. The grass cutters are further classified as Ride-on mowers, zero turn mower, walk mower, rotary mower, push mower, self-propelled mower, hover mower, electric powered mower, gas powered mower, battery-powered mower, RWD mower, FWD mower and AWD mower.

In our project we have used push type mower apparatus but the power to operate this apparatus is provided by the vehicle instead of human force. These mowers are light weight and easy to handle. They offer good motility which provides us the ease of handling.



Figure 4.14: Grass cutter

## 4.7 Roller

The roller is an agricultural device used for levelling of uneven surface of land and fields. These tools are typically used for flattening or shattering up large clumps of mud or soil. These rollers are pulled by heavy duty vehicles such as tractors or other high torque automotives. Flatter field require less weed control and trimming is made subsequently easier. There are different types of rollers used for different purposes. Some of them are segmented rollers, one piece rollers, smooth rollers and ridged rollers. For our application we have used an one piece pitch roller.



Figure 4.15: Roller

# **Chapter 5**

## **Manufacturing**

The manufacturing is defined as the processing of raw material or parts into finished goods through the use of tools, human labour, machinery and chemical processing. Manufacturing allows businesses to sell finished products at a very high cost than the value of raw material used.

### **5.1 Welding**

Welding is a fabrication process that joins materials by using high heat to melt the parts together and allowing them to cool causing fusion. In this process we used arc-welding for some selected components were using MIG welding was not possible. MIG welding was used to fabricate the frame and chassis and a few other components such as collars and foot rests of the vehicle.

#### **5.1.1 Metal Inert Gas (MIG) welding**

Metal Inert Gas (MIG) welding is an arc welding process that uses a continuous solid wire electrode heated and fed into the weld pool from a welding gun. The two base materials are melted together forming a join. The gun feeds a shielding gas alongside the electrode helping protect the weld pool from airborne contaminants.

MIG/MAG welding is a versatile technique suitable for both thin sheet and thick section components. An arc is struck between the end of a wire electrode and the workpiece, melting both of them to form a weld pool. The wire serves as both heat source (via the arc at the wire tip) and filler metal for the welding joint. The wire is

fed through a copper contact tube (contact tip) which conducts welding current into the wire. The weld pool is protected from the surrounding atmosphere by a shielding gas fed through a nozzle surrounding the wire. Shielding gas selection depends on the material being welded and the application. The wire is fed from a reel by a motor drive, and the welder moves the welding torch along the joint line. Wires may be solid (simple drawn wires), or cored (composites formed from a metal sheath with a powdered flux or metal filling). Consumables are generally competitively priced compared with those for other processes. The process offers high productivity, as the wire is continuously fed.

Manual MIG/MAG welding is often referred as a semi-automatic process, as the wire feed rate and arc length are controlled by the power source, but the travel speed and wire position are under manual control. The process can also be mechanised when all the process parameters are not directly controlled by a welder, but might still require manual adjustment during welding. When no manual intervention is needed during welding, the process can be referred to as automatic.

The process usually operates with the wire positively charged and connected to a power source delivering a constant voltage. Selection of wire diameter (usually between 0.6 and 1.6mm) and wire feed speed determine the welding current, as the burn-off rate of the wire will form an equilibrium with the feed speed.



Figure 5.1: MIG welding

### 5.1.2 Arc Stick Welding

Arc welding is a fusion welding process used to join metals. An electric arc from an AC or DC power supply creates an intense heat of around 6500°F which melts the metal at the join between two work pieces. The arc can be either manually or mechanically guided along the line of the join, while the electrode either simply carries the current or conducts the current and melts into the weld pool at the same time to supply filler metal to the join. Because the metals react chemically to oxygen and nitrogen in the air when heated to high temperatures by the arc, a protective shielding gas or slag is used to minimise the contact of the molten metal with the air. Once cooled, the molten metals solidify to form a metallurgical bond.

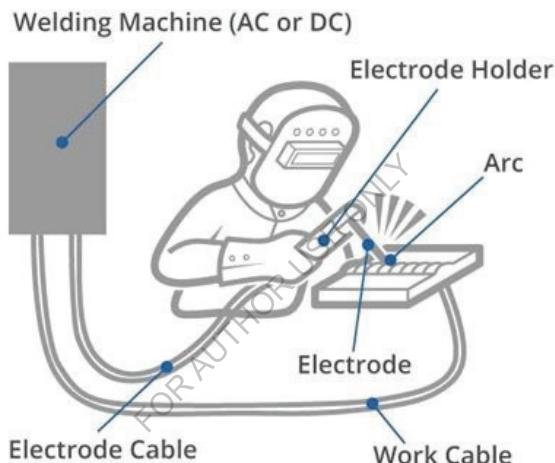


Figure 5.2: Arc welding

## 5.2 Grinding

Grinding is an abrasive machining process that uses a grinding wheel as a cutting tool. Different grades of grinding wheels were used for cutting and surface finishing of unwanted parts and excess welds. Proper safety was ensured by using hand gloves and face masks while performing the procedure. Majority of times angle grinder was used.

### 5.2.1 Angle Grinder

An angle grinder, also known as a side grinder or disc grinder, is a handheld power tool used for grinding (abrasive cutting) and polishing. Although developed originally as tools for rigid abrasive discs, the availability of an interchangeable power source has encouraged their use with a wide variety of cutters and attachments.

Angle grinders can be powered by an electric motor or compressed air. The motor drives a geared head at a right-angle on which is mounted an abrasive disc or a thinner cut-off disc, either of which can be replaced when worn. Angle grinders typically have an adjustable guard and a side-handle for two-handed operation. Certain angle grinders, depending on their speed range, can be used as sanders, employing a sanding disc with a backing pad or disc. The backing system is typically made of hard plastic, phenolic resin, or medium-hard rubber depending on the amount of flexibility desired.

Angle grinders are standard equipment in metal fabrication shops and on construction sites. They are also common in machine shops, along with die grinders and bench grinders.



Figure 5.3: Angle Grinder with different abrasive wheels

### **5.2.2 Cut off machines**

Cut-off machines are heavy but versatile tools designed to cut across concrete, metal, and ceramics effortlessly. These saws are known for making cuts of exceptional precision. Abrasive cut saws are ideally suited for metal cutting purposes. Abrasive cut-off devices are also known as cut-off or cut-off saws. These devices are typically designed as circular saws used to cut hardened materials.



Figure 5.4: Cut off machine

### **5.3 Painting and Aesthetics**

Surface finishing was done on the body and different components of the vehicle with the help Regmar (Sand Paper) papers of coarse grade(80 and 160 no. grit) followed by finer grades (320 and 400 no. grit). Surf acer paint was applied on the body. Any gaps or dents were evened out with the help of filler (NC) putty.

With help of an Air compressor paint sprayer the body was painted with three coats of metallic paint (gloss). Other small components were painted with the help of brush.

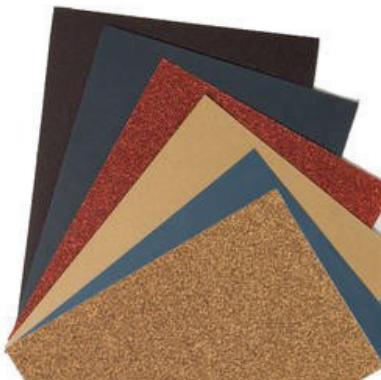


Figure 5.5: Types of regmar paper



Figure 5.6: Air compressor unit for spray paint

## 5.4 Wiring

A typical vehicle wiring system consists of alternator, CDI coil, Throttle sensor, ignition switch, kill switch, rectifier/regulator, headlight, tail lights, indicator lights, brake sensors, 12volt battery, ignition coil, spark plugs, on/off switch and relays.

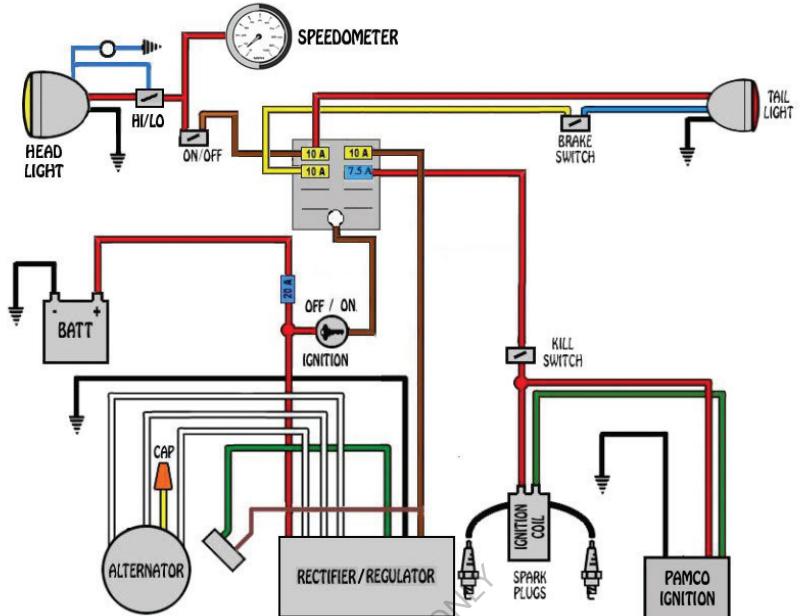


Figure 5.7: Schematic wiring diagram

## 5.5 Assembly

Firstly, the engine was mounted to the chassis. It was followed up with mounting of pedestal bearings and rear axle and sprocket and chain assembly. It was followed by mounting of collar plates and wheels. Sitting components were then assembled followed by the assembly of exhaust pipe. Handle bar and foot pegs were then fitted.

After fabrication, proper test trials were conducted to ensure efficient performance and safety. First the speed tests were conducted to check for maximum actual speeds in different environments and conditions. Secondly, the load bearing test were conducted. Then load towing test was conducted. It was followed by grass cutting and land roller test.

After final tests, small modifications were made and then the finishing touches were given to vehicle.



Figure 5.8: Assembly of Vehicle in Solid-works

# **Chapter 6**

## **Expenditure outlay**

Expenditure outlay also known as cost report is the information provided regarding the magnitude of a project's actual costing. The Detailed costing of MAV project is provided in the following table.

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Table 6.1: Costing of MAV

S.NO.	Component	Amount(I.N.R.)
1	Bearing and Collar plate	705
2	Front suspension, drum brakes, handlebar and axle	1000
3	Engine	3870
4	Spark Plug	60
5	Wires	460
6	Battery	900
7	Nut bolt(unbreakable)	225
8	Seat Sliders	200
9	Nut Bolt	50
10	Nut bolt (unbreakable 1inch)	201
11	Shaft key 2 units	60
12	Accelerator wire	240
13	Relay, Chain lock and headlight	460
14	Nut bolt	40
15	Regulator	180
16	Screw	40
17	Handle grip, levers, bush	200
18	Petrol T	200
19	Ratchet, ball bearing, bush	500
20	Bush	30
21	Rivet	10
22	Paint	1350
23	Potting	215
24	Insulation tapes	160
25	Pipe	40
26	Transportation	1133
27	Tyres with rim	7500
28	Pipe	12000
29	Welding,grinding,assembling tools, electricity,etc	32,000
30	Total	64029

# Chapter 7

## Conclusion

The multipurpose agricultural vehicle has performed more than satisfactorily. The vehicle successfully cleared all the tests and trials it was put to. We were able to achieve our objective and goal. The vehicle is exceedingly complying with the requirements of the job it was made to perform. The vehicle is able to cut grass and pull land roller which was our preliminary objective. The cost of vehicle came around I.N.R. 64,000 which is very less as compared to the similar kind of machines available in the market which are priced in between I.N.R. 2.5 - 8 lac. So, the objective of building a economical vehicle was accomplished. The vehicle is able to trim the grass in about 0.5 the time taken by conventional grass cutters, thus saving ample amount of time.

The experience of making and designing a vehicle was a thrilling and enthusiastic one. The hardships and various challenges faced during this project were really beneficial and a new learning curve. The rigorous brainstorming sessions and every ounce of our work was fruitful. The students were able to gain an enormous amount of practical knowledge by the end of this project. Overall the project was a great learning experience.



Figure 7.1: Multipurpose agricultural vehicle

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