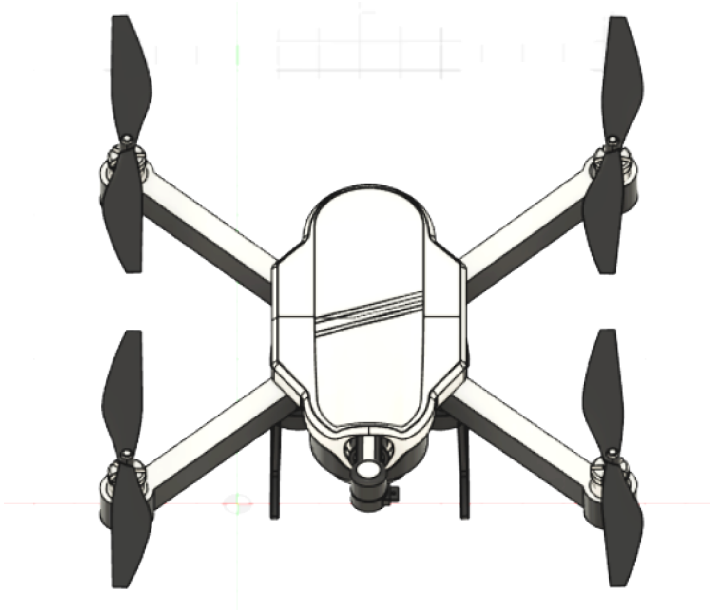
TA201A: Introduction to Manufacturing Processes

DESIGN PROJECT

Session: 2021-2022

Group: M1G2

Quadcopter



Indian Institute of Technology Kanpur

Course: **TA201 Manufacturing Processes I**

Credits : **(1-0-3-0) 6**

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Acknowledgment

We would like to express our sincere gratitude to our course instructor and tutor **Prof. Shashank Shekhar** and our lab-in-charge, **Mr. Anil Kumar Verma** for their support and instruction in this project. Their feedback and suggestions were instrumental throughout the execution of the project and for providing us with this golden opportunity to explore our creativity. We are thankful to **Mr. Indra Pal Singh**, **Mr. Akash Yadav**, and **Ms. Jhilik Sen** for their able guidance in completing our project. Secondly, we would also like to thank our friends and batchmates who helped us with resources that allowed us to complete the project within the deadline. It wouldn't have been possible without all of your guidance, and it helped our team to hone our skills and present this before you.

THANKS AGAIN TO EVERYONE WHO HELPED US!

- Group M1G2

Executive Summary of the project

These are the steps that we followed to complete the project within the deadline:

- Research and study how to execute the plan of a quadcopter camera drone; studying existing models, analyzing what better we can do along with following the guidelines given to us.
- Structuring/planning of the structure and studying its working principle for better knowledge.
- Breaking it down into components (stand, wings, camera mount, etc) which can be assembled to form a full drone.
- Choosing the materials to be used.
- The manufacturing processes to be used.
- Calculating the dimensions of the various parts.
- Division of work/tasks among team members.
- Modeling the complete drone on Autodesk Fusion 360.
- Making drawings (Isometric drawings of the project and sectional drawings of the individual components) from the 3D model.
- Further study on cost analysis and sustainability

Motivation

With the recent article published in the news in July regarding “6 best drones for beginners in 2021, according to experts”.With the various uses including companies using drones for grocery delivery, surveillance, and even speed racing, this is a project that provides us vast knowledge about drones. Most modern-day drones are easy to maneuver and can be used by anyone. Most people use drones for photography. Increasingly improving camera stabilization technology in recent years has made it possible to fly a drone hundreds of feet in the air and take clear high-resolution photos and videos. So we have attempted to design a model of a drone which can range from a simple flying drone to complex ones with a foldable stand and camera, following the constraints provided to us.

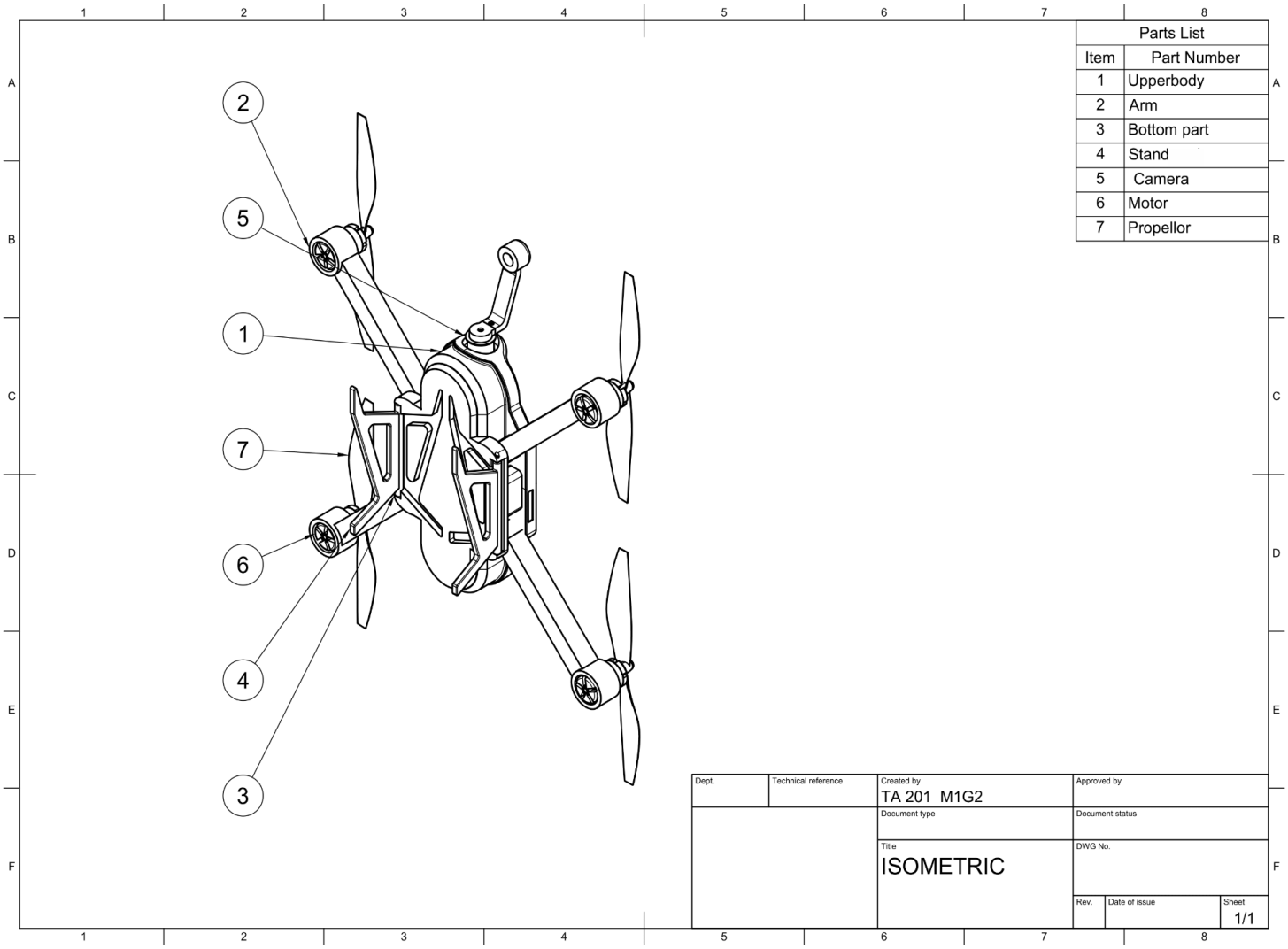
Introduction

Quadcopter or Quadrotor: remote-control aircraft with four propellers. The small size and low inertia of drones allow the use of a particularly simple flight control system, which has greatly increased the practicality of the small quadrotor in this application. As the algorithms determining flight stability and control have become more sophisticated, these miniature aircraft have become cheaper and more accessible. Now, it’s not only high-definition cameras that can be attached to drones. They can also carry thermal imaging units, sensors, and all sorts of tools now being used in all sorts of industries. But our focus is on photography. Camera drones are now being used to capture cinematic shots on Hollywood movie sets and selfies in back yards. Professional filmmakers and hobbyists have embraced technology and the sky, it seems, is the limit.

Isometric view of the complete assembly:

Total Weight of the frame - **3990 grams.**

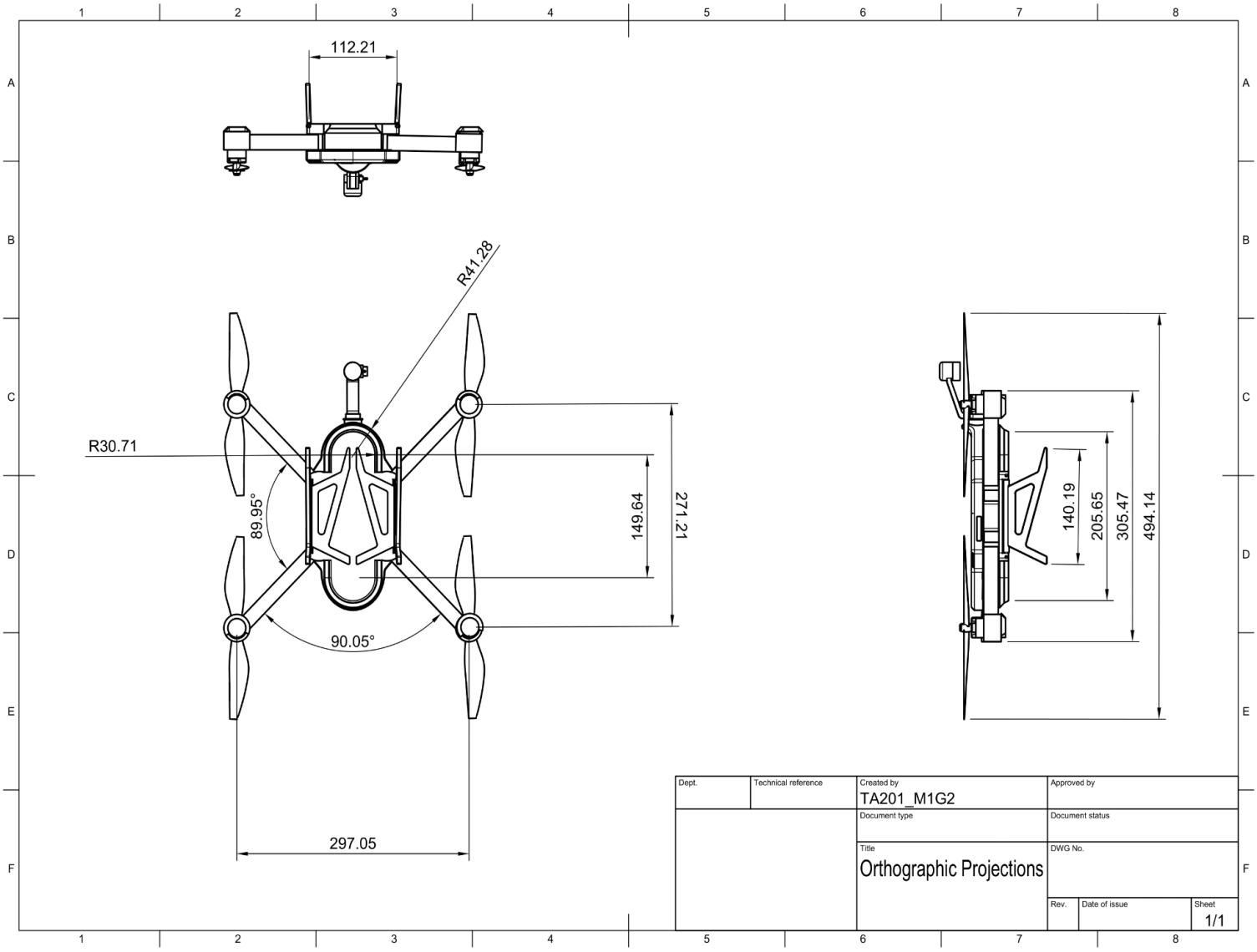
Dimensions of the base frame - **500x300x150 mm**



Parts List	
Item	Part Number
1	Upperbody
2	Arm
3	Bottom part
4	Stand
5	Camera
6	Motor
7	Propellor

Dept.	Technical reference	Created by: TA 201 M1G2	Approved by
		Document type	Document status
		Title: ISOMETRIC	DWG No.
			Rev. / Date of issue / Sheet: 1/1

Orthographic Projection



Design Principles

Each rotor produces both lift and torque about its center of rotation, as well as drag opposite to the vehicle's direction of flight. Quadcopters generally have two rotors spinning clockwise (CW) and two counterclockwise (CCW). Flight control is provided by independent variation of the speed and hence lift and torque of each rotor. Pitch and roll are controlled by varying the net center of thrust, with yaw controlled by varying the net torque. For best performance and smiles control algorithms, the motors and propellers are equidistant. To allow more stability at reduced weight, a quadcopter, like any other multirotor, can employ a coaxial rotor configuration.

Performance goals:

1. Cost-effective.
2. Small in size and hence can fly up to appreciable heights.
3. Drone can fly up to appreciable heights through the efficient design that stabilizes them.
4. Drone can sustain altitude through a balanced design.
5. high-definition cameras, thermal imaging units, sensors, and all sorts of tools can be attached to drones.

Working principle:

If all four rotors are spinning at the same angular velocity, with two rotating clockwise and two counterclockwise, the net torque about the yaw axis is zero, which means there is no need for a tail rotor as on conventional helicopters. Yaw is induced by mismatching the balance in aerodynamic torques (i.e., by offsetting the cumulative thrust commands between the counter-rotating blade pairs).

Manufacturing Processes :

- **Shearing and forming**: If the cutting blades are straight, the process is called shearing; if the cutting blades are curved, they are shearing-type operations.
- **Joining**: Welding, Brazing, Soldering, Bonding, Nailing, Screwing, Bolting, Riveting, Clinching, Stapling, Press fitting
- **Welding**: Welding is a fabrication process whereby two or more parts are fused using the heat, pressure, or both forming a joint as the parts cool.
- **Machining**: Machining is a process in which a material (often metal) is cut to a desired final shape and size by a controlled material removal process.
- **Heating and Rolling Casting:** the cast metal goes through a series of heavy metal rollers that slowly decrease the initial larger cast of metal into the required thickness.
- **Heat Treatment:** Heat treatment involves the use of heating or chilling, normally to extreme temperatures, to achieve the desired result such as hardening or softening of a material.

Components:

- Central Upper Body Frame (1x)
- Bottom Frame (1x)
- Drone Propellers (4x)
- Drone Arm (4x)
- Foldable Drone Stand (2x)
- Drone Camera mount (1x)
- Drone Motors (2x)
- Middle body Part (1x)

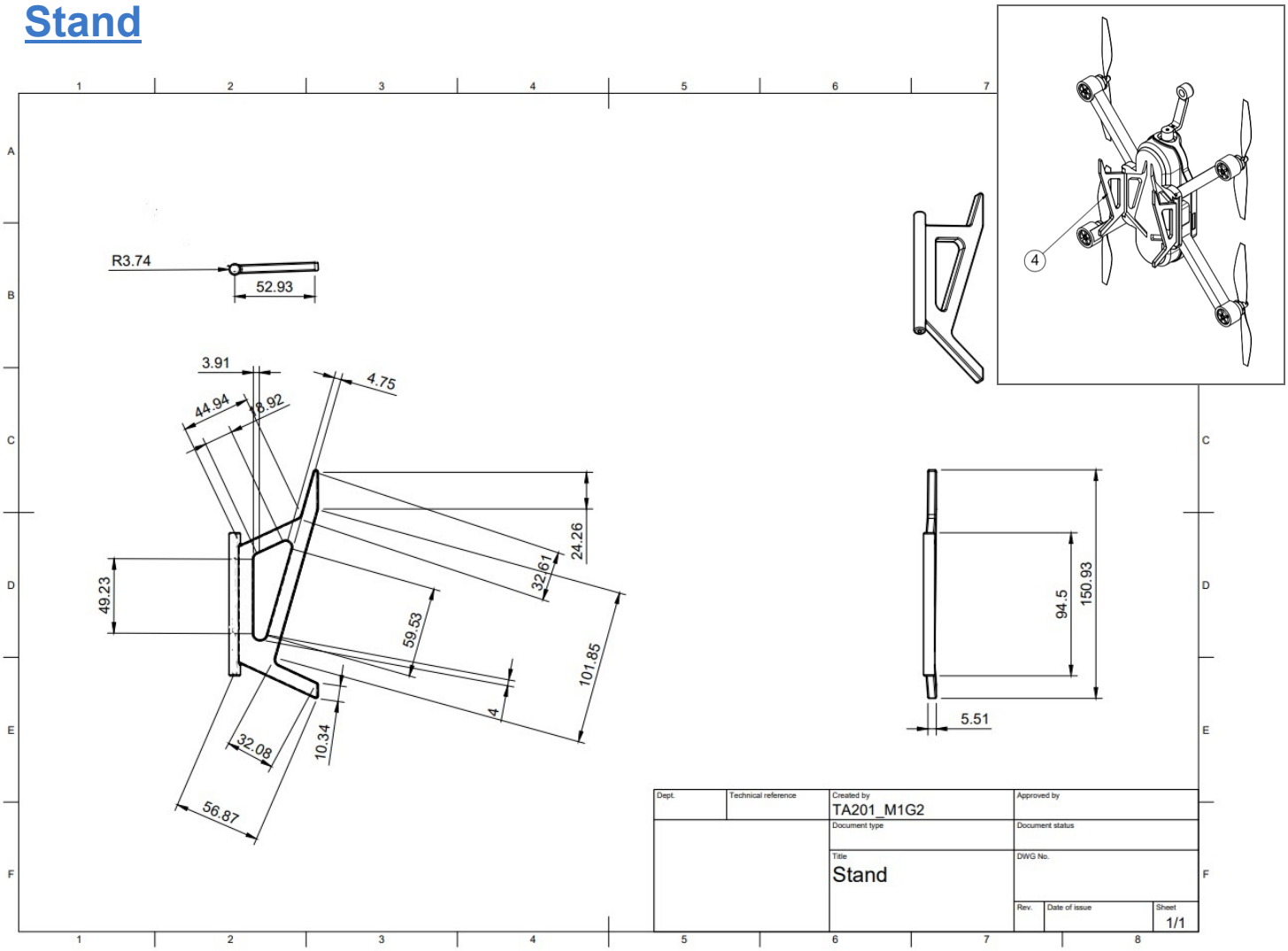
Materials required:

- Mild Steel rod (8 mm dia)
- Mild Steel flat (25*5)
- Mild Steel square pipe (15x15 mm)
- Mild Steel Round Pipe (18mm dia)
- Mild Steel Round Pipe (18mm radius)
- Mild Steel Sheet (2.0 mm)
- Mild Steel Sheet (0.5 mm)
- Mild Steel Round Rod(3 mm dia)
- Mild Steel Round Pipe(25 mm dia)
- Mild Steel Round Rod (25 mm dia)
- Iron for casting for the upper half and bottom part
- Thermocol (3 inch)
- Sandpaper for filing
- Rivets
- Screws

Isometric & Orthographic Views of Individual Parts

(Engineering drawing with dimensions)

Stand



Materials Used:

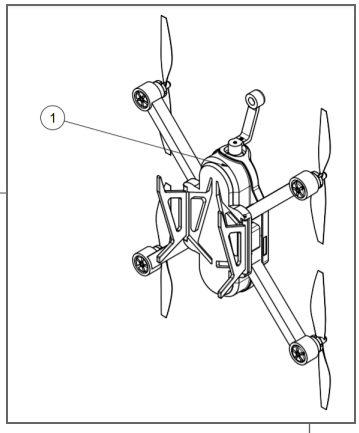
- Steel rod (8 mm dia)
- Mild Steel Flat 25x5 mm

Manufacturing Processes involved:

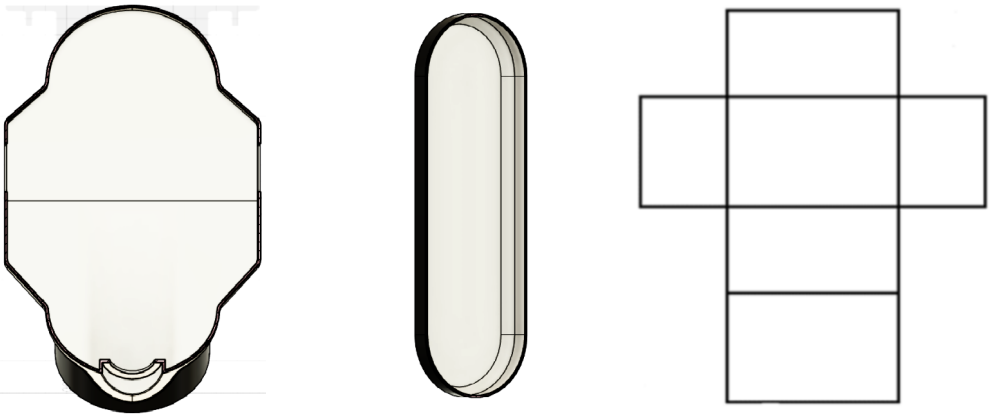
- *Hammering*: Square rod hammered to correct thickness.
- *Cutting*: Flat steel has been cut to appropriate dimensions.
- *Arc Welding*: Joined square rods together using welding to give proper shape
- *Soldering*: Joined steel pipe and flat body using soldering.
- *Filing*: used to remove fine amounts of material.

Steps:

- Take a flat steel strip of 25x5 mm and cut it with appropriate dimensions for individual flat parts. Arc weld the butt joints and T-joints.
- Now using soldering, join the steel rod with the flat body.
- Using file and sandpaper give appropriate shape and size to the fillets.



Central part



Materials used:

- Iron for casting for the upper half, Mild Steel Sheet 2.0 mm for the lower half.
- Thermocol (3 inch & 1 inch), and fevicol
- Sandpaper for thermocol.

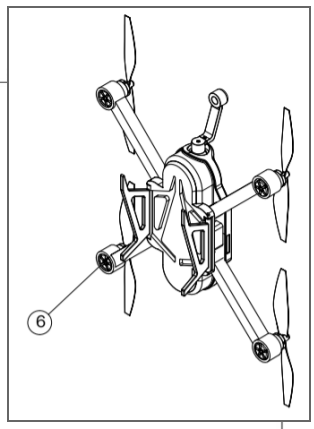
Manufacturing Processes involved:

- *Cutting*: Used cutting of thermocol and steel sheets to make patterns.
- Bending processes for the shaping of steel sheets
- Welding
- *Smoothening*: Thermocol rubbed using sandpaper for surface smoothening
- *Lost Foam Casting*: Used to make the upper part from iron.

Steps:

- The lower central body will be made from steel sheets by cutting them into appropriate dimensions, bending them into desired shapes, and welding them where required.
- For the upper central part, we will use the lost foam casting process to manufacture it.
- Thermocol will be used as a pattern and sandpaper will be used to smoothen the pattern.
- For the final step, the upper and lower central part will be arc welded.

Motor



Materials Required:

- Mild Steel Sheet (0.5 mm thickness)
- Mild Steel Round Rod(3 mm diameter)
- Mild Steel Round Pipe(25 mm diameter)

Manufacturing processes:

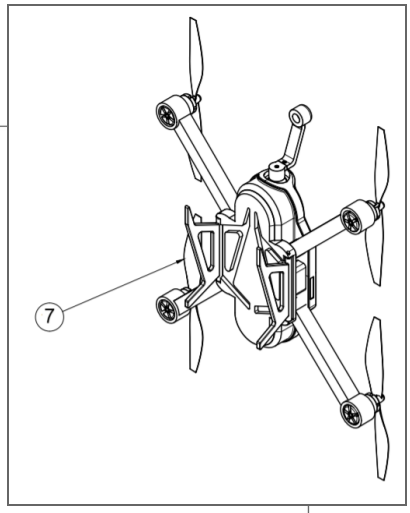
- *Cutting*: Steel sheets have been cut to give proper shape
- *Welding*: To join ends of steel sheet to give cylindrical shape
- *Hammering:* for the appropriate required shape

Steps:

- First of all, a 28 mm long Mild Steel Round Pipe(25 mm diameter) is taken.
- Then a steel sheet of 0.5mm thickness is cut in the given shape.

- The cuttings are then welded to the ends of the steel round pipe.
- For the inner part, a mild steel round rod of length 39.37 mm is taken.Then the copper wire is coiled around it.
- Steel sheets are then hammered to make the other inner parts and all the interior parts are welded to the outer steel pipe.

Propellers



Materials required:

- Steel Sheet(0.5 mm)
- Rivet

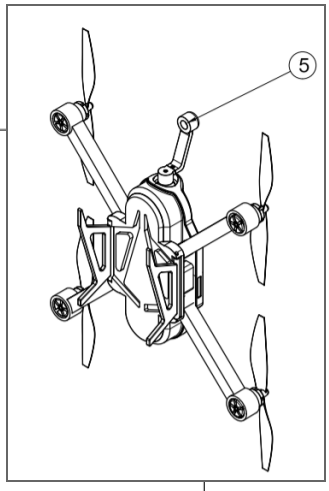
Manufacturing Process:

- Hammering and Cutting of metal sheet
- Riveting at the middle

Steps:

- To make the blades of the fan, a steel sheet of 0.5 mm thickness is cut in the appropriate shape and dimension.
- Both blades are taken together and riveted at the center.

Camera Mount



Materials Required:

- Mild Steel Round Rod 25 mm dia
- Mild Steel Round Pipe 18 mm dia
- Mild Steel flat (25*5)
- Screw

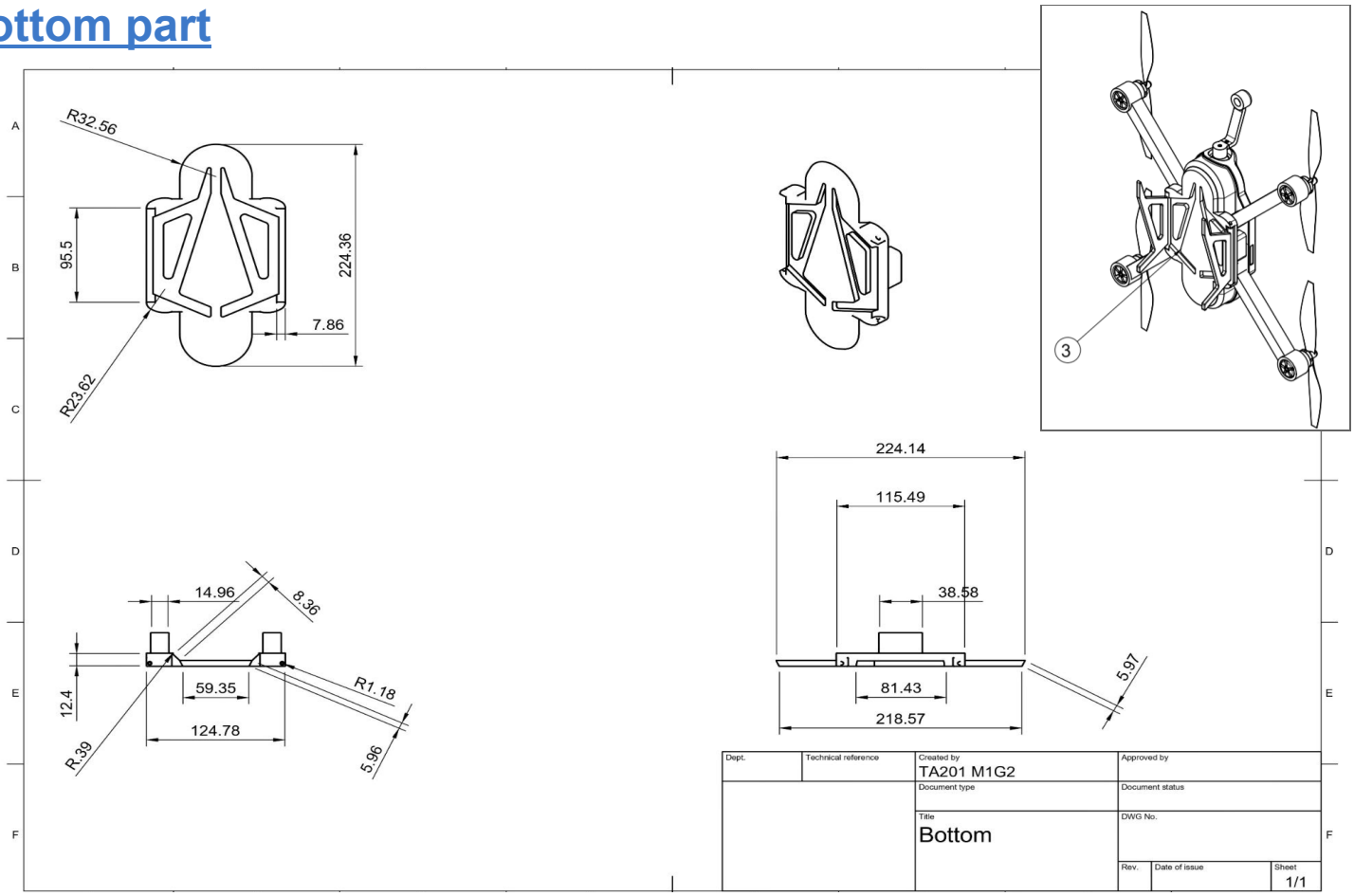
Manufacturing Process:

- *Cutting*: cutting the rod, pipe, and sheet into appropriate dimensions
- *Filing*: the edges to avoid damage or harm through the sharp sheet edges.
- *Hammering and bending*: to bend the rod by an angle of about 110 degrees.
- *Arc Welding*: used to join the cylinders together with the sheet metal
- *Drilling:* to make the slots for the cylindrical part, we can drill out that portion.

Steps:

1. Mild Steel flat is bent using a hammering process at an angle of about 110 degrees for the middle part.
2. For the round part, we will use Mild Steel Round Rod 25 mm dia as the bigger cylinder and then drill out the middle portion for the slot.
3. Mild Steel Round pipe 18 mm dia for the slot in the central drone for the camera.

Bottom part



Materials Required:

- Mild Steel square pipe (15x15 mm)
- Iron for casting.
- Thermocol (3 inch)
- Sandpaper for filing

Manufacturing Process:

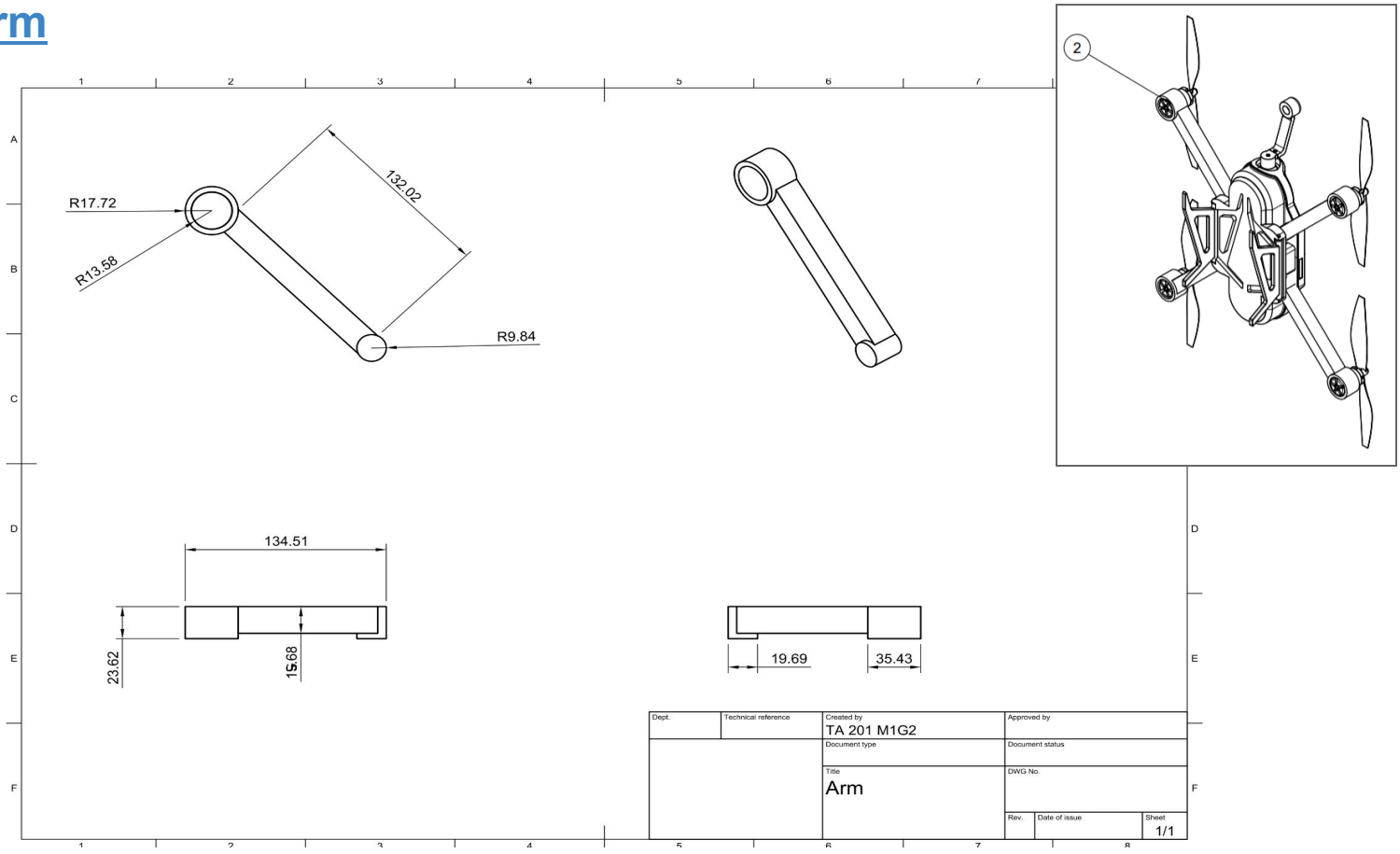
- Cutting: Used to cut the metal sheet to get the desired shape of the bottom part of the drone
- Filing: Used as the finishing operation for the bottom part by removing excess material and deburring the surface

- Arc Welding: Used for joining the square rod on the sheet.
- Lost Foam Casting: Used for casting the bottom part except for the two square support.

Steps:

1. The base of the bottom part will be prepared by the lost foam casting process in which thermocol will be used as a pattern that does not contain the two square supports.
2. After this, the cast product will be filed to remove irregularities in its shapes.
3. We will cut the 15x15 square pipe to the desired length.
4. After this, we are going to attach the two metal square pipes by arc welding with the cast part.
5. Finally to finish our model we are going to do filing to remove the excess material and smoothen it.

Arm



Material used:

- Mild Steel Round Pipe (18mm dia)
- Mild Steel Square Pipe (15x15 mm)
- Mild Steel Round Pipe (18mm radius)

Manufacturing Process:

- *Cutting*: Used cutting of the pipes of desirable lengths
- *Arc Welding*: of the cylindrical pipe with the square pipe
- *Filing*: the welded surface area.

Project Timeline:

Lab turns	Tasks	Date
Lab 2	Idea Discussion	09 Aug
Lab 3	Idea Finalization	16 Aug
Lab 4	Isometric drawing of the assembly with a list of parts and processes	23 Aug
Lab 5	Isometric drawing and engineering drawing of all the parts	06 Aug
Lab 6	A short presentation to the group and final submission	20 Sept
Lab 7	Final Submission	27 Sept

Project timeline, execution plan, and work distribution:

- Discussion on various ideas for our project.
- Finalization of the topic: Drone
- Research on different models of Drone currently existing.
- Discussion and finalization of the details of our model.
- Research on materials required and manufacturing processes involved.
- Preparation of a 3D-CAD model on Autodesk Fusion 360.
- Preparation of the Project Document and the Project Report

Work distribution

Member	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
Diksha	Project Discussion	Worked on oil tank idea with other team members and searched for better ideas	Researched different materials and came up with the most efficient materials for different parts of the project	Discussed the mechanism that helped in doc making and listed the components of the drone.	Worked on all the disassembled components.	Presentation and improvements
Manan	Project Discussion	Worked on gripper ideas with other team members and searched for better ideas.	Worked on the isometric drawings and the materials to be used.	Work on cost analysis, make the doc with other team members.	Worked on basic Idea representation through the doc and made it.	Presentation and improvements
Mihir	Project Discussion	Worked on binoculars idea with other team members and searched for better ideas	Searched about the manufacturing process that can be used in the drone.	Worked on all the disassembled components and the isometric drawings.	Worked on Part A(isometric drawing)and researched the best materials and pricing.	Presentation and improvements
Niranjan	Project Discussion	Worked on archimedean screw the idea with other team members and searched for better ideas	Researched different materials and came up with the most efficient materials for different parts of the project.	Work on cost analysis, make the doc with other team members.	Worked on basic representation through the doc and made it.	Presentation and improvements

Priya	Project Discussion	Worked on the robot hand idea with other team members and searched for better ideas	Made orthographic views of the drone according to discussed dimensions	Worked on basic Idea representation through the doc.	Worked on all the disas--assembled components and the isometric drawings.	Presentation and improvements
Satender	Project Discussion	Worked on vernier caliper idea with other team members and searched for better ideas	Made 3D drawing using Fusion 360. Provided teammates with the proper dimensions.	Discussed the mechanism of foldable stands and helped in drawings of individual parts.	Worked on (isometric drawing)and researched the best materials and pricing for the drone.	Presentation and improvements
Satyansha	Project Discussion	Worked on quadcopter idea with other team members and searched for better ideas	Made orthographic views of oil tanks according to discussed dimensions for the ideal finalization.	Discussed mechanism and the manufacturing processes, made the doc.	Worked on manufacturing processes and isometric drawings. Worked on h the doc and made it.	Presentation and improvements
Vandana	Project Discussion	Worked on folding table idea with other team members and searched for better ideas	Searched about the manufacturing process that can be used in the drone.	Discussed working principle helped in doc making	Worked on all the disassembled components and the isometrics.	Presentation and improvements
Vishal	Project Discussion	Worked on drone ideas with other team members and searched for ideas.	Came up with rough and precise drawings. Provided us the dimensions of the drone.	The mechanism discussed helped in the assembly of drones and doc making.	Worked on all the components and isometric drawings.	Presentation and improvements

Cost Analysis:

	Object	Material	Cost
1	Stand	• Steel pipe (round) (8 mm dia) • Mild Steel Flat 25x5 mm	₹32
2	Middle	• Iron for casting the upper half, • Mild Steel Sheet 2.0 mm for the lower half. • Thermocol (3 inches & 1 inch)	₹255
3	Motor(4x)	• Mild Steel Sheet (0.5 mm thickness) • Mild Steel Round Rod(3 mm dia) • Mild Steel Round Pipe(25 mm dia)	₹16
4	Fan(4x)	• Steel Sheet(0.5 mm) • Rivet	₹6
5	Camera Mount	• Mild Steel Round Rod 25 mm dia • Mild Steel Round Pipe 18 mm dia • Mild Steel flat (25*5) • screw	₹21
6	Bottom Part	• Mild Steel Flat (25x5 mm) x2 • Mild Steel Flat (25x3 mm) • Mild Steel Square pipe (15x15 mm)	₹274
7.	Arm(4x)	• Mild Steel Round Pipe (18mm dia) • Mild Steel Square Pipe (15x15 mm) • Mild Steel Round Pipe (18mm radius)	₹60
8.	Extras	• Thermocol (3 inches) • Fevicol (2x) 14 • Sandpaper (2x) 14 • Rivets • Paints	₹300 (approx)

Total cost **₹964(app.)**

Sustainability and environmental impact analysis:

Steel is a permanent material that can be infinitely recycled and is mostly recyclable without loss of quality. It is one of the most sustainable materials available. It is not only environmentally conscious but economically strategic in its inherent longevity and durability. Steel is the most recycled material in the world. More steel is recycled each year than aluminum, paper, glass, and plastic combined. Every ton of steel produced in 2018 emitted on average 1.85 tons of carbon dioxide, equating to about 8 percent of global carbon dioxide emissions.

Aluminum can be recycled to make the same product, which is why it's considered one of the most valuable items in your recycling bin and ultimately the most recyclable industrial material. Hence, our model uses mostly recyclable materials.

Commercial Uses:

From technically manning sensitive military areas to luring hobbyists throughout the world, drone technology has developed and prospered in the last few years. Individuals, commercial entities, and governments have come to realize that drones have multiple uses, which include:

- Aerial photography for journalism and film
- Express shipping and delivery
- Gathering information or supplying essentials for disaster management
- Geographic mapping of inaccessible terrain and locations
- Building safety inspections
- Precision crop monitoring
- Law enforcement and border control surveillance
- Storm tracking and forecasting hurricanes and tornadoes
- Development of hundreds of more uses of drones are underway due to the multiple investments pouring into this promising industry every day

- Rescue Operations and Healthcare: With the help of thermal sensors, drones can locate lost persons. They are also especially useful at night or even in challenging terrains. Simply put, drones can easily reach places that many humans cannot, and this can be invaluable when timely rescues are critical.

Potential for the future:

Potential future uses in development work includes:

- Delivery of medical supplies
- Search and rescue
- Firefighting (urban and forest fires)
- Radiological, atmospheric, and environmental sensing
- Agriculture (data collection and crop management)
- Internet connectivity in rural and remote areas (through a perpetually airborne network of UAVs)
- Meteorology (re-usable airborne weather sensors mounted on UAVs could be a lot more efficient than the disposable balloon equipment used today)
- Humanitarian operations

Conclusion:

Getting motivated with the recent article published in the news in July regarding “6 best drones for beginners in 2021, according to experts”, we worked on this quadcopter project. While working on this project, we were able to enhance our creativity and design skills. Along with this, we got the opportunity of studying the working and design principles. Being a commercially friendly model, this model is environment friendly and has a lot of scopes to be worked upon in the future, hence supporting its increasing uses in the modern world including photography, medical, agricultural, military, and all sorts of uses. With this project, we now have a better understanding of the various manufacturing techniques taught to us in the lab in the form of a design project. Our idea of a drone can be fabricated in the lab using materials available in the lab.

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THANK YOU!!

Remarks & Comments!!