# Team A2

# Design and Build a Wind Turbine Experimental Test Rig


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TUS


## Aim of the Project

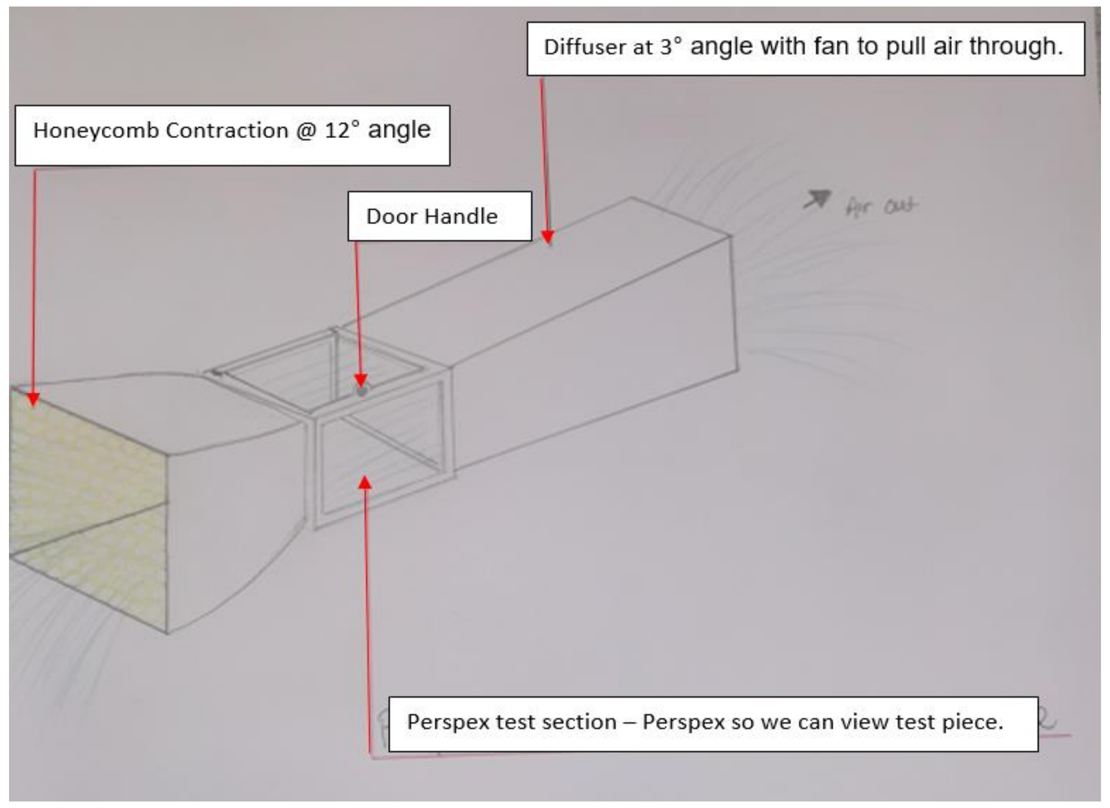
The aim of the project is to research, design and build a wind turbine experimental test rig that can be used by the college in labs in future

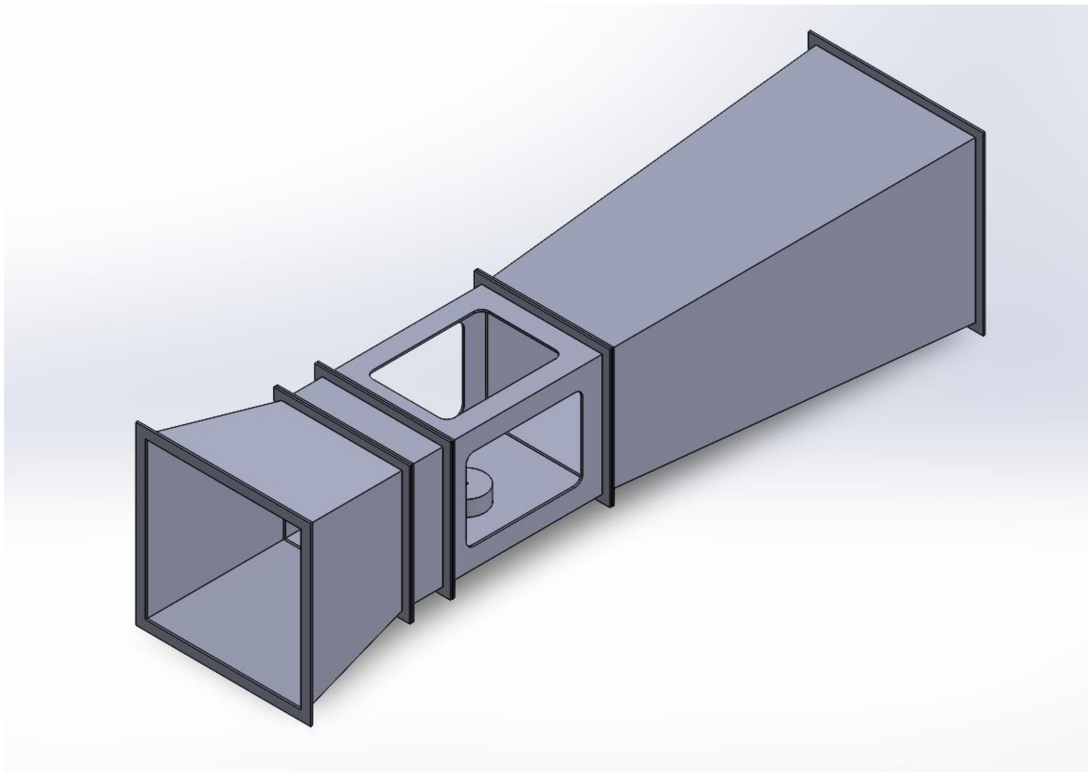
## Background

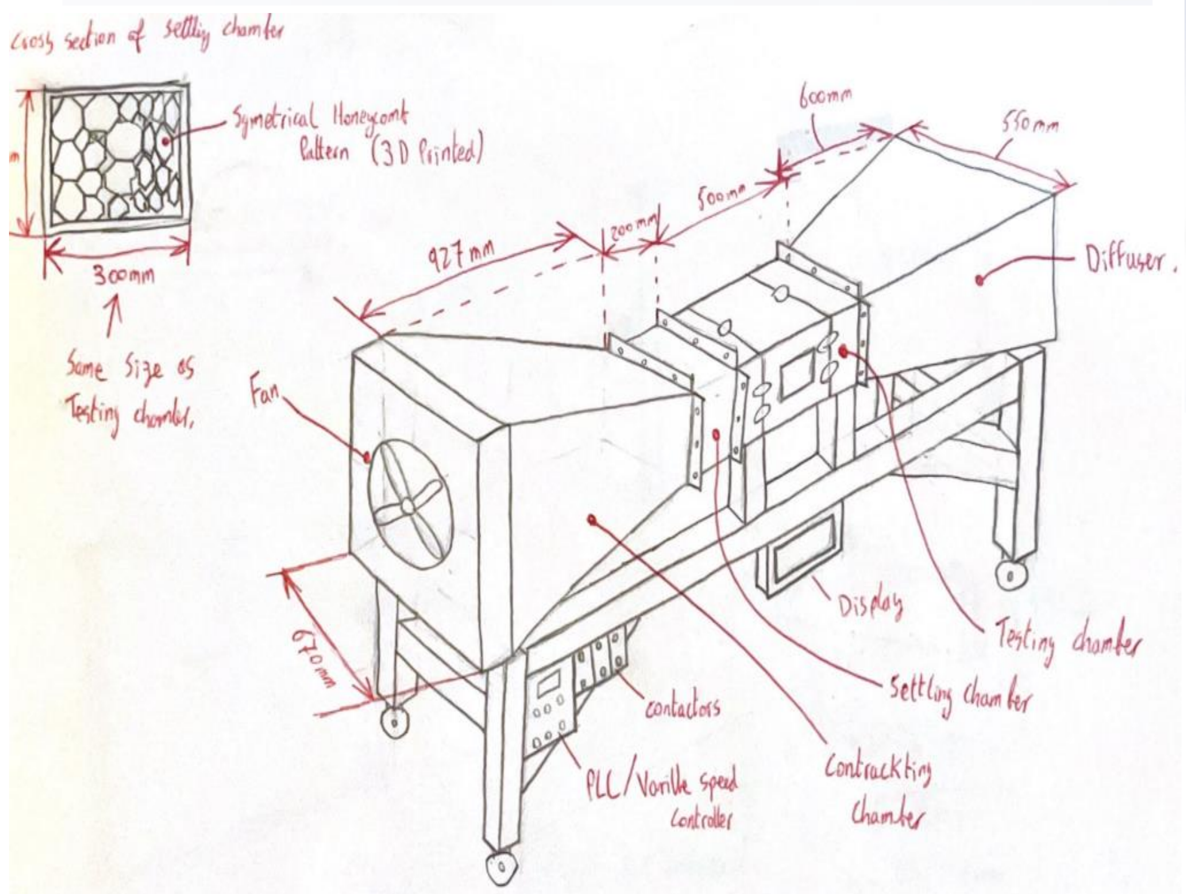
Wind tunnels are devices used to test aerodynamic components in a controlled environment under a variety of conditions. The man credited with the invention of the first wind tunnel was a council member of the Aeronautical Society of Great Britain called Frank H Wenham. He created his first wind tunnel in 1871 after experiencing limitations with the earlier aerodynamic test apparatus the whirling arm. Wind tunnels are used to assess a variety of objects ranging from simple aerofoils to the like of jet aircraft and formula one cars. The design of wind tunnels is varied, and they have a wide range of sizes possible, from less than 300mm in width up to thirty metres depending on the size of the test specimen.

A wind turbine is a machine that will turn kinetic energy received from the wind and turn it into electricity. The rotors on a turbine will typically rotate between 13 and 20 rpm depending on variables like wind speed, design of the rotors and condition of the wind turbine (acciona, 2020).There are two main types of wind Turbines, these being the widely known Horizontal axis wind turbines (HAWTs) and the Vertical Axis Wind Turbines (VAWTs). The most commonly used type of wind turbine and the one you would think of when the word wind turbine comes to mind, is the Horizontal Axis Wind Turbine and there are two main types, upwind and downwind, what this means is that the blades are either facing into or away from the direction that the wind is traveling. With HAWTs the direction that the rotor is facing is critical otherwise there will not be an equal amount of force distributed across the blades, the wind direction is picked up by a senor on the turbine and the whole upper assembly of the turbine will turn to face the wind accordingly (Ramzy, 2023).The Vertical Axis Wind Turbine is used much less frequently as there is inherently less efficiency due to the design of the rotor, the main strongpoint of this design is also its downfall, VAWTs do not need the wind blowing in one direction as the design of the blades allow the force from the wind to be evenly distributed across the blades regardless of wind direction. But this also creates a problem of increased drag on the rotor which in turn means less efficiency. The VAWTs ability to rotate when the wind is constantly changing directions means that the turbine will constantly produce power. The way that VAWTs work is that there is always a Blade facing the wind that will "catch" the wind creating more drag than the other blades combined which means it can then turn in that direction (Ramzy, 2023).

## Concept designs






## Calculations

Contraction Chamber:
To find area of opening:
We have:
Area of test chamber: $0.09m^2$
Contraction ratio: N = 5

$$N = \frac{A1}{A2}$$

$$A1 = N.A2$$

$$A1 = (5)(0.09)$$

$$A1 = 0.45m^2$$

Now find Length by width:

$$\sqrt{0.45} = L\ or\ Width$$

$$L = 0.67082m$$
$$L = 671mm$$

With a chosen contraction ratio of 5 for good quality air flow. (N = 5)

$$tan\Theta = \frac{opp}{aj}$$
$$\Theta = tan^{-1}(\tfrac{1}{5})$$
$$\Theta = 11.31°$$

Then length of contraction chamber needs to be calculated:
Where length of small side:

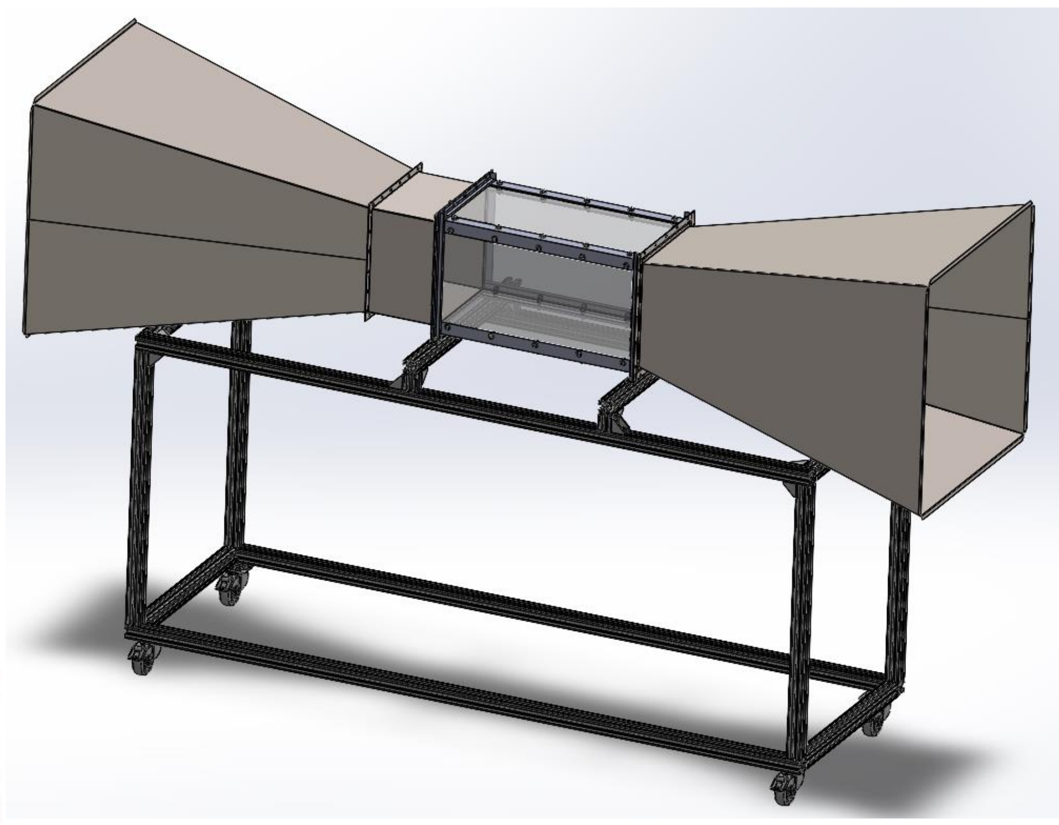
$$L = \frac{0.6708}{2} - \frac{0.3}{2}$$
$$L = 0.18541$$

Then use tan to find length of opposite:

$$\tan 78.69 = \frac{opp}{L}$$
$$opp = 0.18541 \tan 78.69$$

$$opp = 0.9270\ m = 927mm$$

## Final Design



Under the concept design heading you can see the natural progression that helped us come to our final design. The first two concepts were essentially the team brainstorming ideas after doing research into the typical parts and construction of wind tunnels. Once we had figured out the direction of the design the designer done a final concept sketch and then began doing up a solid-works assembly. Once manufactured the design will incorporate Variable speed fans, and the velocity and pressures will be readable, using a digital monometer.

## Conclusion

- Aim of project was to Design and Manufacture a wind turbine experimental rest rig.
- All designs were based on a Testing chamber volume of $0.09m^2$.
- Objective 1: Research wind turbines in particular Vertical Axis Wind Turbines (VAWT's) and research equipment required for the rig.
- Design a table-top experimental rig for the current wind turbine. Complete design process must be adhered to including 3 concept designs which include clear dimensions with an associated material of construction.
- Research and carry out theoretical calculations.
- This process started with three sketched ideas.
- CAD parts were modelled and assembled using Solid-works Sheetmetal and Weldments features.
- CAD drawings were completed with Sheet-metal developments, bend tables and weldments cutting lists.
- All parts were assembled, and slight adjustments made where necessary.
- The team functioned well together and divided the work evenly between all members over the body of the project

## Acknowledgements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