MES MECHATHON 2025: Portable Wind Turbine Challenge

1. Introduction

This year, the MES Mechathon will focus on the intersection of sustainability and engineering innovation. Participants will ***design and build portable wind turbines***, using their creativity and engineering expertise to develop solutions that harness renewable energy. This competition will challenge your understanding of aerodynamics, structural design, and energy generation.

The goal is simple: to design and build a wind turbine that generates the highest power output under specified testing conditions (see *Figure 1* for examples).

Figure 1. General illustrations of what wind turbine designs might look like.

2. The Task

2.1 Overview

Each team will design, construct, and test a portable wind turbine capable of generating electrical power. The turbines will be evaluated based on their power output, efficiency, design innovation, and overall presentation.

2.2 Materials Provided

- 1 3mm brass rod
- 1 Wind Turbine Generator with wires.
    - *Find specifications here*
- Access to MechSpace 3D printers (maximum 2 hours/day).
- Acrylic sheets (300mm x 600mm x 3mm).
- Plywood sheets (300mm x 600mm x 3mm).
    - **Each team is restricted to two sheets of Plywood.**
- Screws, nuts, bolts, and basic fasteners.

- Access to standard MechSpace hand tools and adhesives.
- Access to a wind tunnel for testing (see Figure 3)

2.3 Additional Materials

Teams may bring their own materials; however, all external materials must pass safety inspections by MechSpace mentors. Pre-manufactured wind turbine blades or airfoils are strictly prohibited.

3. Constraints and Rules

3.1 Design Constraints

- The turbine must fit within a 210 x 210 x 210 mm Space (see Figure 3).
- Only one Generator is allowed per turbine.
- The turbine must be free-standing and stable during testing.
- All components must be powered solely by wind energy; no external power sources or energy storage devices are permitted.
- Blades must not use metal or other potentially hazardous materials (e.g., sharp edges).

3.2 Gearbox and Belt Drives

While building a gearbox or a belt drive can be challenging, it can also greatly increase the power output of your wind turbine. Belt drives or gears, as shown in Figure 2, can give your wind turbine a mechanical advantage and multiply the mechanical force of the turning blades.

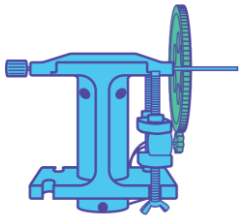

Figure 2. Gearbox design.

3.3 Testing Conditions

The Test Rig used will be a wind tunnel that is like the one in Figure 3.

- Wind turbines will be tested in a wind tunnel with a provided 210 x 210 x 210mm Space with a wind speed of free stream velocity of 3.85 m/s and a flow velocity of 5.7 m/s in the space.
- The allocated space will have high velocity, low pressure with linear flow.
- The wires at the base of your turbine will be attached to a circuit with a 30-ohm resistor in series and will measure voltage.
- Each team will have up to 3 test attempts, with the highest power output recorded as the result.

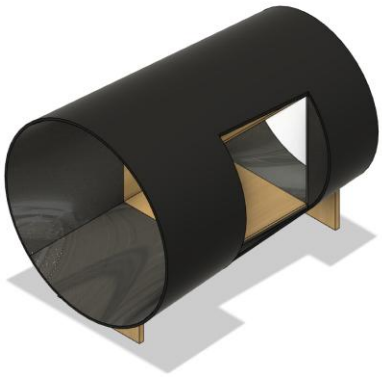

Figure 3. The wind tunnel (Test Rig) that will be used to test the wind turbine designs.

3.4 Safety Rules

- All designs must pass a safety inspection prior to testing.
- Turbines must be securely mounted to avoid tipping or instability during operation.
- Judges reserve the right to disqualify turbines deemed unsafe.

4. Performance Criteria, Deliverables, and Points Systems

4.1 Wind Turbine Performance Criteria

The power output is measured across a 30-ohm resistor using a multimeter. Two quantitative performance criteria are used.

(a) Power Output: Equation (1) is used to calculate the power generated by each design, where V is the voltage.

$$P_{turbine} = \frac{V^2}{R}\ [W] \tag{1}$$

(b) Turbine Efficiency: The ratio of the power generated from the turbine to the maximum available power. Equation (2) is used; The blade swept area is equal to πr^2, where r is the radius of the turbine blades, air density is approximated as $1.23\ kgm^{-3}$, and v is the air speed from the fan.

$$\eta_{turbine}\ (\%) = \frac{P_{turbine}}{0.5 * \pi r^2 * 1.23 * v^3} \times\ 100 \tag{2}$$

4.2 Deliverables (Submission Requirements)

Teams must submit the following by **12:00 PM on Sunday, January 26th**:

1. Wind Turbine for safety and legality inspections.
2. CAD models of the turbine (submitted via email to hovan.cheung.23@ucl.ac.uk, as a '.step' file, with the naming convention: TEAMNUMBER-CAD-2025).

4.3 Points Systems

Teams will be ranked using the following three categories:

1. Power output (50%) – Measured using Equation (1)
2. Turbine efficiency (30%) – Measured using Equation (2)
3. CAD Model (20%) – Accuracy and detail of CAD Model.

For each category, **10 points** is awarded to 1st place, **8 points** is awarded to 2nd place, and **5 points** is awarded to 3rd place. The weighting of each category is as follows: 50% for power output, 30% for turbine efficiency, and 20% for CAD model.

5. Competition Format

5.1 Timeline

Friday, January 24th:

- Begins at 4:00 PM from MechSpace.
- Allocate teams and receive the design brief.
- Teams may begin collecting material and prototyping immediately.

Saturday, January 25th:

- Teams have access to MechSpace from 10:30 to 18:00 to design, build, and test their design.
- Free lunch will be provided for all teams between 13:00 – 14:00.

Sunday, January 26th

- Final testing and submission of deliverables by 12:00 PM.
- Snacks and Drinks before competition
- Competition begins at 14:00.
- Prize & Awards ceremony.

6. Awards

FREE AUTODESK MERCH will be up for grabs: Bottles, Hoodies, T-Shirts, and more.

- **1st Place**: Gift cards, guaranteed tickets to the annual MES Karting event, LinkedIn recommendations.
- **2nd Place**: Lego set, guaranteed tickets to the annual MES Paintball event, and LinkedIn recommendations.
- **3rd Place**: LinkedIn recommendations.

8. General Notes

- Collaboration and teamwork are essential for success. Divide roles effectively within your team. Teams were allocated to ensure they are equal in expertise.
- For any guidance, there will be MES members and MechSpace mentors available to help in MechSpace.
- Above all, have fun and use this opportunity to learn!

Good luck to all participants!

MES Committee