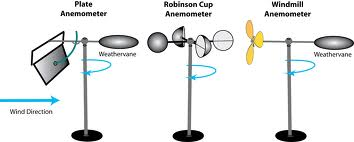
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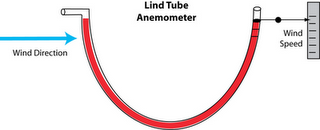
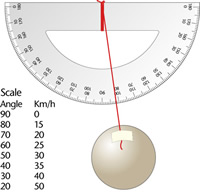
**Design an Anemometer**

A WebQuest PBL for 11th Grade (Pre-Engineering Tech 2)

Designed by

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**Introduction**

This project, to design and construct an anemometer, is the first in a sequence of projects we will construct that explore air and wind, and their effects on flight. Air is a gas, yet it acts like a fluid. It has mass, velocity, and direction. Get a large enough mass of air moving at a high enough velocity, and the force it produces will level a city! To a much smaller degree, this force is what must be compensated for when launching our rockets; what gives lift to our gliders and airplanes; and what pushes against our kites to make them fly. So, before attempting to build and test these flying machines, we need to better understand what we’re dealing with. We will do this by observing, collecting, and analyzing data produced by this invisible force as it spins the blades or cups on an anemometer.

The purpose of this assignment, then, is to answer the following question:

**What sort of device can we design and construct that will accurately measure the force and speed of the wind here at our school in the 95821 area?**

**The Task**

* Research anemometers online. Decide upon the form it will take.
* Determine materials needed for construction.
* Design the anemometer to be built on a sheet of graph paper.
* Complete the Engineering Design Process (EDP) sheet (ongoing).
* Construct the anemometer with the proper materials and according to your design.
* Test your anemometer at various wind speeds and over time on different days.
* Develop a mathematical formula to calculate wind speed in miles per hour.
* Prepare and deliver an oral presentation.

**The Process**

1. Select a partner to form teams of two.
2. Determine the type and size of anemometer to be constructed. If unsure as to what is available, do some internet research to find out more. The key is for your design to **minimize drag** and **friction.** Here are some helpful sites that might help to get you and your partner started:

<http://www.salemclock.com/weather/anemometers.htm>

<http://excelmathmike.blogspot.com/2009/11/answer-is-blowin-in-wind.html>

<http://weather.thefuntimesguide.com/2010/12/anemometer.php>

1. Determine the materials you will need to construct your anemometer. **Remember**: the anemometer **must** survive for a minimum of three weeks, and not break apart in up to 15 mph winds, so the materials and connections should be **durable**. These should include but are not limited to: wind cups or plates, crossbar, stand, stand support, pivot (very important!), and connective material (adhesive). Record this information here:

Wind cups \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Crossbar \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Stand \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Stand support \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Pivot \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Connective material \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Check with me and receive the go ahead to begin construction of the anemometer. \_\_\_\_\_

1. Create a technical illustration of the device. Be sure to maintain proper scale, and clearly dimension and label each part. Create a detailed drawing of the pivot, and describe using text with leaders any modifications you might have made to minimize drag and friction. You may use AutoCAD, or pencil and paper. The sketch may be either in isometric view, or an orthographic multiview (top and front).
2. Complete the EDP (Engineering Design Process) sheet. (shown below)

**Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Score:\_\_\_\_\_\_**

**(EDP) Engineering Design Process**

**Project: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

***\* Take as much space as you need to completely address each step of the EDP\****

1) Identification of a Need (“How can we build / design a …?”; *state in the form of a question*; be general)

2) Possible Solutions (“We can do this by…”; state in the form of a *multiple* choice answer; be creative)

3) Search for Information (internet, teachers, experts, fellow students, etc.; *cite your sites*)

4) Criteria and Constraints (list *any and all* things which might effect the project’s solution; how do the specifics of the project limit the possible solutions listed above)

5) Probable Solutions (*Several* realistic solutions based on constraints)

6) Analysis of Solutions (List *pros* and *cons* of probable solutions)

**Pros** **Cons**

- -

7) Decision (*Which solution is best, and why*; be clear and descriptive; write as sentence)

1. Specifications (What are the specific dimensions and features?; attach a sketch)
2. Construct the anemometer out of the predetermined materials, and build it to the specifications detailed in your technical illustration. This will take several days. If you make changes in the design during the construction process make sure they are cited in your EDP and noted on your plans. Revisions are always okay, in fact, they are encouraged!
3. Perform a controlled test of your anemometer at 5, 10, and 15 miles per hour. This should be done with your partner or parent. **Do not attempt this alone!** One of you should drive a car, observing time and velocity, while the other holds the anemometer out the window and counts the revolutions. Any possible errors in the data collected should be noted in the EDP. **Be safe!**
4. Develop a mathematical formula to convert rotations per minute (your anemometer) to miles per hour. Verify your data with www.wunderground.com. Remember: your anemometer will not be a perfect measuring device by itself. However, your formula can adjust for errors and be mathematically accurate. Your formula will need an error multiplier to account for the margin of error.
5. As a class we will place our completed anemometers on the top of the S-Wing bathrooms. After your anemometer has been carefully placed, perform your first timed test. One partner should be the timer (10, 15, 30 or 60 seconds). The other should count the revolutions (or observe some other wind indicator) depending upon the type of anemometer constructed. Record the data below. You will record this data at least three times a week for three weeks.

DATE REV. / MIN MPH DATE REV./MIN MPH

1. \_\_\_\_\_\_ \_\_\_\_\_\_ \_\_5\_\_\_ 7. \_\_\_\_\_\_ \_\_\_\_\_\_ \_\_\_\_\_\_

2. \_\_\_\_\_\_ \_\_\_\_\_\_ \_\_10\_\_ 8. \_\_\_\_\_\_ \_\_\_\_\_\_ \_\_\_\_\_\_

3. \_\_\_\_\_\_ \_\_\_\_\_\_ \_\_15\_\_ 9. \_\_\_\_\_\_ \_\_\_\_\_\_ \_\_\_\_\_\_

4. \_\_\_\_\_\_ \_\_\_\_\_\_ \_\_\_\_\_\_ 10. \_\_\_\_\_\_ \_\_\_\_\_\_ \_\_\_\_\_\_

5. \_\_\_\_\_\_ \_\_\_\_\_\_ \_\_\_\_\_\_ 11. \_\_\_\_\_\_ \_\_\_\_\_\_ \_\_\_\_\_\_

6. \_\_\_\_\_\_ \_\_\_\_\_\_ \_\_\_\_\_\_ 12. \_\_\_\_\_\_ \_\_\_\_\_\_ \_\_\_\_\_\_

1. Go to Weather Underground (<http://www.wunderground.com>) to verify your data. Type in our local zip code (95821) and see what the officially recorded wind speed currently is. How does your data match up? Why might it be different? As time goes on over the next three weeks your data might become more and more irregular. What factors might be contributing to that? Record any observations in your EDP.
2. Present your fully designed and tested anemometer to the class in an oral presentation. You will be evaluated on **voice quality** (volume and pronunciation), **eye contact** (with audience, doesn’t read from aids), **professional attitude** (on topic, proper use of technology), **thoroughness of presentation** (do you cover all the outlined points on the EDP), **accuracy of analysis** (adequate explanation of design features, and shows careful consideration of constraints), and **effectiveness of solution** (does it work?). This part of the project is worth 25 points. See grading rubric below:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |
|  | **Clarity of Voice** | **Eye Contact** | **Professional** | **Thoroughness** | **Analysis** | **Reasoned** |
|  |  |  | **Attitude** |  |  | **Solution** |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| ***Presenter…*** | speaks loudly enough | maintains eye contact with audience | stays on topic | covers all speaking points on the EDP (Search, Constraints, Analysis, Decision) | provides adequate support for all design decisions | presents an adequately reasoned solution based on research analysis, and demonstration |
|  |  |  |  |  |  |  |
|  | pronounces all words correctly | does not read from screen or notes | utilizes technology properly |  | shows proper consideration of the criteria and constraints in their project | displays a completed product or project and operational |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| Always (4) |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| Usually (3) |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| Sometimes (2) |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| Rarely (1) |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| Never (0) |  |  |  |  |  |  |

**Evaluation**

# You will be evaluated as a team using the following rubric. This part of the project is worth 50 points.

# A– Mastery (10)

* Wind cups and crossbars are accurately shaped, sized, and balanced. \_\_\_\_\_
* Finished anemometer matches sketch, and sketch is completely labeled. \_\_\_\_\_
* Anemometer stands on its own. \_\_\_\_\_
* Crossbars and wind cups spin in very light wind, and do not fall off. \_\_\_\_\_
* The finished anemometer is operational for three weeks. \_\_\_\_\_

# B – Competent (9)

* Wind cups and crossbars are almost accurately shaped, sized, and balanced. \_\_\_\_\_
* Finished anemometer almost matches sketch, and sketch is completely labeled. \_\_\_\_\_
* Anemometer leans to one side or is unbalanced. \_\_\_\_\_
* Crossbars and wind cups spin slowly (friction), but do not fall off. \_\_\_\_\_
* The anemometer is operational over a week in a row, but less than three weeks \_\_\_\_\_

# C – Average (8)

* Wind cups and crossbars are slightly misshaped, sized, or balanced. \_\_\_\_\_
* Finished anemometer doesn’t match sketch, or sketch is incompletely labeled. \_\_\_\_\_
* Anemometer leans severely to one side, or is loose or unstable. \_\_\_\_\_
* Crossbars and wind cups spin very slowly (too much friction), but do not fall off. \_\_\_\_\_
* The anemometer is operational, but only for a day or two in a row. \_\_\_\_\_

# D – Emerging (7)

* Wind cups and crossbars are not accurately shaped, sized, or balanced. \_\_\_\_\_
* Finished anemometer does not match sketch, and sketch is incompletely labeled. \_\_\_\_\_
* Anemometer does not stand up, or frequently blows over. \_\_\_\_\_
* Crossbars and wind cups don’t spin, break, or fall off. \_\_\_\_\_
* The anemometer is not operational for even a day at a time. \_\_\_\_\_

# F – No Attempt \_\_\_\_\_\_

**Conclusion**

Congratulations! As a result of completing this anemometer project you have accomplished the first step in our larger study of aerospace engineering and flight. You should now be able to measure the current wind velocity at our school with a high degree of accuracy. Below I have included the Beaufort Scale – a visual scale of approximating the speed of the wind. How close is it to the measurements you observe on your anemometer?

**Beaufort Scale**

* **Calm**: *Less than 1 MPH*; Smoke rises vertically
* **Light Air**: *1 to 3 MPH*; wind vanes may not move, but smoke will drift in the direction of the wind
* **Light Breeze**: *4 to 7 MPH*; Leaves rustle
* **Gentle Breeze**: *8 to 12 MPH*; Leaves and small twigs move
* **Moderate Breeze**: *13 to 17 MPH*; Small branches move
* **Fresh Breeze**: *18 to 24 MPH*; Small, leafy trees sway
* **Strong Breeze**: *25 to 30 MPH*; Large branches move and wind whistles around utility wires
* **Moderate Gale**: *31 to 38 MPH*; Whole trees move in the wind
* **Gale**: *39 to 46 MPH*; Twigs break off trees
* **Strong Gale**: *47 to 54 MPH*; Branches break off trees and small trees topple
* **Whole Gale**: *55 to 63 MPH*; Trees are uprooted and some shingles come off roofs
* **Violent Storm**: *64 to 72 MPH*; Trees and plants suffer destruction and roofs are damaged
* **Hurricane Force**: *73 MPH or greater*; Windows break and mobile homes and other small structures are damaged or destroyed.

Our next assignment will be to design a kite that will be able to fly in the wind we experience here at school. Here are some things to consider as we move into the new project.

- What kind of shape makes the best kites?

- What kind of materials might be best to use in its construction?

- What is the relationship between the surface area of your kite and its weight?

**Credits & References**

Thanks to [www.wunderground](http://www.wunderground) for its consistent recording of local weather data.

Thanks to Excel Math at <http://excelmathmike.blogspot.com> for the images I used in this WebQuest. This is an excellent site to look at if you want to know more about anemometers and survey what other types of anemometers exist.

Last updated on November 29, 1999. Based on a template from [The WebQuest Page](http://edweb.sdsu.edu/webquest/webquest.html)