The Wind

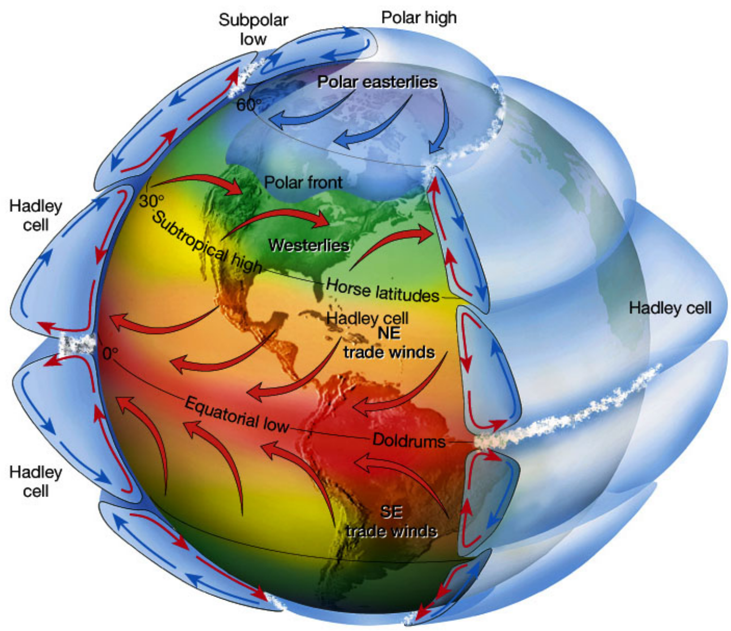
Wind is the flow of gases on a large scale. On the surface of the Earth, wind consists of the bulk movement of air. In outer space, solar wind is the movement of gases or charged particles from the Sun through space, while planetary wind is the outgassing of light chemical elements from a planet's atmosphere into space.

Winds are commonly classified by their spatial scale, their speed, the types of forces that cause them, the regions in which they occur, and their effect. The strongest observed winds on a planet in the Solar System occur on Neptune and Saturn. Winds have various aspects, an important one being its velocity; another one, the density of the gas involved; another one, its energy content or wind energy.

In meteorology, winds are often referred to according to their strength, and the direction from which the wind is blowing. Short bursts of high speed wind are termed gusts. Strong winds of intermediate duration (around one minute) are termed squalls. Long-duration winds have various names associated with their average strength, such as breeze, gale, storm, and hurricane. Wind occurs on a range of scales, from thunderstorm flows lasting tens of minutes, to local breezes generated by heating of land surfaces and lasting a few hours, to global winds resulting from the difference in absorption of solar energy between the climate zones on Earth.

The two main causes of large-scale atmospheric circulation are the differential heating between the equator and the poles, and the rotation of the planet (Coriolis

Effect). Within the tropics, thermal low circulations over terrain and high plateaus can drive monsoon circulations. In coastal areas the sea breeze/land breeze cycle can define local winds; in areas that have variable terrain, mountain and valley breezes can dominate local winds.

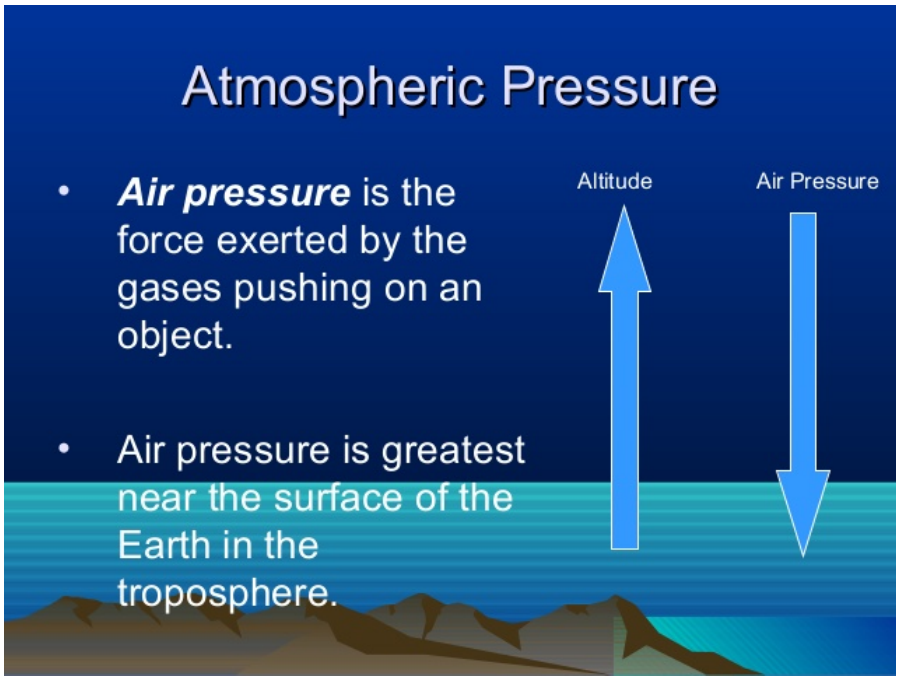


In human civilization, wind has inspired mythology, influenced the events of history, expanded the range of transport and warfare, and provided a power source for mechanical work, electricity and recreation. Wind powers the voyages of sailing ships across Earth's oceans. Hot air balloons use the wind to take short trips, and powered flight uses it to increase lift and reduce fuel consumption. Areas of wind shear caused by va rious weather phenomena can lead to dangerous situations for aircraft. When winds become strong, trees and man-made structures are damaged or destroyed.

Winds can shape landforms, via a variety of Aeolian processes such as the formation of fe rtile soils, such as loess, and by erosion. Dust from large deserts can be moved great distances from its source region by the prevailing winds; winds that are accelerated by rou gh topography and associated with dust outbreaks have been assigned regional names in various parts of the world because of their significant effects on those regions. Wind also affects the spread of wildfires. Winds can disperse seeds from various plants, enabling the survival and dispersal of those plant species, as well as flying insect populations. When combined with cold temperatures, wind has a negative impact on livestock. Wind affects animals' food stores, as well as their hunting and defensive strategies.

Causes of wind

Wind is caused by differences in the atmospheric pressure. When a difference in atmospheric pressure exists, air moves from the higher to the lower pressure area, resulting in winds of various speeds. On a rotating planet, air will also be deflected by the Coriolis Effect, except exactly on the equator. Globally, the two major driving factors of large-scale wind patterns (the atmospheric circulation) are the differential heating between the equator and the poles (difference in absorption of solar energy leading to buoyancy forces) and the rotation of the planet. Outside the tropics and aloft from frictional effects of the surface, the large-scale winds tend to approach geostrophic balance. Near the Earth's surface, friction causes the wind to be slower than it would be otherwise. Surface friction also causes winds to blow more inward into low pressure areas. A new, controversial theory suggests atmospheric gradients are caused by forest induced water condensation resulting in a positive feedback cycle of forests drawing moist air from the coastline.



Winds defined by equilibrium of physical forces are used in the decomposition and analysis of wind profiles. They are useful for si mplifying the atmospheric equations of m otion and for making qualitative arguments about the horizontal and vertical distribution of winds. The geostrophic wind component is the result of the balance between Coriolis force and pressure gradient force. It flows

parallel to isobars and approximates the flow above the atmospheric boundary layer in the midlati tudes. The thermal wind is the *difference* in the geostrophic wind between two levels in the atmosphere. It exists only in an atmosphere with horizontal temperature gradients. The ageostrophic wind component is the difference between actual and geostrophic wind, which is responsible for air "filling up" cyclones over time. The gradient wind is similar to the geostrophic wind but also includes centrifugal force (or centripetal acceleration).

Measurements

Wind direction is usually expressed in terms of the direction from which it originates. For example, a *northerly* wind blows from the north to the south. Weather vanes pivot to indicate the direction of the wind. At airports, windsocks indicate wind direction, and can also be used to estimate wind speed by the angle of hang. Wind speed is measured by anemometers, most commonly using rotating cups or propellers. When a high measurement frequency is needed (such as in research applications), wind can be measured by the propagation speed of ultrasound signals or by the effect of ventilation on the resistance of a heated wire. Another type of anemometer uses pitot tubes that take advantage of the pressure differential between an inner tube and an outer tube that is exposed to the wind to determine the dynamic pressure, which is then used to compute the wind speed.

Sustained wind speeds are reported globally at a 10 meters (33 ft.) height and are averaged over a 10-minute time frame. The United States reports winds over a 1-minute average for tropical cyclones, and a 2-minute average within weather observations. India typically reports winds over a 3-minute average. Knowing the wind sampling average is important, as the value of a one-minute sustained wind is typically 14% greater than a ten-minute sustained wind. A short burst of high speed wind is termed a wind gust, one technical definition of a wind gust is: the maxima that exceed the lowest wind speed measured during a ten-minute time interval by 10 knots (19 km/h). A squall is a doubling of the wind speed above a certain threshold, which lasts for a minute or more.

To determine winds aloft, rawinsondes determine wind speed by GPS, radio navigation, or radar tracking of the probe. Alternatively, movement of the parent weather balloon position can be tracked from the ground visually using theodolites. Remote sensing techniques for wind include SODAR, Doppler lidars and radars, which can measure the Doppler shift of electromagnetic radiation scattered or reflected off suspended aerosols or molecules, and radiometers and radars can be used to measure the surface roughness of the ocean from space or airplanes. Ocean roughness can be used to estimate wind velocity close to the sea surface over oceans. Geostationary satellite imagery can be used to estimate the winds throughout the atmosphere based upon how far clouds move from one image to the next. Wind engineering describes the study of the effects of the wind on the built environment, including buildings, bridges and other man-made objects.

Wind power

Wind energy is the kinetic energy of the air in motion. The kinetic energy of a packet of air of mass m with velocity v is given by ½ $m\ v^2$. To find the mass of the packet passing through an area A perpendicular its velocity (which could be the rotor area of a turbine), we multiply its volume after time t has passed with the air density ρ, which gives us $m = A\ v\ t\ \rho$. So, we find that the total wind energy is:

$$E = \frac{1}{2}\rho A v^3 t$$

Differentiating with respect to time to find the rate of increase of energy, we find that the total wind power is:

$$P = dE/dt = \frac{1}{2}\rho A v^3$$

Wind power is thus proportional to the third power of the wind velocity.

Theoretical power captured by a wind turbine

Total wind power could be captured only if the wind velocity is reduced to zero. In a realistic wind turbine this is impossible, as the captured air must also leave the turbine. A relation between the input and output wind velocity must be considered. Using the concept of stream tube, the maximal achievable extraction of wind power by a wind turbine is 59% of the total theoretical wind power.

Practical wind turbine power

Further insufficiencies, such as rotor blade friction and drag, gearbox losses, generator and converter losses, reduce the power delivered by a wind turbine. The basic relation that the turbine power is (approximately) proportional to the third power of velocity remains.

Average wind speeds

As described earlier, prevailing and local winds are not spread evenly across the earth, which means that wind speeds also differ by region. In addition, the wind speed also increases with the altitude.

Wind power density

Nowadays, a yardstick used to determine the best locations for wind energy development is referred to as wind power density (WPD). It is a calculation relating to the effective force of the wind at a particular location, frequently expressed in terms of the elevation above ground level over a period of time. It takes into account wind velocity and mass. Color coded maps are prepared for a particular area are described as, for example, "Mean annual power density at 50 meters." The results of the above calculation are included in an index developed by the National Renewable Energy Lab and referred to as "NREL CLASS." The larger the WPD calculation, the higher it i s rated by class. At the end of 2008, worldwide nameplate capacity of wind-powered generators was 120.8 gigawatts. Although wind produced only about 1.5% of worldwide electricity used in 2009, it is growing rapidly, having doubled in the three years between 2005 a nd 2008. In s everal countries it has achieved relatively high levels of penetration, accounting for approximately 19% of electricity production in Denmark, 10% in Spain and Portugal, and 7% in Germany and the Republic of I reland in 2008. One study indicates that an entirely renewable energy supply based on 70% wind is attainable at today's power prices by linking wind farms with an HVDC supergrid. Wind power has expanded quickly; its share of worldwide electricity usage at the end of 2014 was 3.1%.

Next, we will present how the power of winds can help you juice more power from The Cold War Generator.

EXTRA WIND SPINS

Wind power is one of the most efficient sources of energy. By capturing the wind power you will increase the RPMs of the Cold War Generator and you will have more power to feed back into the grid.

Next, we will present the step by step instructions to build the blades that will provide the extra spin for the generator. Depending on the wind, it can generate as much as 450 - 500 RPM for the generator which will result in at least 70 KW per day.

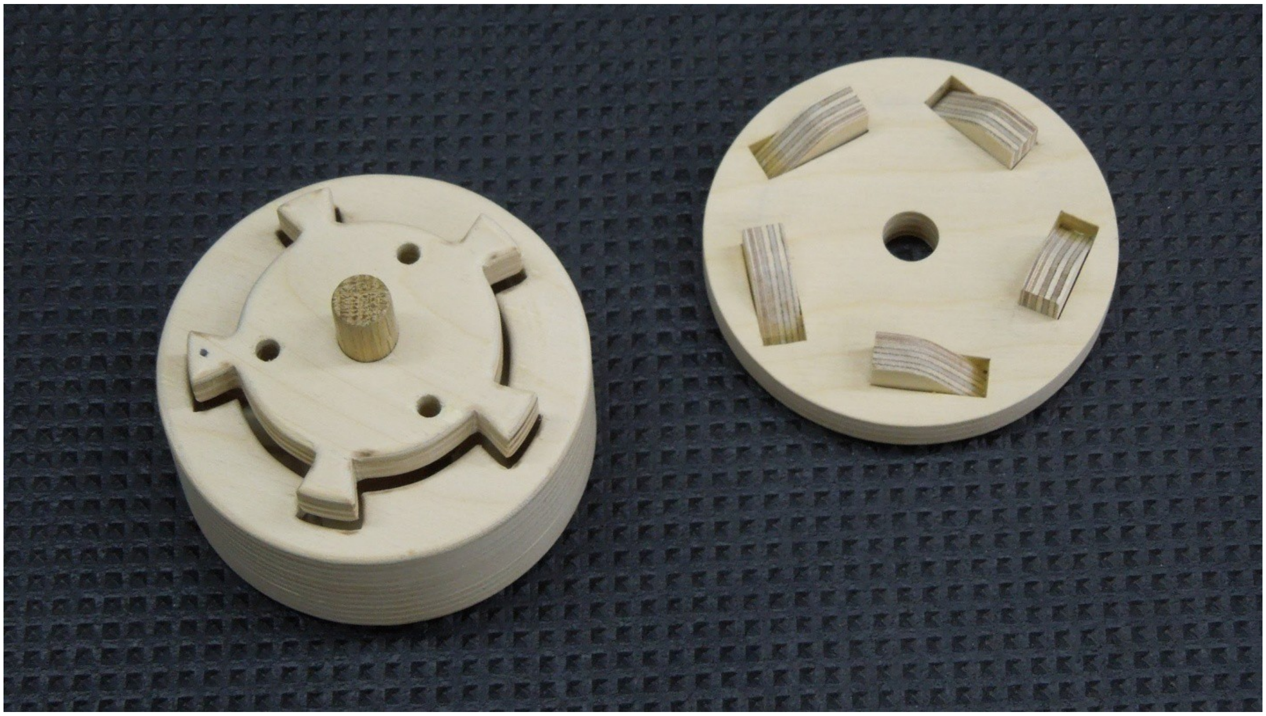
Here is what you need:

1. Three pieces of lumber: 2" x 4" - the blades

2. Two round pieces of plywood:

3. Ten 8 mm screws.

4. One-Way Ratcheting Dog Clutch:

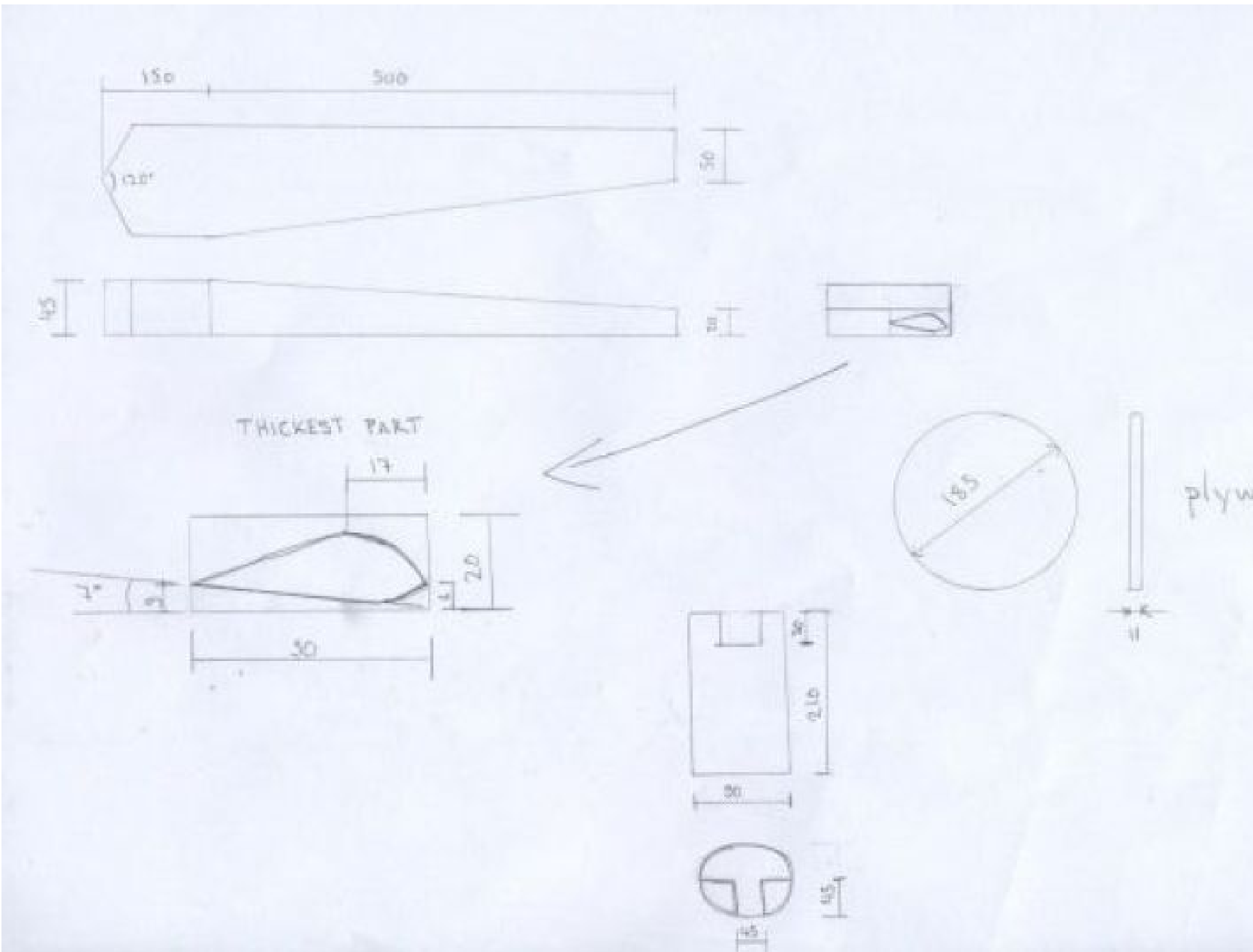


Carving the blades

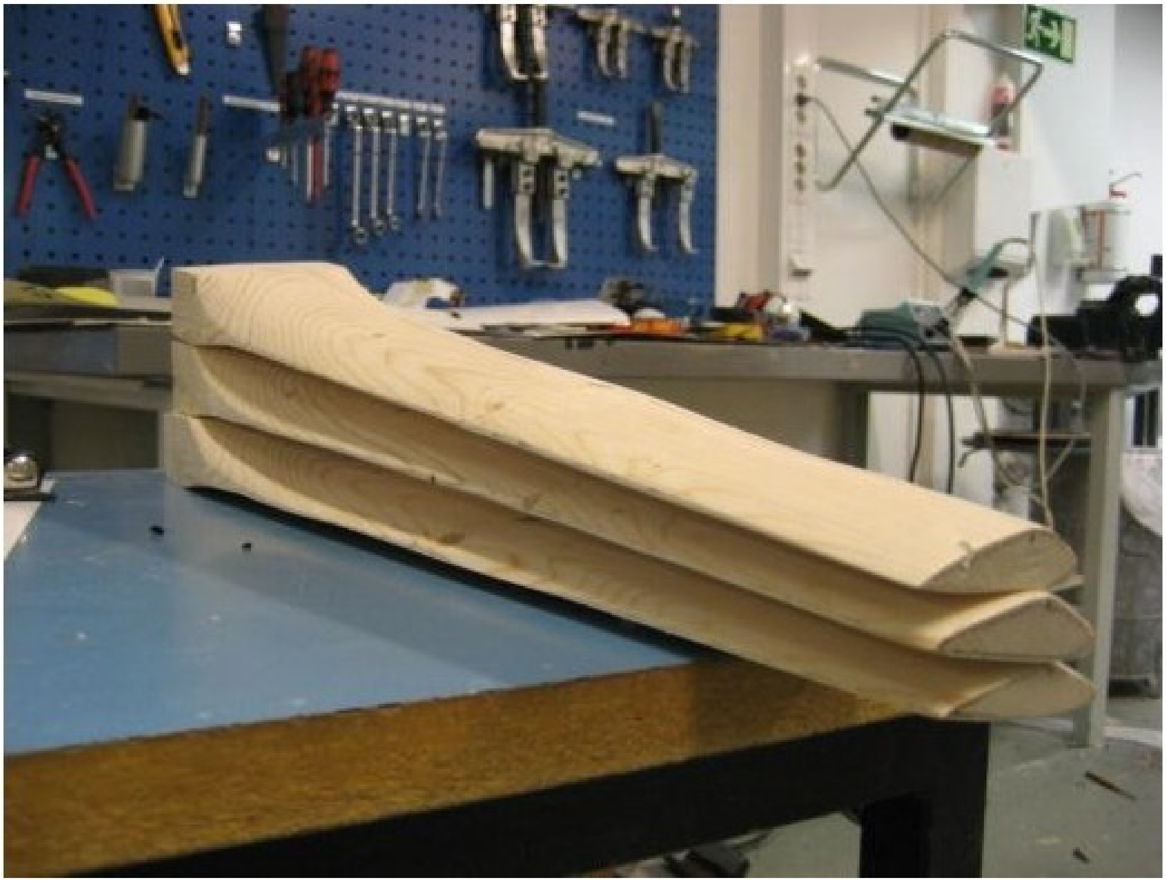
The blades can be carved from lumber. The lighter the material, the better it will work (pine, fir, spruce, cedar). The wood is the best material to use because the strength/weight ratio is good. First saw the wood into 25" pieces - the length is important for the balance so be careful to carve them even.

The end that goes into the base of the propeller must be cut to 120^0 angle so that the blades fit together. The other end of the blades must narrow towards the end. The face of the blades that will not face the wind can be plane, in a straight line. Carve the shape in a seven degree angle. Blades should have the thickest part at about one third from the leading edge (front of the blade). Thickness of the blade should be about one eighth of the width of the blade. Try to make the blades as identical as you can.

Here are the drawings for the blades:



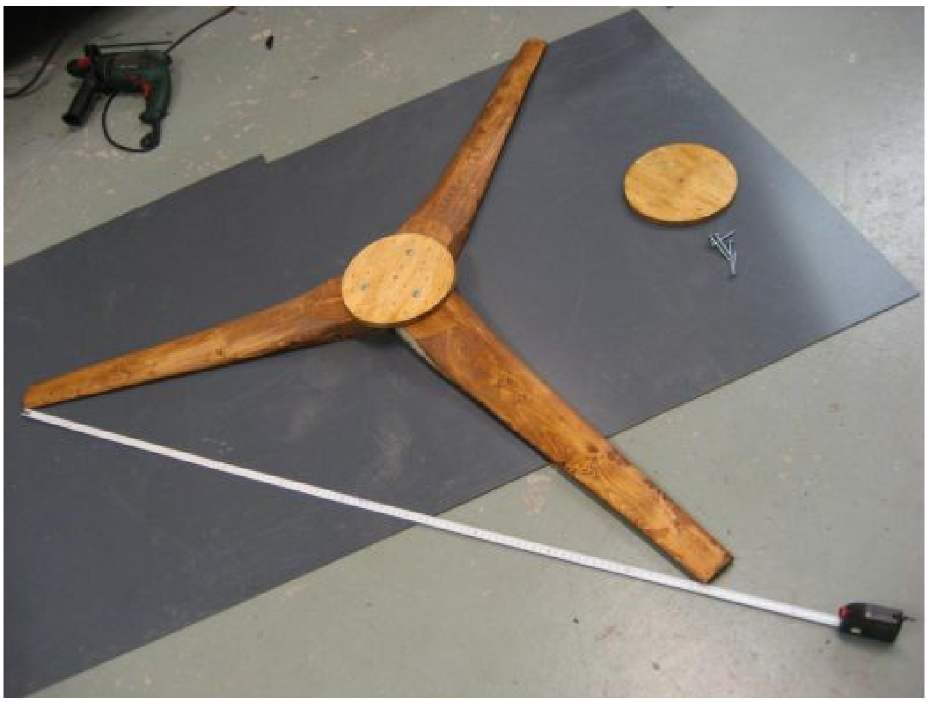
And here are the blades (before and after):



Next, you should weigh the blades as they should be about the same weight.

The two round pieces of plywood must have the same dimensions as the parts of the blades that are not carved - 8" diameter. These two round pieces will keep the blades together. The round piece that is not facing the wind will have a 1" hole in the middle for the driveshaft of the Cold War Generator.

Place all blades together. They should fit as each one is cut in 120^{0}. Measure the distance between the end of the blades to be even, and fix them with both round pieces, with the piece that has the hole in the middle facing the back of the propeller.



At the end of the generator's driveshaft, between the round piece and the driveshaft, place the One-Way Ratcheting Dog Clutch. Fix it to the round piece by using any strong adhesive.

Place the blades and the generator in the wind and see how the RPMs of the generator increase.

The One-Way Ratcheting Dog Clutch will provide the extra spin for the generator as the driveshaft of the generator will maintain the minimum constant of 300 RPM.