



**CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY**

Name(s) Andrew C. Chiang	Project Number J0104
Project Title Wind Winds Windmills	
Objectives/Goals This project investigated various blade configurations in order to optimize wind turbine efficiency.	
Abstract	
Methods/Materials <ul style="list-style-type: none">* Build a wind tunnel; assemble the Kidwind Wind Experiment Kit with a base, a tower, a nacelle with gear set and generator, and a hub for mounting blades* Modify gearbox for higher gear ratios; build rotor with twisted blades and stators with stationary blades* Vary blade shape and dimensions, blade pitches, numbers of blades, gear ratios, and wind speeds.* Record generated power on a load resistor.	
Results <ul style="list-style-type: none">* (2.8 m/s wind/45° blade pitch/8:1 gear ratio) efficiency almost the same with 1, 2, 3, 6, and 12 blades* (2.8 m/s wind/15° blade pitch/8:1 gear ratio) efficiency increased with 1, 2, 3, and up to 6 blades, but dropped at 12 blades* (2.8 m/s wind/45° blade pitch/16:1 gear ratio) efficiency almost 3x of that of gear ratio of 8:1* (1.2 m/s wind) Most of high gear ratio configurations did not work* (1.2 m/s wind/30° blade pitch/12 blades) 16:1 gear ratio produced lower efficiency than 8:1 gear ratio* With 15° pitch, inversed trapezoid blade with wider tip produced higher efficiency* With 45° pitch, trapezoid blade with narrower tip produced higher efficiency* (twisted blade/15° tip pitch/32:1 gear ratio) efficiency improved as the base pitch increased from 15° to 45°* (twisted blade/15° tip pitch/16:1 gear ratio) efficiency plateaued at base pitch of 30° to 45°* Highest efficiency of 12.3% reached with 32:1 gear ratio and base pitch of 45°* Front stator caused drop in efficiency; rear stator caused even higher drop* Front stator penalty much smaller in blow in configuration than that in blow out configuration; positive gain with 45° pitch	
Conclusions/Discussion <ul style="list-style-type: none">* Drag should be minimized with lower blade pitch and torque should be maximized with higher blade pitch* Optimized blade was twisted with high blade pitch at the base to increase torque and low blade pitch at the tip to reduce drag* Stator can reduce drag by changing airflow direction, but also creates air blockage	
Summary Statement <p>Drag should be minimized with lower blade pitch at the tip and torque should be maximized with higher blade pitch at the base in order to maximize windmill efficiency.</p>	
Help Received <p>Dad helped to purchase materials and build wind tunnel.</p>	