2009
MASSACHUSETTS CLEAN TECHNOLOGY AWARDS

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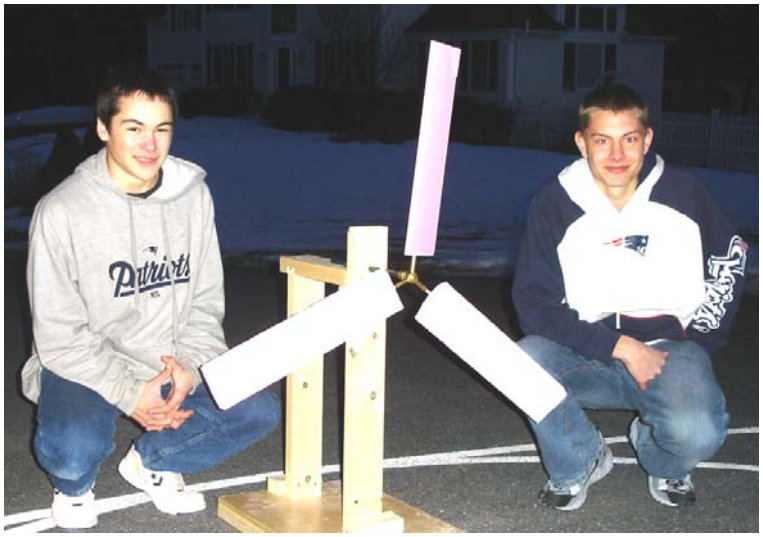


Region: II, Central MA

Danny Cunningham
Andy Ryan
Hopkinton High School

"The Effect of Tubercles on Wind Turbines"

ABOUT US (as of May 2009)**:**

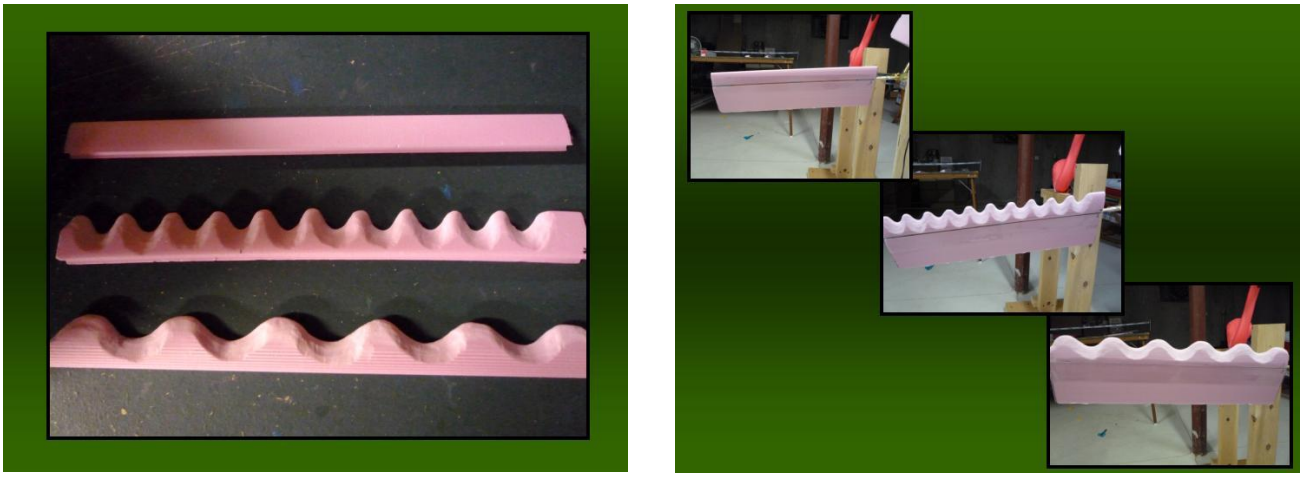
My name is Danny Cunningham. I am 16 years old and next year I will be a senior at Hopkinton High School. I live with my father, mother, and younger brother. I have a pet cat and a pet bearded dragon named Spike. I play the trumpet in the concert band and the jazz band. In the spring I play on the varsity tennis team. I enjoy camping and hiking with my family in the summer. After high school, I plan to study engineering in college.

My name is Andy Ryan; I am 17 years old, and a senior at Hopkinton High School. I have a black lab named Jackson. I play the Baritone Saxophone in the concert band and the jazz band. I play on the varsity tennis team and love to do other sports recreationally. I love the outdoors and enjoy camping and hiking. I am involved in the Boy Scouts and I am currently working on my Eagle Project. After high school I plan to earn a degree in chemical engineering.

OUR PROJECT:

The world is in a major energy crisis and in order to gain access to the full potential of wind power, the many inconsistencies of modern wind turbines must be addressed. Tubercles are the small bumps on the leading edge of the fin on Humpback Whales (see photo at right). [Although scientists do not have a complete mathematical analysis of the role played by these growths which "flout conventional streamlined hydrodynamics"[1], the tubercles in some way improve the fluid flow over the fins, and make the whale more agile in the water.] Our thesis was that by applying this adaptation to rotor blades; wind turbines can become more efficient.

To gather the data a small-scale wind turbine was created with a base and three extruded polystyrene rotor blades (see photo above). Using a DC current motor, the turbine was able to produce power when spun. To spin the blades, the turbine was positioned in front of a large electric fan. The voltage reading



Left: Three different blade edges tested; Right: The edges mounted on tested wind blades.

was measured and recorded by a multi-meter probe. The voltage was measured with blades that had smooth leading edges, and then those with tubercle leading edges, and the data was compared and analyzed.

Upon analyzing the results, it became apparent that tubercles enhance the energy output of wind turbines. The rotor blades with tubercles on the leading edges produced a substantially higher average voltage reading (195%) than the blades with smooth leading edges. When a t-test was used, the difference was found to be very statistically significant.

In conclusion, applying tubercles to the leading edge of wind turbine rotor blades has a positive effect of the energy output on the turbine. They increase lift, decrease drag, and allow the blades to spin faster and generate more power.

[Editor's Note: In a conversation with Daniel and Andy at the Massachusetts State Fair at MIT in May 2009, they stated that they were aware of only one company working on tubercles as a modification for wind turbine blades, from Canada. This summer the company, WhalePower[2] released their results and became a finalist for a major international award for their revolutionary design*[3] At the time of Daniel and Ryan's work, the company had not yet published any data, keeping their results proprietary. In fact, the measurements from Daniel and Andy were the very first reported on the effect of modifying wind turbine blades by altering the leading edges in this way!]

[1] Geotimes: Earth, Energy, and Environment News, July 25, 2008; http://www.geotimes.org/webcasts/article.html?id=windturbine.html.

[2] WhalePower, http://www.whalepower.com/drupal/

[3] Index 2009 Awards (Index: DESIGN TO IMPROVE LIFE!. "The INDEX Award is an International Design Award prize, the biggest design award in the world, financed by the state of Denmark", with a total award sum of €500,000.