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Mathematic Modeling of the Wake Effect

Windmills have been used for thousands of years to capture wind energy. Now, as wind farms increase in size and the cost of construction is increased, efficiency is a key factor for future development. A single turbine in an airstream casts a wake of slower, more turbulent air that affects all turbines behind it. The purpose of this experiment was to model the shape and size of the wake. Current models exist for this, but are based on either results from a wind tunnel or pure abstract math. Such models are accurate to a certain degree, but do not reflect real world conditions. This experiment was done using two windmills mounted in various configurations on a board that was mounted on a vehicle that moved 15 mph. It was found that factors other than the wake cast by the front turbine were affecting the back turbine, so those variables had to be factored out using a model designed by this experiment. Once these results had been adjusted they were mapped visually and compared to visual models of the pre-existing models. The results showed a wake that was more like a flame than the theoretical cone proposed by existing models. In addition, a “sweet spot” with an actual acceleration in wind was found near the back of the wake. Thus, the wake found in a real world setting was modeled and shown to be different than the existing models. Turbine arrangement in a wind farm should consider this model and especially the sweet spot at the back.