**Memorandum**

**Date:** February 11, 2008
**To:** AME 40463 Project Management
**From:** James J. Gates (Group C2)
**Subject:** Engineering Feasibility Study Proposal

**Trade Study Description**

In a horizontal axis wind turbine, blades extending perpendicular to the axis of rotation capture the wind's power, converting it into mechanical energy. Wind-Aid has opted to utilize a lift blade design, as available literature shows that lift blades achieve much higher efficiencies than comparable drag blades. Effective blade shape takes the form of an airfoil, and with more than 1500 types of airfoil designs with available data, possibilities are numerous. This study will investigate ten different airfoil geometries to determine maximum lift to drag ratios attainable with each geometry. Furthermore, it is known that speeds differ at various points along a blade undergoing rotational motion. Therefore, blade twist will be investigated so that all points on the turbine blade see the same relative wind speed for a given average wind speed. This study will attempt to isolate an appropriate airfoil blade geometry and show what twist angle maximizes turbine efficiency for a given generator speed, wind speed, and chosen tip speed ratio.

**Engineering Analysis**

Aerodynamics equations will be used extensively to model blade airfoil design. This study will rely extensively on information available in books and papers containing airfoil drag polar plots. These books include, but are not limited to the following: *The Wind Power Book* by Jack Park, *Wind Power* by Paul Gipe, and *Wind Electrical Systems* by Bhadra, et. al. Internet resources will also be used to supplement information available in books. Basic physics and dynamics knowledge will assist in determining tip speed ratios, angular velocities, and relative wind direction and appropriate angles of blade attack. Dr. Robert Nelson, an expert in aerodynamic design, will also be contacted to further personal aerodynamic knowledge and provide feedback on accuracy of calculations and results.

**Information Developed**

This study will help create a table of maximum lift to drag ratios for various airfoil geometries. Also, efficiency curves for various blade twist angles will be plotted and compared to available power curves for a chosen average wind speed. These curves will be compared to determine the effectiveness of the blade design in capturing available wind energy.

**Influence of Information**

This study will attempt to provide an appropriate airfoil shape for the Wind-Aid turbine blades from a populated list of choices. Furthermore, this study will make a recommendation on blade twist and changing incidence angle along the blade length, from root to tip. Airfoil shape and twist will be considered when investigating ease of manufacture and packaging.

**Task Schedule**

A draft of this study including primary analytical results will be presented to the Wind-Aid group on February 19$^{th}$, 2008. Initial findings will then be compared to those from others in the group, and appropriate modifications to the study will be initiated. The trade study will be fully completed and submitted to the project management on February 28$^{th}$, 2008.