CALIFORNIA STATE SCIENCE FAIR
2001 PROJECT SUMMARY

Your Name (List all student names if multiple authors.)
Ryan Malherbe

Science Fair Use Only

J0921

Project Title (Limit: 120 characters. Those beyond 120 will be ignored. See pg. 9)

Vortex Generators: Effective Airflow Accelerators?

Division
X Junior (6-8) _ Senior (9-12)

Preferred Category (See page 5 for descriptions.)

9 - Fluid Mechanics/ Aerodynamics/ Thermophysics

Abstract (Include Objective, Methods, Results, Conclusion. See samples on page 14.)
Use no attachments. Only text inside these boxes will be used for category assignment or given to your judges.

The primary objective was to determine the vortex generators' ability to delay boundary layer separation at and near critical angle of attack. Another factor in mind was the vortex generators' capability to prolong lift at higher angles of attack without the presence of adverse drag. To test this problem, I built a wind tunnel. A 24cc yard leaf blower was used to provide airflow. I created a 14.3% wingspan section scaled down at a ratio of about 1:15 using the Cessna 172 airfoil (NACA 2412). The wing section was placed in a floating assembly allowing horizontal, vertical, and rotational movement. The drag data (horizontal motion) was retrieved via a digital torque wrench calibrator and lift measurements (vertical motion) were obtained via a precision digital measuring scale. A model aircraft incidence meter mounted on the wing#s rotational axis measured the angle of attack. Pyrotechnic devices (thanks to Moapa Tribal Enterprises) attached to a metal pipe supplied smoke. Using a wing without vortex generators, I captured video of the airstream (smoke probe) and recorded lift and drag data at two-degree increments (from 0-22 degrees). I then repeated the process with vortex generators installed. Without vortex generators, boundary layer separation became apparent as angle of attack increased; all that was noted behind the wing was turbulence. With vortex generators installed, similar occurrences of separation appeared; however, accelerated air leaving the vortex generators remained attached to the upper wing surface longer. Lift and drag measurements increased linearly with angle of attack. The vortex generators visibly energized the air passing over the top of the wing. Lift and drag measurements were inconclusive. This is because lift continued to increase beyond a reasonable angle of attack. At critical angle of attack, lift should begin to decrease (stall). Much like a flat plate, lift and drag continued in an upward trend. From this I conclude that the only lift factor present was downwash. Lift from pressure differential (Bernoulli#s principle) was absent in this experiment. I believe this is due to a lack of air velocity. Since air velocity and density are factors in the Reynolds number, additional research on this subject should provide assistance with creating an accurate environment for future testing.

Summary Statement (In one sentence, state what your project is about.)

Do vortex generators delay boundary layer separation at and near critical angle of attack?

Help Received in Doing Project (e.g. Mother helped type report; Neighbor helped wire board; Used lab equipment at university X under the supervision of Dr. Y; Participant in NSF Young Scholars Program) See Display Regulation #8 on page 4.

Father cut wood and machined parts as requested.