CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)

Daniel Arellano; Desiree Sison

Project Number

S0101

Project Title

What Is the Relation between the Length of Water Bottle Rockets and Their Resulting Altitude?

Abstract

Objectives/Goals

The Purpose of this project is to determine if the length of a rocket can affect the altitude it can achieve. According to our hypothesis, if the weight is equalized among all rockets, then the rocket with the longest length will achieve the highest altitude because of its greater control and stability in the air.

Methods/Materials

For the experiment, we constructed our own water bottle rocket launcher from various materials including wood, rubber stoppers, metal plates and various hardware. Rockets of different sizes constructed of 2 liter water bottle rockets, cardboard wings, and a transmission funnel nose were used. To balance the wieght of all the rockets, the rocket with the most mass would serve as a control and washers would be added to the remaining rockets to add correct amount of necessary mass to equal the heaviest rocket. To calculate altitude, a stopwatch recording the entire flight time and a gravitational protractor were also used. The time was first divided in two so only the total time to its highest point would be recorded. Then the time is plugged into an equation of kinematics to determine distance up it traveled. The gravitation protractor was used to achieve a second calculated altitude to insure accuracy.

Results

Through data analysis, we have been able to determine and calculate that there is no affect on altitude from the length of the water bottle rockets.

Conclusions/Discussion

From this experiment, we have proved our hypothesis incorrect, in that the longest rocket did not achieve the highest altitude but more or less reached the same height as the smaller rockets. This was determined through the analysis of our data and also through observation. However, if the equation of kinematics are taken into consideration, we would be able to foresee that the equations themselves do not take into acount the height or length of an object. The determined results are very conclusive in that further tests would only go to show that our data is further correct.

Summary Statement

Our project is primarily to calculate the effect length has on the altitude of water bottle rockets.

Help Received

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)

Nicholas Bayer; John Dike; Justin Hudson

Project Number

S0102

Project Title

It's a Blast! The Study of Aerodynamic Influences on Shotgun Pellets over Distance

Abstract

Objectives/Goals

Our objective was to prove that shotgun pellets fired from a shotgun will continue spreading over increasing distances with lightest weighted shots having the largest spread. We also wanted to be able to map out exactly how the pellets change in motion over these distances.

Methods/Materials

One (1) Winchester 12 Gauge Shotgun
Twenty (20) Rounds Winchester 8 Shot Shotgun Shells
Twenty (20) Rounds Winchester 6 Shot Shotgun Shells
Twenty (20) Rounds Winchester 4 Shot Shotgun Shells
Sixty (60) Paper Targets
One (1) Wooden Target Stand
Two (2) Spring Clamps
One (1) Measuring Tape
One (1) Drafting Compass
One (1) Ruler

Measure distances of 10, 15, 20, and 25 feet from target stand. Clip target onto stand. Fire one (1) 8 shot round towards center of target from 10-foot mark. Replace target and repeat for a total of five (5) times. Repeat process for both 6 and 4 shots. Repeat process for all shot types at the 15, 20, and 25-foot marks. Measure all spread diameters on targets using a compass and a ruler. Start from outside of spread and come inward until a total of ten (10) pellets have been removed in order to eleminate outliers. Be sure not to measure the mark made by the wadding.

Results

The spread of each shot did increase over distance with the lightest weighing shots showing the greatest spreadas measured by inches. However, we did note that the heaviest shots increased more over the four distances by percentage growth.

Conclusions/Discussion

The lighter shots had started spreading from the barrel of the shotgun immediately, but did not spread much after that point. Heavier shots, though, started out in a tighter formation but spread out more over increasing distances.

Summary Statement

The study of aerodynamic influences on mass and weight projections over distance.

Help Received

Mr. Bayer, Los Angeles Sherrif's Office, fired the shotgun at all times

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
James B. Bonner, IV

Project Number
S0103

Project Title
The Robins-Magnus Effect and the Effect of Increasing the Surface Area on the Velocity of a Rotating Solid Sphere

Abstract

Objectives/Goals
The purpose of this experiment was to observe the effect of increasing the surface area of a rotating solid sphere on its velocity as it traveled through a fluid media. The sphere rolled down a ramp and traveled through the fluid in the aquarium. The sphere continued to spin as it flowed through the fluid, creating a curve in its trajectory. The sphere's trajectory was recorded and analyzed.

Methods/Materials
An aquarium was filled with water and a ramp structure was placed on top of the aquarium. The sphere rolled down the ramp and entered the aquarium vertically. The sphere's trajectory was recorded using the video camcorder. Trial repeated four times. 12 equally spaced holes were drilled into the sphere (Test B), increasing the SA. The trials were repeated. An additional 20 equally spaced holes were drilled into the sphere (Test C). The video replay was analyzed.

Results
Test A: The trajectory of a sphere without any drill holes was recorded using a digital camcorder. The avg. vertical speed of sphere A was 105-cm/sec +/- 6.7%. The avg. overall deflection for A was 2.6 cm.
Test B: 12 equally space holes were drilled into the sphere. The avg. vertical speed of sphere B was 107-cm/sec +/- 2.6%. The avg. overall deflection for B was 6.8 cm
Test C: 20 additional holes were drilled into the sphere. The avg. vertical speed of sphere C was 99-cm/sec +/- 2.2%. The avg. overall deflection for C was 8.9 cm

Conclusions/Discussion
Deflection Hyp. stated that an increase in the SA would augment the sphere's boundary layer. As the boundary layer expanded, there was more skin friction between the fluid particles and the surface. The skin friction is responsible for pulling fluid particles in the direction of the sphere's rotation. This increased the difference between the fluid pressures of the two sides. An increase in the fluid pressure difference increased the magnitude of the Magnus force, which causes the sphere to curve.
Settling Hyp. stated that as the SA increased, the vertical speed of the sphere would decrease. This was unsupported by the data. Logically, an increase in surface area would increase the amount of skin friction between the surface and the fluid, inhibiting motion. In addition, Stokes' Law illustrates that the settling velocity depends on the shape of the particulate. Due to the lack of precision of the measuring equipment (ex. frame rate)

Summary Statement
An increase in surface area increases the interaction between the sphere's surface and the fluid particles. To what extent does the SA of the sphere affect the deflection in the rotating sphere's trajectory and its settling velocity?

Help Received
No outside help was provided.

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)

Christine E. Dempster

Project Number

S0104

Project Title

Up, Up, and Away! Vortex Generators and Increased Angles of Attack

Abstract

Objectives/Goals

To determine which design and set up of vortex generators allows for the greatest angle of attack at a low airspeed velocity before a wing stall occurs.

Methods/Materials

Place vortex generators at desired angles and distances from leading edge of model wing, using earthquake putty to hold them in place. Place inside of wind tunnel, using wind tunnel insert. Turn on wind tunnel. Using a hooked rod, hold the trailing edge of the wing so that the chordline is parallel with the freestream velocity. Slowly lower the wing#s trailing edge until the strings on the wing indicate a stall. Record the height of the trailing edge. Use trigonometric functions to calculate the angle of attack.

Results

Triangular vortex generators are more effective at increasing angle of attack before a stall on the occurs than rectangular vortex generators are; vortex generators are least effective when placed on the leading edge, more effective 2cm back, and most effective 4cm back; they are more effective when parallel to each other than when angled. The individual series that proved to be the most effective had rectangular vortex generators placed 4 cm back from the leading edge, parallel to each other. The least effective was the control group (no vortex generators used), followed by rectangular vortex generators placed on the leading edge of the wing, parallel to each other.

Conclusions/Discussion

The most effective use of vortex generators was almost half way back on the model wing, which was behind where the thickness of the wing was the greatest. They tended to be more effective when parallel rather than angled, especially with the rectangular vortex generators, probably because they were too long to be effective. When five of the vortex generators were used and all were angled, they seemed to make an effective screen rather than simply bringing the air through in vortices. Triangular vortex generators were able to be effective when angled because they taper to the surface of the wing, allowing the air flow to follow the contour of the wing without being blocked by the vortex generator. This is also why triangular vortex generators were, on average, more effective than rectangular vortex generators.

Summary Statement

The project explores the use and most effective design and set up of vortex generators to prevent a wing stall at a low airspeed velocity.

Help Received

Mrs. Marilyn Usher (high school physics teacher) was the project supervisor.

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Andrew D. Durkee

Project Number
S0105

Project Title
The Effect of Winglets on Low Aspect Ratio Wings

Abstract

Objectives/Goals
The purpose of this experiment is to observe if there are any effects of winglets on a low aspect ratio wing, particularly dealing with wingtip vortices.

Methods/Materials
A low aspect ratio wing was constructed and fitted with winglets with heights of 5, 7.5, and 10 cm. Based on the background research and previous knowledge, it was hypothesized that the addition of winglets on a low aspect ratio wing will improve the lift to drag ratio over that of a low aspect ratio wing without winglets. The wing was then placed in the wind tunnel test bed and force instruments were set up to analyze the lift and drag of the wing with each of the different sizes of winglets.

Results
The 10 cm winglet had the highest lift, followed by the control, 5 cm, and 7.5 cm winglets. The drags were relatively insignificant.

Conclusions/Discussion
It was concluded that the winglet needed to be large enough in order to prevent the wingtip vortices from reducing lift. Further experimentation may include testing how much noise the most efficient winglet makes compared to a high aspect ratio wing.

Summary Statement
This project investigated the effects of different sized winglets on low aspect ratio wings, particularly in terms of lift and drag

Help Received
Mother helped with the board. Father helped build the wind tunnel

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Taylor R. Hill

Project Number
S0106

Project Title
Tailgate Efficiency in Relation to Vehicular Aerodynamics

Abstract

Objectives/Goals
The goal of my project was to determine through controlled experiments if it is more aerodynamically efficient to drive with the tailgate down, tailgate up, or with no tailgate at all. Whichever method makes the truck the most aerodynamic, deductively, is the vehicle that consumes less gas, making the vehicle more efficient.

Methods/Materials
Using a 1:16 scale model truck to represent the vehicle and a 9" fan, I simulated the travel of air over a truck in motion. I then focused the air through a funnel to focus it to the front of the vehicle in order to get the proper simulation of actual driving conditions. I then placed 5 incense sticks in front of the vehicle to create smoke. It was then possible to view the air's travel over the vehicle by observing the travel of the smoke over the truck. I repeated the experiment three times with each different scenario. After completing the three test trials I did a final trial with a food scale under the vehicle to show any extra weight due to drag that was added to the vehicle. I also tested the wind speed from the fan using an anemometer to show how fast the vehicle would be traveling if in motion.

Results
After doing the experiment three times with each method, I proved that it is actually more aerodynamically efficient to drive with the tailgate off than it is to drive with it up or down. When the tailgate was down the wind traveled over the cab but would land directly on the tailgate pushing the bed down and causing more drag in the rear of the vehicle.
The second method tested was with the tailgate up. This method created an eddy in the bed of the vehicle and almost all incoming air circulated over the bed of the truck because the eddy pushed the incoming air over the bed.
The most efficient was with the tailgate off. The air traveled over the cab, over the bed, and didn#t touch the rear of the truck.

Conclusions/Discussion
After completing the experiment I determined that my hypothesis of driving with the tailgate down was not correct. Driving with the tailgate down in fact decreases the vehicles aerodynamic efficiency by creating drag on the bed of the vehicle which adds more weight to the rear. In fact, this was the least efficient method because I presume it would cause the vehicle to use more gas to maintain the same speed. If you were looking for the best way to save money on gas, driving with the tailgate off would prove most effective.

Summary Statement
My project is an experiment testing whether it is more aerodynamically efficient to drive a truck with the tailgate up, down, or completely off.

Help Received
No outside help received.

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Anjaney P. Kottapalli

Project Number
S0107

Project Title
An Experimental Analysis of the Thrust Produced by an Ornithopter at Low Reynolds Numbers

Abstract

Objectives/Goals
The objective of this project was to determine important aerodynamic characteristics of an ornithopter configuration, Micro Air Vehicle [MAV] scale vehicle. This project investigated the thrust produced by a small scale, 15 cm wingspan, ornithopter. An important theory that was explored was the Weis-Fogh effect which states that the pulling apart of two wings creates extra thrust over the thrust from each individual wing.

Methods/Materials
To perform this experiment, a test vehicle was designed and constructed using Carbon Fiber, Mylar Plastic, small music wire, and a pager motor. Two configurations were tested. First, a monoplane ornithopter was tested with two, side-by-side wings. Second, a biplane ornithopter was tested with two additional wings (total of four wings) in the same side-by-side configuration.

A testing apparatus was constructed using balsa wood to measure the thrust. Both configurations were tested multiple times using various input voltages which varied the flapping frequency of the wings. The thrust produced was recorded using a gram scale.

Results
The data was analyzed after applying the Reynolds Number [Re] as a leveling factor. The Reynolds Number involves the air viscosity, and the length and velocity of the test vehicle. Using the induced velocity, the Re was calculated to be 3.6 x 10^2 for the monoplane and 6.7 x 10^2 for the biplane; within the same range as that of a butterfly or a small insect. The thrust recorded ranged from 0.2 milliNewtons [mN] to 1.4 mN for the monoplane ornithopter and 0.3 mN to 3.0 mN for the biplane ornithopter.

Conclusions/Discussion
The Weis-Fogh effect was validated in this experiment by showing it was significantly adding thrust (66% of the monoplane ornithopter thrust). The results suggest that the Weis-Fogh effect seems to be dependent on flapping frequency. I would like to research this dependency further. The results indicate that the monoplane ornithopter is more efficient for long range flights while the biplane ornithopter has a greater carrying capacity.

Summary Statement
This experiment studies important aerodynamic characteristics of small scale ornithopters and establishes that a biplane ornithopter produces significantly more than twice the thrust of a monoplane ornithopter, consistent with the Weis-Fogh

Help Received
Professor Kevin Jones of the Naval Postgraduate School provided mentorship. Chinmay Patel, a Stanford Graduate student, aided in the electrical aspects of this project.

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)

Mark A. Severy

Project Number

S0108

Project Title

Windmill Efficiency

Abstract

Objectives/Goals

To see how to make my wind mill most efficient

Methods/Materials

I tested different blade angles and different angles of the wind input.

Results

20 degree blade angle at a head on wind was most effient.

Conclusions/Discussion

The smallest angle would be most efficient as long as it can overcome the force of friction.

Summary Statement

I tested the angle of wind and angle of the blade on my windmill to see which was most efficiant.

Help Received

All by myself

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)

Maia Singhal

Project Number

S0109

Project Title

Harnessing the Wind: How Can We Increase the Power Output of a Wind Turbine?

Abstract

Objectives/Goals

The purpose of my experiment was to test if a wind turbine could be designed to work more efficiently, and also be more eco-friendly, by funneling air through an hour-glass shaped cover around the turbine. My hypothesis was that by forcing the air (wind) through the smaller space, more power would be generated at the same wind speed.

Methods/Materials

To build my wind turbines, I used model airplane propellers and a small 9-volt motor. The covers were made using plastic flowerpots. To control wind speed, I built a wind tunnel from a whole-house fan and poster boards. I measured the power generated by the wind turbines with and without covers around them. I compared the results in order to measure the gain in power for three different covers and three different wind speeds. I also measured wind speed in the wind tunnel, and calculated the efficiency of my wind turbines.

Results

As I predicted, more power was generated with the covers. The power increased an average of 2.3 times when the turbines were placed inside the shaped covers. The maximum gain was 3.3 times. However, the increase was 30 percent less than I predicted. The efficiency of the turbines ranged from less than 1 percent to over 10 percent.

Conclusions/Discussion

My hypothesis was correct. By funneling air into a smaller space the power output of the wind turbine could be increased. Applications of my experiment include creating wind turbines that are more efficient. Since the cover can prevent birds from coming near the blades, the turbines are also more eco-friendly.

Summary Statement

My project is about increasing the power output of a wind turbine by using an hour-glass shaped cover to speed up the airflow.

Help Received

My dad cut the flower pots, helped me with power tools to construct my apparatus, and showed me the statistical formula to use. My mom proofread my poster.

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Evan S. Stanford

Project Number
S0110

Project Title
How Does the Camber of an Airfoil Affect the Lift-to-Drag-Ratio?

Abstract

Objectives/Goals
The object of my science project was to determine how the camber of an airfoil affects its lift-to-drag ratio.

Methods/Materials
I tested the performance of several airfoils in a homemade wind tunnel. I carved four wings out of foam and coated them with paper, each with different cambers. I put each wing in the test section of my wind tunnel and then measured the lift and drag at various angles of attack.

Results
With this information, I was able to analyze the data in several ways. I found that all four of my cambered wings stalled at about +20 degrees and -20 degrees angle of attack. I found out how angle of attack affects lift, drag, and the lift-to-drag ratio. I also determined how camber affects lift-to-drag ratio and optimum angle of attack. I found that the airfoil with fifteen percent camber had the greatest efficiency.

Conclusions/Discussion
My hypothesis (0% would have the greatest efficiency) was not supported by my results. Instead, the airfoil with 15% camber had the greatest lift-to-drag ratio. In addition, I found that my data was consistent and logical. My results are useful for many applications; they can be used to build efficient wings for airplanes, ideal propellers, optimum spoilers for racecars, or effective fins for watercraft.

Summary Statement
My project used a homemade wind tunnel to test how the camber of an airfoil affects lift-to-drag ratio.

Help Received
My father helped purchase supplies for the wind tunnel. My mother helped proofread paperwork.

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)

Robert G. Wright

Project Number

S0111

Project Title

Optimizing a Model for Rocket Stability

Abstract

Objectives/Goals

This experiment tested whether using the RockSim method to calculate the center of pressure (CP) in conjunction with the generally accepted #rule# that the CP must be at least one caliber (one diameter of the rocket#s airframe) behind the center of gravity (CG) accurately predicts a stable rocket flight. The experiment identified which relationship between the CG and CP results in a straight, near vertical rocket flight in a variety of wind conditions.

Methods/Materials

In order to determine the optimal distance between the CG and CP, eight identical rockets were built with varying fin heights, which allowed for a varied CP/CG relationship. In order to classify each of the flights, four wind ranges and seven flight stability profiles were devised. The intent was to launch each of the rockets at least once in each of the four wind ranges and categorize the stability of each flight into one of the flight stability profiles. Using the results, the optimal placement for the CP in relation to the CG was determined.

Results

The results of launching the rockets showed that flights are near vertical when the relationship between the CG and CP falls within a certain range. This range decreases as the wind velocity increases. Outside of this range, rockets either weathercock into the wind or fly in an unstable manner.

Conclusions/Discussion

The experimental results supported he hypothesis. Using the RockSim method for calculating the center of pressure in conjunction with a caliber range of 1 to 1.5 is an accurate method for predicting a stable, near vertical rocket flight in varying wind conditions.

Summary Statement

This experiment determined the optimal relationship between the center of pressure and the center of gravity to predict a stable, near vertical rocket flight in varying wind conditions.

Help Received

My father helped by driving me to the launch site, aiding in the recovery of the rockets, measuring the wind speed, and proof-reading. I discussed rocket aerodynamics with Dr. Knox Millsaps of the Naval Postgraduate School.