CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)

Colleen Loree F. Avila

Project Number

S0101

Project Title

Aerodynamic Airfoils, Phase 2

Abstract

Objectives/Goals

My objective for this project was to identify which of the custom made airfoils is the most aerodynamic when tested for drag within a wind tunnel at various wind speeds.

Methods/Materials

The material I used to make the airfoils was balsa wood, because it is light weight and easy to cut. I tested the twelve airfoils by suspending them in a wind tunnel with a balance, and then connecting them to the drag scale with fishing wire and paper clips. The airfoils were connected to the balance with a steel rod so that it would not pivot up and down, but only back and forth.

Results

The results I received after conducting this experiment was that Airfoil #4 was the most aerodynamic with an average drag of 2.17 grams and a maximum drag of 7 grams at 3200 feet per minute. Airfoil #1 came in second with an average drag of 2.67 grams and a maximum drag of 9 grams at 3200 feet per minute. Airfoils #5 and #9 came in last with average drags of 14.33 grams.

Conclusions/Discussion

In conclusion, my hypothesis was incorrect. Airfoil #1 came in second, and not in first as I had predicted. Airfoil #4 proved to be most aerodynamic of the twelve airfoils tested. This may be due to various factors (ex. mass). My objective and goals for this experiment were fulfilled. The information I have obtained in Phase 2 will work with Phase 1 in the future to create a complete model of an airplane or rocket to expand my knowledge of aerodynamics and physics.

Summary Statement

To determine which custom made airfoil is most aerodynamic when tested for drag within a wind tunnel at various wind speeds.

Help Received

Mr. Schultz helped test and make the airfoils; Used wind tunnel at Centennial High under the supervision of Mr. Kaura

Name(s)
Kristin E. Barker

Project Number
S0102

Project Title
Persistent Holes in Non-Newtonian Fluids

Abstract

Objectives/Goals
The objective of this project is to induce persistent holes in non-Newtonian fluids and to understand the dynamics of fluid behavior under the application of shear force.

Methods/Materials
Experiments were performed by vertically shaking a variety of Newtonian and non-Newtonian fluids (shear-thickening and shear-thinning) in an acoustically driven vertical shaker. Air puffs were administered to the agitated fluid, and if holes were obtained, they were quantified.

Results
Persistent holes were not obtained in the Newtonian fluids; however, persistent holes were produced in the non-Newtonian fluids. They were found in both the shear-thickening and shear-thinning fluids, but appeared to be of different character and driven by different processes. The appearance of persistent holes in shear-thinning fluids extends the known published literature. Complex hole dynamics were observed in the shear-thickening fluids that were studied.

Conclusions/Discussion
The holes formed in the shear-thinning fluid appear to result from processes different from those which produce holes in shear-thickening fluids. The holes formed in the shear-thinning fluid appeared at lower frequencies, and they could be induced spontaneously. The graph of lifetime versus frequency reveals a threshold at which a hole can be determined to be persistent. However, the system dynamics are so complex that this threshold is highly variable for the holes observed. By viewing the video recordings of holes in shear-thickening fluids at an accelerated frame rate, it was observed that the diameters of the persistent holes oscillated slowly in time with small amplitude. Review of the video recordings of holes in shear-thinning fluids revealed a torodial wall structure in which fluid was observed to move more rapidly than in the surrounding regions. Faraday waves were observed to be present when persistent holes were induced in both shear-thickening and shear-thinning fluids. The results of these experiments agree with the known published literature, and the results for the shear-thinning fluids extend the known published literature. Areas for further investigation were identified, including the application of shear-thickening fluids to infantry-soldier body armor and design of antiterrorist patrol vehicles.

Summary Statement
Persistent holes can be induced and sustained in both shear-thickening and shear-thinning non-Newtonian fluids, and shear-thickening fluids have practical applications in personal and vehicular armor.

Help Received
Dr. John C. Howe and Dr. Charles Barker provided supportive mentoring. Also, they provided ongoing supervision to ensure that proper safety procedures were followed during experimentation. The tests were completed at Aurora Networks, Inc. in Santa Clara, California.

CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)

Christopher A. De Maree

Project Number

S0103

Project Title

A Model Rocket's Trajectory

Abstract

Objectives/Goals

The objective of my project was to determine a possible way to calculate a model rocket#s trajectory in order to predict a possible landing zone by using mathematical models. Once a mathematical model is derived an error of margin will also be calculated if needed.

Methods/Materials

A series of six rockets were tested, each with different outer dimensions as well as different masses. Each rocket was measured for the necessary variables to calculate into the mathematical model then a trajectory was produced to match the results. Each rocket was then launched and compared to the mathematical trajectory.

Results

The mathematical model contained a margin of error of less than 5% from the each rocket#s actual flight path

Conclusions/Discussion

I conclude that a mathematical model can be used to show where a model rocket will land and in doing so many applications can be derived to provide a function for knowing where a specific model rocket will land. A couple applications examples could be: the ability to deploy an experimental device at a specific location or perhaps keeping the rocket away from a certain hazardous zone.

Summary Statement

Hypothesizing a zone of space a specific model rocket will land, within very reasonable limits, using mathematical models.

Help Received

CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)
Christine Dempster; Heather Kroll; Elizabeth Leire

Project Number
S0104

Project Title
It's a Drag

Abstract

Objectives/Goals
By exploring the characteristics of the different materials that may compose a ship's hull, this experiment seeks to find that material which creates the least amount of friction with water. By decreasing this friction or drag, it is possible in the long run to increase boat speed and reduce energy cost. The more efficient the material of the hull is, the more cost effective the vessel.

Methods/Materials
The first steop in the process was to build the frame of the stand, which would hold the test pipes of each material. This stand included a socket to place each test strip, legs that could angle the ramp to exactly 30 degrees, and a reservoir overhead to accurately and uniformly drop the water on each bar of material for every test. Water would then be let out of the reservoir, ignite the start clockk, travel down the ramp, and set off the stop clock to reveal a length of time unique to each material and test. This process was repeated 12 times for each of the 8 material (polyurethane-coated aluminum, naval bronze, aluminum, copper, plastic, steel, scratched plastic and welded steel). The result was a collection of data that, when averaged for each pipe material, would provide a comparison chart of times identifying which materials created the least amounts of friction with the water and which were the most consistent

Results
Averages of times for all materials seconds: Aluminum-Polyurethane- 4. 598; Naval Bronze-2.266; Aluminum-3.225; Copper-2.239; PVC-2.467; Steel-2.536; PVC-keyed-3.594; Welded steel-3.655.

Standard Deviation of all Materials: Aluminum-Polyurethane-.991; Naval Bronze-.369; Aluminum-.590; Copper-.358; PVC-.287; Steel-.430; PVC-Keyed-1.461; Welded Steel-.709.

Conclusions/Discussion
Copper proved to create the least amount of skin friction with the water because of its smooth and uniform surface. In addition, we observed that the test results of some materials were less consistent than others. The range of results for scratched PVC was the greatest while that of normal PVC was the smallest (most consistent). This revealed the great importance of not only the selection of material, but also each material's composition.

Summary Statement
Our project is about friction and its relationship with the surface material and the material's composition on the hull of a ship

Help Received
Friend helped cut the materials and orded the pipes, another friend helped wire the clocks

Name(s)
Andrew D. Durkee

Project Number
S0105

Project Title
Flying Boats

Abstract

Objectives/Goals
The purpose of this project was to investigate the possible application of airfoil wing shapes to hydrofoil craft to reduce drag when in the water. It was hypothesized that a whale shape would have the least amount of drag closely followed by forward swept and Delta wing shapes.

Methods/Materials
Five "boats" were built out of balsa wood, each with a different shape. The shapes were a straight wing, a forward swept wing, a rearward swept wing, a delta wing, and a humpback whale shaped wing. A tub was built with a large conduit pipe and a pulley system was used to pull each shape through the six meters of water in the tub. The time the craft took to traverse the tub was measured. The process was repeated ten times for each shape and the averages were compared.

Results
The results showed that the Delta shape took the least amount of time to traverse the tub, which indicates that it had the least amount of drag. The shape took an average time of 5.34 seconds. The whale shape took an average time of 9.08 seconds and the straight, forward, and rearward swept took average times of 11.23, 15.75, and 18.02 seconds respectively.

Conclusions/Discussion
These results could be explained by the Delta shape having a very small front profile while the whale shape had a relatively large front profile. This project could be followed up by an experiment testing the different lift values for each foil shape and comparing them with the average times of each shape.

Summary Statement
This project investigated the use of airfoil wing shapes and applying them to hydrofoil craft to reduce drag in the water.

Help Received
Mother helped type report. Father helped in construction of the experiment.

CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)

Rachel C. Leuthold

Project Number

S0106

Project Title

Tuck to Win: The Effects of Aerodynamics on Speed Skiing

Abstract

Objectives/Goals

The intention of this science project was to study the affect of aerodynamics on speed in speed skiing. I intended to compare an athletic stance, a high tuck, a low tuck with hands in front of my face, and a low tuck with hands below my face.

Methods/Materials

I assumed that the fastest times would belong to the stance that was both low, and had my hands in front of my face. I designed an experiment in which I took around seven runs per stance, and recorded the time at four points on the set distance. I created a cubic function from my data, and used derivatives to find the instantaneous velocity and acceleration. I attempted to test stances in a wind tunnel that I had built, but it did not work.

Results

My data showed that the low tuck with my hands in front of my face had the highest acceleration and velocity.

Conclusions/Discussion

In conclusion, the type of tuck a ski racer assumes can greatly affect their speed, and thus their results. The most effective tuck is low, with the hands positioned in front of the skier's face.

Summary Statement

I studied the aerodynamic properties of different tuck positions.

Help Received

Mr. Matt, my advisor; my dad filmed the runs, helped me drill and cut the metal tube for the wind tunnel; RockLogic and Alliance Gas Supplies loaned me materials.

CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)

Anthony J. Neuberger

Project Number

S0107

Project Title

Real Time Analysis and Optimization of Solid Fuel Rocket Engines

Abstract

Objectives/Goals

Maximizing the efficiency of solid fuel rockets and controlling the flight profile requires the tailor engineering of multiple design features. Previously, I identified engine design features which had significant impact on thrust generation. However, data was collected and analyzed after the burn test. The purpose of this project is to simultaneously monitor multiple engine performance parameters, collect data on the millisecond timescale and analyze it in real time.

Methods/Materials

To achieve these goals, I designed and built a rocket engine test device with multiple sensors integrated into the apparatus. I also wrote a computer program called Rapid Information Procurement with Real-time Analysis Program (RIPRAP) which collects and analyzes data in real time. Thermocouples and pressure sensors were placed in the engine burn chamber and nozzle to monitor temperature and pressure. Analog signals from the sensors were converted to digital signals, imported into RIPRAP and analyzed.

Results

RIPRAP calculated the amount of fuel spent, the amount of fuel remaining, the dynamic pressure in the engine and nozzle, the volume and speed of the gas exiting the burn chamber through the nozzle and the energy and force produced over time. RIPRAP also generated theoretical flight profiles. All data was saved in spreadsheets for re-analysis with user-defined parameters to predict performance prior to building new engines. Finally, RIPRAP monitored engine performance against predefined values and generated digital output signals when appropriate.

Conclusions/Discussion

Future work will integrate these output signals into the rocket test device thereby completing the information and control loop.

Summary Statement

Using a computer program that I wrote, data from rocket engines was collected and analyzed in real time and used to further optimize the test engines.

Help Received

Tuong Phan - taught me basic LabView programing, Phil Salzman - taught me how to work with pressure and temperature sensors, my dad helped me build the rocket engine test devices.

Name(s)

Christopher B. Simpson

Project Number

S0108

Project Title

Winging It: An Analysis of the Effects of Varying Aspect Ratios on a Toy Glider's Flight

Abstract

Objectives/Goals

The primary objective of this project was to analyze the effects of varying the aspect ratio of a rectangular wing while keeping the surface area constant. The secondary objective was to find the optimum aspect ratio for the toy glider. Aspect ratio (AR) is a measure of the slenderness of a wing. As the aspect ratio increases, the wing becomes more slender.

Methods/Materials

The fuselage of a small toy glider was selected as the platform for the experiment. The surface area of the original wing was then calculated. Nine rectangular wings (Wings 1-9) with the same surface area were constructed from balsa wood. The aspect ratios of the wings were: 2.5:1, 4.0:1, 4.7:1, 5.7:1 7.1:1, 9.0:1, 13.5:1, 22.9:1, and 27.1:1. Each glider was then launched from a table with 8 Newtons of force supplied from a rubber band. The location where the gliders hit the ground was marked and measured from the base of the table using a metric tape. This process was repeated 30 times for each of the nine rectangular wing designs.

Results

After 296 total trials, the average distances (cm) for wings with aspect ratios: 2.5:1, 4.0:1, 4.7:1, 5.7:1 7.1:1, 9.0:1, 13.5:1, 22.9:1, and 27.1:1 were 389cm, 458cm, 488cm, 481cm, 465cm, 454cm, 444cm, 426cm, and 415cm, respectively.

Conclusions/Discussion

Wing 3 produced the longest flights # an average distance of 483cm # and had an effective Lift/Drag (L/D) ratio of 6.68. The wing had an aspect ratio of 4.7:1. Wing surface area is the dominant variable related to producing the lift that is necessary to allow the glider to fly. The wing area was held constant in this experiment, thus causing the Lift of the L/D ratio to remain constant. Drag is therefore the independent variable in the L/D ratio and changed as the AR was varied. Total drag is the sum of induced (drag due to lift) and parasite drag (drag due to design). As the AR was increased, the induced drag decreased. However, the shrinking chord (wing width) caused an increase in parasite drag. There is a point where the total drag was at a minimum, or optimum drag. Wing 3 produced the optimum drag and, consequently, exhibited the highest L/D ratio and flew the farthest. An understanding of these concepts is essential in order to design aircraft with maximum efficiency and maximum L/D ratio. This is extremely applicable in glider and sailplane design.

Summary Statement

The student designed, constructed, and tested nine wings with the same surface area but different aspect ratios in order to analyze the effects of varying aspect ratios on a toy glider.

Help Received

The student's brother and mother marked the locations of where the glider hit the ground.

Name(s)

Anson F. Stewart

Project Number

S0109

Project Title

The Robins-Magnus Effect and the Effect of Traversing Different Fluid Media on the Velocity of a Rotating Solid Sphere

Abstract

Objectives/Goals

The goal of this experiment was to determine how traversing different immiscible fluid media affects a rotating solid sphere's position at different points in its fall (i.e. its direction) and speed, as caused by the Robins-Magnus effect.

Methods/Materials

A 30 liter aquarium was filled with water, and a ball with radius 3 cm was dropped vertically into the aquarium from a ramp structure that caused the ball to spin. A digital camera with a slow shutter speed as well as a video camera recorded the fall. This was repeated five times. Then 10 liters of water were removed, 10 liters of vegetable oil were added, and the trials were repeated. Water was replaced with oil in these amounts two more times so that the final test condition was all oil, with five trials for each test condition. After experimentation, each photograph was digitally enhanced with superimposed rulers to measure the deflection of the ball from a vertical line at three points in its fall. The video replay was converted into a digital file and used to determine the elapsed time of the ball's fall.

Results

The time of fall ranged from 0.166 seconds, +/- 3 % for all water, to 0.195, +/-5% for all oil. The largest total average deflection was 0.4 cm, in the test condition with 2/3 oil and 1/3 water. In all test conditions except for the condition with all oil, the ball curved to the right in the second half of its fall.

Conclusions/Discussion

As hypothesized, the ball fell more slowly as more oil was added. In all test conditions, the ball was deflected to the right at some point in its fall. Generally, this deflection was more pronounced as more oil was added, again supporting the hypothesis. This increased deflection likely stems from the higher viscosity and associated lower settling rate of the ball in the oil. The data also support that the Robins-Magnus induced deflection of the ball was amplified by passing through the oil-water interface.

Summary Statement

This project investigates how the behavior of a rotating solid sphere varies while transitioning between different fluid media, as influenced by the Robins-Magnus effect.

Help Received

Father activated digital camera during experimentation

CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)

Robert G. Wright

Project Number

S0110

Project Title

Rocket Stability: Are Simplified Methods of Calculating the Center of Pressure Reliable Indicators?

Abstract

Objectives/Goals

The purpose of this project is to determine if the widely used, simplified methods of calculating the center of pressure (CP) of a rocket are reliable. In order for a rocket to be stable, the generally accepted rule is that the CP needs to be at least the width of the body behind the center of gravity (CG). When modifying or scratch-building model rockets, it is very important to know whether the rocket is stable or not. The problem in determining the CP is that complicated math is required. Several simplified methods have been developed so that the average person building model rockets can determine if his/her rockets are stable. However, each method yields a different result. This experiment tests four of the most popular methods.

Methods/Materials

In order to test the simplified methods, five identical model rockets were built except with varying fin heights. Reducing the fin height moves the CP forward. The CG and the CP (using four methods) were measured for the five rockets. In addition, the Swing Test was performed. Each method predicted a different degree of stability for each rocket. After noting what the methods predicted, each of the rockets was launched multiple times to see which ones were stable and which were not. The actual stability of the rockets, based on observing the launches, was compared to the predicted stability of the different methods.

Results

For all five of the rockets, the launches tended to be more stable than the methods predicted.

Conclusions/Discussion

The results showed that the common methods of determining rocket stability are too conservative, in light wind conditions. Rockets that should have been unstable, according to the models, had stable flights. Only one method, the Complete Barrowman Equations, was a reliable predictor of stability.

Summary Statement

This project tested whether the common methods of determining the center of pressure in relationship to the center of gravity of a model rocket are reliable indicators of its stability.

Help Received

Father provided some advice and proofreading for the written portion of the project. He also retrieved the rockets after the launches.

CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)

Jordan R. Young

Project Number

S0111

Project Title

At What Angle Is the Lift of a Wing Maximized?

Abstract

Objectives/Goals

In order for the pilot of an airplane to be able to gain altitude, they must know at which angle of inclination to put the plane. the purpose is to discoverthe angle that gives the plane the most lift. If the angle of the airfoil is increased, then the amout of lift generated will also increase untill it reaches the stall point.

Methods/Materials

This project requires research and development. To start the project, one needs to have an understanding of how an airplane is lifted off the ground, which is called lift. The project required extensive planning. A wind tunnel was built in order to test the angel of attack of the airfoil. Before using the wind tunnel, the angel of attack was tested outside of the wind tunnel. Then, it was tested inside of the tunnel to determine if the generated lift would increase. The angel was tested and recorded in five degree in crements.

Results

The results show that as the angel of attack was increased five degrees the lift increased about .2 ounces outside of the wind tunnel. As the angel of attack was decreasedfive degrees, there was a negative liftof about .2 ounces. The results of the tests in the wind tunnel were similar. As the angel was increased by five degrees, the lift increased by .3-.4 ounces. The stall point for each test was approximately 30 degrees.

Conclusions/Discussion

Overall, the hypothesis is supported. As the angel of attack was increased the amount of lift generated increased untill it reached an exceeded the stall point.

Summary Statement

The objective was to discover the angel that would maximize the lift generated.

Help Received

My mother proof read my research paper. My father helped assemble the Testing apporatus.