CALIFORNIA STATE SCIENCE FAIR
2004 PROJECT SUMMARY

Name(s)
Colleen Loree F. Avila

Project Number
S0101

Project Title
Aerodynamic Shapes

Abstract

Objectives/Goals
The purpose of my experiment was to determine and compare the aerodynamics of custom made plaster shapes when tested within a wind tunnel for drag.

Methods/Materials
The shapes to be tested were made out of Plaster of Paris poured into Dixie Cups, and then custom shaped by hand. A cart apparatus was created out of circuit board material, nylon spacers, screws, and a welding rod in order to suspend the shapes in air. The suspension of the shapes in air provided more accurate data to be formulated from the testing. The shapes were then connected to the cart and placed within the wind tunnel, where the drag and wind speeds could be calculated. The data was then recorded and analyzed.

Results
Shape #2 had the least drag of the eight shapes with a drag of 23 grams at the maximum wind speed of 3,300 ft/min. In second, Shape #6 had a drag of 24 grams, and closely following was Shape #7 with an average drag of 26.5 grams. Shapes #1 and #4 came in fifth with a drag of 27 grams, while Shape #5 had 29 grams. In last place, Shape #3 had the greatest drag at 32 grams at the maximum wind speed. The drag of Shape #8 could not be determined due to unforeseen circumstances. The situation that occurred was caused by the fact that whenever the eighth shape was tested at exactly the maximum wind speed (3,300 ft/min), the cart, in which it was connected, would tilt upwards. This then caused the drag of the shape to remain undetermined. Four additional trials were made for this specific shape in order to guarantee the accuracy of the event; however the cart constantly tilted causing the drag calculations to undetermined.

Conclusions/Discussion
In conclusion, Shape #2 was the most aerodynamic and contained the least drag. This is due to the small amount of surface area and mass that the shape had compared to the others. The simple conic shape of Shape #2 was hypothesized to overcome drag the best, thus the hypothesis was proven correct.

Summary Statement
To determine and compare the aerodynamics of custom designed plaster shapes when tested with a wind tunnel for drag.

Help Received
Mr. Kaura helped setting up appointments to use the wind tunnel; Mr. Schultz and Mr.Gallaway helped provide, assemble, and instruct the use of the wind tunnel; Used equipment at Centennial High in the Industrial Arts Department under the supervision of Mr. Kaura and Mr. Schultz

CALIFORNIA STATE SCIENCE FAIR
2004 PROJECT SUMMARY

Name(s)

Calder J.C. Block

Project Number

S0103

Project Title

Hydrodynamics

Abstract

Objectives/Goals

The purpose of this experiment was to discover if different boat hull shapes affect drag, acceleration, and velocity

Methods/Materials

14 PVC U-yoke sides with connectors, 6 38-inch PVC pipes with holes, 10 38-inch PVC pipes without holes, 11 12-inch PVC pipes, 6 5-inch PVC pipes, 2 PVC straight coupling, 8 PVC 90 degree elbows, 1 CPVC pipe, 1 6 meter vinyl tank, 6 wooden planks, 18 wooden spacer blocks, 2 splash guards, 1 line guide pulley assembly, 2 pulley block assembly, 4 machine screws, 4 wing nuts, 1 30 foot pulley line, 1 Aqua Trak Data Wheel Interface, 1 Laptop

Results

In both the 100 g trials and the 400 g trials The Red Boat had a greater veloctiy and acceleration than The Blue Boat. However in the 100 g trials The Red Boat had greater drag than The Blue Boat. In the 400 g trails The Blue Boat had greater drag.

Conclusions/Discussion

The hypothesis was mostly correct The Red Boat had greater acceleration and velocity than The Blue Boat, however in the 100 g trail The Red Boat had greater drag than The Blue boat.

Summary Statement

The experimentation of different boat hull shapes and how they affect movement.

Help Received

Used Ribet Academy Engineering Lab under the supervision of Mr. Shirajian

CALIFORNIA STATE SCIENCE FAIR
2004 PROJECT SUMMARY

Name(s)

Cori D. Holmes

Project Number

S0104

Project Title

Blunt vs. Tapered: Determining Which Creates the Most Drag

Abstract

Objectives/Goals

The purpose of this experiment was to see which end of a rooftop cargo carrier, blunt or tapered, would most reduce drag when facing forward. The hypothesis is that when the cargo carrier is placed with the blunt end forward and the tapered end to the rear, it will reduce drag more than if the tapered end was facing forward.

Methods/Materials

A roof rack made of aluminum with roller blade wheels attached to reduce friction were used as a testing apparatus, with the cargo carrier placed on top were attached to the top of a jeep which was then driven down a long straight road. Measurements were made using a fish scale, which measured force in terms of pounds and ounces. The measurements were taken for a distance of one mile at 65 MPH. The pounds and ounces were later converted into Newtons.

Results

The average of all tests when the blunt end was facing forward was 72. 83115 Newtons. The lowest test was 65.73925 and the highest was 80.54177 Newtons.

In the tests in which the tapered end was facing forward, the average force was 53. 87769 Newtons. The lowest test was 50.18459 Newtons of force and the highest was 57.72673 Newtons.

Conclusions/Discussion

Placing the cargo carrier with the tapered end forward would be better than if the blunt end was facing forward. The force in Newtons on the tests with the blunt end forward was almost 20 more Newtons than in the tapered end forward tests. My hypothesis was proven wrong in this experiment.

Summary Statement

To see which end of a rooftop cargo carrier, blunt or tapered, would most reduce drag when facing forward.

Help Received

Father helped with assembling testing apparatus and testing.

CALIFORNIA STATE SCIENCE FAIR
2004 PROJECT SUMMARY

Name(s)

Anthony J. Neuberger

Project Number

S0105

Project Title

Design, Analysis, and Optimization of Solid Fuel Rocket Engines

Abstract

Objectives/Goals

Increasing rocket engine efficiency requires maximizing the total impulse generated and tailoring thrust production to the mass of the rocket. By controlling the design elements of an engine, the total impulse generated can be maximized and the thrust profile can be customized. Last year, I demonstrated that optimal rocket flight parameters can be achieved by matching the rocket mass to engine thrust profile. The goal of this project is to identify critical design elements that can be manipulated to maximize total impulse and customize the engine thrust generation profile to optimize rocket lift.

Methods/Materials

I designed rocket engines that allowed me to investigate the contribution of the nozzle inlet shape, nozzle throat diameter and fuel core length and diameter to engine performance. All rocket engines were built to my design specifications and tested in a static engine test device that I built. Data from the test device was documented using a chart recorder that I designed and built. The Y axis (force) of the chart recorder was calibrated using a spring balance. The data from each engine was analyzed by dividing the area under the curve into 0.1second increments.

Results

Completion of this project identified 2 important design parameters, nozzle shape and fuel core structure. The shape of the nozzle inlet was the single most critical factor. A nozzle inlet angle of 90O resulted in the greatest thrust production; however, approximately 40% of the engines engaged the safety device. In contrast, when the nozzle inlet angle was decreased to 74O, the safety device was never engaged; however, the total impulse was significantly reduced. I increased the total impulse generated without engaging the safety device by increasing the nozzle inlet angle to 86O. Additional design elements that were manipulated to increase the total impulse generated include decreasing the diameter of the nozzle bore, increasing the length of the fuel core and increasing the diameter of the fuel core.

Conclusions/Discussion

Four critical design parameters: nozzle inlet shape, nozzle throat area, fuel core length and fuel core diameter were identified and manipulated to maximize the total force generated and to control the thrust generation profile. By carefully integrating these parameters into the final rocket engine design, individual engines can be customized to achieve the maximum lift of individual rockets.

Summary Statement

This project was designed to identify the key design elements of solid fuel rocket engines that can be manipulated to maximize engine efficiency.

Help Received

Ms. Coordt, Ms. Atkinson, Mr. Preske and Mr. Park helped me to understand the new math and physics concepts that I encountered. My Father built the rocket engines.

CALIFORNIA STATE SCIENCE FAIR
2004 PROJECT SUMMARY

Name(s)

Sarah M. Penicks

Project Number

S0106

Project Title

Got Thrust? Got Lift? Got Aerodynamics?

Abstract

Objectives/Goals

To launch three rockets three times, each will have a different fin material (balsa wood, plastic, cork) to see which one will have superior aerodynamics, as well as, greater altitude achieved.

Methods/Materials

I used three Estes Wizard kits, each rocket was the same in weight, shape, and size the only difference is each rocket has a different material for fin(cork, balsa wood,plastic.) I used epoxy glue and #400-600 grit sanding paper. After each rocket was assembled three colors of spray paint was used to identify them. I launched each rocket three times each with B6-4 engine. Using an altitude tracker I calculated how far each rocket flew.

Results

In the first launch, the balsa wood finned rocket traveled the highest at an altitude of 550 feet;the plastic finned rocket came in second with an altitude of 400 feet;the cork finned rocket came in last with the altitude of 300 feet. For the second set of rocket launches, the balsa wood finned rocket again came in first with an altitude of 450 feet;the plastic finned rocket came in a close second at 400 feet;the cork finned rocket finished last with an altitude of 350 feet.The last cycle of rocket launches confirmed the findings from the other two launches. The wooden finned rocket again flew the highest at an altitude of 550 feet;the plastic finned rocket finished second with an altitude of 500 feet. Finally, the cork finned rocket flew into last place with an altitude of 350 feet.

Conclusions/Discussion

In conclusion after conducting the experiment of launching each rocket three times, I have concluded that the balsa wood rocket has superior aerodynamic quality then other materials. Followed by the plastic finned rocket,then the cork finned rocket.

Summary Statement

To launch three rockets three times, each will have a different fin material (balsa wood, plastic, cork) to see which one will have superior aerodynamics, as well as, greater altitude achieved.

Help Received

Shannon Penicks (mother)helped display board; William Penicks(father)helped make display board;Major Philip Laisure for being adult supervisor; L.D.R.S. (Large Dangerous Rocket Ships) for allowing my to launch my rockets.

CALIFORNIA STATE SCIENCE FAIR
2004 PROJECT SUMMARY

Name(s)

Stephanie L. Reilly

Project Number

S0107

Project Title

Catch a Wave

Abstract

Objectives/Goals

My hypothesis for this project was that if different size surfboards were ridden then the longer surfboards would have a longer duration of ride verses a shorter board.

Methods/Materials

To test this hypothesis I obtained three different size surfboards including a 7'0 board, an 8'0 board, and a 9'6 board. I selected four beaches in southern California and one beach on the Hawaiian island of Oahu to perform my experiment. I ride each board for a total of three waves a peice and the times were recorded with a stopwatch. I then went on to assemble my data formally.

Results

The results I gathered showed that the 8'0 board and the 9'6 definitely had a longer ride than the 7'0. At times it was really hard for me stand up and keep my balance on the shorter boards. Up to two full seconds gaped between the different sized boards.

Conclusions/Discussion

I have concluded that the different boards can tell a person just how long a wave can be ridden just by the size, shape, and dimensions of the board itself. The size of the wave also somes into play when concluding my results. It is found that shorter boards are easily ridden on larger, more powerful waves than longer boards. It is just the opposite on smaller, weaker waves.

Summary Statement

My project is about how the length of a surfboard affects the duration of the ride.

Help Received

Parents: bought supplies, drove and flew me to the locations, rented and bought surfboards, timed and recorded all wave rides, and provided meals and lodging.

CALIFORNIA STATE SCIENCE FAIR
2004 PROJECT SUMMARY

Name(s)

Reed Shea

Project Number

S0108

Project Title

What Size Hydrofoil Does My Sailboat Need?

Abstract

Objectives/Goals

To find out what size hydrofoil(s) would be needed to lift and sustain a small sailboat, with myself on it, out of the water. I own a small sailboat, and want to put hydrofoils on it. The reason for this is to make the boat go faster, and doing this as a science project seemed like a perfect way to learn about hydrofoils

Methods/Materials

I did a lot of research, contacting professors as well as people in the business of hydrofoil design. I also used a program called FoilSim, developed and written (in Java) by a group of people at NASA. This was a large part of my project, and gave me the foundation for my actual experiment.

My experiment was conducted by running water down a sluice to a model hydrofoil which I'd built. I placed the foil upside down, so that I could measure the downforce made by the flow of the water. The foil could move up and down, but was anchored so that it couldn't move backwards with the flow of the water. I rigged up a small contraption using a few scales and some fishing line to measure this force, which is the lift produced by the foil.

Results

I had great results from the FoilSim program that I used, as well as from calculations I did with my mentor (my dad, who has a BA in aerospace engineering). Of course, the numbers that I found wouldn't correspond exactly with real-life data, because I didn't calculate in factors such as induced drag or any kind of friction.

Unfortunately, my testing apparatus didn't work as well as I'd hoped. The main reason for this is that I used too small a scale, and the flow of the water was too fast. I calculated how to get the water to flow at 12mph, which it did, however this was too fast for the small size of the foil. The data taken from my trials differed from my theoretical calculations by a factor of six.

Conclusions/Discussion

Because of the inaccuracies of my testing apparatus, I'm inclined to have more faith in my calculated data. If I did my project over again, I would have a larger-scale model. I tried to do that originally, however when I found out that testing tanks cost about $50 per hour to run, I decided that it would be more cost-effective to make my own apparatus.

Although my project doesn't have much in the way of real-world applications, I learned a lot from it, in a subject that interests me. The information and knowledge gained will help me tremendously if and when I design and build hydrofoils for my boat.

Summary Statement

Finding the necessary hydrofoil area to keep a small sailboat, with myself on it, out of the water.

Help Received

I contacted multiple professors and people in the business of hydrofoil design by email, and recieved some general information back from them. My dad helped me out building my testing apparatus, as well as during testing.

CALIFORNIA STATE SCIENCE FAIR
2004 PROJECT SUMMARY

Name(s)

Christopher B. Simpson

Project Number

S0109

Project Title

Generating and Calculating Water Density's Effect on Hydro-Rocket Flight

Abstract

Objectives/Goals

The purpose of this project was to determine if varying the density of water in a hydro-rocket would affect the rocket#s altitude. Spacecraft use the type of motor in a hydro-rocket (reaction motor) to maneuver in space. The project would demonstrate if spacecraft and other reaction motors would benefit from the use of denser fuels.

Methods/Materials

Research began in January after a previous project was determined inconclusive. A two-liter bottle was used as the rocket body. Fins and a nose cone were constructed and added for stability and aerodynamics. The rocket was launched with 800mL of tap water for the control altitude. The density of tap water was .986g/mL. Adding 50g, 100g, 200g, and 300g of sugar varied the density of the tap water. The resulting densities (g/mL) were 1.056, 1.135, 1.254, and 1.344 respectively. The altitude of the rocket was measured using an Astrolabe.

Results

After 34 total launches, the rocket#s average altitude with tap water for fuel was 49m; the rocket#s average altitudes with the denser fuel consisting of 50g, 100g, 200g, and 300g of sugar were 48m, 48m, 36m, and 33m respectively.

Conclusions/Discussion

Overall, the data show that denser fuel does not increase the altitude of a hydro-rocket. Rather, the denser fuel decreases the altitude due to its increased mass. Therefore, the use of denser fuels would not be beneficial to spacecraft and other reaction motors as they only weigh down the system.

Summary Statement

The project was designed to determine if the altitude of a hydro-rocket would be affected by variations in the fuel#s (water#s) density.

Help Received

The student#s younger sibling was used to pull the string that would launch the rockets. This was because the student was 30m away measuring the altitude of the rocket.

Name(s)

Anson F. Stewart

Project Number

S0110

Project Title

The Effect of Temperature on the Angle of a Fluid Stream's Deflection Resulting from the Coanda Effect

Abstract

Objectives/Goals

This project was designed to investigate fluid dynamics, specifically the Coanda effect. Research was conducted to answer the question "What is temperature's influence on the Coanda effect?" A setup was designed to test the hypothesis that the Coanda effect, driven by viscosity (which is inversely related to temperature in liquids), would more noticeable at lower temperatures and less noticeable at higher temperatures.

Methods/Materials

Water, a pitcher, food coloring, plastic tubing, a protractor a small plastic cylinder, a plastic support base, and a Teflon bailer for use as a valve were all gathered. A setup was devised in which water flowed vertically downward tangent to a small cylindrical plastic container. A protractor was attached to the front of the container, to allow angle measurements. Water, heated or cooled to different temperatures, flowed down from a valve, and the angle at which it departed from the plastic after adhering to it was recorded. This was repeated a minimum of four times for every test condition. Video recordings and playback of the experimentation allowed for accurate observations.

Results

Water at about 2 degrees Celsius, 20 degrees Celsius, and 36 degrees Celsius had similar numerical outcomes. The two coolest test conditions (water at 2 degrees Celsius and 20 degrees Celsius) were very close together in angles of deflection. The warm water (36 degrees Celsius) was the only test condition in which the stream consistently wavered between flowing straight down without deflection and curving, so this test condition is overrepresented by its numerical outcome. The hot water (79 degrees Celsius) clearly had the lowest deflection.

Conclusions/Discussion

No results of the experiment indicated that the mechanisms causing the differences in the influence of the Coanda effect were different than hypothesized. Though viscosity, density, and shear forces were not directly measured, no other forces were clearly identifiable based on the Background Research. The water was deflected much less efficiently in the warm test condition, though this is not evident numerically. The peak in the data could be related to water's peak density at 4 degrees Celsius. It is clear from this experiment that significantly increasing the temperature of a fluid diminishes the deflection from that fluid's original course, as caused by the Coanda effect.

Summary Statement

Using a plastic cylinder and streams of water at various temperatures, it was determined whether the temperature of a fluid stream would affect its angle of deflection resulting from the Coanda effect (wall attachment principle).

Help Received

Sister (age 13) helped with some test procedures. Mother helped glue/tape papers to backboard. Father helped obtain the Teflon bailer and provided assistance by proofreading the research paper.