CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Sydney Adcook; Lydia Ignatova

Project Number

J0101

Project Title

Measuring the Lift of Airfoils Using a Wind Tunnel

Abstract

Objectives/Goals

The objective of this study is to determine if the location of the maximum thickness of an airfoil affects the amount of lift generated.

Methods/Materials

Balsa wood to create airfoils, metric scale, airfoil stand, and wind tunnel. We recorded the amount of lift generated when each airfoil was placed into the wind tunnel and onto the scale. The lift is displayed in negative numbers on the scale, because we were measuring the decrease in weight.

Results

The airfoil with the maximum thickness the closest to the tip of the airfoil generated the most lift, the airfoil with the maximum thickness furthest away from the tip created the second-most lift, and the airfoil with the maximum thickness between that of the other two airfoils produced the least lift.

Conclusions/Discussion

The experiment demonstrated that the location of the maximum thickness does have an effect upon the efficiency of the airfoil. However, we did not have access to the required instruments to determine what changed in the way the air flowed around the airfoils to cause this change.

Summary Statement

We showed that the location of the maximum thickness of an airfoil does have an impact on the amount of lift the airfoil generates.

Help Received

We completed this project without significant help from any professional figures. We designed and constructed the airfoils ourselves, and ran the trials without any help.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Victor E. Agbayani

Project Number

J0102

Project Title

How Bernoulli's Equation and Cavitation Predict the Maximum Arc Height of a Siphoned Flow of Water

Abstract

Objectives/Goals

The objective of this study was to determine the maximum arc height of water in a siphon flow.

Methods/Materials

Set up a siphon system using a ladder, buckets, plastic tubing, rope, carabiner, and colored water to try to determine maximum arc height of water in a siphon flow. Raised the arc of the tubing five inches for each trial run. Used Bernoulli's equation to analyze the flow and prove that the math predicts outcome of the experiment.

Results

The siphon flow still functioned with an arc of 7 1/2 feet high. I reached the maximum height to safely measure arc height with my equipment.

Conclusions/Discussion

The arc of the siphon in my experiment reached a height of 7 1/2 feet and I was unable to safely raise the arc any higher. Further research revealed that a siphon with water tends to break at an arc height of 33 feet because cavitation interrupts the flow of the fluid. Modern industry uses the principles of fluid dynamics in many applications.

Summary Statement

I used Bernoulli's equation and cavitation principles to explain results of experiment using water in a siphon flow.

Help Received

I researched and set up the experiment on my own. My father explained the basics of Bernoulli's equation to me and I researched it further on my own.

Name(s)

Akhilesh V. Balasingam

Project Number

J0103

Project Title

Manhattan Fluidics: On Optimizing Network Geometry by Circuit Analogy for Low-cost 3D Printed Lab-on-a-Chip Devices

Abstract

Objectives/Goals

My research goals are (1) to develop an empirical model for flow in 3D printed channel segments, and (2) to use that model to optimize the flow rate in networks composed of fluidic segments connected in series and parallel.

This work responds to a growing need for rapid point-of-care diagnostics that have the potential to reduce healthcare costs, speedup patient treatment and prevent the spread of global pandemics. Unlike conventional microfluidics, 3D printed millifluidics can be manufactured rapidly and inexpensively. This opens the possibility of widespread adoption of onsite testing in low-income countries that are subject to heavy infectious disease burdens. Since 3D printed fluidics is new, fundamental questions remain open, and my research seeks to close this knowledge gap.

Methods/Materials

I designed and 3D printed a set of discrete millifluidic elements of varying lengths and cross-sectional dimensions ranging from 800 micrometers to 2 millimeters. I built a novel test rig and used a video-based method to determine the flow rate of water/glycerin solutions in these elements as a function of driving pressure (ranging between 100-1000 Pascals) with high accuracy. From this data, I extracted a model of the hydraulic resistance of these components as a function of their interior dimensions. Then, I incorporated this model into a Python program, which utilized the analogy between fluid flow in channels and current flow in circuits, to predict flow rates in complex fluidic networks.

Results

The experimentally measured flow rates in discrete components, as a function of cross-sectional area and length showed trends consistent-though not in full agreement-with the ideal behavior predicted by the Hagen-Poiseuille Law. Using a regression method, I determined empirical coefficients to improve the fit between model equations and the measured data. Using this fitted model, and my program I found sets of geometrical parameters that maximized net flow in hierarchically bifurcating fluidic networks, under fixed interior volume constraints.

Conclusions/Discussion

I designed and printed a set of discrete fluidic elements of varying geometry and measured their hydraulic resistance. Using a model extracted from this data I optimized flow rates in a class of fluidic networks that occur frequently in lab-on-a-chip devices.

Summary Statement

I have demonstrated the feasibility of 3D printing complex millifluidic networks with predictable behavior; my contributions to this emerging research area have potential applications in low-cost blood testing and disease screening.

Help Received

I would like to thank my science teacher Mrs. H. Mackewicz for her helpful discussions. I would like to thank my dad and mom for their encouragement throughout the course of this project.

Name(s)
Max Bhatti

Project Number
J0105

Project Title
An Evaluation of the Flight Characteristics of Ornithopter-Type Aircraft Systems

Abstract

Objectives/Goals
The objective of my project is to observe the flight characteristics of thrust, mass & speed of 2-Wing & 4-Wing Penaud ornithopters & to measure the effect of wing battens on these parameters. This project will use a propeller-driven model as a control.
My hypothesis is that since the membrane wings of the ornithopters are very efficient at thrust generation, the 4-Wing ornithopter should generate the most thrust and the control model the least thrust. While the 4-Wing ornithopter would have the most mass & the control model the smallest. Thrust production is predicted to climb linearly with the symetric addition of wing battens. All models are predicted to have very similar thrust curves. Peak thrust-to-mass ratio is predicted to be highest in the control while being the same in the ornithopters.

Methods/Materials
The control model tested was constructed from a kit, while I construct my own ornithopter models for testing. To take thrust measurements, the models were attached upside down to a long ¼" thick square dowel which was in turn attached to a scale. The rubber band was wound 50 times before being released. A stopwatch started at the activation of the model was placed next to the scale while the two screens were filmed. To take mass measurements, the models were weighed several times & their masses were averaged. More trials of the 4-Wing model, models with battens, & speed will be performed very soon.

Results
The peak thrust of the control was 74.53 mN, while the 2-Wing ornithopter gave 25.5 mN. The control produced a sharp 3.06 second burst of thrust while the ornithopter produced a decreasing amount of thrust over a period lasting between 10.88 & 11.67 seconds. The mass of the control model was 17.55 grams. The mass of the 2-Wing ornithopter was 8.85 grams. The peak thrust to mass ratio of the control was 4.25, while the ornithopter had a ratio of 2.88.

Conclusions/Discussion
My results depart completely from my hypothesis except in the area of thrust to mass ratios. The current results show that 2-Wing ornithopter type aircraft provide a small amount of thrust over a large period of time, as an endurance plane or surveillance drone would require. This information is very useful, as ornithopter systems are being considered more & more for things like military surveillance systems, so it is important to learn about how they fly.

Summary Statement
I tested a 2-Wing ornithopter & a propeller driven control model in the criteria of thrust, mass, & thrust-to-mass ratio; currently I am making a 4-Wing model, measuring speed & measuring how wing baffles affect the models' performance.

Help Received
My science teacher Ms. Copeland lent me the digital scale used. Many thanks to my parents, who bought most of the materials & helped me stay on schedule.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Harrison J. Cameron

Project Number

J0106

Project Title

3D Printed Rocket Science

Abstract

Objectives/Goals

I wanted to see how different 3-D printed rockets would fly in linear distance. I also was trying to see why the rockets we use today fly so well. My hypothesis is that the 4 finned rockets with the normal fin design and a longer nose cone would fly the furthest out of the 8 rockets that I had designed.

Methods/Materials

I used my dads 3-D printer to print out 8 rockets we designed using CAD software. We had two nose cone designs and 3 fin designs, each using either 3 or 4 fins. I then went to a park and launched each rocket 3 times using a launcher that my dad and I built. Then I found the center of pressure and center of gravity for each rocket before adding a 0.8 gram weight to the tip of the nose cone. After which I launched each rocket 3 times again and found the center of pressure and center of gravity for each one of the rockets. We recorded each launch using a high speed camera and scale to calculate release velocities.

Results

The rockets with longer nose cones went 30% further than the blunt nose cone rockets. The rocket with the 3 long bodied fins went about a quarter of the length compared to its 4 fin design and the rockets with other fin designs. The wide finned rockets flew about the same as the normal shaped fins. Once I added weight to the rockets, the long nose cones rockets still went about 30% further and all the fin designs showed significant improvement. Even the long bodied 3 fin rocket flew about the same as the others. The high speed camera showed that all of rockets launched at an average of 41m/s with or without the added weight.

Conclusions/Discussion

I learned a lot about the factors that make a rocket fly the best. I learned how the center of gravity has to be ahead of the center of pressure in order for a rocket to remain stable while flying. I also learned how rockets with a more aerodynamic design can cut through the air better.

Summary Statement

Using 3-D printed rockets I showed that an aerodynamic nose cone and moving the center of gravity ahead of the center of pressure is more important for rocket stability and flight performance than the number of fins or their shape.

Help Received

My dad helped me design, print, and launch the rockets and my mom helped me cut things out on my poster board.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Mandy Chan; Samantha Mah-Gersting

Project Number

J0107

Project Title

How Different Types of Gases Affect Balloon Rocket Speed and Distance

Abstract

Objectives/Goals

Our science fair project is based on the investigative question we came up with: How will different types of gases affect balloon rocket speed and distance? Our hypothesis was that the gas helium would make the balloon rocket go the fastest and farthest because according to the background research we found out that helium was the least dense out of the four types of gases we used: CO_2, helium, atmospheric air, and difluoroethane. Because helium was lighter it would move faster.

Methods/Materials

We made a balloon rocket using a straw connected on a string, suspended by two chairs. Balloons inflated with the different gases (CO_2, helium, atmospheric air, or difluoroethane) were taped to the straw. Balloons were blown up to 41 cm circumference with each of our four different gases (CO_2, helium, atmospheric air, or difluoroethane) and the rockets were let go. We recorded the run using video to confirm the time the balloon traveled and measured the distance it traveled from the start. We did 10 trials for each gas.

Results

Our results for the average speed was 216.95 cm per second for CO_2, 152.25 cm per second for helium, 303.24 cm per second for atmospheric air, and 274.54 cm per second for difluoroethane. Shockingly even though difluoroethane was almost 16 times heavier than helium, difluoroethane went the farthest out of all the other 3 gases. Helium went 187.45 cm, air went 379.48 cm, CO_2 went 446.53 cm, and difluoroethane 608.08 cm.

Conclusions/Discussion

There was no relationship between the average speeds and the weight of the gases. That is what made our hypothesis incorrect. The distances were larger when the gases were heavier. There was a direct linear relationship between the weight of the gases and the distance the balloon rocket traveled.

Summary Statement

From our study, we found there is a direct linear relationship between the weight of gases and how far those gases can propel a balloon rocket.

Help Received

Our science teacher, Mr. Cady, reviewed our project plans and results.

Name(s)

Peter L. Eckmann

Project Number

J0108

Project Title

Airfoil Optimization by Applying Evolutionary Algorithms to Computational Fluid Dynamics

Abstract

Objectives/Goals

The goal of my project was to apply a genetic computational strategy to optimize airplane wing shapes.

Methods/Materials

Materials: Python 2.7 programming language interpreter, Gmsh 2.16 3D finite element grid generator, SU2 4.0 Computational Fluid Dynamics (CFD) software, SigmaPlot 10.0 scientific graphing software, Easel 3D carving software, Desktop 3D carving machine (CNC Mill, Carvey; Inventables) at San Diego Central Library and poplar wood for milling, home-made wind tunnel, Force meters (Phidget Bridge with 100 g Micro Load Cells; Phidgets)

Methods: - Write genetic algorithm with non-sexual reproduction in Python to evolve wing shapes with control vertex points to define splines; - Apply Gmsh to generate wing meshes for CFD (wing width, 40 units; computational domain, 100x100 units) ; - Use SU2 for steady-state CFD analysis of lift and drag of wings; - Extract wing shapes by converting JPEG image into SVG format, and importing SVG into Easel software; - Use CNC mill to cut wing shapes in wood; - Construct wind tunnel with drainage pipe, straws, and leaf blower; - Determine lift and drag of milled wings in wind tunnel using Phidgets force meters; - Compare CFD-predicted and wind tunnel-measured value.

Results

1) My results demonstrate that efficient wing shapes can be generated with genetic algorithms.
2) Very efficient (many times more than in commercial aircraft) wings were obtained, but were so thin they could not be easily built or flown on a plane without breaking, much less be able to hold fuel like modern wings.
3) By placing a constraint on the wing thickness, less efficient (but still similar to commercial wings), more structurally sound wings were produced.
4) Wind tunnel measurements showed a strong positive correlation with predicted wing performances, although the results were generally lower than the CFD calculations.

Conclusions/Discussion

My project shows that using natural principles and applying them to optimization problems in aerodynamics and perhaps other engineering challenges can produce strong results that may compete with or even exceed designs generated by other methods.

Summary Statement

An evolutionary algorithm was implemented to optimize the aerodynamic performance of airplane wing shapes, and some representative shapes were machined and tested in a wind tunnel.

Help Received

My dad and mom helped me in discussing experiments and proof reading my project write-up.

Name(s)

James D. Fagan

Project Number

J0109

Project Title

A Study of Aerodynamic Variables on Ducted and Non-Ducted Propulsion Fans

Abstract

Objectives/Goals

My primary objective was to determine if ducted or non-ducted propulsion fans of the same size and propeller velocity would create more thrust and whether various inlet configurations could improve their performance.

Methods/Materials

Ducted and non - ducted propulsion fans with various inlet configurations were mounted atop scales. Measurements were taken before and after applying power. The difference was recorded as net thrust. Air velocities were measured at intake and exhaust to determine thrust in Newton's (theoretically, by means of the thrust formula).

Material used:
Four fan motors (6.3cm dia.),
Three kitchen scales,
Transmitter/Reciever,
Motor speed control,
12 volt power supply,
Various inlet rings.

Results

I found that impellers are more efficient in generating thrust than propellers, and that different inlet configurations can significantly improve thrust generation on a propeller design.

Conclusions/Discussion

Greater thrust generation in an enclosed duct can be explained by reduction of "propeller tip vortices". I was surprised to find that increasing thrust in my static tests was easily achievable by manipulation of inlet designs with principles I learned in my wind tunnel.

Summary Statement

The purpose of my project is to look for propulsion variables that can eventually be applied to my martian drone aircraft design.

Help Received

My dad supervised my use of power tools. Kevin Brooks was the person I bought my motors from, he explained to me how they needed to be set up and operated by remote control, due to being brushless motors.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Angelo Giangiorgi; Pierce Nelson

Project Number

J0110

Project Title

Which Design of Winglet Best Prevents Wingtip Vortices?

Abstract

Objectives/Goals

Our objective was to see which design of winglet best prevents wingtip vortices and also the efficiency of planes by increasing lift and decreasing drag.

Methods/Materials

Wind tunnel at the Naval Postgraduate School in Monterey, 3 different aluminum winglets, an aluminum sting, and a Force-Balance, tested the three different wings at 3 different angles of attack and 3 different wind speeds.

Results

Different wings were placed in a wind tunnel and the lift and drag numbers were recorded. The tests were repeated after notches were made to help with angle of attack to reduce uncontrolled variables.

Conclusions/Discussion

The repeated tests showed that the winglet with only the top was the best compared to the wing with no winglets. It was concluded that the Top-Only winglet has the best lift-to-drag ratio.

Summary Statement

As measured in the wind tunnel with lift and drag, we showed that the Top Only winglet has the best lift:drag ratio.

Help Received

We had the help of Dr. James Paul of Airflow Sciences, and Dr. Kevin Jones, who works at the Naval Postgraduate School.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Jake M. Graham

Project Number

J0111

Project Title

Taking Flight

Abstract

Objectives/Goals

The goal of my project was to find out which airfoil design created the most lift.

Methods/Materials

Using wood and wire hangers, I built a device to test the airfoils. I purchased foam and a foam cutter to make the airfoils. I already had the rest of the tools I needed to complete the project (drill, drill bit, scale, fan, pliers, and wire cutter).

Results

Six different airfoils were tested, three times each. I learned that the airfoil design that was curved on both the top and the bottom created the most lift. This design was called the "Circular Arc".

Conclusions/Discussion

One of the most important factors in aeronautical engineering is the design and effectiveness of airfoils. My experiment compares different airfoil designs and proves that their shape and design can affect the efficiency of air flight. It was concluded that one design ("Circular Arc") was the most efficient airfoil design.

Summary Statement

I determined which type of airfoil would create the most lift.

Help Received

I designed the project by myself. My grandfather helped me design the structure that held the airfoils. My mother and father helped me by proofreading my report. My teacher, Mr. Scott, helped me by answering any scientific questions I had.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Magnus B. Herrlin

Project Number

J0112

Project Title

The Magnus Effect in Action: The Impact of Surface Roughness

Abstract

Objectives/Goals

The objective of my project was to determine if the speed of a rotor ship as propelled by the Magnus Effect is affected by the surface roughness of the rotor when exposed to the same cross-wind. My hypothesis was that a rough rotor would make the boat go faster.

Methods/Materials

I built a model rotor ship with two exchangeable rotors with two different surface roughness by using materials such as coarse sandpaper, a LEGO Technic motor, a 9V battery, and a boat hull. The two rotors had identical dimensions and weight. Some other items I used were a table fan, a timer, and a plastic flower box to act as a tub. I placed the boat on the water in the tub, started the rotor, and turned on the table fan (cross-wind). I timed the boat travelling from one end of the tub to the other and then changed rotors and repeated the process.

Results

In my winning project to the Regional Science Fair, I identified a couple of less than ideal test conditions (mainly interference by room surfaces). So, I repeated the measurements for the CA State Science Fair in a more controlled environment, and I increased the sample size. I performed 40 trials in two series: 20 with the rough rotor, 20 with the smooth rotor. The boat with the rough rotor surface went consistently faster by an average of 22%. The mean speed for each of the two series are three standard deviations apart. These findings support my hypothesis.

Conclusions/Discussion

In aerodynamics, there are two main forces on a body: lift and drag. Golf balls have dimples because they create more lift and less drag when the spinning ball travels through the air. If golf balls were to have a smooth surface, they would go a shorter distance. The same effect could be seen with my spinning rotors, which helped me understand why the boat with the rough rotor went faster. In my case, the "lift" caused by the Magnus Effect propelled the boat forward. An optimization of the surface roughness may increase the speed of the boat beyond my results.

Summary Statement

My project is about finding out whether the speed of a model rotor ship (propelled by the Magnus Effect) depends on the surface roughness of the rotor.

Help Received

None. I designed, built, and performed the experiments myself.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Andrea X. Liu

Project Number

J0113

Project Title

Wood vs. Plastic: Paddle Materials

Abstract

Objectives/Goals

The objective of this study was to determine what paddle material made the boat move at the fastest speed.

Methods/Materials

Homemade boat (topped with various objects to help move), various paddle materials, various tools used to assemble boat and paddles. Measured time boat took to reach the end of three distances with each paddle pair.

Results

Wooden paddles made the boat move at the fastest speed. Repeated trials were done to secure more accurate results, and the time for wooden paddles was always better than those of its plastic counterparts.

Conclusions/Discussion

My project's finding will help people who are engaged in water sports (involving paddling) make better paddle material choices if achieving high speed is a primary goal.

Summary Statement

I showed that wooden paddles are better than plastic ones in making a boat move at a faster speed.

Help Received

I did all of the work by myself. However, my dad gave advice on how to build the boat and my mom taught me how to create the layout of the data graphs.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)
Stanley C. Liu

Project Number
J0114

Project Title
Development of Advanced Microfluidic Devices for Circulating Tumor Cells Captured from Blood Samples

Abstract

Objectives/Goals
In my project, I focused on developing a microfluidic device, which manipulates microfluidic generated vortexes in order to separate and isolate CTC from a blood sample based on their cell mass difference and compared it to an existing CTC detection technology.

Methods/Materials
I fabricated my microfluidic devices using the soft lithography method. A syringe pump and function generator were used to achieve separation of cells. A microscope was used too in the test. The blood sample tested in this project is a control cell line that is commercially available made by Beckman Coulter. It contains mixture of human blood cells. Breast cancer cells (MCF-7) were obtained from a cell line at UC-Irvine.

Results
Both inertial and acoustic vortex microchannel devices displayed successful capture and separation of CTCs from blood cells. However, for the inertial vortex devices, clogging of the 40 µm wide channels by large particles was a large concern. In the acoustic vortex device, clogging is not an issue, and it can process significantly greater volumes of fluid, but could be a longer process due to low flowrate. Both devices are similar in CTC capture efficiency, but the acoustic vortex device provides greater practicality in cancer diagnostics due to the absence of clogging.

Conclusions/Discussion
The microfluidic vortex devices developed in this project successfully captured and separated CTCs from blood cells. By developing an automated, easy-to-use, inexpensive device which can perform early detection for all types of cancers, this CTC microfluidic device can replace conventional CTC detection methods and has the potential to save millions of lives.

Summary Statement
I developed a microfluidic device to separate and isolate circulating tumor cells from a blood sample and compared it with an existing CTC capture technology.

Help Received
Robin Liu (mentor), RD Biosciences Inc; Professor Abe Lee, UCI; Neha Garg, UCI.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Joseph M. Macko

Project Number

J0115

Project Title

Up, Up, and Away! Which Airfoil Generates the Most Lift at Subsonic Speeds?

Abstract

Objectives/Goals

The objective of this study is to find out the most effective airfoil design to generate lift for aircraft going slower then the speed of sound.

Methods/Materials

I tested four common subsonic airfoils and also created a control airfoil. I produced scale versions of these airfoils out of Styrofoam. I exposed each airfoil to three speeds inside of a home made wind tunnel to see how much lift they generated. I measured the lift in grams using a digital scale.

Results

Of the five airfoils tested, the Laminar Flow Airfoil was able to generate the highest total average of lift at 11.223 grams. The Later Airfoil generated 10.667 grams of lift force. The Symmetrical Airfoil generated the third largest at 10.112 grams of lift force. The Clark #Y# Airfoil generated 9.889 grams of lift force. The control, which was used to show that airfoil design does affect lift, generated 8.998 grams of lift. The results show that my hypothesis was correct. The Laminar Flow Airfoil was successful in generating the most lift.

Conclusions/Discussion

Repeated trials with multiple airfoils show that the amount of lift that airfoils produce depends on if the airfoil has a large camber or leading edge. However, in order for an airfoil with a large leading edge to produce a substantial amount of lift, it has to have a slight camber.

Summary Statement

My project shows which common airfoil is the most succesful at generating lift in aircraft going at subsonic speeds, and the characteristics that made it successful.

Help Received

I asked Judy Schulte, an aeronautical engineer at Integrated Procurement Technologies, basic questions and she helped me design my wind tunnel. My dad help me build the wind tunnel. I tested and did data analysis on my own.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)
Vishnu Murali

Project Number
J0116

Project Title
Jet Engines: Manipulating Airflow within a Turbofan Jet Engine in Order to Maximize Output Thrust

Abstract

Objectives/Goals
My project investigates how changing the order, size, and angle of turbofan jet engine's blades manipulates the air flow to maximize output thrust. This work arose out of my desire to maximize the power and efficiency of the turbofan jet engine in a simple way.

Methods/Materials
A model jet engine was constructed from galvanized hot dip steel, steel tubes, threaded rod, ball bearings, hex-nuts and aviation snips. 6 different blades were cut out to form the 5 engine configurations (the control, oversized initial blade, oversized ending blade, oversized initial blade with extra 10 degrees greater end compressor, control with extra 10 degrees end compressor). Those 6 blades were measured using a compass and cut out of galvanized steel using aviation snips. The angles of each blade were measured using a protractor. The motor mounted on the nose of the engine was turned on and a weighing machine was placed behind the engine to measure the output thrust. The motor was set at 8 different speeds, 4 low and 4 high RPMs. For each RPM, the output thrust measured by the weighing machine, was recorded in grams and then converted to Newton. This was repeated 4 times for each of the different configurations.

Results
In this experiment, 2 results were found since different engine configurations performed better at different RPM. The Big Fan with Extra compressor was the best at high RPM averaging out 0.069678 Newton of thrust at 20,000 RPM. The Big Back blade excelled at the lower RPM since it averaged out at 0.002646 Newton of thrust at 900 RPM.

Conclusions/Discussion
This experiment proves that manipulating the order, size, and angle in a turbofan jet engine can maximize it#s thrust production. This experiment also points out that no jet engine can be made such that it can provide maximum thrust at all RPM. This research backs up my hypothesis that high bypass engines will perform better. Engines with big blades or high bypass generally did better.

Summary Statement
This homemade engine model demonstrates that manipulating the size, angle, and order of turbofan jet engines blades can maximize the output thrust.

Help Received
I would like to thank my science teachers Mrs. Shah and Mr. Okimura for their helpful discussions, and advice on this project. I would like to thank my mom for her brutal criticism throughout the science fair process, and my dad for going to homedepot on short notices to purchase the necessary supplies.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Jaden T. Notehelfer

Project Number

J0117

Project Title

Propulsion Possibilities: Finding the Most Efficient Propellers for Nanobots

Abstract

Objectives/Goals

The objective of my experiment was to find out the most efficient propeller design for a nanobot moving in the blood stream. My hypothesis is that if I use a propeller designed like an Archimedes screw, it will be more efficient than other designs.

Methods/Materials

I designed 7 different propellers and printed them in plastic on a 3D printer.
The propellers were each tested 5 times at 3 different voltages: 0.75 v, 1.0 v, and 1.4 v. The power supply had digital readings for accuracy. Each propeller started at the same point and each one moved 25 centimeters. The recorded data was the electrical current and time for each trial.

Results

The data does not support my hypothesis that the Archimedes screw will be the most efficient. The most efficient one was the "Broken Starfish" (#7) at 0.75 volts. The "Play Dough" design (#6) came next. Only then did the Archimedes screw come in third.

Conclusions/Discussion

The two best propellers both had inclines in their spirals of more than 45 degrees. This made a big difference. Also, the faster a propeller is spinning and the thinner the gap in the propeller for the liquid, the less time the liquid has to fill the gap. This is because the speed of the blades and their thickness decides the actual window of time for the liquid to get in and out. And when it gets pushed away the gap is not fully filled, and less liquid is pushed. Less liquid is less force and less force is less efficiency. (General Thrust Propulsion, 2015)

Scientists can use my information to design better propellers for small scales or dense liquids, and then we can evolve these into a new generation and a way to deliver life-saving drugs into any place in the body, saving people from things such as cancer.

Summary Statement

Finding an efficient propeller design for a robot in the blood stream.

Help Received

I appreciate the advice from my science teacher, Mrs. Miller, and Dr. Steven Long, retired UCSB professor.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Jian Park

Project Number

J0118

Project Title

Elliptical Wingtip Extensions: A Novel Way to Improve Airplane Performance

Abstract

Objectives/Goals

My research focuses on designing prototypes of novel wings with elliptical wingtip extensions that can increase the lift-to-drag ratio of an airplane. This research also seeks to find the optimal length of the wingtip that can improve performance under various flight conditions.

Methods/Materials

After surveying existing wing designs, I designed eight different model wings including wings with various lengths of elliptical wingtips. Desmos, a graphing calculator application was used to calculate and plot coordination of the wings. The plotted geometric data of wings were transferred to Matlab, and I used Tornado (A Vortex Lattice Method Simulator that runs on Matlab) to simulate the lift to drag ratio of each of them.

The computer simulation results were verified with wind tunnel tests of 3D printed wings. Lift and drag of each model were measured with LabQuest 2 Vernier with force sensors. To create physical wings, Matlab lattice data of wings were imported to SketchUp, and airfoil shape was applied to them. Then the 3D models were sent to Sculpteo, a 3D printing service.

Results

In the computer simulation trials, wings with Elliptical Wingtip Extensions have produced a better lift-to-drag ratio compared to the conventional wings or the vertical winglet extension. Among them, a specific Elliptical Wingtip Extension model has shown the most efficient lift-to-drag ratio compared to other wings throughout the majority of the testing conditions.

In the wind tunnel tests, the measured results of lift-to-drag ratio showed higher sensitivity to the angles of attack than the computer simulation. While there was no single model that had the highest lift-to-drag ratio across all the angles of attack, but two models with Elliptical Wingtip Extensions have shown the best lift to drag ratios during several testing conditions.

Conclusions/Discussion

Throughout the computer simulations and wind tunnel tests with different speeds and angles, wings with elliptical wingtip extensions have shown to produce a higher lift-to-drag ratio than conventional wing designs in general. The optimal length of the wingtip was identified through the computer simulations.

Summary Statement

I designed new wing models with elliptical wingtip extensions that can increase the lift-to-drag ratio of an airplane. Performance of the wings were computer-simulated and verified with wind tunnel tests.

Help Received

John Briner, my science teacher and Deborah Terra, a science teacher of Fairmont Prep School allowed me to borrow a wind tunnel and my parents bought Matlab and placed orders for 3d printing. I could design and create wing models and performed computer simulation and wind tunnel tests by myself with

Name(s)

Erik Quiroz; Sriram Tipirneni

Project Number

J0119

Project Title

Wide Plane vs. Narrow Plane: Which Paper Airplane Flies Farther?

Abstract

Objectives/Goals

The objective of this study is to determine which design flies farther, a wide plane or a long narrow plane.

Methods/Materials

10 wide paper airplanes, 10 long narrow paper airplanes, tape measure. We threw each airplane in our our backyard on a calm day. We threw each plane from the same starting point. We measured the distance traveled for each airplane and recorded the data.

Results

The wide planes traveled an average distance of 30 feet 2 inches. The long narrow planes traveled an average of 21 feet and 3 inches.

Conclusions/Discussion

The wide planes traveled an average of 9 feet 1 inch farther than the long narrow planes.

Summary Statement

We determined that wide airplane designs fly farther than long narrow designs.

Help Received

My dad showed us how to create the graphs in Excel.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Blake T. Scurry

Project Number

J0120

Project Title

The Need for Speed: Optimum Angle of Attacks for a Race Car Rear Airfoil

Abstract

Objectives/Goals

The objective of this project is to determine what kind of airfoil or spoiler based on angle of attack provides the best turning performance with the best speed.

Methods/Materials

This experiment was conducted by creating a low speed wind tunnel built of cardboard, wood, Plexiglas, and used a house fan for wind generation. It was built to test the effects of changing angle of attack on a symmetrical airfoil. Dry ice was used for flow visualization. The airfoil is made of foam and cut using a hot wire cutter. The data was collected through photography at various fan speeds and angles of attack of the airfoil.

Results

The results of the images of the airflow over the airfoil or wing and the angle of attack where the flow started to separate correlated to the hypothesis of what was predicted for optimum down force.

Conclusions/Discussion

Despite limitations to the experiment using a home built wind tunnel, The hypothesis was validated through use of photography and analysis. The optimum airfoil for a race car needs to be designed with a -20 degree angle of attack to produce the best traction and braking performance.

Summary Statement

Flow visualization proved optimum down force occurred at -20 degrees angle of attack to due to initial flow separation

Help Received

My father helped me construct the wind tunnel I designed based on research. My father, teacher and neighbor who is an engineer reviewed my work.

Name(s)
Liliana Torres

Project Number
J0121

Project Title
Wind Power: Does the Number of Blades on a Wind Turbine Affect Energy Produced?

Abstract

Objectives/Goals
The objective of this project is to find the optimal number of blades on a pinwheel style wind turbine to produce maximum energy measured in volts.

Methods/Materials
I am using four different plastic pinwheel designs (3, 4, 5, and 6 blades). I am using a Lego Mindstorm kit to attach my pinwheels to and to accurately record voltage produced. I also used a standing fan to create a constant source of wind for my pinwheels.

Results
I discovered the optimal blade number to produce maximum voltage was the four-blade pinwheel. On average the the 4-blade pinwheel produced 2.21 volts. The 3-blade pinwheel was found to be 100% non-optimal as it produced 0 volts in all testing trials.

Conclusions/Discussion
I learned that the pinwheel with four blades produces more energy than any of the other pinwheels I have tested. It is possible that the four blade pinwheel is the best at producing energy, because its blades have the biggest surface area. Since this number of blades on pinwheels produces the most energy, they may be a very efficient way to make energy using wind turbines. This is similar to how scientists test wind turbines in real life. They build prototypes of a wind turbines and see which ones can produce the most energy just as I have done.

Summary Statement
I proved that a 4-bladed pinwheel turbine produced the maximum voltage.

Help Received
Robert Nelson, Robotics Instructor at Sanger Academy Charter School