CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)
Daelin T. Arney

Project Number
S0301

Project Title
M.A.P

Abstract

Objectives/Goals
The purpose of this project was to create a prosthetic forearm that could utilize synthetic muscles, operate off of a biometric system, and be made inexpensively. I based this design off the concepts of my previous years project P.A.M (Pneumatically Augmentable Muscle). My present project by the name of M.A.P (Maximum Articulation Prosthetic) relates to P.A.M in the fact that it uses artificial muscles to actuate, instead of present day standard servo motors or hydraulics. However the distinct dilation of this model to the prior is that of the method of actuation.M.A.P requires and raw electrical impulse to actuate the muscle, and in turn articulate the prosthetic.

Methods/Materials
After a period of study it became apparent that a number of aspects pertaining to M.A.Ps construction had to be revised. For instants the original design called for ten muscles (two per finger). The revised version calls for five muscles (one per finger). Each muscle would only preform subduction and there would be an elastic band that would abduct the finger when flexion is ceased. A more developed version of M.A.P will also allow for a suspension system within the arm that would allow for the Patient to support their body weight on the prosthetic its self. This would solve the ultimate problem of both comfort and strength related to weight capacity.

Results
M.A.P operates using a three stage computing method, as shown in (E). First the muscle sensor (red board in E) receives electrical impulses from the digatorums located in the forearm threw medium of electrodes. These are the muscles used to actuate our natural fingers. Once the sensor receives the signal it then translates that signal into a rectified signal.Once this is obtained it is then relayed to the MCP 3208 p in the bread board this chip applies voltage values. These voltage values are then corresponded to the propeller board which tells which muscle to flex.

Conclusions/Discussion
This project is not yet finished and as a result of that concluding data cannot be provided. Although the research to date is showing promising potential and with time and experimentation the creation of M.A.P can become a reality. Hopefully one day M.A.P can be my first step at creating a piece of technology that will help improve and enrich a person#s life.

Summary Statement
To create a prosthetic that utilizes synthetic muscles and a biometric system

Help Received
Jeff Martin from Parallax Inc.

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)
Jarrison Ball; Matthew Harris

Project Number
S0302

Project Title
The Effect of Frost on an Aircraft Wing

Abstract

Objectives/Goals
Our objective is to learn if sandpaper (simulating frost) on the upper surface of a wing will produce significantly less lift than a clean wing without sandpaper.

Methods/Materials
We constructed three control wings and three dirty wings with sandpaper attached to the upper surface. Each group had three wings so different angles of attack could be tested including 0, 5, and 10 degree angle of attack. After one round of tests we added 4oz of weight to each wing and retested all wings. Finally for the last round we added 10 oz of additional weight. This should simulate flights of empty, partially full, and full aircraft. A wind tunnel made by Aerolab was used.

Results
All light wings with no additional weight produced lift that exceeded the top of the scale with the exception of the dirty wing at zero angle of attack which produced .8 lbs.
Wings with 4 oz of additional weight added showed a reduction in lift for all wings.
Zero degree - clean .6 lbs dirty .4 lbs
5 degree - clean 1.1 lbs dirty .4 lbs
10 degree - clean .85 dirty .8
Wings with 10oz additional weight added:
Zero degree - clean .3 lbs dirty .05 lbs
5 degree - clean .5 lbs dirty .1 lbs
10 degree - clean .4 lbs dirty .35 lbs

Conclusions/Discussion
The data confirmed our hypothesis as tests showed a reduction in lift between the clean and dirty wings. The heavy wings appeared to have the most critical results because there was almost no lift created for the zero and five degree angle of attack dirty wings.

Summary Statement
We wanted to prove that even a slightly rough surface can reduce lift created by a wing.

Help Received
Mentor and father helped assemble the wind tunnel.

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)
Tristan A. Brousseau

Project Number
S0303

Project Title
The Green Steam Engine

Abstract

Objectives/Goals
Can the 2 Cylinders, Green Steam Engine TM be built as easily as stated?
Is this design a viable source of alternative energy?

Methods/Materials
1 - 7/8# X 6# steel bolt; 1 - 2# X 1-1/4# X 2# aluminum bar; 1 - flex rod 1/2# X 6#; 1 - 1/2# X 6# steel rod; 2 - 10-32 rod ends; 4 - 3/8# X 15# steel rod; 1 - 1/8# X 12# brass rod; 2 - 1/2# pillow block bearings; 1 - 1/2" X 6# hardened shaft; 1 - 1# X ## bronze bushing; 1 - 3/4# X 2#stainless steel rod; 2 - 5/8# snap rings; 1 - 10mm X 2-1/2# hardened bolt; 2 - 5/8# OD 10 mm ID needle bearings; 2 - 5/16 nuts; 4 - 3/8# nuts; 4 - 3/8# lock washers; 1 - 12" x 24" x 1" board; 1 - 2# X 1-1/4# X 2# aluminum bar; 1 - flex rod ½# X 6#; 1 - 1/2" X 6# steel rod; 2 - 10-32 rod ends (plastic or steel, hobby shop item); 4 - 3/8# X 15# steel rod; 1 - 1/8# X 12# brass rod; 2 - 1/2" pillow block bearings; 1 - 1/2" X 6# hardened shaft; 1 - 1# X 3/4# bronze bushing; 1 - 3/4" X 2# stainless steel rod; 2 - 5/8# snap rings; 1 - 10mm X 2-1/2# hardened bolt; 2 - 5/8# OD 10 mm ID needle bearings; 2 - 5/16 nuts; 4 - 3/8# nuts; 4 - 3/8# lock washers; 1 - 12" x 24" x 1" board.

Results
The engine was able to be built as stated.
Numerous parts had to be machined at professional machine shop.
The engine ran well utilizing an air compressor to simulate steam pressure.
It needed little lubricant and the noise and vibration was at a minimum.

Conclusions/Discussion
The Green Steam Engine was relatively easy to build with off-the-shelf materials and could be used as alternative power source.

Summary Statement
The potential of using the Green Steam Engine as an alternate source for small scale power.

Help Received
A professional machine shop fabricated some of my parts.

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)

Olin F. Bruton

Project Number

S0304

Project Title

Make Your Own Speed: Novel Use of Fluid Dynamics in Channel Bottoms

Abstract

Objectives/Goals

This experiment sought to discover the most effective angle of channel, and at what angle does air speed begin to decrease? Also the correlation between the opening of the channel and the angle in relation to windspeed.

Methods/Materials

materials: wood-hinges-shop vac -anemometer - air duct -tupperware-weather stripping-caulking sandpaper-electric sander-latches.

Procedure:

1 # set channel to 0 degrees
2 # turn shop vac to blow
3 # measure m/s using anemometer
4 # repeat steps 1 - 3 for angles 5 to 25 degrees
5 # repeat steps 1 - 4 five times, take the average of each angle for the five trials

Results

My experiment concluded that the optimum angle of a channel was 20 degrees with a four inch opening. Any angle larger that that would detriment the wind speed.

Conclusions/Discussion

My first idea was to make a complex yet interesting water channel, it became apparent however that that design would be much too advanced and would require unattainable materials. I then regressed to a simpler yet still complex set of three different channel designs. Soon after, I replaced water with another fluid, air. Though different, air can be used to exemplify the properties of fluid dynamics. My final project, instead of a whole channel focused specifically on the angles of the channel. I wanted to discover at what angle does the speed of the air increase, and at what angle does the small opening begin to be a detriment to the speed. When I first began my experiment. My design worked as I expected, however, my hypothesis was incorrect; I thought that 15 degrees of angle would produce the most speed. My findings showed that 20 degrees actually created the most speed, from that point speed decreased. Even though my final experiment did not occur exactly how I imagined, it taught me about the intricacies of fluid dynamics. Channel Bottoms can be used in many other fields, such as shipping, boats and any application involving fluids. The increased speed a channel provides could be useful in a multitude of designs.

Summary Statement

To discover the correlation between channel angle and opening in relation to wind velocity.

Help Received

My father was a huge help in creating the wind/channel device, and Dwight Rowe provided the anemometer.

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)
John Chapman A. Caddell

Project Number
S0305

Project Title
The Leidenpump: A Non-Mechanical Means of Fluid Delivery

Abstract

Objectives/Goals
The main purpose of this project was to determine the viability of a pump utilizing the Leidenfrost Effect. Non-mechanical, this proposed method of coolant delivery only requires a unique, asymmetrical ratchet pattern and a significant temperature differential between the substance being "pumped" and the surface along which it is moving.

Methods/Materials
Two models of brass modules of a length of one inch with an internal concentrically grooved ratchet pattern were placed end-to-end in both a two-foot and a four-foot electrically heated hose. The temperature was adjusted with a controller using degrees Fahrenheit. Distilled water was dispensed directly into the pipe through a hole in the surface by a thin metal nozzle. Measuring change in mass and the average speed of droplets through the tube allowed ideal conditions to be determined.

Results
Droplets consistently traveled in the same direction through the tube, against the ratchets, at the Leidenfrost point. Average droplet velocity decreased as droplet mass and the slope of the tube increased. Changing the temperature also affected average droplet velocity. After reaching the Leidenfrost point, average droplet velocity rapidly increased before decreasing slowly. Unexpectedly, droplet mass increased as the droplets passed through the tube. A smaller mass gain was found when moisture was evacuated from the tube.

Conclusions/Discussion
A tube with a ratcheted internal surface is a viable method for the non-mechanical delivery of a coolant. This technology could be used for anumber of applications, particularly for cooling nuclear reactors by delivering essential coolant without the use of any energy beyond the thermal energy of the reactor itself. It was also found that hot water vapor in the tubular environment condensed on the relatively cool droplets, an unexpected finding without precedent in the relevant scientific literature.

Summary Statement
This project is concerned with the construction of a non-mechanical means of delivering a fluid, a pump, using only thermal energy.

Help Received
Grandfather helped procure and explain the operation of testing equipment; Dispensing system donated by Nordson/EFD; Heated hoses donated by Universal Heated Hoses; Machining assistance from Sunshine Products USA

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)
Alex L. Chang

Project Number
S0306

Project Title
Surviving Earthquakes: A Novel 2-D Magnetically Levitated Seismic Base Isolation System

Abstract

Objectives/Goals
The aim of this project was to develop a novel seismic base isolation system that utilizes magnetic levitation to isolate the building from the earth and compare its effectiveness to modern seismic base isolation systems.

Methods/Materials
Place model building on magnetically-levitated, fixed, seismic vibration reducing, or friction-reducing platform and place to shaking table. Set up video camera to next to model building so that model building is directly in front of gridpaper in the video and begin recording once experiment begins. Shake the model building for ten seconds. Analyze the video taken by the video camera by playing it in slow motion. Measure displacement relative to the gridpaper at corner positions of the model building.

Materials:
Poplar Wood Board to serve as base of model building
Pine Wood Board for the middle layer and top layer of model building
Reciprocating Saw for powering the shaking table
Neodymium Magnets for levitating the middle slab and the model building
Compression Springs for construction of model building

Results
The lateral displacement of structural members of the model building is reflected by the net change in phi-angle, which measures the angular deviation from initial, vertical position of a structural member when subjected to vibratory shaking, and is directly related to the shear force sustained by the structural member. The phi-angle was calculated by first measuring lateral displacement and then using trigonometric relationships to calculate the phi-angle. In general, magnetically-levitated buildings gain a 75%, a 67%, and a 50% reduction in change in phi-angle from buildings supported by fixed foundation, seismic vibration reducing system, and friction reducing system, respectively.

Conclusions/Discussion
The experiment validated the efficacy of the novel magnetic levitation seismic base isolation system. By levitating the building and maintaining points of friction with only the low friction reducers placed at the sides of the building, magnetic levitation is a viable method of passive vibration control. Experiments conducted along two directions additionally verified that magnetic levitation can be used to reduce structural damage in multiple directions of shaking.

Summary Statement
The project develops a novel seismic base isolation system utilizing magnetic levitation and compares its performance to that of current base isolation systems

Help Received
Father helped with cutting wood; mother and advisor provided significant motiviation

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)

Jerry Y. Chen

Project Number

S0307

Project Title

Time-Variant Damping Method to Reduce Vibration Damages to Mechanical Structures

Abstract

Objectives/Goals

The objective is to try to improve the performance of the tuned mass damper by using a time-variant damping coefficient (a time-variant damping function). A damping function could result in lower building movement amplitude and lower building energy than a traditional constant damping coefficient.

Methods/Materials

The study is done entirely using computer simulations in MATLAB. The building and tuned mass system are represented using the 2-degree-of-freedom spring-mass-damper system. First, building parameters are researched for a realistic representation in the study. Control runs are performed using a constant damping coefficient at three distinct frequencies near the system's natural frequency. The time-variant damping function is then applied under the same conditions as the constant damping coefficient, and the performance of each damping method is compared and investigated. The building displacement and building energy are compared and are used as performance criteria.

Results

The study was carried out at the frequencies of 12, 12.5, and 13 rad/s. At the frequency of 12 rad/s, a 33% reduction in building movement from 17.08 centimeters to 11.46 centimeters and a 52% reduction in building energy from 436 megajoules to 210 megajoules were achieved. At the frequency of 12.5 rad/s, there appeared to be no distinct improvement from the constant damping coefficient. At the frequency of 13 rad/s, a 27% reduction in building movement from 17.04 centimeters to 12.62 centimeters and a 45% reduction in building energy from 527 megajoules to 290 megajoules were achieved.

Conclusions/Discussion

The time-variant damping function has the potential to outperform the traditional constant damping coefficient by reducing building movements by up to 33% and building energy by over 50%. However, the time-variant damping function is frequency specific and not all frequencies exhibit similar improvement in performance. It is also difficult to find the ideal combination of values for the time-variant damping function that will result in the ideal performance in an earthquake. While clearly it is an ideal improvement over the constant damping coefficient, further research is necessary to make a time-variant damping function practical for common use.

Summary Statement

This project studies time-variant damping functions for the purpose of improving tuned mass damper effectiveness at reducing building movements and damages during an earthquake.

Help Received

Professor Chung-Kuan Cheng helped supervise and guide the research, Graduate students Xiang Zhang and Howard Zhuang helped with MATLAB issues, and parents helped with assembling the board

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)

Jessica Chiu

Project Number

S0308

Project Title

Aeroelastic Flight Dynamic Modeling and Fabrication of an Adaptive Camber-Morphing Aircraft Using Nickel Titanium Alloys

Abstract

Objectives/Goals

The concept of an adaptive unmanned aerial vehicle with variable camber morphing wings has been proposed to evaluate its flight characteristics and to investigate the feasibility of using the shape-memory alloy wires, Flexinol, to change the shape of the wing and to address the global challenge of improving aircraft fuel efficiency.

Methods/Materials

The adaptive aircraft was constructed by modifying the fuselage and wings of a D.53 Hummingbird remote controlled aircraft and installing flexible control surfaces which use Flexinol Smart Material Actuators to accomplish the proposed variable camber mechanism. Surface continuity was provided by a flexible skin using the thermoplastic polyurethane-coated film Dureflex, which provided sufficient strength and elasticity for the wing in both baseline and morphing configuration. An unaltered remote controlled aircraft using standard micro servos and ailerons was then constructed as a control for comparison.

The aerodynamic consequences of the wing deformation in the camber-varying morphing wing were then quantified with the experimental data attained from a Scantek AeroStream Wind Tunnel, Computational Fluid Dynamic flight simulation softwares XFOIL and Athena Vortex Lattice, and actual test flights.

Results

The wind tunnel results showed significant advantages of the variable camber over the conventional profiles with a discrete trailing edge, such as higher stall angle and higher lift-to-drag ratio. Shown through titanium-tetrachloride smoke visualization, the variable-camber trailing edge reduces the possibility of a laminar separation bubble, which would lead to lower profile drag. Flight tests demonstrated that the morphing surfaces and the Flexinol wires were sufficient to control aircraft in roll, taking off and landing at a 30% steeper angle than the unmodified rc aircraft. The total flight time of the adaptive aircraft was 15 minutes.

Conclusions/Discussion

Ultimately, it was demonstrated that a non-planar wing optimization concept such as a variable camber morphing wing can reduce the drag on traditional wing configurations during cruise and enhance lift performance during take-off and landing compared to conventional actuation systems, bringing future aircraft concepts to the next level in terms of performance, efficiency, and maneuverability.

Summary Statement

In this research, an adaptive radio-controlled aircraft with aeroelastically tailored variable camber morphing wings using nickel-titanium control surfaces was fabricated and flown in order to assess its aerodynamic benefits and penalties.

Help Received

Aerosente Co. and StevensAero Co. generously supplied balsa wood laser-cut parts, radio transceiver and receiver, motor-gear and servos; NASA engineer referred me to various Computational Fluid Dynamic and CAD software; AP Physics teacher supervised me with wind tunnel.

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)
William deBruynKops; Cooper Johnson

Project Number
S0309

Project Title
Maximizing the Efficiency of a Parabolic Solar Water Heater

Abstract

Objectives/Goals
A solar water heater is designed that uses the properties of a parabola to heat water and maximize the efficiency of this transfer through flow rate. If the flow rate of the system was decreased the overall temperature of the system would increase at a faster rate.

Methods/Materials
A structure is created that includes a 4' x 8' mirrored acrylic sheet that is shaped into a parabolic frame. A copper pipe is positioned through the focal point of the parabola and water is cycled through in a closed system.

Results
Each flow rate is tested by filling the system with 5 gallons of water and then letting the system run for 35 minutes, recording the temperature of the system at 5 minute intervals. The slowest flow rate was most effective and heated the water to 112 degrees fahrenheit after 35 minutes.

Conclusions/Discussion
This proves the hypothesis is correct as the slowest flow rate was the most efficient in heating the water.

Summary Statement
This project is designed to create a parabolic solar water heater and maximize the efficiency of this device.

Help Received
Dad helped with construction and plumbing.

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)
Amy Z. Dong

Project Number
S0310

Project Title
The Development of a Hybrid Battery and Solar Panel System to Power an Ultra-lightweight Small Airplane

Abstract

Objectives/Goals
Currently airplanes must consume fuel to obtain the energy needed to fly. Is it possible to substitute electricity for gas to power an airplane? Is there enough energy produced from solar cells to power an airplane? The objective of this project is to construct a solar harvesting system for a model airplane, and to integrate the solar harvesting system on a model airplane, with and without a battery system.

Methods/Materials
First, to test if a model airplane I assembled can be powered by solar panels alone, I built a solar harvesting system. Four solar panels were soldered with wires and connected in parallel. The wires are connected to the Li-Po balance charger and the airplane power system. The four flexible solar panels were then installed on the wing. Tests were conducted. Second, I constructed an integrated hybrid battery and solar panel system by connecting a Li-Po battery with the Li-Po balance charger and the airplane power system and tested the performance of the airplane.

Results
The power generated from the solar panel system alone was not enough to move the airplane, but noise can be heard from the running motor. However, the energy generated from the integrated hybrid battery and solar panel system was able to power the airplane, and the airplane was able to successfully run on various surface, take off from concrete ground and fly in the air for less than one minute each time I tested the airplane.

Conclusions/Discussion
The experiments demonstrated that an integrated hybrid battery and solar panel system has the potential to generate enough power to fly an airplane. Since the efficiencies of current flexible solar panels on the market are low, the primary way to harvest more solar power is to increase the wing span. The weight increase due to solar panels installed, chargers, and wires, etc in a hybrid system would require additional power to fly the airplane. Increasing solar panel efficiencies is another area for further study to improve the viability of using solar power for airplanes.

Summary Statement
I constructed a solar harvesting system for a model airplane and created an integrated hybrid battery and solar panel system that was able to generate enough power to fly the model airplane.

Help Received
Father taught me how to use soldering tools. Advisor Mrs. Olivares proofread my report.

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)
Eleanor O. Frost

Project Number
S0311

Project Title
Increasing Power Output by Reducing the Windmill Blade Tip Vortex

Abstract

Objectives/Goals
As the blade of a horizontal axis windmill passes through the air, air pressure creates lift which improves blade performance. However, air pressure forms a vortex at the tip, reducing power output. A blade tip winglet can reduce the size of the vortex. (Xia 2013) My hypothesis is that the airfoils with winglets will produce greater electrical output than the airfoils without winglets.

Methods/Materials
To test my hypothesis, I used a windmill and wind tunnel design inspired by a 2009 US Department of Energy Report. The set up was similar to that used by Birch and Wilson in their 2013 study of the vortex. I tested 2 inch and 5 inch, Flat Bottomed and Symmetric blades with and without a winglet, at static angles from 5 to 15 degrees. The winglet was made of balsa wood and added to the blade tip; weight was added to the non-winglet blade so the blades were the same weight and had the same rotational inertia. The construction of the blades was inspired by a 2010 Sandia Labs paper, published in conjunction with the USDOE Office of Renewable Energy. I recorded 20 observations for each test. I averaged the results and calculated the standard deviation for each test. I calculated a t test statistic to see if the results were statistically significant to a 95% confidence level.

Results
My analysis of the experimental data shows that my hypothesis could not be supported to a 95% level of confidence. For the 2 inch blades, the tests without the winglet produced more power than those with the winglet but the results were not statistically significant. The 2 inch flat, 10 degree static angle test analysis showed that the blade without the winglet produced more power to a confidence level of just over 90%, suggesting that any benefit created by the winglet was overcome by additional drag. For the 5 inch flat blades, set to a static angles of 5 and 10 degrees, the blades with the winglet produced more power, however these results are not statistically significant.

Conclusions/Discussion
The test results generally suggest that any benefit from the winglet was overcome by drag added by the winglet. The 2013 winglet study by Xiu suggests there needs to be a match between the local flow and the design of the winglet. In future work, I would like to model the local flow and better match the design of the winglet to that local flow.

Summary Statement
Environmental Science

Help Received
Professor Farhat was very encouraging and supportive.

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)
Rae J. Holcomb

Project Number
S0312

Project Title
A Study of Fluid Resistance in Shear-Thickening Non-Newtonian Fluids

Abstract

Objectives/Goals
This project compared the properties of two types of non-Newtonian fluids, colloidal and polymeric, and searched for and found a mechanism causing those properties at a molecular level.

Methods/Materials
Seven fluids were tested in this experiment: water and glycerin (Newtonian fluids used as controls), two polymeric fluids (polyvinyl acetate and guar gum), and three colloidal fluids (two cornstarch mixtures and a dilution of clay). These fluids were subjected to four tests that measured their viscosity, how much they exhibit the Weissenberg effect, and their behavior when drawn through a syringe. The initial experimental design to test for viscosity failed, so the experimenter designed and constructed an original apparatus. Over five hundred measurements were taken with it.

Results
When testing for the Weissenberg effect, it was found that fluids with similar molecular structures (polymeric vs. colloidal) responded similarly to each other but distinctly from those with different structures. It was also found that when sucked into a syringe, the colloidal fluids separated into fluids with different densities. When testing viscosity, it was found that the viscosity of guar gum fluid (a polymer) decreased in response to mechanical motion slicing through the fluid.

Conclusions/Discussion
The results of the experiments indicated that the properties of each fluid were closely tied to its molecular structure. The sheer thickening properties of the colloids stem from the difference in the relative mobility of the small water molecules compared to the larger solid colloid particles. The polymer fluids derive their properties from the matrix of long chains of molecules that can be rearranged by applying mechanical energy to the fluid.

Summary Statement
This projected investigated the properties of colloidal and polymeric non-Newtonian fluids and found a probable mechanism causing these behaviors.

Help Received
Equipment borrowed from teacher; parents helped acquire materials; mother proofread report; neighbor helped construct apparatus; friend helped during data collection.

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)
Jonathon W. Horbaly

Project Number
S0313

Project Title
Radioactive Pebbles, Space Suits, and Cloud Chambers

Abstract

Objectives/Goals
I investigated if the effectiveness of different materials' ability to block radiation was affected by their mass. The hypothesis is: of all the materials tested, including layers of a multi-piece space suit produced by ILC Dover, the shielding that allows the least radiation (in vapor trails) through it will have the highest mass.

Methods/Materials
I built a cloud chamber, placed a source and different shields, and measured how many vapor trails appeared on the other side.

Results
The source (without shielding or background radiation) gave off an average of 59 trails in one minute, and there were an average of 12 trails per minute on the far side of the entire space suit (which had a mass of 25g), four beyond the binder paper (mass less than 1g), 0 beyond the aluminum foil (mass less than 1g), 13 beyond the Mylar film from the space suit (mass less than 1g), 3.5 beyond the Mylar emergency blanket (mass less than 1g), and 14 beyond the outer shell of the space suit (mass 8g). However, due to the erratic nature of background radiation and similar masses of the shielding, it is not responsible to make a connection between the mass of the shield and how effectively it blocks radiation with this data.

Conclusions/Discussion
However, due to the erratic nature of background radiation and similar masses of the shielding, it is not responsible to make a connection between the mass of the shield and how effectively it blocks radiation with this data.

Summary Statement
I attempted to test whether the mass of different shields (including a portion of a space suit provided by ILC Dover) affected their ability to block radiation in a self-designed cloud chamber.

Help Received
Father helped design, construct, and set up/run cloud chamber and refine experimental design; Teachers (Ms. Beth Dixon and Mrs. Dee Adams) helped refine report and experimental design; STEM Expo judge Gerald Oliver helped refine experimental design; used sample of space suit made by ILC Dover; used

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)

Lauren Kim

Project Number

S0314

Project Title

The Effect of Increased Salinization on the Production of Voltage through Wave Power

Abstract

Objectives/Goals

It is believed that with the increased salinization of water there will be an increased production of voltage because higher salinized water will be of a higher density. The waves will be stronger, heavier and have more ions for reactions in the solution with a higher concentration of salt.

Methods/Materials

Materials: Cuts of Wood Wooden Spool Copper Coils Masking Tape Neodymium Magnets Plastic Container Salt 1N4148 diodes Cen-Tech Digital Multimeter Capacitor Triple-Beam Balance Water
Methods: A wooden spool was attached to a rectangular piece of wood to make waves. A wave power generator was constructed in order to measure the voltage produced. The variable that was altered to test the hypothesis was the amount of salt added to the water. The salt was increased by 100g after five trials. Five trials were conducted at each increment of salt. The increments of salt were 0g, 100g, 200g, 300g, and 400g. The experiment was controlled and there were no outside factors which could have affected the results. The amount of voltage produced was measured in Volts through the Cen-Tech Digital Multimeter

Results

The mean value for trials with 0g of salt was 1.7 V, 100g 2.2 V, 200g 2.5 V, 300g 2.7 V, and 400g 3.2 B. After 400g of salt was added and dissolved in water, there was an increase in the mean production of voltage by 1.7 V. For all trials of different salinities, the percent deviation was all under 10% so the trials were completed with precision.

Conclusions/Discussion

After experimentation, the data supported the hypothesis and the amount of voltage produced increased when more salt was added. The mean values of the voltage produced increased by 1.7 V after the addition of 400g of salt. Wave amplitude and frequency are factors that cause an increase the production of electricity, and it can be inferred that the salinity of water is another contributing factor to this. The data supports the fact that water with increased salinity can produce more electricity and therefore bodies of water with higher salinization should be scouted as locations for potential wave farms.

Summary Statement

The increased salinization of water resulted in an increased production of voltage through a wave power generator.

Help Received

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)

Benjamin Kolland

Project Number

S0315

Project Title

The Effect of Air Pressure vs. Constant Pressure on Water Gun Design

Abstract

Objectives/Goals

This project investigated the difference in water guns with air pressure chambers and elastic pressure chambers. I built an air pressure homemade water gun (APH) and a constant elastic pressure homemade water gun (CPH). I hypothesized that the CPH will deliver more water on a target at 50% of its maximum range because it can stay pressurized longer than the APH, which will quickly lose power before it runs low on water.

Methods/Materials

Both water guns were built from PVC pipe, T couplings, 90-degree elbows, check valves, hose barbs as nozzles, hose tubing, hose clamps, pumps salvaged from squirt syringes and old water guns, and brass ball valves. The CPH pressure chamber used latex tubing, while the APH chamber was 76mm diameter PVC pipe. I used a Digital Manometer, timer, and camera to record data, as well as a 350kPa/50Psi pool pressure gauge for rough pressure estimations. The procedure was to fire each gun at a container at 50% the average maximum range (to hold all the water fired at 50% range or above) while recording time and pressure to create a data curve of how the pressure changed over shot time.

Results

The CPH stayed at close to full pressure for approx. 4.5 seconds, while the APH dropped off quickly, going from 220.63kPa to 103.42kPa after just 2 seconds. The CPH is constantly at a lower pressure (typically starting at 127.76kPa), but it holds that pressure for much longer allowing for more water delivered on target. The APH started with a chamber volume of 850 ml and delivered an average of 427.5 ml, while the CPH started with 750 ml and fired an average of 555ml.

Conclusions/Discussion

My hypothesis that the CPH would stay above 50% range longer than the APH was correct. The APH delivered 50.3% of its water on target while the CPH delivered 74% of its water on target. The CPH is 47% more efficient than the APH. The APH did have better range, but only for about 0.5 seconds and the range advantage was only 1.1 meters.

It surprised me how quickly the APH lost power, and also the power surge at the end of the CPH run. I researched why the CPH didn't deliver all its water at the same pressure and I learned that the elastic force is much more complex than I originally thought. Many factors affect water gun performance, however this project has shown that under the test conditions elastic chamber water guns have a significant advantage over air pressure water guns.

Summary Statement

By measuring pressure over time and water delivered on target, this project shows that under the tested conditions, elastic chamber water guns have an advantage over air pressure water guns.

Help Received

My dad helped with parts ordering, building advice, testing support, and photography. Ben Trettel and many of the people on the sscentral.org and waterwar.net forums, created great threads about water gun construction and performance.

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)
Chloe C. Kuo

Project Number
S0316

Project Title
An Emergency Autonomous Driving System to Improve Safety from Battery Fires in Electric Cars

Abstract

Objectives/Goals
My project sought to test the feasibility of designing and building an emergency autonomous driving system to improve safety from a battery fire in an electric car. My hypothesis is that an emergency autonomous driving system can be designed, built, and tested in a model car which would successfully mimic the system a real electric car might use to improve safety in the case of a lithium-ion battery fire. In the case of a battery fire in a real electric car, my system would begin, where the car would automatically stop, detach its battery, and autonomously drive away from the burning battery.

Methods/Materials
I used the chassis of a radio-controlled off-road vehicle to test my model system, which I named #Ted#. To operate my autonomous driving system, I utilized an Arduino Uno microcontroller which commanded a servomotor, 2 range sensors, diodes, resistors, a transistor, and accompanying wires. I tested each of the subroutines of the entire system separately to ensure that each one functioned as designed and integrated them into one system and optimized the overall system to function as designed. To simulate a battery in a real electric car, I used a 5lb weight, which best mimicked a real lithium-ion battery.

Results
I successfully completed three tests, each simulating different situations of when a battery fire had started, and each successfully working properly for the purpose of this experiment. I was able to design, build, and test an autonomous driving system in a model car so my hypothesis is correct.

In completing my project, I encountered many unexpected difficulties that necessitated inventive and creative solutions. I learned that such occurrences are typical of engineering projects like the one I pursued.

I conducted three different tests on Ted. Each tested Ted#s ability to autonomously drive (in an emergency situation) based on different obstacles placed in front and behind him. Each test proved to be successful.

Conclusions/Discussion
An emergency autonomous driving system should be seriously considered as an additional safety measure for future electric cars. Lithium-ion battery packs in future electric cars should be designed to allow rapid detachment in the case of fire.

Summary Statement
My project sought to test the feasibility of designing and building an emergency autonomous driving system to improve safety from a battery fire in an electric car.

Help Received
David Eldon, a UCSD graduate student in physics, provided technical advice on my project, taught me about electric circuits, and taught me how to program in Arduino.

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)
Larson T. LeDuc

Project Number
S0317

Project Title
Soften the Wave: The Minimization of a Tsunami

Abstract

Objectives/Goals
If an object placed in the path of an oncoming wave can change the velocity of the water and thus decrease its momentum, could a structure be placed in a tsunami#s path, to lessen the waves# impact?

Methods/Materials
Various wood structures were mounted on a continental shelf in a wave tank. A wavemaker generated consistent waves, and the changes caused by the structures were measured. To measure the force of the waves after the structure, a ballistic pendulum was suspended from a supporting beam. Cameras captured the wave height, the pendulum swing, the wave velocity, and the distance the wave run up. The pendulum swing was measured in degrees of swing from static position. The wave velocity was calculated by measuring the distance the wave traveled from one frame to another and then multiplied by the number of frames per second of the recording speed. The run up was measured using lines placed along the width of the shelf. Five test runs were conducted for each test condition. Calculations were made from the measurements to obtain wave energy and force transferred to the pendulum.

Results
Comparing results to the control of no structure: all structures regardless of formation reduced the wave height. The wave velocity was slowed in all formations for the large circle, the L-sharp increased wave velocity in all formations, and all other structures had mixed results. The pendulum swing was less in all formations for the medium circle, large circle, medium diamond, large square, and large diamond. The L-sharp had a greater swing in all formations, and the medium square and L-catch had mixed results. The run up was less in all formations for the large circle, medium diamond, large square, and large diamond. All other structures had mixed results.

Conclusions/Discussion
The reduction of force and velocity were rated higher than wave height and run in for reducing the impact of a wave. The top structures were the medium circle, large circle, medium diamond, and medium square. In looking at formations, the best formation was the wide formation as it had the least force and wave velocity even though it had the greatest run up and a moderate wave height. Based on these results, structure shape can lessen the impact of a wave. Engineers would need to determine which of these factors is most desirable for each location and then apply this research.

Summary Statement
This project was to test if a passive structure can reduce the effects of a large water wave on a shoreline.

Help Received
Consulted engineer on calculations; parents helped prepare test setup and record data.

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)
Jacob D. Loewen

Project Number
S0318

Project Title
Battle of the Windmills

Abstract

Objectives/Goals
The project tested the difference in rotation speeds between the modern three blade wing shaped windmill design and the older eight blade flat windmill design. The author hypothesized that the eight bladed flat windmill design would rotate faster in a wind tunnel at 15 knots.

Methods/Materials
Two windmills were built out of cardstock: one with three smooth, wing shaped blades and one with eight flat, tilted blades. Both windmills had a portion colored red to aid in observation. A base was made out of PVC pipe to support one windmill at a time for testing. Both windmills were tested in a wind tunnel. Each windmill was tested each at 0 and 45 degrees using the Slo-Pro and Ubersense Slow Motion iPhone applications to see how many times the red section rotated around in 2 seconds.

Results
The three bladed design averaged 10.25 revolutions per second (RPS) when at 0 degrees relative to the wind. This design rotated at an average of 9.55 RPS at 45 degrees. The eight bladed design rotated at an average of 15.4 RPS at 0 degrees, and rotated at an average of 25.55 RPS at 45 degrees. At a 0 degree angle to the relative wind, the eight bladed windmill showed a 50.2% increase in speed over the three bladed windmill. At a 45 degree angle to the wind, the eight bladed windmill showed a 168% increase of speed over the three bladed windmill.

Conclusions/Discussion
The data showed that the hypothesis was correct. The eight bladed windmill design rotated faster at 15 knots than the three bladed design. The rotation speeds, however, were entirely different than expected. The windmills moved at a much faster speed than originally thought. The three bladed windmill moved at about 10 revolutions per second at 0 degrees to the relative wind. At 45 degrees, it moved one rotation slightly slower; however, the eight bladed windmill moved much faster than expected. At 45 degrees to the relative wind, the eight bladed windmill moved nearly twice as fast as it did at 0 degrees. This data was additional proof that the hypothesis was correct. This author concluded that due to greater surface area of the eight bladed design, more wind could be converted into energy to produce faster rotation speeds. For this reason the eight bladed flat windmills could be more effective than the modern three bladed ones.

Summary Statement
This project compares and measures the most effective windmill design at 0 and 45 degree angles to the wind..

Help Received
The wind tunnel I used for testing was built by my father.

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)
Omena C. Mushale

Project Number
S0320

Project Title
Engineering and Testing Wings

Abstract

Objectives/Goals
I wanted to create wing designs that would generate more lift than the conventional wing for commercial planes. My question was: Will a wing with a curved leading edge or a straight leading edge generate more lift? My hypothesis was that if wings can generate lift with a straight leading edge, then wings can generate more lift with a curved leading edge. So I applied my research of the leading edge of a wing to the creation of many different wing designs, hoping that they would out-perform the conventional wing.

Methods/Materials
I decided to use the CAD program Autodesk Inventor Professional 2014 to digitally create my control wing and wing designs. Then I had them printed out using a 3D printer that Mr. Green owns, the Cube 3D printer. After printing, I applied wood filler to my articles and sanded it with 150-grit and 400-grit sandpaper to smoothen the articles as much as possible. This is so that there is as little error as possible according to the printing of the articles. I then tested my articles in a small wind tunnel. I used a force sensor from which the wing hung to measure the amount of lift, in newtons. I used Logger Pro Lite 3.3 to get the data from the sensor. I used Microsoft Excel 2013 to create tables and graphs of the data. I kept the wind tunnel speed the same for all the trials.

Results
The conventional wing had an average lift of 0.29 newtons. The conventional curved wing had an average of 0.42 newtons.

Conclusions/Discussion
The data supports the hypothesis that the wing with a curved leading edge generates more lift. Throughout the 30 seconds for each wing, the difference between the control and the conventional was about 0.1 newtons.

The sanding of the test articles were not to perfection, of course. Also, the conventional wing with a curved leading edge was slightly thicker than the control wing, so it may have altered the results. Along with that, during testing the wing was at a 0° AOA, so it may not have generated the maximum lift that it could have generated.

Summary Statement
My project is about altering the edge of an airplane wing to see if the wing produces more lift than a conventional wing.

Help Received
Mr. Green, physics teacher, provided the 3D printer and help on testing; Mr. Poe, woodshop teacher provided the wind tunnel and helped with testing; Robotics mentors and teammates helped with designs;

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)
Loren Newton

Project Number
S0321

Project Title
Cones-Chutes-Coils: Novel Proposals to Ebb Wingtip Vortices

Abstract

Objectives/Goals
To investigate if, curvature forms of Cones, Chutes, and Coils could be better options than Winglets as wingtip devices that minimized wingtip vortices.

Methods/Materials
Test wings of equal length and airfoil shape were attached with crafted straight coils, straight chutes, descending-cones, ascending-cones, and 90#a-winglets, each having the same weight but five different diameters/height. I had built a wind tunnel test rig that equipped with lift and drag measurements. For each wing I mounted on the test platform, I performed a string test for presence/absence of induced vortices, and record the lift and drag generated after an equal duration. In other words, I had recorded a total of 250 data; 2 readings from each of the 5 trials for each of the 25 wings. I had also derived formula for the optimal diameter of the winglet devices.

Results
My experiment showed that Cones, Chutes, and Coils did reduce wingtip vortices while also generated comparable higher Lift than Winglets, of the same weight. Largest Chutes achieved the highest L/D Ratio, and Coils produced the least Drag, while Descending-Cones, regardless of sizes, caused the most Drag, and the lowest L/D Ratio.
According to NASA, "Winglets are responsible for increased mileage rates of as much as 7%." From my Comparison Chart, Chutes could increase 13% more Lift, and Coils could raise 18% more L/D Ratio; and thereby saving at least 10% more fuel than Winglets.

Conclusions/Discussion
Chutes and Coils also generated Drag, but much higher L/D Ratio than Winglets of the same size, and therefore proved to be better than Winglets in improving flight efficiency and saving fuel, with smaller sizes. Chutes were most effective in generating Lift; most useful in high-lift mission. Coils were most effective in minimizing Drag; most useful in low-drag operation.
Chutes and Coils should be further studied for implementations in place of Winglets, as they could be smaller in sizes, easily fabricated separately perhaps by 3D printers, allowing economical retrofitting.
Cones should be ruled out as wingtip devices.

Summary Statement
Explore effects of other wingtip devices options.

Help Received
NASA Glen Research Center website. My dad helped shopping for material, supervising use of power tools, and trouble-shooting test setup.

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)
Alessandro Panighetti

Project Number
S0322

Project Title
Rocket Fuel Grains

Abstract

Objectives/Goals
the objectinve of my experiment was to determine the effects of the rocket fuel grain on the thrust provided over time

Methods/Materials
For the experiment I used a hybrid rocket which consumed polyvinyl chloride and oxygen as fuel. To measure the force provided I allowed the rocket to push against an electronic scale and recorded the results.

Results
In my experiment I tested 4 fuel patterns the single and double port fuel grains began with little power and slowly built up to a more powerful burn the other two fuel grains did not fire properly

Conclusions/Discussion
In conclusion in my experiment I have determined the burn pattern of two fuel grain types and also determined that the other two cores tested began with enough force to stop the flow of oxidizer due to the back pressure

Summary Statement
the focus was to determine the effects of the rocket fuel grain on the thrust provided over time

Help Received
metal donated by frc robotics team 3925

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)
Alyssa N. Pronovost

Project Number
S0323

Project Title
The Wind Beneath My Wings: The Study of Lift on Airfoils

Abstract

Objectives/Goals
The goal of my project was to determine which airfoil would produce the most amount of lift based on airfoil design. I believe that the airfoil that is most commonly seen on aircraft would produce the most lift.

Methods/Materials
I constructed six airfoil models from foam blocks for testing. Four of which are known airfoil designs, one is a modified airfoil design, and one I designed myself. All airfoils were tested in a home built wind tunnel five times at three different wind speeds and three different angles of attack. Data was collected and tabulated; the lift results were then averaged across tests. Drag approximations were calculated for each airfoil based on the drag equation and known drag coefficient.

Results
The airfoil designated as "B" produced the most lift of the six tested. This airfoil has a large upper camber with a long trailing edge and flat lower camber. Airfoil "A" which is commonly seen on aircraft came fourth in the results. Surprisingly, the airfoil I designed, "F," produced results that placed it second to airfoil "B".

Conclusions/Discussion
Airfoil designs play a crucial role in providing lift for aircraft. However, other factors like purpose and overall design of aircraft come in to play when deciding which design to use. My hypothesis that airfoil "A" would produce the most lift was incorrect, but other factors make it a suitable choice for aircraft, where airfoil "B" produced the most lift, but it may not be practical for use because of other factors and design considerations.

Summary Statement
My project was to determine which airfoil design of both common and experimental produced the greatest amount of lift.

Help Received
My father assisted in construction of the wind tunnel and use of Excel. My mother assisted with the design of the board.

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)

Jason S. Provol

Project Number

S0324

Project Title

Analysis of Synthetic Jet Actuators to Enhance Airfoil Safety and Performance

Abstract

Objectives/Goals

The purpose of this study was to evaluate the application of Synthetic Jet Actuators inserted into the upper surface of an NACA 2414 type airfoil to avoid stall and to improve airfoil efficiency

Methods/Materials

The airfoil was tested over a range of angles of attack from 1 - 20 degrees and airflow velocities from 0 - 44.7 m/sec to study the impact of the Synthetic Jet Actuators on airfoil performance. The Synthetic Jets were tested at 3 pulsation frequencies (550, 650, 750 Hz) and compared against the control case with the Synthetic Jets turned off.

Synthetic Jet Actuators inserted into the top surface of the airfoil were located at 33% and 55% of the chord. Six primary forces on the airfoil were measured, and in order to non-dimensionalize the results, the Lift Coefficient (Cl) and the Drag Coefficient (Cd) were calculated along with Cl/Cd ratio

Results

Generally, at all frequencies, the Cd decreased indicating that use of the Synthetic Jets resulted in a decrease in drag, however, at some angles of attack and velocities the drag increased. Generally results demonstrated that the lift/drag ratio improved at these conditions indicating a relative benefit.

Testing at 650 Hertz Pulsation Frequency showed the most improvement in the Change in the Cl with the Synthetic Jets on vs. off. The maximum lift enhancement was observed at the highest airflow velocity of 44.72 m/s and 7 to 8 degrees angle of attack. The Cl increased by 40% versus the same test conditions with the Synthetic Jet Actuators turned off. The Cl at 10 to 11 degrees angle of attack increased by 26%. The greatest improvement in Cl/Cd was seen at 44.72 m/s at 7-8 and 10-11 degrees angle of attack. At the highest air velocity at 7-8 degrees angle of attack, the change in Cl / showed an improvement of about 45%.

Conclusions/Discussion

The Synthetic Jet Actuator is a very promising device to avoid stall and to improve the performance of airfoils, especially relative to lift.

Key factors affecting the ability of the Synthetic Jets to enhance performance are:

1. The oscillating frequency of the Synthetic Jets
2. The location of the synthetic jets

The effect of the Synthetic Jets on drag is very complex. At certain conditions drag is decreased while at other conditions drag may be increased. Further study is warranted in this area to identify the optimum conditions for drag reduction.

Summary Statement

This study is an evaluation of synthetic jet actuators to enhance the lift performance of commercial and/or military aircraft in a high angle of attack situation.

Help Received

Used lab equipment at San Diego State University under the supervision of Mr. Ricardo Torres

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)
Garrett W. Reynolds

Project Number
S0325

Project Title
Constituents that Affect an Object's Friction on Non-Stable Surfaces

Abstract

Objectives/Goals
This project is to demonstrate what alternate materials can be used as a substitution for the traditional snow chains in snow or ice in the event of an absence of proper traction equipment.

Methods/Materials
Materials: Car tire, sandpaper, silicon pot/pan holding pad, cling/plastic wrap, insole of shoe, bottom of shoe, bottle caps, tin cans, bungee cords, standard chains, supercooled water, spring scale, asphalt road, PVC pipe
Procedure:
1.Prep the asphalt road with ice shavings to simulate snowy and icy conditions
2.Attach a harness of PVC pipe to the center of the wheel
3.Attach the selected material to the tire
4.Attach the spring scale to the end of the PVC harness
5.Pull carefully on the spring scale parallel to the ground until the tire slides. When the tire moves, the scale will read how much force it took to move the tire
6.Reset the supercooled water, and repeat steps 3-5 with different materials
Preform at least 3 trials for each material and record results

Results
In this experiment, materials were shown to not perform as well as standard tire chains. However, there were various materials that came very close like the bottle caps which differed by mere 0.2 Newtons.

Conclusions/Discussion
My hypothesis was wrong in stating that I could find a material that could possibly out-perform standard tire chains, I did find several materials that could used come close to the traction of standard chains including the bottle caps. Some small source of error in this procedure may have included the tire rotation as appose to sliding on the slick surface. However I tried to counter that by pulling on the spring scale parallel to the ground. Another source of error could have been Newtons lost in the PVC framing system to pull the tire,but this is why I used PVC as appose to another material- because it is sturdy and will not stretch to lose energy or force. What I have found through this experiment is that if someone is driving on a icy or snowy road without proper traction gear, someone could use any of the materials that he/she might have in their vehicle that were tested and have been shown to have more friction on the road than with a bare wheel besides the plastic wrap.

Summary Statement
My project explains how common materials can be used to increase traction on a vehicle's tire.

Help Received
My 8th grade science teacher provided spring scales for my project.

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)
Nick D. Rhodes

Project Number
S0326

Project Title
Concussions: No More Counting Stars

Abstract

Objectives/Goals
I tested a Riddell Attack helmet and see how it would hold up when I dropped a weight on it. The weight simulated the defensive player giving the hit and the helmet was the simulation of an offensive player taking the force of the impact in the head. I hypothesized that the helmet would probably become scratched but not dented or misshapen by the weight. I also predicted that the top of the helmet create the most impact.

Methods/Materials
I dropped a five pound weight on the helmet, starting at two feet from the helmet's highest point. After each drop I raised the height by two feet to four, then six and finally eight feet. At each drop I measured the ground with a ruler to see how far in the ground the helmet went. I started with fresh ground at every two foot interval. I did this routine with three different locations on the helmet. First I dropped the weight on the top of the helmet. The next test was on the left side of the helmet, and the final test was on the right side. I also dropped the weight once on the back of the helmet.

Results
When I finished testing the helmet, it showed to be in great shape. No dents or scratches existed, but there were deep impressions on the ground. When the weight hit the back of the helmet, the face mask dug straight into the ground, creating the deepest impressions. This disproved the second half of my hypothesis, but proved the first half.

Conclusions/Discussion
The sides of the helmet do a better job of diffusing the impact, whereas the top takes the impact in one location. This also means that when hit on the top of the head, the impact goes straight into the neck of a football player. The neck is safer when hit with side impact. The impact to the back of the helmet was by far the worst effects. These results are important because concussions are an ever-growing problem in high school, NCAA, and professional football leagues. There have been many rules instated to keep players safe. If we can see how the head is impacted, we can better design helmets to protect players of all ages.

Summary Statement
This project examines the impact to a Riddell Attack football helmet to find the most dangerous place for a player to receive impact.

Help Received
Teacher guided the project in class and gramatically revised. Mom assisted with the design of the board and typing.

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)
Adrian E. Samkian

Project Number
S0327

Project Title
Economically Modify Liquid Crystals Displays to Increase Flexibility and Durability

Abstract

Objectives/Goals
The purpose of this project was to redesign a passive matrix liquid crystal display, using a flexible polymer as a substrate as opposed to glass used in commercial displays. This would offer many advantages including lighter, cheaper, shatter-resistant properties, as well as creating flexibility, but would still have to maintain the image quality of a glass display.

Methods/Materials
The core design of the screen included having N-(4-Methoxybenzylidene)-4-butylaniline (liquid crystal) with silica beads between two Indium tin oxide coated substrates: glass as a control, and polymer (PET) as the test screen. Two perpendicular polarizers are then added outside and the edges sealed. Once the screens are built voltage comparisons, qualitative image tests and price comparisons were done to compare the built screens to a commercial screen as well as to each other.

Results
Results indicate that both screens respond similarly to current, changing from a clear yellow to an opaque white, or black to an opaque white, depending on polarizer orientation. The polymer screen was flexible, however bending it greatly affected image quality as resistance heavily dropped. Prices indicate that a polymer screen saves less than 1% money than a glass screen.

Conclusions/Discussion
My hypothesis was correct in that the polymer screen was lighter, flexible, and shatter-resistant, however this still is not enough to make it practical, due to its being more difficult to build, having delayed transition time, and having such a low price difference that it is simply not worth using unless a more suitable polymer or building method is used. However this is a proof of concept that flexible LCDs are a definite possibility.

Summary Statement
I replaced the glass substrate with a flexible polymer in an LCD in hopes that it would decrease price, weight, thickness, eliminate the tendency to shatter, while keeping the same if not better image quality and ease of construction.

Help Received
Ms. Tuason supplied one of the chemicals in my project, a friend found a website that sold another material

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)
Sidney E. Wilcox

Project Number
S0328

Project Title
Comparing Horizontal and Vertical Axis Wind Turbines in a Wind Farm Situation

Abstract

Objectives/Goals
The goal of this experiment was to determine the optimum wind farm configuration for each axial configuration and determine the overall most efficient turbine at different wind speeds.

Methods/Materials
I built six turbines, three HAWTs and three VAWTs, and a circuit with a 1000 ohm resistor and a multi-meter to measure the amperage produced. In addition, a anemometer was used to measure the wind speeds coming from the wind source and control them. Three HAWTs were mounted on a board with five possible configurations and a second board had three VAWTs mounted with the same configurations. The configurations were quantified by assigning each of the configurations an unobstructed frontal area exposed to the wind.

Results
The higher wind speeds produced a higher amperage in all trials. The more unobstructed frontal area for the configuration, the higher the amperage produced for all wind speeds and axial configurations. The HAWTs produced a higher amperage than the VAWTs in all situations.

Conclusions/Discussion
Higher wind speeds produce a higher amperage because there is more energy available in the wind to be harnessed by the turbines. More unobstructed frontal area corresponds to more amperage produced because the wind flow is more laminar and therefore generates more electricity. The HAWTs were more efficient than the VAWTs because the VAWTs had a higher initiation energy and had more drag than the HAWTs.

Summary Statement
This project compares horizontal and vertical axis wind turbines in different wind farm configurations in order to determine which axial orientation is most effective for generating electricity.

Help Received
Father helped with the building; Mother helped with the display

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)

Ryan S. Wong

Project Number

S0329

Project Title

Active Tremor Stabilization for Parkinson's Disease and Essential Tremor

Abstract

Objectives/Goals

Hand tremor affects more than 1 million Americans in the form of Parkinson#s Disease and Essential Tremor. These diseases increase the difficulty in performing fine motor movements, causing some patients to be completely reliant on others throughout the day. The purpose of this project was to develop a wearable tremor-reducing glove that could eventually help these people become more independent. Though the glove was not tested on humans, the project is a theoretical approach, and in the future could be designed for human experimentation.

Methods/Materials

The project consisted of three main components: an Arduino microcontroller, an accelerometer, and a rotating DC motor. The accelerometer was attached to the finger of the glove and was used to measure the excursion of the tremor. The data is sent to the microcontroller and a Fast Fourier Transform (FFT) algorithm is used to determine the frequency of oscillation. An algorithm then drives the motor to this same frequency and changes the phase of the motor in 10 degree increments until the motor is rotating at 180 degree out of phase with the tremor, which brings the amplitude of tremor to a minimum.

Results

This device was tested on a prosthetic arm to determine its accuracy. A second vibration motor was attached to the end of the arm in order to generate an oscillation similar to a hand tremor. In each of 10 trials, the hand tremor was initiated and the amplitude of oscillation was recorded in decibels. The tremor-reducing glove was then applied to the oscillating hand and 15 consecutive amplitude measurements were recorded. It was determined after these 10 experimental trials that the amplitude of oscillation in the hand was reduced by an average of approximately 50% due to the tremor-reducing glove.

Conclusions/Discussion

The phase changing algorithm was proven successful in reducing the hand tremor by a considerable amount. The use of this glove would help people stabilize their involuntary oscillation movements such that their amplitude of tremor effectively becomes much smaller. While the tremor in this situation could not be physically reduced to zero, a reduction of 50% would nonetheless help patients with Essential Tremor or Parkinson#s Disease come closer to completing their daily tasks independently.

Summary Statement

This project attempts to reduce tremors similar to those experienced by people with Essential Tremor or Parkinson's disease by using a glove consisting of an accelerometer, a rotating DC motor, and a microcontroller.

Help Received

Father helped troubleshoot some challenges in the project.

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)
Alexander Woodside

Project Number
S0330

Project Title
How Temperature Impacts Lego Pneumatics

Abstract

Objectives/Goals
The purpose of my project was to confirm in cold temperatures the Lego Pneumatic system would lift and push more weight using less pressure per square inch (PSI).

Methods/Materials
First, I started to create a lift and push Lego Pneumatic system. After a few different models, I finally had the equipment to test my theory. Next, I would lift and push 1 1/4 LB, 2 1/2 LB, 5 LB, and 6 LB with the equipment within every 5^o F interval from 15-80^o F. I started the lift or push with 30 psi and 40 psi in the system. After the push or lift, I recorded the amount of PSI used to complete the push or lift.

Results
I found cold air was denser than warm air using an air density calculator application. The test results prove the opposite of my hypothesis; less PSI was used in warm air than cold air. I believe cold air used more PSI because the air molecules were more tightly packed. In cold air, molecules move slowly and are closer together. In warm air, molecules move fast and are further apart. Since they are further apart they take up more space. When the warm air is pumped into the system, the molecules collide more creating more pressure. When cold air is pumped into the system, more molecules are needed to reach the same PSI as the warm air. So when the warm air was used, the molecules opened the cylinder quickly. The slower cold molecules opened the cylinder slowly, requiring more PSI. This data explains why my hypothesis was not reinforced.

Conclusions/Discussion
Unfortunately after 56 trials for each mechanism, my project results do not support my hypothesis. Even though my project did not prove my hypothesis, I learned a lot. I learned how pneumatics work, how to construct Lego compressors with the pneumatics, how to use air for a purpose other than breathing, and how air density can affect pneumatic systems. I feel my project was a success even without proving my hypothesis

Summary Statement
In this project, a Lego Pneumatic system was developed to confirm less PSI would be used when operating the system in cold temperatures.

Help Received
I would like to thank Mountain Oaks School for allowing me to borrow the Lego Pneumatic kits. I would also like to thank my mom for advice on my board and my dad for setting up a testing environment.

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)
Renden E. Yoder

Project Number
S0331

Project Title
Replicating Biological Walking Patterns in Robotic Systems

Abstract

Objectives/Goals
The main goal of my project is to recreate quadruped walking motions seen in certain species into a self-built robotic system. In addition to this, the aim was to also integrate a level of autonomy into the robot and program a turning sequence to allow the robot to avoid collisions with any object in front of it.

Methods/Materials
To achieve this I built a four legged robot using aluminum sheet metal, acrylic glass panes, servo motors, an arduino, and an assortment of nuts and bolts purchased from my local hardware store. I cut out desired shapes from the aluminum and the acrylic and then shaped them using a dremel. I then programmed the robot to walk, using an arduino microcontroller, with the same biological footfall pattern as a pray mantis, otherwise known as a canter.

Results
I successfully replicated the biological walking pattern of the pray mantis by evaluating and diagramming its walk. I was able to program a walking sequence to control the servos in such a way that the robot was able to efficiently walk in a manner that resembled a canter walking pattern.

Conclusions/Discussion
After multiple attempts to write a code for the walking sequence, I eventually created one which I was satisfied with. Despite minor setbacks and a few stripped gears, I successfully created a walking pattern which mimicked biological quadrupedal walking motions. For future research and experimentation, I would like to create a hexipod robot and create a walking sequence to mimic six legged species to further my investigation of different animal and insect walking patterns

Summary Statement
Mimicking four legged animal walking patterns in a robot.

Help Received
Father aided me in using power tools