CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)

Mihir Angal; Jethro Chan

Project Number

S0201

Project Title

Are Compressed Air Powered Marine Vessels Feasible, Effective and Economical?

Abstract

Objectives/Goals

To prove that a compressed gas powered watercraft would work aka. move, and if it works, it should do so efficiently, and economically.

Methods/Materials

The method we used to test the project was included a swimming pool, with a course built by ourselves, and a boat also constructed by ourselves. The vessel used a compressed gas powered engine, a hull, propeller and ballast. The engine is supplied with gas through an air tank, inside the hull and to compress the air in the tank, we used an air pump. In order to test the boat and that the objective works, we ran our boat through the swimming pool course stated above, while timing every run.

Results

We proved that the technology works, in terms of being efficient, fast, feasible and economical.

Summary Statement

Proving that a compressed gas powered watercraft would work aka. move, and if it works, it should do so efficiently, and economically.

Help Received

None from outside, only help from the two team members

Name(s)

A. Keoni Aricayos

Project Number

S0202

Project Title

Optimal Foundation Design for Model Houses Undergoing an Earthquake

Abstract

Objectives/Goals

The purpose of my project is to test which foundation(cement, rubber, coilspring, ball bearings, magnet, and layers of recycled scap tires and steel) is best suited for high intensity earthquakes.

Methods/Materials

I made the #104 2 bedroom house with the truss roof design. I also made the cement, rubber, ball bearings, recycled scrap tire W/ steel layer, magnet, and coilspring founations and tested them with the Pisco Epicenter Earthquake simulator at the 8.5 and 9.0 setting for 30 sec. each. I used a rolling movement measuring device, water displacement test, accelerameter, and siesmograph device to test which foundation proved to be best.

Summary Statement

My project is to test for the most seismic safe foundation design.

Help Received

worked in the school's science lab

CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)

Norman Bae

Project Number

S0203

Project Title

Robotic Hexapod

Abstract

Objectives/Goals

My objective was to determine which hexapod design would allow for the best performance. Specifically, how the leg design and different servos affected the speed under different payload conditions.

Methods/Materials

The experiment was conducted by testing the rate at which the Hex Crawler and Prototype models were able to move four feet. Different servo motor ramp up speeds were varied to see the effect it had on the performance of the hexapods. Both models were timed in each trial using the same program and battery power.

Results

The results showed that the Hex Crawler performed best with or without payloads. The Hex Crawler was able to achieve a speed of 0.996 in/sec without payload. The prototype performed the worst with a slow servo speed of 0.804 in/sec. Although, the Hex Crawler was able to reach a higher speed of 1.02 in/sec while the prototype reached a speed of 0.612 in/sec under payload.

Conclusions/Discussion

The Hex Crawler performed better at higher forward speeds due to its leg kinematics. The Hex Crawler had a mechanical advantage compared to the prototype. The prototype was only able to lift 0.25 lb vs. the 0.47 lb of the Hex Crawler. Also, the Hex Crawler had more powerful servos than the prototype.

Summary Statement

Using two different hexapod designs, I tested which hexapod performed the best under different conditions.

Help Received

Father helped gather materials for project.

Name(s)

Leonel Banuelos; Nicholas Ross

Project Number

S0204

Project Title

Good Vibrations: A Study of a New Method of Vibration Suppression Using Piezoelectric Patches

Abstract

Objectives/Goals

This project was designed to test the effectiveness of the Piezoelectric patch as a suppressor of vibrations by attenuating various combination of hertz and voltages of sine waves.

Methods/Materials

Materials used were a small-scale model of a plane's ventral fin, a synthesizer/function generator, a power amplifier box, an oscilloscope, and three Piezoelectric patches attached to the fin. Voltages (V) (50, 100, 200, and 300) and hertz (10-50 evens) were sent to the patch acting as the actuator, exciting it, and causing it to produce a vibration. The intensity of the vibration was measured by another patch serving as the sensor. Those readings were the constant and the procedure was done again, but with the third patch being excited in the opposite phase, attenuating the force of the vibration. In total, there were 168 tests: 84 done without attenuation and 84 done with.

Results

The results were compiled into average percentages of vibration reduction. At 50V, the average percent of reduction was 43.03%. At 100V, the average was 42.96%. At 200V, the average was 41.95%. And at 300V, the average was 41.03%.

Conclusions/Discussion

Considering the data, the objective was not entirely supported. The results show that at most, the average percentage of vibration reduction was 43.03%, which did not meet the 50% expectations, but it did come close.

Summary Statement

Our project demonstrates the use of the Piezoelectric patch to attenuate vibrations.

Help Received

Lionel Banuelos assisted with technical support, project knowledge, Edwards Test Pilot School for use of their lab and equipment, and Maria Caballero & Roberta Ross for purchasing materials for the construction of the project

Name(s)

Shawn R. Chiapellone

Project Number

S0205

Project Title

Water to Energy

Abstract

Objectives/Goals

My objective was to create enough hydrogen to power a small gas engine: however, I was never able to produce enough.

Methods/Materials

Materials: 1.10 stainless steel plates (8 inches by 8 inches); 2.10 nylon bolts and nuts; 3.4ft high amp wires; 4.Battery or large battery charger (power supply); 5.Air tight container; 6.Salt; 7.Baking soda; 8.Distilled water; 9.Copper piping; 10.Rubber tubing; 11.Small gas engine; 12.Car alternator; 13. 6 stainless steel nuts and bolts; 14. Volt and amp meter.

Procedures: 1.Fill the plastic container with five liters of tap water. 2.Take the positive and negative anodes and hook them up to their respective power source. 3.Run the power for 20 minutes recording the power every minute. 4.To record the hydrogen produced, use a measuring cup that has ml on it and submerge the vessel. Feed the hydrogen that is being produced into the container and measure the water that is displaced every minute. 6.Repeat steps 1-6 using distilled water with salt ½ tsp salt, ½ tsp baking powder, and distilled water. 7.Run each experiment for at least 7 minutes. To get the best results run for 20 minutes or until loss of power. 8.Get compressed hydrogen that you either made from the hydrolyser or buy some. Take the compressed hydrogen and feed it into a carburetor of a lawnmower engine. 9.Have the lawnmower connect to a car alternator. 10.Start the engine up and record the amount of energy produced at one minute, then use a ratio to compare the input to the output.

Results

My results were similar to what my hypothesis predicted. In my hypothesis I stated that it would create at least 50% of the energy I used to separate the hydrogen from the oxygen; however, I ended up only gaining 40% of the initial energy I put into the reaction back. This resulted in a loss of 60% of the energy proving that this method of converting water into hydrogen was not very efficient.

Conclusions/Discussion

My hypothesis was right and wrong. I knew I would lose energy, but I had no idea I would lose so much. I ended up losing 61% of the energy I put into it. Most of the energy was combusted, and then a lot more was lost due to friction. I believe if I use a fuel cell next time, I will be able to drastically increase my efficiency.

Summary Statement

My project is about making hydrogen from water using electralysis, and then taking the hydrogen and trying to use it to power a gas engine.

Help Received

My father helped with some of the wiring.

CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)

Jacob J. Cole

Project Number

S0206

Project Title

Thermally Accelerated Vacuum Dryer: Method for Direct Extraction of Energy from Temperature Differences in Environment

Abstract

Objectives/Goals

The purpose of this project was to investigate the potential effectiveness of a Thermally Accelerated Vacuum Dryer in saving power and time through the exploitation of temperature differences, and to ascertain whether the device and concepts behind it should be investigated on a higher level. It was hypothesized that when the intercooler chamber temperature was lowered from approximately 25±3 °C to approximately -15±3 °C temperature, the time, power, and the number of pumping cycles required to achieve full evaporation would both significantly decrease (quantitatively by >1.0 x 10^1 %).

Methods/Materials

The dryer, as constructed, consists of a chamber for the object to be dried, an intercooler/condenser chamber, and a vacuum pump, which work synergistically to utilize variation in vapor pressure resulting from temperature differences between the chambers. The vacuum pump lowers the pressure in the drying chamber enough that the relatively warm liquid on the object to be dried boils. It then draws the resulting vapor through the intercooler where it recondenses. The recondensation lowers the pressure, increasing the vacuum, and further facilitating the evaporation of the liquid in the first chamber.

Standard quantities of water were placed on an object in the evaporator chamber, and pump cycles and pump time were recorded, with and without a cooled intercooler chamber.

Results

As theory predicted and high-precision quantitative and qualitative experimentation revealed, this setup allowed an object to be dehydrated significantly more quickly and efficiently than with a traditional vacuum dryer (total time necessary decreased by 19.7% from 207±8.2 sec to 167±6.8 sec, energy necessary decreased 19.8% from 21.9±1.3 kJ to 18.5±0.82 kJ).

Conclusions/Discussion

These positive, precise results indicate that the Thermally Accelerated Vacuum Dryer and the concepts behind it are worthy of further study. It is in the conceptual power of its ramifications that the Thermally Accelerated Vacuum Dryer's strength lies, not in its specific application to vacuum drying - this scheme provides a way to make use of previously inaccessible energy present in the environment (in the form of temperature differentials, such as those over ocean thermoclines) to potentially save tremendous amounts of time and energy in vacuum drying, distillation, desalination, dehumidification, and electricity cogeneration.

Summary Statement

The Thermally Accelerated Vacuum Dryer is a device that uses a separation of temperatures (often already present in the environment) to facilitate vacuum drying, distillation, desalination, dehumidification, and electricity cogeneration.

Help Received

Father, Roger J. Cole, Ph.D, supervised, though did not perform, construction of device (drilling and epoxy).

CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)

Trevor J. Fobel

Project Number

S0207

Project Title

Flying Steady: A Comparison of Flying Wing Aircraft vs. Conventional Aircraft

Abstract

Objectives/Goals

Each year, aircraft become faster and more efficient at their tasks. However, demand for both civilian and military aircraft has been dominated by conventional aircraft. This project was designed to examine and compare a model of a conventional aircraft to a comparable model of potential replacements, flying wings, in an experiment that allowed visual observation of the drag produced by each type of aircraft in simulated flight.

Methods/Materials

The project began by constructing the outer shell of the low-speed wind tunnel from a large appliance box. The fan assembly consisted of two parts: a box-fan in conjunction with homemade cardboard braces secured to the original bottom-end of the appliance box. The second part of the assembly consisted of a honeycomb grid designed to equalize airflow emitted by the fan constructed of cardboard tubes 11 cm in length and 4 cm in diameter connected to each other with crafts glue and encased in a cardboard frame 50cm x 50cm. A small view port 61cm x 46cm was cut into the outer shell and overlaid with a clear plastic poster cover and secured with masking tape. Utilized models were mounted on a cardboard shaft 20cm in height and 4 cm in diameter. The top end of the tube was cut to an angle of 15 degrees to give the models an ideal angle-of-attack, giving the models maximum lift. To examine and visualize the drag produced by each model, a grid and tuft assembly consisting of a metal wire-screen and thin plastic streamers cut to approximately 6 cm and attached with double-stick tape. Upon completion of all necessary assemblies, both models were subjected to a drag test, with the fan outputting a maximum airspeed of 8km/hr and data was recorded.

Results

Both models were tested in the tunnel. In the experiments, the flying wing produced a consistent wake that resulted in a linear pattern of disturbance in the streamers, indicating a low-drag profile. The conventional aircraft model produced a wake that resulted in an erratic pattern of disturbance in streamers positioned toward the edges of grid, but a more stable pattern directly behind the tail section.

Conclusions/Discussion

The data supports the observation that flying wings produce a more stable wake, indicating a design that most efficiently moves through the air. This experiment supports the statement that in the future, flying wings could be favored over conventional aircraft for their superior design qualities.

Summary Statement

This project is about comparing the aerodynamic drag of a flying wing aircraft and a conventional aircraft.

Help Received

Father helped acquire materials and assisted in assembly of wind tunnel; Mother helped in gathering photos and data presentation, in addition to aquiring some research material

CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)

Eric C. Huppert

Project Number

S0208

Project Title

Investigating Biodiesel Feedstocks: How Does Cooking Time Affect the Viscosity of Cooking Oil?

Abstract

Objectives/Goals

Because of our dependence on fossil fuels, there has been significant interest in the potential of biodiesel as an alternative fuel. Researchers have suggested using used vegetable oil as a feedstock for biodiesel. However, one major concern is the high viscosity of used vegetable oil. When vegetable oil is heated, fatty acids break down causing it to become more viscous. This is a potential problem because viscous biodiesel can cause engine problems. In this two part project, I assessed how the cooking time of vegetable oil affects its viscosity.

Methods/Materials

In the first phase, I cooked oil at home for varying periods of time, and in the second phase, I used oil collected from local restaurants. To calculate the viscosity, I dropped a sphere through the vegetable oil and found its terminal velocity. I also calculated the density of the fluid. Then, I used the Stokes formula to calculate the viscosity of the fluid.

Results

In the first phase, a step-down analysis of variance (ANOVA) test showed that the pure oil was significantly more viscous than the cooked oils ($p=0.0056$), which was somewhat surprising. The viscosity of the other three vegetable oils increased with cooking time, but this data was not statistically significant. In the second phase, I found that the viscosity of the vegetable oil increased with the cooking time. A second ANOVA test showed that oil cooked 5 hours was significantly lower than the other phase II oils ($p<0.001$) and the vegetable oil cooked for 35 hours was significantly higher than the other cooked oils ($p<0.001$).

Conclusions/Discussion

This information can be used to decide the allowable cook times for vegetable oil to create biodiesel with the appropriate viscosity.

Summary Statement

The goal of my project is to find a correlation between the cooking time of vegetable oil, a feedstock for biodiesel, and its viscosity.

Help Received

Sisters helped design procedure; Parents helped edit my report; Teacher helped me acquire necessary materials.

CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)

Laurel A. Kroo

Project Number

S0209

Project Title

Efficient Low-Cost Wind Energy Using Passive Circulation Control

Abstract

Objectives/Goals

Circulation control is a way of changing the flow over a wing using a jet of air. By ducting air through a slot at the trailing edge of an airfoil it is possible to transform the shape of the flow, and change the lift, just as if the airfoil pitch were changed. At every wind speed there is an optimal lift distribution and pitch. Conventional variable pitch mechanisms are complex and expensive, but increase the efficiency of wind turbines significantly. This project shows how circulation control can provide the efficiency of variable pitch mechanisms without their complexity.

The rotational motion of wind turbine blades creates a pressure gradient spanwise along each blade. Instead of powering the trailing edge jet with pressurized gas, a wind turbine can utilize this pressure gradient, with an inlet near the root of the blade, and an outlet near the tip. As the wind speed increases, and the rotation rate of the rotor increases, so does the pressure gradient, therefore, so does the air coming out of the trailing edge. The flow then passively adapts with the wind speed. The effect of this kind of flow control is comparable to the effect of changing the pitch. So this project offers the possibly to replace a complex part of a wind turbine with a static system that has the same effect but requires no moving parts and is just a blade modification.

Methods/Materials

I started by experimentally testing different heights of flaps that mimic how a jet slot airfoil would perform at a single wind speed. I created a car-top testing apparatus to collect data on turbine performance. Additionally, I wrote a simulation code to predict the theoretical performance of a turbine with this passive jet slot modification.

Results

The data taken from the experiment (power, rpm, and wind speed) described the characteristics of the generator and the performance of the turbine with and without blade modifications. The data from the flapped blade tests and simulation of the jets suggest that passive jet slots would increase the efficiency of the turbine.

Conclusions/Discussion

The next step is to build new, hollow blades that were modeled in the simulation to experimentally verify that the slots create the same effect as the trailing edge flaps. This project has the potential to increase the efficiency, reliability, and affordability of wind turbines in a way that has not been patented or prototyped before.

Summary Statement

I designed a wind turbine blade modification that increases turbine efficiency over a range of speeds, tested a simplified prototype, and wrote a program that predicts how this modification affects turbine performance.

Help Received

Father helped with simulation and aided with data collection.

CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)

Malika Kumar; Haley Zarrin

Project Number

S0210

Project Title

Creating a SensorGVS: A Sonar/Accelerometer Guided Vehicle Stabilization System

Abstract

Objectives/Goals

The goal is to create a SGVS system for improving vehicle safety and reducing vehicle body motion caused by uneven road surfaces. The system scans the road with sensors and the embedded computer controlled system adjusts suspension according to a predictive algorithm to keep the wheels firm on the ground and reduce undesirable vehicle body motion.

Methods/Materials

First, we studied the behavior of the entire SGVS system by creating s C++ simulation model of system components including a virtual road model. An embedded computer with an on-board accelerometer, sonar, and a USB data logger was built and driven around local streets to collect actual road data. The road data was used in simulation. The simulation environment was used to model different control algorithms, servo motor capabilities, and road data.

Once the characterization of the system was understood within the simulation environment, a prototype of the SGVS system was built using a Parallax microcontroller, sonar sensors, accelerometers, an H-bridge, a servo motor, and a wheel assembly. The closed-loop control system used a sonar sensor to locate the position of the wheel. A second sonar sensor scanned the road ahead. An on-board accelerometer was used to create a mathematical virtual gyroscope as a reference point as if it is mounted on a motionless body. The virtual reference point was used to stabilize the vehicle body.

The video tape of SGVS prototype performance was examined frame-by-frame and the prototype data was back annotated into the simulation model.

Results

An average passenger car requires a 15.5 KW servo. That is about 17% of overall vehicle power. An SGVS in a rover would require a 0.047kW servo. This makes practical use of SGVS in rovers or high-end automobiles. A mid-sized car going 10mph requires a 20 horsepower servo, which is 17,267 times more powerful than our prototype. A rover going 5cm/sec requires a 0.06 horsepower servo, which is 52 times as powerful as our prototype. Our prototype was able to adjust 9.7cm/sec.

Conclusions/Discussion

We found simulation and system modeling to be crucial to understanding and characterizing complex systems such as an SGVS. A closed loop control system allowed accurate positioning of the wheels. This experiment shows the practicality of an SGVS system in high-end vehicles and rovers on rough terrain. This project has the potential of being patented.

Summary Statement

A predictive computer controlled system for enhancing the safety of vehicles and reducing body motion caused by uneven road surfaces.

Help Received

Our adivor, Mr. Simon Zarrin, explained basic concepts to us, then we applied them to the project.

CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)
HyunJeong Lee

Project Number
S0211

Project Title
The Effect of Temperature Change on the Tune of Musical Instruments: String, Woodwind, and Brass Instruments

Abstract

Objectives/Goals

Many musicians have to be conscious of the changes in tune their instruments go through while playing their instruments. This experiment tests how the instruments change caused by the temperature change and whether every instrument changes in different ways and they are categorized into string, woodwind, and brass instruments.
The scientific question that is#How does the temperature affect the pitch and the tuning of musical instruments # string, wood wind, brass instruments, and why?' My hypothesis is that when an instrument undergoes temperature changes, the tuning of the instrument will change; the string isntruments will go flat and woodwinds and brass instruments will be sharp at hotter temperatures.

Methods/Materials

brass instruments (French horn,trombone),string instruments (violin,guitar),woodwind instrument (flute),thermometer or temeprature controller(heater/cooler),electric tuner
- experiment performed one instrument at a time.- rooms into normal room temperature room, heated room, and cooled room- while one of the room is either heated the cooled, the instrument is taken out in the room at normal room temperature and set to the correct tune.- when one of the room has been heated for 30 minutes and the instrument has been sitting in the room at normal room temperature for 15 minutes, take the instrument to the heated or the cooled room and let it sit for an hour.- after an hour, tune the instrument and record data.

Results

When the instruments were heated to the temperature of 30°C, the stringed instrumns showed that their pitch went low. However, the woodwind and brass instruments showed that their pitch went highat high temperature. When the instruments were cooled to the temperature of 13°C, the stringed instruments turned out to have a higher pitch, making the tune to be sharp. However, the woodwind and brass isntruments turned out to have a lower pitch, making the tune to be flat.

Conclusions/Discussion

For stringed instruments,in hotter temperature they have to press harder on the strings to make it sharper and in colder temperature, they have to press lighter for less stress to make it flat. As for woodwind and brass players, they can pull their tuning slides when their instruments are sharp at hotter temperatures and the other way at colder temperatures to contract the space inside the instruments. Brass players can also change the tune through trying different embouchure.

Summary Statement

When string, woodwind, and brass instruments undergo a change in temperature, their instruments will be affected in its tuning and its pitch due to the materials they are made out of.

Help Received

Friends who are in music classes and music teachers helped with background information.

Name(s)
Benjamin E. Levy

Project Number
S0212

Project Title

Putting the Squeeze on Energy Harvesting: Piezoelectric Power Scavengers

Abstract

Objectives/Goals

A growing demand for clean, efficient, low-cost powering systems favors development of mechanical to electrical energy conversion technologies. A currently untapped source, the energy dissipated as crowds walk through busy public spaces, could be captured with piezoelectric elements embedded in flooring tiles. This experiment addressed the optimal internal configuration of these tiles, hypothesizing that mounting the piezo elements in a concave position, to allow them to stretch with tensile strain when stepped on, would result in higher voltage production than would be obtained by simply compressing the piezoelectric material with a direct strike.

Methods/Materials

A hinged wooden apparatus was built to strike a piezoelectric element with an experimentally controllable force, with resulting electrical output recorded on a scope meter. Voltage magnitude was studied as variations were made in the height from which each strike was delivered, surface area of the strike point, and curvature of the thin platform on which the piezo element sat.

Results

Piezoelectric behavior was evident in all configurations tested, giving voltage readings between 100 volts and 258 volts. Increases in height from which a piezo element was struck, and surface area of strike point, both improved output. More interesting from a design standpoint, the platform which forced a piezo element to stretch into a concave shape when struck, inducing tensile strain, resulted in an average production of 21 volts of additional power compared to using a flat platform, on which the element only experienced compressive strain.

Conclusions/Discussion

Manipulation of the character of the force delivered in the test apparatus produced voltages supporting the hypothesis that tension, induced by stressing the element into a concave shape, increases the magnitude of the piezoelectric effect compared to using simple compression. Improved energy output from a piezoelectric flooring tile would therefore be expected with a piezo element mounted over a slight concave gap, allowing it to stretch under the applied force of footsteps. Since fine cracking was noted in the ceramic elements used in this experiment, further testing with higher tensile-strength polymer elements should be considered.

Summary Statement

A mechanical/electrical energy conversion apparatus shows waste energy reclaimed from walking can be optimized by positioning piezoelectric scavengers in flooring such that steps induce tensile, not compressive, strain in piezo elements.

Help Received

Steven A. Press, Director of Data Center Facilities, Kaiser Permanente, loaned me the scope meter used in this experiment.

Name(s)
Patrick A. Lowe

Project Number
S0213

Project Title
Comparison of Fanwing Configuration Efficiency

Abstract

Objectives/Goals
This project was made to find the relation between ducting on a fanwing propulsion system and its efficiency in thrust and lift. A fanwing works on Bernoulli#s principle & the principle of high bypass engines. Bernoulli#s principle states that the velocity of an air flow varies indirectly with its pressure. One of the principles used in high bypass engines states that if more air is taken in more air is moved and thus more thrust is produced. This is done with less energy than an equivalent system with multiple smaller motors. The fanwing takes this further by embedding a squirrel cage fan along the front edge of the wing. This lets the fanwing take in a larger amount of air and thus have thrust to with less energy. The fanwing system takes in air from the front edge, accelerates it, & then expels it over the trailing edge. This creates lift by Bernoulli#s principle. Ducting has been used to make other propulsion systems more efficient. It adds weight, increases the cost of design & manufacturing, & can lessen the thrust to drag ratio. However if made well, ducting boosts thrust & decreases drag so that it overcomes drawbacks. No one has fully used ducting on a fanwing to make it more efficient.

Methods/Materials
The middle section of fanwing was designed to fit the width of the subsonic wind tunnel to eliminate wing tip vortexes. The fanwing was tested in 4 different configurations: configuration 2- ducting with an equal intake & exhaust area; configuration 3- ducting with an equal intake & exhaust area & vectored thrust; configuration 4- ducting with an intake area larger than exhaust area & vectored thrust; & configuration 5- no ducting. Each configuration was tested for lift & thrust.

Results
The average lift of configuration 4 was the greatest at 53.3 g, then configuration 3 at 43.2 g; configuration 5 at 37.4 g: & finally configuration 2 at 30.4 g. The average thrust of configuration 2 was the greatest at 24.0 g. Others measured significantly less: configuration 4 at 5.1 g: trailed by configuration 5 at 0.9 g: & configuration 3 at -6.1 g.

Conclusions/Discussion
The data shows that configuration 4 was the best overall. All of the ducted configurations improved efficiency over the unducted configuration in at least one trial. This experiment has narrowed the field, pointing the way for future experiments with configuration 4 to determine the best intake to exhaust area ratio & vectored thrust angle.

Summary Statement
To create a more effecient fanwing design than the conventional one by using ducting and vectored thrust.

Help Received
Father helped in part fabrication

CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)
Cohberg P. Ng

Project Number
S0214

Project Title
Passive Cooling

Abstract

Objectives/Goals

Is it possible to cool a laptop processor confining to the following points of interest and specifications

Compatibility
1a.The cooling material and components must reside within the current footprint of the stock case
1b.The construct must using existing mounting hardware to anchor itself to the case material
1c.The construct must be able to keep the current hardware within the manufacture#s thermal temperature specifications

Portability
2a.The construct must be able to cool the computer hardware without increasing the weight of the current laptop computer by more than ten percent

Environmentally Friendly
3a.The construct must be able to cool the computer hardware using no power

Methods/Materials

Variables Being Manipulated

Beta, a Boolean Value, indicates if the cooling construct is in adherence to procedure 1a ,1b ,1c ,2a, and 3a

Conclusions/Discussion

In accordance with my data analysis, passive cooling complying with regulations (1a-1c,2a,and 3a) is not a viable solution for passive cooling.

Although the passive cooler was significantly more effective at cooling the processor passively than the manufacturer cooler; air stagnation, limited case airflow, and cramped building zones prevented the cooler from being as effective as originally anticipated.

Setting the stringent requirements for the cooling construct was a warranted path of goal failure however there were several points that I was able to accomplish.

Summary Statement

Can a laptop computer be modified to use a compatible passive cooling construct adhering to compatibility requirements, portability concerns, and environmental regulations.

Help Received

Used milling equipment under the supervision of school shop teacher Mr. Allen Grant. Inspiration for project came from my physics teacher Mr. Scott Holloway. And for auxiliary support, my family.

CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)

Daniel E. O'Leary, III

Project Number

S0215

Project Title

The Effect of Attack Angle and Airfoil Design on the Output of Small Wind Turbines in Low Reynolds Flow

Abstract

Objectives/Goals

The purpose of this study is to optimize the airfoil design and attack angle of the blades of small wind turbines in low Reynolds flow. Wind turbines of this size are ideal for rooftop settings in the suburban environment and the data can be magnified to optimize larger wind turbines. Optimization is sought through both the theoretical and the empirical.

Methods/Materials

I started by taking two common, yet distinct, airfoil designs for small wind turbines the A18 (more cambered and 7.3 percent thickness)and the SD7062(less cambered and 14 percent thickness), and subjecting these airfoils to varying attack angles. I tested each airfoil twice at 0, 15, 30, 45, 60 and 75 degrees at a high speed and a low speed. I built my airfoils by hot wiring foam blocks then sanding the airfoils to create a smooth surface. These airfoil blades were then attached to a free spinning shaft to reduce frictional forces. Wind was provided by an array of fans so as to produce a constant airflow over the blades at all times.

Results

The rotation at 60-degrees was optimal, but it was only optimal with an initial energy input. After an assisted start, the vector of the wind changed allowing it to develop high speeds with limited drag along the rotational axis. Additionally, the output of the A18 Airfoil at the optimal attack angle increased by only 12 percent from the low wind speed to the high wind speed, while the SD7062's output increased by nearly 40 percent. Overall, the A18 airfoil performed better than the SD7062 for all tests.

Conclusions/Discussion

The difference between the SD7062 and the A18 at different wind speeds suggests a threshold. The frictional drag on the blades remained relatively constant as the wind speeds increased but the pressure drag on the A18 greatly increased. The A18 is significantly more cambered and thus experiences turbulent flow at a lower Reynolds number. While providing more lift at lower speeds, the camber of the A18 limits its performance in higher speeds. The SD7062 seemingly maintains laminar flow throughout. Additionally, there appears to be an exponential relationship between output and attack angle, until a point where output collapses. Finally, this project has shown that twist is necessary. By my calculations, for the A18 at 60 degrees, the tips were going 13 m/s faster than the bases. Thus the tips must have a larger attack angle as the vector of the wind drastically changes.

Summary Statement

This project seeks to optimize small wind turbines for low wind speeds by varying attack angle and airfoil design.

Help Received

My dad bought me all the supplies and my mom did all the drilling

CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)
William M. Osman

Project Number
S0216

Project Title
People Power

Abstract

Objectives/Goals
To develop and build a version of the Sirling Engine that converts waste heat, such as human heat, and converts it into mechanical energy, and then convert the mechanical energy into electricity.

Methods/Materials
Creating the engine will involve the use of CNC machines and other common household items.

Results
The machine worked as intended, but not off human heat. Since the device uses two different temperatures reaching equilibrium, and has several inefficiencies, the two temperatures need to be more extreme than the heat from a human and room temperature.

Conclusions/Discussion
The Stirling engine is a very practical device that can turn most heat sources into usable energy. Any two sources of heat and cold will work to power the engine as long as they are far enough apart.

Summary Statement
Turning waste heat into a usable energy source.

Help Received
Kit Jones taught me how to use a CNC water-jet cutter.

CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)

Jonathan T. Ota

Project Number

S0217

Project Title

Helio Tracker

Abstract

Objectives/Goals

Photovoltaic panels are commonly plagued with a single problem: inefficiency due to immobility. However, when photovoltaic panels track the movement of the sun, their efficiency increases significantly. A solution exists in nature: the sunflower. The purpose of this project is to design a device that can track the movement of the sun without consuming electricity by mimicking the phototropic qualities of the sunflower.The three basic actions of a sunflower reacting to light are imitated through three components on the device. A parabolic mirror channels light to a central bottle, thus acting like the photoreceptor in plants. Within the bottle, alcohol absorbs heat and undergoes a phase change to create pressure. The pressure, similar to the hormone in plants, acts as the signal and moves through lengths of tubing to a piston on the opposite side of the device. The pressure triggers the elongation of the pistons emulating the elongation of the cells in plants, thus moving the mounted panel towards the light.

Methods/Materials

mylar (space blanket), 91% isopropyl rubbing alcohol, 20mL plastic syringes (pistons), ¼ vinyl tubing, ¼ polyethylene tubing, 22 gauge copper wire, paper towel rolls (cardboard), Black cloth tape masking tape, "engine enamel" black paint, 1/4 inch aluminum tubing, plastic panel, for mounting photovoltaic panel

Results

Individually, the separate systems responded to sunlight by creating pressure to move the pistons. The elongation of the pistons did not translate into the movement of the head of the device.

Conclusions/Discussion

There are various reasons why the head of the device did not move. Although the pistons respond to pressure and expand, they are not mounted securely to the panel and the main trunk of the device to make the head of the device move. Another example is that the rubber plungers of the pistons exert too much friction against the walls of the syringe which hinders the pistons from reacting to small changes in pressure. Also, the bottles containing the alcohol are not completely clear, thus reducing the amount of sunlight heating the alcohol and the pressure created. All or some of these factors may be a reason the device does not fully function as hypothesized. Further study of these individual factors needs to be undertaken.

Summary Statement

My project aims to Emulate phototropic qualities in plants to increase the efficiency of photovoltaic panels.

Help Received

My father helped me with writing the report. Donal Ferris helped me with different aspects of the structure of the device. Debra Mauzy-Melitz assisted me with my abstract and board.

Name(s)

Joseph D. Papador

Project Number

S0218

Project Title

Fun Factors

Abstract

Objectives/Goals

My objective was to find the factor that most greatly decreases miles per gallon of the four I tested.

Methods/Materials

Method

1. Drive one car, with no applied factors, from Ventura Avenue to Bates Beach and back going sixty-five miles an hour using cruise control. Record results at both the halfway point and at the end.
2. Apply one factor and repeat test and note any changes.
3. Repeat with each factor.
4. Change cars and repeat test.

Materials: Two different cars, gasoline, digital tire gage, racks, and car instrumentation.

Results

I drove a Volvo five times with different factors applied for each test. For my control I received 30.8 MPG. With the windows down I received 28.7 MPG. With the AC and radio on I got 27.3 MPG. with a reduction of 5 PSI of tire pressure I received 30.1 MPG. And with the addition of racks i got 25.5 MPG. I also drove a Honda Hybrid five times with the same factors. I received 50.7 MPG on my control, 48.8 MPG with the windows down, 48.0 MPG with the AC and radio on, 49.5 with a decrease of 5 PSI in the tire pressure, and 40.2 MPG with the addition of racks.

Conclusions/Discussion

The factor that most greatly reduced MPG was the addition of racks to the car. This was caused by the reduction of aerodynamics on both the cars. My hypothesis was incorrect however the electrical devices caused the second highest decrease in MPG next to the addition of racks. I believe that I tested the air pressure incorrectly and didn#t change it enough to make a significant decrease. The factors that I tested had a significant change in MPG that I didn#t expect to happen. Knowing these factors and what they do to your MPG and avoiding them can save you both money and gas. I would like to test other factors in the future and see if any others create a significant difference in MPG and also find some that will increase MPG instead of decreasing.

Summary Statement

I have tested different factors that affect miles per gallon and looked to see which factor would decrease the MPG the most.

Help Received

My father drove the cars

CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)
Andres M. Pineda

Project Number
S0219

Project Title
Stirling Engine, Uses

Abstract

Objectives/Goals
How far does a Stirling engine travel/run using different fuel sources?

Methods/Materials
My Procedure,
1. I first Built a Stirling engine. 2. Test the engine using different power sources. 3. Record data. 4. Make graphs/tables. 4. Build a car. 5. Make a mount for the Stirling engine. 6. Place Stirling engine on the car. 7. Find out how far the car can travel using different power sources. 8. Record data. 9. Try any other means of testing the energy of the Stirling engine. 10. Record data.
My materials,Stirling engine kit, Screw Drivers, PVC pipe, PVC Cement, Copper wire, Steel, Aluminum, Candle, Infrared Thermometer, Timer, Hammer, Tape Measure, Scissors, Velcro, Windbelt , Wrench, Digital Multimeter, Super Glue, Microwave, Lighter, Ice, water, Lego's, Wood, Video tape, Screws, Bolts and Nuts, Drill, Drill bits, Contact cement, Saw, Washers, Propeller, Lithium grease, Silicon adhesive.

Results
The Stirling engine successfully ran after construction without any problems. The engine ran the longest with the candle but the two min. micro waved water started the engine the fastest. I have yet to test if the Stirling engine can move a car and I have yet to get the Stirling engine to run the propeller to power the Windbelt.

Conclusions/Discussion
Based on my experiments I was able to conclude that the Stirling engine can run as long as there is a significant difference in temperature. I could not figure out the exact temperature needed to start the Stirling engine but I found out the Stirling engine could not run on just my hand temperature because the room temperature was too hot. Due to the size of the Stirling engine, I have not been able to run a car. I have also been unable to run the propeller to produce electricity by blowing air into the Windbelt.

Summary Statement
My project is about testing to see what a Stirling engine can do beyond running itself.

Help Received
Father cut wood with a saw; Father cut aluniminum; Step-Brother milled a wheel.

CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)

Agustin Roldan, Jr.

Project Number

S0220

Project Title

Induced Electromagnetic Propulsion

Abstract

Objectives/Goals

Is it possible to improve the efficiency of a Railgun by changing what materials are used to reduce things like friction, noise, and heat dissipation to increase the velocity of the magnets being fired?

Methods/Materials

Two rails made out of aluminum or copper,One Platform,1 capacitor charging circuit board,330v Capacitors,Magnets:{Rare earth magnets (Neodymium)},DC adapter: 12 volts,Rubber Gloves,2 alligator clips,1 axle,1 Flip Switch.

Results

From the data collected I was able to see that the copper rails were more efficient than the aluminum rails. Less degradation occurred with the copper rails. Welding or arcing occurred more on the aluminum rails, because of this, the magnets degraded much faster than on the copper rails. The copper rails are highly more efficient than aluminum rails. Velocity increased as voltage was increased, but when used on copper rails, the velocity was higher than with the aluminum rails.

Conclusions/Discussion

In conclusion, this railgun shows a lot about how forces in magnets work in conjunction with electricity. The railgun is a success because we were able to find out what made a railgun more efficient. From what I said earlier in my hypothesis, I believed that copper rails would work more efficient than aluminum rails. From what I have tested, I can conclude that my hypothesis was correct. I was able to show data that proved that copper rails were more efficient because the velocity of the magnets were faster on the copper rails, then when compared to the aluminum rails.

Summary Statement

Using the given materials at hand, is it possible to improve the efficiency of a railgun.

Help Received

My Dad helped me build the second version of the railgun,

Name(s)
Jacqueline R. Sly

Project Number
S0221

Project Title
Mechanical Analogs Model the Relationship between the Period of the Graph of the Snake's Movement and the Snake's Speed

Abstract

Objectives/Goals
The purpose of this project was to model the relationship between the period of the sine graph representative of the snake's movement and the snake's speed. This project also explored the biomechanics behind the locomotion of snakes and sought to accurately model this motion through a mechanical analog. It was believed that the sine graph with the smallest period would be the most efficient in consideration to speed. A compressed sine graph of motion will result in a higher number of critical contact points between the mechanical analog and the surface. It was believed that a higher number of critical contact points would result in a greater speed. Thus, it was believed that this smallest sine graph of motion would produce the greatest speed in the resulting mechanical analog.

Methods/Materials
Both a virtual and a mechanical analog representative of the locomotion of a snake were designed and constructed based on preliminary observations of snakes through media sources. For the virtual mechanical model, the java program Sodaplay was used to create a system of mass points and springs. Using the Computer Aided Design (CAD) program Solidworks, the initial designs for the mechanical model were finalized and rendered in a 3D computer environment. For the mechanical analog, a circuit board was built to control a series of eight servo (stepper) motors and was then programmed in AVR Studio.

Results
The experiments were run using the virtual mechanical analog and the data collected from these tests supported my original hypothesis. A series of ten tests were run, at different periods, these tests were captured on video and then the speed of the virtual mechanical analog was calculated. The slowest virtual mechanical analog was trial three of period 4.5 cm, the fastest was trial two of period 0.25 cm.

Conclusions/Discussion
The relationship between the period of the representative sine graph of the snake's movement and the snake's speed was found to inverse linear. The sine graph with the smallest period was the most efficient in consideration to speed. As the period of the sine graph became smaller, the behavior of the virtual and mechanical analog became more erratic and the movements lost their original fluidity. In real-world conditions, a smaller representative period would not always result in a greater speed.

Summary Statement
Using virtual and physical mechanical analogs, my project sought to model the unique biomechanics of snake locomotion and the relationship between the period of the representative graph and the snake's speed.

Help Received
Parents funded project; Father assisted in circuit-board debugging process

CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)

Hiro D. Sparks

Project Number

S0222

Project Title

Recycling the Heat Energy Lost from a Common Light Bulb

Abstract

Objectives/Goals

I hope to build a housing for a 150 watt halogen light bulb, that will use the concepts of thermosiphoning to recycle the heat energy lost from a light bulb and transform it into the kinetic energy of a spinning a turbine. The system will release zero emissions and require no more energy then it takes to light a halogen light bulb normally, and it will not sacrifice any of the light given off by the bulb.

Methods/Materials

I accomplished this by wrapping 4 feet of 300 psi rated copper tubing around a light bulb, and attaching two 250 psi rated, quarter turn valves on either end of the tubing. I then ran acetone, a volatile liquid, through this coiling, and when it boiled due to the heat from the light bulb, I used the pressure gained to turn a turbine. I re-tested at different exposure times and temperatures, and observed the effects made on the turbine.

Results

After 1 minute of exposing the acetone to 65.6 degrees C it turned the turbine at 1 RPS, after 3 minutes it turned the turbine 1.5 times. After 5 minutes it turned it at 2 RPS and after 10 minutes of exposure it turned it at 3 RPS. There were very similar results for exposure at 66.6 degrees C. Tests at 67.0 degrees C were my most successful. After 1 minute it turned more than 1 RPS, after 3 minutes it turned at about 2 RPS, and after both 5 and 10 minutes it turned at 3 RPS.

It took 15 minutes and 40 seconds for the coils to reach the boiling point of acetone: 56.5 degrees C.

Conclusions/Discussion

The 15 minutes it takes for the light bulb to heat up is a reasonable amount of time, considering the average person does leave their lights on for more than 15 minutes. Although these results were below my expectations, they still act as a proof of the concept that light bulbs# heat energy can be harnessed and transferred into kinetic energy.

Summary Statement

I have built a housing for a 150 watt halogen light bulb, that uses the concepts of thermosiphoning to recycle the heat energy lost from a light bulb and transform it into the kinetic energy of a spinning a turbine.

Help Received

This project was performed entirely in my home or at my school.

CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)

Zheqi Tan

Project Number

S0223

Project Title

Optimal Projectile Mass

Abstract

Objectives/Goals

When designing projectiles, an important consideration is the mass, for it affects the range of the projectile. The hypothesis states that due to air resistance, the optimal mass is not necessarily the lightest possible, for the force of drag increases as the velocity increases. Instead, the prime mass would be the one that maximizes the distance based on the impact of air resistance and mass.

Methods/Materials

To determine this number, a launch machine propelled numerous cardboard projectiles, each with all variables fixed except the weight, multiple times to note the distance each traveled. The launches were done under mostly controlled conditions, although the wind proved somewhat unpredictable.

Results

The data was then consolidated into charts and analyzed to determine the optimal mass, which was found to be projectile #4#s. The lightest projectile (#1) traveled significantly less than projectile number 4, while the heaviest one (#5) also had less range than #4. However, there was more variance than expected in the launches of projectile #1.

Conclusions/Discussion

While the hypothesis is supported, more data is needed to conclusively accept it. With the construction of some heavier cylinders, the parabolic trend would have stronger support.

Summary Statement

The goal is to optimize the mass of the projectile so that it travels the farthest as a result of minimizing the drag and maximizing the launch velocity.

Help Received

Lance Wright helped with building the launch machine, advised on how to do the experiment, and helped with the experimentation; Ms. Haws helped edit drafts; Mr. Hendrick allowed us to use his classroom

CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)
Curtis Alan Turley

Project Number
S0224

Project Title
The Effect of the Placement of Support Columns on the Structural Integrity of the World Trade Center

Abstract

Objectives/Goals
This expirement will acertain if the spread out placement of the support columns was a factor in the World Trade Center collapses

Methods/Materials
150 5"x0.75"x0.125" pine strips; 10.1' of 0.25"x0.25" wood dowel; 48 twist ties; 1 box cutter; 1 hack saw; 2 5"x5"x0.5" wood squares; 1 hot glue gun; 1 pair of shears; 1 drill; 1 8" inch drill bit (diameter doesn't matter); 1 0.31" drill bit; 1 ruler ; 1 stress anaylzer.

To summarize the procedures, two, 18" high, model towers were constructed out of the materials above. One tower, representing a twin tower, will have its support columns near the perimenter while the second tower will have it columns equidistant from the center and the corner. Both towers were placed into a stress analyzer which applied a compresion force from the top.

Results
The first tower, which represents the World Trade Center, was able to hold 662 pounds of force with 0.235 inches of displacement, while the second tower with the normal column placement was able to hold 894 pounds of force at 0.355 inches of displacement.

Conclusions/Discussion
When placed in the stress analyzer, The first tower, which represents the World Trade Center, was able to hold 662 pounds of force with 0.235 inches of displacement, while the second tower with the normal column placement was able to hold 894 pounds of force at 0.355 inches of displacement. The results are do to a difference of force vectors, which are the measure of a forces magnitude and force. During the stress test, the Newtons exerted on the towers, create two resultant vectors acting against each other. Each resultant vector consists od two, non-colinear, forces applied at one point, which, in this case, represents the support column. The first vector is the result of the two wood planks pushing against the column to secure it in place. The second resultant vector is the force of the two perimeter walls acting against the aforementioned wooden planks. The normal tower was able to carry more weight because the first and second vector were near equilibrium. For the spread-out design, the second vector is much small than in the normal tower as a result of the columns shorter distance from the wall. Since the first vector is disproportionally larger than the second vector, it means that there is more force pushing the column towards the corner than is pushing the column towards the center, causing quicker structural failure.

Summary Statement
This project is about anaylzing any possible defects in the current structure of our skyscrapers to avoid any future collapse and loss of life

Help Received
Used stress analyzer under supervision of Mr. Martin , my engineering teacher

CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)

Alison J. Turner

Project Number

S0225

Project Title

Dry Lubricants: A Quantitative Analysis of Friction Properties

Abstract

Objectives/Goals

To test several types of dry lubricants to determine which type of lubricant decreases the amount of friction required to move an object across a horizontal track. If non-powder dry lubricants are more effective at reducing friction than the powder dry lubricants, then the friction reducing properties of the non-powder dry lubricants should exceed those of the powder dry lubricants.

Methods/Materials

1Cut steel strips into 8- 30.5 cm pieces and 8- 10.15 cm pieces using hacksaw and clamp 2File off sharp edges with grinder 3Clean all steal strips with lacquer thinner and rubbing alcohol.Let dry. 4Assemble pendulum mechanism with erector set. 5Attach a 10.15 cm strip to block and a 30.5 cm strip to track using double sided tape. 6Place block on track. 7Lift pendulum and place pin in second hole of weight. 8Pull pin quickly. 9The block will slide across the track. Record the distance traveled using square to measure exact distance the block traveled.(for no lubricant run)10Perform step 6-9 24 more times, for a total of 25 trials for each product. 11Repeat steps 4-10 applying the dry lubricant brand being tested (NOTE: the Dicronite product is special process and was applied to the two steel strips by the Dicronite Company).

grinding wheel, clamp, 8- 30.5 cm steel tracks, 8- 10.15 cm steel tracks, 3.8cm x 6.4cm x 10.15 cm wood block, lacquer thinner, rubbing alcohol, paper towels, hack saw, wood base, erector set, pendulum weight, 30 cm ruler, role double-sided tape, 4 different powder dry lubricants, 3 different non-powder dry lubricants, carpenters square, scissors.

Results

The track and sliding block lubricated with the Dicronite process yielded the block traveling more than twice the distance compared to the average of all other dry lubricants tested, implying that Dicronite has the lowest coefficient of friction. The Teflon based lubricants (Solvay Solexis powder/Permalon 327 spray) had the worst results. All graphite based dry lubricants (Hob-E-Lube/Tube-O-Lube/Versa Chem) and dry impregnated lubricant (Militec-1) had similar data.

Conclusions/Discussion

After performing the experiment and analyzing the data, the quantitative results indicated that the non-powder Dicronite process had a significantly higher average distance traveled over twenty-five trial runs, compared to all other dry lubricants tested. Based on the hypothesis, a non-powder dry lubricant had the lowest coefficient of friction (.030).

Summary Statement

Determining which dry lubricant, either powder or non-powder form, has the greatest friction reducing properties

Help Received

I had supervision while using all dry lubricants.

CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)
Nishitha Viswanathan

Project Number
S0226

Project Title
The Effectiveness of Surface Passivation Coatings on Copper

Abstract

Objectives/Goals
Copper is utilized as a medium for conducting electricity in electronic devices.However,when any of these components come into contact with moisture,the electron flow is halted,thus ending the life of your device.To prevent this,companies have developed coatings to repel water from the copper surface.Water repulsion is characterized by the contact angle of a droplet formed between the solid/liquid interface:
Hydrophilic:0°-89°
Hydrophobic:90°-149°
Super-hydrophobic:Greater than 150°
Hypothesis:If each sample is immersed in tap water for a period of 24 hours,there will be a decrease in the contact angle measurement due to the deteriorating quality of the coating.

Methods/Materials
The coatings tested include Repellix,Organic Solderability Preservative,and gold with a nickel vanadium barrier.Using a homemade measurement system,a single drop of deionized water was placed onto a sample and an image was acquired using a microscope camera.The contact angles were measured using the software.The samples were placed in tap water for 24 hours and measured again.After the immersion,the contact angle had increased,thus contradicting my hypothesis.However,through research,I was able to determine this was due to ionic contamination from the tap water.It was necessary to repeat this procedure in an autoclave chamber for 5 hours with pressure set to 20 pounds per square inch,100% relative humidity,and 123° Celsius with deionized water.

Results
After the autoclave test,the measurements were obtained and the results were compared against uncoated copper whose angle had slightly increased.This change depicts the surface underwent change and was unstable.OSP had decreased in its contact angle,thus displaying its gradual decrease in quality.Repellix had not showed any signs of a decreasing contact angle however,it did show signs of discoloration due to the fact that it's an organic nano-coating and will change over time.Gold,however,did not undergo any changes of color or contact angle,thus showing that it's very effective.

Conclusions/Discussion
The final outcome is not completely contradictory to my hypothesis.It's true that the contact angles had changed significantly but due to ionic contamination from the tap water.However,it's true that as quality decreases,contact angles will decrease also,as confirmed by the autoclave test.

Summary Statement
The objective of my project is to test the quality of various coatings used to prevent copper oxidation based on how well water is repelled from their surface.

Help Received
My dad helped me set up my apparatus, obtain samples, and place the samples in an autoclave chamber [located in the Skyworks Solutions Inc. facility]. In addition, he and my mom provided me with guidance and supervision troughout my project.