CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)

Blaine S. Anderson

Project Number

J0301

Project Title

Earthquakes vs. Skyscrapers

Abstract

Objectives/Goals

In my experiment I am trying to figure out what style building is best for standing up to earthquakes. Will it be a building like todays skyscrapers, one built with shock absorbers, or one with a wider base?

Methods/Materials

During my experiment I used LEGO's to construct my buildings. I designed a shake table using two plastic cutting boards, two large rubberbands and four 1" diameter balls. I measured the magnitude of my earthquakes by using a Google App called "Science Journal".

Results

During my experiment I tested four different structures with the same height but different base sizes. My widest base structure sustained the largest magnitude earthquake.

Conclusions/Discussion

During my experiment I determined that the wider base the more stable the structure. I found that each time I increased the base width and depth the structure could withstand a higher magnitude earthquake. My largest base building measured 3-1/8" square x 12" high and withstood a 14.7 earthquake, while my smallest building measuring 1-7/8" square x 12" high only withstood a 8.8 earthquake. When I tested the shock absorbers I was surprised that the results were very similar to the narrowest structure. Of course, I was using LEGO's and based on my research real shock absorbers would work better than todays narrow skyscrapers built without shock absorbers.

Summary Statement

I was able to determine which base style for a skyscraper would best hold up to an earthquake.

Help Received

I had assistance with creating my shake table by my parents, I built my structures and performed my experiments on my own.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Bailey K. Autry

Project Number
J0302

Project Title
Which Non-Electrical Speaker Produces the Best All Around Sound?

Abstract

Objectives/Goals
The purpose of this project was to figure out if the more holes a non-electrical speaker has, is better or worse. I said that if the speaker had 2 holes, compared to a speaker that had 4 holes, it would be the louder speaker. My hypothesis was correct. The 2 speakers I compared were both made of the same material and had the same size holes on all sides so, that means my independent variable was the amount of holes the speaker had. From conducting this experiment, I learned that when a non-electrical speaker has more holes it absorbs the sound more instead of making the sound project out louder. When I compared both the speakers to the original phone speaker both of the speakers to the original phone speaker both of the speakers were louder so it did make a difference in the sound.

Methods/Materials
Take the bamboo and cut it into 3, 8in pieces
On 2 of the pieces of bamboo, cut a slot out that is big enough to fit your phone
Put 1 of the slotted pieces of bamboo to the side, that is you first speaker
To start the second speaker take the other slotted piece of bamboo and drill a hole straight through the side, so that it is perpendicular to the other tunnel going through the bamboo
After that take the unslotted piece and cut it so that it will connect to the other bamboo piece and go straight through the holes you just made
After that take the pieces and glue them as perfectly in line with the other holes as you can
Test and compare the sound volume of both speakers by using a sound level meter

Results
The speaker with 2 holes was almost always louder than the one with 4 holes. The only time the speaker with 4 holes was louder was when a song was measured at 0 ft. When I was testing using hrtz the speaker with 2 holes was always louder.

Conclusions/Discussion
The speaker with 2 holes was louder than the speaker with 4 holes overall. It seemed that when I tested with music and measured it up close the speaker with 4 holes was better than the one with 2 holes, but all the other points taken with music and with a steady sound showed that the speaker with 2 holes was better.

Summary Statement
My project was about comparing two non-electrical speaker designs to see if it change the volume of the sound.

Help Received
None

Name(s)
Benjamin E. Bailey

Project Number
J0303

Project Title
Comparing the Load Bearing Capacity of Howe Truss and Pratt Truss Bridge Designs

Abstract

Objectives/Goals
The objective is to measure the different load bearing capacities of the Howe Truss and Pratt Truss bridge designs using models. Comparing the strength of both bridges with the load on top but only in the center vs. load distributed all the way across the top from end to end.

Methods/Materials
Standard size popsicle sticks, glue, level, ruler, bucket, cardboard box, scale, books to make bridge level when building. Built Howe Truss and Pratt Truss bridge models using diagrams from research.
Placed two cinder blocks on level surface then put Howe bridge on top. Placed bucket in center of bridge, added sand one cupful at a time until bridge failed by support popping off. Weighed sand subtracting weight of bucket and noted weight. Repaired bridge and repeated.
Repeated process with Pratt Truss for two trials. Then repeated trials using cardboard box the exact length of Howe until bridge failed by cracking. Repeated with Pratt. Could not do multiple trials with box because both bridges cracked.

Results
The Howe Truss was stronger in both bucket trials, with the load in the center both times. The Pratt was significantly stronger in the box trial with the weight distributed across the top of the bridge.

Conclusions/Discussion
The Pratt Truss is a better choice overall because most bridges need to support weight all the way across a bridge most of the time. But for a bridge or other truss supported structure where the load might be only in the middle, the Howe Truss design might be the better choice.

I think this can be very useful to know when designing a bridge or truss structure - use the design that will be stronger depending on what the bridge is used for.

Summary Statement
I showed that the Pratt Truss is stronger with the load all the way across the top, but the Howe Truss is stronger with the load on the top center.

Help Received
I built the bridges myself from information from the internet. My science teacher gave me notes on making the board more detailed.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)

Michael P. Bedrosian

Project Number

J0304

Project Title

Comparing the Compression Strength of Reclaimed Wood Structures to New Wood Structures

Abstract

Objectives/Goals

The objective of this study is comparing the compression strength of reclaimed wood structures to new wood structures. My goal is to prove that reclaimed wood structures will be stronger than new wood structures. Also with an emphasis on recyclability of reclaimed wood as a building structure material.

Methods/Materials

Purchased reclaimed Douglas fir and Redwood from Crossroads Lumber Co. Purchased new Douglas fir and Redwood from Holt Lumber. Holt lumber fabricated all wood planks to spec. A total of 28 planks for each wood type were made. Planks nailed together by National Raisin Co.Forman, to form a rectangular open ends box. Seven boxes of each wood type were made. Box measurements were 7" long. 3 1/2 " wide, 5/8"thick. The boxes were tested in a Universal Compression Machine at Fresno State Univ. Engineering Dept. Structure placed in compression machine until broken. Compression results recorded for each wood type. PSI calculated, and compression wood average results charted.

Results

The results of my investigation shows that reclaimed wood structures are stronger than new. Reclaimed Douglas fir compression strength average was 567 PSI vs. 464 PSI to new. An 18% compression strength difference in reclaimed Douglas Fir to new. Reclaimed Redwood compression strength average was 345.5 PSI vs. 289.9 PSI to new. An 16% compression strength difference in reclaimed Redwood to new. The results further prove that my hypothesis is correct that reclaimed structures are stronger than new. This gives builders a recyclable option to use reclaimed wood.

Conclusions/Discussion

I found that my hypothesis is correct that reclaimed wood structures are stronger than new. Reclaimed Douglas fir structures were 18% stronger than new which was very significant. Reclaimed Redwood structures were 16% stronger than new which was very significant as well. Consistently reclaimed wood proved to be stronger in both wood types. Reclaimed wood can be used more for building projects for its strength and appearance. Only 15% of reclaimed wood is used, rest goes to landfills. Let's try to utilize this precious resource better!

Summary Statement

Compression testing of reclaimed wood structures proved to be stronger than new wood structures which was very significant and a viable building option.

Help Received

Dr. Kimberly Stillmaker, Assistant Professor Civil Engineering Department, California State University Fresno; Mr. Mar Mandel Owner, Crossroads Recycled Lumber Company, North Fork; Mr. Santos Garcia Lumber Supervisor, Holt Lumber Company, Fresno; Mr. Frank Reyna Yard Foreman, National Raisin

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Claire M. Boles

Project Number
J0305

Project Title
Know the Flow

Abstract

Objectives/Goals
How does the size of different granular materials affects their mass flow rate through a funnel? I will compare materials with different dimensions and textures.

Methods/Materials
Stopwatch, millimeter ruler, scale, funnel, various sized materials (rice, beans etc.),platform to hold the material. Compare three different time trials to determine how long it take the different materials to flow though the funnel.

Results
The smaller the mass of the object the faster the mass flow rate. Objects with a smooth texture and small mass had an increased speed.

Conclusions/Discussion
Within the accuracy of the measurements, the smaller the mass and the smoother the texture of the granular materials allowed for the fastest mass flow rate. The three trials all proved the same data.

Summary Statement
I measured the size of different granular materials and compared their mass flow rate through a funnel.

Help Received
At school I got help with the scientific method. I designed the platform, and conducted the experiment by myself.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Jack Conner; Tazio Oka

Project Number
J0306

Project Title
Disease Identification, with a Spin

Abstract

Objectives/Goals
The objective of this build is to create a cheap, non-electric, hand-powered centrifuge for people in third-world countries to use to identify and prevent the spread of various diseases.

Methods/Materials
We used CDs and string to build our centrifuges, and this method worked. After three prototypes, we came up with the current design, which uses foam to hold the capillary tubes where the blood is held. To test, we used a tachometer to measure the rpm (rotations per minute) in order to compare our centrifuge to a lab-grade centrifuge.

Results
Our centrifuge was able to spin at speeds around 30,000 rpm, while most lab-grade centrifuges spin at 2,500, the speed needed to separate blood in 5 minutes (Note: Many lab-grade centrifuges spin faster, but 2,500 rpm is the minimum speed needed to separate blood). We were also able to separate cow blood (Bovine blood), which proved that our centrifuge would be able to separate human blood in the future.

Conclusions/Discussion
In conclusion, our centrifuge has the capability to separate blood purely through hand power. However, the centrifuge's foam protection for the capillary tubes causes drag, lowering the centrifuge's rpm. In the future, the model would be refined even more so that there is less drag. In addition to that, the centrifuges could be mass-produced easily (around 30 minutes for one) and the materials put into kits and shipped to various third-world countries plagued by illness.

Summary Statement
Our project was to build a cheap, hand-powered, portable centrifuge that could spin at speeds fast enough to separate blood.

Help Received
No professional help.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Elizabeth A. Cullum

Project Number
J0307

Project Title
Can You Make a Hurricane Proof House?

Abstract

Objectives/Goals
Each year, homes, lives and communities are destroyed by hurricanes around the world. In the US alone, billions of dollars worth of damage left the country devastated after hurricanes Harvey, Irma, and Maria. Therefore, the objective of this project is to create a hurricane proof house that can survive a category 5 hurricane.

Methods/Materials
I first researched aerodynamics and current storm resistant shelters. Then I made a scale drawing of the proposed hurricane proof house. Using the drawing, I created a wood template to form the wire frame. I began by bending rebar tie wire around the template representing the steel frame of the house. Then I covered this frame with aluminum wire mesh. Next, I covered the wire frame and foundation of the house with Ferro-Cement. I purchased all my materials from Home Depot. After the structure dried, it was tested in proportional ocean waves at Cardiff Beach. The waves simulated the hurricane flood surge that comes in a category five hurricane. I also tested the model with a leaf blower to simulate the hurricane force winds of 160 mph.

Results
During the wind test, the leaf blower produced winds at 160 mph, which simulated the power of category five hurricane force winds. A dial indicator was set to zero and placed on the model to check for any harmonic oscillation. There was zero movement, during the test. The distance from the wind source varied from 16cm, 8cm, 4cm, and 2cm. The aerodynamic shape of the house allowed the hurricane force winds to easily pass over and around the house without causing damage.
During the flood surge test, the model was placed in 5cm, 10cm, and 15cm wave heights at Cardiff Beach. The pedestal allowed the waves to flow under and around the house, yet left it still standing tall and strong.

Conclusions/Discussion
This project proved the importance shape plays in a building's survival or destruction during a storm. Combining an aerodynamic shape with a pedestal house and a concrete construction, gave strength and durability to the design.

Summary Statement
In this project I designed, constructed, and tested a model of a hurricane proof house.

Help Received
I consulted with Andrew Cullum, a contractor and designer, about the scaled drawing. He provided tools and machinery for building the model. I consulted with Richard Stinchcome, an aeronautical engineer, for understanding of laminar flow and aerodynamics. I did the template, model, and testing.

Name(s)
Natalie R. Dean

Project Number
J0308

Project Title
What Does a Simple, Low-cost, 3D-printed Design for an Automated Robotic Prosthetic Look Like (Phases 1b, II, and III)?

Abstract

Objectives/Goals
Using commercially-available software, hardware, and components, a simple 3D-printed design for a robotic hand will be created. In Phase I of the design (a previous project), a typical 3D printer and software were used to generate, optimize, and print a child-sized model hand. In Phase II, a significantly improved 3D-printed model (Phase Ib) will be fitted with robotic parts such that the hand will function with individual finger movements. Finally, in Phase III, the robotic hand will be retrofitted with automation in order to direct the hand's activities using computer commands. Ultimately, the prosthetic should be able to perform simple tasks, such as gripping an object, picking up an object, and sequenced movements of the fingers.

Methods/Materials
In Phase Ib, commercially-available software and hardware were used to substantially optimize the previous 3D-printed design (from Phase I) for a robotic hand to fit a child. The Phase Ib design allowed the hand to open and close more completely and easily. In Phase II, the improved hand was fitted with parts such that it functioned mechanically with individual finger movements. In Phase III, the prosthetic was fitted with automation parts in order to direct the hand's activities using computer commands.

Results
Once CAD designs were modified or created for each of the parts needed to 3D-print the significantly improved model, and after all robotic and automation components were selected and tested, the individual items needed to build the entire hand were recorded (cost per unit), along with time to print the 3D-printed parts. Total cost and total time were calculated based on the number of each item needed. As proposed in the hypothesis/solution and as required by the design constraints, total material costs for this automated robotic hand were low ($72.39 if not commercially printed). Total time to print all 3D-printed parts was 36.3 hours.

Conclusions/Discussion
The prosthetic functioned automatically with individual finger movements. Automated movements for simple tasks such as grabbing and pinching (picking up an object) were achieved. Phases Ib, II, and III resulted in a low-cost and effective design solution. The overall design requirements for the automated, robotic prosthetic were achieved, although the designed hand had much more range of possible movement than currently occurred using the selected servo motors.

Summary Statement
I designed, built, and tested a functioning, child-sized robotic prosthetic using CAD software, 3D-printing, mechanical parts, and automation hardware and software.

Help Received
Dr. Alexa Alborzi of Alborzi Orthodontics donated orthodontic elastic bands. A staff member at Turner's Outdoorsman in Fountain Valley, CA, provided his knowledge and donated microfilament fishing line. Sean Kilmer at Maker Tree 3D provided support and quick turnaround time for commercial 3D-printing.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Aidan H. Deshong

Project Number
J0309

Project Title
The Strengths of All Five Platonic Solids

Abstract

Objectives/Goals
Triangles have always been known as the strongest shape in two dimensions, but are they the strongest in three dimensions? Does shape even make a substantial difference in three dimensions? This experiment looks at which Platonic solid (one of the five shapes that have the same number of sides touching each corner) is the strongest when built out of both cardstock and uncooked Barilla lasagne.

Methods/Materials
A force gauge was used to apply pressure to the shapes made out of the two different materials, and the magnitude of the force was recorded using Logger Pro software. Based on the exerted force when a Platonic deformed (the dependent variable), I was able to get a conclusion to determine what the strongest shape was.

Results
My hypothesis was that the Platonics would, from strongest to least strong, be in this order: tetrahedron, cube, octahedron, icosahedron, dodecahedron. The results partially supported my hypothesis by showing that the three I had predicted were significantly stronger than the other two, but disproved my hypothesis in the sense that the tetrahedron, cube, and octahedron were always bunched up together in front of the other two (there was no significant difference between them). The experiment also showed that, while I was not testing it, cardstock tends to have a series of deformations, while uncooked pasta completely obliterates once a certain threshold is passed.

Conclusions/Discussion
Accomplishing three smashes of each Platonic solid made me conclude that the number of sides and the simplicity of the shape were more important than the strength of the shape that the solid was made of. This means that the strengths of 2D and 3D shapes are independent of one another. The project also ended with a conclusion that the cube, tetrahedron, and octahedron are the strongest Platonic solids.

Summary Statement
I showed that the strongest Platonic solids are the cube, tetrahedron, and octahedron, and that the number of sides in a 3D shape is better at determining its strength than what the actual shapes that construct it are.

Help Received
My mother helped me create a few of the Platonic solids and start the recordings of the pressure, though I analyzed them myself.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Kessler P. Dyche

Project Number
J0310

Project Title
Are Perpetual Motion Machines Possible?

Abstract

Objectives/Goals
The objective of my project is to determine if perpetual motion is possible by making a machine that will rotate on its own energy. If the right amount of water is placed in each bottle then the wheel becomes unbalanced and rotates indefinitely.

Methods/Materials
I built a perpetual motion machine based on a version of Bhaskara's wheel using a bicycle rim, steel pipe for the frame, water bottles, zip ties, and tubing. I welded together a steel frame and bolted the bicycle rim to the top. My first attempt at making the wheel rotate was filling 8 bottles with water and attaching the bottles to the rim with zip ties. I continued to test my wheel by adding an additional bottle, changing the amounts of water, and adding salt to the water in an attempt to make the water heavier. My final attempt, I attached the bottles together with tubing so that the water would flow between each bottle.

Results
In each attempt I manually rotated the wheel one rotation and released to see how long the wheel would go on its own. The least successful attempt was using 9 bottles of tap water each filled with .623kg of water, which rotated one full rotation on its own. The most successful attempt was using 9 bottles of tap water each filled with .550kg of water, which made 4 full rotations on its own.

Conclusions/Discussion
All attempts were unsuccessful and did not support my hypothesis. I conclude that the wheel will only continue to rotate with an outside energy source. This proves the theory that perpetual motion cannot be obtained because it breaks the first and second laws of thermodynamics. The initial energy provided by manually turning the wheel will always be dispersed and will eventually stop the wheel. This means that you cannot get more energy then you put in. If perpetual motion could be proved, we would no longer have to use fossil fuels or other outside energy sources which would have a positive impact on the environment.

Summary Statement
I created a perpetual motion machine to find out if perpetual motion is possible.

Help Received
I designed and built the perpetual motion machine and my father helped me weld and assemble it.

Name(s)
Kelton K. Garber

Project Number
J0311

Project Title
Alternatives to Sand in Concrete

Abstract

Objectives/Goals
The goal of this engineering model is to discover a reasonable alternative for sand in concrete. One of the central ingredients for engineering is sand, and it is becoming increasingly difficult to obtain. The issue of limited supplies of usable sand affects me personally as concrete is a major building material for places like my home and school.

Methods/Materials
The engineering model comprises of several concrete bricks, made and tested the exact same way. However, each has one different ingredient. The independent variable in each concrete brick is the usage of sand, rice, plastic, or dried beans. The sand made concrete brick is the control variable, which is used to compare the other bricks. The best brick is determined by durability (dependent variable)in multiple scenarios (compression, temperature, and submersion).

Results
The dried bean brick was affected the most by water, was the weakest when lifted up wet, and was the only brick to crumble. The sand brick dried slowly, and the rice brick absorbed the most hot water. Plastic proved to be the best suitable alternative for sand as it handled all of the temperature, compression, and submersion tests with minimal changes to size, weight, and durability.

Conclusions/Discussion
This project tested a variety of concrete bricks, made with rice, plastic, dried beans, and sand (the control variable). During the tests, there were a few uncertainties which could have had a major effect. The cold weather had an effect on the duration for the bricks to dry during their construction. The first attempt had the bricks originally dry for five days, but the temperature and location made them take eight to ten days instead. The sand brick and dried bean bricks were unable to hold their shape after drying for ten days, and both had many cracks. More cement was added in order to stabilize these two bricks. After all of the tests, the results show that the hypothesis is correct. The plastic brick held its shape the best, handled warm, cold, and wet climates with little to no damage, also withstanding the weight of an adult (195 lbs).

Summary Statement
After testing multiple substances, under varying conditions (temperature, pressure, and submersion), plastic proved the best alternative to sand as it handled all the tests with minimal changes to size, weight, and durability.

Help Received
My mother and father helped me desgn my project along with my brother and sister who helped me execute the testing.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Thomas E. Garner, III

Project Number
J0312

Project Title
Comparison of Two Different Propulsion Systems: Combustion vs. Magnetism

Abstract

Objectives/Goals
Can a magnetic-based propulsion system successfully propel a free-floating vehicle forward? If so, how does it's performance compare to jet propulsion systems?

Methods/Materials
Magnetic-based model was composed of Styrofoam, suspended in the air via the repulsion of opposing magnets on the bottom of the vehicle and a cardboard track. The vehicle would travel along the track via the attraction of magnets on the bow of the vehicle towards a stationary magnet at the end of the track (30.48cm). Additionally, another Styrofoam vehicle was placed on water, which was separated into two equal halves attached by a straw. The lagging half had a magnet affixed to it; while rotating a magnetic bar near the leading half (north to south). A combustion based propulsion system was modeled using a rocket simulation, created using a water bottle "rocket" fueled with ½ teaspoon of rubbing alcohol which was ignited using a barbecue lighter, which was inserted to the mouth of the bottle, inside a PVC pipe and sealed using low-flammability paper wadding. Data from 6 trials per vehicle type were used to calculate force, "work", speed, and efficiency.

Results
The average time for the magnetism-powered vehicle to travel 9 centimeters is 0.34 seconds, its average speed is 0.48 m/s, thus taking an average of 0.61 seconds to travel 30.48 centimeters, with 100% efficiency. However, the trial of the vehicle floating in water, resulted in minimal net movement forward. The combustion based propulsion system resulted in the following: The average time for the bottle rocket to travel 30.48 centimeters is about 0.92 seconds, and it took an average time of roughly 1.85 seconds to travel the average distance of about 4.8698 meters. The average speed for the bottle rockets is 2.63 m/s, with 93% efficiency.

Conclusions/Discussion
In conclusion, the data indicates that magnetic-based propulsion systems could be a preferred method of propulsion for long distance space travel from an efficiency standpoint. However, this means of travel would likely need to be coupled with smaller thrust engines near the front, to keep one half of the vessel stationary (relative to the other), in order to produce forward motion. For shorter distance space travel and with heavier payloads, combustion based propulsion systems would be preferred as they generate more energy and thus are able to do more "work".

Summary Statement
A comparison of jet propulsion and magnetic propulsion in space travel.

Help Received
Special thanks to Mrs. Kruczyk for helping me with the project documents and my family for assisting me with the experiments. I came up with the idea for this project, designed the experiments and created the CAD drawing of the final proposed vessel.

Name(s)
Eric K. Gediman

Project Number
J0313

Project Title
How Does the Design of a Building Change the Effect Inertia Has on It during an Earthquake?

Abstract

Objectives/Goals
The objective of this project was to test out the base isolator, a device that keeps the building detached from the ground, and see how the usage of it changes the effect of inertia.

Methods/Materials
Fusion 360 3D modeler, laser cutter to cut out the parts, arduino code and diagram for parts avaliable here: https://drive.google.com/file/d/1HJvE0uji0FFx-wkrk3xvGMi94fuNJ6b8/view?usp=sharing. I created the design for the base isolator, hexagons, and table, but I recieved help with the hexagons and table at the Hexlab, and I designed and wrote the code for the original circutry, but my design was refined at a place called the Hexlab. I gued the parts together and set up the table and performed the experiment with 3 different building designs and adding different amount of weight it the form of coins, the weight added being constant for each design. I measured the time until the initial collapse, and the layer that originally collapsed, layers being the 12 hexagons I stacked to create the building.

Results
The more weight that was added while the building was on the base isolator the longer until initial collapse, and the layer of collapse had no discernable difference. The more weight that was added to the top of the building while not on the base isolator the longer it took until initial collapse, and the lower the layer of collapse was. When the weight was placed on a piece of wood that the building was on that was on the shake table there was no real difference.

Conclusions/Discussion
These results show that the best way to build you building is to use a base isolator, and add as much weight as possible to it, since the more weight that is added the better the chance of the building surviving the earthquake. The results also show that adding weight to the top of the building as dense material isn't a good idea, since that lowers the center of gravity, and more of the building will fall at once, creating a bigger hazard than just having no protection at all.

Summary Statement
I tested how buildings react under an earthquake with a base isolator and differing amounts of inertia, to see how much weight you should have on a building depending on the design of the building.

Help Received
I designed the base isolator myself, and I got acess to a laser cutter and help in refining my designs and code at a place called the Hexlab.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Elizabeth N. Godoy

Project Number
J0314

Project Title
TEA Pot

Abstract

Objectives/Goals
Many people love to have plants growing in their home. Whether it is for increased oxygen in your home, therapeutic purposes, or just for decoration, there are many uses for plants. However, some people just don't have the time to take care of their plants. If you are busy all day, or are going on vacation for a couple of days, who is going to take care of your plant? To try and solve this problem, we have used three different solutions, each getting progressively better.

Methods/Materials
Arduino Uno, MIT App Inventor 2 (used to create our app), Arduino IDE (used to program our plant pot), Bluetooth Module, CdS Photoresistor, Temperature sensor, Water level sensor, Jumper wires, Android smartphone, Solar shield, Solar panel, 9 volt battery, Battery cap, Breadboard

Results
Our first solution was a Bluetooth based plant pot. All this solution did was send data from the sensors connected to the Arduino over to the MIT App Inventor 2 app and watered the plant every two days. Our second solution made the settings customizable. This way, YOU get to choose how often to water your plant. Our third solution was more eco-friendly than the previous solutions. This solution was the same as solution 2, but is powered by a solar panel rather than batteries or a laptop.

Conclusions/Discussion
Although all of the solutions solved the problem, the third was the best. However, the data that was sent over from the Arduino to the app was in voltage and not in common units of measurement. To fix this, we could find an algorithm to convert the input into units of measurements that are commonly used. Also, the Arduino was sending information from the sensors at random intervals to the app. We think this is caused by the timers running the customizability in our app.

Summary Statement
I created a plant pot that automatically waters your plant for you and sends information about your plant to an app on your phone.

Help Received
I created the app myself using MIT App Inventor 2, but received help with the Arduino, 3D printing, and solar panel.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Jake P. Grigorian

Project Number
J0315

Project Title
Which Robotic Apparatus Picks Up a Cone the Fastest?

Abstract

Objectives/Goals
The objective of my experiment is to find out which of the three robotic apparatuses most efficiently picks up cone and places it on a mobile goal. These three apparatuses are a metal claw, a rubber band intake, and a rubber band with mesh intake. The effectiveness of each apparatus will be measured in time(seconds), materials and weight (metal, rubber band, rubber mesh). I hypothesize that the rubber band with mesh intake would perform the best because of the fact that it has a gripping mesh wrapped around its circumference, and it is also lighter than the metal claw.

Methods/Materials
Body of VEX Robot, materials for three different robotic apparatuses(metal claw, rubber band intake, rubber band intake with mesh), yellow VEX cone, mobile goal, joystick, competition field(area in which robot will be tested). The materials provided by St. Francis High School Robotics Department.
I coded the program for joystick and robot function and used my stopwatch.
Designed and built the three apparatuses. Respectively attached each robotic apparatus to the body and had it pick up a cone and place it on the mobile goal. Tested each apparatus ten times and averaged the results.

Results
After ten trials for each robotic apparatus, I averaged the results. I determined that the rubber band intake, having the lowest weight of the materials also had the fastest average time, 1.612 seconds, in picking up the yellow cone and placing it on the mobile goal, meaning that it was the most effective at performing the task at hand as compared to the other apparatuses(metal claw 2.257 seconds, rubber band intake with mesh 1.724 seconds).

Conclusions/Discussion
I designed and built three robotic apparatuses, which are the metal claw, rubber band intake, rubber band intake with mesh, and attached each individually to the body of the robot and programmed and commanded it to pick up the cone. After determining that the rubber band intake was the most effective apparatus, it can be concluded that it should be used during robotics competitions.

Summary Statement
I designed a robotic apparatus, currently used in robotics competitions, that is the fastest and most efficient in its category.

Help Received
I designed, constructed, and programmed all the apparatuses, and performed the trials. Due to the weight and size of the robot's body, I along with the St. Francis High School Robotics Team, built the body.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Sarah M. Hansen

Project Number
J0316

Project Title
Eyedropper Properties that Affect Drop Size

Abstract

Objectives/Goals
Commercial eyedrops are made twice as large as they need to be. This leads to a lot of medical waste. I wanted to understand the factors that determine drop size in order to find a way to construct an eyedropper that could produce a smaller drop in which medicine is not wasted. I decided to only change the eyedropper because changing the liquid would be changing the medicine which could have unforeseen consequences.

Methods/Materials
I used a syringe pump which was attached to a pipette that dropped onto an analytical balance. 10 drops were dropped, then the mass was converted to volume to find the drop size. 3 different orifice sizes were tested, 1.02mm, 1.81mm, and 5.4mm. Hydrophilic and hydrophobic surface properties were tested by treating glass with acid or Rain.x. Angle of use was measured by tilting the pipette. The conditions that made the smallest drops were combined and tested with both water and real eye drops.

Results
When the orifice size almost doubles, so does the drop size. Hydrophobic pipettes only make slightly smaller drops than hydrophilic pipettes. There was not a great difference with different drop formation rates. The smallest drops out of a hydrophilic pipette were at a 90 degrees while the smallest hydrophobic were at 25 degrees. The combined conditions that make the smallest drops decreased the size of a water drop and a real eyedrop from approximately 31ul out of a packaged eyedropper to approximately 12.5ul.

Conclusions/Discussion
When the orifice diameter approximately doubles, so does the volume of the drops produced. Held at 90 degrees, the effect of surface properties and drop formation rate were small. When using a hydrophilic pipette at an angle, the drop can wrap around and adhere to the side of the pipette increasing the adhesive surface area. However it is different for hydrophobic pipette where the water does not adhere to the glass. With the conditions that produced the drops for pure water and Visine eye drops.

Summary Statement
I altered eyedropper size, angle of use, drop formation rate, and surface chemistry to decrease drop size.

Help Received
I took all of my own data, accompanied by my dad. I borrowed equipment from Revolution Medicines.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Jasmine D. Holm

Project Number
J0317

Project Title
Baby Alert

Abstract

Objectives/Goals
I am creating a bathtub drainer to help save babies from drowning in a bathtub when left unattended. I named it the Baby Alert because there is an alarm that is attached to the prototype that will alert the parents by lighting up and sounding. The prototype will also retract the plug to drain the water from the bathtub save the child from drowning. There are about 393 children that die in bathtub drownings per year. I am hoping that my prototype will help lower the drowning and save more innocent lives.

Methods/Materials
Baby Alert Prototype was built with materials that were purchased from varies hardware stores. The materials that were used to build the prototype were a metal chain, wooden box (that was built by me), drain plug, metal puller, motor, relay, timing relay, alarm, light and a float switch.

Results
The Baby Alert Prototype worked as planned. When the floater was activated by mimicking movement, the arm attached to the floater set off the alarm. When the alarm lit up and sounded, the plug retractor activated and coiled back.

Conclusions/Discussion
Baby Alert Prototype could give that extra second or minute that is needed to prevent a child from drowning. The light up alarm is not only sound alerting but visually so the adult knows that something is wrong. It also, can remove the water by unplugging the bathtub so the child does not stay in the water which can cause them to drown. When deciding to create my project I wanted to see if there were others that were similar in the market. There were a few that did alert, but did not prevent in the same way as Baby Alert does. Such as Safety Turtle Pool Alarm System only sounds an alarm to prevent the child from going near the water. Baby Alert allows the child to be in the water and alert the adult when the child is in danger of drowning.

Summary Statement
My Baby Alert Prototype showed that it can alert yet assist in saving a child from drowning.

Help Received
I built and created my prototype by myself with some assistance by my father.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Zara Hommez

Project Number
J0318

Project Title
Table Cleaning Robot

Abstract

Objectives/Goals
The objective of this project is to design a table cleaning robot that will wipe spills and dust off the table without human supervision.

Methods/Materials
I used ev3 lego pieces to build my robotic vehicle and programmed it using the Mindstorms software. I used drag and drop action blocks, flow blocks, sensor blocks and a loop to give commands to the robot on how to move and when to shut off. I attached an ultrasonic sensor to sense the edge of the table. When it reaches the edge, it moves back, does a pivot turn on a ball caster and goes in another direction

Results
I built 3 different prototypes and performed 105 trial runs. The first prototype used a color sensor but only worked on a rectangular shaped table. So I switched to an ultrasonic sensor for the second prototype which could now clean all different table shapes. In the final prototype, I moved the cleaning sponge to the back to minimize drag and added a wet wipe for better cleaning. The robot can clean dust and liquid spills on a table of any shape without human supervision. After 20 testings it did not fall off once from different table shapes. It passed the wet wipe cleaning test and surface wetness test. It shut off after 3 minutes and made a beeping sound to the user to signal the cleaning was finished.

Conclusions/Discussion
An ultrasonic sensor is more effective than a color sensor for the table cleaning robot. The color sensor only works on a rectangular table and gets confused with colored spills like ketchup. The ultrasonic sensor works on all table shapes. It continuously measures the distance from the closest object using sound waves. The table top is near the ultrasonic sensor, but as soon as it crosses the edge, it reads a very large distance from the floor indicating that it has reached the edge and then it is programmed to move back and in another direction. This robot will be useful for those who want to save time cleaning and the disabled.

Summary Statement
I designed and programmed a table cleaning robot that wipes spills without human supervision and uses an ultrasonic sensor to sense the edges of the table

Help Received
I designed and programmed the robot myself using online research. My science teacher and parents reviewed the design and results.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Terry Hsu

Project Number
J0319

Project Title
Flip It Around: How to Get the Best Succeeding Rate for Bottle Flips

Abstract

Objectives/Goals
The purpose of our study is to compare the succeeding rate of a bottle flip in different angles and different water height, in this experiment, we can find out the best angle and water height for a bottle flip to succeed. It is hypothesized that a water height of 1/3 will make a best succeeding rate of bottle flips in most angle.

Methods/Materials
In this experiment, first, we used large 1 large plastic pipe, metal holders, and 3 pieces of wood to make a bottle launcher. Then, we prepare 5 Kirkland bottle with a marked height, each with 600ml capacity, to perform the bottle flip. Next, we will put in the following height of water: 0cm, 3cm, 6cm, 9cm, 12cm, 15cm, 18cm. After preparing the bottles, we can start putting the bottles inside the bottle shooter, and record each test result, we have the following angles to test: 0 degrees, 15 degrees, 30 degrees, 45 degrees, and 60 degrees. Each water height has 30 tests times 5 angles, which is 150 tests per water height.

Results
The result was that 1/3 of the water height does give the best bottle flip succeeding rate. We found that both low water filled and high water filled bottle give a very low succeeding rate, because it will cause the bottle to bounce very high in the bottle flip. We also found that 15 degrees angle actually works better than a 0 degree angle, because of the rounded edge on the Kirkland plastic bottle, therefore, the angle of 15 degrees performs the best succeeding rate. Based on the best condition of 33cm, insert angel of 15 degrees, we found the succeeding rate can reach 93% when the water height is 1/3.

Conclusions/Discussion
The result of our experiment clearly shows that our hypothesis, ¡°A water height of 1/3 will make a best succeeding rate of bottle flips in most angle.¡±, is true. However, in our experiment, we used a machine to eliminate human factors and make an accurate result with more than 1000 tests, the actual bottle flips still depend on the way the person performs it, especially when it comes to the angle. And still, I believe that our experiment can help people determine their water height of bottle flips and is a really fun and interesting idea to work on!

Summary Statement
In our experiment, we tested the insert angle and water height to find the best condition to make a highest succeeding rate for bottle flips using a bottle launcher on more than 1000 trials.

Help Received
My father helped me build some parts of my bottle launcher that I designed, including buying materials and sawing wood. My mother helped me design and organizing my display board.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)

Tharushi Jayasinghe; Fiona Wee Eng

Project Number

J0320

Project Title

Automaton Arm Prototyping

Abstract

Objectives/Goals

Through the creation of each arm prototype, we aim to increase functionality to offer the best product we can. Whether to cater to individuals with disabilities, or just those who want a way to ease the stresses of life, with our arms we want to be able to fit the needs of all. As arms are created to offer solutions to more and more everyday problems, some aspects that will likely see improvement are joint strength, general material strength, portability, and versatility.

Methods/Materials

Cardboard, popsicle sticks, paper, a glue gun, Arduino circuit boards, breadboards, wires, servos, knobs, a computer/laptop, a 3D printer, and a 3D printer filament spool are needed to recreate the arms, as well as the IDE that comes with Arduino. With each prototype that we built, the number of servos plus quality of the materials used increased, as did the functionality, and code was tweaked.

Results

With the addition of servos as we went along building more prototypes, our final product functioned somewhat as a human arm would and worked the best out of all the ones that were made. The other prototypes didn't perform as well. Functionality-wise, the first prototype didn't work to serve our purpose of assisting in the home. The second prototype mimicked shoulder, elbow and wrist movements and performed better than the first prototype but still had room for improvement.

Conclusions/Discussion

From building the prototypes we learned how to wire/write the code for servos and knobs, while also building skills in problem solving, creativity, and teamwork. As each arm was built, it quickly became clear that by bringing them into the home, robotic arms could see uses pertaining to fields other than industrial, medical, or extraterrestrial. Some personal needs include moving objects in the attic or clearing the yard. Most people take those actions for granted, but there are those who aren't capable of doing these activities themselves. Even then, one with the capability to perform those tasks may face difficulties because of diseases like arthritis, something which the arms we built combat.

Summary Statement

With our robotic arms, we aim to better the lives of those who both need and want it, keeping efficiency in mind with each version.

Help Received

My father, Edward Wee Eng, provided us with the resources we needed, including the 3D printer.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Alexis J. Korb

Project Number
J0321

Project Title
Rain-Walker: An Engineering Project Testing the Efficiency of a Handheld Umbrella vs. an Umbrella Designed for a Walker

Abstract

Objectives/Goals
The objective was to design an umbrella that would be more effective for use with a walker, providing convenience to make a user's life easier, drier, and safer.

Methods/Materials
Using PVC, plastic, Velcro, and a few other materials I designed a collapsible umbrella for a walker. I tested my design for convenience and dryness.

Results
The user stayed one hundred percent dry while using my Rain-Walker design during the trials. When testing my control group (a person holding a regular umbrella while using a walker) the user was on average 58 grams wetter. The user also found the Rain-Walker to be more convenient.

Conclusions/Discussion
The results fully supported my goal of making a easy-to-use, functional umbrella for a walker that would keep users drier and safer when using a walker. Using this new design could revolutionize how disabled people get around in rainy weather. Right now there is not any kind of rain coverage for a walker that is hands-free, so this design is much needed, helping unstable users keep both hands in control of their walker, preventing falls and slips.

Summary Statement
The Rain-Walker was designed and engineered to shield a person using a walker from the rain, without having the inconvenience of holding an umbrella.

Help Received
I designed, built, and performed the experiments myself. My parents helped purchase a few materials and I borrowed my grandmother's walker.

Name(s)
Vishnu Matta; Ayush Sheth

Project Number
J0322

Project Title
iTherapy 2.0: A Physical Therapy Humanoid Robotic Companion for Autistic and Cerebral Palsy Kids

Abstract

Objectives/Goals
Physical therapy for cerebral palsy kids and social learning for Autistic kids is a challenge. It involves frequent doctor visits and hours of repetitive exercise at home. A primary issue with such treatment is the kids are easily distracted and do not follow the practices at home. With a family member affected by such condition, we decided to create an engaging, humanoid robot, which acts as a physical therapy companion and provides real-time feedback to the therapist through video recordings of the patient's progress. Thus reducing the need for frequent clinical visits. We built a raspberry pi, based humanoid robot, that can be remotely programmed to perform tasks to guide the patient at home. We also developed a mobile app for the physical therapist to prescribe the necessary exercises, and monitor the progress of the patient.

Methods/Materials
The iTherapy system includes three components - A therapist mobile app, a humanoid robot and a video recording system to send patient videos to the therapist. We developed a native iOS app using Xcode for the therapist to assign exercises to the patient, and receive patient videos. Then, we built a Humanoid robot, using a Raspberry Pi 3, with ten servo motors. The body of the Robot was created using acrylic plastic. We built three robots for this project in 3 phases. Phase 1- robot was created with off the shelf parts. Phase 2 - we built a robot ground up, with two motors, that could perform hand exercises. Phase 3 - we improved from the previous robot, where we added eight more servo motors, incorporated leg movements and robot interaction with the mobile app. For the video recording system, we used a USB web camera.

Results
Our third prototype has achieved the flexibility of movements to demonstrate full set of exercises, we set out to emulate, including voice based guidance. The therapist mobile app can successfully communicate with the robot. The therapist also gets an email notification when the patient completes a set of exercises.

Conclusions/Discussion
Researchers at Vanderbilt University and Georgia Tech found autistic kids and kids with cerebral palsy respond far more emphatically and enthusiastically, to humanoid robots than other systems. Hence, we believe iTherapy 2.0, when productized as a system, has the real potential of saving time and money. Most importantly, the system speeds up recovery for patients.

Summary Statement
We built a humanoid robotic companion for kids with cerebral palsy and autism, to help speed physical therapy and social learning skill training at home, assisted by a therapist mobile app for real time monitoring and feedback.

Help Received
Our families helped significantly in procuring all the materials needed to build the robots. Online resources enabled us to learn python programming and controlling servo motors via a Raspberry Pi. We also, interviewed a professional physical therapist to understand the process and get her feedback about

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Jessica L. McWilliams

Project Number
J0323

Project Title
Optimal Ballista Launch Angle

Abstract

Objectives/Goals
Ballistas were weapons of war used to launch projectiles at enemy fortresses. Attackers would want to fire the ballista from as far away as possible, so the army would want to know which launch angle results in the projectile traveling the farthest distance. The hypothesis is: A 45° launch angle will maximize the distance traveled by the projectile.

Methods/Materials
A model ballista was constructed and a standard projectile was launched from angles ranging from 15° to 75°. A minimum of 10 trials were made at each launch angle and the distance that the projectile traveled was recorded. The data were tabulated and graphed and the mean and standard deviation were calculated. To test if the optimal launch angle remained the same under different conditions, the experiment was repeated using different string tensions with the standard projectile and then with projectiles of different weights keeping the string tension constant.

Results
In the first experiment, the 45° launch angle resulted in the farthest travel distance. Travel distances for launch angles of 30° and 60° were somewhat shorter, and travel distances for launch angles of 15° and 75° were much shorter. Changing the string tension with a constant launch angle of 30° changed how far the projectile traveled. In a later experiment, the distance traveled was once again farthest with a launch angle of 45°, but the travel distance was shorter for launch angles greater than 45° than for launch angles less than 45°. With a lighter projectile there was a lot of variability; there was no significant difference between the travel distance for launch angles of 30°, 45°, and 60°. A heavier projectile traveled a shorter distance but had less variability in the distance traveled.

Conclusions/Discussion
For a variety of string tensions and projectile weights, a launch angle of 45° produced the maximum average travel distance. However, for most conditions there was no statistically significant difference for launch angles between 30° and 45°. A launch angle of 60° resulted in travel distances that were shorter than those for 30°. This is not consistent with the idealized trajectory for projectile motion which predicts that the distance traveled for launch angles 30° and 60° will be the same. Therefore, if the objective is to maximize the distance traveled by the projectile, it is better to use a launch angle that is a little less than 45° rather than a little greater.

Summary Statement
This project evaluated ballista launch angles for a variety of conditions and determined that launch angles of 45° or a little less resulted in the longest projectile travel distance.

Help Received
This project would not have happened without the help of the McWilliams family who ordered the ballista kit, helped me assemble it, and supported me during the experiments.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)

John W. Merwin

Project Number

J0324

Project Title

Glove-Mounted Bell: Wearable Device for Producing Audible Alert while Bicycling or Doing Other Activities

Abstract

Objectives/Goals

To study if a glove-mounted audible alert device could make cycling safer. To determine if a glove-mounted device is easier to use than a traditional bike bell because it does not require the user to remove or reposition the hand on the bike handlebar. A secondary goal was to determine if a similar device had already been invented.

Methods/Materials

The device is a bicycle glove that has copper pieces added to the thumb and middle finger. A wire runs from each of the copper pads to an electronic, sound-producing device mounted on the back of a glove. The electronic device is powered by a battery. To use the glove, the rider can keep their hand on the handlebar. When the rider touches his/her middle finger and thumb together, it produces an audible alert.

Tests compared the device to a traditional handlebar mounted bicycle bell. The first test measured the ability to stay on a straight line while ringing each type of bell. The second test measured rider turning abilities through a slalom course while ringing each type of bell.

Results

Test one: The average number of times that the rider went off the line was 1.5 for the glove-mounted audible device vs. 2.9 for the traditional bike bell. The average amount of times the rider was able to ring the glove-mounted audible device was 10.9 vs. 6.9 for the traditional bike bell.

Test two: The average number of missed cones on the slalom course of 11 cones was 0.7 for the glove-mounted audible device vs. 2.7 for the traditional bike bell. The average amount of times the rider was able to ring the glove-mounted audible device was 33.2 vs. 25.0 for the traditional bike bell.

Conclusions/Discussion

The results support the hypothesis that if a bicycle rider uses the glove-mounted audible alert device then the rider would be safer than if they use a traditional handlebar-mounted bell to alert fellow travelers of their position. The glove-mounted device required less repositioning of the hand so the riders were able to stay on course and ring the glove-mounted bell more often. Riders reported it felt more comfortable to touch the fingers together to ring the bell.

A provisional patent was filed for this device after research concluded that a similar device had not been patented.

Summary Statement

I designed and built a glove-mounted audible alert device, tested it against a traditional bike bell and showed that the glove-mounted device performed better in bicycle riding tests.

Help Received

I came up with the idea, made the device, conducted the tests and analyzed the results. My parents helped me buy the parts and they helped me file the provisional patent. They helped me organize the information I wanted to present.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Diana A. Michaelson

Project Number
J0325

Project Title
Compressive Strength in Concrete vs. Environmental Sustainability

Abstract

Objectives/Goals
My project was designed to figure out if there is potentially a more environmentally sustainable coarse aggregate alternative that will have a similar compressive strength to traditional coarse aggregate in concrete.

Methods/Materials
For my experiment I used 3 different coarse aggregates in my concrete samples: traditional # inch large aggregate (control), recycled aggregate from a previous construction and recycled rubber mulch. I made 3 samples of each aggregate type. My hypothesis was that the control would be the strongest, but that the recycled aggregate would be very close in strength, and the rubber would be the weakest. After mixing, my samples cured in a moisture controlled environment. My tests were performed at Twining Lab in Long Beach, CA, using industry standards for testing compressive strength in concrete.

Results
At 7 days, the traditional coarse aggregate had a compressive strength of 2970 psi, the recycled aggregate was at 2720 psi, and the rubber aggregate was at 480 psi. After 28 days of curing, I tested the remaining 2 samples from each aggregate type. The traditional coarse aggregate samples had an average compressive strength of 4460 psi, the recycled aggregate was at 3925 psi, and the rubber aggregate was at 601 psi.

Conclusions/Discussion
Therefore my hypothesis that the traditional aggregate would be the strongest followed by the recycled aggregate, and that the rubber would be the weakest, was supported by my results. However, I also learned that although rubber aggregate does not give a high compressive strength to concrete, it has other potentially useful qualities.

Summary Statement
I found that recycled aggregate has a similar compressive strength to traditional coarse aggregate, and could be a viable replacement in most construction jobs, while rubber cannot be a replacement for high strength requirements.

Help Received
I mixed my samples with the help of my Aunt Sunny. Corey Rhodes, the laboratory manager at Twining Laboratory, sulfur capped the concrete samples and preformed the compression tests.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Rohan Murali

Project Number
J0326

Project Title
Functional Orthotic Materials: Force Reduction during Impacts

Abstract

Objectives/Goals
My problem was that twenty-five percent of teenage Americans, including myself, play competitive sports everyday while experiencing harmful impacts. The purpose of my experiment was to test the effectiveness of a functional orthotic on reducing force these bodies take, so that they will be less prone to injury. My hypothesis was that functional orthotics will be effective enough to help with injuries if they are prescribed properly. Also, I hypothesized that functional orthotic materials made out of subortholen would be most effective in the category of force reduction.

Methods/Materials
My testing took place inside my house on a hard wood floor. I built a stand to drop a billiards ball with the same acceleration. This stand dropped the billiards ball onto a functional orthotic material on my force sensor. The force sensor was connected to a wireless interface which gave me a reading in newtons on my software. I borrowed this software and force sensor from a scientific company called PASCO. I performed fifty trials for each of my six orthotic materials, while my control was having the billiards ball land on the sensor alone.

Results
I found out that my control had a lower force rate average of 227.5 newtons while all my orthotic samples were at least 20 newtons more. Copolymer, one of my orthotic materials, had the lowest force rate average after my control. These results showed that the functional orthotics worsened force and did not reduce it.

Conclusions/Discussion
Based on my results, I learned that functional orthotics are purely made to control joint movements, to give you a better posture. Accommodative orthotics are made to reduce force. This weights podiatrists with the responsibility to prescribe and mold functional orthotics based on a patient's needs, to help with injuries.

Summary Statement
My project is about testing the effectiveness of functional orthotic materials in the category of force reduction, to determine if they cure injuries.

Help Received
My teacher Mrs. Reed, PASCO, and Mr. Kennedy a co-owner of HERSCO orthotic labs, all helped me with advice as well as materials I needed to obtain.

Name(s)
Wyndia Ohm

Project Number
J0327

Project Title
Pollination Buggy: An Innovative Device that Pollinates in a Safer, Efficient and Easier Way

Abstract

Objectives/Goals
People are forced to hand pollinate 100% of the apple trees in China. In many parts of the world bees are dying out and in some parts of China bees are extinct. People are getting paid to pollinate plants by hand. They use paint brushes to scoop out the pollen but this is an inefficient way to pollinate plants. Many of the pollen gets wasted and it is injury prone. The objective is to build a functioning prototype that can collect and disperse pollen in a safer, easier and more efficient way compared to the paintbrush.

Methods/Materials
DC motor, Batteries, Wires, Casing Material, Filter paper, DPDT switch, Conical Entrapper (my design), Brush, Fan. To test how much wastage of pollen there is, the pollen will be collected from a male flower by the device. Then the pollen will be sprayed on a sheet of white paper. After spraying the pollen on a white sheet of paper, the diameter of the sprayed pollen shouldn't be larger than the diameter of the flower.

Results
Testing indicated that there was good flow control in both directions.
When the device was tested on flowers there was no wastage that could be seen with the naked eye during collection. The diameter of the dispersed pollen was smaller than the diameter of the flower in multiple trials.

Conclusions/Discussion
The device, consisting of three main components, successfully collected and dispersed pollen. The pollinator met all the design criteria. It's ideal to use when pollinating by hand (as of now: future phases will make the device autonomous). The device can pollinate flowers safely. The data shows that the diameter of the patch of pollen dispersed is smaller than the diameter of the flower so the device is efficient. The device it easy to hold so the chances of injury decreases by a large amount.

Summary Statement
A new pollinator that is safer, efficient and easy to use has been created and tested.

Help Received
I designed, built, and performed the experiments myself. My parents referred me to trustable websites.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Rinoa J. Oliver

Project Number
J0328

Project Title
Why Are Honeycombs Hexagonal?

Abstract

Objectives/Goals
The purpose of this project is to investigate why honeycombs are hexagonal. My hypothesis is that honeycombs are hexagonal because hexagons require the least amount of wax for a given cell size and/or hexagons are the strongest shape.

Methods/Materials
The circumradius of each shape was first calculated. Using the circumradius, an array of 36 cells with same wall thickness and cell volume was designed in the program Blender. After 3D printing, the models were weighed and their strength tested using a push-pull force gauge.

Results
As predicted, the hexagon had the smallest total cell perimeter of all the models. Though the hexagon was not the strongest model, it had the greatest value of strength over perimeter of all cells so it is the strongest for a certain amount of material. It also had the greatest value of strength over weight.

Conclusions/Discussion
Of all the models, the hexagon uses the least amount of material, which is important because wax is time consuming to make. The hexagon model is also the strongest for a given amount of wax and a specific weight, which allows bees to create a lightweight, strong honeycomb. Overall, the hexagon is the optimum choice for a honeycomb.

Summary Statement
This project investigated the best cell shape for honeycombs to give highest strength that uses the least material.

Help Received
Testing the strength of the models required strength so my dad helped with the push-pull force gauge. I created models in Blender after my mom taught me how to use the software. The 3D printing course that I took at Cabrillo College taught me the basics of 3D printing.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Kaden T. Roschuk

Project Number
J0329

Project Title
Popsicle Bridges

Abstract

Objectives/Goals
The Objective of my project was to see which bridge type was able to hold the most weight, with the weight applied in the middle of the bridge. The different types of bridges tested were Beam Bridges, Warren Truss Bridges, Suspension Bridges, and simple Baseline Bridges (A Straight-line Bridge).

Methods/Materials
The materials that were used in the experiment were Popsicle sticks, wood glue, a tape measure, weights, books, heavy rocks and a scale.

Results
The results of my experiments showed that the beam bridge was the strongest of the four designs. The Beam bridge did the best due to the fact that it was able to transfer the weight directly from the point where the mass was applied to the ground through various beams. The beam bridge held an average of 105.5 kg.

Conclusions/Discussion
The Beam Bridge was the most successful design variation, holding an average of 105.5 kg. It's ability to support a heavy load was due to where the mass was being applied in relation to the location of the beams which supported the bridge. The second best was the truss bridge which supported an average of 632.25 kg. This bridge did quite well because the truss triangles were able to carry the load away from the center.

Summary Statement
The most effective bridge in my testing was the beam bridge, where the mass being applied is directly supported by the beams underneath.

Help Received
I designed the experiment and bridges by myself. My dad helped with gluing the bridges together. My science and engineering teacher helped with testing.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Sophia G. Ruff

Project Number
J0330

Project Title
Which Bridge Can Hold More Weight?

Abstract

Objectives/Goals
My goal was to see which bridge design could hold more weight.

Methods/Materials
Cedar strips, wood glue, basic red wire.
These items were used in the construction of both bridges.

Results
After I tested both bridges with weights, I concluded that my hypothesis was correct.

Conclusions/Discussion
The suspension bridge held more weight, suffering only a hair line crack at the main suppport. The arch bridge received major damage at less weight. I concluded that a suspension bridge would be a better design for safety.

Summary Statement
I designed and built two bridges to be tested for maximum weight.

Help Received
I designed, built and tested my bridges with minimal help from my father.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Filip Sedlacik

Project Number
J0331

Project Title
Hands Free Turning Music Stand

Abstract

Objectives/Goals
The goal of the project is to design and construct a device which will turn a music sheet for a musician without employing his/her hands.

Methods/Materials
Tripod, plastic tubing, vacuum cleaner, pedal, strings, rotating arm, custom wood pieces and common fasteners to assemble all together.

The design is an original idea, realized purely mechanically.

Measured the force needed to turn the arm, and calculated efficiency relative to ideal lever.

Results
Several iterations of the design lead to a final, mostly functional example. The functionality was demonstrated with a vacuum cleaner and recorded on video. The force needed to turn the rotating arm was too large, limiting practical usage of the device.

Conclusions/Discussion
The prototype I constructed confirmed it's possible to realize a hands free music sheet turner mechanically but a commercial application would need more refinements.
Although the constructed device could turn the pages, the required force on the pedal was so large the stand would tip over without an additional support.
I learnt that proper planing and small step improvements with design verification can lead to the functional prototype. I also understood how the force on the lever is calculated.

Summary Statement
I constructed a mechanical device that turns a music sheet hands free without interrupting musician's performance.

Help Received
I designed the prototype myself. My father helped me to cut the wood to sizes according to my plans.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Stanley Shen

Project Number
J0332

Project Title
More Effective Hearing Protection

Abstract

Objectives/Goals
In America, one out of every three people over the age of 65 have hearing loss. Sixty percent of those people worked in a noisy environment. People with hearing loss are more likely to be depressed because they have a harder time participating in social interactions. There is no doubt that it is important to have appropriate hearing protection for the American workforce. The objective of the experiment is to develop a more effective and affordable hearing protection headphone than what is currently available.

Methods/Materials
My experiment works by having two pieces of Acrylic to form a semi-sphere shape. I used a vacuum pump to create a low pressure pocket, which prevents sound from traveling through. I tested my headphone by exposing it under 500 Hz, 1000 Hz, and 1500 Hz sounds. I had a speaker facing the headphone on a stand, and an Arduino with sound sensor module measures the sound level. The speaker was 1 cm away from the headphone. The Arduino sensor was directly against the headphone. I also used PLX-DAQ application to transfer my results to Excel.

Results
I found that the more air you remove from the headphone, the more sound the headphone blocks. I achieved these results as a result the more air or medium you remove, the harder it is for the sound to travel through the headphone. This is because there are less air particles for the sounds to travel, so the energy of the sound wave deteriorates faster. In the best case, headphone with 57% air pocket blocked 73% of 500 Hz sound, 53.4% of 1000 Hz sound, and 39.7% of 1500 Hz sound.

Conclusions/Discussion
Overall, I found that the more air I removed the more effective the headphone worked. I could improve my product by using to use a better vacuum system, so more sound could be blocked by the low pressure pocket. The lower the pressure, the more sound would be blocked. While 60% of the 500 Hz sound was blocked by Acrylic, only 10 % to 15% percent of the sound was blocked by the vacuum. It was due to some of the sound goes around the headphone then gets detected by the Arduino sound sensor. In conclusion, the best case is 500 Hz, at 57% air, because the headphones blocked an incredible 73% of the sound, which is 3% better than industrial standard.

Summary Statement
I created a more effective and affordable hearing protection headphone that uses a vacuum to block up to 73% of the sound.

Help Received
I would like to thank my parents for buying me all the materials. I would also thank my science teachers, Mr. Bradley Behrens and Mr. Jeffrey Takemoto, for their guidance.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Joanne Teh

Project Number
J0333

Project Title
Experimenting on the Flexural Strength of Reinforced, Renewable, and Biodegradable Casein Plastic

Abstract

Objectives/Goals
The aim of this experiment was to find out if hemp fibers or wood supports would most increase the flexural strength of casein plastic.

Methods/Materials
To make homemade samples of casein plastic, I curdled milk using vinegar and added calcium chloride. While the plastic samples were still malleable, I added wood supports to three of the samples, hemp fibers to another three, and left the last three with no reinforcements. After the samples dried, I assessed their flexural strengths by measuring how much weight each could withstand before breaking. With the data I gathered from the test, I used the formula R=1.05 Pl/bd^2 to ascertain the exact flexural strength of each sample in megapascals and compare them together.

Results
The samples with no structural reinforcement added had an average of 7.145 megapascals of flexural strength, the samples with hemp had an average of 10.558, and the samples with wood had an average of 16.480. The experiment proved that wood supports increased the flexural strength of casein plastic more than hemp fibers.

Conclusions/Discussion
I had hypothesized that the hemp fibers would most increase the plastic's flexural strength, but I was proven wrong. Instead, I found out that the wood supports most increased the plastic's flexural strength. With the results of this project, it can be concluded that reinforcing beams will be of greater advantage in strengthening casein plastic. I now know that the infusion of hemp fibers into the material is an ineffective method of increasing its flexural strength, and that if I were to do another experiment on strengthening casein plastic for commercial use I should not use methods like this.

Summary Statement
My experiment found out that wood support beams within casein plastic gave it more added flexural strength compared to hemp fiber reinforcements.

Help Received
My father, Brian Teh, works as an engineer at Caltrans and was able to use his knowledge of their concrete testing techniques to guide me in creating my testing procedure and understanding the formula for flexural strength.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Linea N. Vizenor

Project Number
J0334

Project Title
Strength in Numbers

Abstract

Objectives/Goals
My project consists of figuring out if there really is strength in numbers, and how it relates to the types of materials used in construction of bridges and structures.

Methods/Materials
I used a certain amount of strands of spaghetti in a bundle for each of the three trials. I used a hook attached to a bucket and placed it in the center of the spaghetti beam. I placed coins in the bucket until the spaghetti bundle broke. The bucket, coins, and hook were weighed and recorded. After the testing, I did my calculations for the average weight needed to break the spaghetti beam and the strength to weight ratio.

Results
The result of my project demonstrated as the spaghetti strands doubled; the average amount of weight needed to break the spaghetti strands doubled too. In other words, the same relative weight broke the spaghetti beams regardless of whether it was fifty strands or one hundred because spaghetti is a brittle material.

Conclusions/Discussion
In conclusion, it did not matter how many strands of spaghetti were used. It took a similar amount of tension and compressive stress to break the bundle of spaghetti regardless of whether it was a small bundle of spaghetti or a large bundle.

Summary Statement
My project is about how important material selection is when building structures.

Help Received
I used the website Science Buddies for guidance on my project. I also had guidance from my parents and science teacher.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Garrett M. Warner

Project Number
J0335

Project Title
Effects of Base Isolators on Building Stability

Abstract

Objectives/Goals
Because I live in southern California near the San Andreas Fault, earthquakes are a problem for my community. Due to this threat, I researched different technologies that improve the stability of buildings during earthquakes. I learned about some structural innovations known as base isolators. I designed an experiment to compare two of the most common techniques: the ball bearing base isolators versus the rubber technique. I hypothesized that the rubber base isolators that dampen the energy would provide more effective protection than the ball bearing isolators that reroute the energy into the motion of the balls.

Methods/Materials
For my project, I performed a total of 60 tests using 11mm and 6mm glass balls and 2mm and 5mm thick rubber pads. I created a model building from 150 Lego bricks, making sure it was strong enough to not collapse instantly, while weak enough so that it could eventually break apart under stress. I placed my structure on a shaker table on top of one of the test base isolators, or no base for the control. I started the shaking at 120 rpm and increased the speed in increments of 20 rpm every 10 seconds. I timed each test and recorded how long the structure remained intact. I performed 12 tests for each of the five base conditions and averaged the results.

Results
To my surprise, only in the ball bearings tests did the structure stand for the full 60 seconds. Overall, the structures on ball bearings remained intact 6.8 times longer on average than structures on rubber and 7.7 times longer than the control. In contrast, the structures on rubber remained intact an average of 1.9 times longer than in the control test.

Conclusions/Discussion
Both techniques improved the time the structure remained intact, but contrary to my hypothesis, the ball bearings were more effective. Although rubber base isolators provided nearly twice the stability as the control, the structure on ball bearings never collapsed, nor had any dangerous movement. My project confirms that use of base isolators could be helpful in preventing structural damage due to earthquakes. Based on my results, I would recommend that architects and engineers emphasize using ball bearing base isolators versus rubber base isolators for structures in earthquake areas.

Summary Statement
The goal of this project was to compare the effects of ball bearing and rubber base isolators on the stability of buildings during earthquakes.

Help Received
My parents drove me to numerous stores so that I could purchase my materials, and also supervised my experiment. My science teacher loaned me a shaker table which I used in my tests. I completed all of the testing and analyzing of the data myself.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Katherine M. Weitzel

Project Number
J0336

Project Title
Hydraulics: Effect of Mechanical Advantage and Range of Motion

Abstract

Objectives/Goals
The purpose of this project is to test mechanical advantage and range of motion in a hydraulic arm. Hydraulic machines were used to clear large debris from roads and drainage ditches in the recent Montecito mudslides. This project examines the effectiveness of these machines, and the uses of mechanical advantage.
A hydraulic arm was built using wood for the main body and syringes for the hydraulic cylinders and actuators. The displacement of fluid in different sized syringes, and the force required were then measured to determine the mechanical advantage and range of motion achieved. The results proved that mechanical advantage can be achieved through different sized syringes, but it limits the range of motion available. This causes a machine that is less effective, and on a larger, real world scale, force is not limited to human strength. Because of these factors, mechanical advantage can be achieved, but range of motion should be examined first.

Methods/Materials
hydraulic arm frame (templates from Professor Stephen Ressler, United States Military Academy at West Point), various sizes of syringes, mail scales. Measured displacement and force in various sizes of actuators and hydraulic rams.

Results
The 20ml syringe actuator and 35ml hydraulic ram has the largest movement of the large syringe in relation to the small syringe. The 35ml syringe moves 89% of the distance the 20ml syringe moves. The mechanical advantage, however, is only 8%.
Based on the data collected the decision was made to use 35ml syringes for both the actuator and the hydraulic ram. The allows the arm to transfer power and still have enough range of motion.

Conclusions/Discussion
In conclusion, this project demonstrated that force can be transmitted through a fluid in a hydraulic system. In this example, no mechanical advantage was attained, however, the range of motion necessary to make the machine useful was achieved.

Summary Statement
I analyzed the relationship between range of motion and mechanical advantage in a hydraulic arm.

Help Received
Templates for the frame were designed by Professor Stephen Ressler of the United States Military Academy at West Point

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Daron S. Yacoubian

Project Number
J0337

Project Title
PorSHA H(2)O (Portable Solar Heating Apparatus)

Abstract

Objectives/Goals
The objective of this project is to design a solar powered floating apparatus that can effectively heat swimming pools. This system eliminates the need for traditional swimming pool water heaters in order to save energy, preserve natural resources, and protect the environment from pollution.

Methods/Materials
The materials needed to build the apparatus are 2 foam kickboards, 2 solar pumps, flat mirrors, 100 feet of black tubing, and 2 identical temperature gauges to measure input and output temperature of the water. With the assembled apparatus, the first step is to determine the rate of water flow through the apparatus. This is done by measuring the amount of water that can flow through the apparatus in 1 hour. The rate is averaged by performing the test 4 times, 1 hour each, to calculate average flow rate and volume per hour. The second step is to determine the change in water temperature as the water travels through the apparatus. This is done over the course of 1 hour daily for 5 days, and the temperature change is recorded at 5 minute intervals. This data is compared to a control to determine the temperature change of the water with the sun alone without the apparatus.

Results
The results show that the apparatus increases the temperature of 7 liters of water an average of 38.4° F in 1 hour. The control has an average increase of 1.1° F for 7 liters of water in 1 hour. Also, it took approximately 5 minutes for the average water temperature output to increase by 38.4° F

Conclusions/Discussion
The results suggest that this project has the potential to revolutionize the swimming pool industry and is a successful proof of concept. The apparatus was successful in increasing the water temperature an average of 38.4° F. This is a significant increase compared to the control of 1.1° F. This project is exciting for future prospects of energy conservation and production of clean energy. The apparatus has the advantages of being portable, cheap, reusable, safe, and environmentally responsible. More importantly, when this concept is increased in scale and efficiency, it will eliminate the need for existing bulky pool systems that are expensive, polluting, and wasteful. The next phases of the project involve adding an effective water filter to the system and a solar powered water mixer to more evenly distribute treated water. I look forward to presenting those results in the future.

Summary Statement
This project introduces a novel floating solar powered device that will eliminate the need for a traditional swimming pool heater.

Help Received
I designed, built, and tested the apparatus myself. My parents helped with purchasing the materials necessary for building the apparatus. My science teacher helped me with the background research.