# CALIFORNIA STATE SCIENCE FAIR
## 2007 PROJECT SUMMARY

**Name(s)**
Jeremy J. Alexander

**Project Number**
**J0201**

**Project Title**
## What Is the Optimum Leverage Point to Achieve Maximum Distance with My Catapult?

**Abstract**

**Objectives/Goals**
My project's goal was to determine at which pivot point of my catapult was the most effective to throw a golf ball the farthest distance.

**Methods/Materials**
My methods for testing are launching ten golf balls for each pivot point. There are three pivot points and each one is distanced one and one half inches apart.
Pivot point C is 5 1/2 inches from the four pound counterweight and also is the closest pivot point to the counterweight. Followed by point C is pivot point B, which is 7 inches from the counterweight. Pivot point A is the farthest pivot point from the counterweight and is 8 1/2 inches away.
Materials:
Catapult Beam 26 1/2 inches
Platform two feet length, one foot width
Upright Posts with dowel hole, 15 inch height
Dowel diameter 5/16 inch x one foot length
Sling a 3 inch and 7 inch string and leather pouch
(10) standard golf balls
(10) 2 inch drywall screws
(4) wheel casters

**Results**
My hypothesis of pivot point C launching a golf ball the farthest was correct. Pivot point A, however, had a much more consistent range of distances. Pivot point A's lowest distance was nineteen feet, while its highest was twenty-five feet.Pivot point C launched a golf ball twenty-six feet and several others in the low twenties.However some launches were unsuccessful.Pivot point C's lowest were four and thirteen feet. If you look at pivot point B, the distances were not good. Three launches went backwards. The other launches didn't go far.

**Conclusions/Discussion**
The reason why there were unsuccessful launches was because of the sling.The sling will release the ball at an unpredictable time. When the sling does an arch, one of the strings could be not tight enough to make a complete arch. Since the string was loose, the ball relased too early and went backwards.The string may have also been too tight and performed the arch too long. This would make the ball go low and not go far.

**Summary Statement**
My science project is about a trebuchet with three pivot points that launches golf balls and I want to know which pivot point will launch a golf ball the farthest.

**Help Received**
My dad helped me build the trebuchet.

# CALIFORNIA STATE SCIENCE FAIR
## 2007 PROJECT SUMMARY

**Name(s)**
Garrett Arbuckle; Brandon Seeto

**Project Number**
**J0202**

**Project Title**
## The Effects of Rolling Resistance on Different Surfaces

**Abstract**

**Objectives/Goals**
The objective of our project is to find out why some cars travel faster on a surface with less friction than a surface with more friction and potentially waste more fossil fuel. We would like to know if the roughness of the surface on our track will effect the amount of time it would take for a car to finish the lane. We hypothesize that the surface of the track will effect the amount of time it takes a Hot Wheel toy car to finish the lane.

**Methods/Materials**
We constructed a model track out of a 1.22 meter by 0.3048 meters wide. The track was raised on the starting end to allow the cars to roll down the incline. We used three different grades of sandpaper for each lane. Lane #1 had the smoothest surface with 1500-grade sandpaper, 220-grade sandpaper in lane #2, and 60-grade sandpaper in lane #3. We used three of the same type of Hot Wheel toy cars to run the test data/trials. Each car was allowed to roll down each lane fifteen times. The finished times were noted and results were recorded for the data.

**Results**
Our results overall showed that lane #1 had less resistance than lanes #2 and #3. This allowed the cars to finish the track faster in lane #1 as compared to lanes #2 and lane #3 in each of the trials.

**Conclusions/Discussion**
Our hypothesis was proven to be valid because the cars traveled faster on a surface with less friction. Our data shows that a car will travel slower on a surface with greater resistance as compared to a surface with less resistance. The rougher the road, the longer it will take for the car to travel using more force and energy. The effects of rolling resistance are factors in how fast a car can travel. Better maintained roads, like lane #1 of our track will reduce in amount of travel time and could potentially save on the amount of fuel used by a vehicle. Smoother roads provide less friction and could possibly increase car mileage.

**Summary Statement**
A car on a road with less resistance will travel faster than on a road with more resistance.

**Help Received**
Our dads helped us purchase supplies needed for the track. They helped us build and construct the track. Our moms helped us set up the project display board and transporting it to the school and county science fairs. Our science fair teacher provided guidance, support, and learning.

# CALIFORNIA STATE SCIENCE FAIR
## 2007 PROJECT SUMMARY

**Name(s)**
Matthew J. Armstrong

**Project Number**
**J0203**

**Project Title**
## Truss Me: The Impact of Structural Design on the Strength of a Truss

**Abstract**

**Objectives/Goals**
Objective: The objective for this experiment was to find out which truss design, a Warren, a Warren with Vertical Supports, a Pratt, or a Curved Chord Pratt, would have the best strength to weight ratio. The hypothesis for this experiment was that the Curved Chord Pratt would have the best strength to weight ratio.

**Methods/Materials**
Materials and Methods: To perform this experiment three trusses were built for each design (a Warren, A Warren with Vertical Supports, a Pratt, and a Curved Chord Pratt). They were built using wood glue and clear pine wood. They were then weighed. Then a truss was selected to be tested and placed on two barstools. Then a rope was attached to the truss and sent threw a pulley and then connected to a tension scale. The scale was then pulled until the truss broke. The breaking weight was recorded. Then the test was repeated with the other trusses. After all the trusses were tested the breaking weight for each truss was divided by its weight. This gives the strength to weight ratio.

**Results**
Results: The average strength to weight ratio for the Pratt was 1128 ounces to 1 ounce. The average ratio for the Warren was 1013 ounces to 1 ounce. The average ratio for the Warren with Vertical Supports was 1182 ounces to 1 ounce. The average ratio for the curved Chord Pratt was >1416 ounces to 1 ounce.

**Conclusions/Discussion**
Conclusion: The results of this experiment support the hypothesis. Even though the Curved Chord Pratt maxed out the scale at 177 pounds without breaking, it still had the best ratio and held the most weight. The results show that even though these trusses have very similar weights, their changes in design make a big difference in their breaking weight. It is important to choose the right truss design because of their difference in strength. The Warren is made for light loads like small cars or people because of its simple design and ease to build. The Curved Chord Pratt is made for very heavy loads like big, heavy trains, and finally the Warren with Vertical Supports and the Pratt are made for loads like heavy cars or trucks and light trains.

**Summary Statement**
This project is about how the importance of truss design effects how much weight it can support.

**Help Received**
Father helped build and test the bridges.

# CALIFORNIA STATE SCIENCE FAIR
## 2007 PROJECT SUMMARY

**Name(s)**
Matthew W. Baldwin

**Project Number**
**J0204**

**Project Title**
## Will the Bog Break the Log?

**Abstract**

**Objectives/Goals**
My objective is to find if relative humidity affects the strength of wood. I predict that as relative humidity rises, the strength of wood will diminish. I don't think that temperature will have much noticeable effect as a factor.

**Methods/Materials**
I subjected 3 identical dowel sticks made up of the same wood to 3 different levels of humidity: a normal, 29% humidity room, a steamed pot at 88% humidity, and a totally saturated (100% humidity) bucket of water. After exposing them at an equal amount of time, I measured the kilograms of pressure required to snap the sticks.

**Results**
On average, the sticks exposed to room-temperature humidity (29%) broke under the weight of 11.31kg. The totally saturated, submerged sticks (100%) broke on average of 7.4kg. The steamed sticks exposed to an average of 88% humidity broke under the average weight of 5.57kg.

**Conclusions/Discussion**
The results of my experiment were quite surprising. As I hypothesized, increased humidity did weaken the wood sticks. What was surprising was that the sticks which were totally saturated in water were harder to break than the sticks heavily steamed in 88% humidity. The 2 groups of steamed sticks were close in humidity, but quite different in temperature; it appears that heat indeed played a factor in this experiment. So my hypothesis was both right and wrong. My results did not go with the logic that sticks subjected to 100% humidity would be more easily broken then with 88% humidity, so the heat of the steam may have been a factor. But nevertheless, humidity does indeed affect the strength of wood.

**Summary Statement**
My project is about whether or not relative humidity will affect the strength of wood.

**Help Received**
My mom helped me gather materials for the experiment.

# CALIFORNIA STATE SCIENCE FAIR
## 2007 PROJECT SUMMARY

**Name(s)**
Michael D. Bucher

**Project Number**
**J0205**

**Project Title**
## Ramp It Up!

**Abstract**

**Objectives/Goals**
The goal of this experiment was to determine which angle (20,25,30,35,40,45,50, degrees) of an inclined ramp would provide the maximum height and distance that an RC (remote controlled) monster truck, driven at a constant speed, could achieve. The hypothesis was that the inclined ramp positioned at a 45 degree angle would provide the maximum height and distance that the RC monster truck could travel.

**Methods/Materials**
1. Placed 2 x 4 blocks of plywood underneath the Flybox inclined ramp to obtain the various angles, and then measured each angle with a large protractor for accuracy.
2. Drove the nitro powered RC monster truck off the ramp five times.
3. Increased the ramp angle by five degrees and performed five more trials.
4. Repeated procedure at each angle until the maximum angle of 50 degrees had been reached.

**Results**
The combined results of this experiment showed that the 30 degree launch angle was the most successful in achieving maximum height and distance. When launched at the 45 and 50 degree angles, the RC truck traveled the shortest distances.

**Conclusions/Discussion**
My hypothesis, based on research indicating that projectiles launched from a 45 degree angle will achieve maximum height and distance, was wrong. In theory, the launch velocity is independent of the launch angle, however that was not the case in this experiment. The RC truck generated its projectile velocity through a combination of the horizontal velocity, which began at the take-off 10' from the ramp, and the vertical velocity that was generated at the launch angle of the ramp.

**Summary Statement**
Determine the optimal angle for launching an RC monster truck from an inclined ramp to achieve maximum height and distance.

**Help Received**
Mother helped take pictures of the experiment and helped edit report. Dad helped measure speed of the monster truck. Cousin helped videotape the jumps and record data.

# CALIFORNIA STATE SCIENCE FAIR
## 2007 PROJECT SUMMARY

**Name(s)**
Justin M. Chan

**Project Number**
**J0206**

**Project Title**
## The Whats and Hows of Fiber Wrap

**Abstract**

**Objectives/Goals**
To prove that fiber wrap strengthens materials

**Methods/Materials**
20 square foot sheet of SikaWrap Hex 103C, 20 square foot sheet of SikaWrap Hex 100G, Sikadur epoxy resin, 4 empty cans, 2 1/4 in. x 3 1/2 in. x 3 ft. wooden planks, 2 3/4 in. x 1 1/2 in. x 4 ft. pieces of wood, 3 water buckets, bricks, brick paver, string, concrete masonry blocks, water, scale, shears, gloves, goggles, apron, paint rollers, resin dish

**Results**
For the Coke can test, the first can collapsed after filling up two buckets, which the total weight was 78 lbs. The second can collapsed after three buckets, where the total weight was 85 lbs. Both cans, after wrapped with SikaWrap Hex 100G, did not collapse after imposing 140 lbs of weight on the cans. There were no signs of distress. For the A¼ in. x 3 A½ in. x 3 ft. plank, the first piece had a A½ inch deflection, and the second had a 5/8 inch deflection. Deflection is decreased by 3/8 of an inch and by 7/16 inch accordingly. The fiber wrap decreased the deflection by about 75% - 85%. For the A# in. x 1 A½ in. x 4 ft. wood, both pieces had 3/16 inch deflections. The fiber wrap decreased the deflection by about 1/16 of an inch and was a 33% improvement.

**Conclusions/Discussion**
Does fiber wrap strengthen materials? Fiber wrap does strengthen materials in terms of buckling and deflection. It more than doubles the amount of strength it takes to buckle an empty Coke can, as proven from 78 lbs and 85 lbs needed to crush it and the 140 lb weight, and it did not show any sign of distress. Also, the deflections of the A¼ in. x 3 A½ in. x 3 ft. plank decreased by 75%, and the A# in. x 1 A½ in. x 4 ft. decreased by 33%. It was hypothesized that fiber wrap strengthens materials. The hypothesis was correct because the buckling strength is increased by more than 200% and decrease the deflection by as little as 33% to 85%.

**Summary Statement**
It describes what fiber wrap is, how it works, and what it does.

**Help Received**
Mother helped with board, Father helped with board, cutting, experiment, brother helped print, Mr. Frett donated materials

# CALIFORNIA STATE SCIENCE FAIR
## 2007 PROJECT SUMMARY

**Name(s)**
Kristy Chang; Lana Ho

**Project Number**
**J0207**

**Project Title**
## Bring on the Heat! A Project Concerning Stirling Engines

**Abstract**

**Objectives/Goals**
The problem is: How does changing the temperature of the water in a Stirling Engine affect its rate of rotation and the amount of water left over from the reservoirs? It is hypothesized that the highest temperature of water would result in the RPM of the flywheel of the engine surpassing the RPM of an engine heated at a lower temperature, and that the most amount of water would be evaporated. The hypothesis was based on both Charles and Boyles Laws, which relate gas temperature to volume, and volume to pressure.

**Methods/Materials**
To test the hypothesis, one would first build the engine according to the procedure. After doing so, one would fill the reservoirs with water and regulate the temperatures with candles. Each trial would be tested under the same conditions. All tests would be repeated five times.

**Results**
After recording and analyzing data, one would find that the results support the hypothesis. With the temperature of the reservoirs at 100 C, the RPM of the flywheel was greater than the trials that involved the engine being heated at a lower temperature. The average RPM for the engine heated at 100 C was 24.6, which was larger than the others. As temperature increased, more water was evaporated. The average amount of water left over from five cups at 100 C was 4.2 cups.

**Conclusions/Discussion**
The hypothesis was correct. As the temperature of the water in the engine increased, the RPM of the flywheels increased, and the amount of water evaporated from the reservoir increased. Using that information, one would be able to create a more efficient Stirling Engine.

**Summary Statement**
The project tests how the temperature of the water in a Stirling Engine affects its RPM and the amount of water evaporated from the reservoir.

**Help Received**
Parents helped with obtaining supplies

# CALIFORNIA STATE SCIENCE FAIR
## 2007 PROJECT SUMMARY

**Name(s)**
Isaac V. Cohen

**Project Number**
**J0208**

**Project Title**
## The Effects of Gyroscopic Force on a Stationary Body

**Abstract**

**Objectives/Goals**
To demonstrate gyroscopic force

**Methods/Materials**
To begin my experiment I needed the following materials:
¡# Bigger bike wheel (68.58 cm diameter)
¡# Smaller bike wheel (50.8 cm diameter)
¡# Two handles per wheel
¡# A stool that can freely rotate over 360¢ª
¡# Person to spin the wheel
¡# A scale to weigh the wheels
Once all the materials were bought and collected I was able to begin my experiment.
These are the steps needed to conduct the experiment:
¡# 1st: Sit on the stool on your knees. (See photo below). Align the mark on the stool with the 0#¬ graduation.
¡# 2nd: While sitting on the stool, hold the smaller wheel in front of you and keep it horizontal.
¡# 3rd: Have a friend spin the wheel.
¡# 4th: Rotate the axis of the spinning wheel 180#¬ and notice the torque it exerts on your wrists. Also notice the rotation of the stool as the wheel is tilted.
¡# 5th: Repeat Steps 1-4 five times and record.
¡# 6th: Repeat from Step #1 with the bigger wheel

**Results**
Spinning the larger wheel resulted in a larger stool rotation. More force can be felt at the handles when moving the larger wheel through different angles.

**Conclusions/Discussion**
Conclusion:
The formulas that describe the energy developed from a spinning gyro involve how the mass is distributed. Two wheels of the same mass but one with its mass further from the center of rotation will generate more force.
Further Research:
I would like to learn more kinematics and how the laws of motion describe complex mechanisms. Also maybe I would like do this experiment on a bigger scale

**Summary Statement**
Demonstrating gyroscopic force

**Help Received**
Mr. Nelson (Mrs. Nelson's dad) and My dad, Mr. Cohen helped with equations.

# CALIFORNIA STATE SCIENCE FAIR
# 2007 PROJECT SUMMARY

**Name(s)**

**Foster D. Collins**

**Project Number**

**J0209**

**Project Title**

## Urban Solar Electric Panel Steering Testing and Proposed New System Design

**Abstract**

**Objectives/Goals**

The objective of the original/first phase of this project was to test if a simple solar panel steering system might improve panel energy production enough to reduce the overall system cost by requiring fewer panels.

**Methods/Materials**

A solar tracking system was created using Lego Mindstorms robotics components. Steered and fixed panels were mounted on a south-facing rooftop fixture tilted up so that both squarely faced the sun at noon. Output voltages of the panels were recorded on a computer every 40 seconds for 14 days of testing.

**Results**

steered panel produced an average of 31% more energy each day. This encouraging advantage motivated the addition of Phase 2 of the project to run 15 more days of testing with the fixed panel mounted at more-realistic, non-ideal orientations, as are more likely on typical houses. The fixed panel was positioned flat on two of the roof surfaces, which were not as steep as the ideal angle and not facing directly south. The new test data showed such significantly greater relative energy output for the steered system, 129% and higher, that Phase 3 was added with the objective of creating new 3-D CAD design concepts for low-profile, low-cost steering systems for residential rooftop use.

**Conclusions/Discussion**

The new preliminary concepts have modular arrays of 16-inch square panels steered by interconnected linkages, which eliminates the need to have a steering motor for every panel. Such steered rooftop solar systems should be attractive to urban home owners because they are low-profile and of such higher panel output efficiency that they should be less expensive than flat-on-the-roof installations typically offered by solar installation companies.

**Summary Statement**

A preliminary design was created for a new solar panel steering system for urban use; because the project testing proved that steered solar panels work much better than ones typically mounted flat on roofs.

**Help Received**

My dad: contacted solar panel companies, soldered solar cells, helped with data acquisition software, initiated system design concepts, did most of the 3-D CAD modeling, helped with display board graphics; Engineer friend: explained electrical theory for panel and load resistor wiring.

# CALIFORNIA STATE SCIENCE FAIR
## 2007 PROJECT SUMMARY

**Name(s)**
Megan E. Cunningham

**Project Number**
**J0210**

**Project Title**
## Does the Amount of Water in Concrete Affect Its Strength?

**Abstract**

**Objectives/Goals**
My project was to determine if different amounts of water would affect the strength of concrete. I believe that there is an optimum amount of water that will make a concrete mix it's strongest.

**Methods/Materials**
In my project, I used water, cement, sand, two molds, a tamper, and a hydraulic jack. I changed the amount of water but kept the amount of sand and cement the same in each of the 12 concrete mixes that I made. To test the compressive strength, I used a hydraulic jack and a steel frame.

**Results**
The range of water cement ratio between 0.40 and 0.45 has shown to produce the strongest concrete.

**Conclusions/Discussion**
Looking at all the data that I have collected and recorded into my data log, my hypothesis was supported. The concrete samples that had a lot of water or a small amount of water, were weaker. This information is helpful because it tells us which range of water cement ratios is going to produce the strongest concrete.

**Summary Statement**
In my project, I tested to see if different amounts of water affected the strength of concrete.

**Help Received**
My mother took pictures and also helped me to put my display board together. My father was my testing supervisor. Steve Campbell of Christian Wheeler Engineering loaned me the two molds and the tamper that I used. Marathon Construction Corporation loaned me the hydraulic jack.

# CALIFORNIA STATE SCIENCE FAIR
## 2007 PROJECT SUMMARY

**Name(s)**
Joey C. Gibbs

**Project Number**
**J0211**

**Project Title**
## Determining the Stop Rate on Different Surfaces with Different Tire Pressures

**Abstract**

**Objectives/Goals**
Using a KTM 65cc dirtbike, I determined how tire pressure would affect the stop rate of the bike on different surfaces.

**Methods/Materials**
I am using my KTM 65cc dirtbike. I first did a safety and maintenace inspection. I then praciticed getting the bike to 15 mph using a speed gun. I had a highway patrolman use speed gun. He would signal when I hit 15 mph. After practicin this. I would slam on back brake at the signal.
I then determined which surface I would begin with. I started concrete.
The different surfaces were: concrete, asphalt, packed dirt, loamy soil, and sand.
I began with a tire pressure of 25psi
The different tire pressures used were: 25, 15 and 5psi.
I rode my bike on concrete until I hit 15 mph. I then slammed on back brake at the signal.
I then measured the stopping rate with a tape measure.
3 trials for each surface under each tire pressure.

**Results**
5psi - longest - concrete 32'9" shortest - loamy soil 15'3"
15 psi - longest concrete 42'6" shortest - loamy soil 18'6"
25psi - longest concret 47' shortest - loamy soil 24'3"

other surfaces fell between the above results.

**Conclusions/Discussion**
I learned that different tire pressures affect the stopping rate. A lower tire pressure showed that it will stop faster. However, if tire pressure is too low, not enough air for tire to work properly. It will effect how smooth your ride is, and could ruin rims.
For safety puposes, if you really want to be able to stop quicker, you should have a tire pressure a little lower than recommended. Recommended amount is 10.

**Summary Statement**
My project will determine how tire pressure effects stopping rate of a dirt bikes.

**Help Received**
teacher taught scientific process, dad helped with supervision, officer Butler CA CHP, helped with safety and speed gun.

# CALIFORNIA STATE SCIENCE FAIR
## 2007 PROJECT SUMMARY

**Name(s)**
Alec Gronberg; Chaz Marshall

**Project Number**
**J0212**

**Project Title**
# The Effect of Blowgun Length on the Energy of Its Projectile

**Abstract**

**Objectives/Goals**
Our project was designed to determine how the barrel length of a blowgun affects the energy of the projectile.

**Methods/Materials**
To conduct our experiment we first used a 61.0 cm (2 ft) blowgun. We then laid out a wooden trough, and put a wooden dowel at the end of the trough. We lined up the blowgun so the end of it was pointed at the center of the dowel. We then put the projectile (the dart) into the blowgun. Next we turned on the air compressor and fitted the nozzle into the mouthpiece of the blowgun. We pulled the trigger, the projectile shot into the dowel, and we measured how far the dowel went. We also did this with the 91.4 cm (3 ft) blowgun, the 152.4 cm (5 ft) blowgun, and the 121.9 cm (4 ft) blowgun. For our experiment we needed two 61.0 cm (2 ft) blowgun barrels, one 91.4 cm (3 ft) blowgun barrel, two blowgun mouthpieces, two connectors, five stun darts, one wooden trough (244 cm), one 2.5 cm (one in) wooden dowel, one measuring stick, one air compressor, and one nozzle. The 121.9 cm (4 ft) blowgun barrel is made by attaching a 61.0 cm (2 ft) blowgun with another 61.0 cm (2 ft) blowgun barrel. The 152.4 cm (5 ft) blowgun barrel is made by attaching a 61.0 cm (2 ft) blowgun with a 91.4 cm (3 ft) blowgun barrel.

**Results**
After we had conducted our experiment we found that the lengths for the different lengths of blowguns, in order of distance, was, the 91.4 cm (3 ft) blowgun at 49.66 cm, then the 61.0 cm (2 ft) blowgun at 51.2 cm, then the 121.9 cm (4 ft) blowgun at 71.58 cm, and finally the 152.4 cm (5 ft) blowgun at 82.94 cm.

**Conclusions/Discussion**
Our results proved that the longer the barrel length is, the more energy there is in the projectile. The reason we think that the 91.4 cm blowgun had the least about of energy in the projectile is because we had one bad trial. In this one bad trial we had a measurement which was far below the average of the other trials and this brought its average down. If we hadn#t done that one trial, the order of blowguns from most powerful to least powerful, would be the 152.4 cm (5 ft) blowgun, then the 121.9 cm (4 ft) blowgun, then the 91.4 cm (3 ft) blowgun, and finally the 61.0 cm (2 ft) blowgun.

**Summary Statement**
Our project is about the relevance of barrel length of a blowgun, to the energy of its projectile.

**Help Received**
We went to Sid's Apholstrey to use their air compressor to conduct our experiment.

# CALIFORNIA STATE SCIENCE FAIR
## 2007 PROJECT SUMMARY

**Name(s)**
Alyssa M. Herman

**Project Number**
**J0213**

**Project Title**
## Rolling Backpacks: Do They Really Reduce the Stress on Your Spine?

**Abstract**

**Objectives/Goals**
The goal of my experiment was to evaluate and compare the compression and twisting forces on the spine caused by the use of a rolling and regular backpack. I hypothesized that the use of a rolling backpack with a given book load would result in a lesser downward pressure and twisting force on the lower spine than use of a regular backpack.

**Methods/Materials**
I built a simple life size model of myself out of wood with wheels to allow travel and with shoulders and arms to hold a backpack. I modified the model to test two different forces. Model 1 was equipped with a weight scale at the region of the lumbar spine to assess downward force in pounds. In Model 2 the scale was replaced by a torque wrench to assess the twisting force in foot-pounds. Each model was tested over a distance fo 50 feet using first a regular backpack and then a rolling backpack carrying book loads of 0lbs, 10lbs, 20lbs, and 30lbs. Weight and then torque recordings were taken every 10 feet in each trial.

**Results**
Model 1: the control at 0lbs recorded 0lbs. For the rest of the book loads the weight recorded on the scale for the rolling backpack was always less than the regular backpack. Rolling to regular backpack recorded weight ratios were as follows: 10lb load (1:19), 20lb load (1:11), and 30lb load (1:9). Model 2: the control at 0lbs recorded 0 foot-pounds. For the rest of the book loads the torque recorded for the rolling backpack was always less than the regular backpack. Rolling to regular backpack recorded torque ratios were as follows: 10lb load (1:12), 20lb load (1:6), and 30lb load (1:5).

**Conclusions/Discussion**
The data from this experiment supported my hypothesis that use of a rolling backpack did in fact significantly reduce the downward pressure and twisting pressure on the region of the lumbar spine when compared to a regular backpack. Knowing these findings will likely influence a student's or parent's future choice of a backpack and hopefully result in less back pain and injury.

**Summary Statement**
I evaluated the compression and twisting forces exerted at the lumbar spine region when using a rolling verses a regular backpack.

**Help Received**
My Father helped me build the experimental Models. My teachers Mr Demaria and Dr Dunn reviewed my project.

# CALIFORNIA STATE SCIENCE FAIR
## 2007 PROJECT SUMMARY

**Name(s)**
Austin J. Hiatt

**Project Number**
**J0214**

**Project Title**
## Determining the Fastest Gear Set-Up on a Single Speed BMX Bike through a Designated Course

**Abstract**

**Objectives/Goals**
The objective of my project is to determine the best gear combinations and crank arm lengths for a single speed BMX race bike on a designated course.

**Methods/Materials**
A 2006 Redman Expert XL BMX Racing Frame with 20" wheels was used with 6 different gear set-ups with 160mm and 165mm crank arms. A testing course was selected on an American Bicycle Association Sanctioned Track and measured with a measuring wheel. Using a hydrraulic strating gate and a line and cones marking the finishing point, I tested the different gear set-ups using a stop-watch to track the results. I rested during each gear change as to be sure that fatigue would not effect the results.

**Results**
After running several tests on the designated course, I recorded my results on a chart. The smaller front chain ring and rear cogs with the 165mm crank arms proved to be the fastest combinations.

**Conclusions/Discussion**
After testing the gear combinations, I realized that the 37 front chain ring gear with a 13 rear gear using the 165mm crank arms produces the fastest average time on the first straight of Tulare BMX track. This set-up had the perfect resistance against my feet at top end speed and surprisingly did not take that much effort to get moving. The slowest set-up was the 43 front chain ring gear with a 16 rear gear using the 165mm crank arms. This set-up was the easiest to get going because of the torque it produces during the start. However, the gear had lost all resistance against my feet at top speed.

**Summary Statement**
My project is about finding the fastest gear set-up for me that has the fastest time on the first straight of a BMX course which is a crucial part of the track in a BMX race.

**Help Received**
My dad helped with the timing and changing gears during the testing as well as helping to put the board together.

# CALIFORNIA STATE SCIENCE FAIR
## 2007 PROJECT SUMMARY

**Name(s)**
Arian E. Khansari

**Project Number**
**J0215**

**Project Title**
## Strength Test for Bridges

**Abstract**

**Objectives/Goals**
The problem that I set out to solve by conducting my experiment was, "How do the different structural designs of the beam bridge, the triangle bridge, the double truss bridge, and the arch bridge affect the amount of weight each bridge can support before collapsing?" My hypothesis was that the arch bridge would be able to hold the most weight because I believed the arch to be the strongest, most durable shape. I also thought that the double truss bridge would come in second, the triangle bridge in third, and the beam bridge last.

**Methods/Materials**
The materials that I used in my project were 27 feet (325 inches or 8.3 meters) of 1/4-inch (.62-cm) balsa wood, a craft knife, tacky glue, a wooden block about 2 X 3 X ½ inches (5 X 7.5 X 1.25 cm), an eye-socket screw, a S-hook, four straight pins, a shallow pan of water, two tables of equal height, a scale, a large plastic bucket, sandpaper, and weights. I began my project by using a cutting knife to cut the balsa wood into the sizes that I would need to build the bridges. I had been soaking four pieces of balsa wood in water for about three days when I took one out and tried to bend it for the arch bridge. However, it snapped. Because of this, I was unable to make or test the arch bridge. Regardless, I finished cutting the wood for the other bridges, glued the pieces together, and left them to dry. Later on, I came back and conducted the actual testing. I did this by placing a wooden block on each bridge, hanging a bucket from this wooden block, and then adding weights into the bucket until the bridge collapsed. Lastly, I weighed each bucket on a scale and recorded the results.

**Results**
After conducting the testing, the beam bridge had supported 17 lbs., the triangle bridge had held 35 lbs., and the double truss bridge had carried 39.5 lbs. before finally collapsing. However, I did not receive any results from the arch bridge, as I was unable to build and test that bridge.

**Conclusions/Discussion**
I concluded that my hypothesis was proven partially correct, as the double truss bridge did carry more weight than the triangle bridge, and the triangle bridge did hold more weight than the beam bridge. However, I was unable to receive any results from the arch bridge, making that part of my experiment inconclusive and neither proving nor disproving that particular section of my hypothesis.

**Summary Statement**
Testing the strenght of the beam bridge, the triangle bridge, the double truss bridge, and the arch bridge.

**Help Received**
Mom helped by driving me around to buy materials, Dad helped by giving me tips on how to cut the wood

# CALIFORNIA STATE SCIENCE FAIR
## 2007 PROJECT SUMMARY

**Name(s)**
Emily T.H. Le

**Project Number**
**J0216**

**Project Title**
## Walk, Stop, and Stroll

**Abstract**

**Objectives/Goals**
Can mechanical legs work and move without the use of electricity, rather the amount of energy supplied by the maneuvering of the lever by human hands? What type of soles would provide the most grips, or conduct the most friction, to prevent the legs from slipping while supporting weight?

**Methods/Materials**
10_10cm springs8_3cm springs2_ 35cm wooden bars2_40cm wooden bars 1_26cm x 26cm board (wooden),25_ 2cm screws6_large rubber1 pair of rubber soles1 pair Dr. Sholl#s gel pads1 pair plastic soles2_12cm rods1_1kg weight1_500g weight1_700g weight1 roll oftape1_screwdriver1_pliars1_scissors3m of wire6 _hinges 2_15.5cm x 7cm wooden board4_ 2m long thin rope1.

**Results**
left leg, the wood block for knee is slightly curved in, uneven when nailed block in (small) crack because not thick enough hinge on right for feet is closer to edge, unstable hinge, place protruding, first time change so that pieces of wood touch one another wood board on ,uneven first time one leg (left) bend inwards, hinge on top tiny holes because tried to staple springs inif legs are towards back, can stand if slightly forward, fall over left leg has more balance right leg slightly bent(hip)board slightly tipped forward to keep stableright leg slant outward to standcannot stand on one leg with one leg bent, fall over immediatelyfeet about 5cm apart left leg is closer in side the board(hip)right leg (hinge) on hip more agapefeet, slanted outward to standscrew loose on left (foot)can stand without distance between feet.

**Conclusions/Discussion**
Apparently, in my case, mechanical legs cannot work or move by using only energy produced by Homo sapiens# hands.the feet are too small to be able to support the weight above it. The springs that are used were too coiled together causing it to pull in which makes the legs unable to stand upright.Adding the block of wood in between the #femur# and #tibia# prevented the #kneecap# to bend backwards. Also the board that connected the two legs and acted as a #hip# were connected by hinges so that every time the legs move the weight would thrust forward.Also, the ankle or heel part was held together by a hinge making the feet swing to nearly 180 degrees with every step to change that I made the tibia touch the feet completely and that made the legs too stiff and unable to balance. The springs were too tightly coiled which only made the legs bend and not straighten.There is also no center of mass for the legs.

**Summary Statement**
How mechanical legs can work without using electricity and use energy supplied through human hands.

**Help Received**
Father_cutting wood, Chris,Bryan, Brandon, Alan (home depot), Thy_taking pictures

# CALIFORNIA STATE SCIENCE FAIR
# 2007 PROJECT SUMMARY

**Name(s)**
Annie G. Lefley

**Project Number**
**J0217**

**Project Title**
## Plies to Perfection: The Force on Your Patellar Tendon

**Abstract**

**Objectives/Goals**
The objective of my science fair project is to test my hypothesis that if a person does a grande plie, then there will be more tension on the patellar tendon than if a person does a demi plie.

**Methods/Materials**
To test this hypothesis, my dad and I built a model knee that contained a spring to measure tension. To collect my data, I first held the knee in the desired position, which was determined by measuring the inside angle of the knee. I then tightened the string, or tendon, using a guitar tuner. I adjusted the tension until the knee stayed in position. Once the knee was in position, I measured how much the spring, or quadriceps, had extended. To convert the extension into tension, I used the equation:

Tension = Spring Extension x Spring Constant + Pretension

The pretension is the minimum amount of force it takes for the spring to begin extending.
Once I collected my data, I graphed it using Microsoft Excel. My graph showed that the tension on the patellar tendon goes up at a faster than linear rate as the plie gets deeper. Putting in a trend line, I obtained the equation:

$y = 0.0007x^2 + 0.0176x + 0.8411$

to describe the relationship between the angle of the plie (x) and the tension on the patellar tendon (y).
I then formed the equation:

Tension = 8.35[(Sin(90-[½ inside angle])) x 2]

to model the theoretical tension on the patellar tendon on my knee model.

**Results**
There was 100% more tension on the patellar tendon in a grande plie than a demi plie. The tension predicted by the theoretical equation above was reasonably close to the measured force, but not precisely the same.

**Conclusions/Discussion**
In conclusion, my data support my hypothesis. There is approximately 100% more tension in a grande plie than there is in a demi plie. I think the reason that the theoretical force did not entirely agree with the model, is because of the many complications of my model that were hard to measure, and include in my theoretical equation. For example, the string is not perpendicular to the upper leg all of the time, as my theoretical equation assumes, the heel rises, and there are varous frictions around the ankle and hip. All of these things make it difficult to have a perfectly accurate theoretical equation.

**Summary Statement**
The objective of my project is to see whether there was more tension on the patellar tendon in a grande plie or a demi plie, two moves in ballet.

**Help Received**
My dad helped build the model; James Neilson, a PhD student at UCSB help with equations; My teacher Mrs. Miller helped with the theoretical tension.

# CALIFORNIA STATE SCIENCE FAIR
## 2007 PROJECT SUMMARY

**Name(s)**
Connor M. Lynch

**Project Number**
**J0218**

**Project Title**
## Hydrogen Fuel: Clean and Powerful!

**Abstract**

**Objectives/Goals**
The objective of this project was to demonstrate that by replacing the fuel source of a gasoline combustion engine with hydrogen gas would produce fewer detrimental emissions while still maintaining a practical level of performance.

**Methods/Materials**
In order to fully evaluate both aspects of my hypothesis, I developed four separate testing experiments. First, I converted a 5 hp Briggs & Stratton gasoline engine to burn hydrogen gas as its fuel source. Then I took the converted engine to Fast Lane Auto for an emissions test while running on gasoline and while running on hydrogen. The next experiment, speed, was measured in RPM (revolutions per minute) using a tachometer which measure the revolutions of the axel while running on gasoline and while running on hydrogen. For my final test, power, I constructed a differential strap brake which measures the differential pressure required to stop the engine at idle speed. This test was also done while gasoline was burning and while hydrogen was burning. I then plugged these measurements into a horsepower conversion formula which gave me the horsepower that was exerted when each different type of fuel was burned.

**Results**
The results from the emissions test showed the engine running on hydrogen demonstrated an 84% reduction in carbon monoxide, 60% reduction in carbon dioxide and a 272 ppm increase in hydrocarbon emissions when compared to the engine running on gasoline. While burning gasoline in the engine the axle had an overall average of 1740 rpm. Where as the same engine burning hydrogen had an overall average of 1725 rpm. After putting the weight differences into the horsepower conversion formula the horsepower that the gasoline powered engine exerted was 2.81. While the horsepower from the hydrogen powered engine was 2.21.

**Conclusions/Discussion**
This experiment demonstrated that an engine running on hydrogen would have an overall positive impact, and would be practical to implement in society.

**Summary Statement**
I converted a gasoline powered engine to run on hydrogen to prove that a hydrogen powered engine would produce fewer emissions while still maintaining an equal power performance when compared to a gasoline powered engine.

**Help Received**
UCSB Graduate Student

# CALIFORNIA STATE SCIENCE FAIR
## 2007 PROJECT SUMMARY

**Name(s)**
Stephanie L. Merrill

**Project Number**
**J0219**

**Project Title**
## Green Concrete

**Abstract**

**Objectives/Goals**
The purpose of this experiment was to determine if adding waste materials to concrete affects its strength. There are two goals to be achieved by adding waste materials to concrete. First, it could be a great way to use materials that clog landfills. Second, the waste materials could make the concrete lighter. Thus, the experiment was to find out if a lightweight concrete could be made from waste materials without affecting the strength.

**Methods/Materials**
The experiment involved adding different amounts of waste materials to test cylinders of concrete. Ten concrete cylinders were prepared, including a control, and different amounts of Styrofoam, cardboard, and tire rubber were added to nine cylinders. Then, the cylinders were brought to the concrete testing lab to cure for 30 days. After the concrete cylinders cured for 30 days, the strength of the concrete cylinders was tested. The strength was tested by using a compression machine that increased the pressure placed on the concrete cylinders until they failed.

**Results**
The waste materials made the concrete cylinders weaker. The Styrofoam cylinders were the strongest and the tire rubber cylinders were the weakest. The weight of the concrete samples was affected as well. Generally, adding waste materials to the concrete cylinders decreased the weight of the cylinders.

**Conclusions/Discussion**
The waste materials made the concrete weaker. The more of the waste material added, the weaker the concrete became. Surprisingly, the rubber, the densest of the waste materials, had the most negative affect on the concrete strength. The Styrofoam concrete was the strongest. The weight of the concrete samples was affected as well. Generally, adding waste materials to the concrete cylinders decreased the weight of the cylinders.

**Summary Statement**
While adding waste materials to concrete may help the environment, the strength of the concrete is weakened.

**Help Received**
My father helped me carry and mix the concrete. Geotechnics, Inc. provided the testing facility.

# CALIFORNIA STATE SCIENCE FAIR
## 2007 PROJECT SUMMARY

**Name(s)**
Eric C. Mintz

**Project Number**
**J0220**

**Project Title**
## The Effects of a Dynamic Load on Structural Integrity

**Abstract**

**Objectives/Goals**
Since I live in California where earthquakes are common, I decided to look at earthquake effects on the structural integrity of arches make from materials of different flexibilities. My hypothesis was that arches supporting a significant weight that are too flexible would lose structural integrity too easily. Some flexibility is required since an arch made of material that is too rigid will not be able to absorb significant ground movement. Therefore, a material with moderate flexibility would be most desirable.

**Methods/Materials**
I designed and had the arches cut made out of different plastics having seven different flexibilities but all the same compression strength. I tested 63 arches, nine replicates for each of seven materials (ABS, Acetal, Acrylic, Fiberglass, Garolite, Polycarbonate, and Nylon 6/6). I fastened each arch to a fixture and #shaker# table that I designed and built. Using a counter I then measured how fast the shaker table was moving and chose three frequencies that the shaker table would go at, 7 hertz, 3 hertz, and 1 hertz. I then steadily poured water into a container hung from each arch while it was on the moving shaker table until the arch either broke or buckled. I then recorded the average weight at which each arch type failed.

**Results**
The arches composed of the #acetal# material were able to hold the most weight, 3813 grams, which was for times more than the acrylic arches which had the least average weight bearing capacity. The material that was second strongest under these conditions was polycarbonate, which supported on average 2410 grams before breaking.

**Conclusions/Discussion**
My results supported my hypothesis that a moderate flexibility for the weighted arches was best able to tolerate the #ground# motions.

**Summary Statement**
This project tests the weight-bearing capacity of different arches in motion on a shaker table I built to simulate earthquake movement.

**Help Received**
Grandfather let me borrow tools; Connie Chow taught me how to use solid works; Professor at UCSD answered some of my questions; Father bought me the materials.

# CALIFORNIA STATE SCIENCE FAIR
## 2007 PROJECT SUMMARY

**Name(s)**
Diego R. Munoz-Cowan

**Project Number**
**J0221**

**Project Title**
## Truss Bridge Tests

**Abstract**

**Objectives/Goals**
My objective is to learn which of three truss bridges will support support the most mass. The three bridges are: the Baltimore (Pratt), the Lattice, and the Subdivided Warren. I believe that the Lattice bridge will support the most mass because it has the most triangular supports.

**Methods/Materials**
Three different truss bridges were constructed using toothpicks and glue. They were each built on same-sized pieces of rectangular cardboard, Each bridge had the same top, roadbed and cube platforms. Each bridge had a different truss design.

I then put a rod with a cord across the roadbed of each bridge. Tied to the end of the cord was a bucket. Then, I slowly poured water into the bucket until each of the bridges collapsed and touched the cardboard base. Lastly, I weighed the bucket, rod, and cord, and added it to the weight of the water.

**Results**
The Lattice supported the most mass. The Subdivided Warren supported the second greatest amount of mass. The Baltimore (Pratt) supported the least amount of mass.

**Conclusions/Discussion**
My hypothesis was correct. The Lattice bridge supported the most mass (6575 gm.). My conclusion is that it supported the most mass because it had the most triangular supports.

**Summary Statement**
My project is to find out which of three different truss bridge designs is the strongest.

**Help Received**
My mother helped me to type the report. My father cut out the cardboard rectangles.

# CALIFORNIA STATE SCIENCE FAIR
## 2007 PROJECT SUMMARY

**Name(s)**
Denise A. Navarro

**Project Number**
**J0222**

**Project Title**
## How Does a Trebuchet Work?

**Abstract**

**Objectives/Goals**
The purpose of the project was to build one trebuchet made of wood with supplies in my school's woodshop class. I changed each feature in order to see at which settings it will perform its best. I also tested to see which feature to change in order to accurately hit a target on the floor at 6.25 and 10 m. I had to document my test well by creating a daily log, research paper, and visual display board.
My hypothesis was that in order for the projectile to go a greater distance, I believe the length of the sling string should be longer, the hook should be curved more, the lever arm should be longer, and the fulcrum should be higher. In order to hit the target, the lever arm should be adjusted.

**Methods/Materials**
I used a trebuchet made of wood, a hackie sack, string, a meter stick, and safety goggles. When I changed the features of the trebuchet, I kept all the other things constant just to be as accurate as possible. I changed the length of the sling string from 35-54 cm. I changed the curvature of the hook from a flat semi-circle to a fully curved semi-circle. I varied the length of the lever arm from 70-100 cm. I also changed the height of the fulcrum from 54-60 cm. In order to hit the target, i changed the curve of the hook, the length of the lever arm, and the height of the fulcrum.

**Results**
The projectile went farther when the sling of the sling string was longer, the curve of the hook was greater, the lever arm was longer, and the height of the fulcrum was higher. The best feature to change in order to hit the target was the length of the lever arm beacuse it allowed me to aim better.

**Conclusions/Discussion**
In conclusion, my hypothesis was correct. When the lengths of the sling string and the lever arm was longer, the projectil went farther. When the hook was curved more and the hieght of the fulcrum was higher, the projectile went farther. The best feature to change to hit the target was the lever arm.

**Summary Statement**
I built one trebuchet made of wood and test each of its different variables to see at which settings it will perform the best and hit two targets on the floor.

**Help Received**
Mr. Wade helped me build the trebuchet in his woodshop class; Mrs. Genota helped me with the research paper and display borad; my parents helped me with my purchases.

# CALIFORNIA STATE SCIENCE FAIR
## 2007 PROJECT SUMMARY

**Name(s)**
Ralph M. Sathre

**Project Number**
**J0223**

**Project Title**
## Does JB-Weld Have a Usable Strength in Space?

**Abstract**

**Objectives/Goals**
My objective was to stimulate the research of space glues that could have prevented the heat shield failure on the Space Shuttle Columbia and future spacecraft repairs by making repairs while in space. I first started with simple tests on a smaller scale with a common epoxy glue, JB-Weld, which was purchased at Home Depot. I created several devices that tested JB-Weld in space like conditions for Shear, Tension, Torsion and Compression forces while vacuumed and at temperatures from -17 to 260 degrees C. I was searching for new methods of actually applying these glues while in a space like environment which is a current problem for N.A.S.A.

**Methods/Materials**
I used springs, wires, Popsicle sticks and 15mm diameter glass tubes to create these testing devices that were then vacuumed and subjected to hot and cold cycles as in space. I also simulated mixing the compounds in a vacuum to see if they would harden and be useable in space by astronauts.

**Results**
The epoxy, once cured above 10 degrees C, hardened into a useable product for the most part during hot and cold cycles. The hardened product at -17C appeared to not develop a brittleness common to ice at that temperature indicating that its strength may continue to be useful at much lower temperatures possibly approaching those lower temperatures of space. My experiment did not test to those lower temperatures. My tests were successful in all strength categories and only failed 6 out of 10 torsion tests at higher temperatures than that on the moon.

**Conclusions/Discussion**
JB-Weld may have a useable strength in space. During one of my final tests in a vacuum, I realized a different approach for astronauts to use. Instead of the conventional two part epoxy where each part must be thoroughly mixed with the other, my experiment showed that by the simple touching of one part to the other a hardened epoxy can be created where a chemical reaction is started at the interface of both substances eliminating mixing. This concept actually happened in my experiment with JB-Weld while under a vacuum to some degree. If scientific research could develop products that did not require mixing but only touching then this approach would greatly simplify the application of epoxy for spacecraft repairs.

**Summary Statement**
I tested an epoxy glue for useable strength for spacecraft repairs while in space by astronauts.

**Help Received**
Used lab equipment and supervised during vacuuming and glasswork by licenced neon manufacturer

# CALIFORNIA STATE SCIENCE FAIR
## 2007 PROJECT SUMMARY

**Name(s)**
Alexander J. Sercel

**Project Number**
**J0224**

**Project Title**
# Effect of Propellant Variation and Aerodynamic Drag on Potato Cannon Performance

**Abstract**

**Objectives/Goals**
This research effort was to gain a better understanding of the physics and engineering principles related to the operation of a potato cannon. Research goals were to find out which common household propellant works best, how much propellant is best, and to learn how air drag effects the trajectory of the potato.

**Methods/Materials**
I made a potato gun and launch stand using PVC and materials available at the hardware store and tested it using a variety of propellant quantities and types. Trajectory performance was recorded on a digital video camera with a calibrated backdrop to capture spud velocity and launch elevation angle. Trajectory range was recorded by flagging ground impact locations then using a tape. Flight distance was predicted using a computer algorithm in a spreadsheet to numerically integrate the equations of motion. By comparing measured spud flight range to predicted range, an indirect measurement of potato drag coefficient was obtained.

**Results**
Spud launch velocities were observed in the range of 20 to 60 m/s. At low fuel amounts, corresponding to 0.5 seconds of spray injection, spud launch speed varied from 30 to 40 m/s. At increasing fuel amounts (up to 2 s of spray), spud launch speed varied from 20 to 60 m/s. Flight ranges of up to 100 m were observed to be less than that which was predicted in the absence of atmospheric drag. Flight range was accurately predicted when drag effects were accounted for in the trajectory integration.

**Conclusions/Discussion**
When there is too much fuel, the gun either works very well or doesn#t have enough oxygen to burn properly. If the fuel mixture is too lean, the gun works predictably but doesn#t have as much launch energy. A medium fuel mixture is ideal for repeatable results because you have higher power than a lean mixture and you don#t run the risk of flooding the chamber. The top three propellants I used all contain denatured ethanol as a main ingredient suggesting that ethanol is an excellent propellant.

My numerical results show that you can't accurately predict how far a potato cannon will shoot unless you include the effects of air drag. It is possible to integrate the equations of motion of a flying potato in a spreadsheet in which the trajectory is broken up into time slices of about 0.01 seconds. This allows accurate prediction of the shape of the potato's trajectory, including the effects of atmospheric drag.

**Summary Statement**
I addressed two questions related to the performance of a potato cannon: What is the best type and quantity of propellant, and how much aerodynamic drag does the potato have in flight?

**Help Received**
My parents took me to the hardware store and bought my materials, my father safety checked everything I did and operated the video camera, my father showed me how to use some features on the computer I had not previously used, and my whole family helped me collect field data on test days.

# CALIFORNIA STATE SCIENCE FAIR
## 2007 PROJECT SUMMARY

**Name(s)**
Analisa K. Shields-Estrada

**Project Number**
**J0225**

**Project Title**
## Does Structure Affect Strength?

**Abstract**

**Objectives/Goals**
My goal was to explore the relationship between the structure of a material and its strength. I answered the question: Will changing the structure (or the form: flat, rolled, twisted, and braided) of a material affect its strength? My hypothesis was: The braided structure of the materials will be the strongest.

**Methods/Materials**
I created four different bridge structures, flat, rolled, twisted and braided, for each of three different materials, cotton, fabric, plastic and paper. I used four 21.65 cm x 14 cm pieces of each material for each structure. Within material, all of the 4 structures were of similar mass. Overturned yogurt containers secured with tape were the bridge supports. To measure the strength of the structures, I placed each across the supports to form a bridge, placed weights on top until the structure broke, then measured and recorded the mass of the weights. I repeated three trials for each structure.

**Results**
For each material, changing the structure changed its strength. Across the three materials, the strength of the types of structures varied similarly: The rolled structures were the strongest supporting the most mass by far (ranging from 15.73g to 7500.00g), the twisted structures were the second strongest (ranging from 5.70g to 189.97g), the braided structures were the third strongest for paper and fabric (ranging from to 8.00g to 93.33g), the flat structures were the weakest for paper and fabric (ranging from 1.00g to 9.00g). The braided and flat plastic structures were both very weak supporting only 1g of mass. A secondary finding was that the paper was stronger than the fabric, and the fabric was stronger than the plastic.

**Conclusions/Discussion**
Structure affected strength across all materials. The data did not support my hypothesis, which stated that the braided structure would be the strongest. My project attempted to model and demonstrate the process of changing a materials# structure to change its strength. Scientists have used this idea in nanotechnology. Carbon nanotubes, a new form of carbon that scientists have made using nanotechnology, are 50 times stronger than steel and have a diameter of only 1 to 10 nanometers.

**Summary Statement**
My project explores the relation between the structure of a material and its strength.

**Help Received**
Mrs. Kilkenny helped me specify my hypothesis. Peggy Estrada helped me refine my braiding techniques and taught me how to iron.

# CALIFORNIA STATE SCIENCE FAIR
## 2007 PROJECT SUMMARY

**Name(s)**
Courtney J. Shipp

**Project Number**
**J0226**

**Project Title**
# Maximizing the Trajectory of a Trebuchet

**Abstract**

**Objectives/Goals**
The purpose of this project is to determine the relationship between several variables of a trebuchet and the distance it is able to throw a projectile. These variables include the length of the counterweight arm, the length of the throwing arm and the length of the sling. It was hypothesized that if the counterweight arm, throwing arm, and sling were lengthened, then the trajectory would be maximized and the trebuchet would throw the projectile farther.

**Methods/Materials**
A trebuchet is a siege weapon that was used in Europe during the Middle Ages before gunpowder was invented. To run this experiment, a model trebuchet was built using PVC and a golf ball was launched fifteen times with each of the following variables: counterweight arms with lengths of 4, 5, 6, 7, 8 and 9 inches; throwing arms with lengths of 16, 18, 20, 22, and 24 inches and slings with lengths of 16, 18, 20, 22, and 24 inches.

**Results**
The 6 inch counterweight arm, 20 inch throwing arm and 20 inch sling combination maximized the trajectory and produced the longest throws, with the distances declining as the counterweight arm, throwing arm, or sling were shortened or lengthened.

**Conclusions/Discussion**
These parameters were optimal because at this setting the trebuchet was releasing the golf ball at an ideal angle after the golf ball had received the maximum amount of energy the trebuchet could transfer to it. With other combinations of the variables, the trebuchet would release the golf ball either too early or too late. This affected the amount of energy transferred to the golf ball. When the trebuchet released the golf ball too late, energy was lost in the release from the sling. When the ball was released too early, it had not received all the energy the trebuchet had to transfer. Therefore, the results did not support the hypothesis.

**Summary Statement**
This project tested a trebuchet by varying the length of the counterweight arm, throwing arm and sling to determine which combination would maximize the trajectory of a golf ball launched from the trebuchet.

**Help Received**
My family helped me to run experiments and collect data accurately, my dad helped me glue the trebuchet together, and my mom helped me arrange my board.

# CALIFORNIA STATE SCIENCE FAIR
## 2007 PROJECT SUMMARY

**Name(s)**
Katelyn E. Shipp

**Project Number**
**J0227**

**Project Title**
## Standing Tall: Strength of Shapes

**Abstract**

**Objectives/Goals**
The purpose of this project was to find out which shape of column is the strongest and will support the most weight. It was hypothesized that the circular shaped column would be the strongest and would support the most weight.

**Methods/Materials**
A column is a vertical structure that is used to support a large load, usually in the form of a building or structure. This experiment involved making several different shaped columns, lifting and setting multiple weights onto the columns until the columns failed, and recording the data. The tests were run using triangular shaped columns, square shaped columns, hexagonal shaped columns, octagonal shaped columns and cylindrical shaped columns. Each shape of column was tested thirty different times with four columns used in each trial.

Originally the experiment was performed 10 times using 110 lb cardstock to make columns that were 5.5 inches tall. In order to validate the results, the entire experiment was run again using 110 lb cardstock and 11 inch tall columns and then a third time using 28 lb copy paper and 5.5 inch tall columns. This gave a total of thirty data points for each shape of column. Throughout all the experiments the perimeter of the columns was kept constant at 6 inches.

**Results**
The results of the experiment supported the hypothesis. The cylindrical shaped column was by far the strongest column and supported the most weight.

**Conclusions/Discussion**
The cylindrical shaped column is the strongest is because of corners. The flat sides of the shapes do not support structural load. Therefore, it is the corners of the shapes that give the columns their strength. The triangle has three corners to support its load, the square has four, the hexagon has six and the octagon has eight corners. In contrast, the circle can be viewed as having 360 corners. Thus, the circle is by far the strongest shaped column.

**Summary Statement**
This experiment tested 5 shapes of columns (triangle, square, hexagon, octagon, circle) varying the height and thickness of the material to determine which shape was the strongest and could support the most structural load before failure.

**Help Received**
I would like to thank my dad for lifting some of the weights that were too heavy for me to lift, my sister for taking pictures during my tests, and my mom for helping me organize my science fair presentation board.

# CALIFORNIA STATE SCIENCE FAIR
## 2007 PROJECT SUMMARY

**Name(s)**
Henry R. Solomon

**Project Number**
**J0228**

**Project Title**
## Bend It Like Beckham or Magnus Force?

**Abstract**

**Objectives/Goals**
I would like to learn how to kick a soccer ball in such a way that it appears to be heading straight, but curves away from goalie (or wall of defenders at the last second. I was always curious how David Beckham of the Los Angeles Galaxy was able to bend the ball around a wall of defenders and score an amazing goal. I would like to learn his awesome trick.

**Methods/Materials**
Use one size four soccer ball, one tape mease, one soccer goal that is 25 feet wide, and one soccer field.

Follow these steps to complete the experiment:
1. Place a size four soccer ball 18 yards away from a 25 foot wide goal.
2. Lay a tape measure arcoss the goal line.
3. Draw an X on the inflation hole of the ball. This will represent the middle of the ball.
4. Then draw 3 more Xs at 40mm, 80mm, and 120mm to the right of the center of the ball.
5. Kick the ball 20 times at each X, making sure that the top of your foot makes contact with each X.
6. After each kick, record how far to the right the ball was when it was half way to the goal, and when it enters the goal.
7. Once the ball has been kicked 20 times at each X, the experiment will have been completed.

**Results**
The ball curved the most when it was kicked at 80mm to the right of the center of the ball. When it was halfway to the goal, the average kick was 1.45 feet to the right of the center of the goal. When the ball was in the goal, it was 6.475 feet to the left of the center of the goal.

**Conclusions/Discussion**
When the results were calculated the ball curved the most when it was kicked at 80mm to the right of the center of the ball. It curved about 7.9 feet in total. This was surprising because the conductor predicted that it would curve the most when it was kicked at 120mm. In order for the Magnus Force to come into play, the ball has to have enough force applied to it. Because 120mm is so far to the right, it is hard to apply enough force. However, 80mm is not so far to the right, so more force was able to be applied. If you kick a ball in the right place with enough force, it will curve the most.

**Summary Statement**
I tested where to kick a soccer ball so it generates enough curve to bend around the goalie.

**Help Received**
My mother helped organize research and my father helped me meausre the curve of the ball when I did my experiment.

# CALIFORNIA STATE SCIENCE FAIR
## 2007 PROJECT SUMMARY

**Name(s)**
Garrett E. Sons

**Project Number**
**J0229**

**Project Title**
## Determining the Damage of a Tsunami Wave Based on the Building's Shape, Angle, and Location

**Abstract**

**Objectives/Goals**
The purpose of my science fair project is to determine whether the buildings shape, angle, and location has an effect on the Tsunamis damage.

**Methods/Materials**
The first thing I have to do to conduct my testing is to buy an aquarium measuring 1' by 2' by 1' long. The reservoir will be 1 foot wide by 9 inches. The sand beach will be 1 3/4 inches high by 1 foot wide by 11 inches long. I will use wood buildings and put them in different locations and angles. The buildings shapes will be a circle, triangle, and square.
To make a tsunami I will partition one end of the aquarium. That area will contain the water. To start the tsunami, the partition will be raised to let the water out towards the building located at the other end of the aquarium. Measuring the lean of the buildings alows me to observe wich building will withstand the force of the tsunami best.
The variables I used are: The buildings will be, 2 triangle pieces of wood 3" high by 2" by 2". 2 circle peices of wood 3" high by 2" diameter. 2 square pieces of wood 3" high by 2" by 2". 810 pounds of water. 59 pounds of sand.

**Results**
After comleting all 60 testings of switching buildings angles and locations. I found out what building got knocked over the least and what building got knoced over the most. Also every thing in between. The building that got knocked over the least was the square when its line e,f was facing the tsunami and the square was on the left side of the aquarium it got knocked to 88.3 degrees. The building that got knocked over the most was the triangle when its angle a was facing the tsunami and it was on the right side of the aquarium it got knocked to 57.9 degrees.

**Conclusions/Discussion**
Overall I learned many things doing my project. I learned what buildings stand up the best and worst. I learned that a buildings density maters on the damage and much more from my research and testings. Lastly I learned what I could next year.

**Summary Statement**
Determining if the shape, angle, and location of a building will minimize the damage of a Tsunami wave.

**Help Received**
Grandpa helped build test ocean; Cousin helped with some typing.

# CALIFORNIA STATE SCIENCE FAIR
## 2007 PROJECT SUMMARY

**Name(s)**
Morgan W. Spadone

**Project Number**
**J0230**

**Project Title**
## Portable Water Heater

**Abstract**

**Objectives/Goals**
To build a portable hot water heater using house hold materials.

**Methods/Materials**
Collect the materials: heater hose, thermos, copper tubing, on/off valves, hose clamps, tube connector, charcoal chimney starter, epoxy glue, charcoal and water pump. Wrap the copper tubing around the chimney in an upward spiral. Cut two hoses and insert one at the top and bottom of thermos. Then connect to the copper tubing. Add shut-off valves and water pump. Fill thermos with water, add chacoal and newspaper to chimney,ignite. Once charcoal is hot, pump water through coils and allow thermal siphoning to take over, heating the entire tank.

**Results**
At first the pump was leaking. Adjustments had to be made to stop the leak. The pump was braced up so not to leak. In following tests the water in the 5 gallon tank did increase from 60 degrees F to 98 degres F within 90 minutes. The temperature of the water on top of the thermos was measured at 115 degrees F.

**Conclusions/Discussion**
When water is heated in a closed container, convection occurs causing cooler water to sink and warm water to rise. Additionally, thermal siphoning occurs when the water is heated. The warm water moves in a circle through the thermos out the hose, through the coils and back into the thermos again. This technique could be used for outdoor survival during emergencies. More testing using environmentally "friendly" materials would be beneficial to improve upon this invention.

**Summary Statement**
A portable hot water heater to be used for outdoor living or in the event of an emergency where hot water is needed.

**Help Received**
My dad helped me select the items from the hardware store. He also helped me with the power tools, Exacto knife and when using the epoxy glue. My mom helped with the testing when having to light the charcoal. She also helped me glue and cut paer for my presentation board.

# CALIFORNIA STATE SCIENCE FAIR
## 2007 PROJECT SUMMARY

**Name(s)**
Conor E. Stanton

**Project Number**
**J0231**

**Project Title**
## Faster Flips: Angular Momentum and Gymnastics

**Abstract**

**Objectives/Goals**
My goal in this project was to find out why it is easier for a gymnast to do a tuck positioned flip compared to a lay-out flip. My hypothesis was that when the mass in a rotating object is moved closer to its center of rotation, it will rotate faster than with its mass further away from the center of rotation.

**Methods/Materials**
An apparatus was built with a rotating arm with masses which could be moved closer or farther from the axis of rotation. A mass suspended over one end of the arm could be dropped to exert a force and get the arm to rotate. Experimental trials were conducted with the moveable masses positioned at different rotational radiuses. For each trial, the number of revolutions the object made in a fixed period of time was counted. Materials included wood; screws and bolts; a large mass to drop; string to suspend the mass; a ruler and a stopwatch.

**Results**
The experiment showed that with the same force applied, the object consistently rotated faster with its mass closer to its center of rotation. Trials were done with the masses at several different radiuses. On my first trials the rotation slowed down much faster when the rotating weight was closer to the center of rotation. I think this might have something to do with friction overpowering the lower inertia of the spinning mass. More initial force and a shorter timing period seemed to reduce the impact of friction or other forces on the results.

**Conclusions/Discussion**
The experimental results support my hypothesis. Newton's 1st law states that a mass at rest tends to stay at rest and a mass in motion tend to stay in motion unless acted upon by an external force. For a mass rotating around an axis, this is called rotational inertia, and this inertia increases as the distance of the mass from the center of rotation increases and vice versa. This means given the same force, the mass will be accelerated to a higher velocity as it is moved closer to the axis of rotation. When a mass is in motion it has something called momentum which is conserved. As a gymnast starts a somersault and pulls into a tuck position, the momentum from the takeoff is conserved but the radius of the rotating mass gets smaller, so the velocity of the spin increases. This makes it easier to do the somersault with less force than if the gymnast stayed in a layout position.

**Summary Statement**
My project explores the relationship between mass, acceleration, and momentum in circular motion.

**Help Received**
My dad helped me build the experimental apparatus, and he also asked me lots of questions.

# CALIFORNIA STATE SCIENCE FAIR
## 2007 PROJECT SUMMARY

**Name(s)**
Kristie M. Tagawa

**Project Number**
**J0232**

**Project Title**
## It's the Blades That Count

**Abstract**

**Objectives/Goals**
My project involves the testing and research of wind turbine design and the electricity it generates. I am interested in this subject area because there has been much discussion and debate about changing the way America generates electrical power. One alternative energy source often suggested is the use of wind power. I want to determine if the number of blades on a wind turbine has a direct affect on the amount of power the wind turbine will produce. My hypothesis states: if a wind turbine contains more blades, then it will generate more electricity than a wind turbine that contains fewer blades.

**Methods/Materials**
I began my experiment by constructing a replica of a wind turbine. I used a cardboard box to simulate a wind tunnel which housed a generator mounted on a metal base. To make the wind turbine blades, I glued model airplane propellers together in sets of 2, 3, 4 and 6 blades. Next, I attached a set of blades to the generator and turned on a fan which served as the wind source. I then recorded the voltage that the wind turbine produced shown on the multi-meter. I repeated this three times with each set of blades.

**Results**
After analyzing the data, I recorded the results. The wind turbine with three blades produced the greatest amount of energy. The turbine with four blades produced less energy than wind turbine with three blades. The turbine with six blades produced even a lesser amount energy than the turbine with four blades. Finally, the wind turbine with two blades produced the least amount of energy out of all of the blades.

**Conclusions/Discussion**
I concluded that a wind turbine containing three blades generates the most amount of electricity. Wind turbines with greater or less than three blades do not produce the same output of electricity.
If I were to conduct this experiment again, I would test the four wind turbines used in my experiment at different wind speeds. I would also test a larger sample of blade sets with varying shapes and sizes. This project can benefit society in several ways. Wind power could prove to decrease the dependence on fossil fuels and other non-renewable energy sources. It is beneficial to society because it is a clean energy source that does not produce carbon dioxide, mercury or any other type of air pollution. Investing in wind power is a smart and necessary move for an economical and ecological future.

**Summary Statement**
My project involves determining how the number of blades that a wind turbine contains affects the amount of electricity it generates.

**Help Received**
Parents purchased materials for project. Father supervised the soldering and electrical procedures of the experiment.

# CALIFORNIA STATE SCIENCE FAIR
## 2007 PROJECT SUMMARY

**Name(s)**
Matthew A. Tatarka-Brown

**Project Number**
**J0233**

**Project Title**
## Stressed Out

**Abstract**

**Objectives/Goals**
Which structural beam shape will withstand the most load-bearing weight?

**Methods/Materials**
Five different polystyrene beam shapes, cut to 15 inches, three of each polystyrene beam shapes, a five gallon bucket (to put bricks in), thirteen bricks (to put in bucket), a hose (to fill up the bucket when the bricks cannot break the beam), a test stand, a gram and ounce scale (to weigh each beam), a regular bathroom scale (to measure the weight of the bucket), a notebook, two clamps (to hold down the beams), an S hook (to hold the bucket to the beam), a camera (to take pictures of the project), a stopwatch (if the water & the bricks do not break the beam, count to two minutes), safety glasses, and a carpenter's square (to measure deflection).

Cut each beam to the length of fifteen inches, weigh each beam with the ounce & gram scale, set up your test stand with a twelve inch gap, clamp the first beam at both ends, put the #S# hook on the center, hang the bucket from the #S# hook, load one layer of bricks into the bucket, record deflection, repeat until all bricks are used, fill remaining space in the bucket with water slowly until the beam breaks or the bucket is full, when beam breaks, dismount the bucket & record it's weight. If the beam does not break leave the bucket full for two minutes, remove the bucket and weigh it. Photograph the results. Repeat this procedure for each beam. Analyze the data.

**Results**
The Square beam withstood the most weight with 70 pounds. The H beam withstood 68, I beam withstood 63 pounds and the T beam followed with 45 pounds in order. The weakest beam was the Z beam, which withstood 38 pounds on average.

**Conclusions/Discussion**
I conclude that if you need to support a tremendous amount of load-bearing weight upon a beam, use a Square beam.

**Summary Statement**
This project tests five structural beam shapes to determine which, Square, H, I, T, or Z, has the greatest load-bearing capacity.

**Help Received**
My step-father helped set up the test bench, loaded the bricks and took many of the photographs, my mother and step-father helped with the poster board.

# CALIFORNIA STATE SCIENCE FAIR
## 2007 PROJECT SUMMARY

**Name(s)**
Grace F. Tobias

**Project Number**
**J0234**

**Project Title**
# The Effect of Centrifugation on Standard Fecal Flotation Procedures in the Recovery of Parasitic Ova in Beef Cattle

**Abstract**

**Objectives/Goals**
My objective is to determine if adding a centrifugation step to a standard fecal floatation procedure will result in an increase in the number of parasitic ova recovered from fecal specimens obtained from beef cattle.

**Methods/Materials**
Fresh fecal samples were collected from 6 beef calves. These 6 month old calves weighing approximately 450 pounds were unweaned and had not been previously treated for parasites. Equal aliquots of each sample were tested in triplicate using standard fecal floatation procedure and a fecal floatation procedure using a centrifuged specimen. The number of ova recovered in each test was counted and recorded.

**Results**
In 5 of the 6 samples (83%), the centrifuged sample recovered greater numbers of ova.

**Conclusions/Discussion**
I conclude from this data that the addition of a centrifugation step to a standard fecal floatation procedure increases the likelihood that parasitic ova will be recovered in greater numbers. The addition of the centrifugation step decreases the probability of false negative test results especially in specimens with low total ova counts.

**Summary Statement**
My project is about improving the reliability of fecal examination for parasites.

**Help Received**
I used lab equipment at my father's veterinary practice. My mother helped in identifiying parasitic ova.

# CALIFORNIA STATE SCIENCE FAIR
## 2007 PROJECT SUMMARY

**Name(s)**
Cameron W. Wallace

**Project Number**
**J0235**

**Project Title**
## The Sweet Zone of a Ball-Bat Collision

**Abstract**

**Objectives/Goals**
Recent research on baseball bats by Robert Adair, Rod Cross and Daniel Russell has shown what happens when the bat hits a ball, and why there are some locations on the barrel that result in less vibration for the batter. The goal of my project is to understand where on the barrel of a baseball bat will cause the least vibration when hitting a ball. Is there a single "sweet spot" or a larger "sweet zone" where the vibration is the least?

**Methods/Materials**
I began by building a model of a freely supported bat holder. Dr. Daniel Russell from Kettering University advised me how to use SpectraPLUS Software to find the frequency of the first three bending modes and the location of the barrel nodes of the first three bending modes for each bat being tested. With some expert help I adjusted the settings on the software to display a graph of amplitude (vibration) vs. frequency. Using this set-up, I tested three bats two times each. First I hit each bat on the tapered end using a plastic handle and found the frequency of the first, second and third bending modes, and the strength of vibration (decibels) for each mode. Then I hit each bat every 1/2" across the barrel, labeling the node as the place on the bat where the vibration for each mode was the least.

**Results**
(1) The location of the nodes of the first and second bending modes were the same for both trials for all three bats. The location of the node for the third bending mode was the same for two bats, and 1/2" different for the third bat; (2) Subtracting the amplitude at the node for each bending mode from the original amplitude calculated the vibration loss at the node. The node of the first bending mode had the largest effect on reducing the overall vibration. The node of the second bending mode had the second largest effect on reducing the overall vibration. The node of the third bending mode had the least effect on reducing the overall vibration.

**Conclusions/Discussion**
My hypothesis was that every bat I tested would have a certain area on the barrel of the bat where the vibrations were the least when hit by a ball. This area would be the "sweet zone" of the baseball bat. My results show that hitting a bat between the nodes of the first and second bending modes causes the least vibration. My conclusion is that the "sweet zone" of a baseball bat is between the nodes of the first and second bending modes. This proves that my hypothesis is correct.

**Summary Statement**
My project uses an accelerometer and vibrational analysis software to determine where a baseball bat hitting a baseball would result in the least vibration; a single "sweet spot" or a larger "sweet zone?"

**Help Received**
Greg Hildebrand gave me advice on using an accelerometer; Dr. Daniel Russell, Kettering University, advised me on how to test baseball bats using an accelerometer; Will Bagnall and Talitha Stimson helped to install the SpectraPLUS Software; My father helped build the freely supported bat holder.

# CALIFORNIA STATE SCIENCE FAIR
## 2007 PROJECT SUMMARY

**Name(s)**
David A. Whiteside

**Project Number**
**J0236**

**Project Title**
## Projectile Efficiencies for a Kinetic Energy Weapon of Medieval Warfare

**Abstract**

**Objectives/Goals**
The objective of this project is to find the optimum ratio of counter weight to projectile weight. Another goal is to find if the optimum ratio, if there is one, will hold strong between three different projectile weights.

**Methods/Materials**
One will need power tools, saws, a nail gun, wood and a set of instructions to guide you as you build the trebuchet. One will also need a projectile or tennis ball, weights for the counter weight, and a measuring tape to measure the distance of each launch.

**Results**
The data shows that for projectile group #one# the optimum ratio is 92:1. The optimum ratio for projectile group #two# is 59:1. The optimum ratio for projectile group #three# is 34:1.

**Conclusions/Discussion**
When the data is studied, it is shown that there is no over all optimum ratio that is listed throughout all the projectile weights. There is a pattern that is shown, but not with enough sample size to be statistically significant. This is a pattern that shows when the projectile weight is increased; the ratio between counter weight and projectile becomes smaller.

**Summary Statement**
This project was trying to find if there was an optimum ratio between counter wheight and projectile wheight and what was the ratio if there was one.

**Help Received**
Mother helped type the report; Friend helped retrieve ball after launches; Dad supervised the building of the trebuchet.

# CALIFORNIA STATE SCIENCE FAIR
## 2007 PROJECT SUMMARY

**Name(s)**
Jonathan A. Wilde

**Project Number**
**J0237**

**Project Title**
## ToughBot: The Pursuit of a Better Urban Search and Rescue Robot

**Abstract**

**Objectives/Goals**
The goal of my project is to build a highly robust custom autonomous search and rescue robot platform. The design of the robot would be a major improvement on previous designs. The robot would be tested to ensure that it met design criteria such as having redundant obstacle detection systems and being made out of tough materials.

**Methods/Materials**
I first constructed the main prototype circuit board for the robot. Upon completion, I machined the body out of polycarbonate and assembled the robot. I then programmed software libraries and test programs for the robot. Finally, I tested the robot by dropping it from two feet onto the ground to test its impact resistance, having it attempt to drive over a piece of PVC tubing to see how it would drive over rough terrain, and by having it drive up a slippery slope to test the traction of the treads.

**Results**
The impact resistance test revealed a weak tread link and the rough terrain test revealed that the plastic treads were too slippery. These issues were quickly fixed by replacing the weak tread link and by coating the treads in rubber.

**Conclusions/Discussion**
A small, tough, lightweight, and easy-to-program robot is clearly feasible. This prototype can clearly survive the hardships that a current search and rescue robot goes through and climb over the same types of objects that a current one can. The prototype even meets many of the specifications set by the Center for Robot Assisted Search and Rescue. A robot like this could clearly make the search and rescue industry safer and more efficient than ever before.

**Summary Statement**
The focus of the project is to build a robust custom urban search and rescue robot platform and test it under simulated conditions.

**Help Received**
Father taught how to use oscilloscope; Used power tools under supervision of father.

# CALIFORNIA STATE SCIENCE FAIR
## 2007 PROJECT SUMMARY

**Name(s)**
Dylan T. Woodbury

**Project Number**
**J0238**

**Project Title**
# Breaking Point: Using Pasta to Find the Effect of Length and Cross-Sectional Area on the Strength of an Object

**Abstract**

**Objectives/Goals**
The objective is to determine whether the cross-sectional area and the length of an object affects the strength and by how much. I believe that the pasta with the greatest cross-sectional area will be strongest, and will therefore support the most weight. I also believe that shorter pieces of pasta will be stronger than longer pieces because longer pieces bend more easily.

**Methods/Materials**
Three different types of pasta of the same brand were used: thin spaghetti, normal spaghetti, and linguini. For each type of pasta, five different lengths were used: two, four, six, eight, and ten inches. I set two blocks, with a notch in them to hold the pasta, on two tables. The tables were moved closer to or farther from each other, depending on what the span of the pasta had to be. A piece of yarn tied to a plastic cup was rested over the pasta. I had someone apply pressure to each end of the pasta to prevent the ends from bending and to keep the pasta from moving. I then dropped pennies one by one into the cup until the pasta broke. This was repeated ten times for each length of each type of pasta. All trials were done inside on the same day to control for atmospheric conditions such as humidity and temperature.

**Results**
The linguini (greatest cross-sectional area) held the most pennies while the thin spaghetti (smallest cross-sectional area) held the least pennies. For each type of pasta, the shortest length (2 inches) held the most pennies, while the longest length (10 inches) held the least. As the length increased, the number of pennies that each type of pasta could support decreased.

**Conclusions/Discussion**
My conclusion is that the strength of an object is definitely affected by its cross-sectional area and length. As cross-sectional area increases, the strength of the object increases. As the length increases, the strength of the object decreases.

**Summary Statement**
My project is about finding whether the cross-sectional area and length of an object affects its strength.

**Help Received**
Father helped with graphs and regression equations; Father and Mother held down the pasta while I dropped pennies in the cup.

# CALIFORNIA STATE SCIENCE FAIR
## 2007 PROJECT SUMMARY

**Name(s)**
Iris Wu

**Project Number**
**J0239**

**Project Title**
## Flipmaster 5000

**Abstract**

**Objectives/Goals**
My objective was to find a way to enable musicians to turn pages of music without interrupting their playing. To do so, it was necessary to use some other means to flip the page, thus freeing the hand.

**Methods/Materials**
At first, I did some product research to see what type of machines were available on the market. I found many good ideas, but was surprised to find no available products. I started brainstorming different designs that used my foot to turn the page and tested them by building prototypes. I knew that my foot would not be able to move a large distance to turn the page as that would disrupt my playing. Then I realized I needed third class levers, mechanisms that use a large force applied over a short distance and convert it into a small force applied over a long distance. With that in mind, I arrived at my final product through trial and error.

**Results**
My machine is composed of several third class levers. Each lever is comprised of one hinge, dowel, and pedal. The bottom of each dowel is attached to the base using a hinge which acts as the fulcrum. Extending from the hinges are pedals where the foot exerts the input force to move the lever. At the top of the dowel is a chain with a clip at the end that attaches to the page of music. This chain is important as it lets the machine adjust to various heights of music stands and sizes of books. There is also a rubber mat on the bottom of the base to prevent sliding on slippery surfaces. Through my testing, I have found that with the proper setup, my machine can turn the pages forward or back as needed. However, I have also discovered the pushing of the pedal can be improved and, though the number the pages turned by the machine is usually sufficient, page capacity may need to be increased for longer pieces. In future prototypes, I hope to address these two problems.

**Conclusions/Discussion**
Although small improvements can be made to increase page capacity and ease, the Flipmaster 5000 is a useful machine for musicians because it lets them turn pages of music without interrupting their playing.

**Summary Statement**
The Flipmaster 5000 is a page-turning machine designed to help musicians turn pages of music without disrupting their playing.

**Help Received**
My mom helped me buy the necessary materials and sawed and drilled the wood

# CALIFORNIA STATE SCIENCE FAIR
## 2007 PROJECT SUMMARY

**Name(s)**
David A. Zarrin

**Project Number**
**J0240**

**Project Title**
## The Effect of Wheels on Catapult Efficiency

**Abstract**

**Objectives/Goals**
The Greek inventor of the catapult, Archimedes, found that wheels increase launch distance of projectiles. He might not have known the physics behind his experiments. I wanted to understand and prove the physics of why adding wheels to a catapult increases launch distance of a projectile.

**Methods/Materials**
I found a catapult simulator on the Internet. After 40 simulated trials, I found the best arm ratio dimension. I built a catapult with removable wheels using the simulated dimensions. To clearly see the launch motion, I used a video camera to tape each launch with and without wheels. I loaded the video into a computer and analyzed the motion frame-by-frame until I understood the effect of wheels on catapults.

**Results**
I found that wheels help transfer more of the weight#s potential energy to the projectile. Wheels allow the weight to drop faster in a straight line thus transferring more energy in a shorter amount of time to the projectile. Also, the projectile is launched while the catapult has a forward motion adding to the speed and launch distance of the projectile. In my experiment, the weight dropped in 0.33 sec. with wheels and 0.37 sec. without wheels. Wheels increase the launch distance by 21.5%

**Conclusions/Discussion**
Catapults with wheels launch projectiles farther than catapults without wheels because:
1. Weight on the catapult wants to go straight down (gravitational force).
2. For the weight to drop straight down, the catapult must move backward and then forward.
3. Forward motion of the catapult happens as the projectile is launched, giving the projectile a boost.
4. The catapult with wheels launch time was 0.33 sec. According to the video frames, removing wheels slowed the launch time down to 0.37 sec, transferring less energy to the projectile.
5. In catapults without wheels the weight is forced to travel down in an arc.
6. When this happens the arm slows down, decreasing the amount of energy transferred to the projectile.
7. There is no boost from the forward motion because without wheels, the catapult cannot move.

I learned: 1. Physics and affect of catapult wheels on launch distance.
2. Newtons Laws, potential and kinetic energy concepts.
3. Computer simulators to find ideas without building real models.
4. Measurement techniques using video cameras.
5. Calculating object speeds using distance and time.
6. Using computer programs: Photoshop, Premiere Pro, and Excel.

**Summary Statement**
I wanted to understand and prove the physics of why adding wheels to a catapult increases the launch distance of a projectile.

**Help Received**
Mr. Simon Zarrin (father) helped with dangerous aspects of the project (power tools, catapult safety)