UNIVERSITY OF CENTRAL FLORIDA

Third IDEAS Showcase

Tuesday, November 25, 2014.

Civil Engineering Atrium 2:00 pm-5:00 pm

About IDEAS

The Interdisciplinary Display for Engineering Analysis Statics-IDEAS was developed and organized with the objective of promoting the creativity, team work, and presentation skills of undergraduate sophomore and junior students, as well as exposing them to the interesting world of scientific/technological research based engineering. This effort is expected to close the gap between the theory and applied engineering at the early stages of education. This is also expected to promote Science Technology Engineering and Mathematics (STEM), even sparking more interest in some students with the desire of pursuing a graduate degree in STEM disciplines. For IDEAS, the students are asked to form groups and work for a project. They select a topic, preferably related with their majors, and conduct research involving some of the concepts learned in the course Engineering Analysis-Statics (EGN 3310). The projects involve physical models, measurements, and comparison of the experimental data with the theoretical calculations. Also, the students write papers and prepare posters, which will be presented on the day of their showcase. These projects will be judged by professors and graduate students from the Civil, Environmental, and Construction Department. The following section presents a list of the original project abstracts that are submitted by the students for the showcase.

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Analysis of Effects of Earthquake Forces on Water Tower Structures

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Generally four types of water towers exist, each varying in dimension, and material. Pedisphere, Fluted Column, Standpipe, and Multi-Leg water towers all take advantage of gravity to help disperse the water. These water towers must be able to withstand all sorts of natural forces. The research conducted in this study is to replicate the four types of water towers and test them against earthquake forces. In order to collect valid results, our team has built viable models of the different water tower types and tested them on a shaking table to replicate an earthquake force. The data was collected and results were compared in order to name the most earthquake resistant water tower type.

Lefty O'Doul Bridge

Modesto Garcia[a], Fernando Baez[b], Xavier Henderson[c], Christopher Carlson[d]
[a b] Mechanical Engineering Department
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[d]Environmental Engineering Department

ABSTRACT

The purpose of this project was to create a replica of the Lefty O'Doul drawbridge, which allowed the creators to visualize how different components and forces interact with the bridge. The authors strived to achieve accurate results to prove their understanding of the concepts of statics that takes place in this bridge. They calculated the forces in this system, formed free-body diagrams, analyzed the structure by hand, and compared the handwritten results with lab tested results. The researchers calculated the forces in this system by first determining the reactions in the supports from this bascule bridge. They applied learned concepts from class, such as trusses and equilibrium of forces and moments in 3D. Their replicated structure was composed out of balsa wood. The pivoting supports were pins, and the creators had weightless links to have the bridge rise and lower. A counter weight was used to balance the system, when the bridge is in motion. Through the results and construction in this project, the investigators had a complete understanding of the fundamental concepts of mechanics.

Forces that are Applied to Stadium Retractable Roofs

Ana Salazar [a], Kevin Odell [b], Joshua Casserino [c]
[a, b]Department of Mechanical and Aerospace Engineering
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ABSTRACT

Using the Marlins Park Stadium as an example, the intent of this paper is to find and explain what forces interact with the retractable roof of this building design. A model will be created in the likeness of the Marlins Park Stadium and used to identify, test and examine the interactions of the forces on the actual structure. With the understanding of what forces are affecting the stadium roof, this paper will examine how the forces change in the process of opening, as well as being completely opened and closed. Once all the forces are identified a shear moment diagram will be made to explain how and where the structure is being stressed under normal conditions. Then using the data calculated and known limits the maximum force that the roof can handle will be calculated, examined and explained.

NASA'S New Launch Pad

Adam Althar[a], Albin Mathew[b], Maximiliano Castrillon[c] , Josh Juergensmeyer[d]
[a c d]Electrical Engineering and Computer Science Department.
[b]Mechanical and Aerospace Engineering Department

ABSTRACT

The purpose of this project is to determine the new structural design for the tower and launchpad for the upcoming Space Launch System (SLS), NASA's new spacecraft, based on the new dimensions as defined by NASA. Due to the SLS being taller and heavier than the Space shuttle, coming in at 322ft and 5.5 million pounds according to NASA, the new tower will without a doubt require an even larger and more intricate tower and platform. The launch tower and launchpad used in NASA's space shuttle program are also being examined in order to understand the design requirements for such a structure. This examination will allow the projected design to better fit NASA's goals for these structures. This project will define new practical dimensions and design that can withstand not only the force of launch of the SLS but also hold it at equilibrium till the time of launch.

Structure Analysis of the Shuttle Launch Pad

Christopher Bellido [a], Spencer Britton [b], Shawn Moore [c]
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[b c] Mechanical Engineering

ABSTRACT

Investigating the structural components of the Shuttle Launch Pad in order to optimize the design when all the forces acting on the static structure are considered. The principles used in our analysis will be based around an engineering analysis of the forces acting using ideas related to static equilibrium. Structural supports will be analyzed and their position will be optimized in order that they may take the load of both the sitting shuttle and the launch. An onsite evaluation will be made of existing launch pad on the Kennedy Space Center in order to better understand the structure of a launch pad in general. This investigation and analysis will culminate in our own optimized design for a Shuttle Launch Pad.

Crane Turnover

Robert Cody[a], Kyle Sankovich[a], Christopher Gooding[b], Jacob Knepper[c]
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ABSTRACT

There are many reasons as to why a crane overturns; from unreliable support systems to human error, crane overturning occurs most frequently. As a result many people are hurt when crane overturning occurs and in several cases, can result in the death of an individual or more. The purpose of this experiment is to research why crane overturning occurs and what can be done in the future to hinder this issue from persisting. To study the components of crane overturning, a small scale model of a crane of an original design, and a wooden barge were constructed and tested to find the various points of measure. These points included, the center mass of the crane, max load put on crane, the angle of tipping of the barge, the angle at which the crane and barge turned over, the physical measurements of the crane, the moment of the crane about the x/y/z plane is positioned on, and the supports systems and the reactive forces they produce in the system. After the crane and barge were built, they were tested thoroughly under different conditions to see what could be done to have the system overturn in a controlled body of water. After many tests the system would consistently overturn due to instability and insufficient weight distribution on top of the barge. As a result, as support system was built to assist in keeping the crane upright and to stop the system as a whole from overturning in the water. With the support system in place and a counterweight to help balance out the weight distributed across the surface of the barge, the crane was more efficient while being used. Even though the support system isn't completely efficient, it does allow for further progress in finding a way to stop crane overturning.

Reality of a Space Elevator: From a Statics Perspective

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ABSTRACT

The current cost of transporting a pound of materials from Earth exceeds $10,000, creating fiscal limitations with regards to our endeavors in space. One potential solution to this logistics problem is the construction of a space elevator, a massive tower anchored to the Earth, tethered by cables spanning the entire length of the building. Such a structure has the potential to provide an efficient and cost-effective mode of transport, provided by lifters that would carry cargo and be in service every day while ultimately revolutionizing the future of the space industry. As of today, there has been no successful execution of a space elevator, largely due to the limitations of present day composites and high tensile strength materials. The upper record of tensile strength properties is currently held by variations of graphenated carbon nanotubes, capable of withstanding up to 125 GPa of force, without breaking their bonds. This paper utilizes a mixture of static models and physics principles to analyze the construction of a simplistic space elevator. This is an attempt to assess the feasibility of building such a structure, using these carbon nanotubes, determining the magnitude of tensile strength that would be necessary for such a feat. Varying methods of construction and anchoring are investigated as well, in order to ascertain the optimal height of the structure. Both the observations and calculations being presented in the paper are taken from a theoretical standpoint and are strictly of the quantitative nature.

Retractable Bridge

Jonathan Graham[a], Akil Gray[a], Kristina Revueltas[b], James Williams[b]
[a] Civil, Environmental, and Construction Engineering Department
[b] Mechanical and Aerospace Engineering Department

ABSTRACT

A modern drawbridge has been efficient in the past but as today's world progresses a new means of technology and structure should be considered to increase efficiency. Naturally, the question arises about what exactly is wrong with drawbridges. The answer to this would be that as the population of humans using vehicles to travel grows the more traffic is created while waiting for a drawbridge to open and close, therefore leading to our idea of speeding up

travel in situations where drawbridges are used. In this IDEAS paper, the idea of a retractable bridge as a more efficient replacement for the drawbridge will be introduced. An innovative design which consists of three parts of the bridge on each side retracting in and out as opposed to up and down will be used. The retractable bridge will eliminate the need for so many cables and piers allowing the bridge to work faster than the average drawbridge. With this retractable bridge working at a faster speed than a drawbridge, many vehicles will be able to travel faster without having to wait and causing as much traffic. The calculations and design the authors have created will prove the higher efficiency of a retractable bridge over a drawbridge. Along with this design, a replica retractable bridge structure will be created to demonstrate the faster results of a retractable bridge over a drawbridge.

Distributed Loading and Geometrical Force Analysis of the Parthenon and Similar Greek Structures

Ahmad Azim[a], Ryan Obszarny[b], Karl Cowart[c], Tyson Tumulty[d]
[a] Electrical Engineering
[b] Civil Engineering
[c] Photonic Science and Engineering
[d] Environmental Engineering

One of the most famous and oldest structures in Greece is the Parthenon, a temple devoted to the Greek goddess Athena. The Parthenon has a classical architectural style that was built by some of the very first engineers in human history. Most Greek and Roman architecture shared similar stylistic qualities and remained relevant until the end of the Renaissance era, when engineering design began to deviate[1]. Rows of long, thick columns are the fundamental element of Greek classical architecture[2]. These columns support a roof that is shaped as a triangular pyramid with a rectangular bottom. To correctly analyze why such a simple structure has held for many years, modern engineering mechanics must first be applied to model the design. Modern knowledge of statics has allowed us to build bigger and more complicated structures than the Parthenon. Therefore, could these principles, if applied determine flaws in the engineering of the architectural design of these ancient structures? To determine and accurately calculate the forces applied to the columns of the Parthenon, many mathematical models must be utilized. Other underlying factors, including the materials used, as well as environmental factors will be considered as well. The reduction of a simple distributed loading and three-dimensional force systems can be modeled mathematically with vector calculus, differential equations and matrix linear algebra. Putting a large portion of prominent mathematical theorems to the test in the structural analysis will give perspective of the knowledge gap between the engineers of our time and those of ancient Greece.

Analysis of Forces Acting on the Members of a Transmission Tower

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ABSTRACT

Transmission towers play a key role in distributing electricity to our technologically driven world. It is important that these structures are statically sound even under extreme conditions. The goal of this experiment is to determine the weakest member of a 220-kV Single Circuit Lattice Steel Tower design. It was assumed that the member acted on by the greatest amount of force would be first to break if the tower was ever overloaded and would be considered the weakest member of the tower. A model of the transmission tower was constructed out of balsa wood and glue. In choosing the 220-kV Single Circuit Lattice Steel Tower design, the difficulty of creating a replica was considered along with the prevalence of similar designs in the world. The total force from the sag of the conductors on the tower was calculated; the load on each member of the tower was determined using the dimensions of the model. The member of the tower with the greatest amount of force acting on it was determined according to these calculations. The structure was tested in the lab under an extreme amount of force until one of the members broke. The results of the test were then compared to the calculations to determine whether the first member to break correlated with the member calculated to have the greatest amount of force.

Sentosa Cable Car Disaster: The 2014 Remodel

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[d] Mechanical and Aerospace Engineering Department

ABSTRACT

Transportation is one of the most vital necessities for humans in this time period. To get from one place to another, heavy machinery has been developed to move mass amounts of people. A major form of transportation seen in large touristic places is aerial cable cars. An aerial cable car system is a set of supports that suspend carts in the air with cables and rotates the carts in a loop using engines to propel the system. Because these gondolas are used to easily mobilize large amounts of people, they tend to be found most useful in locations with large bodies of water or steep mountainsides. These costly structures can greatly stimulate a country's

economy by helping facilitate mobility at main tourist destinations in said countries. Though cable cars can be good investments, there are potential risks in operating and maintaining the system. Since aerial tramways are essential for these locations to run efficiently, they tend to be overused because they have to move thousands of people a day. Accidents are rare with this type of system, but in August of 2014, The Straits Times reported a second cable car disaster occurred at the Sentosa Aerial Tramway in Singapore. The original Sentosa Cable Car Disaster of 1983 was one of the most detrimental cable car disasters in Singapore, reporting seven dead when a cart was launched into the water. After extraneous calculations were made, this system proved to be fixable. A new design was created which added height to the existing towers with newly installed trusses. The added height changed the original distribution of load, forcing new calculations in the forces acting on the towers, as well as the tension forces acting on the cables. These calculations improved the system and now this system will be kept from erring again.

Seat Belts: How Statics Can Save Lives

Dylan DeBerardine[a], Timothy Kostka[b], Hontai Sun[c], Kevin Weng[d]
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ABSTRACT

Society is dependent on automobiles; it puts so much trust in vehicles to take mankind from across the street to across the country. However, whether it is weather, other drivers, or whatever obstacles life throws at people, cars crash. According to the National Highway Traffic Safety Administration and Department of Transportation, it was estimated that over twelve thousand lives were saved due to the use of seat belts in 2012, and even three thousand more lives would have been saved if seat belts were used one-hundred percent of the time**Error! Reference source not found.**. When the inevitability of car accidents occurs, seat belts are one of the solutions engineered to keep passengers safe, but how exactly do seat belts function? This research explores the mechanisms that operate the seat belts in automobiles. The purpose of this presentation is to test the thresholds of these mechanisms while keeping the passenger safe (meaning, no broken bones). The analysis was performed using seat belts and force meters and the results were compared to the amount of pressure required to fracture human bones. Although seat belts are designed to withstand tons of force, humans are not[**Error! Reference source not found.**], and this presentation shows how and why seat belt mechanisms are one of the many ways statics can save lives.

Cable-Stayed Bridge Design Model

Omar Dalusung[a], Joshua Llamas[a], Yousef Nawafleh[a],
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ABSTRACT

The model of a cable-stayed bridge was designed and built to be in an equilibrium state while supporting its own weight. Before building the actual bridge, the strength of the materials being used had to be evaluated. The breaking points of the yarn cables were found using weights. Then, the maximum load the truss is able to support was found by calculating the theoretical shear force of the balsa wood. After determining the strength of the materials, constructing the bridge began with two towers and the frame for the deck of the bridge. The two towers were made out of balsa wood, as was the Pratt truss for the frame of the deck. Using truss analysis, the construction of the truss was ensured to be statically determinate using the formula (2J = M+R) where J is the number of joints, M is the number of members, and R is the number of reactions. After the deck was built, it was attached to the two balsa wood towers. The yarn cables were then connected from the tower to the deck, forming right triangles. A spring scale was used to determine the tension in each cable, and the tensions were then checked on both sides of the towers for equilibrium. For this model, equal tensions in the cables on each side of the towers allow for the system to be in equilibrium, resulting in a downward resultant force.

UCF Dome

Kathryn Pope[a], Louis Shatkun[b], Nicholas Swann[c]
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ABSTRACT

The topic of controlling the destructive weather in Houston, Texas has been widely debated across the United States, with leaders presenting different ideas that range from building reconstruction to disaster clean ups. However, the destruction from weather in Houston will soon be too much for reconstruction and clean ups to reconcile. This project addresses the alternative to these methods, a geodesic dome that could be placed over the downtown area of the city. Specifically, the UCF Dome Project looks at the proposal of the large scale Houston Dome Project. This includes analyzing its constraints and abilities in order to show the validity and value of this structure as a successful solution for Houston's destructive weather issues. The UCF Dome is constructed in a similar fashion to the Houston Dome, which uses several geometric shapes in a particular order. However, due to the size difference, alternative materials are used to construct a scale model. This project aims to tests the horizontal thrust and load capacity that the scale model of the proposed geodesic dome can withstand. The detailed testing of various different loads on the modeled geodesic dome yields conclusions that shed great insight into the large scale counterpart of the project.

Glass Dome of the Underwater City of Atlantis

Ryan Greene[a], Carlos Castro[b], Christopher Koury[c],
Jourdain Francis[d]
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ABSTRACT

The Earth is covered mostly by water which brings up the answer to the question of where humans can go when the part of Earth covered by land reaches its carrying capacity. Glass domes are a suitable form of way to create a sustainable living environment beneath the ocean's surface. The project is investigating the tensile strength such a dome would have in order to withstand the pressure of water from being at the ocean floor. The scale model demonstrated the force a glass hemisphere can withstand with such an immense pressure placed on it. Calculations were made to determine the distributed load that the dome sustained given the pressure of the water above it. In addition to the scale model, further calculations were made in reference to the tensile strength of the dome to determine the thickness required for the dome to withstand the pressure and the force underwater currents at that depth would put on the dome. The calculations conducted in combination with the model glass dome were used to determine the viability of an underwater city covered by a glass dome to create a livable habitat for humans. The results of this project were successful from the calculations and models.

Distributive Load on a Screw

Taylor Forth[a], Andrew Hough[b], Cary Royce[c], Ryan Villanueva[d]
[a] Civil Engineering Department
[b c] Mechanical Engineering Department
[d] Industrial Engineering Department

ABSTRACT

With injuries being so prevalent in sports, our project provides vital information for the prevention of further injuries in athletes due to post operation failures. In our specific case, we deal with a fifth metatarsal fracture with an operation implanting one screw to assist the healing process. Our data shows how the distributive load on the screw and the several different types of screw material can affect the likelihood of it bending. Different pressures on the varying screws can cause bends to occur, thus leading to further complications in the future. In our experimentation, we tested the points in varying foot positions that apply the most pressure, thus creating the highest likelihood of a bend. To expand our testing and data, we also measured additional everyday pressures from other physical movement, such as running or jumping. In doing this, we found the point at which there is there is a maximum risk of the screw bending. This risk becomes more or less prevalent when using certain materials of screws over another. When a person puts this certain force on their foot, the screw in their foot will bend and cause future complications. From our data, we found that this force is attainable under certain circumstances and the individual with the screw in their foot is force to deal with these post operation complications.

Designing a Tilting Rollercoaster Track Segment with an Off-Center Fulcrum

Benjamin Carpenter[a], Kirra Cranford[b], William Feild[c],
Samantha Hansen[d]
[a b c d] Mechanical and Aerospace Engineering Department.

ABSTRACT

Rollercoasters, the epitome of excitement and thrill, have been around for many years. Loops and straightaways, drops and turns have been their hallmark. However, rotating segments of track are almost altogether new to the rollercoaster world. The purpose of this project was to design and test a segment of rollercoaster track capable of rotating ninety degrees downward, thus transforming a horizontal segment into a vertical drop. This design concept is visible in the Gravity Max rollercoaster located in Taiwan, however this project aimed to move the fulcrum of the tilting piece further back on the track as opposed to having a balanced lever with a central fulcrum. This project focused on the structural design of the track piece as a truss rather than the support system for the track, since it is imperative that the extended lever arm is unsupported on the end. Phase one of the project involved researching the general structure of various rollercoaster tracks found around the globe and deciding which one would best suit our purpose. Phase two was to modify the design of the selected track style to minimize bending under a heavy load. Thirdly, using the selected, researched material, calculations were carried out to determine the maximum weight the track segment could support at its end. Lastly, a scale model was built and was tested by holding the track piece up where it would regularly be supported at the fulcrum and by applying an increasingly stronger load on the end where the ride vehicle would be located. This test helped determine whether the calculations made were correct regarding the strength of the track (relative to the model's scale) and regarding the critical member of the track piece. Comparisons were drawn between our track design and the other tracks researched and conclusions were drawn.

Geodesic Domes

Paul Nunez[a], Wesley New[b]
[a b] Mechanical and Aerospace Engineering Department.

ABSTRACT

Geodesic domes are partial-spherical structures, made out of triangles and polygons that maximize volume within an enclosure while minimizing surface area. That efficiency along with the structural stability of a sphere makes geodesic domes a candidate for building designs. The goal of the following study is to produce data on the distribution of force within geodesic dome frames in parallel with their geometry. Testing will involve designing and constructing several models of geodesic dome frames, each with different geometry but similar dimensions. The designs will be modeled in Solidworks, a 3D design software, which also provides plans for construction of the models. The dome models will be made of balsa wood because it is readily available and easy to work with while being relatively strong. The research labs available in the UCF engineering building will be utilized to test the models and produce quantitative data from which conclusions can be made.

Most Energy Efficient Elevator

Kevin Levy[a], Gerardo Pineda[b]
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ABSTRACT

Humans live in a world where saving energy as well as saving cost is a crucial factor in everyday life. This project will help understand how some elevator designs of today are more energy efficient than others. Bigger and taller buildings are being constructed nowadays. The implementation of these designs can improve the productivity of elevators in terms of amounts of energy used. The efficiency of the elevators benefits the companies and residents that want to save energy and reduce cost. In order to find the best elevator design, models, calculations and tests have to be made. Three different designs were constructed to scale involving two variants: use of a counterweight on the other side of the elevator pulley, and the use of rails on the outside walls of the elevator. These designs were tested, data was acquired and annotated for comparison purposes. After obtaining the data, calculations were made to prove the functionality and efficiency of the different designs. This calculations helped draw conclusions as to which of the designs used a smaller amount of energy and whether or not the use of a counterweight or the use of rails contributed to the reduction of power needed. It is then determined the best way to build an elevator and the exact benefits that the specific design will contain.

Structural Analysis of a Vertical Lift Bridge

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ABSTRACT

Vertical lift bridges are designed to be lifted frequently to allow for passage of boats and other vessels underneath. These bridges are best suited for areas in which a high clearance for the boats is not needed. To lift the deck of the bridge, counterweights equivalent to the weight of the moveable portion are found in towers located at each end of the platform. In this case a 1:500 scale model of the Main Street Bridge located in Jacksonville will be constructed. The Main Street Bridge itself is 512.1m long and 17.6 meters tall. A scale model of a span of the bridge would be built as well. This would be used in our structural analysis as the effect of compression forces on the bridge could then be measured and extrapolated. The compression forces would be equivalent to the motor vehicle traffic that would usually be traversing the bridge at given times. The bridge model's forces will be calculated and an equalized counterweight will be attached via a pulley system to the lift able bridge span.

The model itself will be made out of balsa wood put together with adhesive fit for the purpose. The construction of each side of the bridge will be done horizontally before being lifted and assembled. By first assembling the bridge horizontally it would still maintain its structural integrity throughout the building process. Upon completion of the scale model of the bridge span, it would be taken to the Structures Lab where a determination of its structural integrity would be tested.

Cable Tower Held in Equilibrium by Three Tension Forces

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ABSTRACT

Many of society's static constructions, while basic in their looks, are extremely complex in their design to ensure maximum safety and efficiency. The problem approached here involves the construction and testing of one such structure; a tower held in equilibrium by three cables, each attached to the tip of the tower and to the ground. This project determines the optimum locations for those three cables both mathematically and physically. Optimization refers to keeping the tension on each wire as minimal as possible, as well as distributing the tension as equally as possible along each of the three cables. It was assumed that the compression of the tower and the tension of the cables are the only forces present for purposes of calculation.

To mathematically model the construction, hand calculations were utilized to first find the ideal locations for the cables on the ground. After the ideal locations were determined, they were physically tested by creating a scale model. This scale model was made modularly in order to quickly and efficiently change the variables in the experiment, namely changing the x and y coordinates of the three cables on the base. To measure the forces on the cables, as well as the compression of the tower, force sensors were used at the base of the cables and tower. By testing the problem on a scale model and verifying it against hand calculations, the validity of the equations used was proven, and the representativeness of the scale model to larger, non-arbitrary structures.

Structural Analysis of a Load Bearing Tower Crane

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ABSTRACT

Tower cranes are used all over the world to aid with the construction of buildings. They provide the ability to transport heavy materials from ground level to many floors up, and are able to place these materials at a precise location that they are needed. Although they are very slender, they maintain structural stability. To the common eye this may seem impossible that a structure so thing and asymmetrical could not fall over, let alone lift considerably heavy loads. The purpose of this analysis is to find out how this engineering feat is attained. Included will be the breakdown of its individual parts, including but not limited to, the jib, counter-jib, counterweight, mast, and base. As well as the physical limits that this design is capable of achieving.

Analyzing Forces, Loads, and Center of Gravity acting on a P51 Mustang in Flight

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ABSTRACT

Airplanes are one of the most frequently used forms of public transportation in the world today. Over the course of a flight an airplane will experience multiple and varying loads and forces acting across the entire airframe. The purpose of this project is to test and analyze the forces acting on an airplane in static equilibrium at a point during its flight. To do this the investigators constructed a scale model of an airplane (a P51 Mustang airplane was selected for reference) and tested the effect that different loads cause to the joint where the wing connects to the rest of the airframe. Different loads were tested and the effect of the forces position on the wing was also tested. The center of gravity was also determined for the plane in the experiment. Typically the center of gravity is located where the overall strain on the plane is at a minimum. To do this data collected from the model was used in in conjunction with a hypothetical model of a plane in flight. The data collected from the constructed model and the center of gravity calculation helped form concise conclusions based on the information gathered.

Overturning of Gravity Dams

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ABSTRACT

A gravity dam is a massive structure typically made from concrete or stone masonry. They are utilized to raise the level of water on its upstream side, thus providing a means of regulating and utilizing the energy of an otherwise free flowing water source. With this type of dam, the frictional force due to the weight of the dam on its base is used to resist the horizontal component of hydrostatic force pushing against it from the upstream side. This force causes a tendency for the dam to slide along the floor and to turn over towards the downstream over its toe. The objective of this research is to compare the theoretical moment of an arbitrary dam with the measured values of a model dam. The theoretical moment is dependent on a number of vertical and horizontal component forces. Vertical components include the dam weight and the hydrostatic uplift caused by seepage. Horizontal components include the component of total hydrostatic force, in addition to multivariate dynamic factors that will be omitted for the purposes of this investigation, such as air pressure and wave action. The location of these forces in respect to the wall of the dam will each be represented by their center of actions. Components of these forces will be physically simulated and measured using a spring with a known spring constant. In theory, the predicted moment will be comparable to the measured moment.

An Analysis of Forces of the Z-1 Truss and the Control Moment Gyroscope Systems Onboard the International Space Station

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ABSTRACT

The forces acting on the Z-1 truss are broken into to two categories, the forces and effects of zero-gravity and the Central Moment Gyros held within the truss for attitude control of the International Space Station. Production of a short section of the system was completed and tested within the lab. It was subjected to simulated forces along the test parameters and then analyzed for failures. The data that was collected was compiled into a chart to give another visual representation of the stresses. A schematic of the structure is provided in order to clarify the focus of the experimentation. The Central Control Moment Gyros were analyzed and simulated for resultant forces from their spinning to move the International Space Station along the axis of rotation.

The Viking's Longship: A Force-Vector Analysis of a Longship Mast

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ABSTRACT

This paper will present a force analysis of an ancient Viking sea vessel, known as the longship. The purpose of this analysis is to learn how the longship was as successful as it was between the 9th and 13th centuries by measuring the forces that acted on the ship. The effects of wind on the sail and tension in the ropes were the key forces calculated. These various forces that affect different parts of the ship have been translated onto the mast by utilizing a mast-rigging system, making it our sole object of study. The hull of the ship and the ropes attached to the mast were constructed from materials much stronger than that of the mast as to avoid their calculations and focus on the critical points of the mast. These points were plotted for visual interpretation of the highest forces acting on the mast. This data is then analyzed to predict what typical forces a mast would have had to withstand in previous eras.

Analyzing the Truss of a Lift Bridge

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ABSTRACT

How do the trusses of a lift bridge account for the forces being exerted on the bridge? This data is very important because it will teach other engineers the basic information surrounding a lift bridge, the calculation and application of truss, and help them realize which type of bridge is best suited for certain locations. We will first calculate the forces that will be involved with the movement of a bridge and then build a model bridge to test out how the actual forces are involved. The results can then be found by comparing the forces calculated to the forces we measured on the 3-D lift bridge. At the same time we can analyze how much weight the lift bridge can support and measure the average length of the bridge before it becomes unstable. The data we collect will help analyze the usefulness of lift bridges in certain situations based on how feasible it will be to make the bridge comparable to the width of the river as well as the height of the bridge needed for boats of appropriate sizes to pass under the bridge.

Comparison of Two Different Bridge Designs

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ABSTRACT

A contractor wants to build a bridge through the mountains and is considering two different designs; one design will consist of an arch with supporting beams while the other design will not have an arch. The contractor wants to determine which design is better for the bridge at a given length and which could support the most weight without risk of collapse. The authors want to see if the arched bridge could provide more support than the one without it. In order for the authors to construct the bridge models, they used thin pieces of wood to construct the two designs. The two bridges are very similar in design, but the process used to build each one was different. The authors had to warp the wood to the proper angle to get the arched they needed while the other design was easier to build. The authors will take the two models to lab were they were be stress tested. While the results have yet to be determined, it is possible that the arched bridge is able to withstand more force than the non-arched bridge. The best model has yet to be determined but the authors assume that the arched bridge would be the best for the contractor. Furthermore, given the design constraints of building an arched bridge, it might be safer to go without an arch.

Comparison of Wheelchair-Ramp Static Friction on Three Different Materials

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ABSTRACT

According to the American census, the frequency of Americans using a wheelchair was approximately 5 million. And as many as 15 million required the mobility assistance of a wheelchair for more than 6 months. Having the need for a wheelchair inhibits the convenience of traveling for all of the Americans. Wheelchair ramps are necessary to assist these 20 million people with independently commuting to the places they need to go. When building these structures, safety should be a top priority. So, this study was conducted to compare the static friction of three common materials used in the construction of wheelchair ramps: aluminum, wood, and concrete. While investigating this, the materials were studied for user safety. Safety depends on the measure of friction; it can put independent wheelchair users at risk of slipping down. While conducting the experiment, results were gathered when the wheelchair user is at a state of equilibrium halfway down the inclined plane. The inclination of the ramps are consistent for public construction however, situations with greater and lesser gradients were tested, keeping in mind privately owned wheelchair ramps. Many of these permanent wheelchair ramps are constructed outside where they are subject to different weather conditions. Therefore, observing whether precipitation and other environmental factors would variably affect the friction of the materials was important to examine. The material that had the greatest average force of friction amongst our trials was deemed the best material to be used for permanent wheelchair ramps. The results from the averages were used because every trial observed gave slightly different values and the weathering didn't affect the materials symmetrically. The final findings were used to help plan for the new construction of local permanent wheelchair ramps.

A Structural Analysis of the Complimenting Framework of the Canton Tower

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ABSTRACT

The Canton Tower, also known as the Guangzhou Tower, is used as the Guangzhou TV Astronomical and Sightseeing Tower. Construction on the tower began in 2009 and was completed a year later. It is constructed of a vertical concrete cylinder encased by thin steel vertical beams connected by horizontal steel rings to create a hyperboloid shape. The vertical

steel beams are tilted at a forty-five degree angle around the structure. Steel rings connect the outer beams providing more stability to the tower by being separated at intervals that decrease as the tower becomes more narrow. This project was an analytical structural comparison of the outer and inner framework of the Canton Tower and how they complement each other. Models of the outer and inner structures were tested separately by applying a downward force on each. Then, identical models of the previous structures were combined and tested together to understand how the structures complement each other. The results of how well each structure withstood the force were recorded in tables and then compared. An analysis of the results was done and a conclusion was made.

Gateshead Millennium Bridge

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ABSTRACT

The unique Millennium Gate Bridge was designed to be able to lift up allowing boats to go under the bridge. The bridge is capable of lifting itself up to a maximum forty degree angle. The concern is to study how the structures of the bridge will act with regard to the forces acting on the structures while the bridge is horizontal and while it is fully lifted. The main structure that will be focused on are the cables and the supports. Another concern is to find out what would happen if the bridge was lifted up more than a forty degree angle. The investigation will be mainly mathematical and interpretation study. In order to show forces, the tension on each cable that is required to hold up the bridge will be calculated while it is at its horizontal state with transportation passing through it and at its lifted state. To do this, research will be conducted on the bridge's specifications. Through this research and knowledge on statics analysis and summation of forces, it will be possible to calculate individual tensions of the cables at various states of the bridge. A model will be used to demonstrate the tension forces while the bridge is at various states. The model will be tested using different weights to demonstrate the tension forces on the cables while the bridge is at its horizontal state. It will also be lifted up at different angles to demonstrate the difference in tension forces on the cables at these angles.

Equilibrium Demonstration of Lift on an Airfoil

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ABSTRACT

A model of an asymmetric airfoil in a wind tunnel for measuring the relation between weight, lift, and airspeed was used to demonstrate equilibrium of an airfoil. In the demonstration, the movement of the airfoil in the x and y directions was restricted, only allowing movement in the

z-direction. The wind tunnel was used to direct the airflow of a motorized fan to the airfoil. A speed controller was used to modify the airspeed in the wind tunnel. Due to a pressure difference between the top and underside of the airfoil the airflow of the motorized fan allowed the airfoil to have lift, counteracting the force of its weight. Different airspeeds were observed in finding the relation between airspeed, lift, and weight. A hanging scale was attached to the airfoil to determine its weight while under the effects of gravity and varying airflow. The model demonstrated that at a faster airspeed the airfoil reached a higher point in the z-direction, signifying that a faster airspeed would allow the airfoil to gain a higher altitude before succumbing to equilibrium.

Jacksonville Main Street Bridge

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ABSTRACT

The project investigated the principle of statics at work in the the Jacksonville Main Street Bridge. Some of the properties of this bridge that were studied and modeled include the stress on the trusses of the bridge and the pulley system that operate the drawbridge portion of the structure. It was explained how the pulley and counterweight system performs its action of lifting the middle part of the bridge when vessels pass under. A model of the bridge's truss structure was also created with balsa wood and then the strength of the structure was tested in the Engineering Testing Lab. Additionally, the forces working on the bridge in the real world were calculated to compare them with the results from the experimental testing on the model bridge that was built. Another portion of the investigation included researching the effects of the bridge on the city of Jacksonville, including environmental and economic factors. The effects of environmental factors like strong winds, large storms, salt water, and heat and their corrosion and weakening of the bridge were investigated, as well as the effect the bridge has on the local wildlife. Finally, the economic effects of the Jacksonville Main Street Bridge on the city of Jacksonville were examined, specifically how the bridge acts as a major artery of traffic for the city.

Testing Zero-Force Members in Trusses

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ABSTRACT

A common structure used in engineering is the truss. Trusses are used in the construction of bridges, roofs, and various other structures. They are comprised of slender members connected at each end. Trusses are designed to carry a distributed load, which results in the members of

the truss being in either tension or compression. In some cases, given a specific load, some members of the truss do not carry any of the load, therefore they do not experience a force and are called zero-force members. These zero-force members are often in place to reinforce stability and structural integrity. In the case that a compressive force causes a load-bearing member to buckle, the zero-force member is there to provide additional support. Another reason for the necessity of zero-force members is fluctuation of the normal loading on the structure, for example, additional weight due to wind or snow on a rooftop. In this paper, the structural integrity of a truss is examined with and without its zero force members. A force is applied to a truss structure within a design laboratory and statics analysis is used to determine which of the members in the truss are zero-force members. A replica of the first truss structure is built, excluding the identified zero-force members, and the same force is applied to determine whether or not the removal of the zero-force members has affected the structural integrity of the truss. In order to do this, the differences in the internal forces of the load-bearing members are discussed between the two trusses. Additionally, any buckling of the materials in the second truss after the force is applied is noted and the causes are discussed.

The London Eye: An Examination of Forces in Equilibrium

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ABSTRACT

The London Eye is a world renowned Ferris wheel that offers breathtaking views of the English capital and is a spectacular feat in the engineering field. To represent the 443 foot Ferris wheel, two small scale models were created using primarily craft wood. The main structures of the Ferris wheel that keep it stable and at rest are the ultimate focus for the desired research. This includes: the circular frame, the A-frame legs, the trusses, and the actual pod cart in which people ride in. The back stay cables and the spoke cables (connected to the center spindle) were made using aluminum crafting wire. Measurements and calculations were taken on the entirety of the wheel to find the tension in the back stay cables and the forces on the A-Frame supports. After finding these calculations, a single pod at a specific angle (45 degrees) was studied to find how the forces in the truss are able to keep the pod in equilibrium. To examine these parts, two separate models were created: one of the entire structures and one zoomed in model of a pod-truss system. To test the strength of the forces acting on the London Eye that keep it in equilibrium, the modeled structures were taken to the engineering lab and tested on using the UCF Engineering Lab equipment. These tests provided data on the forces on the A-Frame supports and the tensions in the wire. Factors such as weight of the Ferris wheel and surrounding wind conditions were also taken into consideration when final calculations were completed. Tests were also done on the model of the single pod to see how much weight would cause the truss to fail.

What is the Best Truss?

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ABSTRACT

A truss is a framework of materials composed of rafters and posts used to support various types of structures. A truss works by distributing loads between multiple cross beams. This allows structures to be able to support a large magnitude of weight without the need of multiple support beams. These reasons, and its cost effectiveness, are why trusses are used in nearly all buildings, houses, bridges, and other structures. The purpose of this project is to analyze different types of trusses used in houses, and to compare the strengths, weaknesses, and other factors that are unique to each truss. Smaller scale trusses will be built and tested by applying different weights on them. We will analyze how the larger scale trusses are built in order to assure that we don't create any weak points in our scale models that aren't consistent with the larger versions. Each truss will be made from the same material so that the only variable will be the construction of the truss. Calculations will be performed on each truss to see how they respond to different types of stress. These calculations will be performed using methods learned in statics.

Exploring the Evolution of the Airplane Wing

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ABSTRACT

The purpose of this project is to explore the structural design of the airplane wing, which has evolved throughout time to provide improvements in performance characteristics such as speed, altitude, and maneuverability. The study analyzes the structures of the wings on four historically distinct airplane models in order to understand how their structures have evolved chronologically. The centers of gravity and mass, moments, forces, and other loads are all considered when taking measurements and performing calculations. These calculations identify dissimilarities among the four configurations and explain the reasoning behind the respective paths of evolution. In addition, the designs are analyzed with theoretical conditions and variables that, ideally, allow for simulation of a static system. A constant, optimal flight velocity was assumed for each individual model, along with favorable weather conditions, to yield reliable data. In conclusion, studying the manner in which airplane wings have developed offers significant understanding of their evolutionary trend and provides valuable knowledge that can be used to further engineer and progress their design, leading to an increase in the number and merit of advancements in the field of aircraft.

Engineering Truss Bridges

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ABSTRACT

This paper demonstrates the statics principles of two pedestrian bridges, of different spans, and shows how they are affected in equilibrium. Taking into consideration factors such as dimensions and truss design for both scenarios, a Pratt Truss with an underhung floor beam is the most effective design for a bridge of relatively short span. For longer bridges, the H-sections cross design would best suit its needs. In order to best control lateral deflections and sway, the horizontal truss dimension between one twentieth and one twenty-fifth of the bridge span were used. Two in-depth scale models were constructed of both bridges using all of the information available to us in order to test different scenarios and offer visual aid. For both bridges a Pratt design was used, allowing for in-depth force and load calculations. This paper covers load distributions, variations between Truss bridges, different supports, moments, bridge camber, and basic bride design principles, as well as different free body diagrams of the of force distributions along the bridges chords and beams resulting from different sized loads along the span. Intended to create a good overall understanding of Truss bridges and the statics principles behind bridges in general, this paper serves as an in depth examination of different concepts taught in Dr.Zaurin's Engineering Statics Analysis class.

Beams and Supports: Analysis of Strain on Various Types of Supporters

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ABSTRACT

Simple, fixed, hinged and roller supports along with small scale steel beams will be placed under identical conditions. These conditions include placing a load at the end of the beams away from the support as well as halfway on the beam. Strain gauges will be used in order to measure the strain across each beam of the different support types. This will allow the support that can withstand the greatest amount of strain to be identified.

Lock and Dam

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ABSTRACT

Locks were invented with the purpose of raising and lowering boats to different water levels. Having been created over a millennium ago, they have naturally evolved from something that could easily sink boats to something that can safely help a boat traverse waterways. The type of lock most commonly used now is called a pound lock. A safer variation of the flash lock, a pound lock has gates at both ends of it that can open and close freely for boats to enter and exit after the water levels have evened out. The project that will be done is a model of a pound lock system. The purpose of this project is to show how a lock can contain water without bursting open and the water leveling out. The lock system model will be based off the Franklin Lock and Dam in Olga, Florida. The things being measured include the force water exerts on the walls of the dam, the time it takes for the water levels to balance out without creating an unsafe pressure, and the effects of a boat floating in a lock.

Static Mechanical Testing of Rigid Exoskeleton Prototype by Standard Engineering Analytical Methods

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ABSTRACT

Exoskeleton technology aims to enhance the human user's endurance and strength. Currently the main uses for exoskeletons are military applications; aid soldiers in the battlefield by allowing them to hold more while in action. They are also used in the medical field to help people that are physically disabled or have difficulty moving on their own. Unfortunately, current exoskeleton technology is largely limited by its cost to develop and power supply. With this in mind, our group created an upper-body exoskeleton that is not only affordable but effective. This means the design did not incorporate a power supply. The exoskeleton design relies on passive mechanical methods which redistribute weight around the body to increase physical endurance during laborious activities. The design incorporates a back-pack like apparatus from to which the exoskeleton arms will be attached. The arms will consist of three metal segments connected by joints which will simulate the degrees of freedom of the shoulder and elbow. The arm/shoulder joints employ a ratchet braking system to allow the exoskeleton arms to remain in place and help the operator carry loads. It can be disengaged with a button at the end of a cable system running along the exoskeleton arm, into the operator's hand. It is investigated in other exoskeleton projects the apparatus was able to add an additional forty

pounds to what the operator could already hold. Using structural analysis we maximized the exoskeletons capabilities and minimized operators strain. Since our exoskeleton does not require a power source and is economically viable, we may see much use of it rural areas or areas affected by environmental disasters.

Moment of a Billboard

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ABSTRACT

Billboards are used by companies both profit and nonprofit all across the world. There are many different designs of billboards ranging from a single support beam to a truss system, all of which have their advantages and disadvantages. The objective of the project was to determine these advantages and disadvantages of multiple different billboard designs. Before testing these structures, certain parameters were set. These include each billboard being the same height and width, made of the same material, and having the same force applied. This said force simulates the force of wind a real billboard would experience. The force was created by pulling on a string positioned in the middle of the billboard. During these tests, the moment at the base of the billboard was measured was measured by using a torquemeter. It was expected that some designs (single support) would generate moment in 3 directions, while other designs (multi support) would generate moment around an axis at the base of the billboard.

Analysis of Traffic Light Structures

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ABSTRACT

Traffic lights are supported by a myriad of structures. The two most common structures being one with wires connected to support poles and the other being a beam connected to a support pole, both with the traffic light(s) being connected to whichever structure is connected to the support pole(s). The research incorporated in this project focused on analyzing and comparing

the qualities of various traffic light structures. These qualities include varying tensions, compressions, the structure of trusses, as well as beams, and other effects of certain forces at varying angles and positions. Research was gathered from the study of published academic papers, thorough experimentation, analysis of several types of traffic light constructions, and review of real world designs pertaining to the framework. In order to procure further clarification on the characteristics of traffic lights, scale models of structures holding the traffic lights were constructed. The forces were calculated for each circumstance to determine how the stability is produced for the arrangement. These forces were evaluated in two dimensions for simplification. Afterward, these two-dimensional models were represented in three-dimensional form in order to more accurately mimic realistic traffic lights. The goal of this work was to gain an increased understanding of how statics governs the methods used in developing the schematics behind traffic lights. Finally, conclusions were obtained by reviewing the results of the experiments and analyzing other resources.

Balsa Wood Tower Project

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ABSTRACT

Towers have been around for centuries and their sky soaring structures can be observed in different environments and have different purposes, from wind turbine towers in the Sacramento valley in California to observation towers in touristic centers. A tower’s function largely determines its basic structural shape. For instance, a communication tower must be quite tall, but does not have to support much more additional weight than its antennas, while the Burj Dubai actually has a residence floor on the 109th level. Environment is another factor. Towers are built all around the world, including areas that are subject to earthquakes and other natural disasters. To achieve stability, Engineers use geometry, joints, and symmetry. For example, the inelastic structure of a triangle allows it to securely bear the weight of a load, while a square needs bracing not to buckle. Six different designs and prototypes are evaluated and tested for their strength-to-weight ratio.

Stresses at the Base of a Wind Turbine

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ABSTRACT

Over the years, wind turbines have become more and more common as an alternative for clean, renewable energy. When designing a wind turbine there are many factors that come into play to ensure it is stable and efficient. One major factor is the stress produced at the base of the turbine. Calculating the stress is important because the more stress at the base of the turbine, the more the turbine will move when high wind powers are present. After researching, we found almost no information on the stresses at the base of a wind turbine and decided to formulate a project in order to calculate them for various wind speeds. Our project will provide future engineers with information on the stresses at the base of a turbine allowing them to design turbine models that will work more efficiently. In order to calculate the stresses at the base of the turbine, we will design a model turbine with four springs on the bottom, one at each of corners of the base. We will then simulate different velocities of wind applied to the front, sides, and back of the turbine and use the springs to measure the stresses at the base. This is extremely important because if a turbine cannot support a certain amount of stress, then the turbine will fail and become useless. Due to the limited amount of research on this specific topic, we believe our project will be extremely useful and informative. In conclusion, measuring the stresses at the base of a turbine will provide engineers with information that will make their designs more efficient and effective to provide our world with clean and renewable energy.

A Quantitative Comparison of Cable Bridge Designs

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ABSTRACT

The investigation involves the analysis of two separate cable bridge designs. One will involve a singular column bridge supporting the whole structure and another design supported by two columns splitting the structural load. The main points of measurement and focus are the tension in each cable and moments on each column of each bridge as compared to the other. The main focus of this investigation is the cables; the different types of supports for the bridge bed, such as rollers and pins, will be ignored in favor of the cables and columns. No wind or other environmental stresses will be taken into consideration, everything below the bed will be assumed in equilibrium to make calculations less complicated. Virtual models would be constructed using the free software “West Point Bridge Designer 2014” and real world models

would be constructed from balsa wood. The software can be used to create accurate models of our designs and to collect precise measurements needed to calculate accurate comparisons between the bridges. The virtual models also allow for the correct and accurate translation to a real world scale model to be presented at the IDEAS fair. At the end of the calculations, the merits of each design will be evaluated under different conditions.

Calculating the Tension on the Cables of the Sunshine Skyway Bridge by Static Equilibrium

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ABSTRACT

The Sunshine Skyway Bridge is a cable-stayed bridge in Tampa, Florida. In a cable-stayed bridge, all of the tension is located on the cables supporting the bridge. The goal is to determine the individual tension of each of the 84 cables on this bridge. To complete this task, the dimensions of the bridge at key locations (the center of the bridge) were first researched. In order to get proper results, a scale model of the bridge consisting of wood and string was built, with the wood representing the concrete and the string representing the cables of the bridge. To measure the tension on the scale model, springs were connected to each of the strings, and the equation used to calculate the force on the spring (and therefore the tension) was Hooke's law ($F=k\Delta x$), where k represents the spring constant and Δx represents how much a spring has stretched from its original position. After much testing, the results show that each cable had a minimum tension of around 200 Newtons on the scale model. This translates to over 9000 Newtons on the full scale bridge. The cables with the most amount of tension are the cables located near the center of the bridge, since there are no pylons supporting it underneath. Constraints on this report were time, scheduling, the cost of the materials used, and availability of resources (such as tools and locations to work).

Empirical Analysis of Required Support and Support Arm Reactions for Isostatic Structures

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ABSTRACT

The design is to have a platform raised 10-20 feet. It will use the surrounding pillars to support the platform. It will be held in place with connecting beams from the pillars to the platform. To keep the pillars in equilibrium they will be connected with a brace to counteract the inward forces the platform causes.

Comparing Three Different Structures for High-Voltage Direct Current Transmission Towers

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ABSTRACT

The structural integrity of the United States' power grid infrastructure is critical to our everyday lives. If there was any significant damage to power line system, the economy of the nation would be crippled. The backbone of the US power grid is composed of various types of transmission towers which carry electrical energy from power plants to US households, businesses, and industries. Transmission towers must be built properly to ensure adequate support for power lines in normal, high winds, and icing conditions. Our study examines the components and construction of a single-circuit transmission tower, a double-circuit transmission tower, and a specialty designed tower that resembles a Mickey Mouse™ head. For this experiment we completed structural analyses on the various designs to explore the forces acting on them during various conditions, and we built, analyzed, and tested models of the three different transmission towers. Understanding the limits to the structural integrity of each tower is important in order to create specifications that must be adhered to. Destructive testing was carried out in each structure in order to determine these limits. Due to the demands expected of each structure, the double-circuit transmission tower should show greater structural strength than the single-circuit transmission tower and the specialty designed tower should have the greatest structural strength since the Mickey Mouse™ head weighs over 40,000 lbs.

Forces Acting Upon a Tower of Jenga: a Move by Move Analysis

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ABSTRACT

A tower of Jenga must be in equilibrium to remain upright. A game of Jenga has been played while recording the changes occurring to the structure of the tower after every move. The weight of a block was measured to determine the force each individual block exerts on the structure. Determine the forces acting upon the tower after every six turns. Use this data to prove the tower remains in equilibrium at each individual level. Observe the forces acting on the tower in the configuration one move prior to failure. The moment produced from removing the last block which resulted in failure was calculated. The tower configuration was replicated on Solidworks and the design analysis feature was used to confirm the results.

The Study of Transmission Towers

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ABSTRACT

A transmission tower is a tall structure used to support an overhead power line. The towers are used in high-voltage AC and DC systems, and come in different shapes and sizes. Usually, they have a matrix like figure that is made out of steel but wood and concrete are examples of other materials that may be used to construct a tower. This project involves studying the structure of two electricity transmission towers by calculating the forces acting upon the structures as well as the wires they support; the system will consist of two electrical towers and the wires between them. A model of this system will also be designed in Solidworks and constructed in a three dimensional model. Measurement specifications will be scaled from an original transmission tower in order to provide the most precise data. Considering all external reactions and tensions acting upon the cable will help calculate the tension in the cables. To prove the results, the final product will be tested in the engineering lab.

Self-Adjusting Bridge

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ABSTRACT

The purpose of this project is to measure the amount of tension required for a rope to create and maintain stability on a bridge designed to carry a variable hanging load. The challenge is designing and programming the microcontroller to adjust the tension so that there is no slack on the rope. One end of the rope will be anchored into a pillar and will extend over a tension sensor and will be anchored onto a servo that will turn when activated by the microcontroller. The rotating servo will act as a winch and reel the rope causing more tension and less slack as more weight is added to the load. The sensor will constantly send information to the microcontroller and the rope should adjust so that there is enough tension in it to hold the load with no slack. The Arduino microcontroller will be programmed to analyze the incoming signal from the sensor and substitute it into an algorithm. The program will turn the servo the calculated distance needed so that there is no slack on the rope. An LCD display will be connected to the microcontroller and will show the user the tension added to the rope to eliminate slack. This value will be checked with hand worked statics analysis to compare and confirm the accuracy of the bridge's tension analysis.

Demonstration and Analysis of Swing Bridges

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ABSTRACT

Within this study, we analyzed the structure and construction of a swing bridge. Swing bridges rotate from a center pivot point of the bridge and open in a similar style such as a “gate” for maritime traffic underneath. Since these bridges are balanced from the center, the use of counterweights is not necessary. This project was conducted by creating two models that represented swing bridges. First, a working model with actual rotating abilities would be created to represent the balance and mechanics of the bridge. Also, a second model will be created to show real life conditions of stress on the bridge when rotated and open for traffic to pass underneath, or in its locked, closed position.

Cable Draw Bridge

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ABSTRACT

The objective for this project is to construct a single support cable draw bridge. This will allow for vehicles to pass over water when the bridge is lowered and large boats to pass when the bridge is raised. We would calculate the maximum tension the cables could withstand while static and with outside forces while the bridge is down. The support beam will be on the center line of one end of the bridge to allow 2 lane traffic. A series a motors will tilt the support beam back to an efficient angle raising the bridge with the cables. We would calculate the tension, moment, amount of work needed to tilt the bridge (i.e. motors), center of mass, and results of different distributed loads/failures on the bridge and cables.

A program designed to calculate and represent three-dimensional particle equilibrium.

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ABSTRACT

The purpose of this project is to show how a computer program can aid in solving basic three-dimensional systems that are not in equilibrium. The program was designed to allow the user to input various parameters for objects and calculate the forces necessary for the system to reach equilibrium. The program was implemented using a programming language called Visual Python (VPython). This library enables the program to include three-dimensional visuals to represent the system graphically. It was found that the software was more efficient and allows the user to simulate multiple force configurations with little effort, time and knowledge.

Planes, Moments, and Stable Structures

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ABSTRACT

The concepts of moment, centroids, and equilibrium are an essential part of engineering. To study these concepts, a structure consisting of a model airplane that hangs from a beam, which would hang from a wooden structure, will be constructed. The wooden structure is divided into three sections: one in the positive z direction (up), one in the positive y direction (right), and one in the positive x direction (facing you). The structure will be subject to a moment (which would be measured with a torquemeter) due to the downward force of weight by the dangling beam and model airplane. The concepts of equilibrium will be applied when the tension in the supports holding the beam and in the support of the airplane (which equals the airplane's weight) is measured. Measuring the tension of the supports on the beam, which support the weight of the beam plus the airplane requires calculations of the position vectors relative to the center of the beam. Finally, measurements on the position of the center of mass of a symmetric airplane will be made. The first step of this process would be to divide the airplane into regions, calculate each region's volume, and then add them up to obtain the total volume. Next, its mass will be calculated using a scale. This would yield a uniform density throughout the airplane since it would be made of the same material throughout. With the volume of each region and the uniform density calculated, there is enough information to calculate the contribution of mass throughout each respective region. Finally, the position of center of mass of each region will be found; multiplication of mass contribution by position of center of mass of each region and then division by the total mass of the airplane would yield its centroid.

Examining the Forces Keeping a Sailboat in Equilibrium While Under Sail

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ABSTRACT

The research this group plans to conduct this semester will largely be focused around the main component of a sailboat: the mast. It is widely understood that the mast is capable of withstanding large forces from high strength winds, but we aim to find out how this is possible by examining the shrouds, or the supporting elements of the mast. In order to research this topic as accurately as possible, we plan on visiting marinas in the surrounding area and observe the different styles and configurations that the shrouds may be in for the specific style of sailboat. Additionally, we plan on giving attention to the forces involved with the boom, the horizontal supporting structure of the sail, with specific attention regarding the moment with respect to the mast. Also involved with the boom are systems of pulleys exerting forces in the downward direction designed to keep tension in the sail. This is yet another moment we plan on considering. Although more forces may be involved, we will be focusing our attention on these three main components of a sailboat's structure, and, when combined together, we believe we will find that they allow the boat to remain in equilibrium in unfavorable conditions. The final goal will be to understand how and why a sailboat is able to remain relatively sound while under sail.

Analyzing Tensions in Spider Webs and Optimal Design

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ABSTRACT

We will make several models of different spider web designs using a thin material such as string. We will analyze each of the models experimentally, as well as mathematically, using statics equations learned in class. We will look at the tension on each strand; any external forces exerted on them, and find the weak points of each design. Experimentally we will model each web with a form of thread, hung from a wooden frame. We can then hang weights from various spots of the web to verify our calculations and confirm that we found the correct weak points of each web. While the string will not have identical properties, when compared to spider web, we will still be able to conclude which strands are weaker than others. From this

we will attempt to conclude what the most efficient spider web is. We will consider the force from the weight of the spider, the force of bugs getting caught in the web, and a constant wind. We will also have to look at variations of webs from different species of spiders. This will include different strengths of web, different thickness, as well as web designs and anchor points. From here we will look at which web is the strongest overall, which one has the best strength per length of thread used.

Donkey Kong: Is it Possible?

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ABSTRACT

In 1981, Nintendo released the Donkey Kong arcade game in an attempt to expand their market into North America. By 2011, the arcade game had net $650 million and resulted in the creation of Mario, the world's most well-known video game character. While the game's critical success is not in doubt, the structural stability and design of the first level of the game is questionable. The purpose of this project is to ensure that the structure is capable of bending when Donkey Kong jumps before the game starts and is stable while the game is played. The game's first level has a height of twenty-five meters. Using the height as a scale, the dimensions of the entire level in two dimensions was determined. The unseen dimensions were assumed to be the height of the barrels since Mario cannot move around the barrels in game. Barrels are assumed to be standard oil barrels. Using these dimensions, the material that the girders are made of can be determined and the bending phenomenon before the game starts can be explained.

A Comparison of a Parallel Chord Truss and a Basic Circuit Comprised of Resistors and a Voltage Source

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ABSTRACT

Electrical and Computer engineering students all have to take statics, and they all wonder why? Why do they have to take a course completely unrelated to their programs? A reason might be that the disciplines are more closely related than they think a correlation may exist between static structures and electrical circuits. This project is a comparison of the parallel chord truss

and a basic circuit to find correlation in the forces acting on the truss and the current flowing through the circuit. The beams of the truss will be mirrored with resistors of various resistances and the voltage source will be compared with the load applied on top of the truss in the center. Calculations will be performed for the forces acting on the truss at each joint. The circuit will be created once the truss data is known and the current at each node will be compared to the forces acting at each truss joint. The comparison of the truss and circuit will be analyzed to find any correlation between the two. Should there be a correlation between the truss and circuit, the internal relationships in the truss may also hold true for the circuit or vice versa. This would help Electrical and Computer engineering students understand the need to take a course in statics, or that it is generally helpful to take introductory courses in other disciplines.

The Static Components Involved in External Fixators

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ABSTRACT

The purpose of this study is to investigate the uses and applications of external fixators, specifically in regards to compound fractures of the lower tibia and fibula. This study aims to gain a better understanding of how the external fixator works by analyzing the structural properties and forces involved in the utilization of this device. The individual forces and weight distributions will be determined and will provide insight into the function of the external fixator. A further portion of this study will be devoted to placing the system under a large amount of stress to determine the maximum load capacity in the event that the whole system were to be crushed while implemented in a patient's leg. In order to determine the unknowns, a replica of the external fixator will be created and loads will be applied to the system. From there, it will become apparent where the forces are acting throughout the system of rods and pins and it will be determined which of the components is the most structurally important. To address the second part of this study, the replica will be tested to the breaking point of either the external fixator or the bone. Through the testing done during this study, a conclusion will be drawn about the benefits of using an external fixation system in patients that have experienced trauma resulting in compound fractures.

Stability of Card-Stacking

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ABSTRACT

When building a structure, the stability of the entire edifice is of most importance and thought out with extreme care. The art of card stacking involves building with even more care since the slightest mistake can turn hours of work into a fiasco. This project looks at the stability of a famous structure made out of common playing cards, the Eiffel tower, which uses Guinness World Record holder Bryan Berg's cell design for soundness through the tower. Using this design allows for maximum weight to be loaded onto the foundation layer of cards which directly translates into having multiple levels stacked on top for a truly impressive height. Our cell design establishes a thickness of two playing cards per cell which increases not only the load that it can hold per square foot but also the steadiness of the structure built on top of the foundation. Varying types of cards were used to demonstrate the fluctuations in soundness between a foundation made with cheaper, grainy playing cards and one made with expensive, glossy playing cards. Measuring the load that a cell design can withstand will help in determining the stability of structures that use this design and will push the limits that these constructions can achieve.

Distributed Loading of a Space Shuttle on the Surface of the Crawler Transporter

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ABSTRACT

This Interdisciplinary Display of Engineering Analysis Statics (IDEAS) project involves the analysis of a distributed load from the Space Shuttle on the surface of the Crawler-Transport. The Crawler is tasked with transporting the Space Shuttle from NASA's Vehicle Assembly Building to the desired launch pad while carrying a structure known as the Mobile Launcher Platform, which holds the Shuttle in an upright and secure position. Specifically, this project will mathematically and structurally analyze the distributed load applied on the Crawler by dividing the overall load into separate geometric regions, computing the separate loads, then reducing them into one point load located at the centroid. The process for computing the centroid will be similar, starting from the centroids of the separate regions, then reducing to one overall point. The equivalent force and distance will then be summed up as a resulting moment from the vertically-standing Space Shuttle. Although this project is aerospace-related, the use of this technique encompasses every discipline of engineering.

The Leg Machine: Cable tension, Springs, and Moment

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ABSTRACT

The interdisciplinary display of Engineering Analysis Statics, or IDEAS project, requires a group to demonstrate understanding of the statics course by completing and presenting a project related to their major. We decided to analyze our own model of a leg workout machine. The use of a system of pulleys, springs and cables run throughout, allowing us to calculate tension, spring constant, and the moment of the leg. Multiple pulleys were used to calculate the tension at different distances from each pulley. Springs were attached to a weight and were stretched a certain distance based on the spring constants and force that the leg exerted on the system. The moment of the leg about the knee was found measuring the distance from the knee to the line of action and the force produced by the leg. Increasing the weight on the system caused the moment about the leg to increase. This is the basic principle behind today's workout machine.

Determining the Best Material for a Doorstopper

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ABSTRACT

The objective of our project is to determine what it takes to put a door with spring loaded hinges into static equilibrium with a doorstopper, while considering friction. The surface of the floor while stay constant (material will be either carpet or tile) and the variable will be the doorstopper's material.

Initially, we need to find the sum of forces and moments of the door and its hinges (neglecting the friction in the hinges). This will involve summing the forces from the hinges and the force of gravity. Upon finding all the forces, we move to the moment. Since there are two hinges, there are two places where torque could happen. We will find the torque on each hinge. (Hinges: one must be horizontal reaction on the door while other must be horizontal and vertical reactions.) We also need to find the frictional force that will put the door into equilibrium when it hits the doorstopper.

Once all the information about the door and all its forces are applied at a specific spot, then we have to find a doorstopper made of a specific material that will meet the criteria. Theoretical tests will be run to determine which material is best to use for the doorstopper. Options include rubber, wood, plastic, and glass. At this point, we will do the work to find the theoretical best option for the doorstopper.

Finally, in this part, we will put the theoretical answer to the test. Using our model door, we will prove whether the rubber, wood, plastic, or glass doorstopper will achieve the desired results. Lastly, we will compare and contrast the model results to the theoretical results.

Dome Fail Me Now: A Study of the Dome

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ABSTRACT

The dome is a structure that can be found around the world as a common part of modern and ancient architecture. A dome is a half spherical structure set atop a cylindrical base and is usually hollow. The objective of this project is to analyze load capabilities of a dome and realize the maximum amount of force the structure can sustain before failure. The forces acting on a dome are the internal forces of compression, tension, and normal force along with varying external forces that will be applied. Domes are a unique structure and can be constructed in numerous ways to achieve a desired shape such as a pointed dome or a dome with a central opening. These different shapes are possible because of internal forces that keep the dome stabile when external forces act upon it. Also in consideration is the material that each dome was made with. A few historical domes, dating back hundreds of years ago, have been constructed by either concrete, brick and mortar, or clay. By using one of these construction methods and materials, a dome will be constructed and tested. The tests will conclude the maximum force a dome can sustain and provide insight on the internal forces that occur within a dome structure.

Equilibrium of Window Washing Platforms

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ABSTRACT

These are the results for various tests performed to analyze window washing platforms and how they function. The purpose of these tests is to determine the best style of window washing platform to prevent disaster from happening. This was accomplished by testing various small scale models as well as calculating the forces acting on various platforms. Throughout this paper, readers will find calculations based on tension in strings, as well as moments created, and thus resisted on pulleys. The paper also focuses on horizontal forces and how these forces can be neutralized by design of the platform in order to prevent swaying while workers are on the platform. This information will be valuable to any engineers who would like to design safer and more efficient window washing platforms.

Stresses and Moments On and About a Beam Under Conditions of Shifting Tensile Load

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ABSTRACT

The purpose of this study is to investigate the effects that a shifting tensile load will have upon a beam. As beams are a critical component of virtually all modern constructions, a thorough understanding of their characteristics under various loading scenarios is of the utmost importance. As such, this study seeks to observe the phenomena associated with a common circumstance that many beams experience – unevenly distributed loading. For this study, tensile loads will be applied in various locations and/or proportions for the purpose of studying the effects that this has on a sample beam; test instruments will then be used to determine various stresses and moments on and about the beam.

An Analysis of the Louvre Pyramid: Are all its Members Necessary for Structural Integrity?

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ABSTRACT

The Louvre Museum is an art museum located in Paris, France. Home to some of the oldest and most classic pieces of art, one of its main features is a large pyramid that stands tall in the front of the museum. The pyramid itself has a large exterior frame and a smaller interior frame that is also shaped like the pyramid. The objective of this project is to analyze the members of the frames and to calculate the forces upon them so that, through doing so, a conclusion may be made as to whether or not there are zero-force members among the truss systems that comprise the frames. External factors will not be taken into account on the analysis of the system save gravity on the structure as a whole. Two figures of the structure will be provided to show how the structure looks in its present stage and how it would look if the zero force members, if any, are taken out of the frames that make up the pyramids. Even though each member should theoretically be different from each other slightly, an assumption will be made that all members of the same length will be uniform in volume and mass. Connectors between the members in the smaller pyramid will also be excluded in calculation variance because of the fact that they are negligible in size and would only affect the overall calculations in the smallest manner, if at all.

Electromagnetic Levitation: Free Floating Supports

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ABSTRACT

The experiment tests the viability and application of magnetic suspension by applying data and research acquired to real world scenarios. By using two electromagnets with the same charge to create two opposing magnetic fields, it will create a stable levitating structure capable of supporting a downward force. One magnet will be stationary on the bottom surface, while the other will be mounted to four guide rails directly above the stationary magnet. This will restrict horizontal movement within the system and only allow for motion in the vertical direction. Using different amounts of voltage, the strength of the system will change and the data from the control model can be used to derive an equation for the amount of weight capable of being supported based on the strength of the magnetic field. Using research on electromagnetics, the size and strength of the magnets necessary to support practical masses can be determined. Through these derivations, analysis can be made to surmise whether or not this type of system will be viable, and if so, whether or not the values are rational.

Kinetic Sculptures: Art that fuses deep principles of physics with the sculpture

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ABSTRACT

This paper focuses on the analysis of Kinetic Sculptures. The purpose of this project is to analyze how art and physics can be used together to create unique sculptures. An analysis was performed of the hanging kinetic sculpture in the UCF Student Union. Kinetic sculptures are often constructed to follow the principle of equilibrium and typically consist of rods from which weighted objects or other rods hang from. These rods and weighted objects are constructed in such a way so that the entire sculpture is in equilibrium at the end product. In this project, a similar structure was built out of cheaper materials and at a scale. This paper specifically outlines the experimentation performed to calculate perfect equilibrium, calculate centroid locations and tension forces in a similarly built model of the sculpture currently hanging in the Student Union so that we may confirm these deep principles of Statics. Also the purpose of building the structure is to ensure that our theoretical calculations match our experimental calculations when calculating how the sculpture will end up in equilibrium. Among various measurements found, the most important were the ones pertaining to equilibrium and other Static type principles such as centroid location and force of tensions.

Model of 3D Vectors in Space

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ABSTRACT

This IDEAS project is of a model that helps visualize vectors being added and subtracted in 3D space. The main purpose of our device will be for modeling purposes and for teaching people how to visualize vectors in 3D space. Our main design consists of pvc pipe material going in the direction of the xyz axis. Adjustable rods that will attach to the pvc pipe are also to be connected to a standard position vector that will be able to be extended and retracted to fit a specific length that the user can choose, from the origin of the model. Attached to the tip of the original position vector will be another vector that can also be adjusted to a specific length and direction. This vector will be able to slide along the original position vector from the base where you will construct the vector to the tip of the standard position vector. From here, one will be able to construct the third vector that will use the method of "tip to tail" vector addition. There will also be small marks on each of the planes that will signify the coordinate of each respective axis and will help to show where exactly the vector is with respect to each of the three planes. Accordingly, calculations such as vector addition and subtraction can be done to enhance the learning aspect of the design. An electronic device with distance reading capabilities for position will also be considered in the design to facilitate the measuring process. Essentially, the project will be built with the aim to teach about 3D vectors through a design with good functionality and versatility.

Eiffel Tower Trusses

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ABSTRACT

The Eiffel tower is an engineering masterpiece that is highly composed of a plethora of trusses. Our main focus is to obtain the most common and most important truss designs that were used to build the Eiffel tower and study them. Our selection of the trusses will be based on those that carry great loads and those that were seen multiple times throughout. What we're trying to study is how each truss handles different loads. By recreating the selected ones we will gain a better knowledge of trusses as a whole, and see how the different designs of each affect it. After accessing each truss, we could then establish if they were the proper ones needed for the efficiency of material along with having the requirements to support the load.

Gateshead Millennium Tilt Bridge

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ABSTRACT

Tilt bridges are a great new invention as far as pedestrian bridges go. Some of the main advantages to tilt bridges are they do not require columns for support, they can rotate to allow boats to pass under them, and are very aesthetically pleasing. The Gateshead Millennium Bridge in England will be analyzed for this project.

Tilt bridges are an interesting topic as they are subjected to many different types of forces. They are comprised of a bridge where pedestrians may pass from one side of a river to the other, and curved counterweight to help balance the weight of the bridge, cables that connect the bridge to the counterweight, and finally engines or pistons on either bank to rotate the bridge allowing ships to pass. The forces that a tilt bridge like The Gateshead Millenium Bridge experience are a combination of tensions along each cord passing from the counterweight to the walkway, a moment force and reaction moment force, and a torque about its central axis that allows the opening and closing of the bridge.

A purely mathematical approach will be used at first to solve for the reactions of the system when it is static equilibrium. After that, lab tests will be run to help decide on many of factors including material for the cords, amount of moment required from the engines or pistons to rotate the bridge, and the most optimized and safe way to build a bridge of this type. Finally, a model of the bridge will be constructed in order to exhibit the bridge in action with all the forces acting on it to either verify or refute our calculations.

Determination of Appropriate Forces to Operate a Human Powered Pump-Jack

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ABSTRACT

There are nearly 2.5 billion people in the world without access to proper sanitation, which makes it one of the biggest problems modern society faces. In some places people have to stand in line for hours to get water from a small pump-jack. Many times it is the only source of water in reasonable walking distance. Our group decided to tackle this problem by figuring out a way to make the water retrieving equipment bigger, and most importantly for it to be operable by means of manpower. A bigger machine will mean more gallons per minute pumped and also from a larger depth. Leading to possibly cleaner water and reducing altercations between people waiting in line. The project will find the forces acting at the couple joining the supporting tower and the walking beam to then create the most efficient structure possible while assuring the structure will withstand the load. Gear reductions will be used to achieve movement of the entire system by relatively low forces generated by a person pedaling the drive gear, while keeping it simple enough to be built in remote areas.

Vector Model – A 3D approach

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ABSTRACT

A model to more clearly demonstrate vector addition in three dimensions for use in Static Structures courses. This model should demonstrate vectors which are clearly distinguishable by various magnitudes and directions. Vector origin should be easily placed freely in any increment of X, Y, or Z. Vector direction should be directed without complication.

Rube Goldberg Simple Machines

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ABSTRACT

The purpose of this experiment is to investigate the six simple machines and explore how the forces work in each of the machines. The six simple machines consist of the lever, pulley, wheel and axle, incline plane, wedge and screw. Each simple machine is investigated independently of the others and explained thoroughly. This investigation includes how the different simple machines are constructed, why the devices are considered simple machines, how the different forces act on the machines and what advantages these machines have including mechanical advantages. By investigating all of these areas it becomes clear why the six simple machines are the basis for many modern tools used today. This experiment uses a Rube Goldberg machine, a device that is engineered to preform simple tasks in complicated ways, to show how the six simple machines work, when working separately, come together to perform a task. The simple task chosen in this experiment is to move a small ball from the beginning of the machine to the end and repeat the cycle. A design was created as to determine the final structure of the Rube Goldberg machine. Then the forces required for each machine to move the ball were determined separately and later modified to fit the design. Upon building the different machines that are or represent the original simple machines, they were then connected to create a never ending chain reaction.

Magnetic Coaster

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ABSTRACT

Everyone wants to feel the adrenaline rushing as their speeding down the tracks of a rollercoaster. Because of this, people are willing to pay a lot of money to ride a better version of the same thing in order to brag to their friends. As rollercoaster enthusiasts ourselves we sought out to better the experience and concluded that these contraptions have a flaw holding back their potential, friction. How can this be solved? The simple answer, electro-magnetism. This new roller coaster dubbed the ‘Magnetic Coaster’ will use concepts from statics and electro-magnetism in order to give the riders the best experience. How is this done? There will be a magnetic repulsion between the tracks and the cart causing the trolley to experience almost frictionless motion. This is a similar concept to the Maglev trains currently in operation in Europe. After deriving equations for the electric field required and much trial and error a small scale prototype that proves the concept of a ‘Magnetic Coaster’ was created. With this design, the cart will move smoother and with a significantly greater velocity than the normal wheel system. There were many designs for the track/cart system that have been through prototyping and it has been singled down to the best one which is detailed in the project.

PTFE Coated Glass Membrane for Maracana Stadium’s Roof

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ABSTRACT

The main idea of the project is to test the reliability and feasibility of a tensile roof structure. With regard to reliability, building a structure comes with important responsibilities and providing safety for the consumers of the structure is the highest priority of all. Larger scale structures such as stadiums require particular attention to safety because any hazard can harm a large volume of people. However, making the most economical choice that provides safety simultaneously is always the most efficient. In that aspect, finding a safe material with the most sufficiency and lower rates of maintenance makes the project more cost friendly. To illustrate the relationship between reliability and feasibility, when the Maracana stadium was built, concrete material was used to construct the roof. Not only is concrete a high maintenance material, the roof was not structurally sound and collapsed, causing a possible hazard for around 80,000 people. Later, the concrete was replaced with PTFE coated glass membrane, a cost friendly material with low rates of maintenance. This project includes the use of PTFE Coated Glass Membrane, which has the same characteristics as the actual product used on the Maracana Stadium. To analyze it’s reliability, the material is tested for it’s maximum support tension. A scale representation of the actual structure is made to test all its pros and cons.

The Water Mining Project: Green Engineering for Desalination

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ABSTRACT

The Water Mining Project refers to a sustainable desalination system that uses the water pressure of the deep ocean as a force for desalination through Reverse Osmosis. The pressure required for moving salt water through a Reverse Osmosis filter is one thousand (1000) psi or more, which can be reached at depth of 2240 feet. This system could replenish ground water sources and drinking water reservoirs on a large scale with minimal impact to the environment.

The system is designed to be self-sustaining with minimal energy inputs from external sources. It works by harnessing the potential energy of the deep ocean to provide the pressure necessary for desalination and backwash. Ocean waves provide the kinetic energy needed for generating electricity through wave conversion technology.

The model assumes continual operations without component failure and a 70% rate of permeate (desalinated water) production. The concentrate created during desalination is diluted to an environmentally safe level and returned to the ocean. Additionally, treating the osmotic membrane with a high pressured backwash flow will create additional concentrate that will also be diluted to a safe level.

The model requires a mass flow analysis which will provide the volume necessary to dilute the resulting saline concentrate to a level that will match the environment and released. The forces created by the mass flow and oceanic pressure are instrumental for the feasibility of this system and will be modeled. Finally, the opportunity cost of desalinating with this system versus others will be addressed on an energy consumption basis.

Since our raw material is abundant, we could replenish some of the major groundwater sources in key regions of the world. It could very well enhance our ability as a species to weather Global Climate Change.

Determining Reaction Forces Needed to Keep a Synthetic Arm in Equilibrium

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ABSTRACT

The purpose of this project is to determine the forces and moments being applied to an arm holding a weight. The results from this project could be used to improve efficiency in determining what servos and materials may be needed for a robotic arm, for instance. We will calculate the forces first, and then either confirm or deny our results experimentally. A simple arm will be created with cables running from each separately repositionable part to a base, and springs designed to measure force will be added in series with the cables. If we were correct, these springs should each read out roughly the force we calculated beforehand.

Different manual pulleys and there efficiencies

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ABSTRACT

Eleven different elevator pulley systems have been constructed in order to test the predictions made about their two dimensional copies through the use of physics and statics. Each individual pulley was developed in two dimensions and examined to discern their efficiencies and compare which pulley system was the most effective. After each of these pulleys was constructed and examined in two dimensions, they were built in three dimensions and tested again to explore the differences from their two dimensional versions. Each elevator was made with interchangeable parts so that the same motor and the same elevator cart were used to avoid discrepancies in weight and power of the motors. The results were noted and can be found throughout the rest of the paper.

Simplification of Vector Position, Addition and Subtraction Within a Coordinate plane

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ABSTRACT

Vectors can sometimes be a complicated concept to get your head wrapped around. It can be difficult to visualize where and how they are arranged and if you cannot understand the vectors position, then adding and subtracting two vectors can be quite a chore to undertake. We intend to create an apparatus that will physically show vector location and their corresponding angles between the three axis. This will help someone visualize and begin to grasp the concepts of vector position with respect to an axis. This mechanism will also have a system of sliding blocks and tubes to help show the coordinates of each vector along the x, y and z axis. These sliding blocks will also allow someone to physically see how vector addition and subtraction occurs. Simplifying the process and seeing it happen in parts. There will be 3 sets of these sliding systems, one for each vector and the third to show the addition and subtraction of the 2 vectors. Allowing someone to be able to adjust and work out the processes right in front of their faces with their own hands. Helping to achieve comprehension of the topic and concepts associated with vectors.

In the Statue We Truss

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ABSTRACT

In this project, the structure of the Statue of Liberty is highlighted. The Statue of Liberty's structural frame is made up of trusses. The trusses inside the Statue of Liberty form a support system, which sustains the form of the Statue in hazardous weather conditions as well as the weight of the copper making up the Statue. A 3D model of the Statue was built in order to test the significance of trusses as well as the viability of their strength. The experiment was implemented by constructing the 3D model that consists of triangular wood framing and supports. The implementation highlights and proves how the Statue of Liberty is still standing today. Since the trusses that make up the Statue consist of triangular units, the Method of Joints can be used in order to figure out all of the forces acting upon the truss. Results were achieved by constructing and testing this model. All statically determinate values were attempted to be found accordingly.

Egyptian Methods for Transporting Limestone

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ABSTRACT

This IDEAS project is looking into the speculated method that the Ancient Egyptians may have used to transport massive limestone blocks to their destinations. By pouring water in the path of the transportation, the work required to move the materials across the desert is lessened drastically. To display the whole process of the limestone transportation, scaled models are made to simulate the forces in action during the haul across the desert and how the Egyptians may have used pulley systems during the placement of the blocks. An analysis on the distribution of forces throughout the system quantitatively shows the difference in work done for dry sand and wet sand. In each model, the build-up of sand on the front of the blocks is measured and compared, due to the sand being one of the main components that would add to the extra manpower needed for large-scale displacement of the massive stone. Different types of pulley systems that the Ancient Egyptians had made use of during their time are compared to see which would have been the most feasible for their needs. The data gathered throughout this project is used to show if the ancient Egyptians could have realistically imported their materials across the desert using the technologies at their disposal.

Centrifugal Stabilization of Free Standing Structures

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ABSTRACT

Civilization, the comfort and convenience of modern life, is regarded as available only in towns and cities according to the Oxford Dictionary. It is the advancement and demand of civilization that is the driving force behind the increasing demand of natural resources. With land becoming scarce, the future of life is upwards. Taller towers have always been a solution in cities and will continue to provide a solution. They provide more space for living, business, and now agriculture. As buildings such as these grow taller with smaller bases, new stabilization issues arise and there is a greater need for new engineering methods. We believe this can be rectified through the use of fly wheel technology and the centrifugal forces that are created. We plan to build a free standing tower that is supported using DC motors to spin balanced fly wheels to create centrifugal forces. The forces will be powerful enough to keep the tower standing without the aid of added supports such as cables. By calculating these forces we can determine the maximum height that we can construct our model and still maintain stability. Even through adverse conditions the tower's centrifugal forces will resist angular displacement and remain standing.