



REVISED SENIOR DESIGN ORGANIZATION PROJECT DESCRIPTIONS

Fall 2010

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AN INNOVATIVE HEAT ENGINE VALVE SYSTEM DESIGN

Team A: Christine Tarud, Senyon Romero, and Rogelio Muro

An innovative heat engine valve system design for renewable energy application will be developed and presented in this project. The purpose is to design a valve system to work in an engine and ultimately create a new heat engine primarily powered by heat in which its uses are relevant to greener energy methods. It is important to note that this project is not a follow up of a previous project that did not work and did not run despite to its well documented, researched and calculated analysis. It is, however, a reinvention of ingenuity to develop a new device based on trial and error and optimization for the employment of a new heat engine. The overall concept of the creation of a completely new heat engine valve shaft system is part of a larger model that is well above undergraduate level and will be divided into two groups; one responsible for the design of an innovative valve shaft system along with its timing and belt mechanism, while the other group will be responsible for designing of new heat chambers and its working fluid. The distribution of duties will increase time for detailed analysis and ensure the overall system's success. The victory in creating an innovative valve shaft system working in a new heat engine will provide greener solutions to generating energy directly from heat and not fuel; therefore, avoiding release of dangerous pollutant gases into our atmosphere.

As our society becomes more concerned with the global pollution and more active in finding and researching greener and environmentally friendly methods of obtaining energy, the solar energy concept has become increasingly popular. Astonishingly, with only one hour of the sun's energy being emitted to Earth, we could potentially supply energy for over one year to our planet. Regardless of the limitless advantages that solar energy poses as an alternate method of power, it has disadvantages that stand out; a large part of its energy is lost yielding a very low efficiency of only 10%. Alternatively, heat engines are well regarded for their high efficiency of up to 40%. It is evident that the solar powered electrical generation relies on heat engines as an alternate method for renewable energy applications. It is an incredible and delicate balance of medicine, science and engineering working together for the better being of our communities. Our innovative concept integrates sophisticated mechanical design along with the fundamental concepts of heat transfer and thermodynamics to ultimately obtain a system that will open new doors into our modern society.

OCEAN WAVE ENERGY GENERATOR

Team B: Bader Ale, Francis Fernandez, Alfonso Parra

Fossil fuels have been a popular source of energy for a long time. Some of its drawbacks are its finite life and toxic byproducts. Newer technologies have risen to solve this problem. Some of the technologies include devices to harness the solar and wind energy. The project's emphasis is in the development of small buoy units (5-8 ft) able to harness energy from ocean waves specific to low-wave-height coastal areas, such as Florida. The existing bulkier wave-generating units, usually around 12 feet high, are designed with the intent of operating in active wave-rich waters (8-10 ft) and can produce as much as 10 kW of power. Along with the smaller-scale design, the team explores alternatives allowing it to produce 4-8 kW in coasts that average wave heights of 2 to 5 ft. Basic laws of electromagnetism, such as Faraday's Law of Induction, are used. A rare earth magnet, such as a neodymium magnet, is at the core of the buoy and a copper winding is used around the magnet. The undulating motion of the ocean waves generate the current in the copper wire and store it in an underwater central unit nearby. By using lightweight materials, such as high-strength synthetic plastics and fiberglass, and keeping electrical components off the buoy the focus of the design is in maximizing the transduction of energy.

UNMANNED AERIAL RECONNAISSANCE VEHICLE: AUVSI SUAS 2011 COMPETITION

Team C: Seyed Alavi, Natalia Posada, and Ana Puente

The project will focus on the stability, aerodynamics and mission of an unmanned aerial vehicle (UAV) capable of intelligence, surveillance and reconnaissance. In order to design and build a high performance mission ready UAV shall be designed for medium level maneuverability and high stability. There will also be an emphasis on the design of the internal spacing in the fuselage to securely sustain a variety of electrical components on board the UAV. Furthermore, as a design team, we will be working collaboratively with aerobots@fiu members who will assist in the integration of target recognition hardware and software needed for the competition. Our current aim is to design an unmanned aerial vehicle capable of meeting and complying with the following preliminary goals and constraints:

- Altitude: 100 ft < Altitude < 750 ft (note: we will consider airfield elevation to be 10 ft MSL)
- Flight Time: 45 minutes
- Max Aircraft take-off gross weight: 55lbs
- Takeoff and landing crosswinds (speed per nautical mile): 8-11 kts
- Level of Maneuverability: Medium
- Level of Stability: High Aspect Ratio

HEAT WASTE ENERGY RECOVERY SYSTEM

Team D: Allen Christopher Cuadra, Ryan Ortiz, J Rivero De La Guardia

The automotive industry, the construction industry, the fabrication and manufacturing industries and power industry, use some form of thermodynamic cycle for generation such as combustion engines, Bryaton and Rankine cycles engines etc.. Even today, the average efficiency of a gasoline engine runs around 25% and coal power plants around 50%. This means tangible losses in energy, fuel, and ultimately, money and production. Although common, industries' recent endeavors to make these heat engines more efficient have led to hybrid systems which do not necessarily increase efficiency, but rather, divert it to another energy source.

The solution, then, is a different type hybrid system. Instead of introducing another energy source, a hybrid system utilizes energy already available in the current power plant. The Generator Heat Waste Energy Recovery System (G.H.W.E.R.) is that very system. These hybrid systems specially design Stirling Engine that utilizes heat lost from the exhaust, piping and/or flue gas depending on the thermodynamic cycle. Cooling the Stirling Engine would be either pumped water and/or forced convection to provide the necessary temperature gradient for providing power recovery. The generated power is then either converted to AC power by an alternator or DC power depending on the application. The G.H.W.E.R. system is a convenient scalable and adaptable way to increase the efficiency of any thermodynamic cycle by recovering the heat lost, providing fuel savings without having to buy newer, more expensive generating systems.

FIU SAE SUPERMILEAGE COMPETITION

Team E: Roger Laurence, Jenai Alexis, Philip Clarke

The SAE Supermileage Competition is an annual competition hosted by the Society of Automotive Engineers. As fuel prices continue to rise and global warming becomes an ever more popular topic, the need for more fuel efficient cars becomes greater. That is where this competition comes in to address some of these critical issues.

The team intends to design a vehicle to compete against other schools in an attempt to design a more fuel efficient vehicle. The competition places several constraints on the design of the car; however, as long as the technical rules are met, the final design is up to us. By designing the shape of the body to be as streamlined as possible, the drag will be minimized. The chassis can be designed with the thinnest possible supports, leading to a reduction in weight, by performing a stress analysis on it. We hope to achieve the following goals during the competition: (1) a dry weight of 150 lbs, and (2) a drag coefficient of 0.15 (a Toyota Prius has a coefficient of about 0.25). By keeping the weight down and the body streamlined, we plan on achieving our third goal of an overall fuel efficiency of 1000 mpg.

GRAPHENE BASED COMPOSITE HEAT SPREADERS FOR LAPTOP CPUS

Team F: Gregory Burrow, Byron Gaskin, and Christopher Roath

The team intends to design a graphene based composite heat spreader. Since graphene only exists in its planar form for a few atomic layers, it will be stacked with a metal possessing adequate heat conduction properties, such as aluminum, copper, or titanium to create a composite heat spreader. This will allow for the metal layers to transmit the heat to the next layer of graphene which will continue its conduction in the planar direction: the idea being to create a more isotropic thermal gradient in the device and consequentially a lower heat flux. Design parameters for the final product will include the metal used, total number of layers, and the effective surface area of the device.

The initial product is to be tested with a Kapton heater, and have the temperature being measured via thermocouples and infrared camera. The purpose of the set up will be to prove the concept and feasibility of graphene for use in a heat spreader. The same heater will have been used to test a control substrate of the current technology in laptops and the results of both tests should show a thermal efficiency increase of 10% - 15% with a drop of 5°C in max CPU temperature. Once the concept is proven, as a final test, the heat sink device will be installed in a laptop with CPU temperature being measured using the computers built-in sensory system. After rigorously testing the same laptop with and without the device, a more accurate measure of efficiency can be obtained. Initial hypotheses predict the product will work in conjunction with fans already in the computer to increase efficiency by up to 15%.

G.E.N.A.I. ROBOT ASSISTANT

Team G: Leonardo Ampie, Jaime Mudrich, and Andres Pacheco

With time, medicine improves and so does human longevity. This means an increased population of elderly with developing and already existent disabilities. These disabilities create a hindrance in the daily life of those living with them. The team intends to design an assistive companion robot to alleviate this hindrance and improve the quality of life for the elderly.

Considering the unlimited quantity of potential assistive tasks, the team has decided to develop the robot modular in nature so that additional functions can be added as desired. The current development will focus to a single critical task. This task is assistive medication. The robot will use infrared LED and sensor to follow the consumer who wears an IR emitting wristband. The robot will attempt to combat memory difficulties by assisting the consumer with scheduled medication and reminders of other sorts. The robot will be loaded with one week's supply of medication that will be raised with a prismatic arm to a comfortable level for the consumer as scheduled. For example, Tuesday's morning medication will be presented on Tuesday morning. Using a weight sensor, the robot will identify whether or not the medication was removed. If not, the medication will be stored in a reservoir inside the robot. Also, in the event that the

medication is rejected, date will be recorded and the appropriate people will be notified. The team will incorporate video surveillance as well to verify ingestion of the medication. In addition, response to emergency will be provided via voice command or sensation of an indication of emergency. For example, if the signal from the wristband transmitter is coming from the floor for an extended period of time, it may mean that the consumer has fallen and cannot get up.

The robot will be designed as an omni-directional platform to facilitate maneuverability of the robot throughout the home of the consumer. It will employ a four gear system that allows a single central shaft to control the direction of three wheels that will remain parallel at all times. This design eliminates the need for the robot to rotate its body providing more efficient following. The design will require analysis of bearings, shafts, gears and bolts. A successful project would be a step forward into a field with practically endless possibilities and enormous humanitarian and financial payoff.

MICRO HYDROTURBINE MODULE

Team H: Randy Gonzalez, Francisco Morocz, Octavio Oliva

Isolated areas, severely underdeveloped regions, disaster-stricken zones, and remote military outposts have one common need: readily available and efficient means of power generation. The most effective manner to address these needs involves the use of power generating modules that utilize the locally available, renewable energy resources. This senior design project seeks to improve the efficiency of Energy Systems and Design's LH 1000 Turbine by optimizing its intake casing and draft tube while maintaining the flexibility and ease of deployment of the system.

Utilizing MAIDROC's laboratory TESLA 128 super computer, the geometry of the intake casing will be optimized based on three design variables: the width of the intake casing, the radius of the bottom fillet, and the wall angle. Flow separation, cavitations, and increased drag inside of the draft tube will be prevented by placing a small diffuser inside it. A computational fluid dynamics simulation, comparing the effectiveness of the draft tube with and without this inner diffuser will be carried out. Contingent on the results of the CFD simulation, the final draft tube will be optimized based on two or five variables. If a simple draft tube is employed, the design variables will be the height of the tube and its wall angle. If the composite draft tube is chosen, however, the diameter of the inner diffuser, the length of the inner diffuser, the length of the draft tube, the wall angle of the inner diffuser, and the wall angle of the outer diffuser will be the design variables. Furthermore, a structural analysis on the turbine supporting frame and inner diffuser anchoring rods will be done. A final prototype will be constructed and fully instrumented. Empirical tests will be carried out on the prototype in order to corroborate the results of the various computational analyses performed. A design benchmark of 1 kW power output for the minimum possible draft tube length, which will ensure system flexibility and ease of deployment, will be sought.

HEAT CHAMBERS AND COMPONENTS FOR A NEW HEAT ENGINE

Team I: Stalin Centeno, Julio Perez, Livan Roque

The primary objectives of this project are to design and fabricate a heat chamber system as well as a radiator for cooling the intake charge in connection with a new heat engine system. Heat engine is an energy conversion system that converts the heat from a heat source to mechanical work without involving a combustion process. The concept of the heat engine has been around for decades. One of the most popular heat engines is the Stirling engine. The Stirling engine has many advantages over other heat engines and may be the only commercialized heat engine in the present time. However, it also has numerous disadvantages that have impeded it from being widely used. Some of the Stirling engine's disadvantages are: having short alternate contacting time of the working fluid with the heat source or heat sink in a cycle, small heat transfer surface area, and the use of Hydrogen as the working fluid. Although hydrogen has a high thermal conductivity, it has a low density at ambient pressure, meaning that the engine has to be highly pressurized to over 200 bars for a meaningful power generation. In addition, hydrogen has a high diffusion rate because its low molecular weight, causing leakage through the cylinders. Hydrogen is also very flammable and may cause metals to lose ductility, making them brittle.

The new heat engine under study uses Nitrogen as the working fluid. Nitrogen has been chosen because it has similar characteristics as Air. In contrast to Hydrogen, Nitrogen is non-flammable and has a molecular weight of 28.0 g/mol, which is 14 times greater than that of Hydrogen, which has a molecular weight of 2.0 g/mol. This will prevent the working fluid from leaking from the cylinder. Although Air has a molecular weight of 29.0 g/mol, it contains oxygen that could cause explosion at high pressurization. In addition to different working fluid, the new heat engine also provides drastically increased heat transfer time and heat transfer surface area. As a result, the power output of the new heat engine will be drastically increased.

The present project is also the continuation of a previous team's work carried out in Spring 2010. The previous team may have not achieved their objectives in their design due to several factors: Lack of time, manpower, and experience. Furthermore, the previous team has attempted to design and fabricate the entire heat engine with only three team members. On the other hand, the current heat engine project is being undertaken by three teams, including a graduate student team, and two senior design teams. Some of the team members are also equipped with experience and knowledge of rotary engine structures and have worked with the previous senior design team.

The three teams will have different design objectives, but will also collaborate for integration and fabrication of the entire heat engine system. The workload has been divided among the three groups for the ultimate heat engine design. Our design will focus on the heat chamber and radiator and the other teams will focus on the valve system/lubrication and engine structures. The previous senior design team was not able to get the heaters in the heat

chamber work, which was a major objective of their project. We will overcome this difficulty by implementing our new heater element design and providing the working fluid with the expected high temperatures before the power stroke.

SHELL ECO-MARATHON

Team J: Bryam Quiceno, Pablo Andres Salamea, and Ryan Sampath

The Shell Eco-marathon challenges high school and college student teams from around the world to design, build and test energy efficient vehicles. With annual events in the Americas, Europe and Asia, the winners are the teams that go the farthest distance using the least amount of energy. There are two categories of vehicle designs: Urban Concept and Prototype. The competition is further divided into power classes: Internal Combustion Engine, Solar Power, Fuel Cell, and Electric. The competition has about 45 pages in rules and regulations. Due to the limited man power, a student has been recruited to join the team as the rules and regulations specialist. She will be responsible to oversee the designing process and make sure the team follows the imposed restrictions.

The team has decided to design a prototype vehicle for the competition using a hydrogen fuel cell as the drive train. Design components include chassis/frame, brakes, steering, wheels/axles, and a safety harness. The team is aiming to design at least three of these components, and the rest will “come off the shelf.” The designing process of this project will include aerodynamic analysis, finite element analysis, and system dynamics. The software needed is available on campus, and the training for this analysis will be provided by the project mentor, Pradeep Shinde, MSME degree holder from FIU. In-depth research will be carried out not only to find the least expensive and most lightweight components, but also the most environmentally-friendly materials as well as processes. The project is being fully funded by Pradeep Shinde. Finally, the original project objectives will be compared to the actual results of the finished prototype, and improvements to the design will be suggested as necessary.

TRIM REMOVAL SYSTEM

Team K: Omar Armando Espino, Paul Hoffmann, and Walter McKinley

The project is focused on improving the production efficiency of a local flexible packaging manufacturer. Trim removal is the process of removing the excess material from standard size rolls of plastic to make the final size product. At present, the trim removal process has inefficiencies which decrease production, increase labor cost and pose a hazard to the safety of the workers. It is estimated that the total loss is about \$4000 per month. The capital cost of the project is expected to pay for itself in less than two months.

The proposed system relies on the movement of air from a blower to move the scrap in a continuous fashion from the manufacturing area to the disposal location outside of the

conversion area. System operation requires a range of vacuum pressure and drag force at various points within the system to accommodate various types of scrap. The engineering design includes characterization of the mechanisms of scrap removal, design of a piping system, and blower selection. A venturi manifold is conceptualized and analyzed with CFD. The system will be constructed and tested to be fully functional for daily use at the manufacturing facility.

SAE AERO DESIGN EAST 2011

Team L: Robert Erwin, Tim Rogers, and Jesse Grant

The SAE Aero Design Competition is held annually in an effort to present college students with a problem that requires ingenuity, creativity, and project management in a real world, hands on engineering application in the field of aviation. There are two Aero Design competitions hosted by SAE in the U.S. each year, one in the East, and another in the Western portion of the country. We will compete in the East Competition to be held April 29-May 1, 2011 in Marietta, GA. Teams may compete in three separate classes: Regular, Advanced, and Micro. Each class offers different challenges to the teams involved. We intend to compete in the Micro class. This class requires that the team build an electric RC airplane that is very light, yet can carry a heavy payload.

The payload must be fully enclosed and secured within a payload bay. The bay must be able to enclose a block that is 3x4x8 inches. The aircraft and all components necessary for flight must be contained within a small carrying case with inner dimensions specified by SAE as 18x24x8 inches; the aircraft must be assembled out of the case to a flight-ready condition within three minutes by two team members. Our goal is to design and fly an airplane that is simple, reliable, easily assembled, lightweight, and carries a maximum payload. In order to achieve a high score, our airplane should be able to carry at least 200% its empty weight. This means that if our plane weighs 1 lb empty, our additional payload should be 2 lbs for a gross weight of 3 lbs and payload fraction of 2/3. There are other factors in the scoring, such as the empty weight and reliability of the airplane. A lighter empty weight scores higher, and the aircraft must prove its reliability by performing at least three flight demonstrations. As of now, we are planning on an empty weight less than or equal to 1 lb, and a payload weight of at least 2 lbs. We plan on utilizing a harmonious design which will provide optimum flight characteristics combined with simple flight preparation from the case. We will utilize computer simulations for force and stress analysis. We will also perform full-scale wind tunnel testing to examine the physical characteristics of the airplane against our theoretical calculations.

Each team, regardless of aircraft class, must submit a technical report on the design, analysis, construction, and test results of their aircraft. The teams must also give an oral presentation before a panel of judges during the competition. The event comes to a climax with the flight demonstrations of each team's aircraft. The report, presentation, and flight are all scored by a panel of judges.