Midterm I

Team 7

Personal Hydroelectric Generator

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ABSTRACT

For this project, sponsored by Dr. Devine from the FAMU-FSU College of Engineering, the team is working on developing and marketing a personal hydroelectric generator. Faced with the problem that electricity is inaccessible in remote locations, the team decided to design a product that can easily be transported to different locations to be used for any amount of time. The team has spent the past weeks meeting with Dr. Devine and Dr. Gupta to define the target market and refine the design to meet the needs of that market. Unlike current competition, Team 7's generator should be capable of powering a campsite or small cabin with 1kW of power. Small hydroelectric generators on the market today are only capable of charging a phone or other small devices. This report details the background research and selection process that the team went through to decide upon the components for the final design. After dividing the device into major components, the team analyzed each of them to decide upon the best way to accomplish each function. Also detailed is the scheduling of the project for the coming weeks so that the team can stay on track with the progress of the project. The team plans to spend the coming weeks finalizing designs and producing CAD drawings. These CAD drawings will be used to start the final analysis before prototyping begins.

ACKNOWLEDGEMENTS

On behalf of Team 7 we would like to thank the FAMU-FSU College of Engineering for presenting us the opportunity to participate in the 2015-2016 Senior Design.

We would like to personally thank Dr. Devine and Dr. Hahn for their guidance in entrepreneurial engineering and electrical engineering concepts.

Also, much appreciation is given to Dr. Gupta and Dr. Shih for providing the team with supervision and direction on our project progress.

1 Introduction

In this modern day there is a high demand for electricity even in the most remote areas. Whether the need is for outdoor enthusiasts going camping or a secluded community in a third-world country, people want lights and heat. To supply this demand, the production of electricity in these types of regions is necessary. Several methods for generating electricity have been around for over a century, most of which depend on the use of an electromagnetic generator. Electromagnetic generators work under the principle of electromagnetic induction developed by Michael Faraday in the early 1800's. His principle declares that as a conductor is moved through an electric field a current in produced in the conductor.[1]

Simple modern day generators have two major components: a stator and a rotor. The stator is composed of a stationary conducting material, usually copper coiling. The rotor has one or multiple north-south permanent magnetics. A mechanical force is provided to rotate these magnetics, thus producing an electromotive force (EMF) in the stator. This voltage drives a current through the conducting material that can be can directly used or stored in battery.[2]

In order to drive the rotor, some form of mechanical input is necessary. This input can supplied in several ways, by a motor, flowing wind or water, a hand crank, et cetera. When faced with trying to supply this mechanical input in an isolated environment it is beneficial to select a form that is renewable. For this project, a device shall be developed which transforms the kinetic energy of a flowing water stream into usable electricity. This is referred to as hydroelectric generation. Hydropower (controlling water to perform work) has been around for thousands of years, and in the late 1800's it was first used to generate electricity to power lights.[3] Nowadays hydroelectric power generation is quite common, but most, if not all, are in fixed locations like water dams. Water is not restricted to the time of the day which provides a continuous duty cycle that converts usable electricity 24 hours a day 7 days a week and 365 days a year in comparison to PV cells which only operate under sunny conditions. This project is orientated to design and build a generator which is light weight and portable and works efficiently in moderately flowing streams and rivers; thus meeting the needs of a personal consumer.

A conceptual picture of our design is shown below (Figure 1) in which the turbine, driven by water, spins at a set rpm. This rotational energy is used to turn a shaft that is connected to a gearbox in order to increase the rpm to suit our alternator’s specifications. The power generated from the alternator flows through a wire to a connected terminal which is in place in order to make removal of the alternator and battery easy for inspection and maintenance. After the power leaves the terminal it flows into a battery bank in order to store the electricity for later use.

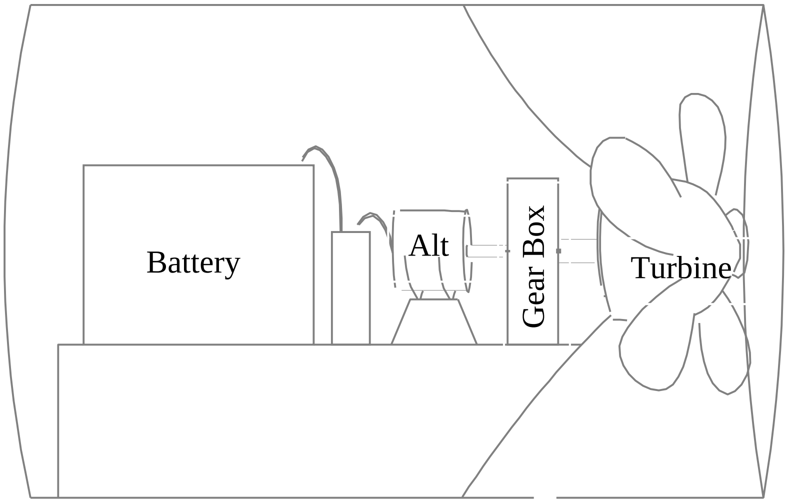


Figure 1- Conceptual design depicting turbine gearbox and alternator setup.

2 Project Definition

2.1 Background Research

The idea being proposed is not entirely original to the team. The gathered research suggests that there are a number of other companies and institutions which have built similar devices. One such product currently available on the market is the StreamBee (Figure 2) available by HydroBee Company. The device can use the flow of the water in a stream to create electrical power. Their idea is similar, however their device works on a smaller scale than the market we intend to influence. The power output of this device is a mere 10W. In order to power essential electrical equipment, as our device intends to do, our power output would have to be on a scale of 50 times of the StreamBee. The team's device intends to produce anywhere from 500W to 1000W. To account for this huge difference in output power, the device will have a capable electrical storage device similar in size to a car battery.[4]

Figure 2 - StreamBee, powers small electronic devices with a USB port

In addition to the StreamBee, another competition on the market exists for a similar type of portable hydroelectric generator. One more closely related to the possible implementation of the team's design, is the Back Pack Power Plant (Figure 3). The Back Pack Power Plant designed by Bourne Energy of California, is a 30lb portable device carried on one's back. The product claims it can generate 600W which is in the same range as the device the team intends to create. Really this device seems like it will conquer all of the obstacles that the team plans to overcome with its design except for some little things. The Back Pack Power Plant needs to be anchored on both

Figure 3 - Back Pack Power Plant: 3 feet in length and weighs 30lbs

sides of a river for proper functionality. Additionally, it does not seem to have the common ports on it for easy access to US standard electric sockets.[5]

2.2 Need Statement

This project is an entrepreneurial-based mission sponsored by FAMU-FSU College of Engineering, specifically through Dr. Michael D. Devine. Currently, there are few effective, simple, and quiet ways to get power in remote locations. These remote locations include campsites, mountainsides, and third world countries. In order to supply energy to items such as lights, heaters, or USB chargers, a gas generator is traditionally used. These types of generators are too loud and too heavy to be effectively used in remote locations.

"People in remote locations do not have access to electricity for powering their electrical devices."

2.3 Goal Statement & Objectives

Goal Statement:

"Develop a portable device that transforms organic kinetic energy into usable electricity."

Objectives:

- Produce 1kW of power from accessible water source.
- Minimize the weight of the device to ensure portability.
- Produce a device that is safe to operate and leaves negligible ecological consequences.
- Produce a device that is conveniently set up and disassembled.

The desired wattage output of the system is 1 kW. This was derived by researching the wattage consumption of a small heater that effectively heats a 20x20 area, 5 LED lights that are equivalent to a 60W incandescent bulb, and an electronic phone/GPS charger. These devices were shown to consume 500W, 50W, and 50W respectively (totaling less than 1000W).

Portability is an important objective because a lightweight system is easier to transport in the naturally harsh conditions of remote locations. This device is trying to appeal to environmentally conscious individuals who want to use a power source that has no carbon foot print as well as individuals far from conventional power grids. The device also needs to be easy to set up and operate in order to appeal to a non-technical consumer and cut down on assembly time.

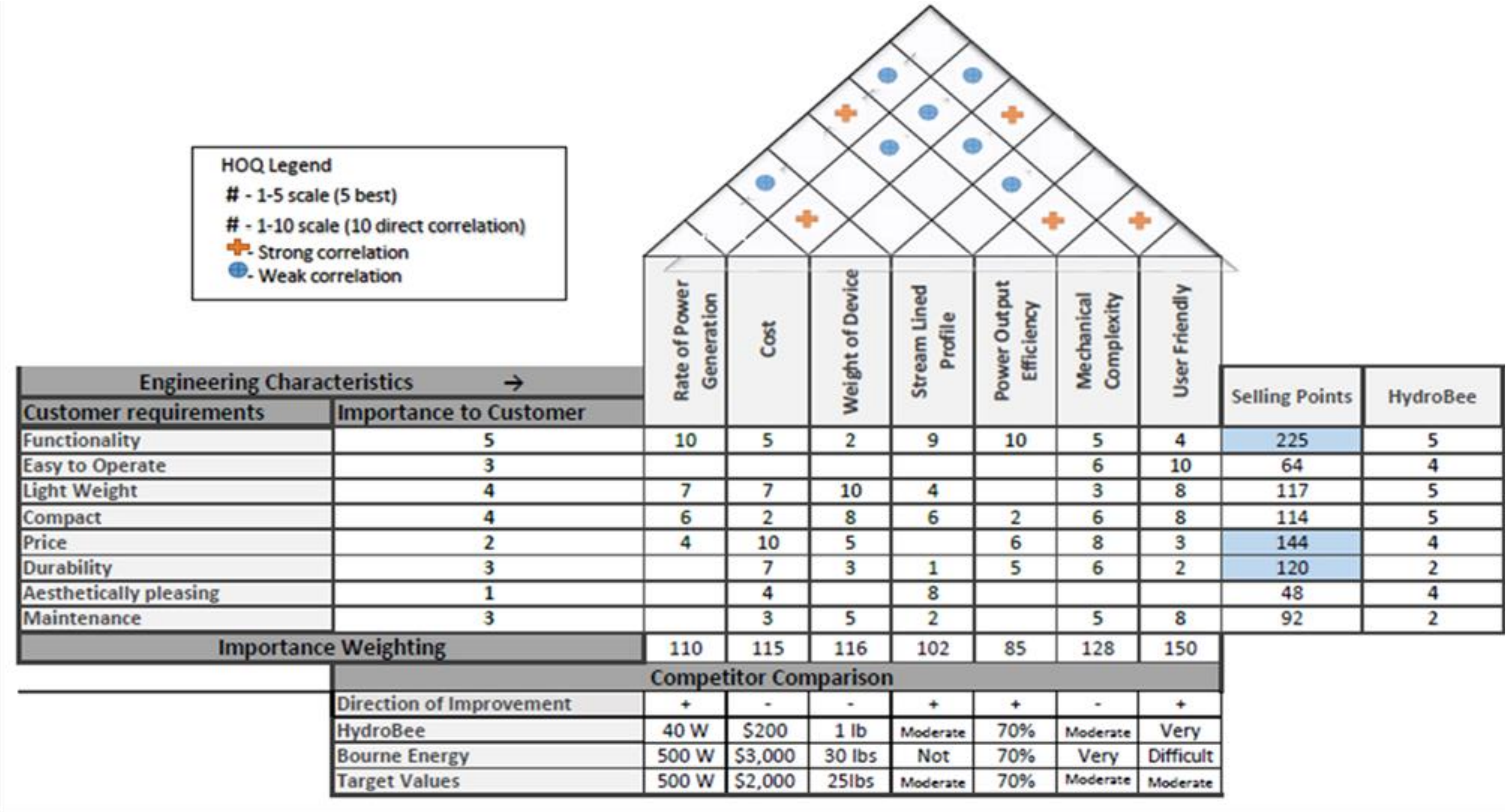
2.4 Constraints

- Device weight must not exceed 70lbs
- Compact (less than 3 ft^3)
- Unidirectional flow
- Water proof / (resistant to corrosion)
- Durable
- Design within the provided budget of $1,500
- Complies with all safety standards
- Operates under 50 dBa (moderate level of sound)

A comparison against the competition mentioned in Section 2.1, as well as the results from the created House of Quality, helped formulate many of the constraints found above. The device's desired weight is 70lbs, while the competitions are at 1lb and 30lbs. Although this is higher than the competition, the weight is still manageable to the average person with some assistance and is negligible considering the higher power output. The unit must be compact in order to be more streamline in the water as well as fit in the bed or trunk of a standard SUV. The mechanism will handle the unidirectional flow of the river with high durability to take the force of the water and handle transportation to the site. Waterproofing the housing is very important so submerged electrical components will not undergo damage while in use. Another important constraint pertains more to the marketability of the unit as an exciter, which includes operation under the sound level of 50 dBa. This was decided comparing moderate sound level of 50-65dB (equal to a normal conversation at 3ft) and unlike typical gas generators (70dB), would not be a nuisance to the user or the wildlife. Finally, our sponsor and the College of Engineering set the budget to be $1,500. This budget seems to be manageable throughout our research and does not appear to be a problem

2.5 Quality Function Deployment

Table 1-House of Quality



HOQ Legend
- 1-5 scale (5 best)
- 1-10 scale (10 direct correlation)
✚- Strong correlation
●- Weak correlation

Engineering Characteristics →		Rate of Power Generation	Cost	Weight of Device	Stream Lined Profile	Power Output Efficiency	Mechanical Complexity	User Friendly	Selling Points	HydroBee
Customer requirements	**Importance to Customer**									
Functionality	5	10	5	2	9	10	5	4	225	5
Easy to Operate	3						6	10	64	4
Light Weight	4	7	7	10	4		3	8	117	5
Compact	4	6	2	8	6	2	6	8	114	5
Price	2	4	10	5		6	8	3	144	4
Durability	3		7	3	1	5	6	2	120	2
Aesthetically pleasing	1		4		8				48	4
Maintenance	3		3	5	2		5	8	92	2
Importance Weighting		110	115	116	102	85	128	150		

Competitor Comparison							
Direction of Improvement	+	-	-	+	+	-	+
HydroBee	40 W	$200	1 lb	Moderate	70%	Moderate	Very
Bourne Energy	500 W	$3,000	30 lbs	Not	70%	Very	Difficult
Target Values	500 W	$2,000	25lbs	Moderate	70%	Moderate	Moderate

The quality function deployment (QFD) is a method that transforms qualitative user requirements into quantitative design parameters. This process was executed by first determining the customer requirements (CR). The CR’s were developed from benchmarking the team’s conceptual design against known competitors, doing back ground research on the developing field of technology micro power generation, and meeting with the group’s financial and academic advisors. From this point the group determined critical aspects of design otherwise known as engineering characteristics (EC). Next the EC’s were related to the CR’s through a relationship matrix known as the house of quality (HOQ) as seen in Table 1. After defining the relationships between the CR’s and EC’s it was determined that the most critical aspects of design will be functionality, price, and durability for the customer.[6] This makes sense since customers want a device that is cheap, does its job, and will not easily break during operation. As a company the most important engineering characteristics were determined to be to create a mechanism that is less mechanically complex, user friendly, and low in weight. This is because the company will not want to confuse the consumer with complex systems and not waste excess funding on material and labor.

3 Design and Analysis

3.1 Flow Characteristics

In generating potential designs, the group recognized that the flow characteristics of the river would heavily influence the project. The underlying principles governing flow characteristics are rooted in a fundamental law of physics, the law of conservation of energy. This law states that the total energy of an isolated system (e.g. the flowing water) remains constant, where energy is the capacity to do work. Building upon this, at higher elevations things such as resting surface water, snow, rain clouds, and ice contain potential energy. This potential is transferred to kinetic energy as the clouds start to rain, ice or snow starts to melt or the water starts to flow into collectively large flowing masses called streams, lakes, or tributaries. These sources converge at point of lower elevation which is known as a river headwaters. The area of land that encompasses said sources is called the drainage basin. From this, the drainage basin was determined to be one of the most influential factor of a rivers flow due to the fact it dictates mass flow properties which are key to determining how fast a river can potentially flow. As seen in Figure 4, the Bradshaw model depicts how different characteristics correlate that contribute to flow.

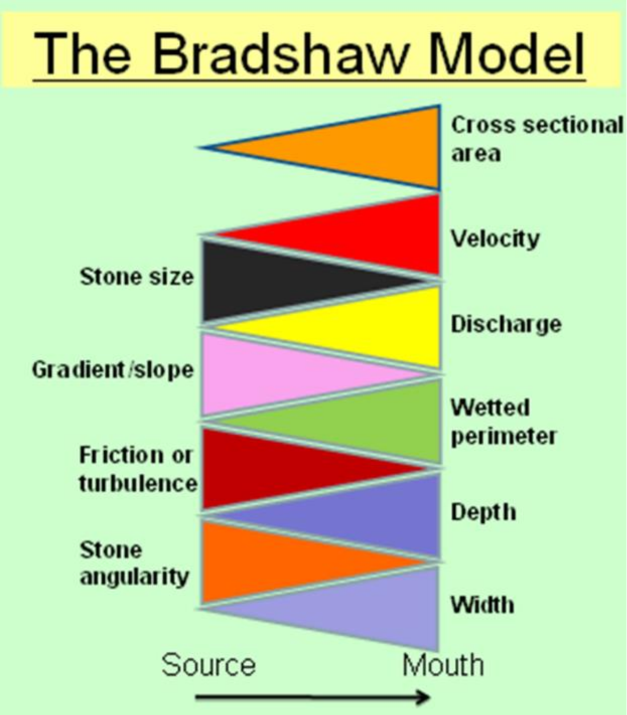


Figure 4 - Flow Characteristics Correlation Graph (Bradshaw Model)

From this, it was clear that dimensional characteristics of the flow channel coupled with the discharge (otherwise known as the volumetric flow rate) were the primary factors that would determine the flow speed. Keeping in mind that elevation drops, size of a drainage basin, and dimensional characteristics of the flow channel would outline the velocity of flow. Five

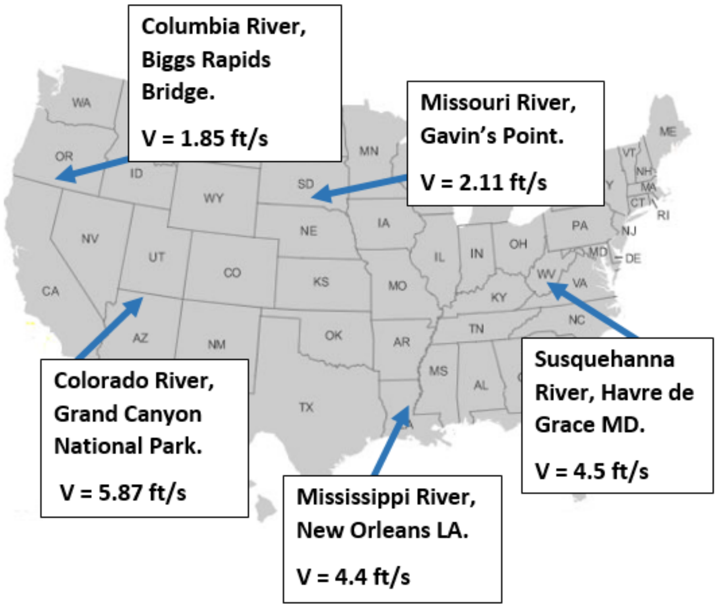


Figure 5 - River flow characteristics

different locations were chosen based on their geographical location, elevation, width, and depth to provide a variety of realistic flow velocity estimations for calculations to model the group's potential designs. As seen in Figure 5, the five selected rivers were analyzed at specific points based off the above characteristics to represent that area of the initial target market. From this, the velocities were averaged to one single value that was 3.75 ft/s for analysis. In the future, to provide a better representation for the potiential buyer a more indepth analysis could be conducted by taking into consideration multiple segments of rivers, seasons, flooding, and a similar analysis that was conducted above just on a much larger scale anaylsis. Idealing a map representing different flows for different rivers would be developed, similarly to the maps of solar irradiance that are avaiable.

3.2 Turbines

Francis Turbine

Francis turbines are the most commonly used turbines in today's popular hydro systems. They are enclosed within a spiral case with a series of guide vanes to direct flow to the turbine runner (blades). The turbine blades are shaped in a cup like design. The blade efficiency is crucial within the Francis turbine. Usually flow velocity remains constant throughout, and is equal to that at the inlet to the draft tube. Francis turbines may be designed for a wide range of heads (height at which the water falls) and flows. This, along with their high efficiency, has made them the most widely used turbine in the world. The turbines exit tube is shaped to help decelerate the water flow and recover pressure within the turbine. Therefore there is less kinetic or potential energy leaving device. Francis turbines are suitable for medium flow and head. The range of a medium head is 45-400m and flow rate is 10-700m^3 /s.

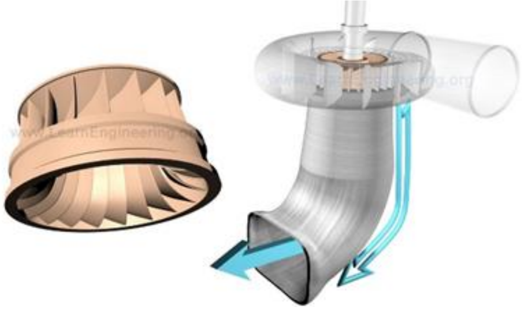


Figure 6 - Francis turbine

Kaplan turbine

Kaplan Turbines are used in low head, high flow areas to generate electricity. Often they are installed in areas where large reservoirs of water are present. Water flow is directed into the top of a tube and flows downwards through a propeller. The blades of the propeller can be manipulated to achieve more or less power output based on the flow of the water. The number of propeller blades is related to the head of the flow. Kaplan turbines are traditionally used in areas with a head of 2 - 25 meters. Kaplan turbines are capable of generating 200 MW as seen in dams. One of the challenges associated with a Kaplan turbine is the amount of infrastructure required to run the turbine. Due to the large flow rates handled by Kaplan turbines, they are the largest type if hydroelectric generator. The flow through the turbine is regulated by guide vanes at the top of the tube to ensure uniform flow over the blades. The flow exits through the bottom of the turbine in a draft tube to prevent cavitation. The water flows over the curved blades of the turbine and the reaction to this flow is what spins the shaft and generates power. This is shown by the Figure 6 below.

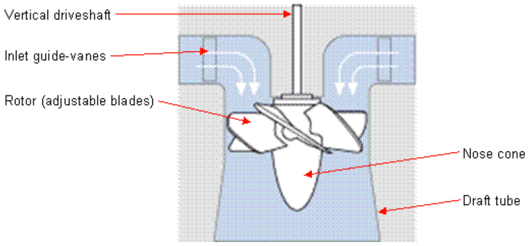


Figure 7 - Kaplan Turbine

Hydrokinetic Turbines

Hydrokinetic turbines are those in which perform efficiently in free-flow environments; meaning that that require little to no head to operate. Instead they are designed to capture the kinetic energy of a flowing fluid. Some examples of these turbines are axial flow rotor turbines and helical turbines. As shown in Figure 8 the axial flow turbines closely resemble that of wind turbine blades and boat propellers. Figure 9 displays a vertical-axis helical turbine. These types of turbines can also be orientated such that their longitudinal axis is in line with the flow.

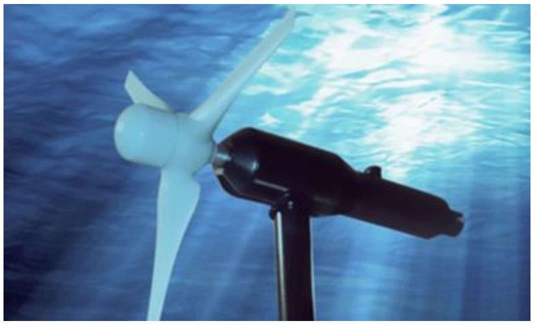


Figure 9 - Axial flow rotor turbines

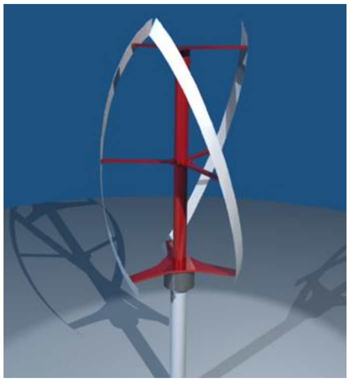


Figure 8 - Vertical-axis helical turbine

3.3 Alternator

Power generation can be produced through a generator or alternator. The decision to use an alternator has been determined due to the advantages over direct-current generators, which makes them simpler, lighter, and more rugged than a DC generator. The stronger construction of alternators allows them to turn at higher speed, allowing an automotive alternator to turn at twice engine speed, improving output when the engine is idling. The availability of low-cost solid-state diodes from about 1960 allowed auto manufacturers to substitute alternators for DC generators. The use of Brushless alternators will eliminate the hurdle of having a high RPM to generate the power needed for the project. Brushless alternators outputs a lower amperage but a higher voltage at lower rpm’s.

Alternators use a rotating magnetic field that induces a voltage in the windings. Since the currents in the stator winding vary in step with the position of the rotor, an alternator is a synchronous generator. The magnetic field can be produced by permanent magnets or a field coil electromagnet. A single cycle of alternating current is produced each time a pair of field poles passes over a point on the stationary winding.

3.4 Battery

Being an essential component of many electronic devices, the battery is one of the most researched devices in the field of electricity. It is important to understand that batteries come in many different sizes and designs. They are made of an array of different chemicals, and can store any amount of energy based on size. For the hydroelectric generator, mainly three types of batteries will be looked at; marine batteries (deep cycle), car batteries (starting), and Lithium ion batteries.

In general, a car battery is classified as a starting, lighting, ignition battery. As the terms suggest, these batteries are built to specifically start a car, and then secondarily to power the car's electronics and ignition system. In order to start the car, the car battery has to be able to provide a high power shallow cycle. In essence, what this means is that the battery has to be able to quickly generate a high current capable of turning an engine over so that it starts. This shallow burst of energy depletes most of the stored energy in the battery leaving it at a low capacity voltage. This low capacity voltage gets recharged by the car's alternator so that it will be able to turn on the car a next time. In the meantime while the car is already on, the low voltage is enough to power all of the car's electronics. In essence this is the case where the battery's storage was depleted too low to turn on the engine. A jump is required to provide the necessary burst of voltage to drive the high current needed to turn over the engine. A car battery is good for providing high bursts of energy for short periods of time, but not so much so for slow depletion over long periods of time.

On the other hand, another option for the battery would be the deep cycle marine battery. This type of battery is designed specifically to provide smooth consistent electricity over long periods of type. The deep cycle marine battery is ideal for storing energy which is discharged in small amounts over long periods of time. These batteries are built to hold more storage than a car battery in less space. The battery is more durable. Deep cycle marine batteries can be charged and recharged many more times than the counterpart car battery. The deep cycle design allows for a dependable smooth current for powering equipment that does not require high electric bursts.

The other type of battery being considered for the hydroelectric generator is the Lithium Iron Phosphate (LiFePO4) battery. The most noticeable difference between this battery design and the others is weight. Lithium Iron Phosphate batteries weigh considerably less than their lead acid counterparts. In addition, the Lithium Iron Phosphate battery has a very high energy density due to the high reactivity of the chemicals within the battery. For comparison, the Lithium Iron Phosphate battery can hold 150 Wh of charge per kg while the car and deep cycle batteries can hold 40 Wh per kg. Additionally, the Lithium Iron Phosphate battery can last a very long time compared to its counterparts, so it is durable. These things can live almost twice as long as the lead-acid counterparts.

Table 2- Comparison of Lead Acid vs Lithium Ion Battery

	Lead Acid	Lithium Iron Phosphate
Energy Density (Wh/L)	100	250
Speicific Energy (Wh/kg)	40	150
Regular Maintenance	No	No
Initial Cost ($/KwH) (Avg.)	120	600
Cycle Life	1,000 @ 50% DoD	1,900 @ 80% DoD
Typical State of Charge Window	50%	80%
Temperature Sensitivity	Degrades above 30ºC	Degrades above 45ºC
Efficiency	100% @20-hr rate 80% @4-hr rate 60% @1-hr rate	100% @20-hr rate 99% @4-hr rate 92% @1-hr rate
Voltage Increments	2 V	3.7 V

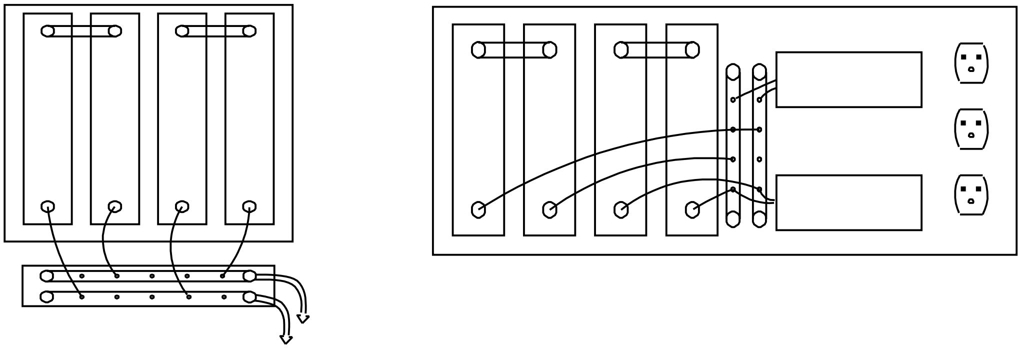


Figure 10 - Two pairs of batteries connected to the terminal for ease of transport

Figure 10 shows a conceptual design of a battery placement unit. Separating the full 1kwh storage into two different storage units of 500W each. There are four total cells that will equate to the energy storage needed and each cell will be paired together in series to increase the amp-hours of the module. This method of paring can help in ease of use for the customer in transporting a much lesser mass. An implementation of a simple terminal block will be used to connect the batteries to the alternator.

3.5 Anchoring

Sinkable Design

Sinkable anchoring systems, or those that use a weight to attach the device to the sea floor have advantages in that they can be placed at virtually any point in a stream of water. In addition they are fairly easy to secure as simply releasing it into the water will suffice. However it should be noted that specific anchors will hold better in different conditions. It is therefore recommended for the greatest anchoring security, you should carry two anchors of different styles. The Danforth style and the plow/scoop variety are shown below and offer different advantages. The type of bottom (mud, grass, sand, coral or rock) will dictate different choices of anchors.

Figure 11 - Scoop style anchor

Figure 12 - Danforth style anchor

This type of anchoring system would be geared toward a design such as a floating barge that requires something to prevent it from floating away. These anchors are efficient if the turbine is free flowing in the water.

Instead of using a combination of anchors to hold the device to the sea floor, an entire platform can be utilized in order to sink the entire device to a depth that is just above the riverbed. An example of this is shown below. An advantage to this design is in its simplicity. However a disadvantage to this type of riverbed anchoring is that in order to retrieve the device one must dive to the bottom to pull it up or use a rope to drag it out of the water.

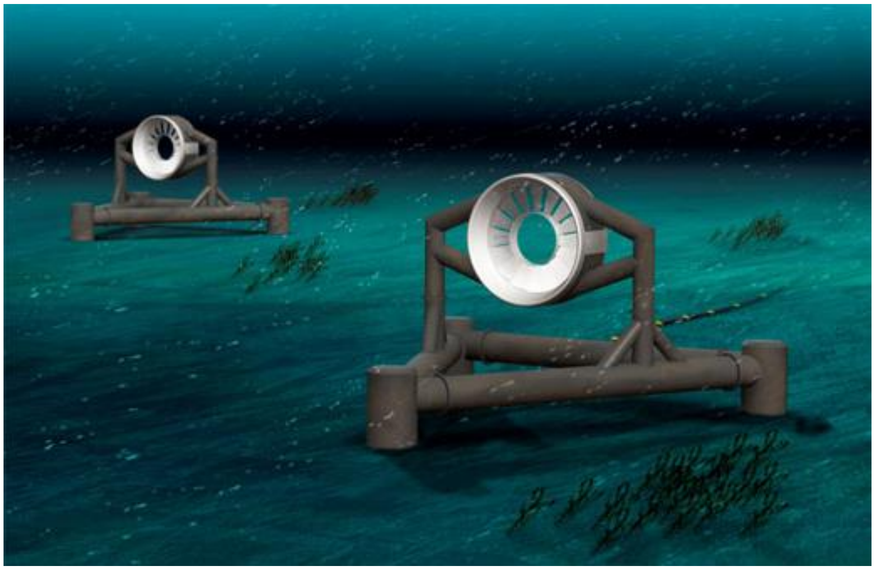


Figure 13 - River bottom anchoring style

Cantilevered Design

The anchoring for this system is achieved by pinning down one side of a elongated light structure to the side of a river bank. The sound foundation is formed by penetrating spikes into the ground. The generator system will be introduced into the water at the other end of the anchoring structure to the desired location as demonstrated in Figure 14. Figure 15 depicts another example of a cantilever system in which it has the ability to slide out to extend into the body of water. This makes the whole anchoring structure act like a cantelever as shown in Figure 10 below. Strong moment forces will be felt by the anchoring structure due to the weight of the alternator and turbine as well as the force due to the flowing river. This is a challenge when selecting a material for the anchoring structure. This design allows for the user to install the generator from one side of the river and does not require the user to enter the water.

Figure 14 - Cantilever style anchoring system

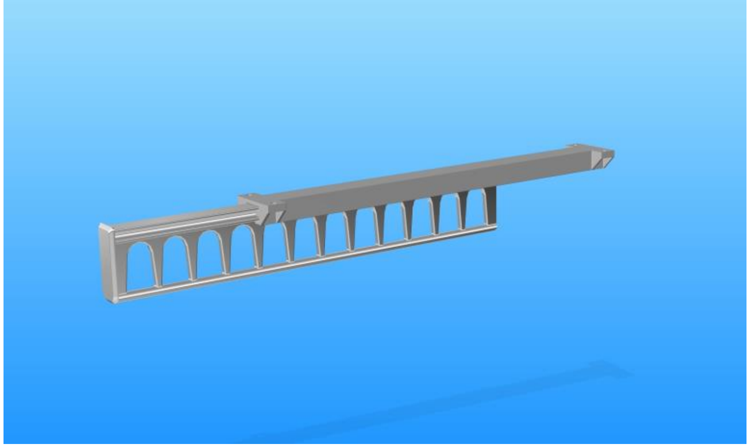


Figure 15 - Cantilever conceptual arm design

3.6 Gear Train

The gearbox design will take a torsional shaft torque and turn it into a high rpm rotation. With analysis of the toque, a metal gear box system will be selected to avoid wear and catastrophic failure. The desired rotational speed in the alternator within the generator will be around 1000 rpm to achieve sufficient power generation. Once the turbine blade design is complete, torque input into the gear box can be calculated with the turbine radius and acting forces caused by the fluid flow of the stream. The gear type may maintain a linear input and output shaft rotation with the use of spur or helical gears. The output shaft may also be able to change orientation with the use of bevel gears.

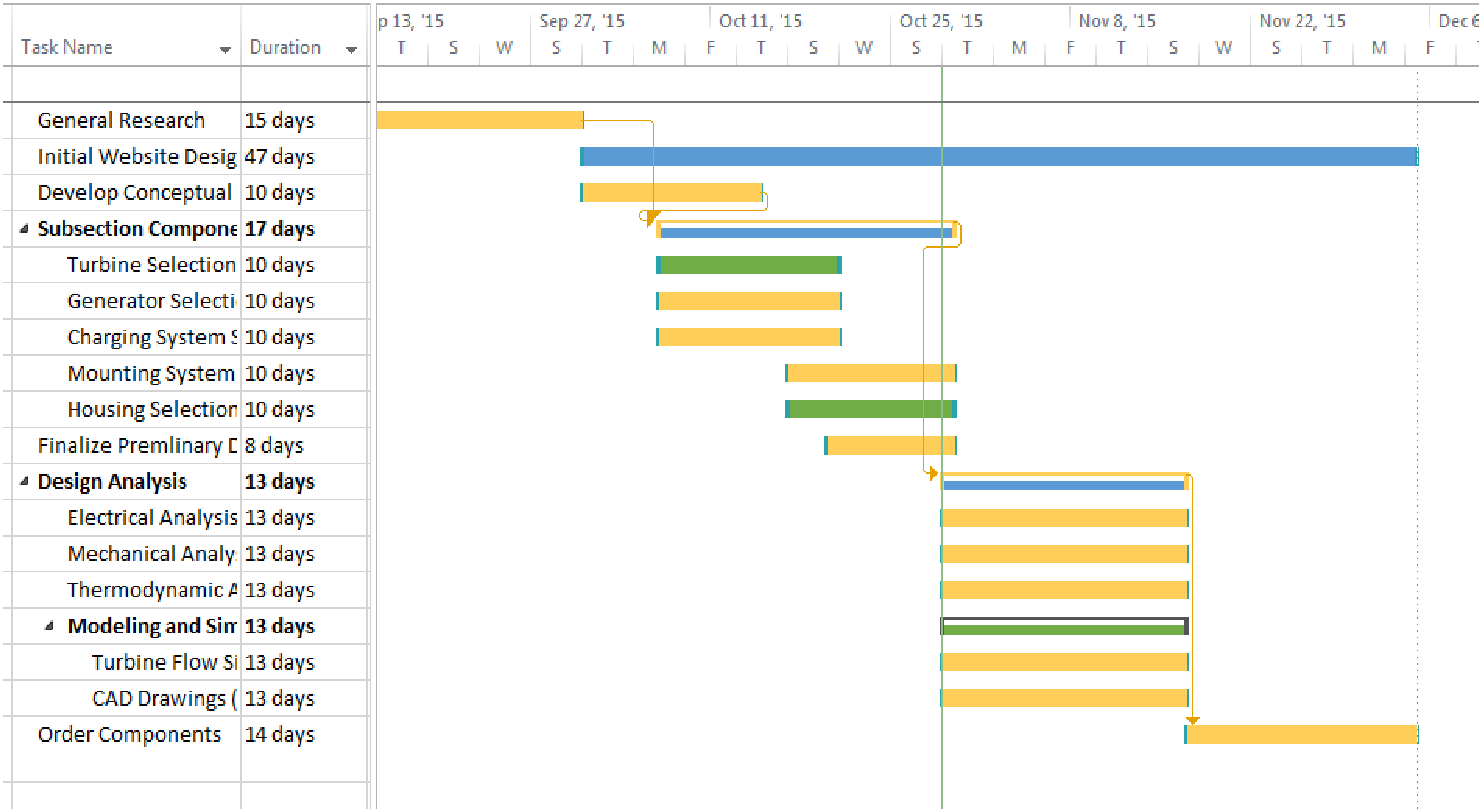
3.7 Housing

The mechanism in the water should be fully enclosed in a waterproof casing, besides where the water meets the fin so that the electrical components do not fail and the mechanical components are less likely to corrode. A strong, transparent plastic that will withstand the beating of the current and allow the user to inspect the mechanism is important for maintenance as well.

3.8 Wildlife Impact

A major concern with introducing a power system into a river or stream is the effect on the ecological system. Turbines that channel the kinetic energy of flowing rivers may interact with the wildlife like fish and snakes. A study showed that with a turbine that reached rotation speeds of 70 rpm in a subtropical river, fish movements were recorded to avoid collision with the turbine. In fact, the study showed that no fish collided with the turbines and only a few specimens passed through the turbine during the testing period. It was shown that fish slowed and then seemed to actively avoid the turbine fixtures.[7]

4 Scheduling and Resource Allocation



Task Name	Duration
General Research	15 days
Initial Website Desig	47 days
Develop Conceptual	10 days
Subsection Compone	**17 days**
Turbine Selection	10 days
Generator Selecti	10 days
Charging System	10 days
Mounting System	10 days
Housing Selection	10 days
Finalize Premlinary	8 days
Design Analysis	**13 days**
Electrical Analysis	13 days
Mechanical Analy	13 days
Thermodynamic	13 days
Modeling and Sim	**13 days**
Turbine Flow Si	13 days
CAD Drawings (	13 days
Order Components	14 days

Figure 16 - Gantt Chart

The schedule was generated using a Gantt chart and covered the duration of the first semester of senior design. The schedule consisted of tasks that were determined to be critical to the completion of the project and organized in a manner to maintain a pace that would ensure the team reached their ultimate goal by the end of the semester which was to order parts for the construction of the hydroelectric generator. The tasks were divided amongst the group according to the strengths of the individual members. Currently the group is slightly behind schedule by a margin of a few days but plans to make up that ground during the duration of design analysis and does not expect this to affect parts being ordered on time.

5 Results

There are several challenges that we face encounter while designing and testing this product. A method of dispersing the heat associated with energy generation is essential to maintaining the integrity of each component. Too much heat can seriously damage electrical components or compromise the strength on any metals. Waterproofing the housing of the device will be crucial as well, because any water introduced into the electrical components of the generator will cause the entire device to fail. Next, the gearbox must be designed so that the necessary RPM can be maintained to achieve proper energy generation. The RPM generated by the force of the river alone will not be enough to generate the required energy. Therefore, a gearbox must be designed to increase the RPM to a speed that will produce a desirable amount of energy. Another challenge will be submerging the apparatus to a proper depth. Water speeds at the surface can be slower and inconsistent, while speeds at deeper depths are faster and more laminar. Overcoming the forces acting on the anchoring device is going another major hurdle in our design process. The water acting on the generator will create a very large force at the end of the beam, creating a huge torque on the land-based anchor. FMEA will need to be done to determine the locations of the greatest stresses and locations where the device might fail. All of these challenges will need to be faced, all the while keeping the design compact and easy to assemble. If the design becomes too large or complicated, it will not be desirable to consumers.

Because of the entrepreneurial nature of this project, more research has needed to be done in order to determine the scope and constraints of this project. Because of this, no testing has been completed at this point. Analysis is being done at this point to further refine the design, and to optimize each component of the design.

Table 3-Decision Matrix for Turbine Selection

Criteria	*Importance Rating*	*Francis*	*Kaplan*	*Hydrokinetic*
Weight	3	2	3	5
Cost	2	3	2	3
Manufacturability	3	2	2	4
Durability	4	2	3	3
Efficiency	4	3	3	5
Total		38	43	65

The axial flow rotor turbine was eventually selected due to its relatively high efficiency and its ability to be oriented with the flow of the stream. Additionally it is optimized for a low head and high flow application which are the conditions that our system will be under.

Table 4-Decision Matrix for Battery Selection

Criteria	*Importance Rating*	*Li-Ion*	*Lead Acid*	*$LiFePO_4$*
Weight	3	4	1	3
Cost	4	1	4	1
Safety	3	2	3	3
Durability	4	3	1	3
Efficiency	4	3	2	4
Total		46	40	50

The selection of a LiFePO4 (Lithium Iron Phosphorus) battery was determined through research and comparison to other types of batteries. These batteries are more expensive but lighter in weight when comparing their Energy Density to lead acid batteries. They are also safer than traditional lithium ion batteries and have a higher Specific Energy.

Table 5-Decision Matrix for Anchoring Selection

Criteria	*Importance Rating*	*Water Based*	*Land Based*
Weight	2	2	1
Cost	2	3	2
Safety	3	1	4
Durability	4	3	2
Ease of use	3	2	4
Total		31	38

We determined that the best anchoring method for this application would be to use a land based cantilever system. This option gives the customer a safer method of setup without having to step into the water's stream thus reducing the risk of injury from fast currents taking someone off their feet. Additionally the ease of removal of the device from the river will be improved if one doesn't have to dive underwater in order to retrieve it.

Table 6-Decision Matrix for Generator/Alternator Selection

Criteria	*Importance Rating*	*DC Generator*	*AC Alternator*
Weight	3	2	3
Cost	2	3	3
Safety	3	3	3
Durability	3	2	4
Efficiency	4	2	3
Total		35	48

An alternator was ultimately chosen over a DC generator due to the fact that it is more efficient in producing power under low rpm. Also alternators by design are lighter than DC generators on a weight per power generation basis. Also when producing the current and voltage by the alternator the use of brushes and slip rings are not needed which are prevalent in dc generators making the generator more cumbersome in maintenance.

6 Conclusion

This team has been tasked with developing and marketing a method of getting clean electricity into remote areas. For the environmentally conscious outdoorsmen, hydroelectric energy can be an appetizing alternative to burning fossil fuels. Currently, the only viable way of producing hydroelectric energy is by installing permanent fixtures that can be costly, labor intensive, and damaging to the environment. After weeks of research, the team has decided upon a conceptual design that has been divided into several distinct components. The team is currently finalizing component selection and putting these components together into a final design. In the coming weeks, CAD drawings will be finalized, and analysis will begin to determine the forces on the device.

7 Risk Assessment Summary

During the designing of the project, many risks have been brought into notice. While dealing with electrical equipment, like the alternator and battery, harm can come to the operators due to the system being within a water medium. The river water flow may also be fast enough to harm the operators where drowning is a possibility. While building the system, misuse of equipment like power tools an improper handling of heavy equipment can also be an issue. All of these issues will be remedied through the use of eye, ear, and hand protection as well as the use of safety flotation devices while working on testing the system in rivers. The use of PPE will help avoid accidents all together. A CPR certified individual will be present during the testing of the system in the case of an accident. All accidents will be dealt with seriously and the proper authorities will be alerted of any accidents during the project.

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9 Biography

Joseph Bonfardino:

Joseph is a native of a small city in Central Florida called Spring Hill. From a young age he always had an inquiring mind wondering how and why things work the way they do, and this lead to a thirst for knowledge. Joseph graduated from Central High School in 2012 with his Associates of Arts Degree, and then moved to Tallahassee, FL to further his education. Currently, he is a Florida State Senior studying Mechanical Engineering with a technical track in Thermal Fluids. Upon graduation in May 2016, he plans to start his career in a renewable energy industry.

Galen Bowles:

Galen Bowles is a senior mechanical engineering student at Florida State University with a focus in Thermal Fluids. Galen was born in Alexandria, Louisiana but grew up in Panama City, Florida where he graduated from the local state college, Gulf Coast State College. After Florida State, Galen plans to remain in the Florida panhandle and continue work and research on renewable energy conversion systems.

Brendan McCarty:

Born in Kansas City, Brendan moved to South Florida at a young age and loved working on the family boat with his father. A senior at FSU, Brendan plans to graduate in the Spring of 2016 with a Bachelor of Science in Mechanical Engineering. Currently taking classes in the Material Science track, Brendan plans to get a job in the same field, hopefully somewhere in the Southeast.

Parth Patel:

Parth is a senior at Florida State University pursuing a Bachelor’s degree in Electrical Engineering. Born in Atlanta, Georgia but my upbringings can be credited to Tallahassee, Florida. Growing up his fascination in how electronics and power tools were designed played a big role in pursuing an engineering degree. Since January of 2015 he has been working at Florida State University’s Utilities and Engineering services, learning and managing the power distribution network within the university.

Shane Radosevich:

Shane Radosevich is a senior in Mechanical Engineering at Florida State University completing his final year. He plans on working after graduation for himself or in a management position for a large company. He hopes to combine his real world experiences with knowledge gained from his mechanical engineering degree to creatively design solutions to problems in life. Born in Allentown Pennsylvania and having lived up and down the east coast Shane has many experiences and real world knowledge about culture having traveled over most of the United States and numerous other countries.

Ilan Sadon:

Ilan is a senior graduating in May of 2016 with his BS in Electrical Engineering. He spawns from the wetlands of Miami Beach, FL. The man is one of the two electrical engineers on the project bringing his expertise in the subject to the team. Ilan's interest into the field began as a sophomore in his Physics II class, when he realized how much more electromagnetics appealed to him than the civil engineering track.

Brandon Shaw:

Brandon Shaw is a senior mechanical engineering student at Florida State University. Brandon was born and raised in Saint Johns, Florida until his move to Tallahassee for college. He has a held a sales management role since arriving in Tallahassee and continues to work at Ring Power Corporation in the heavy equipment parts department. Brandon has also had three internships during summers to further his understanding of the mechanical engineering field. These internships include the following: mechanical engineering intern at Phoenix Products which is the power systems division of Ring Power Corporation, a reliability and maintenance engineering internship at CEMEX USA, and a technical research and marketing internship with Polston Applied Technologies. Brandon's future career will involve either engineering sales or project management.

Mathew Vila:

Matthew is a born and raised Floridian who grew up in the South Miami area. He is a representative for the American Society of Mechanical Engineers (ASME) at the FAMU-FSU College of Engineering. His focus is on Materials Engineering and plans on working in the medical field with prosthetics and joint replacement design.