Team 16: Kite Generator

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1.1 Project Scope

The purpose of this project is to provide affordable power for areas that do not have a reliable major source of power. The idea is to harness the energy of the wind without constructing a permanent wind turbine. Conventional wind turbines need a permanent setup and require a high amount of maintenance. Kite power allows for maneuverability and less maintenance due to less mechanical parts. Primarily, the project will catalogue and engineer a wing, and design a functional generator based on the available wing sizes and two or four motor autonomous drone capacities.

1.1.2 Key Goals

- Catalog engineer an aerodynamic fixed wing aircraft capable of autonomous flight in oscillating sustainable patterns, while attached to a grounded tether.
- Build and test a model
- Convert oscillating airfoil flight path into electrical power.
- Iterate oscillating motion with varying wind speeds.

1.1.3 Markets

Primary Market
- Underdeveloped and Developing countries

Secondary Market
- Disaster relief
- Potential to replace fixed wind turbines
- Small scale recreational use

1.1.5 Assumptions

- Variable wind speeds.

1.1.6 Stakeholders

- Jeff Phipps (Sponsor)
- Ron Pandolfi (providing fixed wing aircraft)

1.2 Customer Needs

The knowledge required for the Customer Needs Table quickly materialized after the Senior Design team asked Jeff Phipps some short questions, during a very brief sponsor meeting. The team targeted Mr. Phipps with broad questions, eventually leading into more specific questions. The team inquired about what the sponsor's primary goal is for the project, the motivation behind the sponsor's involvement, and what the sponsor expects from the team throughout the year. These more abstract questions cut down a significant amount of excess unnecessarily details from the project that may be better left to future project teams. The design team then laid out more questions in order to produce very clear and concise responses. These questions focused on the sponsor's satisfaction with the previous year's results and what aspects of the design this year's team should focus on to produce more satisfactory project outcomes. Combined, these questioned enabled the design team to narrow down the customer needs and focus on the project scope definition. Reduction of the abstract, qualitative initial problem statement also provides the team with an excellent direction of where to achieve quantitative benchmarks to aim for.

Table 1.
Customer Needs Breakdown

Prompt	Customer Statement	Need Statement
Suggested Improvements	Have the generator change electrical currents.	The airfoil generator can convert AC to DC
	Can maximize the power generated by airfoil.	The airfoil can fly in assigned patterns
Applications	Can be used for disaster relief.	The airfoil can be transported to various sites
	Can work in excessive wind speeds.	The airfoil generator operates normally in high winds.
	Can be used multiple times.	The airfoil generator operates normally after repeated uses
Dislike	Makani design is too bulky.	The weight of the system is reduced
	Much less material than a wind turbine.	Better energy to weight ratio than wind turbine

Likes	Doesn’t have to be kept in one place for lifetime of kite.	The airfoil can be moved to various locations
	Can reach better speed winds than a wind turbine.	The airfoil can fly in higher altitudes reaching higher speed winds

1.3 Functional Decomposition

The functional decomposition aims to break down the complex airfoil generator system into smaller sub-sections. Each breakdown describes the desired function of the component in order to achieve the needs of the customer. Below is the overall system decomposition and the component functional decomposition of each component.

1.3.1 Overall System Decomposition

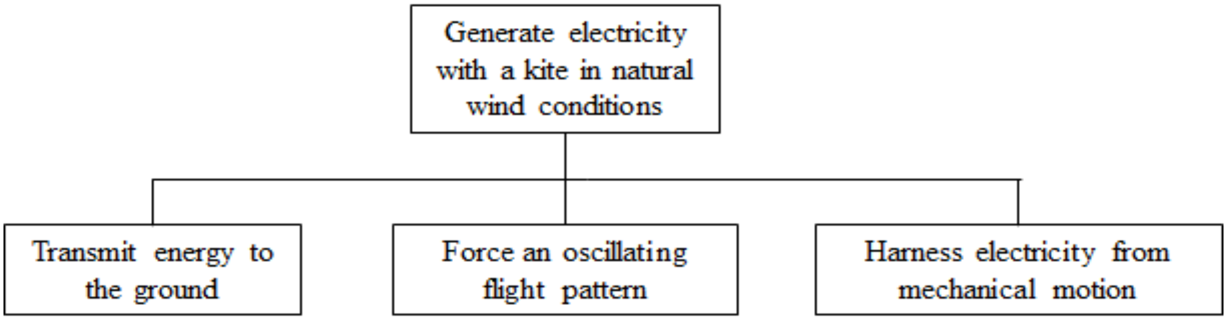

Figure 1. Overall Functional Decomposition of system.

1.3.2 Components of Kite Generator System

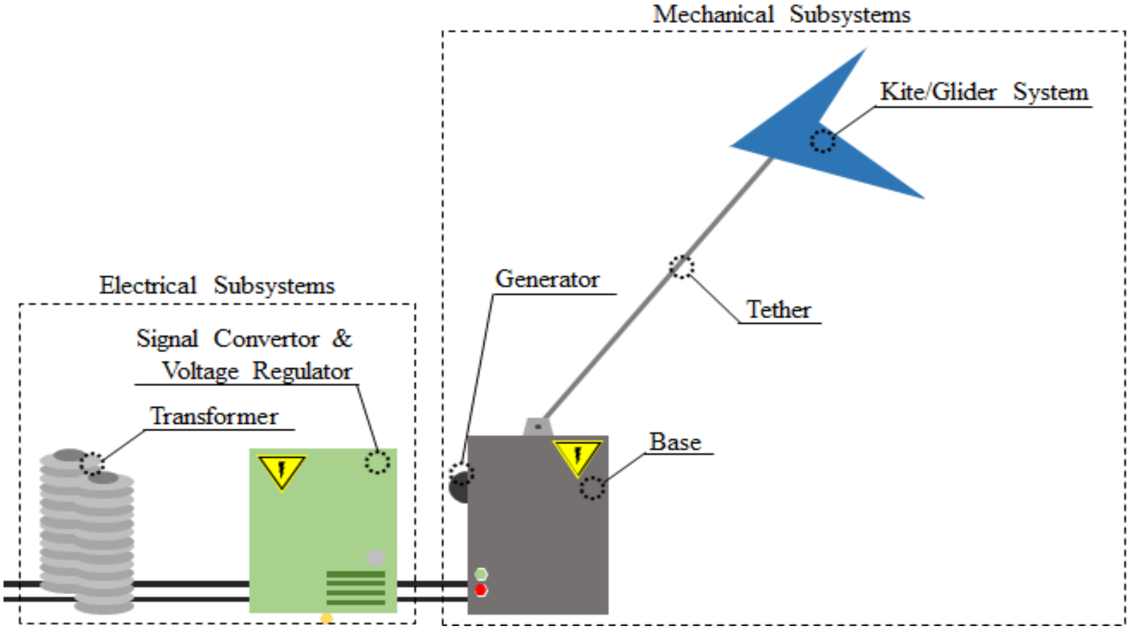

Figure 2. Sketch of the primary components.

Glider Subsystem

The Glider component of the system is the most essential towards the overall performance of the project. It requires a method of takeoff and landing, and performs steady glide control. These features will require crucial sensors and actuators in order to control the dynamic system.

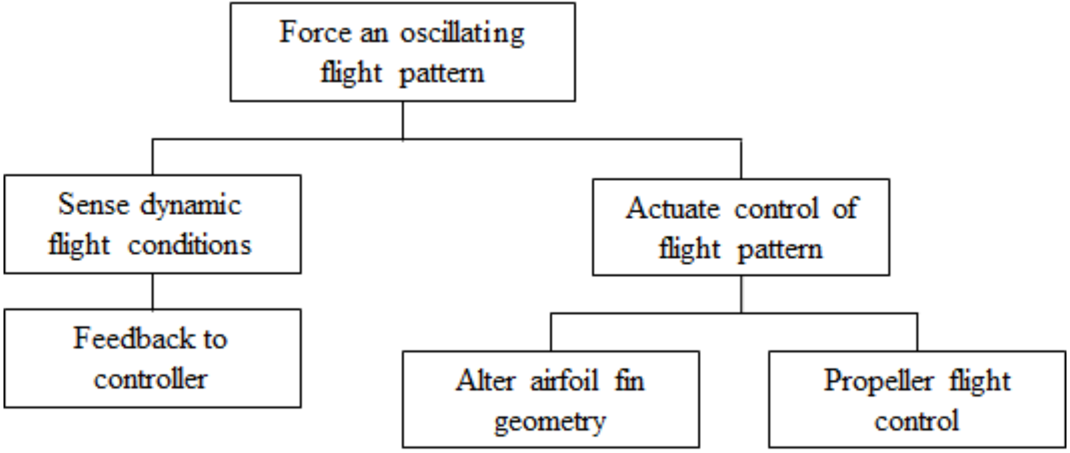

Figure 3. Glider Subsystem functional decomposition.

Tether Subsystem

Although the simplest subsystem in the entire system, the tether is essential to the success of the project. Failure in the tether system would result in catastrophic results, possibly beyond repair. A bulky tether system design may interrupt flight patterns and decrease efficiency.

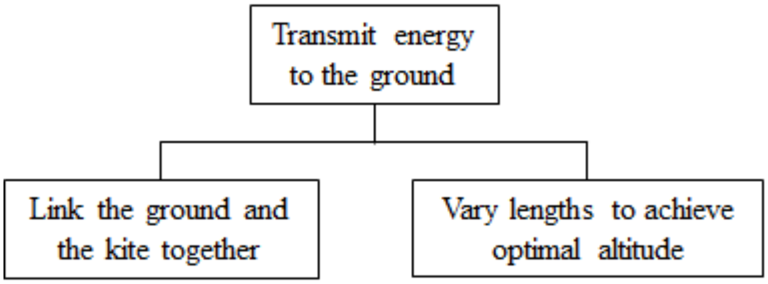

Figure 4. Tether Subsystem functional decomposition.

Base Subsystem

The Base Subsystem is the least essential to the project. Overall, it could be dramatically simplified through the prototyping of the project. The end project design should keep the housing in mind as a finalized product should incorporate some weather proof casing and additional features. A functional decomposition of this system was not performed as it does not fulfill a primary function and holds such a low priority.

Generator Subsystem

All large scale commercial generators convert mechanical rotation into electrical energy. Even in the case of a car engine, where linear mechanical motion is converted into rotational before being passed through an alternator. This fact guides the subsystem design to consider some mechanical power conversion to another form of mechanical power, prior to electrical conversion.

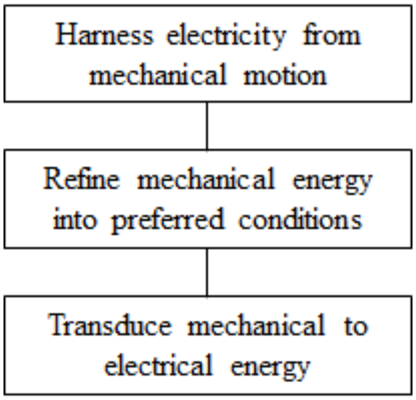

Figure 5. Generator functional decomposition.

Electrical Subsystems

Much like the Base Subsystem, every post generation electrical subsystem currently holds a low priority to the project. The project's innovation exists within the mechanical components of this project as currently existing electrical components already exist to fulfil the functions required for the success of this project.

1.4 Target Summary

Targets of the Kite Generator system are determined for each function of the system. The targets are defined by metrics to measure and achieve the aforementioned functions. Data analysis and customer preference dictate each target and its metrics. As seen in the Target Catalog in Appendix C, 5 kW of power output is set as a suitable target for the kite generator system. The power index is obtained by benchmarking gas generators currently on the market which usually yield 8-10 kW of power. These generators are typically used to power products necessary for life such as electric stovetops, light, and food refrigeration. Referencing the average power and surges for these products, our group feels that 5 kw is sufficient to provide necessary power to individuals following disaster situations.

Another key target is to keep the combined weight of all the subsystems under 200 lbs. with each subsystem weighing less than 50 lbs. With the principles of portability and disaster relief in mind, two people should be able to assemble, operate, and disassemble the kite generator system.

The last notable target was the power to weight ratio of the overall system. The power to weight ratio helps to facilitate comparisons between different forms of sustainable energy as well as other kite generator companies such as Makani. Aiming to produce 5 kW of power with a maximum weight of 200 lbs, the power to weight ratio of the whole system calculates to 25 $\frac{W}{lb.}$.

Some targets were developed with the help of Physics equations shown below.

$$P = I * V \qquad \text{Eq.1}$$

$$V = I * R \qquad \text{Eq.2}$$

$$P = \frac{B^2 * A * L}{(dt * \mu)} \qquad \text{Eq.3}$$

From these equations the team concluded that the strength of the magnet, $B,$ as seen in the equation above, has a significant impact on the overall power produced. Based off the facts the group found the strongest magnet on the market, Neodymium, which operates at 1.32 Tesla. Further examining the power equation, the team evaluate the length, L, and cross sectional area, A, of the inductor. The inductor and its wrappings should possess a weight under 50lbs while covering the largest possible volume. Area and length of the solenoid have initial values of 0.018 m^2 and 1 m, respectively. These values may change following experimental analysis of the induced voltage power generation. This and future experiments will provide the necessary data for confirmation or alteration of the existing targets.

1.5 Concept Generation

To facilitate the concept generation, each member of the group was instructed to find individual background research on the power generation and kite aeronautics. Members were encouraged to perform background research on basic theories and benchmark companies with similar products. Each member then presented his or her own ideas without any interruption or criticism. This technique produced maximum concept generation and chemistry between members. Following every member's presentation, the group debated the concepts to keep, join, and discard producing the list below.

Power Generation Concepts:

Concept 1

This design consists of a slidable permanent magnet attached to a spring disposed within a housing which also contains tightly wrapped inductor coils. As the lift force increases, the tether will pull the magnet through the inductor coils, producing an emf. When the lift load decreases, a spring will bias the magnet in the reverse direction, which will then again produce an emf. This repeated motion will generate electricity. The housing pivots with respect to the direction of the attached tether. This design was the original build suggested by the previous design team during 2016.

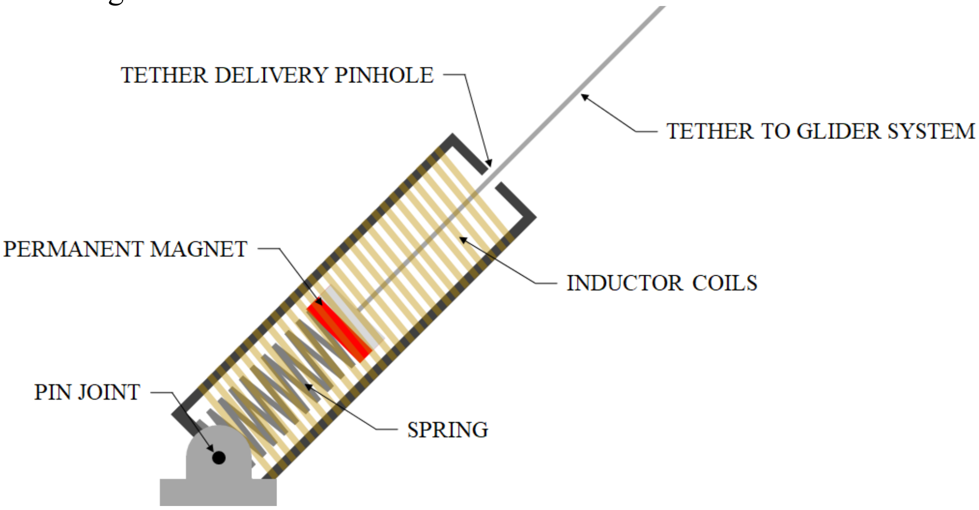

Figure 6. Spring Loaded Design Basic Schematic.

Concept 2

This design is similar to the previous concept, but rather than a spring, gravity is solely used to pull the magnet back to the ground.

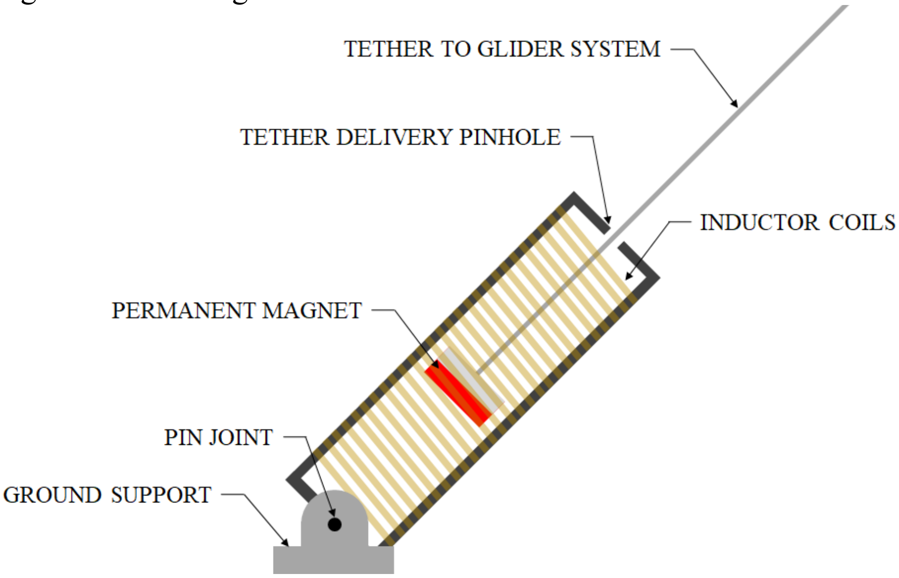

Figure 7. Gravity Fed System Basic Schematic.

Concept 3

This design is similar to the previous designs but now a tether spool allows for varying length of the tether. When the kite reaches a sustainable altitude, the tether is clutched to make sure the magnet is able oscillate. Additionally, the movement of the magnet is assisted by a spring. Unlike Concept 2 and 1, the magnet is oscillated in a fashion which eliminates the additional stress applied by gravity.

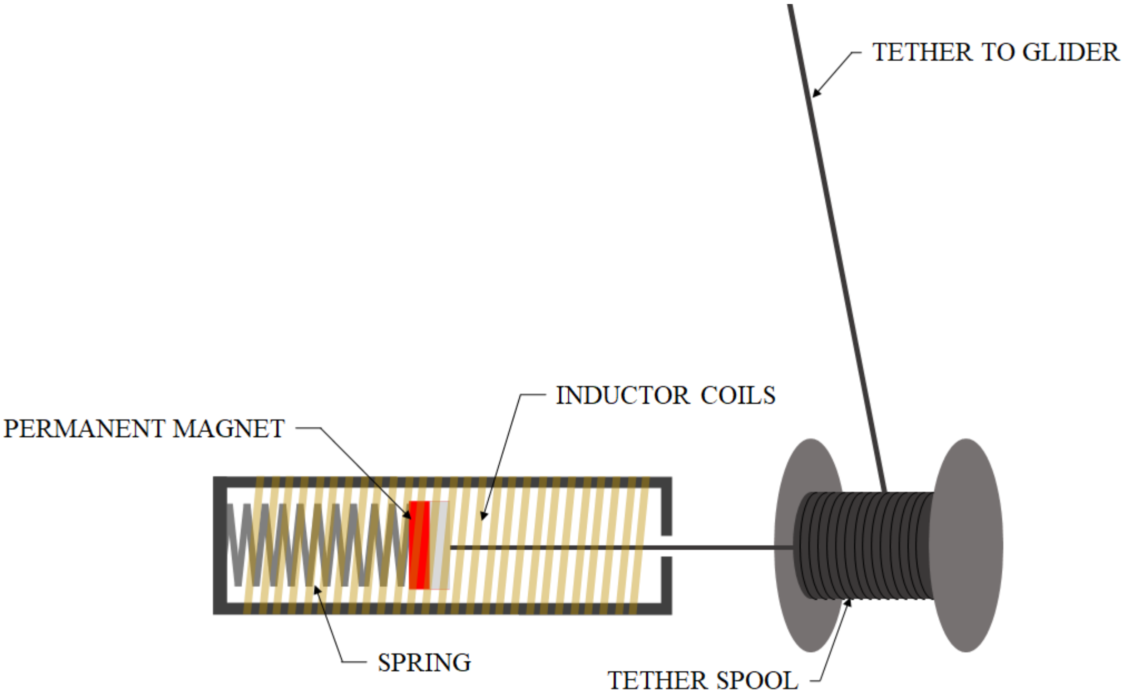

Figure 8. Spring Assisted System Basic Schematic.

Concept 4

Concept 4 utilizes two kites attached to opposite sides of the same solenoid. Depending on the movement of the wind, one of the kites will pull more strongly on the magnet, and the oscillation will generate electricity. In this design the housing is stationary.

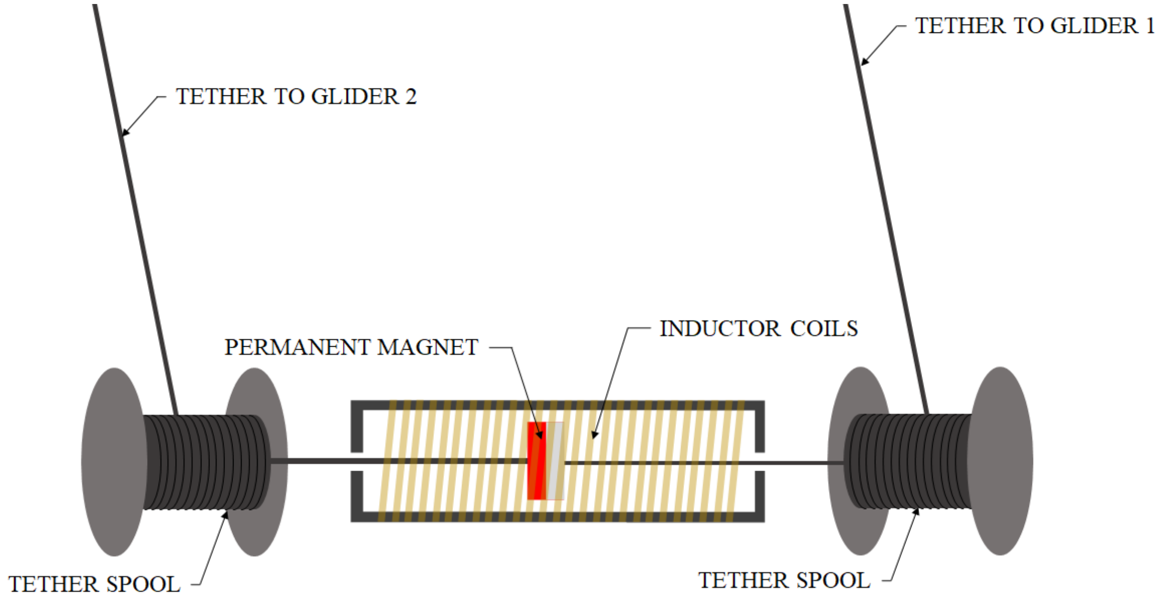

Figure 9. Dual Glider System Basic Schematic.

Concept 5

Concept 5 uses Concept 2’s gravity fed build, but includes a transmission system. This transmission could include a clutch and a gear train such so that the force applied to the tether could be increased or decreased based on varying conditions.

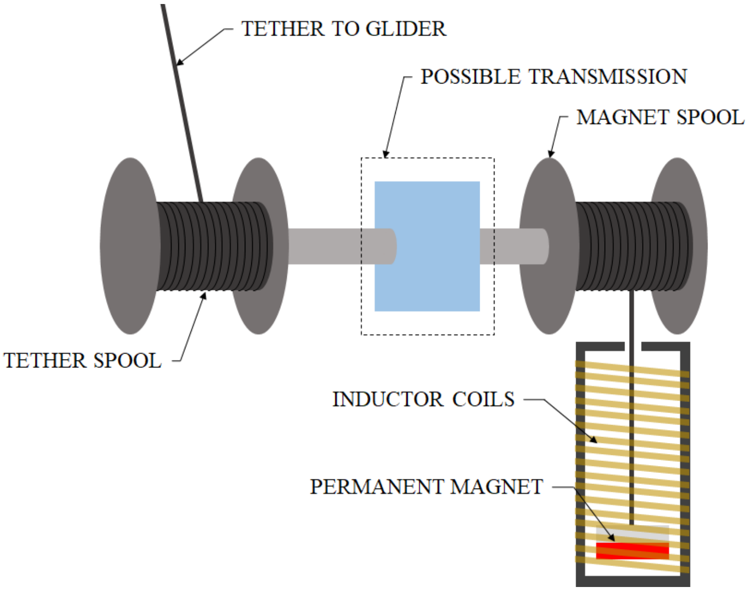

Figure 10. Gravity Fed System with Transmission Basic Schematic.

Concept 6

Concept 6 uses a similar build to Concept 5 and Concept 3, using the transmission and the spring assisted system without the influence of gravity.

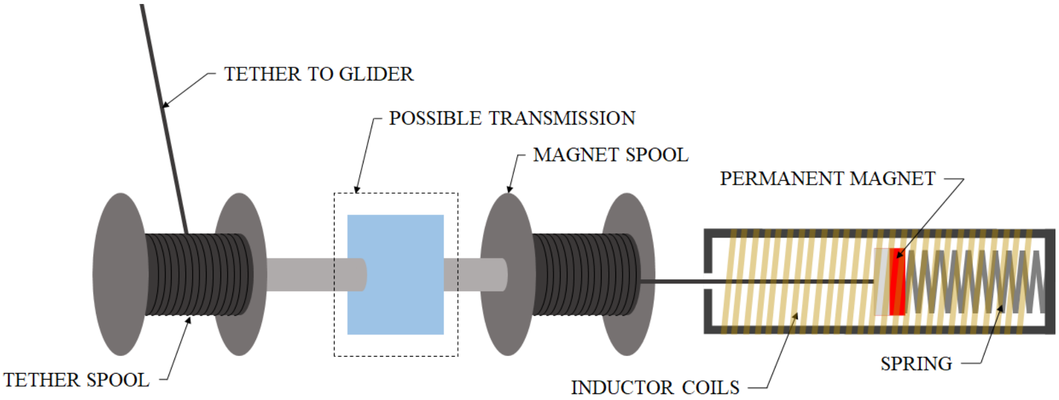

Figure 11. Spring Assisted System with Transmission Basic Schematic.

Concept 7

Much like the previous concepts, this concept is an expansion of Concept 4 combined with the transmission expansion of the other ideas. Two gliders in 180 degree offset flight help rewind and unwind each other as they force the drive shaft to oscillate. Here a flywheel is included to dramatically increase the freedom of the motion of the glider's flight. This flywheel could be included as the transmission discussed in any of the designs which harvest the rotational momentum of a spool.

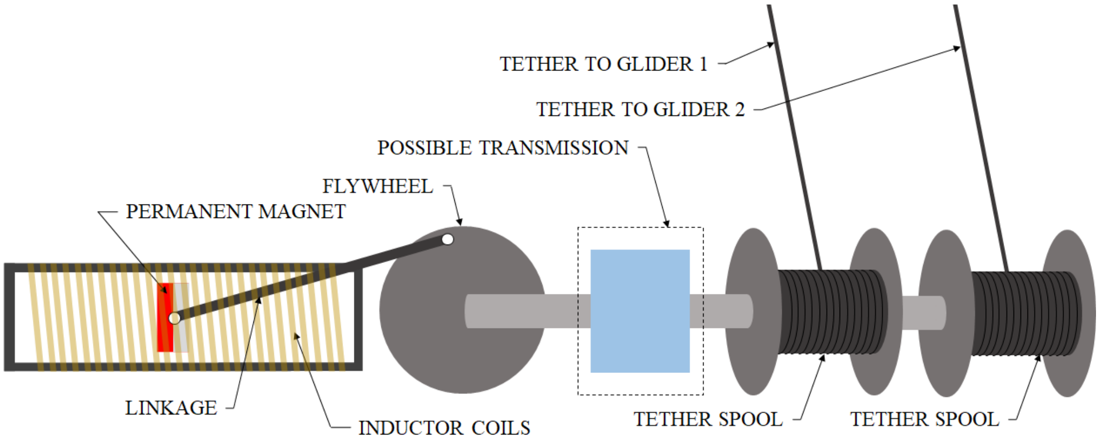

Figure 12. Dual Kite System with Transmission Basic Schematic.

Concept 8

Concept 8, 9, and 10 are iterations of the previous designs with one major change. Instead of using the solenoid, the team thought it wise to consider alternative methods of electrical power collection. Concept 8, 9, and 10 yield no new ideas but include a standardized alternator attached to the main shaft of the systems rather than passing the motion through a solenoid magnet pair. The three concepts build off of the gravity fed, spring assisted, and dual kite oscillation builds

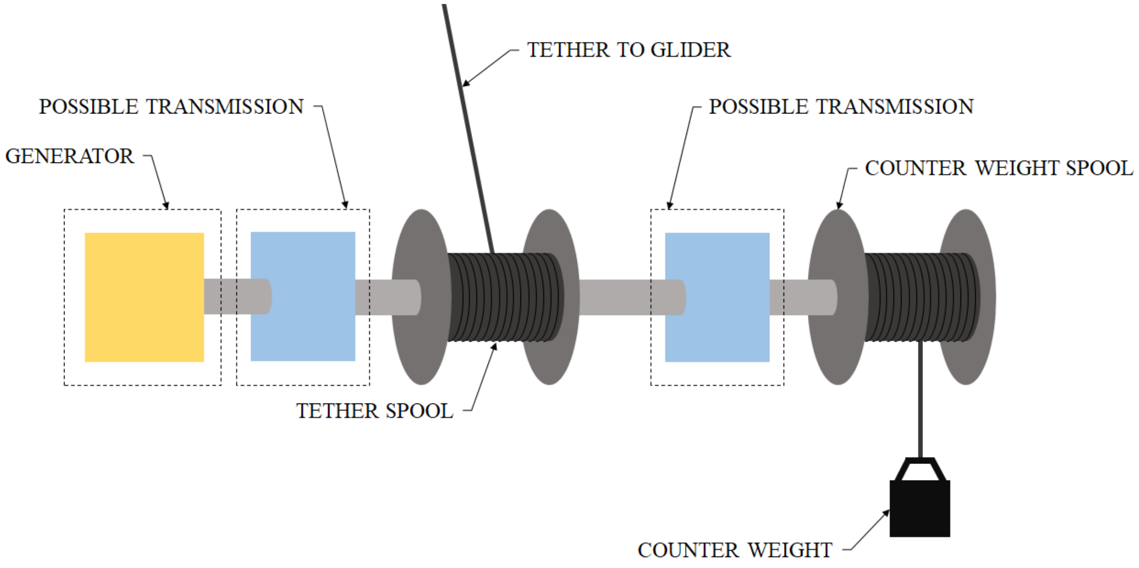

Figure 13. Gravity Fed Alternator System Basic Schematic.

Concept 9

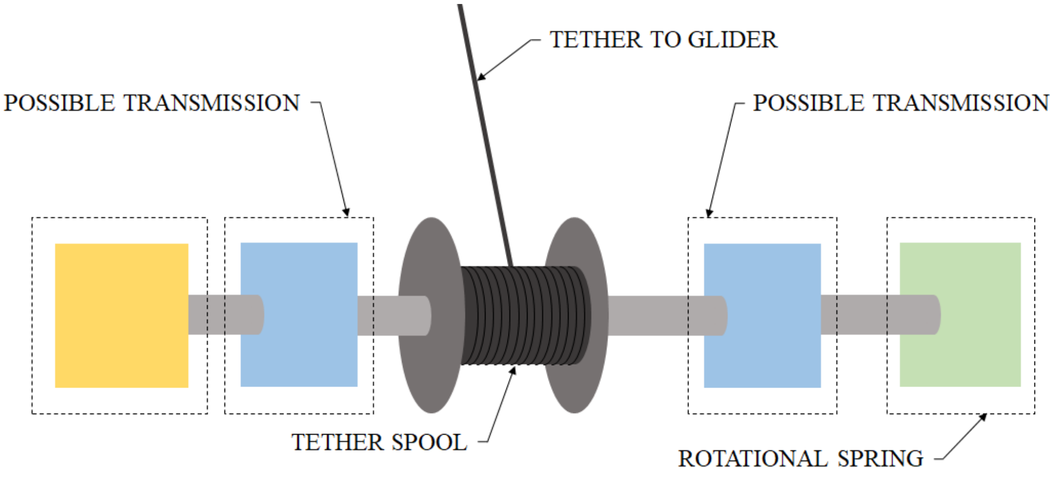

Figure 14. Spring Assisted Alternator System Basic Schematic.

Concept 10

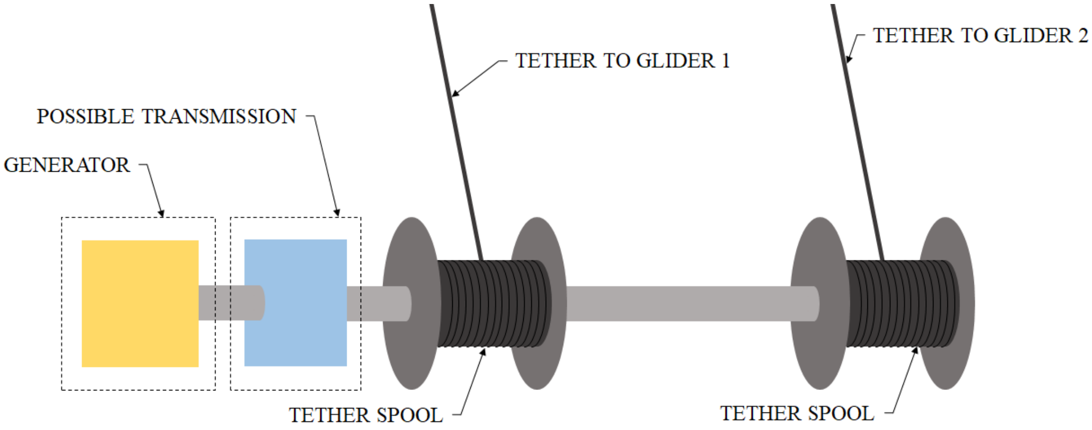

Figure 15. Dual Kite Alternator System Basic Schematic.

Concept 11

Concept 11 goes way out of the project scope's range, as the team was requested to study the capability of harvesting the motion of a glider with a ground centralized generator. The reasoning behind this restraint was because most of the power generation systems that rely on airborne turbines have already been patented. However, one concept was thought of, and written down just in case it proved to open the door for other ideas. Here in Concept 11, solenoids can be built onto the glider system with a freely unrestrained magnet within them. Upon any form of angular change, the magnets within the solenoid will fall to the lowest point possible, and generate emf as they move. This concept seems out of the ordinary when considered for large scale systems, but might prove beneficial for powering onboard sensors.

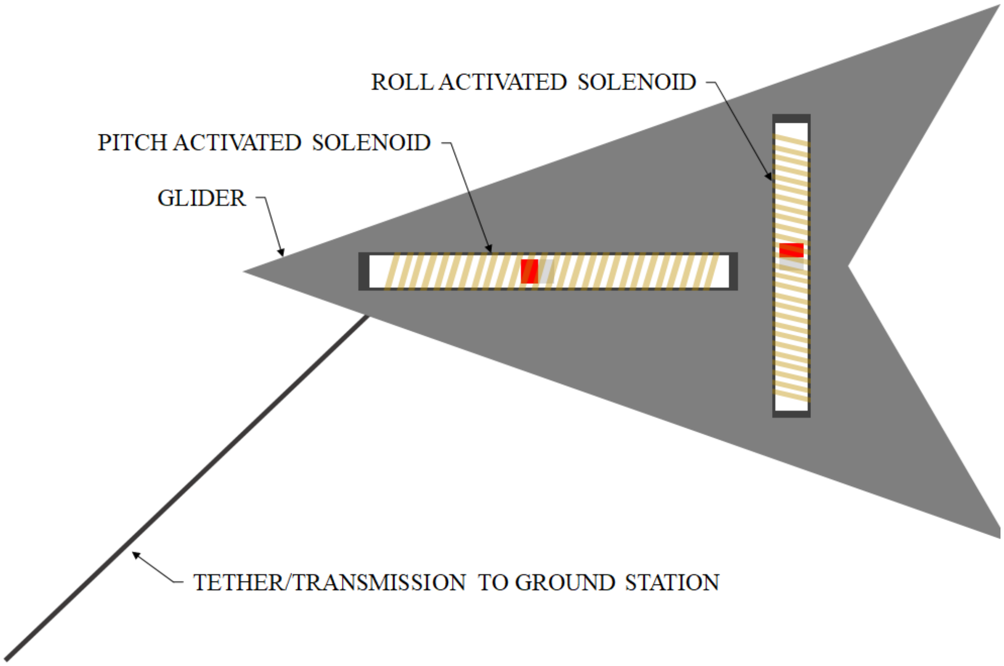

Figure 16. Solenoids Built Onboard Glider Basic Schematic.

Glider Delivery System Concepts:

Much of the team's focus has been centralized around the different methods of harvesting the generated power of the glider's motion. The success of this function is independent on the glider and it's ability to lift itself into the air. So the design team took a modular approach to the concept generation, and began considering a new pair of concepts to fulfil the other requirements.

Concept 12

With the next concept the group focused on finding a way to have the fix wing aircraft lift itself up to the desired height. Therefore, in concept 12 the aircraft has propellers that can move the aircraft in a vertical position and also change to be able to move in a horizontal position. The autonomous portion of the aircraft can change the orientation of propellers in order to create the desired motion. This concept has similarities to a conventional drone in which the takeoff and landing can be controlled.

Figure 17. VTOL Glider Example Image from FAMU/FSU CoE [1].

Concept 13

This design is the only build that considers not using propellers. It is the simplest design and is the only design that does not require electrical input to get the glider into the air. As every other design concept requires some initial energy to setup the system to a desired altitude. Unfortunately, this system has some major drawbacks to these huge advantages. Creating a fully autonomous system with this balloon may prove more challenging than just using a drone with a few propellers. Likewise, the function of the balloon cannot promise the life expectancy the team my desire. Although seemingly positive, the design may require some major changes if it were selected.

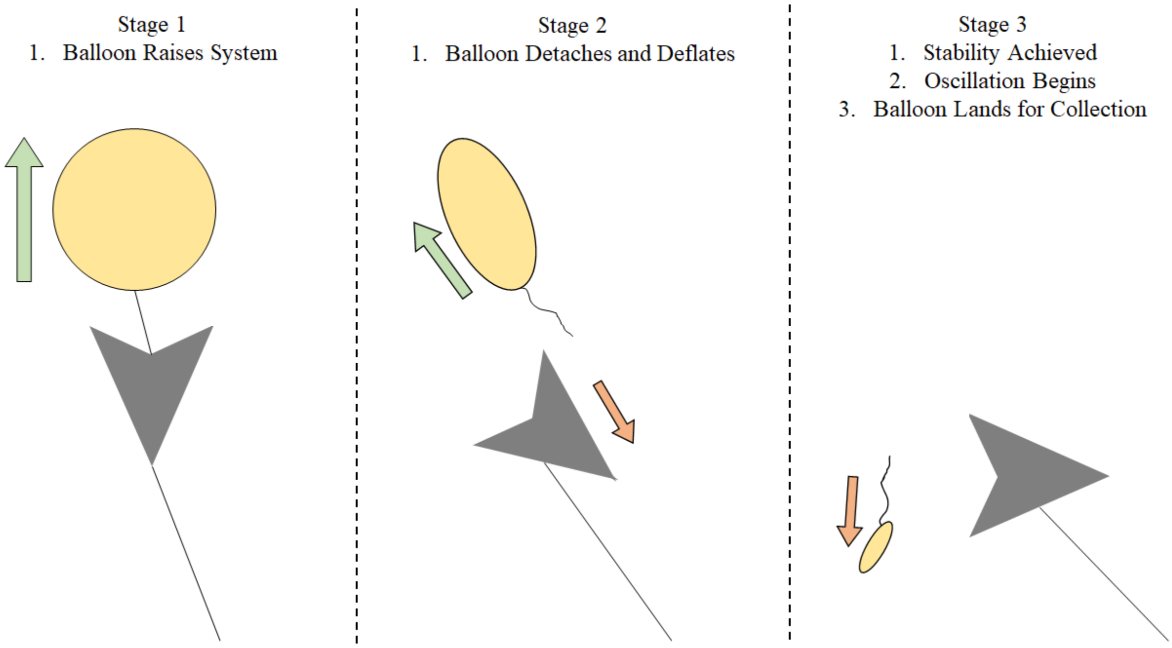

Figure 18. Balloon Delivery System Basic Schematic.

Concept 14

Looking at previous concepts of lifting the fix aircraft to a desired altitude, the team found that it would be easier to use a parachute system. The parachute system can be folded up into a control box that is lifted by a propeller. When the parachute and the control box reached the desired altitude the propeller will separate and open the parachute system that will be controlled with control box. With having the control box attached to the parachute the path of the oscillation created by the parachute can be controlled remotely.

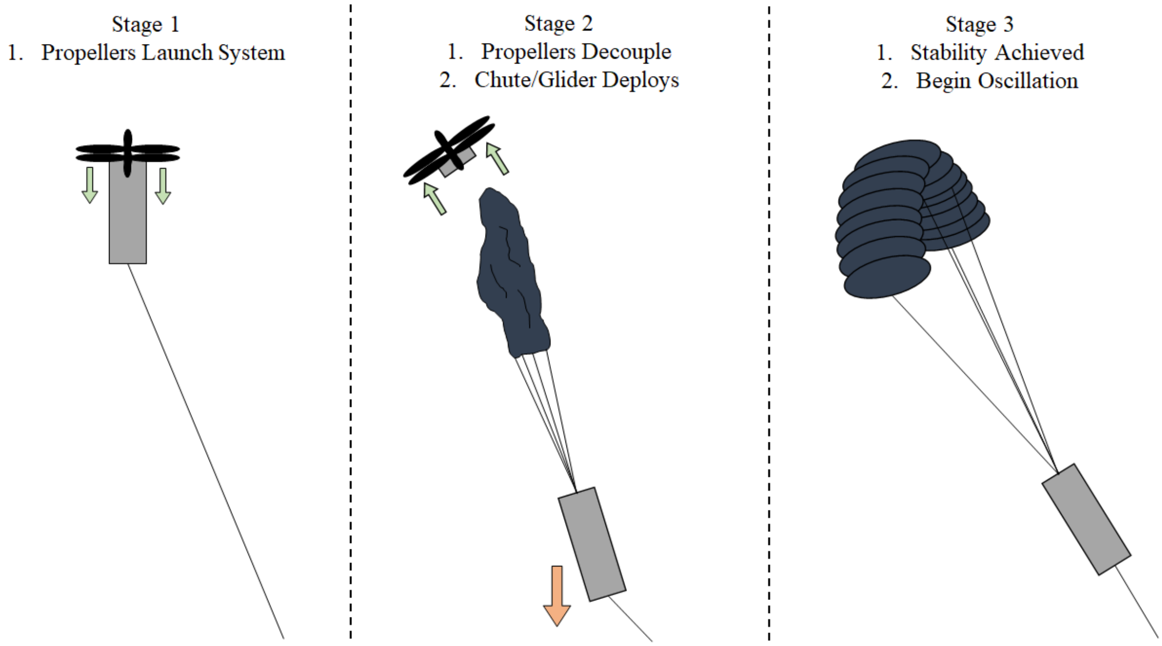

Figure 19. Propeller Launched Chute System Basic Schematic.

Concept 15

Like the previous concept, concept 15 focuses on how to launch the aircraft by using a propeller that lifts it to a secure height. When reaching the desired altitude, the propellers stop, and the wings expand. The autonomous features will turn on the propellers and direct the aircraft to the assigned path that creates the fastest motion for the ground system to generate the most power. A benefit of having the propeller attach to the aircraft is that when the wind is not strong enough to keep the aircraft lifted in the desired altitude, the autonomous part of the aircraft could softly land the craft versus letting the glider fall down uncontrollably, or the craft could push to a higher altitude to reach stronger winds. The propellers could also be flipped as a generator to provide power to maintain the onboard system.

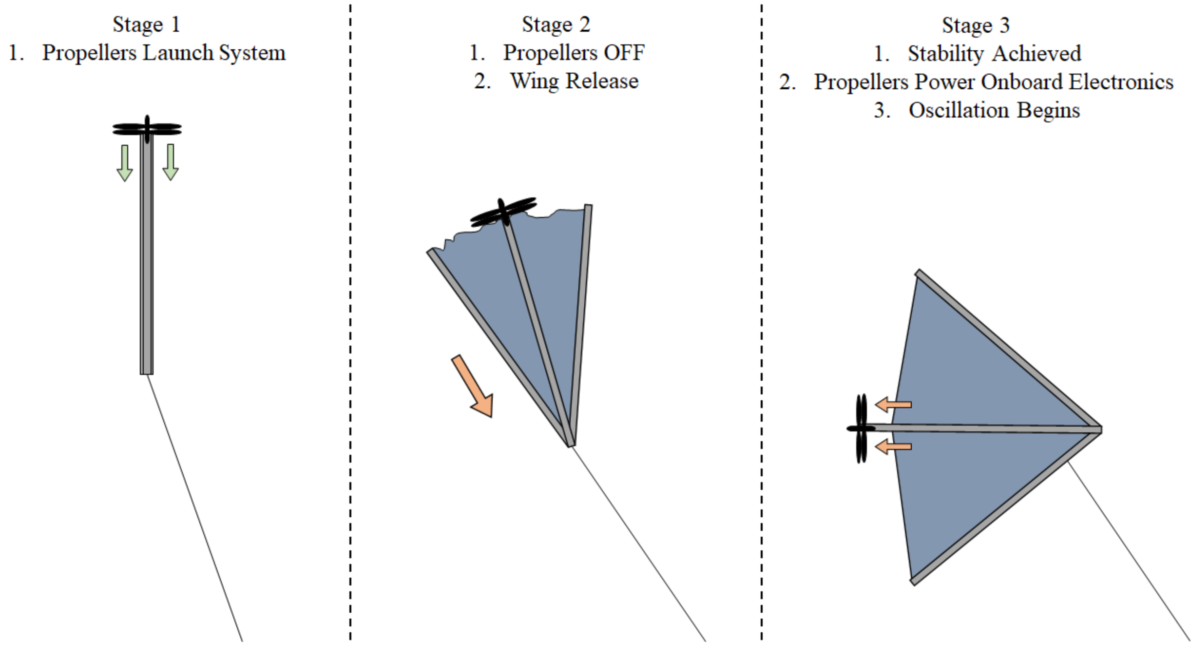

Figure 20. Fixed Propeller Launched, Winged System Basic Schematic.

1.6 Concept Ranking

The team utilized the Pugh Matrix Method as a tool for comparing design ideas against design criteria. By doing so we were able to determine which designs were better than others by ranking the overall designs numerically. This method also allows for certain design criteria to be weighted more highly than others, creating a more accurate evaluation of the design ideas.

To create a reliable Pugh Matrix, evaluations were conducted of all the general variables that affect the power generation and the airfoil. To ensure that the project achieves its best design, these variables must be optimized to provide the highest efficiency at the best cost. To account for this, certain variables are weighted more than others. The priority of the variables was determined by the project scope, customer needs, and functions of the systems. The variables with the greatest influence include size, safety, reliability, efficiency and cost.

Table 2.
Pugh Matrix Selection of Oscillation Method

Criterion	**Scale 1-5**	**Oscillation Method**		
		Gravity Forced	Spring Forced	Dual Kite System
Efficiency	5	1	3	5
Weight	5	3	4	3
Power Output	5	1	3	5
Safety	4	2	3	2
Part Standardization	3	3	2	3
Maintenance	4	4	3	2
Cost	2	5	4	1
Score		68	88	**92**

Table 3.
Pugh Matrix Selection of Mechanical to Electrical Energy Conversion Method

Criterion	**Scale 1-5**	**Energy Conversion Method**	
		Solenoid	Alternator
Efficiency	5	2	4
Weight	5	2	3
Power Output	5	2	4
Safety	4	3	3
Part Standardization	3	2	3
Maintenance	4	4	2
Cost	2	2	3
Score		68	**90**

Table 4.
Pugh Matrix Selection of Mechanical Energy Handling Method

Criterion	**Scale 1-5**	**Mechanical Energy Conditioning**	
		Transmission	No Transmission
Efficiency	5	4	2
Weight	5	2	5
Power Output	5	5	2
Safety	4	4	4
Part Standardization	3	4	5
Maintenance	4	2	3
Cost	2	2	3
Score		**95**	94

Table 5.
Pugh Matrix Selection of Airfoil Type

Criterion	**Scale 1-5**	**AUAV**	**Balloon**	**Chute**	**Propeller Glider**
Cost	3	1	4	3	1
Weight	5	1	5	4	3
Size	3	2	2	4	3
Autonomous Capability	2	5	1	3	3
Flight Path Control	4	5	1	3	2
Detachable from Tether	1	3	3	3	3
Power Gen Capacity	5	3	1	3	3
Max allowable wind force	4	3	1	2	2
Durability	3	3	1	2	2
Reparability	2	1	0	1	1
Score		85	64	**93**	75

1.7 Elimination and Selection Concepts

Concept Elimination

After making the pugh chart and evaluating all the different design options, the team moved to the elimination process. Decisions were made based off of the weighted total scores. Concepts that did not score highly on the weighted criteria lost significant points on their respective scores. Concepts with the lowest score in their respective category were eliminated. It should be noted that all concepts that scored the lowest in their respectives systems for efficiency, weight, and power were eliminated. With efficiency, weight, and power acting as the most vital functions and targets, the team feels that the matrices accurately represent the best concept for the customer and the project.

While the design selection for power generation does align with our customer needs, system functions, and targets defined by our group, it should be noted that our team is still running simulations on Jeff Phipps' patent. Significant time has been spent researching the phenomena of an induced electromotive force (emf) but finding suitable and conclusive equations to model the solenoid and moving magnet application has been difficult. However, there is a simulation software, COMSOL, which can accommodate the increased complexity of the design while providing a suitable approximation of the emf generated. Once the simulation is concluded, the decision matrices will be updated accordingly and the optimal concept will be selected.

Concept Selection

For the power generation selection, we split this up into three different sections; oscillation method, energy conversion method, and mechanical energy conditioning. This is important because we wanted to choose one design from each method with the highest score based on the criteria selected. After creating the pugh matrix we ended up with three different designs. Each design had the best efficiency and power output for each individual method which are the most important factors. The dual kite was chosen for the oscillation method, the alternator for the energy conversion and lastly the transmission for the mechanical energy.

For the airfoil selection, we only had one section so we chose the type of airfoil with the highest score based on selected criterion. After conducting the pugh chart, we saw that the chute was the best option. This has the highest score because it has the highest combined score of the two most important criterion, weight and power generation capacity.

The customer's needs specifically are focused on the efficiency, weight and power output for both the power generation selection and airfoil selection. For all the selected designs, these needs were met.

1.8 Project Plan

The Final Design Work section (Appendix C) aims to finish modeling the solenoid application and compare it against the selected design through a meeting with our sponsor Jeff Phipps. This section also aims at generating and selecting a design for the kite's flight path. When all the design aspects are selected, the team will move into the Project Construction Planning section. This section aims to evaluate all the factors and variables that might occur in the construction phase while also verifying that the product fits within the project scope and budget. Project Construction & Testing will be executed to make sure that the final design is functional and aligns with the previously set targets. Project Completion & Graduation is the final process in which each member of the team shows our families, friends, the FAMU-FSU College of Engineering, Jeff Phipps, and the rest of the world the education we have acquired and how hard we worked for it.

Appendix A: Code of Conduct

FAMU/FSU College of Engineering

Department of Mechanical Engineering

<u>Code of Conduct</u>

Project Title: Kiter Generator

Names:

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Mission Statement

Team 16 is dedicated to harboring an atmosphere of respect, support, and open communication between all individuals. Professionalism and honesty are values which are expected of all members and are of the utmost importance. Each member is expected to contribute fully to this project and to this group atmosphere.

Team Roles

Each member of this team is designated a specific role based on their area of expertise and skill sets.

Team Leader - Jared Gremley

The team leader’s overall responsibility is to conduct and maintain the team’s overall operations. The team leader's responsibilities include but are not limited to: initializing plans and timelines to complete various aspects of the project, allocating assignments for members based off of their strengths and weaknesses, reviewing final submissions of documents and assignments, and providing assistance or input wherever needed. Additionally, the team leader should foster synergy and cohesion amongst team members. In the event of a disagreement, the team leader will act in the best interest of the project. Furthermore, the team leader should facilitate and inform all parties on communications between the project sponsor and team members. Ultimately, the team leader is accountable for achievement of the project and its goals.

Financial Advisor - Andrew Barba

The financial advisor is responsible for but not limited to: managing the budget, maintaining a record (electronically and paper) of all project related credit and debit charges to the project account. Any product, part, or expenditure (ex: machine shop cost) needs must be presented to the advisor. The advisor is then responsible for reviewing the desired need/want and determining if an alternate or equivalent solution exists. The information of approval or disapproval will then be relayed to the whole team and if the request is granted, the financial advisor will then proceed with the purchase. A detailed record of these analyses and budget adjustments must be kept by the financial advisor and be accessible either electronically or physically at all times.

Lead Electrical/Software Engineer - Brian Lyn

Often referred to as the Lead EE or ECE, this position heavily refers to the electromechanical aspect for this project. Sensor selection, circuit designs, and software optimization should be approved by the Lead ECE before finalization. Because this team specifically comes from a purely mechanical background, the Lead ECE should attempt to explain the system circuitry to the group to help keep the team as a whole aware of the general concept within their design. The primary workload regulated to this position will mostly exist within the scope of software development such as; Matlab Simulations, IDE Software, and HTML. Given the centralized software knowledge, this position will also be in charge of the team's website design, as required by the Senior Design Lecture.

Lead CAD - Libni Mariona

The Lead CAD is responsible for reviewing and approving all CAD design aspects of the project prior to submission towards: The ME Shop, Sponsor, or for other reasons requested by the Lecture. This position is responsible for turning the team ideas into a CAD prototype.

Lead Mechanical Engineer - Simone Nazareth

The Lead ME is responsible for managing the mechanical design aspect of the project. This position is also responsible for understanding design details, and must be able to communicate aspects of said designs to other team members during design selection processes. This includes communication with the Lead ECE and Lead CAD regarding details of the designs to be incorporated into the software or design models, respectively. Additionally, the Lead ME is responsible for the organization of design documentation and reports.

All Team Members Must:

- Equally contribute to the project
- Be respectful of all other team members
- Listen to all ideas presented by team members
- Respect one another
- Provide feedback on ideas
- Communicate and participate in meetings

Communication

The main form of communication will be through text messages and weekly meetings on Tuesday and Thursdays. Any absences or cancellations to a meeting must have a 24-hour prior notice.

Any project documentation will be shared in the google drive or by email. Team members are required to check their emails and the google drive at least twice daily for any important information and updates.

The main communication with individuals outside of the team will be through email that must be reviewed by at least one other member. When a team member has a verbal conversation with information pertinent to the project, the team member will document and date all the information in the google drive describing the conversation.

Team Dynamics

Each member of Team 16 will work together to achieve the same final goal. This does not limit individual goals or tasks being assigned to each member which will require the individual to work on his/her own time. Team 16 will ensure a non-hostile communicating environment, allowing each team member the freedom and confidence to make any type of suggestion, comment, or constructive criticism without the fear of being made fun of or singled out. If any member of this team finds any individual task too difficult to complete and has shown an honest effort to complete the task, then the member is required to ask for help from the other teammates or any other source. If any member feels that they are being singled out for their work, or simply being disrespected, they are required to bring the issue to the attention of the entire team in order for full resolution of the issue. Team 16 will never let emotions dictate actions and will respect whatever is in our best interest in regards to the project. All work is done to benefit the project and working together as a team ensures quality.

Ethics

All members of Team 16 are required to exhibit the highest standards of honesty and integrity not only internally within the team, but to the public, the client, the employer, and the profession. Team members are required to be familiar with the NSPE Engineering Code of Ethics as these terms will be the standard of each member of Team 16's ethical behavior each day.

Dress Code

Informal design meetings will have no dress code requirements. Formal business attire is expected for all official meetings and presentations, unless otherwise announced democratically by the group prior to the individual events. Exceptions to requested dress codes must be announced to and accepted by the entire team within at least 2 hours of the official start time of the posted event.

Weekly and Biweekly tasks

Weekly mandatory meetings will occur at the earliest time provided after the Senior Design Lecture on Tuesdays. On days without lecture, the meeting times will occur at 2PM, the time Senior Design Lecture is scheduled to normally start. Thursdays after Senior Design are designated for overflow meetings, overflow meetings will be determined weekly based on the progress completed in the Tuesday Meeting. Overflow meetings are not designed to be meeting times for individuals to work on individual project assignments, but rather maintain a purely administrative flow, focusing on; delegating task, determining roles, setting due dates, and presenting findings to the group.

Decision Making

Decisions for the project will be based on the merit of the project scope, efficiency, and cost relative to budget. In the event that one or more decisions yield similar assessments, the sponsor and team members will weigh the support and concerns for their preferred choice. Subsequently, the decision will be found democratically by the group as a whole. Ultimately, the sponsor's decision will carry the most significance and should be consulted first. All members of the group should participate in the decision making process with the appropriate integrity described in the Ethics section. Subject to these terms, each member is responsible for their own violations and conflicts of interest. In the case a violation is found or presented by any member of the group, a democratic meeting will occur by remaining members for appropriate handling of the situation. All decision making processes should abide by the following guidelines.

- Define Problem Statement - Broadly define the problem at hand with members of the group
- Brainstorming - Encourage and construct solutions amongst team members. Discuss pros and cons of each plan and eliminate unnecessary options.

- Data Analysis - From the remaining brainstorm solutions, gather data necessary for possible integration and evaluate each solution for plausibility.
- Design, Simulation, and Evaluation - Design the preliminary solution and create a testing system. Once examined, revisit the need for adjustments in the design and examine until optimal conditions are met.

Conflict Resolution

In the event of a dispute or disagreement between members, the following methods should be enacted to ensure that the project and team chemistry does not disintegrate.

- Communication of key points by each party through active listening. This may require a member or group mediation.
- Team Leader intervention.
- A democratic referendum on the issues at hand.
- Instructor intervention.

Attendance Policy

All team members must be present for group meetings unless otherwise specified. If a member cannot attend a group meeting they must give notice at least 24 hours prior to the scheduled meeting.

Statement of Understanding

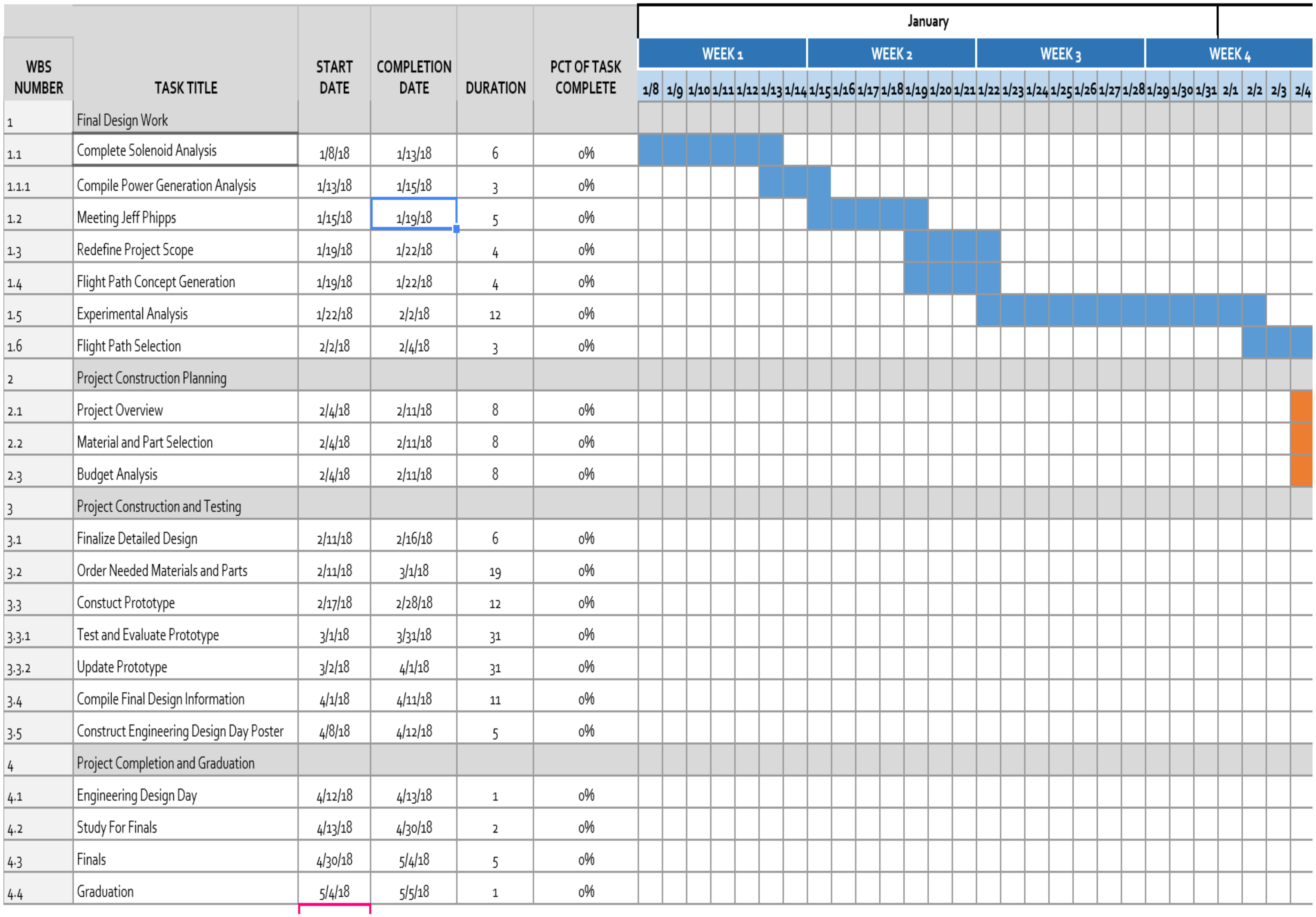
By signing this document, each member of Team 16 acknowledges and agrees to all things stated above as well as maintaining high ethical conduct and moral principles.

Name	**Signature**	**Date**
Andrew Barba		9/26/17
Simone Nazareth		9/26/17
Jared Gremley		9/26/17
Libni Marione		9/26/17
Brian Lyn		9/26/17

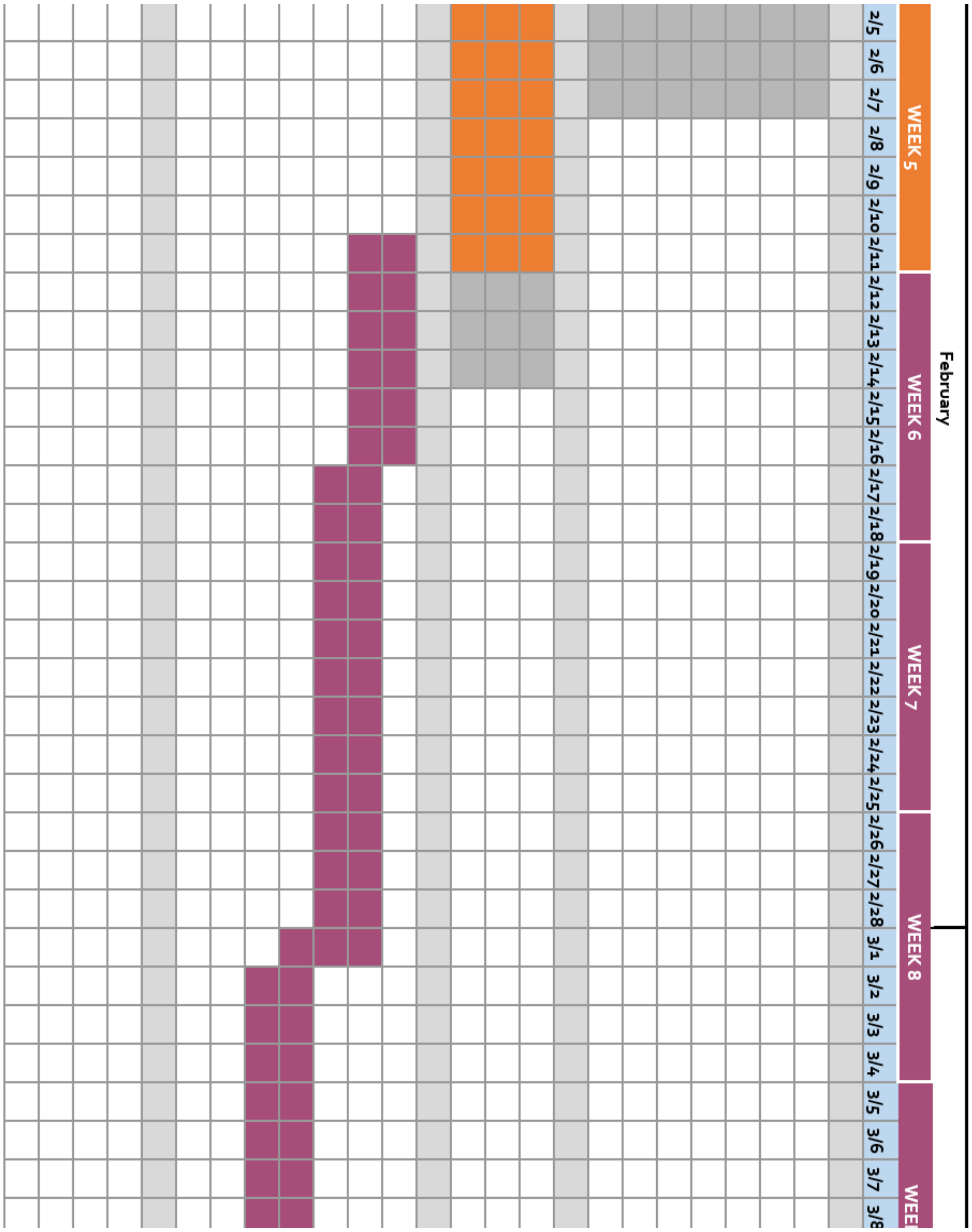
Appendix B: Target Catalog

System Component	**Function**	**Target**
Overall System	Transmit energy to the ground	5 kW output
	Force oscillating flight pattern	Adjust pattern outsider of 20 ft deviation in oscillating flight pattern
	Harness energy from mechanical motion	Produce 10 kW of mechanical energy
	Able to be transported	Weight under 200 lbm
	Affordable to the consumer	Cost of system under $2000
Tether	Link ground and kite	Withstand winds of 40 mph
	Vary the effective length to achieve optimal altitude	0-400 ft variation
Glider	Sense dynamic flight conditions	Send feedback to controller in under 1 second
	Portable	Weight under 50 lbm
Base	Rotate spherically with wind direction	360 degrees of rotation; constant angle of alignment with tether.
	Attach and detach from ground and solenoid	Weight under 100 lbm for both ground and solenoid; attachment methods non-permanent
	Protect power generation equipment	Waterproof housing
Generator	Transduce mechanical to electrical energy	25% efficiency
Electrical System	Maximize magnetic field of solenoid	Use Magnet of 1.32 Tesla

Appendix C: Project Plan



WBS NUMBER	TASK TITLE	START DATE	COMPLETION DATE	DURATION	PCT OF TASK COMPLETE	January																											
						WEEK 1							WEEK 2							WEEK 3							WEEK 4						
						1/8	1/9	1/10	1/11	1/12	1/13	1/14	1/15	1/16	1/17	1/18	1/19	1/20	1/21	1/22	1/23	1/24	1/25	1/26	1/27	1/28	1/29	1/30	1/31	2/1	2/2	2/3	2/4
1	Final Design Work																																
1.1	Complete Solenoid Analysis	1/8/18	1/13/18	6	0%	🟦	🟦	🟦	🟦	🟦	🟦																						
1.1.1	Compile Power Generation Analysis	1/13/18	1/15/18	3	0%						🟦	🟦	🟦																				
1.2	Meeting Jeff Phipps	1/15/18	1/19/18	5	0%								🟦	🟦	🟦	🟦	🟦																
1.3	Redefine Project Scope	1/19/18	1/22/18	4	0%												🟦	🟦	🟦	🟦													
1.4	Flight Path Concept Generation	1/19/18	1/22/18	4	0%												🟦	🟦	🟦	🟦													
1.5	Experimental Analysis	1/22/18	2/2/18	12	0%															🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦		
1.6	Flight Path Selection	2/2/18	2/4/18	3	0%																										🟦	🟦	🟦
2	Project Construction Planning																																
2.1	Project Overview	2/4/18	2/11/18	8	0%																												🟧
2.2	Material and Part Selection	2/4/18	2/11/18	8	0%																												🟧
2.3	Budget Analysis	2/4/18	2/11/18	8	0%																												🟧
3	Project Construction and Testing																																
3.1	Finalize Detailed Design	2/11/18	2/16/18	6	0%																												
3.2	Order Needed Materials and Parts	2/11/18	3/1/18	19	0%																												
3.3	Constuct Prototype	2/17/18	2/28/18	12	0%																												
3.3.1	Test and Evaluate Prototype	3/1/18	3/31/18	31	0%																												
3.3.2	Update Prototype	3/2/18	4/1/18	31	0%																												
3.4	Compile Final Design Information	4/1/18	4/11/18	11	0%																												
3.5	Construct Engineering Design Day Poster	4/8/18	4/12/18	5	0%																												
4	Project Completion and Graduation																																
4.1	Engineering Design Day	4/12/18	4/13/18	1	0%																												
4.2	Study For Finals	4/13/18	4/30/18	2	0%																												
4.3	Finals	4/30/18	5/4/18	5	0%																												
4.4	Graduation	5/4/18	5/5/18	1	0%																												



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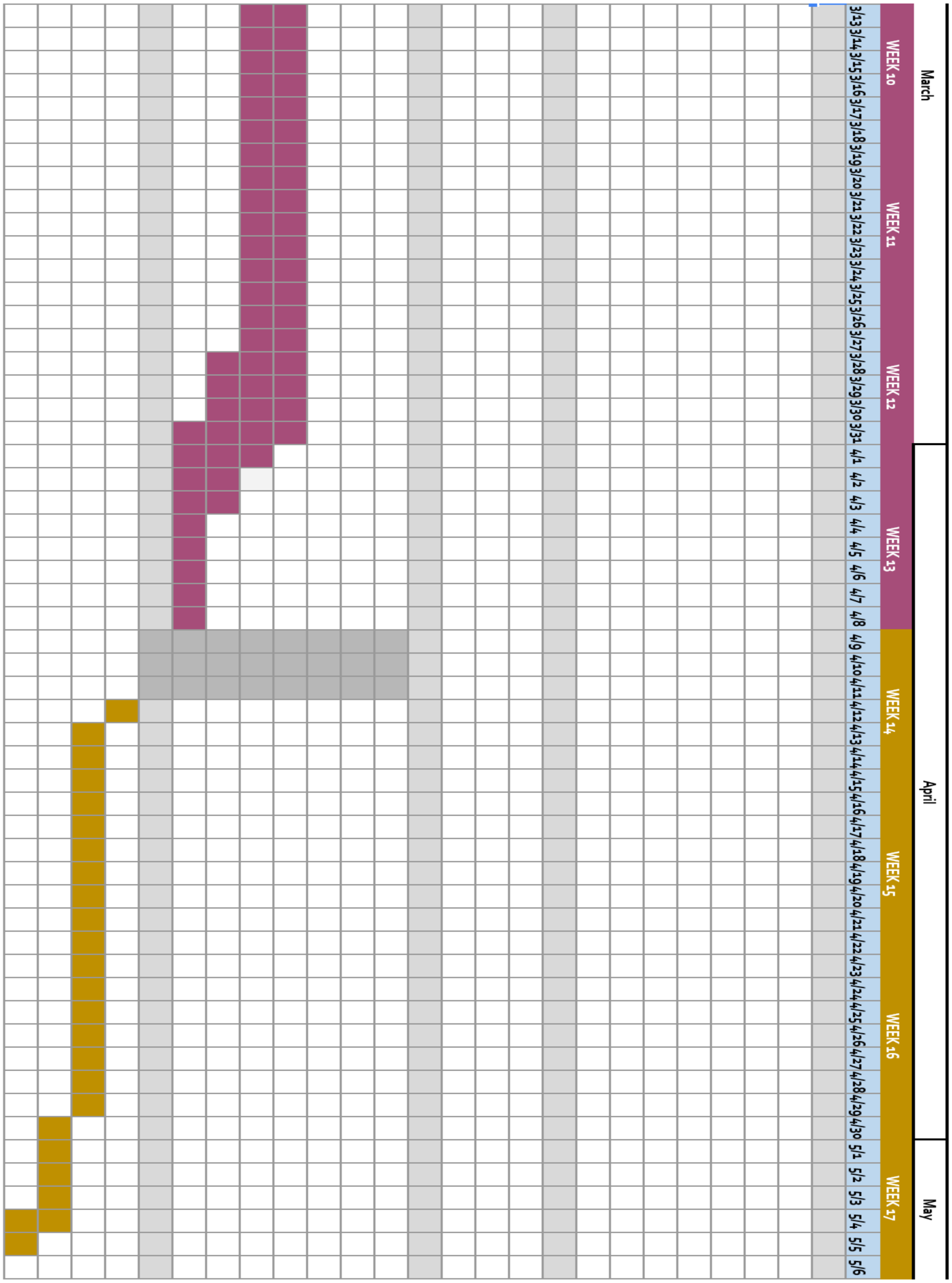
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References

[1] https://digitech.fsu.edu/x/2016/400