Helium Micro Air Vehicle
(MAV)

By

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Team 07

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Executive Summary

The Helium Micro Air Vehicle (H-MAV) Capstone project utilizes the buoyant force potential of a volume of the inert gas Helium to suspend a compartmented gondola for the purpose of environmental data collection. The assessment of areas of contamination such as oil spills and fires, identifying heat losses at the roofs of buildings, or as a means of data collection in any other application which could utilize a relatively close aerial view. The vehicle would be able to maneuver in the air from lift off and return to the launch site by a remote control motor system. The gondola will host the motor system and contain weather sensors and cameras, as client expectation will dictate the response of the instrumentation to the controller as data is acquired. We note that our primary focus is to store data information to a disk and acquire the data after landing and not an active response interface.

After identifying our client's parameters and expectations, our team has developed a materials list in which we would create the final product. By examining recently competitive products, and evaluating criteria using technical methods based on calculations and engineering requirements, this report outlines the process in which we have considered to meet our deadline objectives. These objectives are always in reference to three main goals; client expectation approval, cost effectiveness and efficiency.

The usefulness of the Helium MAV will only be limited to the applications in which our client chooses to focus. Ultimately, the goal of this project is to incorporate the technical approaches we have learned as undergraduate engineers at Northern Arizona University.

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1.1 Introduction

Dr. Srinivas Kosaraju requested to design a Helium Micro Air Vehicle (MAV). The Helium HAV is a device that flies over fires and contaminated areas to take images. There are constraints that will be considered in the Helium MAV project. The budget should not be more $2000, and the maximum size must be 5 X 3 X 3 m^3. Also the remote control guidance system is one of the constraints and last, we must reaching an altitude of 30.5 m. The objectives of Helium MAV are how to optimize weight and payload, minimize the response time and double the distance of quadcopters. In addition, Helium MAV should be more durable than any commercial product in the market.

Extensive updates on an older projects often require a process that is costly. For example, replacing old airplanes and changing the fuel of one airplane would take a lot of hours and would cost the company a lot of money. There are methods available which can incorporate the initial design and construction of the plane to help offset losses when people travel. Many of the airplanes around the world utilize a type of fossil fuel; this is when a plane uses kerosene. By adjusting the weight of the blimp, it can be ensured that it could carry a maximum capacity for people and luggage and can work as efficient as a plane.

We also note that risk management will be necessary for the longevity of the project. Consideration to ensure our client that no one will be harmed in operation and that our design is as environmentally friendly as possible is given importance to the ethical engineer.

1.2 Project Description

1.2.1 Objectives

This set of objectives have been deemed necessary for the Helium Micro Air Vehicle to succeed and function properly. The table below lists the objectives and the units that they will be measured in.

1. Weight/payload - This is important in carrying equipment and since it takes a lot of helium to lift a small amount of weight our team needs to reduce weight and increase the payload capacity, this will be measured in kg.

2. Optimize Response Time - The MAV needs to have optimal response time during flight. This means the helium MAV must be able reach a certain altitude in a reasonable amount of time to begin observations of fires and contaminated areas, this will be measured in sec.

3. Minimize Cost - The budget is important since there is only a limited amount of money, so minimizing the cost is essential.

4. Twice the distance and able to stay in the air longer - This product must be competitive to other commercial products such as quadcopters, the goal is to be able to go at least twice as far and last longer in the air. The distance traveled will be in m.

5. Durable - Durability is important since in the atmosphere the MAV will be exposed to different temperatures, moisture, and winds so the product must be able to last.

6. Ease of storage - A person must be able to lift the MAV up and be able to store it in a compact area so volume matters, and will be measured.

Table 1: Measurement and requirements units

Objective	Measurement	Units
Reduce Weight	Mass	kg
Optimize Response Time	Time	seconds
Minimize Cost	Currency	$
Travel Range	Length	m
Durable	Time	seconds
Easy to Store	Volume	m^3

1.2.2 Constraints

The project's dimensions should not exceed 5 m long, 3 m wide, and 3 m high. The budget of this project will be $2,000 for preliminary testing and final project. The project will require a frame that is capable of carrying temperature and weather data sensors, a GPS locator for remote controlled guidance system capabilities, a propulsion system and mounted camera. The remote controlled GPS guidance system would be able to pinpoint the exact location of the Helium MAV at all times, and objectively allow us to navigate forward, backward, ascend, descend as well as hover at a specified altitude. The mounted cameras on the Helium MAV would be able to provide a live feed visual and broadcast it to the control system. The temperature and weather sensors would be able to measure temperature, precipitation and wind speed velocities.

2 Background

2.1 State of the Art Research

2.1.1 Why Helium?

The advantages and disadvantages of helium over hydrogen. Helium is approximately 7 times lighter than air weighing at about 4.0 $\frac{g}{mole}$ while air is 28.97$\frac{g}{mole}$. Compared to hydrogen, helium is about twice the amount of weight since hydrogen is a diatomic molecule meaning that hydrogen comes in pairs and not individually. Hydrogen also has more lifting power than helium around 8-11 percent more which could allow for a larger payload. Helium is also more expensive than hydrogen so it will cost more.

Even though hydrogen looks like the better choice it has a fatal flaw, hydrogen is highly flammable and will react with other molecules. Helium on the other hand is an inert gas which won't react making it nonflammable. This is crucial when looking at fires and other contaminated area since a hydrogen filled MAV will more likely catch on fire over a helium filled one. An example of a hydrogen filled aircraft is the Hindenburg. The Hindenburg crashed and caught on fire due to a leak of hydrogen that was ignited. Because the Hindenburg was filled with hydrogen this acted as a fuel source accelerating the flames, making the aircraft burn quicker.

2.1.2 Air Penguin

Festo Corporation is a leading innovator in helium air vehicles. Their reputation stems from their performance with Hybrid Air Vehicles (HAV's) that replicate animal movements. Sort of like a realistic, State of the Art balloon animal, the HAV can float around by controlling realistic flipper movements of penguin based on studies regarding behavioral ecology. Not only can the balloon stay suspended, but the design's navigation and propulsion system enables the machine to "sense" objects in its flight path, and reroute accordingly. Our ability to generate enough current with basic battery systems will be a costly decision regarding weight and space. Lithium polymer batteries are the best available option regarding these constraints. Since the Air

Penguin uses the best batteries available, we consider this as the primary option in which to invest.

2.1.3 The largest Aircraft in the World

The Airlander is the largest aircraft in the world. With an envelope volume of 38,000 ft^3, it can carry over 10,000 kg and reach an altitude of 6100 m. The reason our team researched the Airlander is because of the properties that we can emulate in our design. It has an elliptical chamber and longitudinal shape for aerodynamic purposes. This was an original brainstorm idea for our envelope but we went with the standard elliptical shape in comparison. The Airlander II has also attracted the United States government as a client, who is working to develop a technique in which to reach any geographical location at necessity with important cargo. For our purpose of diversified landing capabilities, the Airlander II's method of landing is also of particular interest. Inflatable skid plates that fill and retract for smooth landings may give our team some insight as to how the Airlander II has the ability to hover and descend at such a high volume and buoyancy, as also how the Airlander II is able to retain the same flight characteristics at different payloads.

Figure 1: Airlander II

2.1.4 Garmin Camera

The Garmin is a name brand product that is known for being light weight and portable, so our team decided to use this as a base model for referencing quality expectations. This model is light only weighing 74 g this is ideal since the MAV won't be able to hold a lot of weight. The video and image quality is good and can take videos up to two hours, this is needed to take detailed images of the fire and contaminated zones. Also has a Night mode and is waterproof which is significant in that it can withstand moisture in the atmosphere. This product cost $399.99, this is too expensive so our team is looking for other camera that have similar specs or better specs that are within our budget.

Figure 2: Garmin

2.1.5 Phantom 3 Quadcopter

This quadcopter is the type of product that our team is trying to compete with. This product cost $1280, which includes 4 propellers, a mounted camera and a remote control. The quadcopter can only last 30 mins in the air on one charge and weighs 1.28 kg and reach a speed of 16 m/s, our goal is to create a design that can allow our MAV to last longer, weigh less and do the job more efficiently. The quadcopter also gives our team different aspects that we can incorporate into our design such as the mounted camera, remote control, and how it maneuvers and flies.

Figure 3: Phantom

3 Requirements

3.1 Functional Model

The final design will need to be able to satisfy the customer and engineering requirements. Using a functional model to determine the inputs and outputs of the ideal design operation, it can be ensured that the requirements will be met. Figure 4 shows the final functional model that was designed to meet the project requirements. The model shows the inputs for materials, signals, and energies entering and exiting the system. Analysis of the functional model ensures all aspects of the project have been accounted for and that the design will meet the expectations required.

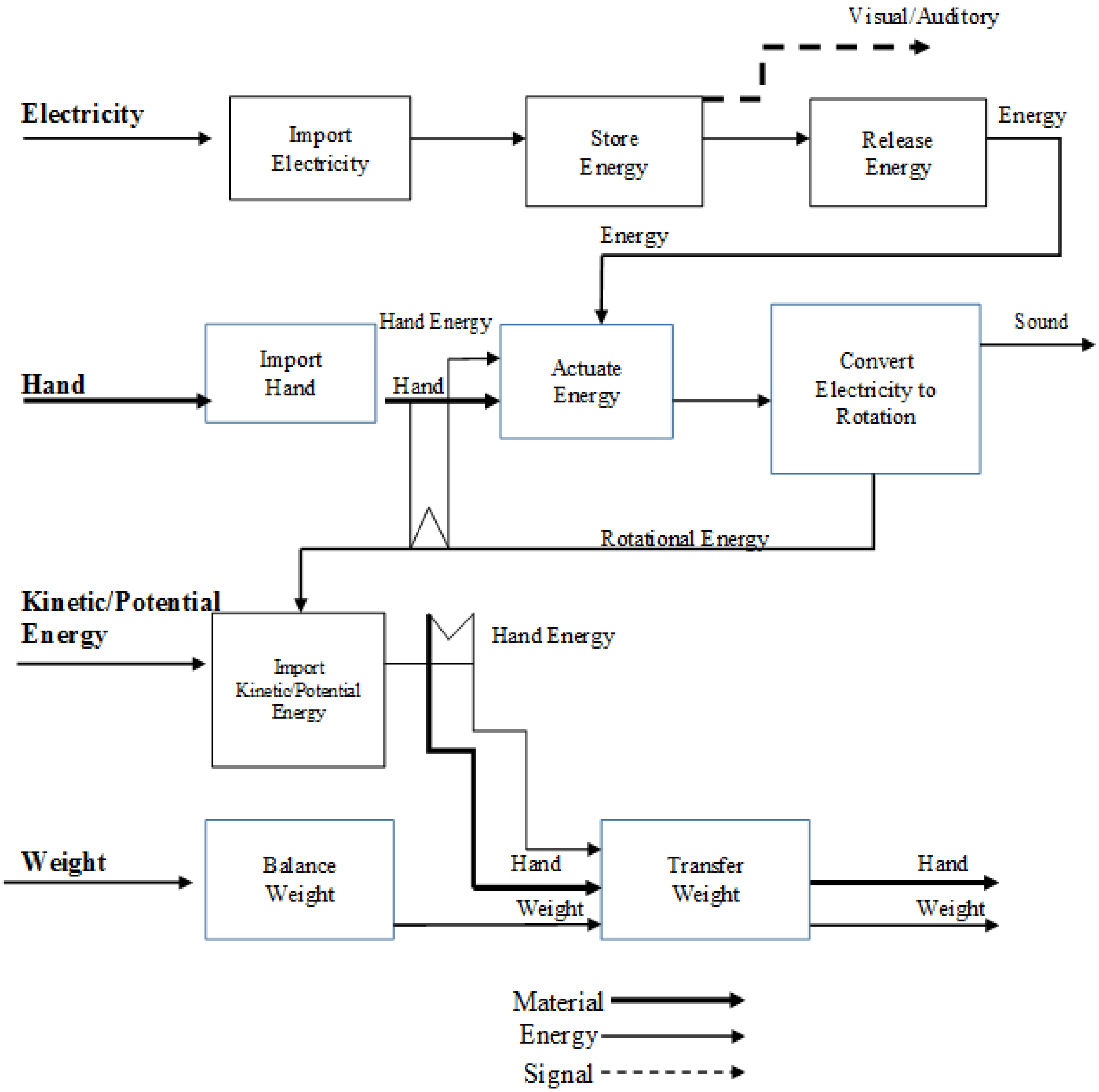


Figure 4: Functional Model

3.2 Quality Functional Deployment

The Quality Functional Deployment (QFD) below depicts the direct relationships between general customer needs and the engineering requirements required for the devices. This chart assists in identifying which subsystems to evolve during the process of design. The customer needs were compared by using weak (1), moderate (3), and strong (9) relationships. Target or Limit Values were also added so that computations could be derived based upon the relationships of the engineering requirements and customer needs. These computations translated into Weight/ Importance (a.k.a. absolute technical importance) and the Relative Weight.

In Figure 5, the absolute technical importance concludes that the Cost, Materials, and the Device Weight are the highest ranking amongst the systems to be focused upon while designing. This shows that these design specifications should have relatively more time spent on them.

Legend		
Θ	Strong Relationship	9
O	Moderate Relationship	3
▲	Weak Relationship	1

Demanded Quality (a.k.a. "Costumer Requirements") \ Quality Characteristics (a.k.a. "Engineering Requirements")	Costs	Maintenance	Weight	Speed	Life Efficiency	Size	Altitude Consistency	Volume	Buoyancy
Effectiveness of flight	O		Θ	Θ		Θ	O	O	Θ
Durability	Θ	O			Θ	O	▲		
Storage	O	▲	O			Θ		Θ	
Distance	O		Θ	Θ		Θ	O	O	O
Manufacture	Θ	▲	▲	▲	O	O		O	O
Camera	Θ	▲	O		▲	O		O	Θ
Maintenance	O	O				O			
Cost	Θ	Θ	Θ	Θ	Θ	Θ		Θ	Θ
User friendly	O	O							
Shelf parts	Θ	O	O	O	Θ	O		O	O
Weather Sensors	Θ	Θ	Θ		O	O		O	O

Figure 5: Quality Functional Deployment

3.3 House of Quality

The House of Quality represents the requirements for engineering in comparison with each other. This will help us as a team to decide which engineering requirements we should focus more on. The engineering requirement are compared as (++) strong positive correlation (+) positive correlation (-) negative correlation and (∇) strong negative correlation. These limiting connections help us to determine how to optimize materials based on quality and importance

The subsystems in the House of Quality will not be dismissed but will be less fundamentally important to the others. As a team we must also pay attention to improving the overall weight of each device, the materials used, the efficiency and repetition of trials, and the energy sources we ultimately will use to help us lift the blimp.

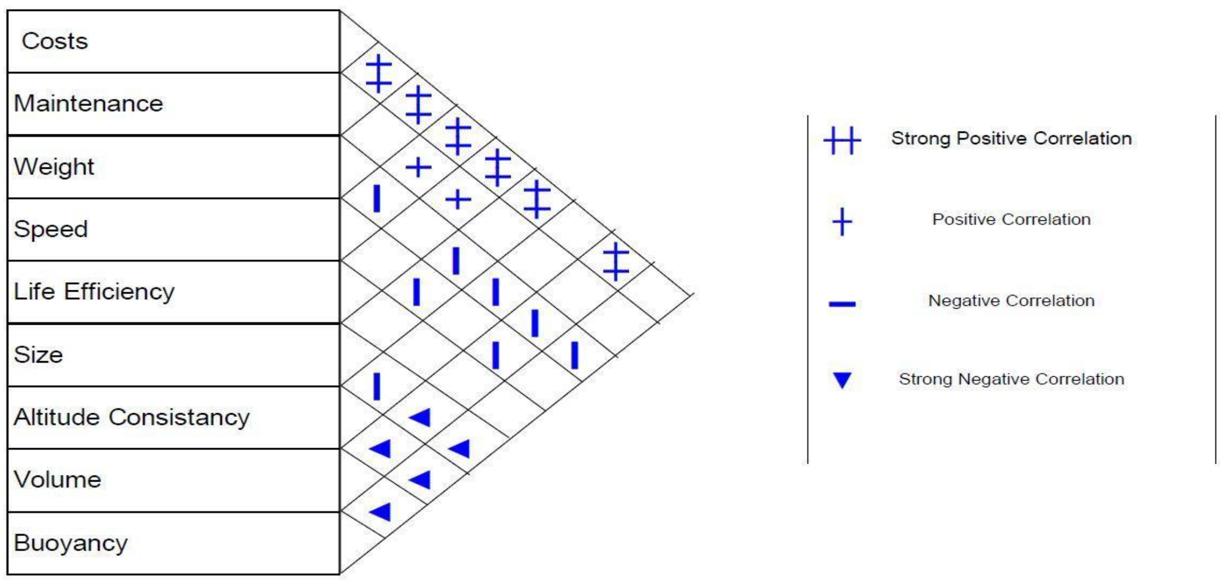


Figure 6: House of Quality

3.4 Attachment Concepts

Methods that were proposed to attach the enclosure and blimp were Velcro, ribbons and suction cups. Using Velcro around the entire top perimeter of the enclosure, we would then attach the enclosure to the bottom of the blimp. For the ribbon method, the team would tie strips of material around the enclosure and then wrap them around the blimp and tie the ribbon again so the enclosure would hang off of the blimp. The last idea that the team came up is attaching multiple suction cups to the bottom of the blimp and with the hooks that are connected to the suction cups, the enclosure is connected to them. In order to safely mount the enclosure to the blimp without it falling off, the team will combine these ideas together to add extra support.

3.5 Enclosure

To be able to keep all electronics together such as the sensors, camera, batteries, etc., the team came up with three different designs that would hold all of these components. The first design was very simple; the enclosure would be shaped into a square box where all the electronics would be placed neatly. This design was easy to make but it would have a high drag force when flying.

The second design is a hollow dome shape that would fit all electronics inside. Velcro would be attached to the edge of the dome and then connected to the blimp.

The third design is a compartment which would be separated into different sections where each piece of electronic has its own. The compartment would have chamfered sides and edges to reduce any drag that it experiences when it is in flight. The compartment would also have shafts connected along the sides where the motors would be placed.

The team chose the compartment design because it would be easier to attach to the blimp. The items would be organized better, and would be sturdier than the other designs. Velcro would be connected along the top edges and attached to the blimp, then ribbon would be strapped round the enclosure to ensure that the compartment doesn't move. The decision matrix below displays the different criteria that all enclosures were scored on and shows that the compartment is the clear winner.

Table 2: Enclosure

Criteria	Square	Dome	Compartment
Organization	6	3	10
Ease of Attachment	7	4	7
Sturdiness	7	6	8
Size	8	5	9
Drag Force	3	8	7
Total	31	25	41

Legend: 1 least preferred – 10 most preferred

3.6 Sensors

In order for the team to determine the pressure, temperature, speed etc., the Berry IMU was consider to perform this job. The sensor has a built in barometer, accelerometer, magnetometer and a gyroscope. The barometer allows the team to record the pressure of the atmosphere as well as record the altitude of the blimp. The accelerometer will record the acceleration at which the blimp is moving. The magnetometer helps us understand the strength and direction of the magnetic field. Lastly, the Berry IMU has a gyroscope that can measure the rate of rotation, so this can tell us whether the blimp is tilting too much either side. The sensor is also compatible with Arduino and Raspberry Pi which is important because the team will be using Raspberry Pi. Another sensor that the team found was the Module MS5607 which can record the altitude of the blimp, atmospheric pressure and also the temperature at a much higher accuracy. The thermometer range is from -40 to 85 C and a pressure range of 10 to 1200 mbar. The Module MS5607 is also compatible with multiple micro-processors. The team chose that using both of these sensors would give the best output of data when testing the blimp.

Figure: Altimeter

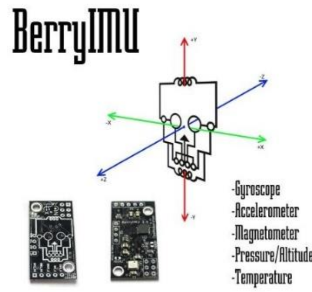


Figure: Berry IMU

4 Criteria

As demonstrated in the functional model, the sub-functions are gathered and divided as followed, frame, battery, GPS/sensor, motor, balloon envelope and camera. These sub-functions are then divided to demonstrate and measure the relative weights of each sub-function. The frame for example is divided into a) weight, b) volume and c) cost. When dividing the frame into these categories to measure the relative weights, each student had to make a table and take the ranking for each of the functions. Each student made the ranking and then we as a group gathered and took the average of all the rankings made. This was performed several times for each of the sub-functions listed below.

Table 3: Criteria for Helium MAV

Frame	GPS/Sensors	Motor	Batteries	Balloon Envelope	Camera
Weight	Controllable	Weight	Life	Payload	Size
Volume	Pre-Programmable	Thrust	Amps	Volume	Cost
Cost	Range	Cost	Voltage	Cost	Weight
X	Wi-Fi	Batteries Capability	Weight	Material	Resolution
X	Cost	X	Cost	Shape	Waterproof

4.1 Relative Weights

The relative weights of this project consist of six categories, frame, battery, GPS/sensor, motor, balloon envelope and camera. These categories are gathered from the functional model as well as the QFD. These tables are the averages of the entire group.

4.2 Frame

The frame is divided into relevant criteria importance: a) weight, b) volume and c) cost.

Table 4: Frame

Frame		
Criteria	Relative Weight	Percentage
Weight	0.533	53.3%
Volume	0.338	33.8%
Cost	0.129	12.9%

4.3 Battery

The battery is divided to a) life, b) amps, c) voltage, d) weight and e) cost.

Table 5: Battery

Batteries		
Criteria	Relative Weight	Percentage
Life	0.244	24.4%
Amps	0.191	19.1%
Voltage	0.284	28.4%
Weight	0.147	14.7%
Cost	0.134	13.4%

4.4 GPS/ Sensor

The GPS sensor is divided to a) controllable, b) pre-programmed, c) range, d) Wi-Fi and e) Cost.

Table 6: GPS/Sensor

GPS/Sensors		
Criteria	Relative Weight	Percentage
Controllable	0.269	26.9%
Pre-Programmable	0.204	20.4%
Range	0.124	12.4%
Wi-Fi	0.178	17.8%
Cost	0.225	22.5%

4.5 Motor

The motor is divided to a) weight, b) thrust, c) battery compatibility and d) cost.

Table 7: Motor

Motor		
Criteria	Relative Weight	Percentage
Weight	0.342	34.2%
Thrust	0.290	29.0%
Cost	0.213	21.3%
Battery Capability	0.155	15.5%

4.6 Balloon Envelope

The balloon envelope is divided to a) payload, b) balloon material, c) volume, d) shape and e) cost.

Table 8: Balloon Envelope

Balloon Envelope		
Criteria	Relative Weight	Percentage
Payload	0.262	26.2%
Volume	0.184	18.4%
Cost	0.193	19.3%
Material	0.229	22.9%
Shape	0.133	13.3%

4.7 Camera

The camera is divided to a) size, b) weight, c) resolution, d) waterproof and e) cost

Table 7: Camera

Camera		
Criteria	Relative Weight	Percentage
Size	0.250	25.0%
Cost	0.110	11.0%
Weight	0.208	20.8%
Resolution	0.277	27.7%
Waterproof	0.155	15.5%

5 Demonstration/Experimental Procedure

A demonstration will occur this winter to test the maximum lift force based on the amount of helium enclosed by the blimp. We will also measure the exact dimensions of the blimp to achieve a more accurate calculation, which will minimize the chances of failure. The experimental procedure will follow a few simple steps.

First, the blimp will be filled with helium. By observing the pressure gauge, we can determine the amount of helium needed to fill the blimp. Second, the dimensions will be measured. Third, a large amount of weight will be added to the blimp. Finally the weight will be removed slowly with an increment of 100g till the blimp begin to rise and it will be recorded as the maximum weight that can be carried by the blimp.

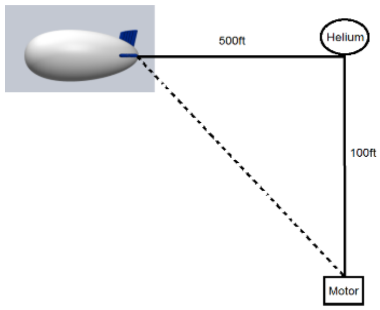
5.1 Propulsion Methods

After inspecting the given project, two main methods of propulsion have been identified. The first method is to use a long rope at one end attached to the blimp and at the other end attached to a motor stationary at the ground level. There will be a helium balloon at the middle of the rope to make it weigh less and to create an L shape rope to avoid any obstacles such as trees and buildings. The motor on the ground will be solely responsible for descending the blimp. The second method will be using a motor system attached to the enclosure with servos, where the servos will direct the motors to push the blimp in the desired directions. After evaluating both methods, pros and cons have been determined and shown in the table below.

Table 3: Pros and Cons of rope and motor methods

Rope		Motors	
Pros	Cons	Pros	Cons
Long Battery Life	Heavier	Lighter	Shorter battery life
Longer Flight time	Limited range	Maximize the lift force	Shorter flight time
Safer	Require a previous setup	Smoother flight path	Programming is challenging
Less Programming	Require more helium	Use less helium	If the program malfunctions while it in the atmosphere it could lead to failure
Easier to control	Cannot fly at relatively low altitude	Can fly at any desired path without worrying about the obstacles	The control will be somehow challenging

After evaluating the pros and cons it could be realized that’s the motors are the better choice to maximize the applications of the blimp.



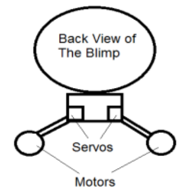


Figure 7: Blimp with ropes attached

6 Calculations

There were for main equations used to get an estimate of how the blimp will work.

Buoyancy Equation 1: $F_b = g\rho V = \rho g h A$

$F_b = Boyancy\ of\ the\ Blimp$ (N)

$g = Gravity$ (9.81) m/s^2

V= Volume (m^3)

$\rho = Density\ of\ the\ air$ (kg/m^3)

Drag Force Equation 2: $F_D = \frac{1}{2} * \rho * C_D * v^2$

$F_D = Drag\ Force\ (N)$

$\rho = Density\ of\ Air\ (kg/m^3)$

$C_D = Coefficient\ Drag$

v = Velocity (m/s)

Lift Equation 3: $L = C_1 * \frac{1}{2} * \rho * V^2 * A$

L = Lift

C_1 = Lift Coefficient

$\rho = Density\ of\ Air\ (kg/m^3)$

V= Volume

A= Area

Thrust Equation 4: $F = [(m * v_1) - (m * v_2)]/(t_2 - t_2)$

m= mass

v=velocity

t=time

Buoyancy is the ability to float. Our team used this equation to determine how much force is being applied upwards so we can counteract it with thrusters. For instance a calculation of an 8.49 m^3 will have a buoyancy force of 102 N at sea level but since we are in flagstaff it changes to 78 N because the air density is lower. This is essential for determining the force need to be generate by the thruster to bring the blimp down.

Drag force is the amount of resistance being applied to an object in the opposite direction. Our team used the drag force equation to determine how much resistance will be opposing the blimp. The drag force is dependent upon the area, so the greater the area the more drag it will produce. For instance the top of a blimp has a larger surface area then the front and back producing more resistance this is shown in the drawing below. Calculations for a blimp with a length 5m width 3m and height 3m, was calculated with a Drag coefficient of .02-.025 this will likely change depending on the volume. This comes out to a drag force of 33.1 N for the top with a surface area of 112 m^2 and an air density of .938 for flagstaff. For the front since it has a surface area of 28 m^2 the drag is lower at 8.2 N

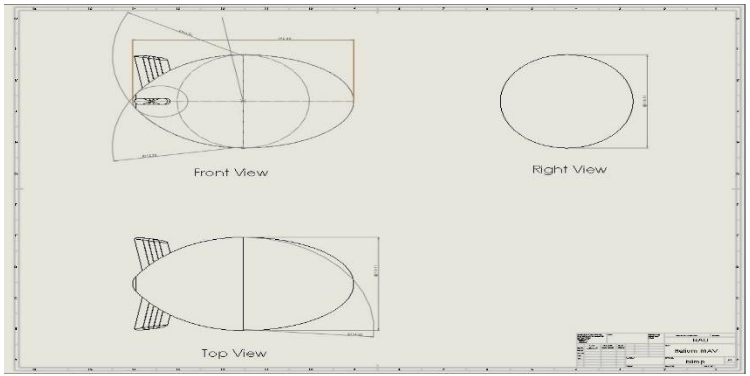


Figure 8: SolidWorks for Blimp

Thrust was calculated for motors without specifications. The main reason for this is to counteract the buoyancy force so that we can push the blimp down or hover in the air. Most motor give and estimated thrust. Lift was used to determine the helium lift due to air density of flagstaff being lighter than at sea level. For this we determined it would take 1.52 kg of helium to lift the blimp.

7 Project Implementation

The timeline for completion of this project depends on whether the blimp will work as efficient as possible without any leaks that needs to be fixed or having a new blimp that will be fit for operation. If the methods for new blimp without leaks are being implemented, the timeline for the installation and adding the helium would be perfect and we would run on track as the Gantt chart is designed. For making fixes to the blimp itself some options would be, that the project would have a delay as to make fixes and ship the items back to be fixed or generally fix it ourselves.

The Project Plan for the project was compiled using Microsoft Excel. The Project Plan serves as a timeline for the completion of the research and design for this project. The timeline for the project was broken down into four major tasks: communicating with the client, Defining the project need and goals, creating the decision matrices, analyzing and generating a report and preparing to find the budget for the project.

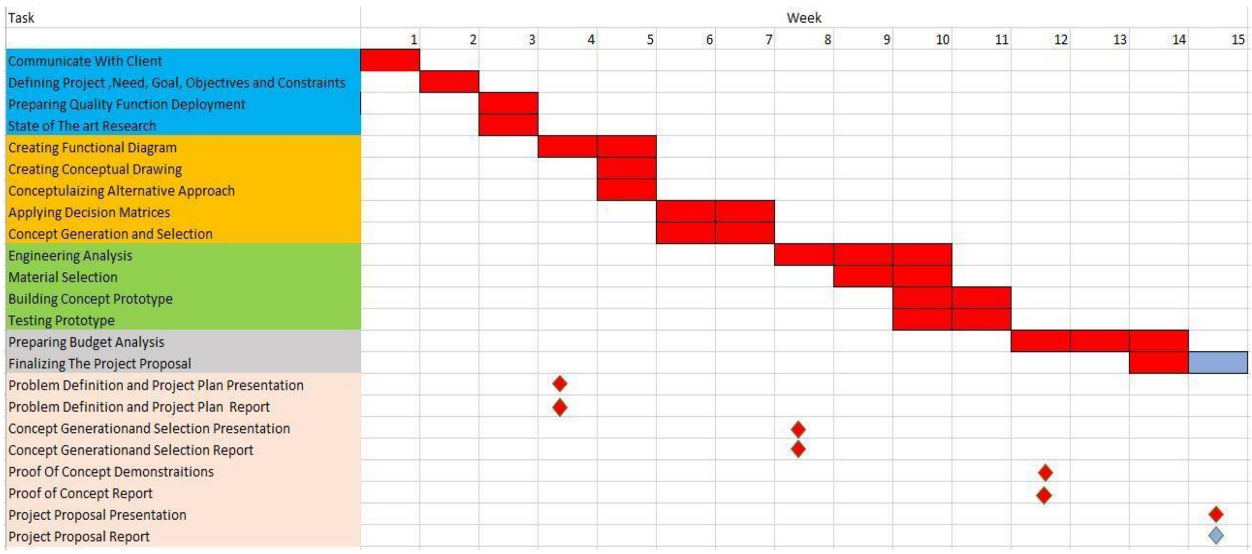


Figure 9: Project Plan for the project. Sections with red bars indicate the task has been completed.

Utilizing the project timeline, completion of significant tasks, which could be attributed to milestones, would allow for the design team to keep the clients up to date on project progression.

7.1 Deliverables

The milestones for this project, aside from the research and design based portions, are theoretical as we have not yet implemented any prototypes yet as we did not receive the blimp yet.

Depending on whether the blimp and all the other items arrive on time to do a demonstration this might be one of the biggest problems we are going to face a group.

7.2 Budget

This budget proposal includes the blimp purchase itself and the enclosure space rental to do a testing method. It also serves us to determine whether all the items would be held effectively and if there is any need to decrease the weight. This would help the group realize the mistakes that have been done and rearrange the objects as necessary to make the blimp able to carry all the items without any problems. Table 4 has the list of requested items project.

Table 4: Requested items and funds for Project

Item	Weight(g)	Quantity	Unit Price	Total
Servos	176	4	$15.6	$62.40
Venom 20C	527.4	2-3	$23.99	$71.97
Shafts	400 (estimate)	4	$10	$40 (estimate)
Motor	156	4	$16.10	$64.40
Propellers	15.9	4	$2.59	$10.36
Enclosure	208.6 (estimate)	1	TBA	TBA
Transceiver	8.5	1	$5.98	$5.98
Berry IMU	8.5	1	$28	$28
Altimeter	8.5	1	$22.49	$22.49
Blimp	TBA	1	$221	$221
Camera	74	1	$399.99	399.99
Velcro	69.17	1	$3.49	$3.49
Helium	TBA	1	$300	$300
Total	1652.57			$1230.08

The Budget consist of 11.1 Volt Venom 20C 2100 mah this is the cheapest and lightest battery that we could find it has a lot of voltage with a good amount of amperage. To power the Donkey ST2204 motor we will have to combine the batteries in parallel to increase the max amperage so that is why we need around 2-3 batteries.

The motors we are using is the Donkey ST2204 it is a light weight brushless motor with a good amount of thrust around 400 g, the motor may change depending on the size of the blimp and the amount of force needed to get the blimp down so we may have to get a larger motor or more to produce enough thrust.

Figure 10 Donkey ST2204

Figure 11: 11.1 Venom 20C

Conclusion

Our mission statement is to optimize the operation and endurance potential of the aircraft while minimizing response time using inert gas Helium. Several objectives, including minimizing cost, optimizing communication and flight duration will determine many aspects of production. We will use sensors to determine the pressure, speed, temperature, direction, and tilt. The Bill of Materials includes the materials needed to construct the project within the budget. The product parameters depend on the projected size, weight, and the applications. The Quality Functional Deployment recognized different designing necessities such as engineering requirements and customer requirements.

In the months to come, our team will implement the research of this report to build a working product. Immediately following the end of this semester, members of this team will conduct the preliminary experiment to determine exactly how much weight our envelope will hold. From this experimental data, we can determine the dimensions of the partitions in the gondola based on material weights that will be used to optimize our ability to hover at the specified altitude. The flight time will also be a function of the overall payload of the envelope volume.

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