Helium Micro Air Vehicle (MAV)

Project Proposal

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Introduction

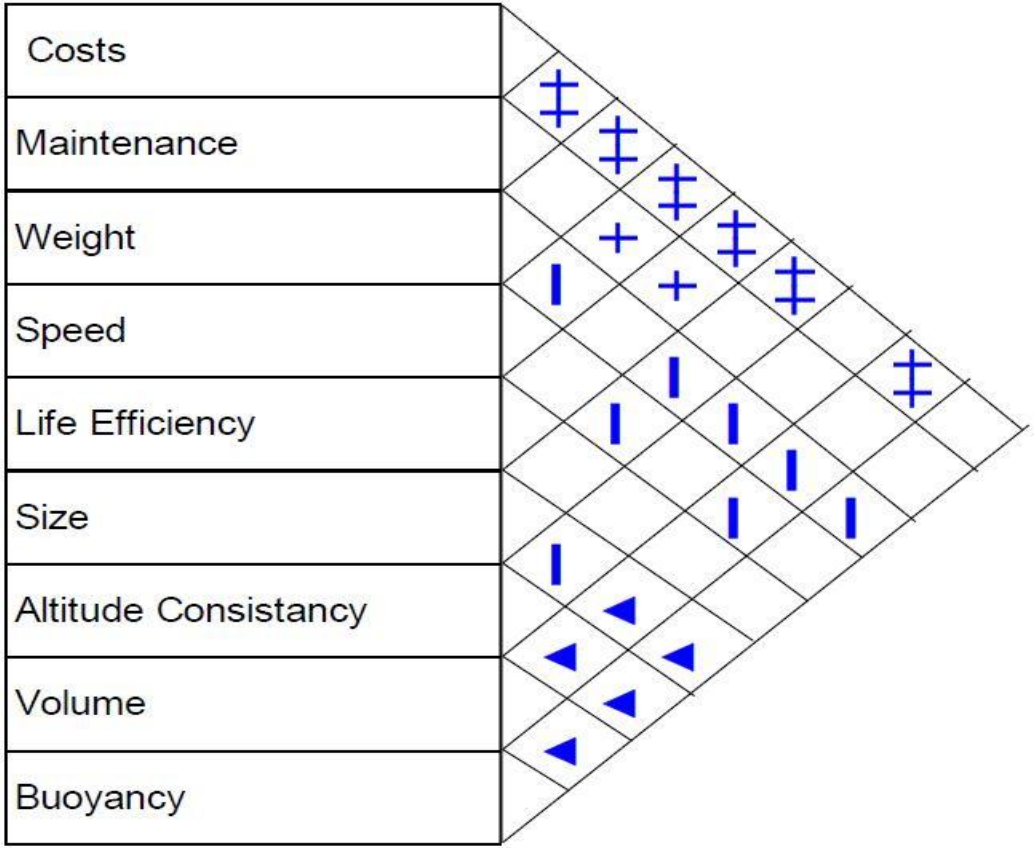
- Dr. Srinivas Kosaraju requested a Helium MAV device to fly over fires and contaminated areas
- Comparable advantage to commercial designs
- Our objectives include are to optimize weight payload limit, minimize the response time, double the distance of quadcopters and is durable

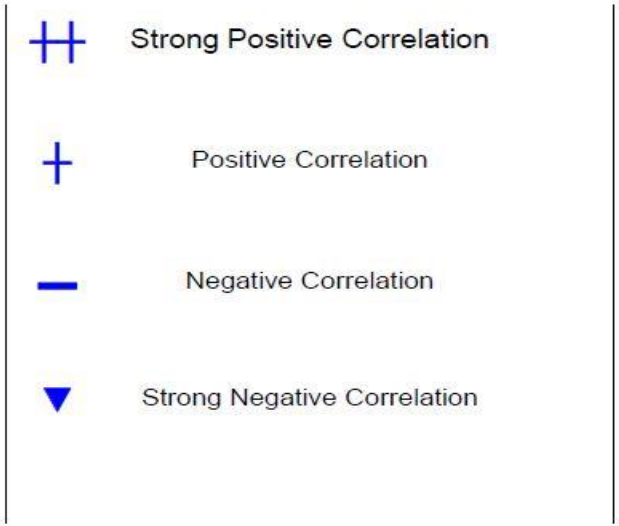
Quality Functional Deployment

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

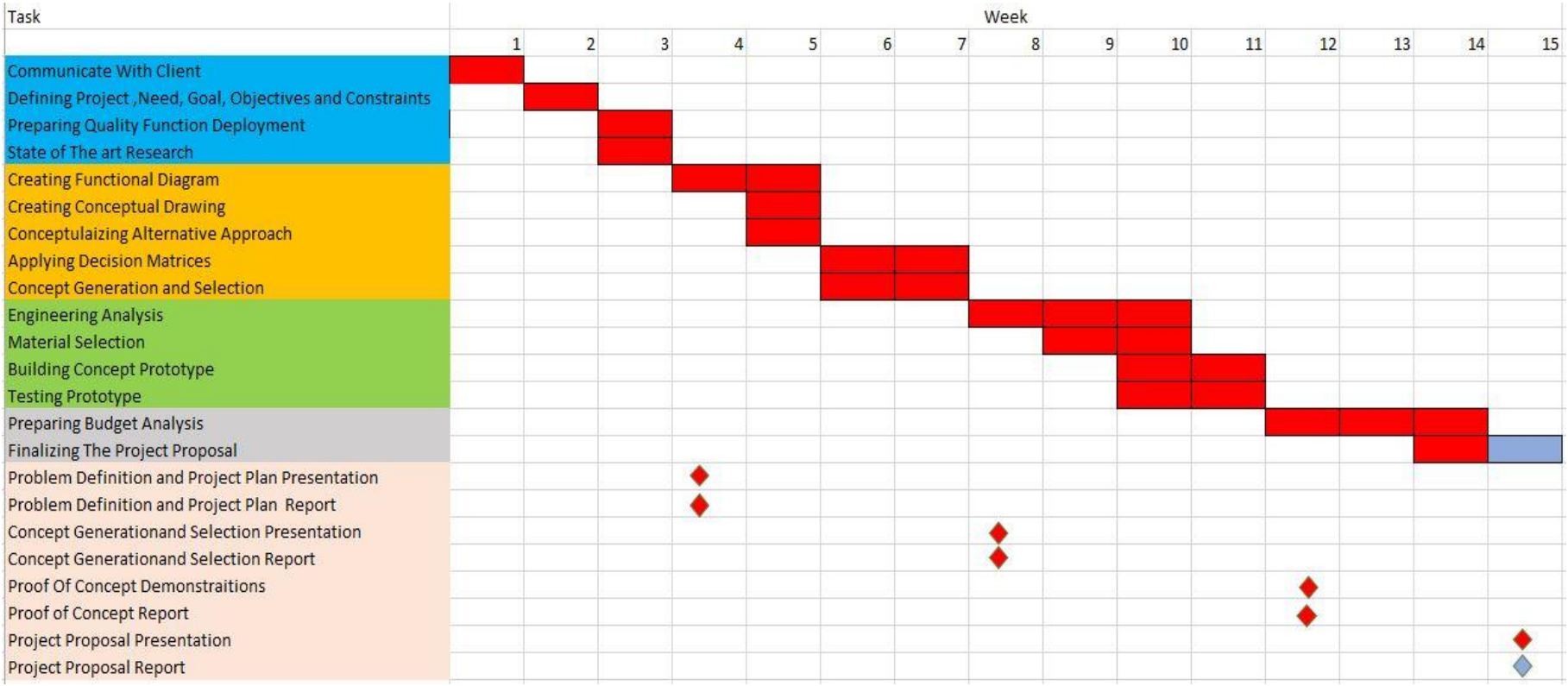
Demanded Quality (a.k.a. "Costumer Requirements") \ Quality Characteristics (a.k.a. "Engineering Requirements")	Costs	Maintenance	Weight	Speed	Life Efficiency	Size	Altitude Consistency	Volume	Buoyancy
Effectiveness of flight	O		⊙	⊙		⊙	O	O	⊙
Durability	⊙	O			⊙	O	▲		
Storage	O	▲	O			⊙		⊙	
Distance	O		⊙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

House of Quality





Project Plan



Objectives

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

Constraint

- Reach a minimum height of 30.5 m
- $2000 budget
- Must have mounted cameras with a live feed
- Remote controlled guidance system
- Temperature and weather sensors
- Must move forward, backwards, ascend and descend and hover at a specified altitude

www.freevector.com

www.dusancech.cz

play.google.com

Criteria

1. Frame
a) Weight
b) Volume
c) Cost

2. Battery
a) Life
b) Amps
c) Voltage
d) Weight
e) Cost

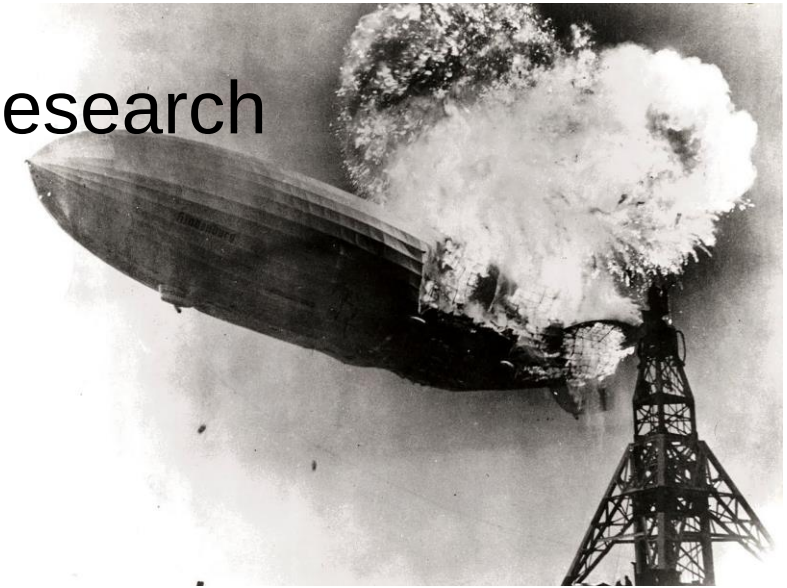
3. GPS / Sensors
a) Controllable
b) Pre- programmed
c) Range
d) Wi-Fi
e) Cost

4. Motor
a) Weight
b) Thrust
c) Cost
d) Battery compatibility

5. Balloon Envelope
a) Payload
b) Balloon material
c) Cost
d) Volume
e) shape

6. Camera
a) Size
b) Cost
c) Weight
d) Resolution
e) Waterproof

Hindenburg Disaster



Source: navair.navy.mil

State of the Art Research

- Advantages
- Inert gas and is nonflammable
- 7 times lighter than air
- Lifts around 0.96 kg/m3
- Hydrogen (H2) is highly flammable
- Disadvantages
- More expensive than hydrogen
- Weighs twice as much as hydrogen
- Hydrogen can lift about 8-11% more

State of the Art Research

Airlander 1

Source: .hybridairvehicles.com

- 6096 m
- 10,000 kg
- 5 days of flight time

Air Penguin

Source: festo.com

- 1 m^3= 1 kg buoyant force
- 3.7 m long
- Aluminium-Metallised Foil, 22 g/cm
- Li-Polymer battery, 2000 mAh, 4.2 V
- Ultrasound Receiver Capsules

State of the Art Research

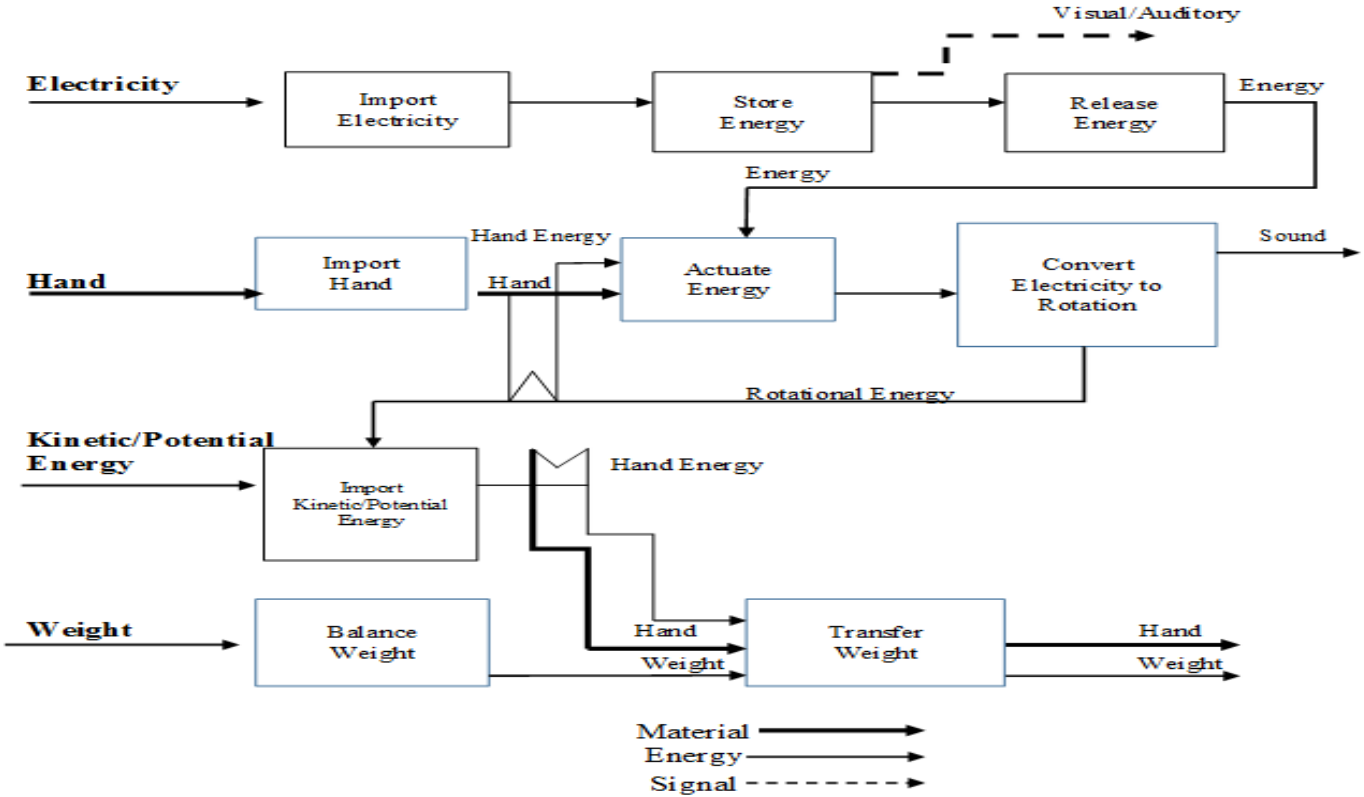
http://www.cabelas.com/

- $399.99 USD
- Estimated time usage: 2 hours
- 74 g
- 4k HD
- 12 Megapixel Sensor
- Night Vision / Waterproof
- Connect to phone

Source: http://www.dji.com/products/

- Phantom 3 Quadcopter
- $1290.00 USD
- Flight time: 30 Mins (max charge)
- 1280 g
- Max Flight Speed: 16 m/s

Functional Diagram



Attachment Concepts (DM)

1. Velcro

- Fastener strips containing hooks on one side and loops on the other
- Will be use to fasten the enclosure to the MAV

http://networkingnerd.net/

2. Ribbons

- Thin pieces of material used to wrap around enclosure

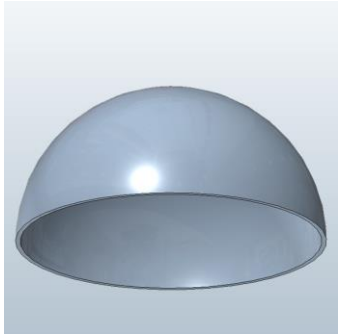
http://stampsimply.com/

3. Suction Cups (optional)

- Creates a partial vacuum that allows it to stick to smooth surfaces

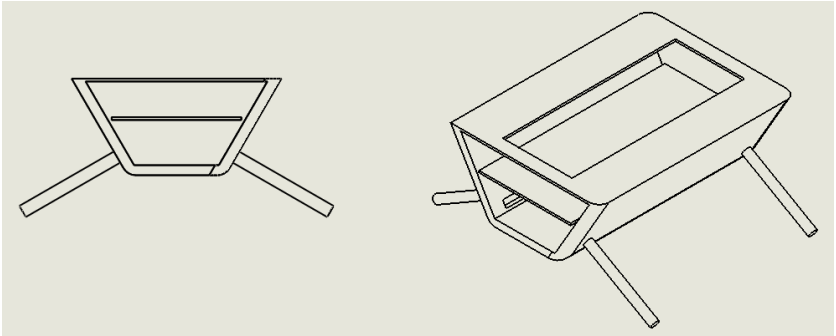
http://www.amazon.com/

Enclosure’s



1. Dome- hollowed out containing all components together.

2. Compartment- Divides components into separate areas, with chamfered sides and edges to reduce drag. Attached using Velcro on sides and top and ribbons along bottom or create hooks.



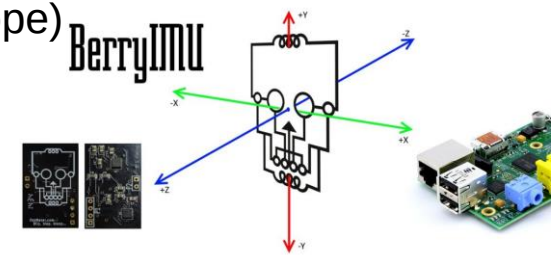
Sensors

- Berry IMU (barometer, accelrometer, magnometer, gyroscope)

  Compatable with both adriuno and rasberry pi.

- Altimeter/Temperature - Module MS5607

  Compatable with different mirco-processors



ozzmaker.com

www.robotshop.com

Demonstration/Expermental Procedure

- Goal:
- Test the maximum lift force based on the amount of helium enclosed by the blimp
- Measure the dimensions and possible enclosure area

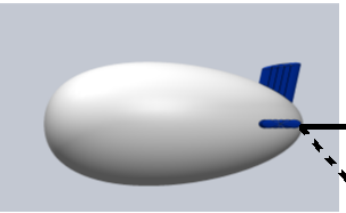
Experimental Procedure:

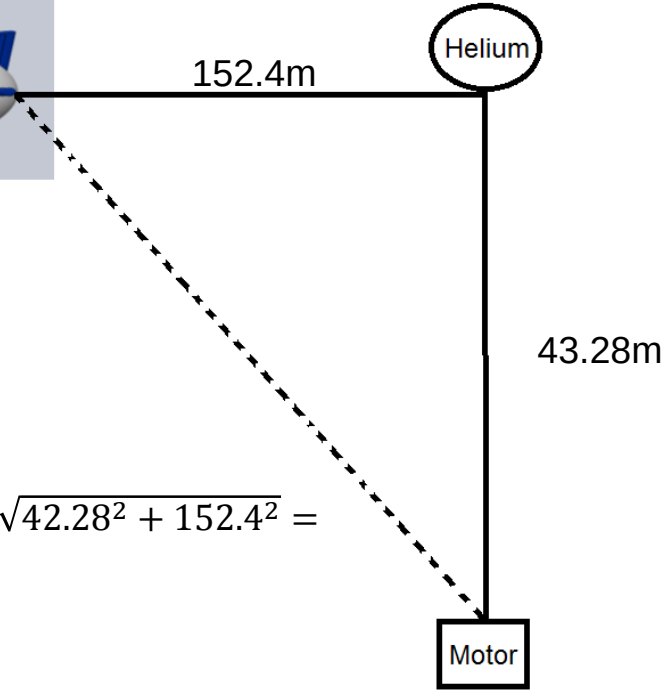
- A large amount of weight will be added, then removed slowly until the blimp will begin to rise
- Tape measure will be used to take dimensions
- View pressure gauge to determine amount of helium going in.

Actual Blimp

- This blimp will be tested by our experimental procedure.
- Length of the blimp is 5 m as stated by manufacturer.

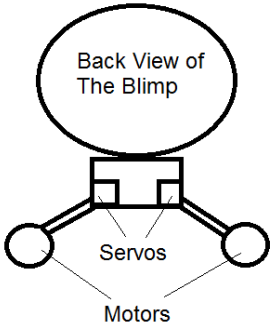
Rope





Hypotenuse $= \sqrt{42.28^2 + 152.4^2} =$ 158.2m

Motors



Pros and Cons?

Rope

Pros:

- Longer Battery Life
- Longer Flight time
- Safer
- Less Programing
- Easier to control

Cons:

- Heavier
- Limited Range
- Requires a Previous Setup
- Requires more Helium
- Cannot fly at relatively low altitude

Motors

Pros:

- Lighter
- Maximize the lift force
- Smoother Flight Path
- Uses less helium
- Can fly at any desired path without worrying about the obstacles

Cons:

- Shorter Battery Life
- Shorter flight time
- Programing is challenging
- If the program malfunctions, while it in the atmosphere, it could lead to failure

Servos and Shafts

- Servo T010051 which has a torque of 3.30 kg-cm
- Will be connected to thrusters by shaft
- Has a 360 degree rotational angle to turn thrusters
- Plastic casing around connection point for support
- Shaft will extend out of the enclosure

T010051 Servo newark.com

Formulas Used

Buoyancy Equation

$$F_b = g\rho V = \rho g h A$$

Thrust Equation

$$F = [(m * v1) - (m * v2)]/(t2 - t2)$$

Drag Force Equation

$$F_D = \frac{1}{2} * \rho * C_D * v^2$$

Lift Force Equation

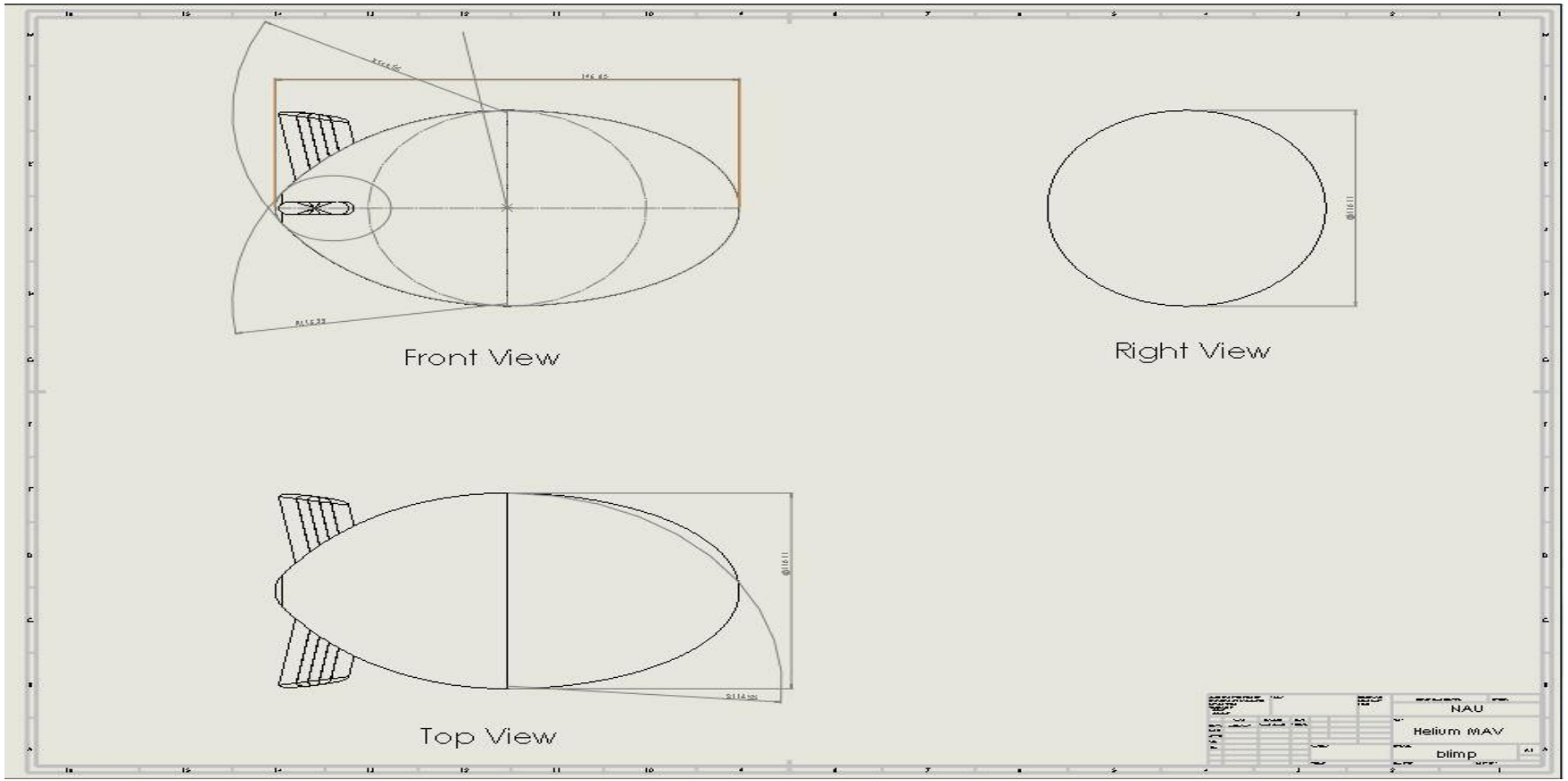
$$L = C_1 * \frac{1}{2} * \rho * V^2 * A$$

Calculations: Drag Force

- Surface Area Top =112.93 m^2
- Density of Air (Flagstaff, $\frac{\mathrm{kg}}{\mathrm{m}^3}$) = 0.938
- Drag coefficient ($\mathrm{C_D}$)= .025
- Velocity (v)= 5 m/s
- Drag Force ($\mathrm{F_D}$) = 33.1 N

- Surface Area front = $28.27\mathrm{m}^2$
- Density of Air (Flagstaff, $\frac{\mathrm{kg}}{\mathrm{m}^3}$) = 0.938
- Drag coefficient ($\mathrm{C_D}$)= .025
- Velocity (v)= 5 m/s
- Drag Force ($\mathrm{F_D}$) = 8.2 N

Blimp Drawing



Calculations: Bouyancy

Assumptions Made at Sea Level

Atmospheric Temperature = 297 K

Atmospheric Pressure = 101.325 kpa

Gas Constant R = 8.314 $\mathrm{J}/(\mathrm{K} * \mathrm{mol})$

Volume (m^3)=8.49

Density of Air (Flagstaff, $\frac{kg}{m^3}$) = 0.938

Density of Air (Sea Level, $\frac{kg}{m^2}$) = 1.225

Density of Helium (Pure, $\frac{kg}{m^3}$) = 0.1786

Volume Displaced (m^3) = 8.49

Buoyancy, Flagstaff (N) = 78.123112

Buoyancy, Sea Level (N) = 102.0265

Bill of Materials

Item	Price	Quantity	Final Price	Final weight
Servos	$15.60	2-4 (estimate)	$62.40	176 g
Venom 20C 3S 2100mAh 11.1V	$23.99	2-3 (estimate)	$71.97	527.40 g
Shafts	$10	2-4 (estimate)	$40.00	400 g (estimate)
Donkey ST2204 Electric motor	$16.10	2-4	$64.40	156 g
9x6 APC Propeller	$2.59	4	$10.36	15.90 g
Enclosure	-	1	-	208.6g (estimate)

Bill of Material

Item	Cost($)	Weight(g)
Transceiver Module	$5.98	8.5g
Berry IMU	$28	8.5g
Altimeter Module	$22.49	8.5g
Blimp	$221	TBA
Helium	$300	TBA
Camera	$399.99	74g
Velcro	$3.49	69.17g
Total	$1230.08	1652.57g

Final Analysis

PROJECTED WEIGHT: 1230.08g

APPLICATION:Building Heat Leakage , forest fire , Oil leakage

Calculated Cost: $1652.57

amazon.com

Hobbyking.com

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

- Using 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

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