AUVSI DESIGN COMPETITION

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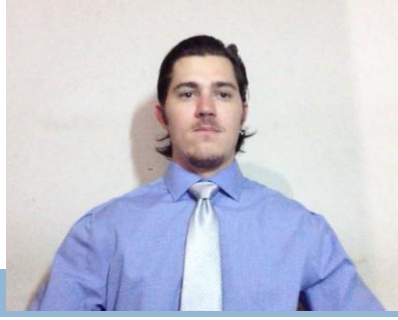
Overview

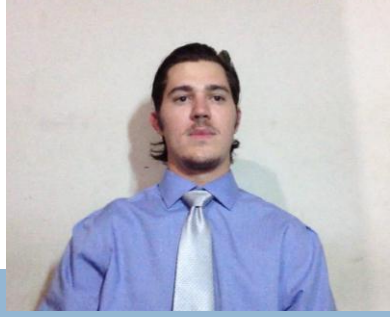


"The goal of this project is work effectively as an international team to create the best possible aircraft for future success at the 2015 AUVSI SUAS Competition."

FIPSE- Fund for the Improvement of Postsecondary Education
- Two members of Team 8 are currently studying in Itajuba, Brazil
- International experience
- Communication and teamwork skills

Tasks:
- **Design** aircraft, optimizing for competition
- **Build** and modify existing Senior Telemaster plane
- **Program** aircraft for automated VTOL and navigation
- **Test** aircraft and adjust accordingly

Progress



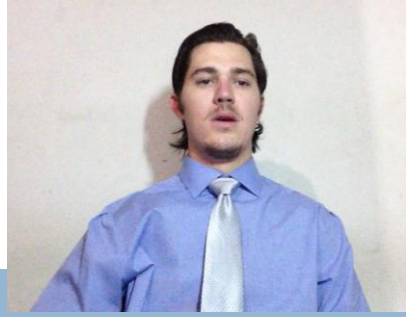
Team 8 has been working diligently to design the most effective aircraft design for the senior design project.

Decision Matrix:

1. Retrofit Last Year's Plane
    - Cost and Time effective
    - Long flight duration and High Payload
2. Build a Multi-Rotor
    - Great Opportunity to Learn
    - VTOL
    - Foundation for Future

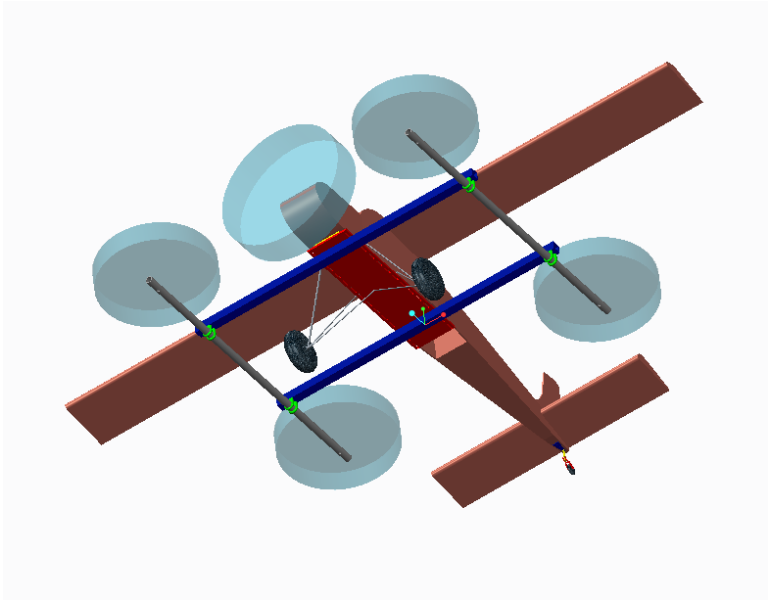
Decided a *Hybrid Aircraft* would combine the best features of both designs.

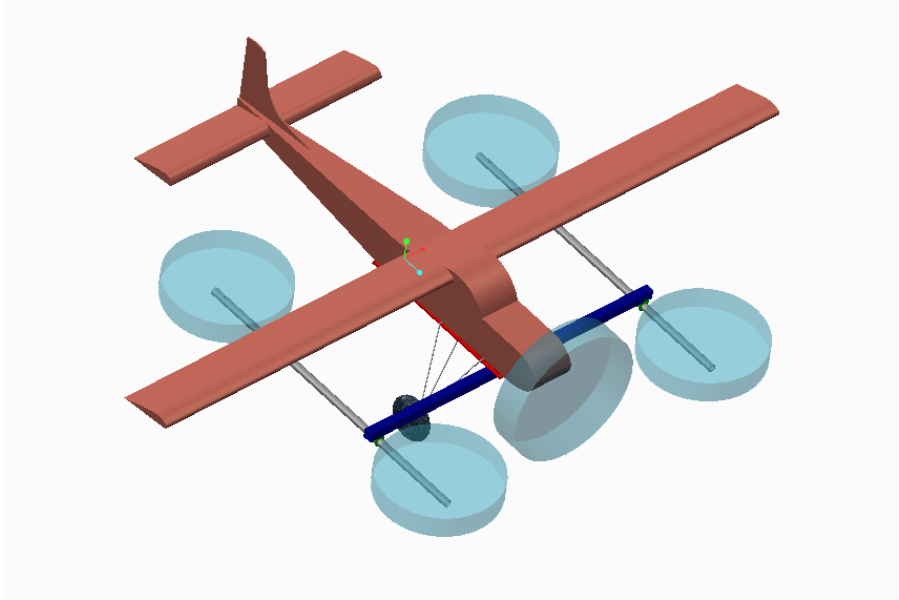
Frame Design



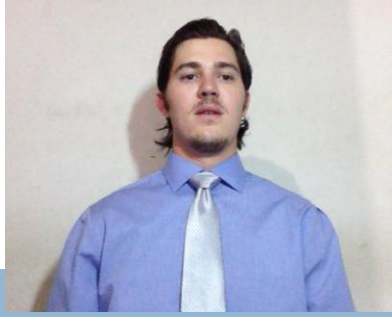
Constraints:

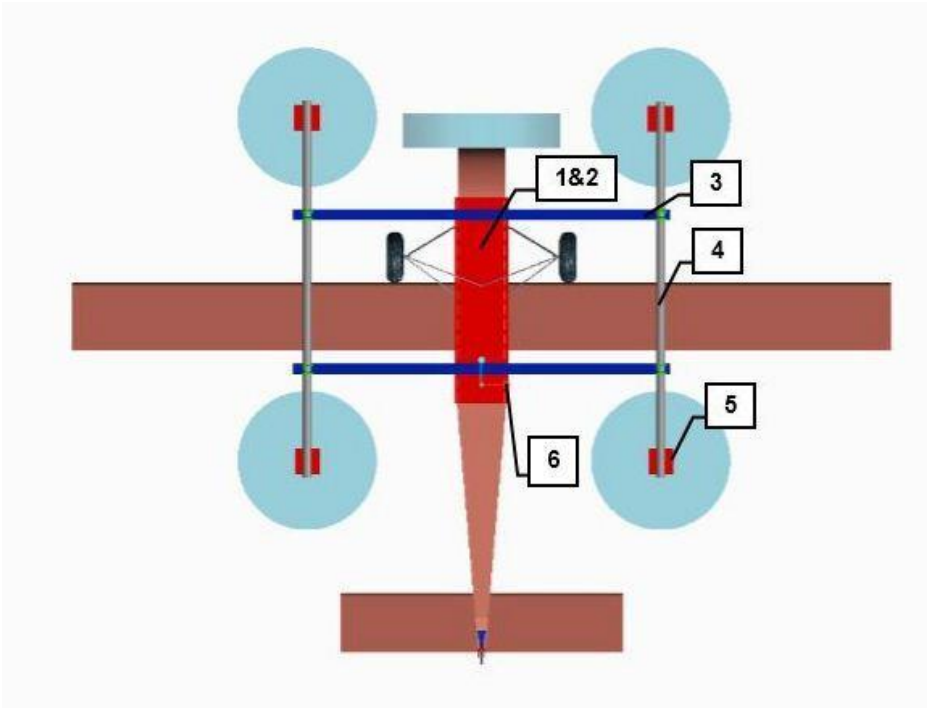
- Lightweight
- Strong
- Low Cost
- Simple
- Removable
- Vibration damping





Frame Design





Material Selection:

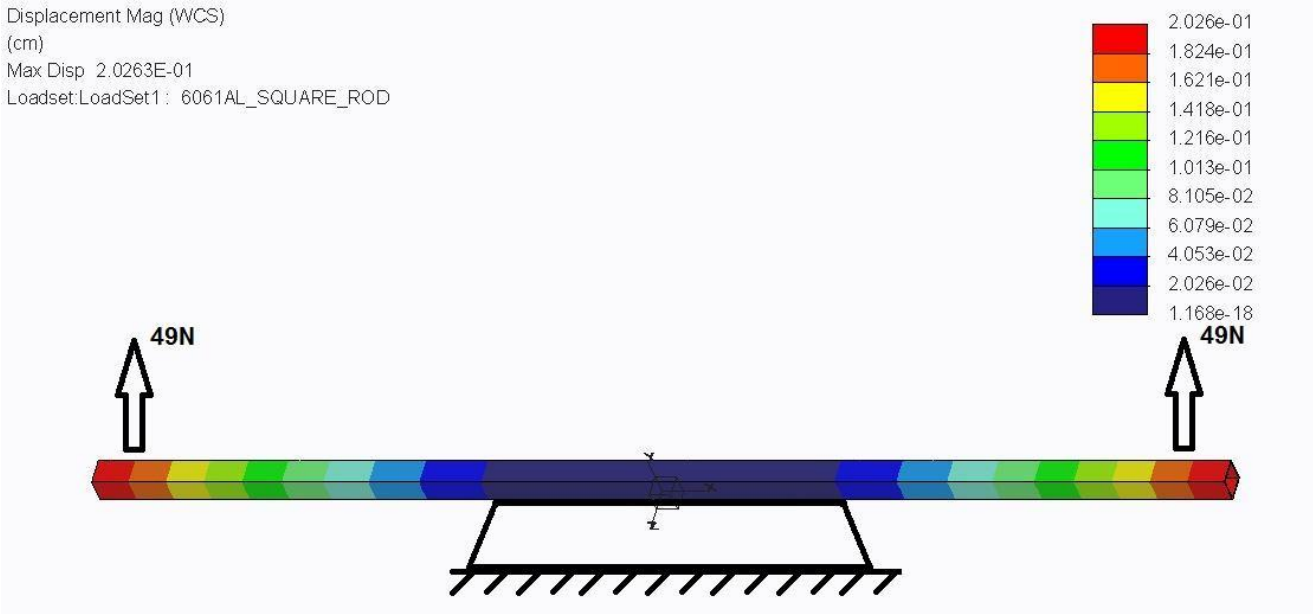
1. G-10 Garolite Base
2. Quick-Recovery Polyurethane Foam Spacer
3. 6061 Aluminum Cross Beams
4. High-Strength Rigid Carbon Fiber booms
5. G-10 Garolite Motor Mount Adapters
6. Industrial Strength Velcro

Frame Design

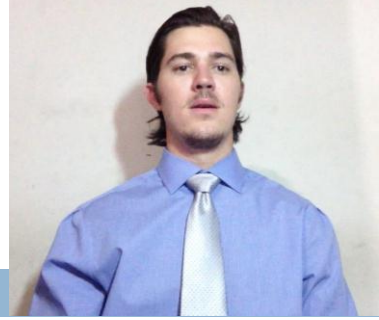
Beam Displacement:
Force of lift on both ends of the beam:
4.45kg for each motor ≈ 5kg = 49N

Forces are applied 5cm from each end, with the width of the body fixed (15cm)

Max Displacement:
0.2026cm

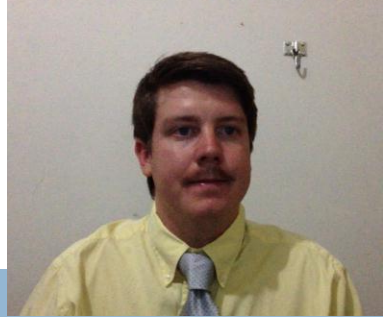


Frame Design



Frame Design: Weight and Cost Analysis											
Component	Description	Dimensions	Volume (in^3)	Density (lb/in^3)	Weight/Part (lb)	Price	Vendor	Qty.	Weight (lb)	Subtotal	Extras
G10	Base Excellent Tensile and Impact Strength	23x6.1x.1575 "	22.097	0.063	1.392	$0.00	n/a	1	1.392	$0.00	
G10	Motor Mount Adapter	2.36 x 2.36 x .1575"	0.879	0.063	0.055	$0.00	n/a	4	0.221	$0.00	
Carbon Fiber Tubes	Parallel Arms for holding the motors Excellent Tensile Strength	0.5ODx0.414 ID x 43.3"	10.690	0.067	0.716	$35.87	McMaster-Carr Part #:2153T41	2	1.432	$71.74	$35.87
6061 Al	Square Tubes Cross Bar Good/good : Tensile/Impact	1 x 1 x 43.3" 0.0625" thick	10.150	0.1	1.015	$23.38	McMaster-Carr Part #:6546K53 6ft.	2	2.030	$46.76	$23.38
Foam Spacer	Padding to Protect Plane and Decrease Vibration	24 x 24 x .25"	35.075	0.012	0.406	$34.03	McMaster-Carr Part #:86375K252	1	0.406	$34.03	
D.B. Orange	Double/Bubbe Orange Epoxy, 10 Pack High Peel Stgth.	n/a	n/a	n/a	0.000	$16.00	theepoxysource.com	1	0.000	$16.00	
Velcro	Industrial Strength Double Sided Velcro to Attach the Frame to the Plane	n/a	n/a	n/a	0.250	$20.00	n/a	1	0.250	$20.00	
Zip Ties	Zip ties to Secure the Carbon Fiber Tubes to the Cross Bars	n/a	n/a	n/a	0.000	$10.00	n/a	1	0.000	$10.00	
Hardware	Screws, Bolts, Etc.	n/a	n/a	n/a	0.000	$20.00	n/a	1	0.000	$20.00	
								Subtotal	5.732	$218.53	$58.87
								Total	2.600 kg		$277.40

Motor Selection

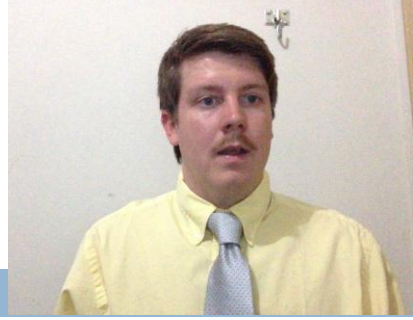


Equipment weight							Total
Frame	Battery (2)	Motor (4)	Prop (4)	ESC (4)	Misc.		kg
8.283	1.080	0.844	0.204	0.216	0.300		10.92

Calculated Weight * Safety Factor = Total Thrust Needed

- Calculated weight 10.92kg
- Safety Factor: 1.5
- Total Thrust Needed: 16.38kg
- Thrust per motor: 4.10kg

Motor Selection



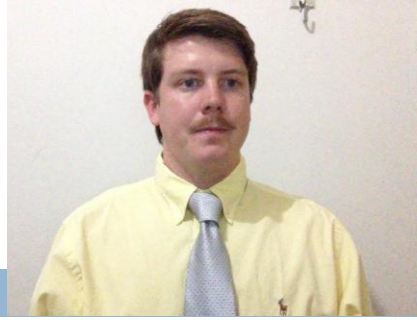
Cobra 4510 Multi-Rotor Motor

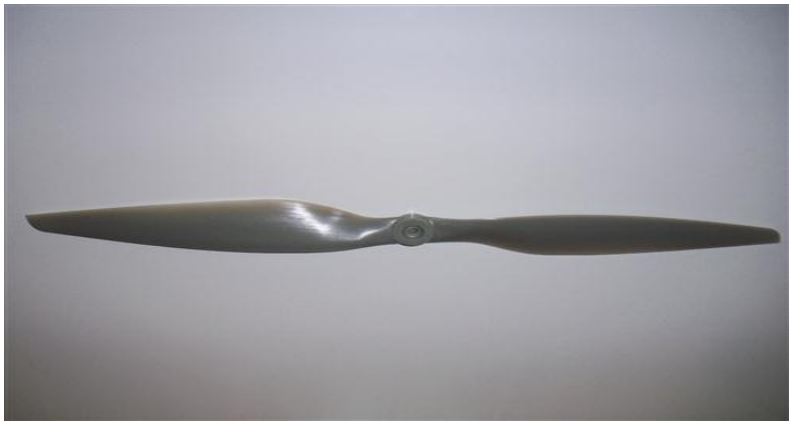
Tiger Motor MN4120

Tarrot 5008 Motor

Motor	Cobra	T-Motor	Tarrot
Thrust	4468 g	4280 g	4100 g
Price	$74.99	$129.90	$59.90
Weight	211g	253g	168g

Motor Selection



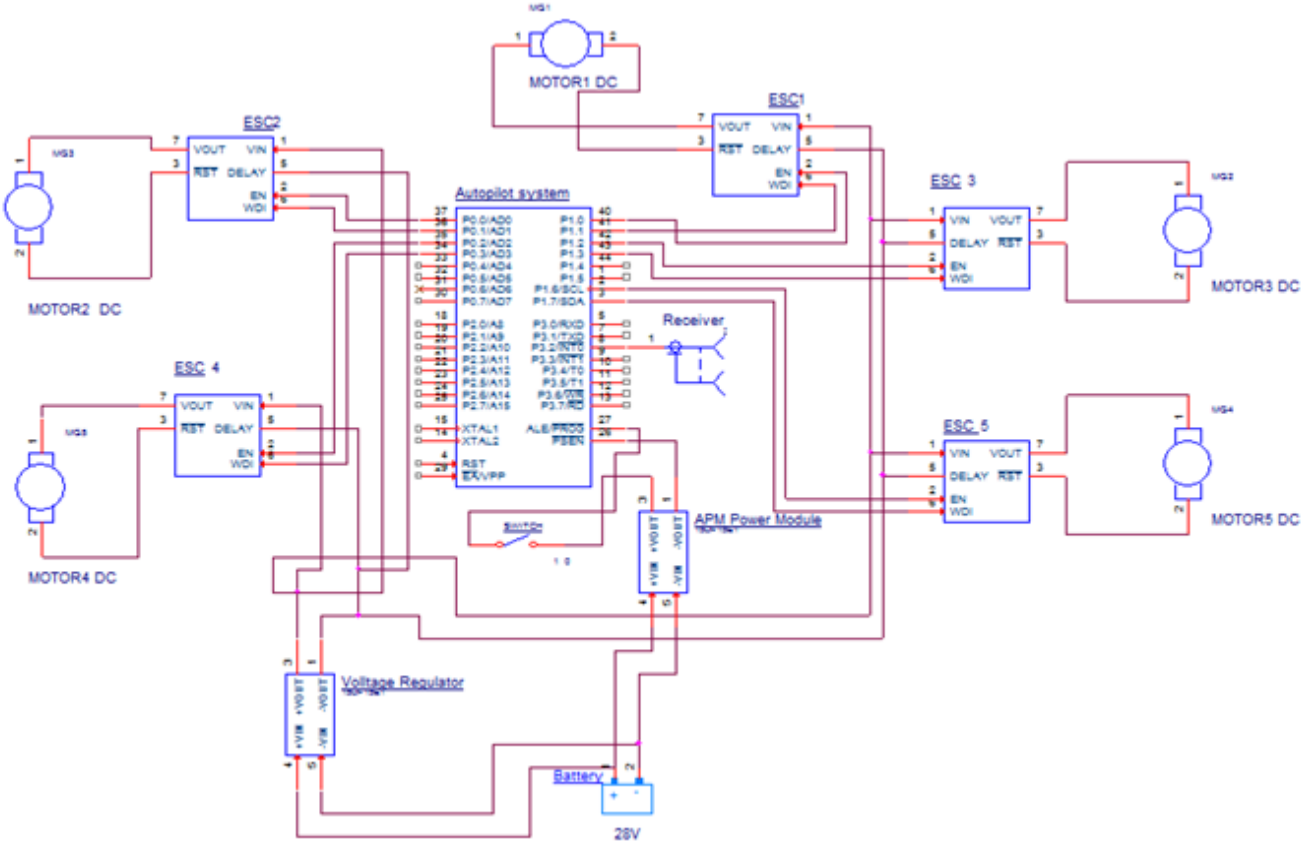


Cobra 4510, KV = 420, Current 35A, Weight 211g

APC 18 x 5.5” Multi-Rotor Propeller

Prop Size	Li-Po Cells	Input Voltage	Motor Amps	Input Watts	Prop RPM	Pitch Speed in MPH	Thrust Grams	Thrust Eff. Ounces	Thrust Eff. Grams/W
18x5.5-MR	6	22.2	38.76	860.5	6,414	33.4	4468	157.60	5.19

Circuit schematic



Autopilot Selection

Autopilot selection:

Ardupilot 2.5

System Features:

- Fully autonomous waypoint navigation for multi-rotor vehicle
- Failsafe programming options if device loses signal
- Relay real-time telemetry data to ground system

ESC Selection

ESC Selection for Quad-Rotor:

Cobra 60A opto multirotor ESC

Design features :

- Permits device to operate with minimal radio interference at high currents
- If the autopilot system loses signal, the system will automatically switch to idle

Electrical Power Calculations

Remaining battery capacity if aircraft land and takeoff for 40s

= (battery capacity – (discharge time * current drawn)

= (10A – (.0111hours * 155.04A)) = **8.28 A**

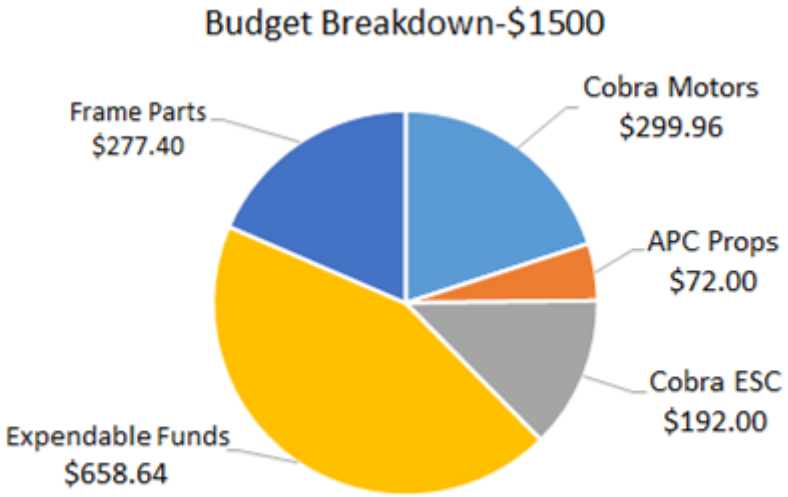
Hover time = (battery capacity)/(current drawn)

= (8.28 A / 96)*60min = **5.175 min**

Total flight time = 5.175 min + .66min = **5.84 min**

Recommended flight time = **4.6733 min**

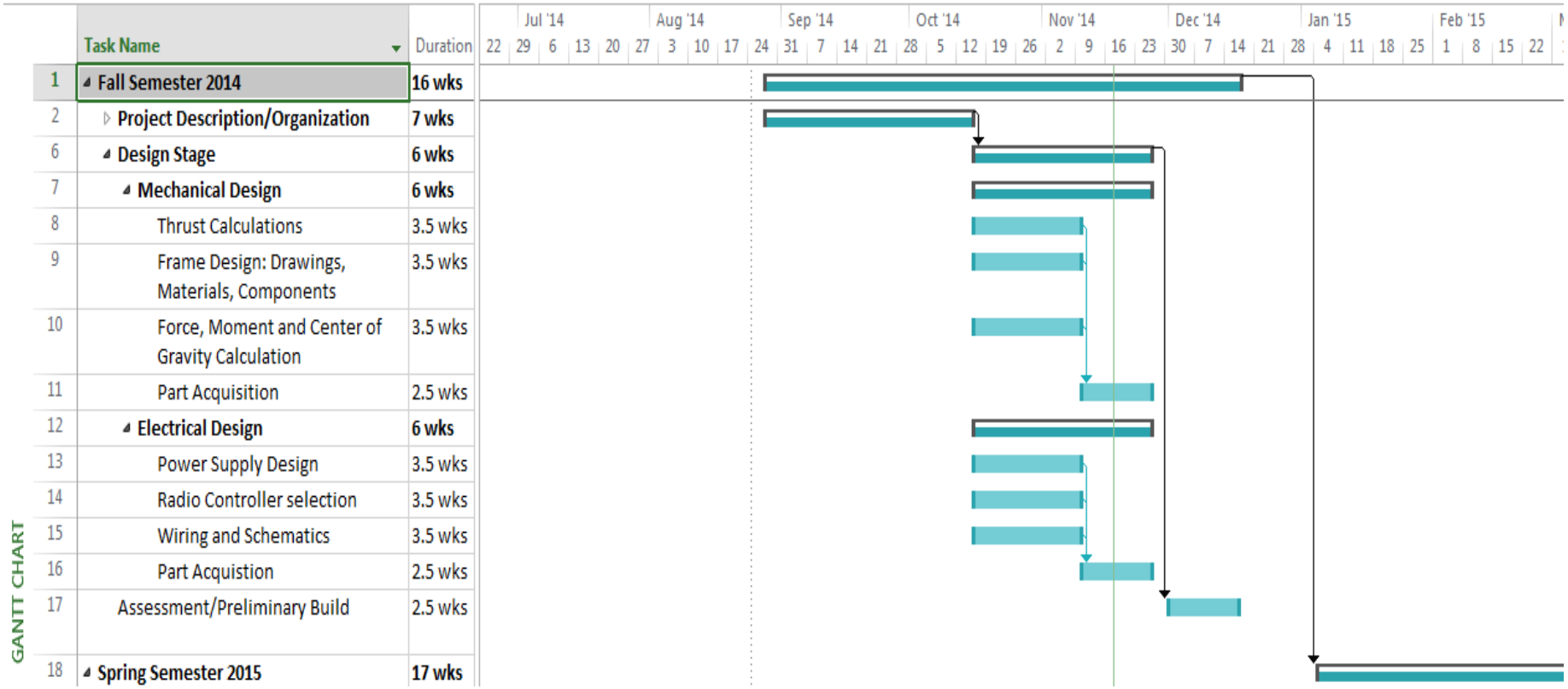
Cost Analysis



Analysis:

1. Utilized 56% ($841.36) of budget
2. Efficient Spending
3. Surplus Added

Schedule/Gantt Chart



Future Work

Fall Semester:

1. Part Aquisition
2. Frame Drawings

Spring Semester:

1. Manufacturing/Preliminary Build
2. Test Flight/Troubleshoot (Horizontal)
3. Finalized Build
4. Test Flight/Troubleshoot (Vertical)

Final Summary

1. Improved multidisciplinary and international communication skills
2. Selection of hybrid design
3. Frame design and material selection
4. Motor, Prop, and ESC selection
5. Electrical Components/Power Design
6. Budget/Schedule

References

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ANY
QUESTIONS
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