SUAS Project

Student Unmanned Aerial System

Senior Design Team# 14

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Sponsored by FCAAP

April 12 2012

Presentation Overview

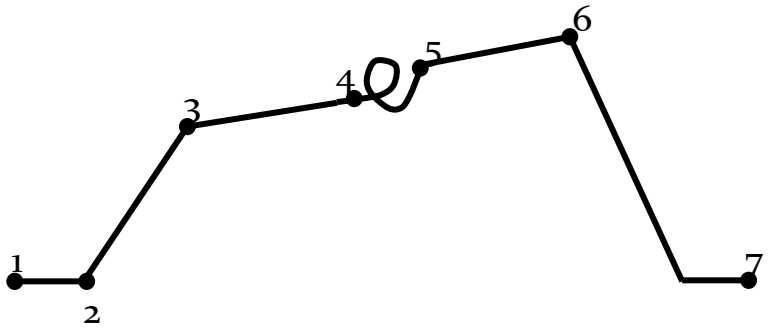
- Introduction
- Concepts Description and Selection
- Final Design
- Engineering Economics
- Project Results
- Conclusion

Introduction

Primary Objectives:

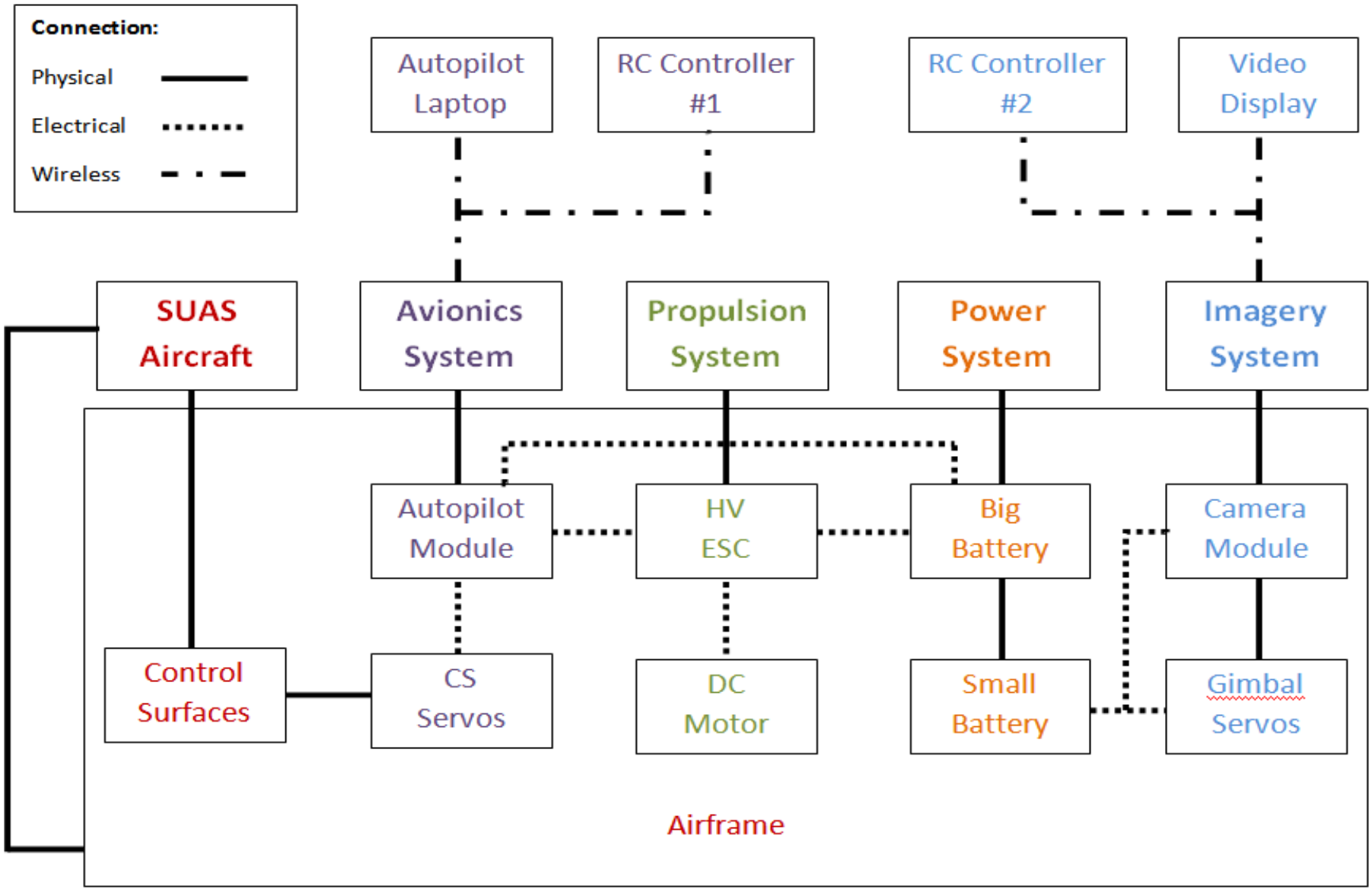
- Systems Engineering approach for the design and manufacture of an Unmanned Aerial System (UAS)
- UAS able to complete specified mission.
- UAS design compliant with the 2012 AUVSI Student UAS Competition requirements.

Mission Profile



1. Warm-up & Take-off
2. Climb
3. Waypoint Navigation
4. Autonomous Area Search
5. Waypoint Navigation
6. Descent
7. Landing

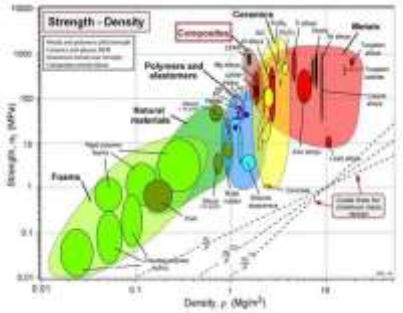
(Constant Target Recognition)


Connection:
Physical
Electrical
Wireless
Autopilot Laptop
RC Controller #1
RC Controller #2
Video Display
SUAS Aircraft
Avionics System
Propulsion System
Power System
Imagery System
Autopilot Module
HV ESC
Big Battery
Camera Module
Control Surfaces
CS Servos
DC Motor
Small Battery
Gimbal Servos
Airframe

Concepts Description

Aircraft Configurations

Materials



Propulsion Systems

Autopilot Systems

Power Supply Systems

Camera Systems

Concepts Selection

Aircraft Configuration:
Conventional

Materials:
Fiberglass
Foam
Carbon Fiber
Balsa Wood

Propulsion System:
Brushless DC Electric

Autopilot System:
ArduPilot Mega

Power Supply System:
LiPo Batteries
BEC

Camera System:
Sony Block Camera
Lawmate Video

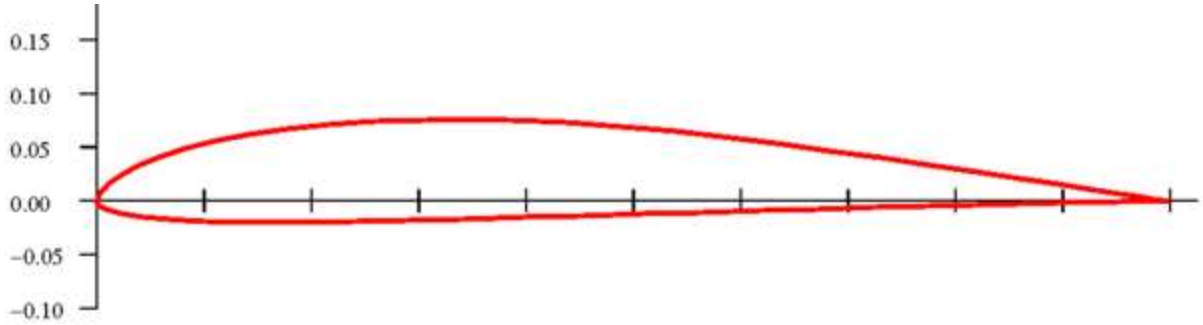
Final Design

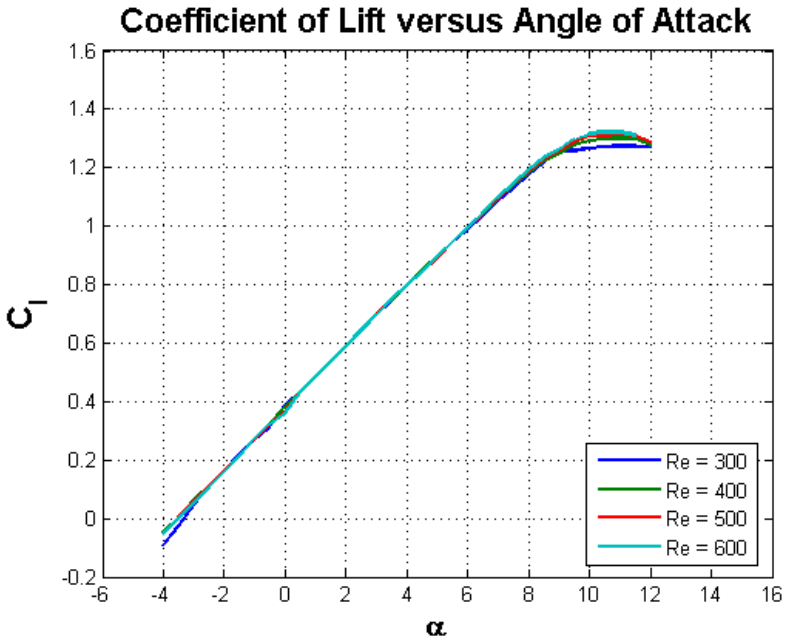
- SUAS Aircraft
- Propulsion System
- Avionics System
- Imagery System
- Power Supply System

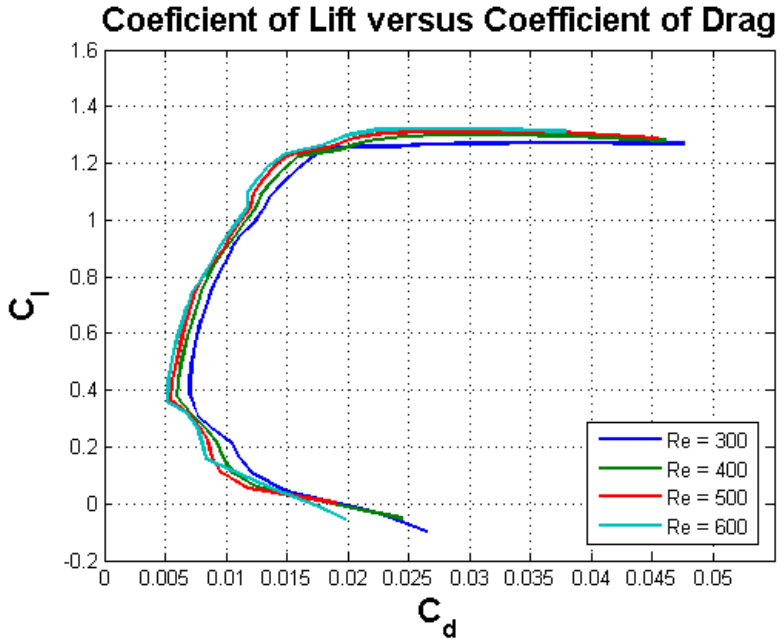
Final Design

- **SUAS Aircraft**
- Propulsion System
- Avionics System
- Imagery System
- Power Supply System

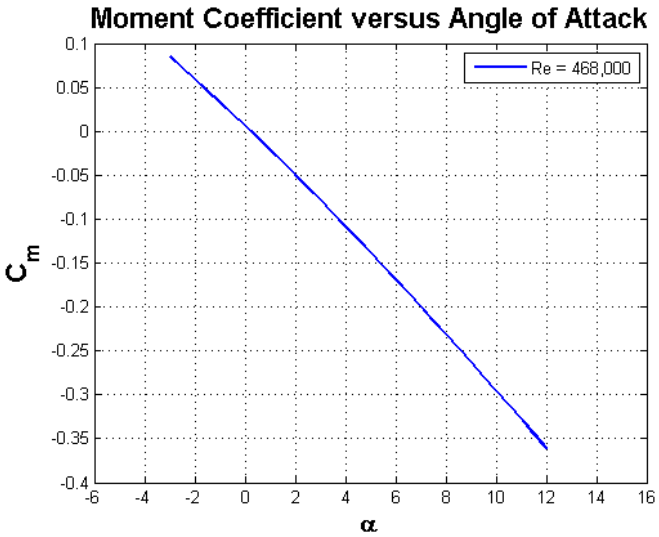
Airfoil Analysis – SD7037

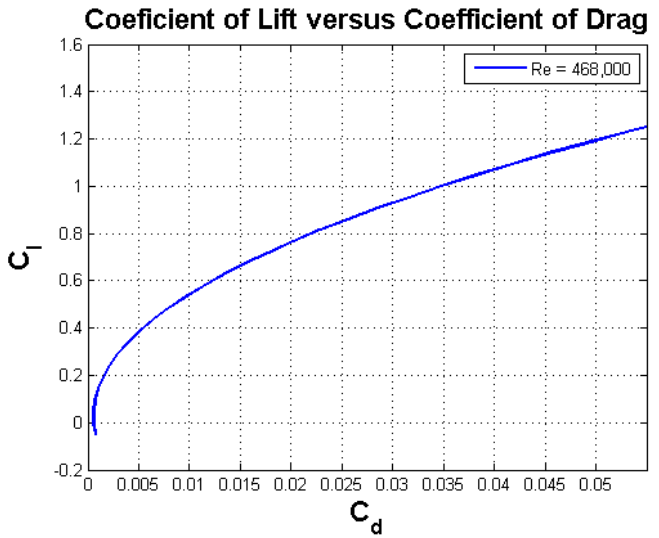


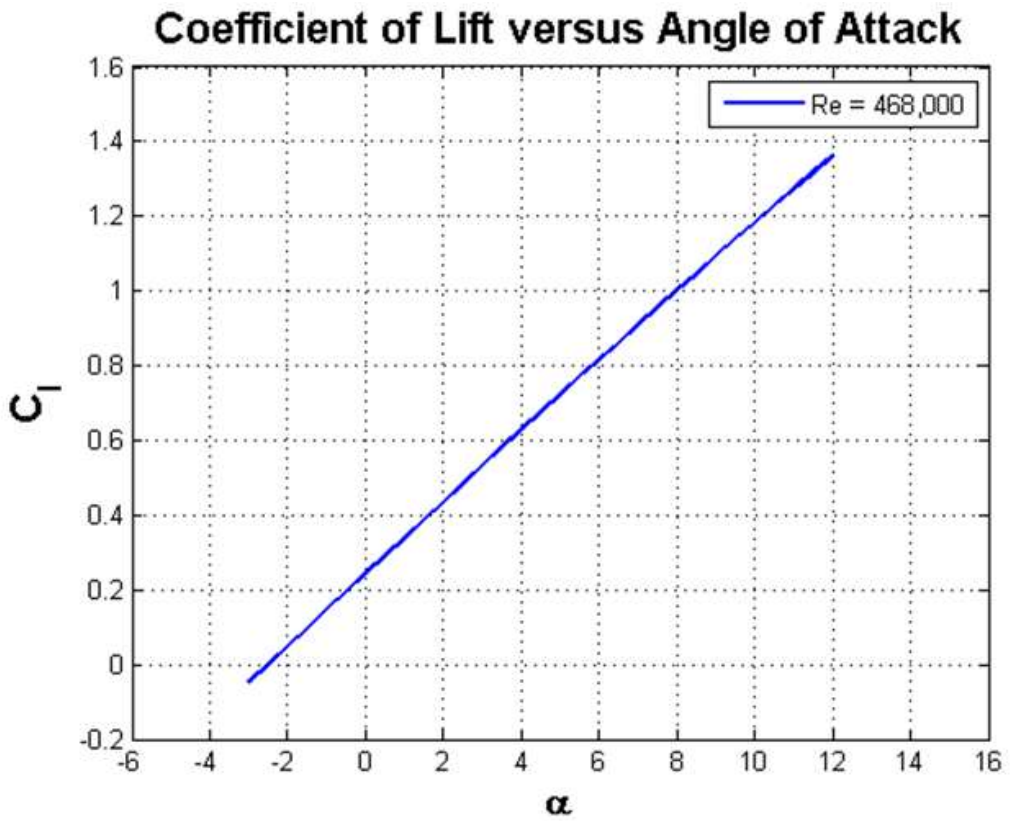




3D Aerodynamic Analysis







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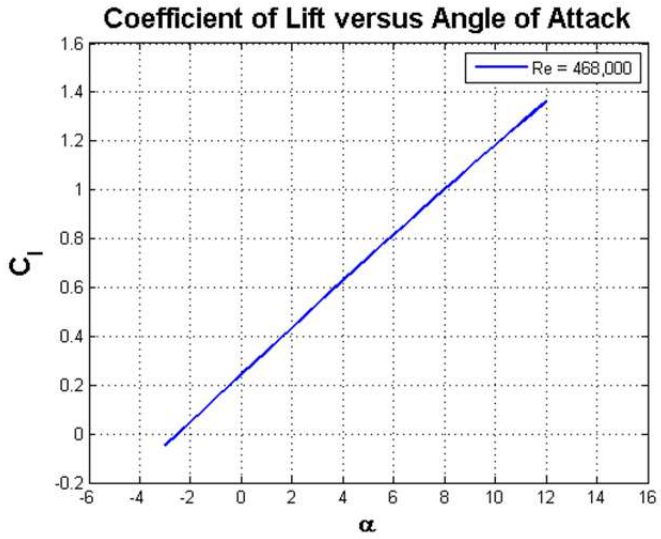

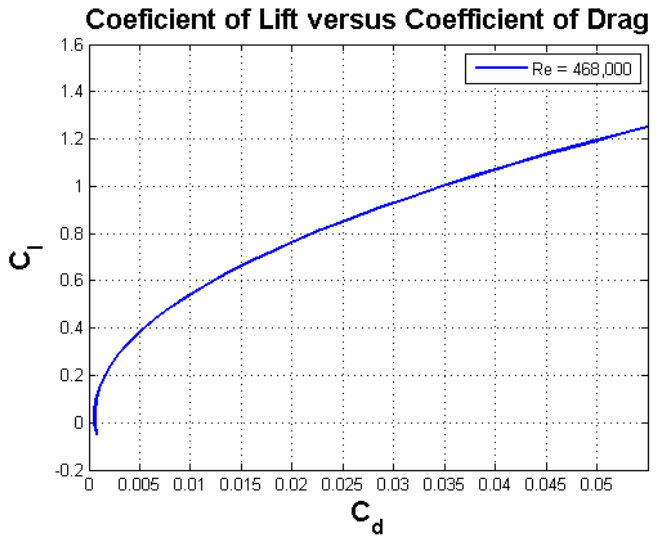

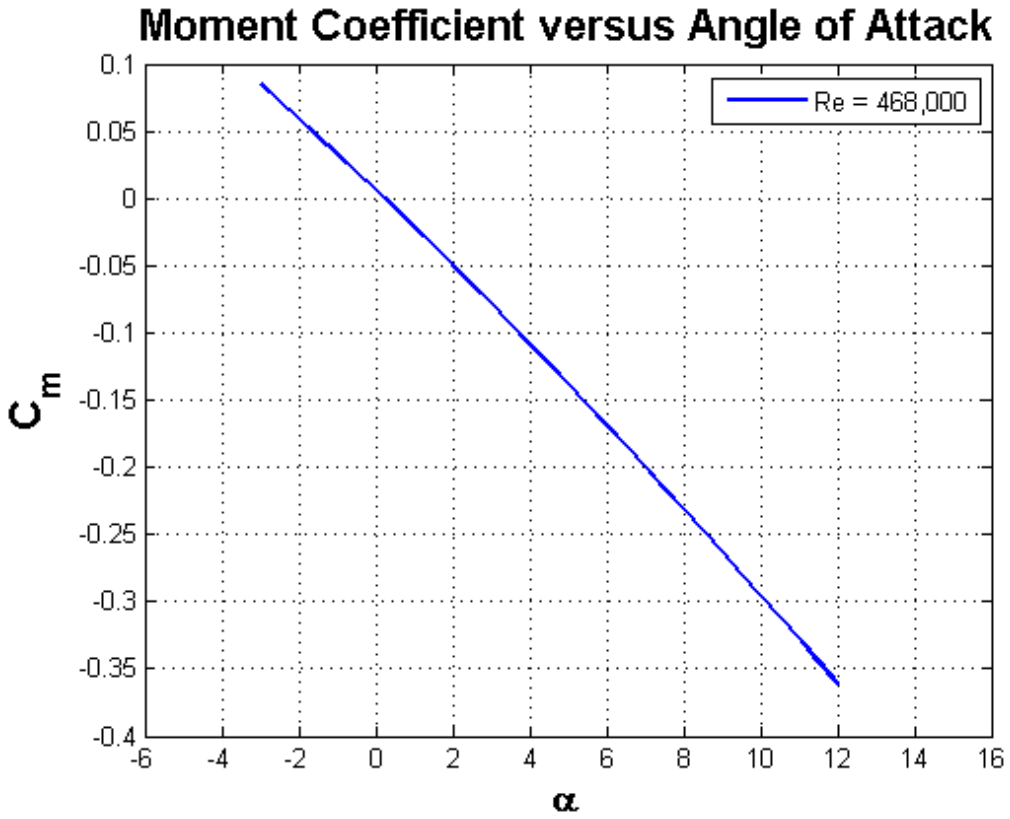

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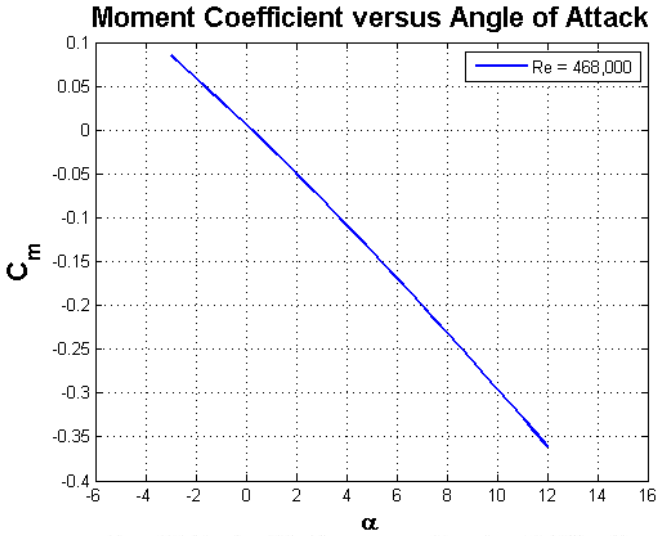
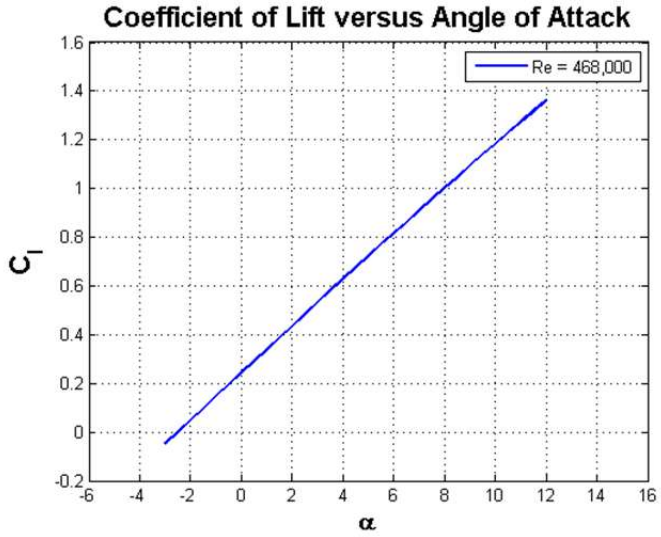
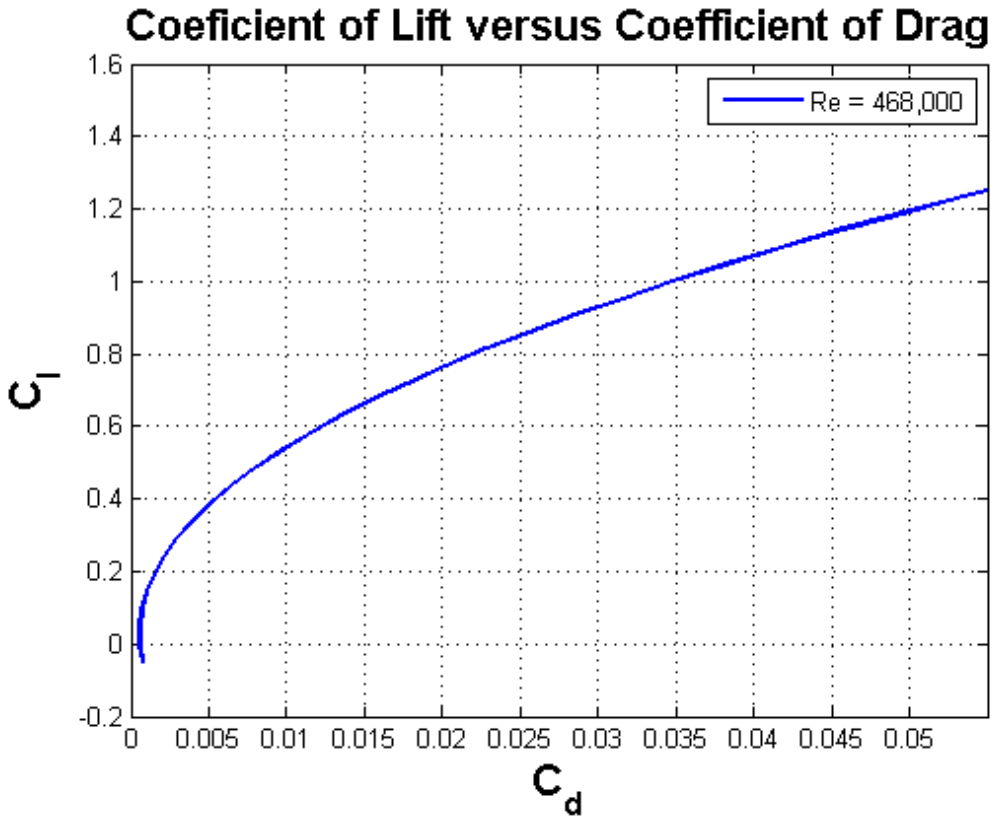
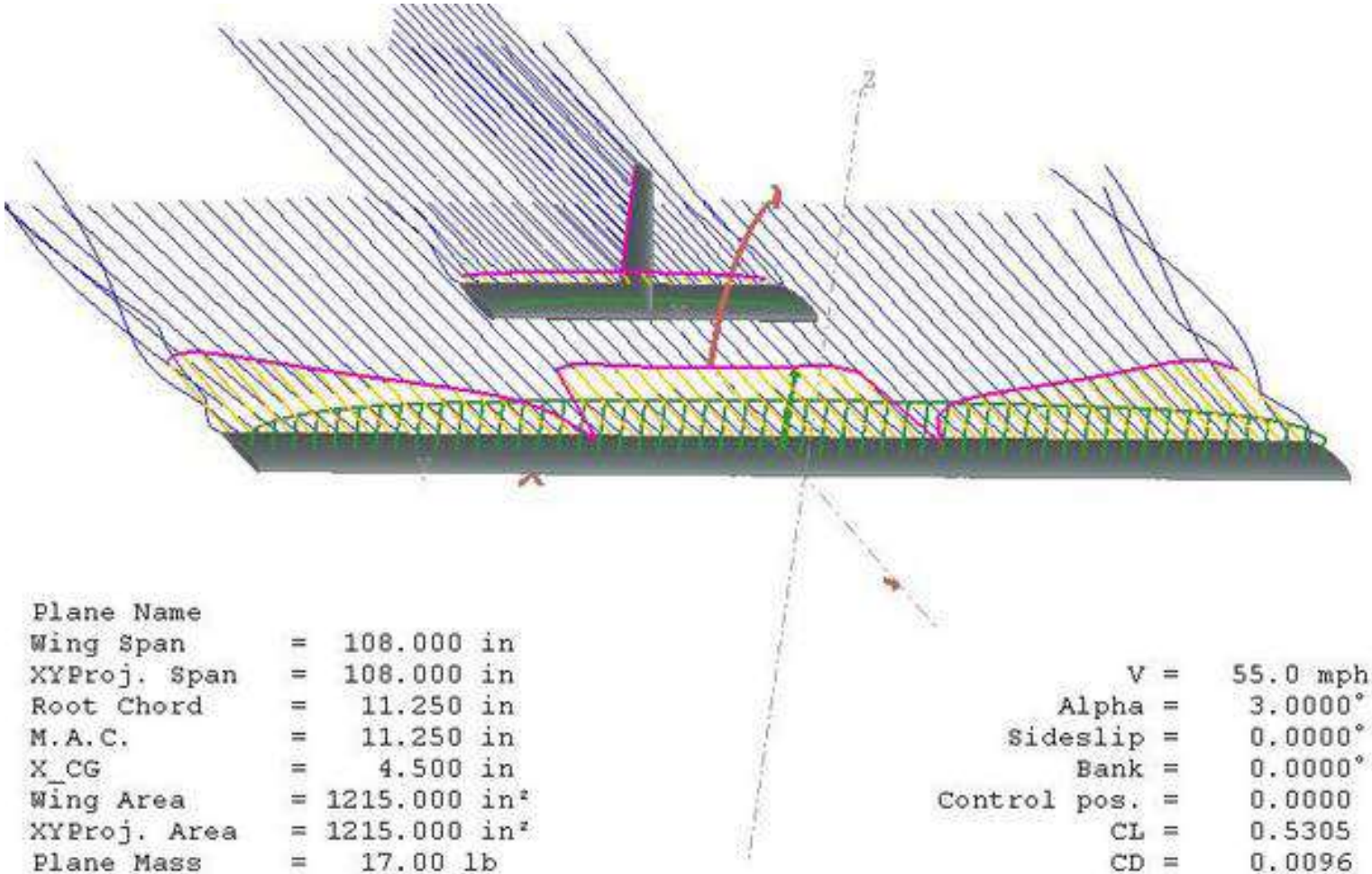






Aerodynamic Analysis

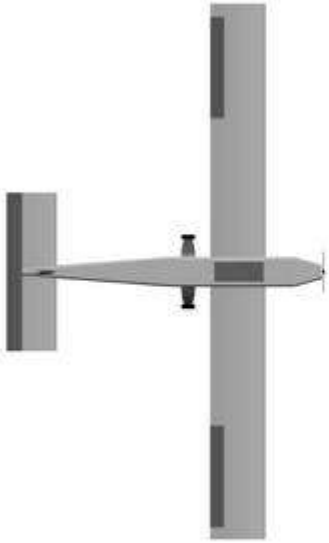


Plane Name		
Wing Span	=	108.000 in
XYProj. Span	=	108.000 in
Root Chord	=	11.250 in
M.A.C.	=	11.250 in
X_CG	=	4.500 in
Wing Area	=	1215.000 in²
XYProj. Area	=	1215.000 in²
Plane Mass	=	17.00 lb
Wing Load	=	0.014 lb/in²

V =	55.0 mph
Alpha =	3.0000°
Sideslip =	0.0000°
Bank =	0.0000°
Control pos. =	0.0000
CL =	0.5305
CD =	0.0096
Efficiency =	0.9750

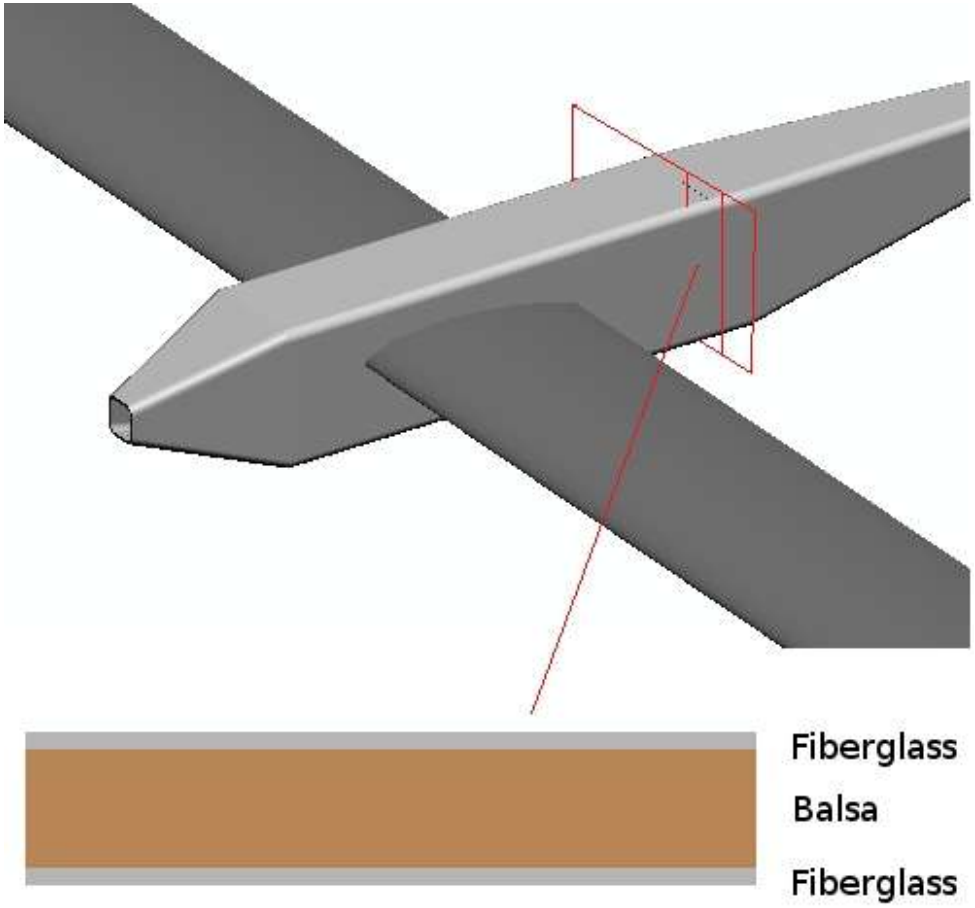
Overall Aircraft Layout

Overall Aircraft Layout

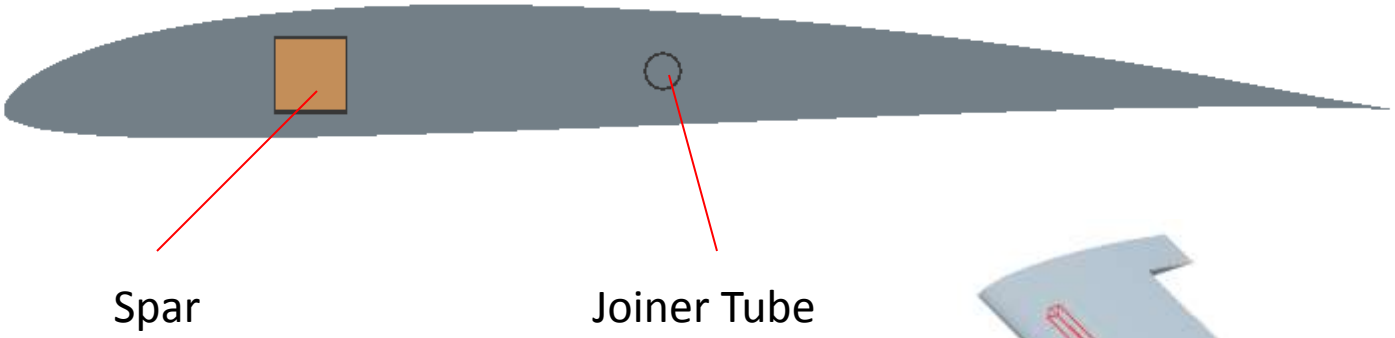


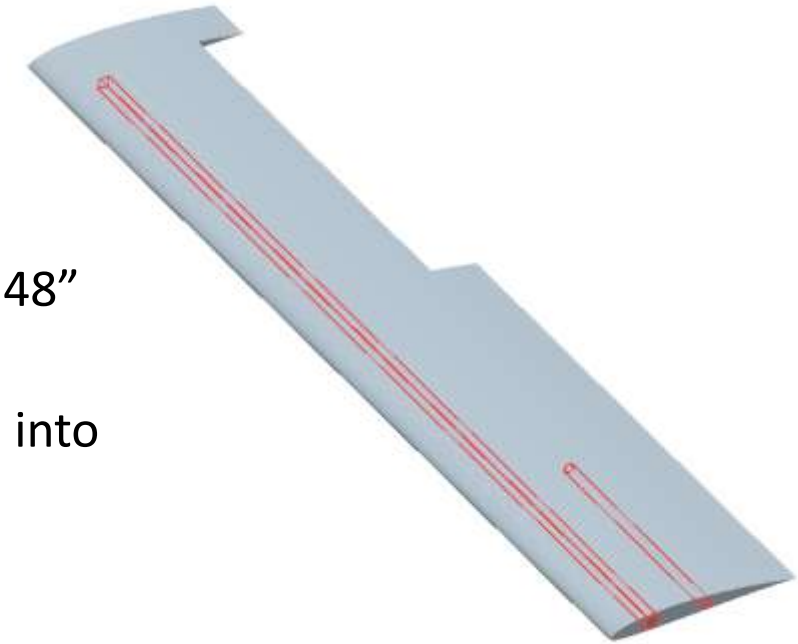
Weight	16.00 lbs.	H. Tail Span	32.00 in.
Length	63.25 in.	V. Tail Span	12.00 in.
Aspect Ratio	9.60	Aileron Area	57.38 sq. in.
Wing Span	108.00 in.	Rudder Area	22.50 sq. in.
Wing Chord	11.25 in.	Elevator Area	80.00 sq. in.
Wing Area	1215.00 sq. in.	Static Margin	10 %
H. Tail Chord	10.00 in.	Motor Power	900 Watts
V. Tail Chord	7.50 in.	Flight Time	>40 minutes

Fuselage Structure



Wing and Spar Structure

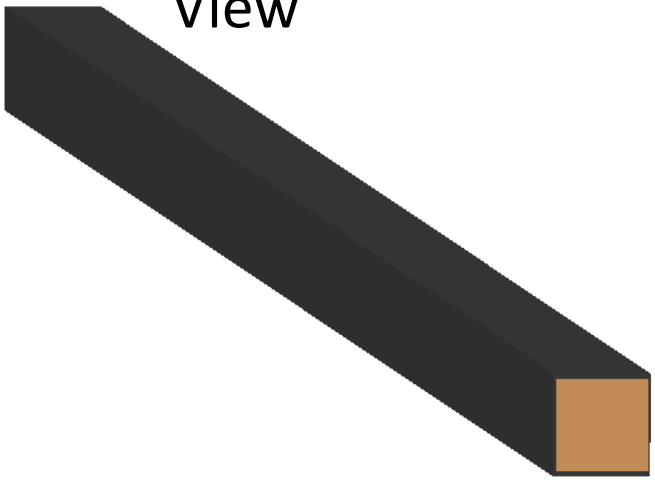




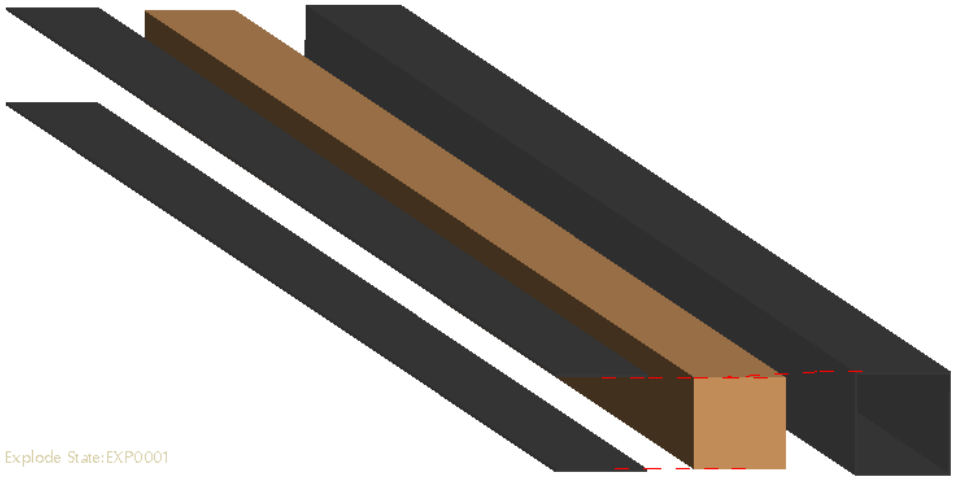
- The spar extends from the root chord to 48” into the wing.
- The carbon fiber joiner tube extends 12” into the wing.

Spar Structure

Unexploded View



Exploded View



- The spar core is a ½” width balsa rod of 48” length.
- The top caps of two layers of carbon fiber weave are attached with CA to the top and bottom of the core.
- The entire section is then wrapped in a 3k weave carbon fiber sleeve.

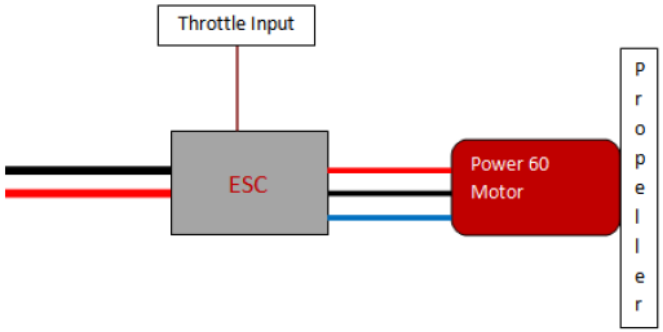
Final Design

- SUAS Aircraft
- **Propulsion System**
- Avionics System
- Imagery System
- Power Supply System

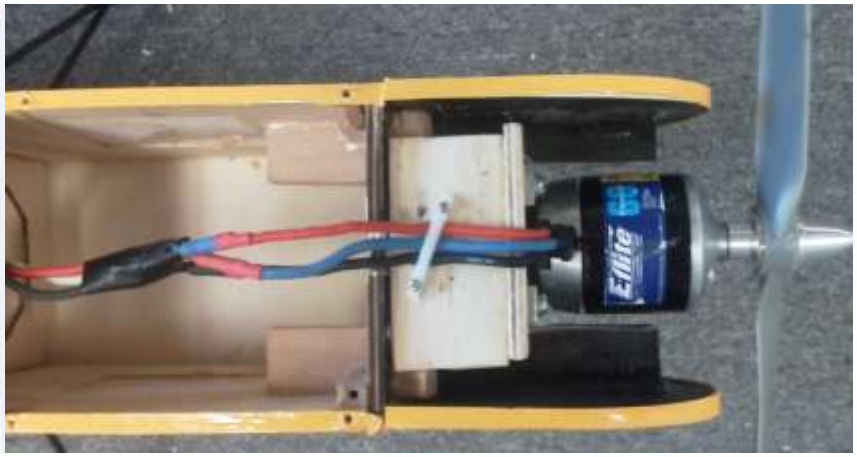
Propulsion System

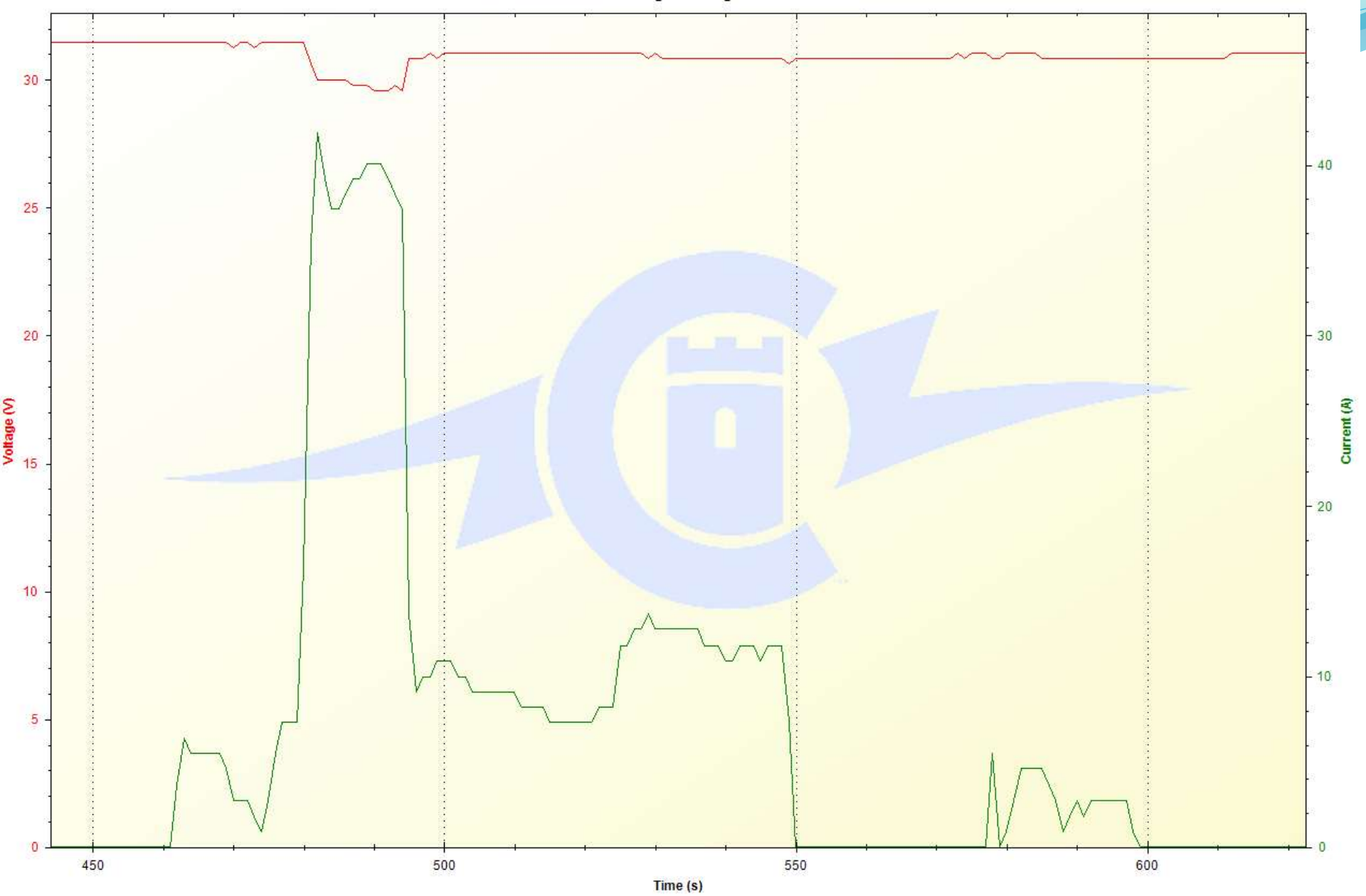
- Eflite Power 60 Brushless DC

- Castle Creations HV ESC



Propulsion System

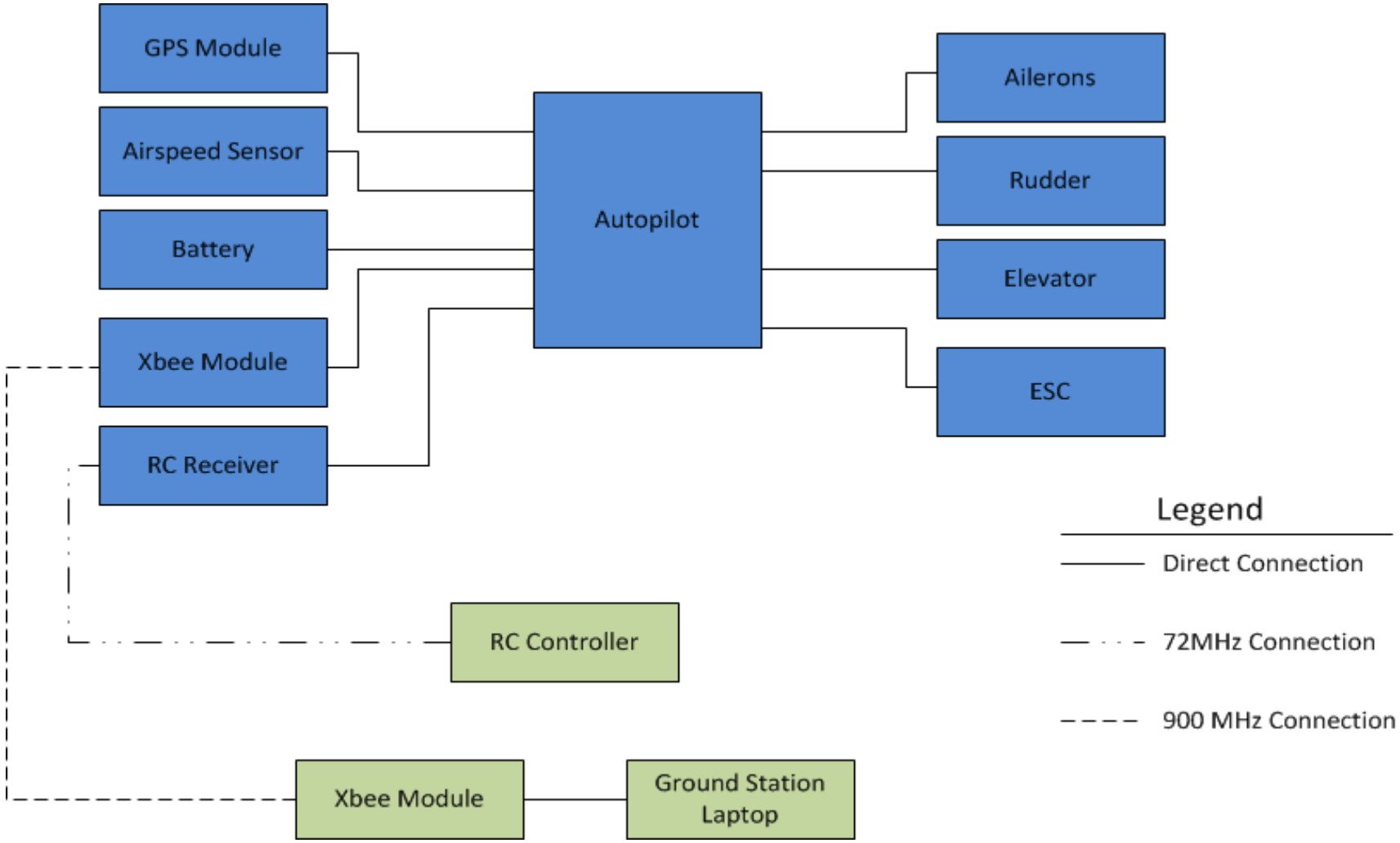



Voltage (V)
Current (A)
Time (s)
0
5
10
15
20
25
30
0
10
20
30
40
450
500
550
600

Final Design

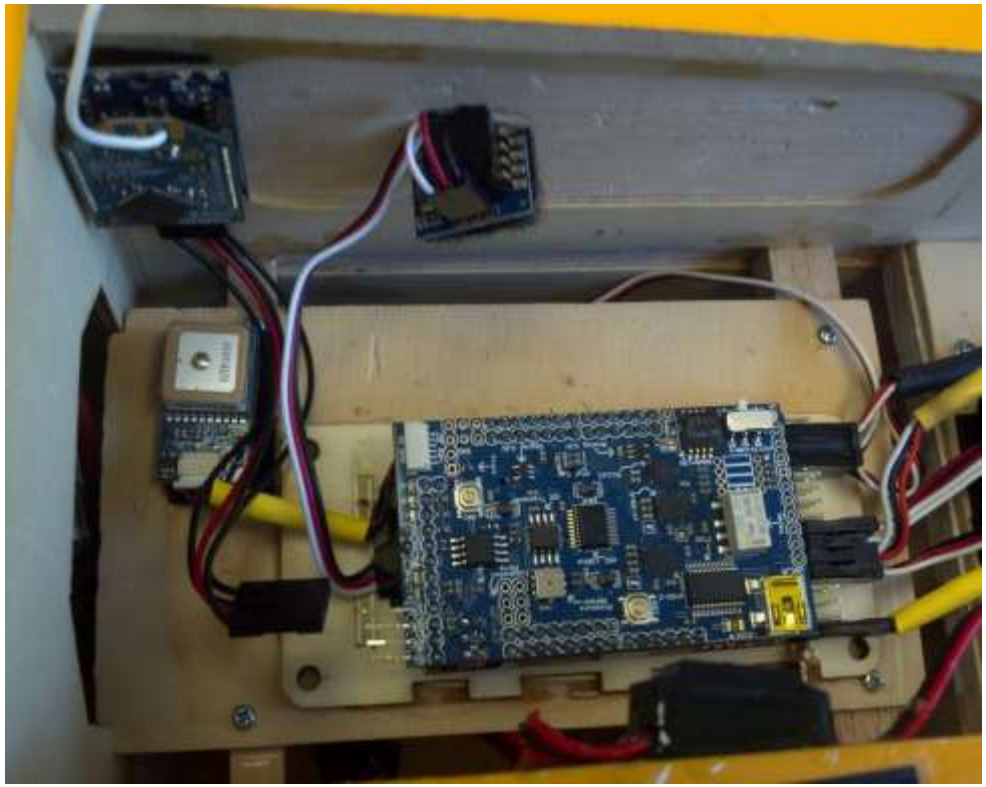
- SUAS Aircraft
- Propulsion System
- **Avionics System**
- Imagery System
- Power Supply System

Avionics System Overview



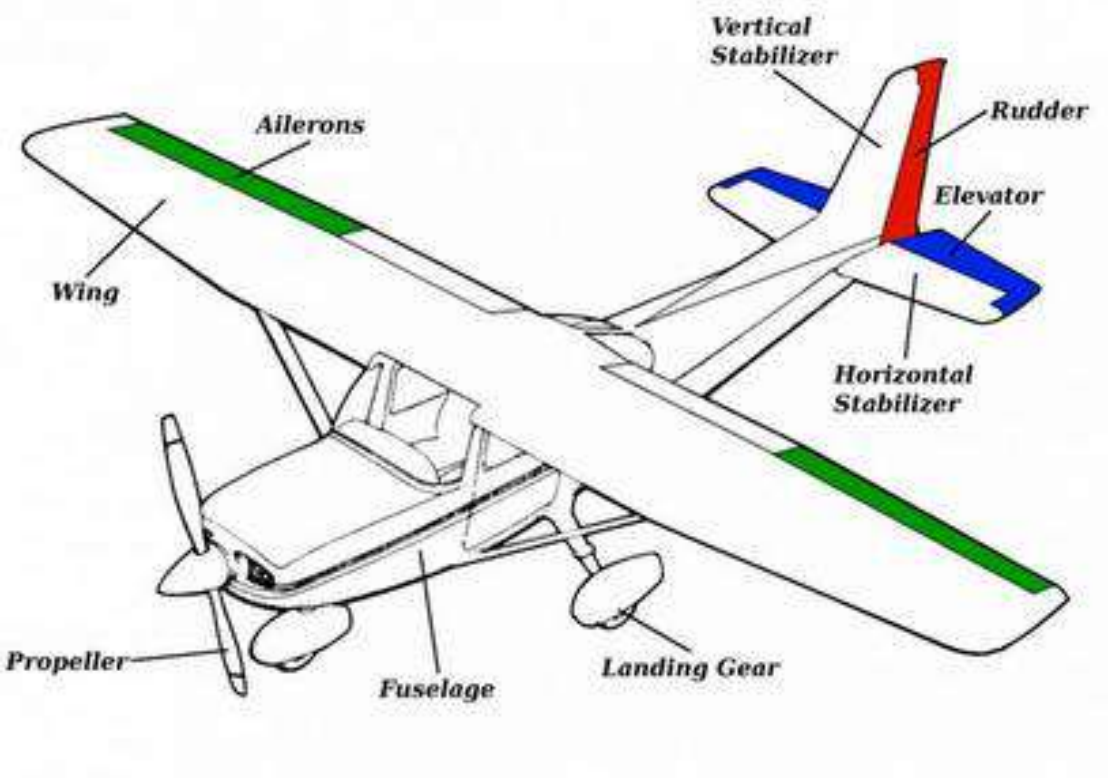
Autopilot System Design

- Ardupilot Mega & ground station software
- Xbee 900MHz Telemetry
- MediaTek MT3329 GPS
- MPXV7002DP Airspeed Sensor
- Personal laptop
- Futaba FPS148 Servos



Autopilot to Control Surface Interface

- The autopilot uses PWM signals to interface with the control surfaces of the plane.

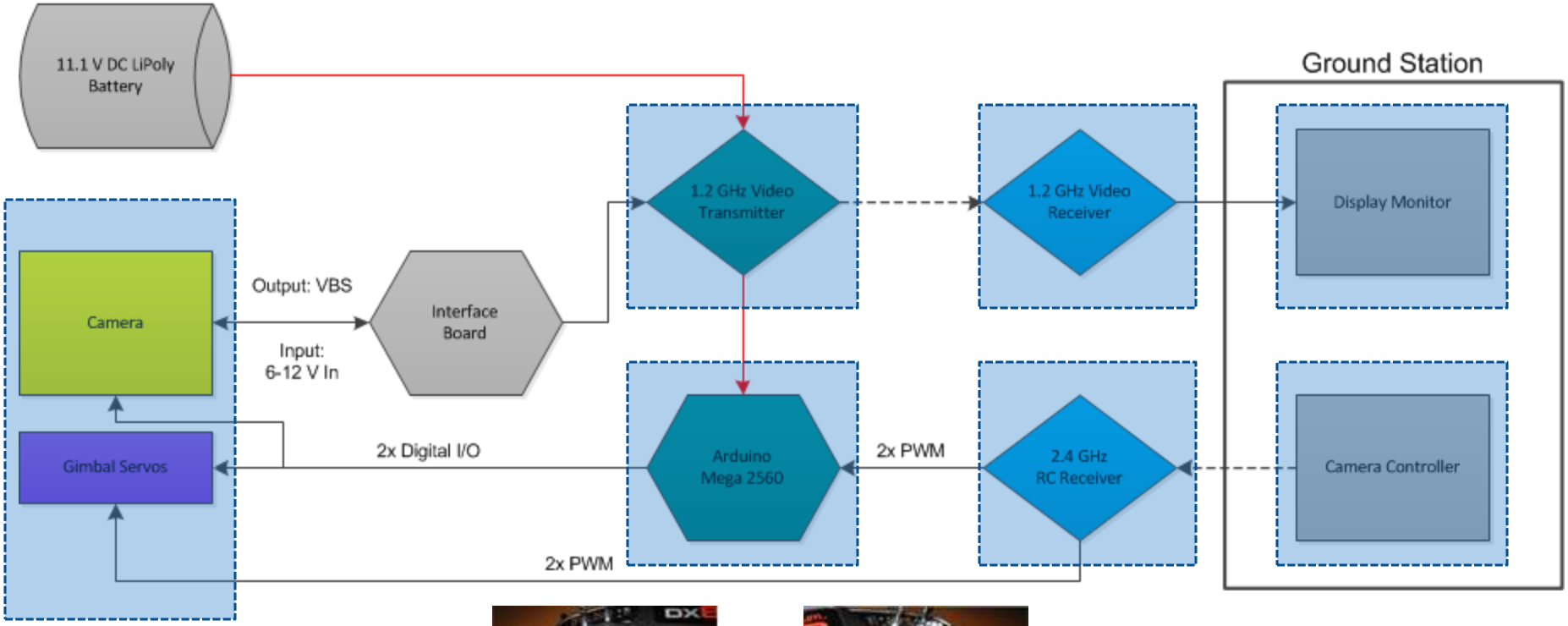


Final Design

- SUAS Aircraft
- Propulsion System
- Avionics System
- **Imagery System**
- Power Supply System

Imagery System Overview

Arduino Based Camera Control and 2-Axis Gimbal



Gimbal Control

Camera Zoom

Video System Integration and Testing

- Arduino Mega 2560
- Sony Block Camera
- Pan / Tilt Servo System
- 1.2 GHz Wireless TX and RX
- RC Camera Controller

Test Description	Pass / Fail
±90˚ Panoramic Rotation	Pass
-90˚ Tilt Rotation	Pass
Arduino and RC Communication	Pass
Block Camera to Arduino Communication	Pass
Wireless Camera and Servo Control	Pass
Long Distance Wireless Video	Pass
EMI Signal Interference	Pass*
Integration with 2-axis Gimbal	N/A

Camera Gimbal

Final Design

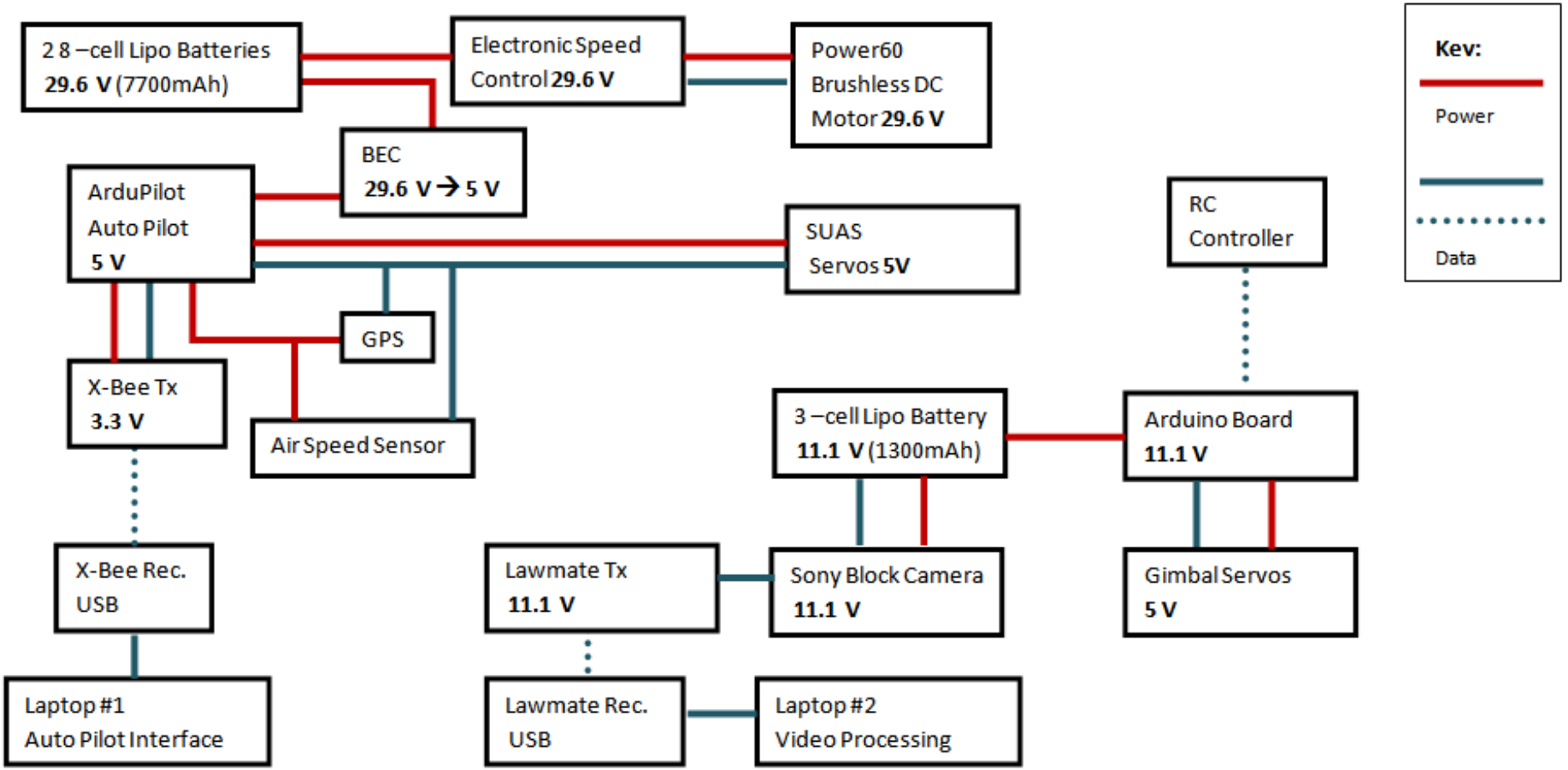
- SUAS Aircraft
- Propulsion System
- Avionics System
- Imagery System
- **Power Supply System**

Power Supply System

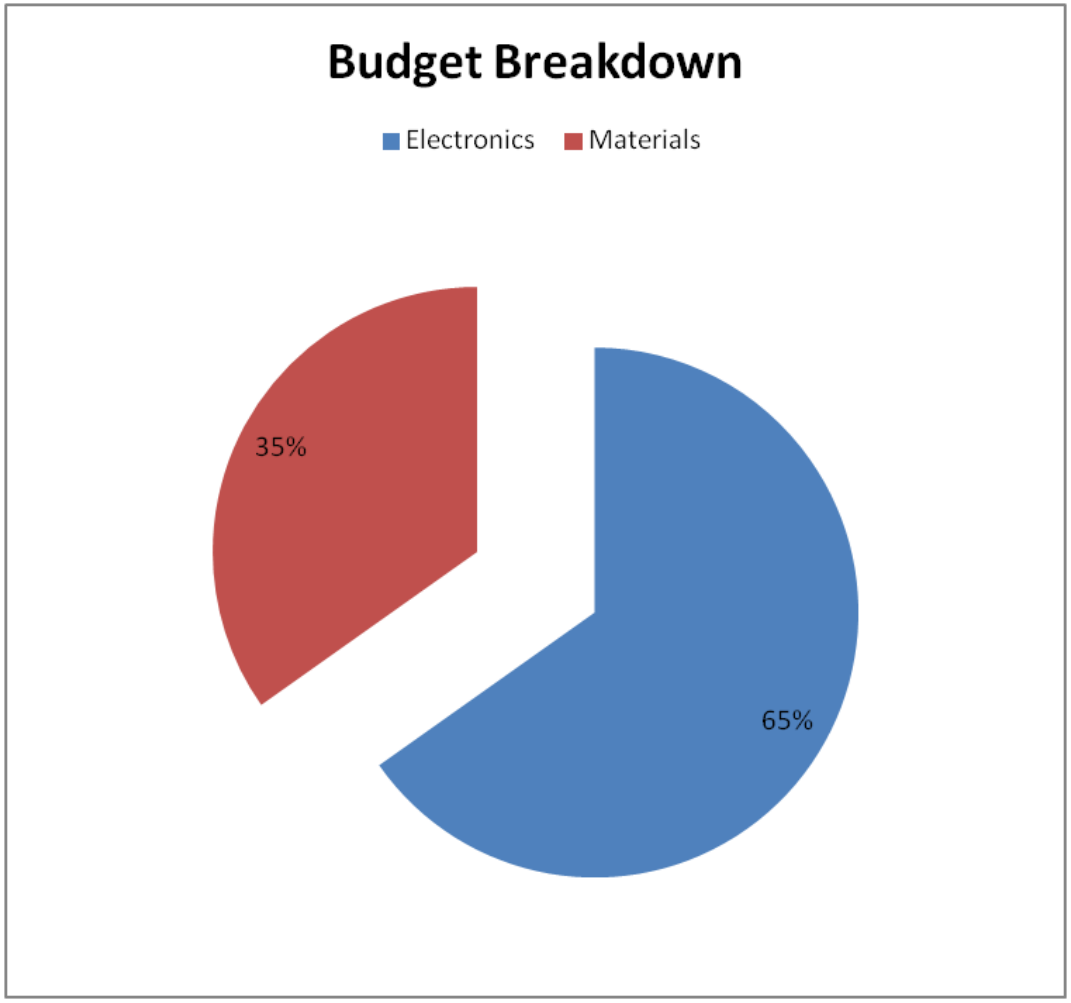
- Big Battery Pack:
  2 8-cell 29.6 V Lipo Batteries (7.7 Ah Capacity)

- Small Battery Pack:
  1 3-cell 11.1 V (1.3 Ah Capacity)

- CC Pro BEC (29.6V→5V)


2 8 –cell Lipo Batteries
29.6 V (7700mAh)
Electronic Speed Control 29.6 V
Power60 Brushless DC Motor 29.6 V
BEC
29.6 V → 5 V
ArduPilot Auto Pilot
5 V
SUAS Servos 5V
RC Controller
GPS
X-Bee Tx
3.3 V
Air Speed Sensor
3 –cell Lipo Battery
11.1 V (1300mAh)
Arduino Board
11.1 V
X-Bee Rec.
USB
Lawmate Tx
11.1 V
Sony Block Camera
11.1 V
Gimbal Servos
5 V
Laptop #1
Auto Pilot Interface
Lawmate Rec.
USB
Laptop #2
Video Processing
Kev:
Power
Data

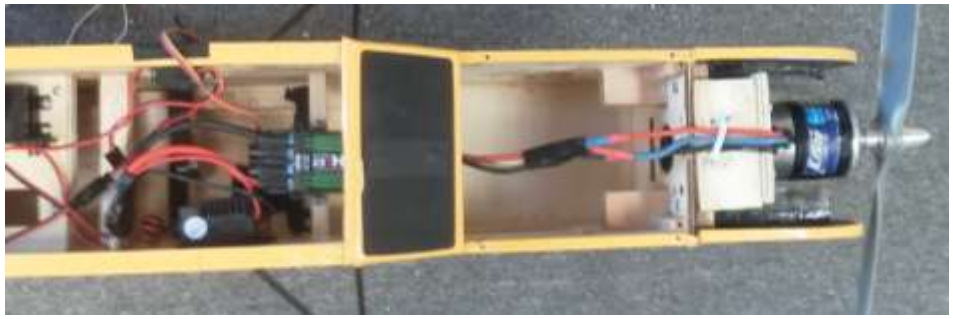
Engineering Economics

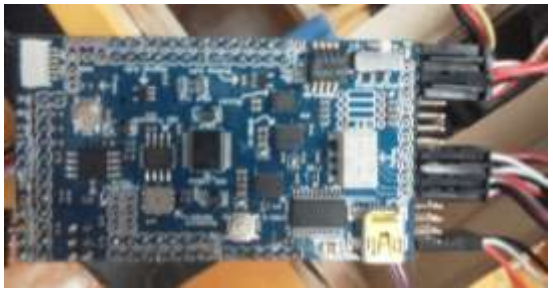


Item	Vendor	units	Price ($)	Total Price ($)
Video Transmitter	ReadyMadeRC	1	89.9	89.9
Video Reciever	ReadyMadeRC	1	99.49	99.49
CCD Test Camera	ReadyMadeRC	1	69.99	69.99
Sony Block Camera	GoElectric	1	566.95	566.95
Block Camera Interface board	GoElectric	1	89.95	89.95
3oz 4hs Fiberglass Cloth (yd)	US Composites	10	6.5	65
Perforated Release Film	US Composites	12	5.6	67.2
Breather Absorber Cloth	US Composites	12	4	48
5.7oz Plain Weave Carbon Fiber	US Composites	7	33.5	234.5
Sealant Tape	US Composites	3	6.95	20.85
PVA #1 Mold Release (1 G)	US Composites	1	16.75	16.75
Nylon Bagging Film	US Composites	6	4.7	28.2
Epoxy Resin and Hardener kit	US Composites	1	72	72
Misc Materials	Varied	1	500	500
3oz 4HS Satin Weave E Glass	US Composites	10	6.65	66.5
Autopilot Telemetry	3D Robotics	1	142	142
Autopilot Board (Full)	3D Robotics	1	300	300
1300mAh 11.1V 3 Cell Lipo Battery	Thunderpower	1	39.99	39.99
Castle Link USB	Hobbytown USA	1	25	25
3850mAh 29.6V 8 Cell LiPo Battery	Thunderpower	2	216.95	433.9
60A Brushless ESC	Thunderpower	1	149.95	149.95
Li Poly Charger & Power Supply	Thunderpower	1	79.95	79.95
Wire and Battery Plugs	Hobbytown USA	1	10	10
Electronics			**Total =**	2097.07
Materials			**Total =**	1119
Grand Total			**Total =**	3216.07

Results

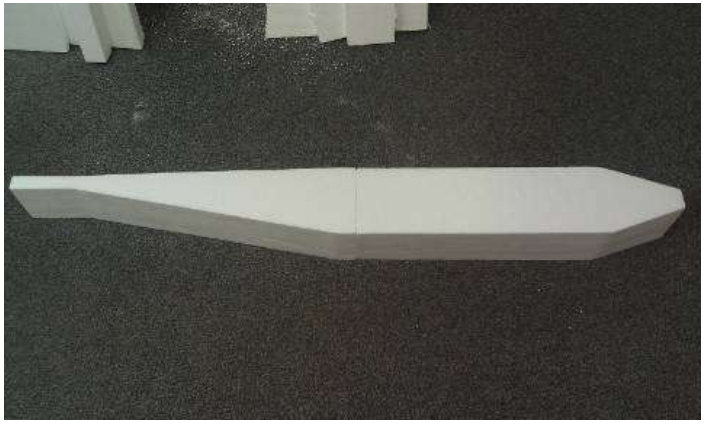
- Electronics Systems Integrated and tested.





Results

- SUAS Aircraft Construction



Initial fuselage mockup prior to wirecut

Cut mockups with mold box

Molds after removal from box. Holes were present in mold walls, so patching was done before molds were sanded to a smooth finish.

Conclusion

- Fun project that explored mechanical, electrical and computer engineering aspects.

End of Presentation

FCAAP
FLORIDA CENTER FOR ADVANCED AERO-PROPULSION

FAMU/FSU COLLEGE OF ENGINEERING
STUDENT UNMANNED AIRCRAFT SYSTEM