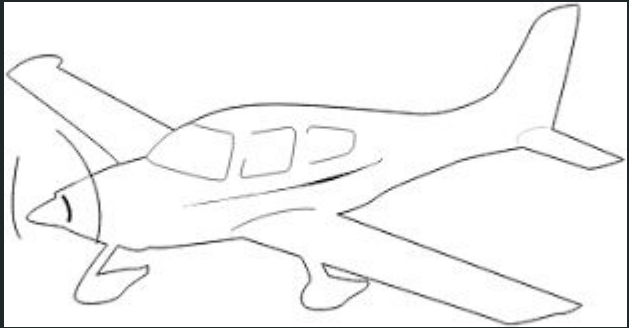

SAE Aero

James Seganti (Project Manager)
Caleb Hatcher (Budget Liaison)
Braden Weiler (Documentation Manager)
Angel Montiel (Website Developer)
Damian Lumm (Client Contact)

Project Description

- The purpose of this team is to design and manufacture an RC aircraft to compete in the SAE West Region competition.
- Fixed wing regular class
- All electric aircraft and has to carry payload
- Stakeholders: John Tester, Sarah Oman, Northern Arizona University, Flagstaff Flyers, ASNAU
- Represent NAU in a positive manner

Figure 1: SAE Aero West Competitor

Black Box Model

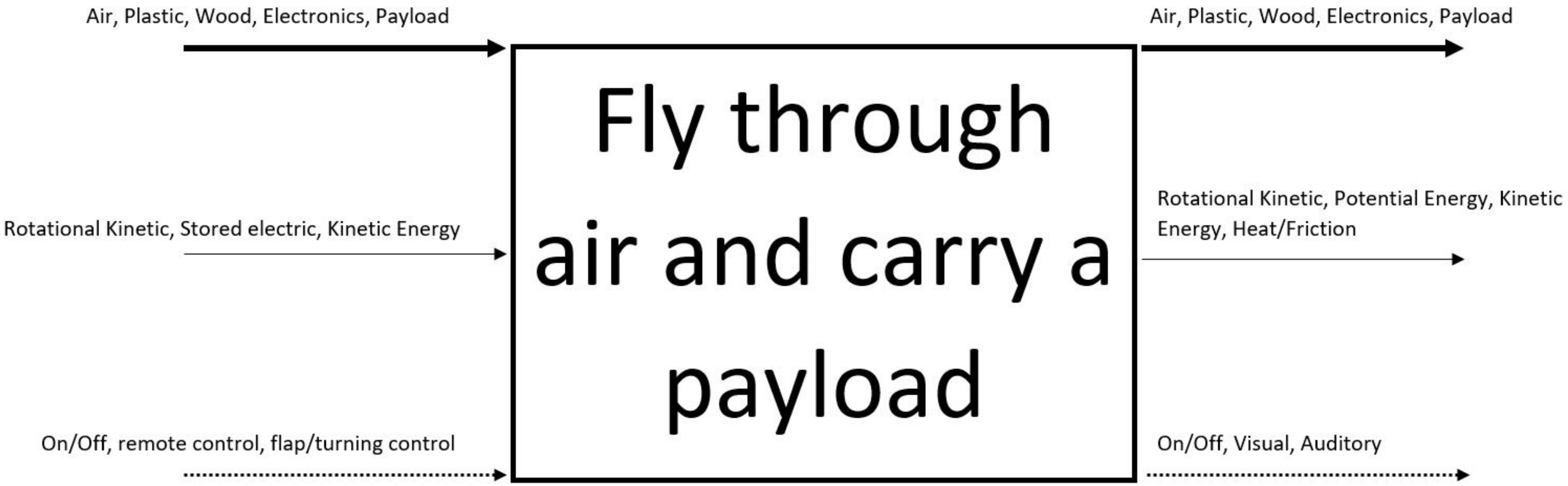

Figure 2: Black Box Model

Functional Model

- **Aided in concept generation by:**
  - Visual schematic of inputs and outputs
  - Electrical component schematic
  - Energy and materials needed in various components
  - Functionality of components
  - Importance of components

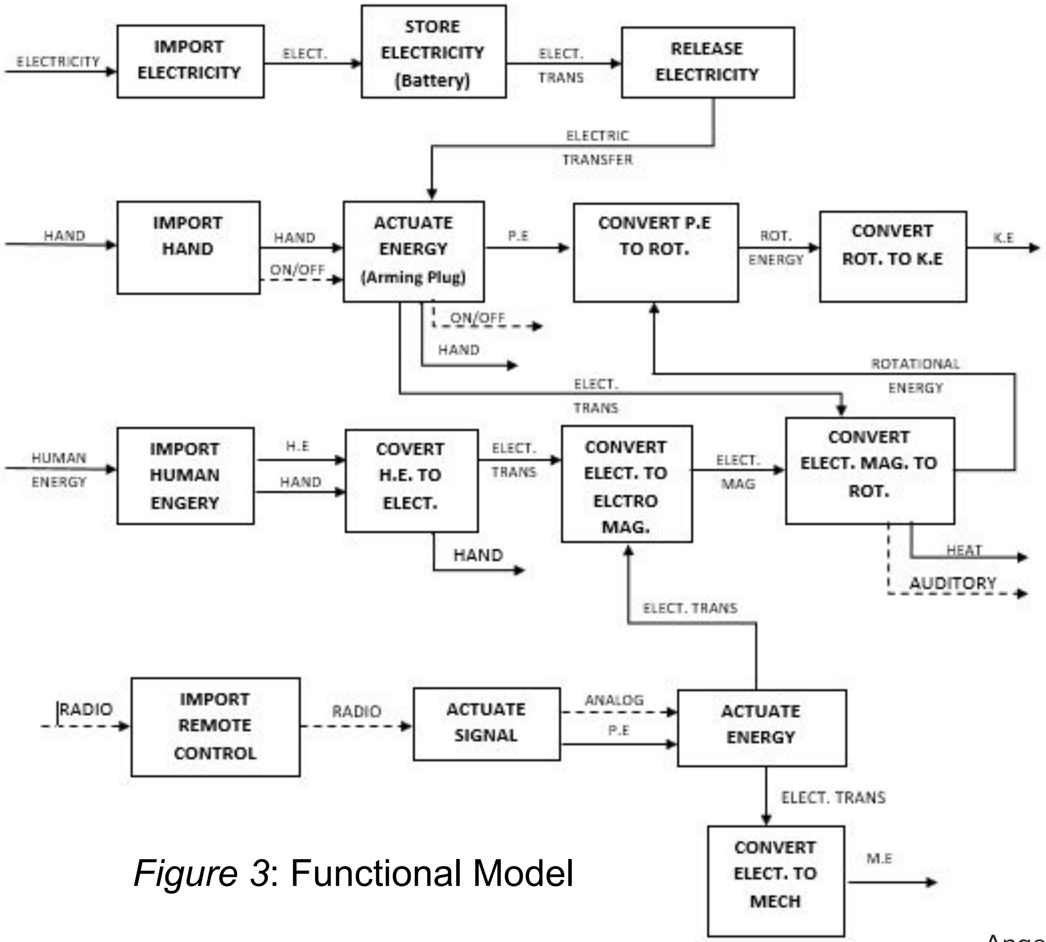

Figure 3: Functional Model

Concept Generation

- **6-3-5 Concept Generation Method:**
- **Modified Method 5-5-3:**
    - 5 people
    - 5 ideas each
    - 3 minute sessions
- **Various Sections:**
    - Propeller/Power Train
    - Body/Fuselage
    - Landing Gear
    - Tail
    - Wings

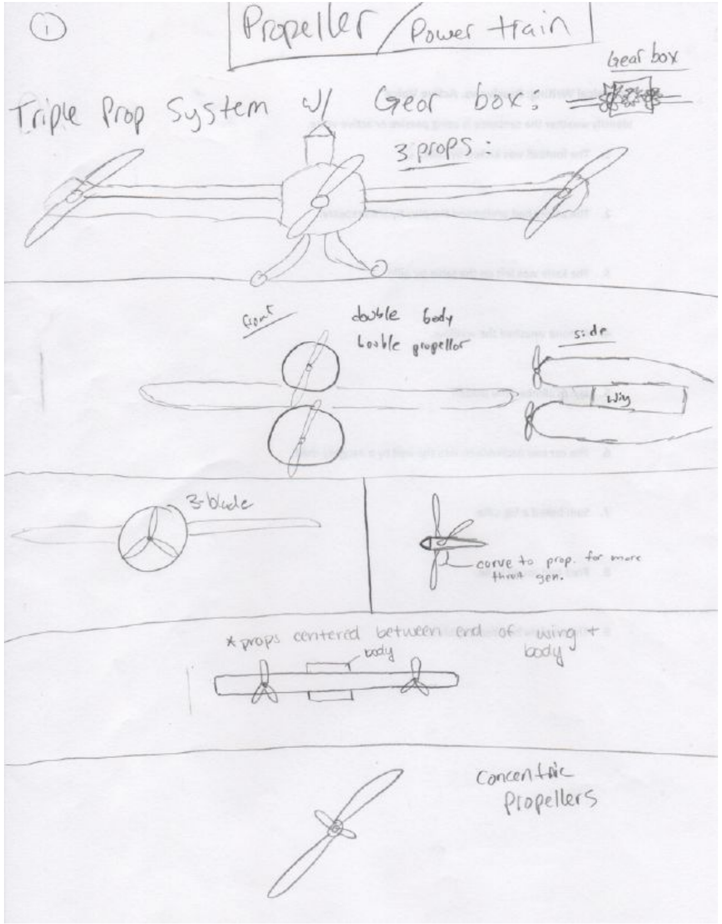

Figure 4: 5-5-3 Concept Generation Sketches

Bio-Inspired Concept Generation

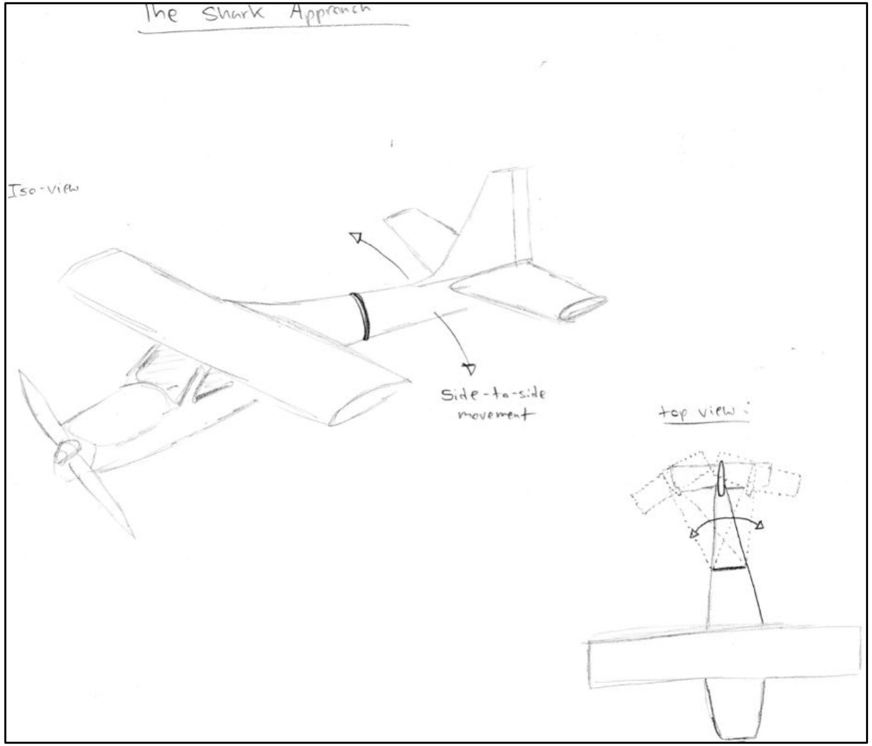

Figure 5: Bio-Inspired Shark Tail Concept

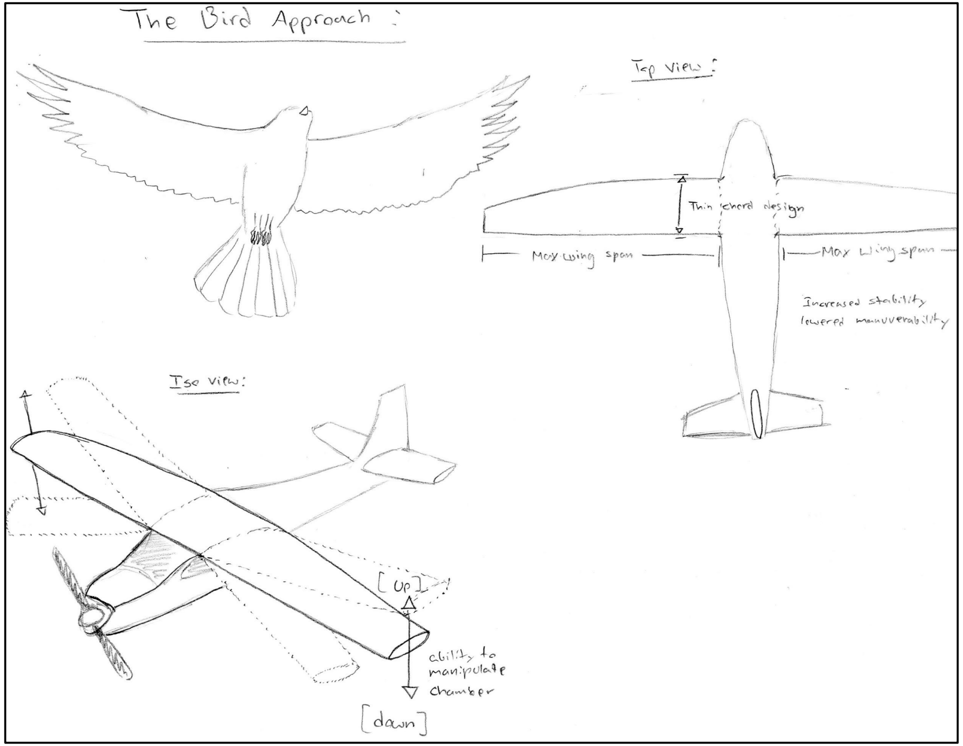

Figure 6: Bio-Inspired Bird Wing Concept

Concept Selection Method

- **Pugh Chart:**
  - Wing Design
  - Propeller/Power Train Design
  - Body/Fuselage Design
  - Landing Gear Design
  - Tail Design

Tail Design							
Concept / Criteria	2017 NAU Design	Conventional	Rocket	Double	T-Shaped	Inverted T (Y)	Shark Tail
Cost		+	-	-	S	+	-
Durability		+	+	-	S	+	S
Safety		S	-	-	S	S	S
Repeatablility	D	S	-	-	S	-	S
Landing	A	S	S	-	S	-	-
Take Off	T	S	S	-	S	-	-
Repairability	U	+	-	-	S	+	-
Scoring	M	-	+	+	S	-	+
Controllability		+	-	-	S	+	+
Manufacturing		+	-	-	S	+	-
Σ+		5	2	1	0	5	2
Σ-		1	6	9	0	4	5
ΣS		4	2	0	10	1	3
Total Sum		4	-4	-8	0	1	-3

Figure 7: Tail Design Pugh Chart

Selected Design

- **Wings:** Rectangular wing with Selig 1223 airfoil
- **Fuselage:** Rounded rectangular tapered body
- **Propeller/Powertrain:** Single two-blade propeller
- **Landing Gear:** Through Fuselage
- **Tail:** Conventional tail

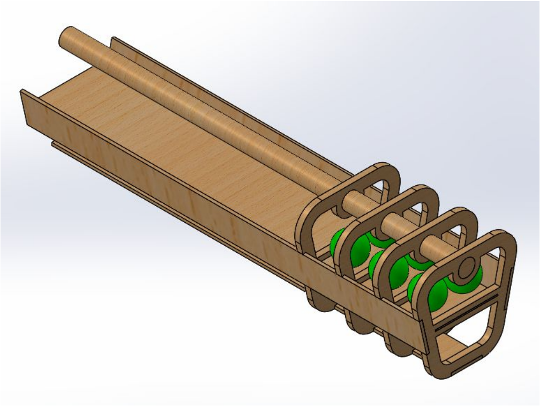

Figure 8: Fuselage CAD Model

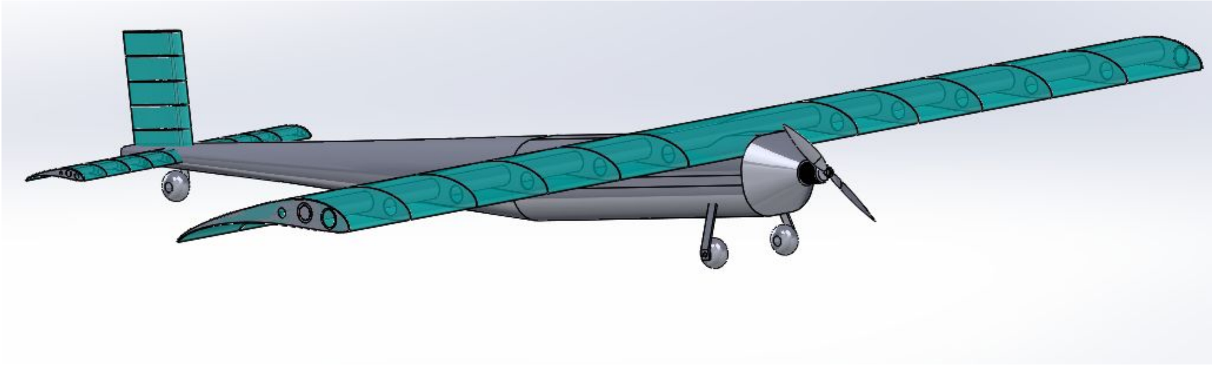

Figure 9: Selected Design CAD Model

Conforming to Customer Requirements

- **Selected design will give us the ability to meet:**
  - Original design
  - Fixed wing aircraft
  - Cargo plane
  - Safe
  - Electric motor

Analyses to Meet Other Customer Requirements

- **Requirements needed to be met:**
  - Must be able to take-off, fly, and land
  - Must carry a payload of at least 6.5 pounds
  - Must be repeatable
  - Must be durable/repairable

Airfoil Selection

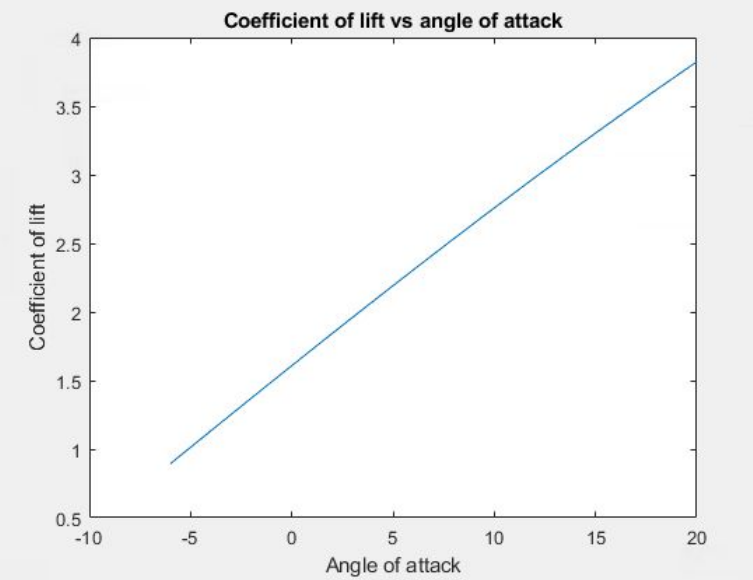

Figure 10: Selig 1223 Coefficient of lift vs angle of attack plot

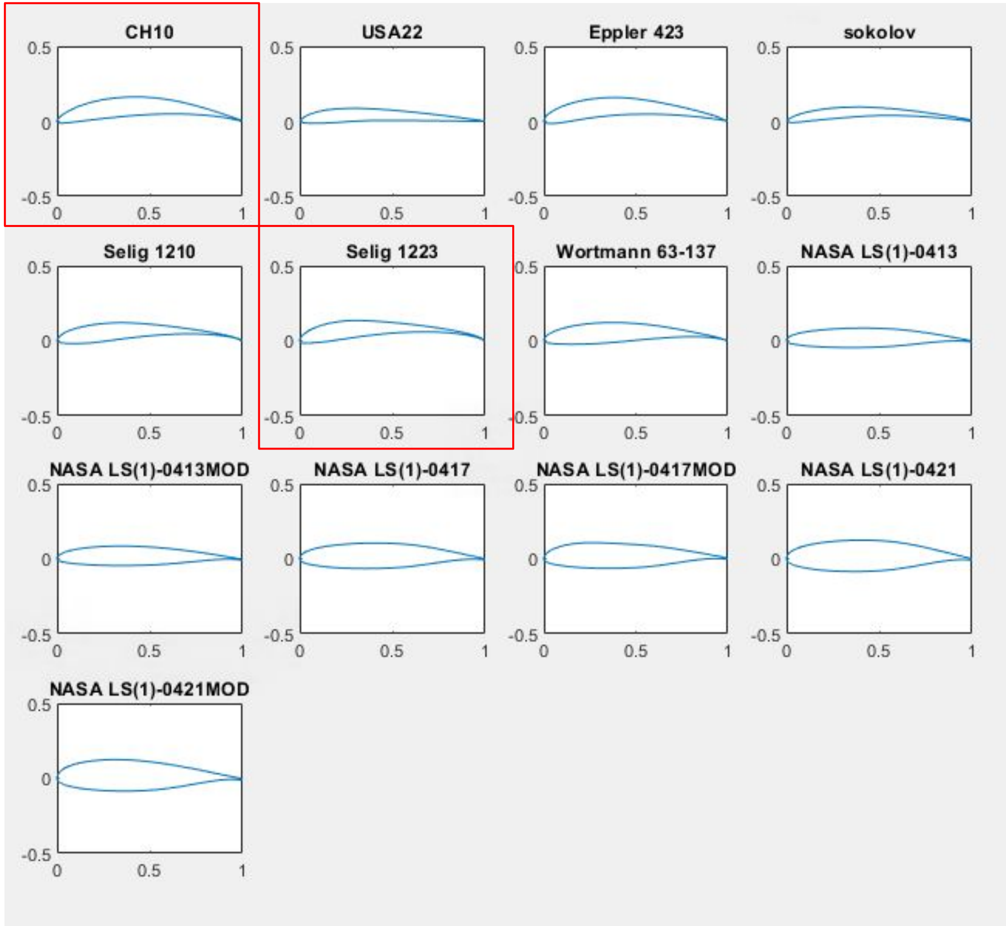

Figure 11: Selected Airfoil Geometries

Propeller Thrust Calculator

```
clear; clc;
rpm = input('What is the rpm of the engine?\n') ;
d = input('What is the diameter of the propeller? (inches)\n') ; %diameter in inches
p = input('What is the pitch of the propeller? (inches)\n') ; %pitch in inches
V = input('What is the plane flight velocity? (m/s)\n'); %velocity of plane, m/s
F = 1.225*(pi*(0.0254*d)^2/4)*((rpm*0.0254*p*1/60)^2-(rpm*0.0254*p*1/60)*V)*(d/(3.29546*p))^(1.5);
formatspec1 = 'Thrust of the propeller is %f Newtons\n';
fprintf(formatspec1,F)
m = input('What is the mass of the aircraft? (pounds)\n') ;
m = m*0.453593 ; %convert pounds to kg
a = F/m;
formatspec2 = 'Acceleration of the aircraft is %f m/s^2\n' ;
fprintf(formatspec2,a)
```

Command Window

```
What is the rpm of the engine?
8500
What is the diameter of the propeller? (inches)
16
What is the pitch of the propeller? (inches)
6
What is the plane flight velocity? (m/s)
5
Thrust of the propeller is 41.429666 Newtons
What is the mass of the aircraft? (pounds)
50
Acceleration of the aircraft is 1.826733 m/s^2
```

Figure 12: Matlab Code for Propeller Thrust Calculator [2]

Opportunities for Test Analyses

- **Possible Measurements:**
  - Thrust
  - Motor temp
  - Esc temp
  - Battery temp
  - Battery life
  - Exit air velocity
  - Entrance air velocity
  - RPM
  - Battery esc motor compatibility
  - Wind Tunnel Thrust
  - Wind Tunnel flow field

Figure 13: Turnigy Thrust Test Stand [3]

Looking Toward the Future

- **Analytical Report Topics:**
  - Drag Force Simulation
  - Airfoil Selection and Lift Force
  - Thrust Force and Prop Analysis
  - Center of Gravity
  - Motor selection and powertrain analysis

Budget

	Item	Cost	Current source of funding	paid
	SAE membership	$ 125.00	Out of Pocket	yes
	Registration	$ 1,050.00	Engineering Department	yes
reference book	Fundamentals of Aerodynamics (Anderson)	$ 111.00	Out of Pocket	yes
Insuring Safe Repeatable Flights	AMA Membership	$ 75.00		
	Flagstaff Flyers Membership	$ 200.00		
	RC practice plane	$ 220.00		
testing equipment	Turnigy Thrust Stand and Power Analyser v3	$ 87.00		
	part/material/manufacturing cost estimaes	$ 1,100.00		
travel estimates	hotel (Airtel Van Nuys)	$ 495.00	NAU SAE club / ASNAU	
	gas	$ 400.00		
	total	**$ 3,863.00**		
	estimated total currently without funding source	**$ 1,682.00**		

Figure 14: Updated Team Budget

Preliminary Bill of Materials							
Product Name	SAE Aero Design Regular class						
Team	18F05						
Part #	Part Name	Qty	Description	Functions	Source	Web Address	Price
1.1	Power limiter	1	1000W SAE limiter	Required by SAE	Neutronics power system bundle	https://neumotors.cartloom.com/storefront/product/	$209
1.2	Motor	1	NeuMotors 4625 motor	rotate prop	Neutronics power system bundle	https://neumotors.cartloom.com/storefront/product/151807	
1.3	ESC	1	Castle Phoenix Edge Lite 100	communicate with remote	Neutronics power system bundle	https://neumotors.cartloom.com/storefront/product/151807	
1.4	Prop Adapter	1	8mm Prop adapter	connect prop to motor	Neutronics power system bundle	https://neumotors.cartloom.com/storefront/product/151807	
1.5	Red Arming Plug	1	Maxx Products 6970	Required by SAE	Amazon	https://www.amazon.com/Battery-Arming-Switch-	$21.94
1.6	battery	1	5000mAh 6 cell 22.2v 30C	provide power	HobbyZone.com	https://www.hobbyzone.com/batteries/lipo/6-cell-	$125
1.7	propeller	1	APC 16x8	provide thrust	APC propellers	https://www.apcprop.com/product/16x8/	$15
						current total	$371

Figure 15: Bill of Materials

Schedule

Design Process Delegation

Airfoil selection and wing/tail:
Caleb and James

Battery, motor, electronics, and propeller selection:
Damian and Braden

Fuselage:
Angel and Caleb

Landing gear:
Braden

Rudders, elevators, and ailerons:
James and Damian

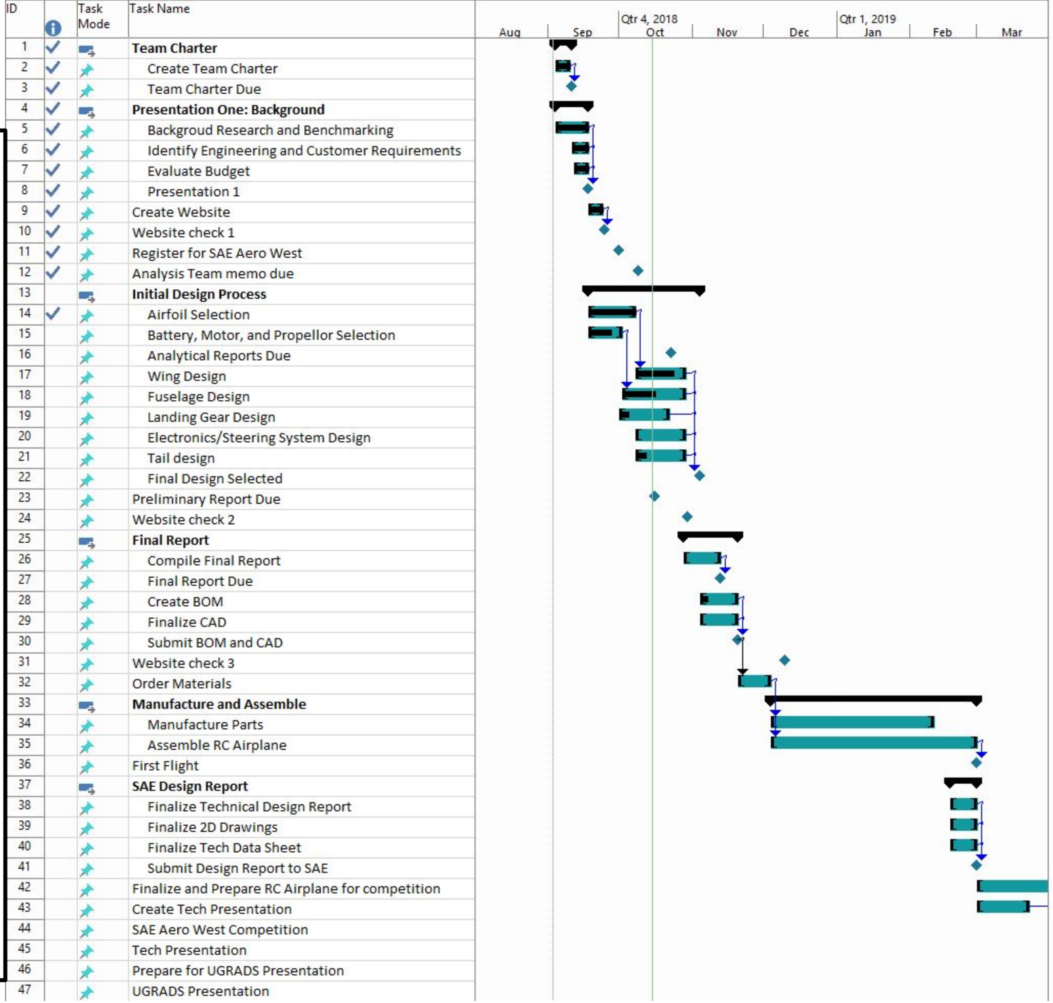

Figure 16: Gantt Chart

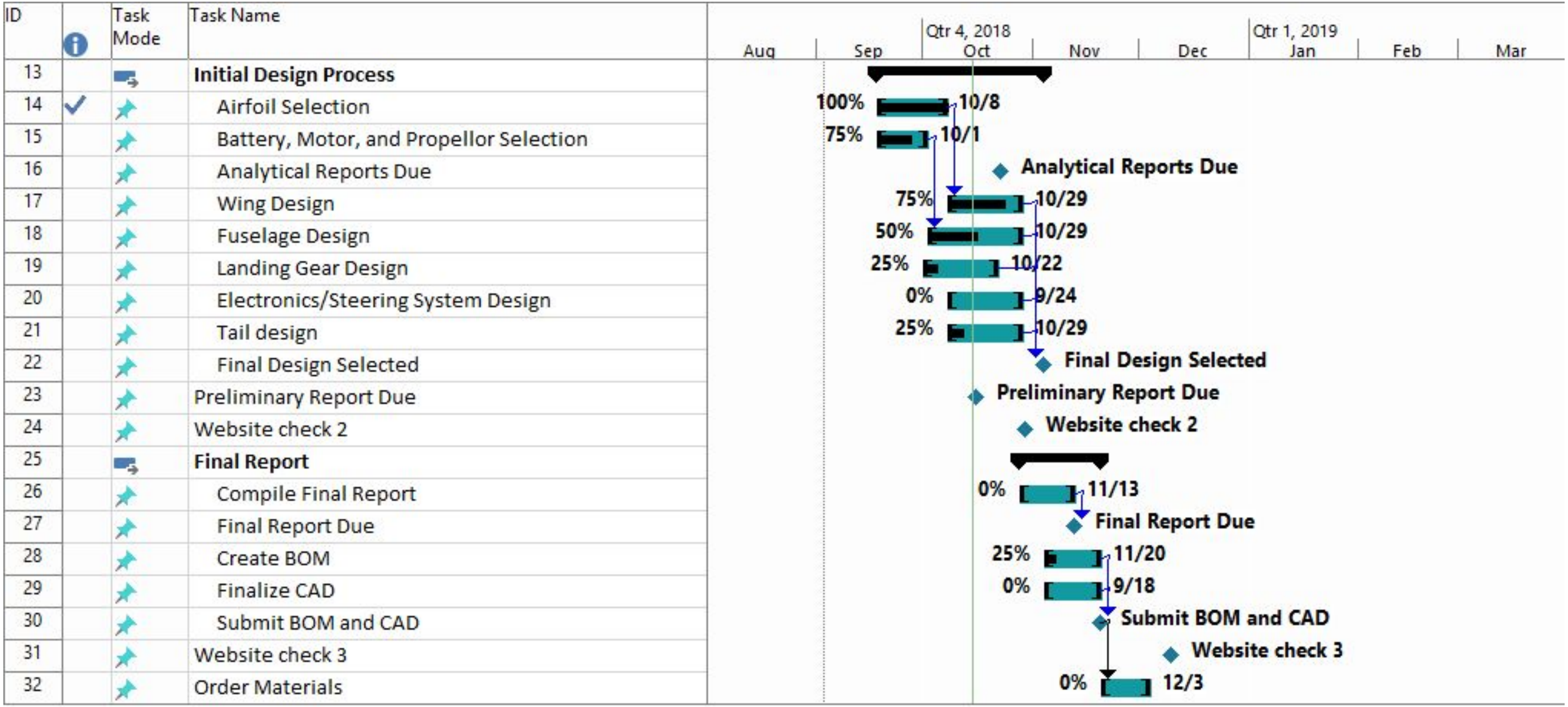

Figure 17: Gantt Chart Continued

References

[1] J. D. Anderson, *Fundamentals of aerodynamics*, 6th ed. New York, NY: McGraw-Hill Education, 2017.

[2] Staples, G. (2014). *Propeller Static & Dynamic Thrust Calculation - Part 2 of 2 - How Did I Come Up With This Equation?*. [online] Electricrcaircraftguy.com. Available at: https://www.electricrcaircraftguy.com/2014/04/propeller-static-dynamic-thrust-equation-background.html [Accessed 2 Oct. 2018].

[3] Hobbyking. (2018). *Turnigy Thrust Stand and Power Analyser v3*. [online] Available at: https://hobbyking.com/en_us/turnigy-thrust-stand-and-power-analyser-v3.html?countrycode=US&utm_source=criteo&utm_medium=cpc&utm_campaign=us [Accessed 11 Oct. 2018].

Questions?