SAE AERO MICRO PRESENTATION 2:

CONCEPT GENERATION AND EVALUATION

NAU CAPSTONE 2019-2020: THE PROP DOGS

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10/8/19

Zach

PROJECT REVIEW & DESCRIPTION

SELF-LEARNING

- RADIO CONTROL SYSTEMS
- FINITE ELEMENT ANALYSIS (FEA)
- COMPUTATIONAL FLUID DYNAMICS (CFD)

<u>CONTENT COVERED</u>

FUNCTIONAL DECOMPOSITION:

- BLACK BOX MODEL
- FUNCTIONAL MODEL

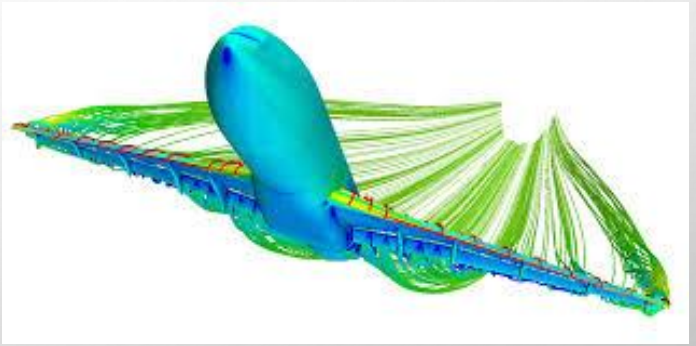
CONCEPT GENERATION

- METHODOLOGY AND SUBSYSTEMS
- SUBSYSTEM VARIANTS
- DESIGNS CONSIDERED

CONCEPT EVALUATION

- PUGH CHART
- DECISION MATRIX

BUDGET/ PROJECT PLANNING



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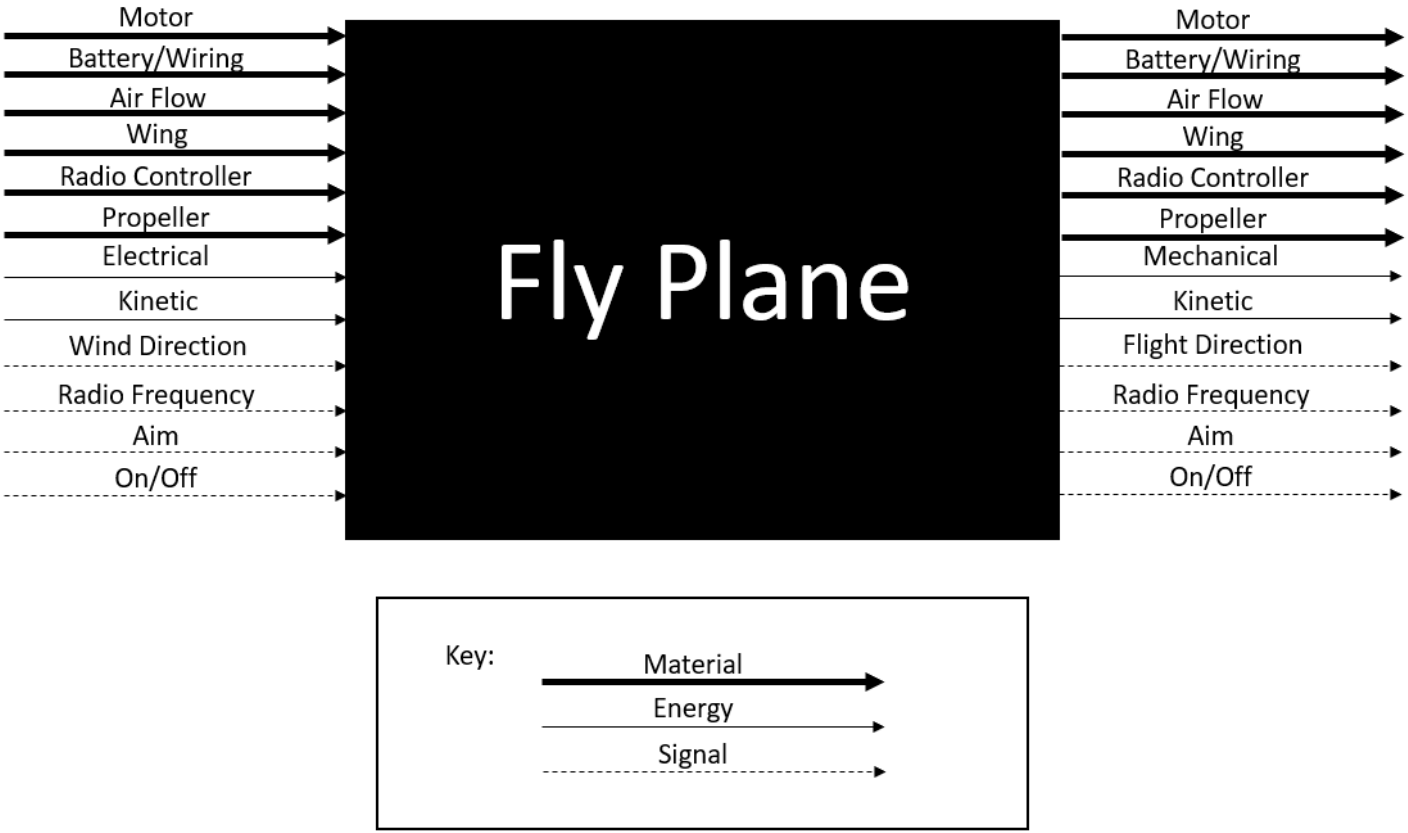
FUNCTIONAL DECOMPOSITION: BLACK BOX MODEL



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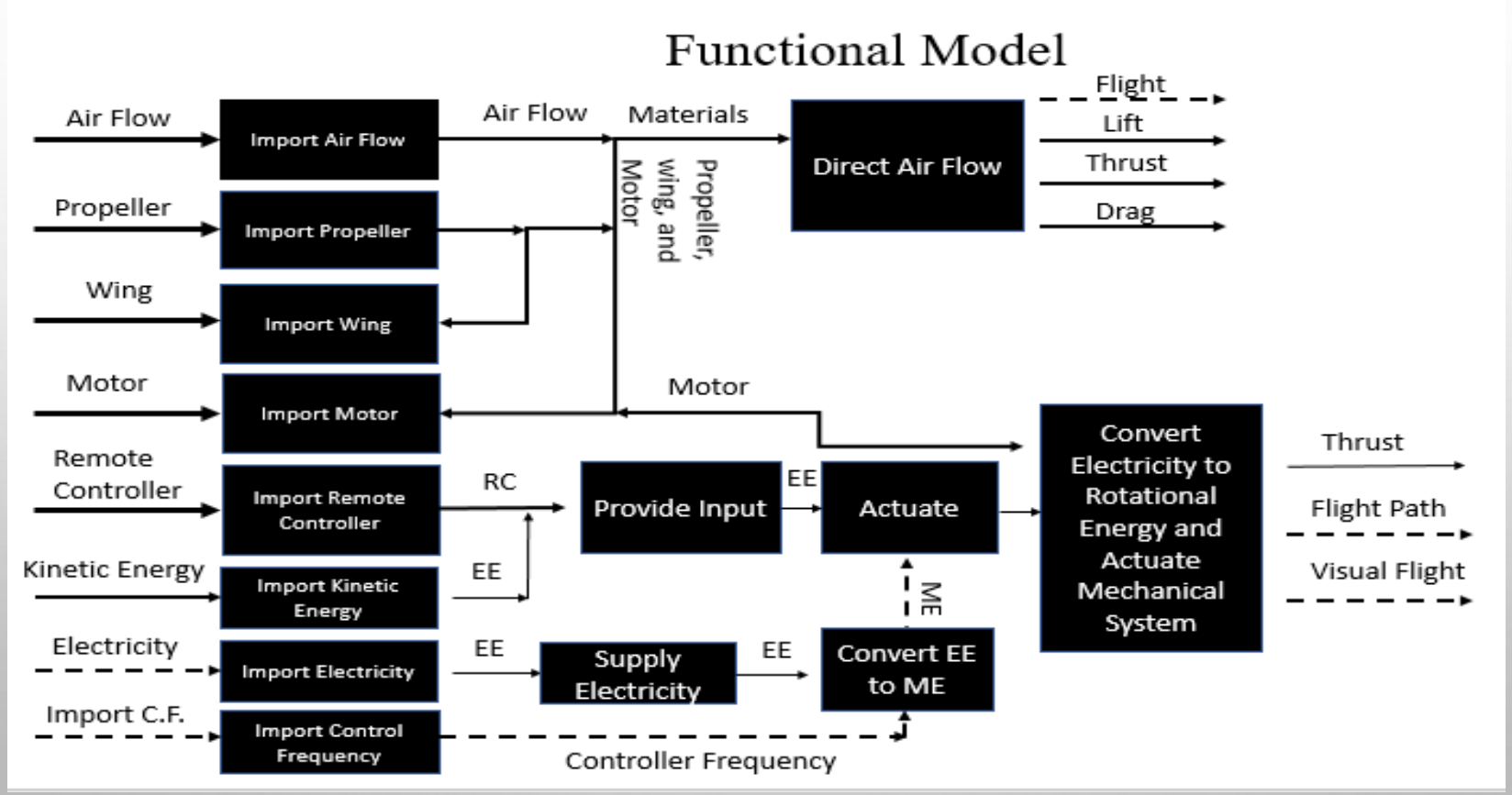
FUNCTIONAL DECOMPOSITION: FUNCTIONAL MODEL



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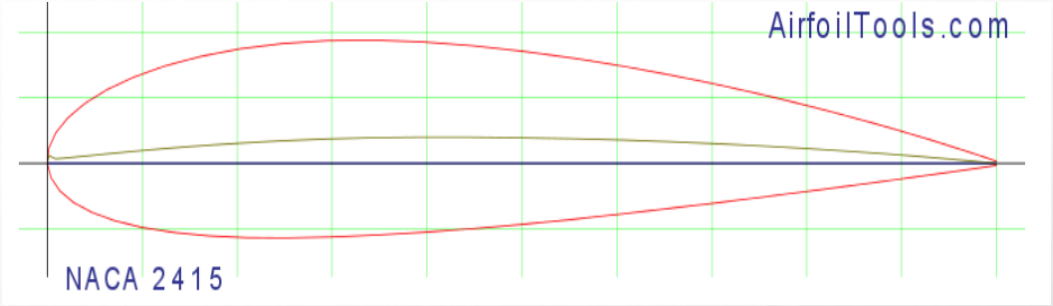
CONCEPT GENERATION: METHODOLOGY AND SUBSYSTEMS

Subsystem #	Subsystem
1	Wing Design
2	Maneuvering Devices
3	Landing Gear
4	Propulsion
5	Fuselage/ Payload Design



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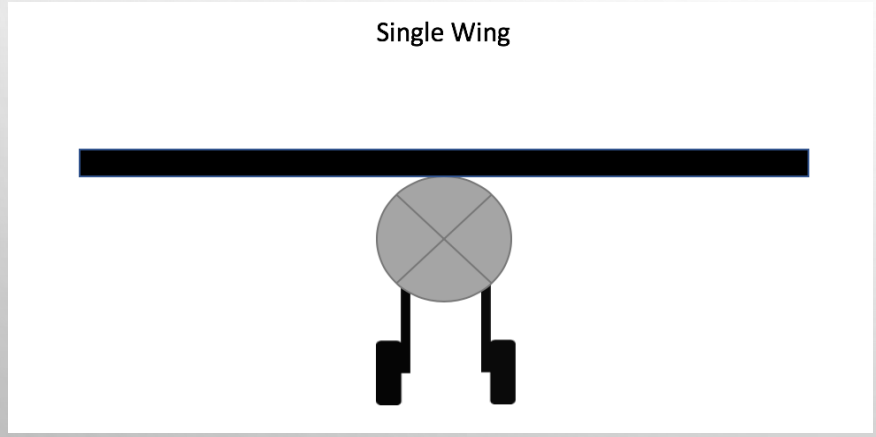
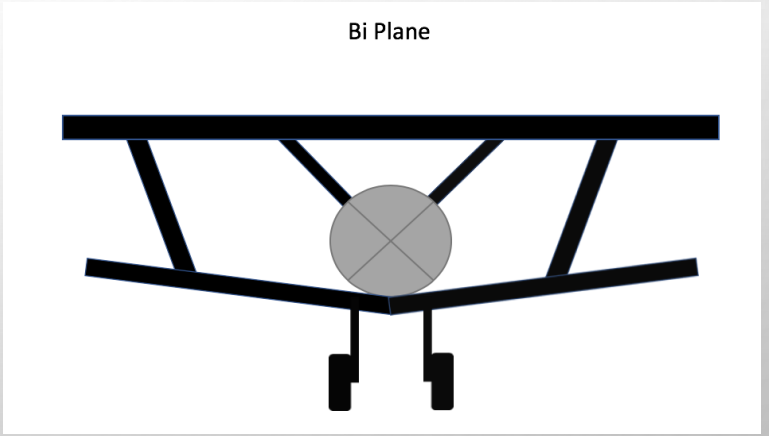
CONCEPT GENERATION: SUBSYSTEM VARIANTS

1. **WING DESIGN**
    a. BI PLANE
    b. SINGLE WING
    c. AIRFOIL DESIGN



Pro: Lighter Weight



Pro: Greater Lift

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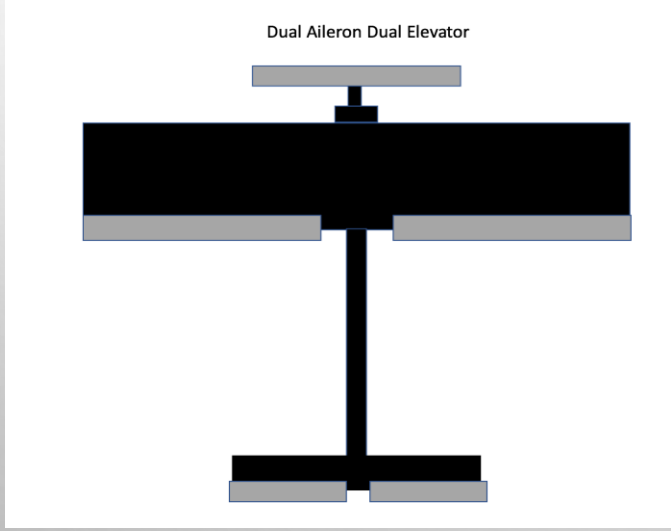
CONCEPT GENERATION: SUBSYSTEM VARIANTS

2. MANEUVERING DEVICES

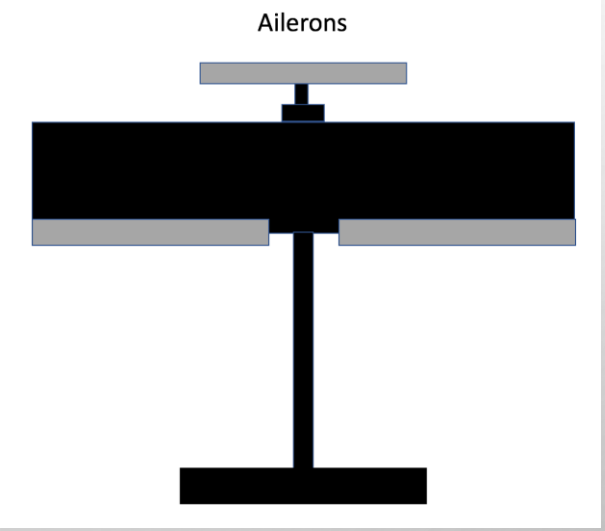
a. DUAL AILERON, DUAL ELEVATOR, RUDDER

b. NO AILERON, DUAL ELEVATOR, RUDDER

c. DUAL AILERON, NO ELEVATOR, RUDDER



Pro: Increase Maneuverability



Pro: Ease of Manufacturing, Cost

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CONCEPT GENERATION: SUBSYSTEM VARIANTS

3. LANDING GEAR

a. SKIDS

b. TRICYCLE FRONT STEER

c. FRONT WHEELS WITH REAR STEER

Pro: Prevents Rollover Landing

Pro: Longer Wheelbase

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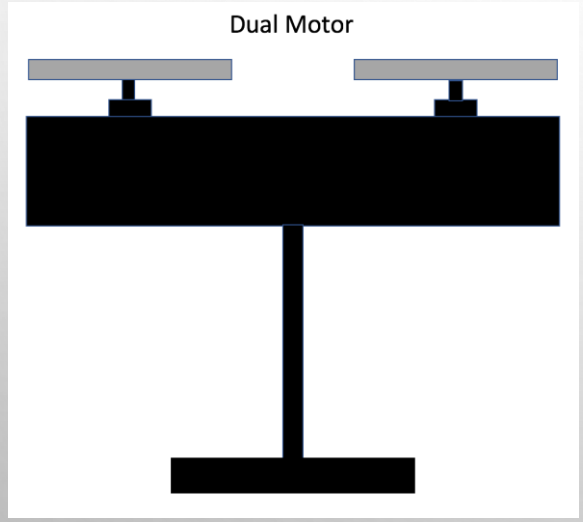
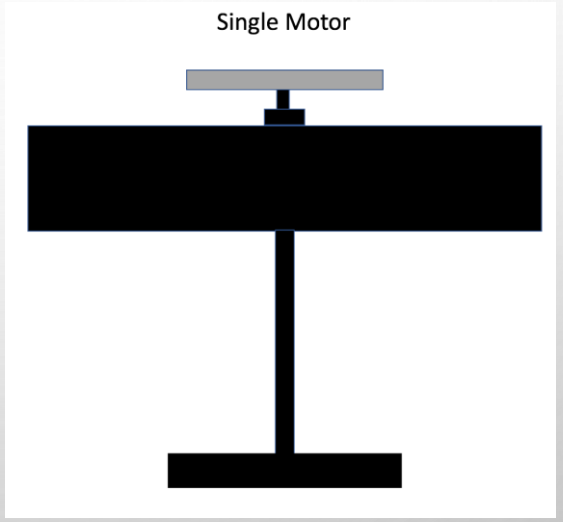
CONCEPT GENERATION: SUBSYSTEM VARIANTS

4. PROPULSION

a. TWIN MOTOR
b. SINGLE MOTOR
c. SINGLE MOTOR WITH SHROUD



Pro: Increase Thrust



Pro: Lighter Weight, Less Volume, Ease of Manufacturing

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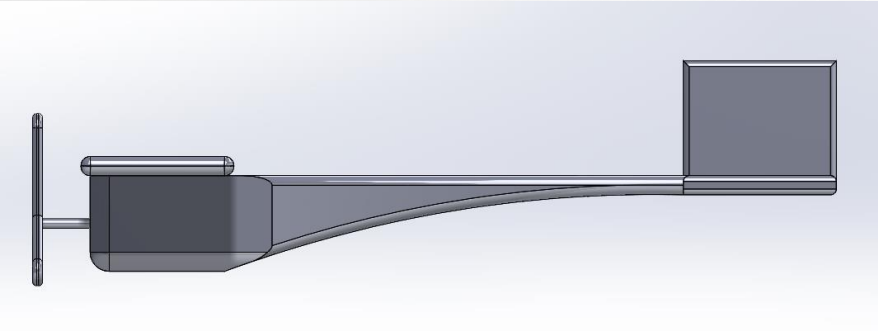
CONCEPT GENERATION: SUBSYSTEM VARIANTS

5. FUSELAGE/ PAYLOAD DESIGN

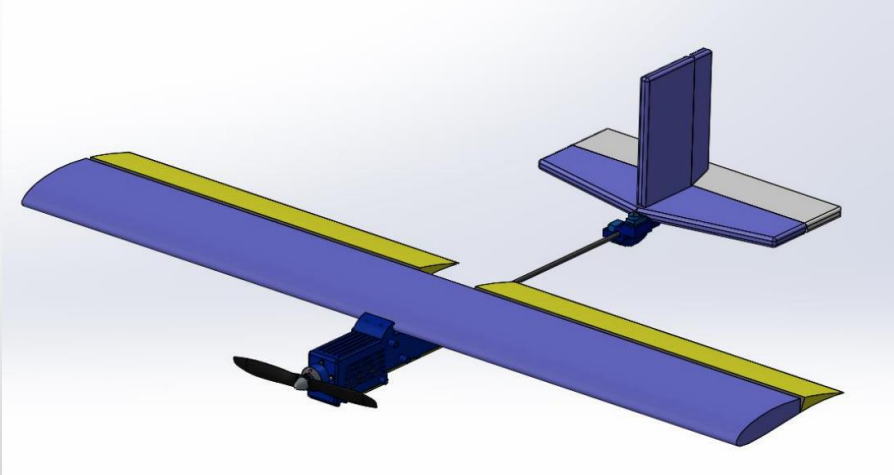
a. UGLY STICK WITH WING STORAGE

a. TAPERED CYLINDER WITH INTERNAL STORAGE

b. ELLIPTICAL WITH FUSELAGE SNAPS



Pro: Payload, Battery, and Actuator Storage on Fuselage



Pro: Lightweight, Battery, and Actuator Storage

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CONCEPT GENERATION: DESIGNS CONSIDERED

Subsystem	Design 1	Design 2	Design 3
Wing Design	Single Wing	Single wing	Dual Wing
Maneuvering Device	Dual Aileron, Dual Elevator, Rudder	Dual aileron, no elevators, rudder	Dual Elevator, Rudder
Landing Gear	Front Wheels Rear Steer	Tricycle front steer	Front Wheels Rear Steer
Propulsion	Single Motor	Single motor	Single Motor/Prop
Fuselage	Elliptical Taper with Fuselage Snaps	Elliptical taper with internal payload storage	Elliptical Taper with Wing Snaps

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CONCEPT EVALUATION: PUGH CHART

Design Criteria (CR's)	Design Alternatives (Datum)	1	2	3
Gross Weight Limit (10 lbs)	DATUM	+	+	+
In-flight radio control (2.4 GHz) w/ fail safe		+	+	+
wheeled landing gear steering mechanism		S	S	S
Payload cannot aid frame integrlty		S	S	S
Payload attached w/ metal hardware		S	S	S
Electric motor/Servo		S	S	S
Red arming plug		S	S	S
3 cell 2200mAh lithium polymer battery		S	S	S
gyroscopic assist allowed		S	S	S
ASTM D1785 PVC Payload weights		S	S	S
Hand launch		S	S	S
12.125 in X 3.625 in X 13.875 in container		S	S	S
3 min assembly		+	S	-
1 min to energize, check, and launch		S	S	S
fly for 400-foot leg of a flight circuit		+	S	S
cost within budget		S	S	S
durable and robust design		+	+	+
reliable design		+	S	-
safe to operate		S	S	S
TOTAL	(+)	6	3	3
	S	13	16	14
	(-)	0	0	2

<u>Datum:</u> SAE Aero Micro 2018-2019

<u>Design 1:</u>

- Single wing with specified NACA airfoil
- Dual ailerons, dual elevators, and rudder
- Front wheels, rear steer
- Single motor with specified propeller
- Fuselage battery linkage storage with external snaps for payload

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CONCEPT EVALUATION: DECISION MATRIX

		Design 1		Design 2		Design 3	
Criteria (ERs)	**Weight (%)**	**Score(1-5)**	**Weighted Score**	**Score(1-5)**	**Weight Score**	**Score (1-5)**	**Weighted Score**
Frequency (GHz)	5	5	25	5	25	5	25
Power (Watts)	9	5	45	5	45	5	45
Weight (lbs)	8	3	24	4	32	4	32
Time (seconds)	5	4	20	3	15	3	15
Capacity (mAh)	4	3	12	3	12	3	12
Storage Volume (in^3)	5	3	15	5	25	4	20
Length (inch)	4	4	16	4	16	4	16
Current (Amperes)	4	5	20	5	20	5	20
Angle (deg)	6	4	24	4	24	4	24
Acceleration (feet/second^2)	7	5	35	3	21	3	21
Angular Velocity (degrees/sec)	5	4	20	3	15	4	20
Angular Speed (rpm)	8	4	32	4	32	4	32
Lift (lb)	8	4	32	3	24	4	32
Thrust (lb)	9	5	45	5	45	5	45
Cost ($)	6	5	30	4	24	5	30
Toughness (in*lb/in^2)	7	4	28	5	35	4	28
Total	100		423		410		417

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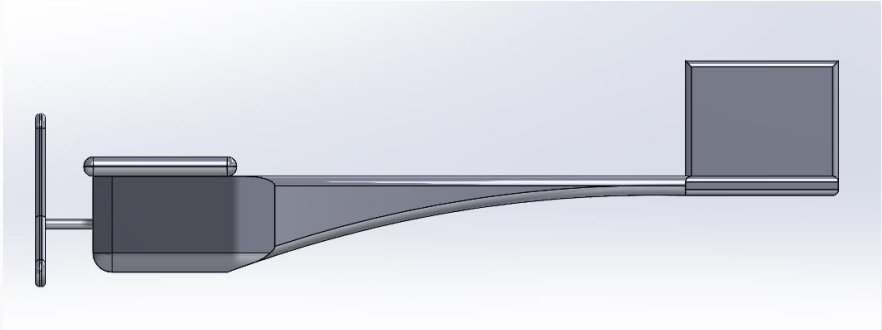
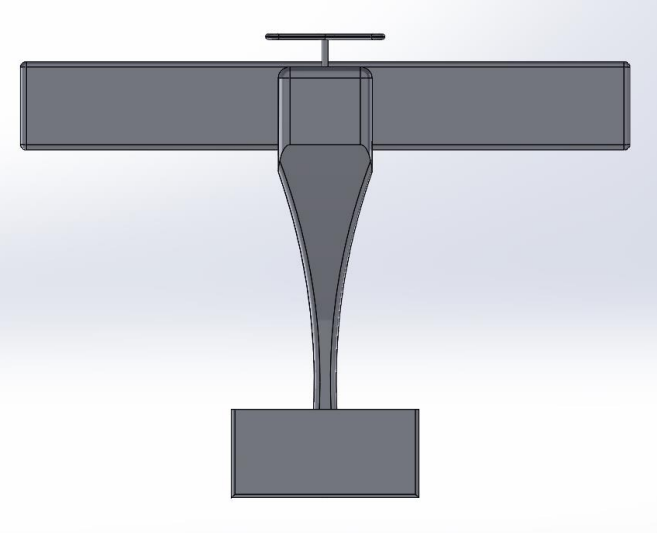
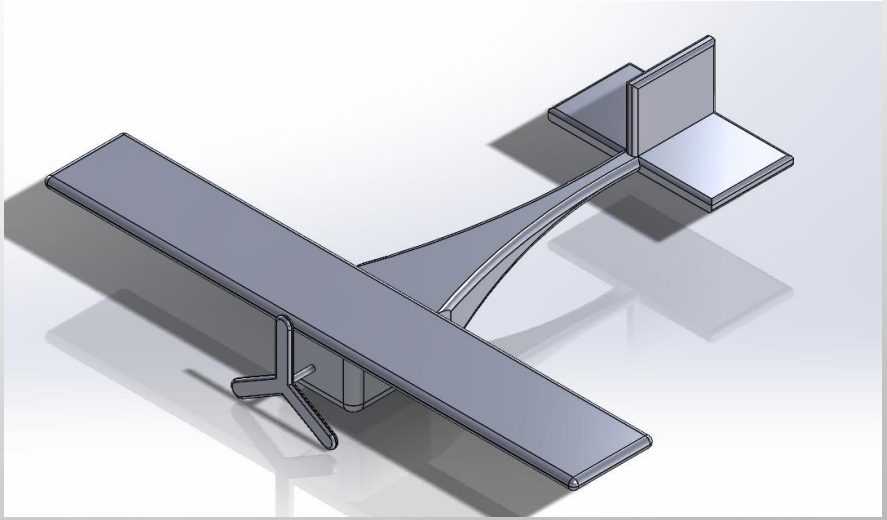
CONCEPT SELECTION: DESIGN ALTERNATIVE 1

- Single wing with specified NACA airfoil
- Dual ailerons, dual elevators, rudder
- Front wheels, rear steer
- Single motor with specified propeller
- Fuselage battery and actuator storage
- External snaps for payload







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BUDGET PLANNING

- TOTAL EXPENSES
- ADDITIONAL COSTS

Expenses	**Cost**
Entry Fees	$1050
Prototypes	$200
Final Design Materials	$560
SAE Membership	$90
Total	$1900

Eli

BUDGET PLANNING

Bill of Materials

Team: Prop Dogs

Part #	Part Name	Qty	Description	Functions	Material	Dimensions	Cost ($)	Link to Cost estimate
1	Propeller	1	Pronged whe	Creates thrust	Composite Wood or Plastic	8.25" diameter	3.99	https://www.horizonhobby.com/airpl
2	Electric Motor	1	Cylindrical me	rotates the propeller	Aluminum	4lbs	89.99	https://www.horizonhobby.com/airpl
4	RC Controller/Receiver	1	Black controll	Controls the electrical compo	Plastic, Metal, electrical Wiring	6"x6"	230	https://www.horizonhobby.com/Prod
5	Servo Motor	3	Small black b	Converts the Mechanical mo	Plastics, and metal	1"x1" and 8" wire	11.95	https://www.adafruit.com/product/2
6	Wing Frame	2	Small stick c	Creates Lift	Balsa Wood	1/8" x 1/8" x 36"	19.18	https://www.amazon.com/Pitsco-Ed
7	Elevators	2	Hinged Flaps	Guides aircraft	Balsa Wood	300x200x1.5mm	12	https://www.amazon.com/BQLZR-30
8	Rudder	1	Hinged Flap a	Guides aircraft	Balsa Wood	300x200x1.5mm	12	https://www.amazon.com/BQLZR-30
9	Fuselage Frame	1	Thin curved v	Creates lift/holds payload	Balsa Wood	300x200x1.5mm	12	https://www.amazon.com/BQLZR-30
10	Snaps	10	Plastic faster	Connects the parts of the pl	Plastic	Diameter = 7/16"	7.99	https://www.amazon.com/Tandy-Le
11	Air Foil (Shrink wrap, ta	1	Film	Creates an aerodynamic desi	Polyethylene	2"x180'	11	https://www.uline.com/BL_2101/Mar
12	Wiring	1	Thin wiring	Actuates the Electrical Comp	Copper/Aluminum	75"	5.91	https://www.amazon.com/OOK-5015
13	Battery	1	Metal/Plastic	Stores Voltage	Metal/Plastic	1"x4"	29.99	https://www.horizonhobby.com/EFLB
14	Adhesive	1	Glue	Holds the internal frame in pl	cyanoacrylate	5 grams	4.4	https://www.grainger.com/product/4
15	PVC Pipe	1	Hollowed cyli	Payload	polyvinyl chloride	2" diameter	9.25	https://www.homedepot.com/b/Plum

Totals: $459.65

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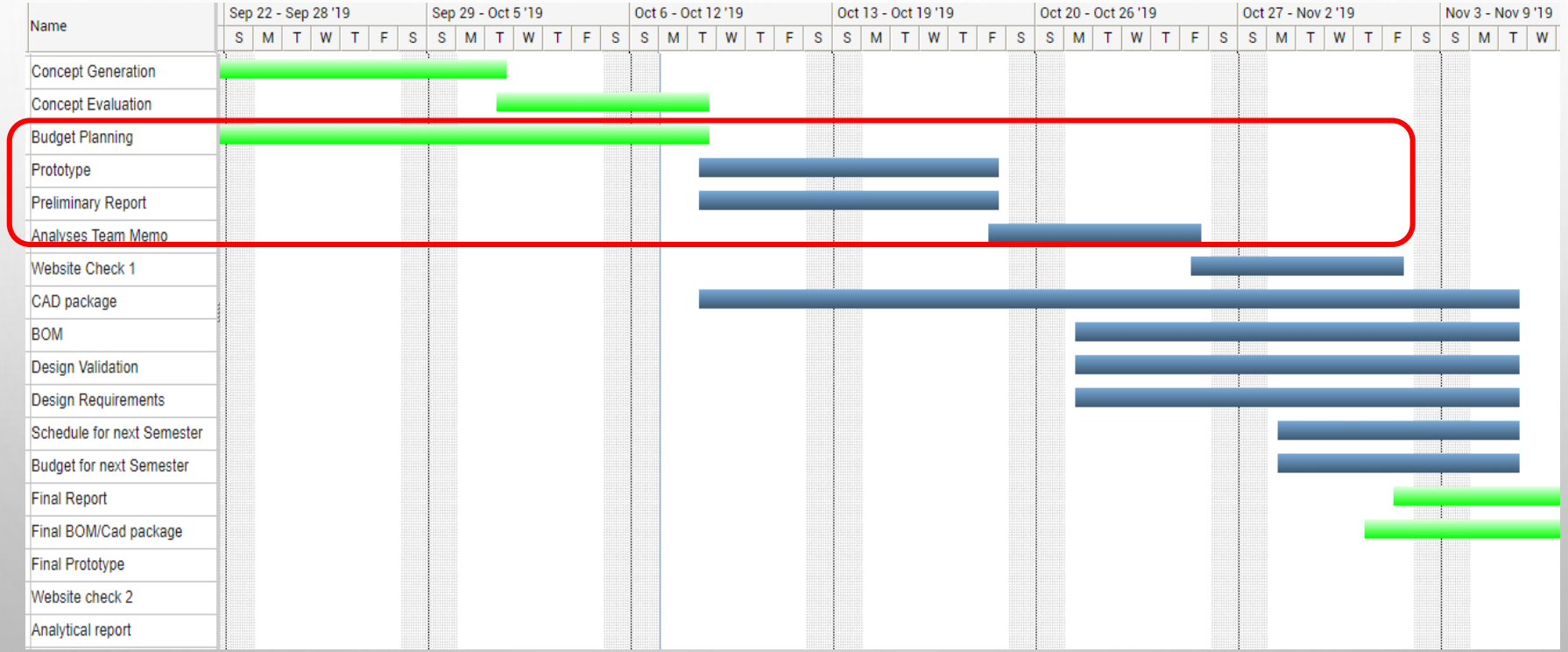
PROJECT PLANNING UPDATE



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PROJECT PLANNING EVENTS

- 2ND MEETING WITH DR. TESTER - OCTOBER 11TH
- SAE MEMBER REGISTRATION - OCTOBER 11TH
- COMPETITION SIGN UP - OCTOBER 14TH
- PRELIMINARY REPORT - OCTOBER 18TH
- TESTING, CALCULATIONS, AND MATERIAL AND PRODUCT SELECTION
- 3-5 APRIL 2020 - FORT WORTH, TEXAS

Eli

QUESTIONS?