Interim Design

FCAAP: AIAA Design Build Fly

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FCAAP

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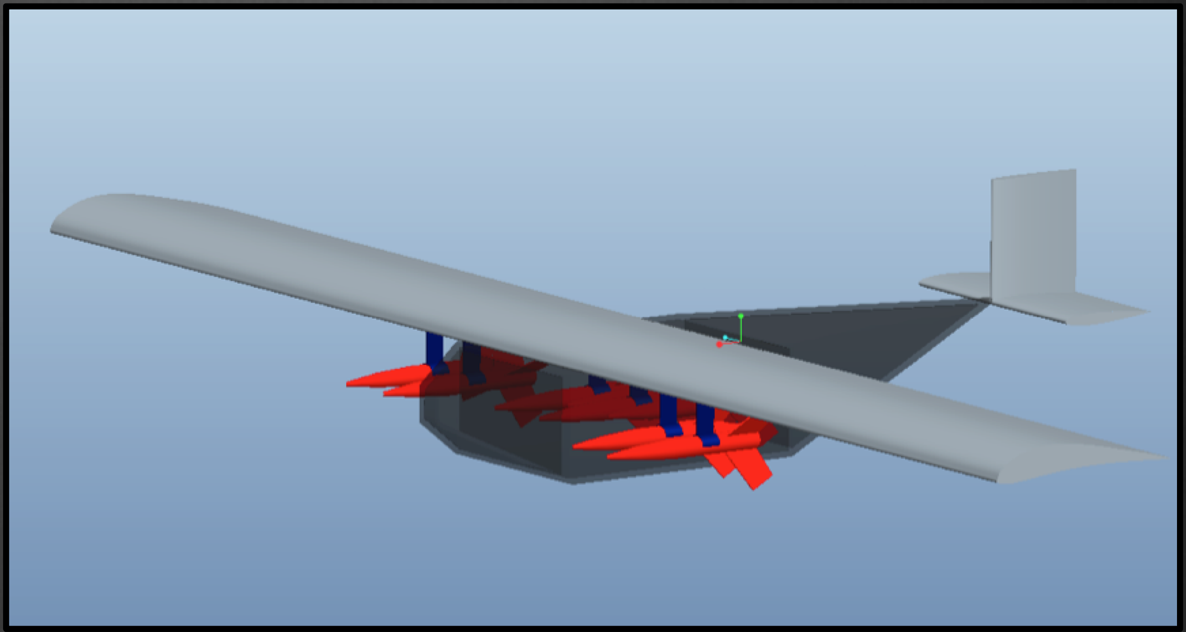
[11/13/12]

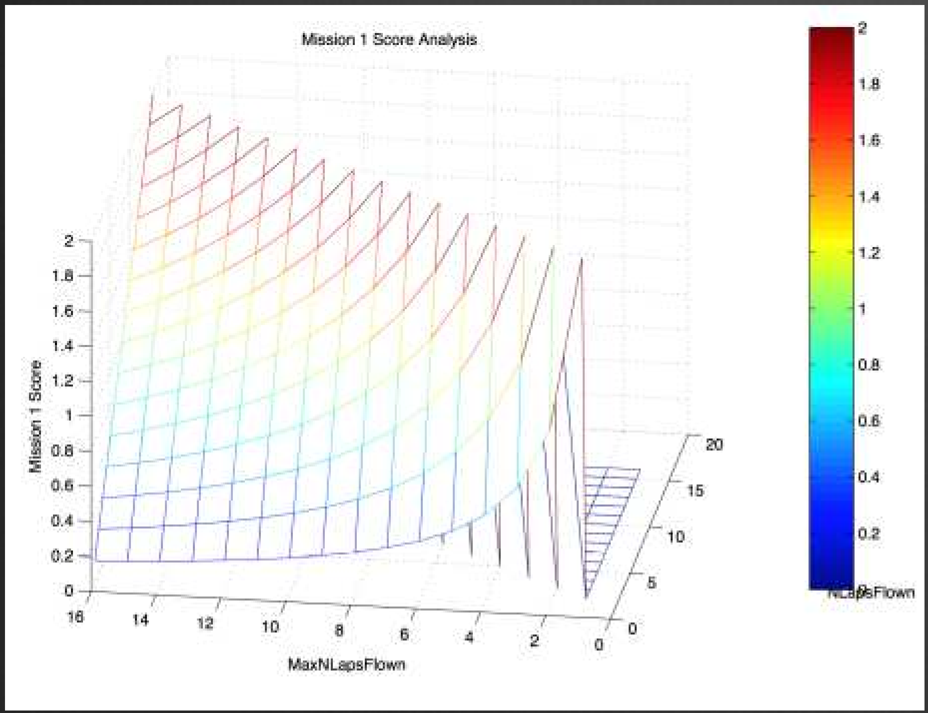
Presentation Outline

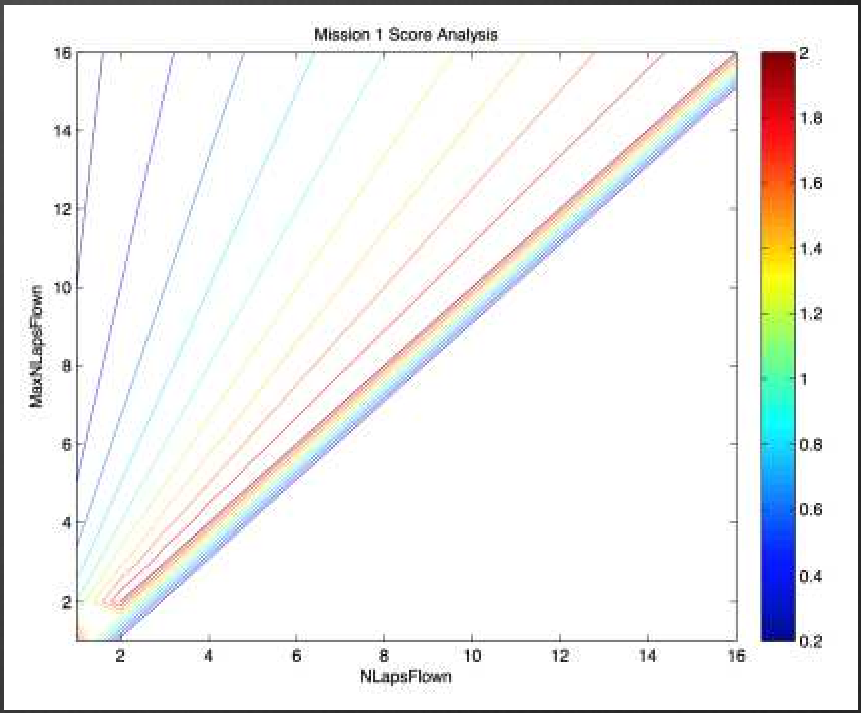
- Scoring Sensitivity Study
- Airframe Layout
- Subsystem Breakdown
- Interim Design



Scoring Sensitivity

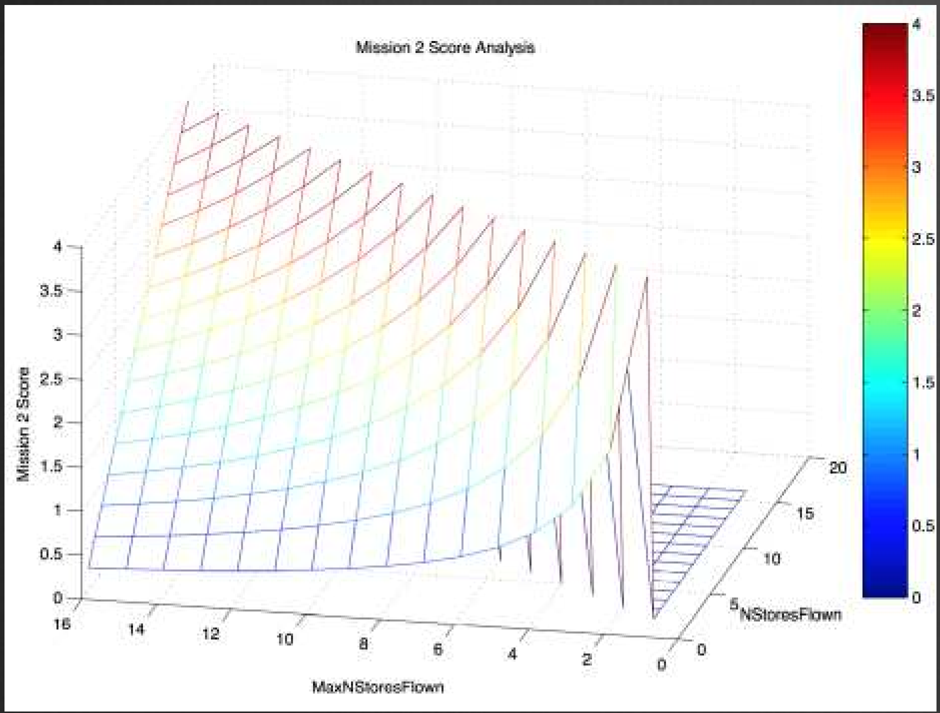
Mission 1 : Max laps flown in allotted time

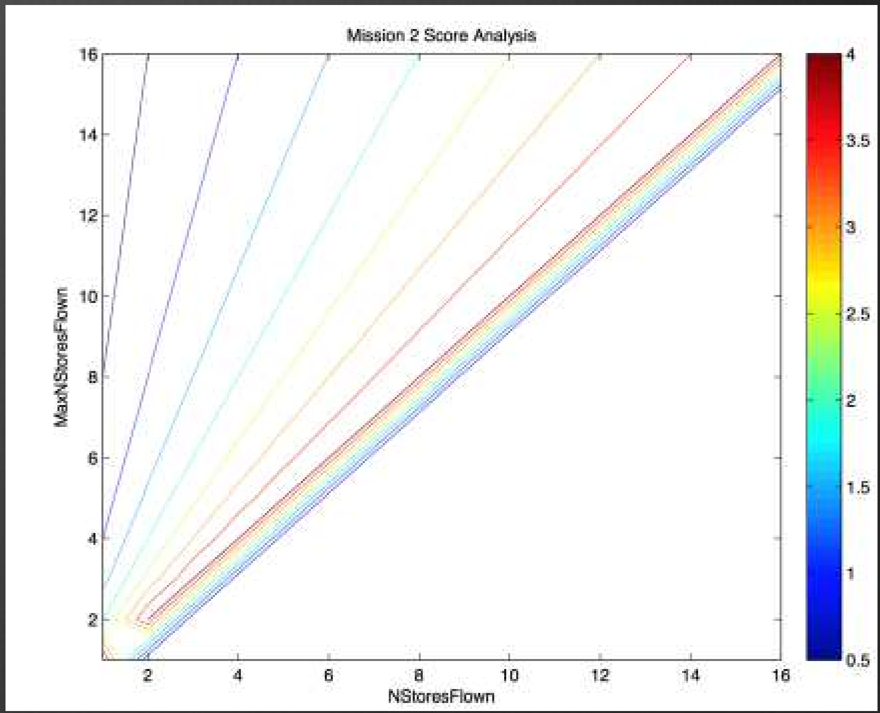




Scoring Sensitivity

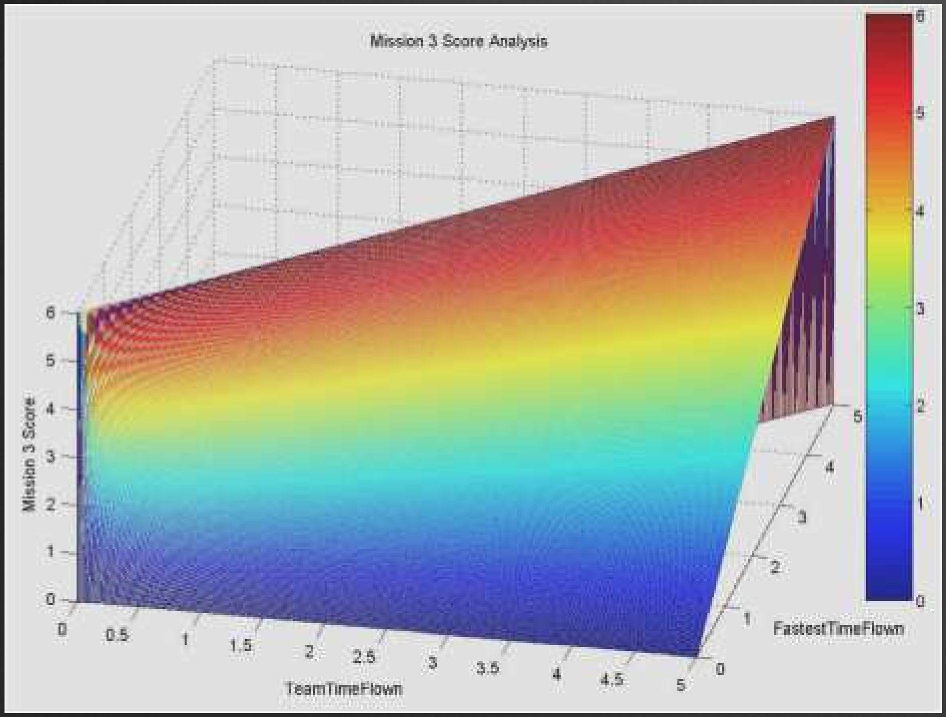
Mission 2 : Max internal stores for 3-lap flight

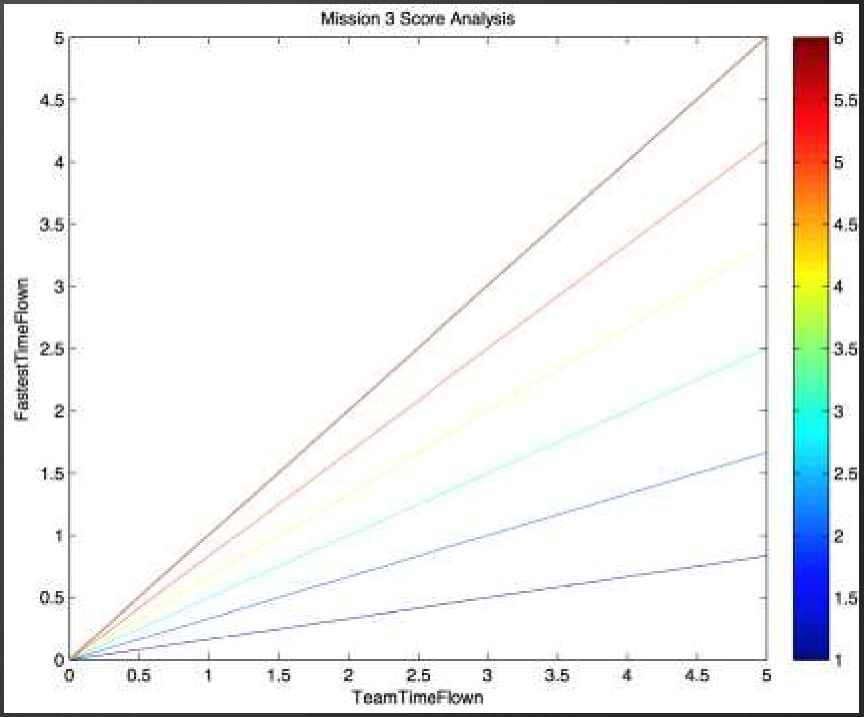




Scoring Sensitivity

Mission 3 : Internal + External stores for 3-lap flight





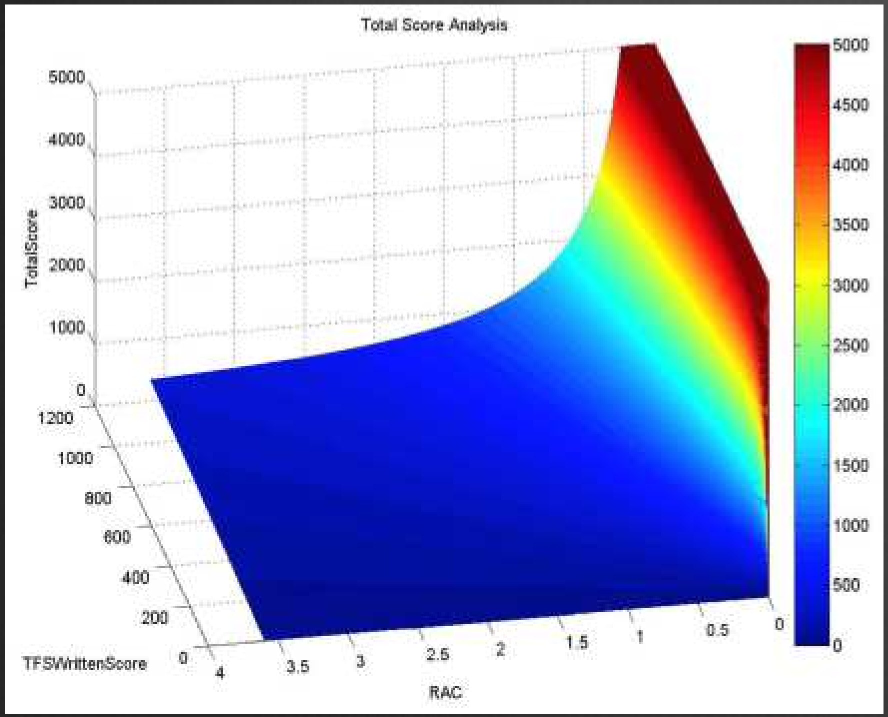
Total Score Analysis

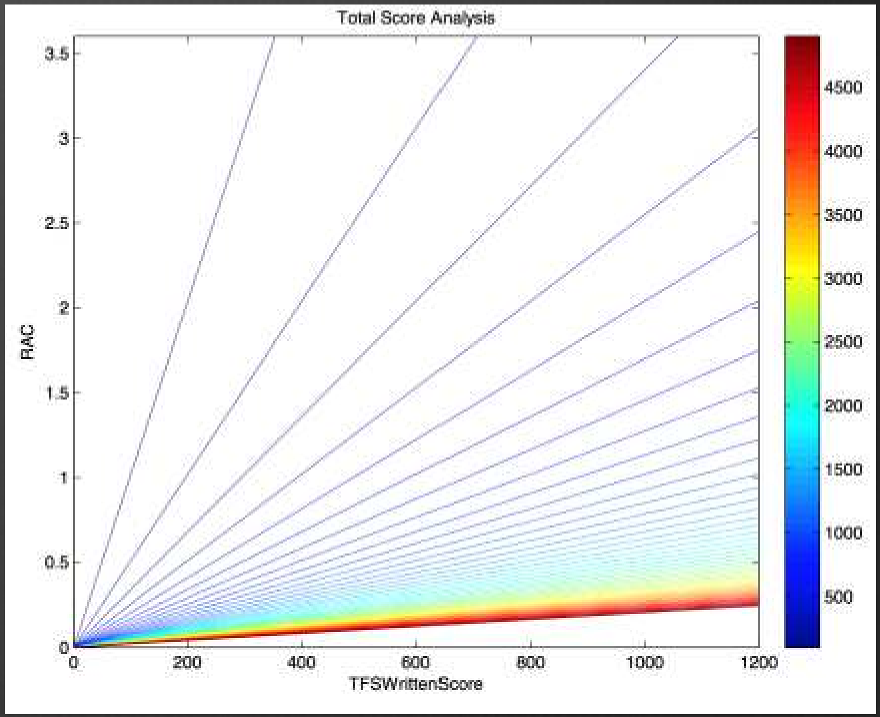
Total Score = Written Report Score * Total Flight Score / RAC

Total Flight Score = M1 + M2 + M3

RAC = Sqrt(EW * SF) / 10

SF = X_max + 2* Y_max





Airframe Layout – Fuselage

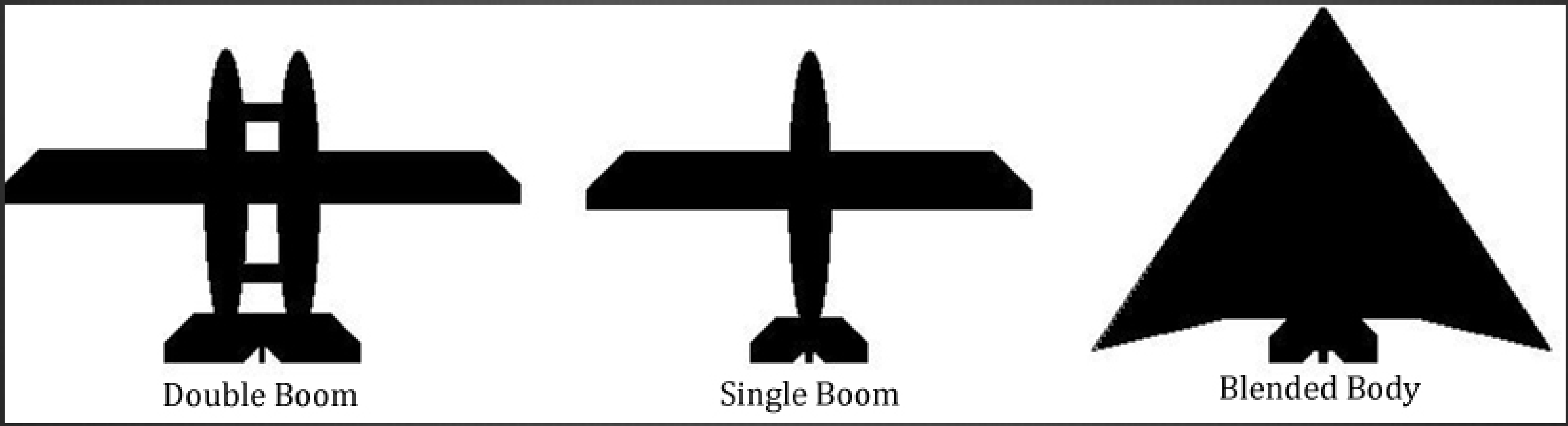


Figure of Merit	Weighting Factor	Double Boom	Single Boom	Blended Body
Weight	0.40	1	3	4
Drag	0.20	2	4	5
Durability	0.10	3	4	5
Storage Capacity	0.30	5	4	1
Total	**1.00**	**2.6**	**3.6**	**3.4**

Airframe Layout – Wing

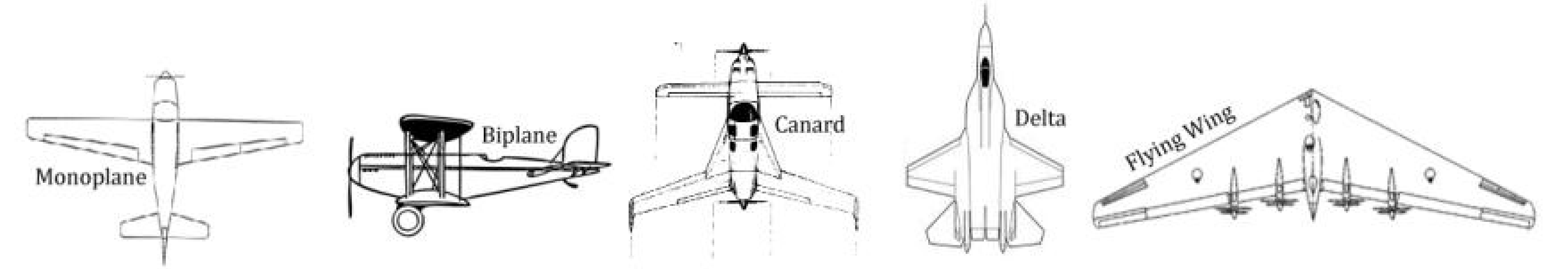


Figure of Merit	Weighting Factor	Monoplane	Biplane	Canard	Delta Wing	Flying Wing
Weight	0.20	4	1	3	4	1
Drag	0.20	4	2	2	1	3
Lift	0.30	3	5	4	3	4
Stability	0.15	4	5	3	3	5
Complexity	0.15	5	4	2	3	1
Total	**1.00**	**3.85**	**3.45**	**2.95**	**2.80**	**2.90**

Airframe Layout – Tail

Figure of Merit	Weighting Factor	Conventional	V-Tail	Twin Tail	T-Tail
Weight	0.15	3	4	3	3
Drag	0.20	4	5	3	3
Stability	0.35	5	2	3	3
Maneuverability	0.20	5	2	4	4
Manufacturability	0.10	4	2	3	3
Total	**1.00**	**4.40**	**2.90**	**3.20**	**3.20**

Airframe Layout - Propeller

Tractor

Pusher

Ducted Fan

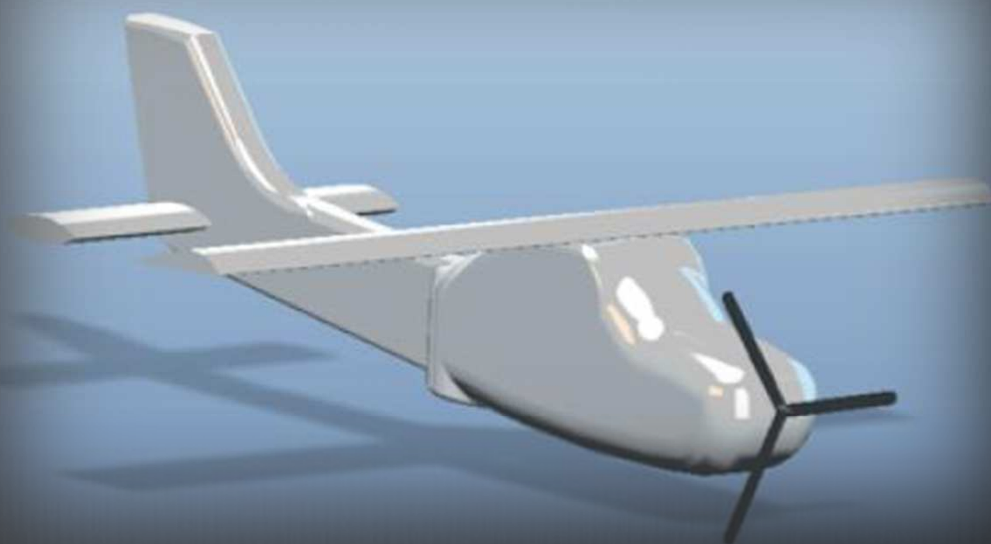
Tractor - Pusher

Figure of Merit	Weighting Factor	Single Tractor	Pusher	Tractor / Pusher	Ducted Fan
Weight/Balance	0.40	5	4	5	2
Efficiency	0.40	4	4	3	3
Complexity	0.20	5	4	2	3
Total	**1.00**	**4.60**	**4.00**	**3.60**	**2.60**

Preliminary Layout

Final Aircraft Configuration:

- Monowing
- Single Boom Fuselage
- Conventional Tail
- Tractor Configuration



Motor Specifications

Motor	ESC	Power	Kv	Weight	Shaft Width	Price
BL400 Ducted Fan Outrunner	19 A	200 W	3500	56 g	2.3 mm	$45
Himax HA2025-4200 Geared Electric Brushless Inrunner	15 A	175 W	4200	66 g	2.0 mm	$53
Neu 1905/1.5Y	24 A	600 W	3500	182 g	5.0 mm	$190
A10-9L Hacker Brushless 75W 1700k/V Outurunner	7 A	75 W	1700	20 g	2.0 mm	$40

Electronics & Controls

Motor Controller Selection:

Figures of Merit	CC Thunderbird 18	CC Phoenix 25	Atlas Black 20
Weight	0.6 oz	0.6 oz	0.625 oz
Size	1.32x0.33x0.90 in	1.08x0.91x0.16 in	1.875x0.875x0.375 in
Continuous Amp	18	25	20
Cost	$33.95	$67.95	$38.99

ESC Requirements:

- ESC Continuous Amp higher than Motor ESC Rating
- Programmable; Can control at least 1 Motor

Electronics & Controls

Transmitter / Receiver

Spektrum DX7 7-channel Transmitter:

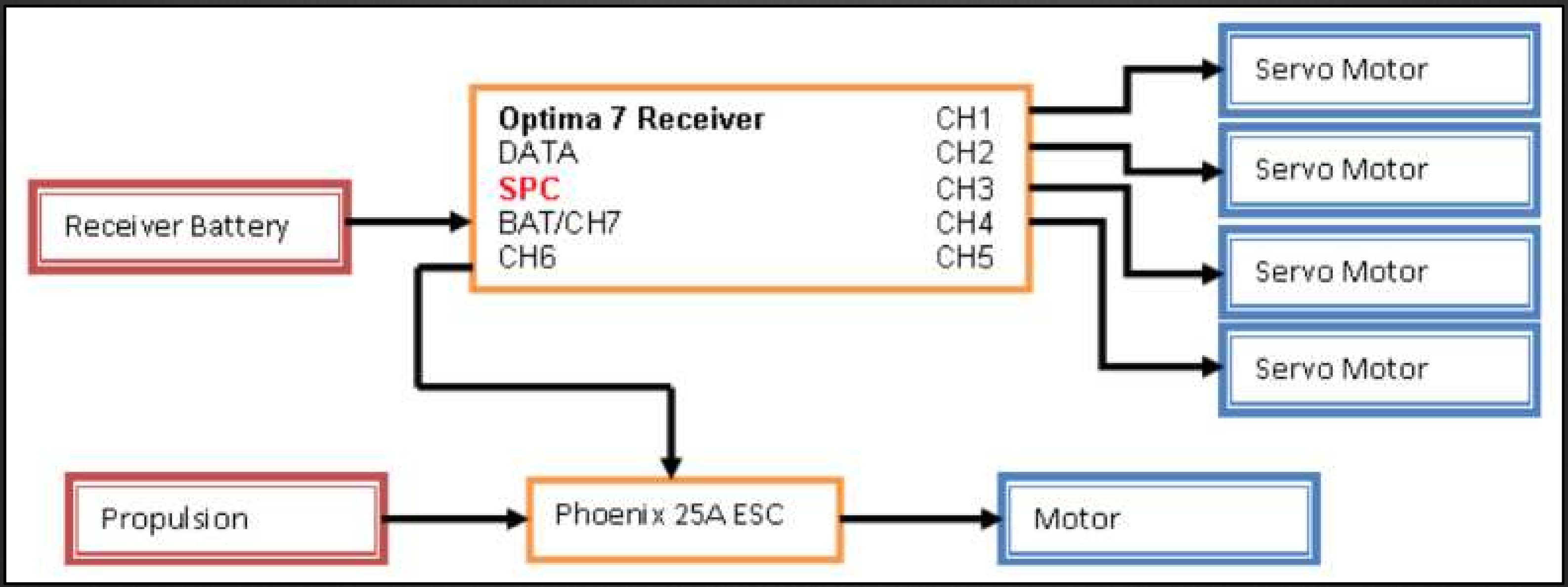
- Transmits on 2.4GHz band
- Programmable Fail-Safe Mode
- Safe from internal and external Radio Frequency (RF)

HiTEC Optima 7 Receiver:

- Combined internal and external receiver (2.4 GHz)
- 7 Channel
- Safe RF linking

Electronics & Controls

Basic Wiring Diagram for Control System:



Electronics & Controls

Specific Battery Type Selection

Figures Of Merit	NiCd	NiMH
Nominal Cell Voltage	1.2V	1.2V
Energy Density	50-150	140-300
Cycle Durability	2000	1500
Memory Effect	Y	N
Internal Resistance	Very Low	Low
Toxicity	Medium	Low

- NiMH best candidate based on Energy Density and NiCd's Memory Effect; Li-Po not allowed
- Competition Requirement: 20A ATO Blade Fuse

Electronics & Controls

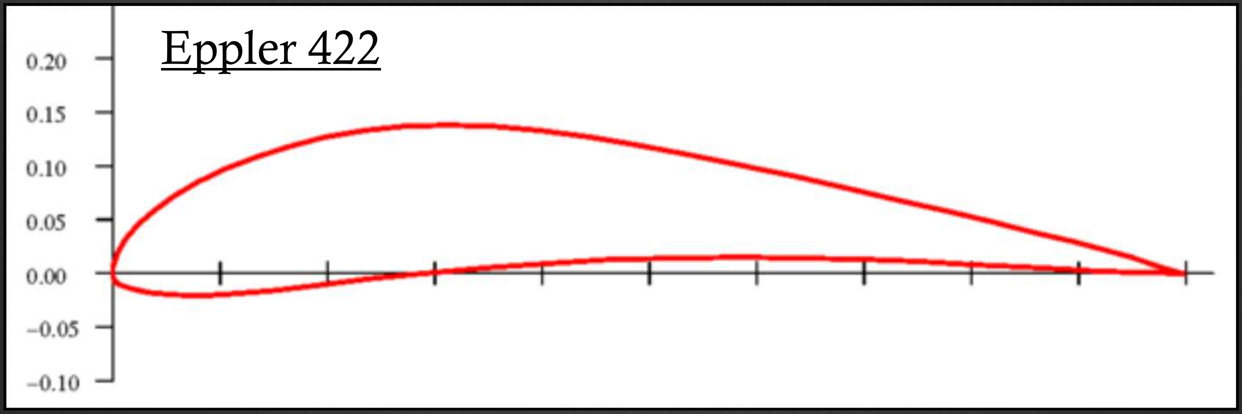
Battery Pack Selection

Figures of Merit	Venom 1540 6-cell	10-Cell NiMH AA 5x2 Pack	Traxxis 7-Cell	DuraTrax Onyx 3000
Cell Voltage	7.2 V	12V	8.4V	8.4V
Amp-Hours	3300 mAh	2000 mAh	3000 mAh	3000 mAh
Weight	11.46 oz	11 oz	13.4 oz	15 oz
Dimensions (in^3)	5.39 x 1.77 x 0.94	2.80 x 3.94 x 0.57	6.10 x 1.7 x 0.91	6.1 x 1.9 x 0.9
Cost	$24.99	$45.00	$25.19	$22.69

- Cell packs
  - Offer range of Capacity, Weight and Cost
  - Fixed dimensions

Wing Design

Airfoil	Max Cl	Stall Angle (deg)	Max Aerodynamic Efficiency (Cl/Cd)	α at Max Eff (deg)	Cl at α
NACA 4412	1.55	12.00	70.60	6.00	1.20
NACA 65-418	1.45	9.00	48.30	6.00	0.97
Eppler 422	1.474	17.00	85.29	6.00	1.45
DAE 11	1.78	15.00	56.00	10.00	1.56

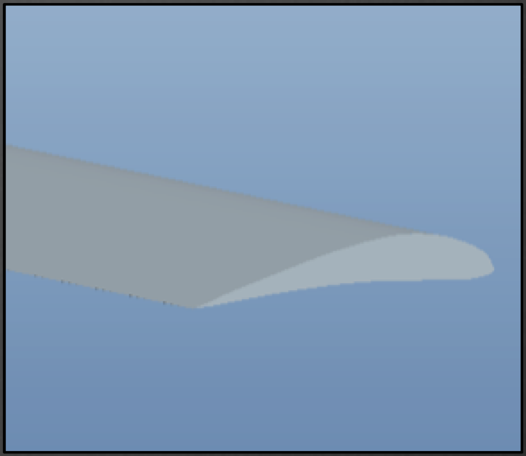


Wing Design

Wing Sizing

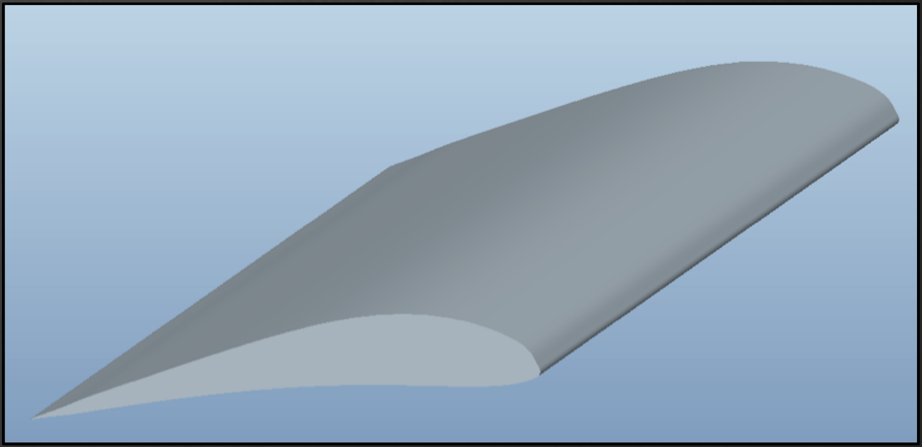
Assumptions:

- Empty weight = 7 lbs
- Payload/Weight Ratio = 1 : 2.333
- Wing Loading = 20oz/ft^2

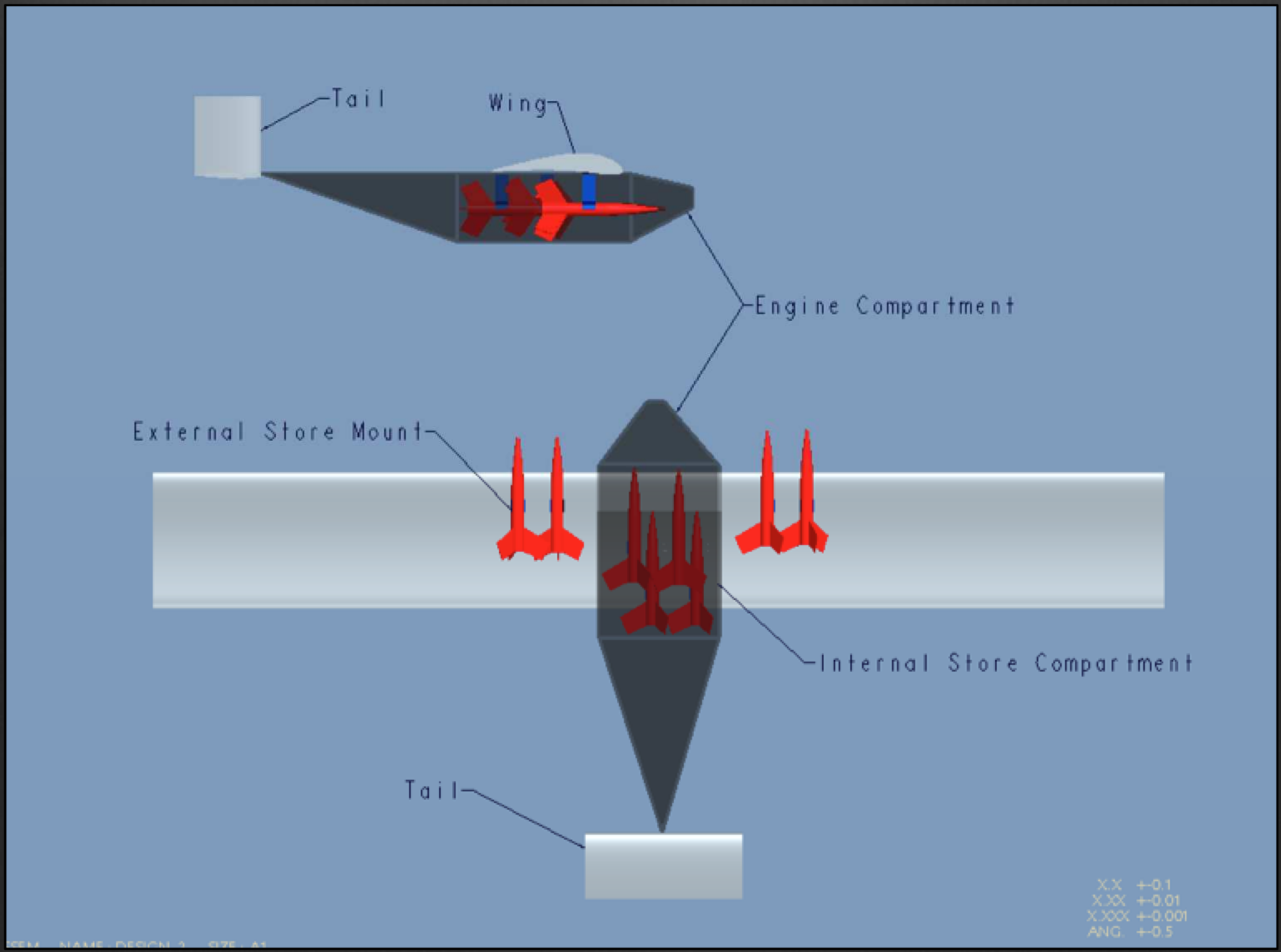


Derived dimensions:

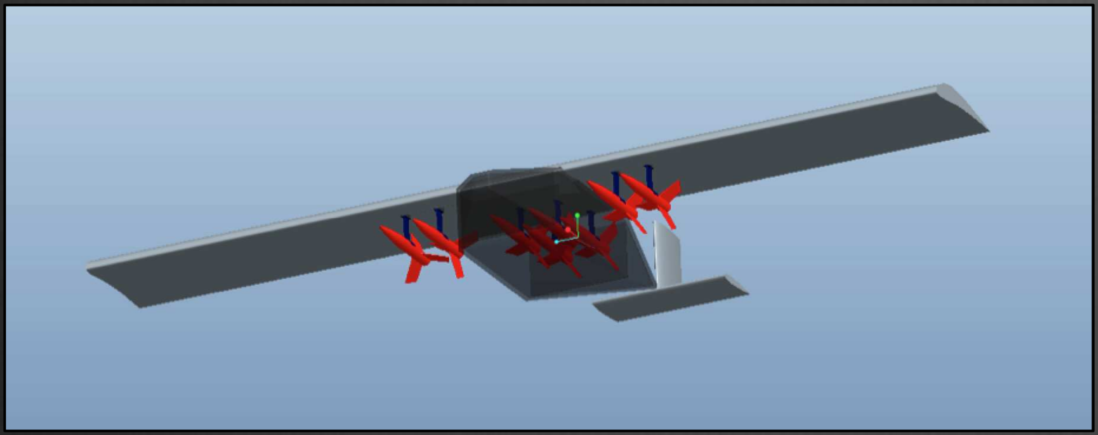
- Wing Area = 806.4 in^2
- Wingspan = 77.769 in
- Chord Length = 10.369 in
- Aspect Ratio = 7.5

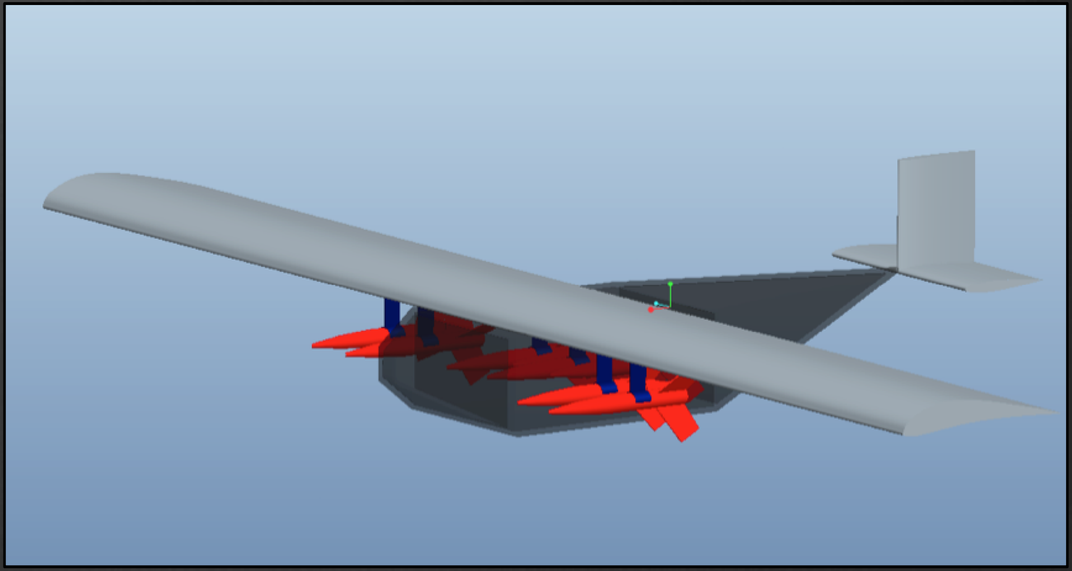


Interim Aircraft Design



Interim Aircraft Design





Future Considerations

- Specific Internal Store Configuration
- External Store Attachment Methods
- Integrated System Analysis
- Theoretical Performance Analysis
- Bill of Materials/Required Parts

Interim Design

Questions ?

Cessna Aircraft Company
Raytheon Missile Systems
AIAA Foundation

Resources

Personal Aircraft Drag Reduction. Bruce Carmichael
"ATMOSPHERIC FLIGHT: AERODYNAMIC LIFT". *NASAQuest,* NASA, 9 February 2012. (accessed September 29, 2012). <http://quest.nasa.gov/aero/planetary/atmospheric/aerodynamiclift.html>.

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Ewans, J.R. "AERODYNAMICS OF THE DELTA". Accessed from the Flight Global Archive, 11 August 1951. pg. 172-174 (accessed September 28, 2012). <http://www.flightglobal.com/pdfarchive/view/1951/1951%20-%201545.html>

Kermode, A.C. FLIGHT WITHOUT FORMULAE. 5th ed. updated by Bill Gunston. *Longman Group UK Limited,* 1989. Print.

Personal Aircraft Drag Reduction. Bruce Carmichael, page 195, Propeller behind tail - pros and cons.

Aircraft Design: A Conceptual Approach. Daniel P. Raymer. AIAA Education Series.

Images

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