MULTIDISCIPLINARY SENIOR DESIGN– II
Spring 2010

FINAL PROJECT REVIEW

UAV AIRFRAME X-4

Jordan Carrick, Stephen Cramb, Michelle Bailey,
Nathan Hardman & Scott Melchionno

UAV Airframe X-4

- Insert pretty picture of plane here…hopefully in flight…not in pieces ☺

Agenda

- Project Overview
- Customer Needs
- Airframe X-4 Specifications
- Testing
- Meeting Customer Needs & Engineering Specs
- Objective Evaluation of Project
- Suggested Design Changes

Customer Needs

- 1. Iterate the design of Airframe C (P10232) to obtain a new airframe that incorporates minimal design deviations but is primarily robust and still able to achieve UAV flight requirements.
- 2. The new design, Airframe X-4, must be designed to be a test mule for future testing, experimentation and research projects for remote aerial imagery.
- 3. Airframe X-4 must possess the ability to withstand testing and flight exercises with minimum maintenance.
- 4. Airframe X-4 must be capable of flight in an adequate R/C airfield under reasonable weather conditions.
- 5. Airframe X-4 must have flight characteristics similar to that of a trainer style aircraft.
- 6. Airframe X-4 must be capable of at least 100 hours of total flight time.
- 7. Airframe X-4 must be capable of sustaining a controlled steady flight for at least 30 minutes.
- 8. Airframe X-4 must be capable of reaching an altitude of 400ft while complying with AMA regulations.
- 9. Airframe X-4 must be capable of supporting a 15 lb payload with relative ease.
- 10. Airframe X-4 must be capable of easy integration with the imaging system payload designed by P11231.
- 11. The total weight of the aircraft including all components and payload must not exceed 50 lbs.
- 12. The budget costs associated with the design and construction of Airframe X-4 must not exceed $3,000.
- 13. Design deviations from Airframe C for Airframe X-4 must be justified.

Product Concepts – Aerodynamic Concepts

- Airfoil
  - NACA 9412 – Airfoil Used by Airframe C
  - NACA 7412 – Less Cambered Airfoil
  - NACA 5412 – Less Cambered Airfoil than both 9412 and 7412
  - E423 – Heavily Cambered Airfoil
  - Other Cambered airfoils
  - Clark Y – Flat Bottom Airfoil
- Wing
  - Candy Bar Wing – Flat rectangular wing
  - Dihedral Wing – Wing as slight upward angle
  - Swept Wings – Wing tips are tapered behind the wing's root
  - Tapered Wing – Wing root cord is larger than tip cord
  - Aspect Ratio – Ratio of the wingspan to it's surface area

Product Concepts – Material Concepts

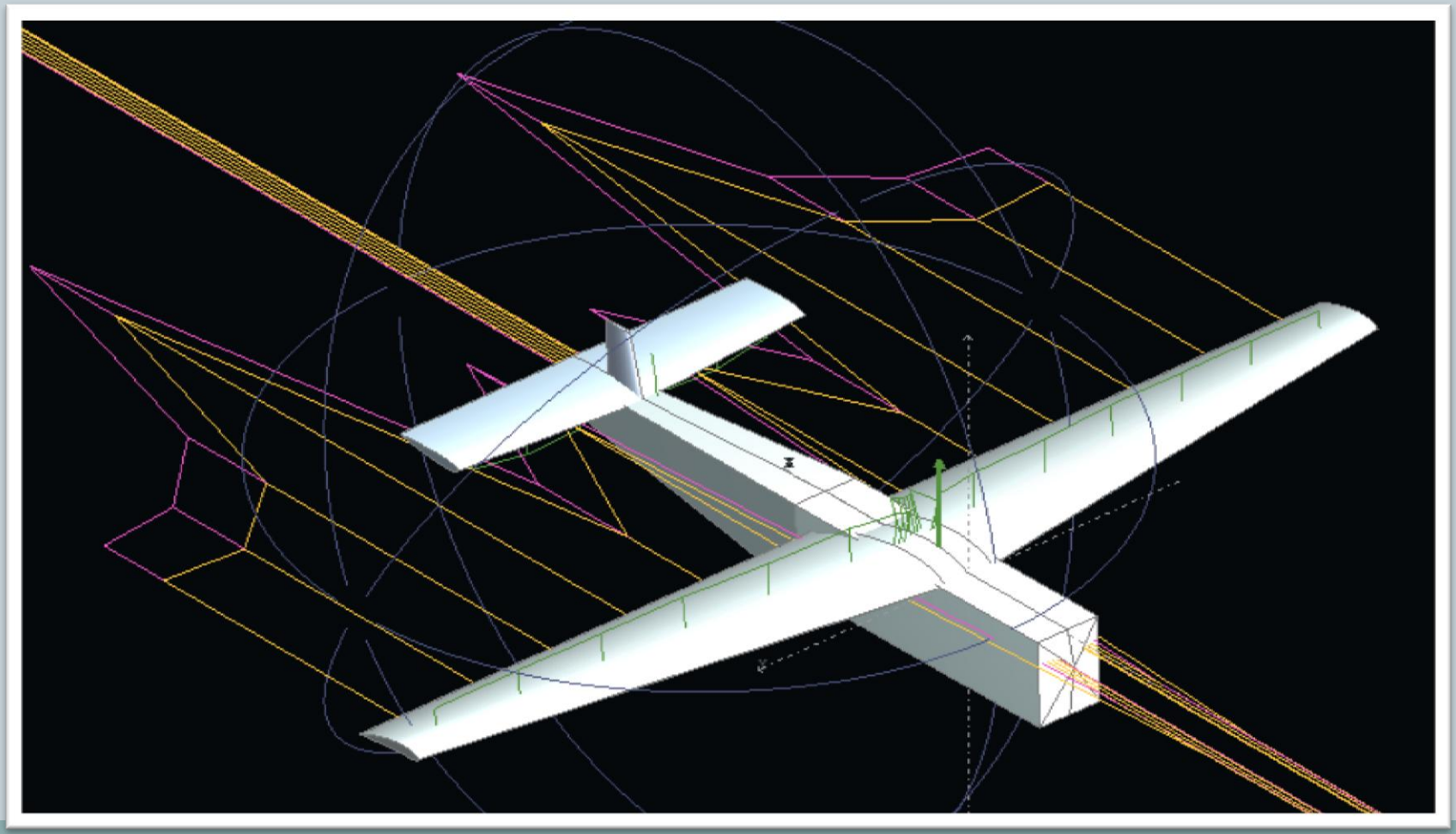
- Fuselage
  - Balsa formers with stringers and Monokote covering
  - Balsa formers with sheeted sides and Monokote covering
  - Balsa formers with sheet sides and fiberglass covering
- Wings
  - Balsa Monokote – Balsa ribs with stringers with Monokote covering
  - Balsa Sheeting – Balsa ribs and sheeting with Monokote covering
  - Balsa Fiberglass – Balsa ribs and sheeting with Fiberglass covering
  - Foam Fiberglass – Foam Core with Fiberglass covering
  - FOLSA – Foam core, Balsa sheeting and Fiberglass covering
  - Foam Carbon Fiber – Foam core with Carbon Fiber covering
  - Hybrid – Foam leading edge with Balsa sheeting back and Fiberglass covering

Aerodynamic Concept Selection

- NACA 5412 Airfoil
  - Less aggressive than Airframe C
  - Provides stability and reliability
- Wing Sweep
  - Adds stability in similar fashion to dihedral orientation
- Increased Aspect Ratio
  - Provides a better glide ratio and overall aerodynamic efficiency of the plane

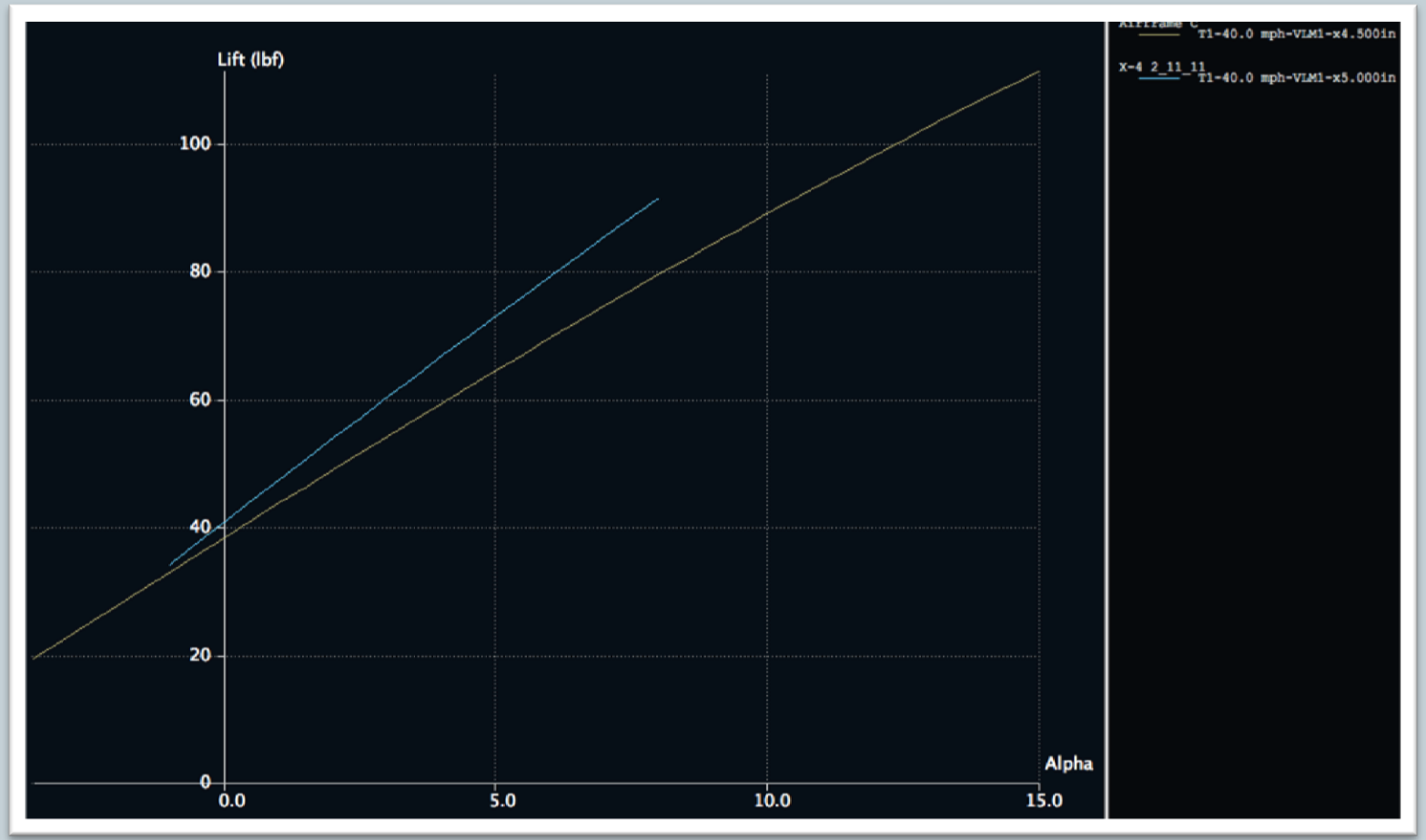
XFLR-5 Analysis

- Isometric view of X-4 in XFLR-5 at $\alpha = 2°$.



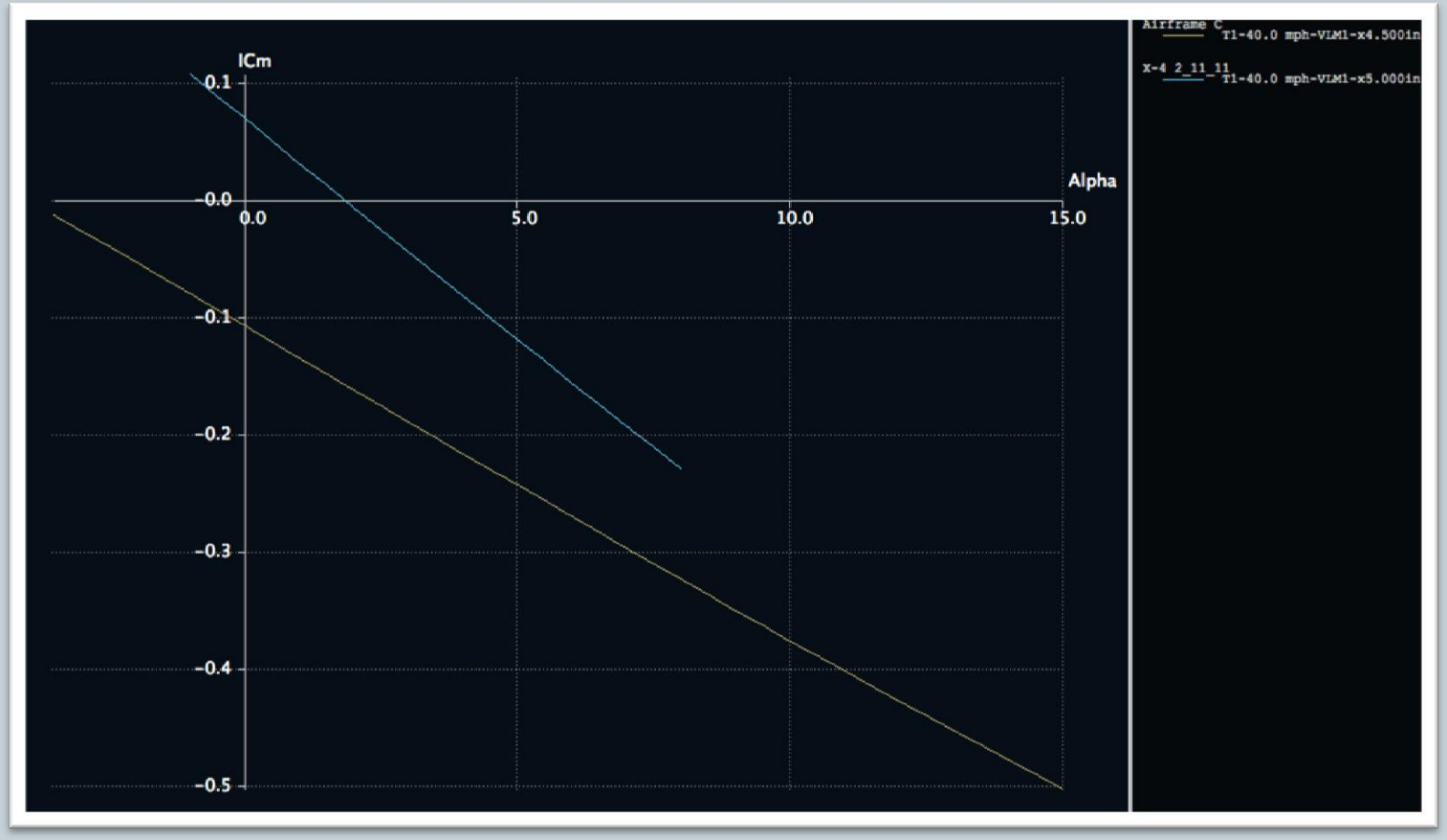
XFLR-5 Lift vs. Alpha

- At α = 2°, the X-4 produces 55 lbs of lift.



XFLR-5 Pitching Moment to Alpha

- The pitching moment for X-4 is zero at $\alpha = 2^{\circ}$.



Material Concept Selection

- Add table for concept selections

Airframe X-4 Specifications

- Need to add general specifications
- Weight, max flight time, T/O distance, payload capacity,

Airframe Fuselage – Critical Dimensions (UPDATE)

Component	Dimension	Value	Unit
Fuselage			
	Length	87.56	in
	Width	9.00	in
	Height	11.50	in
	X-sect	103.5	in^2
Payload Bay			
	Length	22.00	in
	Width	6.50	in
	Height	8.00	in
Center of Gravity Location			
	Payload	3.25	in
	Battery (Loaded)	-17.75	in
	Battery (Unloaded)	-9.00	in
	Motor	-30.00	in
	Tail	54.00	in

Critical Dimensions – Wing (UPDATE)

Critical Dimensions	Value	Unit
Wing Span	144.00	in
Wing Area	2346.00	in^2
Wing Section Length	4.00	ft
Wing Root Chord	22.00	in
Wing Tip Chord	10.00	in
Mean Aerodynamic Chord	17.09	in
Aspect Ratio	8.84	-
Taper Ratio	2.20	-
Root - Tip Sweep	7.13	deg
Preset Anlge of Attack	4.00	deg
Aileron Chord	2.75	in
Aileron Length	41.75	in
Main Spar Length	68.00	in
Secondary Spar Length	44.00	in
Wire Channel	0.50 x 0.30	in^2
Servo Bay	4.00 x 4.00 X1.00	in^3
Wooden Dowel	1.00 X 8.00	in^3

Critical Dimensions – Tail (UPDATE)

Critical Dimensions	Value	Unit
Wing Span	144.00	in
Wing Area	2346.00	in^2
Wing Section Length	4.00	ft
Wing Root Chord	22.00	in
Wing Tip Chord	10.00	in
Mean Aerodynamic Chord	17.09	in
Aspect Ratio	8.84	-
Taper Ratio	2.20	-
Root - Tip Sweep	7.13	deg
Preset Anlge of Attack	4.00	deg
Aileron Chord	2.75	in
Aileron Length	41.75	in
Main Spar Length	68.00	in
Secondary Spar Length	44.00	in
Wire Channel	0.50 x 0.30	in^2
Servo Bay	4.00 x 4.00 X1.00	in^3
Wooden Dowel	1.00 X 8.00	in^3

Detailed Views

- Insert set of detailed pictures of payload bay, servo setup, battery tray, etc.

Project Evaluation

- TBD as a group
- Satisfying Customer Needs
- Lessons Learned
- Suggested Design Changes

Satisfying Customer Needs

- TBD as group

Lessons Learned

- TBD as a group

Suggested Design Changes

- TBD as a group