Progress Update 03

Embry Riddle Aeronautical University - College of Business and Engineering

Team APPA

Agenda

AIRCRAFT DESIGN

SEATING CONFIGURATIONS

UPDATED COST ANALYSIS

ROUTE ANALYSIS

LIFT & DRAG MODELS

STABILITY ANALYSIS

Design Foundations

- Fixed-wing regional aircraft
- Up to 12 passengers
- Highlight hybrid-electric technology
- Reduced emissions and noise
- Optimized cost for short-haul flights

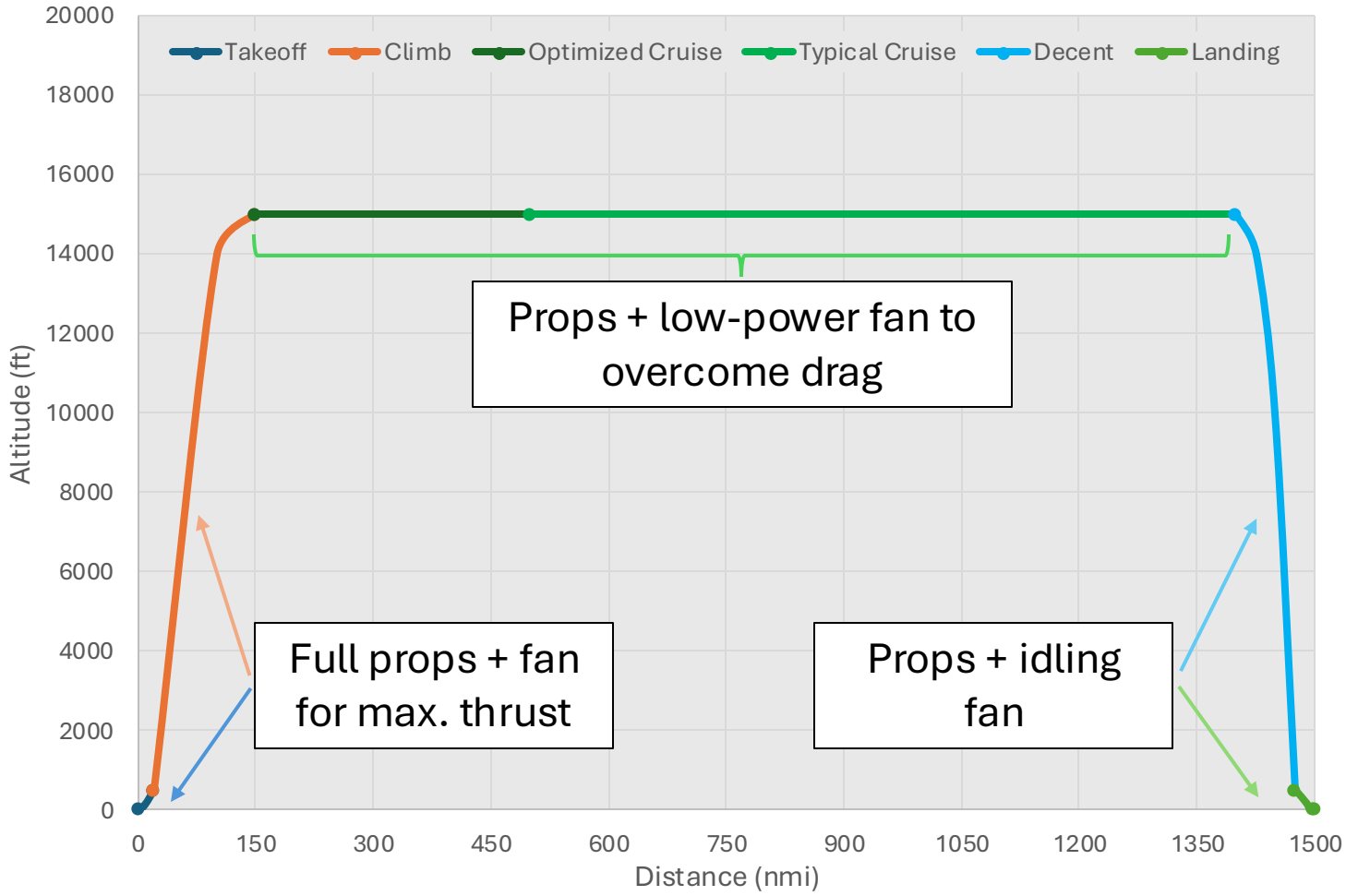
Aircraft Regulations

The aircraft falls under FAA 14 CFR Pt. 23, Level 4, High Speed

Customer Requirements		**14 CFR Part 23 Regulations**	
Passengers	12	Level 4 Passenger Range	10 to 19
Range	1,500 nmi Optimized for 500 nmi	MTOW	≤19,000 lbs
Technical Innovation	Hybrid-Electric Propulsion System	High Speed Category	>250 knots
Reduce Environmental Impact	Fuel Efficiency Noise Reductions	Service Ceiling (Oxygen and pressurization required)	20,000 ft

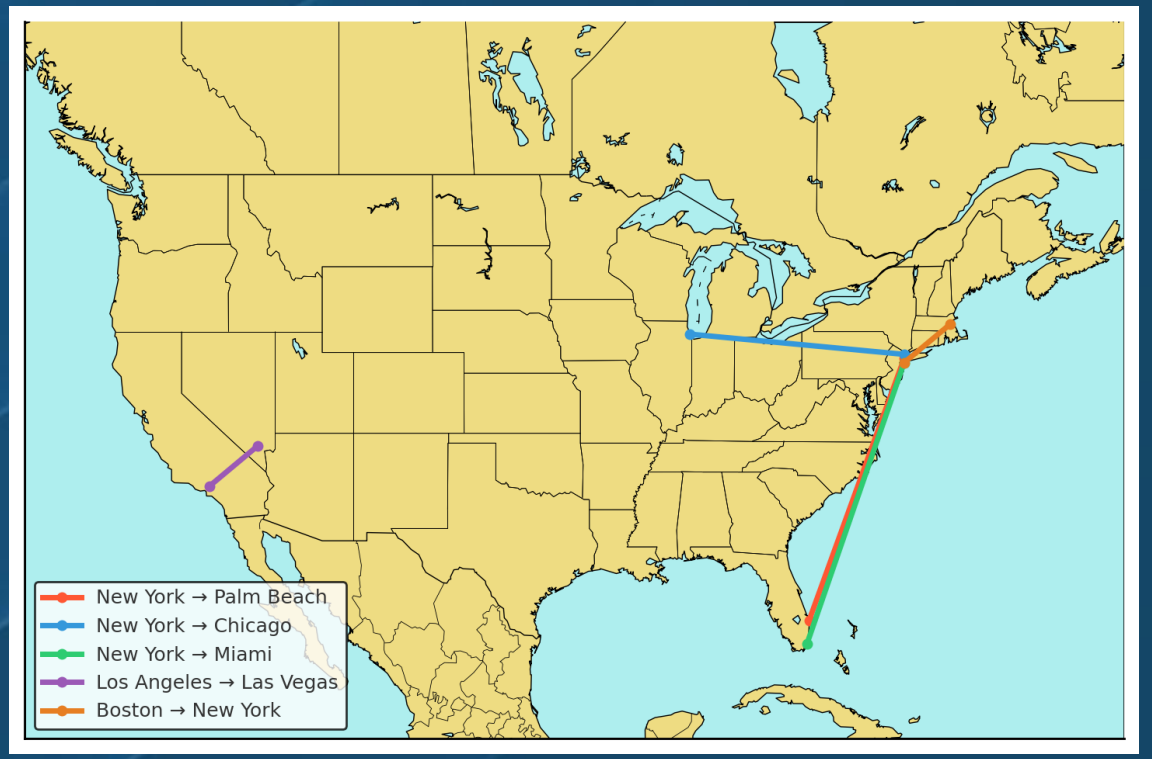
Mission Profile

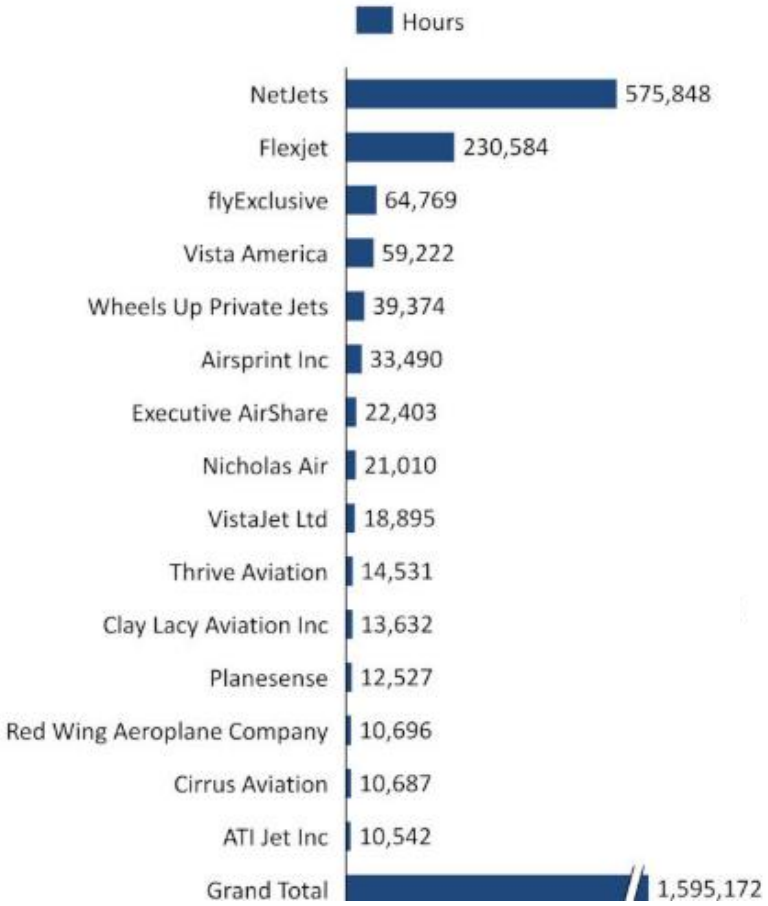
- Cruise altitude of 15,000 ft
  - Reduces climb/decent time
  - Improves fuel & propellor efficiency
- Utilizes entire hybrid system efficiently



Markets for America

- New York → Palm Beach ~ 900 NM
- New York→ Chicago ~ 650 NM
- New York → Miami ~ 1,080 NM
- Los Angeles → Las Vegas ~ 202 NM
- Boston → New York ~ 190 NM



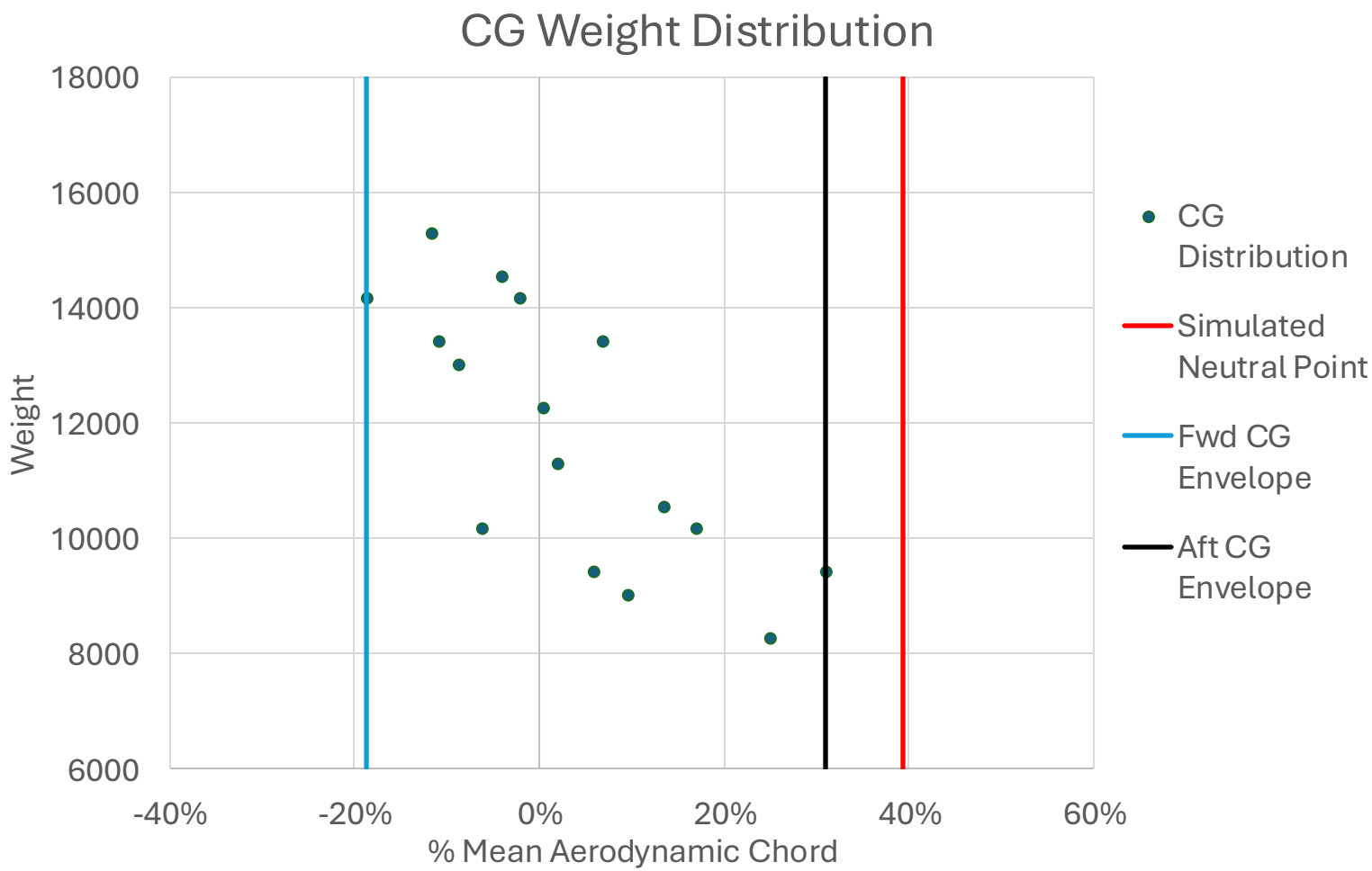


Market Clientele

- Fractional Owners/Operators
- Possess substantial upfront capital investment
- Demonstrated track record of safety
- Consistent market demand
- As of January 31st, fractional operators collectively operate 3,886 aircraft
- Identified market gap for shorter-range aircraft catering to regional travel needs

Weight Distribution & CG Envelope

Type	Weight (lb)
Structural	4400
Crew	570
Payload	750
	2280
	1000
Engines	2300
Fuel	4000
MTOW	15,300



Weight Distribution & CG Envelope

Loading Cloud for CG estimation															
Combination	Empty weight		Crew		Front Seats		Back Seats		Baggage Area		Fuel		Total		
ID	We	XCGe	We	XCGe	W	arm	W	arm	W	arm	W	arm	W	moment	XCG
1	6700	32.3	570	8	1140	17	1140	32.2	1750	15	4000	23	15300	395308	25.84
2	6700	32.3	570	8	1140	17	1140	32.2	1750	15	0	23	11300	303308	26.84
3	6700	32.3	570	8	1140	17	0	32.2	1750	15	4000	23	14160	358600	25.32
4	6700	32.3	570	8	1140	17	0	32.2	1750	15	0	23	10160	266600	26.24
5	6700	32.3	570	8	1140	17	0	32.2	1000	15	4000	23	13410	347350	25.90
6	6700	32.3	570	8	1140	17	0	32.2	1000	15	0	23	9410	255350	27.14
7	6700	32.3	570	8	1140	17	1140	32.2	1000	15	4000	23	14550	384058	26.40
8	6700	32.3	570	8	1140	17	1140	32.2	1000	15	0	23	10550	292058	27.68
9	6700	32.3	570	8	0	17	1140	32.2	1750	15	4000	23	14160	375928	26.55
10	6700	32.3	570	8	0	17	1140	32.2	1750	15	0	23	10160	283928	27.95
11	6700	32.3	570	8	0	17	1140	32.2	1000	15	4000	23	13410	364678	27.19
12	6700	32.3	570	8	0	17	1140	32.2	1000	15	0	23	9410	272678	28.98
13	6700	32.3	570	8	0	17	0	32.2	1750	15	4000	23	13020	339220	26.05
14	6700	32.3	570	8	0	17	0	32.2	1750	15	0	23	9020	247220	27.41
15	6700	32.3	570	8	0	17	0	32.2	1000	15	4000	23	12270	327970	26.73
16	6700	32.3	570	8	0	17	0	32.2	1000	15	0	23	8270	235970	28.53

Lift Model

- Based on Gudmundsson's Wing and Lift Enhancement.
  - Utilizing NACA 4415 airfoil for the wing, and Clark Y fixed slot airfoil for the LE and its single slotted fowler flap configuration for its TE.

Weight	V_c	S_w	α_c	α_{ZL}	C_{lc}	C_{Lc}	$C_{L\alpha}$	C_{L0}	C_L	Total Lift
15,300 lb.	$422\,\frac{\text{ft}}{\text{s}}$	405.7 ft^2	-1.68º	-4.53º	0.30	0.255	0.09 /deg	0.41 /deg	0.297	16,077 lb.

Drag Model

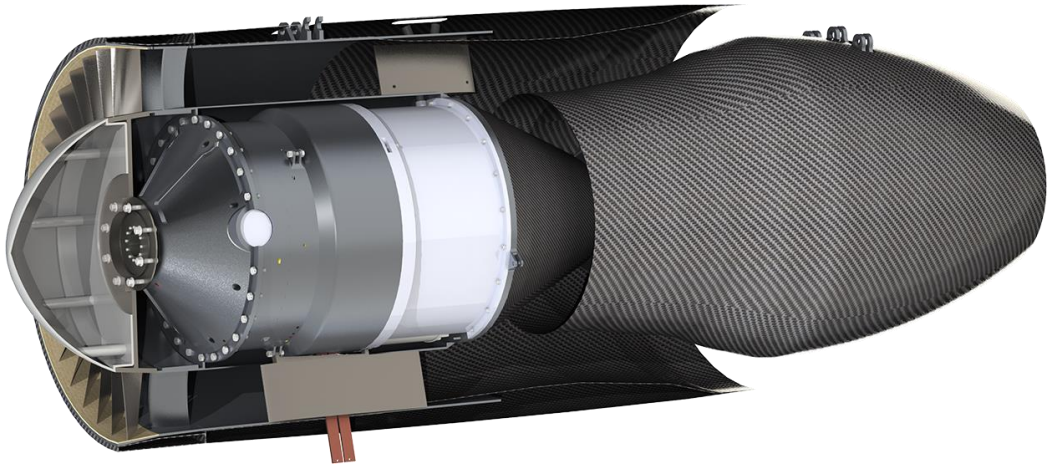
- Based on Gudmundsson's Aircraft Drag Analysis
- Cruise conditions

	S_{ref} (ft^2)	S_{wet} (ft^2)	C_f	C_{Df}	C_{Dmin}	C_{Di}	C_D	Drag (lb)
Wing	405.7	868.2	1.92E-03	4.11E-03	7.33E-03	4.23E-03	3.47E-02	**1875.5**
Tail	352.9	727.1	1.88E-03	3.87E-03	6.25E-03			
Fuselage	40.72	588.1	1.12E-03	1.62E-02	6.78E-03			

Propulsion

- **VerdeGo Aero VH-5**
  - Hybrid-electric turbofan
  - Can generate power in series and/or parallel
  - Generates forward thrust and electrical power during cruise
  - Entry Service Date: 2031
- **Electric Puller-Props**
  - Driven by two MAGIDRIVE 500 kW motors
  - Powered by the Amprius High Power Battery
  - Two 105" Diameter McCauley 4-Bladed Propellors
  - Will be able to be feathered if not in use (e=0.8)
  - Utilizing larger props as they have a higher efficiency than smaller props

Will Generate a Combined Thrust of around 5600lbs at SSL



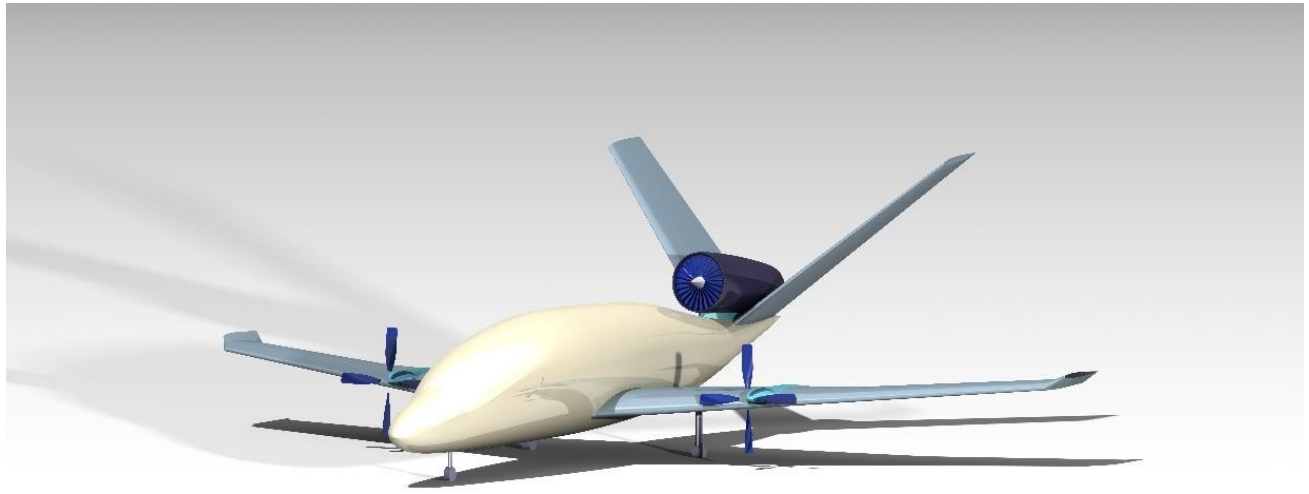
Performance

- Targeted Final Goals vs current calculations.

	Current Calculation	Targeted Goal
T/W	0.37	0.3-0.4
L/D	8.6	10-12
MTOW	15,300 lb	15,000 lb
Combined Max thrust at cruise	3,663 lbf	4,000 lbf
Ground Roll	3,100 ft	3,000 ft
Thrust Required at cruise	1,407 lbs	1,000 lbs

Aircraft Model

- Finalized seating and sizing
- CATIA model and drawings in progress



Parameter	Value	Units
Wing Span	58	ft^2
Wing Area	405.7	ft^2
Fuselage Length	52	ft
Fuselage Max Width	8.16	ft
Projected HT Span	21	ft
V-Tail Area (Actual)	353	ft^2

Initial VSP Stability

Description	Variable	Value	units
Neutral Point	X_{neu}	29.573	ft
Static Margin	SM	.2415	-
Steady-State Roll Rate	$p_{s.s.}$	11.57	deg/s
Max Lift Coefficient	$C_{L,max}$	1.8	-
Stall Speed	V_S	79.4	kts
Trim AoA	α_{trim}	1.5	deg
Ruddervator Deflection	δ_v	4.405	deg
“Elevator” Deflection	δ_e	3.115	deg

Initial VSP Stability

Mode	Natural Frequency (w_n)	Damping Ratio (ζ)
Short Period	8.6e-5	1.4e5
Phugoid	0.26	0.0133
Dutch Roll	.000197	425.8
Spiral Stability	Spirally Stable	

Cost Analysis continued

Certification Cost: $146,000,000 for 500 AC

Development Cost: $9,918,000 For 500 AC

Manufacture/ Production Cost: $304,590,000 for 500 AC

$610,000 per AC

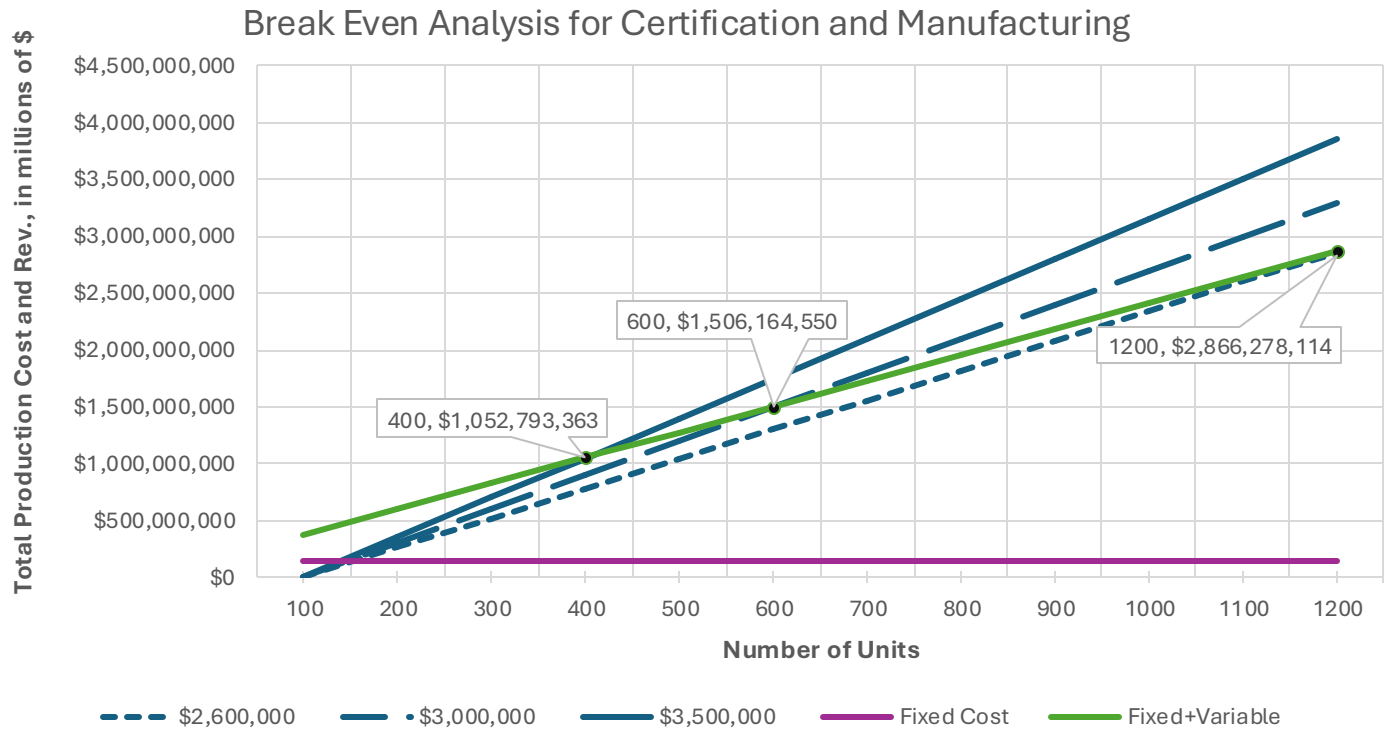
Break Even Point: 427 units.

Total Fixed Cost: $146,051,000

Unit Variable Cost: $2,267,000

Operational: $545,000 per year

$990 per flight hour



Cost Analysis continued

Targeting regional airlines & charter markets.

Maintenance cost advantages over legacy aircraft.

Cost analysis – Train vs Air

- Planes offer significantly faster long-distance travel (e.g., Paris to Rome in 2 hours vs. 11+ hours by train)
- Allows more time at the destination – maximize vacation or work time
- Aircraft can provide a premium cabin experience with better seating, service, and amenities
- In-flight entertainment, Wi-Fi, and refreshments
- Business-class or upgraded seating = better comfort than most train options
- American tourists who prefer air travel over trains

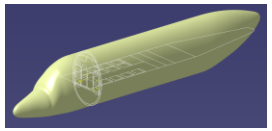
Understanding Marketing Expenses

Company	SG&A	Revenue	Selling & Marketing Expenses	% of SG&A	% of Revenue
Bombardier Inc	$478	$8,665			
Cirrus Aircarft	$117	$475	$57	49%	12%
Embraer	$508.6	$6,396.0	$309.7	61%	5%

Marketing Budget

Budgeting (in millions)		
Branding	10.0%	$1.80
Digital Campaign	25.0%	$4.50
Traditional Advertisement	12.5%	$2.25
Events & Trade Shows	20.0%	$3.60
Customer Engagement	15.0%	$2.70
Partnerships	17.0%	$3.06
Miscellaneous	0.5%	$0.09
	100.0%	$18

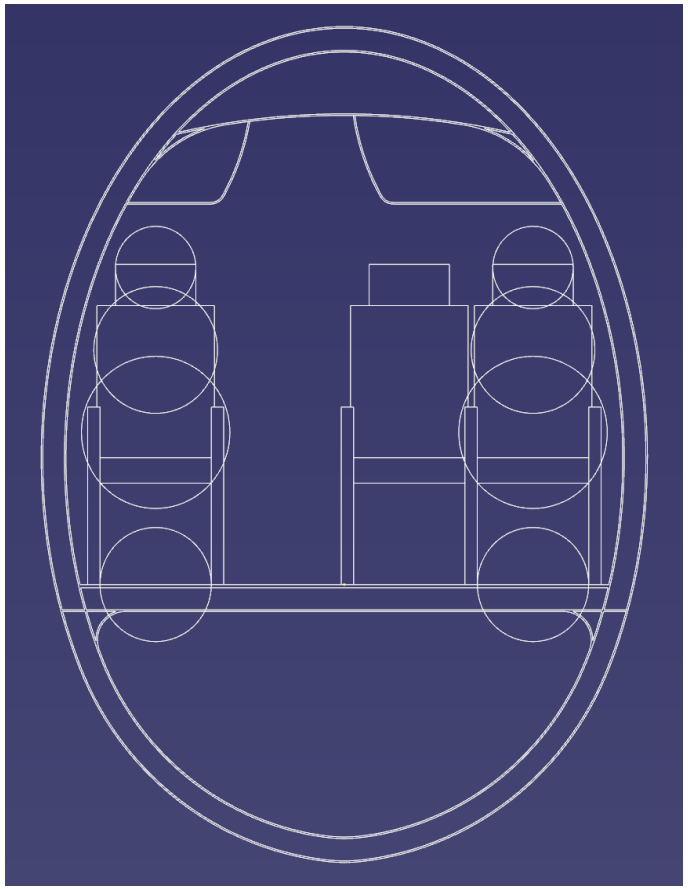
CATIA Layout

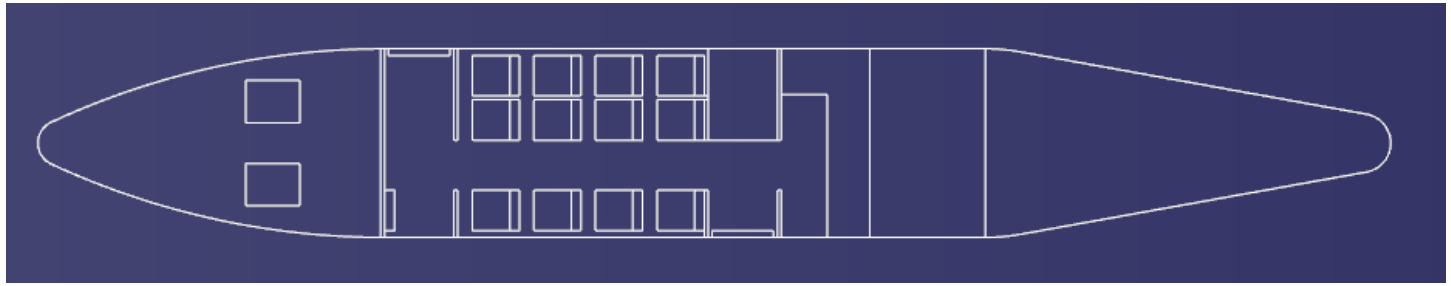


Cabin Height – 74"

Cabin Width – 90.5"

- Lavatory + Galley in Rear
- Cargo Area





- 2 Pilots
- Jump Seat for Crew
- 12 PAX

Seat Width – 19"

Seat Pitch – 32"

Aisle Width – 19"

Seating in Economy style

- Seat models
  - Geven Essenza
  - Recaro SL3710
  - Haeco Vector Light
- Lightweight seats
- Features
  - 27-29" pitch
  - Anti corrosion material
  - Entertainment capabilities

Seating in Business

- Seat models
  - Geven Comoda
  - Collins Air Rest Recliner
  - Haeco Eclipse
- Features
  - 60 inch recline
  - Lightweight
  - In seat tray table
- Option for club seating

Divan

- Built in bench style seating
- Equipped with latest safety features
- Can unfold into beds on certain models
- Provide storage capabilities

Development Plan

- Next Steps:
  - Refine
    - Stability and Control
    - Performance
    - Aerodynamics
    - Costs
  - Finalize Parameters
  - Simulations