Friday 26 Jan. 2024

- Team Structures
- Minion Report
- Update on Report Section 1
  - Past Winning Reports for Reference
  - ConOps, Mission Spec. & Profile
  - Historical Sections
  - Market Assessment
  - Figures, Grading & Design Gems
- Report Section 2

AE 522 Spring 2024

Week		Monday	Tuesday	Wed.	Thursday	Friday
1	January	15-Jan	16-Jan	17-Jan	18-Jan	19-Jan
				1st Day of Classes		AE522/722 Class 2
				AE522/722 Class 1		
				AE 722: 9 - 10am		AE 722: 9 - 10am
				AE 522: 1 - 2pm		AE 522 1 - 3pm
2		22-Jan	23-Jan	24-Jan	25-Jan	26-Jan
		AE522/722 Class 3		AE522/722 Class 4		AE522/722 Class 5
		Last day to make changes	1st DayPaper			
		Report 1 Due				
3	February	29-Jan	30-Jan	31-Jan	1-Feb	2-Feb
		AE522/722 Class 6		AE522/722 Class 7		AE522/722 Class 8
		Report 2 Due		VFS Letter of Intent Due		AIAA Letter of Intent Due to HQ & TC
4		5-Feb	6-Feb	7-Feb	8-Feb	9-Feb
		AE522/722 Class 9		AE522/722 Class 10		AE522/722 Class 11
		Report 3 Due				
		Last day to drop without W				
5		12-Feb	13-Feb	14-Feb	15-Feb	16-Feb
		AE522/722 Class 12		AE522/722 Class 13		AE522/722 Class 14
		Report 4 Due				
6		19-Feb	20-Feb	21-Feb	22-Feb	23-Feb
		AE522/722 Class 15		AE522/722 Class 16		AE522/722 Class 17
		Report 5 Due				Last day for VFS Q's
7	March	26-Feb	27-Feb	28-Feb	29-Feb	1-Mar
		AE522/722 Class 18		AE522/722 Class 19		AE522/722 Class 20
		Report 6 Due	App. for Grad.			PDR
8		4-Mar	5-Mar	6-Mar	7-Mar	8-Mar
		AE522/722 Class 21		AE522/722 Class 22		AE522/722 Class 23
		Report 7 Due				
9		11-Mar	12-Mar	13-Mar	14-Mar	15-Mar
		Spring Trip(s)				

Class of ‘88 Scholarships Available

AIAA UGTeam Heavy Lift Stratoforce	AIAA Grad. Aircraft Electric Sailplane ($8k scholarship for 1 team, AE 722)	AIAA Grad. Missile Rapid Reaction Satellite Launcher ($4k scholarship for 1 team, AE 722)	AIAA UG Individual Stratospheric P/L ($2500 total scholarship funds for up to 5, AE 522)	AIAA DBF AE 592	Military Coleopters	Other
Liliana	Cole	Jeb	Maggie	Peter	Payton	Reanne
Cherry	Ben	Minh	Carson	Rhett	Jennifer	Josh
Gracyn	Tim			Ben		McCoy
Lucy	Josh					Jack
Camden	Reanne					
Sam						

AE 522/722 Weekly Schedule

		Monday	Tuesday	Wednesday	Thursday	Friday
9:00 AM	- 10:00 AM					Bo 9 – 9:30 Shanya 9:30 – 10:00
10:00 AM	- 11:00 AM	Payton & Jennifer Coleopter	Cam9-9:30	Payton & Jennifer Coleopter	Cam9-9:30	
11:00 AM	- 12:00 PM	Swarm Drones	Maggie 11:30 – 12:00	Swarm Drones		Maggie 11:30 – 12:00
12:00 PM	- 1:00 PM	Olivia in Lab Coleopter Build DBF?	Olivia in Lab	Olivia in Lab Coleopter Build	Olivia in Lab	Olivia in Lab Coleopter Build
1:00 PM	- 2:00 PM	Olivia in Lab Cole Glider	Olivia in Lab Stratoforce	Olivia in Lab Cole Glider	Olivia in Lab Stratoforce	General G400
2:00 PM	- 3:00 PM	Reanne	Jeb Missile	Reanne	Jeb Missile	General G400
3:30 PM	- 5:00 PM	Faculty Meeting				
5:30 PM	- 6:00 PM					

Minion Update

Report 1 Update

Chapter 1 Introduction, General Concept of Operations, Mission Specification and Profile

Students must make at least one high quality Concept of Operations including the overall scheme for each aircraft type/class. This will be followed by Mission Specification and Profiles. Cutting and pasting properly done work from AE 521 in the Fall is fine so long as the original author is referenced (so it's not plagiarism). There should be a nice Mission Specification in a neat table (preferably) or bulletized form. The Mission Profile should be done in CAD as was the case for AE 521. A short discussion of the drivers, direct and implied goals is always good. Note that conditions in the Fall were quite lax. Because this will be a competition document which will go to the world's finest missile designers, the standards will be incrementally higher.

Examine all of the details of the Mission Specification and Profile put forth by the AIAA.

References (always at end of report)

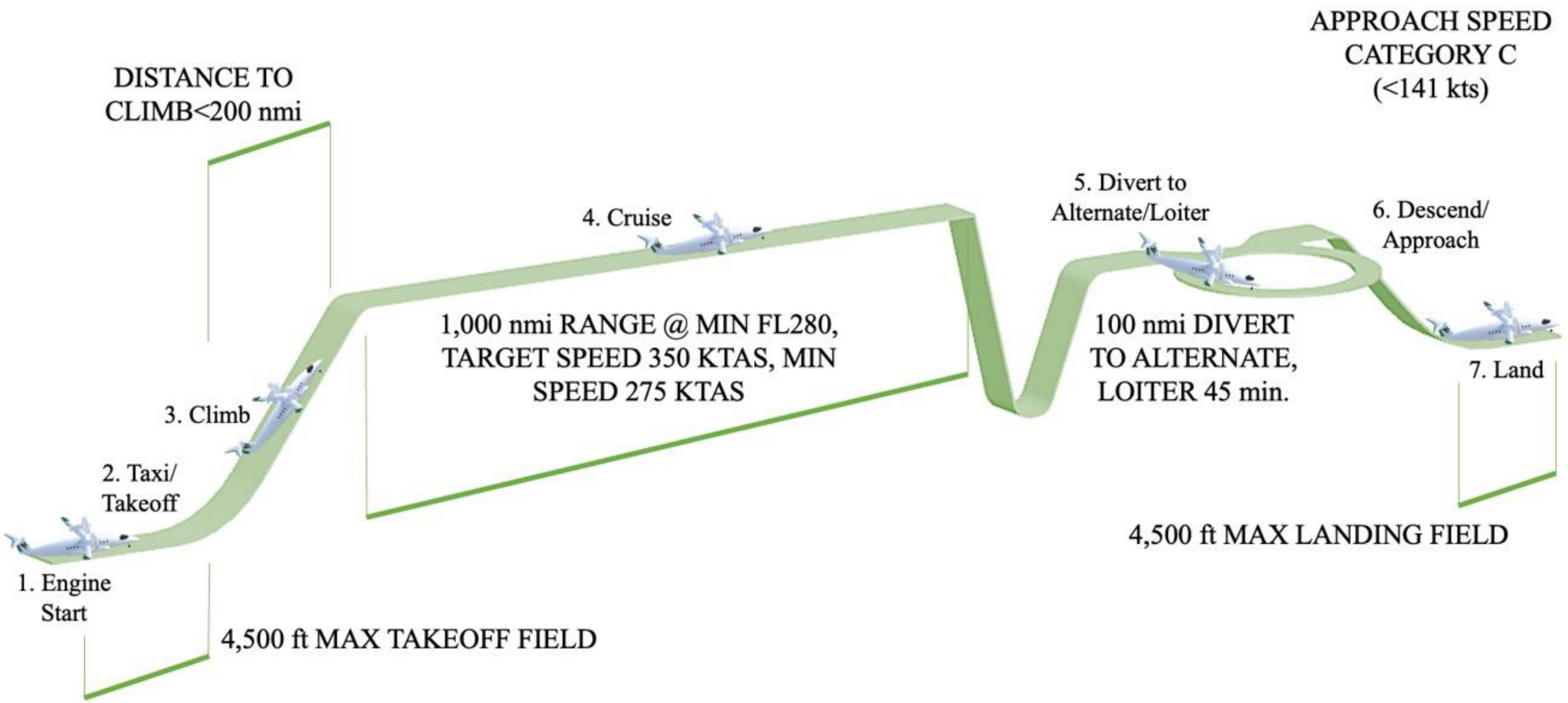
Appendix A:

- List Team Members' actions, roles on the team and contributions
- Recruitment of Minions

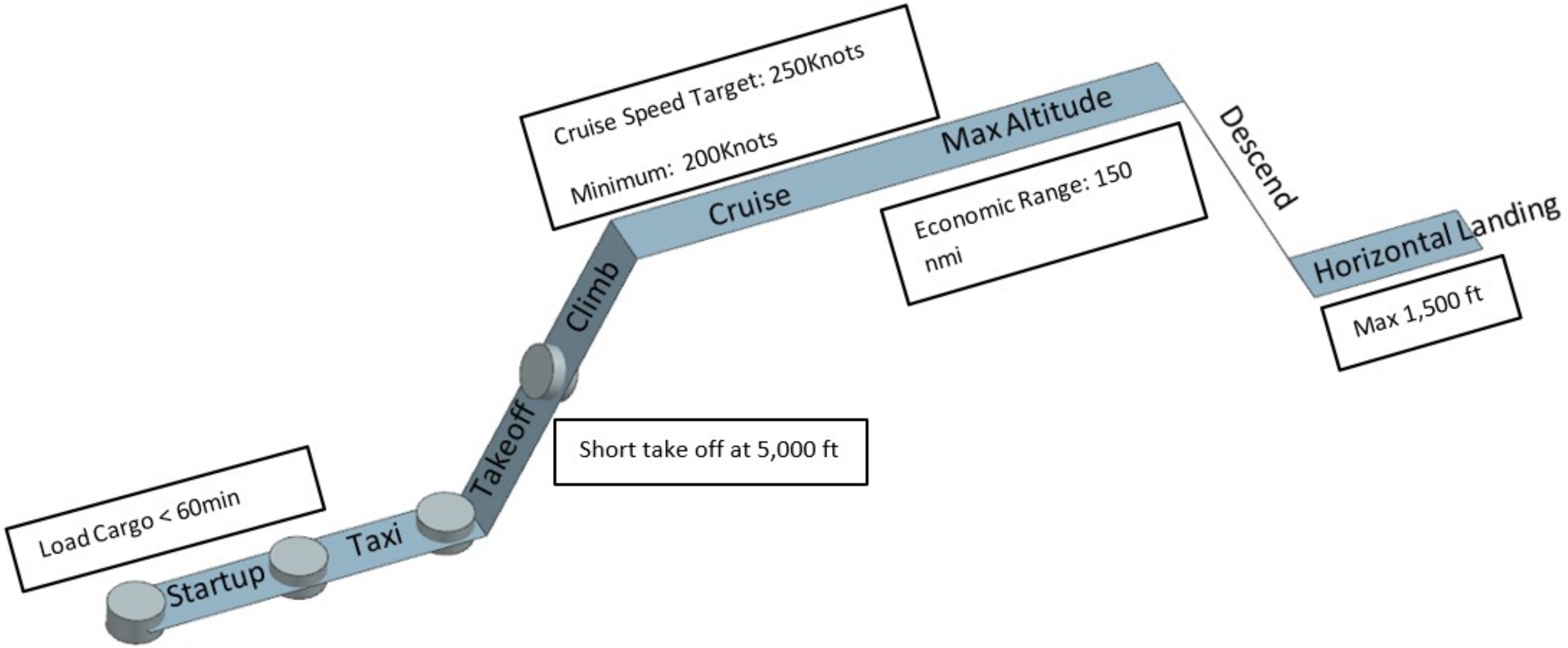
List efforts to enlist freshmen, sophomores, juniors, seniors and Grad. Students to help with the report. Remember that every hour spent on the project by a minion is one less hour you have to spend.

- All Students choosing to compete in the AIAA Design Competitions must get AIAA Membership by 30 January 2024.
- Decide on Team Leadership
    - -Team Leader
    - -Deputy Team Leader
    - -Report Boss
    - -CAD Boss

Report 1 Update



Report 1 Update



Report 1 Update

Chapter 2 Historical Review, Competition in the Market

UG Team Stratoforce	UG Individual Stratospheric P/L	Special Project Coleopters	Special Project Counterdrone Swarm
2.1 Historical Review Summarize all heavy lifters that are relevant to the spec. Include especially all jet-powered strategic lifters from around the world from 1960, forward, American, European, Soviet/Ukrainian. Give a short paragraph about each, a picture with background stripped and top-level information on geometry, costs, fleet sizes and performance. **2.2 Relevant Aircraft Markets and Missions** Describe the market for strategic airlifters. Feel free to lift verbiage from the AIAA RFP (with appropriate reference, of course) Look up articles in Av. Week and other trade publications to describe market	**2.1 Historical Review** Summarize programs and the atmospheric chemistry and physics that are related to the spec. Of course this will be difficult as the spec. itself is weird, but do your best. Describe the aircraft that are used for this role. Give a short paragraph about each, a picture with background stripped and top-level information on geometry, costs, fleet sizes and performance. Check out sources like: https://www.fargojet.com/cloud-seeding/ https://en.wikipedia.org/wiki/Cloud_seeding https://www.wsj.com/story/cloud-seeding-takes-flight-in-western-us-76737400 **2.2 Relevant Aircraft Markets and Missions** Describe the possible market (which will, of course, be limited). Feel free to lift verbiage from the AIAA RFP (with appropriate reference, of course) Look up articles in Av. Week and other trade publications to describe market	**2.1 Review of Present Coleopter Designs** Get the dimensions of all of the tools, parts and shipping containers that currently reside in the lab, 1182 Learned Hall. CAD up all of the existing tools, parts and shipping containers. Present .jpg figures of all the existing components in front, top & side views. **2.2 Powerplant and Rotor Sizing** Given the various components, size the powerplants and rotors for each of the designs, scaling them from the XQ-138. Report the powerplants and rotors and include URLs for each component in this section.	**2.1 Review of Present Counterdrone and Countermissile Systems** Research and summarize each counterdrone and countermissile system that can be found. Concentrate especially on physical systems and counterdrone/countermissile aircraft. Include fixed- and rotary-wing solutions, missiles and gunnery. Get pictures of each system and include a short write up on each system with a properly referenced figure of the system. **2.2 Relevant Aircraft Markets and Missions** Describe the possible market(s) for such systems including Ukraine, the Middle East, Taiwan and elsewhere. Discuss geopolitical implications and potential funding. Estimate market size for such systems and work to quote politicians and decision-makers on the need for such systems.

Report 1 Update

Chapter 2 Historical Review, Competition in the Market

Graduate Team Archytas	Graduate Team Missile Design
2.1 Historical Review Summarize historical dual-seat powered gliders that are relevant to the spec. Include especially the DG-Flugzeugbau DG-1000 family of aircraft **2.2 Relevant Aircraft Markets and Missions** Describe the market for training gliders. Feel free to lift verbiage from the AIAA RFP (with appropriate reference, of course) Look up articles in Av. Week and other trade publications to describe market	**2.1 Historical Review** Summarize historical rapid reaction satellite launch systems and missiles. **2.2 Relevant Aircraft Markets and Missions** Describe the military need for such a system. Copy parts of the RFP as appropriate, with proper reference, of course.

Chapter 3 Design Philosophy & Configuration Constraint Establishment

By examining the Mission Specification and associated specified requirements, develop a "Motto" and "Design Philosophy." The motto should only be a few words (5 or less typically), describing the aircraft, team and/or project. Tell the reader in (preferably) one sentence the overall direction that your design will take. Use this philosophy to guide coming decisions in addition to all of the aforementioned.

By using the listed Requirements and Objectives and Design Optimization Function, layout any and all configuration constraints. Use either a generic CAD of a hypothetical aircraft or superimpose the constraints on a representative aircraft of the class under consideration.

Chapter 4 Objectives, Requirements and Design Optimization Function

As was described in AE 521, list the Requirements, Objectives, Ancillary Objectives and generate an Optimization Function. Include especially guidance that will help with configuration layout and "special" operational considerations and/or supporting systems. List as many flowdown requirements and objectives to the lowest Tiers possible.

Chapter 2 Historical Data -- Discussions

KU THE UNIVERSITY OF KANSAS

2 Historical Review and Market Concept of Operations Comparison

The current regional jet market is based upon aircraft designs with origins in the late 1980s and early 1990s. The industry forecasts that in the next 20 years nearly 2,000 new regional aircraft will be needed to meet the demand of regional travel while the current aircraft in the market begin to age out of service. 50-seat capacity regional jets such as those designed and manufactured in the 1980s were no longer marketable, as the industry moved towards optimizing passenger capacity to decrease the number of flights. However, the U.S. domestic airline "scope clause" opens the opportunity for more economically sound 50-seat aircraft to become more prevalent in the industry. 50-seat and 76-seat regional jets are climbing in popularity for customers with commuter jumps and shorter-range flights; this helps save money by filling aircraft rather than having empty seats on a larger jet. A historical review of regional jets is discussed to provide a reference for the trends and developments through time. A comparison of current regional jet market leaders is also shown with general characteristics to orient the reader.

2.1 50-Seat Regional Jet Historical Review

With its first flight in 1949, the British manufactured De Havilland DH106 Comet was the world's first commercial jet airliner to enter service [2]. Twenty thousand pounds of thrust along with other technological and performance advancements allowed for the Comet to lead the commercial transport market post World War II. After two deadly crashes, investigation found a structural design flaw. This structural failure resulted from repeated pressurization which caused the fuselage to abruptly split [3]. After this investigation, the Comet or any of its successors would never carry another passenger again, leaving the market open to other developments in the United States.

Figure 2-1: De Havilland Comet 1 [2]

Development of the ERJ145 began in 1995 with certification and entry into service in 1996. With over 20 years of operation and servicing 36 airlines in 26 countries, this aircraft has logged over 26 million flight hours [4]. In total, over 1,200 aircraft based off the ERJ145 platform

Figure 2-2: Embraer ERJ145 [5]

KU THE UNIVERSITY OF KANSAS

have been delivered worldwide. This has established the ERJ program to be one of the most successful in the aircraft industry [4].

In the year 1991, the first of three CRJ100 prototypes, designed and manufactured by Bombardier Aerospace, conducted its maiden flight with entry into service the following year of 1992 with Lufthansa [6]. The CRJ200 variant was later established and retained all the features of the CRJ100 but used improved GE engines which resulted in a slightly increased range. In 2006, Bombardier Aerospace concluded producing the CRJ100 and its variant CRJ200, however most CRJ100s and 200s remain in service to date. This has established the CRJ series as a market leader over the past 20 plus years acting as a competitor to Embraer and the ERJ145.

Figure 2-3: Bombardier CRJ100 [7]

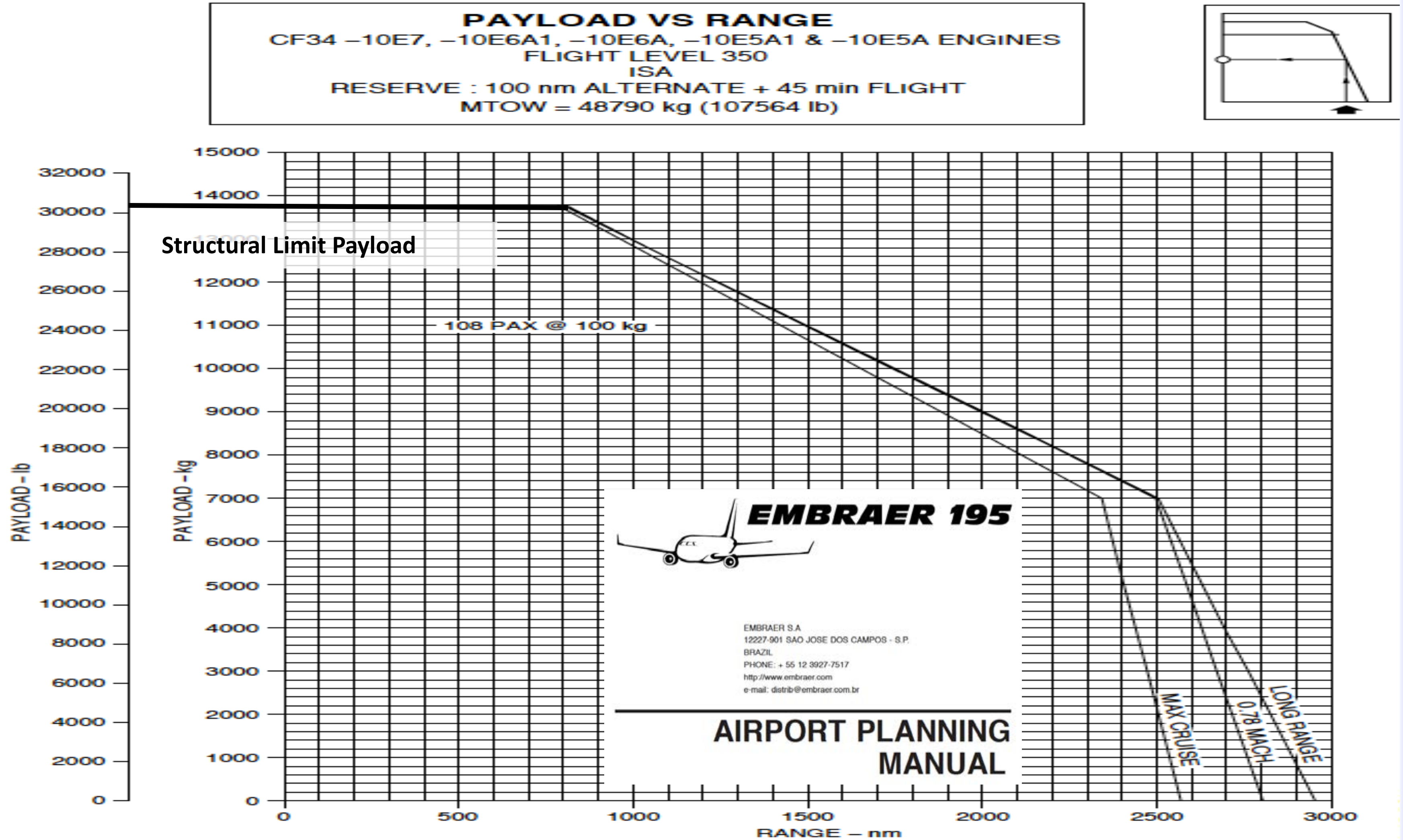
The CRJ550 is Bombardier's newest aircraft type and will be the newest 50-seat regional jet in the market upon its entry into service. In 2019, Bombardier's president described the CRJ550 as "the only solution in North America that can replace the existing fleet of ageing 50-seaters, a market of over 700 aircraft" [8]. This implies that the CRJ 550 will be projected to be a future market leader as other aircraft begin to age out of service. The CRJ550 has also been developed for logistical purposes for United Airlines. Due to labor contracts, United can only fly a finite number of jets that have over 50 seats at once, and the airlines have reached it cap, thus the development of this smaller capacity regional airliner.

Figure 2-4: Bombardiers CRJ550 [8]

The Fairchild Dornier 428Jet had a first flight scheduled for 2001 before it was cancelled. The aircraft was designed for 44 seats but proved inferior in the market to a 50-seat configuration; this caused the cancellation due to lower profits for less seats but similar operating costs. It was originally designed to compete against the Bombardier CRJ and Embraer E-Jet family.

Figure 2-5: Fairchild Dornier 428JET [9]

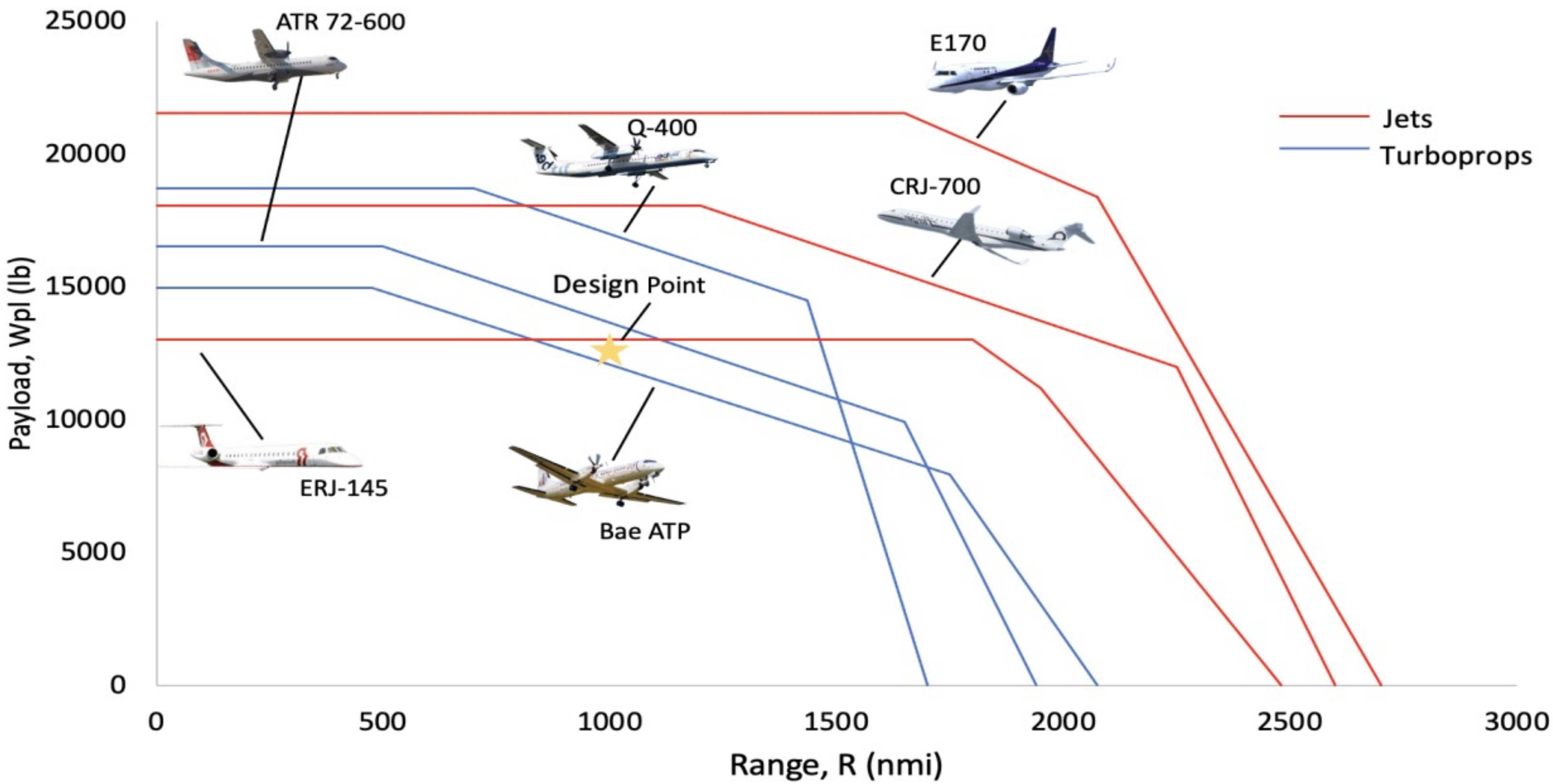
Chapter 2 Historical Data



NOTES:
MAX TAKEOFF WEIGHT - - - - - - 48790 kg (107564 lb)
MAX ZERO FUEL WEIGHT - - - - - - 42500 kg (93696 lb)
BASIC OPERATING WEIGHT - - - - - - 28700 kg (63273 lb)
MAX USABLE FUEL - - - - - - 13100 kg (28880 lb)

Chapter 2 Historical Data (Meadowlark)

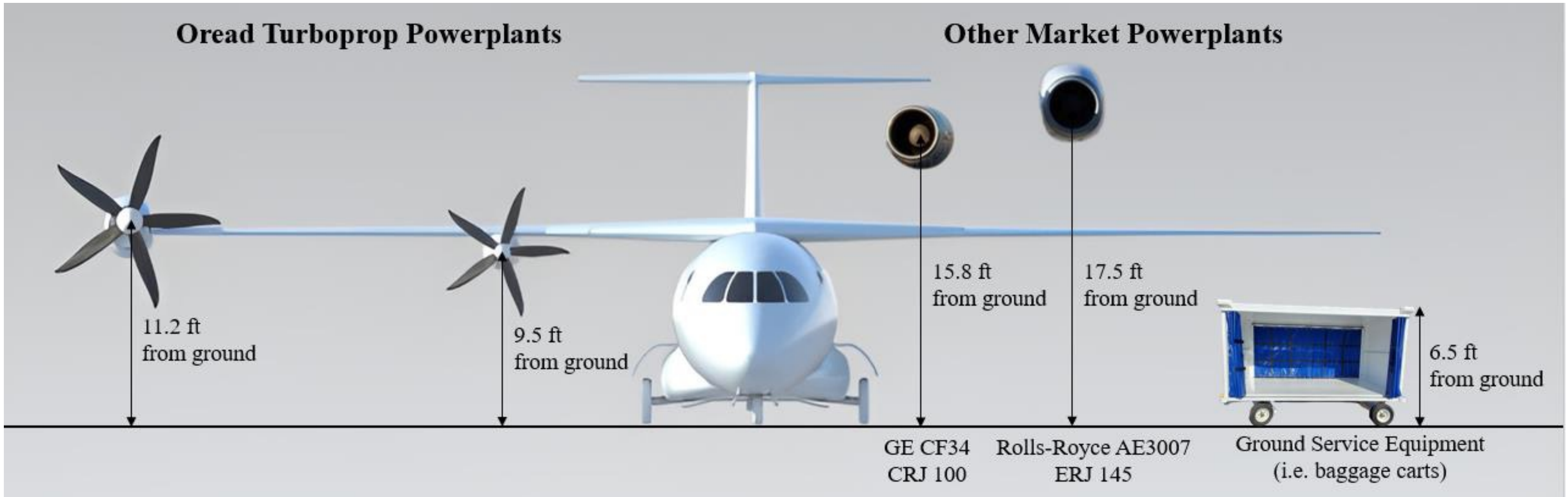
Payload-Range Diagram Overlay



Chapter 3 Motto (Abbreviated Operating Statement) and Design Philosophy

CHAPTER 3 DESIGN PHILOSOPHY & CONFIGURATION CONSTRAINT ESTABLISHMENT
By examining the Mission Specification and associated specified requirements, develop a "Motto" and "Design Philosophy." The motto should only be a few words (5 or less typically), describing the aircraft, team and/or project. Tell the reader in (preferably) one sentence the overall direction that your design will take. Use this philosophy to guide coming decisions in addition to all of the aforementioned.

By using the listed Requirements and Objectives and Design Optimization Function, layout any and all configuration constraints. Use either a generic CAD of a hypothetical aircraft or superimpose the constraints on a representative aircraft of the class under consideration.



Chapter 3 Motto (Abbreviated Operating Statement) and Design Philosophy

Civil Corporations

Abbreviated Operating Statements

- Just a few words
- Describes overall corporate direction

Example:

FAA: "Safety is our passion"

Chapter 3 Motto (Abbreviated Operating Statement) and Design Philosophy

Military

Abbreviated Operating Statements

- Just a few words
- Describes overall corporate direction

Example -- Army:

AN ARMY OF ONE
U.S. ARMY

U.S. ARMY®
ARMY STRONG.℠

ARMY.
BE ALL YOU CAN BE.

Chapter 3 Motto (Abbreviated Operating Statement) and Design Philosophy

- Just a few words
- Describes overall corporate direction

Example -- Navy:

Chapter 3 Motto (Abbreviated Operating Statement) and Design Philosophy

- **Just a few words**
- **Describes overall corporate direction**

Example -- USAF:

AIM HIGH AIR FORCE

Chapter 3 Motto (Abbreviated Operating Statement) and Design Philosophy

- Just a few words
- Describes overall corporate direction

Example:

Pratt and Whitney: "Reliable Engines"

GO BEYOND | PRODUCTS & SERVICES | NEWSROOM | COMPANY | CAREERS | SUPPORT | CUSTOMER LOGIN

Pratt & Whitney GTF™ Engines Achieve World-class Reliability

EAST HARTFORD, Conn., December 18, 2020 - Pratt & Whitney, a division of Raytheon Technologies Corp. (NYSE: RTX), today announced that GTF engines powering the A320neo family have achieved a world-class engine dispatch reliability rate of 99.98%. The GTF engine powers more than 900 aircraft across nearly 50 airlines and three aircraft families: Airbus A320neo, Airbus A220 and Embraer E-Jets E2. GTF engines have saved more than 400 million gallons of fuel and over 3.8 million metric tonnes of carbon emissions since they entered service in 2016.

"Thanks to upgrades completed in close coordination with our customers in 2020, GTF engines for the A320neo family are now delivering industry-leading reliability," said Carroll Lane, president of Commercial Engines at Pratt & Whitney. "When you combine this with our best-in-class fuel efficiency and low carbon emissions, it's easy to see why GTF-powered fleets have seen high utilization as the industry begins to recover."

Chapter 3 Motto (Abbreviated Operating Statement) and Design Philosophy

- Just a few words
- Describes overall corporate direction

Example:

Airbus: "We make it fly"

Chapter 3 Motto (Abbreviated Operating Statement) and Design Philosophy

- Just a few words
- Describes overall corporate direction

Example:

Boeing: "Build something better"

Chapter 3 Design Philosophy

Meadowlark
the clean, green, flying machine

A highly efficient, highly profitable, hybrid-electric aircraft giving customers a jet experience without the emissions.

Zane Black
1340030

Olivia Caudillo
1422281

Matthew Donnelly
1230108

Olivia Hughes
1422975

KU
THE UNIVERSITY OF KANSAS

Chapter 3 Design Philosophy

Meadowlark
the clean, green, flying machine

A highly efficient, highly profitable, hybrid-electric aircraft giving customers a jet experience without the emissions.

Zane Black
1340030

Olivia Caudillo
1422281

Matthew Donnelly
1230108

Olivia Hughes
1422975

KU
THE UNIVERSITY OF KANSAS

Chapter 3 Design Philosophy

Oread Hybrid-Electric Turboprop

Jet Performance, No Emissions.

Brayden Niessen
AIAA: 1421906

Cole Harreld
AIAA: 1339981

Max Harreld
AIAA: 1400565

Megan Carlson
AIAA: 1230071

Advisor: Dr. Ronald Barrett-Gonzalez, AIAA: 022393

University of Kansas Department of Aerospace Engineering, Lawrence, KS

Team Oread

Date of Submission: May 12 2023

Designing regional commuters that give passengers the best ride, shareholders the best bottom line, and the world no emissions.

Chapter 4 Objectives, Requirements and Design Optimization Function

Use survey information, experience & market data to generate an Optimization Function.

Concept 1: Requirements, R_i (i = 1…n)

A performance or physical characteristic below which and/or above which, the design will be considered nonviable.

Concept 2: Objectives, O_j (j = 1… m)

A performance or physical characteristic that is desirable to attain.

Chapter 4 Objectives, Requirements and Design Optimization Function

Use survey information, experience & market data to generate Optimization Function.

Concept 1: Requirement

A performance or physical characteristic below which and/or above which, the design will be considered nonviable.

Typical values: $R_1 = 0/1$, $R_2 = 0/1$, $R_3 = 0.5/1$

Example: Required Ferry Range: 1800nmi

Chapter 4 Objectives, Requirements and Design Optimization Function

Use survey information, experience & market data to generate Optimization Function.

Concept 1: Requirement

A performance or physical characteristic below which and/or above which, the design will be considered nonviable.

Typical values: $R_1 = 0/1$, $R_2 = 0/1$, $R_3 = 0/1$

Example: Required Ferry Range: 1800nmi

Concept 2: Objective

A performance or physical characteristic that is desirable to attain, typically within given bounds.

Typical values: $O_1 = 50$kts, $O_2 = 0.10$, $O_3 = 1500$ft

Example: Objective Ferry Range: 2100nmi

Chapter 4 Objectives, Requirements and Design Optimization Function

Concept 3: Multiplicative Weighting

Typically done to provide a "switch" to null designs that can't meet threshold values

$$OF = R_1 R_2 R_3 R_4 R_5$$

Concept 4 Additive Weighting

Typically done to assess objectives relative to each other

$$OF = O_1 + 3O_2 + 2O_3 + 10O_4 + 2O_5$$

Concept 5 Exponentially Additive Weighting

Typically done to assess objectives relative to each other and more strongly weight high or low performance.

$$OF = 2O_1^2 + 5O_2^{-1} + O_3^1 - 3O_4^2$$

Chapter 4 Objectives, Requirements and Design Optimization Function

Combined Objective Functions:

Example

$$R_1 = \begin{cases} 1 \;\; if\, V_{cr} \geq 250kts \\ 0 \;\; if\, V_{cr} < 250kts \end{cases}$$

$$O_1 = \begin{cases} \dfrac{V_{cr} - 250kts}{100kts} \;\; if\, 250kts < V_{cr} < 350kts \\ 1 \;\; if\, V_{cr} > 350kts \end{cases}$$

Chapter 4 Objectives, Requirements and Design Optimization Function

Combined Objective Functions:

Example

$$R_1 = \begin{cases} 1 \ \ if\ V_{cr} \geq 250kts \\ 0 \ \ if\ V_{cr} < 250kts \end{cases}$$

$$O_1 = \begin{cases} \dfrac{V_{cr} - 250kts}{100kts} \ \ if\ 250kts < V_{cr} < 350kts \\ 1 \ \ if\ V_{cr} > 350kts \end{cases}$$

$$R_2 = \begin{cases} 1 \ \ if\ W_{pl} \geq 1800lbf \\ 0 \ \ if\ W_{pl} < 1800lbf \end{cases}$$

$$O_2 = \begin{cases} \dfrac{W_{pl} - 1800lbf}{1200lbf} \ \ if\ 1800lbf < W_{pl} < 3000lbf \\ 1 \ \ if\ W_{pl} > 3000lbf \end{cases}$$

Chapter 4 Objectives, Requirements and Design Optimization Function

Combined Objective Functions:

Example

$$R_1 = \begin{cases} 1 \;\; if \; V_{cr} \geq 250kts \\ 0 \;\; if \; V_{cr} < 250kts \end{cases}$$

$$O_1 = \begin{cases} \dfrac{V_{cr} - 250kts}{100kts} \;\; if \; 250kts < V_{cr} < 350kts \\ 1 \;\; if \; V_{cr} > 350kts \end{cases}$$

$$R_2 = \begin{cases} 1 \;\; if \; W_{pl} \geq 1800lbf \\ 0 \;\; if \; W_{pl} < 1800lbf \end{cases}$$

$$O_2 = \begin{cases} \dfrac{W_{pl} - 1800lbf}{1200lbf} \;\; if \; 1800lbf < W_{pl} < 3000lbf \\ 1 \;\; if \; W_{pl} > 3000lbf \end{cases}$$

$$R_3 = \begin{cases} 1 \;\; if \; BFL \leq 2500ft \\ 0 \;\; if \; BFL > 2500ft \end{cases}$$

$$O_3 = \begin{cases} \dfrac{1000ft}{BFL - 1500ft} \;\; if \; 1500ft < BFL < 2500ft \\ 1 \;\; if \; BFL < 1500ft \end{cases}$$

Chapter 4 Objectives, Requirements and Design Optimization Function

Combined Objective Functions:

Example

$$R_1 = \begin{cases} 1 \ \ if\ V_{cr} \geq 250kts \\ 0 \ \ if\ V_{cr} < 250kts \end{cases}$$

$$O_1 = \begin{cases} \dfrac{V_{cr} - 250kts}{100kts} \ \ if\ 250kts < V_{cr} < 350kts \\ 1 \ \ if\ V_{cr} > 350kts \end{cases}$$

$$R_2 = \begin{cases} 1 \ \ if\ W_{pl} \geq 1800lbf \\ 0 \ \ if\ W_{pl} < 1800lbf \end{cases}$$

$$O_2 = \begin{cases} \dfrac{W_{pl} - 1800lbf}{1200lbf} \ \ if\ 1800lbf < W_{pl} < 3000lbf \\ 1 \ \ if\ W_{pl} > 3000lbf \end{cases}$$

$$R_3 = \begin{cases} 1 \ \ if\ BFL \leq 2500ft \\ 0 \ \ if\ BFL > 2500ft \end{cases}$$

$$O_3 = \begin{cases} \dfrac{1000ft}{BFL - 1500ft} \ \ if\ \ 1500ft < BFL < 2500ft \\ 1 \ \ if\ BFL < 1500ft \end{cases}$$

Caution! Ill-posed OF!

Chapter 4 Objectives, Requirements and Design Optimization Function

Combined Objective Functions:

Example

$$R_1 = \begin{cases} 1 \;\; if\, V_{cr} \geq 250kts \\ 0 \;\; if\, V_{cr} < 250kts \end{cases}$$

$$O_1 = \begin{cases} \dfrac{V_{cr} - 250kts}{100kts} \;\; if\, 250kts < V_{cr} < 350kts \\ 1 \;\; if\, V_{cr} > 350kts \end{cases}$$

$$R_2 = \begin{cases} 1 \;\; if\, W_{pl} \geq 1800lbf \\ 0 \;\; if\, W_{pl} < 1800lbf \end{cases}$$

$$O_2 = \begin{cases} \dfrac{W_{pl} - 1800lbf}{1200lbf} \;\; if\, 1800lbf < W_{pl} < 3000lbf \\ 1 \;\; if\, W_{pl} > 3000lbf \end{cases}$$

$$R_3 = \begin{cases} 1 \;\; if\, BFL \leq 2500ft \\ 0 \;\; if\, BFL > 2500ft \end{cases}$$

$$O_3 = \begin{cases} \dfrac{1000ft}{BFL - 1500ft} \;\; if\;\; 2000ft < BFL < 2500ft \\ 1 \;\; if\, BFL < 2000ft \end{cases}$$

Better…

Chapter 4 Objectives, Requirements and Design Optimization Function

Combined Objective Functions:

Example

$$R_1 = \begin{cases} 1 \ \ if\ V_{cr} \geq 250kts \\ 0 \ \ if\ V_{cr} < 250kts \end{cases}$$

$$O_1 = \begin{cases} \dfrac{V_{cr} - 250kts}{100kts} \ \ if\ 250kts < V_{cr} < 350kts \\ 1 \ \ if\ V_{cr} > 350kts \end{cases}$$

$$R_2 = \begin{cases} 1 \ \ if\ W_{pl} \geq 1800lbf \\ 0 \ \ if\ W_{pl} < 1800lbf \end{cases}$$

$$O_2 = \begin{cases} \dfrac{W_{pl} - 1800lbf}{1200lbf} \ \ if\ 1800lbf < W_{pl} < 3000lbf \\ 1 \ \ if\ W_{pl} > 3000lbf \end{cases}$$

$$R_3 = \begin{cases} 1 \ \ if\ BFL \leq 2500ft \\ 0 \ \ if\ BFL > 2500ft \end{cases}$$

$$O_3 = \begin{cases} \dfrac{1000ft}{BFL - 1500ft} \ \ if\ \ 2000ft < BFL < 2500ft \\ 1 \ \ if\ BFL < 2000ft \end{cases}$$

$$R_4 = \begin{cases} 1 \ \ if\ Cacq \leq \$8.5M \\ 0 \ \ if Cacq > \$8.5M \end{cases}$$

$$O_4 = \begin{cases} \dfrac{\$7.5M}{\$8.5M - Cacq} \ \ if\ \ \$1M < Cacq < \$8.5M \\ 10 \ \ if\ \$500k < C_{acq} < \$1M \\ 100 \ \ if\ Cacq < \$500k \end{cases}$$

Chapter 4 Objectives, Requirements and Design Optimization Function

Combined Objective Functions:

Example

$$R_1 = \begin{cases} 1 \;\; if\; V_{cr} \geq 250kts \\ 0 \;\; if\; V_{cr} < 250kts \end{cases}$$

$$O_1 = \begin{cases} \dfrac{V_{cr} - 250kts}{100kts} \;\; if\; 250kts < V_{cr} < 350kts \\ 1 \;\; if\; V_{cr} > 350kts \end{cases}$$

$$R_2 = \begin{cases} 1 \;\; if\; W_{pl} \geq 1800lbf \\ 0 \;\; if\; W_{pl} < 1800lbf \end{cases}$$

$$O_2 = \begin{cases} \dfrac{W_{pl} - 1800lbf}{1200lbf} \;\; if\; 1800lbf < W_{pl} < 3000lbf \\ 1 \;\; if\; W_{pl} > 3000lbf \end{cases}$$

$$R_3 = \begin{cases} 1 \;\; if\; BFL \leq 2500ft \\ 0 \;\; if\; BFL > 2500ft \end{cases}$$

$$O_3 = \begin{cases} \dfrac{1000ft}{BFL - 1500ft} \;\; if\; 2000ft < BFL < 2500ft \\ 1 \;\; if\; BFL < 2000ft \end{cases}$$

$$R_4 = \begin{cases} 1 \;\; if\; Cacq \leq \$8.5M \\ 0 \;\; if Cacq > \$8.5M \end{cases}$$

$$O_4 = \begin{cases} \dfrac{\$7.5M}{\$8.5M - Cacq} \;\; if\; \$1M < Cacq < \$8.5M \\ 10 \;\; if\; \$500k < C_{acq} < \$1M \\ 100 \;\; if\; Cacq < \$500k \end{cases}$$

$$R_5 = \begin{cases} 1 \;\; if\; Pk \geq 90\% \\ 0 \;\; if Pk < 90\% \end{cases}$$

$$O_5 = \begin{cases} \left(\dfrac{P_k - 90\%}{10\%}\right)^2 \;\; if\; 90\% < Pk < 100\% \\ 1 \;\; if Pk = 100\% \end{cases}$$

Chapter 4 Objectives, Requirements and Design Optimization Function

Combined Objective Functions:

Example

$R_1 = \begin{cases} 1 \ if \ V_{cr} > 250kts \\ 0 \ if \ V_{cr} < 250kts \end{cases}$ $R_2 = \begin{cases} 1 \ if \ W_{pl} > 1800lbf \\ 0 \ if \ W_{pl} < 1800lbf \end{cases}$ $R_3 = \begin{cases} 1 \ if \ BFL < 2500ft \\ 0 \ if \ BFL > 2500ft \end{cases}$ $R_4 = \begin{cases} 1 \ if \ Cacq \leq \$8.5M \\ 0 \ if Cacq > \$8.5M \end{cases}$ $R_5 = \begin{cases} 1 \ if \ Pk \geq 90\% \\ 0 \ if Pk < 90\% \end{cases}$

$$O_1 = \begin{cases} \frac{V_{cr} - 250kts}{100kts} \ if \ 250kts < V_{cr} < 350kts \\ 1 \ if \ V_{cr} > 350kts \end{cases}$$

$$O_2 = \begin{cases} \frac{W_{pl} - 1800lbf}{1200lbf} \ if \ 1800lbf < W_{pl} < 3000lbf \\ 1 \ if \ W_{pl} > 3000lbf \end{cases}$$

$$O_3 = \begin{cases} \frac{1000ft}{BFL - 1500ft} \ if \ 2000ft < BFL < 2500ft \\ 1 \ if \ BFL < 2000ft \end{cases}$$

$$O_4 = \begin{cases} \frac{\$7.5M}{\$8.5M - Cacq} \ if \ \$1M < Cacq < \$8.5M \\ 10 \ if \ \$500k < C_{acq} < \$1M \\ 100 \ if \ Cacq < \$500k \end{cases}$$

$$O_5 = \begin{cases} \left(\frac{P_k - 90\%}{10\%}\right)^2 \ if \ 90\% < Pk < 100\% \\ 1 \ if Pk = 100\% \end{cases}$$

Inclusion of overall design drivers like W_{TO} & DOC

$$OF = R_1 R_2 R_3 R_4 R_5 \frac{\left(5O_1^1 + O_2^3 + 2O_3^2 + 2O_4^{-2} + 2O_5^1\right)}{DOC * W_{to}}$$

Chapter 4 Objectives, Requirements and Design Optimization Function

Combined Objective Functions:

Example

$$R_1 = \begin{cases} 1 \text{ if } V_{cr} > 250kts \\ 0 \text{ if } V_{cr} < 250kts \end{cases} \quad R_2 = \begin{cases} 1 \text{ if } W_{pl} > 1800lbf \\ 0 \text{ if } W_{pl} < 1800lbf \end{cases} \quad R_3 = \begin{cases} 1 \text{ if } BFL < 2500ft \\ 0 \text{ if } BFL > 2500ft \end{cases} \quad R_4 = \begin{cases} 1 \text{ if } Cacq \leq \$8.5M \\ 0 \text{ if } Cacq > \$8.5M \end{cases} \quad R_5 = \begin{cases} 1 \text{ if } Pk \geq 90\% \\ 0 \text{ if } Pk < 90\% \end{cases}$$

$$O_1 = \begin{cases} \dfrac{V_{cr} - 250kts}{100kts} \text{ if } 250kts < V_{cr} < 350kts \\ 1 \text{ if } V_{cr} > 350kts \end{cases} \quad O_2 = \begin{cases} \dfrac{W_{pl} - 1800lbf}{1200lbf} \text{ if } 1800lbf < W_{pl} < 3000lbf \\ 1 \text{ if } W_{pl} > 3000lbf \end{cases}$$

$$O_3 = \begin{cases} \dfrac{1000ft}{BFL - 1500ft} \text{ if } 2000ft < BFL < 2500ft \\ 1 \text{ if } BFL < 2000ft \end{cases} \quad O_4 = \begin{cases} \dfrac{\$7.5M}{\$8.5M - Cacq} \text{ if } \$1M < Cacq < \$8.5M \\ 10 \text{ if } \$500k < C_{acq} < \$1M \\ 100 \text{ if } Cacq < \$500k \end{cases}$$

$$O_5 = \begin{cases} \left(\dfrac{P_k - 90\%}{10\%}\right)^2 \text{ if } 90\% < Pk < 100\% \\ 1 \text{ if } Pk = 100\% \end{cases} \quad O_6 = \frac{DOC_{A-10} - DOC}{DOC_{A-10}} \quad O_7 = \frac{W_{TOA-10} - W_{TO}}{W_{TOA-10}}$$

$$OF = R_1 R_2 R_3 R_4 R_5 \left(5O_1 + O_2^3 + 2O_3^2 + 2O_4^{1.5} + 2O_5\right) O_6^1 \sqrt{O_7}$$

Chapter 4 Objectives, Requirements and Design Optimization Function

Combined Objective Functions:

Apply OF to evaluate designs

$$OF = R_1 R_2 R_3 R_4 R_5 \left(5O_1 + O_2^3 + 2O_3^2 + 2O_4^{1.5} + 2O_5\right) O_6^1 \sqrt{O_7}$$

Wing Mounted Engines			
+	Reduced Cabin Noise	–	Engine Maintenance
+	Low CG excursion	–	Engine Placement w/ respect to Engine Non-Containment Event
+	Co-Locate Landing Gear & Engine Pylon Structure		
+	Reduced Risk of Engine FOD		

Figure 6-14: Wing Mounted Engines

Three Surface			
+	Co-Locate Wing Spar & Rear Bulkhead	–	Landing Gear Integration
		–	Not Widely Accepted
+	Low Trim Drag		
+	Passenger Ground View		
+	High L/D		

Figure 6-15: Three Surface

Chapter 4 Objectives, Requirements and Design Optimization Function

Combined Objective Functions:

Apply OF to evaluate designs

$$OF = R_1R_2R_3R_4R_5\left(5O_1 + O_2^3 + 2O_3^2 + 2O_4^{1.5} + 2O_5\right) O_6^1\sqrt{O_7}$$

Wing Mounted Engines			
+	Reduced Cabin Noise	–	Engine Maintenance
+	Low CG excursion	–	Engine Placement w/ respect to Engine Non-Containment Event
+	Co-Locate Landing Gear & Engine Pylon Structure		
+	Reduced Risk of Engine FOD		

Figure 6-14: Wing Mounted Engines

$OF = 3.62$

Three Surface			
+	Co-Locate Wing Spar & Rear Bulkhead	–	Landing Gear Integration
+	Low Trim Drag	–	Not Widely Accepted
+	Passenger Ground View		
+	High L/D		

Figure 6-15: Three Surface

$OF = 2.91$

Chapter 4 Objectives, Requirements and Design Optimization Function

Combined Objective Functions:

Apply OF to evaluate designs

$$OF = R_1 R_2 R_3 R_4 R_5 \left(5O_1 + O_2^3 + 2O_3^2 + 2O_4^{1.5} + 2O_5\right) O_6^1 \sqrt{O_7}$$

Wing Mounted Engines			
+	Reduced Cabin Noise	–	Engine Maintenance
+	Low CG excursion	–	Engine Placement w/ respect to Engine Non-Containment Event
+	Co-Locate Landing Gear & Engine Pylon Structure		
+	Reduced Risk of Engine FOD		

Figure 6-14: Wing Mounted Engines

$OF = 3.62$ ✓

Three Surface			
+	Co-Locate Wing Spar & Rear Bulkhead	–	Landing Gear Integration
+	Low Trim Drag	–	Not Widely Accepted
+	Passenger Ground View		
+	High L/D		

Figure 6-15: Three Surface

$OF = 2.91$

Chapter 4 Objectives, Requirements and Design Optimization Function

Example Ancillary Design Considerations

1. Reduce total fuel burn to most efficient in class
2. Minimize Time on Ground per Turn
3. Under FAA 90 sec. Evacuation requirement
4. Rapid Cabin Sterilization
5. Exceed most stringent EASA noise regulations for RJ's
6. Special accommodations for business travelers
7. Allow pax to have ready access to all luggage without wait
8. Allow for growth of the physical dimensions of the traveling public
9. Operate from austere airports with neither jetways nor air-stairs
10. Allow for rapid powerplant inspection, LRU replacement, drop
11. Enable all normal ground operations with engines running
12. Minimal to no de-icing dispatch delays
13. Powerplants reachable without special equipment
14. Minimize number of engine start cycles per operational day
15. Allow for powerplant diameter growth with time without significant aircraft changes
16. ADA compliant cabin section, ingress and egress from ground w/o special equipment

Chapter 4 Optimization Function Example

11 Requirements Weighting Functions from the Design Characteristics:

R_1: Certification Base: FAR-25
R_2: Entry into Service: EIS 2030 -100, EIS 2031 -200
R_3: Passengers: 30" pitch, 50 pax -100, 76 -200
R_4: Range: 2,000nmi -100, 1,500nmi -200
R_5: Cruise Mach: ≥0.80
R_6: Seat Width: ≥18"
R_7:(Folded) Wingspan: ≤ 24m
R_8: Approach Speed: V_A < 141kts
R_9: Takeoff Field Length: 5kft MSL, ISA+18, 4,000/50ft -100 6,000/50ft -200
R_{10}: Landing Field Length: 5kft MSL, ISA+18, 4,000/50ft -100 6,000/50ft -200
R_{11}: Crew: Pilot, Copilot, 1 F/A -100, 2 F/A's -200

6 Objectives Weighting Functions from the Specified Design Objectives:

O_1: Maximize structural commonality between -100 & -200
O_2: Good aesthetics
O_3: Enhanced Reliability WRT SOTA
O_4: Reduced MRO load WRT SOTA
O_5: Minimize DOC
O_6: Minimize production costs

16 Objectives Weighting Functions from Anciliary Objectives:

AO_1: Reduce total fuel burn to most efficient in class
AO_2: Minimize Time on Ground per Turn
AO_3: Under FAA 90 sec. Evacuation requirement
AO_4: Rapid Cabin Sterilization
AO_5: Exceed most stringent EASA noise regulations for RJ's
AO_6: Special accommodations for business travelers
AO_7: Allow pax to have ready access to all luggage without wait
AO_8: Allow for growth of the physical dimensions of the traveling public
AO_9: Operate from austere airports with neither jetways nor air-stairs
AO_{10}: Allow for rapid powerplant inspection, LRU replacement, drop
AO_{11}: Enable all normal ground operations with engines running
AO_{12}: Minimal to no de-icing dispatch delays
AO_{13}: Powerplants reachable without special equipment
AO_{14}: Minimize number of engine start cycles per operational day
AO_{15}: Allow for powerplant diameter growth with time without significant aircraft changes
AO_{16}: ADA compliant cabin section, ingress and egress from ground without special equipment

Chapter 4 Optimization Function Example

11 Requirements Weighting Functions from the Design Characteristics:

R_1: Certification Base: FAO-25
R_2: Entry into Service: EIS 2030 -100, EIS 2031 -200
R_3: Passengers: 30" pitch, 50 pax -100, 76 -200
R_4: Range: 2,000nmi -100, 1,500nmi -200
R_5: Cruise Mach: ≥0.80
R_6: Seat Width: ≥18"
R_7:(Folded) Wingspan: ≤ 24m
R_8: Approach Speed: V_A < 141kts
R_9: Takeoff Field Length: 5kft MSL, ISA+18, 4,000/50ft -100 6,000/50ft -200
R_{10}: Landing Field Length: 5kft MSL, ISA+18, 4,000/50ft -100 6,000/50ft -200
R_{11}: Crew: Pilot, Copilot, 1 F/A -100, 2 F/A's -200

$$R_i(binary) = \begin{cases} 0 \text{ if criterion not met} \\ 1 \text{ if criterion met} \end{cases}$$

6 Objectives Weighting Functions from the Specified Design Objectives:

O_1: Maximize structural commonality between -100 & -200
O_2: Good aesthetics
O_3: Enhanced Reliability WRT SOTA
O_4: Reduced MRO load WRT SOTA
O_5: Minimize DOC
O_6: Minimize production costs

$$O_j = \begin{cases} 0 \text{ if worst in meeting objective} \\ \text{Linearly varying if neither worst not best} \\ 1 \text{ if best in meeting objective} \end{cases}$$

16 Objectives Weighting Functions from Anciliary Objectives:

AO_1: Reduce total fuel burn to most efficient in class
AO_2: Minimize Time on Ground per Turn
AO_3: Under FAA 90 sec. Evacuation requirement
AO_4: Rapid Cabin Sterilization
AO_5: Exceed most stringent EASA noise regulations for RJ's
AO_6: Special accommodations for business travelers
AO_7: Allow pax to have ready access to all luggage without wait
AO_8: Allow for growth of the physical dimensions of the traveling public
AO_9: Operate from austere airports with neither jetways nor air-stairs
AO_{10}: Allow for rapid powerplant inspection, LRU replacement, drop
AO_{11}: Enable all normal ground operations with engines running
AO_{12}: Minimal to no de-icing dispatch delays
AO_{13}: Powerplants reachable without special equipment
AO_{14}: Minimize number of engine start cycles per operational day
AO_{15}: Allow for powerplant diameter growth with time without significant aircraft changes
AO_{16}: ADA compliant cabin section, ingress and egress from ground without special equipment

$$AO_k = \begin{cases} 0 \text{ if worst in meeting objective} \\ \text{Linearly varying if neither worst not best} \\ 1 \text{ if best in meeting objective} \end{cases}$$

Chapter 4 Optimization Function Example

11 Requirements Weighting Functions from the Design Characteristics:

R_1: Certification Base: FAO-25
R_2: Entry into Service: EIS 2030 -100, EIS 2031 -200
R_3: Passengers: 30" pitch, 50 pax -100, 76 -200
R_4: Range: 2,000nmi -100, 1,500nmi -200
R_5: Cruise Mach: ≥0.80
R_6: Seat Width: ≥18"
R_7:(Folded) Wingspan: ≤ 24m
R_8: Approach Speed: V_A < 141kts
R_9: Takeoff Field Length: 5kft MSL, ISA+18, 4,000/50ft -100 6,000/50ft -200
R_{10}: Landing Field Length: 5kft MSL, ISA+18, 4,000/50ft -100 6,000/50ft -200
R_{11}: Crew: Pilot, Copilot, 1 F/A -100, 2 F/A's -200

$$R_i(binary) = \begin{cases} 0 \text{ if criterion not met} \\ 1 \text{ if criterion met} \end{cases}$$

6 Objectives Weighting Functions from the Specified Design Objectives:

O_1: Maximize structural commonality between -100 & -200
O_2: Good aesthetics
O_3: Enhanced Reliability WRT SOTA
O_4: Reduced MRO load WRT SOTA
O_5: Minimize DOC
O_6: Minimize production costs

$$O_j = \begin{cases} 0 \text{ if worst in meeting objective} \\ \text{Linearly varying if between} \\ 1 \text{ if best in meeting objective} \end{cases}$$

16 Objectives Weighting Functions from Anciliary Objectives:

AO_1: Reduce total fuel burn to most efficient in class
AO_2: Minimize Time on Ground per Turn
AO_3: Under FAA 90 sec. Evacuation requirement
AO_4: Rapid Cabin Sterilization
AO_5: Exceed most stringent EASA noise regulations for RJ's
AO_6: Special accommodations for business travelers
AO_7: Allow pax to have ready access to all luggage without wait
AO_8: Allow for growth of the physical dimensions of the traveling public
AO_9: Operate from austere airports with neither jetways nor air-stairs
AO_{10}: Allow for rapid powerplant inspection, LRU replacement, drop
AO_{11}: Enable all normal ground operations with engines running
AO_{12}: Minimal to no de-icing dispatch delays
AO_{13}: Powerplants reachable without special equipment
AO_{14}: Minimize number of engine start cycles per operational day
AO_{15}: Allow for powerplant diameter growth with time without significant aircraft changes
AO_{16}: ADA compliant cabin section, ingress and egress from ground without special equipment

$$AO_k = \begin{cases} 0 \text{ if worst in meeting objective} \\ \text{Linearly varying if between} \\ 1 \text{ if best in meeting objective} \end{cases}$$

Chapter 4 Optimization Function Example

11 Requirements Weighting Functions from the Design Characteristics:

R_1: Certification Base: FAO-25
R_2: Entry into Service: EIS 2030 -100, EIS 2031 -200
R_3: Passengers: 30" pitch, 50 pax -100, 76 -200
R_4: Range: 2,000nmi -100, 1,500nmi -200
R_5: Cruise Mach: ≥0.80
R_6: Seat Width: ≥18"
R_7:(Folded) Wingspan: ≤ 24m
R_8: Approach Speed: V_A < 141kts
R_9: Takeoff Field Length: 5kft MSL, ISA+18, 4,000/50ft -100 6,000/50ft -200
R_{10}: Landing Field Length: 5kft MSL, ISA+18, 4,000/50ft -100 6,000/50ft -200
R_{11}: Crew: Pilot, Copilot, 1 F/A -100, 2 F/A's -200

6 Objectives Weighting Functions from the Specified Design Objectives:

O_1: Maximize structural commonality between -100 & -200
O_2: Good aesthetics
O_3: Enhanced Reliability WRT SOTA
O_4: Reduced MRO load WRT SOTA
O_5: Minimize DOC
O_6: Minimize production costs

$$R_i(binary) = \begin{cases} 0\ if\ criterion\ not\ met \\ 1\ if\ criterion\ met \end{cases}$$

16 Objectives Weighting Functions from Anciliary Objectives:

AO_1: Reduce total fuel burn to most efficient in class
AO_2: Minimize Time on Ground per Turn
AO_3: Under FAA 90 sec. Evacuation requirement
AO_4: Rapid Cabin Sterilization
AO_5: Exceed most stringent EASA noise regulations for RJ's
AO_6: Special accommodations for business travelers
AO_7: Allow pax to have ready access to all luggage without wait
AO_8: Allow for growth of the physical dimensions of the traveling public
AO_9: Operate from austere airports with neither jetways nor air-stairs
AO_{10}: Allow for rapid powerplant inspection, LRU replacement, drop
AO_{11}: Enable all normal ground operations with engines running
AO_{12}: Minimal to no de-icing dispatch delays
AO_{13}: Powerplants reachable without special equipment
AO_{14}: Minimize number of engine start cycles per operational day
AO_{15}: Allow for powerplant diameter growth with time without significant aircraft changes
AO_{16}: ADA compliant cabin section, ingress and egress from ground without special equipment

$$O_j = \begin{cases} 0\ if\ worst\ in\ meeting\ objective \\ Linearly\ varying\ if\ between \\ 1\ if\ best\ in\ meeting\ objective \end{cases}$$

$$AO_k = \begin{cases} 0\ if\ worst\ in\ meeting\ objective \\ Linearly\ varying\ if\ between \\ 1\ if\ best\ in\ meeting\ objective \end{cases}$$

Chapter 4 Optimization Function Example

How to Handle Requirements Weighting Functions:

11 Requirements Weighting Functions from the Design Characteristics:

R_1: Certification Base: FAO-25
R_2: Entry into Service: EIS 2030 -100, EIS 2031 -200
R_3: Passengers: 30" pitch, 50 pax -100, 76 -200
R_4: Range: 2,000nmi -100, 1,500nmi -200
R_5: Cruise Mach: ≥0.80
R_6: Seat Width: ≥18"
R_7:(Folded) Wingspan: ≤ 24m
R_8: Approach Speed: V_A < 141kts
R_9: Takeoff Field Length: 5kft MSL, ISA+18, 4,000/50ft -100 6,000/50ft -200
R_{10}: Landing Field Length: 5kft MSL, ISA+18, 4,000/50ft -100 6,000/50ft -200
R_{11}: Crew: Pilot, Copilot, 1 F/A -100, 2 F/A's -200

Chapter 4 Optimization Function Example

How to Handle Requirements Weighting Functions:

11 Requirements Weighting Functions from the Design Characteristics:

R_1: Certification Base: FAO-25
R_2: Entry into Service: EIS 2030 -100, EIS 2031 -200
R_3: Passengers: 30" pitch, 50 pax -100, 76 -200
R_4: Range: 2,000nmi -100, 1,500nmi -200
R_5: Cruise Mach: ≥0.80
R_6: Seat Width: ≥18"
R_7:(Folded) Wingspan: ≤ 24m
R_8: Approach Speed: V_A < 141kts
R_9: Takeoff Field Length: 5kft MSL, ISA+18, 4,000/50ft -100 6,000/50ft -200
R_{10}: Landing Field Length: 5kft MSL, ISA+18, 4,000/50ft -100 6,000/50ft -200
R_{11}: Crew: Pilot, Copilot, 1 F/A -100, 2 F/A's -200

Just meet them all...

Chapter 4 Optimization Function Example

How to Handle Requirements Weighting Functions:

11 Requirements Weighting Functions from the Design Characteristics:

R_1: Certification Base: FAO-25
R_2: Entry into Service: EIS 2030 -100, EIS 2031 -200
R_3: Passengers: 30" pitch, 50 pax -100, 76 -200
R_4: Range: 2,000nmi -100, 1,500nmi -200
R_5: Cruise Mach: ≥0.80
R_6: Seat Width: ≥18"
R_7:(Folded) Wingspan: ≤ 24m
R_8: Approach Speed: V_A < 141kts
R_9: Takeoff Field Length: 5kft MSL, ISA+18, 4,000/50ft -100 6,000/50ft -200
R_{10}: Landing Field Length: 5kft MSL, ISA+18, 4,000/50ft -100 6,000/50ft -200
R_{11}: Crew: Pilot, Copilot, 1 F/A -100, 2 F/A's -200

Just meet them all...

$$\cdot\ni\cdot \quad \prod_{1}^{l} R_i = 1$$

Chapter 4 Optimization Function Example

How to Handle Specificed Objectives Weighting Functions:

6 Objectives Weighting Functions from the Specified Design Objectives:

O_1: Maximize structural commonality between -100 & -200
O_2: Good aesthetics
O_3: Enhanced Reliability WRT SOTA
O_4: Reduced MRO load WRT SOTA
O_5: Minimize DOC... Or is it Maximize DOP?
O_6: Minimize production costs

Chapter 4 Optimization Function Example

How to Handle Specificed Objectives Weighting Functions:

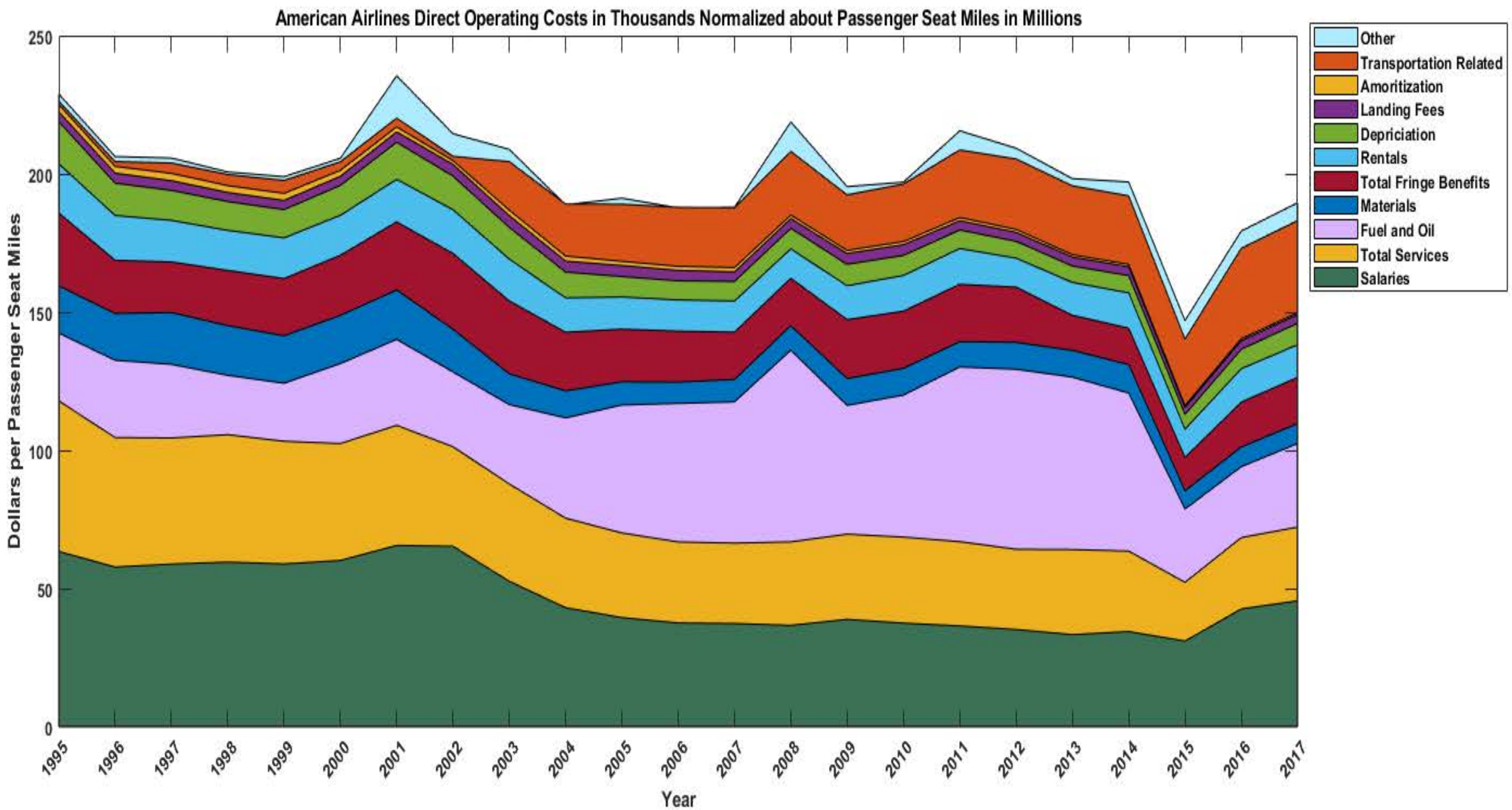
6 Objectives Weighting Functions from the Specified Design Objectives:

O_1: Maximize structural commonality between -100 & -200
O_2: Good aesthetics
O_3: Enhanced Reliability WRT SOTA
O_4: Reduced MRO load WRT SOTA
O_5: Minimize DOC ... Or is it Maximize DOP?
O_6: Minimize production costs

Develop methods to weight each value from 0 to 1. If guidance is given on their relative importance with respect to each other, apply such weighting.

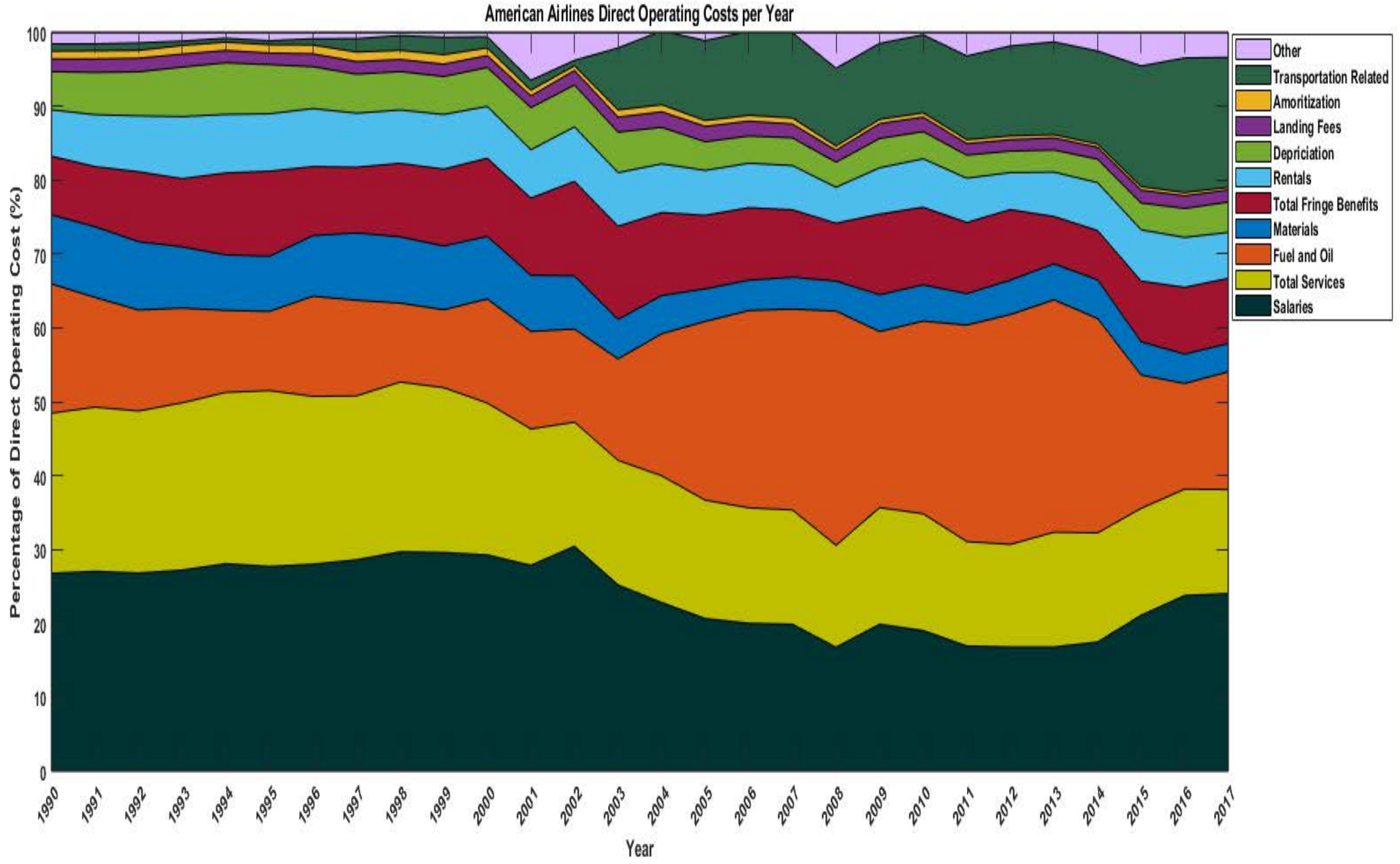
Chapter 4 Optimization Function Example

Recall...



Chapter 4 Optimization Function Example

Recall...



Chapter 4 Optimization Function Example

How to Handle Specificed Objectives Weighting Functions:

6 Objectives Weighting Functions from the Specified Design Objectives:

O_1: Maximize structural commonality between -100 & -200

0 if no part by weight is common between the two, 1 if all parts can be made with the same tooling jigs, procedures and processes

$$O_1 = \left|\frac{weight\ of\ items\ that\ use\ the\ same\ tooling, jigs\ and\ processes\ between\ the\ -100\ and\ -200\ aircraft}{W_{e-100}+W_{e-200}}\right|$$

O_2: Good aesthetics

$O_2 = 0$ if ranked the worst aircraft among surveyed candidates, 1 if best among candidates, rank ordered in between

O_3: Enhanced Reliability WRT SOTA

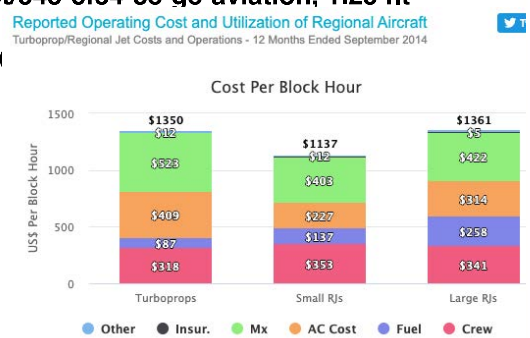
$O_3 = 0$ if < SOTA 99.7% Dispatch Reliability (Brooks, Robert, "Embraer Draws Regional Jet Order Worth Up to $1 B," 2014.)

$O_3 = 333(DR – 0.997)$ if > SOTA 99.7% Dispatch Reliability

O_4: Reduced MRO load WRT SOTA

$O_4 = 0$ if T_O < 18,000hrs (14,400cycles) MTBO (GE Aviation, "CF34-10E Engines Outperforming Expectations," May 2014, https://www.aerocontact.com/en/virtual-aviation-exhibition/product/545-cf34-8e-ge-aviation, 1.25 flt hrs/cycle)

$O_4 = \frac{T_O}{42{,}000} - \frac{3}{7}$ **if T_O > 18,000hrs MTBO (considering maximum airframe life of 60,00**



O_5: Minimize DOC ... Or is it Maximize DOP?

$O_5 = 0$ if DOC > $1,361 ($2014) (https://www.planestats.com/bhsr_2014sep)

$$O_5 = 4\frac{\$1{,}361 - DOC}{\$1{,}361}\ if\ DOC < 1{,}361$$

O_6: Minimize production costs, $C_{pro} \propto C_{acq} \propto W_{TO}$

$O_6 = 0$ if $W_{TO} > W_{TOref}$

$$O_6 = 4\frac{W_{TOref} - W_{TO}}{W_{TOref}}\ if\ \ W_{TO} < W_{TOref}$$

Chapter 4 Optimization Function Example

How to Handle Anciliary Objectives Weighting Functions:

16 Objectives Weighting Functions from Anciliary Objectives:

AO_1: Reduce total fuel burn to most efficient in class
AO_2: Minimize Time on Ground per Turn
AO_3: Under FAA 90 sec. Evacuation requirement
AO_4: Rapid Cabin Sterilization
AO_5: Exceed most stringent EASA noise regulations for RJ's
AO_6: Special accommodations for business travelers
AO_7: Allow pax to have ready access to all luggage without wait
AO_8: Allow for growth of the physical dimensions of the traveling public
AO_9: Operate from austere airports with neither jetways nor air-stairs
AO_{10}: Allow for rapid powerplant inspection, LRU replacement, drop
AO_{11}: Enable all normal ground operations with engines running
AO_{12}: Minimal to no de-icing dispatch delays
AO_{13}: Powerplants reachable without special equipment
AO_{14}: Minimize number of engine start cycles per operational day
AO_{15}: Allow for powerplant diameter growth with time without significant aircraft changes
AO_{16}: ADA compliant cabin section, ingress and egress from ground without special equipment

Develop methods to weight each value from 0 to 1. If guidance is given on their relative importance with respect to each other, apply such weighting.

Chapter 4 Optimization Function Example

How to Handle Anciliary Objectives Weighting Functions:

	Configuration 1 Scores	Configuration 2 Scores	Configuration 3 Scores
O_1: Maximize structural commonality between -100 & -200	1	1	0.9
O_2: Good aesthetics	0.9	0.8	0.6
O_3: Enhanced Reliability WRT SOTA	0	0	0
O_4: Reduced MRO load WRT SOTA	0.5	0.4	0.4
O_5: Minimize DOC	0.1	0.05	0.05
O_6: Minimize production costs	0.1	0.1	0.05
Sum:	2.6	2.35	2
Weighted Sum (ROWF = 2):	0.87	0.78	0.67
AO_1: Reduce total fuel burn to most efficient in class	1	0	0
AO_2: Minimize Time on Ground per Turn	1	0	0
AO_3: Under FAA 90 sec. Evacuation requirement	1	1	1
AO_4: Rapid Cabin Sterilization	1	1	1
AO_5: Exceed most stringent EASA noise regulations for RJ's	1	1	0
AO_6: Special accommodations for business travelers	1	1	1
AO_7: Allow pax to have ready access to all luggage without wait	1	1	1
AO_8: Allow for growth of the physical dimensions of the traveling public	1	1	1
AO_9: Operate from austere airports with neither jetways nor air-stairs	1	1	1
AO_{10}: Allow for rapid powerplant inspection, LRU replacement, drop	1	1	1
AO_{11}: Enable all normal ground operations with engines running	1	1	1
AO_{12}: Minimal to no de-icing dispatch delays	1	1	1
AO_{13}: Powerplants reachable without special equipment	1	1	1
AO_{14}: Minimize number of engine start cycles per operational day	1	1	1
AO_{15}: Allow for powerplant diameter growth with time without significant aircraft changes	1	1	1
AO_{16}: ADA compliant cabin section, ingress and egress from ground without special equipment	1	1	1
Sum:	16	14	13
Weighted Sum:	1	0.875	0.8125
Total Score:	1.87	1.66	1.48

Chapter 4 Optimization Function (Oread)

3.1 Requirements

$$General\ Optimization\ Function = GOF = \prod_{1}^{21} R_i\left(\frac{1}{3} * 2\sum_{1}^{3} O_j + \frac{1}{12}\sum_{1}^{12} AO_k\right)$$

Requirement No.	Requirement	Values
R_1	>1000 nmi Range with Full Passengers	$R_1 = \begin{cases} 1 \text{ if Range} \geq 1000\text{nmi} \\ 0 \text{ if Range} < 1000\text{nmi} \end{cases}$
R_2	>250 KTAS Cruise Speed (V_{cr})	$R_2 = \{1/\ V_{cr} \geq 250\text{KTAS}, 0/V_{cr} < 250\text{KTAS}$
R_3	50 +0/-4 Passenger Capacity	$R_3 = \{1/46 \leq \text{Passengers} \leq 50, 0/\text{Passengers} < 46$
R_4	>3 Crew Members, 2 Pilots, 1 Cabin Crew	$R_4 = \begin{cases} 1 \text{ if Crew Members} \geq 3 \\ 0 \text{ if Crew Members} < 3 \end{cases}$
R_5	>FL 280 Cruise Altitude	$R_5 = \begin{cases} 1 \text{ if Cruise Altitude} \geq \text{FL } 280 \\ 0 \text{ if Cruise Altitude} < \text{FL } 280 \end{cases}$
R_6	<141 kts Approach Speed (V_{AP})	$R_6 = \{1/V_{AP} \leq 141\text{kts}, 0/V_{AP} > 141\text{kts}$
R_7	<118 ft wingspan (b)	$R_7 = \{1/b \leq 118\text{ft}, 0/b > 118\text{ft}$
R_8	<4500 ft Takeoff Distance	$R_8 = \{1/\ \text{TOFL} \leq 4500\text{ft}, 0/\text{TOFL} > 4500\text{ft}$
R_9	<4500ft Landing Distance	$R_9 = \{1/\ \text{LFL} \leq 4500\text{ft}, 0/\text{LFL} > 4500\text{ft}$
R_{10}	>20% Block Fuel Reduction	$R_{10} = \begin{cases} 1 \text{ if Fuel Reduction} > 20\% \\ 0 \text{ if Fuel Reduction} < 20\% \end{cases}$
R_{11}	Reduction in emissions compared to current turboprops	$R_{11} = \begin{cases} 1 \text{ if Reduction in emissions} \\ 0 \text{ if no Reduction in emissions} \end{cases}$
R_{12}	>18 inches aisle width (w_{aisle})	$R_{12} = \{1/\ w_{aisle} \geq 18 \text{ in}, 0/\ w_{aisle} < 18 \text{ in}$
R_{13}	>17.2 inches seat width (w_{seat})	$R_{13} = \{1/\ w_{seat} \geq 17.2 \text{ in}, 0/\ w_{seat} < 17.2 \text{ in}$
R_{14}	>2 inches arm rest width	$R_{14} = \{1/\text{arm rest w} \geq 2 \text{ in}, 0/\text{arm rest w} < 2 \text{ in}$
R_{15}	EIS before 2035	$R_{15} = \{1/\text{EIS} \leq 2035, 0/\text{EIS} > 2035$
R_{16}	VFR and IFR flight with autopilot capability	$R_{16} = \begin{cases} 1 \text{ if Capable} \\ 0 \text{ if not Capable} \end{cases}$
R_{17}	Meets FAA Part 25 certification requirements	$R_{17} = \begin{cases} 1 \text{ if meets Part 25} \\ 0 \text{ if does not meet Part 25} \end{cases}$
R_{18}	Capable of flight in icing conditions	$R_{18} = \{1/\text{Capable}, 0/\text{not Capable}$
R_{19}	Stand up height in the aisle similar competitive aircraft	$R_{19} = \begin{cases} 1 \text{ if similar stand up height} \\ 0 \text{ if dissimilar stand up height} \end{cases}$

Chapter 4 Optimization Function (Oread)

Table 3.2.1: List of Objectives [18]

Objective No.	Objective	Values
O_1	>350 KTAS Cruise Speed	$O_1 = \begin{cases} \frac{V_{cr} - 250KTAS}{100KTAS} \text{ if } 250KTAS < V_{cr} < 350KTAS \\ 1 \text{ if } V_{cr} > 350KTAS \end{cases}$
O_2	<79 ft wingspan	$O_2 = \begin{cases} \frac{118ft - b}{39ft} /79ft < b < 118ft, 1/b < 79ft \end{cases}$
O_3	>18-inch seat width (w_{seat})	$O_2 = \begin{cases} \frac{w_{seat} - 17.2in}{0.8in} /17.2in < w_{seat} < 18in, 1/w_{seat} > 18in \end{cases}$

3.3 Ancillary Objectives

Table 3.3.1: List of Ancillary Objectives [2][8][18]

Ancillary Objective No.	Ancillary Objective	Value
AO_1	Complies with Americans with Disabilities Act (ADA) guidelines	$AO_1 = \begin{cases} 1 \text{ if Complies} \\ 0 \text{ if doesn't Comply} \end{cases}$
AO_2	Development cost is lower than that of competitors	$AO_2 = \begin{cases} 1 \text{ if cost} < \text{competitors} \\ 0 \text{ if cost} \geq \text{competitors} \end{cases}$
AO_3	Maintenance doesn't require any special equipment	$AO_3 = \begin{cases} 1 \text{ if meets requirement} \\ 0 \text{ if doesn't meet requirement} \end{cases}$
AO_4	Four entrances for quick passenger loading/unloading	$AO_4 = \begin{cases} 1 \text{ if Entrances} = 4 \\ 0 \text{ if Entrances} < 4 \end{cases}$
AO_5	Meets stage 5 noise restrictions	$AO_5 = \begin{cases} 1 \text{ if Noise} = \text{Stage 5 restrictions} \\ 0 \text{ if Noise} > \text{Stage 5 restrictions} \end{cases}$
AO_6	Improve passenger ride quality of current turboprops	$AO_6 = \begin{cases} 1 \text{ if Quality} > \text{competitors} \\ 0 \text{ if Quality} \leq \text{competitors} \end{cases}$
AO_7	Cargo hold turn under 8 minutes	$AO_7 = \begin{cases} 1 \text{ if Cargo Turn} \leq 8 \text{ min} \\ 0 \text{ if Cargo Turn} > 8 \text{ min} \end{cases}$
AO_8	Aircraft is compatible with current ground vehicles and operations	$AO_8 = \begin{cases} 1 \text{ if Compatible} \\ 0 \text{ if Not Compatible} \end{cases}$
AO_9	Ability to swap out batteries as technology improves	$AO_9 = \begin{cases} 1 \text{ for Upgradeable Batteries} \\ 0 \text{ if Batteries can't Upgrade} \end{cases}$
AO_{10}	Allow for future engine upgrades and growth	$AO_{10} = \begin{cases} 1 \text{ if Engines Can Upgrade} \\ 0 \text{ if Engines Can't Upgrade} \end{cases}$

Chapter 4 Optimization Function (Meadowlark)

Table 3.1: Design Objectives

Label	Requirement
R_1	50 +0/-4 in a single class arrangement with 30 inch seat pitch
R_2	1,000 nmi range (R) with full passengers
R_3	Seat width (W_s) >17.2 inches
R_4	Arm rest width (W_{ar}) >2 inches
R_5	Aisle stand up height similar to competitive aircraft
R_6	Baggage compartment tall enough for ergonomic servicing
R_7	Aisle width (W_i) >18 inches
R_8	Wingspan (b) <36 m
R_9	Able to be certified by 2035
R_{10}	Capable of flight in known icing conditions
R_{11}	Takeoff field length (TOFL) <4,500 ft over 50 ft obstacle dry pavement
R_{12}	Landing field length (LFL) <4,500 ft over 50 ft obstacle dry pavement
R_{13}	Performance should be shown 5,000 ft above mean sea level
R_{14}	Distance to climb <200 nmi to initial cruise altitude
R_{15}	Approach speed (V_{at}) category C, <141 kts
R_{16}	Cruise altitude >FL280
R_{17}	Cruise speed (V_{cr}) >275 KTAS
R_{18}	20% reduction in block fuel on 500 nmi mission
R_{19}	Meet 14 CFR 25.121 Climb Gradient Requirements
R_{20}	2 pilots and 1 cabin crew member for every 50 passengers

Table 3.2: Design Objectives

Label	Objective
O_1	Target cruise speed of 350 KTAS
O_2	Target seat width of 18 inches
O_3	Minimize wingspan
O_4	Autonomous capabilities

Table 3.1: Ancillary Objectives

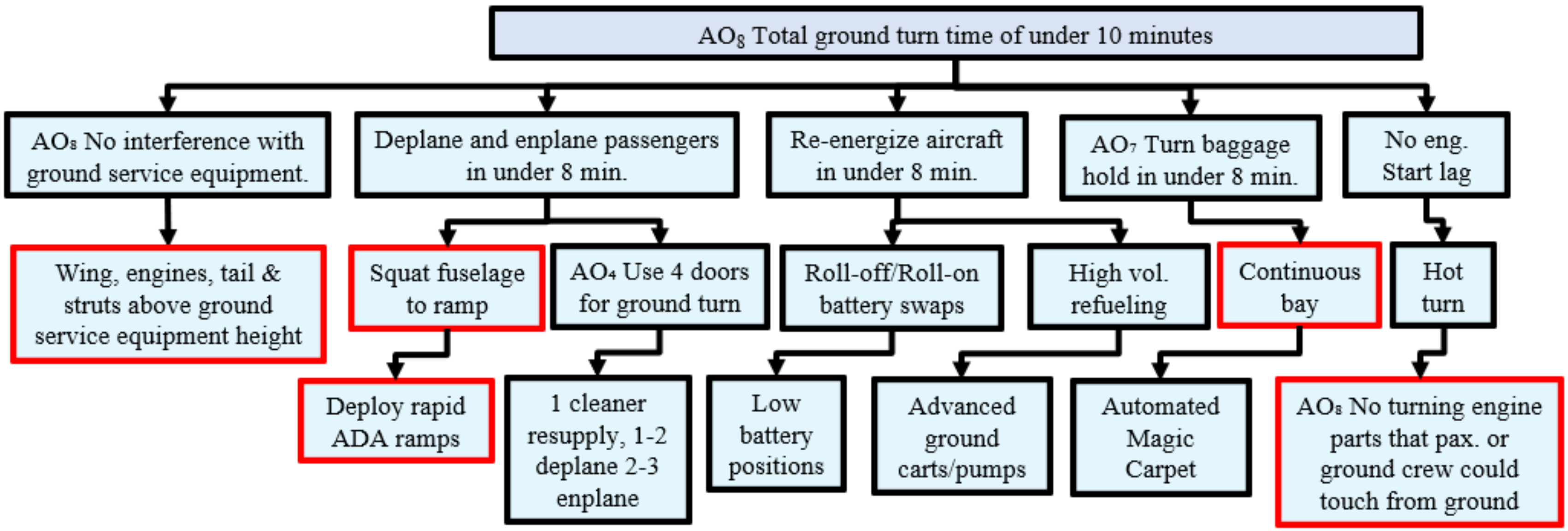
Label	Objective	Weight
AO_1	Door width large enough for standard wheelchair	0.8
AO_2	Large tray-tables for an average laptop	0.5
AO_3	Ground turn less than 8 minutes	1
AO_4	European standards for cargo bay	0.7
AO_5	Multiple doors for simultaneous loading and off boarding docks	0.6
AO_6	Allow for engine diameter growth and powerplant upgrades	1
AO_7	Minimal interference with ground traffic	0.5
AO_8	Batteries are on outer mold line of fuselage	0.9
AO_9	Allow for battery pack changes as they improve over time	1
AO_{10}	Ease of meeting Stage 5+ noise regulations	0.9

Chapter 4 Flow-Down Chart Construction

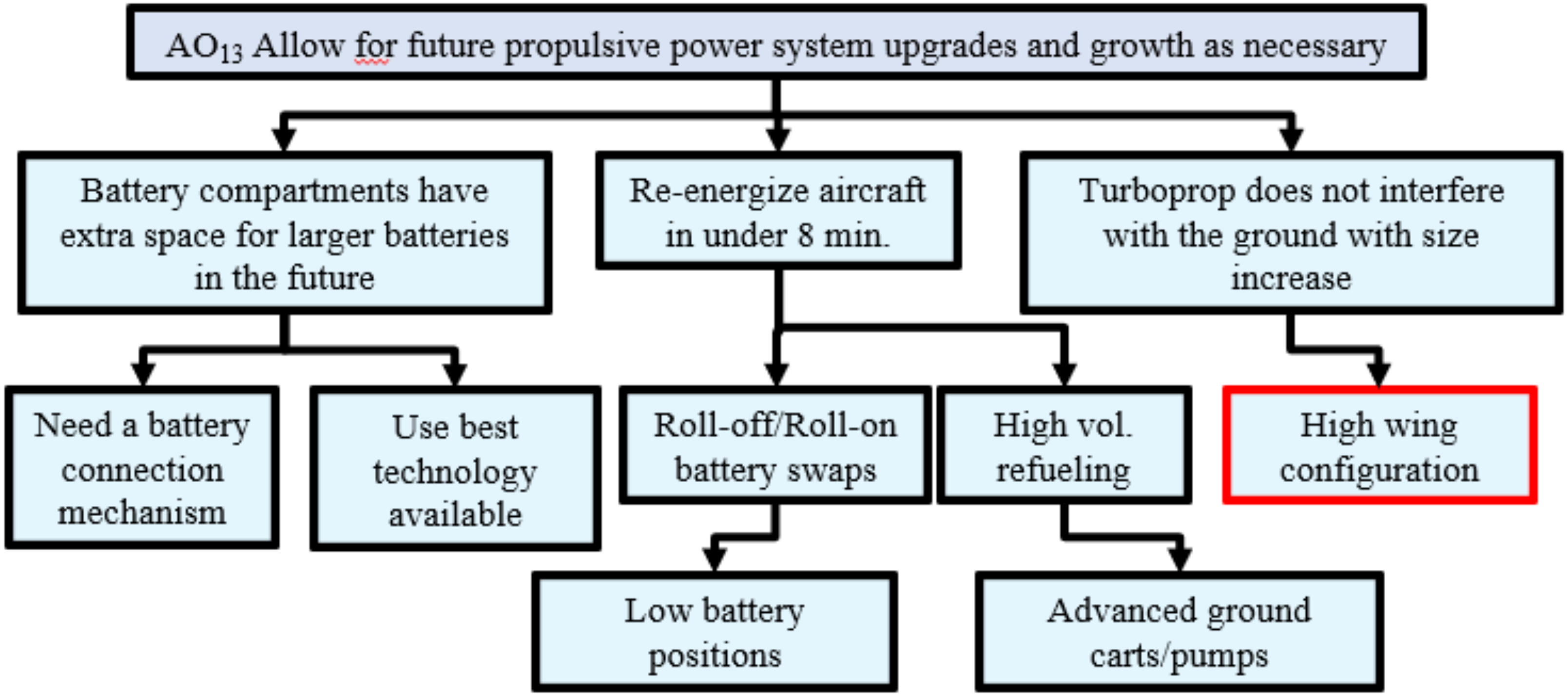
System Engineering Requirements Flow-Down Specifications (missile example)

Tier 0 System of Systems (SuperSystem) Performance Requirements and Goals	Modular Missile System that will be at least effective as the best Air-to-Air, Air-to-Ground, Anti-Radiation and Anti-Ship Missiles			
Tier 1 System Performance Requirements	Flight Performance	*Probability of Kill*	Cost	Etc.
Tier 2 Interdependent Subsystem Requirements	Warhead	Guidance Accuracy	Fuzing	Etc.
Tier 3 Subsystem Requirements	Guidance Law	Time Constant	Gain	Etc.
Tier 4 Interdependent Component Requirements	Seeker	Flight Control	Radome	Etc.
Tier 5 Component Requirements	Canard, Wing & Fin Shapes, Sizes	Actuator	Gyro	Etc.
Tier 6 Granular Component Requirements	Bandwidth = 16 Hz	Rate = 360 Deg / s	Deflection = +/- 30 Deg	Stall Torque = 17,000 in-lb

Chapter 4 Flow-Down Chart Construction (Oread Example)



Chapter 4 Flow-Down Chart Construction (Oread Example)



Chapter 5 STAMPED Analysis

CHAPTER 5 STAMPED ANALYSIS

UG Team Stratoforce	UG Individual Stratospheric P/L	Special Project Coleopters	Special Project Counterdrone Swarm
Gather relevant geometric, weights, engine and performance data and track the data with time. Include especially weights, We, Wto, Wpl, Geometries, b, S, AR, Power or Thrust, Performance, Vmax, Vcr, any and all Ranges, costs for all historical aircraft.	Gather relevant geometric, weights, engine and performance data and track the data with time. Include especially weights, We, Wto, Wpl, Geometries, b, S, AR, Power or Thrust, Performance, Vmax, Vcr, any and all Ranges, costs for all historical aircraft. Of course, the data will be sparse given the oddity of the spec.	Get as much information as possible on the XQ-138 and the ST Aerospace Fantail series aircraft as well as AVID and Honeywell and others. Include especially weights, We, Wto, Wpl, Geometries, b, S, AR, Power or Thrust, Performance, Vmax, Vcr, any and all Ranges, costs for all historical aircraft.	Get as much information as possible on existing physical counter UAS devices and countermissile systems. Make a nod to the electromagnetic and energy weapons, but concentrate on physical systems if possible. Include especially weights, We, Wto, Wpl, Geometries, b, S, AR, Power or Thrust, Performance, Vmax, Vcr, any and all Ranges, costs for all historical aircraft.

CHAPTER 5 STAMPED ANALYSIS

Graduate Team Archytas	Graduate Team Missile Design
Gather relevant geometric, weights, engine and performance data and track the data with time. Include especially weights, We, Wto, Wpl, Geometries, b, S, AR, Power or Thrust, Performance, Vmax, Vcr, any and all Ranges, costs for all historical aircraft.	Gather relevant geometric, weights, engine and performance data and track the data with time. Include especially weights, We, Wto, Wpl, Geometries, b, S, AR, Power or Thrust, Performance, Vmax, Vcr, any and all Ranges, costs for all historical missiles. Of course, the data will be sparse given the oddity of the spec.

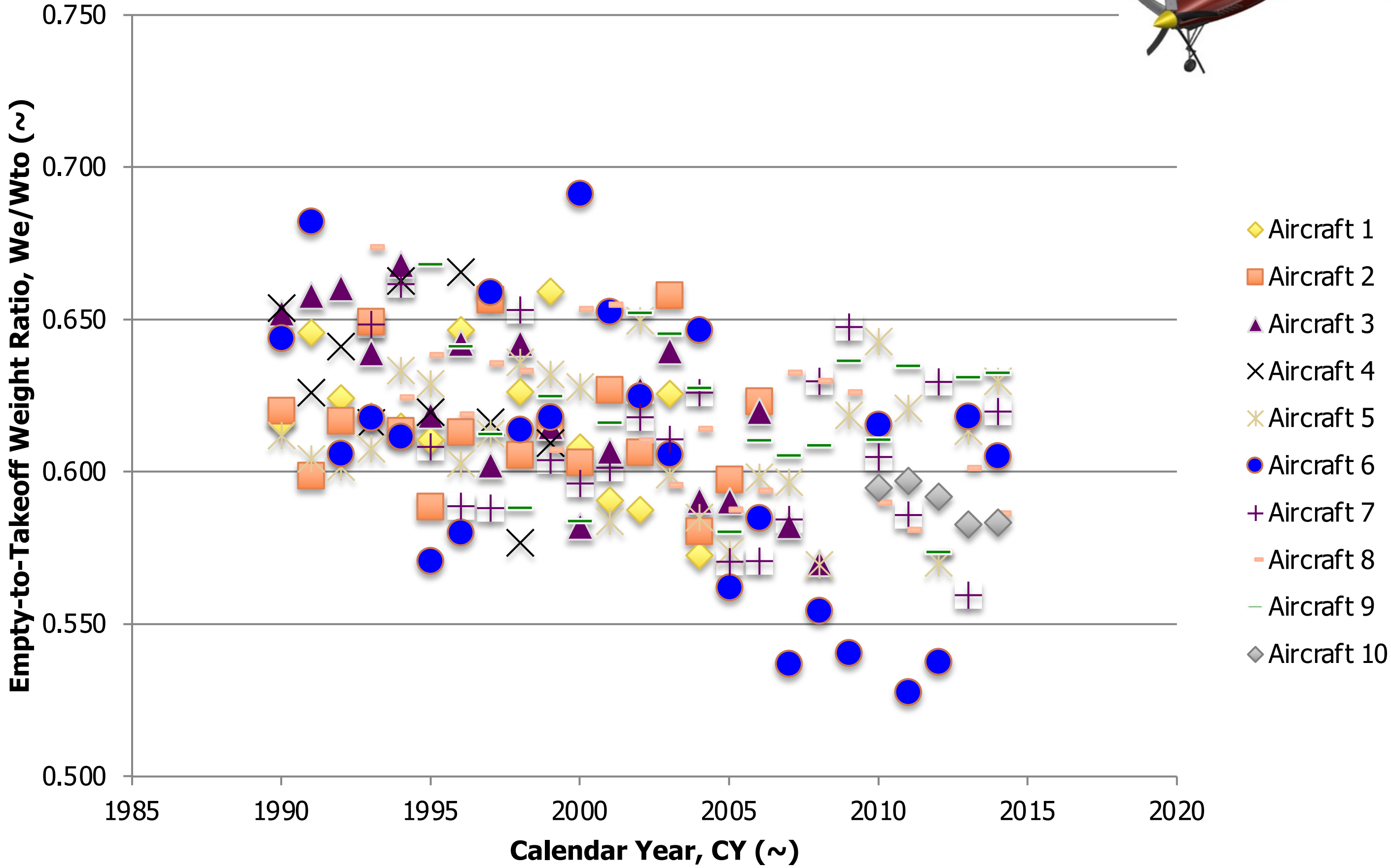
Chapter 5 STAMPED Analysis

6.1 Gather STAMPED We/Wto Data – Get Aircraft We/Wto in given market

					We/Wto					
Year	Aircraft 1	Aircraft 2	Aircraft 3	Aircraft 4	Aircraft 5	Aircraft 6	Aircraft 7	Aircraft 8	Aircraft 9	Aircraft 10
1990	0.616	0.620	0.652	0.654	0.612	0.644				
1991	0.646	0.599	0.658	0.626	0.604	0.682				
1992	0.624	0.617	0.660	0.641	0.602	0.606				
1993	0.618	0.649	0.639	0.616	0.608	0.618	0.648	0.674		
1994	0.615	0.613	0.668	0.663	0.633	0.612	0.662	0.624		
1995	0.611	0.589	0.619	0.620	0.629	0.571	0.608	0.638	0.668	
1996	0.647	0.613	0.642	0.666	0.603	0.580	0.589	0.619	0.641	
1997	0.659	0.656	0.602	0.616	0.613	0.659	0.588	0.636	0.612	
1998	0.626	0.606	0.642	0.577	0.636	0.614	0.653	0.633	0.588	
1999	0.659	0.615	0.615	0.609	0.632	0.618	0.604	0.607	0.625	
2000	0.608	0.603	0.582		0.628	0.691	0.596	0.653	0.584	
2001	0.591	0.627	0.607		0.584	0.653	0.601	0.655	0.616	
2002	0.587	0.606	0.627		0.650	0.625	0.618	0.610	0.652	
2003	0.626	0.658	0.640		0.599	0.606	0.611	0.596	0.645	
2004	0.573	0.580	0.591		0.585	0.646	0.626	0.614	0.627	
2005		0.597	0.590		0.574	0.562	0.571	0.587	0.580	
2006		0.623	0.620		0.598	0.585	0.571	0.594	0.610	
2007			0.582		0.597	0.537	0.584	0.633	0.605	
2008			0.570		0.570	0.554	0.630	0.630	0.609	
2009					0.619	0.540	0.648	0.626	0.636	
2010					0.643	0.616	0.605	0.590	0.611	0.595
2011					0.621	0.528	0.586	0.581	0.635	0.597
2012					0.570	0.538	0.630	0.574	0.574	0.592
2013					0.613	0.618	0.560	0.601	0.631	0.583
2014					0.630	0.605	0.620	0.586	0.633	0.583

Chapter 5 STAMPED Analysis

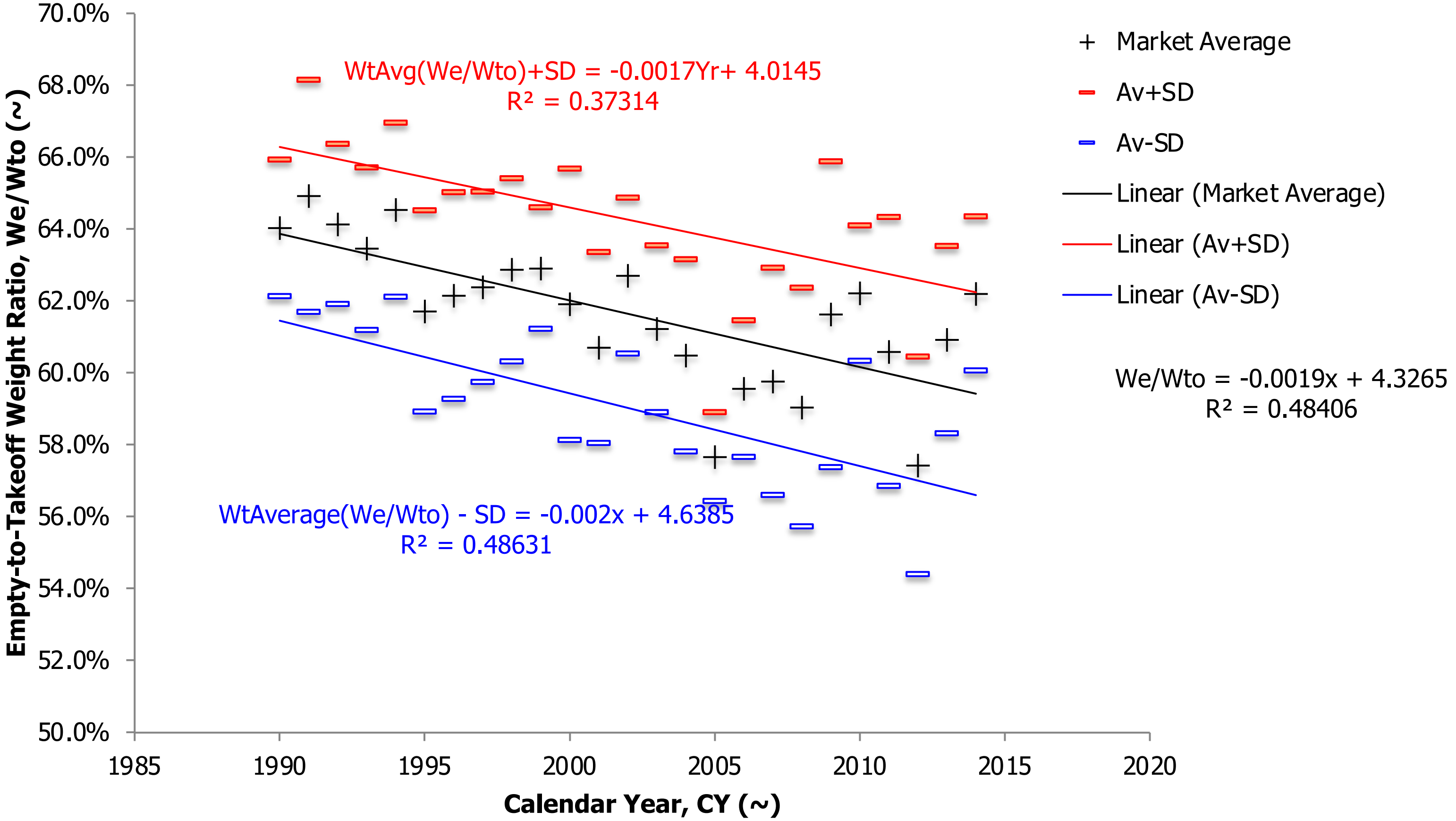
6.5. Plot We/Wto Data



Chapter 5 STAMPED Analysis

6.6. Plot Weighted Averages of We/Wto (that is sum of We/Wto*%share) and Standard Deviations on either side of that data

6.7. Decide on appropriate trendlines for each value, plot, get equations & R-values

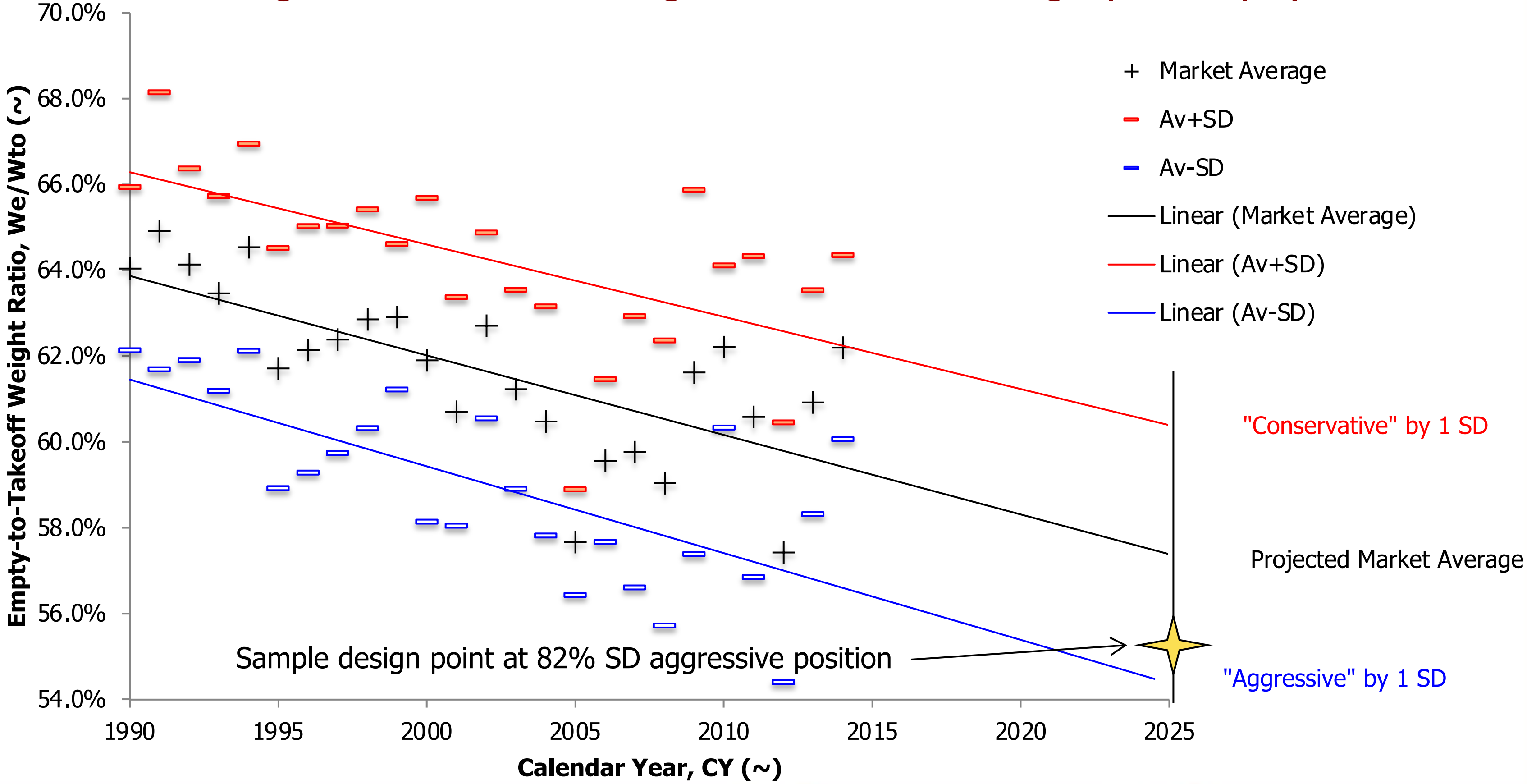


Chapter 5 STAMPED Analysis

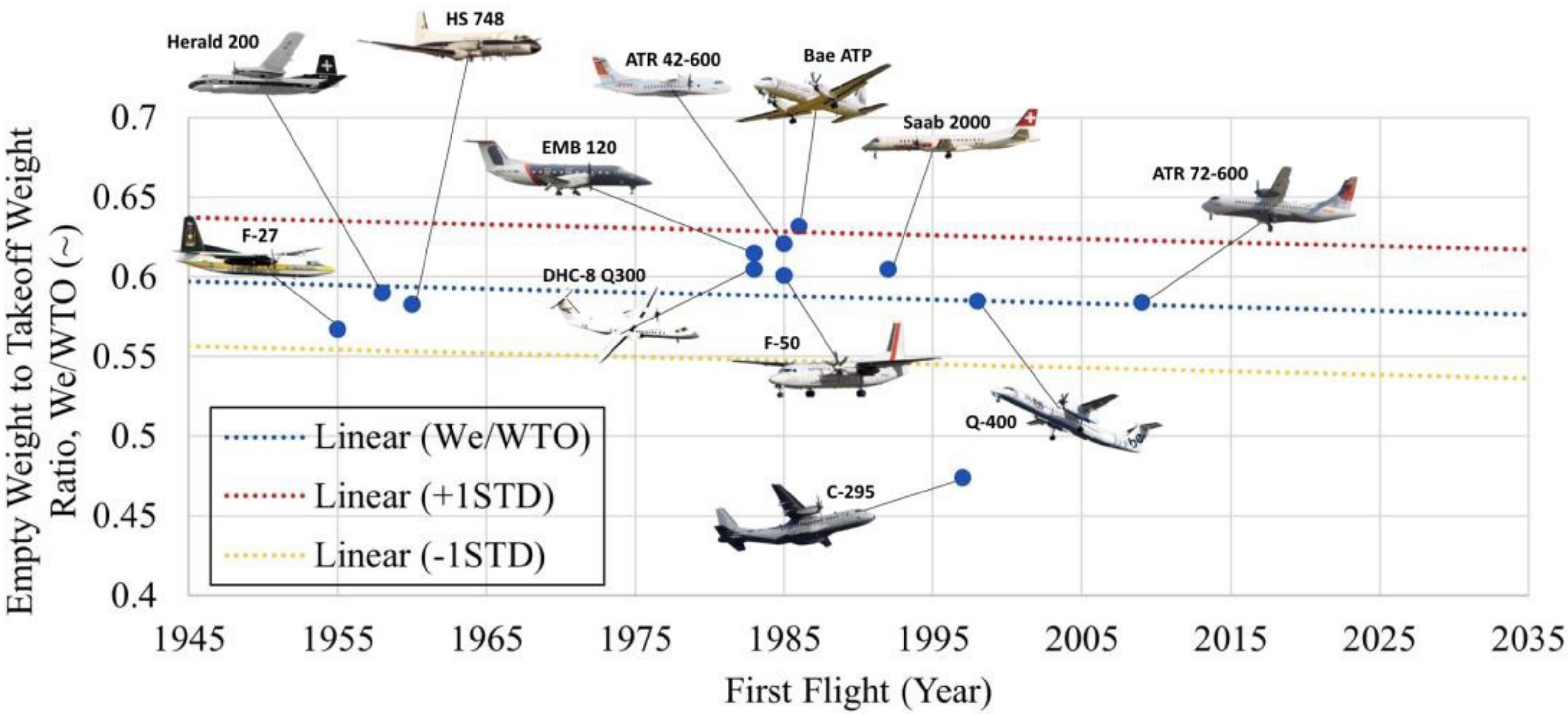
6.8. Extrapolate plots to Date of First Delivery (for example below, 2025)

6.9. Review Design Philosophy and Market Trends to decide on an aggressive or conservative approach to We/Wto selection

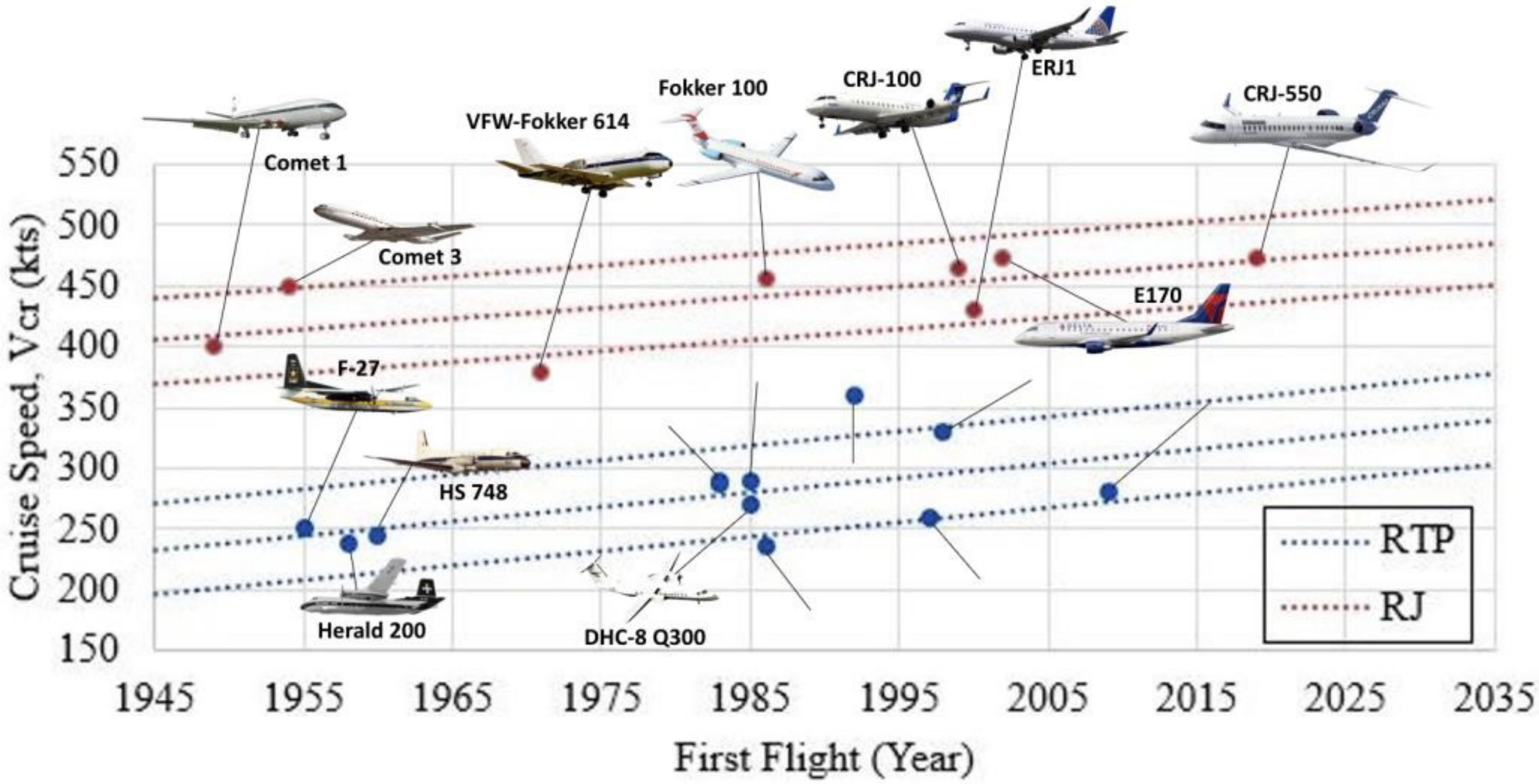
6.10. Select Design We/Wto according to trends and design philosophy



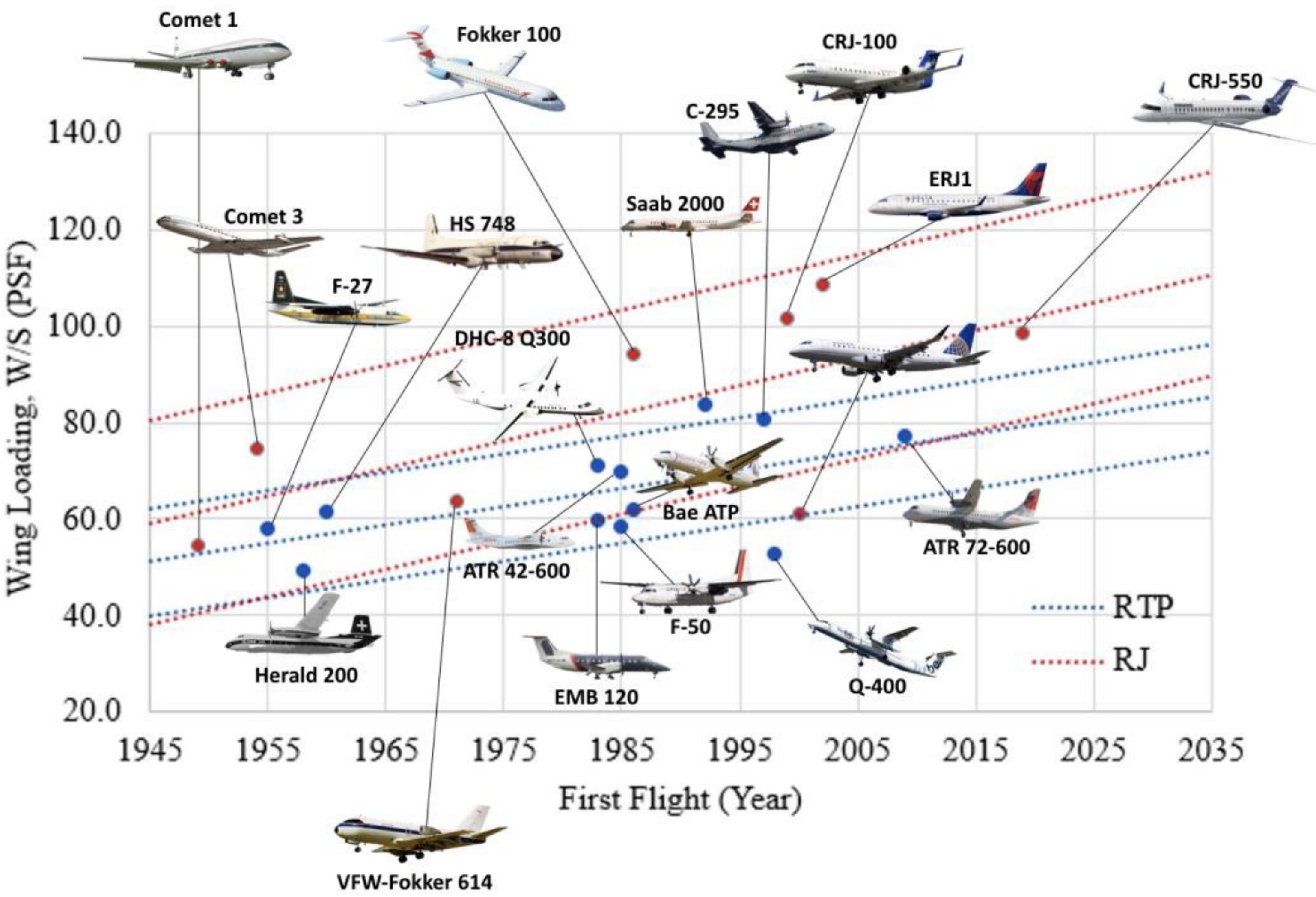
Chapter 5 STAMPED Analysis - Meadowlark Charts



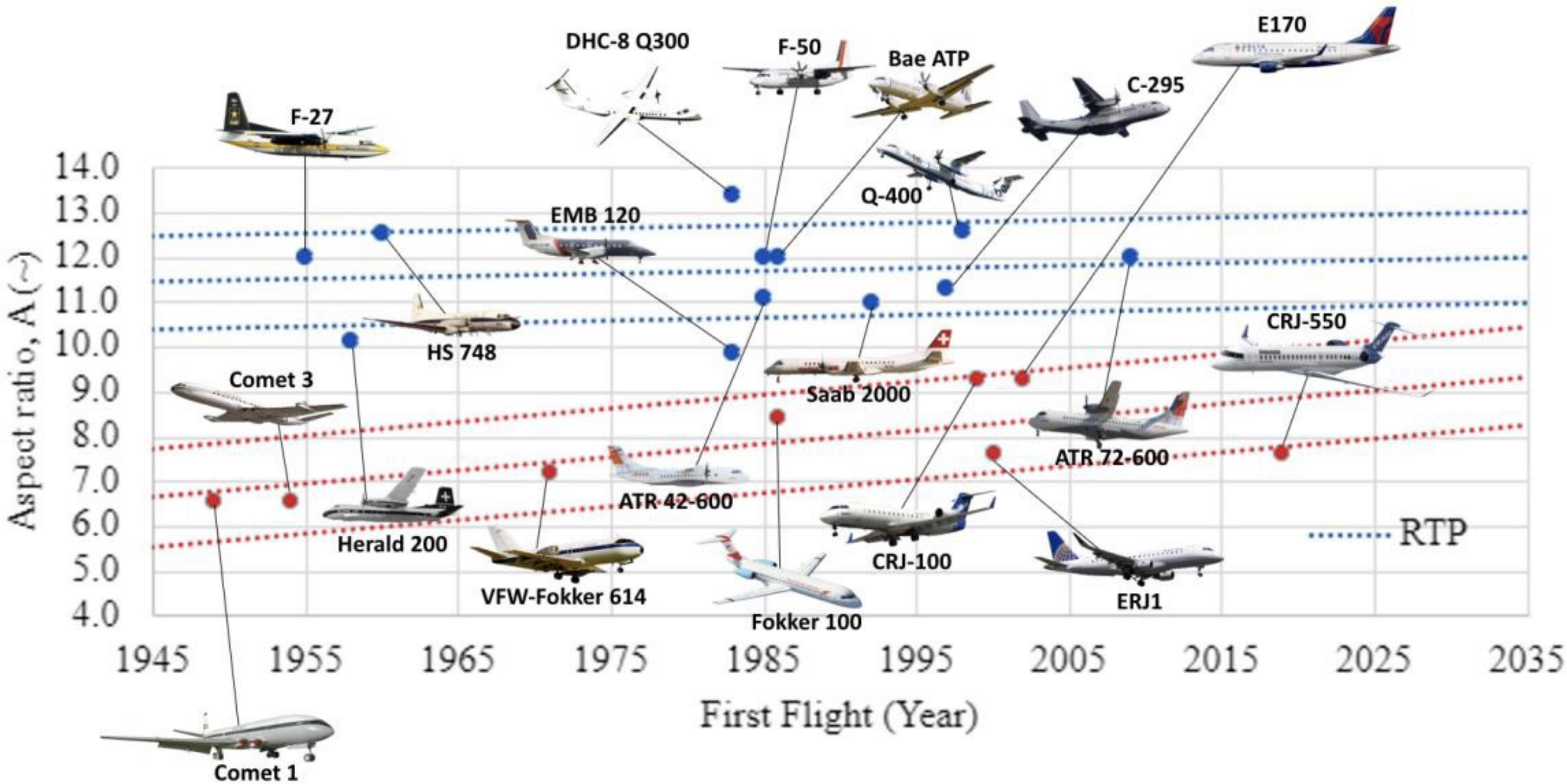
Chapter 5 STAMPED Analysis - Meadowlark Charts



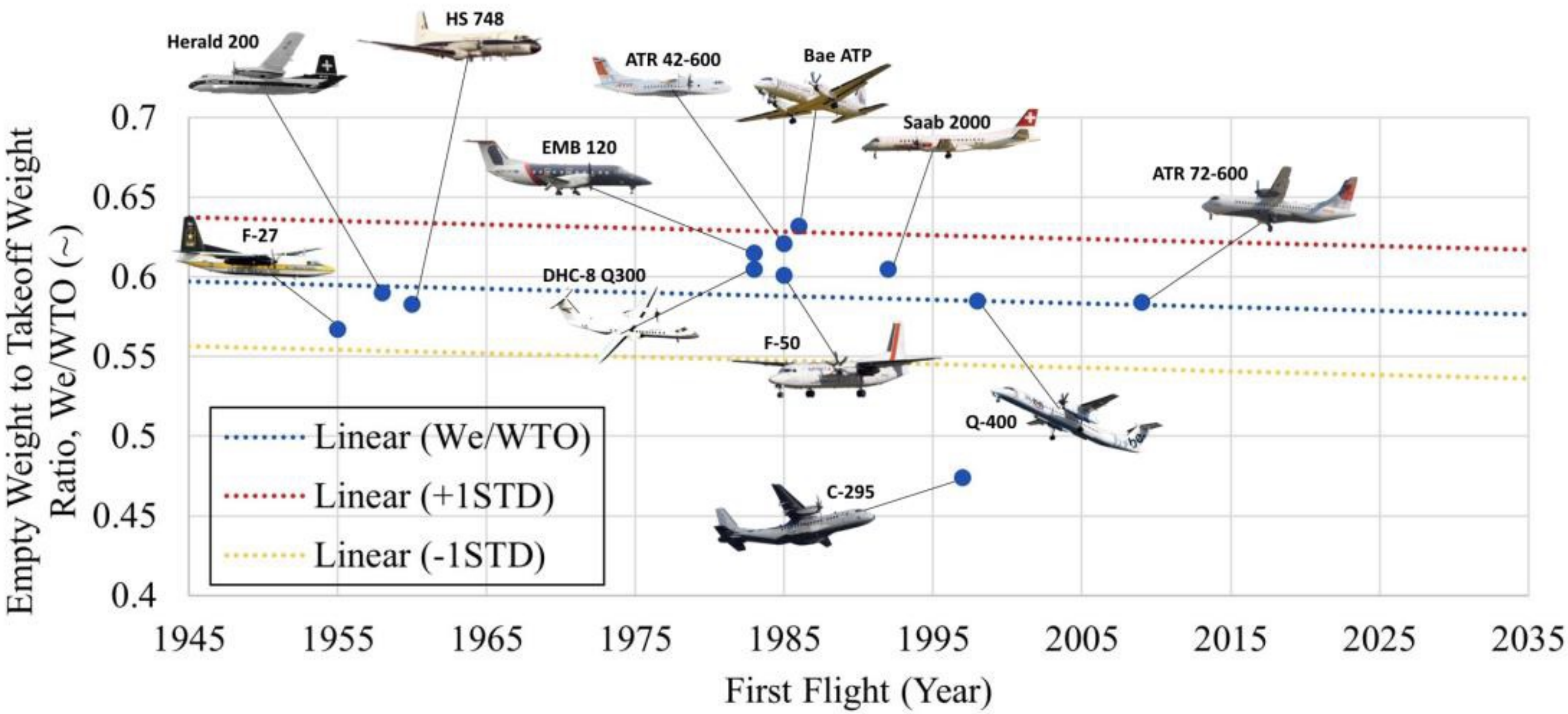
Chapter 5 STAMPED Analysis - Meadowlark Charts



Chapter 5 STAMPED Analysis - Meadowlark Charts



Chapter 5 STAMPED Analysis - Meadowlark Charts



Report 3

Due 5 Feb. 2024 8am to kuaerodesign@gmail.com

All Preceding Chapters and Contents, reworked as directed as well as Appendix A

Chapter 6 Candidate Configuration Matrix Establishment

Following the examples in previous reports and the notes, generate a sweep of candidate configurations. It's perfectly acceptable to generate configurations that reflect common configurations and design practices, but that may be directly at odds with the Design Philosophy and will be almost instantly deselected once your Configuration Constraints are applied. That's okay as you'll need to explain to the reader what you've done and why. For this first configuration matrix, just cast your net wide. Keep configurations simple -- no need for aerodynamic profiles on wings -- just simple extrusions will do. Fuselages are to be kept simple, jet engines devolve to cylinders, propellers become disks etc. This is the most basic sweep of generic configurations, NOTHING FANCY!

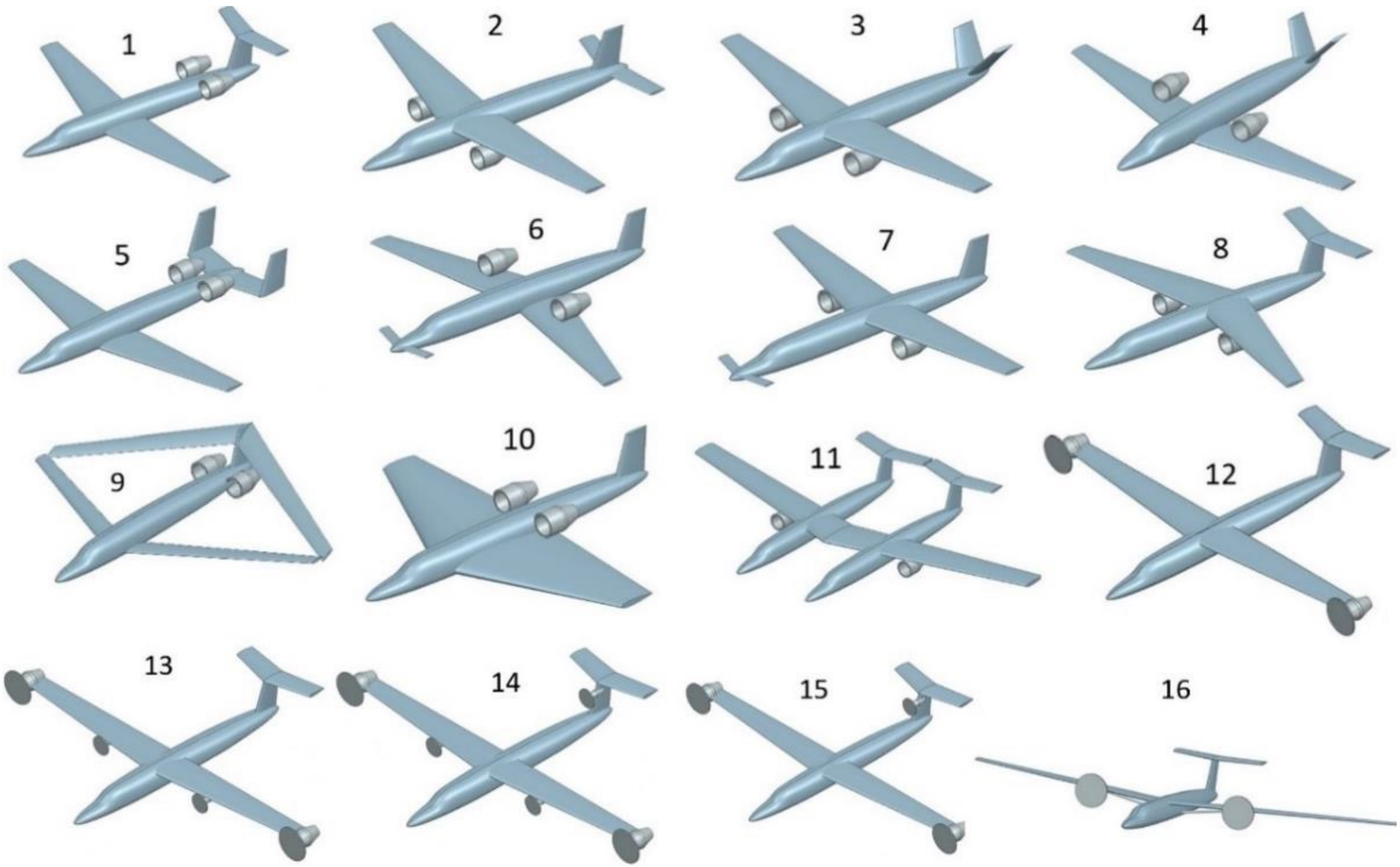
Chapter 7 Application of Optimization Function and Requirements Flowdown Charts to Configurations and Downselection

Using the Optimization Function and the Flowdow charts downselect the bulk of designs to just a handful of designs or one design family. For teams, downselect one to several. For individuals, downselect to one design to carry forth (you won't have the time to do several). Coleopter team – you'll do your own thing as this section is meaningless for you.

Chapter 8 Weight Sizing

Note that this is a placeholder section. You will perform Class I weight sizing via the Appendix B below. Chapter 8 of the Competition Report will be devoted to Class II weight sizing, but will use Class I as a starting point. Coleopter team – you will have to properly size the powerplant assemblies for both hover and dash. We'll go over it in our individual meetings.

Chapter 6 Configuration Matrix



Chapter 6 Configuration Matrix

Model	Pros	Cons	Image
1	-Tail away from wing downwash -Common aircraft look -Engines easy to access -Less prop drag	-Engines in the back -Cabin Noise -Tail needs more structure adding weight - No continuous cargo bay	 Figure 6.2.1: Config 1
2	-Common aircraft look -Engines easy to access -Better prop efficiency -Good roll stability -Passenger visibility	-Difficult to differentiate from competition -More engine noise	 Figure 6.2.2: Config 2

Chapter 6 Configuration Matrix

Table 6.2.2: Configuration Pros and Cons (Cont.) [2][3][18]

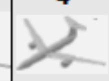
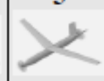
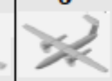
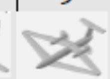
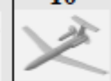
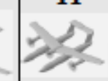
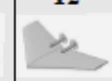
Model	Pros	Cons	Image
3	-Engines easy to access -Better prop efficiency -Good roll stability -Passenger visibility	-Coupling of control surfaces -More engine noise -Bad in engine out scenario	 Figure 6.2.3: Config 3
4	-Less prop drag	-Coupling of control surfaces -Difficult to access engines -Passenger visibility -No continuous cargo bay	 Figure 6.2.4: Config 4
5	-Engines easy to access -less prop drag	-Engines in the back -Cabin Noise -Tail needs more structure adding weight -Passenger visibility - No continuous cargo bay	 Figure 6.2.5: Config 5
6	-Less prop drag -Downwash does not affect empennage	-Difficult to access engines -Passenger visibility -Canards look different from normal aircraft -No continuous cargo bay -More engine noise -Higher development costs	 Figure 6.2.6: Config 6
7	-Engines easy to access -Better prop efficiency -Good roll stability -Downwash does not affect empennage -Passenger visibility	-Canards look different from normal aircraft -More engine noise	 Figure 6.2.7: Config 7
8	-Tail away from wing downwash -Engines easy to access -Better prop efficiency -Good roll stability -Passenger visibility	-Tail needs more structure adding weight -More engine noise -Higher development costs	 Figure 6.2.8: Config 8

Chapter 7 Application of Optimization Function

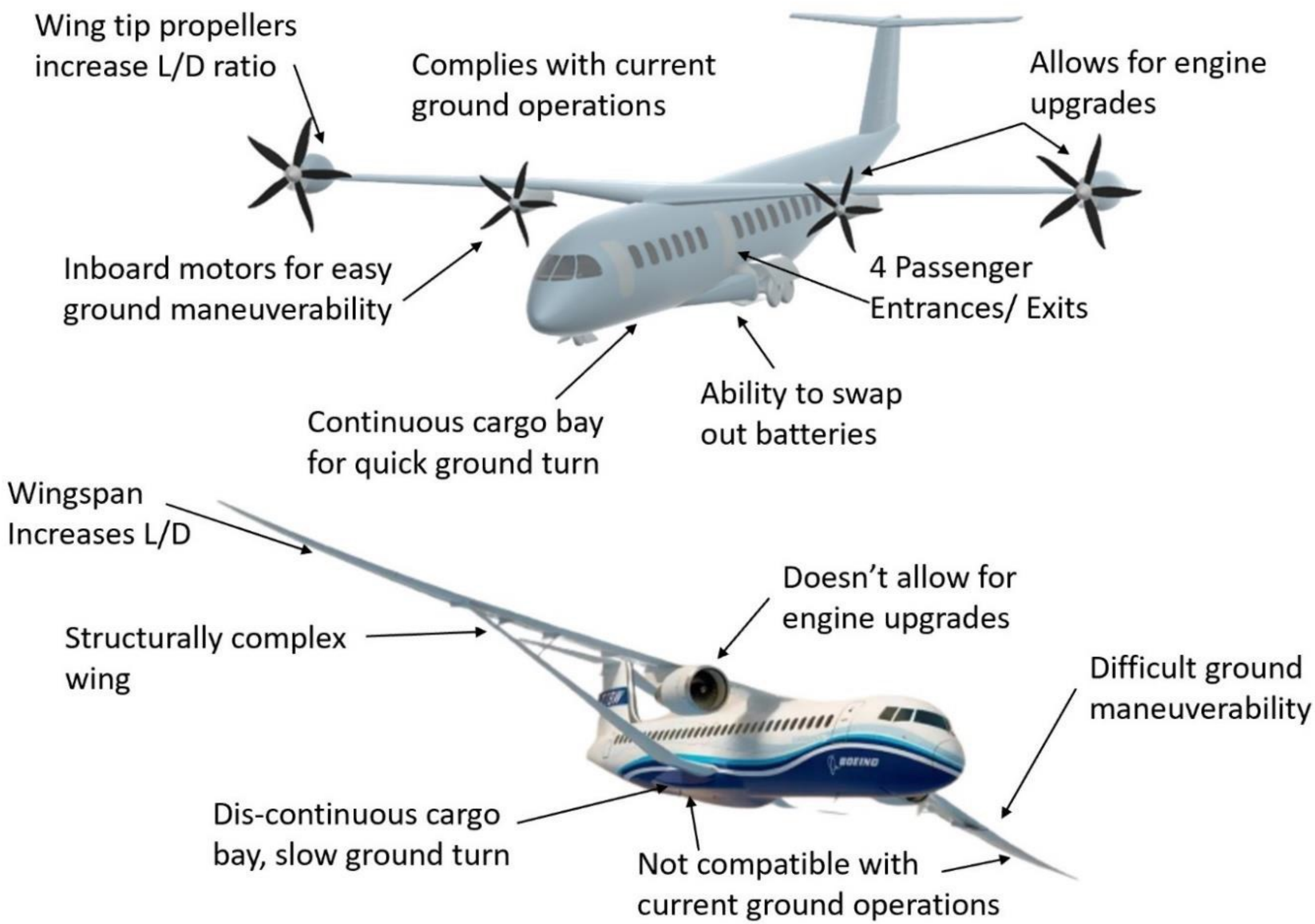
Table 7.1.1: Objective Function Scores for Configurations

Objectives \ Configuration	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
O_1: >350 KTAS Cruise Speed	1	1	1	1	1	1	1	1	1	.5	.5	1	1	1	1	1
O_2: >46 Passengers	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1
O_3: <78.74 ft wingspan	1	1	1	1	1	1	1	1	1	1	.5	1	1	1	1	0
AO_1: Complies with ADA guidelines	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
AO_2: Development cost is lower than that of competitors	1	1	0	1	1	0	1	0	0	0	0	1	0	0	0	1
AO_3: Maintenance doesn't require any special equipment	1	1	1	0	1	0	1	1	1	0	1	1	1	1	1	1
AO_4: Four entrances for quick passenger loading/unloading	1	1	1	1	1	1	0	1	0	0	1	1	1	1	1	1
AO_5: Meets stage 5 noise restrictions	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
AO_6: Improve passenger ride quality of current turboprops	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
AO_7: Cargo hold turn under 8 minutes	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0
AO_8: Aircraft is compatible with current ground vehicles and operations	1	1	1	1	1	1	1	1	0	0	0	0	1	0	0	0
AO_9: Ability to swap out batteries as technology improves	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
AO_{10}: Allow for future engine upgrades and growth	0	1	1	1	0	1	1	1	0	1	1	1	1	0	0	1
AO_{11}: Increase L/D ratio over current turboprops	0	0	0	0	0	0	0	0	1	0	0	1	1	1	1	0
AO_{12}: Maneuverability on taxiway	1	1	1	1	1	1	1	1	0	1	0	0	1	1	0	0
SUM	12	13	12	12	12	11	12	12	9	7.5	9	13	14	12	11	10

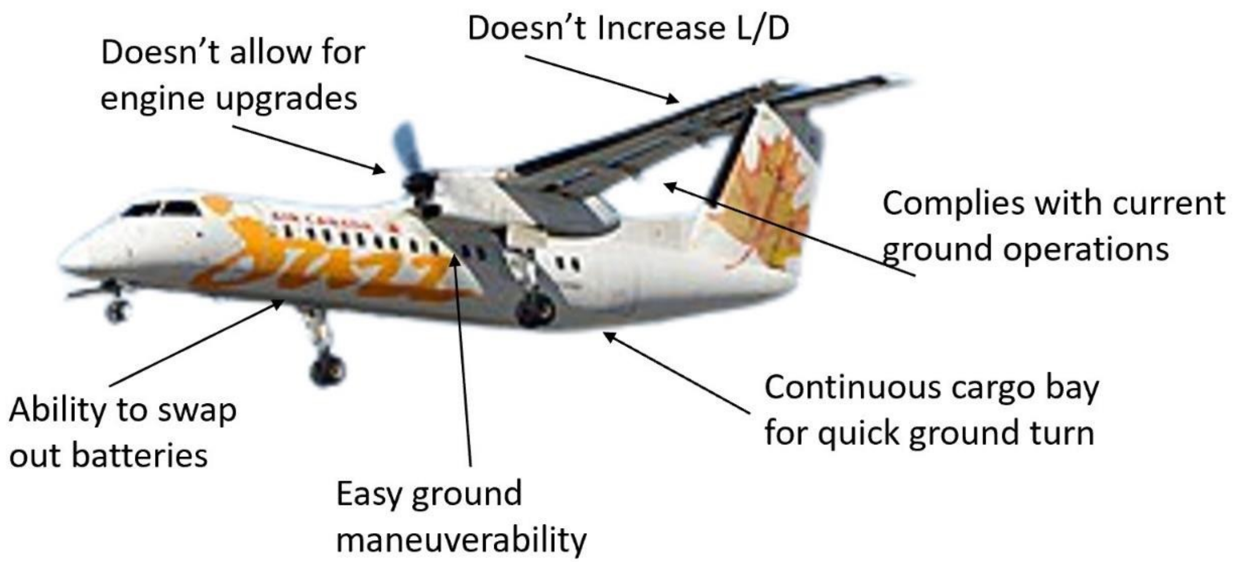
Chapter 7 Application of Optimization Function

	Configuration Number											
	1	2	3	4	5	6	7	8	9	10	11	12
												
O_1 : 350 KTAS cruise speed	1	1	1	1	1	1	1	1	1	1	1	0
O_2 : > 18" seat width	1	1	1	1	1	1	1	1	1	1	1	1
O_3 : < 24 m. wing span	1	1	1	1	1	1	1	1	1	1	1	1
O_4 : Systems and avionics that will enable autonomous operations	1	1	1	1	1	1	1	1	1	1	1	1
SUM	4	4	4	4	4	4	4	4	4	4	4	3
WEIGHTED SUM	1	1	1	1	1	1	1	1	1	1	1	0.75
AO_1 : Door width large enough for standard wheelchair	1	1	1	1	1	1	1	1	1	1	0	0
AO_2 : Large tray-tables for an average laptop	1	1	1	1	1	1	1	1	1	1	1	1
AO_3 : Fast ground turn (<8 min.)	0	0	0	0	1	1	1	1	0	0	0	0
AO_4 : European standards for cargo bay	1	0	0	0	1	1	1	0	0	0	1	1
AO_5 : Multiple doors for simultaneous loading and off boarding docks	1	1	0	1	1	1	1	1	0	0	1	0
AO_6 : Allow for engine diameter growth and powerplant upgrades	1	1	0	1	0	1	1	1	1	0	0	1
AO_7 : Minimal interference with ground traffic	1	0	1	1	1	0	1	1	0	1	0	0
AO_8 : Batteries are on outer mold line of fuselage	1	1	1	1	1	1	1	1	1	1	1	1
AO_9 : Allow for battery pack changes as they improve over time	1	1	1	1	1	1	1	1	1	1	1	1
AO_{10} : Ease of meeting Stage 5+ noise regulation	0	0	1	1	0	0	1	0	0	0	0	0
AO_{11} : Aesthetic appeal (surveyed by multiple non-engineers, ranked 0-1, 1 as best)	0.5	0.42	1	0.67	0.17	0.33	0.83	0.58	0.083	0.91	0.25	0.75
WEIGHTED SUM	6.5	5.22	5.6	6.87	6.17	6.83	8.73	6.88	4.28	4.61	3.95	4.85
TOTAL WEIGHTED SUM	0.74	0.60	0.64	0.79	0.71	0.78	1	0.79	0.49	0.53	0.45	0.56
COMPLETE WEIGHTED TOTAL	0.74	0.60	0.64	0.79	0.71	0.78	1	0.79	0.49	0.53	0.45	0.42

Chapter 7 Application of Optimization Function

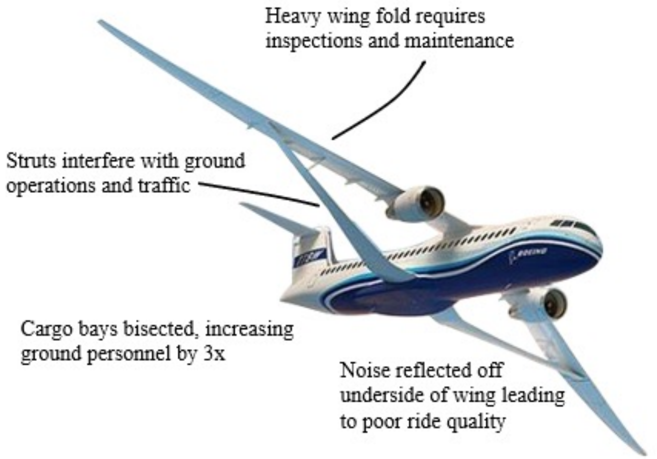


Chapter 7 Application of Optimization Function

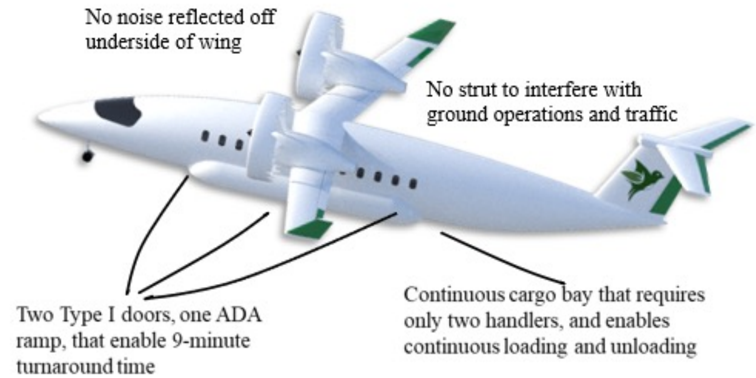


Chapter 7 Application of Optimization Function

Conventional Configuration Design Philosophy: Increase AR to minimize induced drag, increasing L/D at the expense of operating tempo.



Meadowlark Configuration Design Philosophy: Suppress C_{Do} by cleaning and polishing the aircraft every flight, minimizing wetted area, thereby increasing L/D while enabling high operating tempo.



Static Design Approach: Optimize one aircraft configuration for all markets, all seasons, over entire aircraft lifetime.

Dynamic Hybrid Design Approach: Configure aircraft to accept best battery and electric motor technologies that are optimized for each leg, entire season and operator over aircraft lifetime