Aero Lab Milestone 2

Group 013-9:
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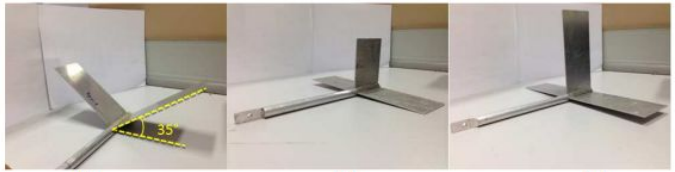
Design Overview

Initial Design Concept

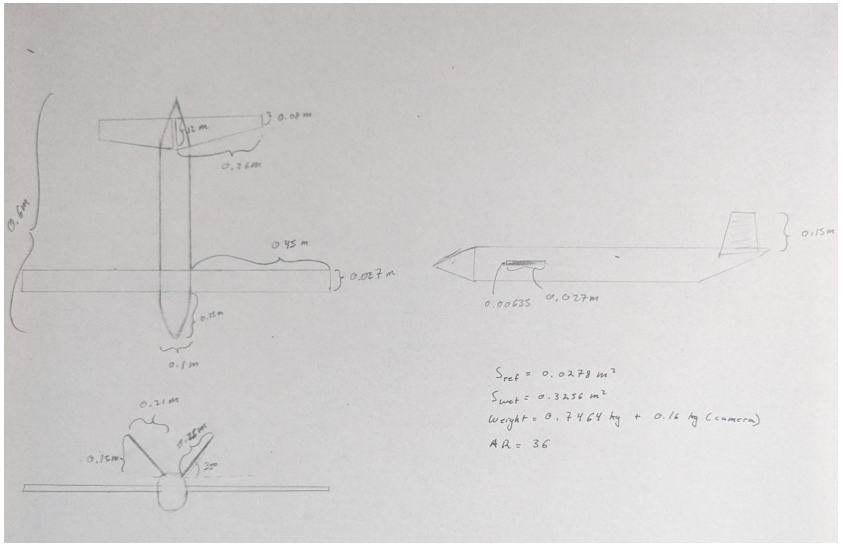
Table 1: Summary of the model geometry

Model	Dihedral angle	Flat Plate Span, b $[m]$	Chord, c $[m]$	Total Surfaces area$[m^2]$	Characteristics length$[m]$	Reference Area, S$[m^2]$
V-tail	35°	0.141	0.062	0.01829	0.244	0.01513
Tail-1	0°	0.116	0.062	0.01829	0.244	0.01513
Tail-2	0°	0.141	0.062	0.02703	0.295	0.01829



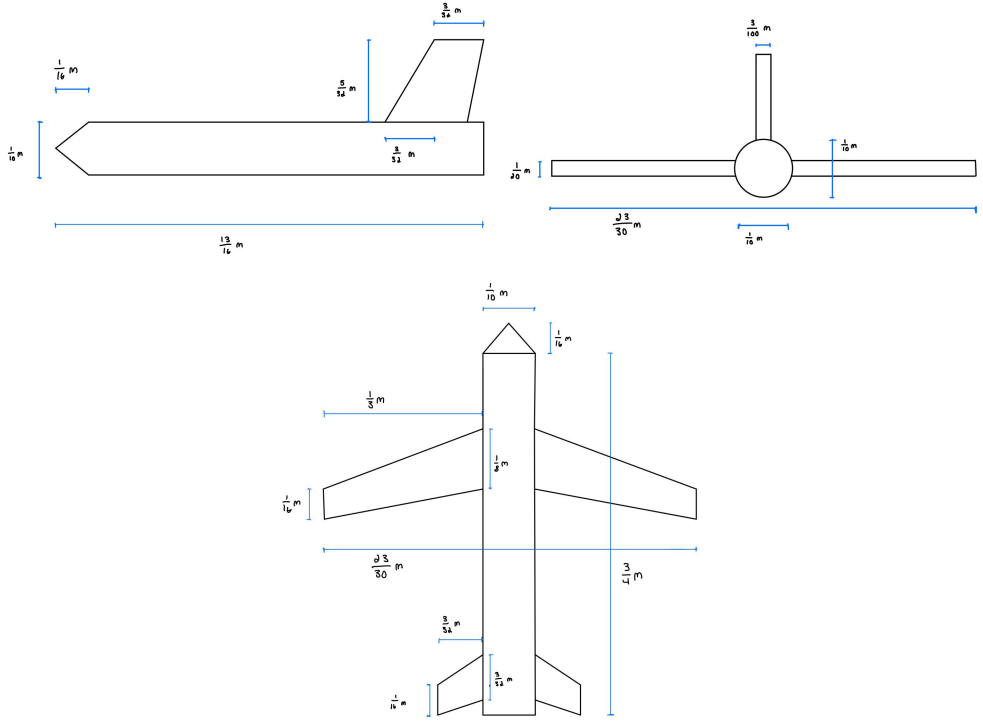
(a) (b) (c)

Figure 1: (a) V-tail Configuration; (b) Tail-1: Conventional tail with tail equal to projected dimensions of (a), (c) Tail-2: Conventional tail with equal surface dimensions but without dihedral

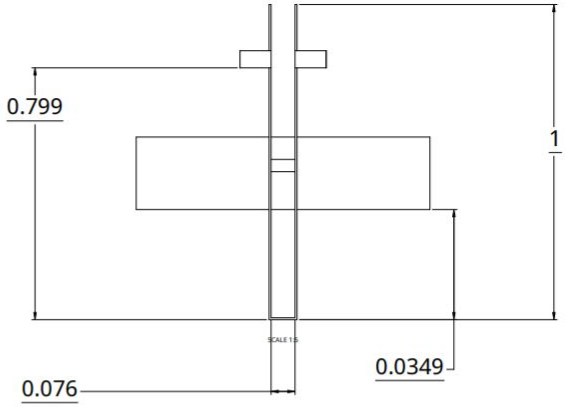


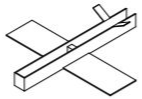
Initial Design Concept: Swept Wing

Sweep Angle	30 degrees
AR	7.837
Sref	.075 m^2
Swet	.4339182875 m^2
Weight	2.8253 N
Range	143.98 m
Endurance	12.46 s
Velocity	11.55 m/s
Wingspan	0.766 m

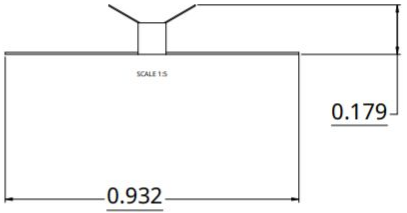


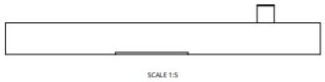
Final Design





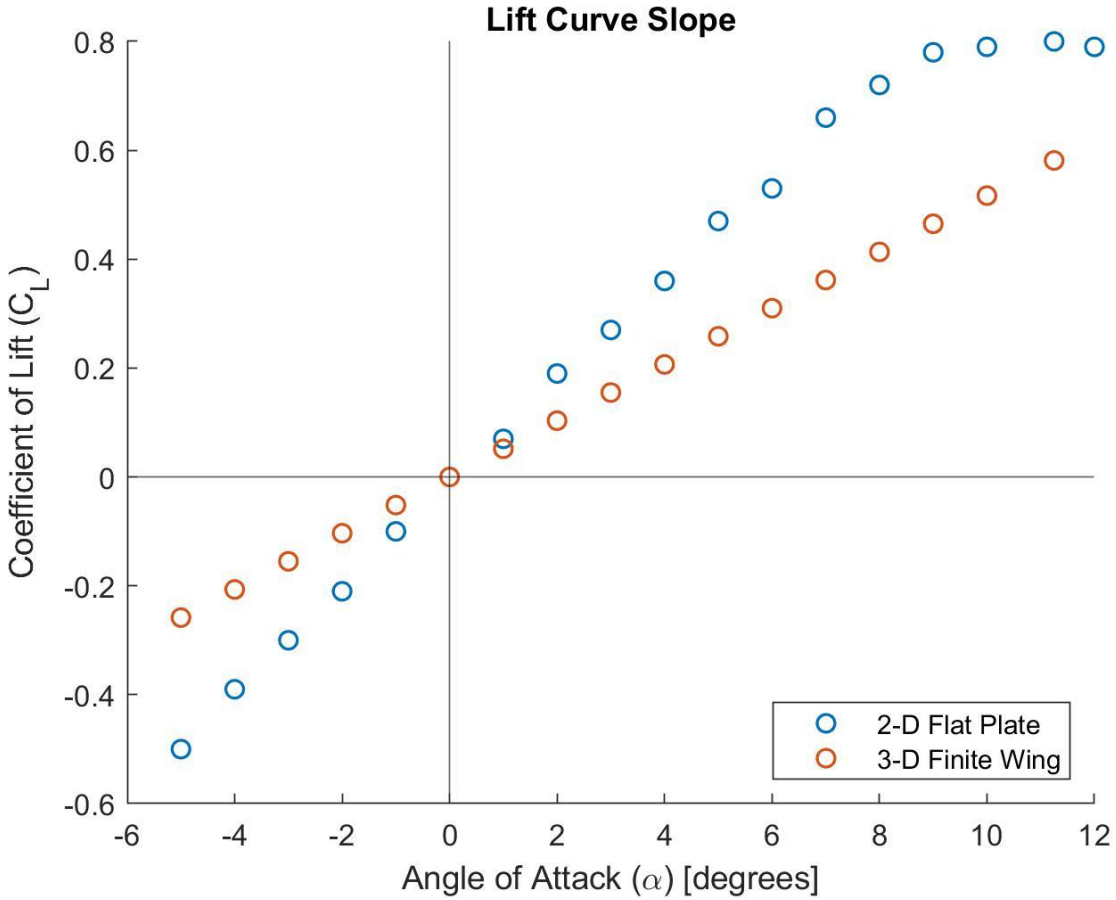
Dimensions	
AR Wing	4
AR Tail	2.5
Chord	0.230
Taper Ratio	1.00
Weight	3.26 N
Wingspan	0.932



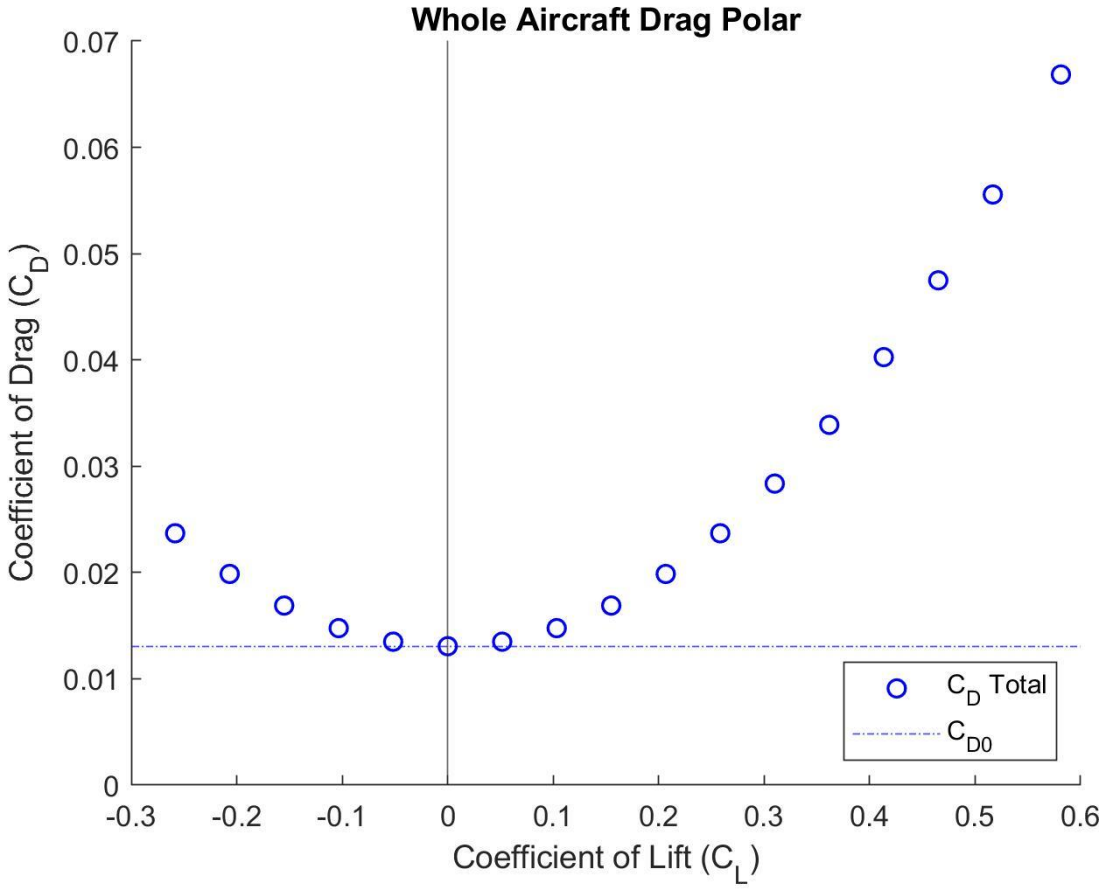


Aerodynamics Analysis

Lift Curve

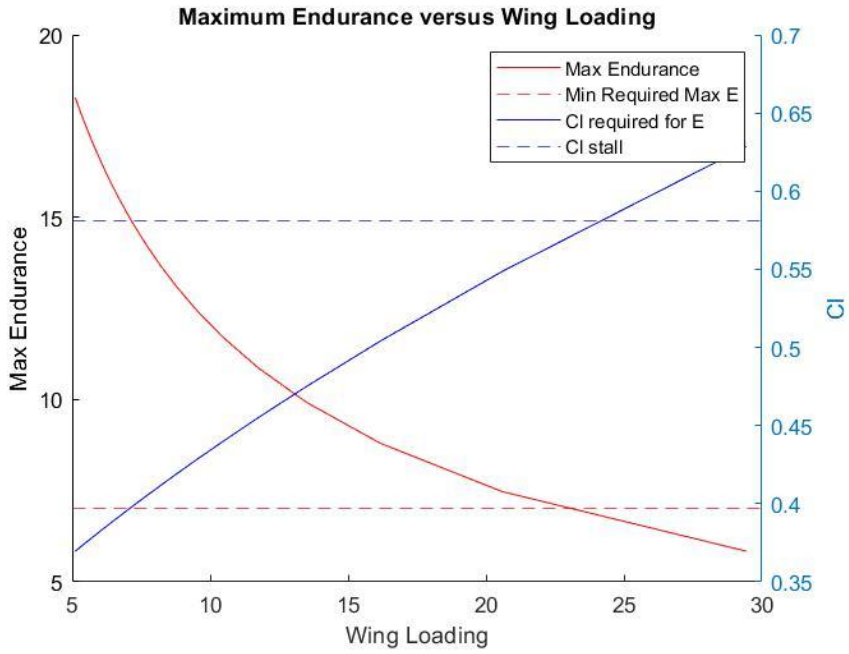

Lift Curve Slope
Coefficient of Lift (C_L)
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-6
-4
-2
0
2
4
6
8
10
12
Angle of Attack (α) [degrees]
2-D Flat Plate
3-D Finite Wing

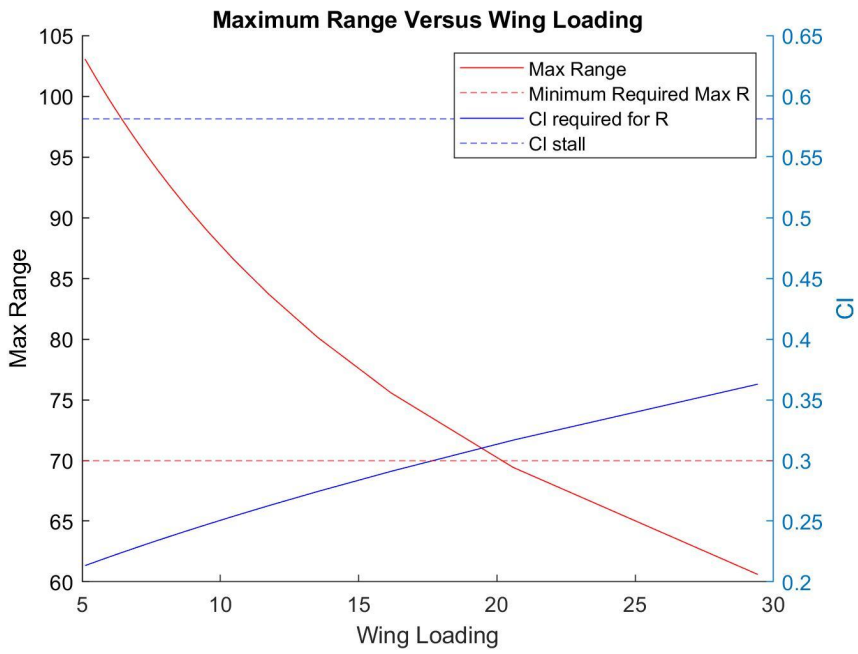
Drag Polar


Whole Aircraft Drag Polar
Coefficient of Drag (C_D)
Coefficient of Lift (C_L)
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
C_D Total
C_{D0}

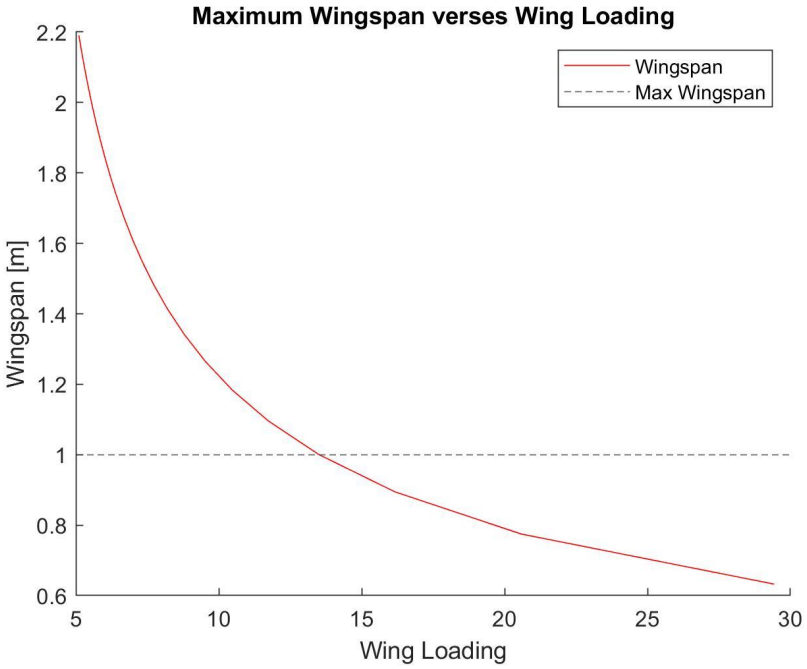
Performance Analysis vs Requirements

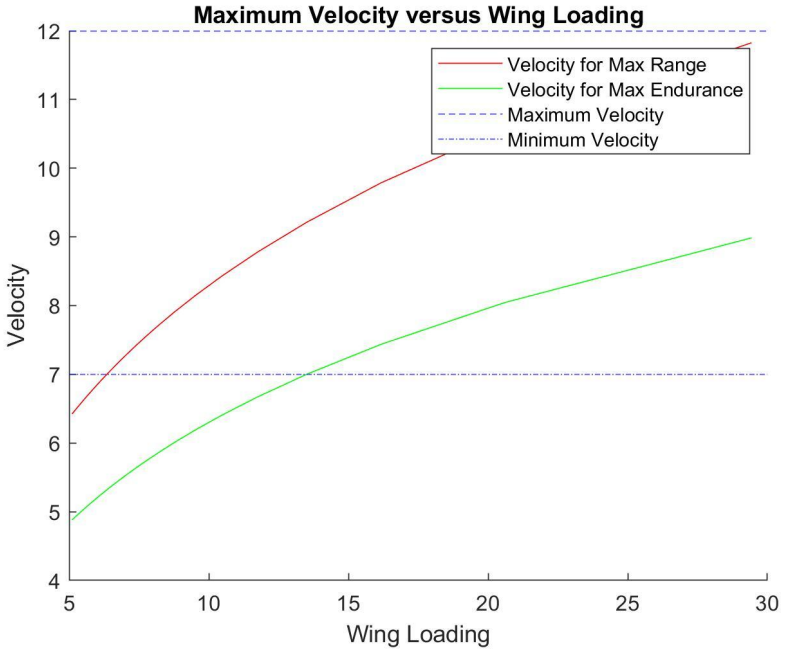
Sizing Aircraft: Endurance and Range





Sizing Aircraft: Velocity and Wingspan

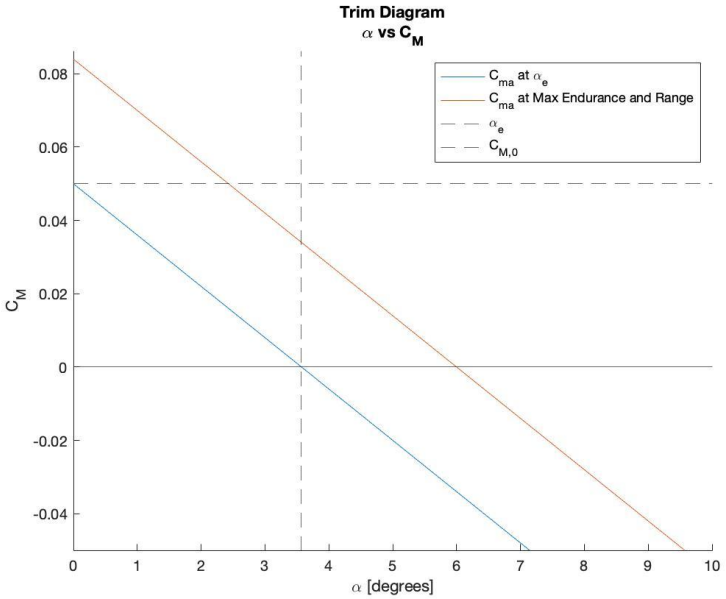


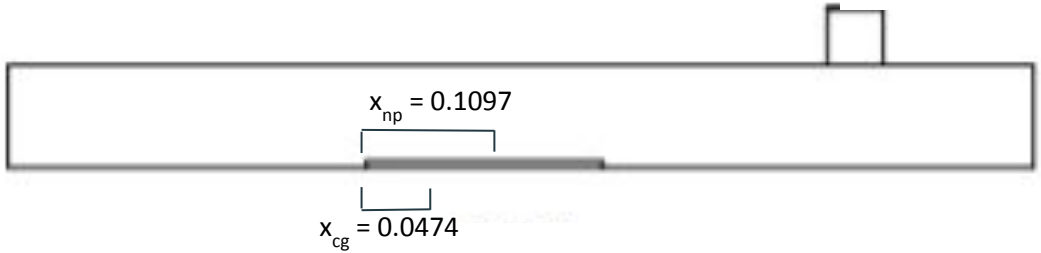


Stability

Static Margin: 27.09%

Lateral Directional Stability: ~25 degrees





Glider Design Performance Requirements

System Requirements	Threshold	Objective	Min or Max	Our values
Glide Range	70 m	100 m	Max	77 m
Glide Range Velocity	12 m/s	7 m/s	Min	9.6 m/s
Glide Endurance	7 sec	10 sec	Max	7.9 sec
Elevator Pitch Control	+/- 8 deg	+/- 10 deg	Max	+/- 6.54 deg
Longitudinal Stability	$0c < X_{cg} < 1.0c$	$X_{cg} = 0.25c$	-	$c = 0.23$ $X_{cg} = 0.0474$

Glider Design Performance Requirements

System Requirements	Threshold	Objective	Min or Max	Our values
Longitudinal Stability	V_H= 0.3	V_H = 0.6	-	V_H = 0.4
Lateral Stability	V_V= 0.02 B ≥ 5	V_V= 0.05 B ≥ 5	-	V_V= 0.03 B = 7
Maximum Wingspan	1.0 m	N/A	Max	0.92 m
Payload Requirement				
Unit Cost	No limit		Min	$173.11

Conclusion

Possible Further Iterations

Stability

- Develop better understanding of stability components
- Start analyzing their effects earlier in design process

Tail

- Simpler configurations
- More research on V tail before using it in the future

Wings

- Attempt other wing configurations
  - Sweep
  - Winglets

What We Learned

Multiple Pieces

- Many pieces to account for to meet requirements
- Small changes can make big differences

Difficulty Level

- Many considerations we couldn't account for
- Designing a glider is challenging overall
- It is easy to get set back by pieces that don't work out

Flexibility

- There is room for flexibility early on in design
- More changes result in more opportunities for mistake
- Must be able to roll with what works well enough in an initial iteration