C-17.

http://www.sflorg.com/aviation/av032006_01.html

Tyler, Jason R., and Instan-Tanious

Humble Roots: the Tale of the “Globemaster“

C-74 Globemaster

C-124 Globemaster II

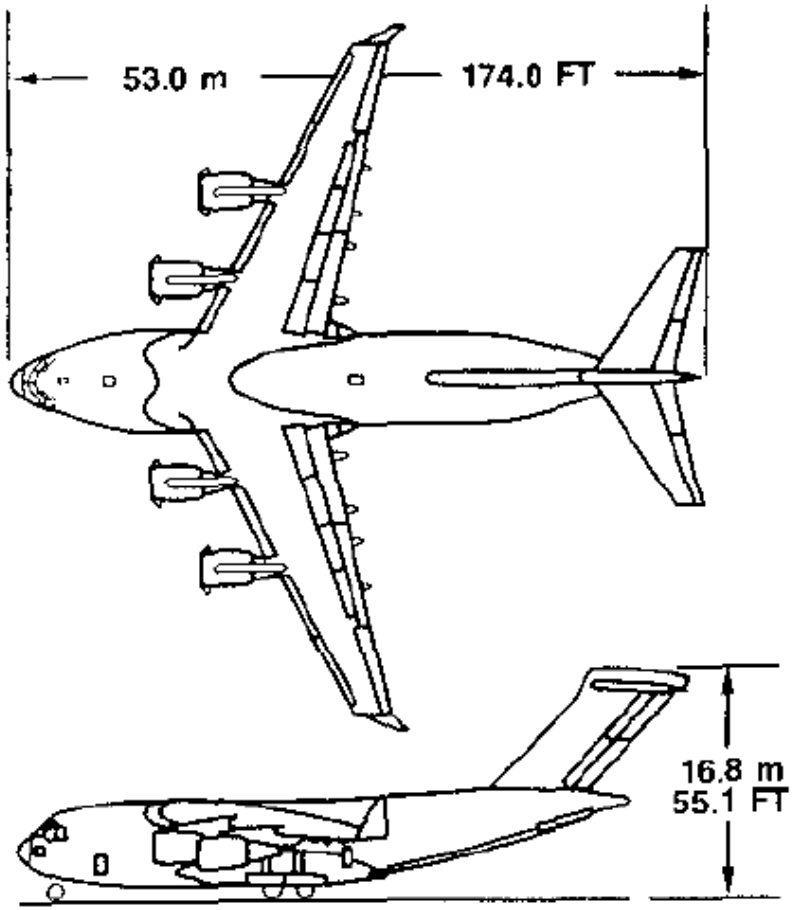
Images from Wikipedia

The C-17 Globemaster III

- Manufactured by Boeing Integrated Defense Systems
- Developed from McDonnell Douglas YC-15
- Strategic tactical airlifter
- Major Assembly in Long Beach, CA with Component Assembly in Macon, GA
- 200+ Active US Military
- Winner of 1994 Collier Trophy
- First Flight Sept 15, 1991
- Commercial Version Considered (MD-17)

Configuration

Basic Geometry	
Wing Span	169 ft 9 in
Wing Span (Without Winglets)	165 ft
Wing Area	3800 ft^2
Wing Mean Aerodynamic Chord	25.35 ft
Wing Sweep (quarter chord)	25˚
Wing Anhedral	3°
Wing Aspect Ratio	7.2
Horizontal Stabilizer Area	845 ft^2
Height	55 ft 1 in
Length	174 ft



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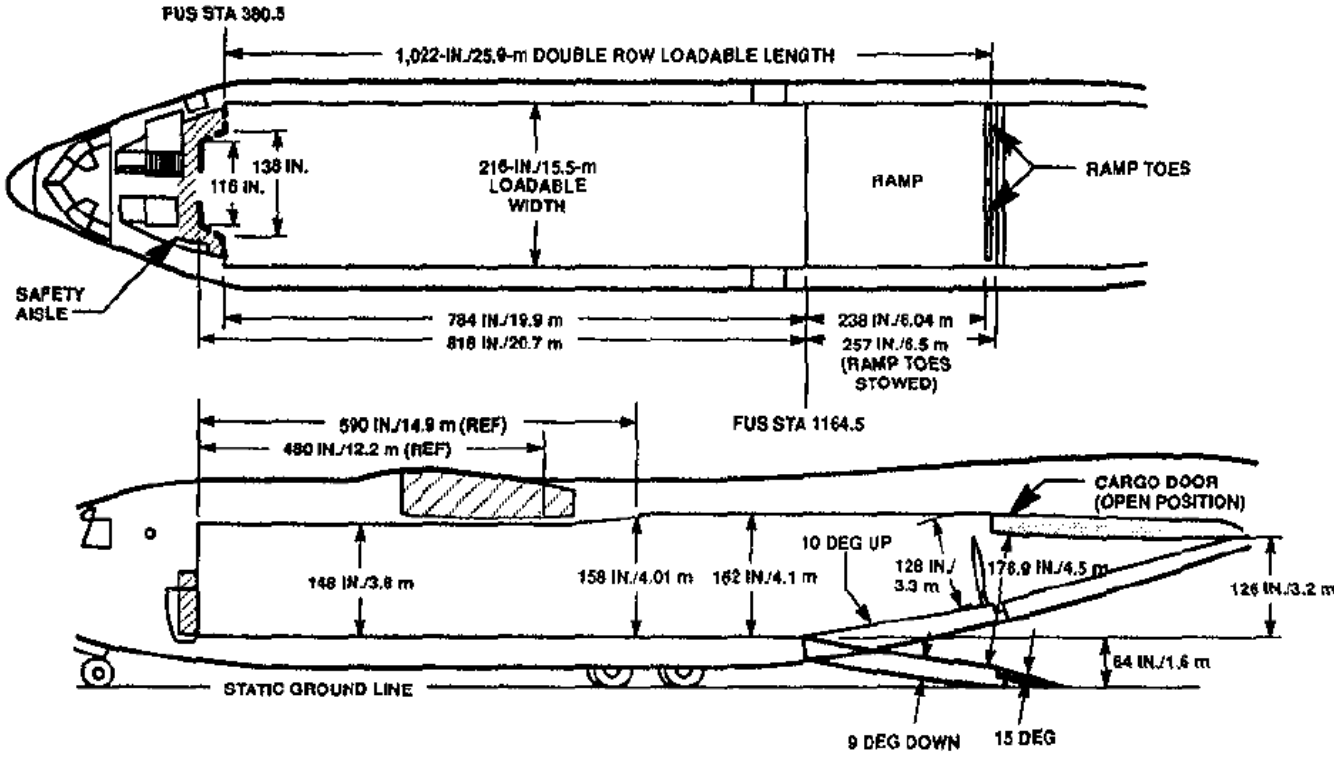
Payload Considerations

Cargo Box	
Length (inc. Ramp)	88 ft
Width	18 ft
Height	12 ft 4 in
Ramp Length	19ft 10 in



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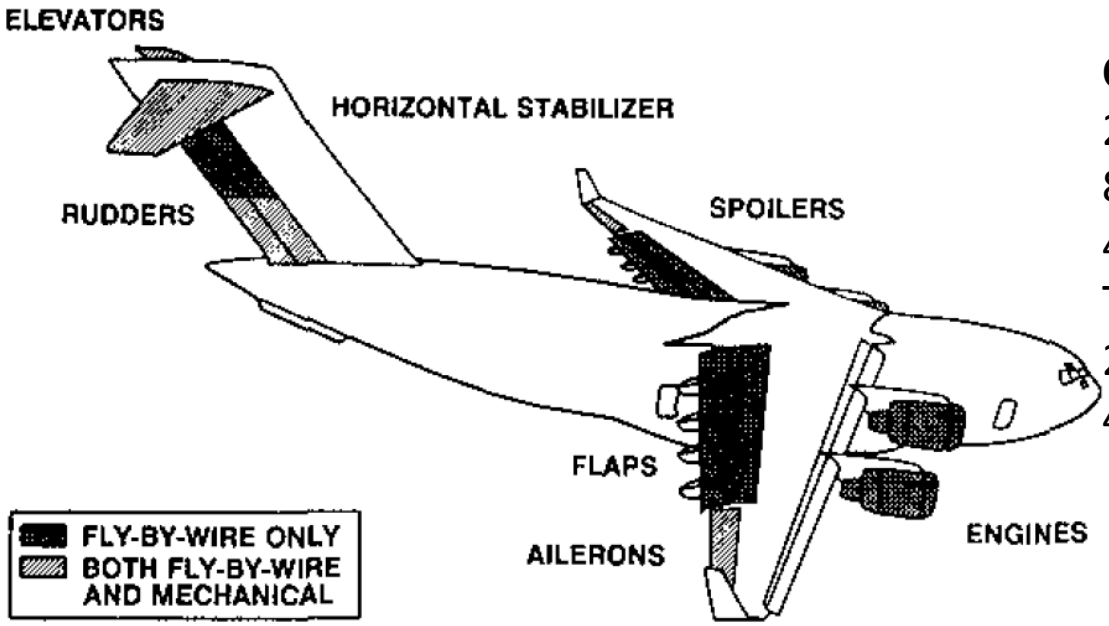
Cargo Capacity:

- Maximum Payload of 170,900 Pounds
- 6 5-ton expansible vans
- 18 USAF 463L Pallets (12 on the main floor, 4 on ramp)
- 140+ Passengers (102 Paratroopers)

Flight Controls



Control Surfaces
2 Ailerons
8 Spoilers
4 Elevator Surfaces
Trimming Horizontal Stabilizer
2 Rudder Sections
4 Flaps and 8 Slats

Electronic Flight Control System
4 Flight Control Computers
2 Spoiler Control/Elevator-Feel Computers
2 Dual Air Data Computers
3 Three-Axis Rate Sensors
3 Three-Axis Accelerometers
1 Quadruple Sensor per Control Column
1 Quadruple Sensor per Rudder Pedal

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- Quadruple Redundancy
- Hydro-mechanical Backup to electrical systems
- Glass Cockpit with dual HUDs

Flight Control Geometry

Spoilers (8 Sections)	
Surface Area (Total)	482 ft^2
Span (Single Wing)	48.2 ft
Average Chord	5 ft
Spanwise Location on Wing (Local Average Chord)	15% - 68%
Chordwise Location on Wing (Local Average Chord)	65.5% - 81%

Ailerons (2 Surfaces)	
Surface Area (Total)	127.34 ft^2
Span (Single Surface)	21.1 ft
Average Chord	3.09 ft
Spanwise Location on Wing (Local Average Chord)	70% - Winglet
Chordwise Location on Wing (Local Average Chord)	80%

Elevator (4 Sections)	
Surface Area (Total)	308.0 ft^2
Span (Single HT Side)	28.5 ft
Average Chord	5.4 ft
Chordwise Location on H.T. (Local Average Chord)	70%

Rudder (2 Sections)	
Surface Area (Total)	252 ft^2
Span	31.5 ft
Average Chord	8 ft
Spanwise Location on V.T. (Local Average Chord)	0% - 85%
Chordwise Location on V.T. (Local Average Chord)	64%

Weights and Performance

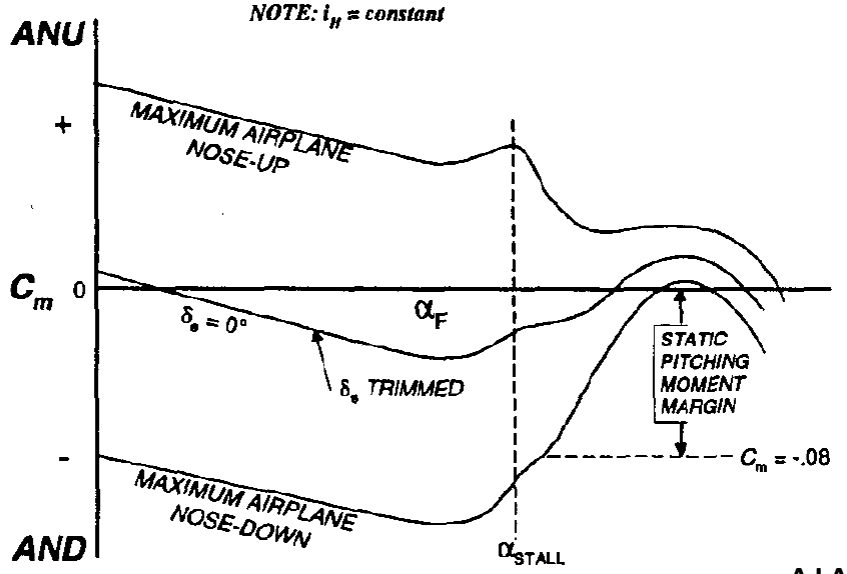
Weights	
Max Takeoff Gross Weight	585,000 lbs
Operating Empty Weight	276,500 lbs
Max Payload Weight	170,900 lbs
Max Fuel Weight	180,806 lbs
Max Wing Loading	161.84 lb/ft^2
Max Power Loading	3.80

Note: Additional tanks can be added for longer range and increased fuel weight.

Performance	
Cruise Speed (FL 280)	Mach 0.77
Airdrop Speed	115-250 kts
Approach Speed	115 kts
Service Ceiling	45,000 ft
Landing Field Length (including TRs)	3,000 ft
Takeoff Field Length	7,740 ft
Range (160,000 lbs Payload)	2,240 nm
Range (40,000 lbs Payload)	4,200 nm
Cruise C_L	0.55

Deep Stall

- Originally, no Angle of Attack Limiting System
- Deep Stall Potential
- α-Limiter Designed and Installed to comply with Air Vehicle Specification



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Propulsion (Forward and Reverse)

- Uses four F-117-PW100 (PW2040 used in the B757)
- 40,400 lb. thrust per engine
- 5.9 bypass ratio
- 30.8 overall pressure ratio
- T/W = 5.7
- Specially designed to be “fully reversible”
  - Core AND bypass exhaust redirected
- Uses cascades to direct thrust up and forward (to avoid FOD)
- Enough reverse thrust to push a fully loaded aircraft up a 2° slope

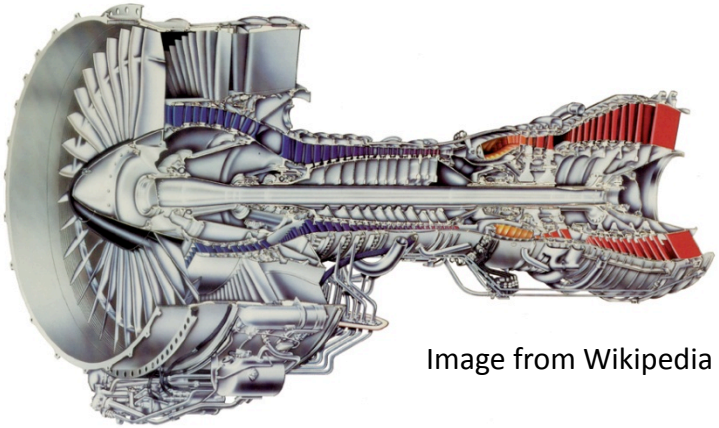

Image from Wikipedia

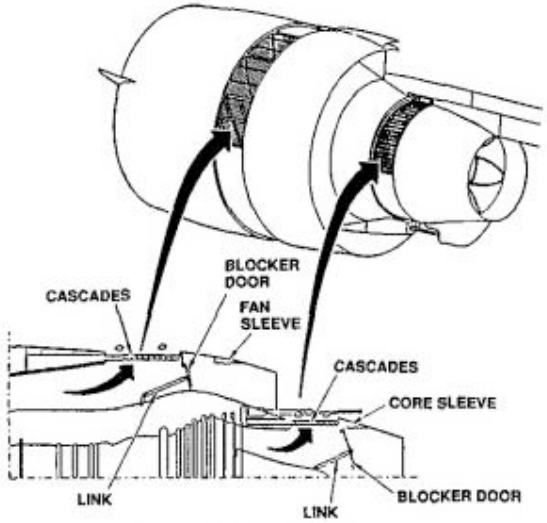

Figure 4. Thrust Reverser

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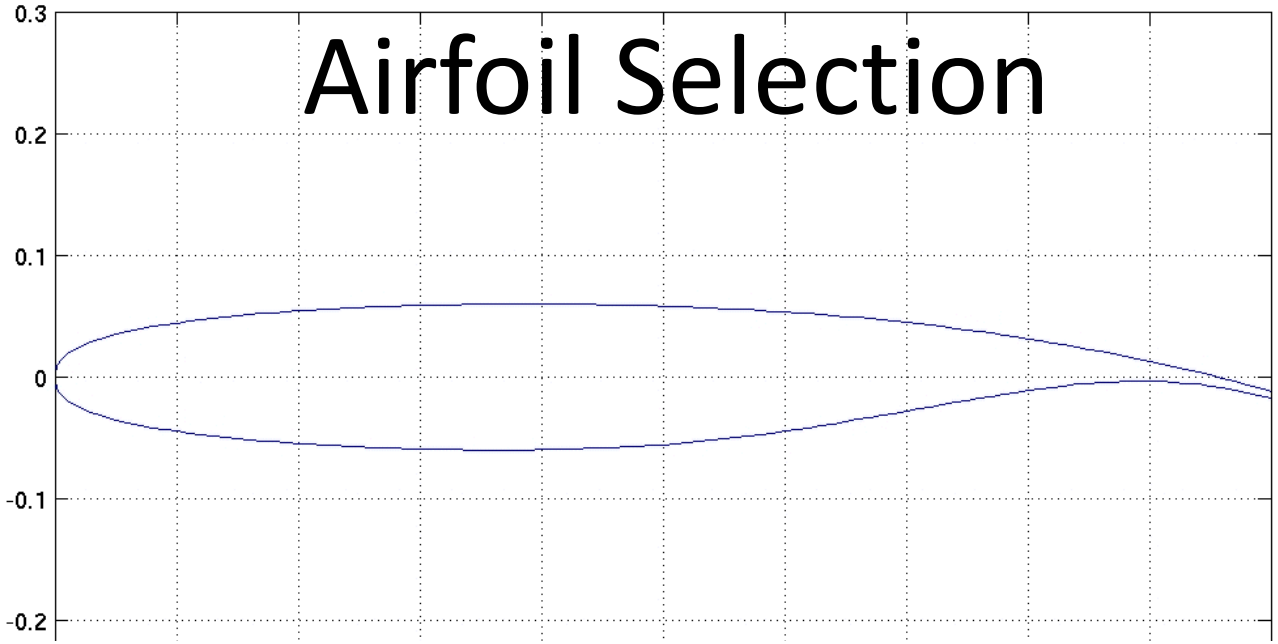
Airfoil Selection



- 12% thick supercritical airfoil
- Developed by Richard Whitcomb to reduce wave drag by producing weaker upper surface shockwaves
- Equal drag to thinner non-supercritical airfoils allows for higher fuel volume

Winglets

S = 35.85 ft^2 (total)

30° Sweep Angle

15° declination from vertical

Supercritical Airfoil

Vortex Generators

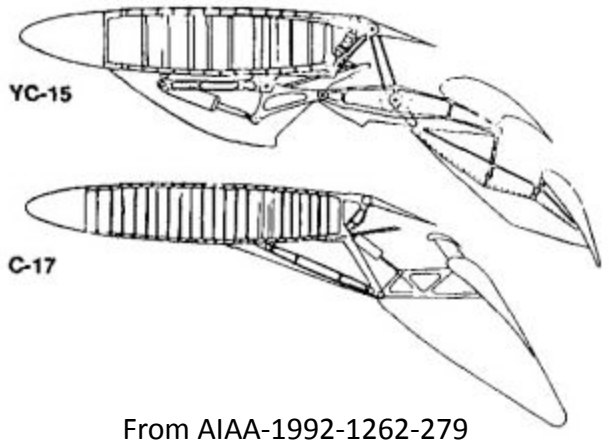
http://www.fas.org/man/dod-101/sys/ac/c-17-1999415c17.jpg

http://www.flickr.com/photos/31864937@N00/1318527070/in/set-72157594530625401/

Increase “effective span” and decrease wingtip losses which decreases lift induced drag for improved cruise efficiency.

High-Lift Systems

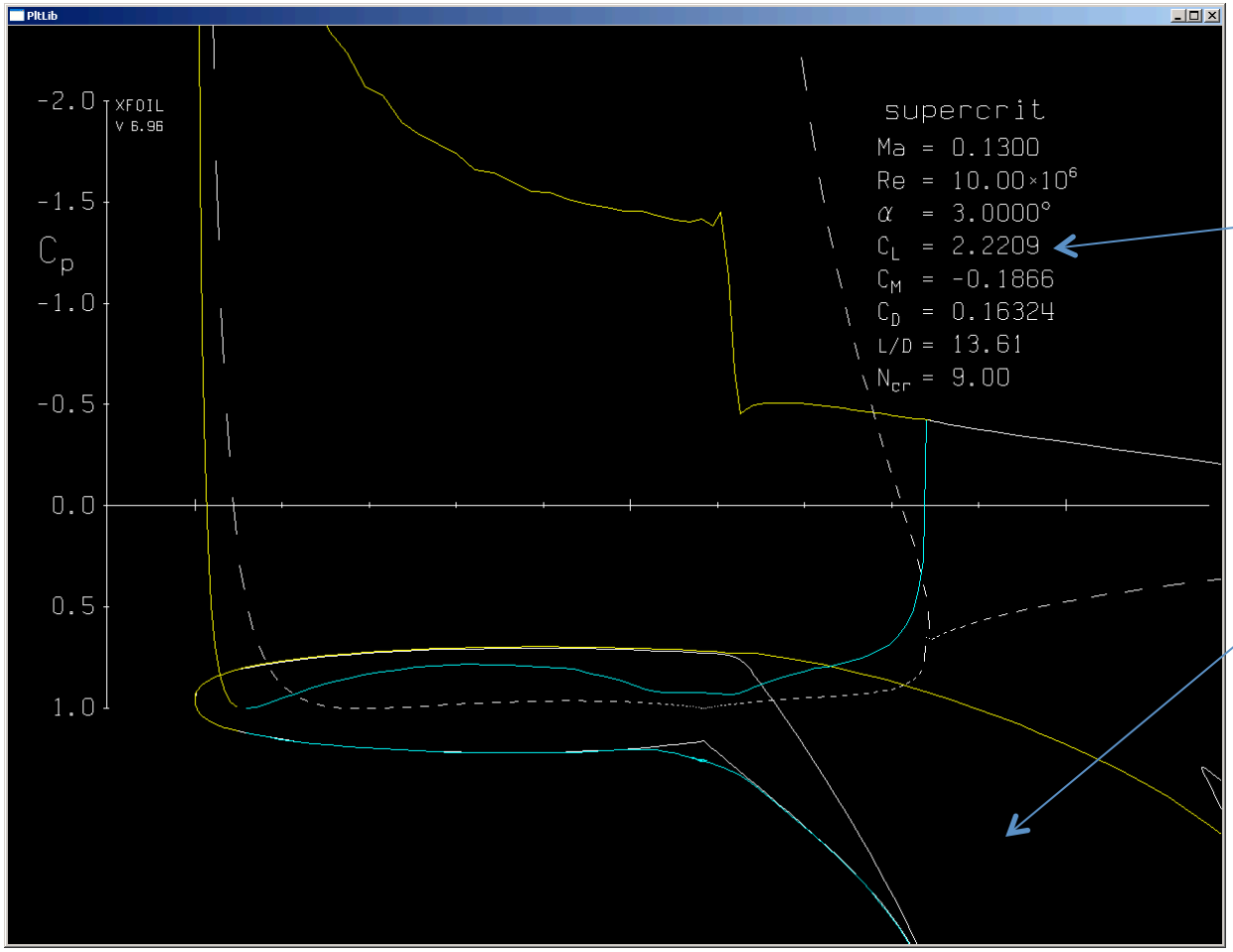
- Slotted Lowering-flaps system
- Externally blown flaps
  - Directly blown by turbofan exhaust
  - Requires extremely strong material flaps
  - Can generate very large nose-down pitching moments
- Need for very large horizontal stabilizer
- Slats control LE flow at high angles of attack



From AIAA-1992-1262-279

NASA Langley full-scale tunnel model
http://oea.larc.nasa.gov/PAIS/Partners/C_17.html

High-Lift Systems cont'd.



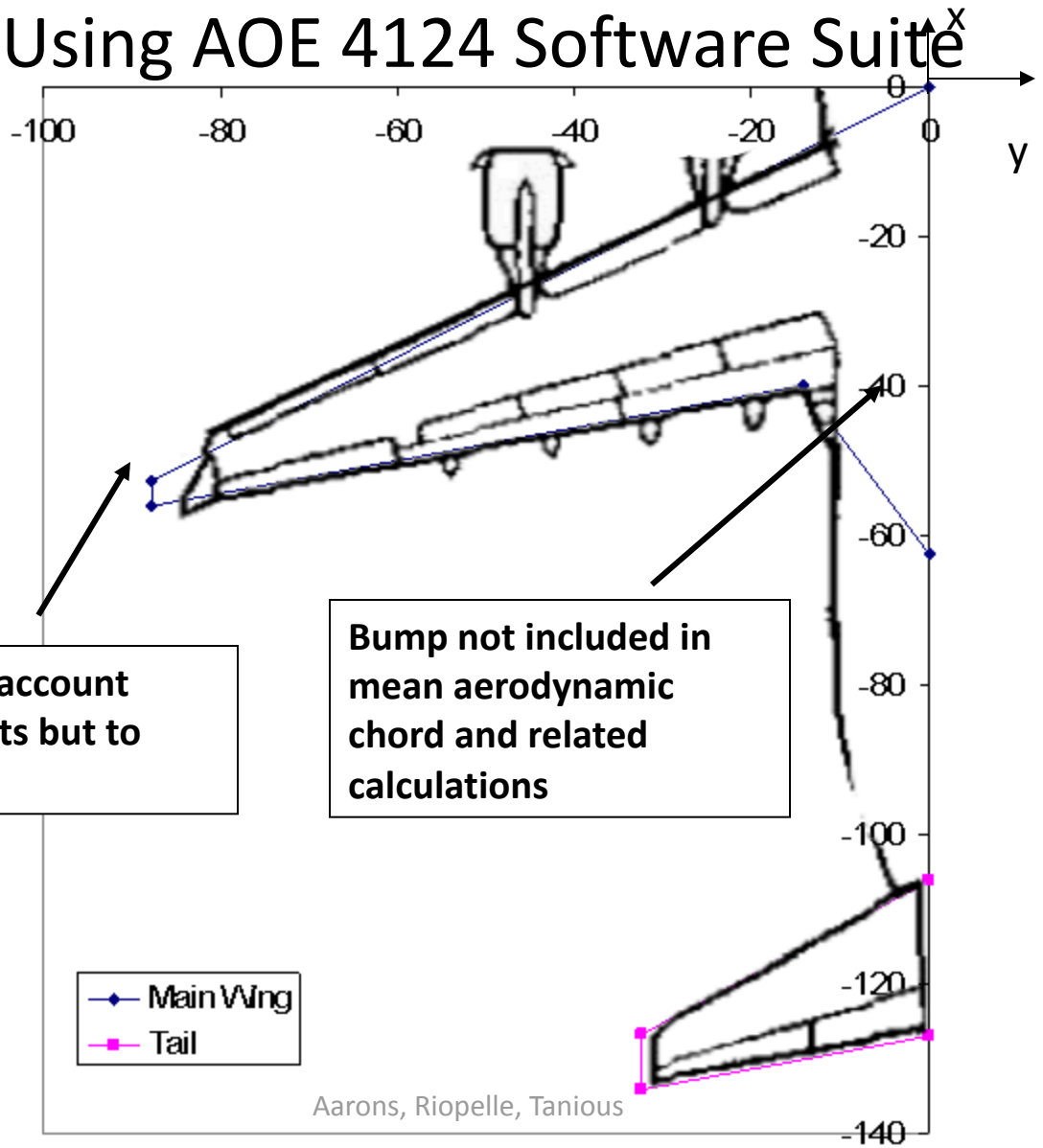
CL for takeoff and Landing are much higher than shown due to powered lift devices

Separated flow would remain attached due to double slotted flap and external surface blowing (ESB)

Although we are unable to model the C_L caused by addition of powered lift devices, we estimate $C_L = 4 – 5$ for STOL operation

C-17 Aerodynamic Analysis

Using AOE 4124 Software Suite



Winglets flattened to account for aerodynamic effects but to simplify geometry.

Bump not included in mean aerodynamic chord and related calculations

Aerodynamic Analysis

Wing Only (for reference):

Mean Aerodynamic Chord = 25.35 ft

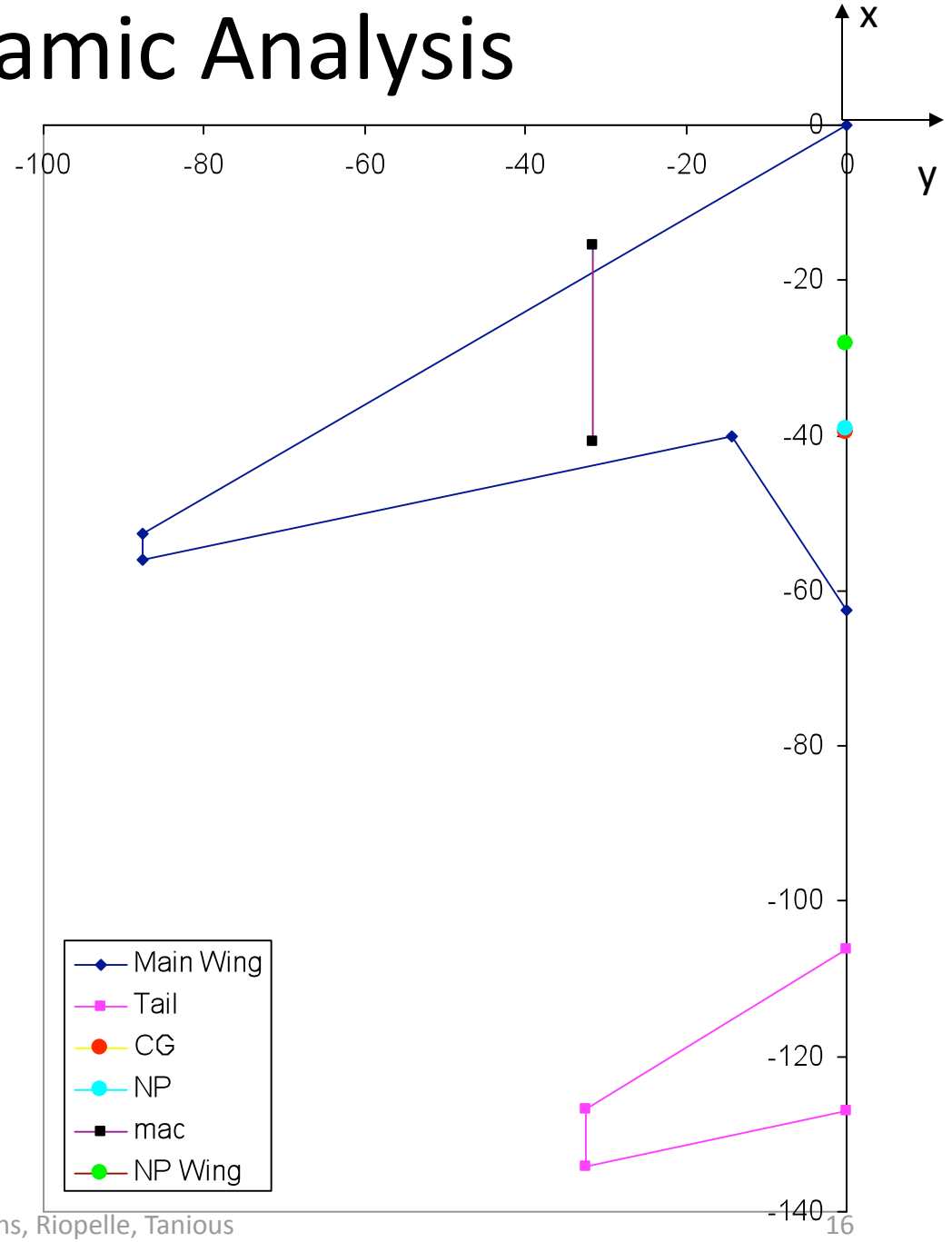
x_{LE}mac = 15.4049 ft
y_{LE}mac = 31.6118 ft

Neutral Point = 28.247 ft

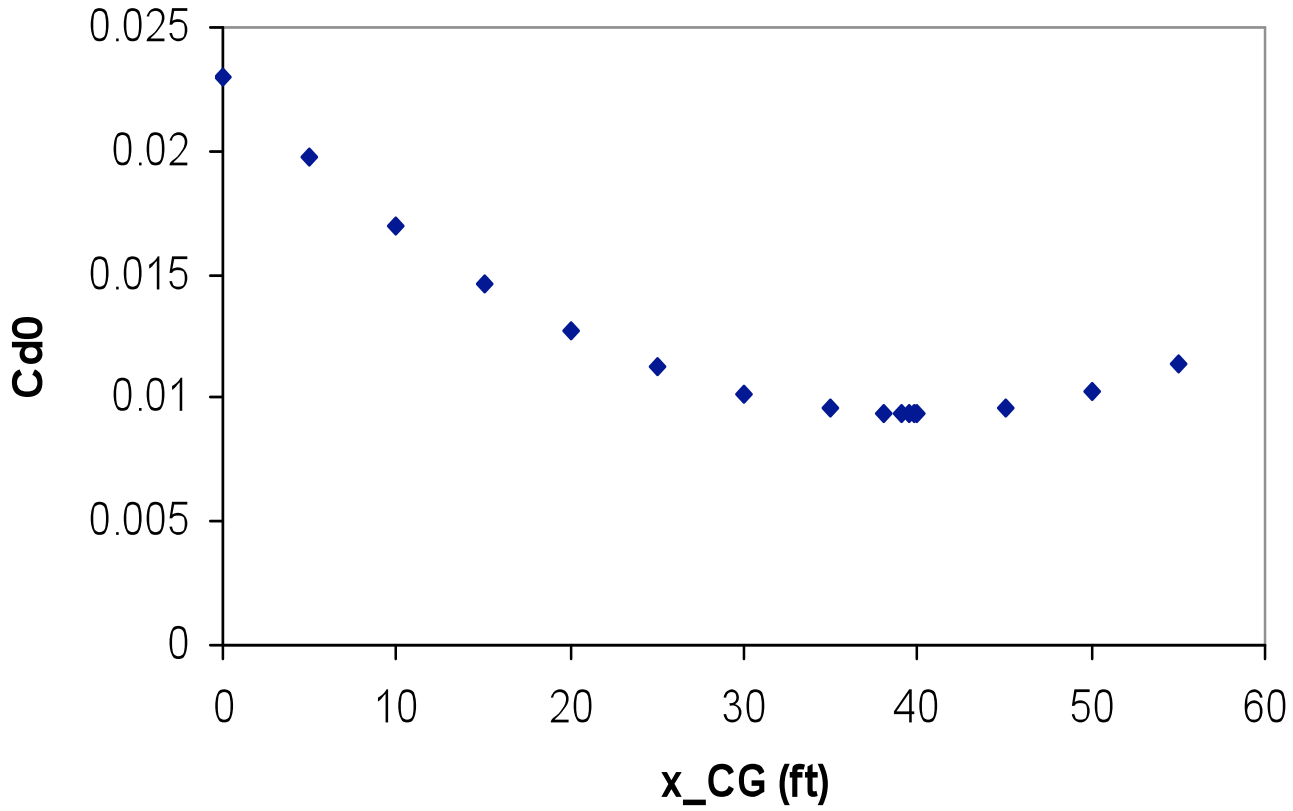
Total Aircraft:

SM = -2.45% (norm w/ wing mac)
Neutral Point = 39.127 ft
CG (min trimmed drag) = 39.75 ft
E = 1.0513

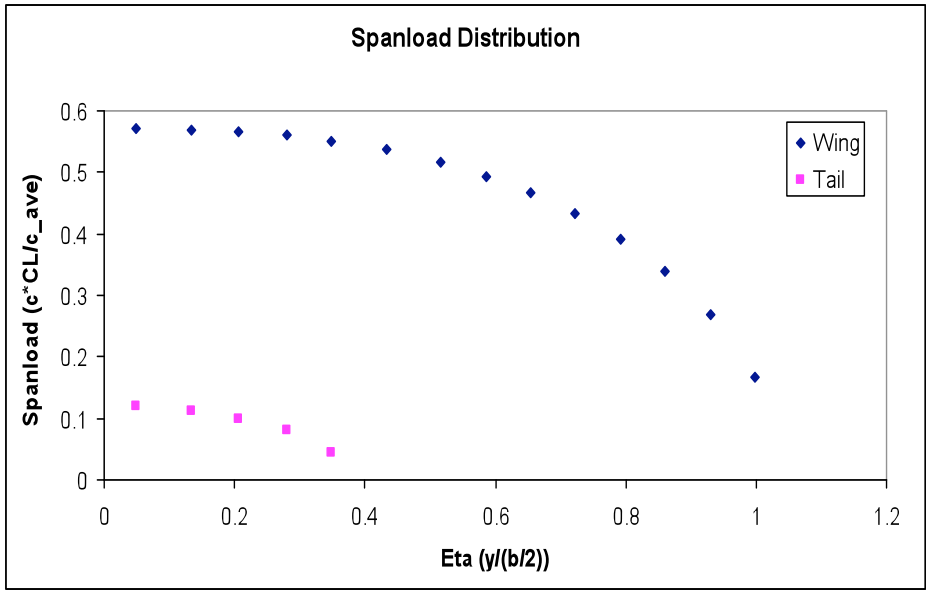
*Neutral Points calculated in VLMPc
*CG and E calculated in LAMDES

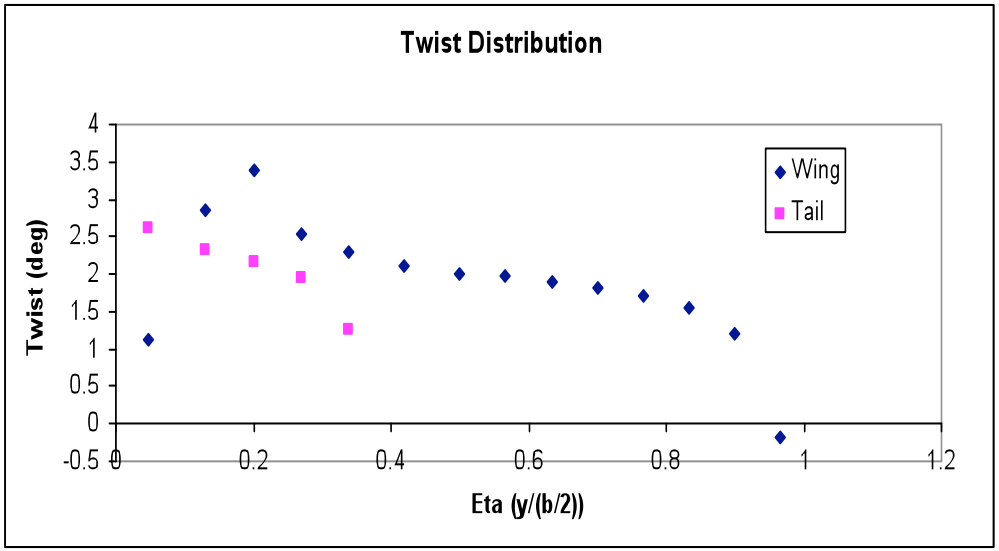


CG for Minimum Trimmed Drag



From LAMDES, Balanced at CG location for minimum trimmed drag





From LAMDES, Balanced at CG location for minimum trimmed drag

Special Abilities

Short Takeoff and Landing	
Shortest Takeoff Distance	3,700 ft (unloaded)
Shortest Landing Distance	2,300 ft (unloaded)

Unrestricted Climb

- Get out of trouble FAST

Air Drop Capabilities

- Over 100 Paratroopers
- Up to 120,000 pounds

Full Thrust Reversal

- Aircraft can Self-propel up 2% Slope in reverse

http://oea.larc.nasa.gov/PAIS/Partners/C_17.html

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