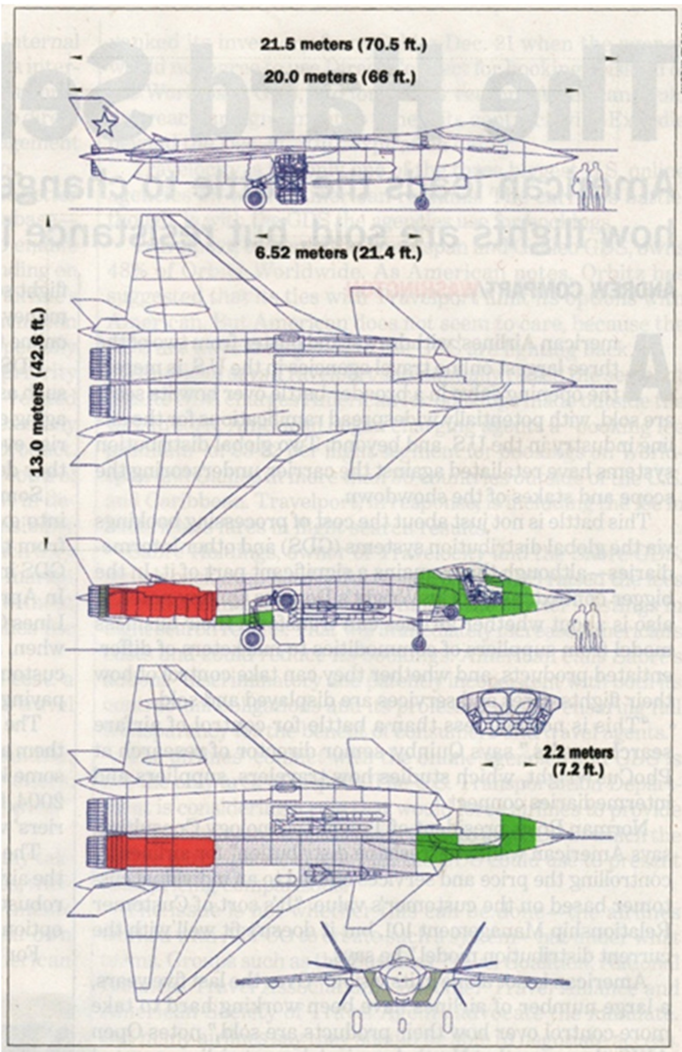
The Chengdu Jian-20

Kris Douglas, Sam Kantor, Michael Palles and Grant Parrish

Configuration and Geometry



- Geometry estimated using 3-view drawing and graphics application
- Relatively long, high-volume fuselage compared to existing 5th generation fighters

J-20 AIRFRAME GEOMETRY				
Length (ft)	Height (ft)	Span (ft)	S_{wet} (ft^2)	V_{fuse} (ft^3)
70.5	14.4	42.6	3025.7	2377.3

Configuration and Geometry

J-20 PLANFORM GEOMETRY										
S_{wing} (ft^2)	b (ft)	S_{ref} (ft^2)	AR	C_r (ft)	C_t (ft)	C_{ave} (ft)	λ	Λ_{LE} (°)	Λ_{TE} (°)	Γ (°)
493.2	42.6	829.9	2.19	34.0	4.9	19.5	0.15	49.9	-8.4	-3.9

Wing-Mounted Control Surface	Area (ft^2)	% C_{ave}	% b/2	Centroid Location Relative to Nose (ft)		
				x	y	z
Aileron	20.8	13.0	38.7	55.7	17.2	0.1
Trailing Edge Flap	30.8	23.2	32.0	56.1	10.3	0.6
Leading Edge Slat	17.9	9.7	44.6	44.0	14.8	0.3

Non-Wing-Mounted Control Surface	Area (ft^2)	Average Chord (ft)	Length (ft)	Dihedral (°)	Centroid Location Relative to Nose (ft)		
					x	y	z
Canard	48.0	6.6	7.3	10.7	25.2	8.3	1.8
Tail	53.5	6.6	8.2	59.8	60.2	4.1	3.9
Aft Ventral Fin	16.7	4.9	3.4	-60.3	59.6	7.1	-2.2

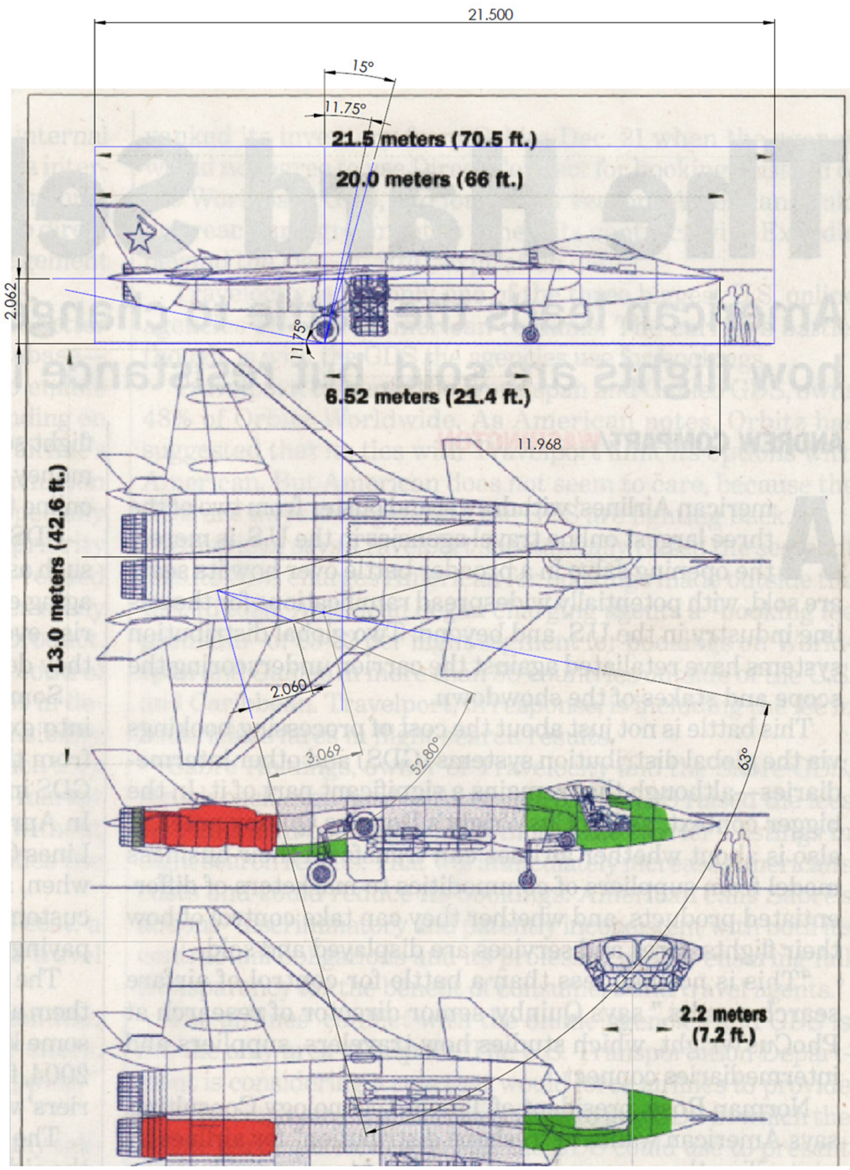
Weight Estimation

Aircraft Component	Multiplier and Reference	Reference Value	Weights (lb)	CG Location Aft of Nose Apex (ft)
Main Wing	9.0×Wing Area (ft^2)	493.2	4438.8	48.8
Horizontal Tail	4.0×Horizontal Tail Area (ft^2)	125.3	501.2	40.0
Vertical Tails	5.3×Vertical Tail Area (ft^2)	73.0	386.9	60.7
Fuselage	4.8×Fuselage Wetted Area (ft^2)	1566.7	7520.3	33.0
Landing Gear	0.033× GTOW Guess (lb)	75000	2475.0	37.9
Installed Engine	1.3×Engine Weight (lb)	5000	6500.0	53.2
"All-Else Empty"	0.17×GTOW Guess (lb)	75000	12750.0	33.0

Empty Weight (lb)	34572.2
Fuel and Payload (lb)	40427.8
CG Location (%MAC)	20
CG Estimate based on Gear Placement (%MAC)	18.6

Wing Loading (lb/ft^2)	90.5
Thrust-to-Weight	0.507
Thrust-to-Weight (Afterburners)	0.853

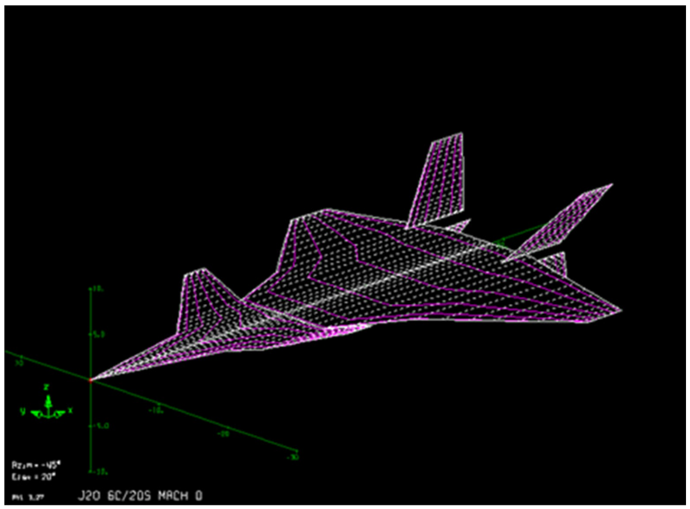
Gear Placement Guidelines

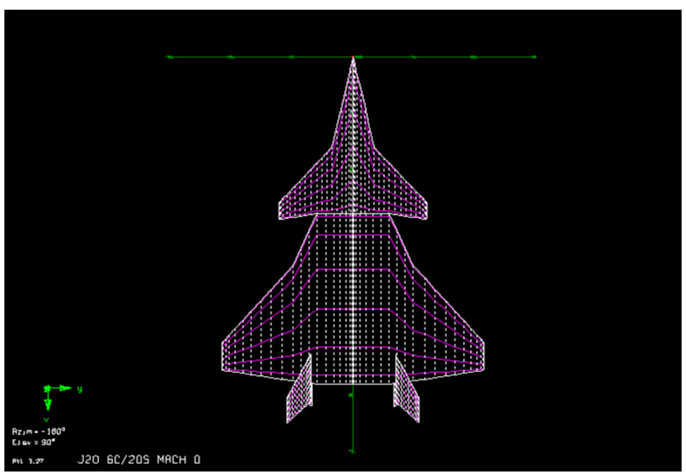


- Tipback angle between 12 and 15 degrees
- Overturn angle between 54 and 63 degrees
- Results in CG location of approximately 18.6% MAC

Stability Characteristics

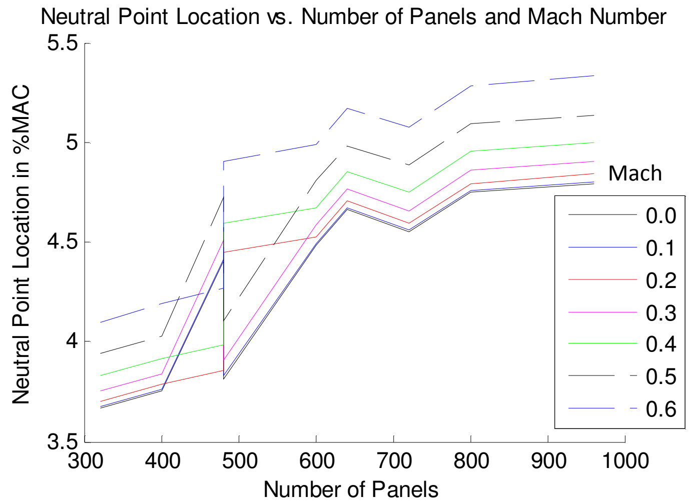
AVL 3.27 Model (960 Panels)

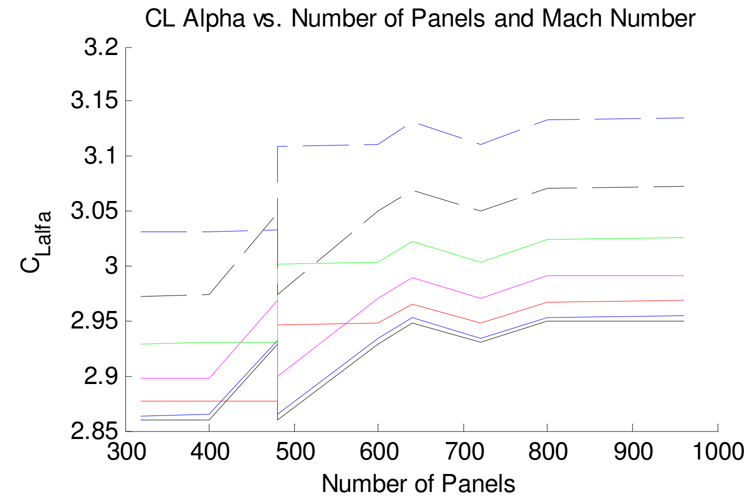


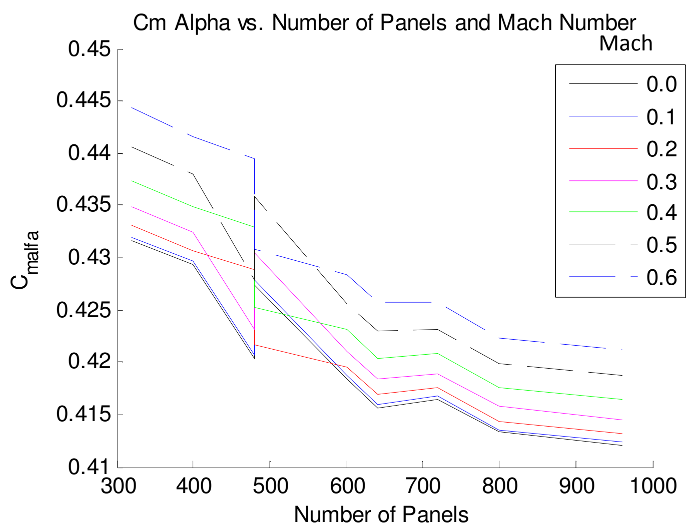


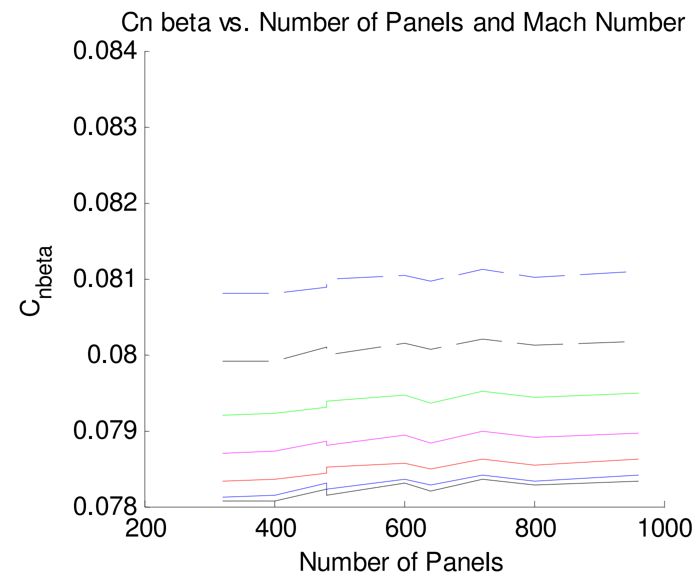
- Varied Number of Panels
  - Chordwise
  - Spanwise
- Multiple Runs Varying
  - Mach Number
  - Angle of Attack
  - Sideslip Angle
  - CG Location
- Produced
  - Stability Derivatives
  - Lift Induced Drag
  - Trim Drag
- Wing Airfoil: NACA 64206
- Tail Airfoils: 7% Thick Biconvex

Convergence History

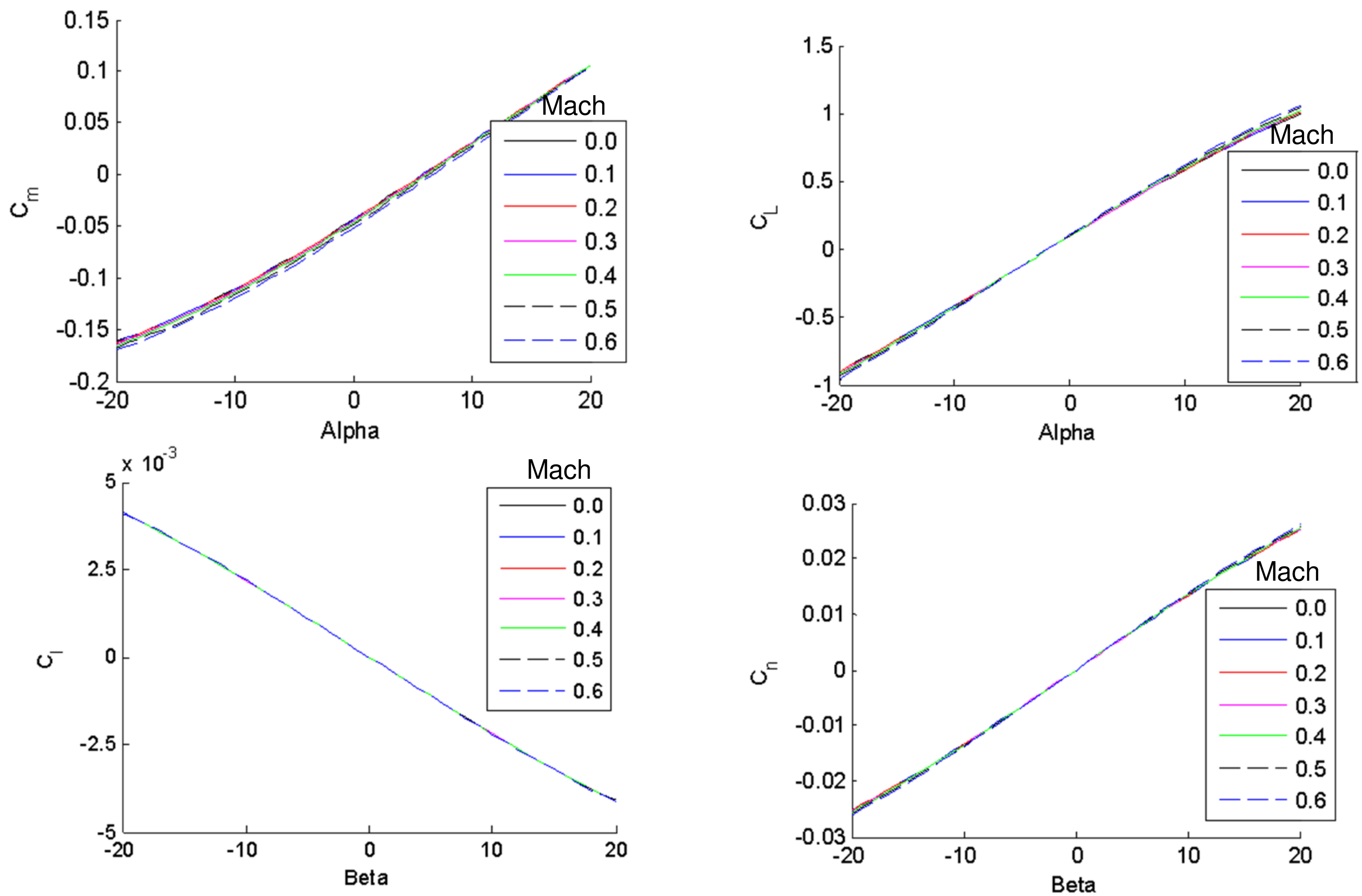




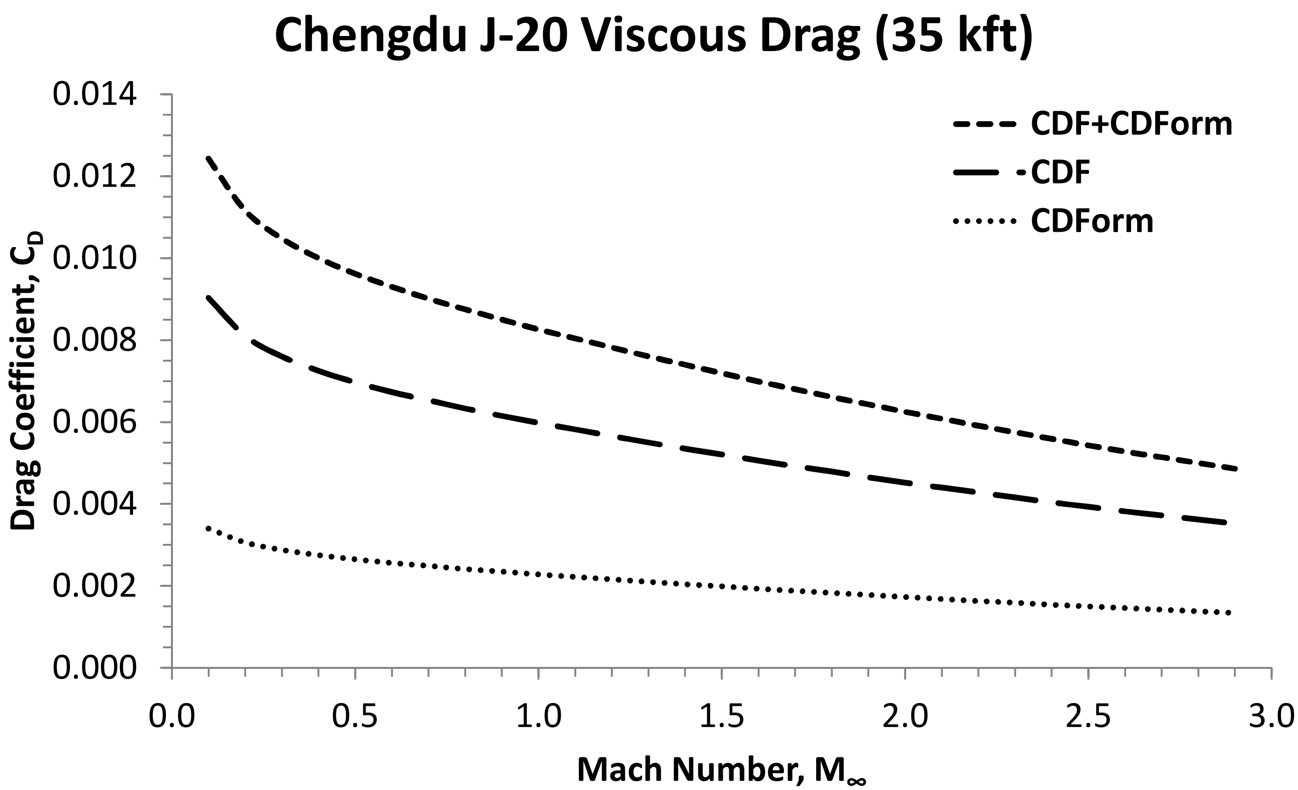




Stability Derivatives

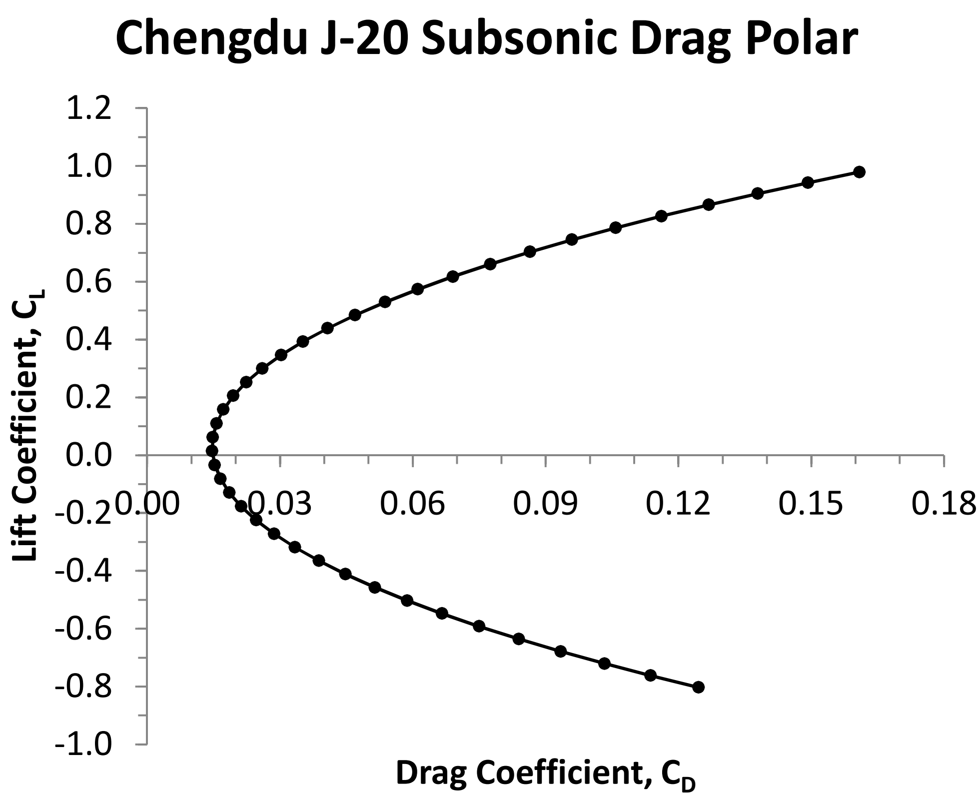


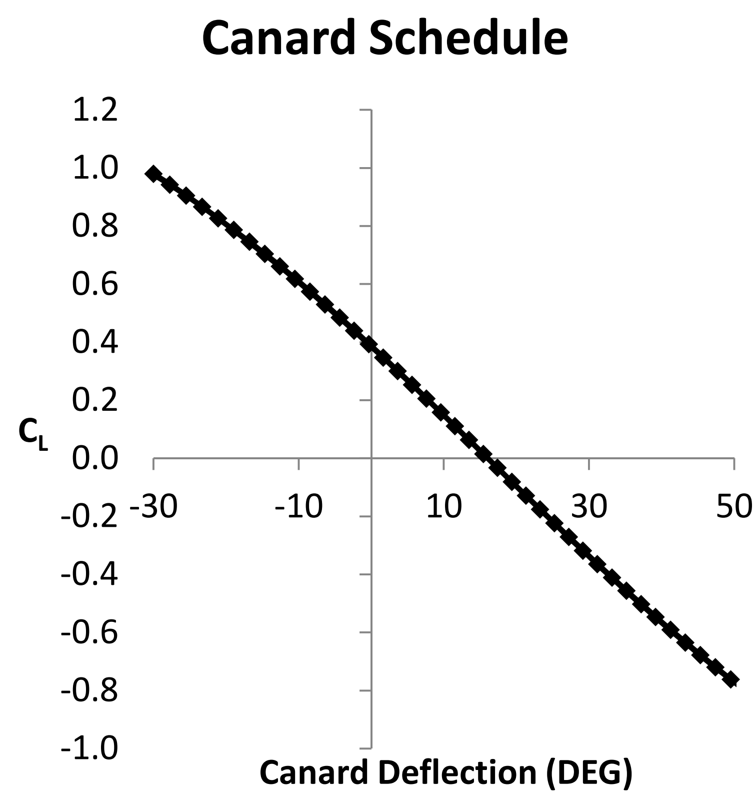
Drag Estimation: Viscous Drag



- Viscous Drag calculated using friction2k6 code on course website, at Mach 0.1 to 2.9 and altitudes of 15, 25, and 35 kft
- Combined skin friction and form drag coefficient did not vary with altitude (identical to four decimal places)

Drag Estimation: Lift-Induced Drag

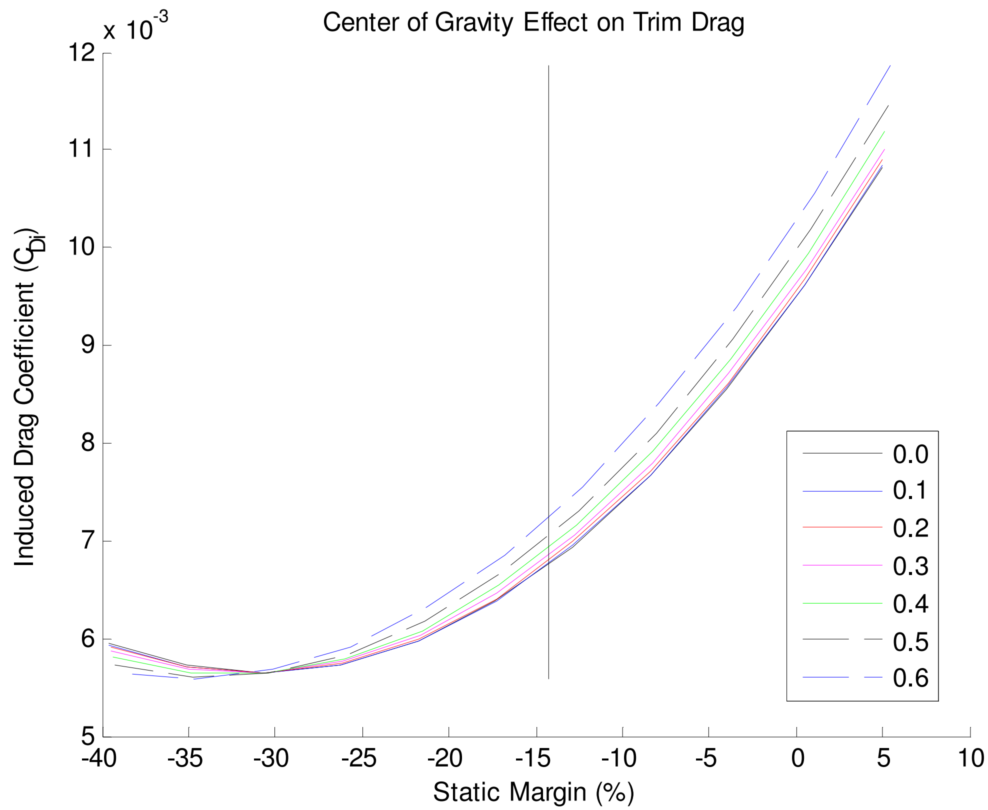




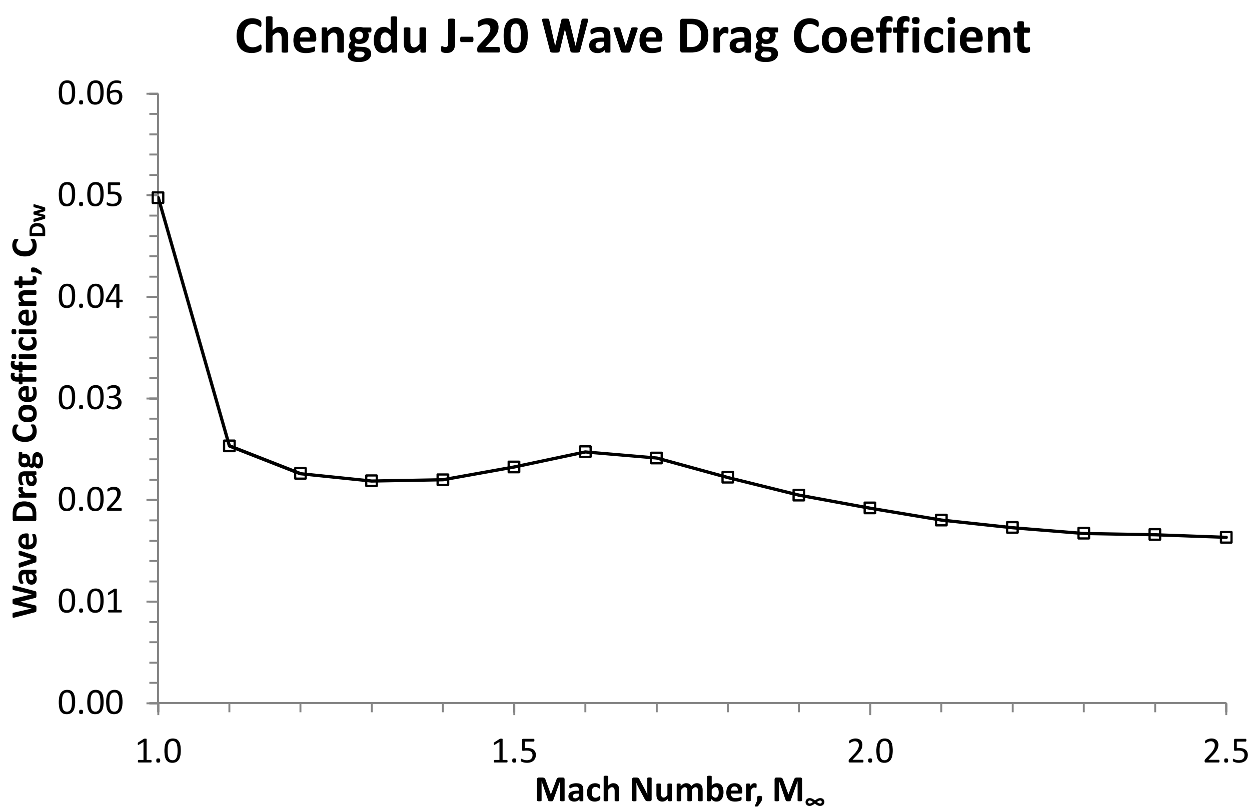
- Calculated using AVL and FRICTION.exe
  - FRICTION.exe for profile drag
  - AVL for induced drag
- Trim drag included

Drag Estimation: Trim Drag

- Balanced 14% unstable
- Minimum trim drag near 30% unstable
- Suggests other factors drive static margin
- Varies little with Mach number

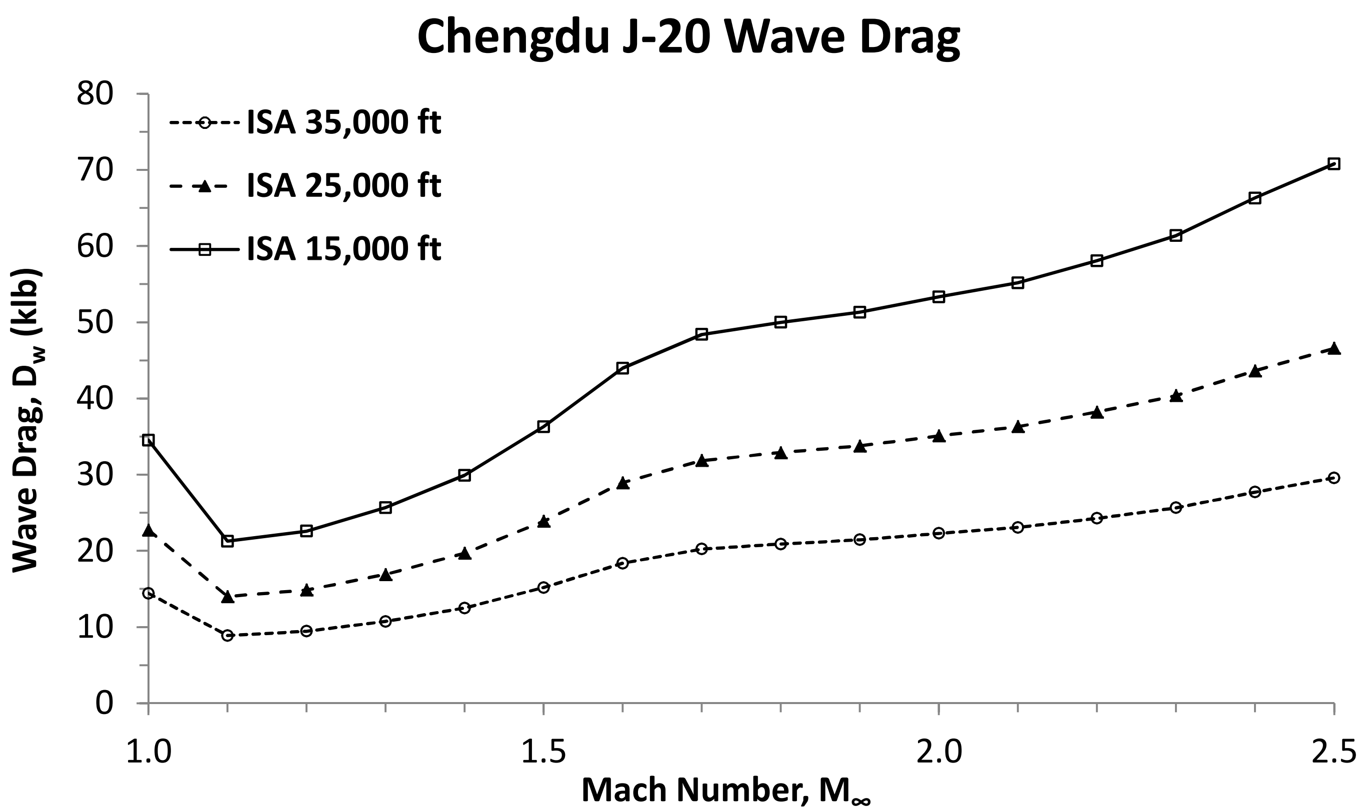


Drag Estimation: Wave Drag



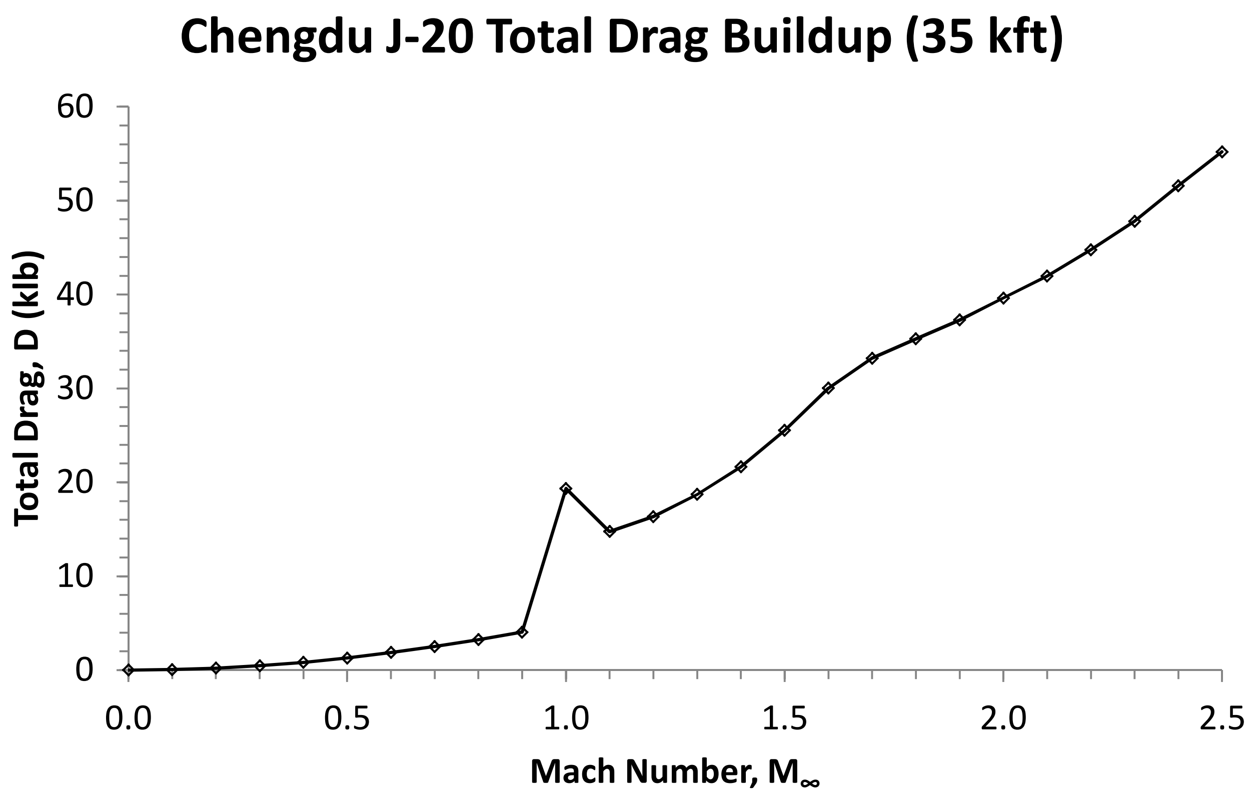
- Wave drag estimated using AWAVE and awaveFileMake.m updated to include arbitrary fuselage shapes
- Little variation with angle-of-attack for small α

Drag Estimation: Wave Drag



- Volumetric wave drag represents a high percentage of the available thrust at high Mach

Drag Estimation: Total Drag



- Note the jump in drag at the sonic speed due to onset of wave drag
- Maximum Mach clearly impacted by engine performance

Performance: Maximum Speed

- M = 2.13 (shock forms on nose cone)
- M = 2.81 (shock forms on probe)
- Enough thrust to achieve M ≈ 2.5

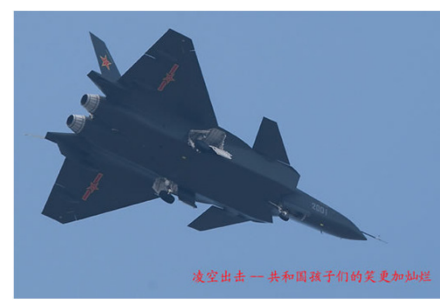
F-22

M = 2.25

F-35

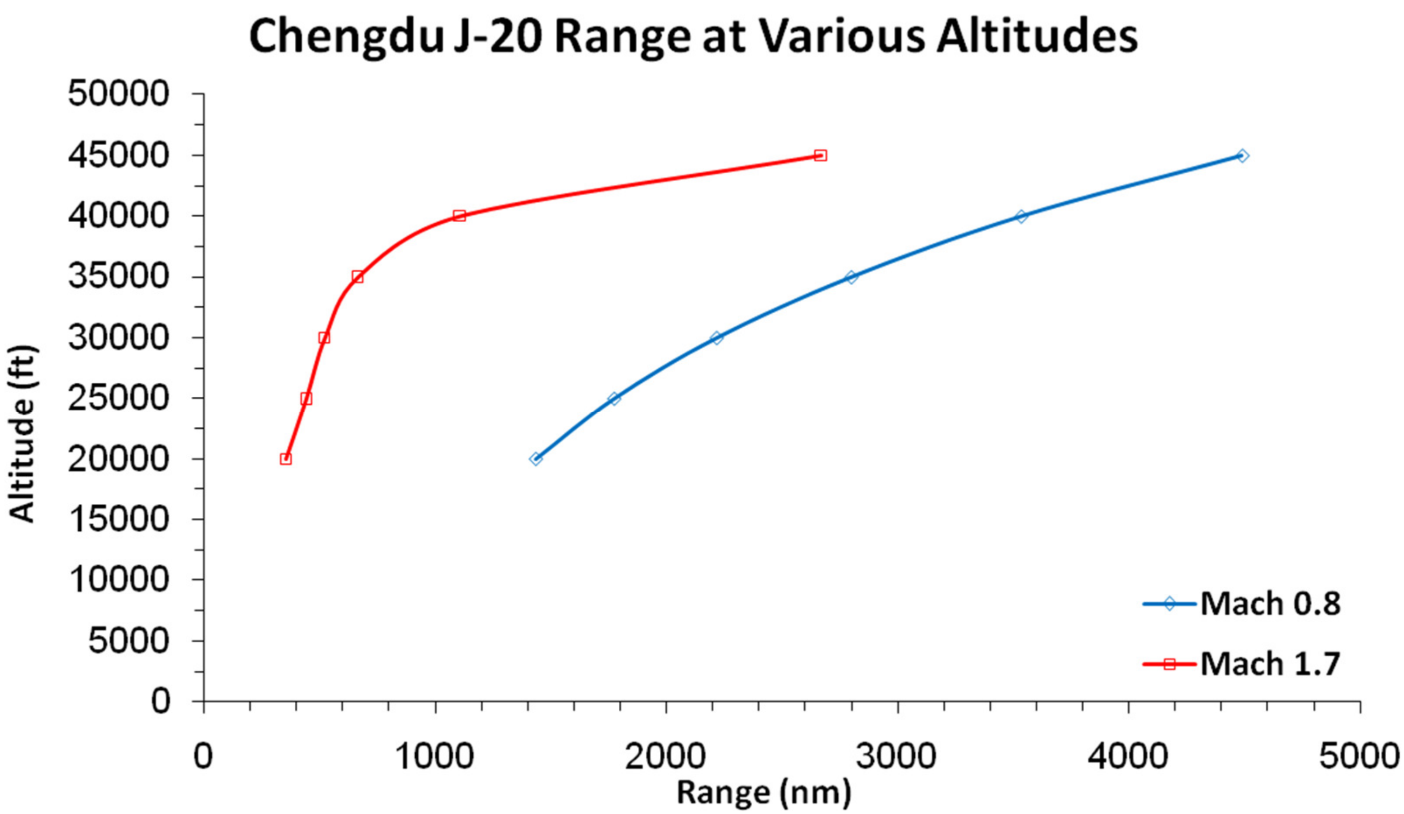
M = 1.6+

J-20



M = 2.1-2.5

Performance: Range



- Max range calculated using Breguet Range equation and weight fractions
- V/C assumed constant at each speed for these calculations

Performance:
Takeoff Distance & Climb Rate

- Ground roll required: 1398ft (black)
- Distance to achieve MIL 50’ clearance requirement: 144ft (red)
- Total take-off distance: 1542ft
- Climb angle for best rate of climb: 19.2°

Conclusions

- Configuration characteristics
  - large internal volume (i.e. munitions capacity)
  - long range
  - supercruise capability
- Optimized for use as a long-range interceptor and air-to-surface attack platform
- Actual performance dependent upon engine development

References

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Questions?

http://www.freerepublic.com/focus/f-news/2655343/posts