

Joint Strike Fighter F-35C



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F-35 Purpose

- The JSF is a fighter platform with a variant design for all branches of the military.
- 3 production versions are planned:
 - 1) **F-35A: CTOL variant to replace F-16 & A-10**
 - 2) **F-35B: STOVL variant to replace AV-8B, F/A-18 C/D, Sea Harrier, and GR-7. Will complement F-22**
 - 3) **F-35C: CV variant. Our analysis will focus on this version of the JSF**
- The F-35C model was designed with larger wings and tail control surfaces for carrier operations
- It is also strengthened structurally to handle catapult launches and arrested landings

F-35C Mission Roles

- The F-35C is the carrier based variant of the JSF, designed and built for STOL capability.
- It is a multi-role, stealthy, survivable fighter designed to complement the F/A-18 E/F.
- AI: Medium level attacks using precision guided, freefall or retarded bombs
- CAS: Air action against hostile targets, in close proximity to friendly forces
- Fleet defense: Aerial patrolling of ships

F-35C Overview

First flight: 02/12/2001

Crew: 1

Wingspan (ft)	43.0
<i>Folded span (ft)</i>	29.8
Length (ft)	51.4
Height (ft)	15.5
Tailspan (ft)	28.3
Tailsrape angle (deg)	15.25
Reference Area (ft²)	620.00
W_{empty} (lbs)	30,618
MTOGW (lbs)	66,850
Payload (lbs)	20,000+
Max speed at altitude	Mach 1.8

F-35C

Carrier Variant (CV)

Span (ft) 43
Length (ft) 50.8
Wing Area (ft²) 620
Internal Fuel (lb) 19,624



Data for F-35C available “Jane’s All the World’s Aircraft 2004-2005”

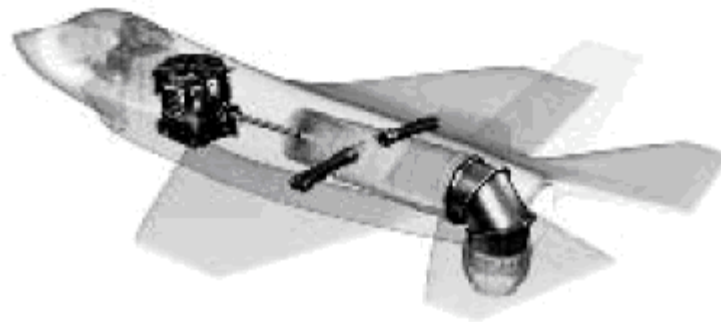
Picture available www.jsf.mil

Propulsion

- Pratt & Whitney F135
- Thrust = 40,000 lbs
- $T/W_{\max} = 0.598$
- TSFC was unavailable



PW F135



F-35B STOVL lifting fan

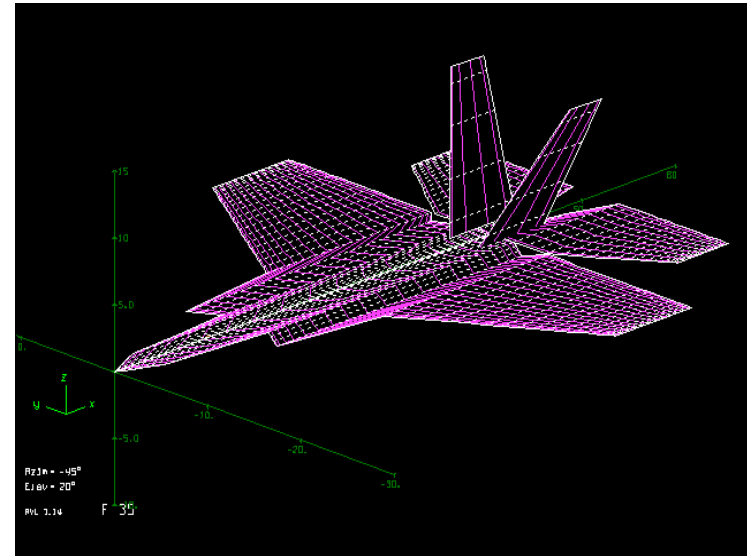
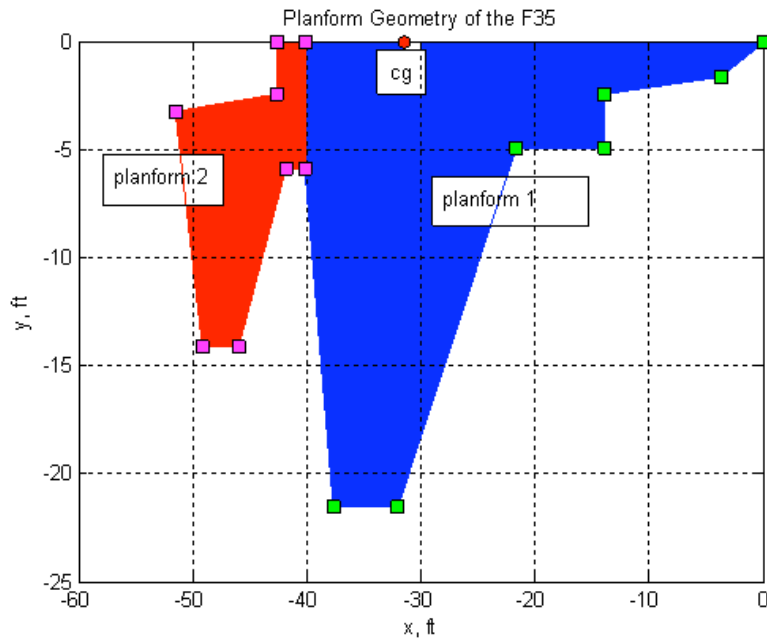
Weights

W_{empty} (lbs)	30,618
Max Payload (lbs)	20,000+
W_{fuel} (lbs)	19,624
MTOGW (lbs)	66,850
W/S_{max} (lb/ft²)	107.82
$W_{\text{payload}}/\text{TOGW}$	0.3
$W_{\text{fuel}}/\text{TOGW}$	0.29



F-35B STOVL variant on display at NASM Dulles Airport

VLMpc vs. AVL



Method of Analysis	Center of Gravity (ft. from nose)	MAC (ft)	Neutral Point (ft. from nose)	Static Margin (% mac)	Static Margin (% mac)	C_{L_α} (per degree)
VLMpc	31.44	16.93	29.24	-10.30	-10.30	0.06214
AVL	31.44	16.93	29.69	-12.99	-12.99	0.07070

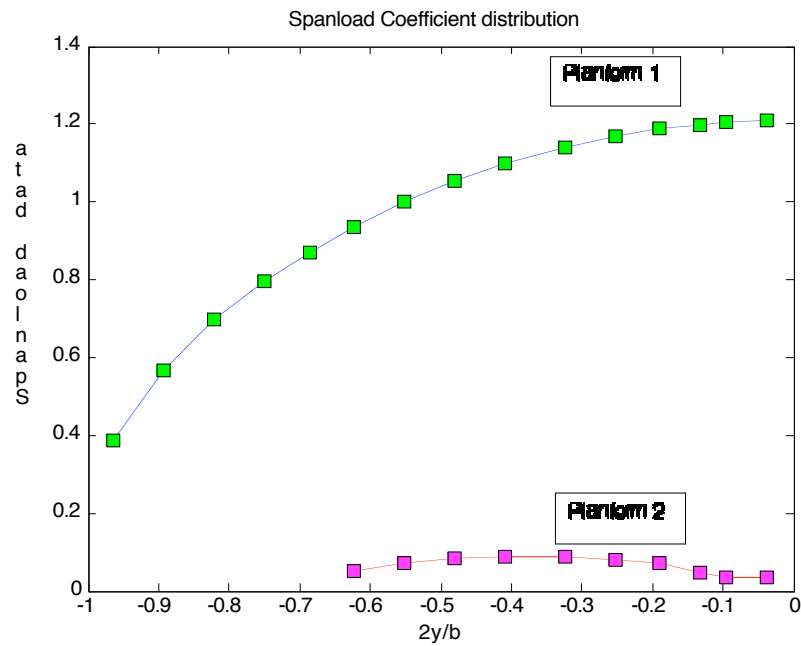
AVL available from <http://raphael.mit.edu/avl/>

VLMpc available from http://www.aoe.vt.edu/~mason/Mason_f/MRsoft.html

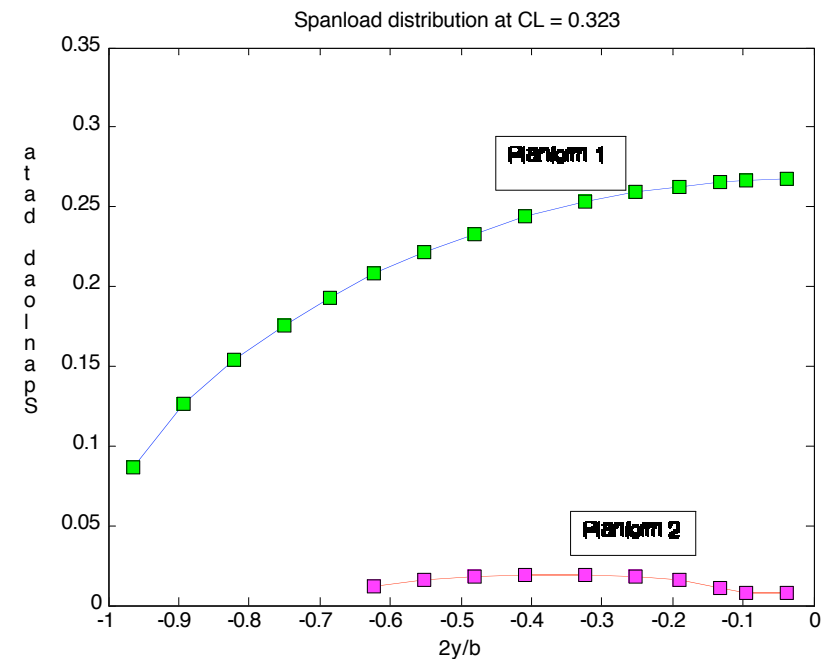
CG Estimate done using landing gear locations and Kirschbaum's suggestions

Spanload Distributions

- Obtained from VLMpc
- Load split: 67% wing-body 33% tail

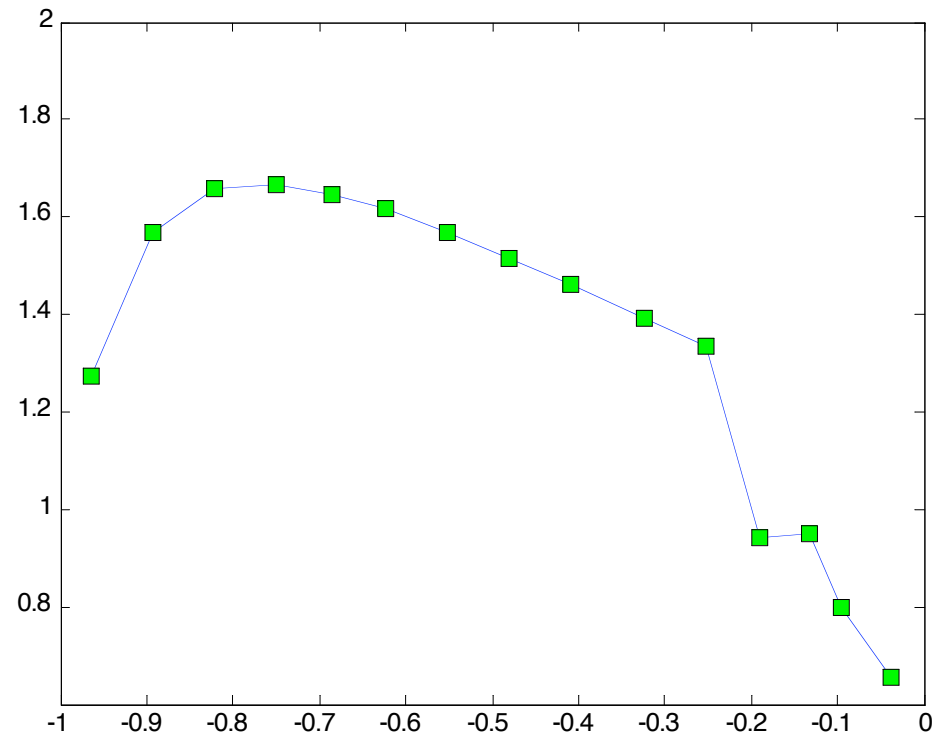


Flat Wing Spanload coefficient



Flat wing Spanload at cruise

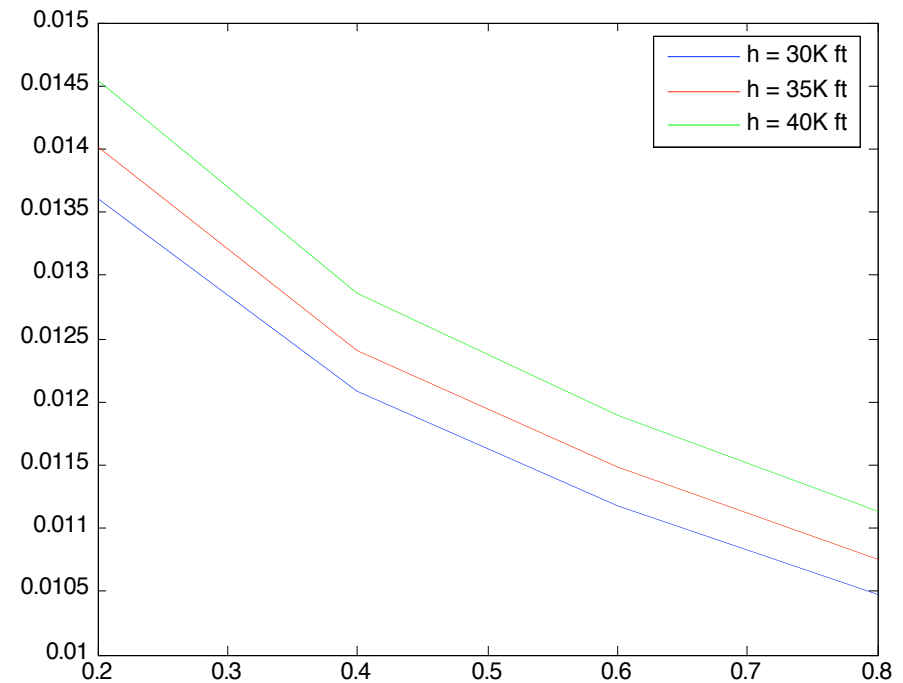
C_L Distribution



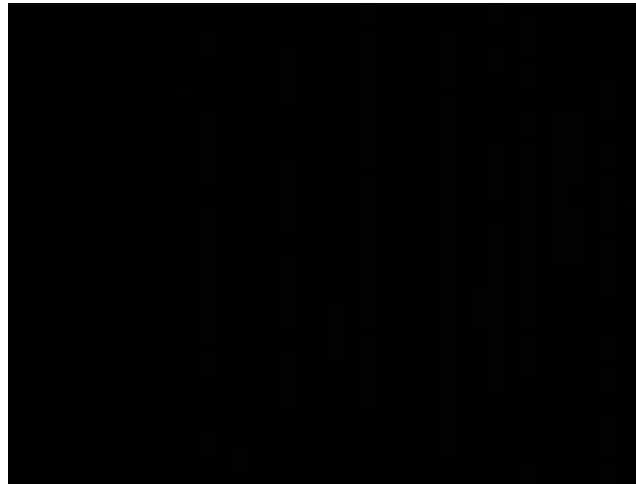
FRICTION Analysis

- Wetted area is estimated of the figure of the airplane
- $S_{\text{wet}} = 2589.63 \text{ ft}^2$

Altitude	30,000 ft
M	0.6
C_{D0}	0.0119
L/D_{max}	14.47
$C_{L \text{ cruise}}$	0.324



STOVL Video



References

- <http://www.deagel.com>
- <http://www.raf.mod.uk>
- <http://www.airforce-technology.com/projects/jsf/specs.html>
- www.jsf.mil
- Jane's All The World's Aircraft: 2004-2005

Relevant Equations

- $(L/D)_{\max} = 14.47$ (FRICTION)
- $\text{Range}_{\max} = 1480 \text{ km}$
 - TSFC Data unavailable from Pratt
- $C_{L \text{ Cruise}} = 0.324$
- $C_{L \text{ max}} = 3 - 3.5?$
 - Raymer¹ suggests that STOL aircraft such as carrier-based fighters require a max lift coefficient upwards of 3.0. It is our estimation that with the F-35C's high lift devices it could achieve slightly more.

$$\frac{L}{D}_{\max} = \frac{1}{2} \sqrt{\frac{\pi A \text{Re}}{C_{D_0}}}$$

$$C_{L_{\text{cruise}}} = \sqrt{C_{D_0} \pi A \text{Re}}$$

$$C_{L_{\max}} = 0.9 C_{l_{\max}}$$

$$\text{Range} = \left(\frac{V}{\gamma}\right) \left(\frac{C_L}{C_D}\right) \ln \left(\frac{W_1}{W_2}\right)$$