BREAK THE STORE NOT THE AIRFRAME:

COMPATIBILITY FLIGHT PROFILE TESTING IN 30 YR OLD FIGHTERS

1Lt Michael "Meatloaf" Brueder, 40 FLTS

Maj Tucker "Cinco" Hamilton, 40 FLTS

Overview

- Compatibility Flight Profile (CFP) Test Mission
  - Refresher Academics
  - Flight Clearance
  - Test Planning Challenges
  - Test Flight Overview
- CFP Moving Forward
  - High Speed Analysis
  - Future CFP Testing

Lessons Learned

CFP Defined

- STORE Integrity
- STORE Endurance
- Aircraft Flying Qualities

- Maximum Buffet Maneuver
- Symmetric Pulls / Pushovers
- Asymmetric Rolls
- Speed Soak – Max Vibration
- Throttle Chops

HQ Set
- Doublets
- SHSS

- Aircraft Structural Integrity?

Flight Clearance

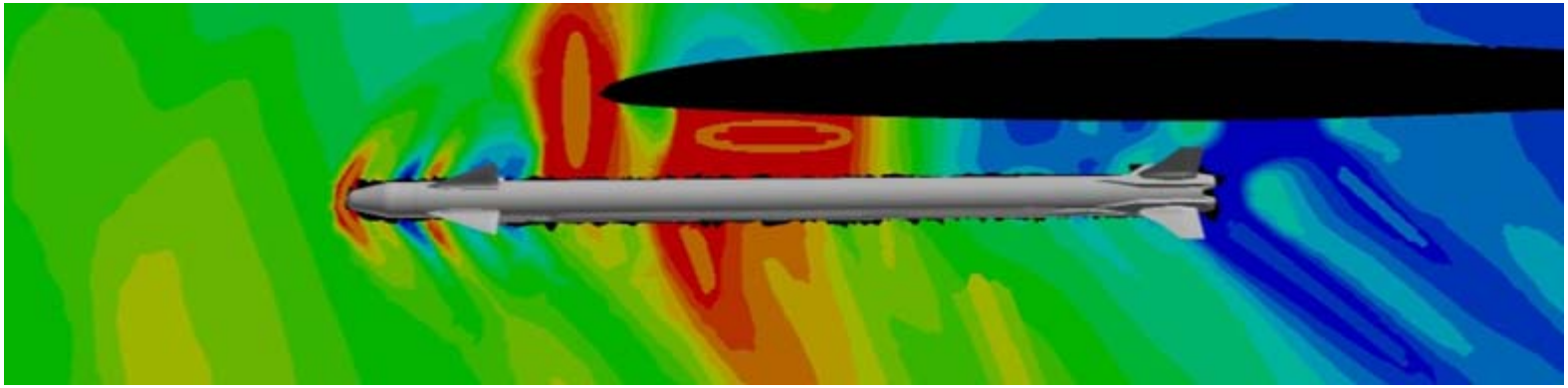
- Air Force Seek Eagle Office (AFSEO)
  - Creates flight clearances through analysis/testing
- Loads
  - Inertial / Aerodynamic loads: easily modeled
    - CFD / Wind Tunnel
  - Vibration loads: cleared through flight test
  - Flight Testing
    - Concurrent Vibration loading + Aerodynamic Loads + Inertial Loads

Test Objective

Clear Aim-120D to Basic Aircraft Limit (BAL) envelope for the F-15C/E & F-16

…also courtesy carry and clear Aim-9X Block II and P5 Pod

OBJECTIVE MET



Test Planning

- Historical Analysis
- Basic Aircraft Limit Profile planning

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Historical Analysis

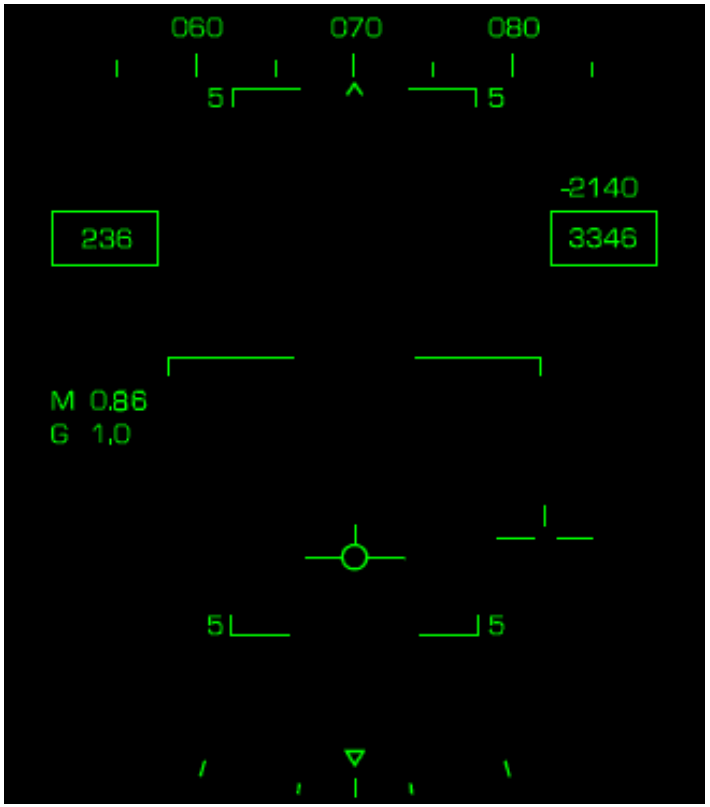
- F-15C CFP Accident: same exact profile, high Q point, vertical tail debonding occurred. Immediate loss of aircraft / pilot
  - Limit exposure to 800 KCAS, i.e. high Q
- F-22 Accident: TSM planning

- SETP Papers found after the test mission

Conduct historical analysis prior to flight test

Know Your Aircraft

- Prohibited maneuvers
  - C vs D model
- HUD symbology
  - Max Buffet
  - Negative G
- Idle Cutoff
  - Want to slow down?...not so fast
- Best Acceleration
  - 2+ G at high speed



Understand how your system changes under differing conditions

CFP Profile

- Flying Qualities Set – Doublets, Raps
- Maximum Buffet
- 0.9M & 1.5M; Symmetric/Asymmetric
- 2.3M
- High Q
- Throttle Chop
- Speed Soak

CFP Profile

- Flying Qualities Set – Doublets, Raps
- Maximum Buffet
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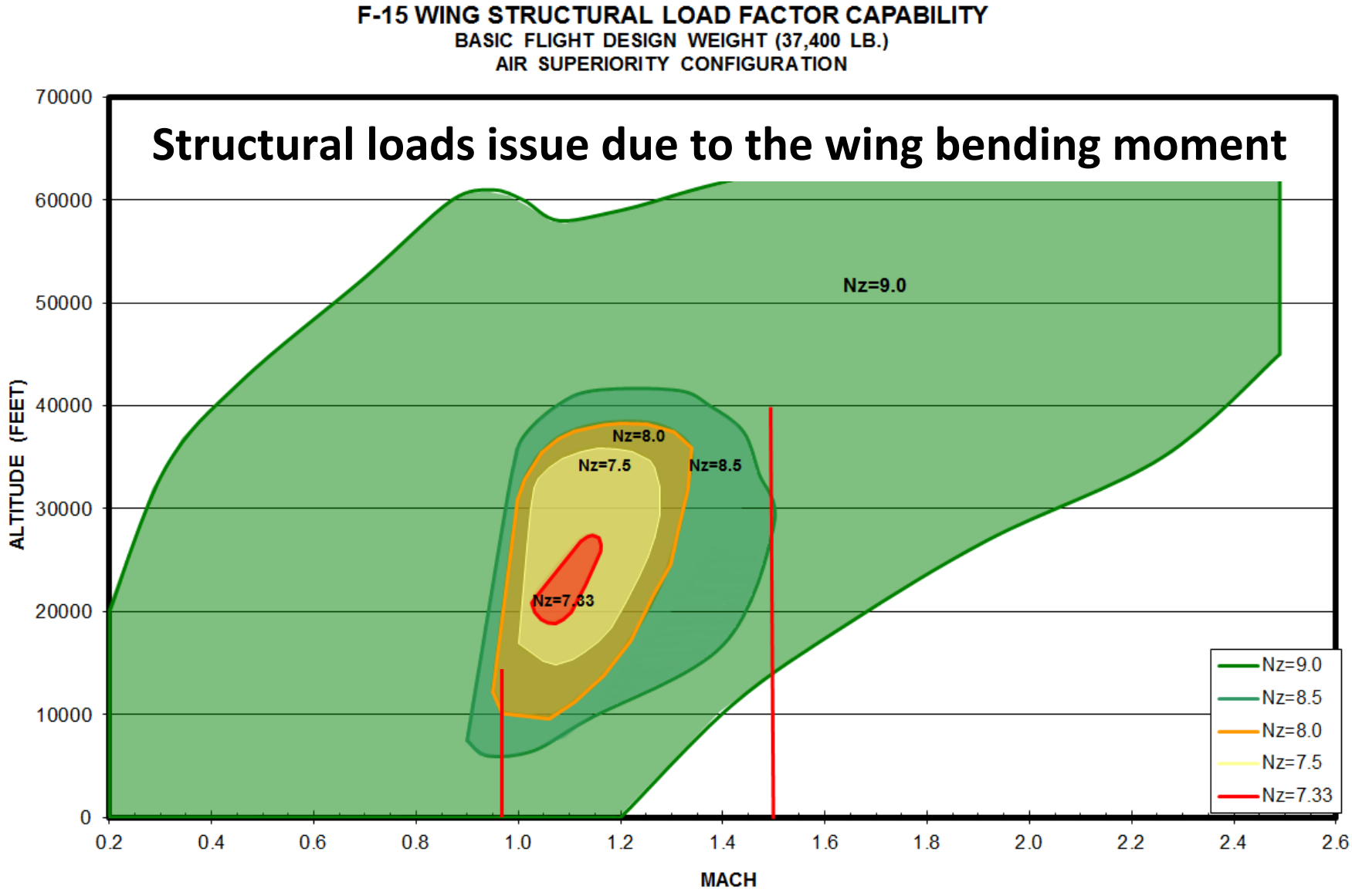
Eagle Thumbprint



0.9M Symmetric Loads

- What does Seek Eagle need?
  - 0.9M sustained 9-g turns…really

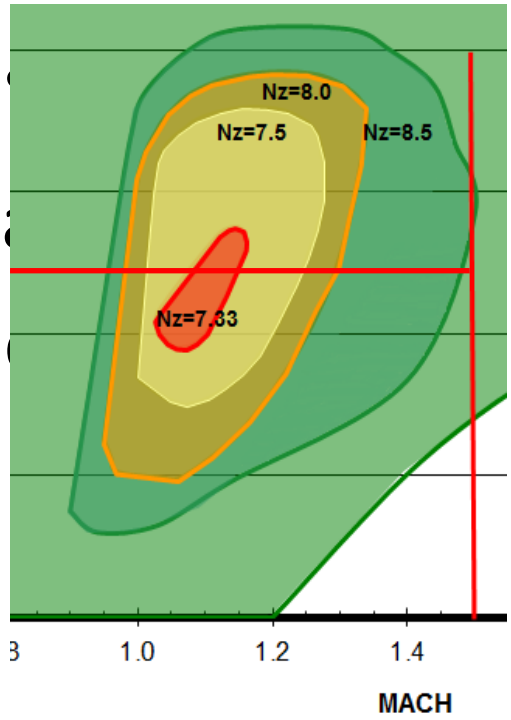
At 0.90M/14K	
Fuel	G Available
1000	9.00
2000	**9.00**
5000	**8.50**
8000	7.90

  - How about a simple break-turn instead

Question the requirements - find out what is needed & understand why

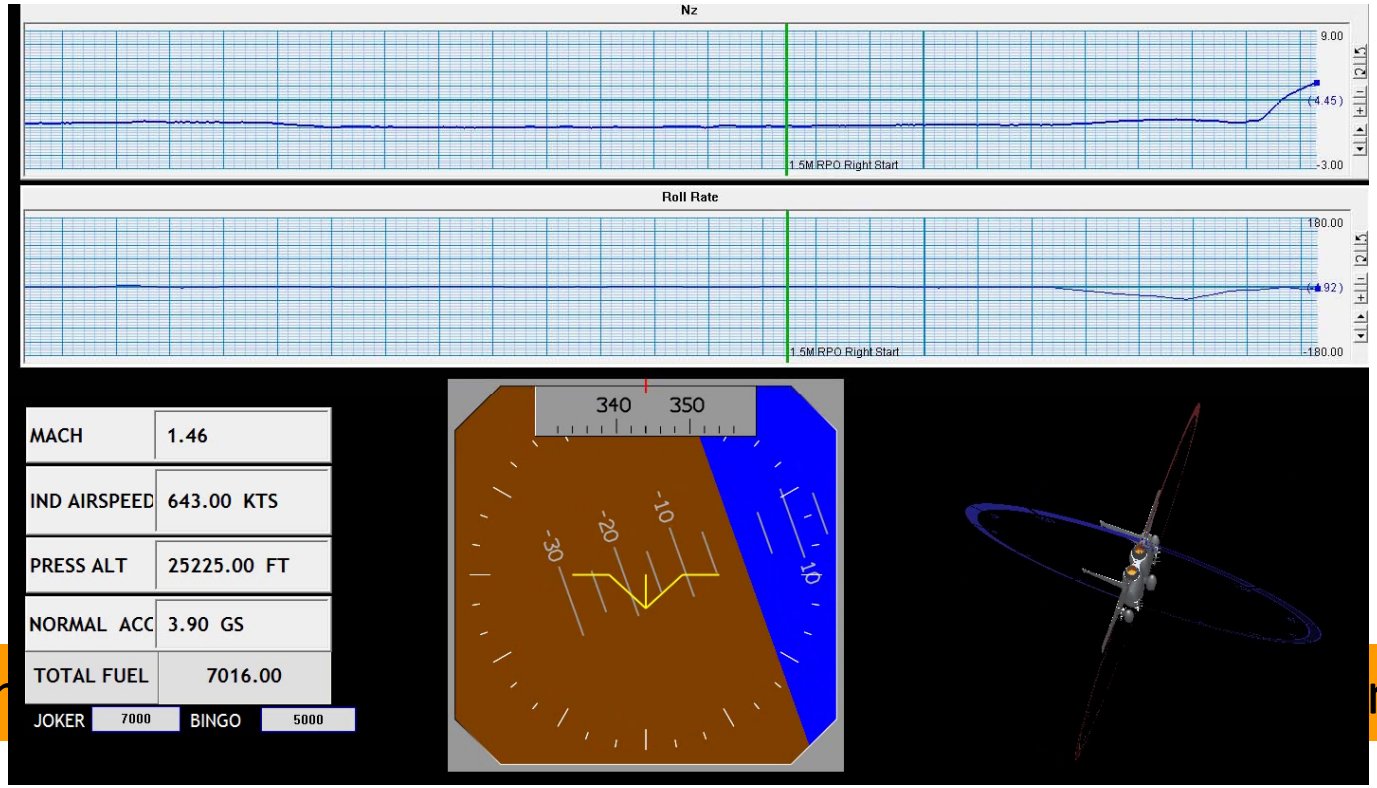
1.5M Maneuver Set

- Negative Ps = 15
- ~5 sec in the data
- Dropping into th



Loaded Rolls

- Max roll rate at target g
  - Difficult to maintain g while inputting lateral stick
  - G Suit Limitation



Flying with n

High Mach Test Point

- What does Seek Eagle need?
  - How fast is fast enough
- The trick with 2.3M
  - Airspace, Fuel, Profile…simulator vital!
    - How much fuel does it take
    - Level accel vs roller coaster

Are we accepting undo risk by flying a test point that operational pilots won't get to?

Provide feedback to the customer about test point attainability

1st Test Flight July 2013

- Asymmetric Missile Loadout
  - Noticeable Directional instability above 1.7M
    - Nose started to hunt, felt like the jet was on ice
  - Bleed Air Light at 1.85M
    - If last maneuver, would it have been good enough

Expect the unexpected…hold that thought

High-Q Test Point

- Target – 800 KCAS @ 5,000 ft
  - Loud ECS pop at 720 KCAS
    - Abort call
    - Attempted maneuver again
      - Same loud pop at 720 KCAS continued
      - Lost TM at 750 KCAS
      - ORM applied, test point complete

Expect the unexpected, but understand that flight test can be uncharted

Test Flight, 23 Sep 13

- High speed point last, 1.97M – no directional instability
- 2 min remaining, 5 air refueling trips later – profile complete in 1 sortie
  - Risk Mitigation reduced test point attempts
    - Questioning requirements
    - Understanding and smartly planning our profile
    - GOOD CRM/ORM through real-time point analysis

Good CRM/ORM: do your homework and understand the requirements

Future CFP Testing

- Currently at high-speed stop test
- Action Team is Formalizing Eglin process
  - Currently accomplishing historical analysis

    …which turns out is repeating itself

How do you account for structural integrity risk?

History

- 1992 2x F-16 Flaperon Losses
- 1993 F-16 Action Team

OBJECTIVE 1 - DEFINE AND DOCUMENT CURRENT FLIGHT TEST PROCESS

In defining the test process, the team realized that no independent structural flight test process exists; rather, structural flight testing is an integral part of the overall process. Therefore, the the global test process to encompass all types of testing.

P A NEW PROCESS WHICH ENSURES FLIGHT TEST
INTEGRITY AND SAFE FLIGHT TEST EXECUTION

f adequate inspection criteria; and 2) inadequate communications.
ajority of the required process improvements. Additional issues
nsidered out of scope.

nd develop tracking models for a simplified
rogram for flight test aircraft (including chase

porate a full-up tracking program--Completion

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History

- 2000 F-15 Action Team – reduced maneuver set
  - Occurred proactively to mitigate risk
- 2002 Vertical Tail Failure Accident
  - Even while flying under new maneuver set
- 2006 F-16 Action Team – reduced maneuver set
- 2013 F-16 Ventral Fin Peel Back
  - Aim-120D CFP to BAL
  - Faulty perception of mitigating tools

Lessons Learned process has gaps…that need filling by us!

Historical Class A / B Analysis

257 F-16, F-15, F-22 Class A / B accidents since 2002

- 238 (92.6%) occurred during a flight that was completely subsonic
- 6 (2.3%) unknown, Class B's, engine issues found after flight
- 9 (3.5%) supersonic, Class B's, engine issues found after flight
- 2 (0.8%) supersonic, Class B's, material failure

2 (0.8%) supersonic, Class A's, both Test Flights

CAF F-15C Pilot Survey

43 F-15C Pilots with an average of 1600 hours

- How many pilots have flown over 1.5M, non-FCF: **22**
- How many pilots have flown over 1.8M, non FCF: **3**
- How many pilots have simulated weapon employment over 1.5M: **15**
- How many pilots have pulled 7+ G's over 1.2M: **1**
- Reason for not flying over 1.5M:

  40% Cited Fuel / 33% Cited Tactical Considerations / 27% Cited Structural Integrity

Out of 28 Pilots who have flown over 1.5M

- Pilots with EP's above 1.5M: **11** with ~23 Separate EPs
  - 10 Rudder Limiter malfunction
  - 9 ECS Related Issues
  - 3 Engine
  - 1 Canopy Unlock Light

CAF F-16 Pilot Survey

22 F-16 Pilots with an average of 1000 hours

- How many pilots have flown over 1.6M, non-FCF: **6**
- How many pilots have flown over 1.8M, non FCF: **2**
- How many pilots have simulated weapon employment over 1.6M: **2**
- How many pilots have pulled 7+ G's over 1.2M: **0**
- Reason for not flying over 1.6M:

  50% Cited Fuel / 32% Cited Tactical Considerations / 18% Cited Structural Integrity

No EPs Noted Above 1.6M

High-Speed Study Summary

- The only Class A accidents since ‘02 that have occurred supersonic have been Test Missions
- CAF Pilots rarely go fast, but if they do…
  - Extremely unlikely to pull more than 6 Gs
  - Have a pretty good chance of having an EP in the F-15C

What other types of Test missions can this analysis apply to?

If not test pilots then who?

Future CFP Recommendations

- Invest in CFD analysis to account for vibrational loads
- If 1.97M was good enough, why not 1.8M?
- Question requirements if the point is unrealistic
- Create CAF-wide high-speed database to capture aircraft issues
  - Use those issues to develop Mx inspection criteria
- Limit flight above 1.8M/720KCAS to Test Missions

Flight Org Responsibilities

- LL are out there even though they may not be in a paper/presentation
- Is our current method working?
  - Is it too reactive?
  - A paradigm shift may be necessary

Conduct historical analysis prior to flight test

Understand how your system changes under differing conditions

Question the requirements - find out what is needed & understand why

Flying with different equipment can impact test point execution

Inform the customer if a point is not attainable

Expect the unexpected, but understand that flight test can be uncharted

Good ORM: do your homework and understand the requirements

How do you account for structural integrity

Lessons Learned process has gaps…that need filling by us!

What other types of Test missions can this analysis apply

Lessons Learned

CFP Test Mission

- Conduct historical analysis prior to flight test
- Question the requirements - find out what is needed & understand why
- Flying with different equipment can impact test point execution
- Provide feedback to the customer about test point attainability
- Expect the unexpected, but understand that flight test can be uncharted
- Good CRM/ORM: do your homework and understand the requirements

CFP Testing in General

- How do you account for structural integrity risk?
  - Undo risk – why are we going there?
- Lessons Learned process has gaps…that need filling by us!

QUESTIONS?