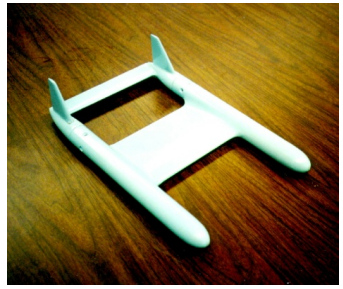
Some Airplanes and Related MDO and Technology Programs Mason has worked

- Virginia Tech: 1989 – 2010, and emeritus
- Grumman Aerospace: 1974 - 1989
- Summer Job/Co-op
  - – US Army/Edwards AFB (1969)
    - •Huey Cobra
  - –McDonnell Douglas, St. Louis (1966-67)
    - • various F-4s
      - – including the swing wing F-4
    - • advanced spacecraft trajectories/entry



The F-4 - at McDonnell Aircraft

As a co-op student in St. Louis in the mid 1960s
- flight test instrumentation
- flight test data reduction
- wind tunnel testing

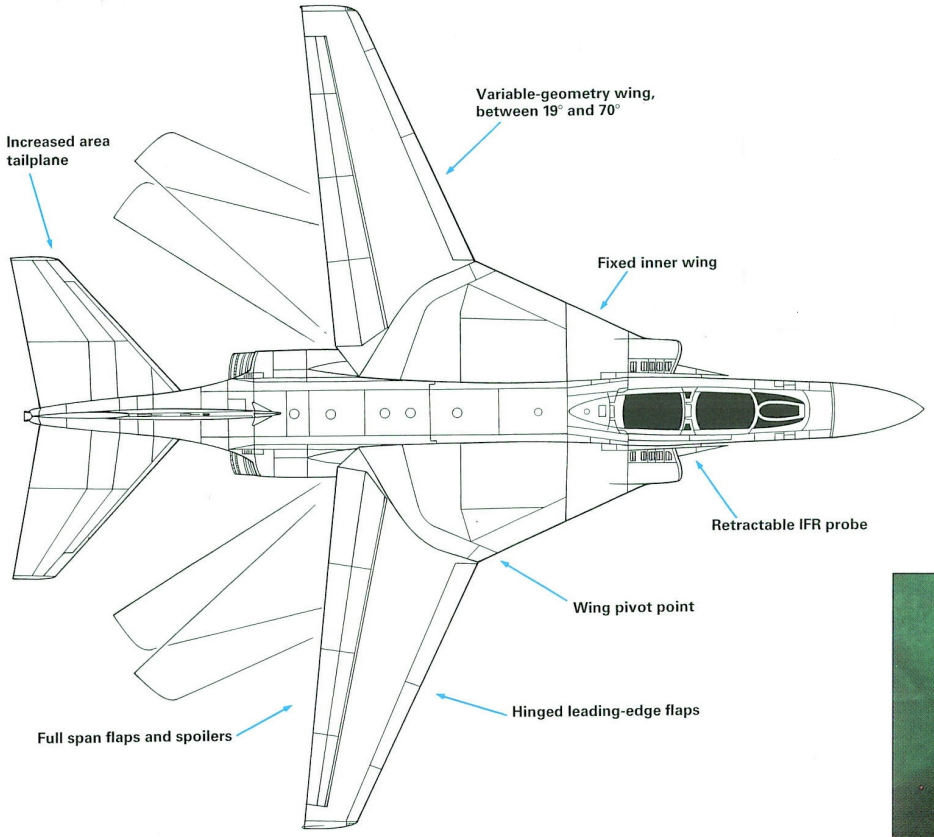
Photo from the San Diego Aerospace Museum

Slats added on the horizontal tail to lift down, first used on the F-4J

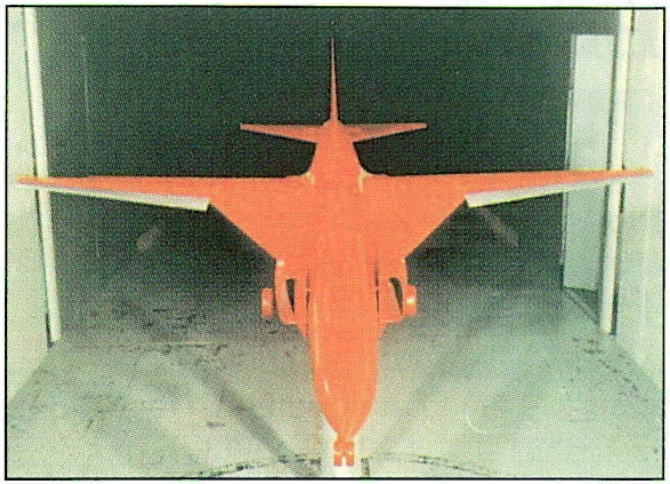
Photo from the Pima Air and Space Museum, Tucson, AZ

The Variable Sweep Wing F-4: Got as far as wind tunnel models

When the F-111 seemed to be in trouble, McDonnell tried to modify the Phantom



I sat on top of the McDonnell Low Speed Wind Tunnel taking tuft photos

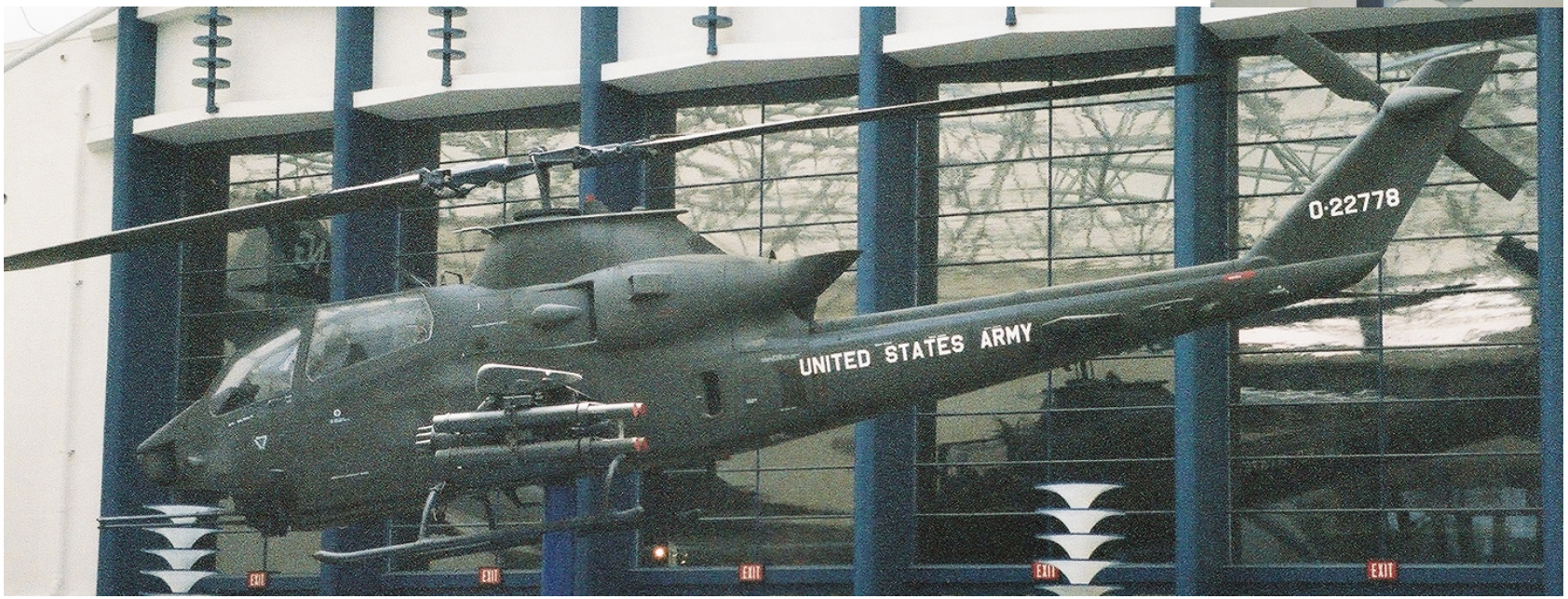


Pictures from *McDonnell F-4 Phantom, Spirit of the Skies*, Jon Lake, Ed., Airtime Publishing, USA 1992

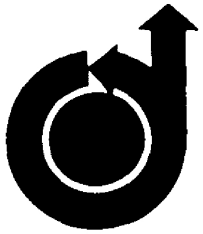
Edwards AFB - Army Helicopters

Can't tell it from the side, the Cobra is small viewed from the front.

Reducing flight test data, and in particular, digitizing oscillograph traces, the world's worst work



Some Early CFD Work



78-101

A NUMERICAL THREE-DIMENSIONAL VISCOUS
TRANSONIC WING-BODY ANALYSIS AND DESIGN TOOL

W. MASON, D. A. MACKENZIE, M. A. STERN,
Grumman Aerospace Corporation, Bethpage, N. Y.

and

J. K. JOHNSON, *Air Force Flight Dynamics Laboratory,*
Wright-Patterson Air Force Base, Ohio

AIAA 16TH AEROSPACE SCIENCES MEETING

Huntsville, Alabama/January 16-18, 1978

NASA Contractor Report 3676

The COREL and W12SC3 Computer Programs for Supersonic Wing Design and Analysis

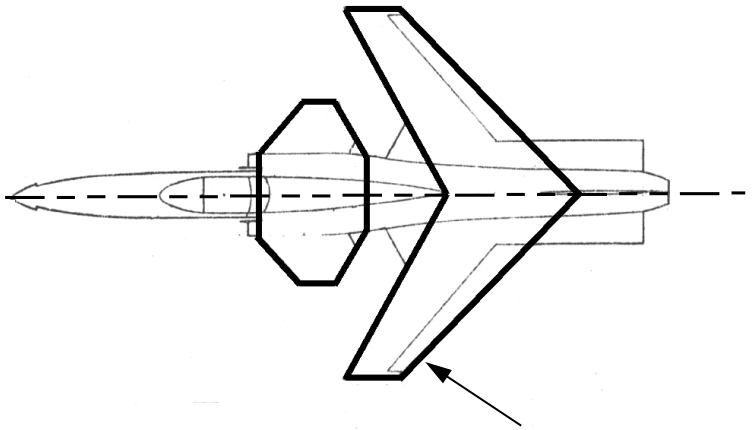
William H. Mason and Bruce S. Rosen

CONTRACT NAS1-15357
DECEMBER 1983

25th Anniversary
1958-1983

NASA

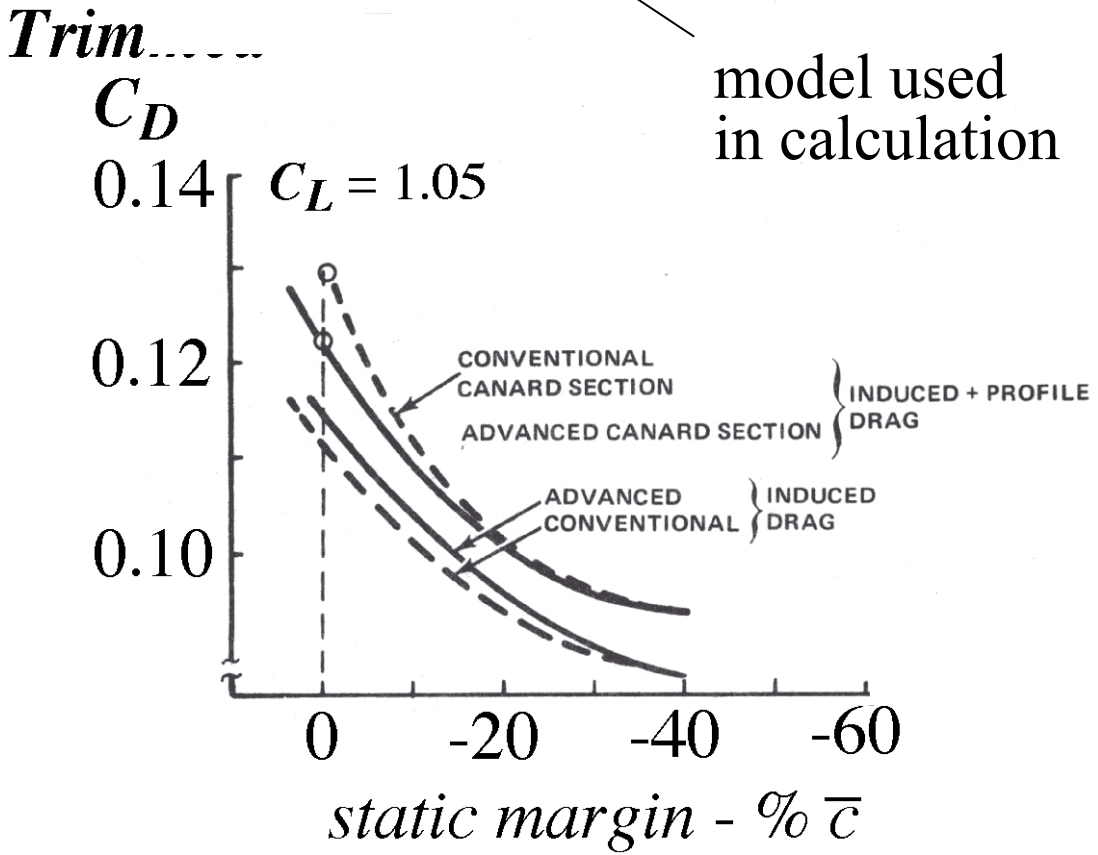
At Grumman: the X-29



model used
in calculation

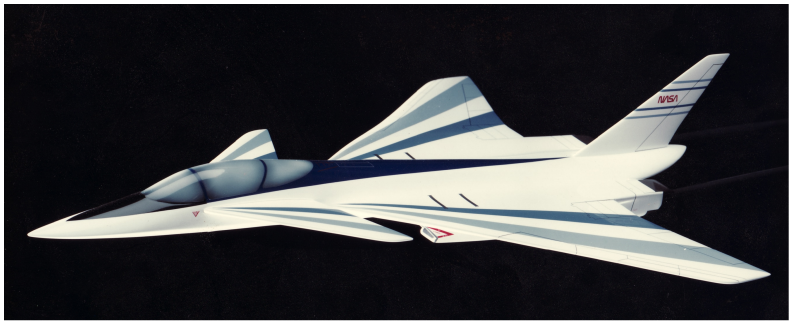
I found out that the plane had to be highly unstable to get the benefit of the forward swept wing/canard concept, and expected the study to end.

AIAA Paper 82-0097



The NASA/Grumman RFC

- The Research Fighter Configuration, a program to study a supercruiser with low speed hi-α, transonic maneuver, supersonic cruise and supersonic maneuver



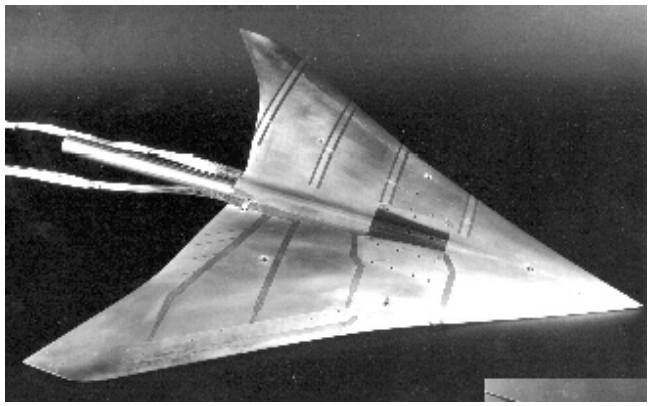
In the NASA Langley Full Scale Tunnel

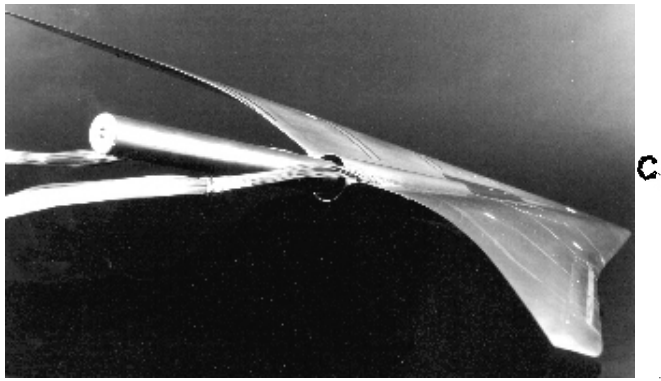
Flow Viz to understand high-α canard forebody wing vortex interaction

Free Flight Testing at NASA

NTF WT Model

NASA/Grumman SC3 Wing Concept

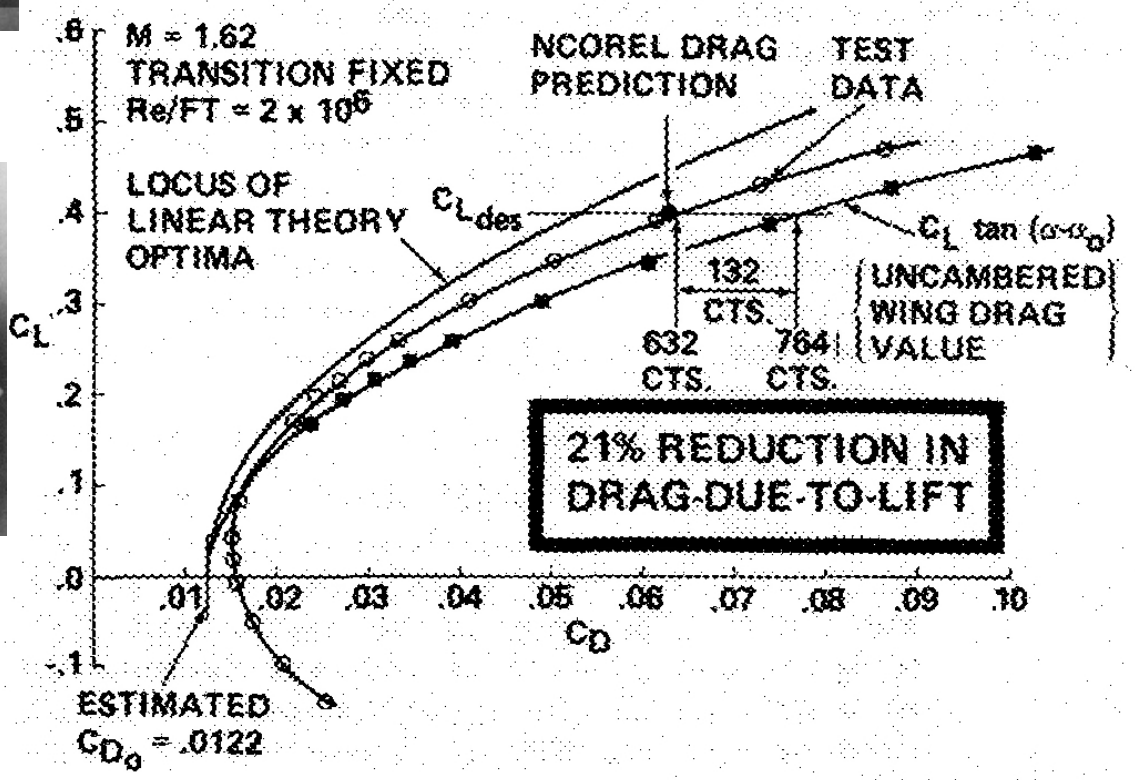




This wing would have gone on the NASA/Grumman Research Fighter Configuration. It set a record at NASA LaRC for low drag at high lift supersonic performance.

Supercritical Conical Camber, SC^3

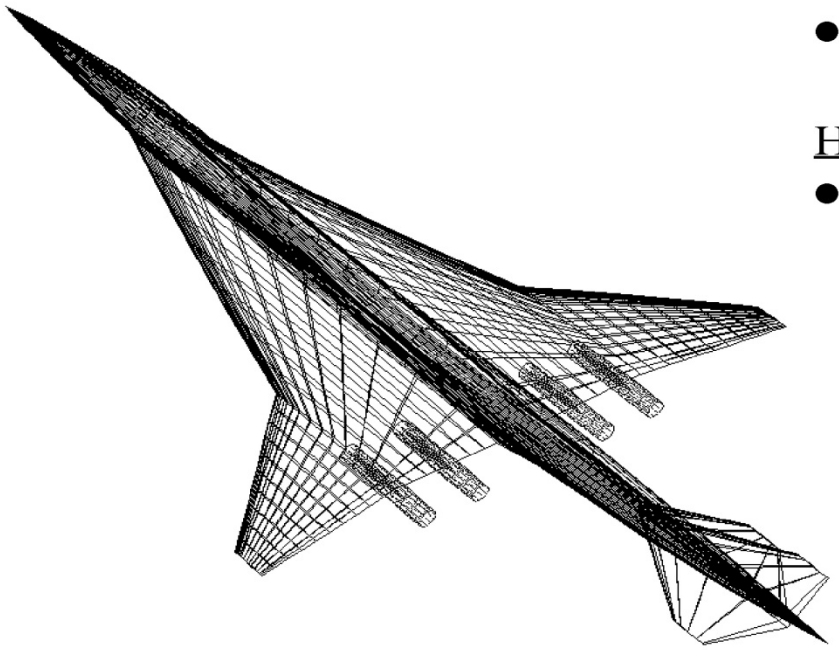
An attached flow maneuver wing with controlled supercritical crossflow



NASA CR 3763/AIAA Paper 83-1858

At VT: High Speed Civil Transport (HSCT) MDO

HSCT Optimization Problem



Design Requirements

- $\text{Mach}_{\text{cruise}} = 2.4$, Range = 5500 n.mi., Payload = 250 passengers
- Objective: minimize takeoff gross weight (TOGW)

HSCT Model Parameterization

- 29 variables:
  - 8 - wing planform
  - 8 - fuselage
  - 5 - airfoil section
  - 2 - nacelle location
  - 2 - vertical and horizontal tail areas
  - 1 - engine thrust
  - 3 - mission variables: fuel weight, initial cruise altitude, rate of climb

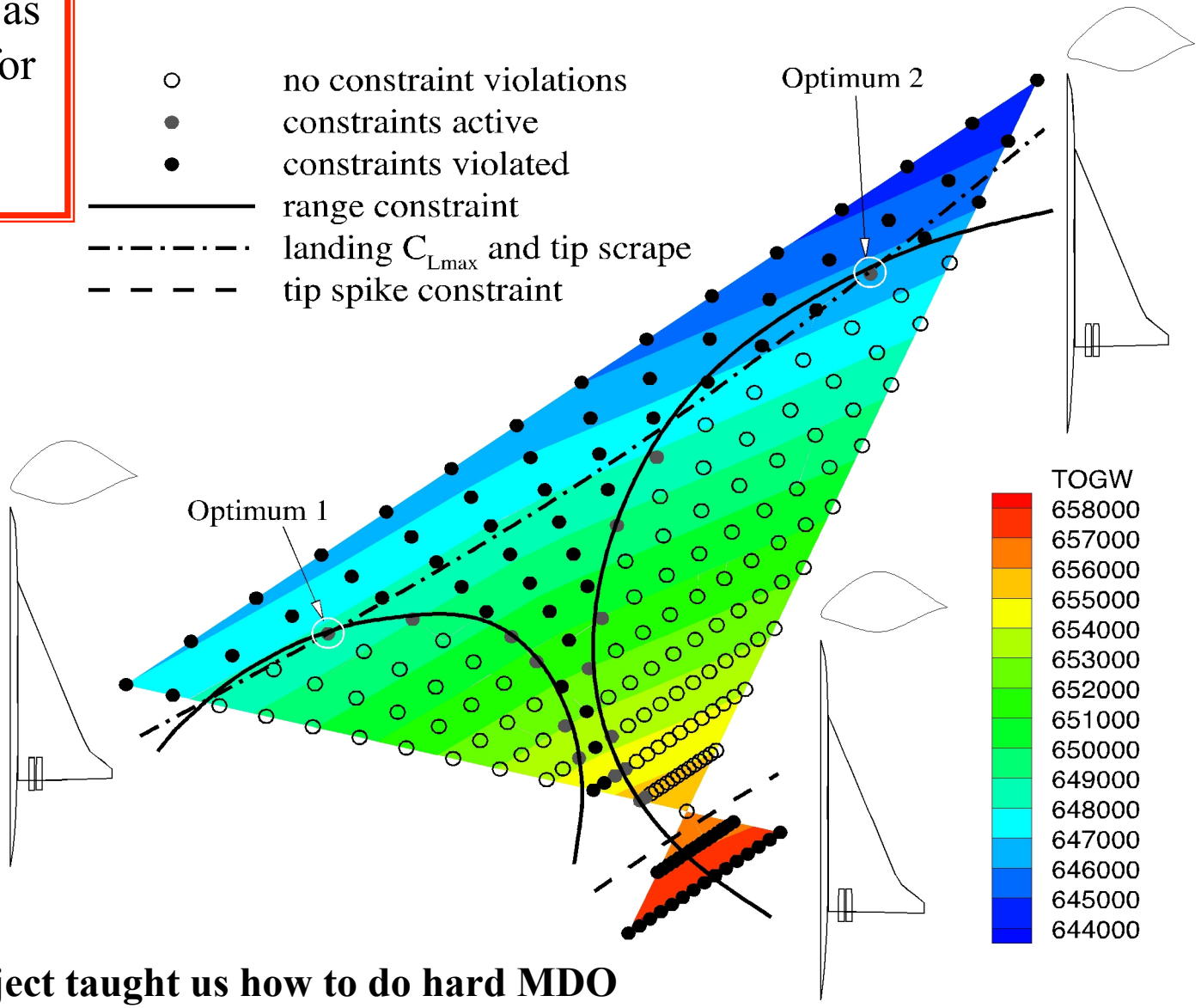
Optimization Problem

$$\underset{x \in R^{29}}{\text{minimize}}\ TOGW(\boldsymbol{x}), \quad \text{subject to}\ \ g_i(\boldsymbol{x}) \le 0,\ i = 1,\ldots,70$$

Journal of Aircraft, Vol. 39, No. 2, March-April 2002, pp. 215-220, among many others

For nearly a decade we worked HSCT as a model problem for MDO with NASA and NSF Funding

Visualization of the Design Space



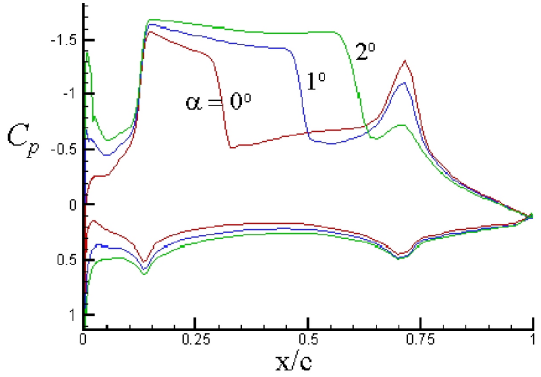
The HSCT project taught us how to do hard MDO

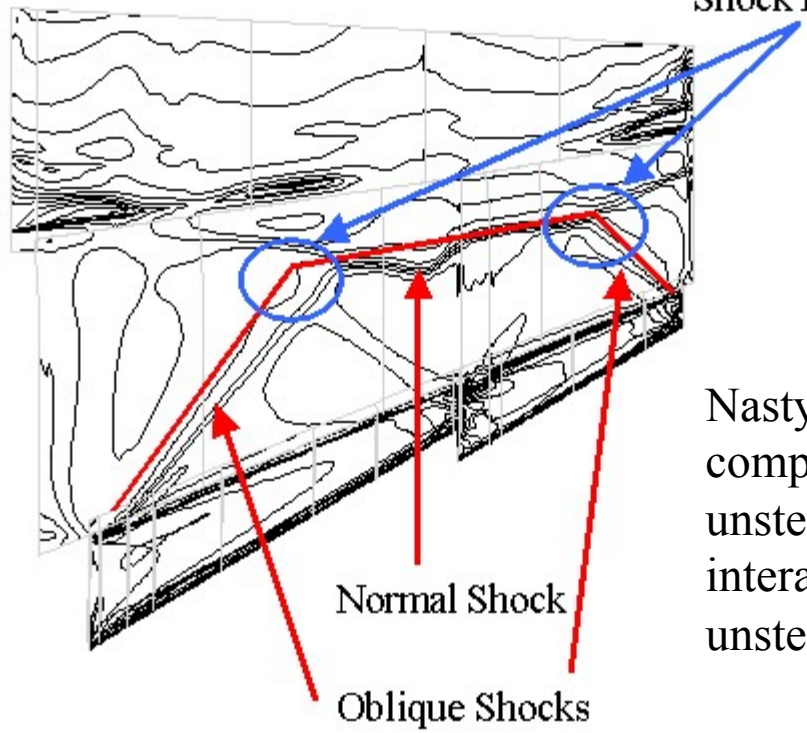
F-18 E/F Red Team/Abrupt Wing Stall Pgm

- Member of the F-18 Red Team Panel, and ONR support of flowfield models investigating the Abrupt Wing Stall Problem

Kevin Waclawicz, MS, 2001
Mike Henry, MS, 2001

Chordwise pressure distributions, showing effect of LE and TE device deflection





Nasty, complicated, unsteady, shock interations and unsteady flow

The solution: a porous wing fold fairing

The Transonic Strut Braced Wing
studied at VT in the late 90s, it's back in 2008/2009

- Werner Pfenninger's strut-braced wing concept from 1954
- Needs MDO to make it work

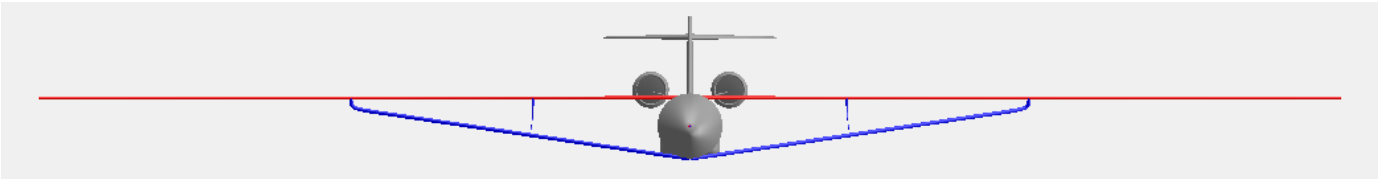
With Lockheed

Compared to a conventional cantilever design:

- 12-15% less takeoff weight
- 20-29% less fuel
- less noise and emissions

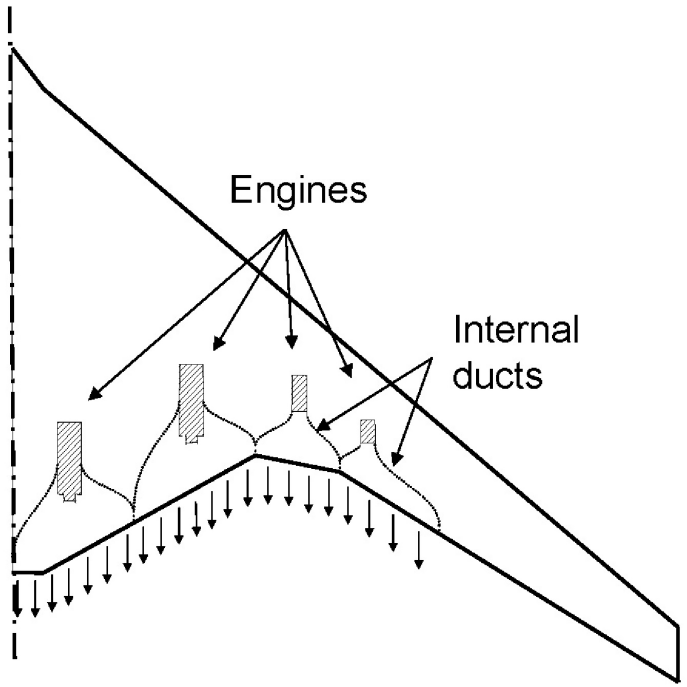
See AIAA Paper 2005-4667

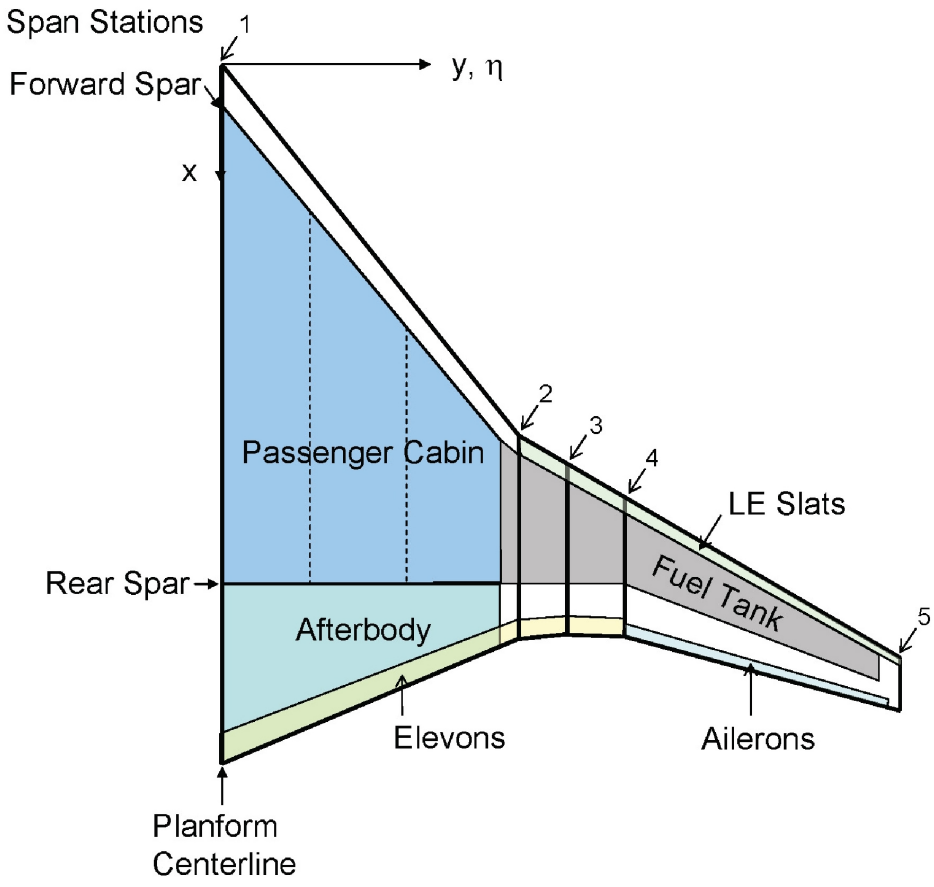
In 2008 we added a jury strut



Distributed Propulsion MDO BWB for Langley

- Included noise investigation

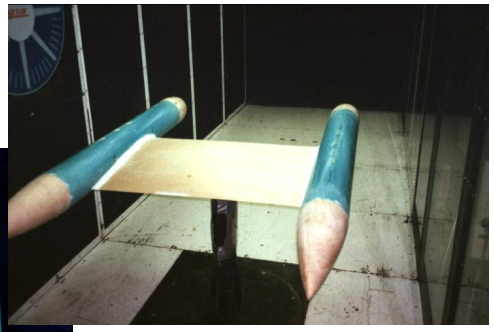




Ando Ko, PhD, 2003
Leifur Lefsson, PhD, 2006

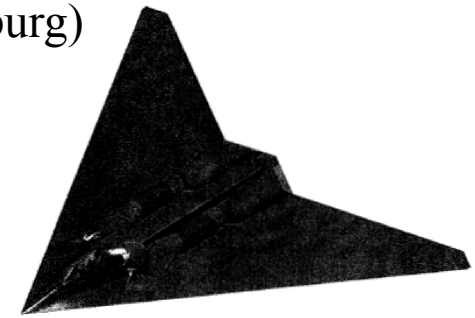
Other unusual MDO configurations and methods

The Inboard Wing

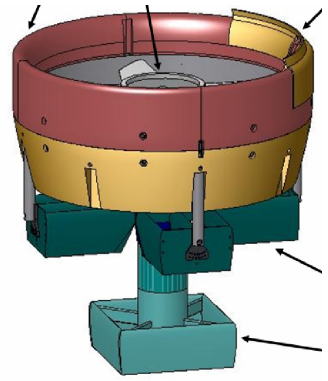


Switchblade Assessment,
Ryan Plumley, MS 2008

All moving tip control
Brady White, MS 2007
(Techsburg)

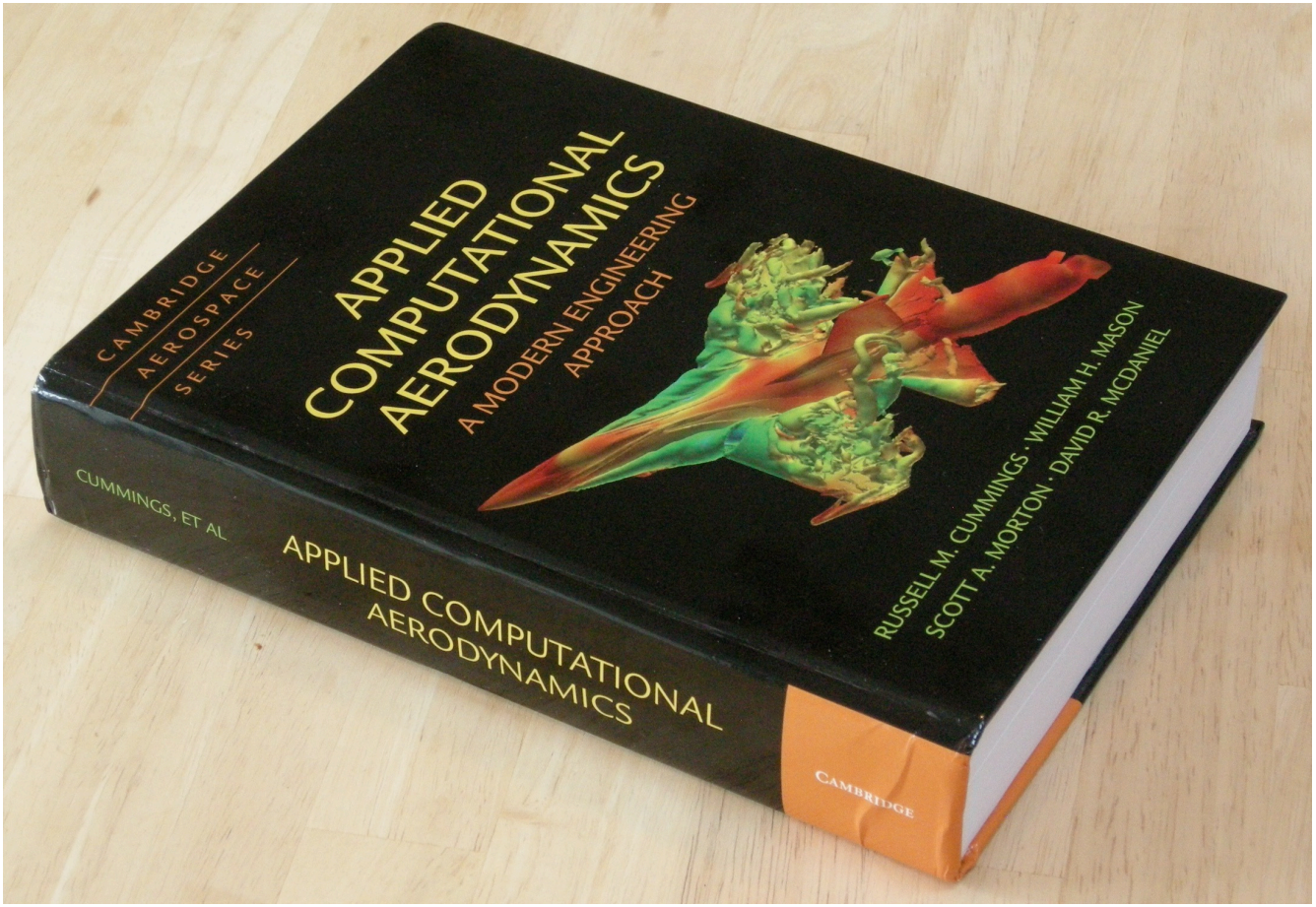


Will Graf, MS 2005
(Techsburg)



- Circulation Control Prediction for Conceptual Design, Ernie Keen, MS 2004 (AVID), being used in Germany, AIAA Paper 2005-5216
- Landing Gear Design for MDO, Sonny Chai, MS 1996 (NASA Ames) AIAA Paper 1996-4038
- Hitchhiker Pgm, Sergio Iglesias, Formation Flight, AIAA Paper 2002-0258

And in 2015: A Book on Computational Aerodynamics with Russ Cummings, Scott Morton and Dave McDaniel



http://www.cambridge.org/us/academic/subjects/engineering/aerospace-engineering/applied-computational-aerodynamics-modern-engineering-approach