HSR High Lift Research
Ames Research Center

HSR High Lift Research Program

Status & Plans

Jim Rose
Fixed Wing Aerodynamics Branch

High Speed Research Workshop May 16, 1991

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- Ames participants
- Objective and approach
- Current status
- Research plans

Ames Participants

- Fixed Wing Aerodynamics Branch (FFF)
  - NFAC
  - 7- x 10-Foot Wind Tunnel
  - Applied CFD
- Applied Aerodynamics Branch (RAA)
  - Applied CFD
  - 12 Foot Wind Tunnel
- Applied Computational Fluids Branch (RFA)
  - Computational tools
  - Applied CFD

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Benefits of Improved High Lift Performance

- Reduced Noise
  - Increased rate of climb
  - Reduced thrust required
  - Increased utilization (avoid curfew restraints)
- Reduced Weight
  - Shorter landing gear
  - Smaller/lighter wing
- Improved control/performance
  - Reduced horizontal tail size
  - Lower cruise drag
- Lower cost
  - Reduced complexity
  - Lower maintenance/down time

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Objectives

- Evaluate & develop advanced concepts
- Validate design/analysis methods

High-lift systems that contribute to meeting FAR Stage III noise abatement rules

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Approach

CFD Techniques and Analysis:

- Potential flow
  - Concept development
- Euler
  - Design
  - Concept development
- Navier-Stokes
  - Analysis
  - Concept development
  - Rn effects

Wind Tunnel Experiments:

- 7x10 W.T.
  - Flow physics & understanding
- 40x80x120 W.T.
  - Concept evaluation & development
  - Scale effects
  - Integrated aerodynamics, acoustics, & propulsion
  - High fidelity experiments
- 12 Foot High-Re W.T.
  - Rn effects
  - Mach number effects

Advanced High-Lift Concept

Trapped vortex to provide high lift at low α

Current Status

- Identified trapped vortex as promising technology
- Parametric studies using CFD tools
- Preliminary W.T studies with Boeing on simple systems
- Tests in preparation for 7 x 10 in summer '91
- Continuing CFD work to Euler & N-S computations of realistic configurations

Experimental Results to Date

- 2-D water channel experiments are encouraging
- Several 2-D wind tunnel experiments have shown similar results
- Tests of single fence configurations on Boeing low-speed model showed only small lift and pitching moment benefits

Two-fence configuration should increase performance

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Tests Planned in FY '91

- Basic Research Test 7/91
  - Ames 7x10 W.T.
  - Examine effects of sweep and fence geometry
- Boeing HSCT test 8/91
  - Ames 7x10 W.T.
  - Two-fence configurations based on above results

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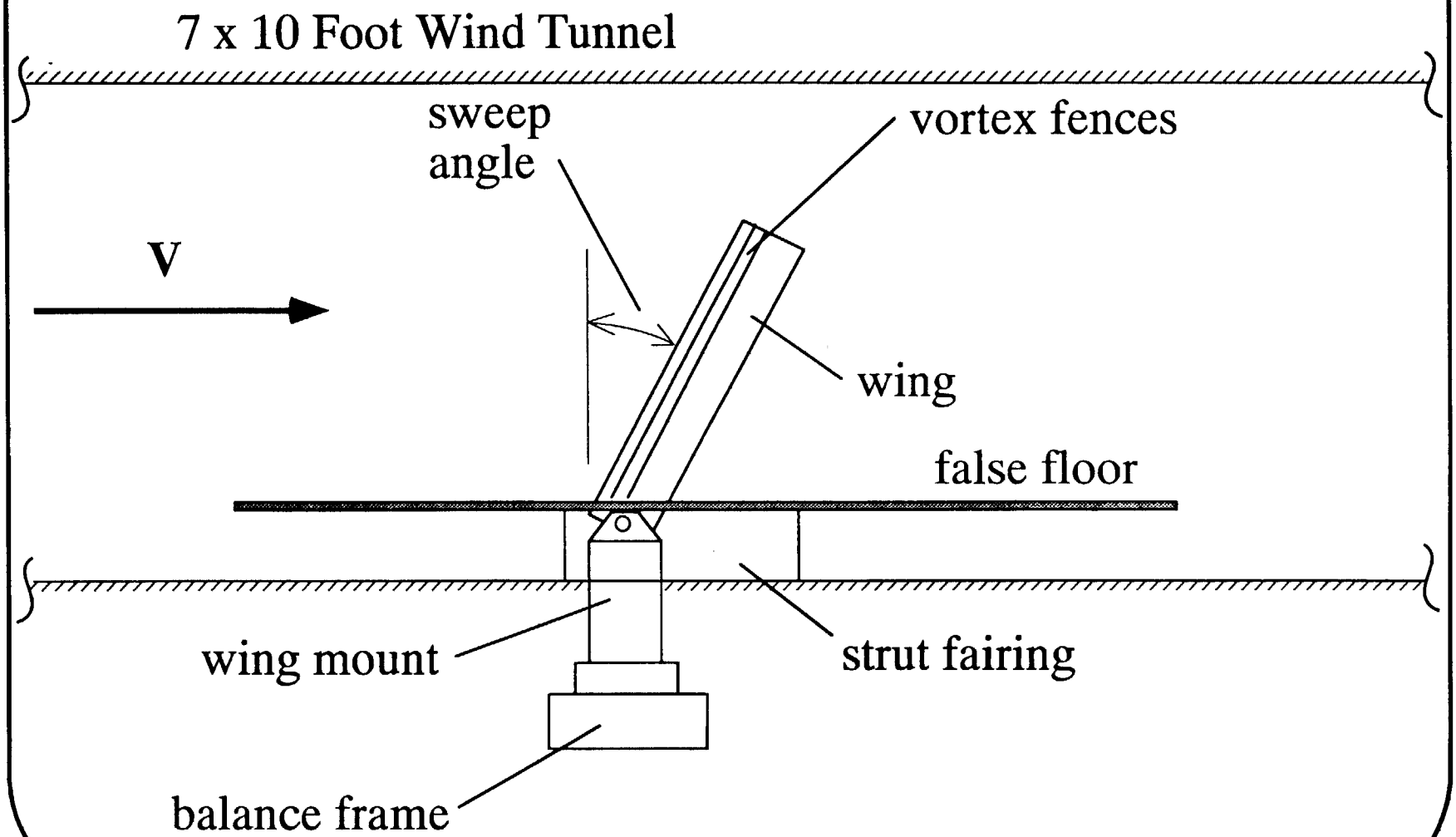
Basic Research Test



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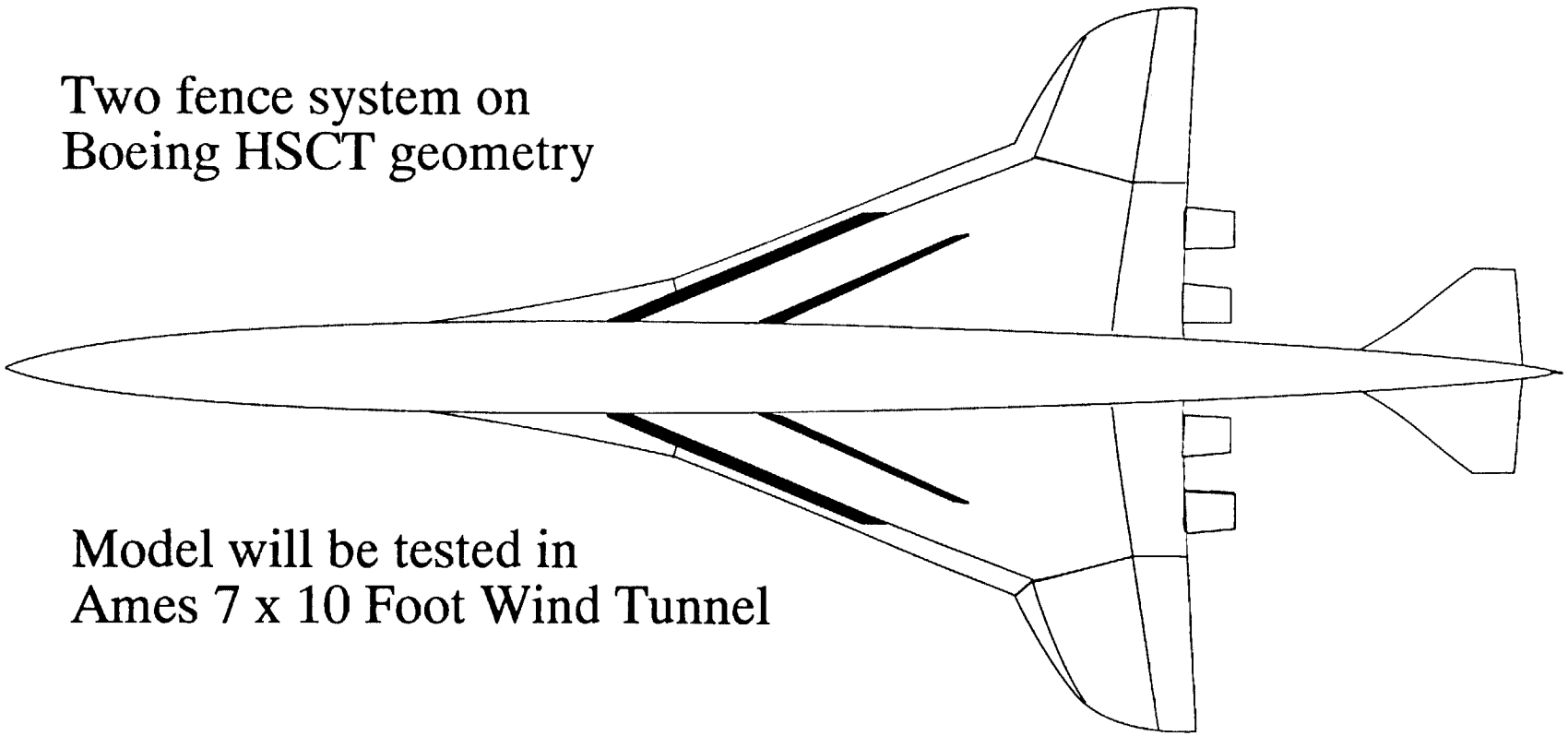
Application to HSCT Configuration

Two fence system on
Boeing HSCT geometry



Model will be tested in
Ames 7 x 10 Foot Wind Tunnel

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Applied CFD

Objective:

To use and improve computational methods for evaluation and development of high-lift systems for HSCT configurations

Approach:

Use codes appropriate to level of development

- Potential flow
- Euler
- Navier-Stokes

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Potential Flow Analysis

Trapped Vortex Stability Analyses

- Mapping technique
- Compute stable point for vortex
- Determine suction requirements
- Parametric fence geometry variations

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Euler Method

- Unstructured Grid Code (TIGER)

  - Cell refinement capability
    * Delta wing generic fighter (vortex tracking)
    * ONERA M-6 wing (shock refinement)

  - Deflected flap analysis capability
    *Straight wing with adjacent leading edge flaps

- Plans

-Trapped vortex configurations (model small-scale tests)
- SCAT-15 model

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Navier-Stokes

- Incompressible N.S.
  - INS2D code validated for trapped vortex
    * Backward facing step
    * Single and double fence on plate
  - Initial 3-D results obtained for double fence case
- Plans
  - Examine Rn effects
  - Model small-scale experiments
  - Realistic HSCT wing geometry

Additional Research Opportunities

- Trapped vortex performance on SCAT-15 model (LaRC 14 x 22 test)
- Trapped vortex on E-7 model (40 x 80)
- Examine leading edge radius effects, drooped leading edge, & Krueger flap on E-7 model (cooperative studies with LaRC, Boeing and DAC in 40 x 80)
- LaRC vortex flap on E-7 model (40 x 80)

Summary

- Have identified trapped vortex as a candidate high-lift technology
- Preliminary analyses and experiments are promising
- Extension of analysis to 3-D is underway
- Two 3-D wind-tunnel experiments are in preparation and scheduled to begin in July