COOPERATIVE HIGH-ALPHA PROGRAMS BETWEEN TRANSONIC AERODYNAMICS BRANCH (TAB) AND WRDC/FIMM

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COOPERATIVE HIGH-ALPHA PROGRAMS
BETWEEN TRANSONIC AERODYNAMICS
BRANCH (TAB) AND WRDC/FIMM

- General purpose is to improve the understanding and control of vortex-vortex, vortex-shock, and vortex-tail interactions at subsonic, transonic, and supersonic speeds

- Specific thrusts of program
  - Forebody and wing vortex interactions
  - Forebody blowing control concepts
  - Interaction of vortical flows with vertical tails
FOREBODY AND WING VORTEX INTERACTIONS

- Purpose is to augment the aerodynamic and stability characteristics of configurations at moderate to high alpha by (1) decoupling the forebody and main wing vortices or (2) individually tailoring the forebody or wing vortices

- Status
  - Tests of 65° cropped delta wing with and without planar forebodies are complete
  - Flow visualization tests of Fighter Aerodynamics Development (FAD) model are complete
  - Extensive series of tests foreseen for Modular Transonic Vortex Interaction (MTVI) model
FEATURES OF MODULAR TRANSONIC VORTEX INTERACTION (MTVI) MODEL

- 60° leading edge sweep
- Centerline or twin vertical tails (instrumented)
- Interchangeable fuselage cross sections and planform
- Segmented leading edge flaps
- Highly pressure instrumented
  - 3 pressure rings on forebody
  - 3 pressure rows across wing panels and aft fuselage
MODULAR TRANSSONIC VORTEX INTERACTION MODEL
Baseline configuration

- Alternate tail position
- Tail buffet gage
- Replaceable outer shell
- Replaceable forebody
- 60° delta
- Segmented L.E. flap
MODULAR TRANSONIC VORTEX INTERACTION MODEL

Fuselage with larger included chine angle

- Alternate tail position
- Replaceable outer shell
- Replaceable forebody
- Tail buffet gage
- 60° delta
- Segmented L.E. flap
MODULAR TRANSONIC VORTEX INTERACTION MODEL

Fuselage with conical forebody

- Alternate tail position
- Replaceable outer shell
- Replaceable forebody
- Conical planform
- Segmented L.E. flap
- Tail buffet gage
- 60° delta
MODULAR TRANSONIC VORTEX INTERACTION MODEL

Circular fuselage

Alternate tail position

Replaceable outer shell

Replaceable forebody

Tail buffet gage

Segmented L.E. flap

60° delta
RESEARCH OBJECTIVES OF MTVI MODEL PROGRAM

- Decoupling of forebody and main wing vortices by deflecting inner leading edge flap segment
  - Strong wing vortex forms outboard of fuselage/wing junction region
  - Separation of forebody and wing vortices augments lateral stability—Shown by ViGYAN Phase I
  - Present effort is part of ViGYAN Phase II contract managed by TAB
RESEARCH OBJECTIVES OF MTVI MODEL PROGRAM, CONT’D

- Determine effects of alternate fuselage cross section with larger included chine angle
  - Changing forebody vortex strength
  - Expect to weaken forebody and wing vortex interaction

- Determine effects of forebody planform change from ogival to conical

- Determine if differentially deflected (port to starboard) leading edge flaps can augment control authority
RESEARCH OBJECTIVES OF MTVI
MODEL PROGRAM, CONT'D

- Pneumatic controls for altering interaction between forebody and wing vortices will be implemented following other cooperative blowing experiments
FOREBODY BLOWING CONTROL CONCEPTS

- Purpose is to control the forebody vortex development and forebody-wing vortex interactions for enhanced high alpha stability and controllability

- Status
  - Port and slot blowing tests planned for F-16
  - Port blowing tests planned for 55° Cropped Delta Wing Model
VORTEX-EMPENNAGE INTERACTIONS

• Purpose is to control the interaction of vortical flows with vertical stabilizers for improved aircraft maneuverability and tail buffet environment

• Status
  – Initial tests of canted verticals completed on 65° Cropped Delta Wing
  – More tests with additional cant angles are planned in Langley 7x10 ft HST
WING-MOUNTED FIN (30° OUTWARD CANT) EFFECT ON HIGH-ALPHA CHARACTERISTICS

Reduced lift

Increased roll stability at small β

Breakdown of interacting vortices

Increased pitch instability

Increased yaw stability
SUMMARY

• Significant progress in understanding vortex flows has resulted from NASA/WRDC cooperative programs
  – 65° Cropped Delta Wing Model tests involving vortex-vortex and vortex-empennage interactions
  – Tests of FAD model

• More progress expected with planned programs
  – Tests of additional vertical tail cant angles with 65° Cropped Delta Wing Model
  – Test program with MTVI model to look at vortex-vortex and vortex-empennage interactions
  – Forebody blowing experiments with F-16 and 55° Cropped Delta Wing models