Flight Dynamics Research Facility – Perspective on Future Impacts

FDRF Design-Build Kickoff
September 30th, 2021

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LaRC Research Directorate

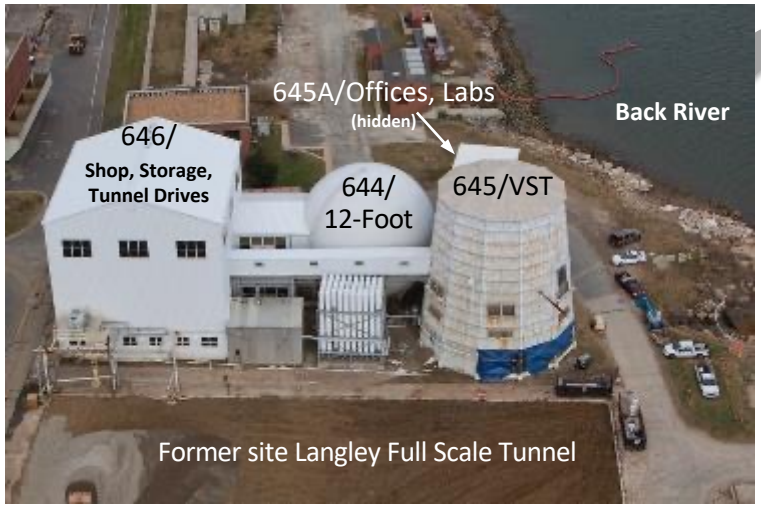
Outline

- Background: Agency decision to proceed with FDRF
- Role of flight dynamics R&T within NASA
- FDRF enabling future missions
- Summary

NASA Executive Council Decision Memo 5-10-002 (2015)

HQ assigned Langley action to "*Accelerate Flight Mechanics Facilities consolidation within LaRC*"

- At time of decision, baselined in LaRC *facility revitalization plan* for FY23 funding
  - ➢ Project was accelerated with FY20 funding
- Improves flight mechanics testing capability for NASA Aeronautics Research, Human Exploration, and Science missions.
- Four buildings to be demolished and replaced with one new building



Current Flight Dynamics Research and Support Facilities
LaRC East Area (Langley AFB)

- Replace with single new facility having greater capability that supports NASA mission for 40+ years
- Utilize existing SOA test rigs/DAS – design for future upgrades
- Vacate of major flood zone on LAFB

Flight Dynamics is Key to Mission Success

- **Flight Dynamics & Control is fundamental to NASA's core missions in Human Exploration, Science, & Aeronautics Research that involve atmospheric flight vehicles.**
  1. Mission success will continue to be heavily dependent on experimental capabilities due to inherently time-dependent and often separated flow aerodynamics that drive most flight dynamics challenges.
  2. Developing reliable computational tools for robust prediction of flight dynamics will also require enhanced flight-dynamic experimental capabilities.

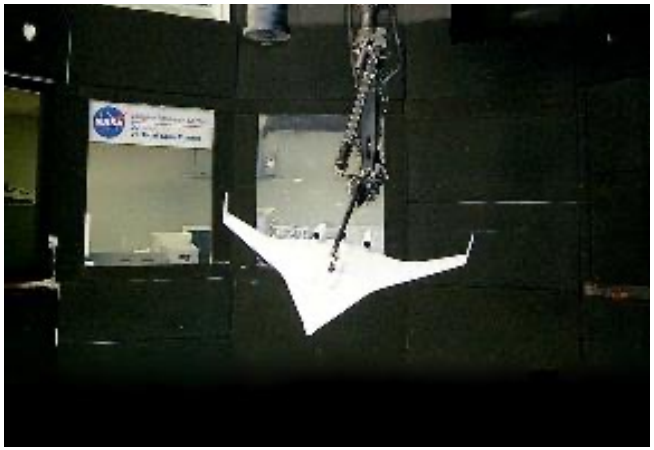
Existing 80+ year old flight-dynamics facilities (> 100% beyond typical facility design life) cannot support future missions' complex technology needs due to poor flow quality, low dynamic pressure range, unlikely ability to keep them technically viable (even for less demanding applications) as they approach 100 years old.

Conversely, an experimental facility that combines rapid, low-cost access with significantly greater technical capability than current assets will be an enabler for planned future mission research, development and science thrusts.

Risk Reduction for X-Plane Flight Demonstrators and Advanced Concepts

X-59 QueSST Low Boom Flight Demonstrator

X-57 Maxwell Distributed Electric Propulsion Demonstrator



X-48B Low Speed Vehicle Blended Wing Body Demonstrator

D8 “Double Bubble” Advanced Transport Concept

Autonomous Vehicle Safety Research

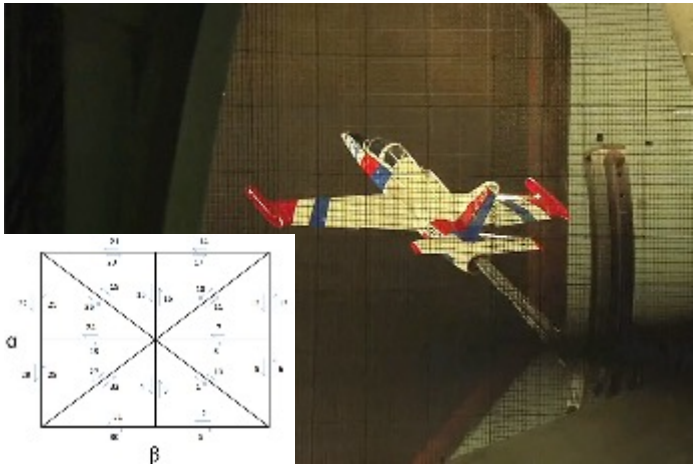
Prediction of autonomous vehicle flight dynamics for safety of the public

Flight dynamics experimental facilities are needed to help ensure air vehicle safety both in the sky, and on the ground…

Rapid Testing and Development of Vehicles

GL-10 Greased Lightning VTOL

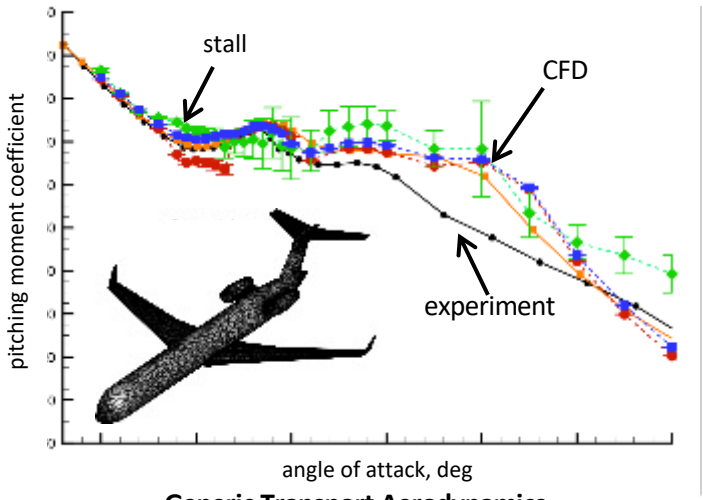
TACP/CAS MADCAT High Frequency Morphing
(Mission Adaptive Digital Composite Aerostructure Technologies)



"Learn to Fly" Real-Time Modeling + Learning Controls

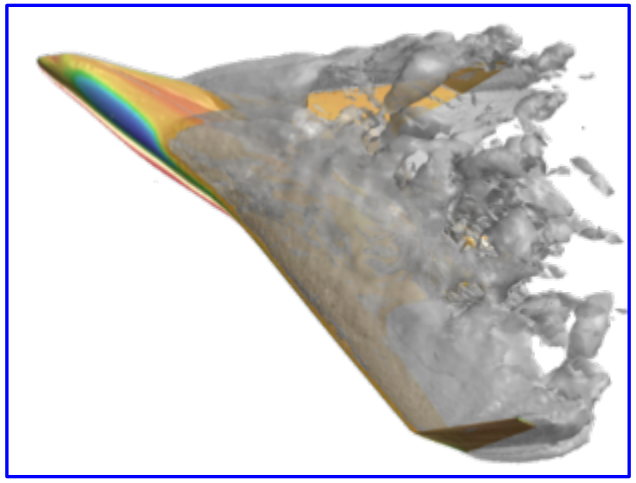
Laying groundwork for future vision of self-learning vehicles

CFD Vision 2030 – Beyond the Linear Range



Generic Transport Aerodynamics – CFD vs. Experiment

"Perhaps the single, most critical area in CFD simulation capability that will remain a pacing item by 2030 in the analysis and design of aerospace systems is the ability to adequately predict viscous turbulent flows with possible boundary layer transition and flow separation present" – *CFD Vision 2030 Study: A Path to Revolutionary Computational Aerosciences, p. 12*



BWB Dynamic Stability using DES

"Key experimental datasets are critically important in the ongoing development and refinement of the full range of turbulence models from RANS to LES… test data from complex, integrated flow fields using geometries that are more representative of complex aerospace systems is needed" – *CFD Vision 2030 Study, p. 12*

Human Exploration – Vehicle Risk Reduction

- Free-flight dynamic stability
- Static aero modeling
- Dynamic aero modeling
- Drogue chutes

Orion Launch Abort Vehicle (early concept)

Orion Crew Module

Orion Parachute Test Vehicle (PTV) Drogue Aero Modeling

NESC Max Launch Abort System Concept

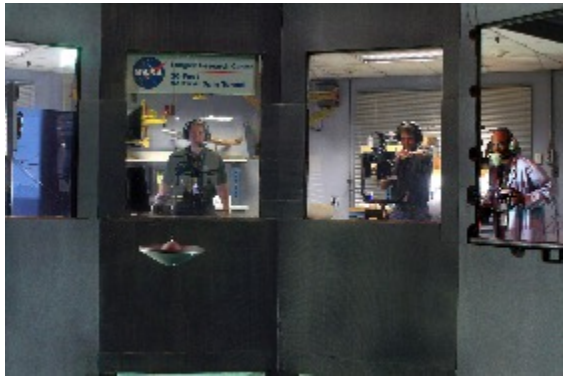
Planetary Science Mission Risk Reduction

Venus SAGE

Stardust

OSIRIS REx

ARES Mars Airplane



Multi-Mission Earth Entry Vehicle

Moonrise Earth Entry Vehicle

In Summary…

- Current flight dynamics research tunnels have served the nation for over eighty years
- Many of today's uses bear little resemblance to those originally envisioned as a result of:
  - Simple yet capable, rugged, well-designed tunnels
  - High degree of adaptability
- FDRF will provide high fidelity experimental data that are needed to both directly enable new technologies, vehicles and missions, and to help bring computational methods into the mainstream for flight dynamics research