National Aeronautics and Space Administration

NASA Advisory Council Aeronautics Committee Report

Mr. John Borghese,
Vice-Chair

December 11. 2013

Committee Information

- **Members:**
  - Ms. Marion Blakey, Chair (Aerospace Industries Association)
  - Mr. John Borghese (Rockwell Collins)
  - Dr. Karen Thole(Penn State University)*
  - Dr. John Langford (Aurora Flight Sciences)
  - Mr. Mark Anderson (Boeing)
  - Dr. John-Paul Clarke (Georgia Institute of Technology)
  - Dr. Mike Francis (UTRC)
  - Dr. Mike Bragg (University of Illinois)
  - Mr. Tommie Wood (Bell Helicopter)
  - Mr. Mark Pearson (General Electric)
- Plans for next meeting: Face-to-face Committee Meeting at NASA Headquarters, March, 2014.

* New Member

Areas of Interest Explored at Current Meeting

Topics covered at the Aeronautics Committee meeting held on December 3, 2013 at NASA Langley Research Center:

Langley Research Center Overview*

Rotary Wing Project Discussion*

Advanced Composites Project Planning Update

NRC Autonomy Study Discussion

* These topics have related findings provided by the Aeronautics Committee

NASA Langley at a Glance (2013)

Langley's Economic Impact (2012)

National economic output of ~ $2.3B and generates over 18,000 high-tech jobs

Virginia economic output of ~ $1B and generates ~ 9,000 high-tech jobs

Founded in 1917 as the first civil aeronautical research lab

~$767M PY2013 Budget Estimate

(Awaiting Agency Op Plan Approval)

~$733M NASA Langley budget

~$34M External business

~3,600 Workforce

~1,900 Civil Servants

~1,700 Contractors (on/near-site)

Infrastructure/Facilities

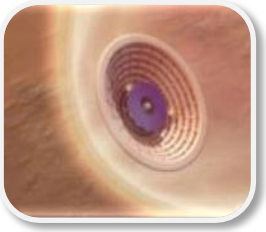
788 acres, 169 Buildings

~$3.6B replacement value

Aeronautics
$193m

Science
$126m

Space Tech
$70m



Human Exploration
$35m

Education
$2m

Cross-Agency Support Programs & Construction/Environmental Compliance & Restoration

Center Management & Operations
(Facilities, Fab, Engineering, Tech Authority, B&P, IRAD, Safety/Mission Assurance, Legal, Finance, Procurement, Human Resources)

Agency Management & Operations
(NASA Engineering & Safety Center, Office of Chief Engineer, Agency IT)

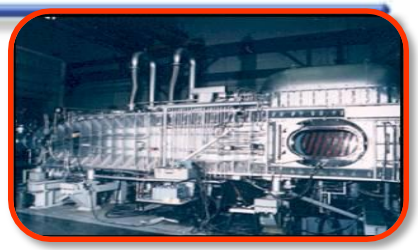
Construction/Env Compliance & Restoration
(Revitalization Plan)

NASA Langley Facilities

14 x 22 Foot Subsonic Tunnel
Subsonic, Alternate Uses

National Transonic Facility
High Reynolds Number Flow
Nationally Unique

LaRC Unitary Plan Wind Tunnel
Supersonic Speed Range



Aerothermodynamic Complex
Exploration Workhorse

Subsonic **Transonic** **Supersonic** **Hypersonic**

National Assets needed to meet the needs of the Agency, DoD, and Industry – ongoing revitalization with Langley's VITAL effort

Flight Simulation Facilities

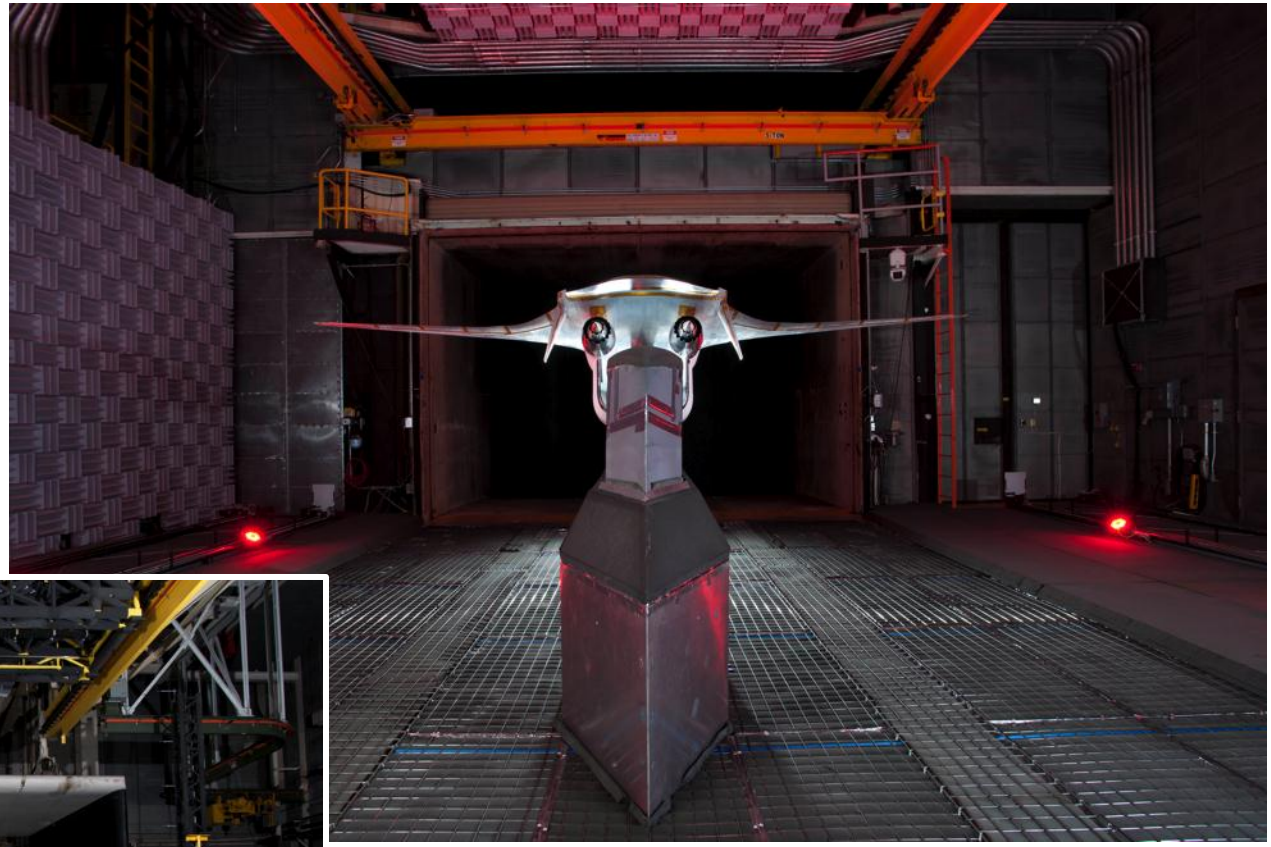
20-Foot Vertical Spin Tunnel
Spin Characteristics & Dynamic Stability
Nationally Unique

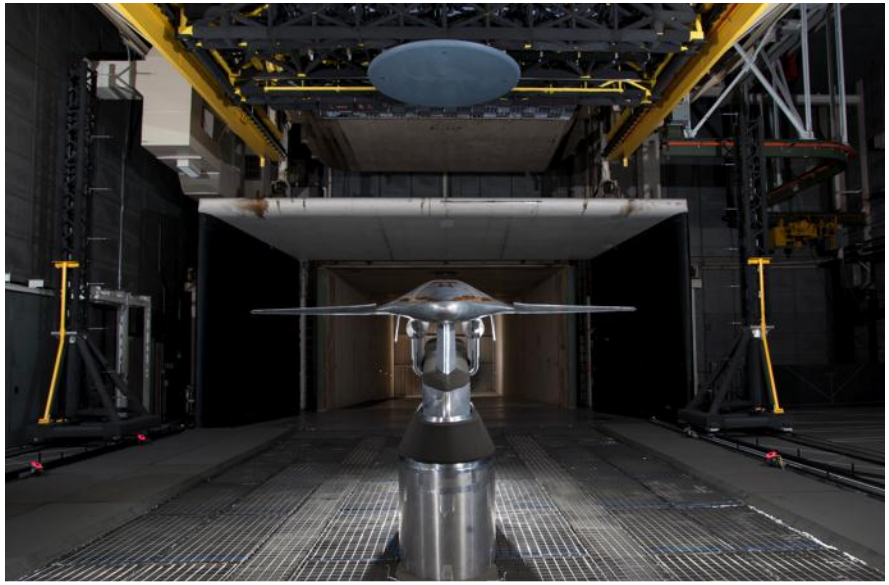
Transonic Dynamics Tunnel
Aeroelasticity & Flutter
World Unique

High Temperature Tunnel
Large-scale Hypersonics
& Propulsion

Specialty Facilities

HWB Community Noise Experiment in 14x22 Wind Tunnel





- Demonstrated new Aeroacoustic measurement capability and new propane fuel system in 14x22
- Acquired critical data for Broadband, Airframe, and Jet Noise components on HWB
- Results will help demonstrate ERA Project noise reduction goals and improve noise prediction model

Committee Finding

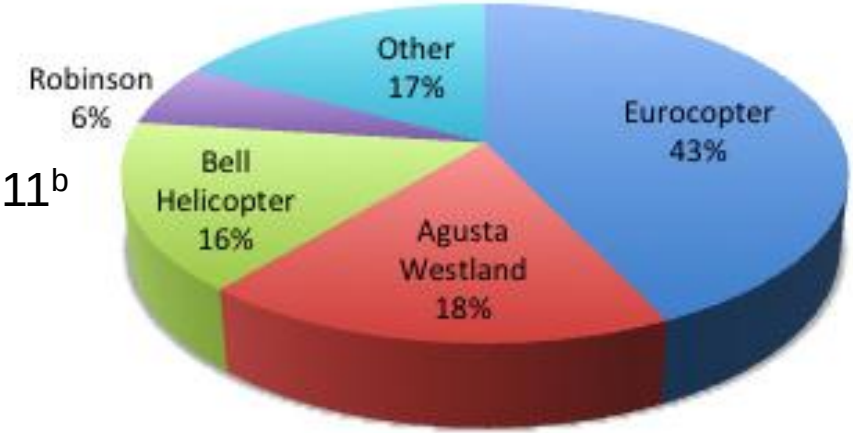
The Committee endorses the approach that NASA Langley Research Center has taken toward establishing a strategic effort to inform future facility and workforce decisions. The Committee feels that the underlying process of utilizing strategic partnerships and community/stakeholder engagement has enabled ARMD/LaRC to efficiently manage facilities and more effectively plan for future research needs.

Civil Rotorcraft Market Share

Between 1999-2003, the US lost leadership in civil rotorcraft market share[a]

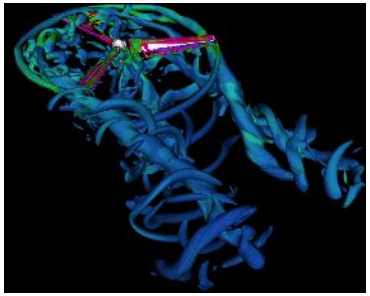
- EU focus and investment in civil rotorcraft research has affected US market share
  - In 1992, Eurocopter was formed from the merger of two helicopter companies, German MBB and French Aerospatiale
  - Civil market share of Eurocopter grew from 28% to 43% worldwide last two decades
  - European Union (EU) investing heavily in high-speed civil tiltrotor technologies for commercial use; demonstrator planned under EU Project Clean Sky
  - Huge Asia/Pacific/South America civil market expected to open; EU is aggressively targeting market
- Other countries are entering civil rotorcraft industry: India, Korea, China, etc.

Civil Market Share, 2011[b]



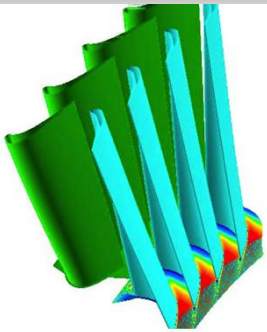
[a] World Civil Rotorcraft Market, Vertiflite Vol. 46, No. 1, 2000. The World Rotorcraft Market, Vertiflite Vol. 50, No. 1, 2004.
[b] http://www.aviationtoday.com/rw/commercial/ems/CEO-Bertling-Predicts-CivilMilitary-Rotorcraft-Market-Parity-by-2025_75692.html#.UZaP3-CUIsp

FY13 RW Key Elements/ Areas of Research



FY13 RW Project Summary*

~95 work/years (78 CS / 17 Contractor)
~ $24M per year (includes salary)
Host Center is LaRC



Ames Research Center
~30 work/years

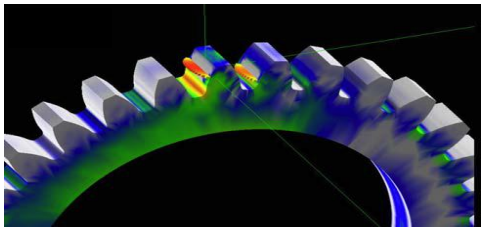
- Aeromechanics
- CFD
- Flt Dyn & Ctrl
- Exp Capability
- System Analysis

Glenn Research Center
~33 work/years

- Drive Systems
- Engines
- Icing
- System Analysis
- CBM

Langley Research Center
~32 work/years

- Acoustics
- Aeromechanics
- Exp Capability
- CFD
- Crashworthiness



*based on FY13 President's budget

Research Themes & Tech Challenges

Research Themes	Technical Challenges 2013-2017	Other Technical Focus 2013-2017
Advanced Efficient Propulsion Demonstrate and mature engine and drive system technologies to enable increased vehicle speeds while maximizing propulsive efficiency and minimizing weight penalty	**RW.TC1.1 VSPT Technology Demo:** Demonstrate 50% improvement in efficient operational capability using a Variable Speed Power Turbine concept **RW.TC1.2 Two Speed Drive System Demo:** Demonstrate two-speed drive system with less than 2% power loss while maintaining current power-to-weight ratios	• High efficiency gas generators • Condition Based Maintenance
Advanced Concepts and Configurations Extend flight envelope; maximize performance and efficiency capabilities of rotorcraft vehicles	**RW.TC2.1 Active Rotor Concepts Evaluated:** Quantify performance, noise and vibration benefits of 3 Active Rotor concepts by test and analysis **RW.TC2.2 35% Accuracy Improvements in CFD:** Demonstrate 35% improvement in accuracy of predictions for rotor loads and performance for both hover and forward flight	• Low noise concepts • Noise prediction • Fuselage drag reduction
Rotorcraft Integration into NextGen Foster, develop and demonstrate technologies that are critical to the successful commercial operation and passenger acceptance of rotary wing vehicles	No Technical Challenge for this Research Theme	• Flight dynamics and control • Icing research • Crashworthiness research • Cabin Noise • Flight path integration

US Rotorcraft Research Roles

- **Industry Research**
  - Recent focus for US industry has been to meet significant military demand, with upgrades, manufacture, and spare parts stretching industry to capacity, at the expense of civil development and IR&D
  - As military demand wanes, industry investing in new civil ventures (S-92, S-76D, Relentless)
  - Industry does not typically invest in advanced experimental methods and new computational capabilities; investments typically tied to product requirements
- **US Government Research – DoD**
  - Recent focus on incremental upgrades to existing platforms
  - Current emphasis on moving technology forward with the Joint Multi-Role Technology Demonstrator, looking forward to Future Vertical Lift Program of Record
  - Has a low risk tolerance for program-of-record acquisitions
- **US Government Research – NASA**
  - NASA focus typically longer term than industry or DoD
  - NASA possesses unique facilities, advanced computational methods and experimental capabilities that US industry lacks
  - Recent NASA investment in test facilities and computational capabilities position NASA to further the state of the art through understanding the fundamental physics
  - NASA research is more risk-tolerant to explore innovation

Partnerships and Agreements

Key Partnerships

NASA-Army MOU for Collaborative Research in Aeronautics, August 2007

- Army Aeroflightdynamics Directorate (AFDD)
- Army Research Laboratory, Vehicle Technology Directorate (ARL-VTD)
- Army Applied Aviation Technology Directorate (AATD, Ft. Eustis)

Vertical Lift Research Centers of Excellence (VLRCOE) SAA through FY15

- Army AFDD
- Office of Naval Research (ONR)

Army and Vertical Lift Consortium (Icing research, Airloads workshop)

Smart Twisting Active Rotor (STAR) International partnerships—likely end FY14

Key Agreements

Bell Helicopter Future Advance Rotorcraft Drives SAA

Sikorsky—impact damage

FAA Spiral Bevel Gear Maintenance Credit Evaluation SAA

PSU-ARL—windage gearbox collaboration SAA (follow-up to NRA)

Navy/FAA/Army/Cobham—transport fuselage impact drop test, seat evaluation SAA/IA

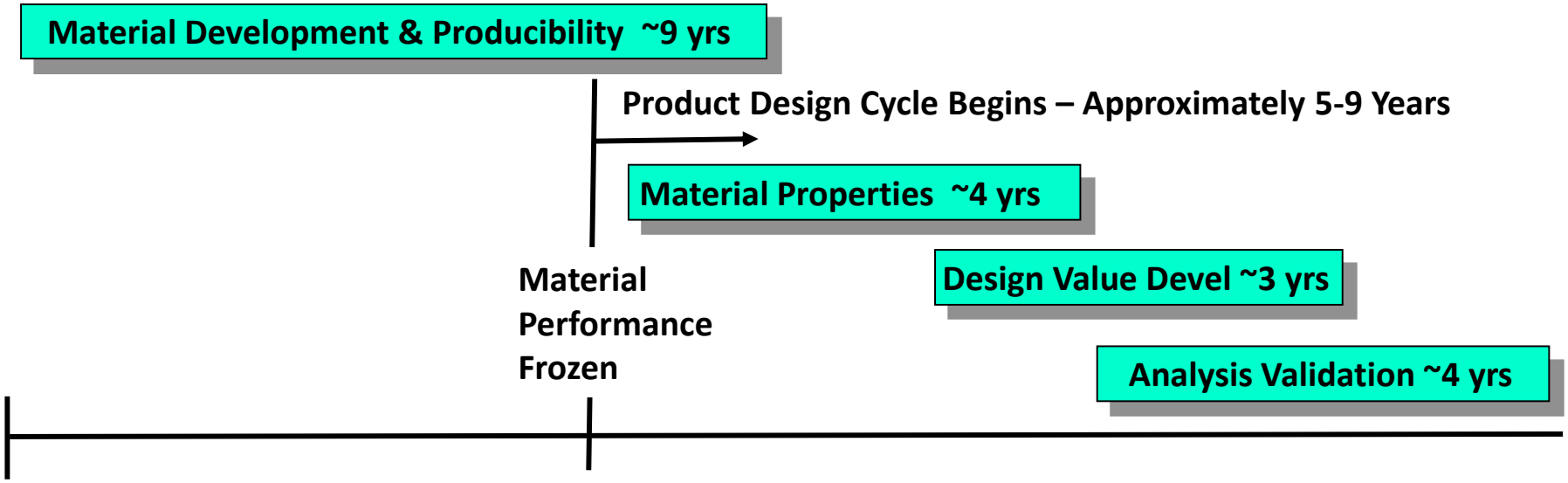
Bell Helicopter—spur gear evaluation SAA

Committee Finding

The Committee supports ARMDs continued investment in Rotary Wing research and encourages maintaining research efforts that provide advancements in dual use (civilian and military) capabilities. The Committee finds that it is a great strength of the research to invest in technologies that provide benefit primarily to civil aviation, but also serve to advance military capabilities. The Committee encourages ARMD to maintain those partnerships with the DoD that will foster the development of those technologies, and enable NASA to hasten the civil use of technologies developed primarily for military rotorcraft. In addition, rotorcraft research is a logical place in which to make advances in NASA's autonomy agenda/initiative.

Composites Research Problem Statement

Timeline for development and certification of advanced composite materials and structures for aerospace approaches 20 years



WHY SLOW

- Complexity: parameters in construction; failure modes; variability
- Strength and life can not be predicted reliably
- Empirical and iterative 'trial and error' methods; lots of testing

Inhibits vehicle innovation; Impacts national competitiveness

Activities to Date

- NRC-organized Meeting of Experts
- DARPA: Advanced Composites Workshop
- Partnership engagement with FAA
- Partnership engagement with DoD
- Advanced Composites Consortium Formation
- Technical Planning Workshop with Industry stakeholders

Advanced Composites Consortium (ACC)

- Sept. 2013: NASA announced Partners selected to form ACC
  - Bell Helicopter Textron
  - GE Aviation
  - Lockheed Martin Corporation
  - Northrop Grumman Corporation
  - The Boeing Company
  - United Technologies Corporation:
    - Pratt & Whitney, Sikorsky, Hamilton Sunstrand, UTRC

- Initial Responsibility:
  - Develop with NASA the Articles of Collaboration to govern the ACC
  - Informal refinement of ACP Technical Plan

- ACC Kick-off Meeting, Nov. 14 at NASA LaRC

Scope of NRC Study

- ***Develop a National Research Agenda for Autonomy in Civil Aviation***
  - Prioritized set of integrated and comprehensive technical goals and objectives
  - … of importance to the civil aeronautics community and the nation
- ***Consider***
  - current state of the art in autonomy research and applications, including non-aviation sources
  - current national guidance on research goals and objectives
- ***Describe***
  - forms and applications of autonomy reviewed
  - potential contributions of autonomy to civil aviation … evolved and 'game-changers' … with a 10-20 year focus
  - technical and policy barriers to operational systems and implementation
  - key challenges and gaps to be addressed by a national research agenda for autonomy in civil aviation
- ***Outline***
  - a prioritized set of research projects that
    - enable development of CONOPS
    - lead to development, integration, testing and demonstration
    - predict system-level effects to the NAS
    - define approaches to verification & validation … and certification
  - The outline should be developed with due consideration of required resources and organizational partnerships, and it should describe potential contributions and roles of U.S. research organizations

STUDY PLAN

- Interviews and presentations to study team
  - NASA (sponsor) perspective … and current program overview
  - Aviation issues
  - Autonomy & other related relevant technologies (e.g. robotics, communications, …)
  - Non-aviation applications of autonomy and implications (e.g. automotive, space, …)
  - Policy perspectives
  - Other issues/factors that influence the agenda
- Schedule … 4 meetings
  - ➢ July 10-12 Washington, DC
  - ➢ August 27-29 Irvine, CA
  - ➢ November 13-14 Washington, DC
  - – December 16-18 Irvine, CA (Closed meeting)
- Deliberate, discuss, integrate, adjudicate, achieve consensus …
- Prepare study report for NRC release