WHAT IS THE NACA MODEL OF RESEARCH AND DEVELOPMENT?

Reflections on a Century of Aerospace Development

Roger D. Launius
National Air and Space Museum
Smithsonian Institution
Washington, D.C.

"Angle of Attack"

- Introduction
- Establishing an R&D Structure
- The NACA and the Aeronautics Revolution of the 1930s
- The NACA and the X-1
- The NACA Reaches into Space
- Conclusions

Introduction

- NASA's pathways into twenty-first century:
  - New space vehicles owned and operated by NASA.
  - "Return" to NACA model of R&D.
- NACA created in 1915, charter called for it "to supervise and direct the scientific study of the problems of flight, with a view to their practical solution, and to determine the problems which should be experimentally attacked, and to discuss their solution and their application to practical questions."
- So what was the NACA model for aerospace research and development (R&D)?

American Aviation in the Doldrums

- Wright Brothers first flight, December 17, 1903.
- Within decade technological capability had migrated to Europe.
- U.S. technology mired in patent wars, other difficulties.
- No investment by U.S. government.
- NACA specific attempt to resolve this problem.

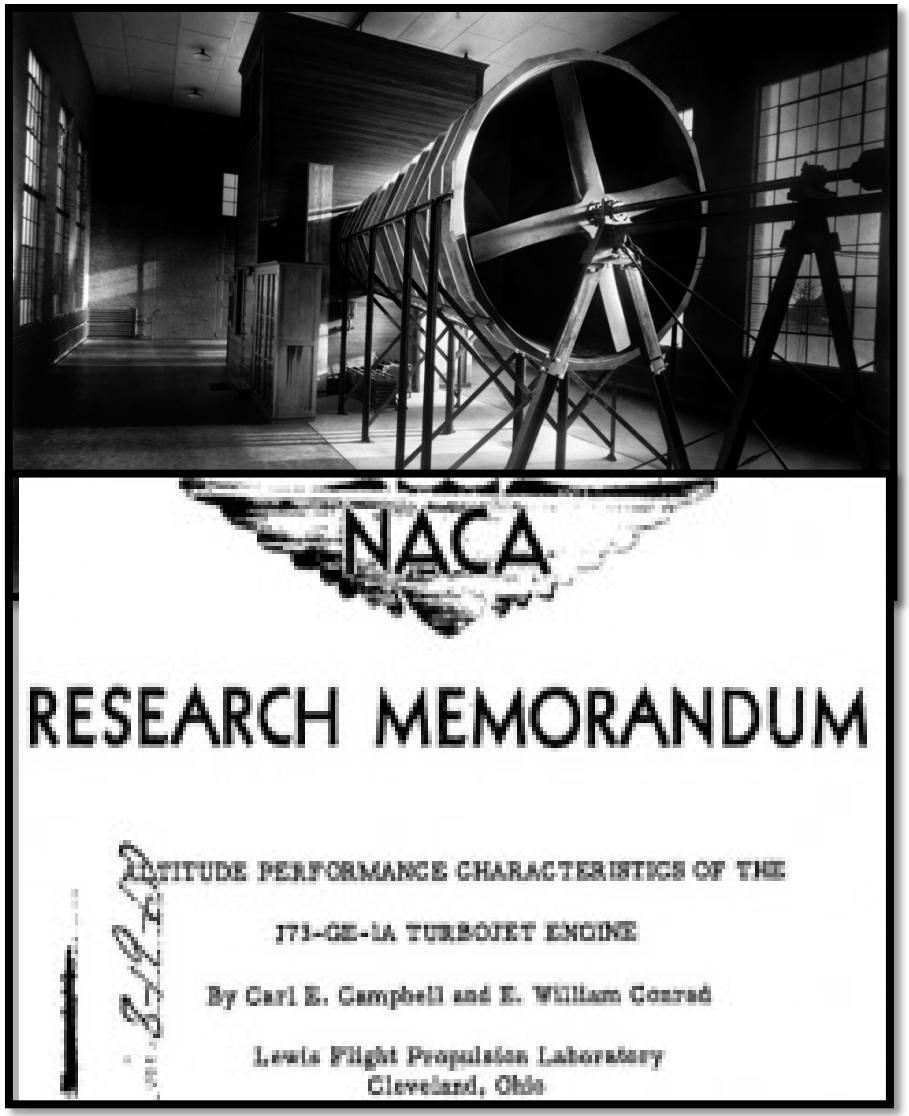
Charles Miller's Assessment

One of the most astute observers of the NACA's research approach, Charles E. Miller, has made the case that the NACA's guiding principle required it to "Build an Industry, Not a Program." The NACA approach in accomplishing this principle, according to Miller, was aimed at open innovation with industry as the central customer. He also concluded that the NACA achieved consensus on which problems to pursue but that the results were open to all. In addition, as Miller emphasized: "No government competition with the private sector. Smaller, more numerous, more frequent projects and programs. No single-point failures. Diversify risk via portfolio investment approach."

How about taking an NACA Approach?
Build an Industry — Not a Program

- **NACA approach:** A proven open innovation model
  - Focus is on Industry as the "Customer"
  - Develop a partnership with all key agencies (USAF, DOT, DOC
    - No gaps. Increased effectiveness
- **Guiding Principle:** "Build an Industry, Not a Program"
- **Guiding Strategy:**
  - Develop consensus on most important problems of industry
    - "Problems" broadly defined (much more than technology)
  - Develop Practical solutions to industry's prioritized problems
    - Involving more than one company (multiple winners)
    - No government competition with the private sector
  - Smaller, more numerous, more frequent projects and programs
    - No single-point failures
    - Diversify risk via portfolio investment approach

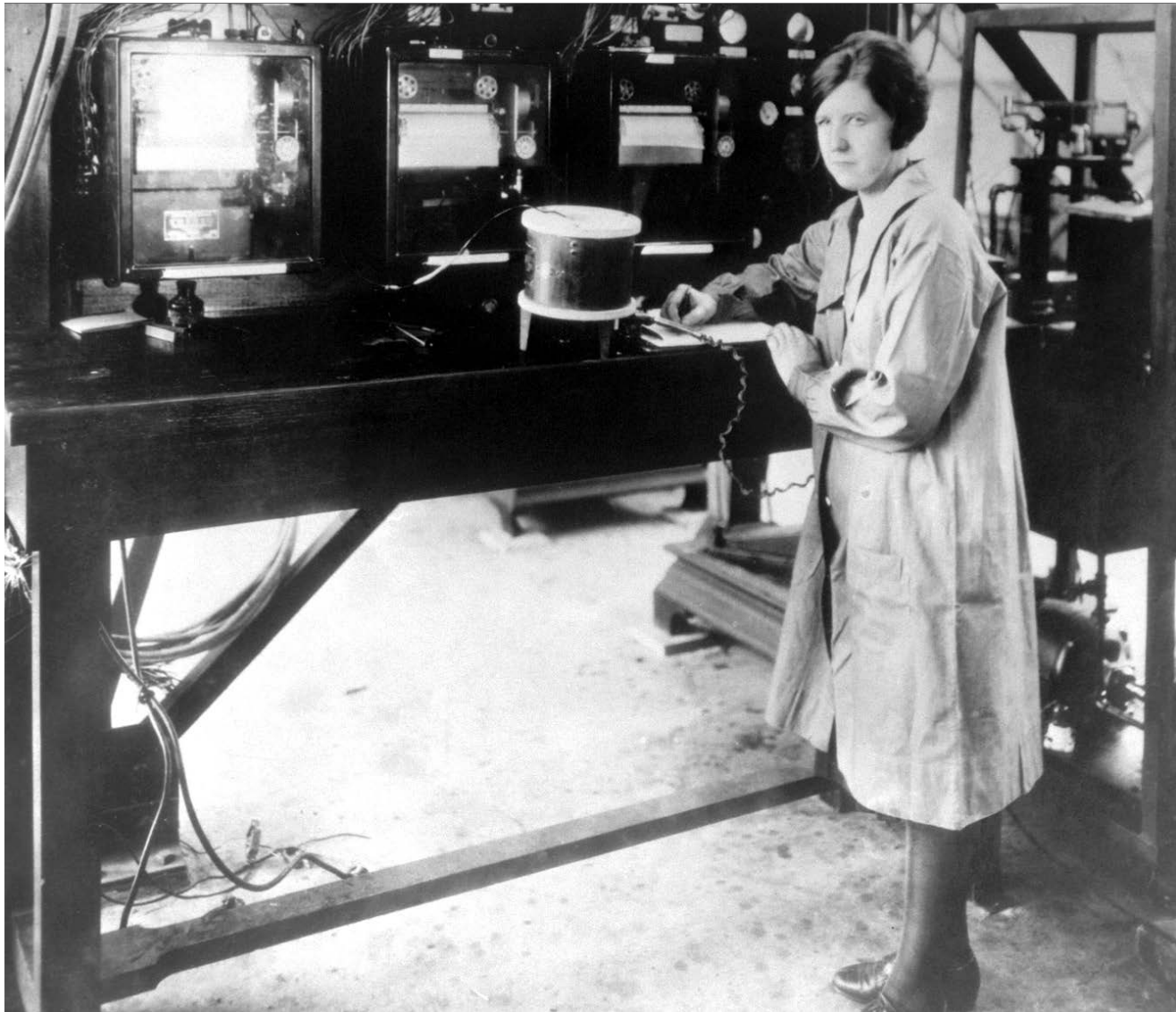
Establishing an R&D Structure



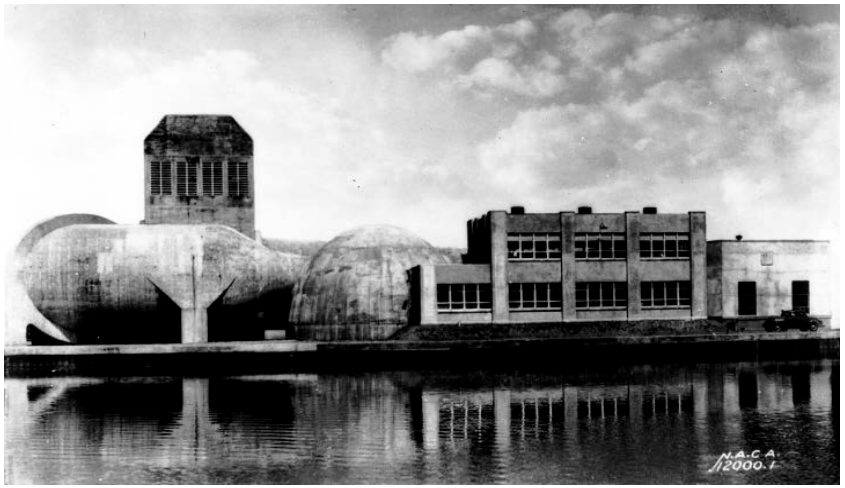
- Technical Reports: Most prestigious and widely distributed report; described "lasting contributions to the body of aeronautical knowledge."
- Technical Notes: Reported on work in progress.
- Research Memoranda: Introduced in 1946, reported on classified work.
- Advance Confidential Reports: Introduced after World War II, reported on sensitive military aeronautical subjects.
- Bulletins: Short progress reports.
- Memorandum Reports: Focused on aeronautical research of interest to a very small group.
- Technical Memoranda: Reported on aeronautical research conducted somewhere other than at NACA; often translations.

Pearl Young and the NACA's Research Program

The architect of the technical reporting was Pearl S. Young (1895-1968), who came to work at the NACA's Langley Laboratory in 1922 after graduating with a physics degree from the University of North Dakota. After working in the instrumentation division for a few years she suggested that Langley required someone to oversee the technical reports system, which at that time was in disarray. Young took on that responsibility and led the effort until World War II. She created the multitude of documents issued by the NACA, enforced the NACA style of presentation on authors, ensured technical verisimilitude, and handled document distribution far and wide.



NACA Inspection/Industry Conference



- Sponsored annual government/academia/industry aeronautical conference beginning 1926.
- Obtained research requests, interchanged ideas, and got feedback on NACA work.
- Example was Research Authorization 201, "Investigation of Various Methods of Improving Wing Characteristics by Control of the Boundary Layer," signed Jan. 21, 1927. Provided broad-based research on airflow. Research took place between 1927 and 1944, taking a variety of twists and turns.

The NACA and the Aeronautics Revolution of the 1930s

- Began with greater L/D systems.
- More sophisticated Infrastructure.
- Boeing 247/DC-3 Transformation of Aviation.
- Greater government investment in R&D.
- NACA research effort critical to transformation.
- Results published in more than 16,000 research reports.
- By end of World War II NACA had three laboratories: Langley, Ames, and Lewis.

NACA and Navigational Systems

The NACA and the X-1

- Focus on basic research.
- Greater emphasis on cooperative projects.
- Partnerships pioneered in X-1 served NACA well in future.
- Virtually all larger projects the agency undertook involved partnership of some kind.
- With X-1 project the traditional model of NACA R&D that had dominated the agency's activities prior to World War II was swept away in the high speed frontier of the postwar era, not to be seen as a dominant part of the agency's activities ever again.

The Quest for Higher and Faster

- Because of World War II many new possibilities for R&D could be pursued
- NACA emphasized three broad areas that overshadowed others in urgency and importance
  - Practical solution of problems high-speed flight
  - Missile and rocket technology
  - Nuclear power for aircraft

The NACA Reaches into Space

- Jerome Hunsaker (December 1944): "the policy of the Committee is to include scientific and engineering research bearing on the design of guided missiles and their means of propulsion and control….the NACA should have the same relation to guided missiles as it has to airplanes."
- NACA's research in missiles and rockets required flight testing but no existing laboratories were suitable.
- NACA acquired part of Wallops Island, on the Virginia coast.
- Formally established as Pilotless Aircraft Research Division (PARD) on August 11, 1946.

Wallops Island Launch Site

- An aerial view of early facilities at the Pilotless Aircraft Research Station, Wallops Island, Virginia, in 1947.
- The launch ramp in the foreground sent rockets out over the Atlantic Ocean, beyond the beach at the right of the photograph.

The PARD Mission

- Gilruth served as PARD Chief, 1946-1951.
- Oversaw initially oversaw research to understand transonic (600-800 mph) flight characteristics.
  - A wind tunnel at Langley employing a slotted-throat principle for transonic research began in 1951.
  - Later supersonic (Mach 1-5) and hypersonic (Mach 5+) flight characteristics became the focus of addition.
- NACA became adept at firing small solid–propellant rockets to gather data on various aerodynamic shapes accelerated past mach 1.
  - On July 4, 1945, the first test vehicle was launched from Wallops, a small two-stage, solid-fuel rocket to check instrumentation.
  - Many launches supported military missile studies.

Initial PARD Launch

- Initial flight check launch on June 27, 1945.
- Checked Doppler radar for measuring velocities of missiles.
- Five 3.25 inch rockets were fired at 39.4 elevation angle.

RM-2 PARD Tests

- Project engineer Sidney Alexander adjusts typical RM-2 model in its special launcher at Wallops Island, October 1945.
- The first RM-2 was launched October 18, 1945.
- This launcher was a simple guide rail with no moving parts set at a fixed launching angle of 75 degrees.
- This program evaluated wing sections, aspect ratios, sweepback, and wing tapers from high subsonic speeds through the transonic speed and into the supersonic realm.

The Launch of Little Joe

- Little Joe on launcher at Wallops Island.
- Little Joe was a major project for Space Task Group.
- It was a test of the escape and recovery systems on the Mercury spacecraft.
- Launched on August 21, 1959.

Conclusions

- Several differences of interpretation about NACA model of R&D.
- Three case studies suggest three distinct NACA models for R&D.
  - Traditional NACA approach emphasizes R&D as support for industry in latter 1920s and 1930s. Among other artifacts of that effort, the Boeing-247 and the DC-3 became the mainstays of American commercial developments.
  - NACA supersonic R&D in 1940s suggests a public-private partnership—NACA, Air Force, and industry—in X-1 program.
  - Work of Pilotless Aircraft Research Division (PARD) precursor for NASA projects of 1960s.

Lessons

1. **Progress comes by fits and starts, linear. Rapid development followed by plateaus. Revolutions. Evolution.**

2. **Flight needs to be viewed as a system: not just an airplane. Progress comes through a continuum of interrelationships: heterogeneous engineering.**

3. **Flight is a tightly woven spectrum from low-level, slow aircraft to interplanetary travel. While the flight regimes may vary, the interrelatedness of all is compelling.**

4. **Flight in 20th Century has brought two enormous changes to the lives of all people; one, it has shrunk the size of the globe; second, it has made possible the rapid and irreversible destruction of our civilization.**

5. **Flight may well be the single most significant technology of this century. The debate rages about whether or not it has driven technology in all manner of other areas.**

6. **Government investment has been critical. Aerospace has been profitable because of its governmental investment—directly in the form of civil and military procurement—indirectly in the form of R&D and infrastructure support.**