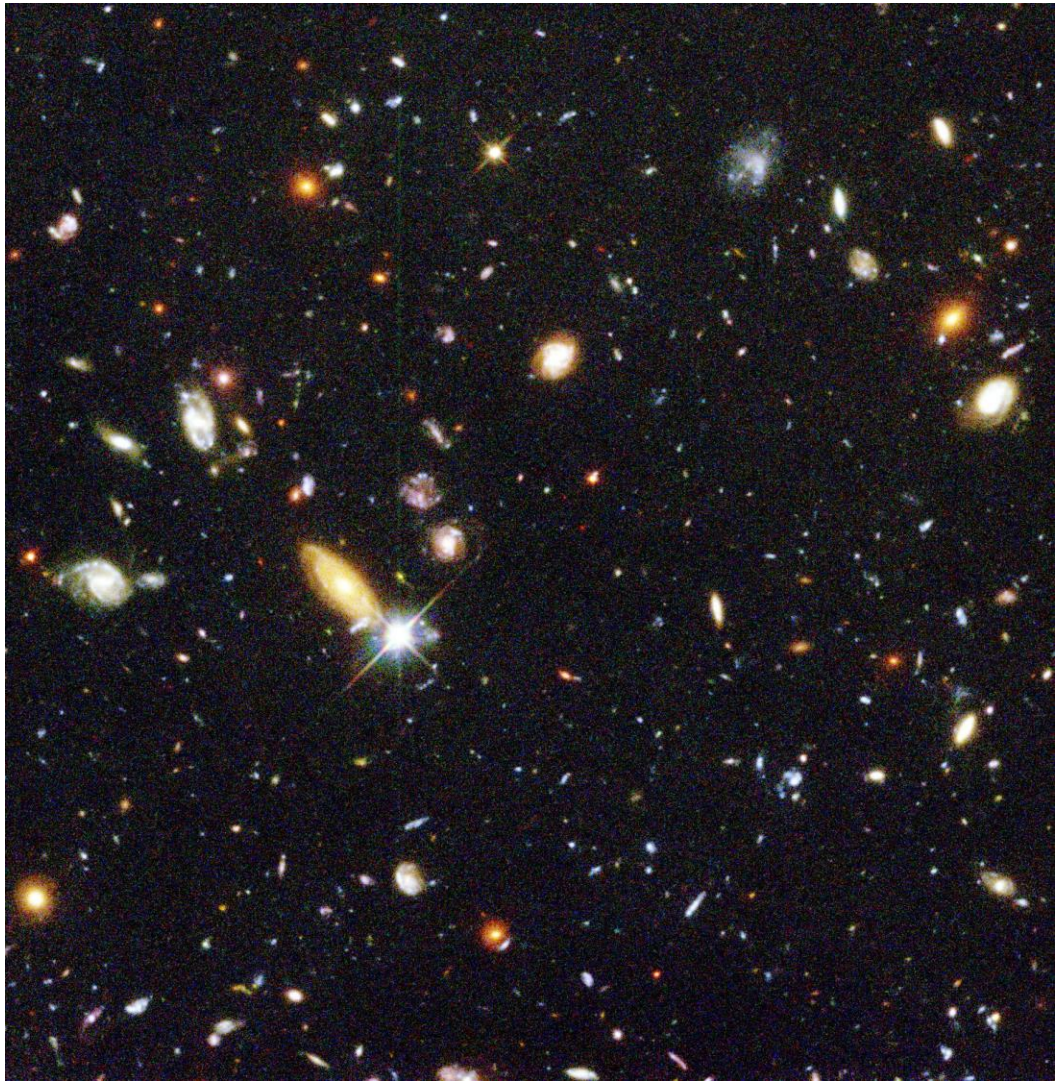
Engineering Month:
Building Mission Success at NASA
March 2025

Engineering & Science
From the NACA to NASA

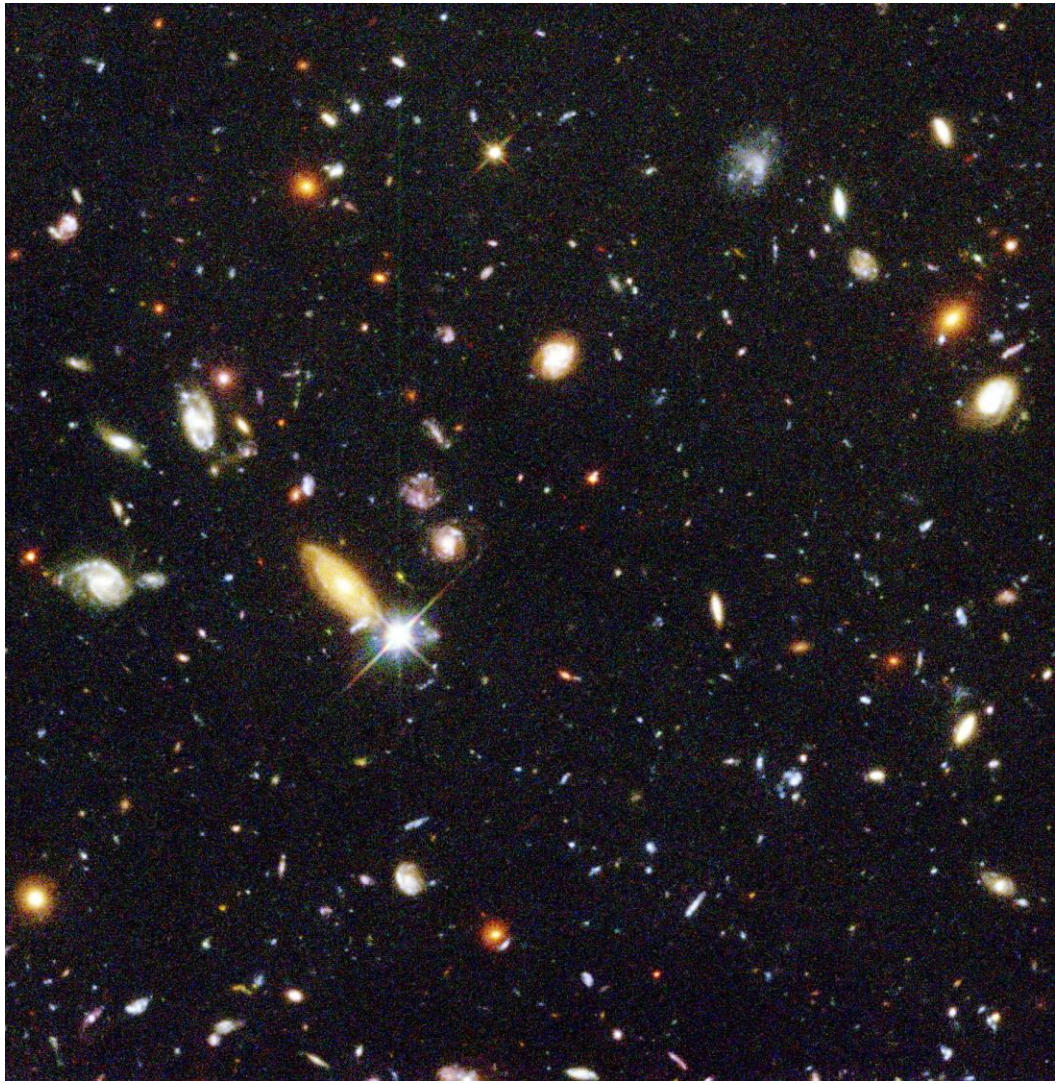
Three Milestones

- **Hubble Deep Field (1995)**



Three Milestones

- **Hubble Deep Field (1995)**
- ***The Creation of the Universe* (1985)**
- ***The Structure of Scientific Revolutions* (1962)**



Three Milestones

- **Hubble Deep Field (1995)**
- ***The Creation of the Universe* (1985)**
- ***The Structure of Scientific Revolutions* (1962)**

History at NASA

67
Years (NASA)

66
Years (NASA History)

200+
Books & Monographs

2
In Production Now

1,500+
Oral Histories

2M+
Social media

NASA's First Headquarters

History at NASA

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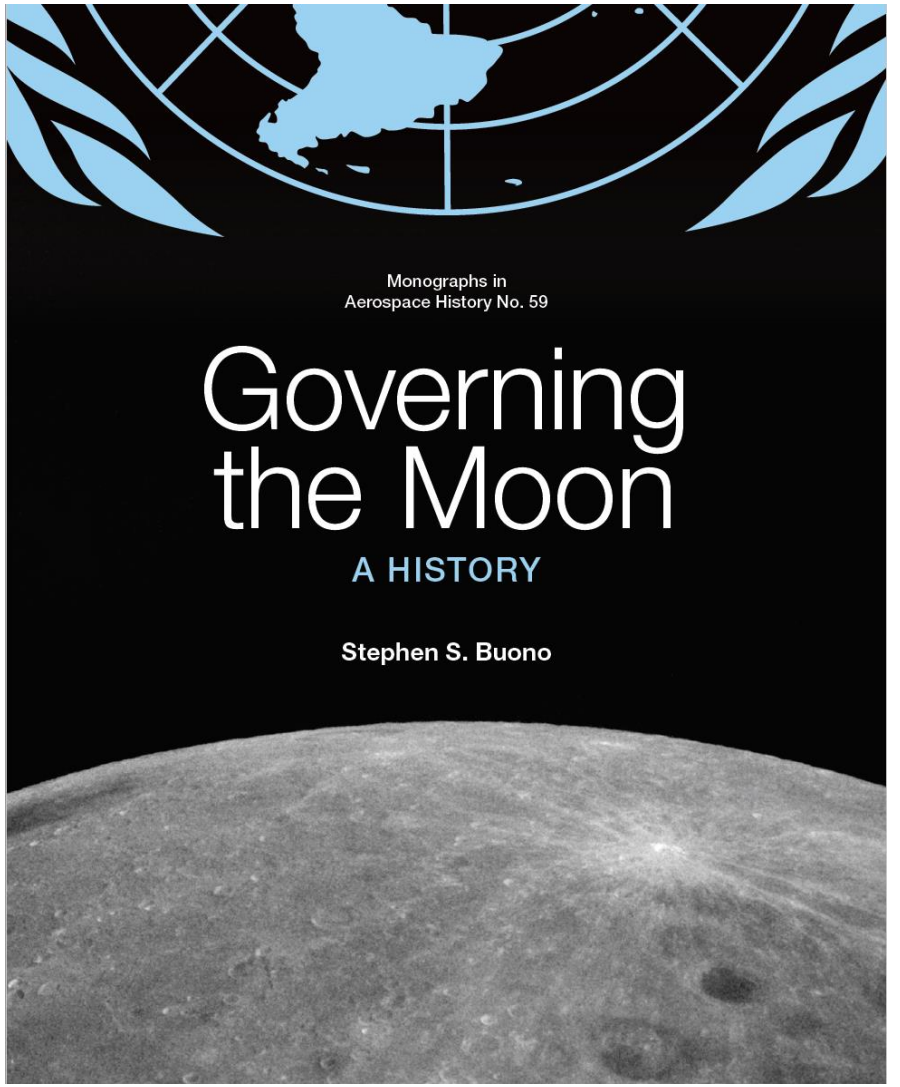
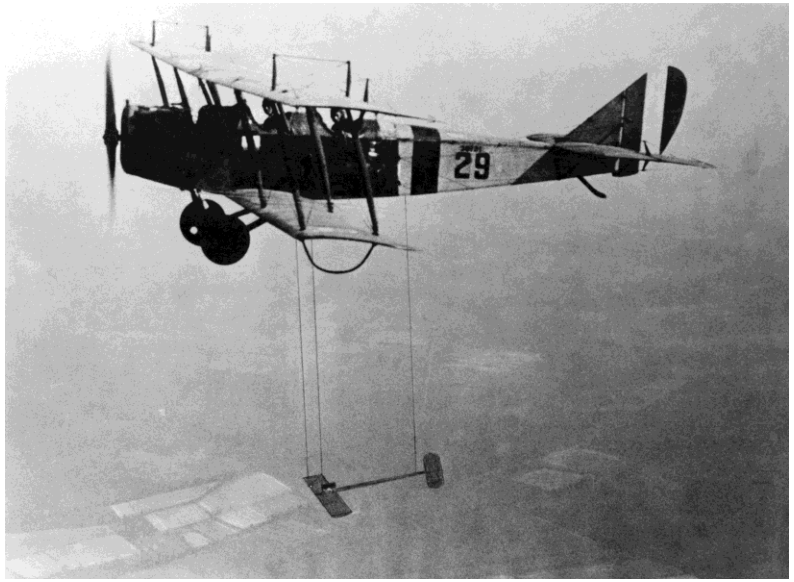


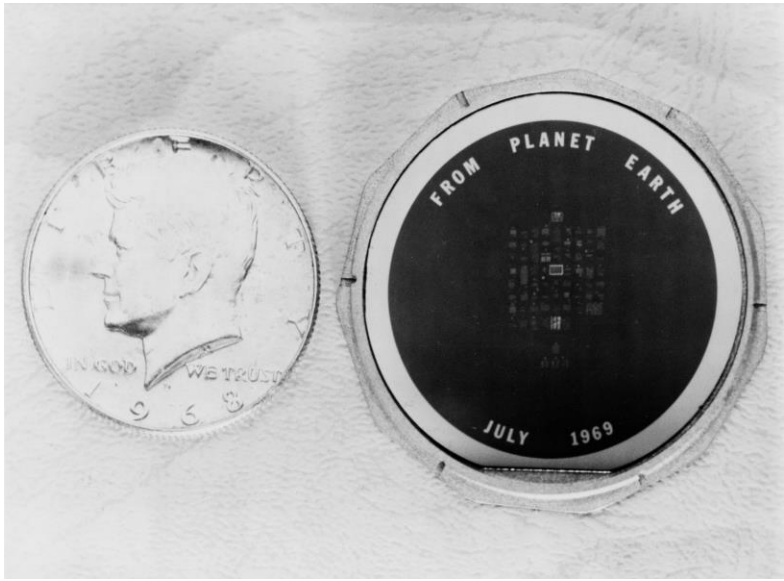
NASA SP-2024-4559

Engineering & Science: From the NACA to NASA



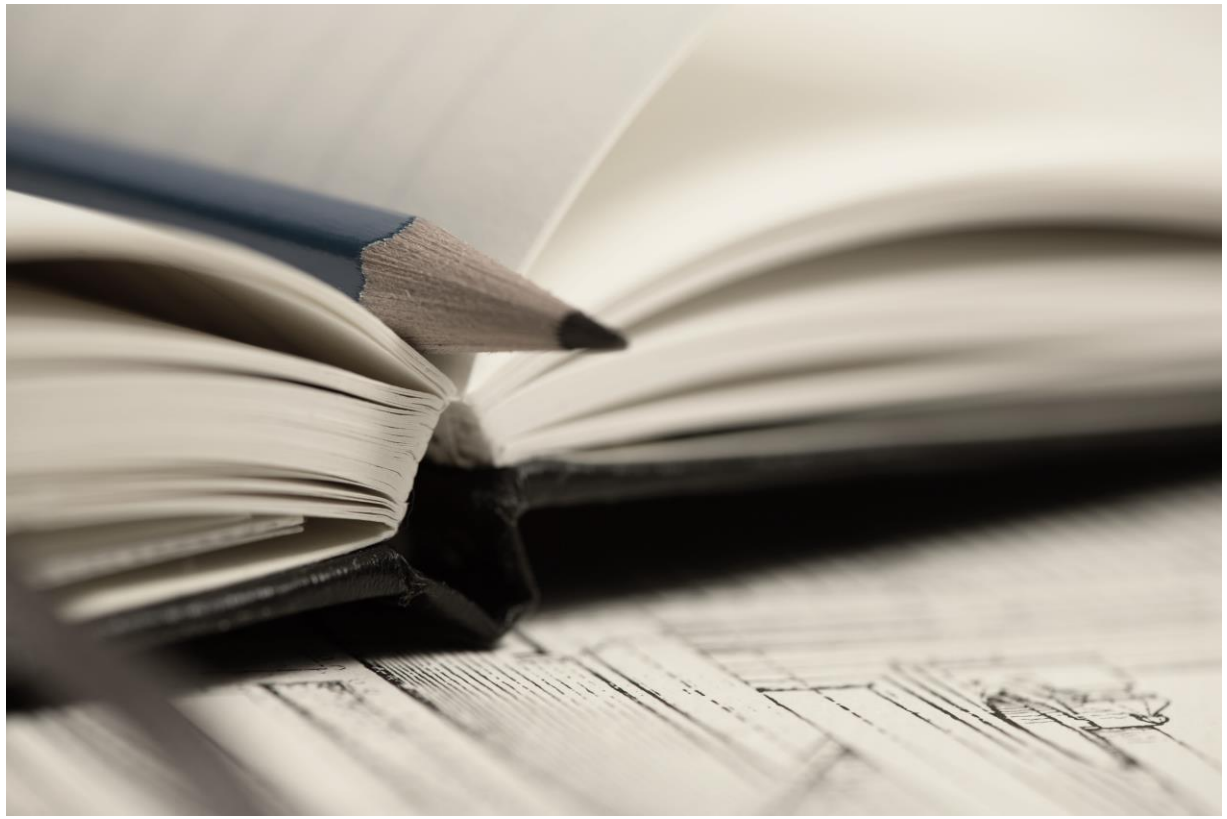
NACA Founded
1915

Sound Barrier Broken
1947



Apollo 11
1969

Engineering & Science: How do YOU define them?



In the chat, please write a brief sentence that distinguishes science and engineering from each other.

Engineering & Science: How do YOU define them?

engineering is "mechanical;" science is study of the natural world.

Science searches for new information, engineering attempts to solve problems with existing knowledge.

Science = natural study
Engineering = application of that knowledge

Science - producing new knowledge to produce new tools
Engineering - producing new tools to produce new knowledge

Engineering is building things.
Science is about research of the world, not application.

Engineering & Science: How do YOU define them?

engineering is "mechanical;" science is study of the natural world.

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*Science - producing new **knowledge** to produce new tools*
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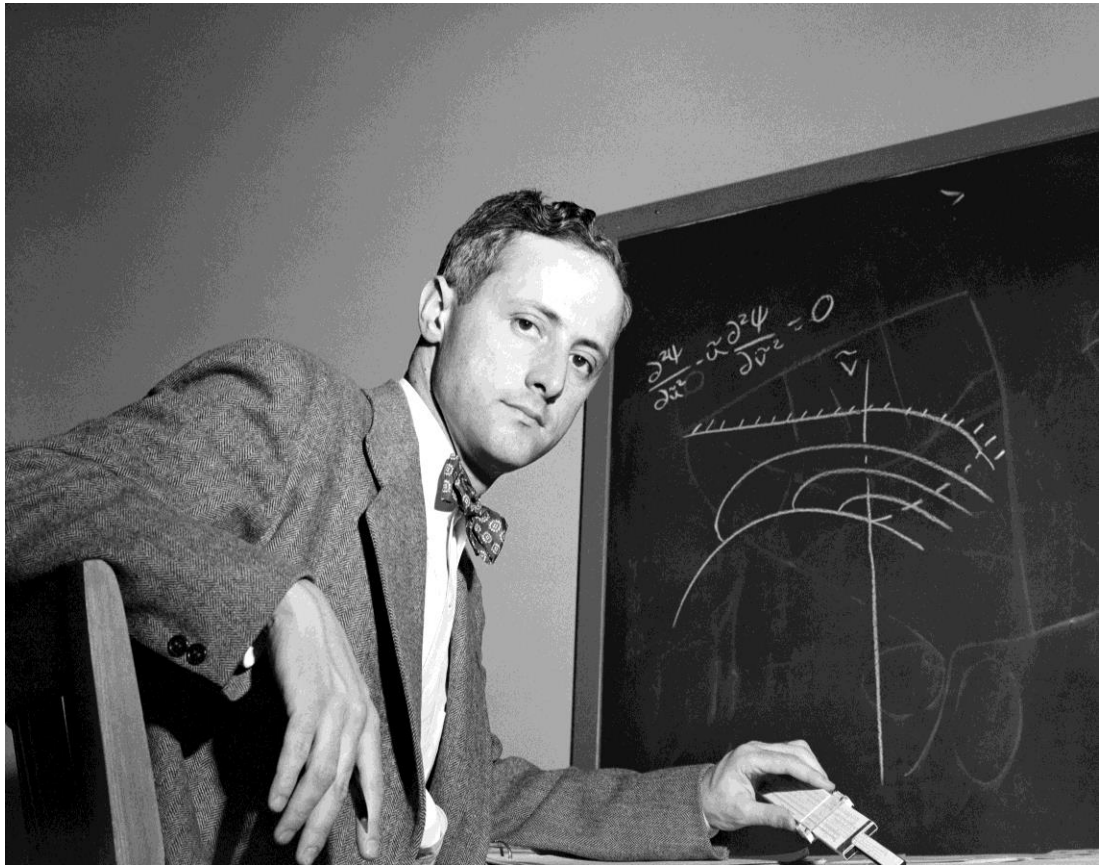
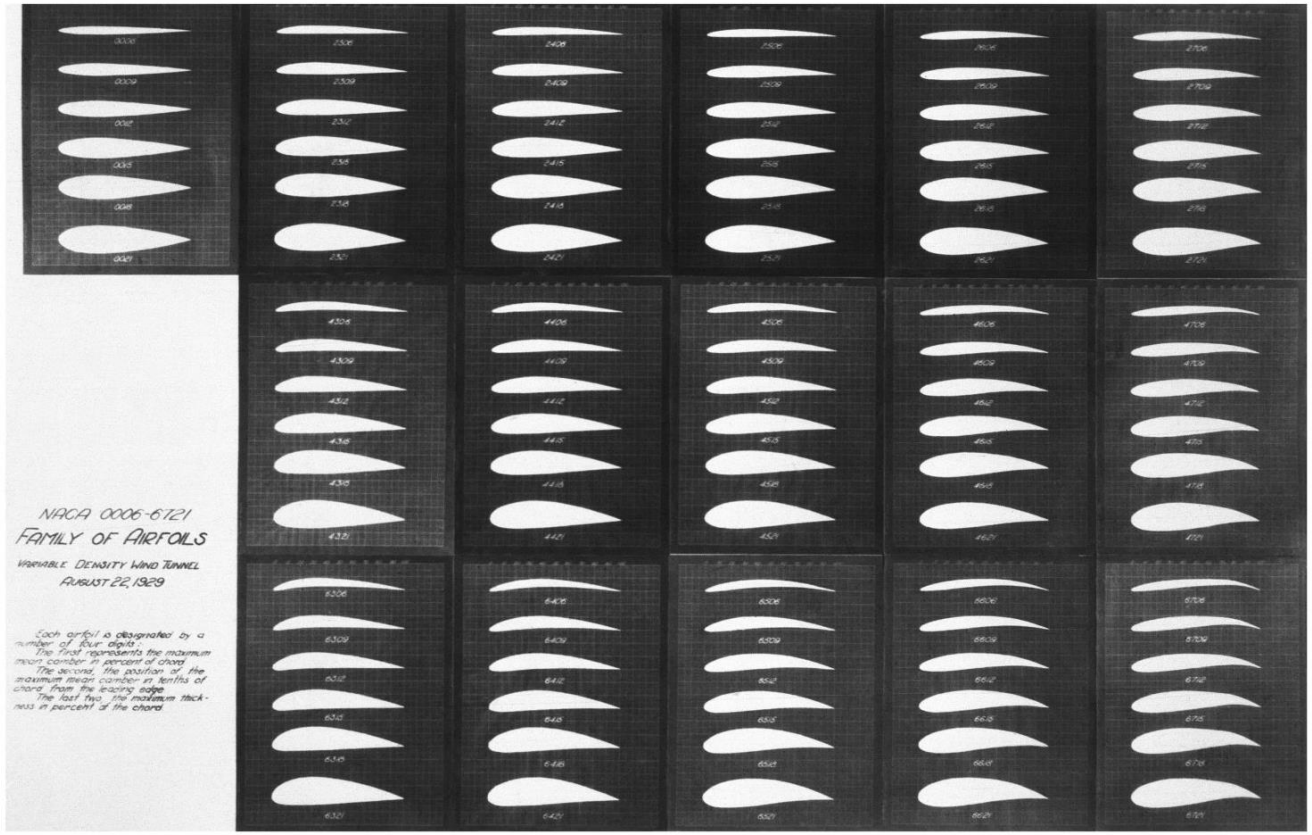
Engineering as Knowledge



- Walter Vincenti
  - NACA
  - Aeronautics and Astronautics at Stanford
  - *Introduction to Physical Gas Dynamics* (1965)
  - Program in Science, Technology and Society at Stanford (since 1971)
- *What Engineers Know and How They Know It: Analytical Studies from Aeronautical History* (1990)

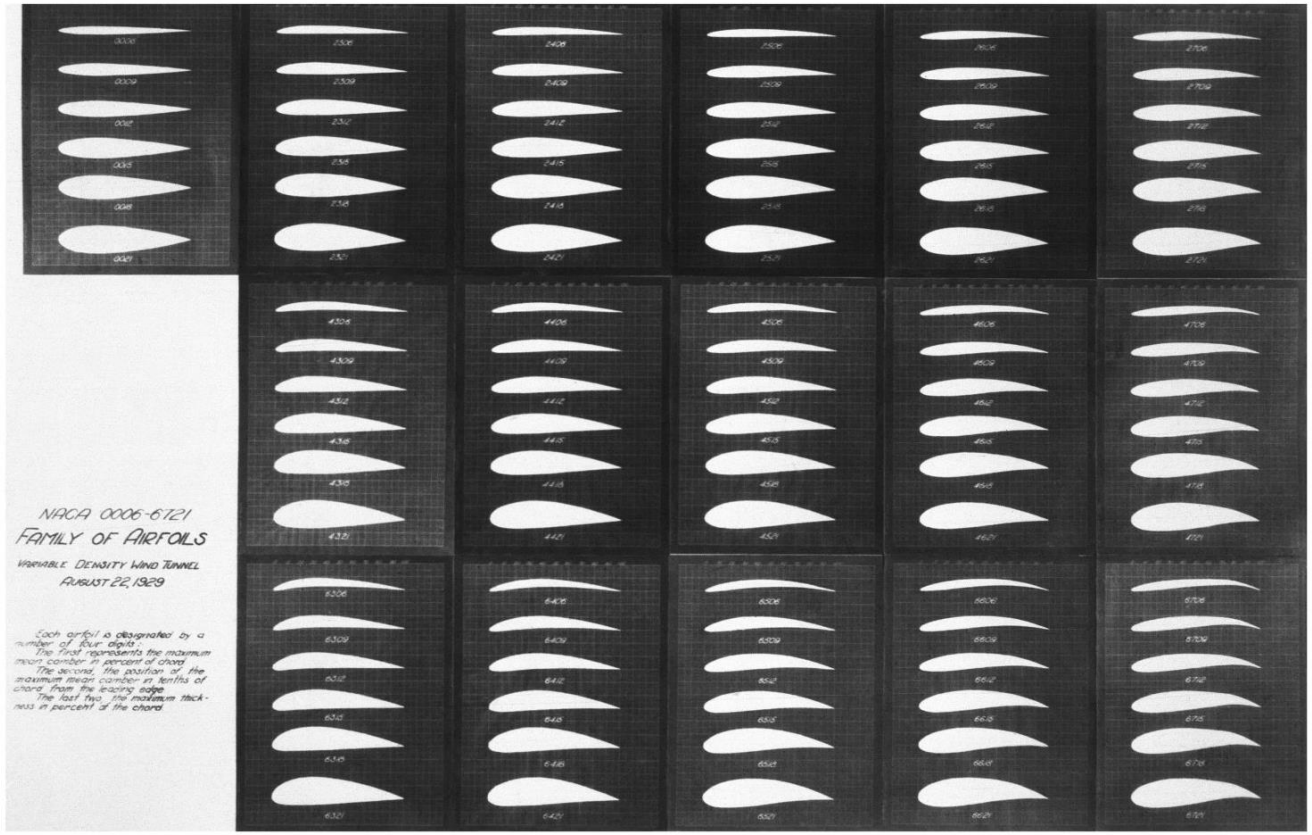
"Engineering Science"



- Vincenti on the relationship between engineering and science:

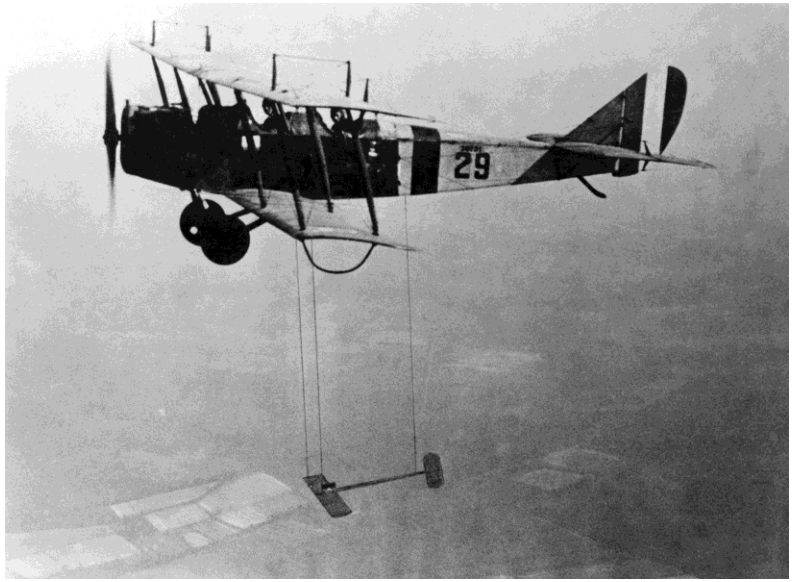
- Similarities
  - Follow the same natural laws
  - Diffuse knowledge through mechanisms (e.g., textbooks, journals, teaching, apprenticing)
  - Cumulative, incremental
- Differences
  - Science seeks to understand nature
  - Engineering creates artifacts

"Engineering Science"



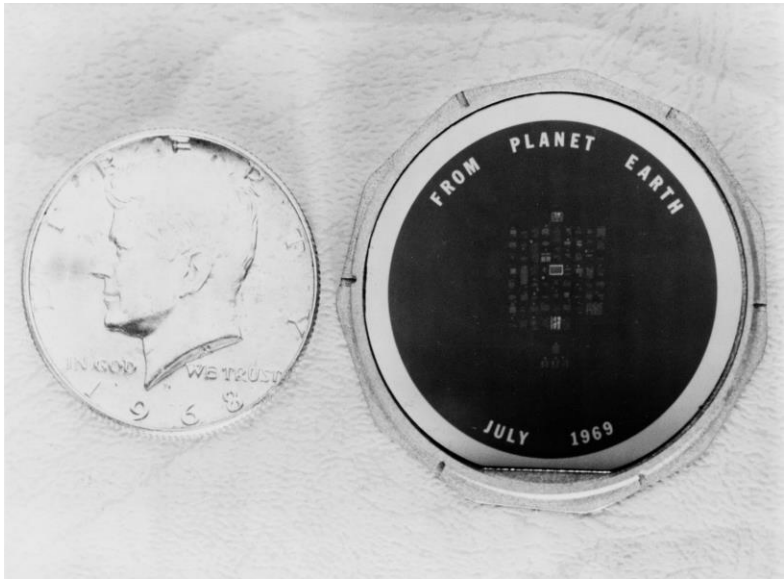
- Systematic research into fundamental design parameters
- The NACA airfoils are one example that embodies the process and represents a clear set of "artifacts"

Engineering & Science: From the NACA to NASA



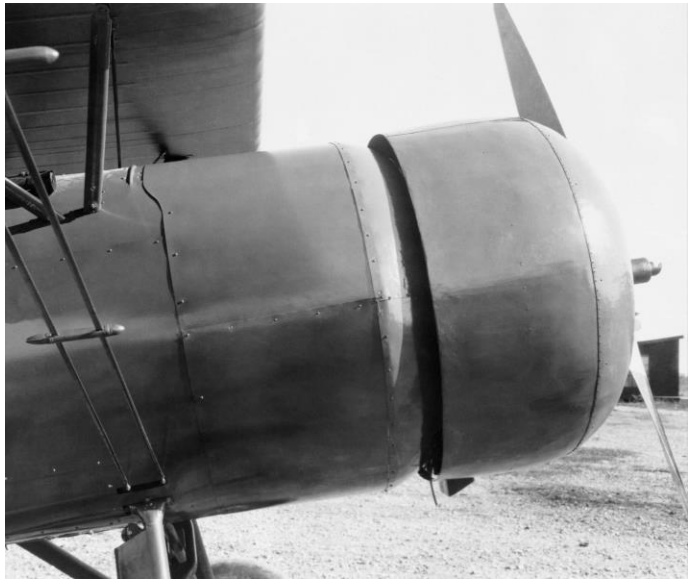
1915 to 1939
"Engineering Science"
The NACA until WWII

1940 to 1957
Science & Technology
From WWII to Sputnik



1958 to 1972
Big Science, Big Technology
Apollo

Three Stories Today



The NACA Cowling
"Engineering Science"
The NACA until WWII

1940 to 1957
Science & Technology
From WWII to Sputnik

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Three Stories Today

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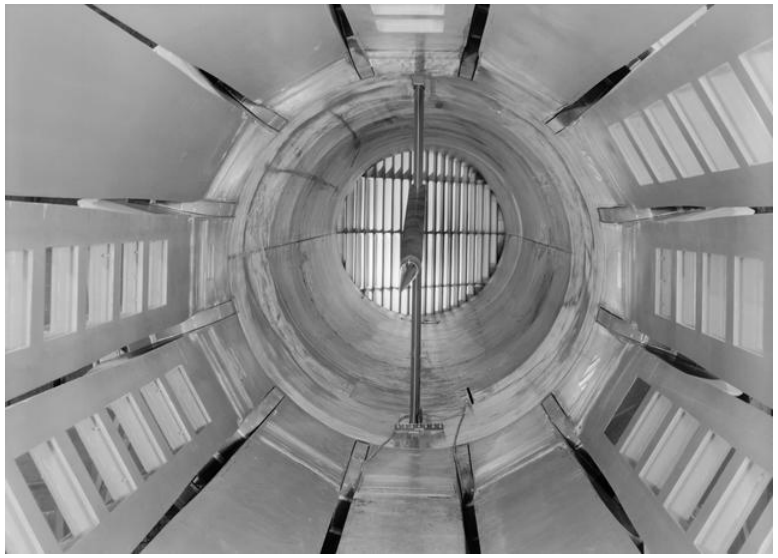

Transonic Research
Science & Technology
From WWII to Sputnik

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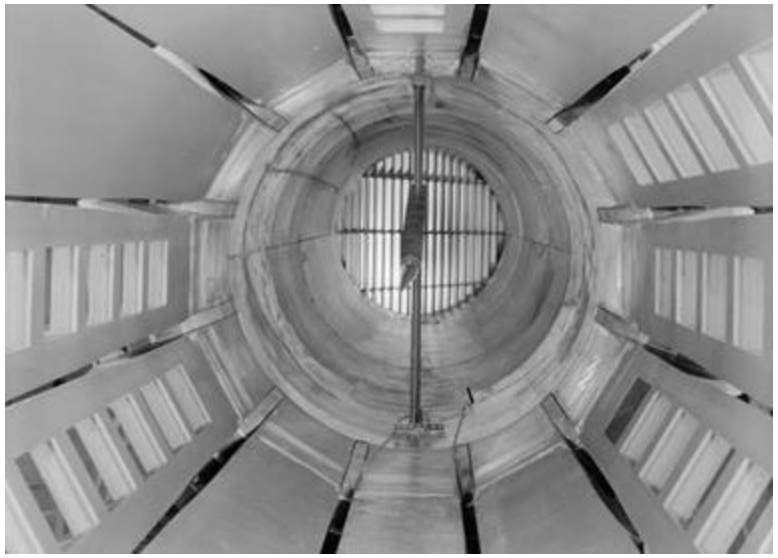
Electronics Research Center
Big Science, Big Technology
Apollo

Three Stories Today: Key Takeaways

The NACA Cowling
"Engineering Science"
The NACA until WWII



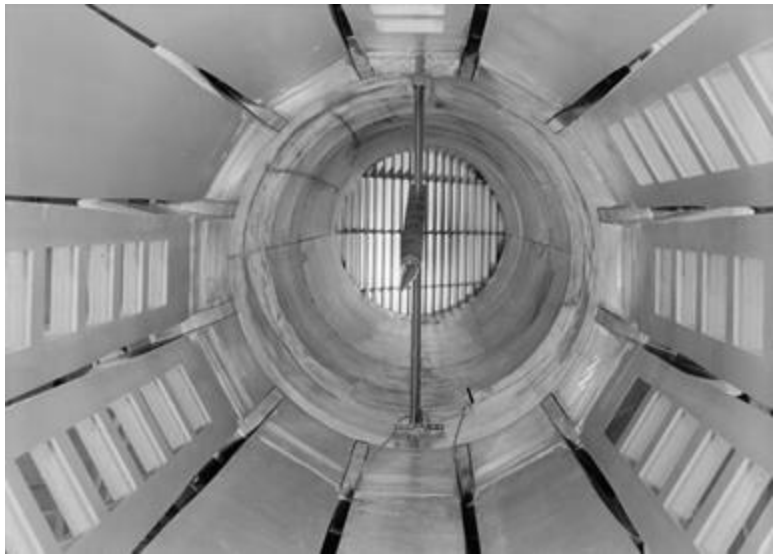
Transonic Research
Science & Technology
From WWII to Sputnik

Electronics Research Center
Big Science, Big Technology
Apollo

Three Stories Today: Key Takeaways

The NACA Cowling

#1 Process Matters



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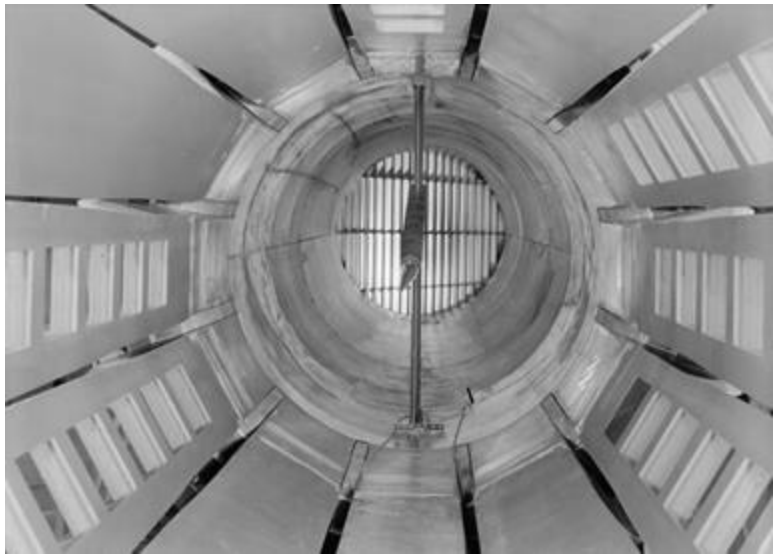

Transonic Research

#2 Research Matters

Electronics Research Center
Big Science, Big Technology
Apollo

Three Stories Today: Key Takeaways

The NACA Cowling

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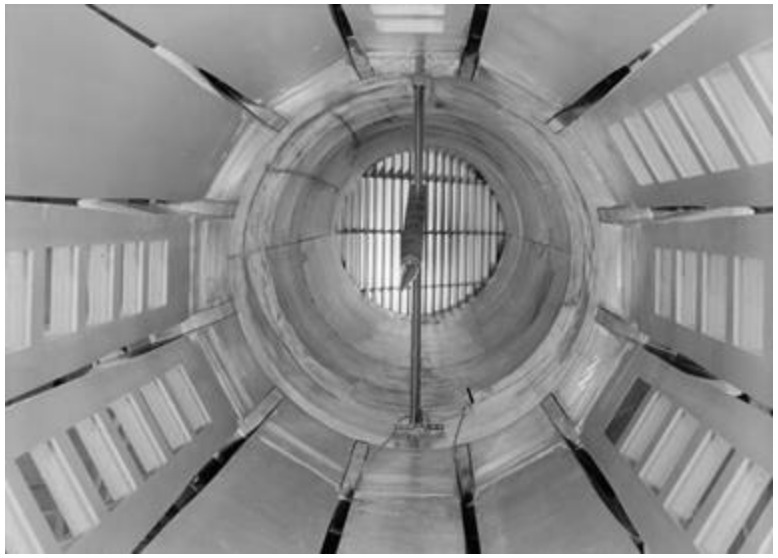


Transonic Research

#2 Research Matters

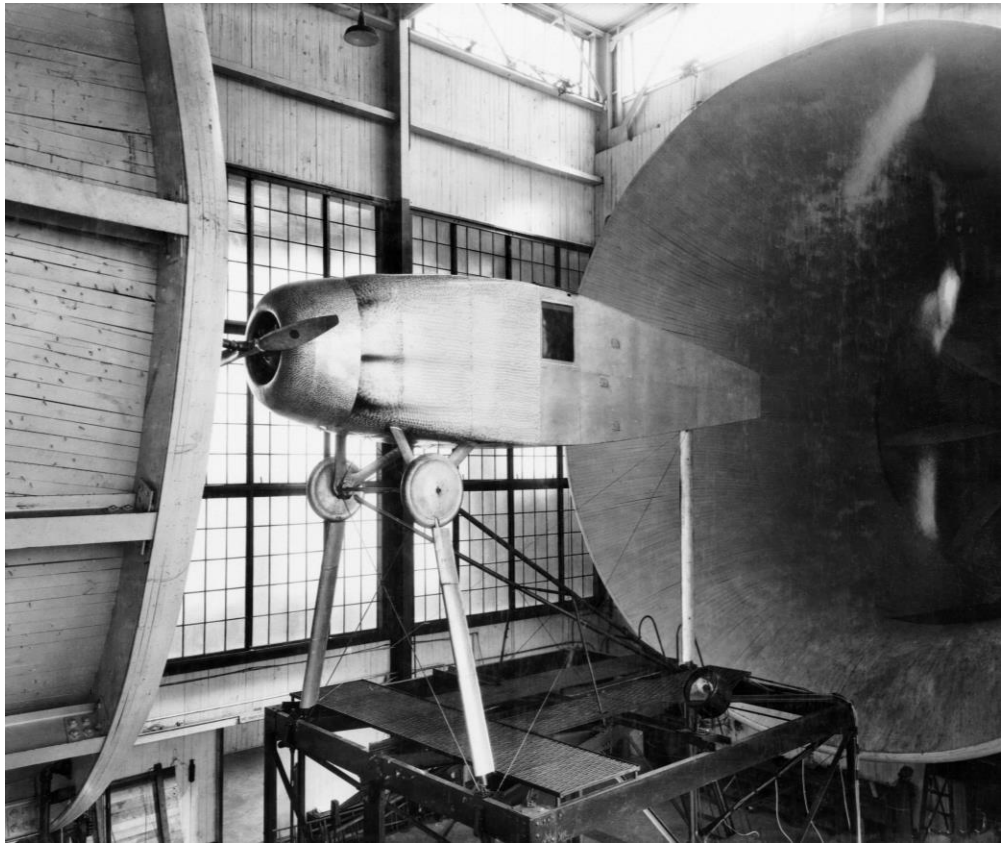
Electronics Research Center

#3 Infrastructure Matters

The NACA Cowling: Process

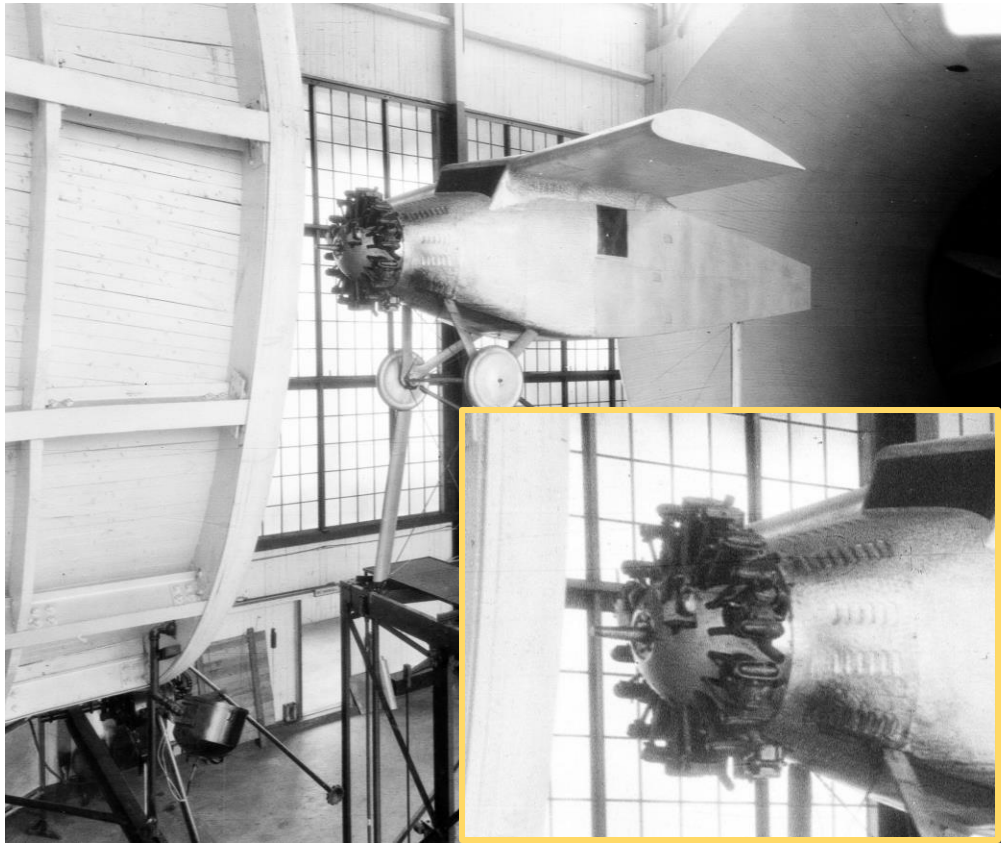
- What was it?
- Not an “invention” or singular product to purchase as a one-size-fits-all.
- Curtiss Hawk AT-5A speed increased from 118 mph to 137 mph.

The NACA Cowling: Process



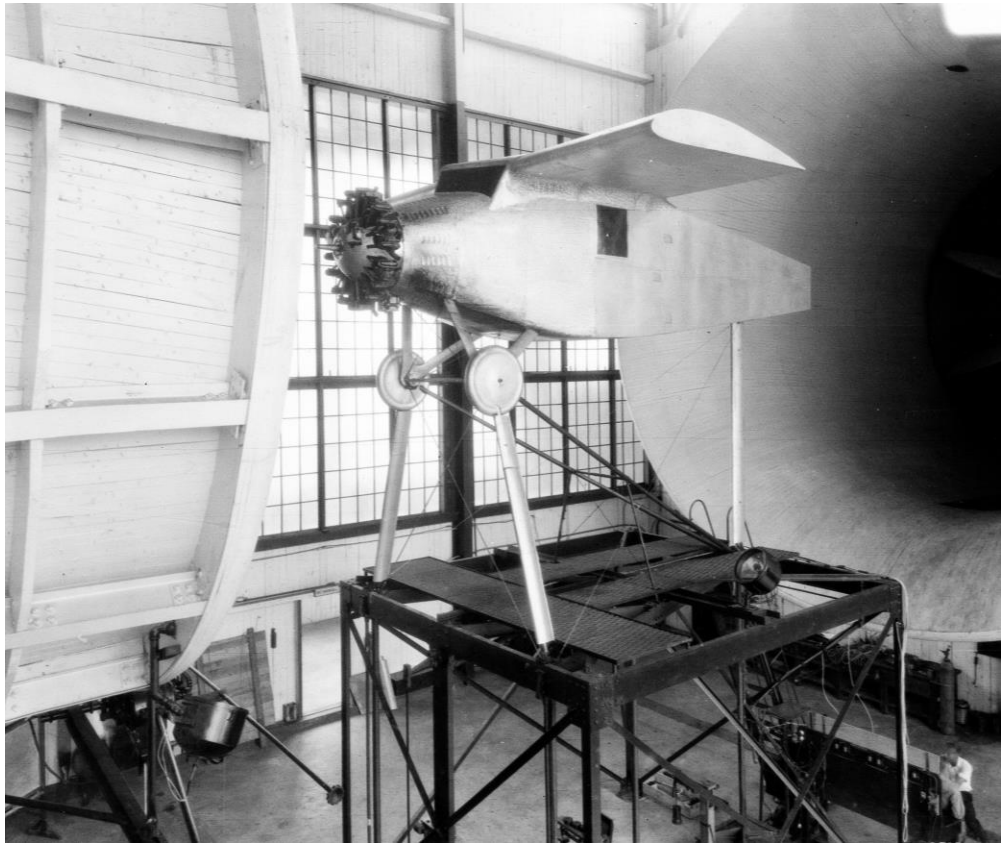
- Shape depended upon the specific airplane
- Multiple aviation records set in 1920s
- Winner of the 1929 Collier Trophy

The NACA Cowling: Process



- Counterintuitive result
- Reduced drag and improved the cooling
- Experimental parameter variation produces results, but not answers to basic questions

The NACA Cowling: Process

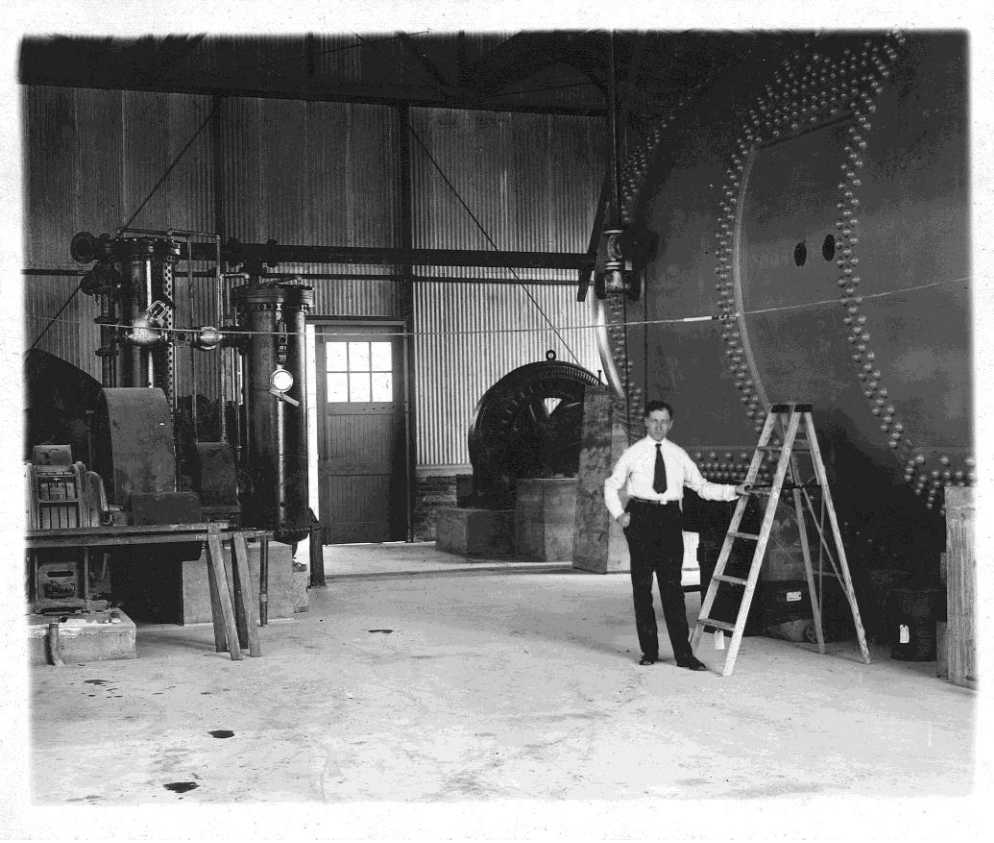


- Connection to infrastructure
- The Propeller Research Tunnel
- NACA founded "*to supervise and direct the scientific study of the problems of flight, with a view to their practical solution*."

The NACA Cowling: Process

- Atmospheric Wind Tunnel #1
- Design based on existing tunnels at Britain's National Physical Laboratory, the Massachusetts Institute of Technology, and Stanford University
- Obsolete as soon as operational in 1920

The NACA Cowling: Process



- The Variable-Density Tunnel
- Crucial in the development of airfoil design
- Max Munk

The NACA Cowling: Process

- The 1929 Collier Trophy
- President Herbert Hoover
- NACA Chairman Joseph Ames

The NACA Cowling: Process

- The 1929 Collier Trophy
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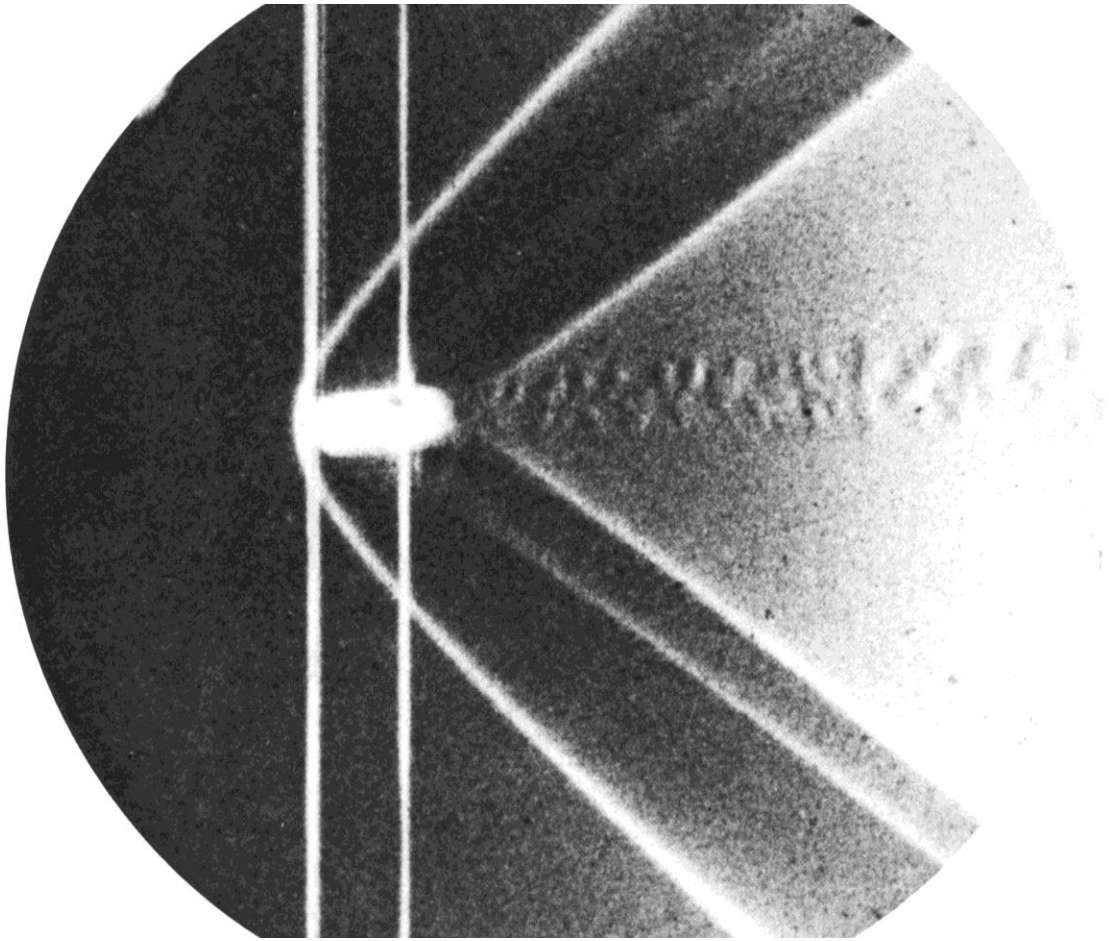
The NACA Cowling: Process

Questions?

Transonic Research

- What happens near the speed of sound?
- X-1 as a research platform
- Two more Collier Trophies for the NACA

Transonic Research

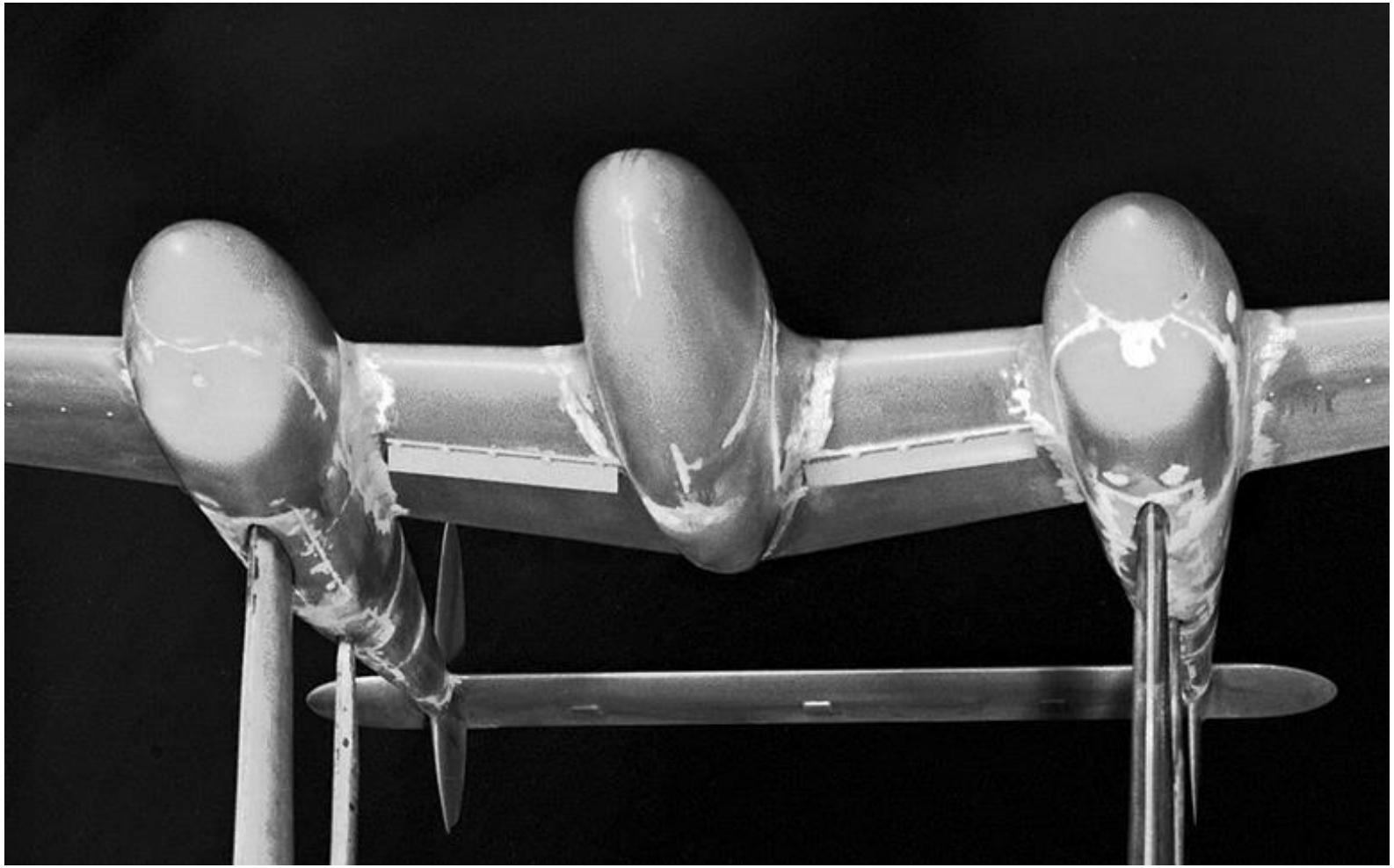


- Transonic drag rise already known to exist
- First photograph of shock waves (Ernst Mach, 1887)
- From artillery shells to airplanes

Transonic Research

- The “tuck under” problem and the P-38
- Quick and practical solutions return to prominence
- Dive-recovery flap

Transonic Research



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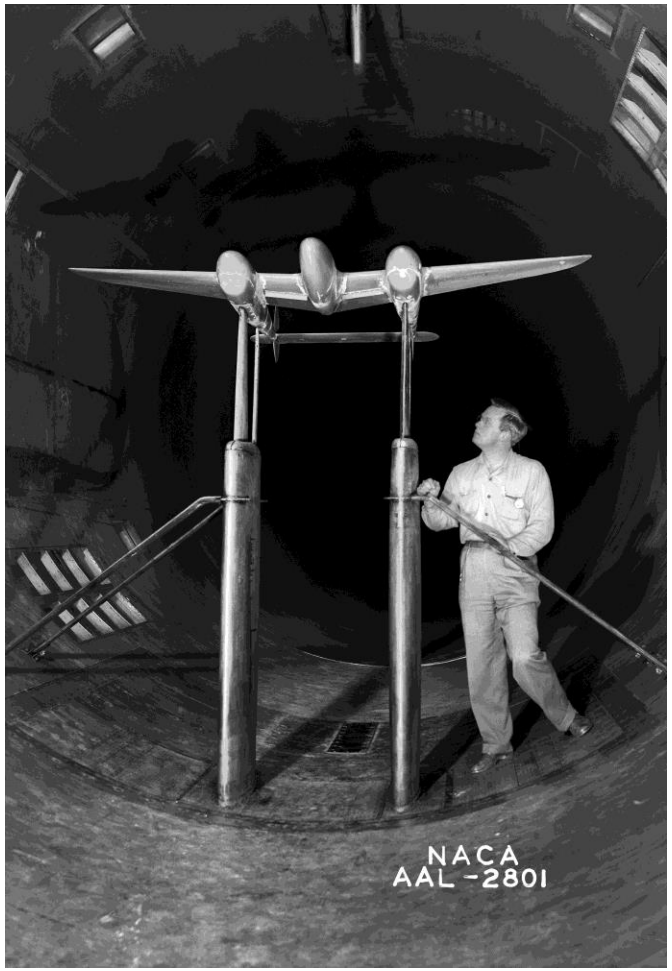

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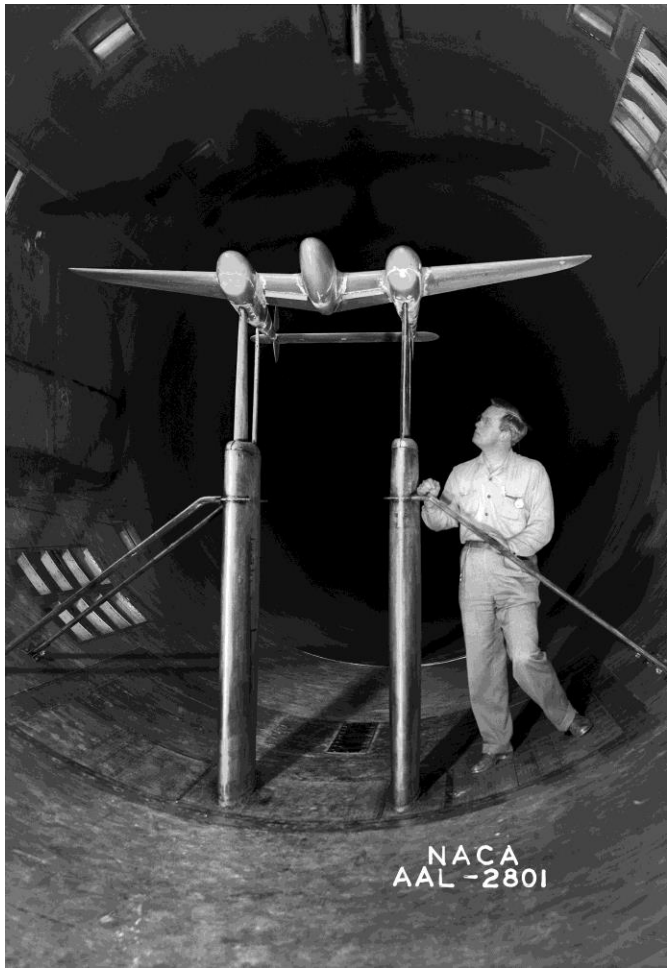

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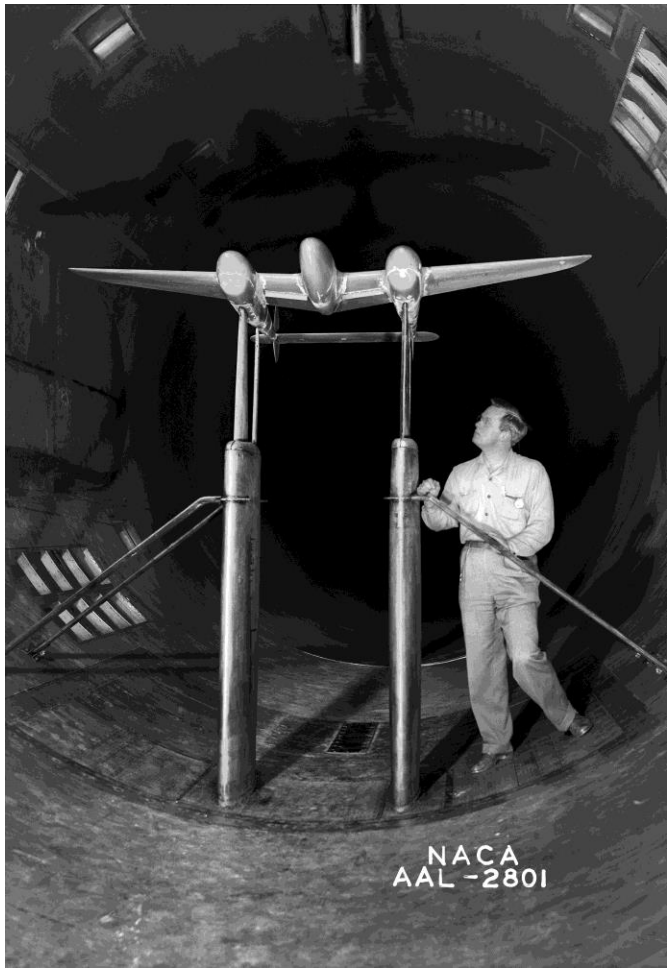
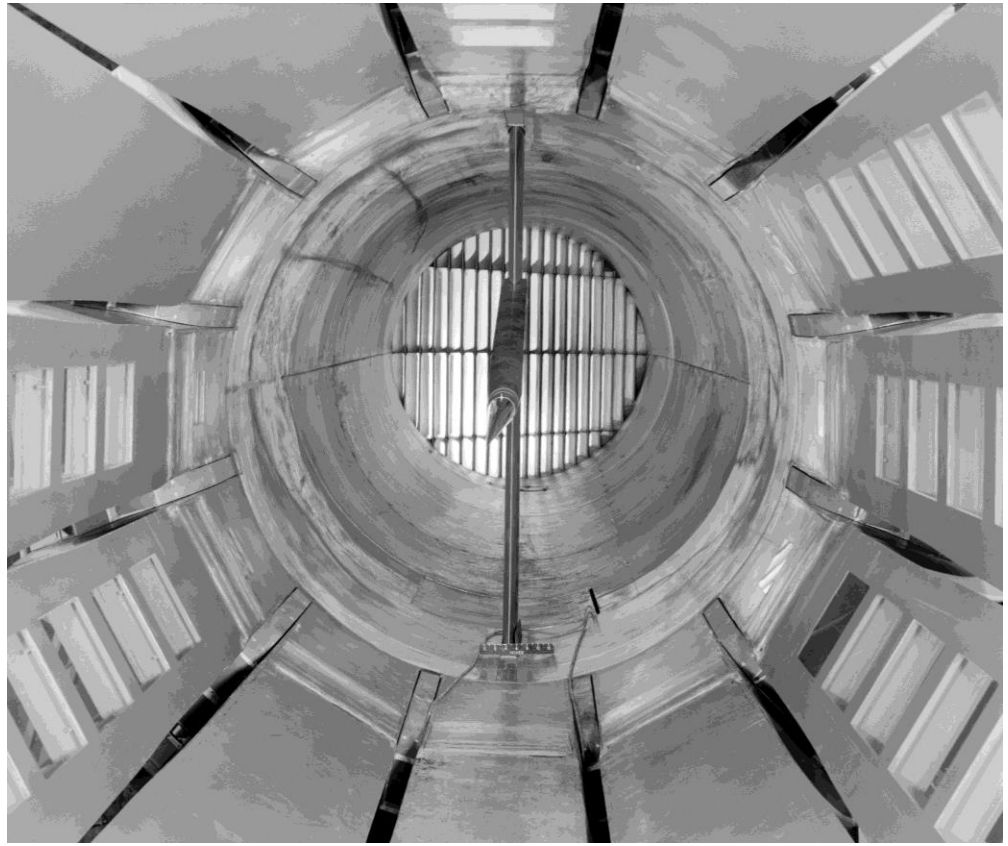
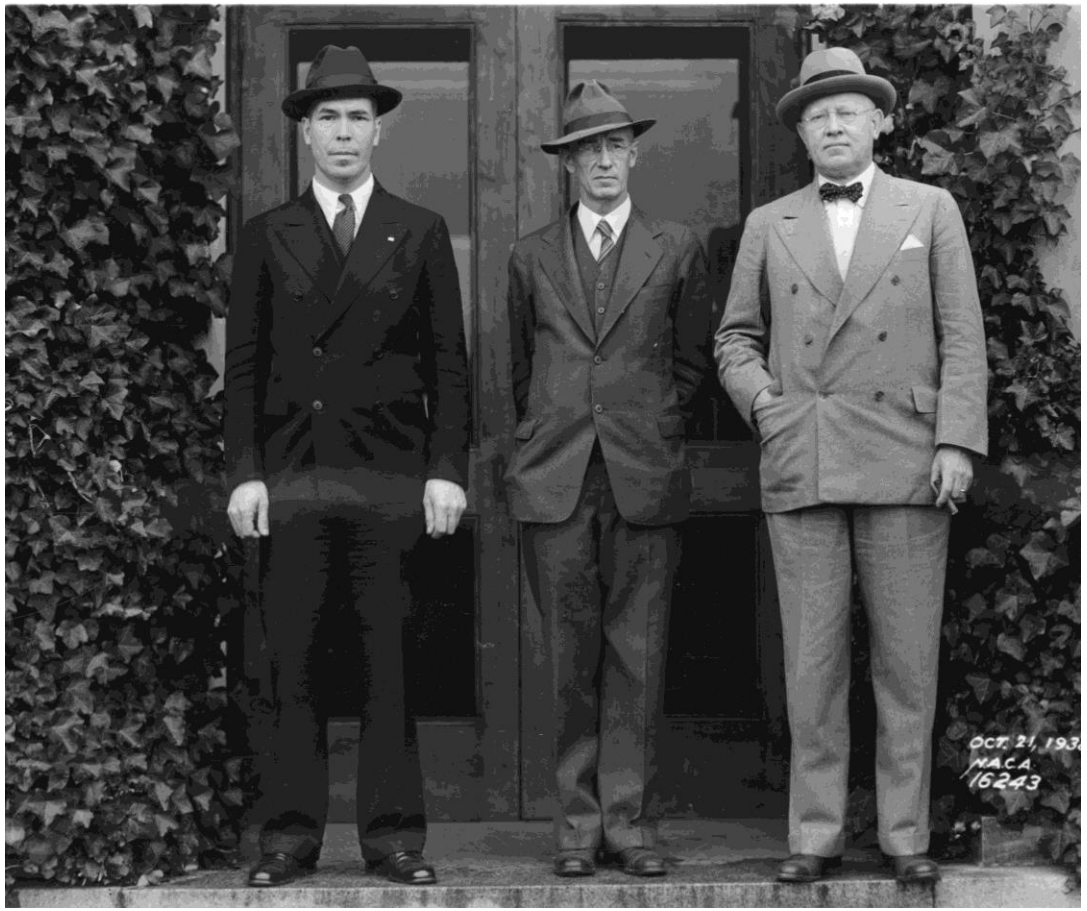


- Dive-recovery flap
- Wind tunnel testing
- Lockheed and the NACA

Transonic Research



Engineer-in-Charge vs. Director



- Henry J. E. Reid
- Vannevar Bush
- George Lewis

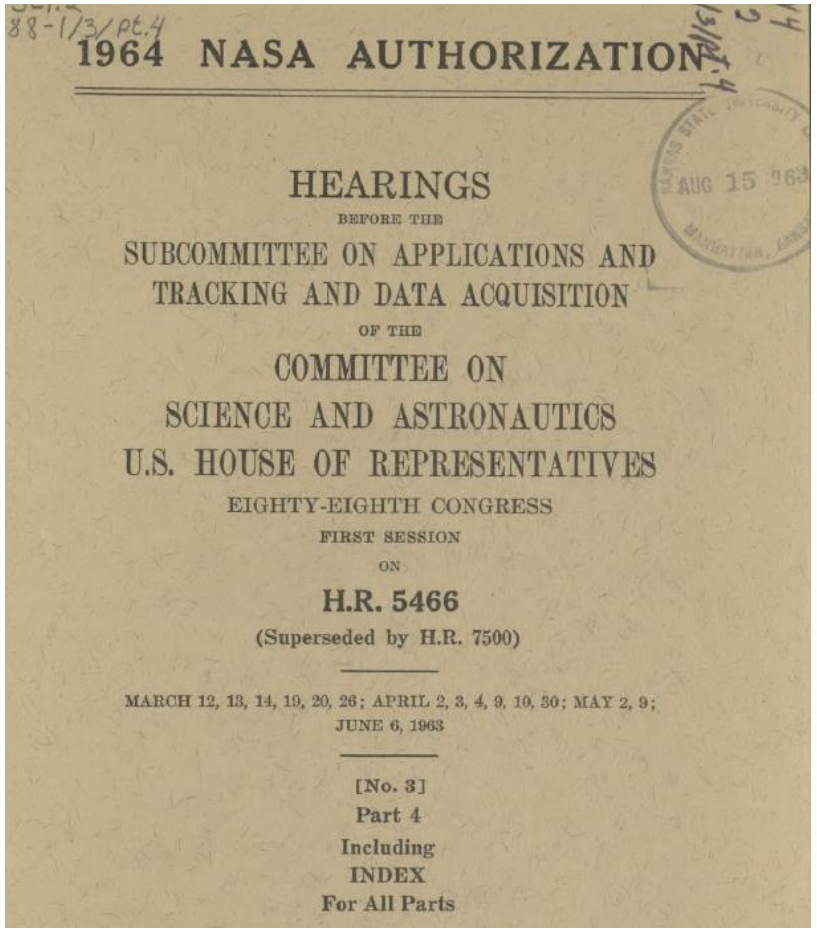
Transonic Research

Questions?

Electronics Research Center: Infrastructure

- Electronics were a huge fraction of rocket and spacecraft cost
- Electronics expertise at NASA was decentralized
- NASA established the ERC to provide technical expertise, direction, and oversight for electronics work at the agency

Electronics Research Center: Infrastructure


88-1/3/pt.4

1964 NASA AUTHORIZATION

HEARINGS
BEFORE THE
SUBCOMMITTEE ON APPLICATIONS AND TRACKING AND DATA ACQUISITION
OF THE
COMMITTEE ON
SCIENCE AND ASTRONAUTICS
U.S. HOUSE OF REPRESENTATIVES
EIGHTY-EIGHTH CONGRESS
FIRST SESSION
ON
H.R. 5466
(Superseded by H.R. 7500)

MARCH 12, 13, 14, 19, 20, 26; APRIL 2, 3, 4, 9, 10, 30; MAY 2, 9; JUNE 6, 1963

[No. 3]
Part 4
Including
INDEX
For All Parts

- The Boston area was objectively the superior location based on the metrics used
- Antipathy from Midwest representatives
- Appearance of pork barrel favoritism among the Kennedys

Electronics Research Center: Infrastructure

- Kendall Square in Cambridge, MA
- Opened in September 1964
- Ten distinct laboratories within the ERC

Electronics Research Center: Infrastructure

Cambridge NASA Workers Bask in Apollo's Glow

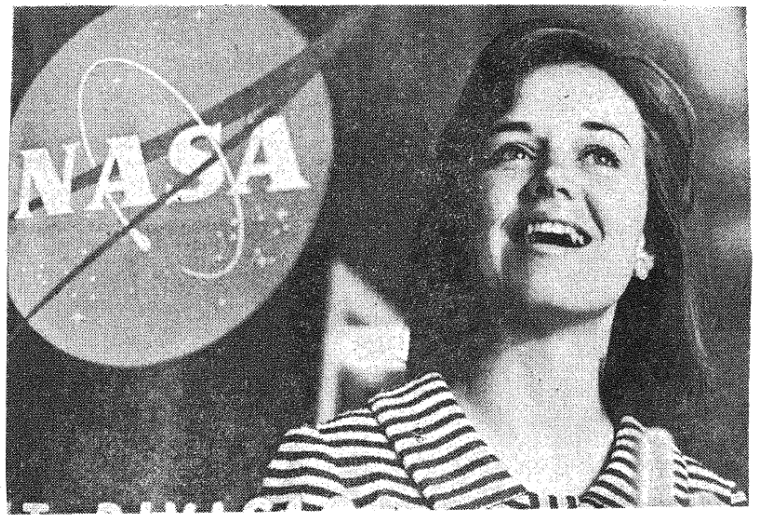
By LOUIS KAUFMAN
Staff Writer

Those special Cambridge smiles reflecting a pride shared by all the world belong to workers zooming the new, fast moving NASA Electronics Research Center skyward.

As one walks through the rambling 29-acre NASA site you sense that the Moon victory is only the beginning, and a myriad of people insist the feeling is infectious.

For the Moon victory has clearly brought out that NASA's Cambridge home is one of the starting points for the great expeditions of the future — Mars, Venus and all the marvelous romantic "way out" places.

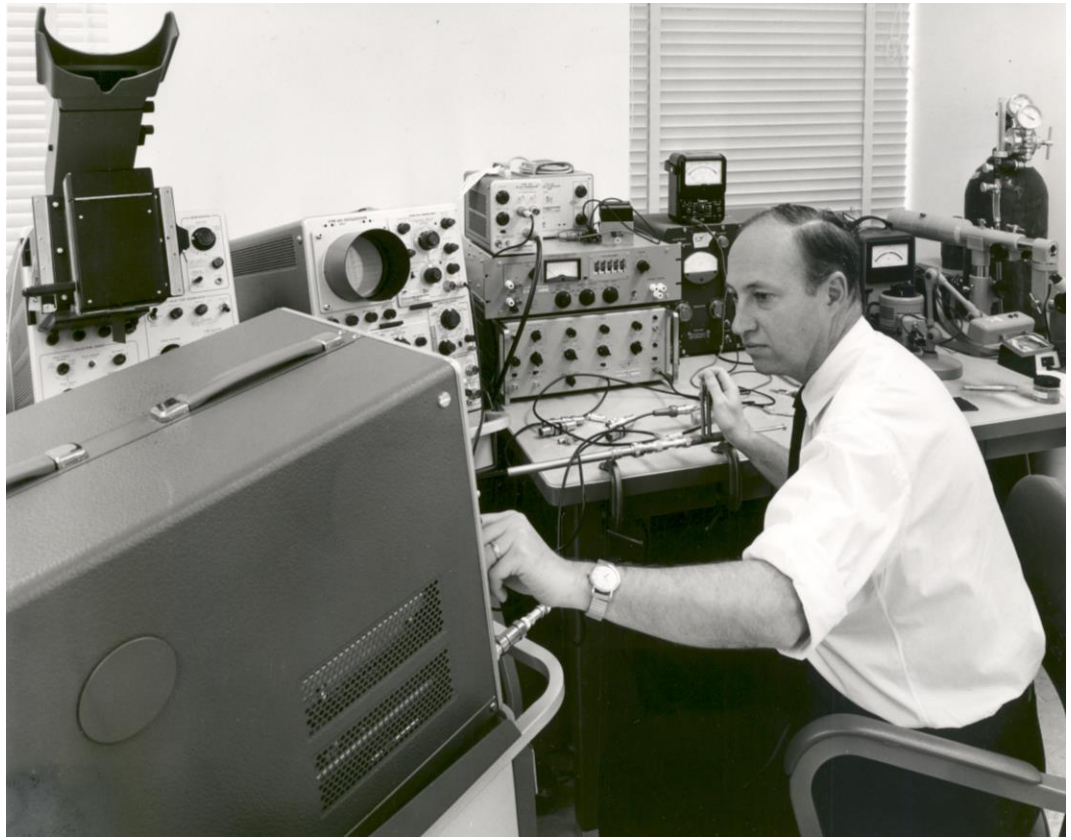
The sophisticated NASA facility is reaching skyward, almost telling you it's something special. It is emerging from its raw construction stage of a few months past to a near final product, with occupancy by National Aeronautics and Space Ad-



"I'M SURE THIS IS ONLY THE BEGINNING," says Mrs. Anne Healy of Waltham, employee of Cambridge NASA complex. And she says research to

- Apollo funding winding down almost as soon as ERC opened
- Nixon had little incentive to keep the ERC
- Planning for the Shuttle

Electronics Research Center: Infrastructure



- Lack of consensus regarding how to stimulate more tangible benefits on Earth
- Equipment at ERC
- Office space at ERC

Electronics Research Center: Infrastructure

- Closed in June 1970
- Lab equipment transferred to other centers
- Buildings transferred to DOT

One final story…