One can get a proper insight into the practice of flying only by actual flying experiments. . . .

— Otto Lilienthal, 1896

Flight Test & Demonstration

• Provides confidence in airworthiness

• Evaluates new designs

• Matures technology
Flight as an element of Fundamental Aeronautics Research

- **Objectives:**
  - *Advance basic understanding*
  - *Validation of theory and tools*

- **Characterized by:**
  - *High investment risk*
  - *Science driven experiments*
The X-1 as an example of: Fundamental Flight Research

• **Context**
  *Part of a broad aeronautic research effort*

• **Motivation for flight**
  *Known deficiencies in ground laboratory (wind tunnel)*
X-1 Example
Configured for Research

- Rocket – boost
- Air-launch
- Straight wing
- Payload: 100% instrumentation
X-1 Example
Far-Reaching Results

‘the meat of the research airplane program, and its very reason for existence, has been the obtaining of research information . . .

- Walter Williams, 1957

X-1 Flight Results

• Aero performance
• Buffet boundaries
• Hinge moments
• Pressure distributions
• Stability and control
• Flying qualities
Decades of subsequent flight research projects –
Free-flight
Natural atmosphere
Full-scale
Physical aspects of aeronautical science that are not fully replicated in ground facilities

Free-Flight

- Unsteady, non-uniform flows
- Aero/inertial coupling
- No walls or model supports
Physical aspects of aeronautical science that are not fully replicated in ground facilities

**Free-Flight**
- Unsteady, non-uniform flows
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**Natural Atmosphere**
- Quiet background
- Extent
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• Geometric detail
• Viscous flow similarity
• High enthalpy effects
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**Full-scale**
- Geometric detail
- Viscous flow similarity
- High enthalpy effects
Outlook

Advanced space transportation

Ultra-efficient air transportation
High performance aircraft as testbeds for fundamental research
Versatility of air launch

B-29 carrier

B-52 carrier

Aero-Tow
Recent towing investigations

F-106 demonstration

Hypersonic research vehicle carrier

Transonic research vehicles
Summary

Conducting Research in Flight

• Unique capability to address certain aeronautic problems

• Important NACA/NASA contribution

• Needed to pursue revolutionary configurations and unexplored flight regimes
All photos not cited below are available from the NASA Armstrong Photo Gallery: http://www.nasa.gov/centers/armstrong/multimedia/imagegallery/index.html

Slide 3


Slide 4

Slide 5


Slide 6


Graphic from http://history.nasa.gov/SP-4219/4219-095.jpg

Slide 7
Data set not expected to be comprehensive, but includes representative large flight research projects, typical of government sponsorship. Data depict max Mach number and the approximate date of the mid-point in the research phase.


Slide 8

Slide 9
photo from: http://www.grc.nasa.gov/WWW/k-12/airplane/Images/f18test1.jpg

Slide 10
Photo from: NASA's Contributions to Aeronautics Vol. 1, p. 198

Slide 12
Discussion of wind tunnels, CFD and current state of the art:


Slide 13


Slide 15

Slide 16