The Air Transport Revolution: A Selective Review

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Aero 2050

Aeronautics and Space Engineering Board

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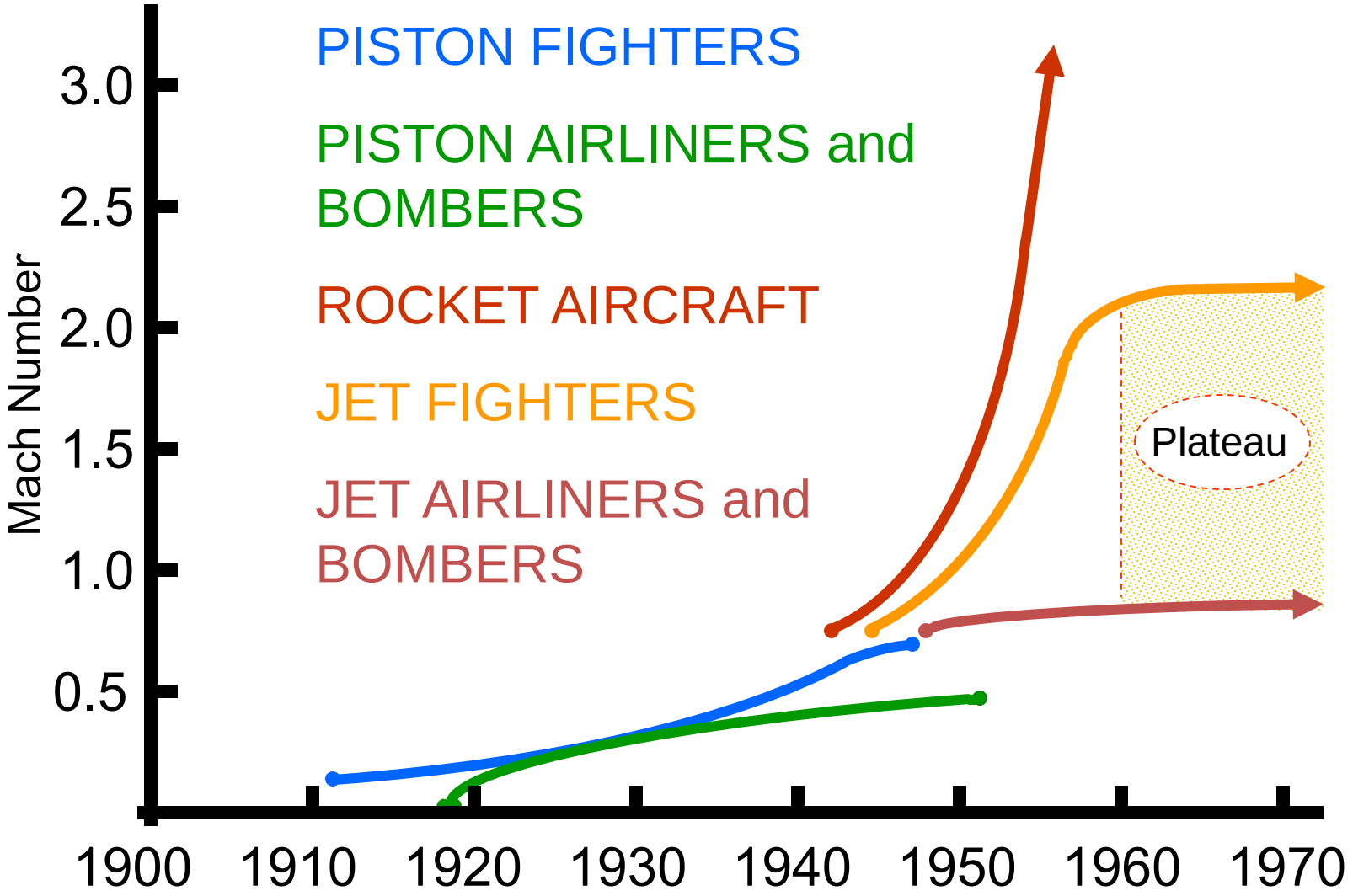
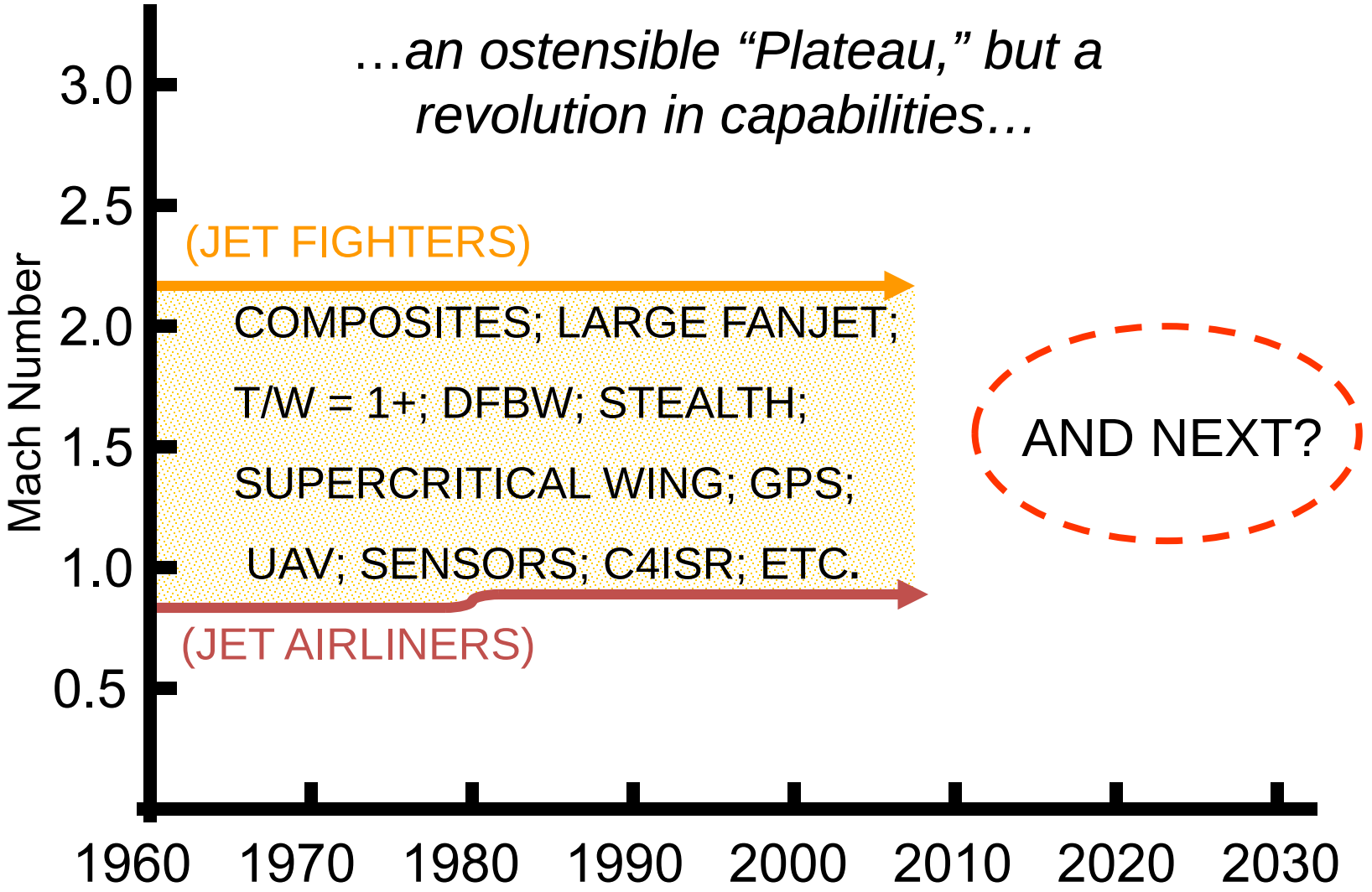
…The Aerospace Revolution…

- 1903 1st Powered, Sustained, & Controlled Flight
- 1926 1st Liquid Fuel Rocket Flight
- 1935 1st Intercontinental Airliner
- 1939 1st Turbojet Airplane
- 1943 1st Ballistic Missile
- 1949 1st Jet Transport
- 1957 1st Earth Satellite
- 1958 1st Transatlantic Jet Travel
- 1969 1st Wide-body “Jumbo Jet” (the B-747)
- 1981 1st Reusable Routine Space Access System
- 1989 1st GPS Block II Satellite launch
- 2001 1st Global-Ranging Intercontinental RPA
- 2010 1st Thermally Balanced Hypersonic Scramjet

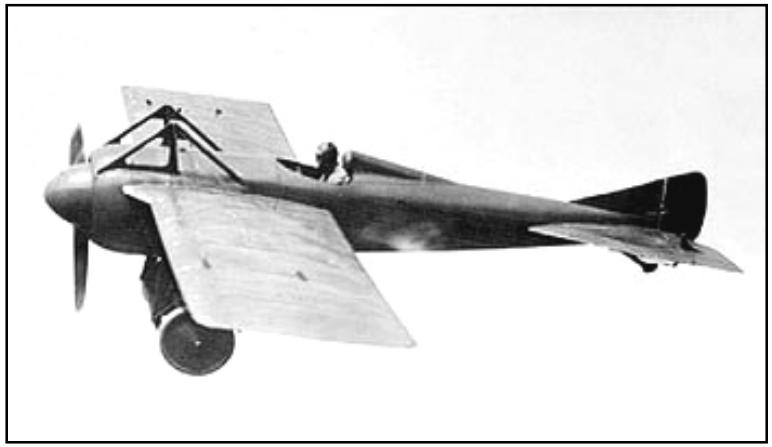
Aviation Progression: One View…



…A Merger of Revolutions…



…From Subsonic to Supersonic…



Deperdussin Monocoque

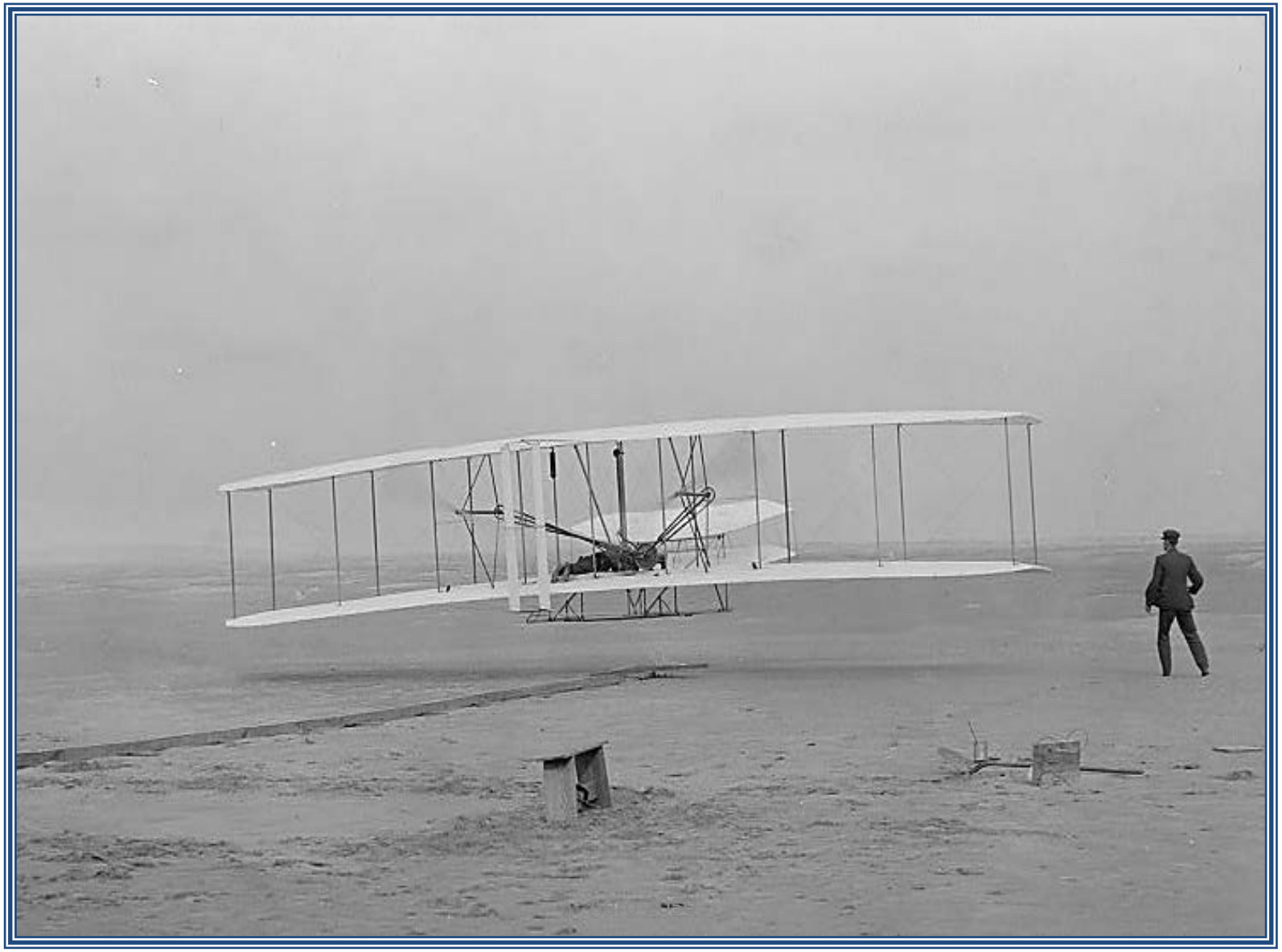
Douglas DC-1

Boeing 707

Lockheed Blackbird

Photographs courtesy The Boeing Company, NASA Dryden Flight Research Center, and the *Musée de l'Air et l'Éspace,* Le Bourget

17 December 1903
…Powered, Sustained, and Controlled Flight…



17 December 1903
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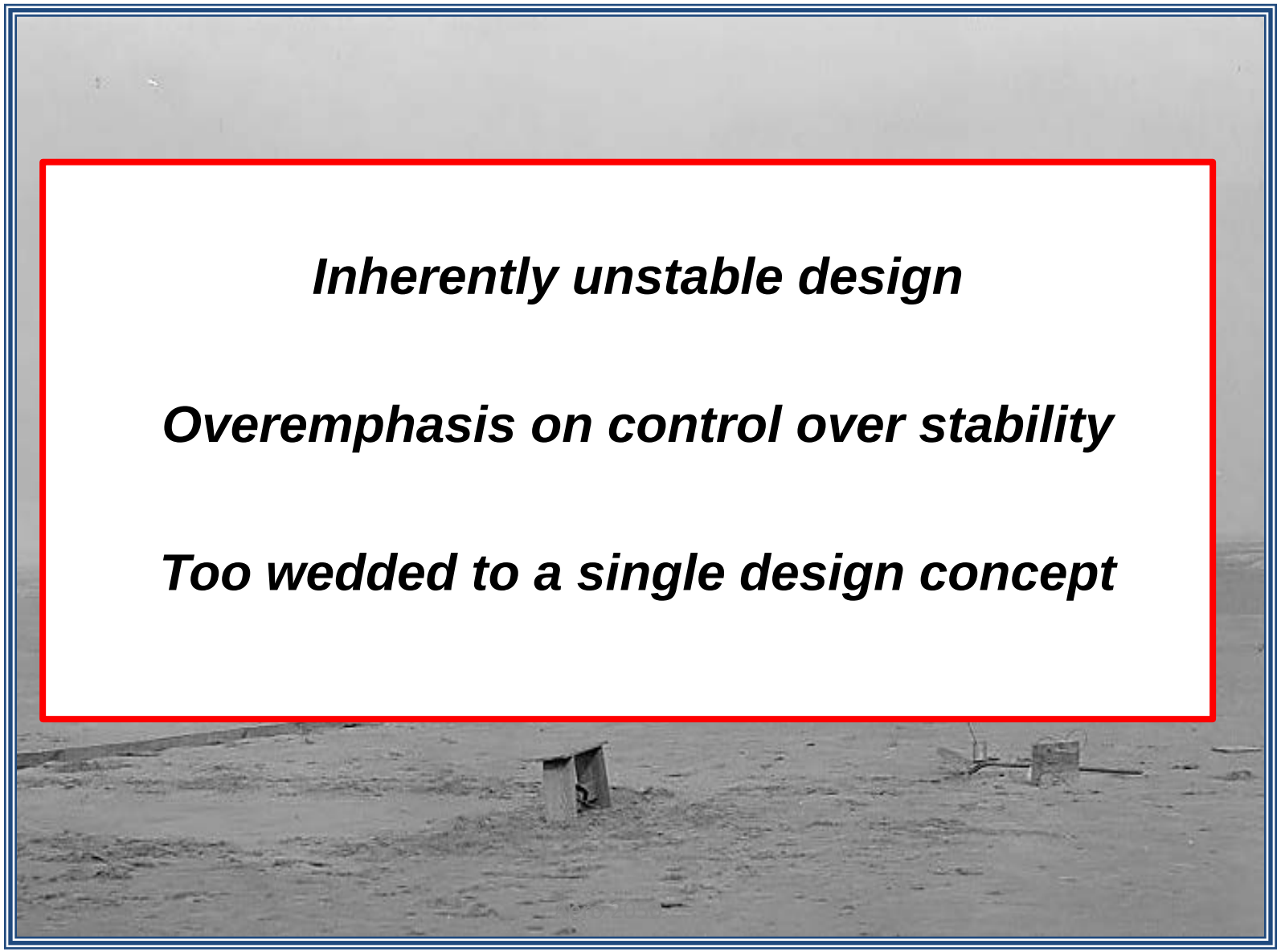


Inherently unstable design

Overemphasis on control over stability

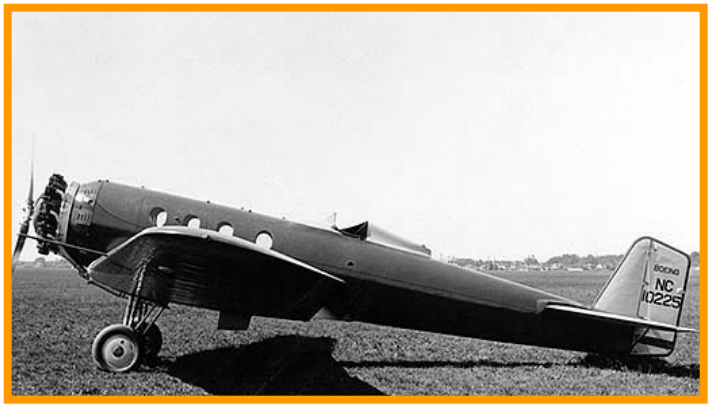
Too wedded to a single design concept

Deperdussin Monocoque Racer, 1912-1913

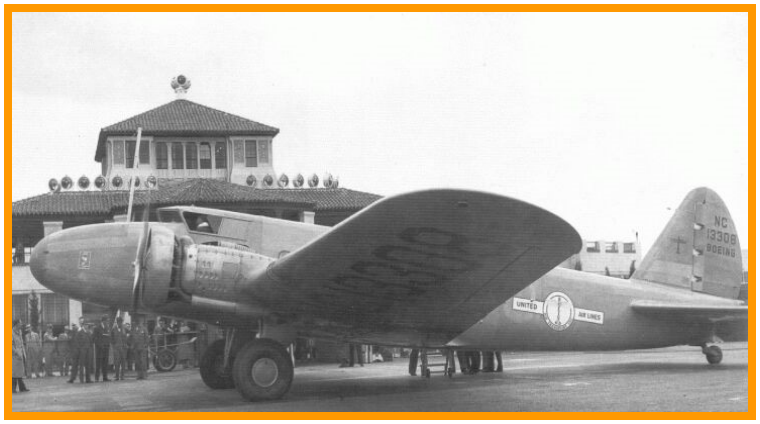
Zeppelin-Staaken [Rohrbach]E.4/20 Sep-Oct 1920

…Birthing the Safe & Economical Airliner…

Lockheed Vega



Boeing Monomail



Boeing 247

Douglas DC-1

The DC-1: America's First "Scientific" Airplane…

Douglas DC-1 on early test flight, 1933 NASM Photo

In contrast…(Handley Page H.P. 42)

…America Has a “Dual Use” Industrial Base…

MILITARY

CIVIL

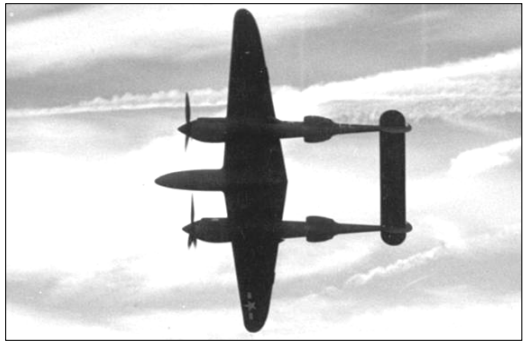
Wartime Production in Perspective

Country	Number of Aircraft
United States	299,293
Soviet Union	142,775
Great Britain	117,479
Nazi Germany	111,787
Imperial Japan	68,057
Fascist Italy	11,508

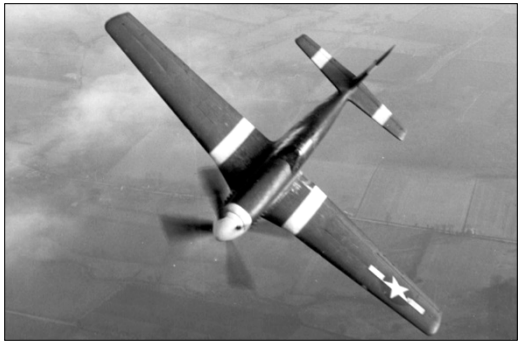
…an almost 3 : 1 Allied advantage…

…that Generated Profound Military Effects…

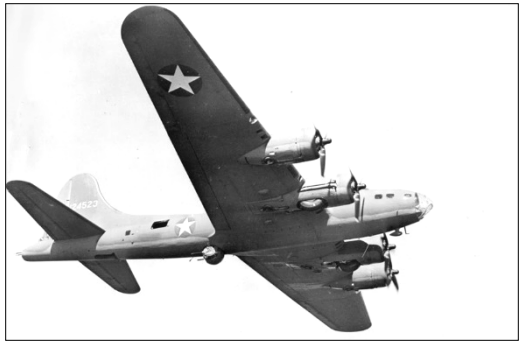
Civil Air Power → *Military Air Power*



Reconnaissance



Air Superiority



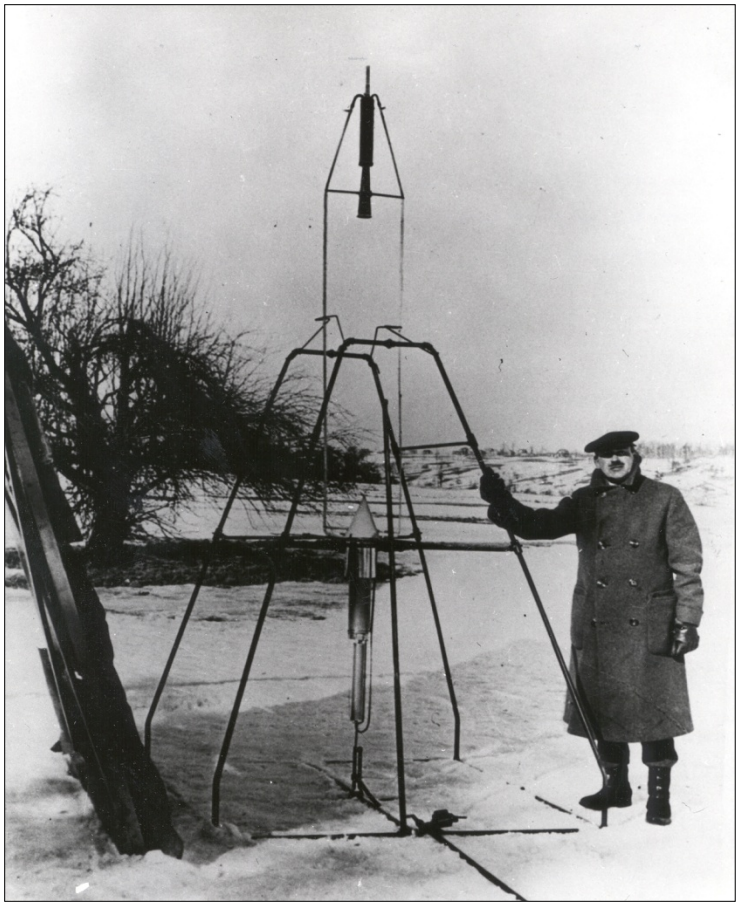
Strategic Bombing

Tactical Attack

Sea Control

Airlift

…The Spaceflight Revolution…

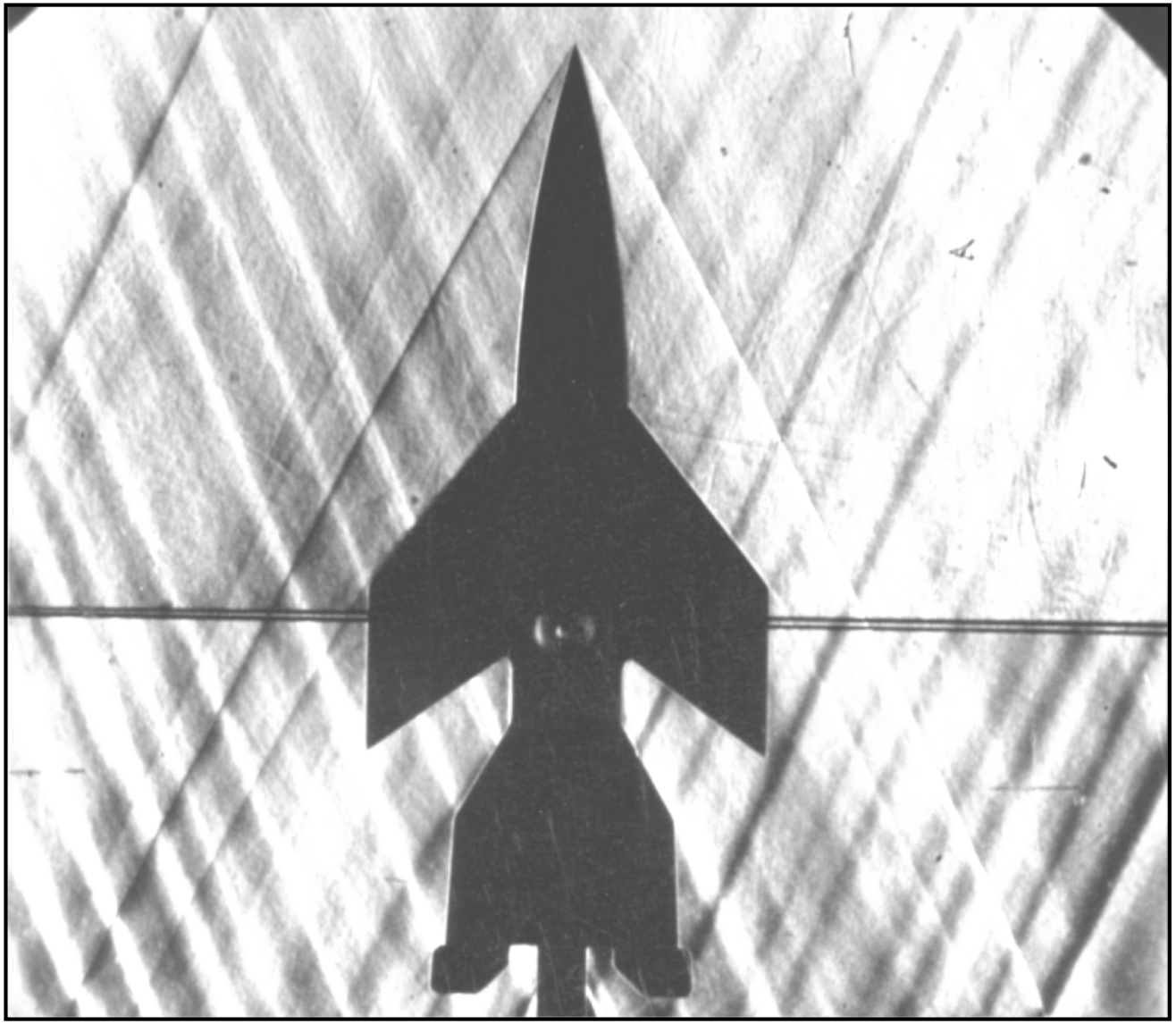


Robert Goddard, 1926

Opel Rak-1, 1929

V-2 on Transporter, 1944

1935: Advent of the High-Speed Sweptwing

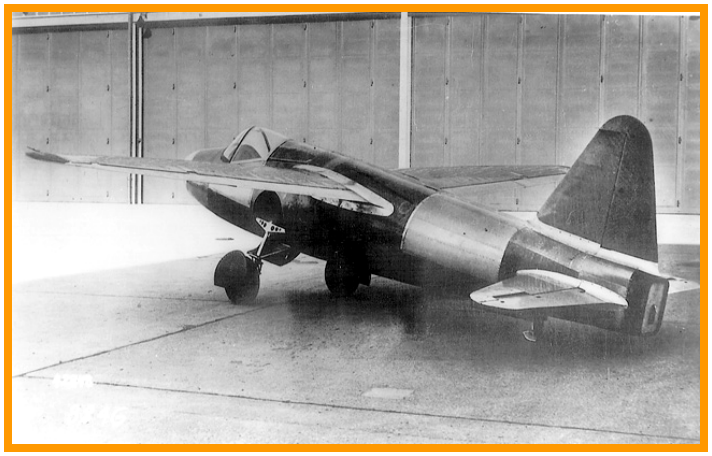


Presented at the 1935 Volta Conference by Adolf Busemann

1940 Test of Winged A-4 Derivative at Peenemünde

AF AEDC Photo

The Arrival of the Jet Age…



Heinkel He 178 (1939)

Gloster E.28/39 (1941)

Bell XP-59A (1942)

Messerschmitt Me 262 (1944)

Through the “Sound Barrier”

Clockwise: X-1A, D-558-1, XF-92A, X-5, D-558-2, X-4, center X-3 (1953)

NASA Photo

Creative Incrementalism…

Leader-Follower Relationship from Fighter to Transport

367-80

B-47

F-86

…Applying the Sweptwing to Military and Commercial Aviation

1954: Advent of the Boeing 367-80

Boeing

…America's Postwar Air Supremacy…

Global Reach

Global Power

Naval Superiority

Mach 3+ Cruise

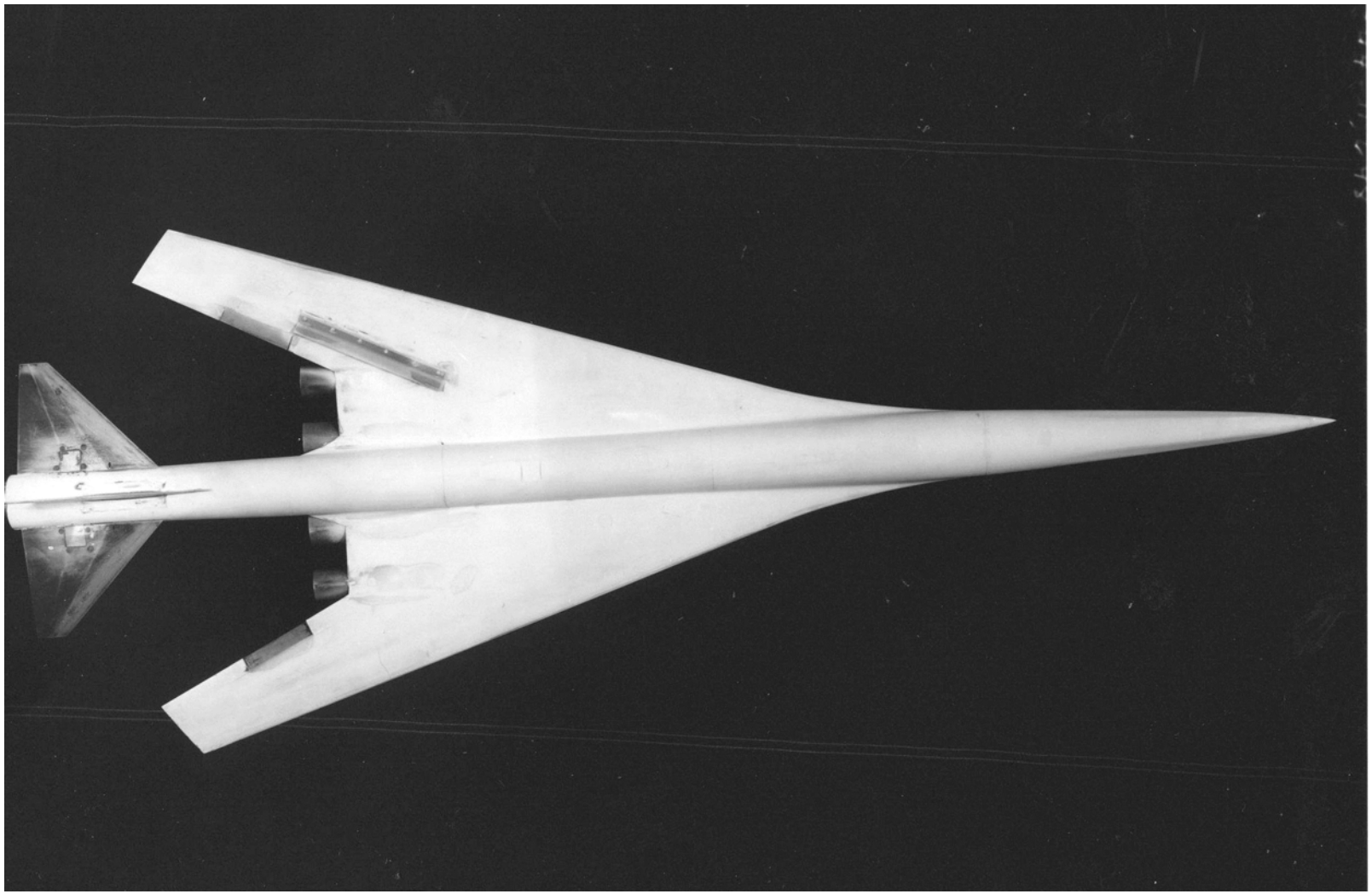
Hypersonics

Stealth

The Arrival of the Jumbo

Boeing

Premature Supersonics…



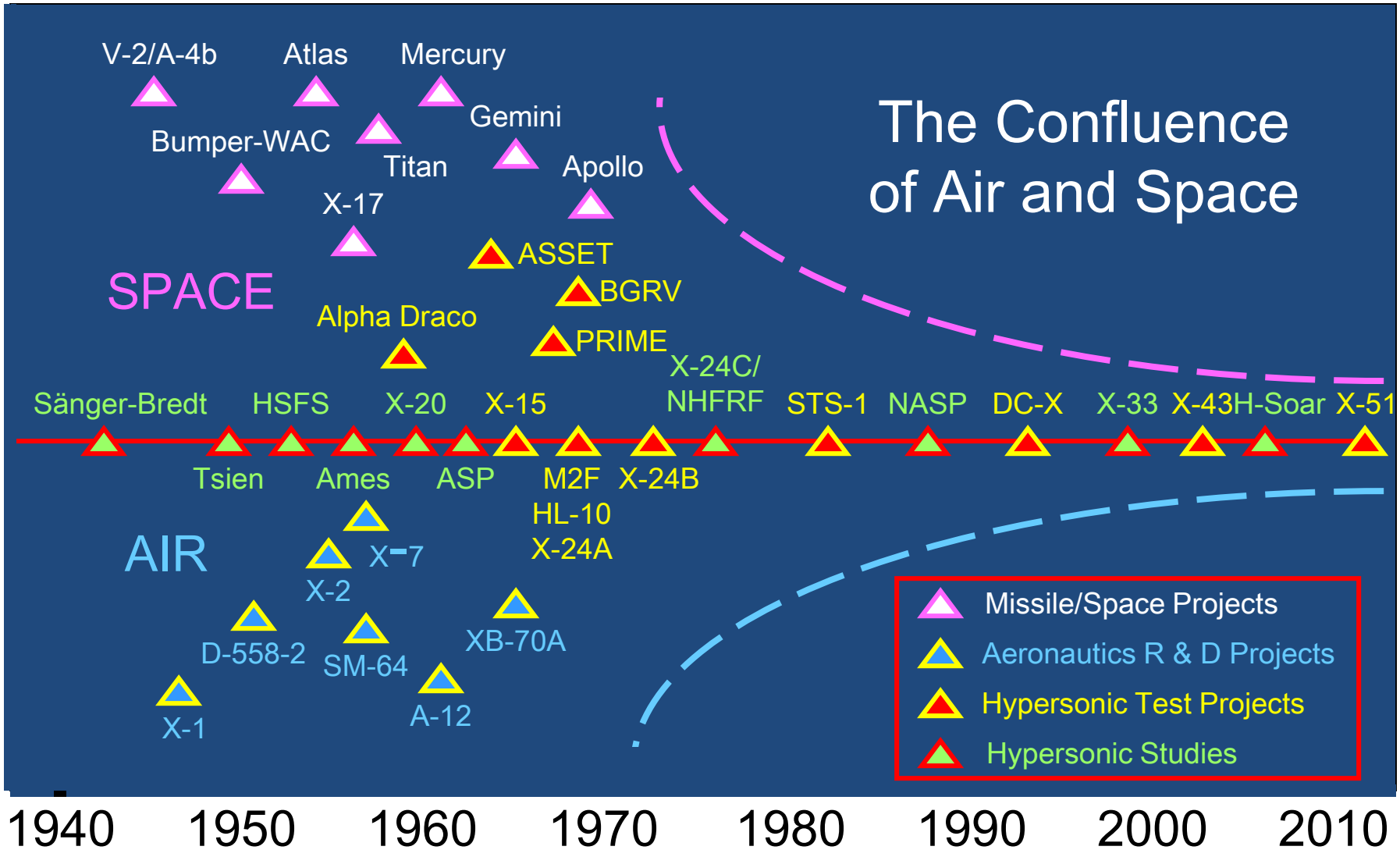
NASA

Advent of the Supercritical Wing

NASA F-8 with Whitcomb Supercritical Wing, 1971

NASA

Over Seventy Years of Effort…



X-51 Scramjet Flight Test, 2010-2013

AFFTC

Transformations in Normative Design Practice

- Aerodynamics
  - From Emulating Birds to Applied Mathematics to CFD
  - Straight to Swept to Supercritical to Blended
- Materials/Structures
  - Wood to Wood/Metal to Metal/Composite to Composite
- Propulsion
  - From piston to pure-jet to prop-jet to fanjet to scramjet
- Controls
  - From mechanical to augmented to electronic
- Instrumentation
  - From flight safety to mission-enabling
- Systems
  - Aircraft becomes an integrated system within systems

A Possible Future—but Will It be Ours?