The Air Transport Revolution: A Selective Review

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Aero 2050
Aeronautics and Space Engineering Board
11 October 2017
...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
...A Merger of Revolutions...

...an ostensible “Plateau,” but a revolution in capabilities...

- COMPOSITES; LARGE FANJET;
- T/W = 1+; DFBW; STEALTH;
- SUPERCRITICAL WING; GPS;
- UAV; SENSORS; C4ISR; ETC.

(JET AIRLINERS)

(JET FIGHTERS)

AND NEXT?
…From Subsonic to Supersonic…

Deperdussin Monocoque

Boeing 707

Douglas DC-1

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

…Powered, Sustained, and Controlled Flight…

Inherently unstable design

Overemphasis on control over stability

Too wedded to a single design concept
Deperdussin Monocoque Racer, 1912-1913
...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...
## Wartime Production in Perspective

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of Aircraft</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>299,293</td>
</tr>
<tr>
<td>Soviet Union</td>
<td>142,775</td>
</tr>
<tr>
<td>Great Britain</td>
<td>117,479</td>
</tr>
<tr>
<td>Nazi Germany</td>
<td>111,787</td>
</tr>
<tr>
<td>Imperial Japan</td>
<td>68,057</td>
</tr>
<tr>
<td>Fascist Italy</td>
<td>11,508</td>
</tr>
</tbody>
</table>

...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**

*Aero 2050*
...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
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)
Creative Incrementalism…

Leader-Follower Relationship from Fighter to Transport

...Applying the Sweptwing to Military and Commercial Aviation

F-86

B-47

367-80
1954: Advent of the Boeing 367-80
...America’s Postwar Air Supremacy...
The Arrival of the Jumbo
Premature Supersonics...
Advent of the Supercritical Wing

NASA F-8 with Whitcomb Supercritical Wing, 1971
Over Seventy Years of Effort…

The Confluence of Air and Space

Missile/Space Projects
Aeronautics R & D Projects
Hypersonic Test Projects
Hypersonics Studies
X-51 Scramjet Flight Test, 2010-2013
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?

LONG-RANGE MOBILITY RATES SINCE 1800

MIGHT WE NOT ENTER THE 22ND CENTURY AT 6,000 MPH??