A Case Study of the Boeing B-47 Stratojet

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Outline

- The political and economic climate
- The evolution of the B-47
- B-47 innovations in aerodynamics, stability and control, and structures
- The legacy of the B-47

At This Time in History ...

- It's 1943 and World War Two is raging
- Aircraft production in the U.S. is staggering
- Aircraft development is rapid
  - Piston engine technology reaching limits
  - Turbojet engines show promise
  - Britain and Germany have advantage
  - Reports of German fighter jets prompt U.S. to consider jet bombers

Origins of the B-47

- Air Corps Design Competition, 1944
  - Design high speed jet bomber, 500 mph +
  - 8,000 pound payload
  - Range of 2,500 to 3,500 miles
  - Service Ceiling of 40,000 feet
- Designs submitted in 1944
  - North American B-45
  - Convair B-46
  - Boeing B-47
  - Martin B-48

Evolution of the B-47

- B-47 began as straight wing design
  - Limited top speed to under 500 mph
- Operation Paperclip
  - Adolph Busemann
  - Swept wing theory in 1935
- Engines and more engines
  - Fuselage and wing mounted
  - Four or six?

Evolution of the B-47

Model #	Date	Wing	Engines
413	Jan. 1944	Straight	4 Turbojets
422	early 1944	Straight	4 Turboprops
424,425	early 1944	Straight	4 Turbojets
426	early 1944	Straight	4 Turboprops
432	Dec. 1944	Straight	4 Jets in Fuse.
446	Sept. 1945	Swept	4 Jets in Fuse
448	Sept. 1945	Swept	6 Jets in Fuse.
448-2-2	Sept. 1945	Swept	6 Jets in Fuse.
450	Oct. 1945	Swept	6 Jets under wings

Evolution of the B-47

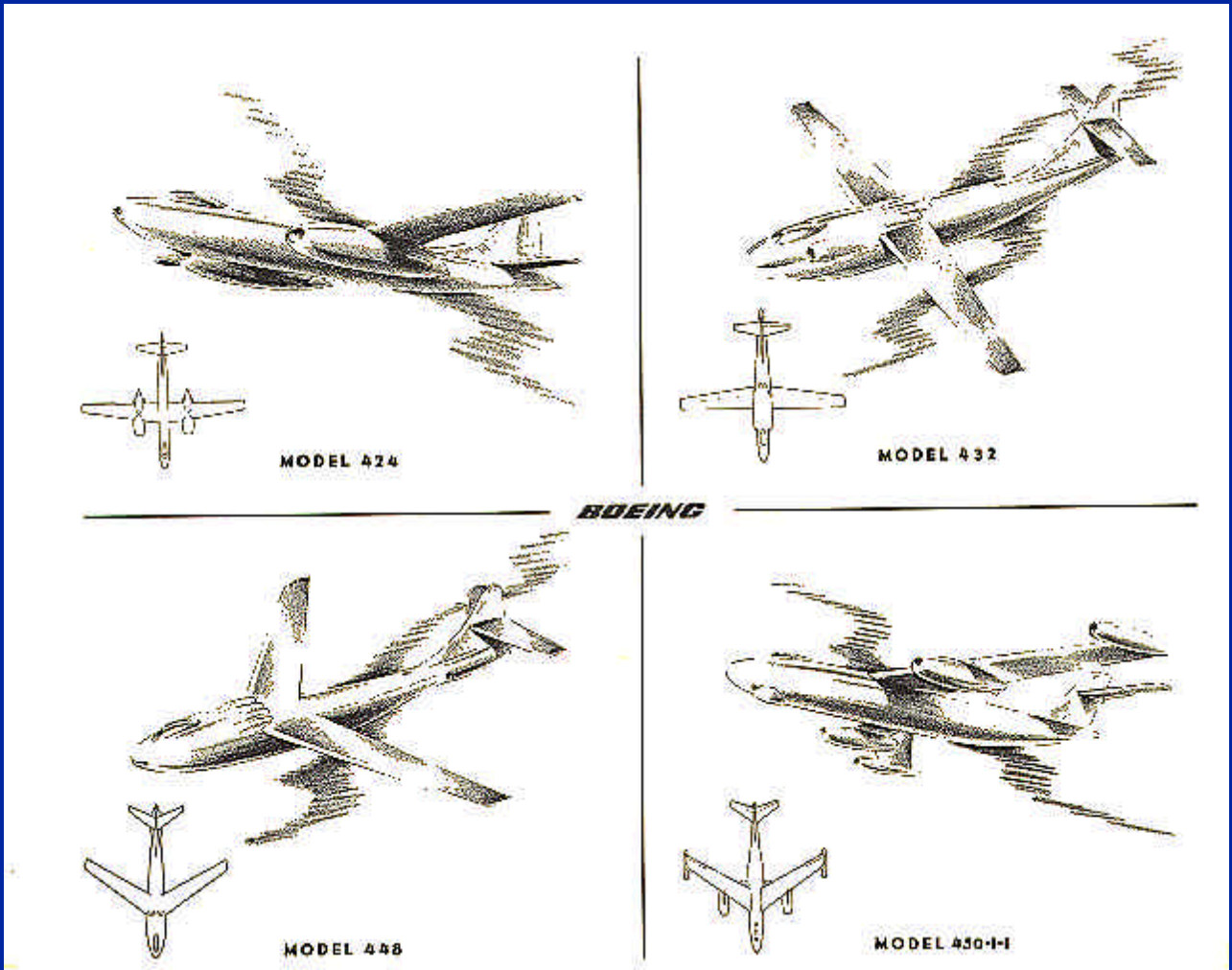
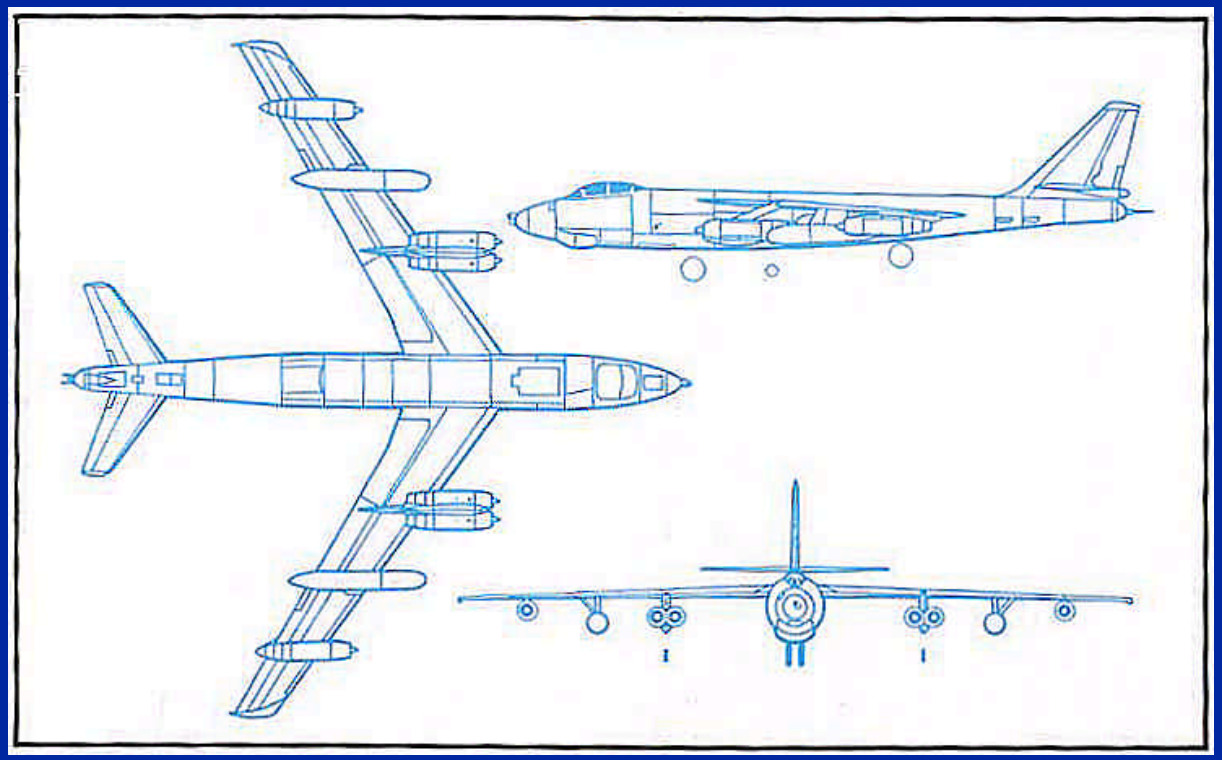


Image from: The Politics of the U.S. Strategic Bomber Program
Michael E. Brown, 1992.

The Production B-47



Images From: American Warplanes, Bill Gunston, 1986.

Podded Engines on the Wing

Image From: American Warplanes, Bill Gunston, 1986.

Podded Engine Advantages

- Interference drag was reduced in the wind tunnel
- Strut weight was minimal
- Increased span loading
  - Reduced the wing root bending moment
  - Reduced wing weight
- Forward mass increases flutter resistance
- Increased accessibility for maintenance
- Increased passenger safety in case of an engine fire

Pitch-up Problems (Dana)

Longitudinal Stability (Dana)

The Yaw Damper (Dana)

The Flexible Wing

- Long range transonic cruise requirements:
  - Large span for minimum induced drag (116 ft.)
  - Thin airfoils for minimum wave drag (12%)
- This led to a very flexible wing
- The load distribution was shifted inboard at high g's
  - This allowed an 8 ft. span extension at each tip without changing the original wing structure or engine locations
- Acted as a shock absorber to reduce gust loads

The Legacy of the B-47

- The B-47 led directly to the development of the 707
- Today's commercial transports follow the design paradigm of the B-47/707

Boeing 720
1960

Boeing 777
1996

References

- Brown, Michael E., *Flying Blind - The Politics of the U.S. Strategic Bomber Program*. Cornell University Press, London, 1992.
- Cook, William H., *The Road to the 707*, TYC Publishing, Bellevue, 1991.
- Donald, David, Ed. *American Warplanes of World War II*. Aerospace Publishing Limited, London 1995.
- Gunston, Bill, *American Warplanes*. Salamander Books, New York, 1986.
- Irving, Clive, *Wide-Body: The Triumph of the 747*, William Morrow, New York, 1993.