XB-70 Valkyrie

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Outline

- Mission/Purpose
- History
- Specifications
- Aerodynamic Analysis
- Compression Lift
- Overall Assessment

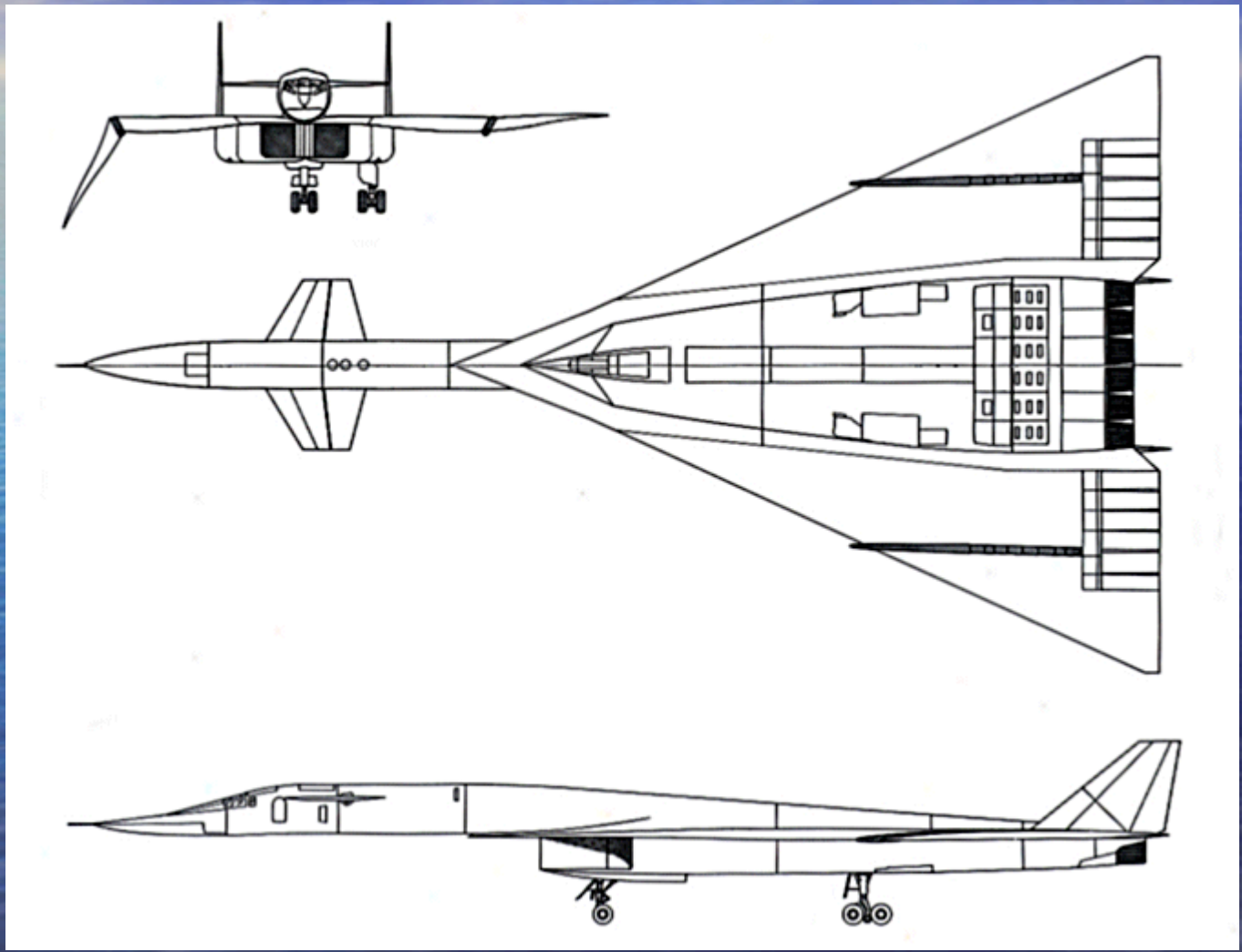
Mission and Purpose

- Mission Profile outlined by "Weapons System 110" (WS-110) Contract
  - Top Speed of Mach 3
  - Intercontinental Capability
  - Take-Off weight of 500,000 pounds
- By far the most complex aircraft to be designed in history
- Proposals submitted by only Boeing and North American

Mission and Purpose

- North American was awarded the contract with their XB-70 concept which met the follow criteria:
  - Cruise Speed of Mach 3 (2,000mph)
  - Cruise Altitude of 70,000 feet
  - A "shirtsleeve" environment for the crew.
  - 50,000 pound payload
  - A range of 7,500 miles
  - Sized such that existing runways, hangars, etc. that had already been built for the B-52 could be used without further modification.
  - Have flying characteristics suitable for use with average USAF line crewmen.
  - Carry 4 high-yield thermonuclear bombs to Russia

Final Configuration



Dryden Flight Research Center ECN-1814 Photographed 1967
XB-70A Valkyrie on ramp (NASA photo)

History

- In 1959, The US Air Force awarded the WS 110 contract to North American to produce three XB-70 prototypes.
- Bomber program canceled by President Kennedy because of SAM improvements in 1964 and cancelled third prototype.
  - Turned into a research and development program for the American SST program.
  - Data would be shared by Air Force and NASA
- First prototype rolled out on May 11, 1964.
- First Flight on September 21, 1964.

History

- Second Prototype first flight on July 17, 1965.
  - Much better airplane than the first.
  - Almost entirely new wing.
  - Streamlined construction methods.
- Second prototype lost in accident on June 8, 1966.

- Program ends on February 4, 1969.

Basic Geometry

- Length: 190 ft
- Wing Area
  - Subsonic: 6720 ft^2
  - Supersonic: 5440 ft^2
- Vertical Tail Area: 506 ft^2
- Canard Area: 500 ft^2
- Wing Span
  - Tips up: 106 ft^2
  - Tips down: 85 ft^2
- AR = 1.67
- Wetted Area:
  - Canard: 532.6 ft^2
  - Wing: 9307.7 ft^2
  - Vertical Tail: 937.7 ft^2
  - Fuselage: 2850.0 ft^2
- Tail Scrape Angle: 11.89°
- Wing Sweep: 65.5°
- Airfoil:
  - Root t/c: 3.6%
  - Mid Span t/c: 2.5%

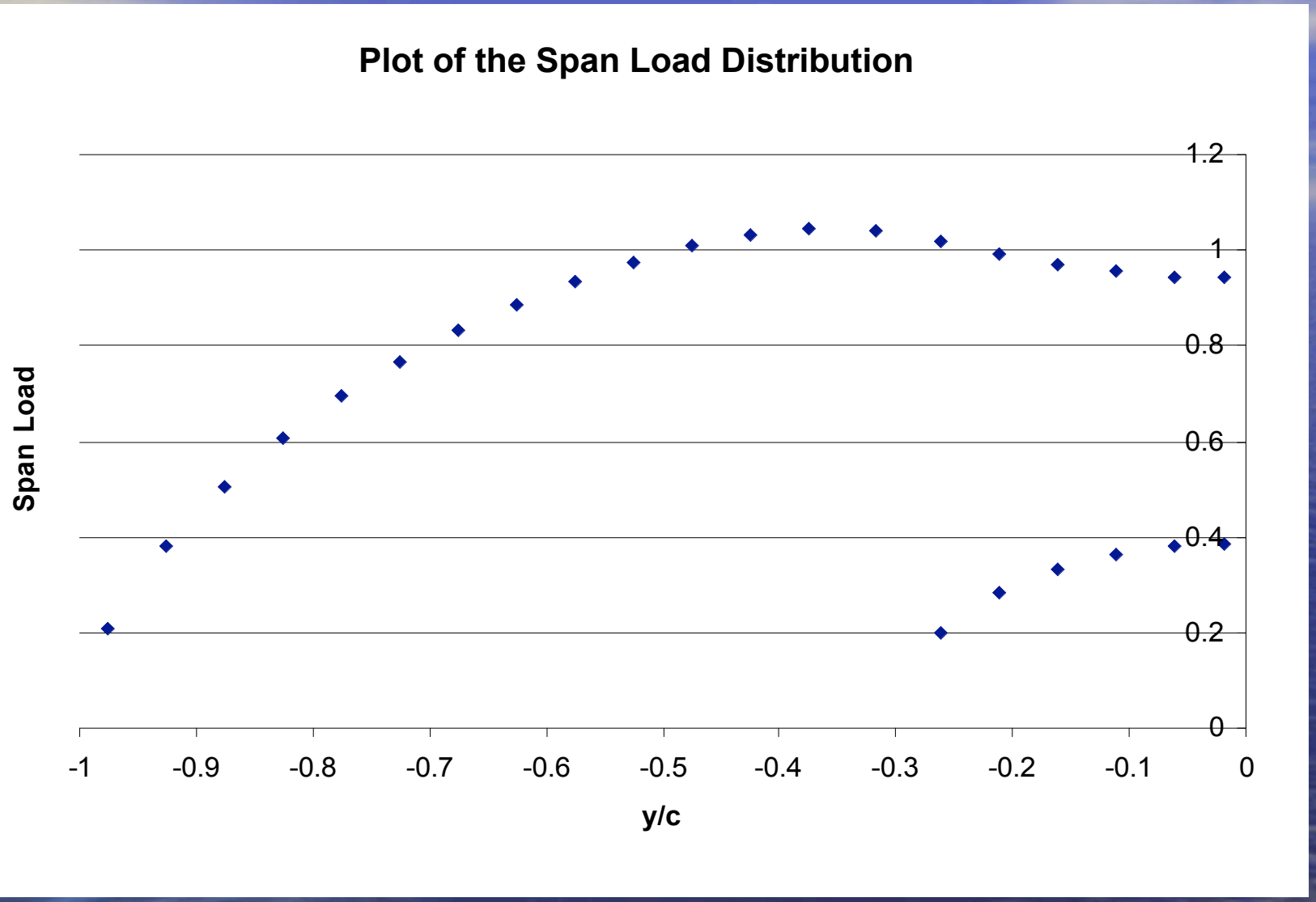
Characteristics

- TOGW: 534,700 lbs
  - 50,000 lbs payload
  - Wpayload/TOGW: 9.35%
  - 4 high yield thermonuclear bombs
- W/S: 80 lb/ft
- T/W: 0.337
- $(L/D)_{max}$: 7.2
- C_{LMax}=0.87
- C_{DO}=0.00432 @ M=3.1
  C_{DO}=0.01328 @ M=0.5

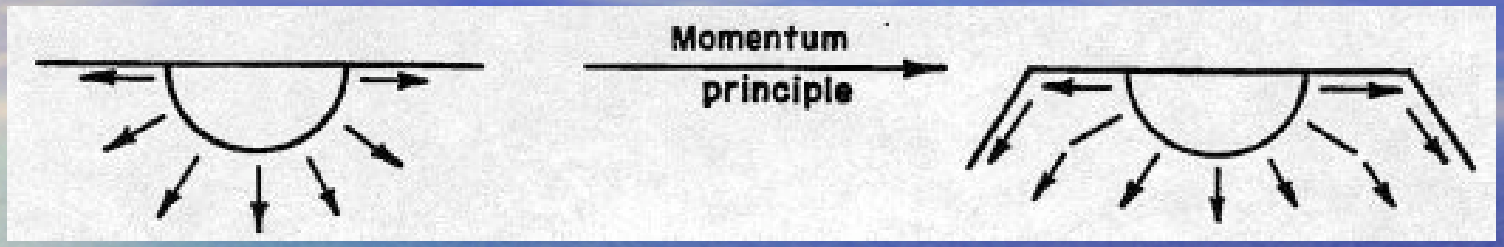
- Propulsion System
  - 6 GE YJ-93
  - 30,000 lbs each
  - Basis of GE 4 engine to be used on American SST
- Top Speed
  - Mach 3.1 @ 72,000 ft

Aerodynamic Analysis

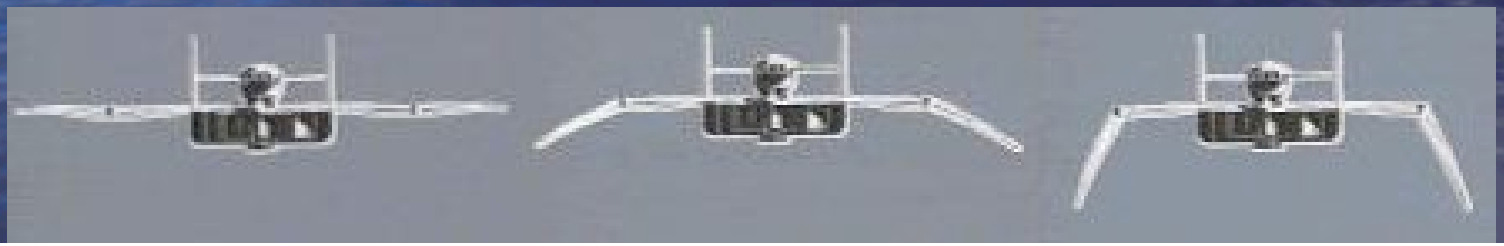
- The maximum range was 4288 miles with a ceiling of 77,350 feet.
- The neutral point was found to be 99.01 feet aft of the nose.
- The Cg was found to be 127 feet aft of the nose.
- The Aerodynamic Center was 132 feet behind the nose with a Static Margin of 8.83 feet.
- The load split for trimmed flight put 90.02% of the load on the main wing.


Plot of the Span Load Distribution
Span Load
1.2
1
0.8
0.6
0.4
0.2
0
-1
-0.9
-0.8
-0.7
-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0
y/c

Compression Lift



- Using the momentum of a shock wave produced on the underside of the aircraft, the momentum is directed downward to produce a lift.
- Increased the lift of the XB-70 by 34%
- Also helps with the AC shift during supersonic flight.
- One of only two airplanes ever to use this concept (British TSR 2)



Overall Assessment

- Pros:
  - Could complete specified mission.
    - Flew at Mach 3.1 for 33 minutes on August 17, 1965
  - Was the first airplane to use many new technologies.
- Cons:
  - Cancelled before built.
  - Technology was before its time and therefore PROBLEMS.
  - Expensive: $750 million a piece

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Questions?