Audacious strategic aircraft of the mid 20th century

The late 1930s through 1960s was a period of incredibly rapid development in large fixed-wing aircraft. The developments of the early 20th century were remarkable in their own right (the Wright brothers et al.), and the late 20th century saw advances in electronics and materials and minor refinements to aircraft shapes.

In contrast, World War 2 and its aftermath (the Cold War) caused the development of aircraft shapes and configurations to proceed at an astounding pace. The result was huge, long-range aircraft the likes of which had never been seen before. Wars tend to do that. Strategists during and soon after World War 2 struggled with intercontinental range, nuclear bomb loads, and the need to evade enemy radar, missiles, and piloted interceptors. Certain designs even included probing the edge of space. Designers pitted propellers against jet engines, straight wings against swept-back[1] wings, heavy bombers against medium bombers, all-wing designs against conventional (fuselage) designs, and speed and altitude against low-level penetration capabilities.

Most of the aircraft described below flew at least once. Some were produced in significant numbers. Some of the most fascinating were scrapped after just one or a few prototypes were produced. All were audacious, either because they were produced in large numbers despite their obsolescence, were important contenders for critical roles in strategic deterrence, or were simply startlingly ambitious applications of futuristic technology. Some are classified relicts of the distant past (Fig. 1c) or, as in the case of the B-2 (Fig. 26), hint at classified projects of the future. Most of these aircraft have been forgotten. All exemplify the rapid development in large aircraft technology during the middle decades of the 20th century.

Figure 1. Also-rans not discussed in detail in the text: (a) The Victory bomber, a WW2 British design. (b): British Vulcan nuclear bomber, a 1950s design that flew missions in the 1982 Falkland Islands War. (c) Artist's conception of a possible U.S. orbital nuclear bomber of early 1960s design, (d) FB-111, medium swing-wing bomber of mid 1960s design. (e) A supersonic heavy bomber of U.S. design of the 1970s. (f) Soviet Buran (yes! not the U.S. space shuttle), unmanned prototype shown landing after its single orbital flight in 1988.

B-36

The B-36 (Fig. 2) may have been one of the strangest aircraft ever produced in large numbers. Convair built 385 of these gigantic bombers for the U.S. air force in the late 1940s and early 1950s (see timeline in Fig. 25).

One aspect, perhaps, makes the B-36 stand out: it was gargantuan. It had the longest wingspan of any combat aircraft ever built, 230 ft.[2]

Its development and deployment (1941–1959) spanned a period of intense geopolitical conflict, i.e., late World War 2 and the early Cold War. Its payloads (none delivered) consisted of both conventional and nuclear bombs. It spanned the propeller and jet ages, being powered by six piston-driven pusher propellers that were later augmented by four turbojet motors ("six turnin' and four burnin'"). Though it served well, it was essentially obsolete once it left the factory and has been essentially forgotten.

The B-36 was the first true intercontinental bomber capable of carrying nuclear weapons. Its range was 9,900 mi, and it carried a payload of 73,000 lb. However, its beginnings were not as a Cold War (1947–1991) strategic weapons system.

[1] And even forward-swept wings.
[2] The B-36 was also the largest mass-produced piston-engine aircraft ever produced. Certain noncombat transport planes have featured greater wingspans: the H-4 (1947), wingspan of 320 ft.; An 225 (1988), wingspan of 290 ft.; and Airbus 380 (2005), wingspan of 262 ft..

Figure 2. The B-36 was the mainstay of U.S. nuclear strategic deterrence from 1949 to 1959. Its crews described its operation as flying an apartment building. Note the greenhouse-style cockpit canopy and outboard pairs of turbojets.

In 1941, before the U.S. entered World War 2, Britain appeared to be on the verge of losing to the Nazis, either by a severing of maritime supply lines from the west across the North Atlantic or in aerial warfare against the Germans over the English Channel. The U.S. recognized a possible eventual need to hit Nazi targets in an occupied England or mainland Europe from North American soil. The existing U.S. B-17s and B-25s and similar English bombers, though they eventually proved capable during World War 2, sorely lacked the needed range. A new bomber that could fly from Newfoundland, Canada, to the U.K. and back was required, and initial development of the B-36 began.

As the RAF won control of the skies over Britain, Hitler's invasion of Britain no longer seemed imminent, and the development of the B-36 slowed. Eventual entry of the B-36 into U.S. service only began in 1948. The B-36 then became the world's first bomber with an unrefueled intercontinental range. Many were based in Alaska and northwestern Greenland,[3] where they were intended to fly a route over the Arctic Ocean and drop nuclear payloads on a new target, the Soviet Union, which, in addition to its takeover of Eastern Europe, had begun to show its intention of expanding its influence and imposing its strange ideology elsewhere.[4]

The B-36 had a service ceiling of 43,600 ft. and a combat radius of 4,000 miles. Until it was replaced by the jet-powered B-52 Stratofortress, which first became operational in 1955, the B-36 was the primary nuclear weapons delivery vehicle of the Strategic Air Command for about a decade (Fig. 25), and the B-36 set the standard for range and payloads of subsequent U.S. intercontinental bombers.

Planes of the Nazi *AmerikaBomber* program

Although the Nazis likely lacked knowledge of the B-36, they explored a similar weapon system but in reverse: an *AmerikaBomber*, a long-range plane or other system of some sort capable of hitting New York with a bomb load on a round trip from the Azores.[5] German designers entertained such plans as early as 1937. Various designs from the Messerschmidt, Heinkel, and Junkkers factories were considered beginning in 1942.

[3] Thule Air Force Base.

[4] For example, in East Berlin (1948–9), the coup in Czechoslovakia (1948), relations with the Chinese communists in 1949, lukewarm support for the communists in the 1946–1949 civil war in Greece, and support for the invasion of South Korea by North Korea (1950).

[5] An island group located 930 mi. west of Portugal and 1,200 mi. east of Newfoundland, Canada.

Messerschmidt 264. Three prototypes of the Me 264 (Fig. 3) were built. Its handling, climbing performance, and maneuverability were reportedly subpar. Wingspan was 141 ft. This aircraft merits mention as a candidate in the *AmerikaBomber* program, although it was essentially equivalent only to the U.S. B-29. There is a report of flights between Finland and Japan. Its development was severely hampered by Allied air raids and diversion of German resources to other programs.

Figure 3. The Me 264 in a test flight during World War 2.

Junkkers 390. The Ju 390 (Fig. 4) was selected for production. The Germans recognized that a bomber with a huge wingspan and six engines would be needed to achieve intercontinental range. Two Ju 390s were constructed and tested in 1943 and 1944. This design reportedly performed well. Wingspan was 165 ft. The plane flew slowly, at 314 mph, but had a substantial range of some 6,000 miles. There are reports of one actually making a transAtlantic flight, coming within 12 miles of the northeastern U.S. coast in early 1944, but these reports are contested.

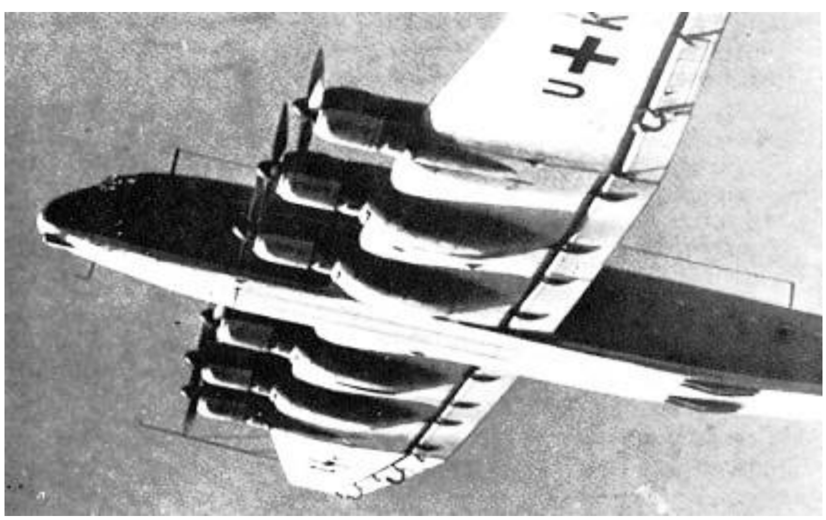

Figure 4. Ju 390 in flight in 1943 or 1944. Note the conventional nonswept wings and flaps along the entire lengths of the wings' trailing edges, which would have aided low-speed (takeoff and landing) handling.

The Axis considered several other aerial strategies for striking cities in the northeastern U.S. (nineteen targets) and Greenland from Europe and for bombing Vancouver, Canada, from Japan. These ambitious weapons systems and exotic technologies included piggybacks on huge carrier aircraft, kamikaze aircraft powered by jet engines, one-way trips with crew pickups by U boats waiting in the Atlantic, flying wings, and rocket-powered bombers that would reach the edge of space on suborbital trajectories. Unpiloted and piloted versions of a suborbital spaceplane bomber were considered from 1941 to 1944 (Fig. 5)

Silbervogel. The Silbervogel (Fig. 5) was to have begun its mission in Nazi-occupied Europe, propelled to about 500 mph by a large rocket-powered sled along 2 mi. of rail track. Once airborne, it was to fire its own rocket engine and climb to an altitude of 90 mi., in other words, into space. There, it would be traveling at some 3,000 mph. It then would have skipped into and out of the atmosphere several times, along the way dropping an 8,000-lb. bomb on the continental United States, and then land somewhere in Japanese-held territory somewhere in the Pacific, perhaps even in a potential Japanese stronghold in California.

The concept dated back to the mid 1930s. The project was finally submitted in all seriousness to the Reich Air Ministry in September 1944. Two manned versions and an unmanned version were proposed. Obviously, the autumn of 1944, as the Red Army was advancing from the east and the other Allied forces began advancing from the west, was too late for any significant development of the Silbervogel. Later studies indicated that this spaceplane would have overheated upon reentry into the Earth’s atmosphere anyway.

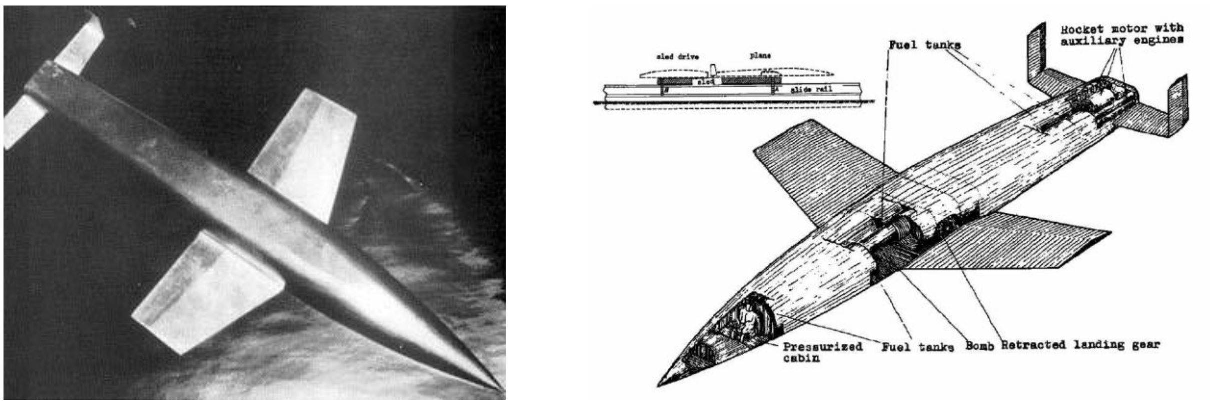

Figure 5. (Left) wind-tunnel model of the Sänger Silbervogel photographed in 1935. (Right) diagram.

Ho 229. Although the Horten 229 may not have been a significant part of the *AmerikaBomber* program, it deserves mention as an early flying-wing fighter bomber (flying-wing concept discussed in detail later). With a wingspan of only 55 ft. and range of only 600 mi., the Ho 229 (Fig. 6) was merely intended to penetrate British airspace. However, its production in quantity early enough might have changed the course of World War 2. A prototype glided unpowered in March 1944, and a powered flight occurred in February 1945. The Ho 229 (powered) handled adequately, performed well in testing versus a jet-powered Me 262, was capable of dashing at 607 mph, and was mildly stealthy, owing to its configuration and clever use of radar-absorbing materials, including plywood, charcoal, sawdust, and glue.

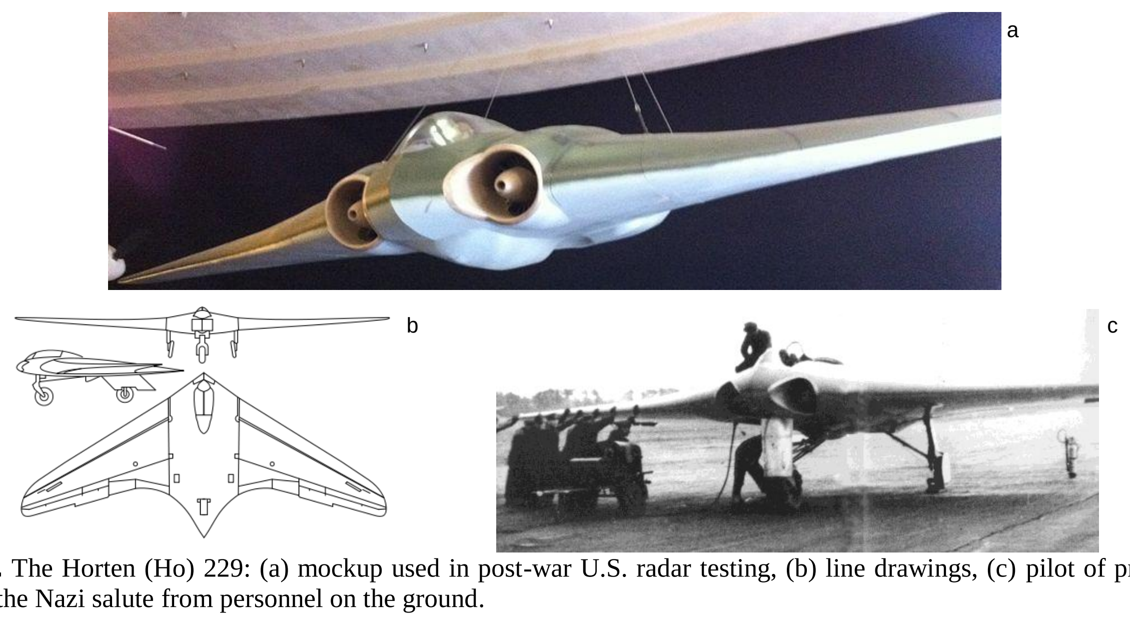

Figure 6. The Horten (Ho) 229: (a) mockup used in post-war U.S. radar testing, (b) line drawings, (c) pilot of prototype receiving the Nazi salute from personnel on the ground.

XB-46: wartime jet bomber prototype

The XB-46 (Fig. 7) bomber program ramped up in 1944 through early 1945 in response to similar Nazi developments. Had the Germans and Japanese been able to extend the war into 1946, 1947, or 1948, as many feared, they might have faced a fleet of B-46s (or B-45s, described later). The XB-46 was a medium bomber with a wingspan of 113 ft. As the Axis was rolled back and ultimately defeated, the XB-46 program slowed, resulting in a single prototype, which first flew in April 1947. The project was cancelled later the same year.

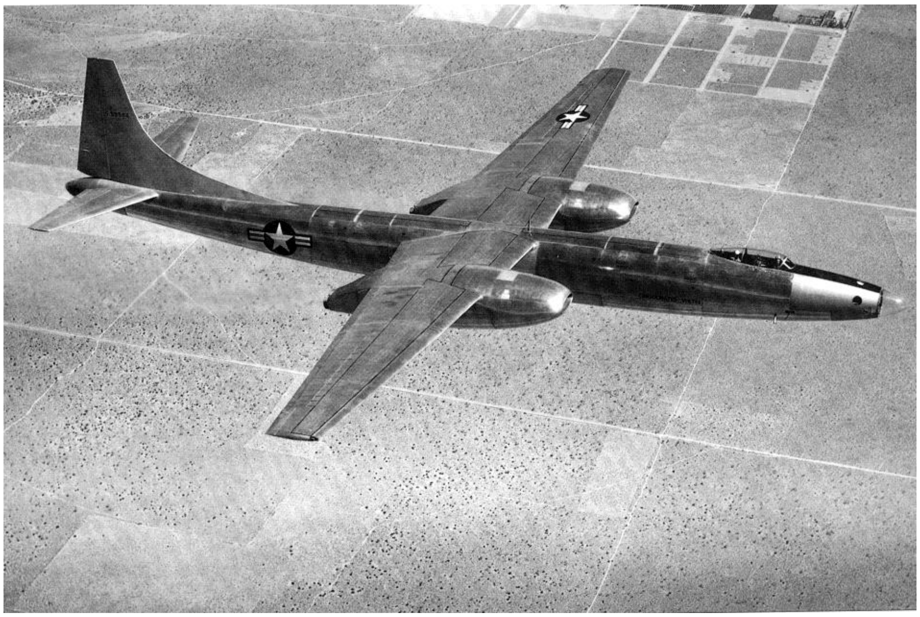

Figure 7. The single XB-46 prototype is shown in a test flight, probably in mid 1947.

This plane featured highly refined aerodynamic lines and a fighter-type cockpit canopy. Power was provided by four turbojets paired in two nacelles integrally fitted into the undersides of the wings. Otherwise, however, it was a conventional, straight-wing design. Only one was built, owing to successful development of the B-45 (Fig. 9) and, ultimately, the B-47.

During development of the XB-46, Convair found itself in competition with its own XB-53 (Fig. 8), which was a radical medium bomber concept: its wings were given 30° of ***forward*** sweep and 8° of dihedral, based on captured Nazi research data. The XB-53 also lacked a tail or at least any dedicated rear horizontal surfaces. Three turbojets would have powered it, and its wingspan would have been 81 ft.. Planning of the XB-53 spanned from 1945 through 1949, and work on prototypes was begun, but none was completed.

Figure 8. Artist's conception of the XB-53.

B-45 Tornado

Development of the B-45 (Fig. 9) began in 1944. The end of World War 2 resulted in the cancellation of many projects and the delay of many others. In 1946, rising tensions with the Soviet Union caused the Air Force to assign higher priorities to jet bomber development and production. In mid 1946, the Boeing XB-47 (described later) was two years in the future, and the U.S. air force was evaluating the XB-45 and the XB-46. The XB-45 design appeared to be superior, and in January 1947 a contract to produce numerous B-45s was signed. A prototype first flew in March 1947. However, the B-47, by then undergoing flight tests, proved to be superior still. President Truman curtailed production of the B-45 during the period of 1948–1950.

The B-45 had a wingspan of 89 ft. and a top speed of 570 mph. It differed little from the Convair XB-46 (Fig. 7): straight wings and four turbojets housed in pairs in two nacelles molded into the undersides of the wings.

Figure 9. The B-45, 106 of which were built.

The B-45 (Tornado) differed from the XB-46 in one important respect: it was produced in significant numbers and placed into service. The first B-45s entered service in November 1948, and the initial order of 96 was completed in March 1950. The B-45, like most post-World War 2 U.S. bombers, was equipped to carry both nuclear and conventional bombs. Simultaneous progress in weapons technology had led to a great reduction in the weight and size of nuclear weapons in the U.S. inventory, allowing smaller aircraft such as the B-45 to potentially perform strikes with nuclear bombs.[6] Suddenly, the small fleet of B-45s gained great value again as a nuclear deterrent. The plane was stationed in various places in the southern U.S., but it may have served its main role when 55 nuclear-capable B-45s arrived in the U.K. in 1952 and began serving as part of the first line of deterrence against potential Soviet aggression in Europe.

A reconnaissance variant was also used in clandestine overflights of the Soviet Union in the 1950s. All variants of the B-45 were removed from active duty by 1959.

Planes of the era similar to the B-45 were the XB-51 (Fig. 10) and B-57 (Fig. 11). The XB-51 was a small (wingspan 53 ft.) jet-propelled bomber that first flew in October 1949; only two prototypes were built. It was powered by three jet engines, two attached under the fuselage and one buried in the tail section. This configuration allowed for clean wing surfaces. The B-57 was the U.S.-made version of the English Electric Canberra, which first flew in May 1949. Of the two planes, the Canberra (wingspan 64 ft.) proved superior, and the U.S. built 403 planes of this design under license as the Martin B-57. The B-57 saw combat in Vietnam, serving in a ground-support role of low-level bombing and strafing.

Figure 10. Martin XB-51. Note the highly swept wings, high T tail, and three engines.

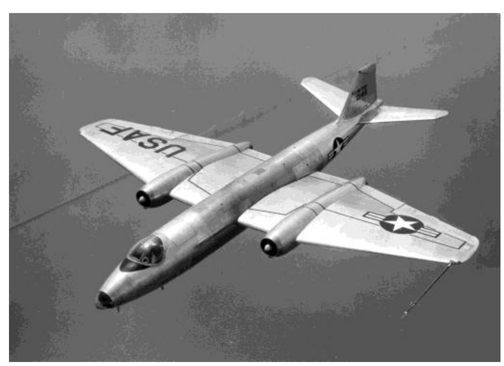

Figure 11. Martin B-57, essentially the English Electric Canberra.

[6] This miniaturization of nuclear warheads allowed the U.S. to rely, for a time, on aircraft for potential strikes on the Soviet Union. The Soviets, evidently delayed in a similar process of bomb miniaturization, aggressively pursued rocket technology as a means of potentially lobbing nuclear bombs in the opposite direction, onto U.S. soil. Consequently, Sputnik orbited the globe in October 1957, sending Americans into a tizzy, and the Soviets led in space technology from then until the mid 1960s.

YB-49: a 1940s flying-wing ancestor of the B-2

Figure 12. The XB-35, an early ancestor of the B-2, during a test flight in the mid 1940s.

Predecessors. John Northrop began investigating the concept of a flying wing in the late 1920s. The first prototypes, flown beginning in 1929, were powered by pusher propellers, as were the famous Wright Flyer (of 1903) and the later B-36 (Fig. 2). Northrop advocated the flying wing as a means of reducing the drag and weight of the fuselage, which, on a conventional plane, produces little lift compared to the wings.

In the early 1940s, as described earlier, the U.S. Army asked for a bomber that could strike Europe in the event that Britain fell to Nazi occupation. Work toward this mission was mostly directed to the B-36, but Northrop was also invited to participate, resulting in the Northrop XB-35, shown in Fig. 12. In theory, the XB-35 could carry a greater payload faster, farther, and more cheaply than a conventional bomber. The XB-35 was powered by four conventional powerplants driving pusher propellers. Thirteen XB-35s were produced though not placed into service. Flight testing revealed problems with vibrations in the propeller shafts and issues involving propeller control and the exhaust system. While the XB-35 was superior to the B-36 in several ways, the B-36 was instead given the green light, and the XB-35 program was cancelled in 1945.

An also-ran. The exotic XB-79 was conceived by John Northrop in late 1942 and developed under his guidance beginning in 1943 as World War 2 raged. A single prototype of the XB-79 was then produced and first flew in September 1945, just days after Japan ceased hostilities. The XB-79, with a wingspan of only 38 ft., was essentially a fighter plane. It merits mention only as another product from the Northrop stable of flying-wing aircraft. The pilot lay prone between the twin jet engines built into the structure, affording views of the scene above and below (but not to the side), as shown in Fig. 13. On its first test flight, the aircraft flew for 15 minutes without problems. Soon thereafter, the plane spun out of control, and its test pilot perished, as did the XB-79 program.

Figure 13. The single XB-79 flying wing fighter prototype on its only test flight, in September 1945.

The YB-49. However, the Air Force remained sufficiently interested in the flying wing concept to order conversion of a few XB-35s to jet-engine bomber prototypes, and thus the YB-49 was born. The YB-49 (Fig. 14) was powered by eight turbojets housed inside the wings. Two prototype YB-49s were built, and the first of the type flew in October 1947. This heavy bomber was large, with a wingspan of 172 ft. (same as the XB-35), and proved to be fast, with a top speed of 520 mph.

One YB-49 was lost in June 1948, killing its crew of four. Their aircraft suffered structural failure, with both outer wing sections detaching from the center section. Speculation at the time was that this YB-49 was lost due to excessive pullout loads imposed on the heavy airframe when a scheduled flight test of the large bomber's recovery in a stall resulted in a sudden and dramatic high-speed, nose-over dive. The post-stall, high-speed dive purportedly resulted from the clean, low-drag, all-wing design, which had given the YB-49 its great speed. In March 1950, the remaining prototype was destroyed in a fire on the tarmac during high-speed taxi testing.

There was a third prototype, also built from a converted XB-35, which was intended for a reconnaissance role. Thirteen test flights of this aircraft spanned from 1950 to 1951. With that, Northrop's all-wing program was terminated (for the time being). The conversion of the long-range XB-35 to the jet-powered YB-49 essentially cut the effective range of the latter aircraft in half, putting it in the medium-range bomber category along with Boeing's new swept-wing jet bomber, the B-47. The B-47 was optimized for high-altitude, high-speed flight, and, in an era when speed and altitude were becoming everything, the YB-49's thick airfoil could never be maximized for high-speed performance. Thus, the obsolete but sturdy B-36 (and the recently flown B-47 and the yet-to-fly but well-into-development B-52) prevailed over the YB-49 as it had over the XB-35.

The 1953 film *The War of the Worlds*, by Paramount Studios, used color footage of a YB-49 test flight in one of several scenes depicting failed attempts by the Earthlings to defeat the invading Martians.

Figure 14. The YB-49, a flying-wing strategic bomber concept too far ahead of its time (1947).

John Northrop retired from aviation shortly after seeing his dream of a pure, all-wing aircraft destroyed. His son, John Northrop Jr., later recounted his father's devastation and lifelong suspicion that his flying-wing project had been sabotaged by political influence and back-room wheeling-and-dealing between Convair (builder of the B-36) and the Air Force.

Resurrection. The flying wing of the late 1940s and early 1950s may have had distracting "teething problems," and the YB-49 was ultimately cancelled for what may have been sound technological, strategic, and fiscal reasons of the time. However, its basic design was solid. Beginning in the mid 1950s, Soviet advances in surface-to-air missiles (SAMs), interceptor aircraft, and radar caused U.S. designers and strategists to rethink the roles and designs of strategic bombers.

Gradually, a previously overlooked aspect of the flying wing gained appreciation. It was stealthy.

A flying wing is basically, and can be further rendered, nearly invisible to radar. Lacking any bulky, rounded fuselage with surfaces facing in all directions, the surfaces of a flying wing mostly face directly down and up, the exceptions being the edges of the wings and any irregularities along the upper surfaces, including the cockpit canopy. The leading and trailing edges face essentially in only four directions (two on each wing), and the upper surfaces matter little in a bomber flying over foreign territory at an altitude of some 40,000 ft.. An interceptor pilot flying an intercept path from below or a radar operator manning a single radar installation on the ground will receive little in the way of radar reflections off a flying wing unless the radar signals are bounced vertically off the aircraft. Theoretically, the primary radar signals sent from one point will only be reflected to and received at a single other distant point, and only for a brief time, given that the target aircraft is moving rapidly. The radar observabilities of the B-1 (Figs. 23 and 24) and B-2 (Fig. 26), discussed later, are reportedly $^{1}/_{10}$ and $^{1}/_{100}$, respectively, of that of a B-52.

In April 1980, roughly 3 decades after seeing his visionary flying wing die a premature death, John Northrop, by then quite elderly and bound to a wheelchair, was taken back to the company he founded. There, he was ushered into a restricted area and shown a highly classified scale model of what would become the Air Force's forthcoming B-2 bomber. It was a sleek, stealthy, all-wing design. Looking over its familiar lines, Northrop, unable to speak due to various illnesses, was reported to have written on a pad: "I know why God has kept me alive for the past 25 years." John Northrop died 10 months later, in February 1981, 7½ years before the public unveiling of the Northrop-Grumman B-2 bomber, which soon thereafter entered Air Force service. The B-2 (Fig. 26), perhaps not coincidentally, has the same wingspan, 172 ft, of the XB-35 and YB-49, and data collected during test flights of the YB-49 were used in the development of the B-2.

NB-36: plane flight by nuclear power

In a conventional jet engine, thrust is provided by accelerating air, which is accomplished by heating it with burning jet fuel. In a nuclear engine, the heat is primarily supplied by a nuclear (fission) reactor, although a small amount of jet fuel is carried to add extra energy during high-power portions of flight: takeoff and high-speed dashes. Theoretically, the ultimate goal of a nuclear powered plane is, or was, endurance, i.e., long flight times or extended range, perhaps limited only by the needs of the crew. The concept of such an aircraft was first envisioned in 1947. The U.S. project was an on-and-off affair. It was halted in 1953 and then restarted in 1955.

Figure 15. The NB-36, test bed for a potential nuclear-powered U.S. bomber. A similar Soviet program may have advanced beyond the preliminary testing stage of its U.S. counterpart.

The one NB-36 (Fig. 15) was built using parts from a damaged B-36. Power for the NB-36 was supplied by six Pratt & Whitney propeller engines and four GE jet motors, essentially the configuration of the B-36 bombers in service. The greenhouse-style cockpit canopy of the production B-36 (Fig. 2) was replaced with a different cockpit structure. The crew was also provided with abundant radiation shielding consisting of lead, rubber, and water and with provisions for rapid extraction of the crew after a crash. The nuclear reactor has been variably rated at 1 to 3 megawatts and was housed in bomb bay 4, the one farthest aft. The reactor did not provide propulsion nor power any of the NB-36's systems in its testbed configuration but was placed on the prototype to determine the effects of vibrations and other aspects of flight on the nuclear reactor and the effects of the nuclear reactor on the plane and its crew. The NB-36 completed 47 test flights and 215 hours of flight time (during 89 of which the reactor was operated) between September 1955 and March 1957 over New Mexico and Texas. In the mid 1970s, an elderly engineer who had contributed to the design showed and described to me a model of the plane displayed in his home.

Not to be outdone, the Soviet Union began its own similar initiative in 1954. Having given up on an earlier nuclear-powered seaplane, or flying boat, the Soviets began developing a nuclear powered Tu 95.

The basic concept of a nuclear-powered bomber was perhaps doomed from the start, due to several factors. The concept was hampered by the weight loads imposed by the reactor and its necessary shielding (although, theoretically, this could have been counteracted by the saving of the weight of jet fuel) and the safety concerns created by a nuclear-powered plane flying over U.S. territory and other friendly nations. The NB-36 was also hampered by the inherently low speed and high visibility of the mid-1940s design of its B-36 airframe, which rendered it highly vulnerable to enemy interceptor aircraft and SAMs. Strategists and politicians of the time also noted that the purported range or loitering abilities of a nuclear bomber were being superseded by newer jet engines, systems for midair refueling, and plane configurations capable of extensive range.

In March 1961, President Kennedy cancelled the project, commenting that

> nearly 15 years and about $1 billion have been devoted to the attempted development of a nuclear-powered aircraft, but the possibility of achieving a militarily useful aircraft in the foreseeable future is still very remote.

Meanwhile, the Soviet Union had been conducting similar research. The Soviets, perhaps using a Tupolev Tu 119, which was based on the Tupolev Tu 95 bomber, or perhaps just using a modified Tu 95, completed 34 research flights, although most of these were performed with the reactor disengaged. By August 1961 (or perhaps as late as 1969), the Soviets also pulled the plug on their own program, due to its inordinate expense and after learning of the demise of the U.S. nuclear-powered bomber program.

B-47: forerunner of large jet aircraft

The B-47 was a long-range bomber that entered service with the U.S. Air Force in 1951, although it took until 1953 to turn the B-47 into a truly operational aircraft (Fig. 16).

In May to July of 1945, as the German forces were rolled back, American studies of aeronautical research found in captured German laboratories (including a Ho 229, described earlier) revealed certain interesting findings: swept-back wings on aircraft as they approached the speed of sound resulted in superior performance. Word was sent back to the U.S., and Boeing stopped work on straight-wing designs and switched to swept wings.

Boeing designers soon settled on a 35° wing sweep. The B-47's wingspan was 116 ft., substantial but nothing like the 230 ft. of the B-36 (Fig. 2), whose deployment it overlapped with (see Fig. 25). The B-47 incorporated several other innovations. Its jet engines were housed in nacelles on pylons slung under the wings, which evened out wing loads and facilitated maintenance, a configuration that was later adopted in nearly all large modern aircraft. Observers viewing the initial assemblies of the B-47 were reportedly awe-struck by what they saw.

A prototype first flew in December 1947, and a second took to the air in July 1948. On a test flight in 1948, Chuck Yeager, piloting a chase plane, a Lockheed P-80 Shooting Star, reported that he was unable to keep up with the B-47.

The mere 4,000-mi. range of the B-47 was disappointing (less than that of the B-36), and midair refueling was vigorously pursued to address this shortcoming. Beginning in 1950, the Boeing KC-97, essentially an upgraded B-29, was placed into service as an aerial tanker.

Variants of the basic B-47 design totaling 2,032 aircraft were produced, mostly by Boeing. Despite its production in large numbers, the B-47 never saw combat in its mainstay role as a strategic bomber, which was to potentially drop nuclear bombs on the Soviet Union from bases in the U.K., Morocco, Spain, Alaska, Greenland, and Guam between 1951 and 1965. The plane was powered by six jet engines and flew at high subsonic speeds at high altitudes to avoid enemy interception. In the mid 1950s, reconnaissance variants of the B-47 were able to pierce Soviet airspace and conduct a variety of spectacular overflights of the Soviet Union. Some of these flights probed deep into the heart of the Soviet Union and involved photographs and radar recordings of the routes that potential attacking U.S bombers could follow to reach their targets.

The jet engines of the era did not develop good thrust at low speeds, and to help the heavily loaded bomber take off, the XB-47 prototype and early production variants had provisions for fitting eighteen solid-fueled rocket-assisted takeoff (RATO) rockets with 1,000 lbs of static thrust each. Fittings for nine such units were built into the rear fuselage, arranged in three rows of three bottles (Fig. 16).

Figure 16. A B-47 on takeoff. Note the tan smoke from the RATO rockets and the innovative "bicycle" undercarriage with outriggers on the wings. The pods roughly ⅔ outboard on each wing are merely auxiliary fuel tanks.

Large-scale production of the B-47 ended in 1957. In 1959, the B-52 gradually began to take over the duties of the B-47, which began its phase out in 1963. Around that time, training by B-47 bomber crews switched from high-altitude bombing runs to low-altitude strikes, which were judged more likely to penetrate Soviet defenses. Bomber crews were trained in "pop-up" attacks: coming in at low levels at 425 knots and then climbing abruptly near the target before releasing a nuclear weapon.

B-52: big brother to the B-47

While the B-47 was being developed and tested in the mid 1940s, the top U.S. military brass and Boeing's aeronautical engineers spent several years dithering with various combinations of straight or slightly swept-back wings and turboprop propulsion in a truly long-range (unrefueled) intercontinental bomber. The eventual result was the B-52, essentially a gargantuan, rapid followup to the B-47.

In October 1948, the familiar B-52 as we now know it (Fig. 17), as a long-range strategic bomber powered by eight turbojet engines and swept wings (wingspan 185 ft.), was conceived. It took its maiden flight in April 1952 and became operational in 1955. Like the B-47, the B-52 was designed primarily to deliver nuclear bombs over the Soviet Union. Unlike the B-47, it has performed bombing runs in combat (perhaps a few thousand), though only with conventional munitions.

Figure 17. The familiar B-52 is essentially a 1940s design. It served as the mainstay of U.S. aircraft-borne strategic deterrence during the Cold War and may serve into the 2040s.

A total of 744 B-52s were built between 1954 and 1963. B-52s flew hundreds of sorties during the Vietnam War, and ten were gunned down over North Vietnam. They also saw combat in Iraq during the 1991 Gulf War, hit targets in Serbia during the 1999 Kosovo conflict, and struck targets in Afghanistan in 2001 and Iraq in 2003. Upgraded and refurbished B-52s have been and will be produced periodically. Strangely, as of 2013, 78 B-52s remain on active duty, based primarily in North Dakota and Louisiana. Stranger still, it is anticipated that the remaining planes will serve into the 2040s, roughly 80 to 90 years after their basic airframes left the factory.[7]

YB-60: a loser in competition with the B-52

In August 1950, Convair issued a formal proposal for a swept-winged version of its B-36 with all-jet propulsion. The YB-60 shared 72% parts commonality with its piston-engine predecessor, and the fuselage of the YB-36 (Fig. 18) was largely identical to that of the B-36. The 206 ft. wingspan of the YB-60 was only slightly less than that of the gargantuan B-36. Essentially, the YB-60 was a B-36 with swept back wings and tail surfaces and fitted with eight jet engines paired in four nacelles slung below the wings. This configuration of wings and engines was essentially the same as that of the B-52.

The YB-60's unofficial competitor was the Boeing B-52, which happened to make its maiden flight 3 days earlier than did the YB-60, in April 1952. The YB-60 was approximately 100 mph slower than the YB-52 and also had severe handling problems. It carried a heavier bomb load than did the B-52, but later modifications to the bomb bay of the B-52 increased its bomb load far beyond that of the YB-60.

Flight testing of the YB-60 ended in early 1953, and the single airworthy prototype and another prototype under construction were scrapped a few months later.

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[7] During the 1980 U.S. presidential campaign, Reagan (U.S. president 1981-1989), challenging Carter's (U.S. president 1977-1981) alleged softness on defense issues, complained that the B-52s were older than the pilots flying them. Strangely, the few remaining B-52s are now or will soon be older than the ***grandfathers*** of some of the crews flying them.

Figure 18. The YB-60, probably in mid 1952. It was clearly a derivative of the obsolete B-36, and it was passed over in favor of the similar B-52.

B-58 Hustler

The Convair B-58 Hustler (Fig. 19) was the first operational bomber capable of Mach 2 flight. The design began taking shape in late 1952. The Convair design was based on a delta wing with a leading-edge sweep of 60°. Its large wing made for relatively low wing loading, and it proved to be surprisingly well suited for low-altitude, high-speed flight.

Because of the heat generated during cruises at Mach 2, not only the crew compartment but also the wheel wells and electronics bay were pressurized and air conditioned. The B-58 used one of the first extensive applications of honeycomb panels, in which outer and inner aluminum skins are bonded to a honeycomb of aluminum and fiberglass.

Compared to the (thoroughly subsonic) B-52, the supersonic B-58 carried a much smaller weapons load, had a limited range, was expensive to acquire, required considerable maintenance, cost three times as much to operate, and had a high accident rate. The B-58 was difficult to fly, and its three-man crews were constantly busy, but its performance was exceptional, and it could climb at a fast rate. Its crews eventually became enthusiastic about the aircraft's performance and design. It featured a novel crewman escape capsule, and its electronic controls were ambitious and advanced for the day.

The B-58 was based for operations in Texas, Arkansas, and Indiana from 1960 to 1970. Each plane carried four nuclear bombs and fuel in a large pod under the fuselage rather than in an internal bomb bay. This small plane (wingspan of 57 ft.) had a combat radius of only 1,740 miles.

As with other U.S. strategic aircraft weapons systems of the time, the B-58's theoretical vulnerability to Soviet SAMs became evident. The purported solution to this problem was to force the B-58 into a low-altitude penetration role, thus minimizing exposure time to enemy radar. However, the B-58 was unable to fly at supersonic speeds in the dense air at low altitudes, and its moderate range was reduced further, thereby negating its high performance and strategic value that had been obtained at such a high price. In late 1965, Secretary of Defense McNamara ordered the B-58's retirement by 1970. The B-58's role was taken over by the more-flexible, less-expensive FB-111 (Fig. 1d), which was a swing-wing fighter-bomber specifically designed for low-altitude attack.

A total of 116 B-58s were built, most of which attained operational status.

Figure 19. This photograph of a B-58 was taken in June 1967. Note the tail-less delta wing design and fuel pod under the fuselage.

X-20, DynaSoar, the would-have-been space shuttle

With the X-20 (Fig. 20), the U.S. nearly had an operational space shuttle as early as the mid 1960s.

The concept of the X-20 can be traced back to the Silbervogel, a WW2 Nazi intercontinental bomber project (described earlier; see Fig. 5). The concept was that of a rocket-powered bomber that could travel vast distances by being boosted into the low reaches of space and then gliding to its target.

The X-20's Titan or Saturn rocket booster would fall away after injecting the spaceplane into a suborbital or orbital trajectory. There, its single rocket motor and crew of one would maneuver the craft. When the vehicle would first partially reenter the atmosphere, instead of fully reentering, it would use its wings (wingspan of 21 ft.) and some of its speed to generate hypersonic lift and bounce the vehicle back again into space, beyond the atmosphere. This cycle would repeat until the speed was low enough that the pilot could glide the vehicle to a landing, preferably on an airstrip. This strategy belongs to the category of boost-glide, or VTHL (vertical takeoff, horizontal landing). As a result, this spaceplane would have been immune to enemy interception and thus need none of the defensive weaponry or armoring of conventional bombers.

The X-20 program began in late 1957. Its result was unveiled in a public ceremony in late 1962. Meanwhile, its largely military mission had begun to suffer from overlaps with NASA's civilian space program, in particular NASA's MISS (Man in Space Soonest) program. NASA had been achieving success lobbing astronauts into orbit in crude single-use capsules that plunged back down through the atmosphere atop an ablative heat shield that essentially melted and burned away during reentry. The more-advanced X-20 spaceplane thus succumbed primarily to competition from the Gemini spacecraft and the race to land men on the moon. The X-20's potential reconnaissance role may have also been overtaken by developments in high-resolution photographic reconnaissance from unmanned satellites. In late 1963, after 6 years of development and $1.5 billion in expenditures, and a month before a prototype under construction was to have left the Boeing factory and been dropped in glide tests from a larger plane, Defense Secretary McNamara cancelled the X-20 project.

Roughly a decade later, the spaceplane concept was resurrected and pursued in earnest in the form of the well-known Space Shuttle, or Shuttle Transportation System (STS), which operated from 1980 to 2011. Perhaps the X-20, absent any moon race, would have, during the 1960s, 1970s, and 1980s, eventually been scaled up to the size of the STS, which could ferry a crew of seven and a large cargo into orbit.

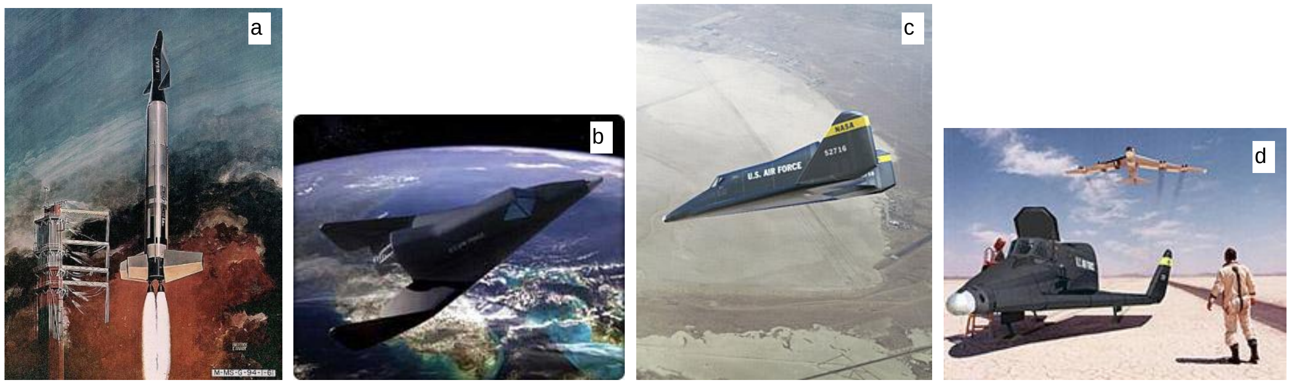

Figure 20. Artists' conceptions of the X-20 (a) at launch, (b) in orbit, (c) during a glide on landing approach, and (d) after landing. In 1963, a prototype was a month away from flight testing.

The familiar STS differed from the X-20 in many respects: it wasn't intended for bombing runs, and it carried its (complex, expensive) primary booster motors aloft and thus featured a greater degree of reusability than the X-20. Unfortunately, the STS orbiter also sat alongside, piggyback style, its external fuel tank and solid-fuel booster rockets rather than atop its rocket stack as the X-20 was to have been (Fig. 20a). Had the STS designers somehow copied the configuration of the X-20, with the orbiter atop the booster,[8] the STS Challenger and Columbia disasters of 1986 and 2003, respectively, might have been averted.[9]

B-70: futuristic yet obsolete

In the mid 1950s, strategists perceived a need for a plane that could deliver a substantial bomb load to the Soviet Union and also dash at high speeds when required. After releasing a nuclear bomb, the delivering plane would need supersonic speed to escape the weapon's critical blast radius; that and the need to evade enemy supersonic interceptors and missiles on the way in. Thought on such a design began in 1954 with the goal of putting a plane in service by 1963. Desired was a plane with the range and payload capacity of the B-52 and the speed of the Convair B-58 Hustler. In a limited sense, this goal was nearly achieved by 1964 in the form of the B-70 Valkyrie (Fig. 21).

Nuclear fuel was considered (see NB-36). Boron-enhanced fuel was also considered for a time and then dropped from consideration in 1959, as it was observed to eat away at moving engine parts. Fuel tanks on huge detachable wing tips that could be jettisoned along the way were considered at one point (Fig. 22). Design work and evaluations intensified in 1956. Meanwhile, advances in supersonic flight were proceeding rapidly, and designers began converging on a configuration with a long fuselage and a delta wing.

The engineers at North American scoured the literature and found an obscure wind-tunnel report on the subject of compression lift. This concept involved taking advantage of the shock waves generated by the nose and other sharp points on the aircraft as a source of high-pressure air. North American added a set of hinged outer wing-tip panels (Figs. 21 and 22) that could droop down 65° from horizontal while the plane flew at high speed. This configuration tended to trap the shock wave under and between the downturned wing tips, and it added additional (nearly) vertical surfaces to improve directional stability at high speeds. This design had the additional advantage of decreasing the surface area of the rear of the wing when the wing tips were moved into their high-speed (lowered) position, thus offsetting the rearward shift of the center of pressure, or average lift point, with increasing speeds and thus reducing the need for control input.

As if all that weren't complex enough, the buildup of heat due to air compression during sustained supersonic flight had to be addressed. During a Mach 3 cruise, the aircraft would reach an average temperature of 450 °F, and portions would reach temperatures as high as 650 °F. At those temperatures, steel and aluminum lose much

[8] Quite difficult: the primary rocket motors would have needed to be mounted essentially near the wingtips of the orbiter and offset away from the primary fuel tank and auxiliary solid rocket boosters.
[9] And had the boosters and external fuel tank been given glide-back capability, the entire system would have been fully reusable.

of their strength. Titanium, fuel heat exchangers, and sandwich panels consisting of two thin sheets of stainless steel welded to opposite faces of a honeycomb foil core became part of the design. All this in the late 1950s.

Figure 21. A B-70 prototype on a test flight in the 1960s. Note the wing tips in the down position.

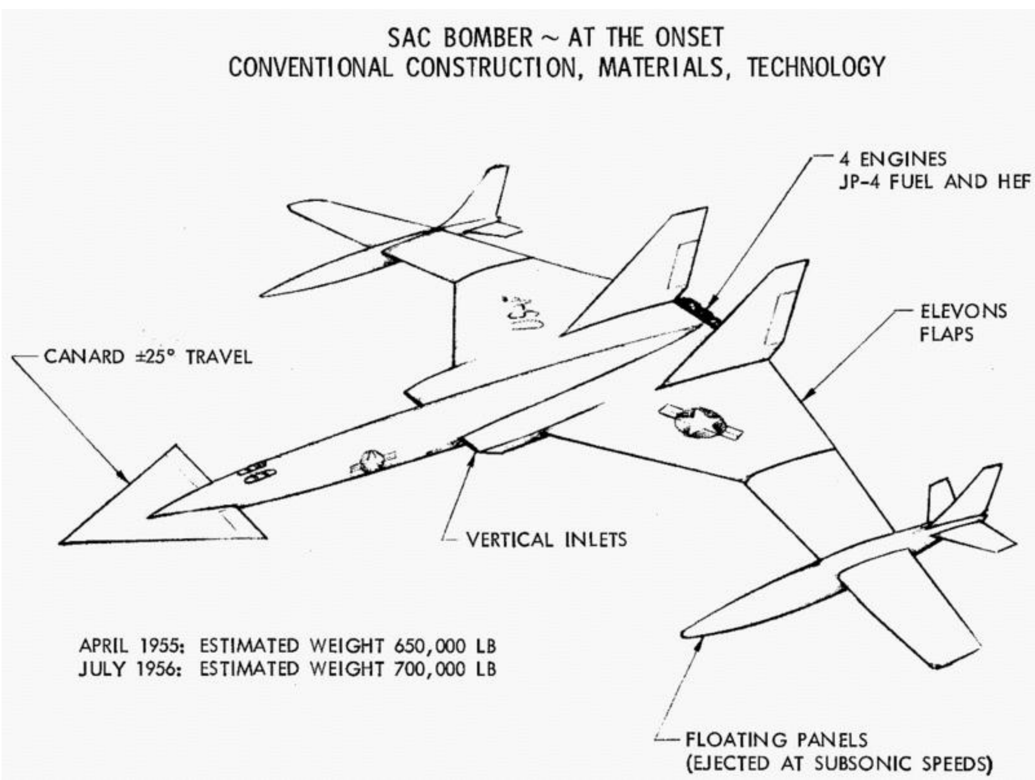

Figure 22. An early concept for a supersonic heavy bomber of the B-70 type. The ejectable outer wing panels were intended to hold fuel tanks.

Meanwhile, missile technology, particular the technology possessed by the Soviets, was advancing rapidly. By 1959, the military brass and President Eisenhower realized the near futility of the B-70 mission, and the program was downgraded to the production of a single prototype. The program then floundered amidst the 1960 presidential campaign and dithering by Congress and the new administration under President Kennedy.

By the late 1950s, Soviet defensive measures, i.e., radar installations, interceptor aircraft, and, in particular, SAMs, were making the potential missions of the U.S.'s B-52s, B-47s, and B-58s highly problematic. In May 1960, the Soviets famously succeeded in bringing down a U-2 reconnaissance plane. The U.S. Air Force began shifting its bombers to a low-level penetration role. This tactic was intended to greatly reduce radar detection distances by the use of terrain masking. At that time, Soviet SAMs were ineffective against low-flying aircraft. Also during this era, low-flying aircraft were difficult to detect by interceptors flying above, as their radar systems could not readily pick out opposing aircraft against the radar clutter from ground reflections.

Planners outlined a series of low-level flight profiles for the B-70. However, the higher drag in the thick lower atmosphere would have limited the B-70 to subsonic speeds while dramatically decreasing its range. The result would have been an aircraft with essentially the same speed and less range than that of the B-52 it was meant to replace. Unsuited for this new role, the B-70 bomber program was more or less canceled in 1961 by President Kennedy.

Eventually, however, two prototype B-70s were built. The first flew in 1964. The two prototypes flew a combined total of 129 flights spanning 252 hours, often at speeds up to Mach 3.08 and altitudes up to 78,000 ft., from 1964 to 1969. These flights were for purposes of testing and research, primarily in studies of sonic booms. One of the prototypes crashed on June 8, 1966, due to error by the pilot of a nearby F-104.

B-1: a few dozen fly today

Despite the problems and cancellation of the B-70 and successful deployment of nuclear-tipped rockets (ICBMs) and submarine-launched ballistic missiles (SLBMs), the U.S. took yet another run at developing a high-speed, high-altitude bomber starting in 1964. This effort began as a big-brother successor to the FB-111 (Fig. 1d) and evolved into the B-1 concept. The B-1 program languished for several years until it was resurrected by the Nixon administration (1969–1974). In 1970, a design from the Rockwell factory received a development contract. In 1976, plans called for 240 B-1As to be built, with deployment beginning in 1979.

The B-1A (Fig. 23) design featured large, variable-sweep wings that provided high lift during takeoff and landing and low drag during high-speed dashes, as in the swing-wing FB-111.[10] With its wings set in their widest position, the B-1A had considerably better lift and power than the B-52, allowing it to operate from more bases (with shorter airstrips). Penetration of Soviet defenses would potentially take place at supersonic speed, crossing these zones as quickly as possible before entering the less-well-defended heartland of the Soviet Union, where the bomber's speed could then be reduced. These variable aspects of its mission profile and the large size and fuel capacity of the B-1A gave it an expansive range. A prototype B-1A flew in December 1974.

Given that the B-1A's armaments were similar to those of the B-52 and it appeared no more likely to survive Soviet airspace than the B-52, the B-1 program was increasingly questioned during the mid 1970s. When Jimmy Carter (U.S. president, 1977–1981) took office, he was informed of the start of work on stealth aircraft that had begun in 1975, and he decided that this stealthy strategy was superior to that of the B-1. Meanwhile, there was progress in fitting the existing B-52 fleet with air-launched cruise missiles (ALCMs). With a range of 1,500 miles, an ALCM could be launched from its mother bomber well outside the range of Soviet defenses and could penetrate and strike its target from a low altitude. Thus, a small number of B-52s could launch hundreds of ALCMs and thereby saturating Soviet defenses at much lower cost than a large fleet of new bombers.

[10] The FB-111 (Fig. 1d) pioneered the swing-wing (variable geometry) design. Several hundred were produced. It entered service with the U.S. Air Force in 1967, served over southeast Asia in the 1970s and Iraq in 1991, and was last flown by the U.K. in 2010.

Figure 23. B-1A, with wings fully extended for low-altitude flight; compare with Fig. 24.

Jimmy Carter was no fool: he was a graduate of the U.S. Naval Academy and served as a junior submarine commander in the U.S. Pacific and Atlantic fleets. In 1977, Carter, as president, cancelled the B-1A in favor of a fleet of modernized B-52s armed with ALCMs.[11] Carter called this "one of the most difficult decisions that I've made since I've been in office." No public mention was made of the ongoing work on stealth aircraft at that time, but in early 1978, Carter authorized the advanced technology bomber (ATB) project (see also Fig. 1e), which eventually led to the B-2 (Fig. 26).

The reaction to Carter's decision was mixed. Flight tests of the four B-1A prototypes continued through April 1981. The program included 70 flights totaling 378 hours. A top speed of Mach 2.22 was achieved by the second prototype B-1A.

During the 1980 U.S. presidential campaign, Ronald Reagan asserted that Carter was weak on defense, citing the cancellation of the B-1 program as one example. Meanwhile, Carter's defense secretary, Harold Brown, announced the stealth bomber project, apparently implying that this semisecret program explained Carter's cancellation of the B-1. Upon taking office in early 1981, Reagan faced the same decision that Carter faced: whether to continue with the B-1 in the short term or wait for development of the ATB, a much more advanced aircraft.

In 1981, it was believed the B-1 might be in operation before the ATB and span a transition between the B-52, with its increasing vulnerability, and the introduction of the ATB. Reagan decided the best solution was to procure both the B-1 and ATB, and in October 1981, Reagan went ahead with production of the ATB, redesignated as the B-2.

Figure 24. The B-1B, with wings swung back.

In January 1982, the U.S. Air Force ordered 100 bombers of the basic B-1 design. Numerous changes were made, resulting in the B-1B. No longer would this plane, now designated the B-1B (Fig. 24), be intended for a high-speed (Mach 2 or 3), high-altitude penetration role. Instead, it was designed for a low-altitude, terrain-hugging role mostly at a subsonic speed of Mach 0.9.

The former variable-aspect intake ramps were replaced with simpler, fixed-geometry intake ramps. The reduced radar signature of the B-1B versus that of its B-1A predecessor was considered a good tradeoff for the speed decrease, although the B-1B was still capable of dashing at a speed of Mach 1.25 at high altitudes. The

[11] Meanwhile, there was ample U.S. deployment of ICBMs and SLBMs.

B-1B's maximum takeoff weight was increased by 21% over that of its B-1A predecessor, allowing it to carry more in the way of fuel and external weapons, and its electronic warfare capabilities were significantly upgraded. Its wingspan varies from 137 ft (swept forward) to 79 ft (swept back).

For a while, the B-1B fought for survival against the B-52 fitted with advanced electronics. Meanwhile, the U.S. Air Force spread subcontracts for producing the B-1B across many congressional districts, making the aircraft more popular among U.S. congressional delegates.

Two B-1As were modified to include B-1B systems, and the first B-1B began flight testing in March 1983. One hundred B-1Bs were eventually produced and placed into service between 1984 and 1988. Still, as B-1s were being deployed, the air force believed that the aircraft was vulnerable to Soviet air defenses.

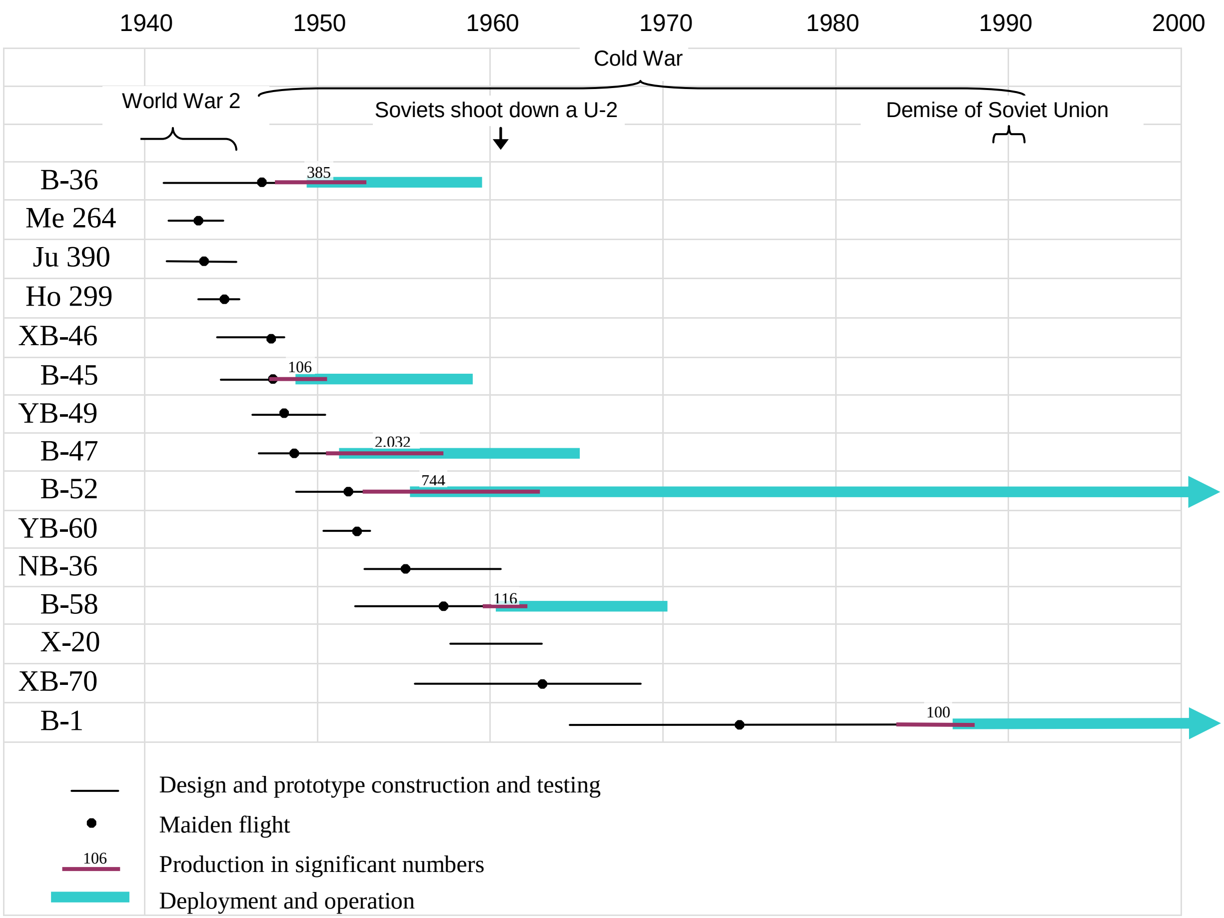

Figure 25. Timelines of development and deployment of selected strategic aircraft of the mid 20th century.

During the 1990s, with the demise of the Soviet Union, the B-1B was converted to a role of carrying conventional rather than nuclear bombs. By 1995, the conversion was complete. The B-1B flew combat missions over Iraq in 1998, Serbia in 1999, Afghanistan in 2001, and Iraq again in 2003, served in an overwatch role over Afghanistan during the 2000s and early 2010s, and is now (2015–2016) dropping bombs on ISIS. The B-1 is capable of higher speeds and is expected to show a higher rate of survivability than would the older B-52, which it was intended to replace, and it holds numerous world records for speed, payload, distance, and time-to-climb in various aircraft weight classes. Sixty-five remained in service as of September 2010, and the air force expects to keep the plane in service perhaps into the 2030s. Swing-wing designs may be a thing of the past, however, with advances in computer-aided design that allow a single planform to serve in a wide variety of flight configurations.

The Cold War draws to a close

The familiar FB-117 and B-2 (Fig. 26) were fielded in 1984 and 1989, respectively. These stealthy planes were intended for penetration bombing runs into Eastern Europe and the Soviet heartland, respectively, while the Cold War still seemed to be in progress. Simultaneously, although few in the West were aware at the time, the Soviet Union was stagnating. Its defense programs were moving along as always, consuming an inordinate portion of social resources, but this militaristic focus was itself contributing to the extensive rot in nearly all other aspects of Soviet society.

Figure 26. The by-now-familiar B-2. Twenty-one were built.

Reagan advanced the Strategic Defense Initiative (SDI), derisively called the *Star Wars* program, during his term as president (1981–1989). The Soviets saw SDI as an opportunity to spook and politically detach the NATO allies in Europe from their ally to the west, the U.S., and understandably so: the Soviets were themselves highly spooked by the SDI technology.

Meanwhile, the Soviets attempted to copy the basically unsound American STS in the form of their own Buran space shuttle (Fig 1f), whose expenditures ate greatly into Soviet aerospace budgets. Industrial resources were everything, as they were during World War 2, and the U.S. seemed up to the task, whereas high-level Soviet planners realized that their own society couldn't hope to keep pace.

Another little-known but important thought that occupied the minds of Soviet upper-echelon strategists at the time, perhaps including Gorbachev, was this: The Americans, when they decided to marshal their resources, were able to land men on the moon, in 1969, just as they said they would, well ahead of us (we Russians), and do so repeatedly. Recall JFK's announcement, in 1961: "… this nation should …, before this decade is out, … [land] a man on the Moon …" Perhaps the Americans would focus their creativity and productivity in a similar manner on their (Reagan's) audacious *Star Wars* program.

The Soviets finally gave up the fight during the period of 1989–1991, essentially peacefully, beginning when their Premier Mikhail Gorbachev declared an end to Russian domination over its eastern European satellite nations,[12] which Russia conquered during its rollback of the Nazis[13] in the last months of World War 2. Perhaps its leaders accurately viewed this domination as one of the last of the 20th century's vestiges of unsustainable, shameful control of nations densely populated with proud peoples of various languages and identities, even if these territories had been fairly captured in a war with Germany. Perhaps the only other remaining examples of similar military capture of note in the second half of the 20th century were the relatively small takeovers of neighboring Arab territories by Israel in 1967[14] and of South Vietnam by North Vietnam in 1975,[15] although observers and those involved may quibble over the exact meanings of those particular events. The unsustainable

[12] Poland, Ukraine, Belarus, Romania, Hungary, Albania, the former East Germany (now part of Germany), the former Czechoslovakia (now subdivided into two states), Bulgaria, Latvia, Lithuania, Estonia, Finland, and Yugoslavia (now subdivided into several states) are the Eastern European buffer states that were occupied or dominated by or in some other manner in the orbit of the Soviet Union to greater or lesser degrees after World War 2.
[13] Who had extended their forces into the Russian heartland as far east as Stalingrad and Moscow.
[14] Approximately 2,200 sq. mi.
[15] Approximately 67,000 sq. mi. The result included 1 to 2½ million South Vietnamese being sent to reeducation camps, with an estimated 165,000 prisoners dying, 100,000 to 200,000 being executed, and 50,000 being moved to "New Economic Zones" and dying performing hard labor out of the 1 million who were sent, and 200,000 to 400,000 dying at sea attempting to escape the communist bloodbath. No, you haven't and never will be reminded of those events by listening to or watching NPR or PBS, whose producers and funding sources are lulled by the Neanderthal-like mantra "socialism good; freedom bad".

Russian (Soviet) empire also gave up its hold over a vast set of peripheral republics within the Soviet Union, including the Baltic republics, Ukraine, and the "stans," e.g., Kazakhstan and Uzbechistan.

Gorbachev was a true believer in communism and believed and gambled that an era of *glasnost* and *perestroika* could revive his stagnant, decrepit, financially and morally bankrupt, environmentally contaminated[16] communist empire. He gambled wrong. His openness and the inherent instability of the Soviet Union resulted in its decomposition into the several component nation states that had been subjected to central Russian control, centralized economic planning, and totalitarian repression for several decades.[17]

Earlier, Presidents Eisenhower (1953–1961), Kennedy (1961–1963), and in particular Johnson (1963–1969) arrived at a conclusion similar to Gorbachev's. In the game of geopolitics, the U.S. could not present itself as a model (versus its foe, the Soviet Union) for other nations to emulate and associate with if it shamefully continued to repress its own racial minority populations. A set of groundbreaking civil rights laws regarding public accommodations, voting, and housing was signed into law in 1964 by Johnson rather than being delayed far into the inevitable future. The aiming of weapons across the Arctic Ocean during the Cold War thus resulted in several critical advances in social justice.

Kennedy and Reagan may be credited with helping to bring the Cold War to an early end.[18] We may, using 20-20 hindsight, credit Eisenhower, Kennedy, and Carter with reigning in audacious, unsound bomber programs and diverting their resources to better strategic uses. President G.H.W. Bush (1989–1993) watched carefully from the sidelines as the Soviet Union broke apart and its repressive political and economic regimes were replaced with systems more consistent with human flourishing.

Beginning in the 1970s, the development of strategic aircraft slowed to a snail's pace. Minor exceptions were copycat development by the Soviets, e.g., the Tu-22M, Sukhoi T-4, and Tu-160,[19] and the U.S.'s B-2 (only 21 were built). The Russians and Chinese will likely field their own versions of the B-2 sometime later in the first half of the 21st century.

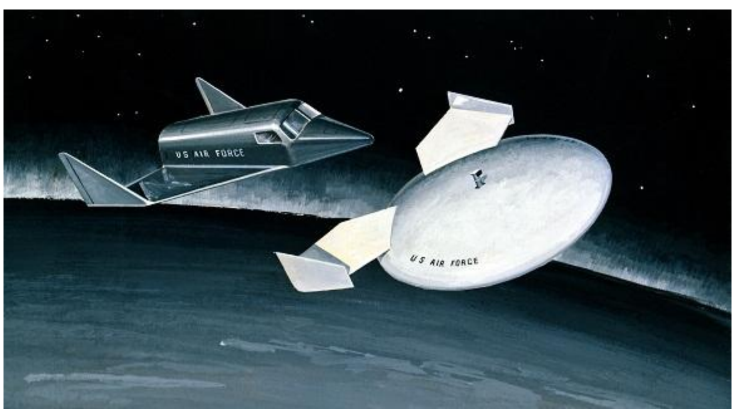

Figure 27. What might have been by the late 1960s: spaceplanes carrying nuclear bombs in orbit around the Earth in the absence of the Outer Space Treaty of 1967.

[16] 40,000 mi^2 of land was contaminated with fallout from the 1986 Chernobyl disaster. China, in a centrally planned push to produce energy and products whatever the environmental consequences, now finds itself in a similar desperate bind.

[17] Vladimir Putin has recently shown his intent to reverse Gorbachev's error to the extent that he can, beginning in Crimea and Ukraine.

[18] Equal amounts of credit may be assigned to the inherent internal contradictions, nonsense, deprivation, and corruption of socialism that were eventually recognized by the Soviet Union's residents and, of course, to the drop in oil prices from $100 in 1981 to $35 in the mid 1980s through early 1990s (prices per barrel expressed in 2011 U.S. dollars), which adversely affected the Soviet economy greatly.

[19] The Tu-22M was produced in large numbers. It was essentially a copycat of the FB-111, although it was substantially larger. The T-4 was a prototype copycat of the prototype B-70 but was smaller and lacked the exotic drooped-wingtip technology. The Tu 160 is a swing-wing bomber similar to the B-1 but substantially larger (wingspan of 190 ft.) and faster (Mach 2.05) and with a slighter greater range. Thirty-six were built, and roughly eleven were airworthy as of 2013.

The U.S. has seemed satisfied with its assortment of B-1s, B-2s, and B-52s and the stand-off ALCMs carried by a few aircraft[20] for a few decades now. The U.S., too, may field follow-up versions of the B-2 later in the early 21st century if it can avoid the nearly inevitable upheavals to be brought on by its $20 trillion (and growing rapidly) load of national public debt and $100–200 trillion in unfunded government liabilities and not circle and drop down the fiscal/social drain as did Argentina and Greece.[21]

We do indeed live in interesting times. History never repeats, but it does produce echoes. We may never experience an exact replay of World War 2 or the Cold War, and these developments in large fixed-wing weapons systems may not seem important now. However, we may observe their renewed importance as events of the 21st century unfold.

[20] Not to be forgotten, and perhaps more important than its bomber fleets, the contingent of U.S. nuclear-tipped ICBMs and SLBMs round out the U.S. triad of strategic deterrence weapons systems.

[21] Brought on by the printing of unsound money, i.e., currency not backed by some stabilizing, compact, scarce, inherently valuable commodity, such as some combination of units composed of the elements with atomic numbers 79, 47, or 48. Or backed by future returns from a robust, sound national economy: money (typically in the form of debt) is as money does. Nixon and the federal bank chairmen of his era may thus be thanked (blamed) for beginning the mismanagement of the U.S. dollar that started in the late 20th century and continues today.

Bibliography

Aviatime, 2013 (March), Convair NB-36: Bomber Aircraft with an Internal Nuclear Reactor: http://www.aviatime.com/en/did-you-know/7057-convair-nb-36-bomber-aircraft-with-an-internal-nuclear-reactor.

Chant, C, 1990, *Aircraft Prototypes*: Quantum Publishing Ltd., London.

Endicott, J.B., 2013, B-36, a test aircraft for nuclear research: http://www.cowtown.net/proweb/nb36h_jde.htm, accessed October 28, 2013.

Scott, P., 2003, *The Wrong Stuff?*: Hylas Publishing, New York.

Simons, D., and Withington, T., 2005, *The History of Flight*: Barnes and Noble Books, New York.

Various authors, 2014, Convair B-36, Wikipedia entry http://en.wikipedia.org/wiki/B-36.

Various authors, 2014, Victory bomber, Wikipedia entry http://en.wikipedia.org/wiki/Victory Bomber.

Various authors, 2014, Avro Vulcan: Wikipedia entry http://en.wikipedia.org/wiki/Vulcan_bomber.

Various authors, 2014, General Dynamics F-111 Aardvark, Wikipedia entry http://en.wikipedia.org/wiki/FB-111#FB-111A.2FF-111G.

Various authors, 2014, Messerschmidt Me 264: Wikipedia entry http://en.wikipedia.org/wiki/Me_264.

Various authors, 2014, Junkkers Ju 390: Wikipedia entry http://en.wikipedia.org/wiki/Ju_390.

Various authors, 2014, Silbervogel: Wikipedia entry http://en.wikipedia.org/wiki/Silbervogel.

Various authors, 2014, Convair XB-46: Wikipedia entry http://en.wikipedia.org/wiki/Convair_XB-46#See_also.

Various authors, 2014, Convair XB-53: Wikipedia entry http://en.wikipedia.org/wiki/XB-53.

Various authors, 2014, North American B45 Tornado: Wikipedia entry http://en.wikipedia.org/wiki/B-45_Tornado.

Various authors, 2014, Convair NB-36: Wikipedia entry http://en.wikipedia.org/wiki/NB-36.

Various authors, 2014, Martin XB-51: Wikipedia entry http://en.wikipedia.org/wiki/XB-51.

Various authors, 2014, Martin B-57 Canberra: Wikipedia entry http://en.wikipedia.org/wiki/B-57_Canberra.

Various authors, 2014, Northrop YB-35: Wikipedia entry http://en.wikipedia.org/wiki/XB-35.

Various authors, 2014, Northrop YB-49: Wikipedia entry https://en.wikipedia.org/wiki/YB-49.

Various authors, 2014, Boeing B-47 Stratojet: Wikipedia entry https://en.wikipedia.org/wiki/B-47.

Various authors, 2014, Boeing B-52 Stratofortress: Wikipedia entry https://en.wikipedia.org/wiki/B-52.

Various authors, 2014, Convair YB-60: Wikipedia entry https://en.wikipedia.org/wiki/YB-60.

Various authors, 2014, Convair B-58 Hustler: Wikipedia entry https://en.wikipedia.org/wiki/B-58_Hustler.

Various authors, 2014, Boeing X-20 Dyna-Soar: Wikipedia entry https://en.wikipedia.org/wiki/X-20.

Various authors, 2014, North American XB-70 Valkyrie: Wikipedia entry https://en.wikipedia.org/wiki/B-70_Valkyrie.

Various authors, 2014, Rockwell B-1 Lancer: Wikipedia entry https://en.wikipedia.org/wiki/B-1_Lancer.

Various authors, 2014, Northrop Grumman B-2 Spirit: Wikipedia entry https://en.wikipedia.org/wiki/B-2.

Various authors, 2014, Vietnam War: Wikipedia entry https://en.wikipedia.org/wiki/Vietnam_War.