

Nick: Invisibility sounds like something out of a work of Sci-Fi. However, Northrop Grumman's B2 Spirit is just that. While the B2 is not invisible to the naked eye, it can avoid detection by radar thanks to a specially designed frame and coating that deflects and nullifies radar waves. Radar waves are sent outwards, and bounce off of features such as engines and straight wings. By altering its shape and applying radar absorbent material, the B2 is able to minimize the radar waves that can be analyzed, making the B2 almost impossible to find. On top of being a stealth plane, the B2 is a flying wing, meaning it has no fuselage or tail. The B2 is meant to be a low observable stealth plane used to penetrate anti-aircraft defenses. It can carry both conventional and thermonuclear weapons, and is a unique aircraft that can carry heavy air-to-surface weapons while also remaining in stealth. But where did this technology come from?

Daryl: As soon as radar was developed during World War Two, there was a need to evade radar. Efforts were made during and after the war to counter radar, and two German brothers were the first to find a solution. Walter and Reimar Horton were pilots with the German Luftwaffe, but also designed aircraft of their own. One of these was the Horton HO-229 jet, the earliest flying wing propelled by a jet, which also had radar wave absorbing material on the wings. They used a wood-carbon powder to absorb radar waves, making this the earliest stealth plane. It could fly at up to 620 mph, which would have made it the fastest plane in World War Two, but it was designed too late to be used in the war.

Nick: Another important antecedent to the B-2 was the work of Jack Northrop, the founder of Northrop, which would go on to design the B-2. Like the Horton brothers, Jack Northrop was interested in flying wings. He built his own flying wing bomber, the Northrop YB-35, a heavy bomber that was not produced, but did inspire another flying wing bomber, the jet-powered

Northrop YB-49. Neither of these designs went into production, but elements from them were later used in the B-2.

Lindsay: The B2 was built in the midst of the Cold War, and was designed to be a countermeasure to Soviet missile defenses that defended their border. The United States and the Soviet Union were the two dominant world powers, and each wielded powerful nuclear arsenals. Towards the end of the Cold War, the two powers had enough nuclear weapons to wipe out all life on Earth. This left both sides in a precarious situation. Each was capable of destroying the other, but if one attacked the other would respond. This was known as Mutually Assured Destruction. Each side needed nuclear weapons, and a means to using them, in order to deter the other side from using theirs. However, the Soviet Union's border defenses were so thorough that there were fears that the United States would be unable to retaliate against the Soviet Union if they attacked. This meant the United States could not deter their enemy with the threat of mutual destruction, increasing the chances for nuclear war. This threat to the power balance led to the creation of a bomber that could drop nuclear bombs and get through Soviet defenses.

Daryl: Tests with miniature remotely-piloted vehicles (known as RPVs) led to an interesting discovery in 1973. An object's radar signature could be altered, and a small enough signature would not show up on radar. Tests were conducted using a Soviet air defense gun, and the RPV proved that it was able to avoid the gunfire. The Defense Advanced Research Projects Agency (DARPA) saw a need for a plane with minimal radar signature. So, they contacted Lockheed Martin and Northrop, and the two created their own designs. This competition not only led to the creation of the Lockheed F-117 Nighthawk, a stealth fighter, and to the research that became the

foundation of the B-2, it also generated interest in stealth technology within the United States Air Force.

Nick: Lockheed Martin's design, which became the F-117 Nighthawk, was chosen because it more closely fit the requirements set by the Air Force. However, there was still interest in the Northrop design. The Pentagon approached Northrop, looking for a stealthy battlefield control aircraft. This became known as the Tacit Blue, and it was meant to be an airborne command platform. Developments made by Northrop during the design of the Tacit Blue were also used for the B-2.

Daryl: In the spring of 1979, Northrop employees met with government officials who wanted a stealth bomber. Northrop was still working on the Tacit Blue and were reluctant to try to design a bomber as they had little experience with bombers. However, Air Force General Tom Stafford wanted to issue a formal request. Lockheed Martin had already begun work on a stealth bomber, and the Air Force wanted Northrop working on one to incentivize Lockheed Martin. Northrop reluctantly agreed, and brought on Boeing as a subcontractor, as they had more experience with building bombers. Together, they were able to put together a design. They even built a scale-model that they were able to show the 85 year old Jack Northrop, who was reminded of his older flying wings.

Nick: In October of 1980, the tests between Lockheed Martin's bomber design and Northrop's began. Both teams built scale-models which were laid out on top of giant poles where they could be targeted by radar waves. The initial tests went poorly for the Northrop team. However, as they looked over what could have gone wrong, they realized that the problem lay not with the design, but with the model. They had used wood in the design and painted over it, but the wood was

expanding and contracting, which wore at the paint enough to reduce the efficiency. Northrop's final proposal, which ended up being fifteen volumes long, was turned in on November 30th, 1980, but another test was to be done using the models. In late January, the teams met again, and the tests were conducted again, with the Northrop model doing much better. This was a new model which used fiberglass rather than wood, which prevented the problems with the earlier design. There were months of debates before a final decision was made, but the Northrop design was chosen, and an order was placed for 132 B-2 Bombers. However, this was meant to be a top secret project, so the nature of the program would be kept secret.

Lindsay: The B-2 was built to be a part of the Cold War, to pierce through Soviet air defenses in the event of a nuclear war between the Soviet Union and United States. However, it finished development just as the Cold War was winding down. As the Soviet Union dissolved, so did the need for the B2. This stealth bomber was the most expensive aircraft in US history, and the cost could not be justified. It was a relic of the Cold War need to constantly improve the nuclear defense program, but with the fall of the Soviet Union there was no need for it. Criticism from both the public and from within Congress led to the original plan to purchase 132 B2 bombers being reduced to an order for 21.

Nick: The B2 has still served an important role in the United States Air Force. It was used in the 1999 Kosovo War, and has also been used in the War on Terror, serving in Iraq, Afghanistan, and Libya. While these bombers were prohibitively expensive, they will last a long time. The Air Force plans to keep them in service until 2058. And these machines will last that long. Only one of the 21 B2 Bombers has been destroyed, and that was in an accident in 2008. The B2 is also a

popular attraction at airshows. The B2 continues to play an important role in our nation's military, but it also serves as a symbol for American engineering.

Bibliography

- Bernard Zee, 2009, Bernard Zee Photos, accessed April 1, 2017,
<http://www.bernardzeephotos.com/Edwards09/Edwards09.html>.
- Bernard Zee, 2012, Bernard Zee Photos, accessed April 1, 2017,
<http://www.bernardzeephotos.com/SFFleetweek12/SFFleetweek12.html>.
- Bernard Zee, 2012, Bernard Zee Photos, accessed April 1, 2017,
<http://www.bernardzeephotos.com/SFFleetweek12/SFFleetweek12.html>.
- Bernard Zee, B-2 Spirit of New York, 2009, Bernard Zee Photos, accessed April 1, 2017,
<http://www.bernardzeephotos.com/Edwards09/Edwards09.html>.
- Bobbie Garcia, B-2 Spirit, 2015, digital, United States Air Force, accessed March 16, 2017,
<http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104482/b-2-spirit.aspx>.
- Bobbie Garcia, B-2 Spirit, 2015, digital, United States Air Force, accessed March 16, 2017,
<http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104482/b-2-spirit.aspx>.
- Bobbie Garcia, B-2 Spirit, 2015, digital, United States Air Force, accessed March 16, 2017,
<http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104482/b-2-spirit.aspx>.
- Bobbie Garcia, B-2 Spirit, 2015, digital, United States Air Force, accessed March 16, 2017,
<http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104482/b-2-spirit.aspx>.
- Bobbie Garcia, B-2 Spirit, 2015, digital, United States Air Force, accessed March 16, 2017,
<http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104482/b-2-spirit.aspx>.
- Charles Levy, Nagasaki Bomb, 1945, National Archives, accessed April 4, 2017,
<http://www.archives.gov/research/military/ww2/photos/images/ww2-163>.
- F-117 Nighthawk, Lockheed Martin, accessed April 4, 2017,
<http://www.lockheedmartin.com/us/100years/stories/f-117>.
- Horten Brothers, 1943, Luftarchiv, accessed April 4, 2017,
<http://www.luftarchiv.de/index.htm?flugzeuge/horten/firma>.
- Jack Northrop with Plane, Northrop-Grumman Corporation, accessed April 4, 2017,
<http://www.northropgrumman.com/AboutUs/OurHeritage/OurFounders/JackNorthrop/Pages/default>.
- Jack Northrop, Northrop Corporation Logo, 1939, Northrop-Grumman, accessed April 4, 2017,
<http://www.northropgrumman.com/AboutUs/OurHeritage/Pages/default>.

Jack Northrop, Smithsonian Air and Space Museum, accessed April 4, 2017,
<https://airandspace.si.edu/exhibitions/america-by-air/online/abaImage.cfm?webID=213>.

Kenneth S. Kik, Horten from 1950, 1950, Smithsonian National Air and Space Museum,
accessed April 4, 2017, <https://airandspace.si>.

Master Sgt. Val Gempis, Andersen Air Force Base, 2004, Wikimedia, accessed March 16, 2017,
https://en.wikipedia.org/wiki/File:B-2_Spirit_050413-F-1740G-001a.jpg.

Northrop Tacit Blue, National Museum of the US Air Force, accessed April 4, 2017,
<http://www.nationalmuseum.af.mil/Visit/MuseumExhibits/FactSheets/Display/tabid/509/Article/195769/northrop-tacit-blue>.

Operation Crossroads Baker, 1946, Library of Congress, accessed April 4, 2017,
<http://memory.loc.gov/master/pnp/cph/3b10000/3b13000/3b13500/3b13566u>.

Staff Sgt. Bennie J. Davis III, B-2 Spirit, 2006, Wikimedia, accessed March 16, 2017,
https://en.wikipedia.org/wiki/File:B-2_Spirit_original.jpg.

Staff Sgt. Bennie J. Davis III, Joint training at Valiant Shield, 2006, digital, Wikimedia, accessed
March 16, 2017,
<https://upload.wikimedia.org/wikipedia/commons/thumb/2/21/B2PlanView.jpg/800px-B2PlanView.jpg>.