

## ***Nomination of the Pioneers of Stealth National Aviation Hall of Fame Spirit of Flight Award***

The Pioneers of Stealth is a group of US Government and aerospace industry people who covertly worked on highly classified aircraft programs from 1974 through 1993 developing and fielding revolutionary new concepts in combat aircraft design employing low observable technologies and weapon systems under the direction of the Aeronautical Systems Division (ASD) located at Wright Patterson AFB, OH.

In the early 1970's, the Israeli Air Force lost in excess of 100 front-line U.S.-built F-4 aircraft to enemy radar and infrared-directed missiles, guns and aircraft in the Yom Kippur War. This was unacceptable to the U.S. and clearly demonstrated that a means to reduce combat manned aircraft losses while maintaining mission effectiveness needed to be devised. In late 1974, the Defense Advanced Projects Agency (DARPA) initiated the Experimental Survivable Testbed (XST) studies and ground tests program with the aim of creating an aircraft design that could accomplish the combat mission and survive solely by the use of signature reduction, or stealth.



HAVE BLUE

Earlier work with mini-RPV's had shown the benefits of small size in reducing radar signatures. The early competitive DARPA XST studies and tests, under the leadership of former ASD engineer Ken Perko, showed some interesting promise. Northrop and Lockheed Corporations were then selected to build large-scale aircraft mockups that would be competitively subjected to low radar cross section testing. The XST tests led to a contract with the Lockheed Skunk Works to design and build two flight technology demonstrator aircraft. These aircraft were to be the core of this first very low observables technology demonstrator program. Air Force interest was subsequently further heightened to the point that a joint DARPA/Air Force program, designated HAVE BLUE, was approved and funded to probe the potential of a manned aircraft with extreme stealth features.

Air Force responsibility for the HAVE BLUE project was established with personnel from the Air Force Remotely Piloted Vehicle (RPV) Program Office. Major Jack Twigg (later Col.)

Program Director, and Mr. William Elsner, the chief engineer, working with Ken Perko and Dr. Alan Atkins from DARPA, were to provide the program leadership for this effort. Mr. Herbert Hickey, Mr. Ralph Grimm, Mr. Mark Owen, Mr. Gary VanOss and Capt. Rob Bongiovi (later general), with support from Tom Kane, Tom Eddinger, and John Griffin, were the nucleus of the technical team. They journeyed to the Pentagon from time to time to discuss program development plans and secure the necessary development funds. The key contacts in the Pentagon were LtCol. Ken Staten and Maj. Joe Ralston (later generals). Maximizing the use of internal off-the-shelf components and achieving remarkable stealth technology design breakthroughs, the program proceeded from initial contract go-ahead to first flight in December 1977, an incredible period of only 20 months! In secrecy, the highly successful and unconventionally designed HAVE BLUE test aircraft flew 88 missions that proved its flying qualities and also proved that the unique stealth design would meet the potential missionized survivability requirements.

In parallel with the airframe work, DARPA and the Air Force began programs during 1976 to develop stealthy weapon systems including radomes, radar, infrared, missiles and communications. That work was done by Northrop, Hughes Aircraft, Ford Aerospace and others. These much smaller programs were managed by the same ASD team mentioned above. Some of those programs demonstrated the feasibility of additional stealthy weapon systems.



F-117

At the completion of the successful HAVE BLUE flight tests, go ahead was approved by the Air Force to study development of a comprehensive and scaled-up missionized aircraft for potential use as a 'stealth fighter' which was designated the F-117A. In late 1978, Col. Dave Englund (later general), LtCol. Don Merkl, and LtCol. Allen Koester joined the program. Five full scale engineering development F-117A aircraft were fabricated. The F-117A first flight was in June 1981 with all major flight control objectives achieved. In January 1982 the first fully low observable signature F-117A was evaluated. Ultimately, 59 of the F-117A stealth fighters were built for the US Air Force and they served in a critical first strike role. The fighters logged 1300 sorties during Operation Desert Storm conflicts in the defense suppression role with no combat losses due to enemy actions.

Northrop's very low signature design work had also caught the attention of the Department of Defense. In December 1976, Northrop was introduced to the "Assault Breaker" concept and asked to study a stealthy "Battlefield Surveillance Aircraft – Experimental (BSAX)" that would find targets for the Assault Breaker weapon systems. In April 1978, Northrop was awarded a contract to design and build the TACIT BLUE aircraft, which first flew on 5 February 1982 and completed 135 very successful air-worthiness and stealth performance flight tests. Following the very successful HAVE BLUE program, LtCol. Jack Twigg became the Air Force Program Director of the highly classified TACIT BLUE proof-of-concept development and flight test program. A new, stealthy radar system for TACIT BLUE was designed and built by Hughes Aircraft.



Tacit Blue

Several of the Pioneers of Stealth also contributed to the development of stealthy cruise missiles, ships and land vehicles.

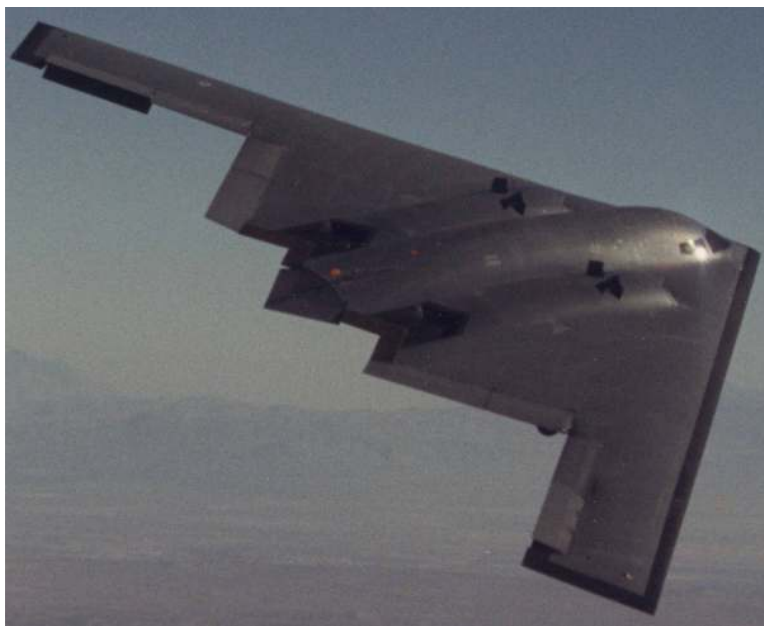
Toiling in the Top Secret classified world, this small program office located in a vault in the basement of the ASD headquarters building grew slowly and was given enormous responsibilities. They and their Lockheed and Northrop counterparts could not speak about the existence of the work underway to anyone not cleared on the programs. A special security expert from the Air Force Office of Special Investigations, Major Pete Knauth, was brought aboard early and very effectively enforced the strict special access Top Secret security requirements.

The management complexity of both the Government and industry teams was enormous, because each of the programs' aircraft systems - including engine interfaces, radar, avionics, redundant flight controls, and other subsystems - was unique and unproven. Most participants in the programs made very significant personal sacrifices and endured family hardships due to the secrecy and heavy travel requirements, the destinations of which they could not reveal.

As experimental test data was gathered, the Air Force grew more confident in low observables concepts and technologies being able to achieve the expected mission and survivability results.

The Air Force then put in motion a competition for a new bomber capable of successfully penetrating large and highly defended target areas. The Advanced Technology Bomber program also was conceived with highly classified security restrictions. Northrop won a very competitive contract in October 1981. Using the lessons learned and some technologies developed on TACIT BLUE, Northrop built the B-2B stealth bomber. The state-of-the-art radar on the B-2B was developed by Hughes Aircraft. It was a very complex follow-on to the low probability of intercept radar (LPIR), first flight tested on a non-stealthy aircraft in 1978-79. Later a second generation radar was flight tested on the TACIT BLUE technology demonstrator aircraft. Mr. David Lynch, the first Hughes program manager for both TACIT BLUE and the B2B, presently serves as the President of the 'Pioneers of Stealth' organization. These programs were so ambitious that they never would have succeeded without the many creative and hard working teams in both the Government and the aerospace industry.

The Air Force was prescient enough to recognize that at some time in the future other nations would also pursue stealth technologies. Early on in the late 1970's and through 1980's both the Air Force and DARPA recognized the necessity to develop counter stealth technologies. Several still classified counter-stealth programs were developed. One now less classified program was the first operational active electronically scanned array (AESA) radar in the F-15 APG-63V2 squadron deployed to Alaska to counter such emerging stealth aircraft threats as the Chinese J-20 and Russian T-50 fighters. This was a USAF-Boeing-GM Hughes Aircraft development and deployment.

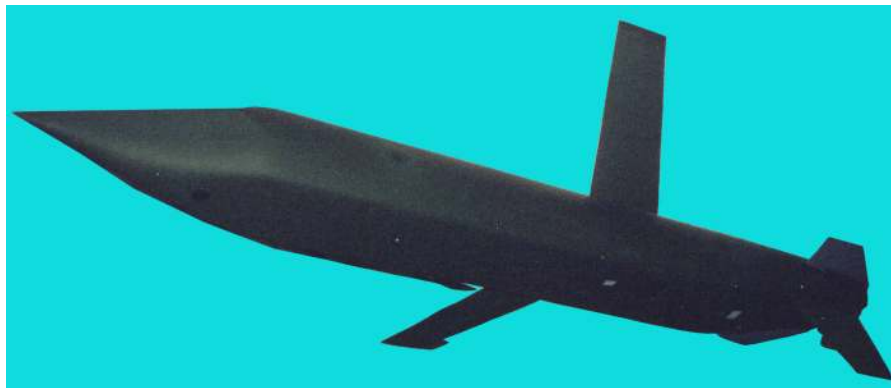


B-2B

The B-2B was rolled out in a public ceremony in November 1988, and first flew in July 1989. The technical management challenges for Northrop and the Air Force in bringing the B-2B into production and through flight test were huge. The B-2B design, test and manufacturing teams passed through these challenges and a final authority to build 20 bomber aircraft was approved. The B-2 successes are legendary considering most combat missions were flown from its home base in Missouri to locations as distant as the Kosovo War in 1999, the Afghanistan and

Iraqi conflicts, and most recently, the Libyan civil war - and then returning home without landing. Colonel Richard Scofield, a Pioneer of Stealth, directed the B-2B program and later, as Lt. General Scofield, returned to the Aeronautical Systems Center, Wright-Patterson AFB, as its Commander.

The Pioneers of Stealth, industry and Government program offices alike, developed numerous management and technical innovations. They created significant inventions that are critical to aerial war-fighting today. The Pioneers developed concepts that required not only inventions necessary to meet the schedule, but also required extreme attention to design and manufacturing details. The team effort was able to move rapidly from an idea to manufactured reality. Many innovative management and business practices developed by Pioneers of Stealth were adopted by industry and codified in follow-on DOD management rules, specifications, regulations, and practices in use today.



Advanced Cruise Missile AGM-129

Also during that time (the 1980's) the stealthy AGM-129 Advanced Cruise Missile was developed and deployed. It not only had stealth airframe features but also had the first stealthy TERCOM guidance system. This was long before any other nation had conceived of these capabilities.

Teamwork was the hallmark of these Government and industry engineers and managers, perhaps as never previously seen. They were clearly the forerunners of today's integrated product team concepts. The Government and contractor teams were characterized by their brilliant minds, openness, integrity and trust. In addition to the many state-of-the-art technologies necessary for achieving the stealth aircraft requirements and the incredible effort of designing, testing, building and fielding these aircraft, some of the specific achievements of the Pioneers of Stealth include:

- Aircraft radar absorbing materials, large-scale radar absorbing composite aerostructures, specular and surface wave radar absorbing coatings and materials
- Full spectrum low signature observables including radar, infrared, acoustics
- Integrated computer aided design (CAD)/computer aided aircraft manufacturing (CAM)
- Very high speed machining
- Persistent surveillance and air-land battle management techniques
- New GPS-aided weapon delivery practices
- Precision tuned radomes and low observable apertures

- Complex engine inlet airflow solutions and exhaust designs
- High speed fly-by-wire aeroelastic compensation techniques
- Computational models for full spectrum system signature predictions
- Observables measurement processes and techniques
- Low signature air data and “avionics sensor covers and housings”
- New flight line diagnostic tests and aircraft maintenance methods
- Very low signature aircraft planform shaping design and test methods
- Large scale aircraft structural composites design, fabrication machines and manufacture



B-2 Assembly Line

The firsts named above have given our country a new and preeminent strategic advantage in national defense for both manned and unmanned weapon systems.

The payoff of the efforts by the Pioneers of Stealth was observed by the world on live television during the Gulf War where most of the defense suppression initial strikes were accomplished by the F-117A, at night without any of the aircraft sustaining battle damage. During the second Gulf War, B-2's flew non-stop from Missouri to Iraq and back on combat missions and the B-2B bomber continues to proudly serve America today.

Some innovative and key leadership lessons learned for success do stand out for the Pioneers of Stealth:

1. The small initial AF program office team was empowered (full authority and charter) to meet the extremely challenging program goals from the start. Minimal administrative burden and timely and maximized internal communications were foremost priorities.
2. Through sincere teamwork, American ingenuity can meet seemingly impossible challenges head-on, and succeed.
3. Success follows when a highly qualified small multi-skilled program office cadre is created.
4. With bureaucracy cut, using small and smart program teams, and streamlined management procedures with abbreviated milestone oversight and control, the

probability of success is greatly enhanced.

While the B-2 program office continues today, the F-117A aircraft was retired on 22 April 2008. In July 1991, an early version of the F-117A was flown to the Museum of the United States Air Force in Dayton, Ohio. TACIT BLUE last flew on 14 February 1985 and the aircraft was revealed to the public on 30 April 1996 and was put on display in the Museum. An early version of the B-2B stealth bomber was added to the Museum on 16 December 2003.



F-22

Both the F-22 and the F-35 incorporate many of the stealth features pioneered on the programs described above including shaping, RAM treatments, GPS aided weapons, low observables radomes, radars and communications, structural composites, computer aided manufacturing, sophisticated engine airflow, and integrated air-land battle management. Some of the Stealth Pioneers continue to contribute to these programs up to the present. Many of the Pioneers are still contributing to our nation's aerospace and defense systems on new programs at present. Sadly some of the best of the Pioneers of Stealth passed away before they could reveal to their loved ones what they had worked on for so many years in the deepest secrecy.



F-35

There are many books published about stealth technology and deployment including:

1. *Radar Cross Section*, E.Knott, J. Shaeffer & M. Tuley, 1985
2. *Stealth Technology: The Art of Black Magic*, J. Jones, 1989
3. *Lockheed F-117A*, W. Sweetman & J. Goodall, 1990
4. *Desert Storm Air War*, Robert Dorr, 1991
5. *Gulf War Debrief*, Stan Morse, 1991
6. *Inside the Stealth Bomber*, Bill Scott, 1991
7. *Radar Cross Section Analysis and Control*, A.K Bhattacharyya & D.L Sengupta, 1991
8. *America's Stealth Fighters and Bombers*, James Goodall, 1992
9. *Skunk Works*, B. Rich & L. Janos, 1994
10. *Laser and Radar Cross Section Engineering*, Dave Jenn, 1995
11. *Have Blue and The F-117A*, D. Aronstein & A. Piccirillo, 1997
12. *Frequency Selective Surfaces*, Ben Munk, 2000
13. *Lockheed Stealth*, Bill Sweetman, 2001
14. *Theory of Edge Diffraction in Electromagnetics*, Pyotr Ufimtsev, 2003
15. *Introduction to RF Stealth*, David Lynch, Jr., 2004
16. *Detecting and Classifying Low Probability of Intercept Radars*, Phillip Pace, 2004
17. *Hughes After Howard*, Kenneth Richardson, 2011

Notice that all of these books were published well after the initial demonstration of successful stealth platform design and development. Some of this is the result of security classifications. However, once these aircraft came "Out of the Black and Into the Blue" the general public's curiosity was so high that much information in the open literature was assembled into book form.

The Pioneers of Stealth have clearly made a highly significant and enduring contribution to America's aviation heritage and in the process have changed the world.